Foraging behaviour and daily time budget of Scaly-sided Merganser *Mergus squamatus* breeding on the Iman River, Russia

D.V. Solovieva

Lena-Delta State Reserve, Fiodorova St. 28, Tiksi, Sakha, 678400, Russia
Email: Diana@DS3902.spb.edu

Daily time budget (DTB), foraging behaviour and the human affect on DTB of breeding Scaly-sided Merganser were studied on the upper Iman River, Primorye, Russia. Daytime averaged 14.8 hours in the period from arrival on the breeding grounds until mid-incubation. The Scaly-sided Merganser is a daytime feeder, and feeding increased prior to night ($F_{7,136}$=2.34, P<0.03). Detailed DTB was obtained for entire breeding period in males and for laying and incubating periods in females. Scaly-sided Mergansers employed two different feeding techniques: diving for fish after river ice break up and non-diving foraging before ice break up. Durations of feeding bout, diving bout, daytime sleep, dive and inter-dive acts were measured in both sexes. Disturbance by people required 0.11 hours additional flight during an average day. Incubating females have one or two non-active periods per day, which mainly occurred around the noon.

Key Words: Scaly-sided Merganser, *Mergus squamatus*, daily time budget, foraging method, disturbance by humans

The Scaly-sided, or Chinese Merganser *Mergus squamatus* breeds in a restricted area in southeast Russia and northeast China, and spends the winter using inshore zones around China and Korea (Shibnev 1989). After a known decline in the 1970s, the world population is now estimated to be only within the range of 2,400-4,500 individuals (Hughes & Hunter 1994; BirdLife International 2001). The biology and ecology of the Scaly-sided Merganser is poorly studied, but the species decline is considered to be the result of anthropogenic influences related to habitat loss, persecution and disturbance.

However, the affect of each factor has not been quantified. This species is included in the Red Data Books of IUCN, Russia (category 3 - rare), China and South Korea.

Time and energy budgets of Scaly-sided Mergansers are unknown for the breeding period and in the winter. However breeding biology has been studied in some locations in Russia and China (Kolomiytsev 1992; Zhengjie *et al.* 1995). Scaly-sided Mergansers inhabit rivers in mountainous forests where few allochthonous inputs affect water quality and where there are suitable cavities for nesting. This study of breeding Scaly-sided Mergansers at the Iman River, on the western slope of Sikhote-Alin Range, Russia had three key objectives: (1) to document detailed daily time budget (DTB) of both sexes; (2) to describe main feeding methods; (3) to document human affects on DTB.

Methods

Breeding Scaly-sided Mergansers were observed in the upper reaches of the Iman River (44°51'N; 135°31'E, **Figure 1**), one of the key breeding area for the species during years of 2000-2001 (Surmach & Zaykin 1994; see also for details of the study area). Observations were made from the bank of 2 km stretch of the river, inhabited by five pairs of Merganser in 2000 and by three pairs in 2001. The Iman is 35m wide, and flows as a single channel at the study site. Upstream, the river is met by the Krasnaya tributary. The valley through which the Iman flows is 1.5km wide, and largely comprises broad-leaved forest habitats. The surrounding slopes of the Sikhote-Alin Range comprise pine-spruced taiga. In winter, there are both frozen and open water bodies at the study site. Most water at the site in winter has a depth of less than 0.7m. After the main river clears of ice during the spring, the water becomes generally turbid and can reach a depth of nearly 2.5m.

The study was conducted between 14 April and 21 May 2000, and between 1 April and 7 April 2001. Observations for DTB were randomly distributed over daylight hours between 06:00 and 21:30 on 39 days. A 'scan session' method was chosen as being appropriative for a study of unmarked birds under restricted visibility. Two hides were built, from which known roosts and feeding areas could be observed. Scan sessions ranged between two and 189 minutes. A total of 45 hours of scan sessions were undertaken to observe pairs, groups of males, single males and single females. The behaviour of each bird was recorded every 30 seconds. Artificial lighting or moon light were used to observe birds at night-time roosts. Roosts were observed twice per night on 13 occasions. During scan sessions, the following behaviours were categorised:

- Feeding (diving and non-diving foraging)
- Alert

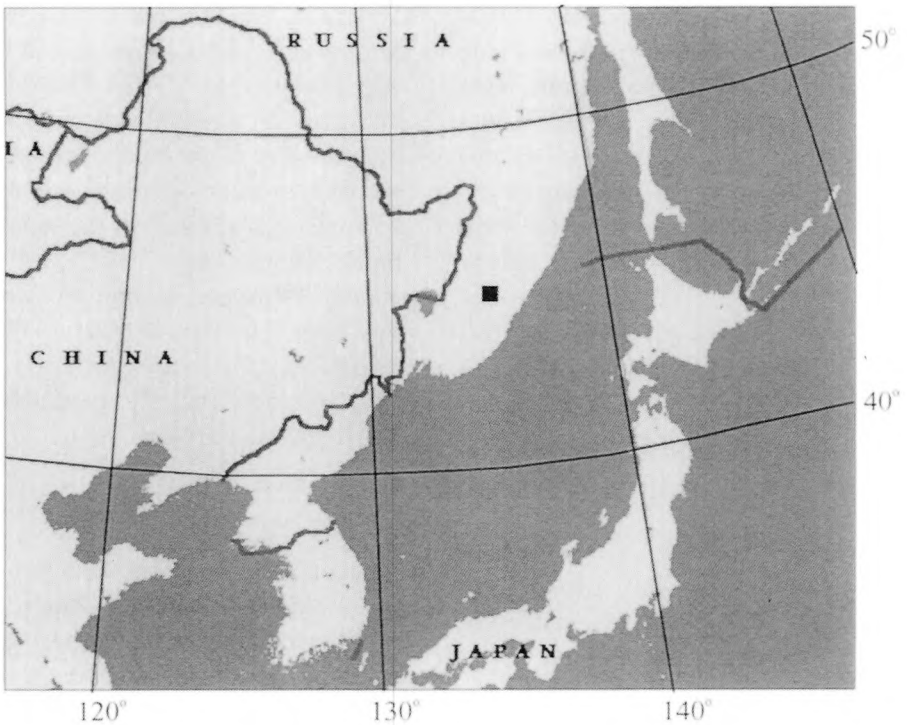

Figure 1. Map of Eastern Asia with the location of the study area marked with a square.

- Resting (night and daytime sleeping combined; resting)
- Comfort (preening on water or land)
- Locomotion (swimming with speed more than 0,7m/sec; swimming with speed less than 0,7m/sec; walking, running; flying; flying-persecution)
- Social (courtship; copulation; agonistic interaction)

The reaction of birds to the approach of humans was also timed and recorded. Human related flights were considered separately from the time budgets. The type of prey captured was recorded from visual observations and categorised simply as: fish, frog or insect larvae. The duration of the following major activities were measured: daytime sleep session, feeding (diving), single dive and single pause between two dives.

Mergansers were identified as breeding male (male stays on the nesting area for 1.5 months, when it might be seen paired, single or in flocks), laying female (female in pair with laying features as follows, visible egg in the abdomen and 'mirror' brightness of

feather), or incubating female (single female after males gathered into flocks). As no nomadic birds were recorded during laying period, it was considered that all single females which appeared at the study site for the short time (few minutes to one hour) during the incubation period, to be incubating hens.

To avoid time of day biases, the following method of DTB calculation was used.

- Scanning sessions less than 8 minutes were excluded from the analyses.
- Scanning sessions of an individual bird of any duration was considered to be a unit.
- Day time, which averaged from 6:50 to 21:40 (14,8 hours) was divided into eight intervals: 6:50-8:00; 8:00-10:00; 10:00-12:00; 12:00-14:00; 14:00-16:00; 16:00-18:00; 18:00-20:00; 20:00-21:40. The total of scanning minutes for the interval averaged 285±76 (range 41-706) for laying females and 322±87min (range 73-825) for males.
- The interval TBint was calculated from the scanning sessions. Each activity was presented as a proportion of one minute of observation within the given interval (TBmin). To get TBint the TBmin was multiplied by the duration of the interval.

Laying females are known to take an average 2.3 hours per day to lay an egg (Kolomiytsev 1992). The interval between consecutive eggs is 36 hours, thus the egg might be laid either in the morning or in the evening, and female normally doesn't stay in the nest for a night (Kolomiytsev 1992). It was assumed that egg laying occurs during the time intervals of 8:00-10:00 and 18:00-20:00. To obtain TBint from scanning sessions, the interval duration is 120-140/2=50 minutes.

- The final DTB is the sum of night time sleeping and all TBint.

Incubation averages 22.4 hrs.d^{-1} in Scaly-sided Merganser (Kolomiytsev 1992) Females were observed only during their non-incubating times in this study. Thus the DTB of non-incubating time was averaged for females (scanning sessions) and multiplied by 1.58 hours.

Results

Scaly-sided Merganser pairs arrived at the study site on 8 April 2000 and on 2 April 2001. Most feeding occurred during daytime hours ($F_{7,136}$=2.34, P<0.03). Periods of daytime roosting averaged 21.5±2.2 minutes (n=15) and occurred most frequently prior to midday (**Figure 2**). Mergansers roosted on two stony beaches along the river bank. Daytime activity started with a flight from these roosts to nearby feeding sites. Early morning flights started at approximately 07:10 in mid-April and at

06:40 in late May. The DTBs of Scaly-sided Mergansers during a daily cycle are presented in **Table 1**. Females started to lay eggs within a few days after arrival (first territorial single males were recorded on 17 April 2000 and 4 April 2001). No laying or incubating activities were observed during the current study, as no nests were located. Incubating female activities are presented in **Figure 3**, and the DTBs of incubating females presented in **Table 2**.

Scaly-sided Mergansers were found to employ two different feeding techniques depending on water turbidity and availability of food. In winter, when the water was relatively clear and shallow, birds spent 2.8% ± 2.9 % of their feeding time in pursuit dives (**Table 3**). Prey items were predominantly aquatic larvae and frogs, the latter being abundant in shallow areas of the river. In addition to diving, birds obtained food items by neck-dipping or rarely by up-ending (**Table 3**). Up-stream fish migration started during the break-up of river ice and the water level started to rise and increase in turbidity. At this time, Mergansers switched to diving for fish (**Table 3**). Ice break-up started on 17 April 2000 and 18 April 2001. Diving bouts averaged 6.6±0.9 minutes in females (n=10) and 5.8±2.1 minutes in males (n=10). The difference is not sig-

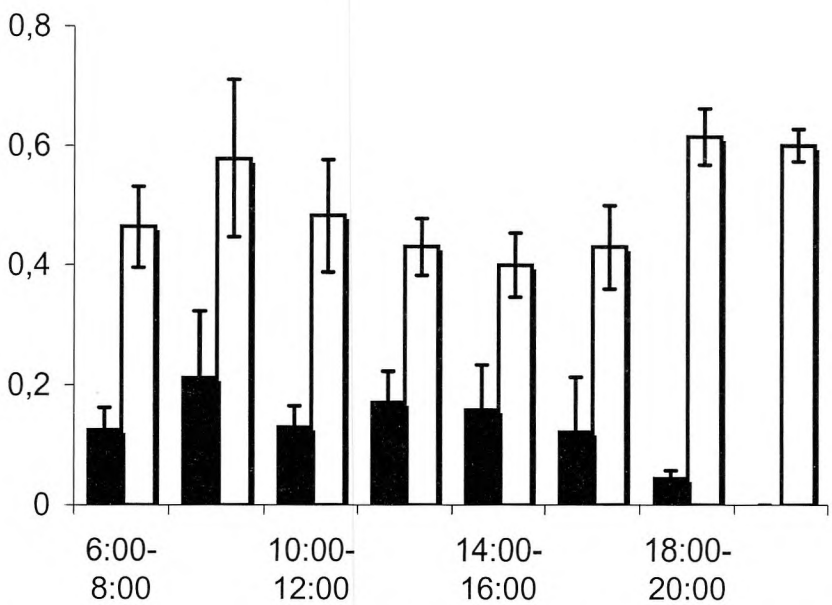

Figure 2. Relative distribution (mean±SE, minutes/minute of observation) of feeding (open columns) and sleep (filled columns) during daylight in Scaly-sided Merganser, Iman River, Primorye, Russia.

Table 1. Daily time budget (hrs d^{-1}) of breeding Scaly-sided Mergansers on the Iman River, Primorye, Russia.

Behaviour	Male	Female (laying period)
Feed	6.44	5.20
Alert	1.13	0.66
Sleep	11.61	11.75
Rest	0.59	0.66
Comfort on land	1.92	1.98
Comfort on water	0.14	0.07
Swim slowly	1.06	0.70
Swim rapidly	0.18	0.16
Pedal locomotion	0.08	0.04
Fly	0.53	0.32
Courtship	0.19	0.13
Agonistic	0.12	0.03
Laying	0	2.34
Total	24.00	24.00

Table 2. Recess time budget (hrs d^{-1}) of incubating females (n=6) of the Scaly-sided Merganser on the Iman River, Primorye, Russia. Average duration of recess (1.58 hrs) is calculated from Kolomiytsev 1992. The rest of time (22.42 hrs) is an attendance.

	Feeding	Alert	Comfort	Swim	Fly
Mean	0.80	0.08	0.48	0.12	0.10
SE_6	0.65	0.06	0.41	0.09	0.09

nificant. The average feeding bout duration was 17.5±2.4 minutes for pairs (n=11), during which time birds were moved downstream by the current an average of 151±38 m (n=6). Dive and between dive durations for both sexes are presented in **Table 4**. Between sexes difference were significant for dive duration (t_{135}=-2.94; P<0.003), but not for between dive duration (t_{114} =0.15, n.s.). Diving was asynchronous within pairs, ie one bird was submerged, the other at the surface. This was also the case for preening behaviour.

The frequency of fishermen using the site was 0.34 persons h^{-1} before river ice break-up, and 0.07 persons h^{-1} after river ice break-up. Weekend disturbance frequencies were three to four times greater, than on working days. Birds typically responded to the presence of fisherman by flying away (76% of cases). Thus people were responsible an average for 0.26 flights h^{-1} in birds during working days, and for 0.9 flights h^{-1} during weekends.

Discussion

This study has shown that the DTB for Scaly-sided Mergansers in Russia differs from that recorded for birds breeding on the Todaobai River in China. There, birds feed for the majority of daytime ie 14-15hrs d^{-1} (Zhengjie & Zhengjie 1998), whilst the current study recorded only 5-7 hrs d^{-1} devoted to feeding. Another behavioural difference between the two populations is that Mergansers primarily use non-diving foraging techniques (location and head-dipping for insect larvae) on the Todaobai River, while diving predomi-

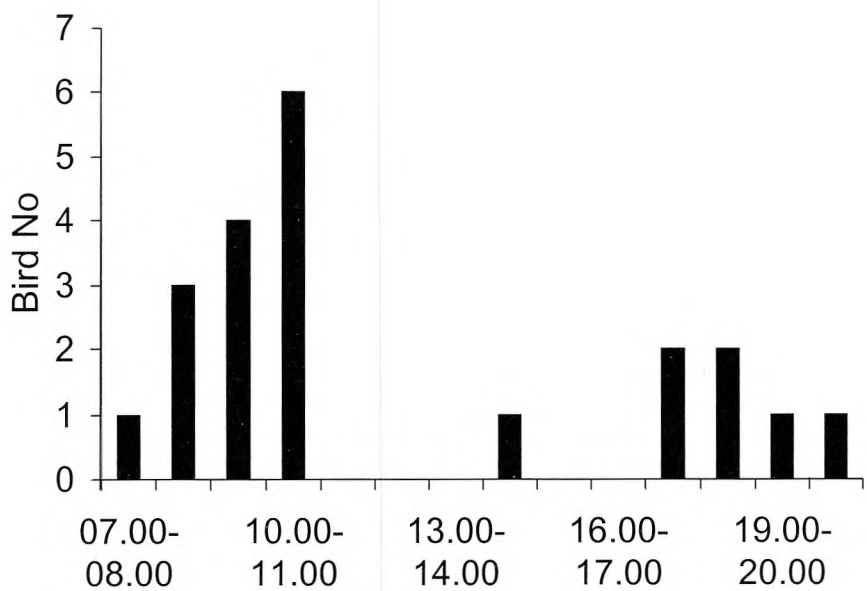

Figure 3. Distribution of off-nest periods in females of Scaly-sided Merganser during daylight according to single female registrations on the feeding site, early to late May 2000, Iman River, Primorye, Russia (22 days of hourly scanning of feeding site).

Table 3. Feeding methods of the Scaly-sided Merganser before (218 minutes of scanning) and after (2,073 minutes of scanning) river ice break-up, Iman River, Primorye Russia.

	Feeding activity as a percentage of total foraging time			
	Diving	Food searching (eyes submerged)	Head-dipping	Up-ending
Before break-up	2.8±2.9	80.9±5.1	15.4±5.0	0.9±0.8
After break-up	99.3±0.4	0.3±0.1	0.4±0.2	0.0±0.0

Table 4. Male and female dive patterns: water depth 1-2.2m, Iman River, Primorye, Russia.

	Male		Female	
	dive	inter-dive	dive	inter-dive
Mean±SE (seconds)	11.6±0.6	5.2±0.4	13.8±0.5	5.3±0.4
n	52	67	74	63

nated in Mergansers breeding on the upper Iman River (Zhengjie & Zhengjie 1998). These differences are probably the result of differences in water turbidity, and this in turn is related to logging activities. The Todaobai River is situated in the Changbai Mountain Nature Reserve and has non-logged forest on surrounding slopes, while intensive logging occurs on the slopes surrounding the Iman River which leads to high turbidity after break-up of river ice. Diving requires greater energy expenditure, but provides bigger and higher caloric value prey (fish), than picking insect larvae from the bottom. It appears that 5-7 hours of diving per day provides sufficient energy for breeding Mergansers on the Iman. Diving also dominates activity budgets in breeding Scaly-sided Mergansers at other rivers of Primorye, Russia (Shibnev 1985; Pugachuk 1974) and wintering Scaly-sided Mergansers employ diving at large non-forested rivers in China (Zhengjie & Zhengjie 1998).

A body of information is now being accrued on different populations of the Scaly-sided Merganser, and this can be used to underpin its conservation. However, further research is urgently

needed on this rare waterbird species. In particular, information is needed to quantify the frequency, distribution and impacts of anthropogenic influences related to habitat loss, persecution and disturbance.

Acknowledgements

I would like to thank my field assistant Sergey Vartanyan for a two-year period of data collecting and logistics. Thanks also to Ivan Laschenko, the owner of hunting cabin on the Iman River, for his hospitality. Field expeditions were funded by Lundi Co, Ferl, Germany in 2000 and by The Wildfowl & Wetlands Trust, Slimbridge, UK in 2001.

References

BirdLife International. 2001. Scaly-sided Merganser. *Threatened Birds of Asia: the BirdLife International Red Data Book*. BirdLife International, Cambridge, UK.

Hughes, B. & Hunter, J. 1994. The Scaly-sided Merganser *Mergus squamatus* in Russia and China. (eds. B. Hughes & J. Hunter). *Special publication of the Wildfowl & Wetlands Trust* No 1: pp. 2.

Kolomiytsev, N.P. 1992. To the biology of Scaly-sided Merganser in Kievaka-River basin (South Primorye) (translation of title) in: *Ornithological studies in the nature reserves* (translation of title) (ed. V.E. Sokolov), Nauka, Moscow; pp. 68-83 (in Russian).

Shibnev, Yu.B. 1985. The current status of *Aix galericulata* and *Mergus squamatus* on Bikin River in: *Rare and endangered birds of the Far East*. Far East Scientific Centre RAS, Vladivostok; pp. 95-99. (In Russian with English summary).

Shibnev, Yu.B. 1989. Scaly-sided Merganser (translation) in: *Rare vertebrates of the Far East and their conservation* (translation of title), (ed. P.A. Ler), Nauka, Leningrad; pp. 78-79 (in Russian).

Surmach, S.G. & Zaykin, D.V. 1994. The Scaly-sided Merganser *Mergus squamatus* (Gould) in the Iman basin, Far-East Russia. The Scaly-sided Merganser *Mergus squamatus* in Russia and China. (eds. B. Hughes & J. Hunter). *Special publication of The Wildfowl & Wetlands Trust* No 1: pp. 11-17.

Zhengjie, Zh., Han, X., Zhang, S., Wu, J. & Piao, Zh. 1995. Breeding ecology of the Chinese Merganser in the Changbai Mountains, China. *Journal of Field Ornithology* 66 (1): 54-59.

Zhengjie, Zh. & Zhengjie, P. 1998. The foraging behaviour of the Scaly-sided Merganser *Mergus squamatus* in the Changbai Mountains and Xiao Xingangling Mountains of China. *Forktail* 14: 76-77.