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Ferruginous Duck *Aythya nyroca* breeding population development and habitat selection at Durankulak Lake, Bulgaria

Razvoj gnezdeče populacije kostanjevke *Aythya nyroca* in njen izbor habitatov na jezeru Durankulak, Bolgarija

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Presented are the results of a study on the development of the Ferruginous Duck *Aythya nyroca* breeding population, site / habitat fidelity and habitat selection by breeding pairs at the Durankulak Lake complex, Bulgaria, from 1995 to 2002. The lake is the most important breeding site for the species along the Bulgarian Black Sea coast, holding up to 10% of the national breeding population of 125 – 230 pairs. Annual and seasonal variation in bird numbers, breeding success and habitat use are described in relation to human impact, wetland and habitat conditions. The Ferruginous Duck breeding pairs nest in the shallower and more vegetated marshy areas of the lake complex. Ferruginous Ducks preferred the south-east marshland, with annual breeding numbers varying in the northern part of the lake and the tail ends probably due to variation in water levels. There was some indication of slight avoidance of the Eagle Marsh area, caused presumably by disturbance and human pressure. During the period of the study the breeding population varied from 5 to 25 pairs depending on the wetland condition with no clear trend throughout the investigated period. Breeding success varies from year to year, but it has never exceeded 40% of broods per breeding pair. The early abandonment of the broods is thought to be a regular phenomena for the wetland and contributes to low survival of the ducklings. Currently the wetland is not sheltering moulting birds, possibly because of poor forage conditions and much human disturbance. The study reveals the need for increased protection from disturbance and zoning of its area, especially during the breeding season.

Key words: Ferruginous Duck, *Aythya nyroca,* Durankulak Lake, Bulgaria, vegetation structure, breeding pairs, habitat selection, disturbance
Ključne besede: kostanjevka, *Aythya nyroca,* jezero Durankulak, Bolgarija, struktura vegetacije, gnezditveni pari, izbor habitata, motnje

1. Introduction

The Ferruginous Duck *Aythya nyroca* has been recently downlisted from globally threatened "Vulnerable" status (Collar *et al.* 1994) to low risk / near threatened (BirdLife International 2000). Nevertheless, many of the threats remain, especially for its European population, and overall population decline continues. In Bulgaria, the Ferruginous Duck is a breeding and migratory species listed in the Red Data Book. The breeding season for the species starts in the second half of April and continues until the end of July (Petkov 1997). During the breeding season, it is concentrated mainly along the Danube River with smaller numbers along the Black Sea coast and in inland areas (Petkov 1997 & 1998a).

Recent studies on the Ferruginous Duck in Bulgaria revealed a national population of 125 to 230 breeding pairs, with marked year to year variation depending on wetland conditions (Petkov 2003). The studied Durankulak Lake is one of the most important breeding sites of Ferruginous Duck in Bulgaria, and of the few Bulgarian breeding sites for Greylag Goose *Anser anser*. Other breeding species include Mute Swan *Cygnus olor*, Garganey *Anas querquedula*, Mallard *A. platyrhynchos*, Pochard *Aythya ferina* (rarely), Gadwall *Anas strepera* (rarely), Common Coot *Fulica atra*, Great Crested Grebe *Podiceps cristatus* and Little Grebe *Tachybaptus ruficollis* (Georgiev 2002, Petkov *unpubl.*).

The aim of the study was to investigate the Ferruginous Duck breeding population trends and status during the breeding season in the Durankulak Lake complex and to establish the habitat preferences and site selection by the breeding pairs.

2. Study area and methods

2.1. Study area

Durankulak Lake is a natural wetland situated in north-eastern Bulgaria close to the border with Romania (43°40'N, 28°33'E; Figure 1). The lake complex is a natural firth at about 0.5 m a.s.l. with a surface area of about 462 ha (Georgiev 2002). The lake comprises about 4% of the surface area of the natural wetlands in Bulgaria. It has a closed basin hydrology, the water level regime relying mostly on underground waters, as surface inflow is very low. The mean salinity is 0.2‰ (ranging from 0.2 – 0.4‰) due to infiltration of seawater. The average depth of the wetland is 1.4 m with a maximum depth of 6.0 m (Ivanov 1994).

Figure 1: Geographical location of Durankulak Lake in Bulgaria

Slika 1: Geografska lega jezera Durankulak v Bolgariji

Hydrological and hydrobiological studies in recent years define the wetland as eutrophic to hypereutrophic, caused largely by anthropogenic activities over the last 30 years, especially the inflow of polluted underground and surface water from surrounding agricultural fields and villages. The marsh vegetation at the site is composed of about 80% Common Reed *Phragmites australis,* either in monoculture or co-dominated with Reedmace *Typha angustifolia* (Georgiev 2002).

Three more or less separate water bodies form the Durankulak wetland complex (Figure 2): Durankulak Lake (DL), Eagle Marsh (EM) and the marshland in the south-eastern part of the lake (SEM). Durankulak Lake, which covers most of the wetland complex, has steep banks and sparse lakeshore vegetation. The largest hygrophyte stands are in the lake tail ends (TE) with large stands of *Phragmites australis* and *Typha angustifolia.* Eagle Marsh is separated from the lake by an old dike (now broken and allowing water exchange), where most mixed hygrophyte associations are present.

Typical associations are *Ph. australis-Bolboschoenus maritimus, Typha angustifolia-Ph. australis, B. maritimus-Schoenoplectus lacustris-Juncus gerardii* and *Schoenoplectus lacustris* (one of the largest in the country) with *Bolboschoenus maritimus* and *Butomus umbellatus* (Georgiev 2002). Water depth in Eagle Marsh is 1.0 – 1.5 m and there are also some dry areas and floating reed beds.

The third wetland body, SEM, is covered by *Ph. australis-T. angustifolia, Ph. australis-Bolboschoenus maritimus, Schoenoplectus lacustris, B. maritimus,* and other mixed plant associations. It is very shallow – about 0.5 – 1.0 m deep. Hydrophytes are found mostly in Eagle Marsh, and include large stands of *Utricularia vulgaris, Ceratophyllum demersum, Myriophyllum spicatum, Ranunculus aquatilis,* mixed and pure associations of *Potamogeton natans, P. pectinatus* and *P. crispus.*

Past studies of the zoobenthos at Durankulak Lake found an overall biomass density of 23 g/m^2 dominated by Chironomidae larvae – about 78% (Ivanov 1994). A more recent study reported a lower mean biomass density of 18.4 g/m^2, with Chironomidae still dominating. The average biomass of the zoobenthic community in Eagle Marsh is much lower at 5.4 g/m^2. The zoobenthic community is more diverse in shallower lake shore areas and in macrophytes stands which provide good feeding areas for birds and fish (Georgiev 2002).

Durankulak Lake is a protected area declared as a Natural Monument (in 1980), Ramsar Site and

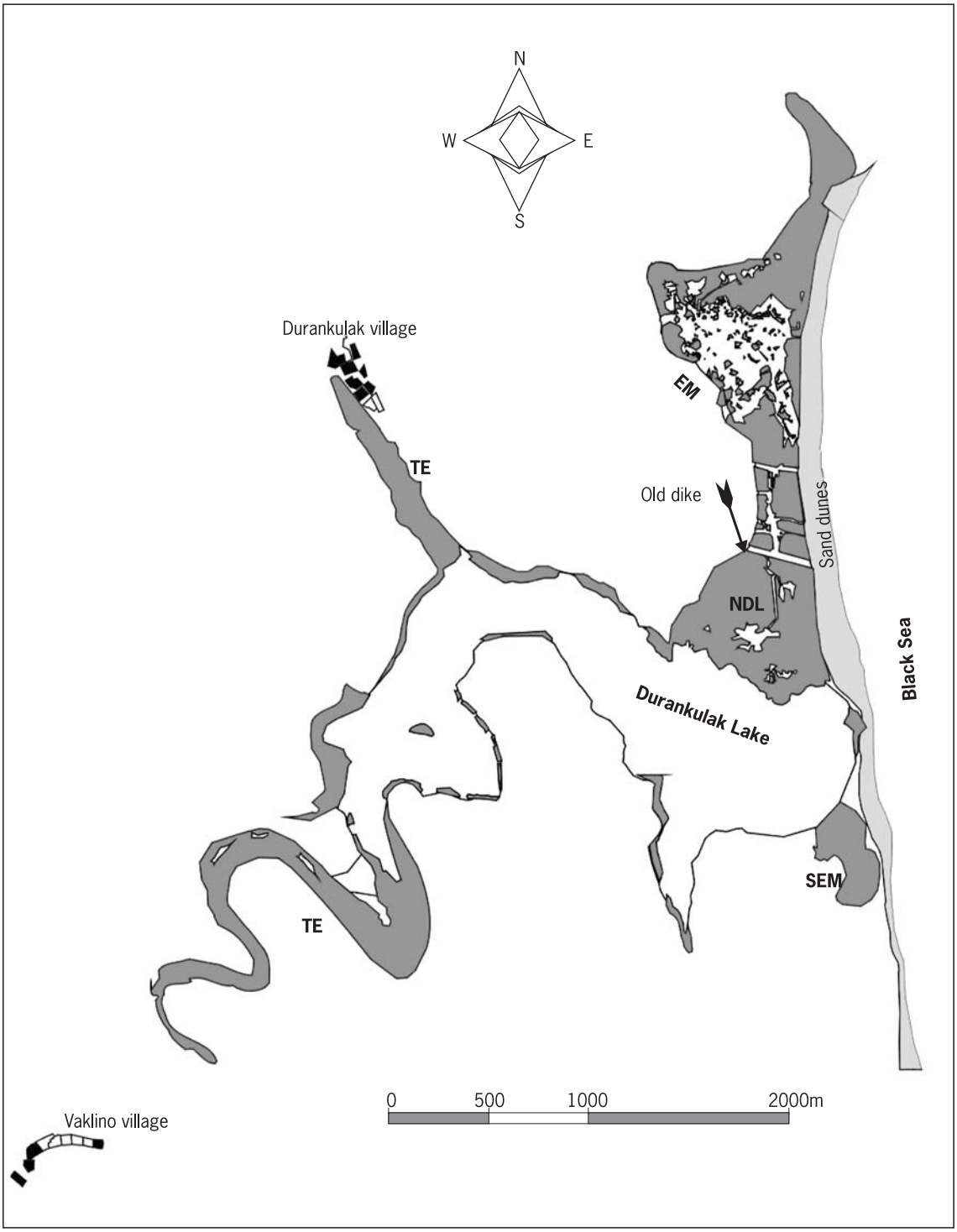

Figure 2: Map of Durankulak Lake complex (EM – Eagle Marsh, NDL – northern part of Durankulak Lake, TE – tail ends of the Lake, SEM – south-east marsh); reedbeds and hygrophyte vegetation are given in dark grey

Slika 2: Zemljevid kompleksa Durankulaškega jezera (EM – Eagle Marsh, NDL – severni del jezera, TE – skrajni deli jezera, SEM – jugovzhodno močvirje); temno siva barva ponazarja jezerska trstišča in vodno vegetacijo

Important Bird Area. Previous studies have identified it as the most important breeding site for the Ferruginous Duck along the Black Sea coast (Petkov 1998b). In 2002, a management plan was adopted for the lake and the Dobrudga project team of the Bulgarian Swiss Biodiversity Conservation Programme (BSBCP) and the Regional Inspectorate of Environment and Water is implementing various management activities. Currently only the water body and lakeshore is protected, with no protection of adjacent land.

2.2. Methods

The data were collected during monthly surveys of 3 – 5 days each, from April to July, 1995 to 2001, using binoculars and telescopes. Most of the lake was surveyed by foot from the lakeshore, but Eagle Marsh was surveyed both by foot and from boats. All Ferruginous Ducks were recorded, identifying their sex and age (adult and juveniles), and the wetland section that they were observed in. Considering that there is a male-biased sex ratio (Johnson *et al.* 1992), breeding pair population estimates were expressed as the total number of females. This included both paired females and lone females seen in the second half of May, presumed to pair up subsequently, although the latter category only accounts for one or two pairs per year. Breeding success is described in terms of the number of observed broods. The number of breeding pairs was compared to an expected number of breeding pairs calculated according to the area of the four wetland sections. The expected number of pairs was calculated from the pooled total number of pairs for the wetland according to the proportional size of the wetland section area. For each year and each wetland section a Selection Index (SI) was calculated as the observed values divided by the expected value, following Green (1998). Statistical processing was done using Sigma Stat ver. 1.0 software package.

3. Results and discussion

3.1. Breeding status

Ferruginous Ducks were first recorded breeding at Durankulak in the 1950s (Petrov & Zlatanov 1955). Subsequent information is scarce – Donchev (1967) saw 20 birds on 10 Jun 1965, while Robel *et al.* (1978) noted the species' presence. During the 1990s, Ferruginous Ducks were regularly registered at Durankulak, though there has been no confirmation of breeding for over 34 years (Ivanov 1994).

Systematic studies on the species started in 1995 as part of the BSBCP Dobrudga project (formerly the Northern Coastal Wetlands Project). Further research conducted by BSPB/BirdLife Bulgaria has led to a much better understanding of the status of Ferruginous Ducks at Durankulak. From 1995 to 1997, there was an increase in breeding pairs – from 3 – 5 in 1995 to 10 – 12 in 1996 and 25 pairs in 1997

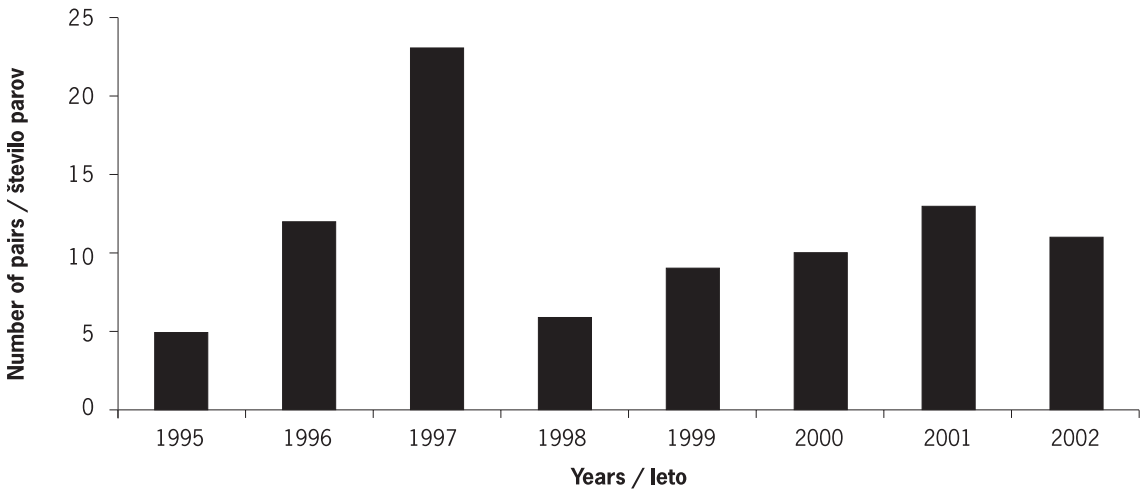

Figure 3: Population dynamics of the breeding population of Ferruginous Duck *Aythya nyroca* at Durankulak Lake, 1995 – 2002

Slika 3: Populacijska dinamika gnezdečih kostanjevk *Aythya nyroca* na Durankulaškem jezeru v obdobju 1995 – 2002

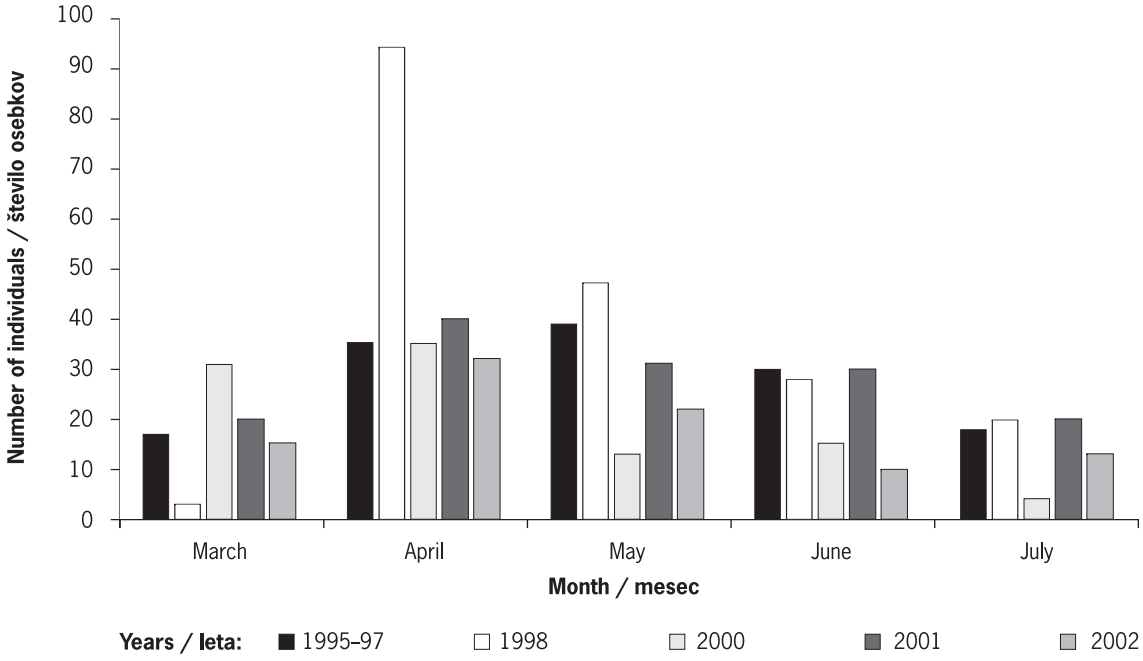

Figure 4: Annual and seasonal variation in Ferruginous Duck *Aythya nyroca* numbers at Durankulak Lake in 1995 – 2002

Slika 4: Letna in mesečna nihanja števila kostanjevk *Aythya nyroca* na Durankulaškem jezeru v obdobju 1995 – 2002

(Petkov 1997). Only 5 – 7 pairs were present in 1998 (Petkov 2000), 10 pairs in 2000 (Mittev 2000*)* and 13 pairs in 2001. In 2002, there were 9 – 11 pairs registered during the breeding season. It therefore appears that 10 – 15 pairs of Ferruginous Duck currently breed at Durankulak Lake (Figure 3). The lack of a clear trend in numbers suggests that wetland conditions are probably responsible for the population fluctuations, rather than any population specific parameters.

Ferruginous Ducks appeared at Durankulak Lake in March and numbers peak in April before gradually declining through June and July (Figure 4). The absence of large numbers in July probably means that the species does not moult here, although ducks are very secretive at this time of the year. Observations at other wetlands in Bulgaria show that moulting Ferruginous Ducks spend most of the day inactive, either in secluded pools surrounded by reeds, or in large flocks on open water. No such moulting concentrations have been recorded at Durankulak, probably due to the levels of human disturbance, as Ferruginous Ducks prefer undisturbed moulting sites (Schneider-Jacoby 2003).

3.2. Habitat selection

Ferruginous Duck pairs at Durankulak Lake utilised only marshy areas during the breeding season (EM, NDL, SEM and TE). The SEM held the highest breeding density, averaging 1.2 pairs/10ha over the six-year period (Table 1). The TE area held an average of 0.8 pairs/10ha, with highest variation from 0.0 to 2.4 pairs/10ha. The EM and DNL held lower densities of 0.6 pairs/10ha and 0.5 pairs/10ha, respectively, although numbers fluctuated more in the EM (0.3 pairs/10ha to 1.2 pairs/10ha).

Ferruginous Ducks at Durankulak appeared to prefer the SEM, while use of other lake sections varied from year to year (Table 2). The EM was used less than expected (with all selection indices <1), whilst use of the other two areas varied from year to year. Although a Chi-square test on these data was not statistically significant ($p > 0.05$), this was probably due to the small sample size, with as few as six breeding pairs in some years.

Cues driving habitat selection in species include site fidelity, pressure from conspecifics, and physical features. Wetland-nesting birds can nest when the

Table 1: Breeding density of Ferruginous Duck *Aythya nyroca* pairs (pairs/10 ha) in the four parts of the Durankulak wetland complex (main lake body excluded as no breeding pairs were there)

Tabela 1: Gnezditvena gostota kostanjevke *Aythya nyroca* (pari/10 ha) v štirih predelih mokriščnega kompleksa Durankulaškega jezera z izvzetim osrednjim jezerskim delom, kjer gnezdeči pari niso bili zabeleženi

Year/ leto	Eagle Marsh	North Durankulak Lake	South-east Marsh	Tail Ends
1996	0.5	0.6	1.3	0.5
1997	1.2	0.8	1.3	2.4
1998	0.3	0.4	0.7	0.0
2000	0.4	0.4	1.3	0.5
2001	0.5	0.4	1.3	0.8
2002	0.4	0.6	1.3	0.5
Mean / povp.	0.6	0.5	1.2	0.8
SD	0.33	0.16	0.24	0.83
Surface/ površina	113.1 ha	50.9 ha	15.2 ha	20.8 ha

physical environment is suitable. Thus differences in water level and vegetation growth can influence suitability and determine the timing of nesting (Cody 1985). Factors affecting nest site selection include concealment, protection of the nest, clutch and young from flooding, heat stress, predators etc. The variable physiognomy of the environment of Durankulak Lake complex forces the Ferruginous Duck to vary its use of the wetland complex from year to year.

The marshland areas of the Durankulak Lake complex hold a diverse mosaic of microhabitats, including vegetated water bodies with mixed hygrophyte vegetation, open water, dry reed beds, dense reedbeds with patches of shallow or deep open water, shallow banks with vegetated mudflats, and shallow waters with floating and submerged vegetation. Despite the fact that the SI suggested an overall avoidance of the Eagle Marsh, this area appears to offer the most appropriate conditions for nesting, especially the thick mixed or monoculture reed beds along the old dike. Suitable nesting vegetation is also present along the eastern bank, in the north of the marsh, and in patches in the west and north-west. The lower than expected numbers of breeding Ferruginous Duck in the EM may be due to the high levels of human disturbance it suffers from local people entering the reedbeds to poach fish.

The SEM includes only a small nesting area suitable for 1 – 3 pairs at most. It is extremely exposed to disturbance from anglers and grazing cattle, due to its small size and shallowness. Nevertheless, the SI clearly shows that Ferruginous Duck prefer to breed in this area. In 1996 – 1998, it was a favoured area for feeding and courtship activity for up to half of the Ferruginous Ducks present in the wetland. However, by 2002 the SEM was almost entirely covered by vegetation and therefore no longer attracted such large numbers of birds. This increased vegetation growth into previously open water areas occurred because of a long dry period with reduced water levels.

Table 2: Distribution of Ferruginous Duck *Aythya nyroca* pairs and selection index (SI) for wetland parts of Durankulak Lake complex (Exp – expected number of pairs; Obs – observed number of pairs; SI – selection index (Observed number of pairs/ Expected number of pairs; SI > 1 relative selection, SI < 1 relative avoidance, SI = 1 used to the extent of its availability)

Table 2: Razširjenost kostanjevke *Aythya nyroca* (v parih) in selekcijski indeks (SI) za močvirne predele kompleksa Durankulaškega jezera (Exp – pričakovano število parov; Obs – opazovano število parov; SI – selekcijski indeks (opazovano število parov / pričakovano število parov; SI > 1 relativna selekcija SI < 1 relativno izogibanje, SI = 1 uporabljeno glede na razpoložljivost)

	Eagle Marsh			North Durankulak Lake			South-east Marsh			Lake Tail Ends		
Year / leto	Exp	Obs	SI	Exp	Obs	SI	Exp	Obs	SI	Exp	Obs	SI
1996	6.8	6	0.9	2.9	3	1.0	0.9	2	2.2	1.4	1	0.7
1997	14.1	14	1.0	6.1	4	0.6	1.9	2	1.0	2.8	5	1.7
1998	3.4	3	0.9	1.5	2	0.9	0.5	1	2.2	0.7	0	0.0
2000	5.6	5	0.9	2.4	2	0.8	0.8	2	2.6	1.1	1	0.9
2001	7.3	6	0.8	3.2	3	0.9	1.0	2	2.0	1.5	2	1.3
2002	6.2	5	0.8	2.7	3	1.1	0.8	2	2.4	1.2	1	0.8

Nevertheless, the persistent high density of breeding Ferruginous Ducks suggests that the SEM offers ideal conditions for foraging and nest concealment. The Ferruginous Duck was the only duck that selected the SEM for nesting, with only a few pairs of Common Coot and Little Grebe nesting in the same area.

The NDL south of the Old Dike, dominated by reedbeds providing secure nesting conditions, contained similar habitat to Eagle Marsh and regularly held small numbers of breeding Ferruginous Duck. The TEs of Durankulak Lake are heavily vegetated with *Phragmites* and *Typha* but offer only small pools of open water. The TE at Vaklino village, which has three open water patches, held one pair of Ferruginous Ducks in 1997 and 1999, but numbers declined after this area became overpopulated with Nutria *Myocastor coypus* (Petkov *unpubl.*). The TE at Durankulak village held 1 – 2 pairs of the Ferruginous Duck, despite the fact that cows grazed in the shallows. However, the area is now unsuitable for nesting as it is overgrown by *Scirpus* and *Carex* vegetation.

The distribution of breeding Ferruginous Duck at Durankulak suggests that breeding site selection is based on the physiognomy and structure of the vegetation rather than on the plant species themselves. In general, areas containing a complex of emergent vegetation, open water and shallow water with sparse reed are preferred. Reed covered areas in the southern part of the EM were rarely utilised by Ferruginous Ducks. However, these areas were immediately occupied by breeding Ferruginous Duck after they were burnt in spring 2002 forming areas of sparse reed vegetation and open water.

Patterson (1976) postulated that breeding ducks are evenly distributed in available waters due to intraspecific aggression, while other studies such as Elmberg *et al.* (1993) reported a significant relationship between duck numbers and vegetation structural diversity. In the different sections of Durankulak Lake, there is only slight variation in zoobenthic biomass and vegetation physiognomy (Georgiev 2002) although there are differences in vegetation species composition and structure. That is why we consider that the distribution in the wetland complex is mostly driven by the availability of the proper nesting and forage habitat in the different wetland sections, but heavily influenced by the human pressure. But even so, the species is mostly found in the more luxurious sections of the lake complex.

3.3. Breeding success

We conducted very little nest searching at Durankulak due to time constraints and fears of the effect of additional disturbance. Since 1995, no more than 4 – 5 broods have been observed at the site, even in 1997 when 22 – 25 pairs were present. In 2000, a detailed field study of Ferruginous Ducks found no broods or juveniles at the lake, which was attributed to a lack of suitable nest sites (Mittev 2000). However, the results of this study suggest this is not the case. It is likely that many broods remain concealed in small pools in the reed beds, due to disturbance from humans. Despite of a conservation scheme in the area, and the fact that access to the lake

Table 3: Breeding pairs, broods and ducklings of the Ferruginous Duck *Aythya nyroca* in Durankulak Lake complex (– no data)

Tabela 3: Gnezdeči pari, zarodi in mladiči kostanjevke *Aythya nyroca* v kompleksu Durankulaškega jezera (– ni podatka)

Year/ leto	No. of pairs/ št. parov	No. of broods/ št. zarodov	No. of ducklings/ št. mladičev (min – max)	Ducklings per pair/ št. mladičev na par	Ducklings per brood/ št. mladičev na zarod
1995	5	–	–	–	–
1996	12	4	12 (2–5)	1.0	3.0
1997	23	7	26 (2–6)	1.1	3.7
1998	6	1	4	0.7	4.0
1999	9	3	10 (2–5)	1.1	3.3
2000	10	0	0	0.0	0.0
2001	13	5	13 (3–4)	1.0	2.6
2002	11	5	16 (2–5)	1.4	3.3
Mean / povp. (± SD)	11.1 (± 5.54)	3.57 (± 2.44)	11.6 (± 8.40)	0.9 (± 0.45)	2.84 (± 1.33)

is prohibited, poachers still enter the wetland in late evening between April and June, especially when fish are spawning. In addition, a public road surrounding the lake means that people have direct access to these areas. The main disturbance is caused by the fish poachers entering the EM, mainly late at night, to set their nets. Such disturbance may result in poor physical condition in females so that they do not breed, or may cause direct nest abandonment (Korschgen & Dahlgen 1992). There is a positive correlation between the number of pairs established during the years and the number of ducklings. Though this result could be expected, it has to have been noted that in 2000 there were 10 pairs and no broods or ducklings (Table 3). The correlation between observed pairs and registered broods is 0.79 with $p < 0.05$ and, between breeding pairs and registered ducklings, 0.85 with $p < 0.05$. The correlation between number of broods and number of ducklings was highly significant, with correlation coefficient 0.97 and $p < 0.001$.

In 2001, surveys resulted in only one Ferruginous Duck nest being found. This was located in a reed bed in Eagle Marsh and contained eight eggs. From an estimated 13 breeding pairs, only five broods were recorded. This result may not be unexpected, taking into account that over 10% of diving duck pairs may not breed (Johnson *et al*. 1992), that mortality in the first week may approach 60% (Street 1977), and that 20 – 50% of broods may be lost entirely before fledging (Ringelman 1992). Low food availability of benthic invertebrates in Eagle Marsh (biomass 5.4 g/m²) may have contributed to the low breeding success in 2001. This may be supported by the fact that Ferruginous Ducks unusually choose to feed on water fleas *Daphnia* spp. and *Bosmina* spp. in June and July. Low water levels in 2001, especially in the Tail Ends and the SEM, caused by the lack of rainfall from late May to the end of July 2001, meant that suitable nesting habitat was limited to EM and the NDL south of the old dike. Despite similar dry conditions in 2002, resulting in low water level and poor wetland conditions, 11 pairs of Ferruginous Ducks were present at the lake in June to July, producing a total of five broods. These consisted of two broods of five ducklings (7 – 10 days old), and three almost full-grown broods of 1 – 3 ducklings, thus suggesting a low fledging success. The total number of young produced in 2002 was slightly higher than in 2001, despite the fact that fewer pairs bred.

There have been a number of observations of very young ducklings (6 – 7 days old) not accompanied by females. If these broods have been deserted by their mothers, this would contribute to the Ferruginous Ducks' low breeding success at Durankulak. Other studies have shown that in poor wetland conditions, Ferruginous Duck hens abandon their ducklings at quite an early stage (for example at Srebarna Lake in June to July 2002; Petkov *unpubl.*). At the same time, observations at Srebarna Lake in 2001, when the species had a flourishing population, the hens accompanied the juveniles almost till fledging. Ferruginous Duck ducklings at Durankulak fledge by the end of July or early August and most leave the area. The earliest fledglings at Durankulak have been observed in mid June but most are still not feathered by mid July. In general the Ferruginous Duck is one of the latest breeders among duck species in Bulgaria.

Other waterfowl species at Durankulak Lake also suffered low breeding success during this study. Greylag Goose and Mallard were the most successful, though in very low numbers. Mute Swan and Garganey had varying breeding success, in some years rearing almost no young. Common Coot and Great Crested Grebe usually have better success, raising 2 – 3 chicks to fledging.

4. Conclusions

The Ferruginous Duck is a regular nesting species at Durankulak Lake complex with an annual population of 6 to 25 pairs. The number of breeding pairs is determined mainly by the condition of the wetland complex and disturbance pressure. In very dry years, or when disturbance is high, only a small number of ducks breed. However, in good years the site can hold up to 10% of the national breeding population in Bulgaria and up to 60% of the breeding pairs along the Bulgarian Black Sea coast.

Ferruginous Ducks are thought not to moult at Durankulak, as most birds leave the site in July. The lack of moulting flocks in late summer suggests that the wetland does not provide suitable conditions. I attribute this to the combined effect of the suppressed zoobenthic community and human disturbance by poachers and holidaymakers.

Breeding pairs nested only in the shallower and more vegetated marshy areas of the wetland complex. Breeding pair density and the Selection Index show that the SEM is the most favoured area, while EM is relatively avoided, most probably due to human pressure in the early and mid-breeding season. The other two habitat areas, the TE and NDL, are utilized variably from year to year, perhaps due mostly to wetland conditions and their water regime.

Breeding success varies from year to year, but it has

never exceeded 40% of broods per breeding pair. Brood abandonment probably contributes to a lack of recruitment for Ferruginous Ducks at Durankulak. The generally low breeding success in all waterfowl species in the wetland indicates that this is not solely a problem for the Ferruginous Duck, though it is most notable for it.

Though a conservation scheme has reduced disturbance from holidaymakers and anglers, the area still faces significant disturbance from local fish poachers, despite the fact that the lake is protected and any entry or fishing is forbidden within the marshy areas of the wetland complex – EM, NDL, SEM and TEs.

Improvement/restoration of wetland conditions, as outlined in the Durankulak Lake management plan, could stabilise or increase the Ferruginous Duck population. Restoration and management activities should focus both on the vegetation structure and benthic community. Cattle grazing needs to be restricted, especially in the small marsh areas, so as not to increase disturbance levels. In addition, reed cutting or controlled burning should be considered. This however should be applied in a way not to destroy breeding habitat for other species, such as Bittern *Botaurus stellaris* and Bearded Tit *Panurus biarmicus*. Efforts should continue to provide areas with less disturbance during the breeding season. The need of a buffer zone is urgent due to the vulnerability of the area, and every effort should be made to secure the Eagle Marsh area as a non-disturbance zone to provide the necessary conditions for the breeding of waterfowl in this key area. The small pods in the tail end of Vaklino village should be broadened and new ones should be made, connected by canals to the main Lake area in order to make them more attractive for nesting.

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5. Povzetek

Predstavljeni so rezultati preučevanja razvoja gnezdeče populacije kostanjevke *Aythya nyroca*, zvestobe gnezdišču/habitatu in izbor habitata v kompleksu Durankulaškega jezera v Bolgariji v obdobju med letoma 1995 in 2002. Jezero je najpomembnejše gnezdišče vrste vzdolž bolgarskega dela Črnega morja, saj vključuje do 10% bolgarske gnezdeče populacije, ki šteje od 125 do 230 parov. Opisane so letne in mesečne razlike v številu ptic, njihov gnezditveni uspeh in izbor habitata glede na človekov vpliv in razmere, ki vladajo v mokriščih in habitatih jezerskega kompleksa. Pari kostanjevk gnezdijo v plitkejših in vegetacijsko bogatejših močvirnih predelih jezera. Ugotovljeno je bilo, da se kostanjevke najraje zadržujejo v jugovzhodnem močvirju in da se število gnezdečih parov v severnem predelu jezera in v njegovih skrajnih delih najbrž spreminja zaradi nenehnega nihanja vodne gladine. Poleg tega je bilo ugotovljeno, da se kostanjevke do neke mere izogibajo predelu, imenovanem Eagle Marsh, bržkone zaradi nemira in pritiskov, ki jih v ta prostor vnaša človek. V preučevanem obdobju se je število gnezdeče populacije sukalo med 6 in 25 pari, odvisno od mokriščnih razmer, a brez jasnega trenda v celotnem obdobju. Gnezditveni uspeh se spreminja iz leta v leto, vendar ni nikoli presegel 40% zaroda na gnezdeči par. Ugotovitev, da starša zgodaj zapustita svoje mladiče, danes velja kot običajen pojav za mokrišča, kar seveda prispeva k njihovi visoki smrtnosti. Mokrišče trenutno ne daje zavetja golečim se pticam, najbrž zaradi pomanjkanja hrane in precejšnjega nemira, ki ga v kompleksu povzroča človek. Pričujoča študija opozarja na potrebo po povečanem varstvu pred motnjami in tudi po zonaciji območja, še posebno v gnezditvenem obdobju.

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