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SHORT COMMUNICATION

A survey to the distribution of the Scaly-sided Merganser (*Mergus squamatus*) in Changbai Mountain range (China side)

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Abstract In 2008 and 2009, we made continuous and repeated breeding surveys of the Scaly-sided Merganser (*Mergus squamatus*) in the Changbai Mountain range (China side), using a combination of rubber-boat drifting and walking. Each survey consisted of a census of breeding pairs in the spring and broods in the summer. A total of 1553 km in length of 17 river stretches were surveyed in four different river systems of the Yalujiang, Songhuajiang, Tumenjiang and Mudanjiang rivers. A total of 1354 individuals of the Scaly-sided Merganser were recorded during the both surveys. The breeding density for all the stretches surveyed over both years averaged 0.26 ± 0.30 pairs per km; the population density in the spring averaged 0.75 ± 0.88 individuals per km. According to our survey results, we estimated that the breeding population in the Changbai Mountain range was about 170 breeding pairs of the Scaly-sided Merganser. Three major breeding sites of this bird were found in the Changbai Mountain range in these surveys.

Keywords Scaly-sided Merganser, Changbai Mountain range, breeding pair, brood, distribution

Introduction

The Scaly-sided Merganser (*Mergus squamatus*, Plate I) is recognized as a globally threatened waterfowl and is among the rarest sea ducks in the Palaearctic realm. Since its small and declining population is suffering from habitat loss, illegal hunting and disturbance, this species is included in the EN (Endangered) category of the IUCN Red List (BirdLife International, 2001, 2004). It is listed in the first rank category of the List of the Protected Wildlife of National Importance in China (China Wildlife Conservation Association, 1990), as well as in the category of rare birds in Russia and Korea. It is estimated that the global population size of the Scaly-sided Merganser is between 2400–4500 individuals. They breed mainly in far eastern Russia and in the northeast of China and winter in the southern China and Korea (Hughes and Bocharnikov, 1992; Hughes and Hunter, 1994; Kolomiitsev, 1995; BirdLife International, 2001; He et al., 2002; Shokhrin and Solovieva, 2003). The Changbai Mountain range is a very important and a major breeding ground of this bird in China. Given the lack of continuous studies on the breeding population of the Scaly-sided Merganser in the Changbai Mountain range after the 1990s, the distribution and current status of this species is not well known in this area. With the guidance of methodology from Drs. Solovieva and Hughes, we made continuous and repeated surveys for the breeding population of the Scaly-sided Merganser in the Changbai Mountain range during the spring and

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Plate I Scaly-sided Merganser (*Mergus squamatus*). Photos by Peiqi Liu on October 2009 (**a**), June 2008 (**b**) and October 2009 (**c**) at Fusong County, Jilin Province, China.

summer of both 2008 and 2009. Besides the breeding densities, this study provided the sex-age structure and brood size of this species in the Changbai Mountain range.

Study area and methods

Our study area covers mountain rivers between coordinates 41–44°N and 125–129°E. A total of 1553 km, 17 stretches in four different river systems of the Tumenjiang, Songhuajiang, Yalujiang and Mudanjiang rivers, were repeatedly surveyed during 2008 and 2009 (Fig. 1). In order to decrease the error in the surveys, we randomly selected stretches longer than 60 km and kept the survey distance on each stretch as long as we could, but always more than 30 km. The first 30 km from the source of each river were not surveyed, because these represent unsuitable habitats for the Scaly-sided Merganser (Kolomiytsev, 1990; Shokhrin and Solovieva, 2003; Fu and Chen, 2006). Seven stretches were surveyed both in 2008 and 2009. The breeding survey started in the middle of April, soon after the river ice cover broke up when the Scaly-sided Mergansers just arrived at their breeding habitats in the spring, while the brood survey was conducted during the middle of July and the middle of August when most ducklings had hatched but before they got fully fledged. During our surveys, only the individuals left behind the surveyors were counted. We counted the numbers of breeding pairs, trios, single males, single females, broods, brood-rearing females and flocks of this bird. We counted single males as breeding pairs since the coupled females might be laying eggs in their nests. We judged single females as breeding pairs only when single males were not found within

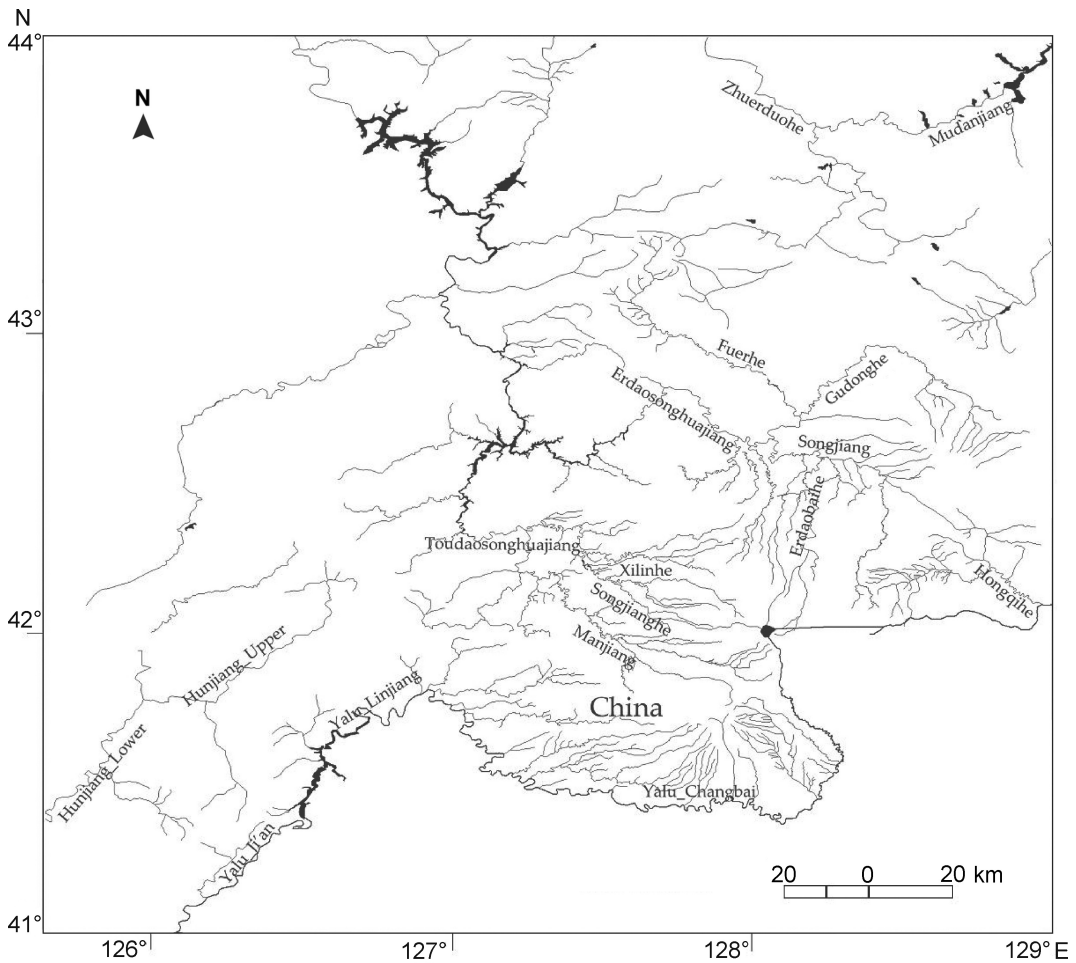

Fig. 1 Study area and river stretches surveyed in 2008 and 2009

the nearest 3 km. Since trios (one male with two females) are common in the breeding season, we counted trios also as breeding pairs (Solovieva et al., 2006). The densities of breeding pairs, broods and individuals are expressed as the number of breeding pairs/broods/individuals (inds) per km of river ± 1 SD respectively.

Results

Densities

The densities of breeding pairs, broods and individuals of the Scaly-sided Merganser along each river surveyed in the Changbai Mountain range during 2008 and 2009 are presented in Tables 1 and 2. The total densities of breeding pairs were 0.26 ± 0.30 pairs per km, for broods 0.14 ± 0.14 per km and 0.75 ± 0.88 individuals per km at all the rivers over both years.

Sex-age structure

During the spring surveys, all the flocked birds were counted as sub-adults or non-breeding individuals. In total 127 individuals and 19 flocks were counted in the spring surveys over both years. The proportion of flocked birds was 24.56%. We counted a total of 189 breeding pairs (102 in 2008 and 87 in 2009) over both years, including 26 trios (15 in 2008 and 11 in 2009). The proportion of trios to all the breeding pairs was 13.76%. A total of 59 sub-adult males and 167 adult males were counted over both years. The proportion of sub-adult males to all males was 26.11%. In the spring surveys, we counted a total of 230 males and 268 females. The sex ratio was 1:1.17.

Brood size and numbers

We counted a total of 49 and 39 brood clusters in the summer surveys in 2008 and 2009. These brood clusters included 6 amalgamated broods (2 in 2008 and 4 in 2009). Brood amalgamation is common in the Scaly-sided Merganser in the Changbai mountains. They are often formed in some habitats with high brood densities. Some broods become amalgamated or had already combined one or two days after they left their nests, through the competition between brood rearing hens. The amalgamated brood size varies considerably, but usually ranges from 20 to 40. We once recorded an amalgamated brood

Table 1 Breeding pairs and individual densities of the Scaly-sided Merganser in the Changbai Mountain range in the spring of 2008 and 2009

River	Survey distance (km)		Number of individuals		Pair density (pairs·km^{-1})		Bird density (spring, inds·km^{-1})		Total density over both years	
	2008	2009	2008	2009	2008	2009	2008	2009	Pair density (pairs·km^{-1})	Bird density (inds·km^{-1})
Manjiang	34	51	25	47	0.353	0.353	0.735	0.922	0.353	0.829
Yalujiang_Changbai_ Linjiang	32	270	3	7	0.094	0.007	0.094	0.026	0.051	0.060
Hunjiang_Upper	–	34	–	0	–	0.000	–	0.000	0	0
Hunjiang_Lower	–	29	–	2	–	0.000	–	0.069	0	0.069
Yalujiang_Ji'an	–	40	–	2	–	0.025	–	0.050	0.025	0.050
Toudaosonghuajiang	38	19	87	51	0.711	0.526	2.289	2.684	0.619	2.487
Erdaosonghuajiang	29	29	8	10	0.103	0.172	0.276	0.345	0.138	0.311
Fuerhe	33	36	75	84	1.030	0.806	2.273	2.333	0.918	2.303
Songjiang	26	26	33	1	0.538	0.000	1.269	0.038	0.538	0.654
Erdaobaihe	–	12	–	6	–	0.250	–	0.500	0.250	0.500
Hongqihe	–	32	–	3	–	0.063	–	0.094	0.063	0.094
Xilinhe	–	27	–	12	–	0.111	–	0.444	0.111	0.444
Songjianghe	29.5	34	31	26	0.305	0.382	1.051	0.765	0.344	0.908
Mudanjiang	21	–	4	–	0	–	0.190	–	0	0.190
Zhuerduohe	26	–	0	–	0	–	0	–	0	0
Total/Mean	268.5	639	266	251	0.35	0.21	0.91	0.64	0.26	0.75

Table 2 Scaly-sided Merganser brood densities in the Changbai Mountain range during the summer of 2008 and 2009

River	Survey distance (km)		Number of individuals		Number of broods		Brood density (broods·km^{-1})		Total brood density over both years (broods·km^{-1})
	2008	2009	2008	2009	2008	2009	2008	2009	
Manjiang	30	51	98	150	13	19	0.433	0.373	0.403
Yalujiang _Changbai_Linjiang	32	–	0	–	0	–	0	–	0
Yalujiang_Ji'an	–	40	–	0	–	0	–	0	0
Hunjiang_Lower	–	29	–	0	–	0	–	0	0
Hongqihe	–	32	–	11	–	1	–	0.031	0.031
Toudaosonghuajiang	38	–	13	–	2	–	0.053	–	0.053
Erdaosonghuajiang	29	29	12	15	2	2	0.069	0.069	0.069
Fuerhe	47	36	105	106	13	12	0.277	0.333	0.305
Songjiang	26	–	4	–	1	–	0.038	–	0.038
Erdaobaihe	–	12	–	0	–	0	–	–	0
Xilinhe	30	27	42	32	5	4	0.167	0.148	0.158
Songjianghe	40	34	171	78	19	11	0.475	0.324	0.400
Mudanjiang	21	–	0	–	0	–	0	–	0
Gudonghe	37	–	0	–	0	–	0	–	0
Zhuerduohe	26	–	0	–	0	–	0	–	0
Total/Mean	356	290	445	392	55	49	0.140	0.140	0.140

with 44 ducklings in 2008. According to a report of the largest clutches of this bird (Yelsukov, 1994), as well as a total 16 eggs once recorded in a natural nest of the Scaly-sided Merganser by us in 2007, we regarded those brood clusters with more than 16 (not including the 16) ducklings as amalgamated broods. The normal brood size had an average of 7.83 ± 2.92 ducklings in 2008 and 7.49 ± 2.98 in 2009; no significant difference was found in brood size between 2008 and 2009 (t_{80}= 0.60). Estimation that how many broods an amalgamated brood was composed of was made by dividing the number of ducklings of an amalgamated brood by the average brood size of the same year. In this way, we estimated that the 2 amalgamated broods with 32 and 33 ducklings respectively in 2008 were composed of 4 broods each, while the 4 amalgamated broods in 2009 with 17, 22, 29 and 34 ducklings were composed of 2, 3, 4 and 5 broods respectively. We made a correction to the number of broods to 55 in 2008 and 49 in 2009.

Distribution

From the data of breeding pair density over both years in Table 1 and brood density over both years in Table 2, we found the rivers with high densities of the Scaly-sided Merganser (pair density > 0.3 pairs per km and brood density > 0.1 broods per km) to be the Manjiang, Songjianghe, Fuerhe and Xilinhe. All four rivers are tributaries of the Songhuajiang river system. They are situated at the two ends of a rectangle strip of about 120 km long and 50 km wide. Obviously, these rivers are the key sites for the Scaly-sided Merganser breeding in the Changbai Mountain range. They account for more than 50% of the breeding pairs and for more than 90% of the broods of this bird in this mountain range. High densities of breeding pairs were recorded in the Toudaosonghuajiang and Songjiang rivers in the spring of 2008, while brood densities in these two rivers were extremely low. Nor did we find any broods along the stretch of the Songjiang river, surveyed in the summer of 2008 and concluded therefore that these two places were not breeding locations, but merely stop-over sites for the Scaly-sided Mergansers. Every year, the Scaly-sided Mergansers come first to the lower and middle reaches of the Yalujiang River. Their arrival occurs around the middle of March. Birds may stay there for some time and suddenly leave around the middle of April. We did not record any broods of this merganser along this river during either year. The Yalujiang River could be an important stop-over site and a pass way for the migratory Scaly-sided Mergansers.

Population estimates

During our surveys along the Manjiang, Songjianghe, Fuerhe and Xilinhe rivers, a total of 50

broods were recorded in 2008 and 46 in 2009. They accounted for 92.31% of the total number of broods over both years (90.9% in 2008 and 93.8% in 2009). According to our investigation, we estimated the length of the brood rearing habitats of the Scaly-sided Merganser along each of these four rivers to be as follows: 80 km along the Manjiang River, 60 km for the Songjianghe River, 75 km along the Fuerhe River and 30 km along the Xilinhe River.

Multiplying the length of each suitable stretch with the average brood density over the two years of any particular river, we obtained the estimated number of broods for each river. From the four estimates, we summarized the number of broods, accommodated along all these four rivers, to be 83. With this summary and the ratio of 92.31%, we estimated the total number of broods for the entire Changbai Mountain range to be about 90. Broods stay on their natal rivers until fledging, hence the ratio between breeding pair density and brood density can serve as an indicator of nesting success (Shokhrin and Solovieva, 2003; Solovieva and Shokhrin, 2008). During the spring survey, we recorded a total of 102 breeding pairs in 2008 and 87 in 2009. The brood vs breeding pair ratios were 53.92% in 2008 and 56.32% in 2009, as well as 55.03% on average. From the ratios between the average number of breeding pairs and broods for both years, we calculated the number of breeding pairs of the Scaly-sided Mergansers in the Changbai Mountain range, to be about 164. Actually, we could arrive at this estimation directly from the number of breeding pairs. By multiplying the length of each suitable stretch with the average breeding pair density of the same river, we could obtain the estimated number of breeding pairs along all four rivers as 124 pairs in total. During our survey in the spring of 2008 and 2009, a total of 55 and 64 breeding pairs were recorded along the partial stretches of these four rivers. The number of breeding pairs along the four rivers as a proportion of the entire number of breeding pairs surveyed, over both years, is 62.96%. With this ratio and the estimated total number of breeding pairs for the four rivers, we estimated the number of breeding pairs for the entire Changbai Mountain range to be about 197 pairs. Considering the far higher breeding pair densities in the spring and the extremely low brood densities in the summer along stretches of the Toudaosonghuajiang and Songjiang rivers in 2008, we suspect that the breeding pair density in 2008 was overestimated. Considering these estimated results, we would prefer to decrease the estimated range to 150–190 pairs of Scaly-sided Mergansers in the Changbai mountains.

Discussion

Distribution area and population estimates

Historically, the Scaly-sided Merganser was once widely distributed in the northeast of China during the breeding season, including some areas in the Great Xing'an mountains, the Lesser Xing'an mountains, Inner Mongolia and the Changbai mountains. But with social and economic developments, tremendous environmental changes have taken place in the breeding grounds of this species in northeastern China. These developments include large-scale deforestation, dam construction and other intensive anthropological activities. These changes might have serious effects on the status of the Scaly-sided Merganser in northeastern China, both in terms of distribution area and population trend. It was squeezed out and is absent from many of its historic habitats. At present in northeastern China, it is highly compressed in only a few sites. The distribution area of this species has sharply decreased during the last 50 years in northeastern China. This sharp decrease covered the Changbai mountains as well. Deforestation of the Changbai mountains started during the Japanese occupation and the Puppet Government in the 1930s. Most of the virgin forests outside the boundaries of the Changbai Mountain Nature Reserve were harvested during the period from the 1950s to the 1990s. While after the 1990s, our government enforced the protection of virgin forests in the Changbai mountains, the areas of virgin forests left are too few and most of the secondary forests are too young to provide enough natural cavities for breeding of this bird. With intensifying disturbance and deterioration of the remaining habitats of this species, largely caused by sand dredging, road and dam construction, as well as profitable boat drifting activities in the 2000s, the distribution of the Scaly-sided Merganser in the Changbai mountains greatly changed. Some major known historic breeding sites were lost (e.g. the Gudonghe and Sandaobaihe rivers), but a few unknown breeding sites have been recently discovered (e.g. along the Fuerhe and Hongqihe rivers). In addition, the present breeding densities of the Scaly-sided Merganser in some rivers (i.e., the Erdaobaihe and Manjiang rivers) are much lower than those in the 1990s. Nevertheless, the number of

the Scaly-sided Mergansers in the Changbai mountains we estimated during our study, are more than the number estimated by Zhao and his collaborators in the 1990s (Zhao et al., 1994; Zhao and Wu, 1994). We attribute this difference to errors accrued from the differences in survey methods and survey areas between our present study and that in the 1990s, not necessarily to an increasing population trend of the Scaly-sided Merganser in the Changbai mountains over the past two decades.

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长白山脉（中国境内区域）中华秋沙鸭分布状况调查

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摘要：2008和2009年，我们采取漂流调查和行走调查相结合的方式，对长白山脉（中国境内区域）的

中华秋沙鸭（*Mergus squamatus*）繁殖种群分布状况进行了连续和重复调查。每年的调查都包括春季对中华秋沙鸭繁殖对和夏季繁殖家族的调查。两年期间，共调查了鸭绿江、松花江、图们江、牡丹江4个水系的17个河段，调查距离总计1553 km，共记录到中华秋沙鸭个体1354只。全部调查河段的中华秋沙鸭繁殖密度为每公里河段0.26 ± 0.30个中华秋沙鸭繁殖对；春季中华秋沙鸭种群个体密度为平均每公里河段0.75 ± 0.88只中华秋沙鸭个体。根据调查结果，我们初步估计在长白山脉我国境内区域分布的中华秋沙鸭繁殖种群数量大约为170对。在该项调查过程中，我们还探明了在长白山脉3个最主要的中华秋沙鸭繁殖栖息地。

关键词：中华秋沙鸭（*Mergus squamatus*），长白山脉，繁殖对，家族，分布