

ARTIFICIAL NEST-SITES FOR SCALY-SIDED *MERGANSER MERGUS SQUAMATUS* (GOULD, 1864) – A WAY TO BREEDING HABITAT RESTORATION

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[Соловьёва Д.В., Вартанян С.Л., Вартанян Н.И-Ф. Искусственные гнездовья для чешуйчатого крохала *Mergus squamatus* (Gould, 1864) как способ повышения ёмкости гнездовых местообитаний]

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Ключевые слова: *чешуйчатый крохаль, Mergus squamatus, искусственные гнездовья, рубленые и нерубленые поймы, гнездовые трубы и ящики*

Summary. Habitat degradation due to deforestation of riverine forest could be compensated with artificial nest-sites for cavity-nesting ducks. Occupation of artificial sites by Scaly-sided Merganser differed significantly between logged and un-logged river banks. This paper details construction of nest tube for Scaly-sided Merganser, rate of destruction for nest-boxes and nest-tubes and recommendations for artificial nest maintenance. Two types of artificial nests (tubes and boxes) are of equal attractiveness to Scaly-sided Mergansers: occupation of tubes (13%) did not differ from boxes (12,5%). Significant difference in occupation by Scaly-sided Merganser was found for the first versus following years site existence with lower occupation rate the first year. Pest species used artificial nest in Primorye, Far East Russia, are listed.

Резюме. Деградация естественных местообитаний прирусловых лесов может быть компенсирована развеской искусственных гнездовий для закрыто гнездящихся уток. Занимаемость дуплянок чешуйчатым крохалем в рубленых и нерубленых поймах рек достоверно различалась в ходе представленного исследования. Эта статья представляет вариант конструкции дуплянок для чешуйчатого крохала, а также данные по скорости разрушения этих дуплянок и рекомендации по их развеске и поддержанию в рабочем состоянии. Два типа дуплянок – ящики (занимаемость 12,5%) и трубы (13%) – были одинаково привлекательны для чешуйчатого крохала. Доказаны различия в занимаемости дуплянок в первый год и последующие годы их существования; занимаемость в первый год достоверно ниже, чем в последующие. В статье представлен список животных, заселявших искусственные гнездовья в Приморье.

Scaly-sided Merganser breeds in southeast Russia, North Korea and northeast China. Most of the world population (over 85%) breeds in Russia. Most birds winter in central and southern China with small numbers also winter in Korea Japan, Russia, and Taiwan, and there are a few records from Myanmar, Thailand and northern Vietnam [BirdLife International, 2001]. Scaly-sided Merganser is listed as Endangered by IUCN and as 'rare' in Red Data Book of Russian Federation and the first-ranked category in the List of Protected Wildlife of National Importance in China. Scaly-sided Merganser breeds along rivers with old growth riverine forest, mainly within the temperate conifer-broadleaf forest zone. Old-growth forest provides this hole-nesting duck with an abundance of potential nest-sites, particularly in older rotting trees [Коломийцев, 1992, Zhao et al., 1995]. Scaly-sided Merganser is an obligatory hollow-nesting duck.

Improving of breeding habitat capacity for hollow-nesting birds include installation of artificial cavities such as nest boxes [Newton, 1998; Harper et al., 2005; Beyer, Goldingay, 2006]. Many studies have shown that addition of nest boxes resulted in increases in breeding populations of cavity-nesters [Newton, 1994] suggesting that nest site availability was limiting these populations at least locally. Artificial cavities have resulted in other spectacular population recoveries of ducks such as the Common Goldeneye *Bucephala clangula* (L., 1758) in Scandinavia over last 270 years [Phillips, 1925 in Limsden et al., 1980; Poysa, Poysa, 2002], the Wood Duck *Aix sponsa* (L., 1766) [Haramis, Thompson, 1985], the Bufflehead *Bucephala albeola* (L., 1758) [Gauthier, 1993], the Barrow's Goldeneye *Bucephala islandica* (Gmelin, 1789) [Savard, 1988] and the Hooded Merganser *Lophodytes cucullatus* (L., 1758) [Dugger et al., 1994] in North America.

First attempts to attract Scaly-sided Merganser to artificial nests were made in 1962 in Lazovskiy State Reserve, Primorye, when 20 nest-boxes of goldeneye *Bucephala* spp type were erected along the river for Mandarin Duck *Aix galericulata* (L., 1758) [Поливанов, 1981]. Nest-boxes were occupied by Mandarin Duck but no case of occupation by Scaly-sided Merganser was reported. At that time (1960th) Scaly-sided Merganser was rare in Kievka basin and its breeding was not proven here [Литвиненко, Шибяев, 1971]. No population estimates are available for that period, but it seems that there were less than five pairs nesting in Kievka basin in the 1960th. N. Kolomiytsev [Коломийцев, 1986, 1992] started an artificial nest programme to address Scaly-sided Merganser recovery at Kievka River in 1981 and mergansers started to occupy nest-boxes 3-4 years after their placement. This programme lasted until 1988, however, some of the boxes may have continued to be used after the programme finished. Numbers of Scaly-sided Merganser reached 11–17 pairs in Kievka basin in 1981–1988 [Коломийцев, 1992]. N. Kolomiytsev [Коломийцев, 1986] suggested a special type of artificial nest for Scaly-sided Merganser, a nest-tube: his tube was a 90 cm long six-angled wooden barrel, open in the top. N. Kolomiytsev reported this type of nest site was preferable to Scaly-sided Merganser. Our artificial nests programme started in 2000 on several rivers of Primorye, including Kievka basin. Fifty five to eighty pairs of mergansers were found in the Kievka basin in 2000–2008, a pronounced increase in numbers since the 1980th and even more since 1960th [Solovieva et al., 2006]. Here we present first results of the artificial nest programme for Scaly-sided Merganser in Primorye including:

- improved construction of nest-tube and recommendations for nest-site maintenance;
- rate of artificial nest destruction;
- occupation of artificial nest-sites depending on logging history;
- comparison of tubes versus boxes;
- artificial nest occupation as related to years after placing;
- list of pest species and their seasons.

METHODS

Study area

In Primorye, Scaly-sided Mergansers inhabit clean mountain rivers of both the eastern and western slopes of the Sikhote-Alin' Range. Typical riverine forest was conifer-broadleaf with predominance of Japanese poplar *Populus maximowiczii* A Henry, elm *Ulmus propinqua* (Koidz), black pine *Pinus koraiensis* Siebold & Zucc, limes *Tilia amurensis*

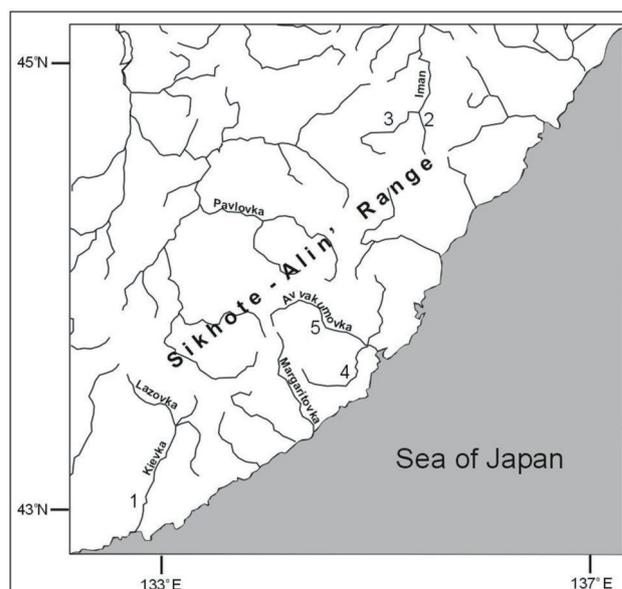


Fig. 1. Map of study area, rivers with artificial nests are indicated. Small rivers are given by figures: 1 – Krivaya R.; 2 – Krasnaya R.; 3 – Berezovaya R.; 4 – Vasilkovka R.; 5 – Mineral'naya R.

Рис. 1. Карта района работ с указанием рек, где были развешены искусственные гнездовья. Мелкие притоки даны цифрами: 1 – р. Кривая; 2 – р. Красная; 3 – р. Березовая; 4 – р. Васильковка; 5 – р. Минеральная

Rupp., 1869 and *T. mandshurica* Rupr. & Maxim, 1857, and Mongolian Oak *Quercus dentate* Thunb., 1784. After intensive deforestation which started 150 years ago and lasted until the 1980th, river valleys represent a mixture of fields, remains of native forest and pieces of young forest. An additional source of forest degradation is the regular forest fires following burning of grass on fields. Only tolerant Mongolian Oak does not suffer with fire and thus field vicinities are often covered with oaks.

Artificial nest programme area

The artificial nest programme was undertaken on the rivers Avvakumovka (with tributaries Mineral'naya and Vasilkovka), Bol'shaya Ussurka (with tributaries Berezovaya and Krasnaya), Kievka (with tributaries Lazovka and Krivaya), Margaritovka and Pavlovka (Fig. 1). A total of 148 artificial nests were placed in 2000–2004 (Tab. 1). We distinguished between rivers with logged forest on banks (later logged rivers) and rivers with untouched or almost untouched old-growth forest on banks (un-logged rivers). Sometimes a part of a river was considered as logged and a part as un-logged eg. on Pavlovka River, upper reaches contain old-growth riverine forest while lower reaches are agricultural lands. A first series of seven nest-tubes was built and placed in spring 2000 (Tab. 1); 49 tubes were placed in spring 2001. Thirty nest-boxes were placed in close

Table 1
Number of artificial nests, tubes and boxes, for Scaly-sided Merganser placed in 2000-2004 on logged and un-logged rivers of Primorye

Таблица 1

Количество дуплянок, труб и ящиков, развешанных в 2000-2004 годах для чешуйчатого крохалея в рубленых и нерубленых поймах рек Приморья

Nest site type	tubes			boxes	Total
	2000	2001	2004	2003	
Logged rivers or river parts					
Avvakumovka	no	10	no	10	20
Kievka	no	10	16	11	37
Krivaya	no	no	6	no	6
Lazovka	no	1	1	2	4
Margaritovka	no	1	no	1	2
Pavlovka	no	no	10	no	10
Total	0	22	33	24	79
Un-logged rivers or river parts					
Berezovaya	no	2	no	no	2
Iman	6	13	no	no	19
Krasnaya	1	4	no	no	5
Margaritovka	no	5	5	5	15
Mineral'naya	no	3	no	2	5
Pavlovka	no	no	10	no	10
Vasilkovka	no	no	13	no	13
Total	7	27	28	7	69

proximity (within 200 m) to 30 nest-tubes of 2001 in spring 2003. Taking into account the breeding density of Scaly-sided Merganser (mean one pair per 2 km of river) each pair received a choice between tube and box situated near each other [Шохрин, Соловьёва, 2002]. In autumn 2004 we erected 61 more tubes.

Artificial-nest construction

Following recommendations by Kolomiitsev [1986] we selected tubes as priority artificial nest-sites for Scaly-sided Merganser. The first series of seven tubes was made by gouging from a whole broadleaf log 80 cm long which was both time and labour consuming. The later series of tubes were easier to build. Each had an eight-sided bottom 50 mm thick and walls made of coniferous slab (Fig. 2). The tube was 85 cm in length and the internal cavity was 27-29 cm in diameter. In 2001 the walls were fixed with metal nails and wire was used on top of the tube. In 2004 we used screws and a metal strip for fixing the walls (Fig. 2). Tubes were attached to branches at an angle of 30-90° to horizontal. The branch was cut flush to the tube entrance.

Nest-boxes of the goldeneye type were built and erected in order to investigate whether the tube is the favoured nest-site of Scaly-sided Merganser. In spring 2003 we built 30 nest-boxes and placed them on trees in close proximity to the 30 nest-tubes from 2001. Nest-boxes had a base of 300 x 350 mm and length of 600 mm with an oval entrance of 80 x 120 mm. Boxes were made from wooden boards and painted [see review on

goldeneye nest boxes in Lumsden et al., 1980].

Nest site checking

Artificial nests were checked in early to middle May, 2000–2008. Nest-sites on logged rivers and on Mineral'naya River and un-logged parts of Margaritovka and Pavlovka rivers were checked annually except in 2002, while on other un-logged rivers checking occurred irregularly. Indicators of occupation, egg down and feathers, egg-shells, vegetation, excrements, remains of insect nests, were collected and identified during checking of nest-sites. Nesting of Scaly-sided Merganser occurred from late-March to late-June and was variable among females. Occupation of an artificial nest-site was documented if we found (1) a live clutch of this species (laying or incubating stage); (2) dumped egg of this species; (3) abandoned or depredated clutch of this species; (4) occupation in year *n* was reported if full downy lining and egg-shell pieces were found in the year *n*+1. There were three cavity-nesting duck species breeding in the study area: Scaly-sided Merganser, Mandarin Duck and Mallard *Anas platyrhynchos* L., 1758 and a collection of lining (down and small feathers) for each species was made. This collection was used for distinguishing duck species when the nest was first inspected in the year after the breeding year.

Different animals sometimes used artificial nests for reproducing and wintering. We distinguished between spring occupations (mid-March to late-June) when Scaly-sided Merganser use nest-sites,

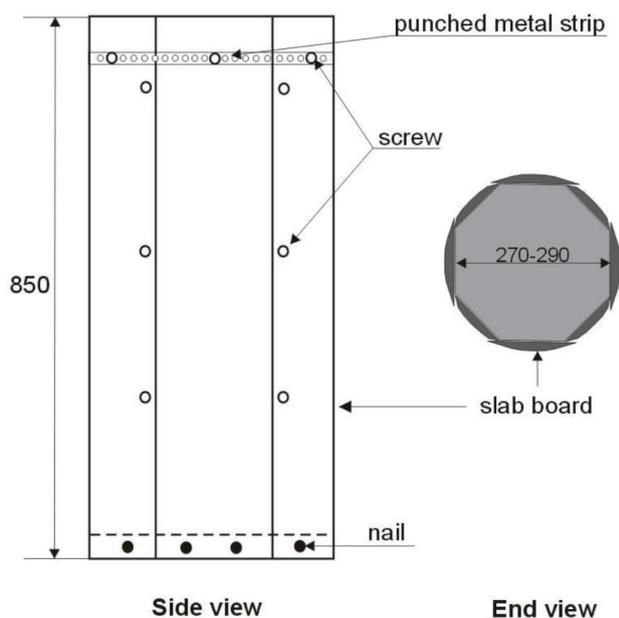


Fig. 2. Construction of nest-tube for Scaly-sided Merganser. Sizes and fastening elements are indicated
 Рис. 2. Конструкция гнездовой трубы для чешуйчатого крохала. Размеры и крепежные элементы указаны на рисунке

summer occupations (July and August) after Scaly-sided Merganser breeding, and winter occupations (November to mid-March). Each seasonal occupation was considered as a separate event when calculating the occupation rate. A nest-site was considered unavailable for duck nesting during a season if there was either a winter nest of Red Squirrel *Sciurus vulgaris* (L., 1758) or Flying Squirrel *Pteromys volans* (L., 1785), or a hornet *Vespa* sp nest from the previous summers, found at the site during checking.

We always cleaned nest-sites by removing winter and summer nests, however, cleaning occurred in May, which was too late for occupation by nesting ducks. Since 2006 we cleaned artificial nests on Kievka, Lazovka and Krivaya rivers prior to Scaly-sided Merganser nesting in late March, increasing site availability on these rivers. Numbers of nest-sites available for ducks at the beginning of a nesting season varied between years as spring occupation of nest-sites by breeding owls, falcons, squirrels, and ants also made sites unavailable for ducks. Unavailable sites were excluded from the analyses of occupation rate of Scaly-sided Merganser.

Statistical analyses

Occupation rate was calculated as the number of nest-sites occupied by a given user divided by the number of nest-sites available in the season. Data on nest site occupation were non-parametric and was not distributed normally. One-sided t-test for the massive with different dispersions was selected for analyses of difference in occupation between logged and un-logged habitats. Two-sided t-test for the massive

with different dispersions and for small number of observations ($22 < 30$) was selected for analyses of difference in occupation between tubes and boxes. We used one-sided t-test for small massive to compare occupation rate between years.

RESULTS

Artificial-nest destruction

Artificial nests disappeared from their places due to (1) destruction by people (6 from 128 nest-sites, or 4.7%); (2) drying or falling of tree or branch (13 from 128 nest-sites, or 10.2%), (3) destruction with age and by woodpeckers. In the last case destruction is determined by solidity of construction and by features of material. The coniferous slab was found to be attractive for beetle larvae and thus for woodpeckers that destroyed nest-site walls. We estimated destruction with age and by woodpeckers separately for tubes and boxes. Boxes were usable for five years while oldest tubes had worked for seven years. There is no difference in survival between boxes and tubes during five years although the data weren't enough for statistical analyses (Fig. 3). Rapid destruction of tubes started in the sixth year and less than 40% of tubes survived to their seventh year (Fig. 3). Poplar and willow were the least firm trees at study area. All cases of unexplainable falling or drying of tree with artificial nest site occurred in poplars and willows. Explainable cases were linked to the typhoon of late August 2006 which changed river-beds and during which all species of trees fell.

Effect of deforestation

We found that placing of artificial nests improved breeding habitats for Scaly-sided Merganser and other animals. Occupation of artificial sites by merganser differed significantly between logged and un-logged

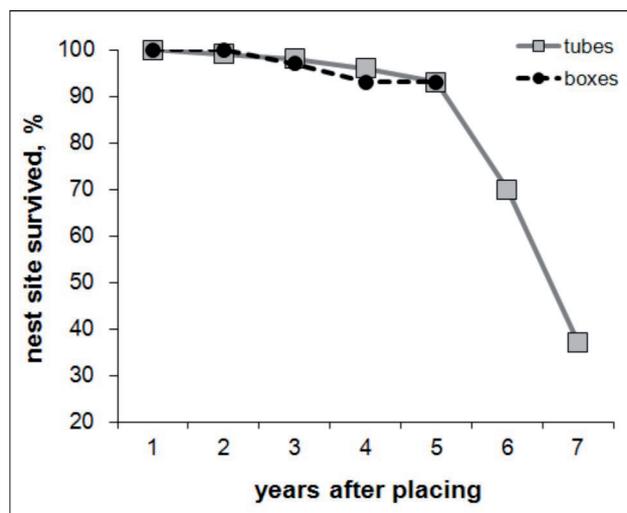


Fig. 3. Survival rate of nest-tubes and nest-boxes with years of work

Рис. 3. Скорость разрушения гнездовых труб и гнездовых ящиков

Table 2
Occupation rate (mean / SD) for artificial nests on logged (78 sites) versus un-logged rivers (54 sites), Primorye, 2000-2008

Таблица 2
Занимаемость (среднее/ SD) дуплянок в рубленых (78 дуплянок) и нерубленых (54 дуплянки) поймах рек Приморья, 2000-2008

Site user	Logged rivers	Un-logged rivers
Scaly-sided Merganser	0.120/0.045	0.015/0.004
all animals ¹ during all seasons	0.150/0.014	0.038/0.005

¹ – including Scaly-sided Merganser

¹ – все виды, включая чешуйчатого крохала

rivers (t-test, $t = -4.08$, $dF = 97$, $P < 0.01$, tab. 2). Besides Scaly-sided Merganser several other animals were found to use artificial nest-sites during different seasons (Tab. 3). We estimated a deficit of cavities on logged rivers versus un-logged rivers by comparing the use of artificial nest by all cavity users. Site occupation differed significantly between logged and un-logged rivers (t-test, $t = -6.70$, $dF = 29$, $P < 0.01$, tab. 2).

Effect of artificial nest type

Since the occupation rate on logged rivers was found to be eight times higher than on un-logged rivers we used only artificial sites situated on logged rivers for estimation of nest type effect. From the experiment, when 30 nest-boxes were placed close to 30 nest-tubes, we used only 22 couples tube/box situated on logged rivers. Occupation of tubes by Scaly-sided Merganser in 13.0% did not differ to this of boxes in 12.5% (t-test, $t = 0.07$, $dF = 41$, n.s.).

Effect of nest site age

Occupation of artificial nests (boxes and tubes combined, only logged rivers) varied with nest site age (Figure 4). Occupation in the first year was lower than in other consecutive years. Significant difference was found for the first versus third, fourth and sixth

years (Tab. 4); for the second and fifth years difference was insignificant from the first year.

Pest species

There were two mammalian, six avian and 3-5 insect species reported to use artificial nest sites for Scaly-sided Merganser in Primorye (Tab. 3). Strongest competitors were both species of owls and both squirrels during their breeding. If above species occupied a nest site in spring there is no possibility for ducks to use it. Squirrels were known to move their cubs after nest checking by observers and this made a site available for late ducks to nest. Wintering squirrels often provided large amount of faeces and this faeces bed seemed to be favoured by ducks (Mandarin and merganser). Some nest boxes filled with hornet nests to full were unsuitable for duck nesting in the following spring.

DISCUSSION

Nest boxes have been added to logged forests (where trees with hollows had been removed) led to significant recoveries of populations of some cavity-dependent species. There was a slight doubt that deforestation had no effect on breeding habitats

Table 3
Animal species using artificial nest sites for Scaly-sided Merganser in different seasons, Primorye, 2000-2008

Таблица 3
Список видов животных, заселявших искусственные гнездовья для чешуйчатого крохала в различные сезоны года в Приморье, 2000-2008

Taxa	Species	Spring	Summer	Winter
Insects	Ant <i>Liometopum orientale</i> or <i>Camponotus</i> sp.	+	+	
	Hornet <i>Vespa</i> sp.		+	
	Wasp <i>Vespula</i> sp. and <i>Dolichovespula</i> sp.		+	
Birds	Mallard <i>Anas platyrhynchos</i>	+		
	Mandarin Duck <i>Aix galericulata</i>	+		
	Common Kestrel <i>Falco tinnunculus</i>	+		
	Ural Owl <i>Strix uralensis</i>	+		+
	Long-eared Owl <i>Asio otus</i>	+		
	Eastern Tit <i>Parus minor</i>	+		
Mammals	Red squirrel <i>Sciurus vulgaris</i>	+		+
	Flying squirrel <i>Pteromys volans</i>	+		+

Table 4

Statistics for occupation of artificial nests by Scaly-sided Merganser in different years, couple test comparison of the first year with each of consecutive year. Boxes and tubes combined, only logged habitats were considered

Таблица 4

Статистика занимаемости дуплянок чешуйчатым крохалем в разные годы (парный тест сравнения первого года с каждым из остальных лет). Использованы только дуплянки в рубленых поймах, трубы и ящики объединены

Year	1	2	3	4	5	6
mean	0.03	0.12	0.18	0.17	0.14	0.22
SD	0.025	0.11	0.151	0.146	0.12	0.174
Number of observations	78	41	66	52	37	37
T actual		1.68	2.97	2.56	1.76	2.63
dF		51	84	64	44	41
T critical		2.01	1.99	2	2.015	2.02
α		n.s.	0.05	0.05	n.s.	0.05

of Scaly-sided Merganser. However, reliable comparisons of logged and un-logged habitats were undertaken for the first time during this study. Scaly-sided Merganser occupied artificial nest-sites eight times more intensively on logged rivers than on un-logged; all other inhabitants of artificial nests did so four times more intensively (Tab. 2). These findings were consistent with several nest box studies conducted elsewhere in the world [reviewed by Newton, 1994]. At this point we are completing our experiment with artificial nests on un-logged rivers.

The idea by Kolomiytsev [Коломийцев, 1986] that nest-tubes are more attractive for Scaly-sided Merganser than nest-boxes was not proven during this study. Tubes seemed to be shorter lived compared to boxes, although no difference was found due to the short period of observation (six years in boxes). Additionally, a tube requires more labour during installation because of the need to locate a tree with suitable branch (angle, orientation, height). However, we found that Scaly-sided Merganser nest success was twice as high in tubes versus boxes, mainly due to nest abandonment by females; and competition for tubes was lower than for boxes. Further experiments with nest-boxes of other sizes and of improved construction are required to determine the most suitable nest-site for Scaly-sided Merganser. We found the artificial nests live is short under the climate and forest conditions of Primorye and increasing numbers of nest boxes fell to the ground over time. Lindenmayer et al. [2009] found that nearly all nest boxes fell in 10-year period in forests of Victoria, South-eastern Australia; nest box destruction rate is similar in our study. Forest age was found to be a factor of nest box attrition in Australia [Lindenmayer et al., 2009], the factor has not been studied by us.

Scaly-sided Merganser was found to avoid newly appeared cavities (Fig. 4). Ringing of nesting females showed that a female was familiar with several nest-sites, including artificial, along at least 3-5 km of the

river. An adaptation period seems to be required for a female to occupy a new site. The number of nest boxes used by Goldeneye and Hooded Merganser was low in the first year but increased in the second year and occupancy rate stabilized at 51-55% in Goldeneye by the fourth year of the program [Lumsden et al., 1980]. In this study no increase in occupation by Scaly-sided Merganser occurred after second year of nest-site presence. Lumsden et al. [1980] reported Goldeneye use of nest boxes outnumbered Hooded Mergansers three to four times and thus merganser occupation rate was 13-18% what is similar to our findings in Scaly-sided Merganser (Tab. 2).

CONCLUSIONS AND RECOMMENDATIONS

Habitat degradation via logging of riverine forest could be improved with installation of artificial nest-sites for cavity-nesting ducks. We recommend the construction and placement of nest-tubes for Scaly-sided Merganser (Fig. 2), although standard goldeneye boxes are also suitable for this species. We

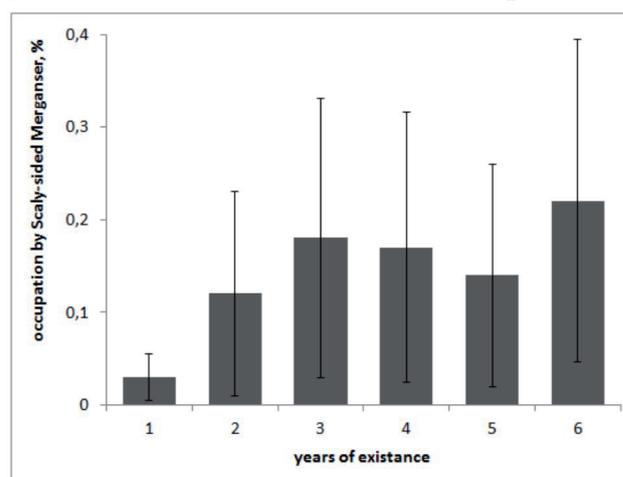


Fig. 4. Occupation of artificial nests (mean and SD occupation rate) by Scaly-sided Merganser depending on year of nest site existence

Рис. 4. Занимаемость (среднее и SD) дуплянок чешуйчатым крохалем в зависимости от времени существования дуплянки

recommend do not involve poplars and willows for placing of artificial nests. Maintenance of artificial nest-sites should include annual cleaning of sites from winter nests of squirrels and from summer hornet nests. It is better to clean and renew nest-sites in February – early March prior to arrival and nesting onset in Scaly-sided Merganser. During cleaning squirrel faeces shouldn't be removed in full.

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