Acrocephalus 34 (156/157): 5–11, 2013
10.2478/acro-2013-0001

# Roost-site characteristics of the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* along the Slovenian coast

## Značilnosti prenočišč sredozemskega vranjeka *Phalacrocorax aristotelis desmarestii* v slovenskem morju

Dejan Bordjan[1], Matej Gamser[2], Aleksander Kozina[3], Jure Novak[4] & Mitja Denac[5]

[1] Dejan Bordjan, Nacionalni inštitut za biologijo, Večna pot 111, SI–1000 Ljubljana, Slovenija, e–mail: dejan.bordjan@gmail.com

[2] Matej Gamser, Na griču 3, SI–3202 Ljubečna, Slovenija, e–mail: matej.gamser@gmail.com

[3] Aleksander Kozina, Jurjevica 61, SI–1310 Ribnica, Slovenija, e–mail: aleksanderkozina@hotmail.com

[4] Jure Novak, Velika Pirešica 27k, SI–3310 Žalec, Slovenija, e–mail: jurenovak15@yahoo.com

[5] Mitja Denac, Mala Slevica 2, SI–1315 Velike Lašče, Slovenija e–mail: mitja.denac@gmail.com

Several bird species utilize artificial structures for communal roosting. Between 26 May and 28 Jun 2012, the selection of buoys and times of departure by Mediterranean Shags *Phalacrocorax aristotelis desmarestii* were studied at three communal roosts within shellfish farms in the Bays of Sv. Jernej (Debeli rtič), Strunjan and Piran (Sečovlje). A total of 3,110 buoys were counted and categorized into two groups according to their shape (horizontal and vertical) and colours. The black horizontally floating buoys were of two types (barrel-shaped and oval). The Shags chose to utilize the horizontally floating buoys only, most often black and white in colour. Owing to their poorer stability and smaller standing surface, the vertically floating buoys are clearly unsuitable for them. The highest share of Shags with regard to the number of buoys of separate types was registered on black barrel-shaped buoys. As the percentage of occupied buoys was similar at all roost sites (36–39%), it was deduced that Shags distribute evenly among roosts, regardless of the number of individuals present in the Slovenian sea. At the larger roost at Debeli rtič, the percentage of adult individuals (73.5%) was greater than at Strunjan (42.5%). This could be due to the competition for better places, given that competitively stronger individuals select safer larger roosts. Between 5.42 and 9.00 hrs, 53.3% and 69.1% of Shags departed from the roost sites at Debeli rtič and Strunjan, respectively, with the majority of departures recorded between 7.50 and 8.30 hrs. They left their roosts mostly individually (48.7%) or in pairs (23.3%), at Debeli rtič predominantly in the SW (58.9%) and W (16.9%) directions, and at Strunjan in the NE (42.3%) and N (38.5%) directions.

**Key words**: Mediterranean Shag, *Phalacrocorax aristotelis desmarestii*, roost-site, buoys, Slovenian coast
**Ključne besede**: sredozemski vranjek, *Phalacrocorax aristotelis desmarestii*, prenočišče, boje, slovensko morje

### 1. Introduction

Several bird species use communal roost-sites (Newton 1998), either for protection or for information exchange about prey distribution (Ward & Zahavi 2008). When natural roost-sites are in short supply, birds often use artificial ones (Toomer & Clark 1992). Seabirds generally feed on marine organisms and catch most food in the upwelling zones or over continental shelf. Cormorants along with terns and most of the gulls are considered inshore feeders due to the fact that they generally feed within the sight

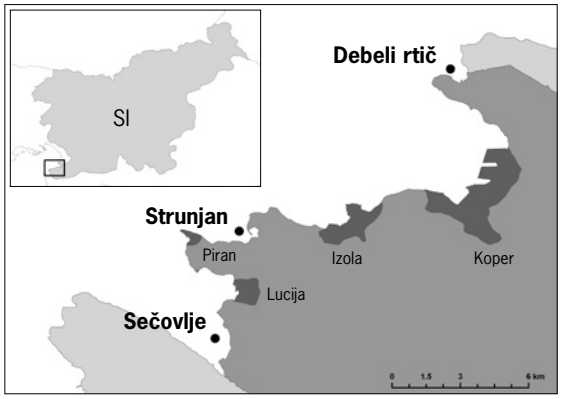


**Figure 1**: Study area with locations of roost sites studied (dots)

**Slika 1**: Obravnavano območje s prikazanimi lokacij prenočišč, vključenih v raziskavo (pike)

of shore (Oro & Martínez-Abraín 2009).

Shag *Phalacrocorax aristotelis* is a marine species that inhabits coastal waters (Cramp 1998) in most of the Western Palearctic (del Hoyo *et al.* 1992). Europe constitutes more than 75% of species world population (BirdLife International 2004). Three subspecies are known – *P. a. aristotelis* from western and northern Europe, *P. a. desmarestii* from the Mediterranean and the Black Sea, and *P. a. riggenbachi* from the Atlantic coast of Morocco (del Hoyo *et al.* 1992). Shags overall population is stable (BirdLife International 2004). On the other hand, the Mediterranean subspecies has small population, numbering around 10,000 pairs (Aguilar & Fernández 1999) and has witnessed large decline in the past (Wanless *et al.* 1997). Shag is present in Slovenia throughout the year, but does not breed here (Geister 1995). The nearest known nesting colonies are in Istria and in the Kvarner Archipelago, Croatia (Radović *et al.* 2005).

In the 1980s, the Mediterranean Shag was considered a rare species in Slovenia (Komisija za redkosti 1989 & 1993, Škornik *et al.* 1990). In the 1990s, however, it was no longer a rare species according to the national Rarities Committee's reports (Sovinc 1993 & 1995). In the 2007–2012 period, from 39 to 312 individuals were counted during the January waterbird census (Božič 2007, 2008a, 2008b, 2010, 2011 & 2012) – a clear increase from the early 1990s, when 0–10 birds were present along the coast (Sovinc 1994). Shags reach peak numbers in summer and autumn (Škornik 2012), when around 11.4% of the entire subspecies and more than half of the Adriatic population is present (Vrezec 2006). In 2004, an estimation of max. 1,500–2,000 individuals was made for the entire Gulf of Trieste (Benussi 2005). In the last few years, their numbers may have even increased, since more than a thousand individuals gather solely in front of Sečovlje saltpans (Škornik 2012). In 2012, 1,485 individuals were counted in the Slovenian part of the Gulf of Trieste (U. Koce *pers. comm.*).

Mediterranean Shags utilize shellfish farms, breakwaters, navigation lights, beached trees and sand or rocky islets for roosts in the Gulf of Trieste (Benussi 2005). Along the Slovenian coast, they most often use shellfish farms and also spur dikes of Sečovlje saltpans (Škornik 2012). Three biggest roosts can all be found on shellfish farms in front of Sečovlje and Strunjan saltpans and at Debeli rtič, where several hundred individuals roost in summer and early autumn (Škornik 2012, B. Rubinić & U. Koce *pers. comm.*).

For efficient conservation of Shags in Slovenia, it is essential to understand their roosting ecology in the Gulf of Trieste. Since data on this topic is essentially missing, our aim was to gather data on (1) the type of buoys Shags use for roosting and (2) on the time of their departures from roost.

## 2. Study area and methods

### 2.1. Study area

The study was conducted in three bays along the Slovenian coast with known Shag communal roost sites: Sv. Jernej Bay (Debeli rtič roost), Strunjan Bay (Strunjan roost) and Piran Bay (Sečovlje roost). All are situated in the Gulf of Trieste, a closed, shallow sea with max. depth 37.5 m in the northernmost part of the Mediterranean Sea (Figure 1). On all sites, the majority of individuals roost on buoys used for shellfish farming (Škornik 2012, B. Rubinić & U. Koce *pers comm.*). Roost sites at Debeli rtič and Strunjan are surrounded by land in E and S directions, while the Sečovlje roost faces the open sea only in the NW direction. Buoys are situated close to the coast; 200 m at Strunjan, 400 m at Sečovlje and 220 m at Debeli rtič. At Sečovlje and Debeli rtič, shellfish farms are located on both sides of the national border, but only those on the Slovenian side were included in the study.

***Buoys***

Altogether, 3,110 buoys were counted on all three roosts during the study. The highest number of buoys was present at Sečovlje and the lowest at Strunjan. 13 types of buoys, based on colour-shape combination, were detected that were divided into two groups: (1)

**Table 1**: Numbers of different types of buoys, divided into two groups, at separate Mediterranean Shag *Phalacrocorax aristotelis desmarestii* roosts off Sečovlje, Debeli rtič and Strunjan

**Tabela 1**: Število različnih tipov boj, razvrščenih v dve skupini, na prenočiščih sredozemskega vranjeka *Phalacrocorax aristotelis desmarestii* pri Sečovljah, Strunjanu in Debelem rtiču

| Type of buoy / Tip boje | Debeli rtič | Strunjan | Sečovlje | All roosts / Vsa prenočišča |
|---|---|---|---|---|
| White oval / Bela ovalna | 267 | 372 | | 639 |
| Black oval / Črna ovalna | 91 | 13 | 223 | 327 |
| Black barrel-shaped / Črna valjasta | | 34 | 165 | 199 |
| Green oval / Zelena ovalna | 7 | | | 7 |
| Yellow oval / Rumena ovalna | 66 | | 361 | 427 |
| Blue oval / Modra ovalna | 158 | 41 | | 199 |
| Red oval / Rdeča ovalna | 527 | | 459 | 986 |
| Horizontal buoys / Ležeče boje | 1.116 | 460 | 1.208 | 2.784 |
| White oval / Bela ovalna | 7 | 7 | | 14 |
| Black oval / Črna ovalna | 23 | 5 | | 28 |
| Green oval / Zelena ovalna | 4 | 3 | | 7 |
| Yellow oval / Rumena ovalna | 4 | 2 | | 6 |
| Blue oval / Modra ovalna | 7 | 1 | | 8 |
| Red oval / Rdeča ovalna | 93 | | | 93 |
| Vertical buoys / Pokončne boje | 138 | 18 | 170* | 326 |
| Total / Skupaj | 1.254 | 478 | 1.378 | 3.110 |

* Buoys not categorized according to different types / Boje niso bile razdeljene po različnih tipih

horizontal and (2) vertical (Table 1). Both groups are physically the same but are functionally different. Horizontally floating buoys have ropes with shellfish attached on both sides, while vertical buoys have them attached on one side only. Most buoys were oval-shaped, while some of the black horizontal buoys were larger and barrel-like (Figure 2). Horizontal buoys were prevalent at all roosts (89.5%). The difference between the ratio of two main types of buoys at different roosts was significant (Chi-square, $\chi^2 = 24.7$, df = 2, $P < 0.001$).

## 2.2 Methods

Shags were counted during the Ornithological Youth Camp between 26 and 28 Jun 2012. Counts were conducted at three communal roosts on shellfish farms along the Slovenian coast (hereinafter referred to as "the roosts") with spotting scopes from the nearest point on the land. At Debeli rtič, Shags were counted in the mornings of 26 and 28 Jun, at Strunjan in the morning of 27 Jun and at Sečovlje in the evening of 27 Jun. Morning counts were carried out between 5.30 and 9.30 hrs, evening counts from 19.00 hrs till dusk. At the Sečovlje roost, only the number of roosting individuals was recorded due to contrary light, while at the other two sites individuals were separated by age

**Figure 2**: Example of two different types of buoys from two groups: black barrel-shaped buoys (horizontally floating buoys, above) and red oval buoys (vertically floating buoys, below)

**Slika 2**: Primer dveh različnih tipov boj iz dveh skupin: črne valjaste boje (ležeče, zgoraj) in rdeče ovalne boje (pokončne, spodaj) (photo / foto: A. Kozina)

(adults / immature). Individuals in their 4th calendar year were counted as adults, due to their similarity (Cramp 1998).

Number of roosting Shags was recorded for each type of buoys separately. Departure of individuals from roost sites counted in the morning was recorded with one minute accuracy. Chi-square test was used for comparison between occupied and unoccupied buoys and for the buoy occupancy between roosts. To test whether any colour / type of buoys was preferred by Shags, the Cochran-Mantel-Haenszel test was used (Cochran 1954, Mantel & Haentszel 1959).

## 3. Results

### 3.1 Number of Shags at roosts

Altogether, 1,204 individuals were counted at all three roosts. The highest number was recorded at Sečovlje (530), then at Debeli rtič (493 during the first count and 478 during the second count), and the smallest number at Strunjan (181) (Figure 3). Adults constituted 73.5% of all counted individuals at Debeli rtič, while age classes were represented in almost equal share at Strunjan (Figure 4). The ratio between the number of Shags and buoys was similar between roosts (Sečovlje 0.36, Strunjan 0.38, Debeli rtič 0.39; Chi-square, $\chi^2 = 1.1$, df = 2, $P = 0.58$).

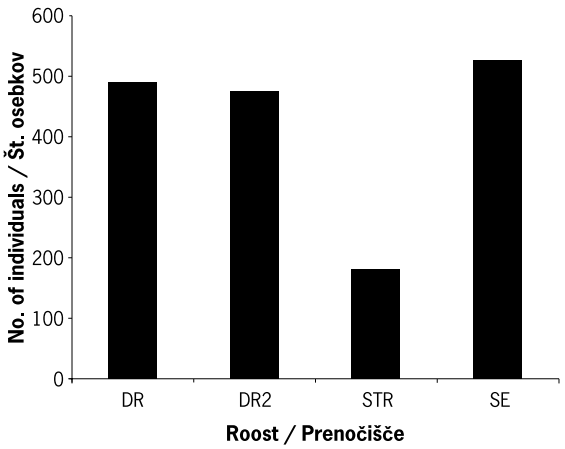


**Figure 3**: Number of Mediterranean Shags *Phalacrocorax aristotelis desmarestii* at communal roosts (DR – Debeli rtič 26 Jun 2012, DR2 – Debeli rtič 28 Jun 2012, STR – Strunjan, SE – Sečovlje)

**Slika 3**: Število sredozemskih vranjekov *Phalacrocorax aristotelis desmarestii* na skupinskih prenočiščih (DR – Debeli rtič 26. 6. 2012, DR2 – Debeli rtič 28. 6. 2012, STR – Strunjan, SE – Sečovlje)

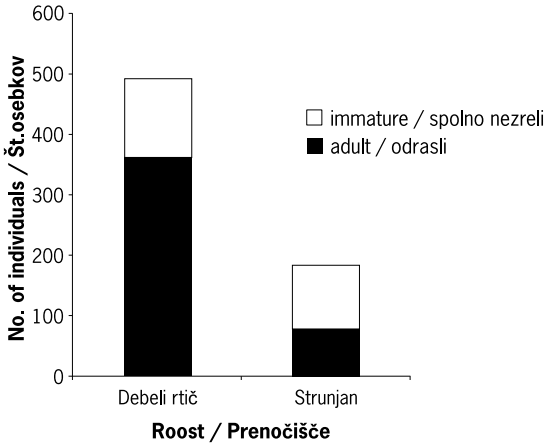


**Figure 4**: Age structure of Mediterranean Shags *Phalacrocorax aristotelis desmarestii* at two communal roosts along the Slovenian coast

**Slika 4**: Starostna struktura sredozemskih vranjekov *Phalacrocorax aristotelis desmarestii* na dveh skupinskih prenočiščih ob slovenski obali

### 3.2 Buoy selection

Only Shags using horizontal buoys were observed. They showed preference for some types of buoys regardless of roost site (Cochran-Mantel-Haenszel, $M^2 = 963.3$, df = 12, $P < 0.001$). There was no difference in utilization of the white and black horizontal buoys (Chi-square, $\chi^2 = 0.1$, df = 1, $P = 0.78$), but both were used significantly more often that the rest (Chi-square, $\chi^2 = 205.5$, df = 3, $P < 0.001$). Overall, the type most often used by Shags was the black barrel-shaped buoy (Figure 5). Moreover, this type harboured higher number of Shags than the number of available buoys. On several buoys, more than one individual was observed. Two Shags were observed on 25 black barrel-shaped and on one white oval-shaped buoys, while three were observed on four barrel-shaped and on one black oval-shaped buoys.

### 3.3 Departure from roost

At Debeli rtič, the first individuals left roost at 5.42 hrs, which is more than an hour after dawn (4.34 hrs). At Strunjan, the first individuals departed even later, at 6.22 hrs. The majority of Shags departed between 7.50 and 8.30 hrs (Figure 6). Till 9.00 hrs, when the count was completed, 53.3% and 69.1% of individuals left Debeli rtič and Strunjan roost, respectively.

Most departures concerned single (48.7%) and

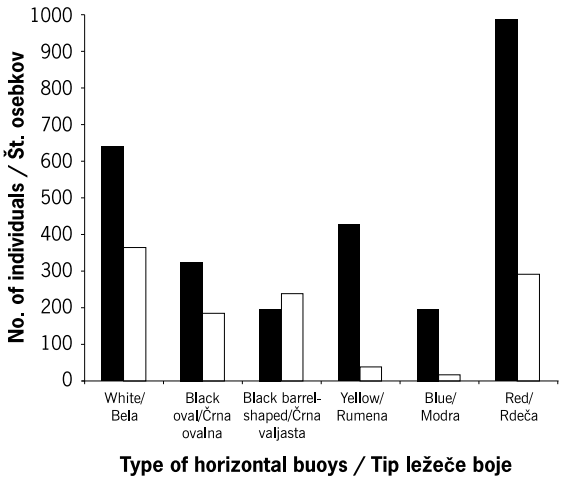


**Figure 5**: Occupancy of different types of horizontal buoys by Mediterranean Shags *Phalacrocorax aristotelis desmarestii* at three roosts (Sečovlje, Debeli rtič, Strunjan); black columns – No. of buoys, white columns – No. of Shags

**Slika 5**: Zasedenost različnih tipov ležečih boj s sredozemskimi vranjeki *Phalacrocorax aristotelis desmarestii* na treh prenočiščih pri Sečovljah, Strunjanu in Debelem rtiču; črni stolpci – št. boj, beli stolpci – število vranjekov

two birds (23.3%). The largest group was comprised of 25 individuals at Debeli rtič and 10 at Strunjan. At the time of the highest frequency of departures, the first individuals were already retuning. Altogether, 52 at Debeli rtič and 11 individuals at Strunjan returned by the time the count was completed. Most of the individuals departed from Debeli rtič in the SW (58.9%) and W (19.6%) directions, and from Strunjan in the NE (42.3%) and N (38.5%) directions. While monitoring departures at Strunjan, 42 individuals, probably departing from the Sečovlje roost, were also observed. All were heading NE. Among these, apart from three groups with six, seven and 15 individuals, all concerned single (46.2%) or two birds (30.8%).

## 4. Discussion

The numbers of Shags counted differed among roosts, but buoy occupancy was similar irrespective of their number. This indicates that Shags distribute evenly among roosts along the Slovenian coast regardless of the number of individuals present here in any given period. On the larger roost at Debeli rtič, a higher percentage of adults was noted than on the smaller roost at Strunjan. Percentage of immature individuals at Sečovlje in 2009 was 80% (Škornik 2012), but this was recorded in late summer when 1st-year individuals are present in higher numbers in the Slovenian coastal waters. Age structure for the Sečovlje roost was not determined in this study, but age structure at the Debeli rtič roost was similar to that in summer at Milje (Muggia) in Italy, where immature individuals represented only 10% of all individuals (Škornik 2012). At the Strunjan roost, the percentage of adult and immature Shags was similar. Since individuals compete for best positions at roost sites (Velando 2000), we assume that more adults, which are stronger competitors, use larger roost, given that it offers more safety (Dimond & Lazarus 1974). Direct intraspecific competition was observed at Strunjan, where an adult chased away an immature Shag from a black barrel-shaped buoy. The same may apply for distribution inside roost where Škornik (2012), for example, found more adults on larger barrel-shaped than on smaller oval buoys at Sečovlje.

Vertically floating buoys proved unsuitable as roost sites for Shags. This may be due to lower stability and smaller standing surface for birds. Shags preferred black barrel-shaped buoys that offer most standing space. Multiple use of the same buoy was also noted on this type, proving that this type indeed offers more space. Oval-shaped buoys have concave tops and also probably provide less grip.

Buoy colours most frequently used by Shags at roost were black and white. These are also the basic colour of their plumage (Cramp 1998). Since colours are important for birds (Kushlan 1977, Gutzwiller & Marcum 1997) and as the evolution of avian colouration was mostly influenced by the environment

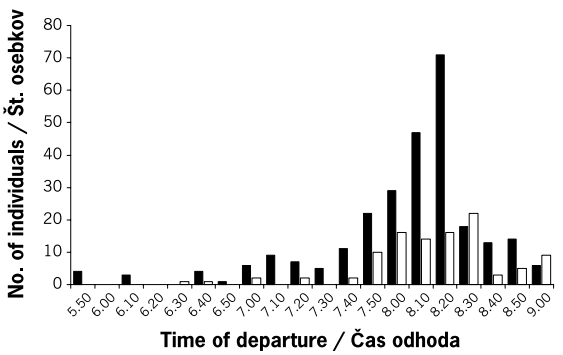


**Figure 6**: Morning departure time of Mediterranean Shags *Phalacrocorax aristotelis desmarestii* from roost at Strunjan and Debeli rtič till 9.00 hrs

**Slika 6**: Jutranji odhodi sredozemskih vranjekov *Phalacrocorax aristotelis desmarestii* s skupinskih prenočišč pri Strunjanu in Debelem rtiču do 9. ure

according to the "Light Environment Hypothesis" (McNaught & Owens 2002), it is possible that Shags preferred certain buoys simply due to their colours.

Influence of other factors was not studied, but we allow the possibility of other factors in selection of buoy types. Age of buoy may also play an important role. In 2012, a large quantity of yellow buoys was deployed at Sečovlje. First Shags were observed using these buoys only after several months (U. Koce *pers. comm.*). One of the possible explanations for this is that with time live organisms cover the buoys and they become abraded, thus offering better grip later on.

**Acknowledgements:** We thank DOPPS - BirdLife Slovenia for organising the Youth Ornithologists' Camp at Prade, thus enabling the implementation of this study. The Camp was conducted within the framework of the EU-funded SIMARINE-NATURA (LIFE10NAT/SI/141) project.

## 5. Povzetek

Več vrst ptic uporablja umetne strukture za skupinsko prenočevanje. Med 26. in 28. 6. 2012 smo na treh skupinskih prenočiščih na školjčiščih v zalivu Sv. Jerneja (Debeli rtič), Strunjanskem zalivu (Strunjan) in v Piranskem zalivu (Sečovlje) proučevali izbiro boj in čas jutranjega odhoda sredozemskega vranjeka *Phalacrocorax aristotelis desmarestii*. Skupaj smo zabeležili 3110 boj; razdelili smo jih na dve skupini (pokončne in ležeče) ter po barvah. Črne ležeče boje so bile dveh oblik (valjaste in ovalne). Vranjeki so izbirali samo ležeče boje, najpogosteje črne in bele. Pokončne boje so zaradi slabše stabilnosti in manjše stojne površine zanje neprimerne. Največji delež vranjekov glede na število boj posameznega tipa je bil zabeležen na črnih valjastih bojah. Odstotek zasedenih boj je bil na vseh prenočiščih podoben (36–39 %), zato sklepamo, da se vranjeki enakomerno razporejajo med posameznimi prenočišči, neodvisno od števila osebkov v slovenskem morju. Na večjem prenočišču pri Debelem rtiču je bil odstotek odraslih osebkov (73,5 %) večji kot na manjšem pri Strunjanu (42,5 %). To bi lahko bila posledica tekmovanja za boljša mesta, saj kompetitivno močnejši osebki izbirajo varnejša, večja prenočišča. Med 5.42 in 9.00 h je 53,3 % oziroma 69,1% vranjekov zapustilo prenočišče pri Debelem rtiču oziroma Strunjanu. Glavnina odhodov je bila zabeležena med 7.50 in 8.30 h. Vranjeki so prenočišče zapuščali v glavnem posamič (48,7 %) ali v parih (23,3 %); pri Debelem rtiču največ v JZ (58,9 %) in zahodni (16,9 %) smeri, prenočišče pri Strunjanu pa v SV (42,3 %) in severni (38,5 %) smeri.

## 6. References

Aguilar, J.S. & Fernández, G. (1999): Species Action Plan for the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* in Europe. Final Draft, December 1999. – BirdLife International on behalf of the European Commission.

Benussi, E. (2005): Shag *Phalacrocorax aristotelis* (Linnaeus, 1761). pp. 117–118 In: Guzzon, C., Tout, P. & Utmar, P. (eds.): Wintering waterbird censuses for the wetlands of the Friuli Venezia Giulia, NE Italy (1997–2004). – Associazione Studi Ornitologici e Ricerche Ecologiche del Friuli - Venezia Giulia (A.S.T.O.R.E. – FVG), "Centro Stampa" di A. Candito & F. Spanghero Snc, Monfalcone.

Birdlife international (2004): Birds in Europe: population estimates, trends and conservation status. – BirdLife Conservation Series No. 12. BirdLife International, Cambridge.

Božič, L. (2007): Rezultati januarskega štetja vodnih ptic leta 2007 v Sloveniji. – Acrocephalus 28 (132): 23–27.

Božič, L. (2008a): Rezultati januarskega štetja vodnih ptic leta 2008 v Sloveniji. – Acrocephalus 29 (136): 39–49.

Božič, L. (2008b): Rezultati januarskega štetja vodnih ptic leta 2009 v Sloveniji. – Acrocephalus 29 (138/139): 169–179.

Božič, L. (2010): Rezultati januarskega štetja vodnih ptic leta 2010 v Sloveniji. – Acrocephalus 31 (145/146): 131–141.

Božič, L. (2011): Rezultati januarskega štetja vodnih ptic leta 2011 v Sloveniji. Acrocephalus – 32 (148/149): 67–77.

Božič, L. (2012): Rezultati januarskega štetja vodnih ptic leta 2012 v Sloveniji. – Acrocephalus 32 (152/153): 109–119.

Cochran, W. G. (1954): Some methods for strenghtening the common $\chi^2$ tests. – Biometrics 10 (4): 417–451.

Cramp, S. (ed.) (1998): The complete birds of the western Palearctic on CD-ROM. – Oxford University Press, Oxford.

del Hoyo, j., Elliott, a. & Sargatal, j. eds. (1992): Handbook of the Birds of the World. Vol. 1. Ostrich to Ducks. – Lynx Editions, Barcelona.

Dimond, S. & Lazarus, J. (1974): The Problem of Vigilance in Animal Life. – Brain, Behavior and Evolution 9 (1): 60–79.

Geister, I. (1995): Ornitološki atlas Slovenije. – DZS, Ljubljana.

Gutzwiller, K.J. & Marcum, H.A. (1997): Bird Reactions to Observer Clothing Color: Implications for Distance-Sampling Techniques. – Journal of Wildlife Management 61 (3): 935–947.

Komisija za redkosti (1989): Seznam do sedaj ugotovljenih ptic Slovenije s pregledom redkih vrst. – Acrocephalus 10 (41/42): 75–80.

Komisija za redkosti (1993): Seznam redkih vrst ptic Slovenije 1990. – Acrocephalus 14 (58/59): 99–119.

Kushlan, J.A. (1977): The Significance of Plumage Colour in the Formation of Feeding Aggregations of Ciconiiforms. – Ibis 119 (3): 361–364.

Mantel, N & Haentszel, W. (1959): Statistical Aspects of the Analysis of Data From Retrospective Studies of Disease. – Journal of the National Cancer Institute 22 (4): 719–748.

McNaught, M.K. & Owens, I.P.F. (2002): Interspecific variation in plumage colour among birds: species recognition or light environment? – Journal of Evolutionary Biology 15 (4): 505–514.

Newton, I. (1998): Population limitation in birds. – Academic press, London.

Oro, D. & Martínez-Abraín, A. (2009): Ecology and behavior of seabirds. In: Duarte, C.M. & Lota, A. (eds.): Marine Ecology, Encyclopedia of Life Support Systems (EOLSS). – Eolss Publishers-UNESCO, Oxford.

Radović, D., Kralj, J., Tutiš, V., Radović, J. & Topić, R. (2005): Nacionalna ekološka mreža – važna područja za ptice u Hrvatskoj. – Državni zavod za zaštitu prirode, Zagreb.

Sovinc, A. (1993): Poročilo o redkih vrstah ptic za Slovenijo 1991. – Acrocephalus 14 (58/59): 120–123.

Sovinc, A. (1994): Zimski ornitološki atlas Slovenije. – Tehniška založba Slovenije, Ljubljana.

Sovnic, A. (1995): Redke vrste ptic v Sloveniji v letu 1992: Poročilo Komisije za redkosti. – Acrocephalus 16 (71): 113–116.

Škornik, I. (2012): Favnistični in ekološki pregled ptic Sečoveljskih solin. – SOLINE pridelava soli d.o.o., Seča.

Škornik, I., Miklavec , M., & Makovec, T. (1990): Favnistični pregled ptic slovenske obale. – Varstvo narave 16: 49–99.

Toomer, D.K. & Clark, N.A. (1992): The roosting behaviour of waders and wildfowl in Cardiff bay. BTO Research Report No. 89.

Wanless, S., Bacon, P.J., Harris, M.P., Webb, A.D., Greenstreet, S.P.R. & Webb, A. (1997): Modelling environmental and energetic effects on feeding performance and distribution of shags (*Phalacrocorax aristotelis*): integrating telemetry, geographical information systems, and modelling techniques. – Journal of Marine Science 54 (4): 524–544.

Ward, P. & Zahavi, A. (2008): The importance of certain assemblages of birds as "information-centers" for food-finding. – Ibis 115 (4): 517–534.

Velando, A. (2000): The importance of hatching date for dominance in young shags. – Animal Behaviour 60 (2): 181–185.

Vrezec, A. (2006): Tržaški zaliv – mednarodno morsko območje IBA / SPA? – Acrocephalus 27 (130/131): 117–119.

Arrived / Prispelo: 19. 7. 2012
Accepted / Sprejeto: 24. 2. 2014