FACULTY OF AGRICULTURE
UNIVERSITY OF BELGRADE
SERBIA

POLJOPRIVREDNI FAKULTET
UNIVERZITET U BEOGRADU
SRBIJA

INTERNATIONAL AQUATIC
VETERINARY BIOSECURITY
CONSORTIUM,
LUDWIG-MAXIMILIANS-UNIVERSITY
MUNICH, GERMANY

MEĐUNARODNI VETERINARSKI
KONZORCIJUM ZA BIOSIGURNOST
AKVATIČNIH ORGANIZAMA
LUDVIG-MAKSIMILIJAN UNIVERZITET
MINHEN, NEMAČKA

VIII INTERNATIONAL
CONFERENCE

VIII MEĐUNARODNA
KONFERENCIJA

WATER & FISH

CONFERENCE
PROCEEDINGS
June 13 - 15, 2018

ZBORNIK
RADOVA
13. - 15. Jun 2018.

UNIVERSITY OF BELGRADE, FACULTY OF AGRICULTURE - SERBIA
AND INTERNATIONAL AQUATIC VETERINARY BIOSECURITY CONSORTIUM, LUDWIG-MAXIMILIANS-UNIVERSITY MUNICH, GERMANY

SUPPORTED BY
EUROPEAN AQUACULTURE SOCIETY, EAS
AND
PAN-HELLENIC SOCIETY OF TECHNOLOGISTS ICHTHYOLOGISTS, (PASTI)

8th INTERNATIONAL CONFERENCE "WATER & FISH"

CONFERENCE PROCEEDINGS

Faculty of Agriculture, Belgrade-Zemun, Serbia
June, 13 – 15. 2018.

PUBLISHER
University of Belgrade - Faculty of Agriculture

FOR THE PUBLISHER:
Prof. Dr. Milica Petrović

COMPUTER DESIGN
GRAPHIC, Novi Sad

TECHNICAL PREPARATION OF A COVER
Dr. Božidar Rašković

TECHNICAL TEXT PREPARATION
Dr. Ivana Živić

PRINTED BY
GRAPHIC, Novi Sad

NUMBER OF COPIES PRINTED
400 COPIES

ORGANIZATION OF THE CONFERENCE SUPPORTED BY:
Ministry of Education, Science and Technological Development Republic of Serbia

GENERAL DONOR
DTD RIBARSTVO, Bački Jarak

UNIVERZITET U BEOGRADU, POLJOPRIVREDNI FAKULTET - SRBIJA
I MEĐUNARODNI VETERINARSKI KONZORCIJUM ZA
BIOSIGURNOST AKVATIČNIH ORGANIZAMA,
LUDVIG-MAKSIMILIJAN UNIVERZITETA U MINHENU, NEMAČKA

UZ PODRŠKU
EVROPSKOG DRUŠTVA ZA AKVAKULTURU - EAS
I
PAN-HELENSKOG DRUŠTVA TEHNOLOGA IHTIOLOGA - PASTI

VIII MEĐUNARODNA KONFERENCIJA ”VODA I RIBA”

ZBORNIK PREDAVANJA

Poljoprivredni fakultet, Beograd– Zemun, Srbija
13. – 15. jun, 2018. godine

IZDAVAČ
Univerzitet u Beogradu, Poljoprivredni fakultet

ZA IZDAVAČA:
Prof. dr Milica Petrović

GLAVNI I ODGOVORNI UREDNICI
Prof. dr Vesna Poleksić, Doc. dr Božidar Rašković i Prof. dr Zoran Marković

RAČUNARSKA OBRADA
GRAPHIC, Novi Sad

TEHNIČKO UREĐENJE KORICA
Dr Božidar Rašković

TEHNIČKA PRIPREMA TEKSTA
Dr Ivana Živić

ŠTAMPA
GRAPHIC, Novi Sad

TIRAŽ
400 primeraka

ODRŽAVANJE SKUPA POMOGLO:
Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije

GENERALNI DONATOR
DTD RIBARSTVO, Bački Jarak

DIET OF GREAT CORMORANT (*PHALACROCORAX CARBO)* IN THE „CARSKA BARA" SPECIAL NATURE RESERVE, WITH A PARTICULAR REFERENCE TO THE CARP (*CYPRINUS CARPIO*) SHARE

SKORIĆ STEFAN[1]*, ĐIKANOVIĆ VESNA[2]
[1]*Institute for Multidisciplinary Research, University of Belgrade, Kneza Višeslava 1a, 11 000 Belgrade, Serbia*
[2]*Institute for Biological Research «Siniša Stanković», University of Belgrade, Boulevard Despot Stefan 142, 11 060 Belgrade, Serbia*
**Corresponding author e-mail: stefan.skoric@imsi.rs*

ISHRANA VELIKOG KORMORANA (*PHALACROCORAX CARBO*) U SPECIJALNOM REZERVATU PRIRODE „CARSKA BARA", SA POSEBNIM OSVRTOM NA UDEO ŠARANA (*CYPRINUS CARPIO*) U ISHRANI

Apstrakt

Veliki kormoran se u potpunosti hrani ribom. Dnevna količina hrane koju veliki kormoran pojede kreće se između 425-700 grama, odnosno u proseku od 15 do 17 % svoje telesne težine. Opsežnija istraživanja ishrane velikih kormorana u Srbiji nisu vršena. Jedini podaci o ishrani kormorana i drugih ihtiofagnih vrsta ptica kod nas odnose se na štete koje one nanose proizvodnji ribe na ribnjacima. Podaci o ishrani kormorana van ribnjaka odnose se na ishranu tokom sezone gnežđenja u koloniji u Kopačkom ritu i zimsku ishranu na akumulaciji Gruža. Analiza ishrane velikog kormorana i značaj šarana u njegovoj ishrani rađena je na području Specijalnog rezervata prirode „Carska bara". U periodu od 2007 do 2010 godine prikupljane su gvalice za analizu ishrane velikog kormorana. Gvalice su prikupljane u dve sezone: sezona gnežđenja (mart-jun) i jesenje-zimskom periodu (oktobar-februar). Prikupljane su na mestima gde se ptice odmaraju i u samom mestu gnežđenja. Analiza gvalica je najčešće korišćen metod analize ishrane kod kormorana. U periodu oktobar–februar, 2007 – 2010. godine prikupljeno je 507 gvalica iz kojih su identifikovani ostaci 2433 jedinke od 16 različitih vrsta riba, od kojih je 9 vrsta bilo iz familije Cyprinidae, zatim tri vrste iz familije Percidae i po jedna vrsta iz familija Gadidae, Esocidae, Ictaluridae i Gobiidae. Ostaci šarana identifikovani su u 184 gvalice (36,29%). Šaran je u ovom periodu bio zastupljen sa 18,10%, u pogledu brojnosti. Po masenom udelu u plenu najznačajnija je vrsta, sa učešćem od 36,24%.

Tokom sezona gnežđenja od 2007. do 2010. godine prikupljeno je 80 gvalica. U plenu, identifikovanom iz gvalica, po brojnosti su dominirale dve vrste, babuška i šaran, a registrovano je prisustvo 11 vrsta riba iz 5 familija (6 Ciprinidae, 1 Ictaluridae, 1 Esocidae, 2 Percidae,1 Gobiidae). Ostaci šarana su registrovani u 44 (55%) gvalica. Šaranske vrste riba su još značajnije zastupljene u ishrani kormorana tokom sezone gnežđenja nego u jesenjem i zimskom periodu. Tako, one čine 85% ukupnog broja ulovljenih jedinki, a udeo u biomasi plena je oko 90%. Rezultati istraživanja ishrane velikih kormorana na području Carske bare u skladu su sa mnogim studijama sprovedenim širom Evrope.

Ključne reči: *ishrane, veliki kormoran, šaran, ribnjak, Carska bara.*
Keywords: *nutrition, great cormorant, carp, fishpond, Carska bara.*

INTRODUCTION

The great cormorant is completely feed by the fish. The daily amount of food eaten by the great cormorant ranges between 425-700 grams, or an average of 15 to 17% of its body weight (Van Doben, 1952). The rapid increase in the number of cormorants across Europe has led to dissatisfaction among fish and fish farmers due to the losses caused by birds. This has led to many studies in many European countries over the last 20 years, with the aim of determining the daily intake of food, composition and size of prey, and so on (Sutter, 1997; Leopold et al., 1998; Keller and Wisser, 1999; Grémillet et al., 2003; Gwiazda, 2004; Santoul et al., 2004; Opačak et al., 2004).

Carp is the main species in fish production in Serbia with a share of over 85% in carp fishponds, accounting for around 80% of total production (Marković and Poleksić, 2011). Since these ponds are mainly located in Vojvodina, near the lowland rivers, they represent the ideal feeding base for ichthyophagous birds.

Extensive research of the great cormorants diet in Serbia has not been carried out. The only data on nutrition of cormorants and other ichthyophagous bird species in our country relate to the damage they cause on the production of fish on fish farms (Pihler et al., 2000). Also, in the former SFR Yugoslavia, data on nutrition of cormorans are mainly related to fishponds (Đorđević and Mikuška, 1986; Mikuška, 1986), while the data on nutrition of cormorants outside the fishpond is relate to feed during the breeding season in the colony in Kopački rit (Mikuška, 1983) and winter food on the accumulation of Gruža (Skorić, 2013/14).

The aim of this paper is point to the significance of the carp in the diet of great cormorant in Serbia.

MATERIALS AND METHODS

The analysis of the great cormorant's diet and the importance of the carp in its diet was made in the area of the special nature reserve «Carska bara». Cormorants have wide activities area, and within it, along the water areas within the reserve (Stari Begej, Carska bara) there are the rivers Tisa and Begej, and above all, the lake of the Ečka fishing farm, which represent the largest aquatic areas in this area and are of particular importance to wading birds.

In the period from 2007 to 2010, pellets were collected for analyzing the nutrition of great cormorants. The pellets were collected in two seasons: breeding season (March-June) and autumn-winter period (October-February). They are collected at places where birds rest

in the nest itself. Pellet analysis is the most commonly used method of nutrition analysis in cormorants.

Only fresh and complete pellets were collected, which were then placed individually in plastic bags and freezed at -20ºC. The bone structure of the collected pellets used to identify the carp is the otolith, the gallbladder and the keratinous structures on the basicocipital bone - the so-called «Chewing pads». These structures are separated and measured. The number of individuals present in the pellets is defined as the largest number of fish residues identified. To make a reference collection, a carp from aquatic habitats of the investigated area was sampled. Measure is the total length (TL: length from the tip of the mouth to the end of the tail fin) and weight, on a technical scale of precision of 0.1 g. The fish were then cooked for several minutes, and the length of bones separated for identification were measured. Regression equations have correlations between the total length of the reference fish body (TL) and the length of bitter teeth or otolith, and only those values with high degree of correlation ($r > 0.95$) were taken into account. The weight estimate was made according to the exponential equation of the mass and body length ratio: $W = a \times TL^b$

On the basis of the obtained values, the correlations between the length of the body and bitter teeth or otolites are the estimates of the length and weight of the fish whose residues are identified in pellets.

RESULTS AND DISCUSSION

In the period from October to February 2007 - 2010, 507 pellets were collected, from which 2433 specimens of 16 different fish species were identified, of which 9 species were from the Cyprinidae family (*Cyprinus carpio*, *Carassius gibelio*, *Abramis brama*, *Blicca bjoerkna*, *Scardinius erythrophthalmus*, *Rutilus rutilus*, *Leuciscus idus, Chondrostoma nasus*, *Aspius aspius*), then three species from the Percidae family (*Perca fluviatilis*, *Gymnocephalus* sp., *Sander lucioperca*) and one species from the families Gadidae (*Lota lota*), Esocidae (*Esox lucius*), Ictaluridae (*Ameiurus melas*) and Gobiidae (*Neogobius* sp.). The average length of prey was 17.12 cm and ranged from 3.7 cm (*Neogobius* sp.) to 37.3 cm (*Sander lucioperca*); the average weight was 86.17 g in the range of 0.46 g (*Neogobius* sp.) to 582 g (*Abramis brama*). The remains of carp were identified in 184 pellets (36.29%). The most numerous prey in the autumn-winter period is prussian carp (24.62%), followed by Eurasian ruffe and carp (18.50% and 18.10%). By weight in the prey, the most important species is carp (36.24%). The average length of the carp in the winter period was 223.22 mm and ranged from 89.96 mm to 338.89 mm; and the average weight was 179.29 g and ranged from 10.98 g to 578.92 g.

During the breeding season in the period 2007-2010, 80 pellets were collected. In the prey identified from pellets, two species were dominant - prusian carp and carp, and also 11 fish species from five families - 6 Ciprinidae (*Cyprinus carpio, Carassius gibelio, Abramis brama*, *Blicca bjoerkna*, *Rutilus rutilus*, *Scardinius erythrophthalmus*), 2 Percidae (*Perca fluviatils*, *Gymnocephalus* sp.), 1 Ictaluridae (*Ameiurus melas*), 1 Esocidae (*Esox lucius*), 1 Gobiidae (*Neogobius* sp.) were recorded. The average length of prey was 17.53 cm and ranged from 6.3 cm (*Carassius gibelio*) to 43.5 cm (*Esox lucius*); the average weight was 94.77 g and ranged from 1.45 g (*Carassius gibelio*) to 625 g (*Cyprinus carpio*). The remains of carp are registered in 44 (55%) pellets. Carp fish species are even more important in feeding cormorants during the breeding season than in autumn and winter periods. Thus, they account for 85% of the total number of caught individuals, while the share of prey biomass

is about 90%. Prussian carp and carp are the most important species in the diet during the breeding season with a share of 40.26% and 37.26% in number and 29.41% and 55.33% in biomass, respectively. The length of the carp during the breeding season is 232.7 mm, and ranged from 105.92 mm to 347.72 mm, while the average weight was 208.12 g and ranged from 17.9 g to 625.19 g. Average length and weight of carp as a prey of great cormorant in different seasons in the period from 2007 to 2010 is presented in Table 1.

Table 1. Average length and weight of carp in different seasons in the period from 2007 to 2010

Year	Season	Number of ind.	Average prey length (mm)			Average prey weigth (g)		
			Mean value ± SD	Min	Max	Mean value ± SD	Min	Max
2007	breeding							
	winter	6	241.71±30.19	206.78	294.74	219.19±87.19	132.22	381.43
2008	breeding	56	218.67±47.03	105.92	347.72	177.32±111.74	17.9	625.19
	winter	99	208.75±49.51	86.96	338.89	158.25±103.04	10.98	578.92
2009	breeding	14	260.76±31.06	223.43	315.46	275.05±101.52	166.64	467.3
	winter	227	222.79±34.16	117.13	312.4	176.69±79	24.18	453.9
2010	breeding	21	251.4±28.17	209.16	318.86	245.65±84.44	136.82	482.5
	winter	107	236.5±20.62	187.77	297.46	202±54.72	99.09	392.04

Statistically significant differences were found between the length and weight of the carp as the prey of cormorants between different seasons (autumn-winter and breeding season) (t-test, $p < 0.05$) (Figure 1).

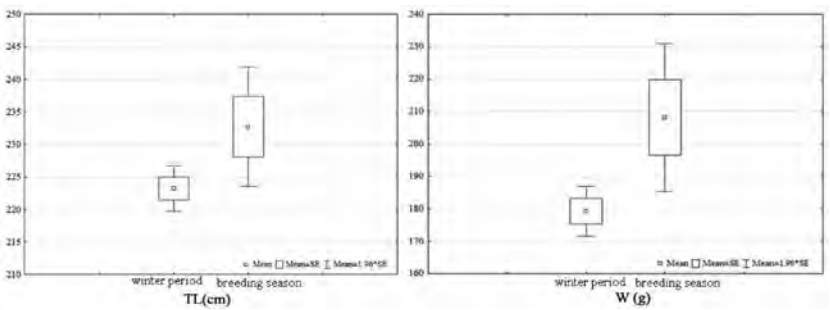

Figure 1. Differences between the length and weigth of the carp in different season

Many studies on the nutrition of great cormorants used pellet analysis. In a short time and with a minimal disturbance of birds, a large sample can be collected (Duffy and Jackson, 1986). Basically, this analysis provides good information on the qualitative composition of the diet content (percentage representation of species) (Warke and Day, 1995), and a number of authors (Dirksen et al., 1995; Keller, 1995, Engstrom, 2001; Gwiazda, 2004; Santoul et al., 2004) calculates the length of the fish (and therefore the weight) based on the residues from the pellets, and estimates the total fish weight per pellet considering as the daily intake of food. Cormorant diet depends on the type of aquatic ecosystems that birds inhabit, as well as the seasons (Kirby et al., 1996). Also, the probability of catching a larger prey is more frequent in winter, since the lower water temperature reduces the speed of fish swimming. Although many fish species are involved in the diet spectrum of cormorants,

only a few of them are dominant in its diet. The carp dominates in the cormorant diet in areas where colonies were located near the pond, while the share of fish from the open waters is smaller. These examples are found in several areas of Poland (Mellin et al., 1997; Gwiazda, 2004), France (Trolliet, 2002), Croatia (Opačak et al., 2004; Đorđević and Mikuška, 1986; Mikuška, 1986).

The results of the great cormorants diet in the Carska bara region are in accordance with the mentioned studies, relative to Prussian carp and carp, making the most significant prey in both quantity and biomass. Cormoran is opportunistic and feeds on the most numerous and available prey (Grémillet et al., 2001), which are definitely Prussian carp and carp. This is especially the case during the breeding period when the share of these species in the diet is about 80%. Also, as in many studies conducted throughout Europe (Keller, 1995; Gwiazda, 2004; Santoul et al., 2004; Čech and Vejřik, 2011), the share of carp species in cormorant diet in our research was between 50 and 90%.

A great cormorant catches a prey of a wide range of body size. In studies carried out in many European countries, the results show that the prey length ranges from 2 to 3 cm, up to 70 cm and weight from less than 1 g to 900 g (Keller, 1995; Sutter, 1997). The most frequently hunted prey is in the range of 10 to 25 cm (Martyniak et al., 1997; Gwiazda, 2004; Opačak et al., 2004; Santoul et al., 2004). The range of the prey length, as well as the average values of the prey length, measured in our study are in compliance with the results of above research. The average size of carp in this study is larger than in the studies carried out by Adámek (1991) where the most frequently caught specimens were 13 to 17 cm, Mellin et al. (1997) from 8 to 10.9 cm and Opačak et al. (2004) from 10 to 15 cm. According to Schreckenbach et al. (1998), when carp are larger than 600 g it is «safe from cormorants», which was confirmed by this study. Only one individual had weight over this value (625 g).

ACKNOWLEDGEMENTS

This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Project No. 173045 and 37009.

REFERENCES

Adámek, Z. (1991): Food biology of great cormorant (*Phalacrocorax carbo* L.) on the Nové Mlýny reservoirs. Bull. VÚRH JU Vodňany 27: 105-111.

Čech, M., Vejřík, V. (2011): Winter diet of great cormorant (*Phalacrocorax carbo*) on the River Vltava: estimate of size and species composition and potential for fish stock losses. Folia Zoologica, 60 (2): 129-142.

Dirksen, S., Boudewijn, T.J., Noordhuis, R., Marteijn, E. (1995): Cormorants *Phalacrocorax carbo sinensis* in shallow eutrophic freshwaterlakes: prey and effect of large – scale fish removal. Ardea, 83(1): 167-184.

Duffy, D.C., Jackson, S. (1986): Diet studies of seabirds: a review of methods. Colonial Waterbirds 9: 1-17.

Đorđević, V., Mikuška, J. (1896): Utjecaj velikog vranca (kormorana) *Phalacrocorax carbo* L. na uzgoj ribe u ribnjacima PIK «Belje». Ribarstvo Jugoslavije, 1-2: 74-76.

Engstrom, H. (2001): Long term effects of cormorant predation on fish communities and fishery in a freshwater lake. Ecography, 24: 127-138.

Grémillet, D., Wanless, S., Carss, D.N., Linton, D., Harris, M.P., Speakman, J.R., Le Maho, Y. (2001): Foraging energetics of arctic cormorants and the evolution of diving birds. - Ecology Letters, 4: 180 – 184.

Grémillet, D., Wright, G., Lauders, A., Carss, D. & Wanless, S. (2003): Modelling the daily food requirements of wintering great cormorant: a bioenergetics tool for wildlife management. – Journal of Applied Ecology, 40: 266-277.

Gwiazda R. (2004): Fish in diet of the great cormorant and yellow-legged gull breeding near fish ponds (upper Vistuala river valley, southern Poland) – preliminary study. Acta zoologica cracoviensia, 47: 17-26.

Keller, M.T., Wisser, G.H. (1999): Daily energy expenditure of Great Cormorants *Phalacrocorax carbo sinensis* wintering at lake Chiemsee, Southern Germany. Ardea, 87(1): 61-69.

Keller, T. (1995): Food of cormorants *Phalacrocorax carbo sinensis* wintering in Bavaria, Southern Germany. Ardea, 83(1): 185-192.

Kirby, J.S., Holmes, J.S., Sellers, R.M. (1996): Cormorants *Phalacrocorax carbo* as fish predators: an appraisal of their conservationand management in Great Britain. Biological Conservation, 75: 191-199.

Leopold, M.F., van Damme, C.J.G., van der Veer, H.W. (1998): Diet of cormorants and the impact of cormorant predation on juvenile flatfish in the Dutch Wadden Sea. Journal of Sea Research, 40: 93-107.

Marković, Z., Poleksić, V. (2011): Aquaculture anfd fisheries in Serbia. Belgrade. 289 pp.

Martyniak, A., Mellin, M., Stachowiak, P., Wittke, A. (1997): Food composition of cormorants *Phalacrocorax carbo* in two colonies in north-eastern Poland. Ekologia Polska, 45(1): 245.

Mellin, M., Mirowska-Ibron, I., Martyniak, A. (1997): Food composition of cormorants *Phalacrocorax carbo* shot at two fish farms in north-eastern Poland. Ekologia Polska, 45(1): 247.

Mikuška, J. (1983): Prilog poznavanju ishrane vranca velikog, *Phalacrocorax carbo* (L., 1758) u specijalnom zoološkom rezervatu Kopačevski rit. Larus, 33-35: 31-36.

Mikuška, J. (1986): Prilog poznavanju ishrane velikog kormorana, *Phalacrocorax carbo* L. (1758), na ribnjacima Slavonije i Baranje. Ribarstvo Jugoslavije, 1-2: 24-26.

Opačak, A., Florjančić, T., Horvat, D., Ozimec, S., Bodakoš, D. (2004). Diet spectrum of great cormorant (*Phalacrocorax carbo sinensis* L.) at Donji Miholjac carp fishpond in eastern Croatia. European Journal of Wildlife Research, 50: 173-178.

Pihler, I., Popović, E., Ćirković, M. (2000): Štete koje ribnjacima nanose ihtiofagne ptice. Savremeno ribarstvo Jugoslavije (monografija), Beograd - Novi Sad, 118-126.

Santoul, F., Hougas, J-B., Green, A., Mastrorillo, S. (2004): Diet of great cormorant *Phalacrocorax carbo sinensis* wintering in Malause (South – West France). Arch. Hydrobiol., 160: 281-287.

Schreckenbach, K., Dersinske, E., Schulz, A. (1998): Utjecaj kormorana na šarane u nezaštićenim ribnjacima i u ribnjacima zaštićenim mrežama. Ribarstvo, 56: 65-81.

Skorić, S. (2013/14): Winer diet of great cormorant Phalacrocorax carbo on Gruža reservoir. Ciconia, 22/23: 48-51.

Sutter, W. (1997): Roach rules: shoaling fish are a constaint factor in the diet of cormorant *Phalacrocorax carbo* in Switzerland. Ardea, 85: 9-26.

Trolliet, B. (2002): Cormorant and extensive fish-farming in France. [In:] Der Kormoran (*Phalacrocorax carbo*) im Spannungsfeld zwischen Naturschutz und Teichbewirtschaftung, 1 (Publisher: Sächsische Landesstiftung Natur und Umwelt Akademie, Dresden, Germany), 60-67.

Van Doben, W.H. (1952): The food of cormorant in Netherlands. Ardea 40, 1-63.

Warke, G.M.A., Day, K.R. (1995): Changes in abundance of cyprinid and percid prey afftect rate of predation by cormorant *Phalacrocorax carbo carbo* on salmon *Salmo salar* smolt in northern Ireland. Ardea, 83(1): 157-166.