Bird Conservation International (2001) 11:287–300. © BirdLife International 2001

Natural history and conservation of Brazilian Merganser *Mergus octosetaceus* at Serra da Canastra National Park, Minas Gerais, Brazil

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Summary

Brazilian Merganser *Mergus octosetaceus* is considered to be one of the rarest and most threatened species in the Neotropical region, yet little is known about its distribution and life-history. We studied the population of Brazilian Merganser in and around Serra da Canastra National Park (SCNP) in Minas Gerais, Brazil, during 1996, with additional observations from 1997 to 2000. In this paper we report the sighting of previously undiscovered pairs and present some new behavioural data, including a description of calls performed by males and females, feeding behaviour, home ranges, parental care and population density. We also describe a previously unreported plumage of the young. A total of 39 individuals were recorded, comprising 12 adults (six pairs) and 27 young. Brood size ranged from two to four (mean 2.7), being smaller than in other *Mergus* spp. (e.g. Goosander *Mergus merganser*). Two pairs were located within the SCNP, and four on unprotected stretches of river outside. Home range was large compared with other *Mergus* spp., each pair using on average 9 km of river. Range size was thought to be related to the availability of suitable nesting and feeding sites. SCNP and its environs contain very little mature gallery forest with trees large enough to provide nest sites (most having been selectively logged in the past). There is also competition for nest sites with other birds and mammals. All suitable habitat surrounding the SCNP is now occupied by adult birds, leaving none for young birds. Further research is needed to determine the fate and dispersion routes of juveniles. Future conservation priorities for Brazilian Merganser in and around SCNP include the installation of nest boxes to test whether the availability of good quality nest sites limits breeding success. A captive breeding programme could be established using eggs from these nest boxes. This would help to ensure the survival of this species and to provide birds for future reintroduction programmes should they be deemed necessary. Further surveys, with subsequent establishment of reserves at key sites, are required throughout the Brazilian Merganser's range.

Introduction

Brazilian Merganser *Mergus octosetaceus* inhabits rivers of clear water and rapids, and is considered one of the most threatened birds in the Neotropics (Collar *et al.* 1992). The species is distributed throughout Brazil, Paraguay and Argentina, with the most recent records coming from Brazil (Bartmann 1988, Collar *et al.* 1992, Anjos *et al.* 1997, Silveira 1998, Stattersfield and Capper 2000, Pineschi and Yamashita pers. comm.).

Considered to be one of the few Brazilian birds adapted to mountainous regions (Sick 1997), Brazilian Merganser has had its habitat reduced to irregularly distributed plateaux known as ''Chapadas'' or ''Chapadões'', through eastern Brazil. In these geological formations, rivers run over rocks that are somewhat friable and the water is highly oxygenated. It is interesting to note that these formations are also found in the Argentine province of Misiones, where Brazilian Merganser was common until the mid-1950s (Partridge 1956, Yamashita and Valle 1990).

Pairs of Brazilian Merganser occupy long stretches of river, resulting in low population densities. This, combined with their extremely vigilant behaviour and ability to detect observers from afar, make observing their daily activities a hard task. Thus, its biology is still largely unknown, save for the pioneering studies of Partridge (1956) and Bartmann (1988).

In June 1996 we began a project to investigate the population density and habitat requirements of Brazilian Mergansers at Serra da Canastra National Park (SCNP), Minas Gerais, Brazil. The purpose was to discover more pairs, mainly outside the SCNP, as well as to evaluate the population requirements and verify some aspects of the species's biology. Since observations by Bartmann (1988), the SCNP has become one of the best places to watch Brazilian Merganser, with at least three pairs known in this area.

Study area and methods

The SCNP was founded in 1972 and is situated in south-west Minas Gerais State (20°15'S; 46°40'W, Figure 1). The park covers some 73,000 ha, most of which comprises one rocky plateau with an altitude of 900 to 1,400 m. It has an irregular topography, with deep valleys and many springs. The São Francisco River, one of the most important in Brazil, rises in the SCNP. The vegetation of the Park is ''cerrado'' *latu sensu*, with gallery forest lining the larger rivers (IBAMA 1981; Silveira 1998). Outside the SCNP some patches of preserved gallery forest can be found, but much has been destroyed to make way for mining and cattle pasture.

Brazilian Merganser observations were conducted mainly outside the SCNP, within 50 km of its borders. In 1996, five trips (15 days each) were made, giving a total of 75 days of fieldwork. Additional trips were made during 1997–2000 (Table 1).

We began our activities on 13 June 1996, interviewing farmers of São José do Barreiro District with the aim of identifying potential areas for Brazilian Merganser, verifying if people were able to recognize it and requesting permission for access to land. Most farmers could recognize the species, but always described it as being very rare, shy and difficult to see.

All potential habitats for Brazilian Merganser were surveyed by foot, by walking through the riverside gallery forest. Observations were made with binoculars and telescopes (8.5×45 mm and 20×60 mm, respectively). Calls were tape-recorded using a Sony TCM 5000 EV and a Sennheiser ME 66 microphone, and deposited at Arquivo Sonoro Elias Coelho (ASEC, Universidade Federal do Rio de Janeiro, UFRJ, RJ). A sighting was defined as one individual (or pair or family group) located per day per home range.

Observations began around 06h30 and lasted until the time the birds went to

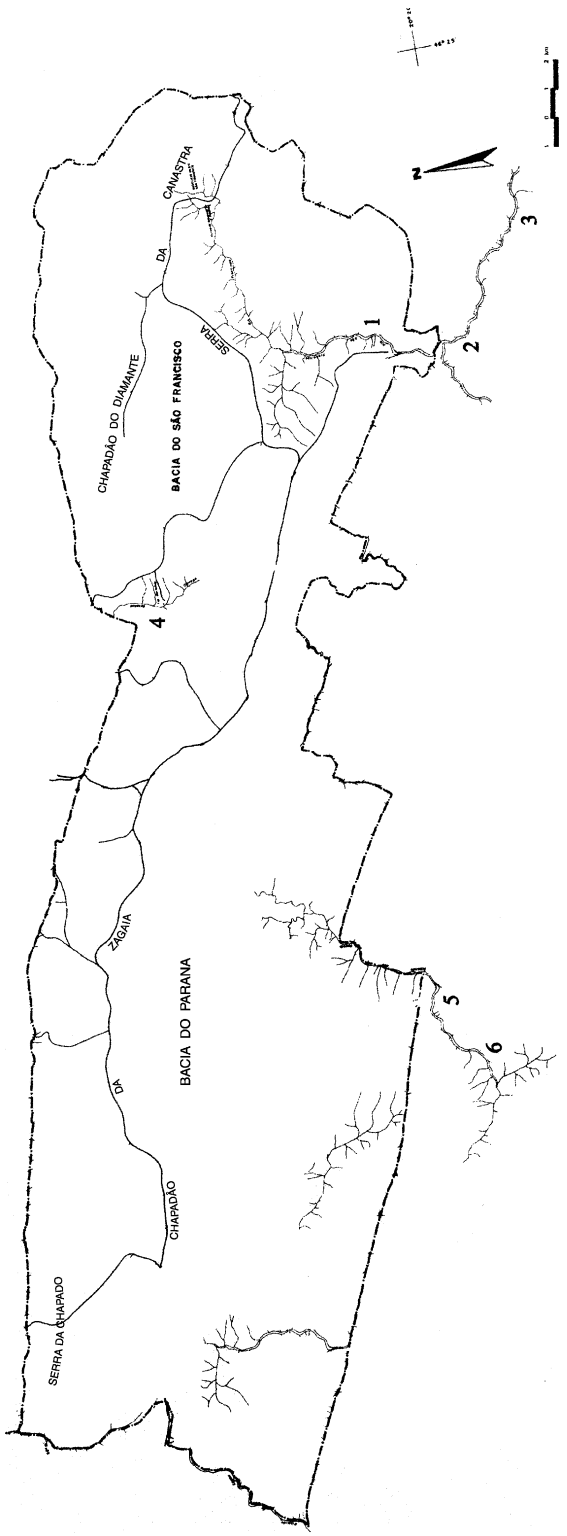

Figure 1. Map showing the location of Serra da Canastra National Park (marked with a star) and surrounding areas in Minas Gerais State, Brazil (modified from IBAMA 1981). Numbers denote the river stretches where each pair of Brazilian Merganser was found. Dashed lines denote the SCNP boundaries and solid lines represent the main road of the SCNP. Only the larger rivers and streams are represented. The length of river used by particular pairs is not accurately mapped.

Table 1. Sightings of Brazilian Merganser at Serra da Canastra National Park, Brazil, and surrounding areas, 1996–2000.

	1996	1997	1998	1999	2000	Total
Jan			0 (4)		1 (1)	1 (5)
Feb			0 (3)			0 (3)
Mar		0 (5)				0 (5)
Apr			0 (5)			0 (5)
May		0 (5)				0 (5)
Jun	4 (15)					4 (15)
Jul	6 (15)					6 (15)
Aug	8 (15)		1 (5)			9 (20)
Sep	5 (15)		2 (3)		1 (1)	8 (19)
Oct	3 (15)			2 (5)		5 (20)
Nov		1 (3)		1 (5)		2 (8)
Dec		0 (5)		0 (5)		0 (10)
Total	26 (75)	1 (18)	3 (20)	3 (15)	2 (2)	35 (130)

Days in field in parentheses.

roost or until we lost contact with them. At each site where Brazilian Merganser was found, some habitat details were recorded, especially the water clarity (checked by eye, in relation to water turbidity) and the condition of the surrounding gallery forest (i.e. primary or selectively logged; presence or absence of large trees).

Results

We visited the SCNP region in all months of the year, with a total of 130 days in the field, mostly in 1996. We recorded 35 contacts with Brazilian Mergansers, most of them between July and October (Table 1). Six different pairs of Brazilian Merganser were found, three of them entirely outside the Park, as follows (Figure 1):

Pair 1: On a 12-km stretch of the São Francisco River, above Casca d'Anta waterfall, in SCNP. First recorded on 15 June 1996.

Pair 2: On a 10-km stretch of the São Francisco River, below Casca d'Anta waterfall, almost to the district of São José do Barreiro (most of the home range lies outside the SCNP). First recorded on 17 June 1996.

Pair 3: On a 9-km stretch of the São Francisco River, below the district of São José do Barreiro (outside SCNP). First recorded on 24 June 1996.

Pair 4: On a 5-km stretch of Rolinhos stream, at Retiro das Pedras, in SCNP. First recorded on 4 August 1996.

Pair 5: On a 7-km stretch at Ribeirão das Posses, outside SCNP. First recorded on 20 September 1996.

Pair 6: On a 7-km stretch at Ribeirão das Posses, around 8 km below the place where Pair 5 were recorded, also outside SCNP. First recorded on 25 October 1996.

The river stretches occupied by Pairs 1, 2 and 4 were known and studied by Bartmann (1988), whilst those used by Pairs 3, 5 and 6 were previously undiscovered.

General behaviour

Our first contact with the species occurred on 15 June 1996, in the home range of Pair 1. One individual was observed (later discovered to be a male) which swam down the São Francisco river (at 15h20), calling for about 10 minutes. These calls were recorded and when played back the bird responded promptly by lifting its tail in a fanned position, lowering its wings slightly, stretching its neck and moving its head up and down whilst calling. After this the male took off and could not be re-located. As we observed just a male, the female was probably already incubating. On 16 June 1996 we returned to the same place and, some minutes after playing the male's call at 13h30, we saw the pair flying quickly and silently, close to the river. As they flew past they moved their heads laterally, as if looking for the source of the sound. On 17 June 1996, again by using playback, we located Pair 2 and were able to observe them for about five minutes.

Pair 3 was discovered on 24 June 1996 at 08h00, from the road of Casca d'Anta waterfall to São José do Barreiro district. After playback, the birds approached us to within 2.5 m, calling and displaying in a similar manner to the male of Pair 1. Morphological and behavioural differences were apparent between male and female. The female was smaller, with a shorter crest and shorter beak. The male was more robust, with a larger crest. We made about 40 minutes of observation of this pair before they flew off up the river. After we played the call again, five minutes later, this pair returned chasing another pair (Pair 2), pecking them on the back and calling. After forcing Pair 2 to alight on the river, they began to fight again, forcing this pair to leave. This fight may have happened because the playback had attracted two pairs into the same home range, something that is rare under normal conditions. After expelling Pair 2, Pair 3 floated down the river for about 40 m, before perching on an exposed rock to preen.

Males and females of the same pair always performed the same activities together, interspersed with small pauses of alert behaviour. To feed they dived to a depth of about 0.5 m, remaining submerged for an average of 15 seconds ($n = 17$). Most of the resting and feeding areas of Brazilian Merganser were where the water flow was slower, forming pools (locally known as ''remansos''). Partridge (1956) reported the use of rapids as a feeding area, but in our study area these were used much less.

Adults in the study site are thought to feed mainly or exclusively on a characid called ''Lambari'' (tetra fish *Astyanax* sp.), one of the smallest fish species found in the rivers of the area. As we did not observe the birds feeding on other organisms and did not examine any stomachs, our results are still inconclusive and preliminary. Partridge (1956) reports some fish species and invertebrates in the stomachs of Brazilian Mergansers collected in Argentina.

Resting and preening occupied most of the day, during which time Brazilian Mergansers could be easily found, loafing on exposed rocks. They usually defecated in the water (which can reduce detection due to a lack of white excrement on exposed stones).

In the evening, Brazilian Mergansers typically remained near rocks in the middle of the river, hauling out onto rocks to roost. This presumably reduces the risk of predation by land predators, such as ocelots *Felis* sp., and also allows an easier escape route than shore-based roost sites.

Figure 2. Female Brazilian Merganser with two of four young, São Francisco River, Minas Gerais, Brazil, 16 June 1996. (Photograph by Wolf Bartmann.)

Reproductive behaviour

Copulation by Pair 3 was observed on 24 June 1996. At 11h15, after preening, the female entered the water, followed by the male, which swam around her, lifting his tail and neck and moving his head up and down. The female swam in the centre of the river, making the same movements as the male. As the male mounted her back, and held her crest with his beak, the female's body became submerged with only her neck out of water. This first copulation lasted *c.* 15 s, after which they returned to the rocks again. The second copulation occurred five minutes later and was longer (*c.* 25 s). Observations on this pair continued until 17h30, when they flew up river (perhaps searching for a roosting site), and could not be relocated. This pair probably bred but, despite intensive searches during subsequent days and trips, no young were detected in 1996.

On the morning of 16 September 1996, we re-located Pair 1 followed by four young. The offspring were more developed than those described by Partridge (1956) and Bartmann (1988), with a plumage that has not been previously described. These ducklings were almost the same size as an adult bird and had a dark upper mandible, reddish lower mandible, a white eye ring, no crest, whitish cheeks and neck, and a dark head, giving a capped appearance. The breast was greyish, the back grey, as in the adult, the wing-bars were present, and the feet were red (Figure 2). These young were not able to fly, and the parents never left them. When the birds perceived our presence, they swam quickly into riverside vegetation to hide, their dark colour providing effective camouflage.

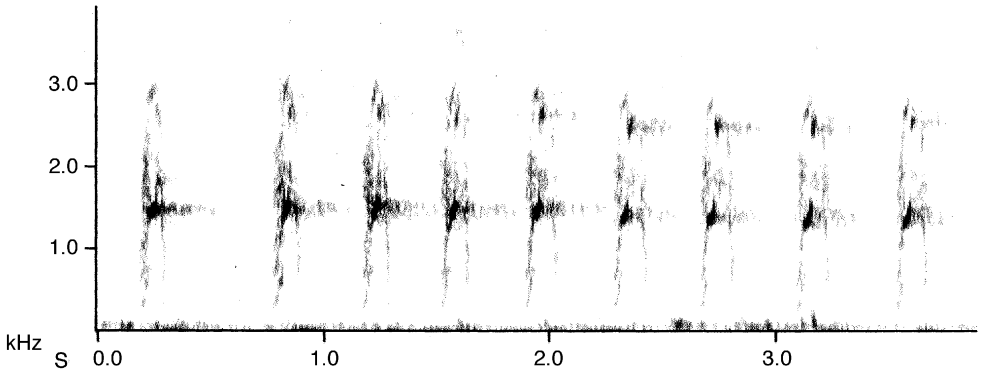

Figure 3. Sonogram of main call of male of Brazilian Merganser, recorded on the São Francisco River, Minas Gerais, Brazil, 15 June 1996 (''barking dog''). Prepared with Canary programme (1.2.4) by Charles Ozanick. Voice deposited at ASEC.

Voice

Four different types of calls were recorded (all deposited at ASEC, see Acknowledgements). The main call of the male Brazilian Merganser resembled a barking dog, being nasal and strident, composed of many repeated notes, at short intervals (Figure 3). Another male call was a sequence of a sharp and nasal ''ák-uí-rrrrr . . . -uí'' (Figure 4) and a sequence of ''ák-rrrrr . . . -ák'' notes (Figure 5). The female's most frequent call consisted of a sequence of raucous ''rrrr . . . -rrrrr . . . . -rrrrr . . . . '' (Figure 6). A contact call was recorded, consisting mainly of the male's call ''uí-uí-uí'' and the female's ''rrrr . . . rrrrr . . . rrrrr . . . '' (Figure 7). Pairs were observed calling together and a single male was observed calling on one occasion.

Vocalizations were also reported by Partridge (1956) and Bartmann (1988), although the former noted that he heard the voice only when the bird was in

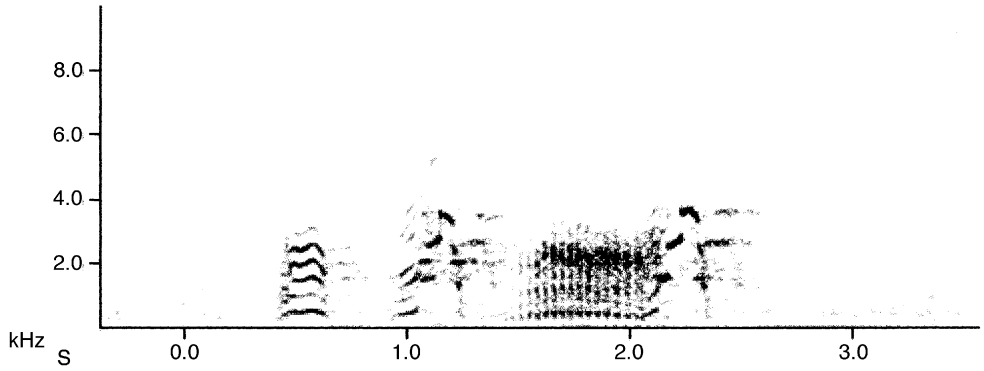

Figure 4. Sequence of male's ''ák-uí-rrrr . . . -uí', recorded on the São Francisco River, Minas Gerais, Brazil, 15 June 1996. Prepared with Canary programme (1.2.4) by Charles Ozanick. Voice deposited at ASEC.

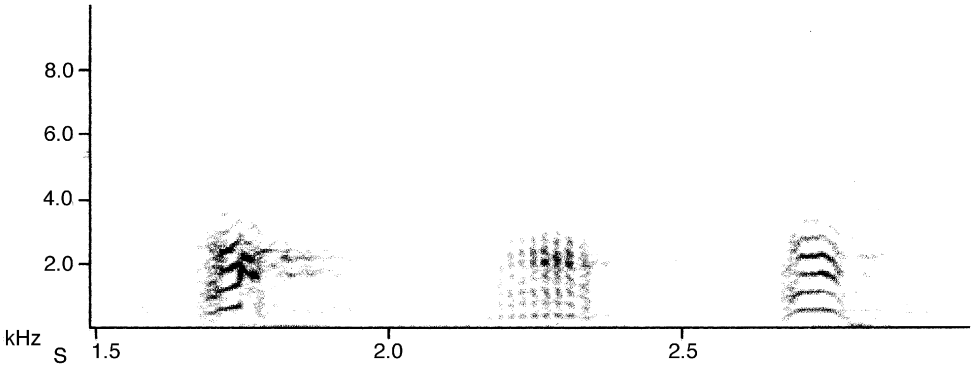

Figure 5. Sequence of male's ''ák-rrrrr . . . -ák'' recorded on the São Francisco River, Minas Gerais, Brazil, 24 June 1996. Prepared with Canary programme (1.2.4) by Charles Ozanick. Voice deposited at ASEC.

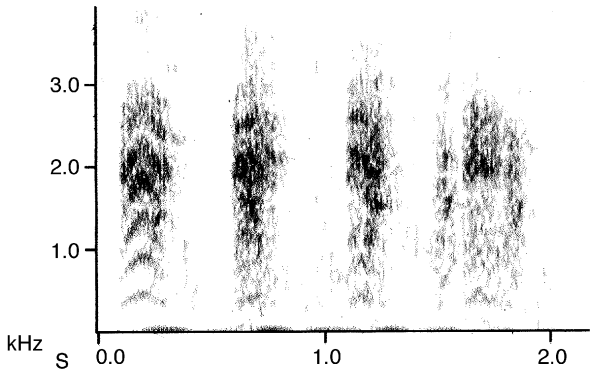

Figure 6. Female's more frequent call (''rrrr . . . -rrrrr . . . . -rrrrr . . . .'') recorded on the São Francisco River, Minas Gerais, Brazil, 24 June 1996. Prepared with Canary programme (1.2.4) by Charles Ozanick. Voice deposited at ASEC.

flight. Brazilian Merganser called more frequently in the breeding season, and in flight when frightened by observers. Contact calls were frequent when the birds were swimming.

Habitat selection, population density and reproductive rate

Brazilian Mergansers inhabited places where the water was clear, greater than 1 m in depth and 3 m wide, with rapids, and contained exposed rocks where they roosted. They fed mostly in pools where the water current was weaker.

Preserved gallery forest alongside rivers provides nest sites for Brazilian Merganser, but the species was apparently not dependent on a large and continuous forest for survival. Most recent records of Brazilian Merganser in Brazil are from ''cerrado'', with just one sighting in Atlantic Forest (Anjos *et al.* 1997). Water

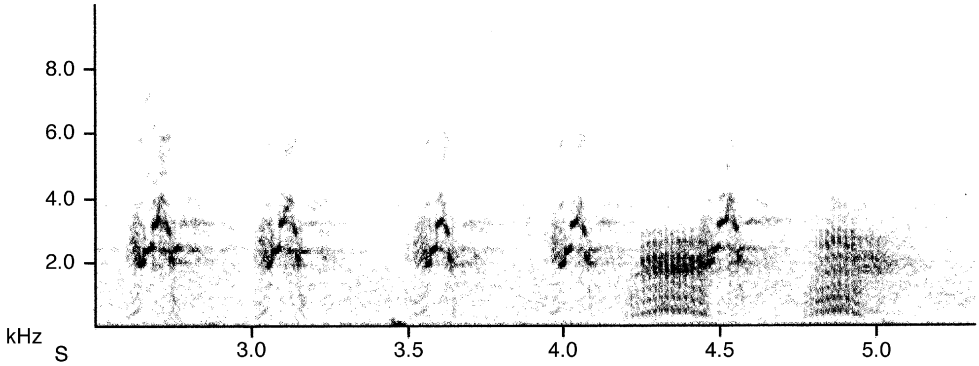

Figure 7. Contact call of Brazilian Merganser, recorded on the São Francisco River, Minas Gerais, Brazil, 24 June 1996 Prepared with Canary programme (1.2.4) by Charles Ozanick. Voice deposited at ASEC.

quality and the maturity of the gallery forest are probably more important. When these two conditions are met, birds can withstand some human perturbation, as we observed in SCNP. The areas used by Pairs 1 and 2 were near camp sites and Pair 3 was located close to the road that runs from São José do Barreiro village to the city of Vargem Bonita. When disturbed, the birds always flew to places where the gallery forest was taller, and there were few people.

When, after the rains, the main rivers became turbid with soil sediments, Brazilian Mergansers moved to small tributaries (surrounded by gallery forest) with cleaner water, as we observed on four occasions in August and October 1996. Very shallow streams (around 50 cm deep and 2–4 m wide) may be used. Brazilian Mergansers returned to the main tributaries when water clarity improved.

Pairs 1, 2 and 3 were distributed along approximately 30 km of the São Francisco River, while Pairs 5 and 6 were found along about 15 km of the Ribeirão das Posses. Pair 4 used the smallest range, about 5 km long in the Retiro das Pedras region. In SCNP average home range length was 9 km. The size of home range may be related to food availability and the maturity of gallery forest.

During the study period, five of the six pairs produced 10 broods with a total of 27 young (Table 2).

Table 2. Number of ducklings raised by Brazilian Mergansers in SCNP, Brazil, 1996–2000.

Pair no.	1996	1997	1998	1999	2000	Total
01	4	4	2	2	-	12
02	0	0	-	0	2	2
03	0	0	-	3	-	3
04	4	2	2	0	-	8
05	0	-	-	-	-	0
06	2	-	-	-	-	2
Total	10	6	4	5	2	27

A hyphen denotes a pair not re-located in that year.

Discussion

Reproductive behaviour

Copulation behaviour in Misiones described by Partridge (1956) and Giai (1976), was similar to that which we observed, although Partridge (1956) noted a ''long cry'' after mating, not heard by us. The behaviour of the male, holding the female's crest during copulation, was also reported by these authors.

No nests were found during our study. Partridge (1956) reported a nest in a tree hole 25 m above the river. Brazilian Mergansers in SCNP probably breed in holes in trees, and may compete with other animals for this resource (see below).

Habitat selection, population density and reproductive rate

There could be a number of factors influencing breeding success in Brazilian Mergansers, including the availability of nest holes, age of pairs (too old or too young) and nest predation. Old, large and holed trees were rare in the gallery forest in the region of SCNP because many of them have been removed by man. Tree holes are in any case a limited resource sought by many other animals, such as Muscovy Ducks *Cairina moschata*, the toucans *Ramphastos dicolorus* and *R. toco*, parrots (e.g. *Pionus maximilianii*) and mammals such as opossum *Didelphis albiventris*. We do not know if distance to the river is a limiting factor in the choice of nest site by Brazilian Merganser.

South-western Minas Gerais State has a well-defined dry season (March–September), when river levels are low, exposing many rocks that are submerged at other times. The Brazilian Merganser's breeding season begins in June/July, and ducklings hatch in late July. As the river is shallower at this time of year, with many pools, this could be the best time to rear ducklings. Marquiss and Duncan (1993) observed that the low water level could aid the survival of the ducklings of Red-breasted Merganser *Mergus serrator*, because in fast-flowing water the food is dispersed. This can also be applied to Brazilian Merganser ducklings. By the time the rainy season begins, the chicks are able to feed by themselves and strong enough to cope with faster-flowing water.

The reproductive rate of Brazilian Merganser seems to be low in comparison with other mergansers. Brood size ranged from two to four ducklings (mean 2.7) being smaller than that recorded in other *Mergus* spp. (e.g. six to seven ducklings per brood in Goosander *Mergus merganser*, Marquiss 1998). Some pairs of Brazilian Merganser did not rear young in some years, but a few were not re-located and could have bred successfully.

Juvenile Brazilian Mergansers probably remain with their parents until December–January, after the moulting period, when the parents are thought to drive the young from their home range. However, no young bird was found alone in other parts of the rivers. All suitable habitat on the São Francisco River appears to be occupied by mature pairs, presumably forcing young birds to leave the area in search of further suitable habitat. The fate of young and dispersion routes remain a mystery.

Most of the birds collected in Brazil (Collar *et al.* 1992) and Argentina (Partridge 1956; Johnson and Chebez 1985) were collected in the breeding season. As suggested by Johnson and Chebez (1985), birds actively defending their range

at this time of year are probably more vulnerable than in other months. The moulting period could explain the paucity of records at the end of the rainy season, when the birds are more secretive after losing their flight feathers. Giai (1976) noted that February was the moulting period in Misiones.

Conservation threats and future priorities

Good water quality and the presence of gallery forest seem to be the basic habitat requirements of Brazilian Merganser. The width of the gallery forest adjacent to rivers and the surrounding vegetation are apparently not so crucial, and in suitable habitats Brazilian Mergansers can withstand some human disturbance. More pairs of Brazilian Merganser were found outside the SCNP, even though pairs within the Park were well protected and breeding more successfully.

The main threat to the survival of Brazilian Merganser in our study area has been the destruction and degradation of its habitat, caused by mining activities during the 1980s and 1990s. Although these activities are now prohibited, the areas used for mining have not been restored, leading to increased erosion and greater river turbidity. Gallery forest has also been damaged as a consequence of these activities. Brazilian Merganser is no longer found in areas previously used for mining, although it was well known by diamond miners before mining activities began.

Ecotourism may now be a threat, as Brazilian Mergansers are generally sensitive to human disturbance. During holiday periods, about 1,500 tourists visit areas near the ranges of Pairs 1 and 2 (2,500 in 2001 Carnaval, Rosilene Ferreira pers. comm.). Camp sites have also been established close to the São Francisco River in the ranges of Pairs 2 and 3. These places have no infrastructure to support the increasing number of tourists visiting SCNP. This disturbance could restrict Brazilian Mergansers to places not accessible to tourists, or drive birds into less suitable habitat. An educational programme involving the local farmers and tourists to raise the profile of Brazilian Merganser is important, especially in those areas directly affected by the tourism activities.

Hunting is not thought to be a serious threat to Brazilian Mergansers in and around SCNP. Two hunters said that they had hunted this species for food about two years ago, but not now. The species is too shy, making it difficult to capture, and because it is a small bird (according to the hunters, Brazilian Mergansers weigh 600–700 g), the carcass does not compensate for the effort required to hunt it.

Further surveys should be concentrated near the north and south-west borders of the Park in less accessible areas that still possess good stretches of gallery forest. Key areas include the Santo Antônio River and the Chapadão da Babilônia. Inside the Park, further surveys are needed in the Córrego do Quilombo and Córrego da Zagaia. The use of playback is an efficient tool for detecting Brazilian Merganser in the breeding season, and could be tried in these areas.

We suggest the installation of nest boxes in the gallery forest adjacent to the São Francisco River outside the SCNP, in river stretches without mature trees, to counteract the deficiency of nest sites available to pairs of Brazilian Merganser. Other merganser species, such as Hooded Merganser *Lophodytes cucullatus* and

the globally threatened Scaly-sided Merganser *Mergus squamatus*, accept nest boxes, and re-use them from year to year (Kolomiitsev 1986, Zicus 1990).

Establishing a captive population is an idea that should not be dismissed. Indeed, it may be crucial to the long-term survival of the species. Captive breeding of other Mergini species is relatively straightforward, and there is no reason to suggest that Brazilian Merganser will be any different. Since the failure of previous attempts to establish a captive population (e.g. Partridge 1956, Johnson and Chebez 1985), captive breeding techniques have improved markedly. If the birds accept nest boxes this would provide a source of eggs that could be reared artificially or by other *Mergus* species. As in many waterfowl, females are likely to re-lay if a first clutch is taken and so little impact is anticipated at the population level. Captive groups could then supply any future reintroduction programmes in areas such as Misiones or in others where initial causes of decline have been addressed. Such initiatives must be endorsed by national environmental authorities, and be a part of a coordinated international action plan to save this species.

Although Hayes (1995) suggests that in Paraguay there is no suitable habitat left for Brazilian Mergansers, surveys of streams in the remaining Atlantic Forest of Paraguay and Argentina are important to detect potential places where Brazilian Merganser might still occur. The record from Tibagi River, in Paraná State (Anjos *et al.* 1997) must be investigated and, if the species still persists there, the site should be protected as the only site for Brazilian Merganser in the Brazilian Atlantic Forest domain. Intensive surveys in Emas National Park and Chapada dos Veadeiros National Park (Wege and Long 1995) are also urgently required, as there have been no recent sightings from these areas. Recent records from western Bahia State (Pineschi and Yamashita pers. comm.) are extremely important. The occurrence of ''cerrado'' habitat in this state and the number of birds found (34) suggests that western Bahia could be a stronghold for the species. Unfortunately, none of these sites are currently protected and they are threatened by deforestation and construction of dams.

Acknowledgements

This paper benefited greatly from the discussions at the First Brazilian Merganser workshop, held in Serra da Canastra National Park on 18–22 September 2000. We thank all participants: Andrés Bosso (Aves Argentinas, Argentina); Bruce Dugger (Southern Illinois University, U.S.A.); Guillermo Gil (Regional Nordeste de la Administracíon de Parques Nacionales, Argentina); Baz Hughes (Wildfowl and Wetlands Trust, U.K.); Mike Lubbock (Sylvan Heights Waterfowl, U.S.A.); Nancy López de Kochalka (MAG/PARN, Paraguay) and Douglas Piekarz (Akron Zoological Park, U.S.A.) for their dedicated involvement in Brazilian Merganser conservation. Rosilene A. Ferreira, director of Serra da Canastra National Park provided logistical support during the meeting and tourist information about the park. To the people who shared our searches and observations in the field: Líliam Pinto, Guy Kirwan, Edson Endrigo, Cibele Ferreira, Sávio Bruno, Pedro Develey, Flávio Lima, Roberto Murta, Karin Werther and Juan Barnett. To the staff of IBAMA at SCNP for permits to carry out research in the park. To Zoologische Gesellschaft Frankfurt – Hilfe für Bedrohte Tierwelt,

Coordenação de Aperfeiçoamento do Pessoal de Nível Superior (CAPES) and Fundação de Amparo à Pesquisa no Estado de São Paulo (FAPESP) for grants for LFS. To Dr Elizabeth Höfling (Departamento de Zoologia, Universidade de São Paulo) for her continuous guidance. To Professor Dr Luiz Antônio Pedreira Gonzaga (Laboratório de Bioacústica – Arquivo Sonoro Elias Coelho, ASEC) of the Departamento de Zoologia da Universidade Federal do Rio de Janeiro, UFRJ who kindly helped with the descriptions of vocalizations and Charles Ozanick for preparation of the sonograms. Jeremy Minns and Patrícia Narvaes kindly reviewed the text and Helno Trench Júnior (Museu de Zoologia da Universidade de São Paulo) prepared the map. Special thanks to Dr Baz Hughes for his enormous patience in reviewing the manuscript, contributing many suggestions and commentaries and for his enthusiastic work for merganser conservation. Richard Hearn and Dr Mick Marquiss also contributed with many important suggestions and pertinent literature.

References

Anjos, L., Schuchmann, K.-L. and Berndt, R. (1997) Avifaunal composition, species richness, and status in the Tibagi river basin, Parana State, Southern Brazil. *Orn. Neotrop.* 8: 145–173

Bartmann, W. (1988) New observations on the Brazilian Merganser. *Wildfowl* 39: 7–14.

Collar, N. J., Gonzaga, L. A. P., Krabbe, N., Madroño Nieto, A., Naranjo, L. G., Parker, T. A. and Wege, D. C. (1992) *Threatened birds of the Americas: the ICBP/IUCN red data book*. Cambridge, U.K.: International Council for Bird Preservation.

Giai, A. G. (1976) *Vida de un naturalista en Misiones*. Buenos Aires: Ed. Albatros.

Hayes, F. E. (1995) *Status, distribution and biogeography of the birds of Paraguay*. Albany, New York: American Birding Association, Monographs in Field Ornithology.

Instituto Brasileiro de Desenvolvimento Floresta (IBDF, now IBAMA) and Fundação Brasileira para a Conservação da Natureza (1981) *Plano de manejo: Parque Nacional da Serra da Canastra*. Brasilia: Editora Gráfica Brasiliana.

Johnson, A. and Chebez, J. C. (1985) Sobre la situacion de *Mergus octosetaceus* Vieillot (Anseriformes: Anatidae) en la Argentina. *Hist. Nat.*, Suppl.1: 1–16.

Kolomiitsev, N.P. (1986) Factors limiting M. squamatus numbers and recommendations for conservation and rational use. Pp. 36–37 in: *Izuchenie ptic v SSSR, ikh okhrana i ratsional'noe ispol'zovanie*. Vol. 1. Leningrad: All-Union Ornithological Society.

Marquiss, M. (1998) The abundance of sawbills. Pp. 8–27 in: M. Marquiss, D. N. Carss, J. D. Armstrong and R. Gardiner eds. *Fish-eating birds and salmonids in Scotland*. Report on fish-eating birds research (1990–97) to The Scottish Office Agriculture, Environment and Fisheries Department.

Marquiss, M. and Duncan, K. (1993) Variation in the abundance of Red-breasted Mergansers *Mergus serrator* on a Scottish river in relation to season, year, river hydrography, salmon density and spring culling. *Ibis* 135: 33–41

Partridge, W. H. (1956) Notes on the Brazilian Merganser in Argentina. *Auk* 73: 473–488.

Sick, H. (1997) *Ornitologia Brasileira*. Rio de Janeiro: Nova Fronteira.

Silveira, L. F. (1998) The birds of Serra da Canastra National Park and adjacent areas, Minas Gerais, Brazil. *Cotinga* 10: 55–63.

Stattersfield, A. and Capper, D. R. (2000) *Threatened birds of the World*. Cambridge, U.K.: BirdLife International and Barcelona: Lynx Editions.

Wege, D. C. and Long, A. J. (1995) *Key areas for threatened birds in the Neotropics*. Cambridge, U.K.: BirdLife International (BirdLife Conservation Series 5).

Yamashita, C. and Valle, M. C. (1990) Ocorrência de duas aves raras no Brasil Central: *Mergus octosetaceus* e *Tigrisoma f. fasciatum. Ararajuba* 1: 107–109.
Zicus, M. C. (1990) Nesting biology of Hooded Mergansers using nest boxes. *J. Wildl. Manage.* 54: 637–643.

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Received 22 May 2001; revision accepted 14 August 2001