

Historical changes of biodiversity in Baikal Siberia and dynamics of nest settlements of the Great Cormorant (*Phalacrocorax carbo* L., 1758) in the first quarter of the XXI century

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Abstract. The article presents the history of nesting, disappearance from the fauna and the current spatial distribution of Great Cormorant (*Phalacrocorax carbo* L., 1758) breeding colonies in Baikal Siberia. The main research sites were the Selenga River Delta, Strait of the Maloye More and islands of the Chivyrkuy Bay, Upper Angara Bay on Baikal Lake; the Upper Angara and Barguzin hollows, Gusinoe Lake in the Pribaikalye and Transbaikalye, where this species once lived according to well-known literary sources in the XVII to the middle of the XX centuries. Direct accounting of newly nesting birds after a 50-year absence in known colonies with young birds that flew out by autumn, as well a non-breeding birds, allowed us to estimate the total number of cormorants in 2021 on Baikal Lake. It amounted to 39-40 thousand birds, which indicates the settlement of the species in the Baikal Lake ecosystem and population stabilization in accordance with the environmental ecological capacity.

1 Introduction

At present, over the greater territory of Baikal Siberia the Great Cormorant (*Ph. carbo*) is a migratory nesting species, which has restored its former range in the Russian part of Baikal Lake literally over the past 20 years. Baikal Siberia is Baikal region, the Baikal Lake basin is understood as a transboundary territory between the Russian Federation and Mongolia, while within the Russian part it is actually Baikal Lake and the constituent entities of the Russian Federation - the Buryat Republic (73% of the total territory), Zabaikalsky Kray (21 %) and Irkutsk region (6%).

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In the first editions of the Red Data Books of the Baikal Region (Irkutsk Oblast, the Buryat Republic, and Zabaikalsky Krai), the Great Cormorant (*Ph. carbo*) belonged to the extinct [1, 2] or rare [3] species. And in the subsequent ones it was assigned either to the recovered (V category) [4], or completely excluded from the list of the "Red Data Book" [5-7]. In the Mongolian part, the situation was and remains relatively stable: nesting was noted in the water bodies of the Bol'shoy Khangai ridge (between the Tamir and Orkhon rivers, Ugiy Lake), the Tarbagatay and Bolnay ridges (Telmen, Sangiin-Dalai, Terhiin-Tsagaan Lakes), (the Shishgad River valley, Dood-Tsagaan Lake), on Khovsgol Lake, reservoirs in the middle mountains of the Selenga and Orkhon basins [8].

Due to this, taking into account the history of the stay of this species in the region and the problem of preserving the biodiversity of Baikal Siberia, it is important to organize monitoring of the number of the restored species and its probabilistic regulation.

2 Results and discussion

The history of the Baikal cormorant population is quite dramatic. In the second half of the 19th century, the species was widespread throughout Eastern Siberia, especially on Baikal Lake which is one of the largest inland water bodies in the south of Eastern Siberia. So, Gustav Radde, traveling on Baikal Lake in 1857, noted thousands of flocks on Baikal Lake, in the Barguzin and Selenga rivers deltas [9], the same situation was described by B. (I.) Dybowski and V. (A.) Godlevsky [10]. However, already at the end of the XIX - beginning of the XX centuries its number began to decline [11-15], and in the early 1970s it disappeared on Baikal Lake and only rare flights of these birds were recorded [16-23]. The last cormorant colony was found at the end of 1957 by O. K. Gusev [13], and in the summer of 1969 there were no more birds here; the last nest in Chivyrkuisky Bay was found in 1967 [14, 20], on the western shore of the lake, in particular on Kobyl'ya Golova Cape and in the vicinity of the village Tashkai - in 1962 and 1964 respectively [21]. After that, despite rather intensive ornithological studies, until the beginning of the 21st century, only rare migratory birds were recorded on Baikal [22].

The disappearance of cormorants happened so rapidly that the biology and ecology of this species on Baikal Lake remained practically unexplored, only fragmentary information about the dates of arrival, the nature of nesting and the approximate number remained. Due to the high number and commonness of the cormorant, no one "was in a hurry" with the study of its ecology and counting the number [24]. Apparently, it was one of the background species on the Baikal Lake coast, as evidenced by the numerous preserved geographical names (capes, islands: Baklaniy Cape, Bolshoy (Maly) Baklaniy Kameshek, etc.). In Southwestern Transbaikalia, the only Cormorants colony, which existed until the 40s of the XX century, was located in a mixed forest on the northwestern shore of Gusinoe Lake at the mouth of the Akhur river [25]. All the stuffed animals and carcasses of this species, which are in the Academician V.A. Obruchev's Kyakhta museum of local lore belong to the beginning of the XIX century and were found at Baikal, Gusinoe Lakes, along the Chikoy river [26].

Since the end of the 70s of the XX century, cormorants again began to appear on Baikal Lake and in Transbaikalia. So, in the summer of 1977, V.G. Egorov [27] met one individual on the Maly Arangatuy Lake. From 1979 to 1986 cormorants in the colonies of herring gulls were observed annually on the islands of the Maloye More by S. V. Pyzh'yanov [28], at the beginning of June 1979 - in the south of Baikal Lake by V. Razvozhayev, 14 / V 1984 - at the mouth of the Goloustnaya river [29]. In 1983, there were especially many meetings [21]. Migrating cormorants were also found at the "Priboy" tourist center in 1972 [30], in the Selenga river delta from 1979 to 1994, on northern Baikal in 1982, 1987, 1991 [22], at Muzhinay Cape in 1979, at Krestovy Cape in 1985, in Pokoinaya Bay in 1994 [21, 31]. We

saw migratory birds on Arangatuy Lake in early June 1995, in the vicinity of the Kiran village (Kyakhtinsky district) 2 / V 1998 [32].

Thus, from the end of the 70s-beginning of the 80s to the end of the 90s of the last century, cormorants with different frequencies began to occur in Baikal Siberia. Solitary birds and small flocks were recorded in different areas of Baikal Lake and in southern Transbaikalia [21, 22, 32, 33]. The only nesting place for cormorants in the south of Eastern Siberia and Northern Mongolia at that time were the Torey Basin Lakes in Southeastern Transbaikalia and Khovsgol Lake [34-39].

Currently, the number of the Great Cormorant on Baikal Lake is recovering, and the rapid pace of natural reintroduction of this species is due to its mass relocation from other regions [40-48]. The settlement of the Baikal Lake islands and capes is so rapid that the situation changes annually, since 2006/08 until now (Figure 1).

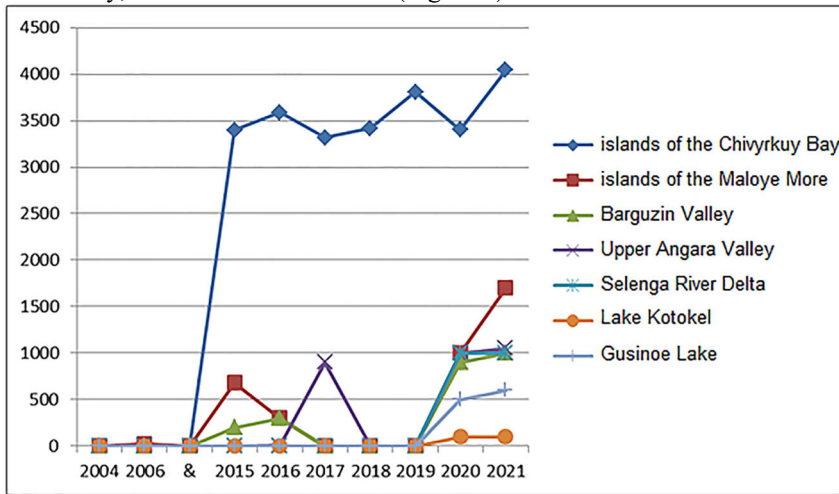


Fig. 1. The total dynamics of the number of nesting cormorants on the Baikal Lake and Transbaikalia within the Buryat Republic in the first quarter of the XXI century.

So, according to the accounts of 2006-2007 [24] the number of cormorant nests on Khubyn Island was 26, and in 2015 - 450-500 nests; on Edor Island in 2007 - 15, and in 2015 - already 180 nests. Other islands gradually were settled as well: Isohoy - 155 cormorant nests (2015); Ugungoy (522 and 116 nests).

Cormorant also inhabited the Olkhon Island capes, where its number today is about 300 nests. In 2021, close to Olkhon, in the Maloye More area, 21 cormorant settlements were recorded (the average number of nests in the colony was 85; Lim 10-230), in which, according to the most general counts, there were 1700-1800 inhabited nests.

In general, on the Maloye More islands after a natural outbreak at the beginning of the secondary expansion, the number of birds in this area of Baikal Lake has stabilized, which indicates that the species is “embedded” into the ecosystem of the lake, and its abundance comes in line with the ecological capacity of the environment (Figure 2).

In Chivyrkuisky Bay, the number of nesting birds in 2015-2017 stabilized at 3200–3500 pairs. The non-breeding part of the group (young immature birds and adults that did not start nesting for various reasons) amounted to at least 2000–3000 individuals [45-47]. On numerous channels and lakes in the Upper Angara river valley has about 10 collective overnight sites with a population of 150 to 500 individuals. In the summer of 2017, the Upper Angara group of the Great Cormorant numbered at least 5,000 individuals [47]; in 2021, the abundance of the species remained at approximately the same level [49] (Figure 3).



Fig. 2. The "Malomorsk" population of the Great Cormorant nesting colonies (photo by S.V. Pyzhyanov; May-June, 2021).



Fig. 3. Cormorants colonies in the Chivyrkuisky Bay of Baikal Lake (Goly Island; photo by E.N. Elaev; June 10, 2021).

In the Barguzin river valley cormorants began to be seen in 2008. In 2013, on low, crooked islands in the middle part of the Barguzin river valley, the first nesting colonies of the species located on the ground were recorded. Cormorants along the Barguzin river are also found on floodplain channels and lakes. According to the Environmental Management Supervision Service (Republican Service for the protection, control and supervision of the wildlife objects in the field of nature management) and survey data in 2015-2016, in the Barguzin river valley, the number of the species reached 3000-3700 individuals, there were nesting colonies on the channels in the Barguzin Valley middle part, including up to 200-300 nests. The colonies are concentrated on the Borogol, Ina, Barguzin, Bystraya and Argada rivers. In the spring-autumn period, the main places of concentration of overnight cormorants are located on the Nizhny Kuytun lakes: Sagan-Nur, Baragkhan and Kharamodun lakes.

Since 2012, the cormorant began to appear in the Barguzin river upper reaches in the areas of Balan-Tamur, Churikto, Yakondykon lakes in groups of 10-20 individuals, but no colonies were recorded [47].

On Gusinoe Lake in southwestern Transbaikalia, where a cormorant once lived, in a larch forest on the northwestern shore of the lake not far from the former colony at the mouth of the Akhur river a mixed colony of about 250-300 cormorant nests and about 50 grey herons (*Ardea cinerea*) was found.

Thus, the Great Cormorant not only began to nest again on Baikal Lake and in its basin, but, as is usually the case, at the initial stages of expansion (especially the secondary one), it increased its numbers almost everywhere in the Baikal Lake basin Russian part. Against this background (as an example), on the Khovsgol Lake in Mongolia, since there was and remains a stable food base (and this is mainly shallow-water fish), the species has not disappeared and here its number remains relatively stable.

3 Conclusion

Considering the range of a species with different subspecies (see Figure 4), with additions by L.S. Stepanyan [50], E.A. Koblik and others [51], we can conclude the following.

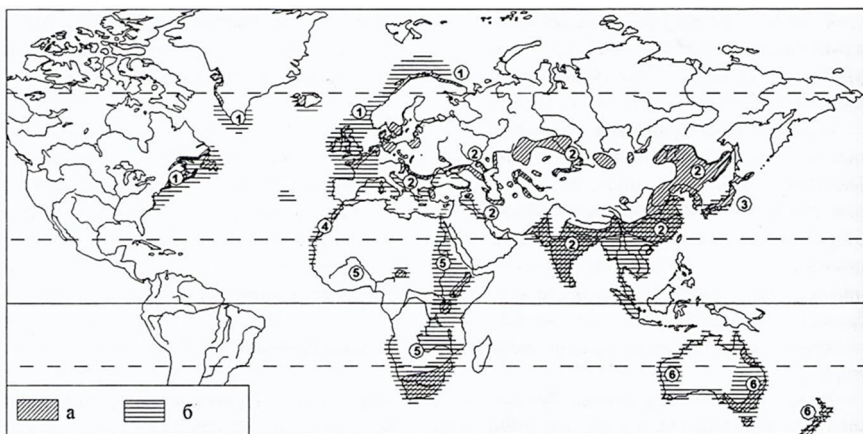


Fig. 4. Area of distribution of the Great Cormorant: a - nesting area, b - wintering area. Subspecies: 1 - *Phalacrocorax c. carbo*, 2 - *Ph. c. sinensis*, 3 - *Ph. c. hanedae*, 4 - *Ph. c. maroccanus*, 5 - *Ph. c. lucidus*, 6 - *Ph. c. novaehollandiae* (cited: A.E. Lugovoy [52]; p. 56).

Inhabited within Central Asia the subspecies *Ph. c. sinensis* on the northern border of its range is subject to various kinds of invasions (periodic or non-periodic), fluctuations in abundance, like any other peripheral species [53]. Changed due to natural historical (cyclical) processes (in relation to the cormorant "moisture - drought", as well as forest - steppe), as well as habitat on the border of the range, including ecotonic (transitional) territories [54, 55], "forces" the species to explore new territories. Since at the end of the 20th century, taking into account these natural processes, the cormorant habitats closest to Baikal Siberia, namely Khovsgol Lake (Mongolia) and Torey lakes in the south of Zabaikalsky Krai (Russia), have undergone various hydrological changes, the species "found" both a good food base and convenient (former) nesting sites, thereby occupying its own (once lost) ecological niche.

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References

1. A. I. Plotnikov et al., *Red Book of rare and endangered species of Animals and Plants in Buryat Autonomous Soviet Socialist Republic* (Buryat book house, Ulan-Ude, 1988)
2. Ts. Z. Dorzhiev, E. N. Yelayev, *Red Book of Buryatia: Rare and vanishing species of Animals. Birds 2nd edn* (Publishing house «Informpolis», Ulan-Ude, 2005)
3. A. M. Vozmilov et al., *Red Book of the Chita district and Aginsk Buryat Autonomous Area (Animals)* (Poisk, Chita, 2000)
4. O. Yu. Gaikova, V. V. Popov, *Red Book of Irkutsk district* (Time of wanderings, Irkutsk, 2010)
5. E. V. Vishnyakov et al., *Red Book of Transbaikalia: Animals* (Novosibirsk Publishing House, Novosibirsk, 2012)
6. N. M. Pronin, *Red Book of Buryat Republic: Rare and endangered species of Animals, Plants and Mushrooms 3rd edn* (Publishing house of Buryat Scientific Centre of SB RAS, Ulan-Ude, 2013)
7. S. M. Trofimova, V. V. Popov, *Red Book of Irkutsk district* (Republican printing house, Irkutsk-Ulan-Ude, 2020)
8. B. M. Zvonov, S. A. Bukreev, Sh. Boldbaatar, *Birds of Mongolia. Non-Passeriformes part I* (Agricultural technologies, Moscow, 2016)
9. G. Radde, *Reisen im Süden von Ost-Sibirien in den Haren 1855-1859 Die Festkand-Ornis des Südöstlichen Sibiriens* **11**, 392 (1863)
10. B. I. Dybowsky, V. A. Godlevsky, *Preliminary report on faunal studies on Baikal Lake Report on the Actions of the Sib. Br. Imper. Russ. Geogr. Societies for 1869 (appendix)* (St. Petersburg, 1870), pp. 167-204
11. S. S. Turov, *Materials on the birds fauna in the Barguzin region Coll. of works of the Irkutsk State University professors and teachers* **4** 132-169 (1923)
12. B. K. Shtegman, *Birds of Northern Baikal Ornithology* **84(1)**, 58-139 (1936)
13. O. K. Gusev, *About nesting birds on the Chivyrkuysky Bay and Arangatuy Lake islands Works of East-Sib. BR AS USSR* **23**, 69-88 (1960)
14. O. K. Gusev, *Great Cormorant on Baikal Lake Hunting and hunting household* **3**, 14-17 (1980)
15. T. N. Gagina, *Birds of Eastern Siberia (list and distribution) Works of Barguzinsky Reserve* **3**, 99-123 (1961)
16. N. I. Litvinov, *Fauna of the Baikal Islands (terrestrial vertebrates)* (Publishing House of the Irkutsk State University, Irkutsk, 1982)
17. V. G. Egorov, V. N. Prokop'yev, A. V. Nekrasov, *Conf by waterfowl birds* (Moscow, 1984)
18. Ts. Z. Dorzhiev et al, *They need protection* (Buryat publishing house, Ulan-Ude, 1985)
19. Ts. Z. Dorzhiev, G. M. Khabaeva, B. O. Yumov, *The animal world of Buryatia (Composition and distribution of terrestrial vertebrates)* (Irkutsk, 1986)
20. A. A. Vasil'chenko, V. N. Prokop'yev, *Great Cormorant Red Book of the Buryat ASSR* (Buryat Publishing house, Ulan-Ude, 1988), 63-65

21. V. V. Popov, *Great Cormorant Rare Animals of the Irkutsk region Terrestrial vertebrates* (Irkutsk, 1993), 78-80
22. S. V. Pyzhyanov, I. I. Tupitzin, N. N. Safronov, *J. Express Issue* **31**, 16-18 (1997)
23. V. E. Yesheev, E. N. Yelayev, *Great Cormorant Red Book of the Buryat Republic: Rare and endangered species of Animals 2nd edn, ed Ts Z Dorzhiev and E N Yelayev* (Ulan-Ude: Publishing house "Informopolis", 2005), 72-74
24. S. V. Pyzh'yanov, M. S. Pyzh'yanova, I. I. Tupitzin, *The problem of protection of the Great Cormorant on Baikal Lake in the light of the natural dynamics of its range Proceedings of the Samara Scientific Center of the Russian Academy of Sciences* **18(2)**, 182-185 (2016)
25. I. V. Izmaylov, G. K. Borovitskaya, *Birds of South-Western Transbaikalia* (Vladimir, 1973)
26. Ts. Z. Dorzhiev et al, *Catalogue of bird collections of the Kyakhta Museum of Local Lore* (Ulan-Ude, 1990)
27. V. G. Egorov, *On the state of aquatic and near-water birds of the Chivyrkuy Bay (Baikal) Ecology and protection of birds and mammals of Transbaikalia* (BF SB AS USSR, Ulan-Ude, 1980), 31-37
28. S. V. Pyzh'yanov, I. I. Tupitzin, N. N. Safronov, *New in the avifauna of the Baikal coast Works Baikal-Lena State Nature Reserve* **1**, 99-102 (1998)
29. Yu. V. Bogorodsky, *Birds of the Southern Baikal Region* (Irkutsk: Publishing House of the Irkutsk State University, 1989)
30. A. P. Shkatulova, *Ciconiiformes, Pelecaniformes and Laridae in the Buryat ASSR Fauna and resources of vertebrate animals of the Baikal Lake basin* (Ulan-Ude, 1980), pp. 144-147
31. V. V. Popov et al, *Rare bird species of the Baikal-Lena Nature Reserve Works Baikal-Lena State Nature Reserve* **1** (Moscow, 2002), pp. 95-98
32. Ts. Z. Dorzhiev et al., *Spring flight of birds in Southern Transbaikalia Ecosystems of Southern Transbaikalia: history of study, assessment and problems of biodiversity conservation Conf* (Ulan-Ude, 1998), pp. 46-50
33. I. V. Fefelov, V. A. Tupitzin, V. A. Podkovyrov, V. E. Zhuravlev, *Birds of the Selenga Delta* (Irkutsk, 2001)
34. V. A. Zubakin, *Colonial birds of the Torey Lakes Placement and state of nesting sites of near-water birds on the USSR territory* (Nauka, Moscow, 1981), pp. 132-134
35. A. A. Vasil'chenko, *Materials on birds of the Torey Lakes Ecological research in the Reserves of Southern Siberia* (Moscow, 1989), pp. 91-102
36. D. Sumyaa, N. G. Skryabin, *Birds of the Prikhubsugulya* (Publishing House of the Irkutsk State University, Irkutsk, 1989)
37. A. Bold, Ts. Z. Dorzhiev, B. O. Yumov, N. Tsevenmyadag, *Bird fauna of Baikal Lake basin Ecology and fauna of birds in Eastern Siberia* (Publishing House of the Buryat Scientific Centre SB of the AS USSR, Ulan-Ude, 1991), pp. 3-24
38. E. N. Yelayev et al., *Ornithological studies in Russia* **2**, 54-73 (2000)
39. E. E. Tkachenko, V. N. Puzansky, *Great Cormorant Red Book of the Chita region and the Aginsky Buryat Autonomous Okrug* (Animals, Chita, 2000), pp. 48-49
40. S. V. Pyzh'yanov, I. I. Tupitzin, V. V. Popov, *Baikal Zool J* **4**, 65-70 (2010)

41. M. S. Pyzh'yanova, *Influence of Great Cormorant reintroduction upon population of Baikal semiaquatic birds Biodiversity: global and regional processes* (Institute of General and Experimental Biology of SB RAS, Ulan-Ude, 2016), pp. 202-203
42. S. V. Pyzh'yarov, M. S. Pyzh'yanova, I. I. Tupitzyn, *Bulletin of Samara Scientific Centre of Russian Academy of Sciences* **18(2)**, 182-185 (2016)
43. I. V. Fefelov, Yu. A. Anisimov, A. V. Bezrukov, *Russ ornithol J* **25(1233)**, 3-6 (2016)
44. A. A. Ananin, A. E. Razuvaev, *Features of population dynamics of the Great Cormorant (Phalacrocorax carbo L.) on the northeastern coast of the Baikal Lake Proc. III All-Russian Scientific Conf "Diversity of Soils and Biota of North and Central Asia"* (Ulan-Ude, 2016), pp. 27-31
45. A. A. Ananin, M. E. Ovdin, A. E. Razuvaev, *Russian Ornithol J* **27(1584)**, 1390-1392 (2018)
46. A. A. Ananin, M. E. Ovdin, G. A. Yankus, *Russian Ornithol J* **27(1685)**, 5238-5241 (2018)
47. M. E. Ovdin, G. A. Yankus, A. A. Ananin, *Baikal Zool J* **2(21)**, 75-8 (2017)
48. M. E. Ovdin, G. A. Yankus, A. A. Ananin, *Baikal Zool J* **2(23)**, 57-60 (2018)
49. G. A. Yankus, *Bulletin of Buryat State University Biology Geography* **3**, 33-37 (2021)
50. L. S. Stepanyan, *Abstract of the ornithological fauna of Russia and adjacent territories (within the borders of the USSR as a historical region)* (Akademkniga, Moscow, 2003)
51. E. A. Koblik, Ya. A. Red'kin, V. Yu. Arkhipov, *Checklist of the birds of Russian Federation* (KMK Scientific Press Ltd, Moscow, 2006)
52. A. E. Lugovoy et al., *Great Cormorant Phalacrocorax carbo L. 1758 Birds of Russia and adjacent territories: Pelicaniformes, Ciconiiformes, Flamingoformes ed S G Priklonsky, V A Zubakin and E A Koblik* (Comrade Scientific ed. KMK, Moscow, 2011)
53. Ts. Z. Dorzhiev, *Sympatry and comparative ecology of congeneric bird species (Baikal Lake basin)* ed L S Stepanyan (Ulan-Ude, 1997)
54. A. B. Imetkhenov, *Ecotone Zone Nature (Baikal Region)* (Publishing House of the SB RAS, Novosibirsk, 1997)
55. E. N. Yelayev, *Bird communities of the ecotone areas in the South of Eastern Siberia* (LAP LAMBERT Academic Publishing, 2016)