

Winter Ecology and Conservation Threats of Scaly-sided Merganser *Mergus squamatus* in Poyang Lake Watershed, China

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Abstract. First multiple surveys were conducted along eight river sections within the Poyang Lake watershed, Jiangxi Province, China, to examine winter ecology of the scaly-sided or Chinese Merganser (*Mergus squamatus*) and to assess threats to its conservation. Transect lines and point counts were combined to estimate the population size of the scaly-sided Merganser during the period November 2010 to March 2011. Along all eight surveyed river sections in four rivers, the riparian environment was mountain forest or close to mountain forest on one or both sides of the rivers. The scaly-sided Merganser was often found in the rivers with scattered shoals. The largest number of scaly-sided Mergansers seen during each of the five months varied from 61 to 91. Groups of Chinese Merganser were classified as male, female, mixed sex, solitary female and solitary male. Mixed sex groups were the most frequently encountered (64 sightings) and comprised 71.91% of all groups sighted (89 groups). Solitary mergansers accounted for 22.47% (male, 15.73%; female, 6.74%) of all sightings and were also frequently encountered. Solitary Merganser and groups with 2-9 individuals account for 22.47% and 64.04% of total group number (n=89). Feeding, swimming, resting and maintenance were the most frequent behavior patterns. For the first time, mergansers were observed copulating in winter in the Wuyuan River section. The sex ratio was 1:0.74 (Females + sub-adults: males, n=432). Threats to the conservation of the scaly-sided Mergansers included sand mining, fishing, riparian vegetation destruction and water pollution. Taiyangsheng, Taopi, Qinghu and Wuyuan sections should be prioritized for protection because these areas have relatively large and stable population. We recommend specific conservation strategies designed to protect this endangered species.

Key words: Scaly-sided Merganser, *Mergus squamatus*, Chinese Merganser, Jiangxi, conservation threats.

INTRODUCTION

The scaly-sided or Chinese Merganser (*Mergus squamatus*) is an endemic species restricted to East Asia and is regarded as an endangered species by IUCN (He *et al.*, 2002; BirdLife International., 2008). It is listed in the first category of the nationally protected wildlife species in China (Zheng and Wang, 1998; Liu *et al.*, 2008). The number of scaly-sided Mergansers is currently estimated to be 1,000 to 2,499 individuals globally including 400 to 600 in China (Zhao and Wu, 1994; Wang *et al.*, 2010). In China it breeds in Heilongjiang and Jilin Provinces, northeast China. Wintering areas include a wide range along the south of Yangtze River, where the Poyang Lake

watershed in Jiangxi Province provides the main wintering habitat for this species in China (Zhao, 1993; Zheng and Wang, 1998; Liu *et al.*, 2008; Shao *et al.*, 2010a). Previous studies of the behavior, distribution and population size of this bird have been carried out in China (Lin *et al.* 2008; Yi *et al.*, 2010; Fang *et al.*, 2009; Li *et al.*, 2010; Shao *et al.*, 2010b; Wang *et al.*, 2010). We report on the winter ecology of mergansers and identify threats related to the conservation of this bird during the wintering period in the Poyang Lake watershed because only a little comprehensive research on these topics has been published.

MATERIALS AND METHODS

Study area

Our study area included four rivers in the Poyang Lake watershed, Jiangxi Province (114°39'-117°51'E □ 27° 34'-29° 33'N), at an elevation of 10–90 m above sea level. The four rivers include Xiuhe,

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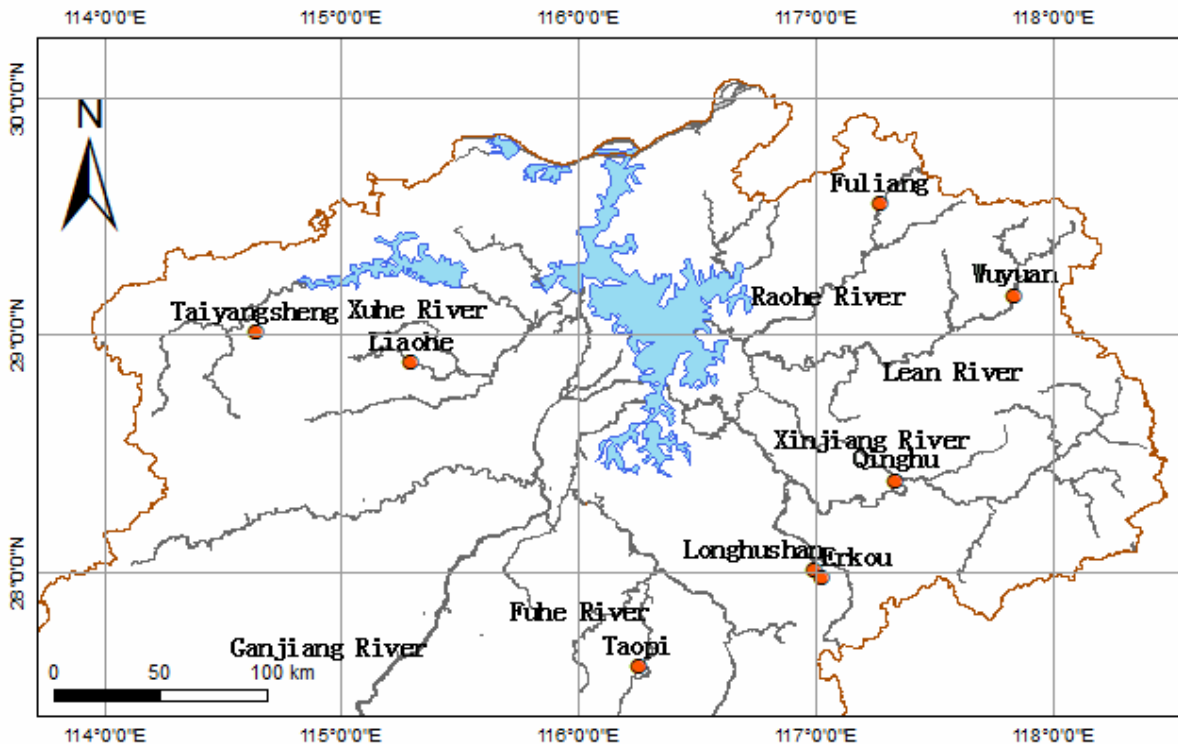


Fig. 1. Distribution of surveyed areas in four rivers of Poyang Lake watershed in Jiangxi Province.

Fuhe, Xinjiang and Raohe River (Fig.1). Climate in the study area is sub-tropical, with an average annual temperature of 18°C and annual precipitation 1,816 mm (Yi *et al.*, 2010). The vegetation was dominated by broad-leaved deciduous forest and broad-leaved evergreen forest. Areas of the Poyang Lake watershed reported in the literature as having wintering mergansers were included during this study, with the exception of Wuning County where access was very difficult. We selected eight river sections along four rivers based on our previous field investigations, literatures and interviews from local forestry workers. The river sections included two sections (Taiyangsheng section in Xiushui county and Liaohe section in Jing'an county) in Xiuhe River, one section (Taopi section in Yihuang county) in Fuhe River, three sections (Longhushan section in Yingtan city, Erkou section in Guixi city, and Qinghu section in Yiyang county) in Xinjiang River, two sections (Fuliang section in Jingdezhen city and Wuyuan section in Wuyuan county) in Raohe River (Fig.1).

Data collection

Transect lines and point counts were combined to estimate the population size of the scaly-sided Merganser from November 2010 to March 2011. Seventeen transect lines were selected in eight river sections in the Poyang Lake watershed (Table I). Each transect line was 4 to 7 km long. The length of each transect line was estimated by GPS. We used transect lines to count birds when there were roads along the rivers. Point counts were also conducted by systematically establishing observation points 1.5–2.5 km apart throughout the sampled area where there were no good roads along the rivers. Two to three observers at each point or transect line recorded the number of mergansers observed, time of observation, sex ratio and behavior patterns. Counts were conducted once or twice each month at each transect or point. The maximum count for scaly-sided Mergansers in each river section was summed for all four rivers in the Poyang Lake watershed to determine merganser numbers for each month.

One-way ANOVA was used to test for differences in group sizes along the eight river sections. Group types were tested by Kruskal-Wallis test. We used Chi-square tests to test the differences in sex ratios along the eight river sections. Differences in behavior patterns between the sexes were tested by a Mann-Whitney test.

RESULTS AND DISCUSSION

Wintering habitat of the scaly-sided Merganser

Along all eight surveyed river sections, the riparian environment was mountain forest or close to mountain forest on one or both sides of the rivers (Table I). Scattered farmland and villages occurred on at least one side of eight river sections. The scaly-sided Merganser was often found in the rivers with scattered shoals (Table I). This species often rests in the shoals or forages close to the shoals.

Distribution and abundance

Scaly-sided Mergansers arrive in the Poyang Lake watershed during late October and leave the wintering area in early April. The mergansers were detected in all eight river sections of the four rivers in the Poyang Lake watershed. Although temporal and spatial variations were observed in their numbers mergansers were recorded in nearly every river during every month (Table II). This might be explained as follows: First, the wintering range of this species in the study area was small and limited to a few finite river sections. Second, only a few rivers were suitable for the mergansers because of habitat modification. Third, no other rivers provided suitable wintering habitat for this species. Last, food was relatively abundant and available in these river sections that attracted the mergansers.

The largest number of scaly-sided Mergansers counted in each month varied from 61 in December to 91 in November (Table II). This survey accounted for at least 3.64–9.10% of the total number of mergansers known to exist globally (Zhao and Wu, 1994; Wang *et al.*, 2010). Our estimate may be slightly conservative because of the secretive nature of this species. The protection of this species in Jiangxi Province is important if we want to improve population stability and ensure the survival of this species. However the outlook for the continued

survival of this species in the Poyang Lake watershed is not optimistic because of ongoing habitat modification.

No mergansers were detected in three sections during January 2011 perhaps primarily because of increased human activity at that time (Table II). With the upcoming Chinese Spring Festival holiday, an increase in fishing activities was observed in January 2011. The scaly-sided Merganser migrated to other river sections with less human activity, indicating the actual population size was larger than the numbers counted during this survey.

Xiuhe River

The largest numbers of scaly-sided Mergansers counted in the i) Taiyangsheng Section varied from nine in January and February to 48 in November (Table II). Compared with other locations, the population of this species in the Taiyangsheng section was stable. The river section where the merganser could be recorded in the Taiyangsheng section is less than 6 km long and human activities such as sand mining continue to impact this area.

The population size was small in the ii) Liaohe section although more survey lines were selected at this location. The number of birds counted in this area was never more than 10 individuals. The count was smaller than counts (31 individuals) from past years perhaps because of annual variation (personal observation).

Fuhe River

Mergansers were first observed in the iii) Taopi section of the Fuhe River in 2009 (Li *et al.*, 2010; Wang *et al.*, 2010). None were observed here in December, but starting in January a large population was observed in this area. Almost all mergansers seen in this river section were observed in less than 3 km of river, indicating other areas of the Taopi section were perhaps not very suitable for merganser because of scarcity of food and because the habitat has been degraded due to sand mining operation.

Xinjiang River

The numbers counted in the iv) Longhushan and v) Erkou sections were small and not stable

Table I.- The riparian characteristics of the wintering Scaly-sided Merganser along eight river sections of Poyang Lake watershed.

Rivers	River sections	Location	Longitude/latitude	Transect lines	River section length	Riparian environment
Xiuhe River	Taiyangsheng section	Xiushui county	E 114°39' □ N 29°08'	1	10	Farmland and village on both sides of the river
	Liaohe section	Jing`an county	E 115°17' □ N 28°53'	3	40	Mountain forest with scattered villages and farmland on both sides
Fuhe River	Taopi section	Yihuang county	E 116°15' □ N 27°36'	2	15	Mountain forest on one side and mountain forest with scattered villages and farmland on other side
Xinjiang River	Longhushan section	Yingtang city	E 117°04', N 28°02'	2	15	Railway on one side, and mountain forest next to railway, mountain forest on other side of the river
	Erkou section	Guixi city	E 117°07' □ N 27°59'	1	7	Mountain forest on one side and mountain forest with scattered village and farmland on other side
	Qinghu section	Yiyang county	E 117°20' □ N 28°23'	1	7	Farmland on one side , mountain forest with scattered farmland and village on other side
Raohe River	Fuliang section	Fuliang county	E 117°16' □ N 29°33'	4	80	Mountain forest on one side, mountain forest with scattered farmland and village on other side
	Wuyuan section	Wuyuan county	E 117°50' □ N 29°10'	3	40	Mountain forest on one side and mountain forest with scattered farmland and village on other side

Notes: River section length includes areas conducted by transect lines and point counts.

Table II.- Number of the wintering Scaly-sided Merganser along eight river sections of Poyang Lake watershed from November 2010 to March 2011.

Rivers	November 2010	December 2010	January 2011	February 2011	March 2011
Taiyangsheng section	48	11	9	9	16
Liaohe section	4	10	6	1	2
Taopi section	-	0	24	32	20
Longhushan section	9	0	0	8	3
Erkou section	3	9	0	2	0
Qinghu section	7	12	32	15	17
Fuliang section	8	6	1	8	9
Wuyuan section	12	13	0	14	18
Total	91	61	72	89	85

Notes: □ "-" Means not surveyed

(Table II). Shao *et al.* (2010a) observed about 40 individuals in Longhushan section in 2008 (Shao *et al.*, 2010a). The low water level and numerous human activities might explain the population decreases in the Longhushan section during this study. There were more than 20 workers repairing the railway in the Longhushan section from

December 2010 to March 2011, which could contribute to population instability and perhaps temporary disappearance of this species here. The mergansers were detected again in the Longhushan section after February 2011 when the water was not very low for this species.

The vi) Qinghu section of the Xinjiang River

has long been known to support scaly-sided Mergansers. Mergansers were observed along the Qinghu section for the first time in Jiangxi Province in 1992 and ornithologists began to pay more attention to the Jiangxi birds (Liu and Jia, 2000). Fang *et al.* (2009) reported that the number of mergansers in the Qinghu section gradually declined from 56 in 2001 to 12 in 2006 mainly because of human activities and water pollution, but then gradually increased to 46 in 2008 (Fang *et al.*, 2009). The maximum population size was 32 individuals in this section during this study, which was similar to the 2003 count (Table II). The closure of two large sand mining operations might explain the stable and relatively large population size in the Qinghu section during our study.

Raohe River

The number of mergansers was small in the vii) Fuliang section, although the bird was observed during every month of our study. The viii) Wuyuan section is a well-known area for mergansers and other birds. The population counted in the Wuyuan section was stable (Table II). However, a large proportion of the Wuyuan section had been heavily impacted by human activities, and this species was concentrated on a small river section less than 6 km long. We could not find any mergansers at many spots in the Wuyuan section where the mergansers were often seen in the past years (personal observation), mainly because of habitat modifications.

Group size and composition

Groups of Chinese Merganser were classified as male, female, mixed sex and solitary groups (Table III). Group size was not significantly different among the eight river sections ($F=1.038$, $df = 7$, $P >0.05$). Mixed sex groups were the most frequently encountered (64 groups) and comprised 71.91% of all groups sighted (89 groups). Solitary mergansers accounted for 22.47% (male: 15.73% and female: 6.74%) of the total group number and were also frequently encountered. Solitary Merganser and groups with 2-9 individuals accounted for 22.47% and 64.04% of total group number ($n=89$) respectively, indicating that the Merganser preferred to remain in small group sizes.

The small group sizes may be a result of low population size and/or food scarcity. Along eight river sections differences in group types were detected ($X^2 = 61.132$, $df = 7$, $P <0.05$) (Table III).

Behavior patterns

Feeding, swimming, resting and maintenance are the most frequent behavior patterns ($n=465$) (Table IV). We only detected a significant difference between males and females in the amount of time spent resting ($Z = -2.012$, $P <0.05$). Two factors may explain this difference. First, females we observed included sub-adults who had less experience in feeding, so they spent less time resting and more time feeding. Second, females probably spent less time resting and more time accumulating energy to prepare for the following breeding season than males.

For the first time, mergansers were observed copulating in winter in the Wuyuan River section.

Sex ratio

It is difficult to distinguish the female and sub-adult mergansers in the field because they have similar coloration. So the females we recorded included females and sub-adults. The sex ratio was 1:0.74 [(Females and sub-adults): males; $n=432$]. Non-significant spatial variation in the sex ratios was detected ($X^2 = 10.991$, $df = 7$, $P >0.05$) (Table V). Qinghu, Fuliang and Wuyuan sections were close to each other and had the similar sex ratios, indicating the mergansers in these three river sectors may come from adjacent regions with similar environmental conditions.

Conservation threats and management strategies

The sizes of the isolated areas suitable for the scaly-sided Merganser were decreasing owing to identified threats. Habitat fragmentation and a decline in the size of suitable habitat are expected to contribute to future population declines. Threats to the conservation of the scaly-sided Mergansers included sand mining, fishing, riparian vegetation destruction and water pollution. Sand mining operations could be seen in every river section where the mergansers lived (Table VI). During our surveys, often more than one sand mining operation was found within only 4–6 km of river. Sand mining

Table III.- Group types distribution of *Mergus squamatus* along different river sections of Poyang Lake watershed.

Group types	Taiyangs-heng	Liaohe	Taopi	Longhushan	Erkou	Qinghu	Fuliang	Wuyuan
Male	1							
Female	2						2	
Mixed	12	4	13	3	3	14	7	8
Solitary (F/M)	9(5/4)	2(0/2)	1(0/1)	2(0/2)	2(0/2)	1(0/1)	3(1/2)	

Table IV.- Behavior patterns (%) of Mergansers *Mergus squamatus* in Poyang Lake watershed.

Sex	Feeding	Swimming	Resting	Maintenance	Flying	Social	Alert
Male	31.64	20.34	22.03	16.95	3.39	1.13	4.52
Female	42.71	24.31	7.99	15.97	1.74	2.08	5.21
Overall	38.49	22.80	13.33	16.34	2.37	1.72	4.95

Table V.- Sex ratio* of *Mergus squamatus* along different river sections during wintering period (2010-2011) of Poyang Lake watershed.

River sections	Taiyangsheng	Liaohe	Taopi	Longhushan	Erkou	Qinghu	Fuliang	Wuyuan
Sex ratio	1:0.74	1:1.22	1:1.11	1:0.91	1:1	1:0.49	1:0.45	1:0.63
N	113	20	95	21	14	85	32	52

*Female and sub-adults : Male

Table VI.- The conservation threats and management strategies for the Scaly-sided Mergansers along different river sections of Poyang Lake watershed.

Location	Conservation threats	Management strategies
Taiyangsheng section	Sand mining, fishing, raising domestic ducks	Enhance river management, Limit the intensity of sand mining, Establish protected area for this bird
Liaohe section	Comparatively less human activities	Include this river section into the Jiulingshan National Nature Reserve
Taopi section	Sand mining, fishing, raising domestic ducks	Limit the intensity of sand mining, prohibit fishing, Include the river section used by mergansers into the Yihuang Wetland Park
Longhushan section	Comparatively less human activities	Establish protected areas for this bird, decrease human activities
Erkou section	Riparian vegetation destruction	Protect the riparian vegetation; Include this area into the Yangjifeng National Nature Reserve
Qinghu section	Sand mining, raising domestic ducks	Reduce the intensity of sand mining and water pollution in the upper reaches of the river
Fuliang section	Fishing, hydrologic engineering	Regulate the water level for the benefit of mergansers in areas with hydrologic engineering
Wuyuan section	Hydrologic engineering, water pollution, sand mining,	Limit sand mining and control water pollution

modified the habitat of this bird and might be the main cause of the disappearance or decline of the mergansers. Fishing activity caused disturbance to the species in each river section and might affect the

food availability for the mergansers. The destruction of riparian vegetation made the mergansers easier to find. The Merganser population in Erkou section was not stable mainly due to the riparian vegetation

destruction. Water pollution modified the habitat of the scaly-sided Mergansers and might decrease the abundance of food (such as fishes and invertebrates). Hydrologic engineering such as an electric generating station modified merganser habitat by increasing the water levels and eliminating shoals. Our surveys showed that the merganser selected rivers with some scattered shoals. We could not detect mergansers in many river sections (such as Liaohe section, Fuliang section) when the shoals were flooded, although this bird frequently occurred in these areas with shoals in the past prior to flooding.

We recommend more attention be paid to the welfare of the scaly-sided Mergansers in Jiangxi Province due to relatively large and steady population. However protecting this species has proved difficult because of its scattered distribution, dispersion into small groups and the lack of a fixed winter range (Zhao, 1993; Zheng and Wang, 1998). With the exception of the protected areas of the Qinghu and Wuyuan sections, all other river sections surveyed in this study were not protected formally by local governments. A well-defined conservation strategy, as given below is needed for scaly-sided Merganser because populations occur in isolated areas and the habitat continues to be degraded:

1. Local people should be made aware of the endangered status of the mergansers. During our survey, many local people were found to know the endangered status of mergansers were. We also helped inform local people of measures that could be taken or ways they could modify their activities to protect this species.
2. The Taiyangsheng, Taopi, Qinghu and Wuyuan sections should be prioritized for protection because these areas have relatively large and stable population (Table II).
3. Water pollution, fishing, sand mining and other human activities should be controlled in at least an area of 15–30 km along each river section that supports mergansers.
4. The raising of domestic ducks should be limited or prohibited in the Taiyangsheng, Taopi sections because more than 200 ducks were seen in each of these two river sections.
5. Some sections such as the Liaohe,

Longhushan and Erkou sections which lie outside the protected area boundary, should be added to the protected areas.

6. Hydrologic engineers, such as at electric generation stations, should manage the water level in a way that protects and benefits the merganser. During our surveys, the mergansers often disappeared when the shoals were submerged by the water released by hydrologic engineers, indicating the merganser preferred rivers with some shoals.

7. We also recommend conducting annual merganser surveys during winter to assess the population structure and trends. The number of mergansers and environmental factors should also be quantified.

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