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New data collected by the authors in north central Amazônia are included in sections on habitat, behaviour and diet. Based on all information reviewed by the authors, specific measures are recommended to conserve remaining Giant Otter populations in South America.

MORPHOLOGY

The Giant Otter is known by the common name 'ariranha' (Portuguese), 'ariraí, perro de água, lobo del río grande, lobito de cola ancha, lobo gargantilla, lobo corbata and nutria gigante' (Spanish). It is the largest of the four Latin American otters. Its total body length typically ranges from 1.5 to 1.8 m in males and 1.5 to 1.7 m in females (Hershkovitz, 1969; Mondolfi, 1970; Duplaix, 1980). Historically, considerably larger measurements were reported: Cabrera & Yepes (1940) state that old males with a total body length of 2.20 m have been hunted; Santos, (1984 [originally published in 1945 by F. Briguiet & Cia., Rio de Janeiro]) personally observed skins longer than 2 m and cites a skin from Amazonas state which measured 2.40 m; and Harris (1968) cites a personal communication referring to a 1959 book by the Brazilian Ministry of Education and Culture which gives a total body length of 2.40 m for the largest specimens hunted. The present authors were unable to examine the reference reported in Harris (1968). These large measurements have not been confirmed by recent data and we suggest that they probably represent older males, as indicated by Cabrera & Yepes (1940) which may have been more common prior to the commencement of heavy hunting in the 1950s. Other measurements are clearly taken from skins (Santos, 1984) which likely overestimate whole body lengths and may in addition be stretched or otherwise distorted. Body weight generally ranges from 26 to 32 kg for males and 22–26 kg for females (Duplaix, 1980); the heaviest individual on record weighed 34 kg (75 lbs) (Fountain, 1902). In the water, the Giant Otter's heavy body is propelled by its powerful bilaterally flanged tail, $\cup\supseteq$0.45–0.65 m in length, and extensively webbed feet (Foster-Turley, Macdonald & Mason, 1990).

Skull, jaw, dentition, baculum and limb measurements of Giant Otters are given by Harris (1968), Bjork (1970), Van Zyll de Jong (1972), Robertson (1976) and Husson (1978). The Giant Otter is the only species of otter in which the rhinarium is completely haired (Foster-Turley *et al.*, 1990) and each individual can be identified from birth by the irregular pattern of whitish or cream-coloured hairs on its chin and throat (Fig. 1). The thick coat is composed mainly of short soft guard hairs, $\cup\supseteq$8 mm long; there is very little underfur (Foster-Turley *et al.*, 1990). Fur colour varies from fawn to reddish brown or darker, appearing almost black when wet (Harris, 1968; Husson, 1978). Two anal scent glands are used in territorial marking and may be involuntarily contracted if the animal is startled (Duplaix, 1980; Laidler, 1984; S.K. Carter, personal observation).

Vision has not been studied in the Giant Otter, but studies of the North American River Otter *Lutra canadensis* and Sea Otter *Enhydra lutris* have found these species to be emmetropic or slightly myopic in both air and water (Ballard, Sivak & Howland, 1989; Murphy *et al.*, 1990). Above water, Giant Otters are capable of recognizing observers at distances of $\cup\supseteq$50 m (Duplaix, 1980). Under water, Giant Otters hunt primarily by sight (Schweizer, 1992) and very likely have an accommodative range similar to that confirmed for the Sea Otter and North American River Otter which is 54–59 dioptres, several times greater than what has been reported for other mammal species (Ballard *et al.*, 1989; Murphy *et al.*, 1990). This accommodation is believed to result from the well-developed ciliary and iridial muscles acting to change the curvature of the lens upon immersion (Walls, 1963; Ballard *et al.*, 1989; Murphy *et al.*, 1990). The external morphology of *Pteronura*'s brain, specifically an enlarged coronal gyrus, suggests increased sensitivity of the facial vibrissae (Radinsky, 1968), which appears to assist Giant Otters hunting in murky waters (Schweizer, 1992). Hearing is acute, and well-developed scroll bones in the nasal chambers indicate an excellent sense of smell (Duplaix, 1980).

Although the Giant Otter's physical characteristics are distinctive, it has been confused in the

Fig. 1. Captive adult female Giant Otter *Pteronura brasiliensis*. National Institute of Amazon Research, Manaus, Brazil (Photo by F. C. W. Rosas).

past with two other mustelids. The Neotropical Otter *Lutra longicaudis* is of similar build and colouring, but the distinctive neck marking of the Giant Otter and the difference in size and behaviour patterns between the two species should clearly separate them to the informed observer (see Harris, 1968; Mason & Macdonald, 1986; Chanin, 1985). Until the early 1800s, the Giant Otter was also frequently confused with the well-known Sea Otter because of their similar size (both species are significantly larger than all other Lutrinae). Clear differences in their physical characteristics, habitats and ranges soon distinguished the two species (Harris, 1968).

SYSTEMATICS

Nomenclature of the Giant Otter has been discussed by several authors (see Harris, 1968; Husson, 1978). In recent works, authorship of the species is most widely given to Gmelin, 1788. Based on the discussion presented in Husson (1978), we employ here the name *Pteronura brasiliensis* (Zimmermann, 1780).

The extinct species *Satherium piscinaria* from the late Pliocene (⊃1.5–3 million years ago) has been suggested as an ancestor of the Giant Otter based on skull, dental and skeletal features (Bjork, 1970). Robertson (1976) also noted strong similarities between *Satherium* and *Pteronura* based on his examination of the humerus and podial elements of *Satherium* sp. from Florida.

Of the 13 extant otter species in the subfamily Lutrinae, family Mustelidae (following Mason, 1990), Van Zyll de Jong (1972) found *Pteronura* to be most closely associated with the Smooth Otter (*Lutra perspicillata*, formerly *Lutrogale perspicillata*) of south and south-east Asia. This controversial finding was based on an analysis of skull, dentition, feet, mammae and vertebrae.

Recently, Davis (1978) divided the subfamily Lutrinae into three tribes based on baculum shape and vocalizations. He placed *Pteronura brasiliensis* in the tribe Aonychini along with the Asian Small-Clawed Otter *Aonyx cinerea*, Cape Clawless Otter *Aonyx capensis*, Congo Clawless Otter

Aonyx congica, Smooth Otter and Sea Otter. These morphologically diverse species are united by having no affection call, an inflected contact call, baseball shaped bacula and a preputial button (except in *Enhydra*). They all live in social groups and, with the exception of *Enhydra*, pairing is generally for life and the male participates in cub care.

A subspecies, *Pteronura brasiliensis paranensis* (Rengger 1830), inhabiting the Paraná and Paraguai Rivers, has been described, but its validity is questionable. The type specimen was very similar in general appearance to *P. brasiliensis*. It would likely have been regarded as a variety of *P. brasiliensis* had it not apparently had abnormal dentition, possessing only four molariform teeth on each side of the upper jaw instead of the normal five (Harris, 1968). IUCN (1992) states that the colour of the throat patch differs in this subspecies, but this is not mentioned as a subspecific characteristic in Harris' review of the species. Other differentiating characteristics given for *P. brasiliensis paranensis* are smaller size, a more gregarious nature, larger teeth and a broader skull (Harris, 1968). No recent taxonomic studies have validated the subspecific status of *P. brasiliensis paranensis*; hence we consider *Pteronura* a monotypic genus in this review.

DISTRIBUTION AND ABUNDANCE

The Giant Otter originally inhabited most of South America, ranging from the Guyanas across Venezuela and Colombia, south to northern Argentina and west to the Andes (Harris, 1968; Thornback & Jenkins, 1982). Although the latitudinal range of the Giant Otter remains large, intense pelt hunting greatly reduced their numbers and completely eliminated populations in many localized areas. The current population of Giant Otters may be as low as 1000–3000 individuals (Brecht-Munn & Munn, 1988). However, this is probably an underestimate as $\cup\supseteq$500 inhabit the southern portion of the upper Paraguai River basin of Brazil alone (Schweizer, 1992).

The country-by-country distribution of Giant Otters reported here is based on published accounts and sightings by the authors. Reliable information received in 1993 and 1994 through personal interviews and written communication from regional authorities is also included where it updates published information and/or identifies newly discovered areas of habitation. The published source follows the personal communication in the case of the former. The presence of Giant Otters has been confirmed in each location within the last 25 years unless otherwise noted.

Suriname, Guyana and French Guiana (Fig. 2)

The last major Giant Otter strongholds are probably Suriname, Guyana and French Guiana (Chehébar, 1990). In Suriname, Giant Otters are considered common on almost all rivers in the forested central and southern parts of the country (H. A. Reichart, personal communication). Duplaix (1980) sighted over 250 individuals in a survey of the country from 1976 to 1979. She verified their presence on the following rivers (only major tributaries are listed here): the Corantijn and the Zuid River of its Lucie tributary, the Nickerie and its Maratakka tributary, the Wayombo, the Coppename and its Coesewijne, Tibiti and Tangnimama tributaries; and the Commewijne and its Cassewenica, Cottica and Perica tributaries. She received reports indicating that they also inhabit the Marowijne, Saramacca and Suriname Rivers.

In Guyana, Giant Otters were reported from near the city of Morawhanna in the north-west and from the Mahaica and Abary Rivers by Melquist (1984). Laidler (1984) studied four resident family groups in her study site in Demerara District encompassing parts of Russel Lake and the Mahaica River and its Lama, Maduni and Carabice Creeks (Laidler, 1984). Healthy populations of Giant Otters inhabit the upper Mazaruni Basin and the upper Potaro River (above Kaieteur Falls) (Laidler & Laidler, 1983). They were present in the Karanambo area of the northern Rupununi in 1988 (N. Gordon, personal communication) and there are unconfirmed reports of healthy populations in Spectacle Lake on the northern Rupununi River (Laidler & Laidler, 1983). The species has been

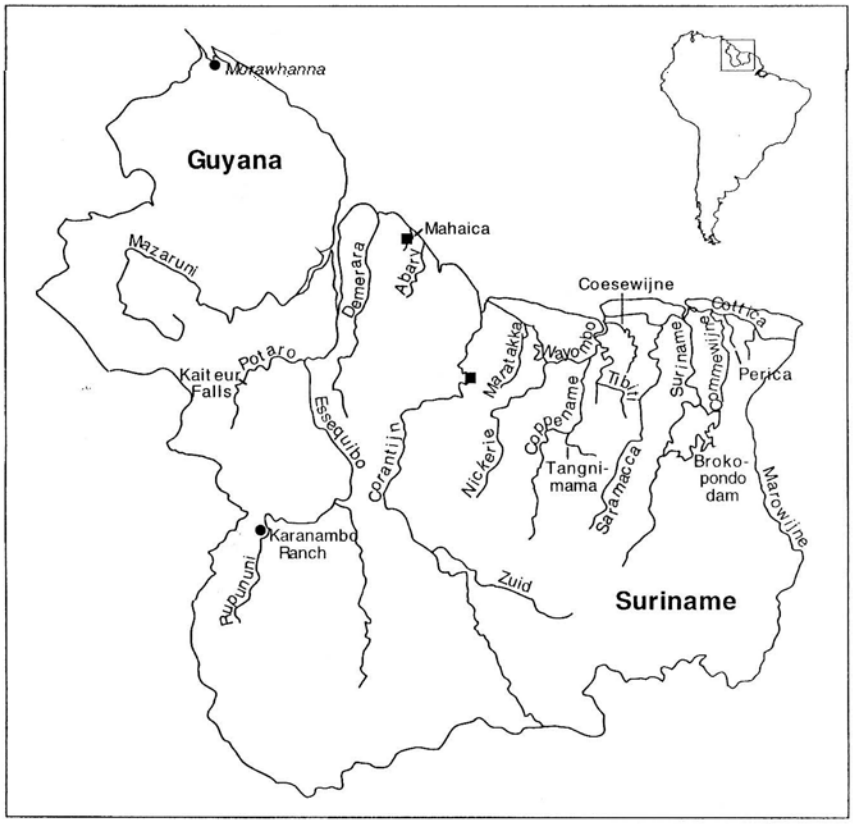

Fig. 2. Distribution of Giant Otters in Guyana and Suriname, showing rivers and areas inhabited by Giant Otters as cited in text. Squares indicate study site of Duplaix (1980) on Kaboeri Creek in Suriname and of Laidler (1984) on Russel Lake in Guyana.

heavily hunted on the southern Rupununi because of its proximity to Brazil and the consequent ease of smuggling pelts across the border, Giant Otters also inhabit the Mashivean and Morewan Rivers, tributaries of the upper Essequibo in southern Guyana (Melquist, 1984).

No specific information is available from French Guiana, but the Giant Otter is presumed to be widely distributed in the interior (Melquist, 1984).

Venezuela and Colombia (Fig. 3)

In a review of the status of the Giant Otter in Venezuela, Mondolfi & Trebbau (1978) report that their numbers have been greatly depleted along the coast and in the mid and lower Orinoco and its tributaries. Relict populations may still exist in parts of the Orinoco delta, and in the lower Orinoco Basin Giant Otters are reported from the lower Caura and its tributary the Nichare, where they are apparently very scarce due to hunting (Mondolfi & Trebbau (1978). The IUCN (1982) reports that Giant Otters inhabit Canaima National Park in the Caroni Basin and Melquist (1984) reports sightings on the Caroni and Paragua Rivers (above the Guri hydroelectric dam).

In the mid Orinoco Basin, Mondolfi & Trebbau (1978) report that Giant Otters have been nearly exterminated on the Aguaro River (in the Aguaro-Guariquito National Park), although Rios (1987) maintains they still inhabit this area. Giant Otters were recorded from the Apure River near Puerto

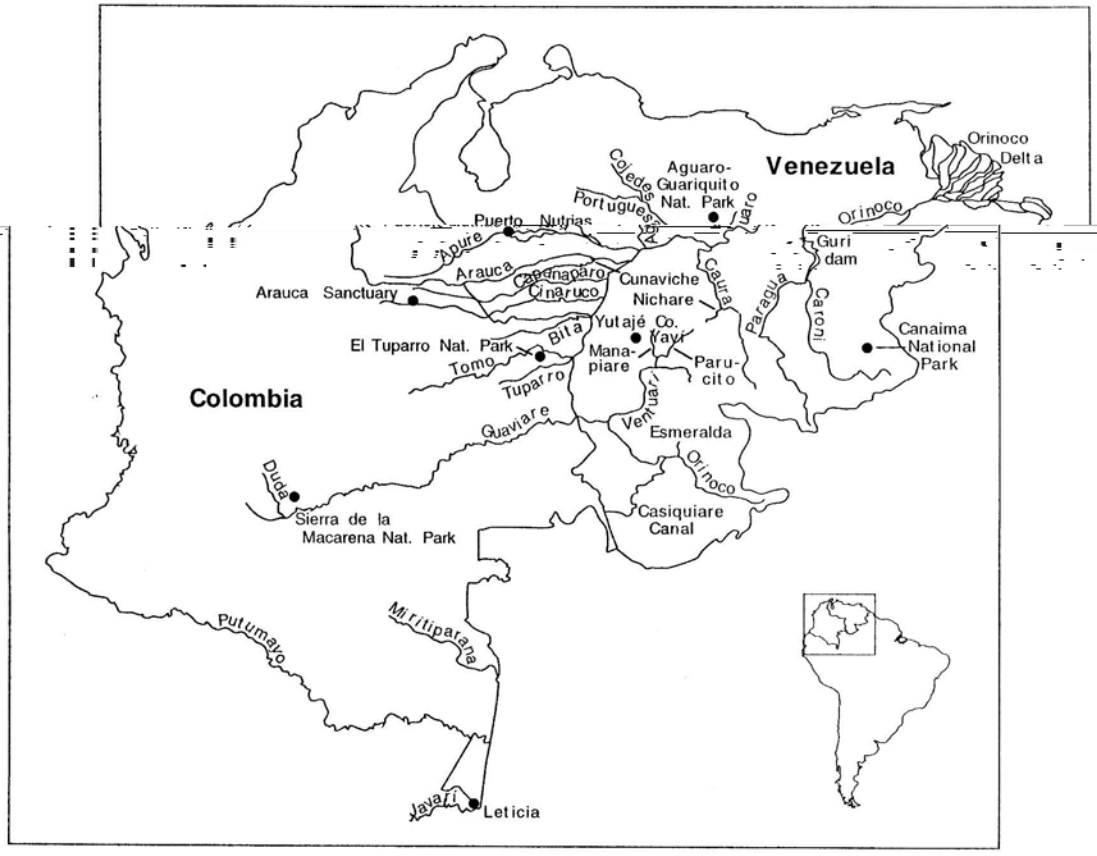

Fig. 3. Distribution of Giant Otters in Venezuela and Colombia, showing rivers and areas inhabited by Giant Otters as cited in text. Circles indicate cities or the approximate centre of protected areas.

Cojedes (Mondolfi & Trebbau, 1978). They are very scarce on the Capanaparo, Claro and Cunaviche Rivers, but were present in 1976 on Caño Macanillal, a tributary of the latter (Mondolfi & Trebbau, 1978). A specimen was collected from the Cinaruco River in the late 1960s (Handley, 1976), but inquiries in 1978 indicated that populations on the Cinaruco had been exterminated

[illegible] (Mondolfi & Trebbau, 1978). This is disputed by Rios (1987). In the Ventuari Basin of the

the Manapiare and Parucito Rivers and the Yutajé and
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s are reported to be very scarce in several rivers of the
nal because of intense hunting, but they were present on
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exterminated Giant Otter populations in vast areas of the
970). Defler (1986) found ⊃30 groups of Giant Otters
o Rivers and Quinvaza Creek of the El Tuparro National
ieves they are present on the Bita River just north of the
yo and a tributary of the Javarí (near Leticia) in the early
rs were counted on the Miritiparena River in 1976 and

Orinoco, Giant Otters are reported from t
Cerro Yaví areas just north of the watersh
(Mondolfi & Trebbau, 1978). Giant Otters
upper Orinoco as far as the Casiquiare Can
the upper Esmeralda River in 1976 (Mond
sighting on the upper Orinoco near Platana

In Colombia intense hunting has nearly
Orinoco and Amazon basins (Mondolfi, 19
inhabiting the Tomo, Tuparrito and Tuparr
Park in north-eastern Colombia and he bel
park. They were recorded from the Putuma
1970s (Donadio, 1978). A total of 24 otte

Brazil (Figs 4 and 5)

In Brazil Giant Otters inhabit the Amazon and upper Paraguai River basins and restricted areas of the Atlantic Forest. The Brazilian Amazon encompasses ⊃⊇5 million km² of sparsely populated land and probably supports significant populations of Giant Otters in remote areas, although this is unconfirmed due to the logistical problems of surveying an area this large. In the Negro River Basin, Giant Otters inhabit the Unini River and may be present on the upper Jaú and Pauini Rivers within Jaú National Park (C. E. M. Miller, personal communication; G. H. Rebêlo, personal communication; IUCN, 1982). They were present on the Itapará and Itaparazinho Creeks (near Boiaçu), Catrimani River and Uraricoera River (tributaries of the Branco River) in 1991, 1994 and 1988, respectively (C. M. Carvalho, personal communication; V. Py-Daniel, personal communication; Colares, 1990). There are reports of Giant Otters on the lower Parima (V. Py-Daniel, personal communication). Groups also inhabit the Xixuaú, Xiparaná and Mucucuaú Creeks of the lower Jauaperi River (S. K. Carter & F. C. W. Rosas, personal observation; N. Gordon, personal communication). In the Solimões River basin, Giant Otters were observed on the upper Javarí and the Japurá Rivers in 1981 and 1984, respectively (V. Py-Daniel, personal communication). In the Purus Basin, they are reported to inhabit the Rio Acre Ecological Station (IUCN, 1982).

In the Madeira River basin, Giant Otters were present in 1979 on the Canumã, the Aripuanã and its Branco tributary (C. R. Bueno, personal communication; K. Yuyama, personal communication); and groups were sighted on the Roosevelt River in 1992 (J. Ferraz, personal communication; G. M. Santos, personal communication). Sizable populations are reported from the upper Jamari (C. Colares, personal communication) and a group was sighted on Paraiso Creek of the Ji-Paraná in 1987 (P. Martuscelli, personal communication). In the Uatumã River basin, Giant Otters are present

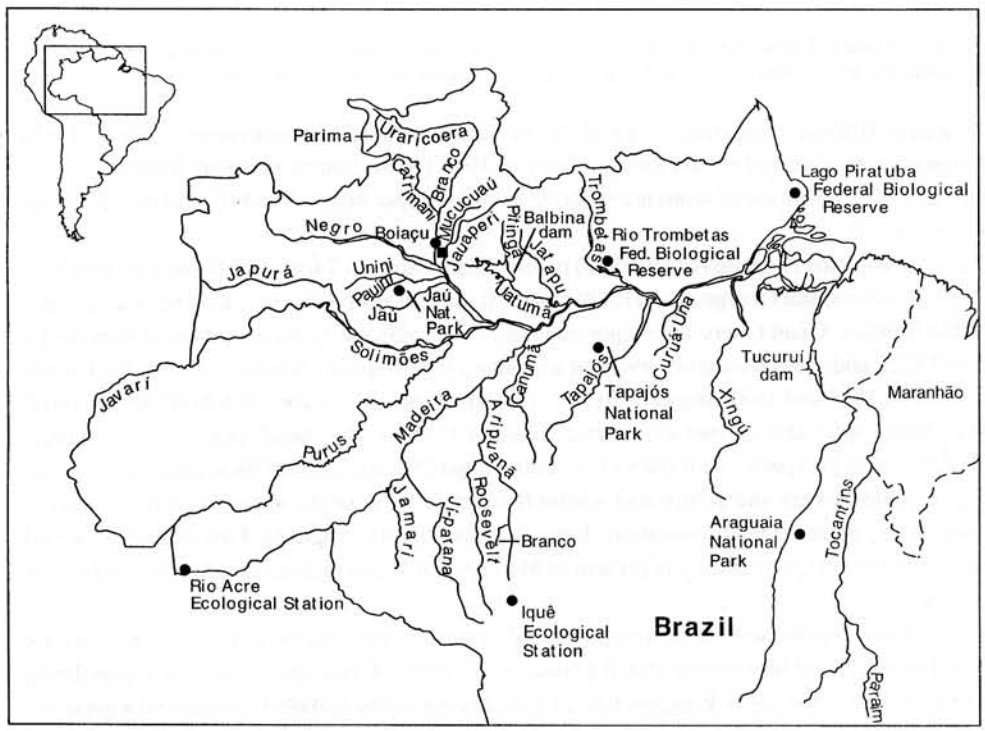

Fig. 4. Distribution of Giant Otters in the Brazilian Amazon, showing rivers and areas inhabited by Giant Otters as cited in text. Square indicates study site of the authors on Xixuaú Creek. Circles indicate cities or the approximate centre of protected areas. Dashed line indicates state boundary of Maranhão.

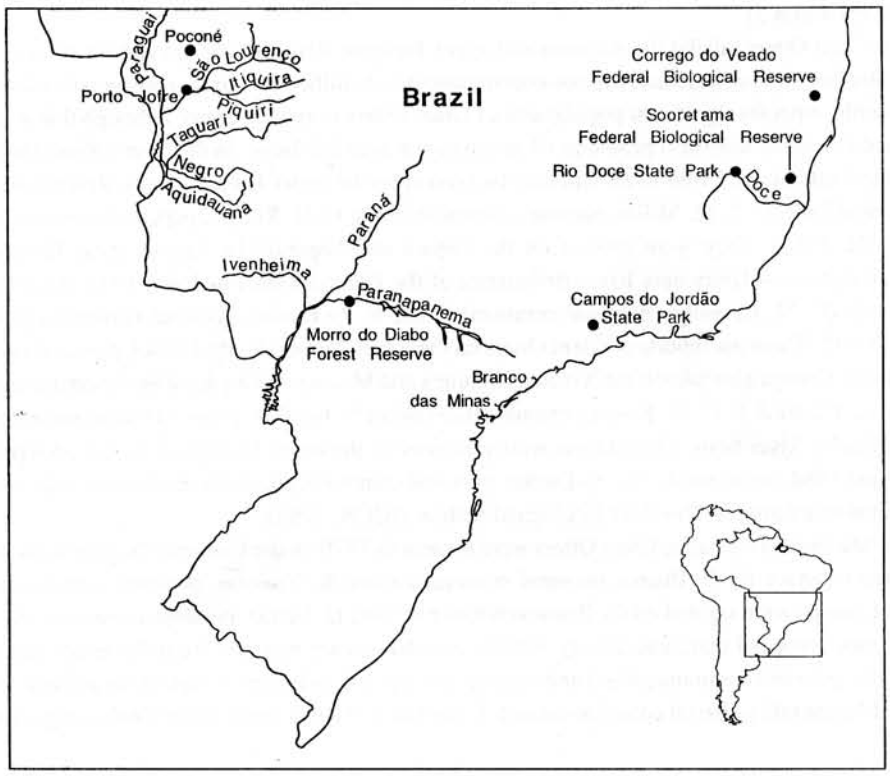

Fig. 5. Distribution of Giant Otters in central and southern Brazil, showing rivers and areas inhabited by Giant Otters as cited in text. Circles indicate cities or the approximate centre of protected areas.

in the area of Balbina hydroelectric dam (F. N. Armond, personal communication; Colares, 1988) and groups were observed on the Pitinga River in 1994 (A. A. Souza, personal communication; Colares, 1988). Sizable populations are reported from the upper Jatapu River (C. Colares, personal communication).

Further east in the Amazon IUCN (1982) reports Giant Otters in Tapajós National Park and Iquê Ecological Station, and George *et al.* (1988) state that they are probably present on remote tributaries of the Tapajós. Giant Otters were reported in the Rio Trombetas Federal Biological Reserve by IUCN (1982), and groups were observed on a tributary of the upper Trombetas and on the Curuá-Una River in 1985 and 1982, respectively, (V. Py-Daniel, personal communication; Salvo Souza, 1982). Groups were also sighted on the mid Xingú in 1993 (V. Py-Daniel, personal communication). IUCN (1982) reports Giant Otters inhabit the Lago Piratuba Federal Biological Reserve and Araguaia National Park and groups still inhabit the Paraim River of the upper Tocantins basin (C. L. Magalhães, personal communication; Lima & Lima, 1984). Almeida, Pimentel, & Pimentel (1992) indicate that Giant Otters are present in Maranhão state but give no specific distribution information.

Giant Otters also inhabit the south-eastern and central western regions of Brazil, but they are believed to be extinct in southern Brazil (Rosas *et al.*, 1991). Giant Otters are now repopulating almost all rivers in the upper Paraguai River basin, known as the Pantanal, because of a great decrease in hunting pressure (J. Schweizer, personal communication). This includes, but is not limited to, the Paraguai River itself, the São Lourenço, Itiquira and Piquiri tributaries in the northern Pantanal; and the Negro and Aquidauana Rivers in the southern region (Schweizer, 1986, 1992; personal communication). They are not found on the extremely polluted Taquari River

(J. Schweizer, personal communication). Dalponte & Cintra (1986) also reported Giant Otters in the northern Pantanal from the area between the cities of Poconé and Porto Jofre and they are present on the Ivenheima River (J. Schweizer, personal communication). Coimbra-Filho (1972) states that the Giant Otter is practically extinct in the entire eastern region of the country, with only very rare sightings on tributaries of the Paraná. They may inhabit the Paranapanema River within the Morro do Diabo Forest Reserve (Coimbra-Filho, 1972) and the Rio Doce State Park (C. Blacher, personal communication; Melquist, 1984) and they are reportedly present in the Corrego do Veado and Sooretama Federal Biological Reserves (IUCN, 1982) and Campos do Jordão State Park (CONSEMA, 1985). Since 1991 a resident pair has also been observed on both the Branco and the das Minas Rivers in the Atlantic Forest (P. Martuscelli, personal communication).

Ecuador, Peru and Bolivia (Figs 6 and 7)

Giant Otters are found only in isolated locations in Ecuador. Melquist (1984) reports sightings of Giant Otters on the Güeppi, a tributary of the Putumayo. They are also reported from several tributaries of the Napo River: the Aguarico, including its Tarapoa and Cuyabeno tributaries, the Garza

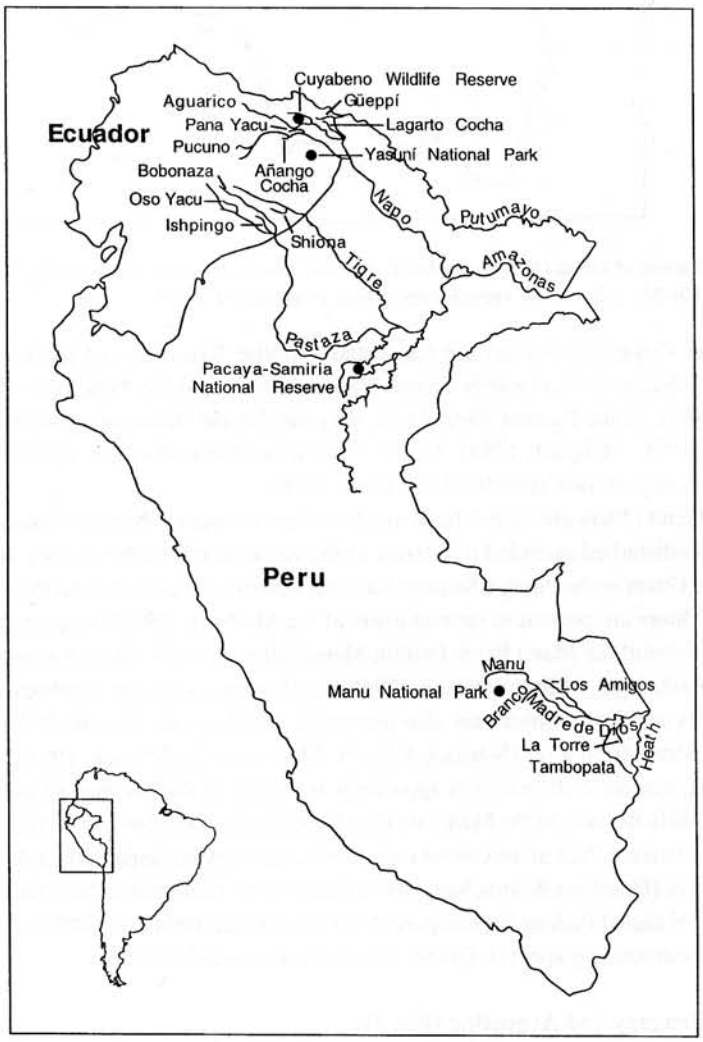

Fig. 6. Distribution of Giant Otters in Ecuador and Peru, showing rivers and areas inhabited by Giant Otters as cited in text. Circles indicate the approximate centre of protected areas.

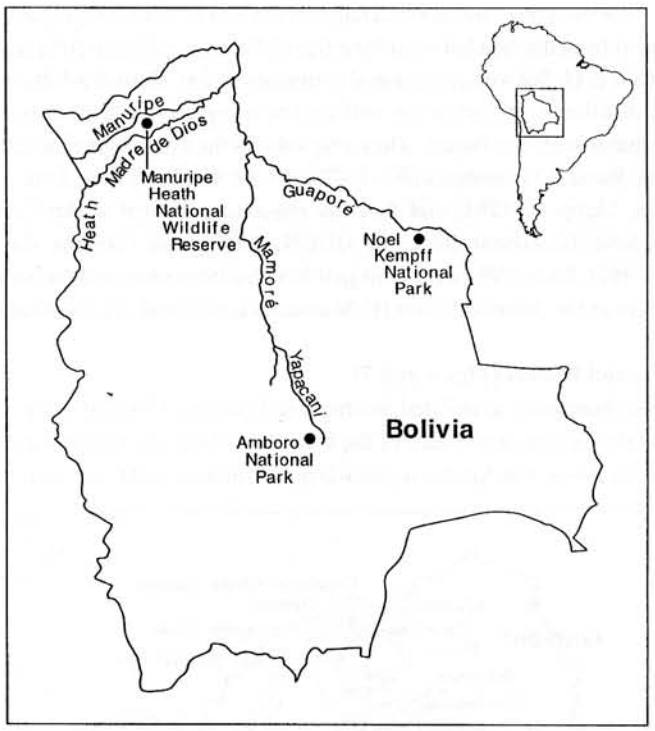

Fig. 7. Distribution of Giant Otters in Bolivia, showing rivers and areas inhabited by Giant Otters as cited in text. Circles indicate the approximate centre of protected areas.

Cocha of the Cuyabeno (within the Cuyabeno Wildlife Reserve) and the Lagarto Cocha; the Pucuno; the Añango Cocha (within Yasuní National Park); and the Pana Yacu (Melendres, 1978; Melquist, 1984). In the Pastaza River basin, they inhabit the Bobonaza, Oso Yacu and Ishpingo (Melendres, 1978; Melquist, 1984). In the Tigre River basin, they are recorded only from the Shiona, a tributary of the Conambo (Melendres, 1978).

In Peru, Giant Otters are absent from much of their former range and remnant populations are confined to undisturbed secluded tributaries of the Amazon (Chehébar, 1990). Brack-Egg (1978) reports Giant Otters in the Pacaya-Samiria National Reserve in north-eastern Peru. In south-eastern Peru, Giant Otters are present in several areas of the Madre de Dios Basin: an estimated 65–100 Giant Otters inhabit the Manu River (within Manu National Park) (Brecht-Munn & Munn, 1988; Schenck & Staib, 1992; Staib & Schenck, 1994), ∪⊇25 otters inhabit the Tambopata River and its La Torre tributary and low numbers are also present in the Madre de Dios itself and its Blanco, Los Amigos and Heath tributaries (Schenck & Staib, 1992; Staib & Schenck, 1994).

In Bolivia, current distribution is apparently restricted to the vicinity of the Manuripi Heath National Wildlife Reserve in the Madre de Dios River basin of northern Bolivia, the Mamoré River and Amboro National Park in the central region, although they are apparently only very rare visitors to the latter area (Dunstone & Strachan, 1988). Recently 65 Giant Otters have been identified in the Noel Kempff National Park on the Guaporé River (McFarren, 1994); ∪⊇300 are believed to inhabit the park and surrounding area (D. Quinn, personal communication).

Paraguay, Uruguay and Argentina (Fig. 8)

The limited distribution information for Paraguay indicates that in the early 1980s Giant Otters were present on the Verde and Ypané tributaries of the Paraguai River and were occasionally sighted on tributaries of the Paraná River in eastern Paraguay (Melquist, 1984). Remnant

Fig. 8. Distribution of Giant Otters in Paraguay, Uruguay and Argentina. Circles indicate cities or the approximate centre of protected areas. Dashed lines indicate boundaries of the departments of Salto and Rocha.

populations may also exist in marshes adjacent to the Paraguai and Pilcomayo Rivers in the south, but this is unconfirmed (Melquist, 1984).

In Uruguay, the last confirmed register of the species was from Sauce Creek of the Negro River in 1963 (G. Bardier, personal communication). Sightings were made in 1972 on the Uruguay River north of Salto, a single individual was seen on Itapebi Creek in this area in 1975 (Melquist, 1984) and there were two unconfirmed sightings from Salto state in the 1980s (G. Bardier, personal communication). There are unconfirmed reports from Salsipuedes Creek of the mid Negro River (Melquist, 1984). Giant Otters were believed to exist in the streams and marshes of the department of Rocha in the early 1980s and are apparently present in the Bañados del Este Biosphere Reserve (IUCN, 1982; Melquist, 1984).

In Argentina, Giant Otters are probably now extinct (A. Parera, personal communication). Individuals and pairs were seen on the Iguazú River and its tributaries within Iguazú National Park until 1988, but there are no current indications of *Pteronura* in the area (Parera & Bosso, 1991). Massoia *et al.* (1987) observed and/or collected seven Giant Otters in the Urugua-í tributary of the Paraná,

but the lower portion of this river has since been dammed and shows no recent evidence of *Pteronura* (Parera, 1992b). Reports from local residents indicate that Giant Otters were present in low numbers on the Paraná River as late as the 1980s, until 1989 in the Laguna Iberá and surrounding marshes and on the upper Miriñay River and until 1984 in the Curuzú Cuatiá Creek and its tributaries in the lower Miriñay (Parera & Masariche, 1989; Parera, 1992b).

Captive animals

Table 1 lists known institutions where Giant Otters are currently held in captivity. Captive animals are breeding in Dortmund and Hamburg, Germany and Cuiabá, Brazil.

HABITAT

Giant Otters inhabit many types of rivers, creeks and lakes in the tropical forests, llanos and wetlands of South America. Slow moving rivers and streams and oxbow lakes are preferred (Duplaix, 1980; Schenck & Staib, 1992). Some authors report that Giant Otters prefer larger rivers (Mondolfi, 1970; Donadio, 1978), although they also frequently inhabit smaller forest creeks (Duplaix, 1980; S.K. Carter & F. C. W. Rosas, personal observation) and occasionally reservoirs of large dams (Laidler, 1984; Colares, 1988) and agricultural canals (Chehébar, 1990). A decided preference is shown for black or clear waters (Mondolfi & Trebbau, 1978; Duplaix, 1980;

Table 1. Locations where Giant Otters (*Pteronura brasiliensis*) are currently held in captivity. No recent information was obtained from Ecuador or Bolivia

Location	M	F	Indet	Source
GUYANA				
Georgetown	1	0	0	M. Remdass, personal communication, 1994
VENEZUELA				
Zoológico Miguel Romero Antoni, Barquisimeto	1	2	0	V. Katz, personal communication, 1994
Parque del Este Rómulo Betancourt, Caracas	1	1	0	V. Katz, personal communication, 1994
Zoológico Leslie Pantin, Turmero	1	0	0	V. Katz, personal communication, 1994
PERU				
Iquitos	0	0	1	E. McCallie, personal communication, 1994
BRAZIL				
Instituto Nacional de Pesquisas da Amazônia, Manaus, AM	0	1	0	personal observation, 1995
UHE Balbina, AM	2	1	0	F.N. Armond, personal communication, 1994
Emílio Goeldi Museum, Belém, PR	1	0	0	A.S.L. Peralta, personal communication, 1994
Brasília, DF	2	2	0	personal observation, 1993
Goiania, GO	1	1	0	E. Rodrigues, personal communication, 1994
Cuiabá, MT	2	2	0	J. Batista, personal communication, 1994
Sorocaba, SP	1	0	0	L.C. Camargo, personal communication, 1994
Americana, SP	0	1	0	S.M.C. Machado, personal communication, 1994
BOLIVIA				
Santa Cruz	1	1	0	Dunstone & Strachan, 1988
GERMANY				
Tierpark Dortmund	1	1	0	I. Schappert, personal communication, 1995
Zoo Duisberg	1	1	0	M.G. Hartmann, personal communication, 1994
Carl Hagenbecks Tierpark, Hamburg-Stellingen	4	0	0	M. Flügger, personal communication, 1995
UNITED KINGDOM				
Chestnut Centre, Chapel-en-le-Frith, Derbyshire	1	1	0	R.N. Heap, personal communication, 1995

Schweizer, 1992) which are reasonably transparent (1.0–4.3 m) and support a large diversity of fish species (Sioli, 1984; Goulding, Carvalho & Ferreira, 1988). Giant Otters living in muddy or white waters (transparency 0.1–0.5 m) hunt in isolated areas of clearer water (Mondolfi & Trebbau, 1978; Schweizer, 1992).

Based on the few long-term studies available, home range appears to be 12–32 km of creek (including its side tributaries) or 20 km^2 of lake (Duplaix, 1980; Laidler, 1984). Within these large home ranges which may overlap, smaller territories centred around good feeding locations are defended by each family group. These territories encompass 2–9.6 km of creek or 5 km^2 of lake, depending on food availability, otter density and habitat type (Duplaix, 1980; Laidler, 1984; Schweizer, 1992). In seasonally flooding areas, territories are defended continuously throughout the dry season; they are apparently abandoned during the flooded season when the otters move into the flooded forest to exploit the influx of fish (Duplaix, 1980; Schweizer, 1992). In more stable environments Giant Otters may display cyclic foraging patterns, visiting and defending specific territories for a 2–3-day period every 2–3 weeks (Fugger, 1981; Laidler, 1984).

Giant Otters maintain various campsites within these home ranges. Campsites are semicircular or rectangular areas along the river or lake bank which the otters clear of vegetation and use regularly for scent marking, during social meetings, resting and sleeping (Duplaix, 1980; Laidler, 1984) (Fig. 9).

Campsites often begin as simple resting areas 2–3 m in diameter and are enlarged during subsequent visits to an average of 8.7 m in length (range 1.3–31.0) by 4.4 m in width (range 1.0–14.7 m) (Duplaix, 1980; Laidler, 1984; Schweizer, 1992; S. K. Carter & F. C. W. Rosas, personal observation). Each site contains 1–5 communal latrines which are usually peripheral and average 2.2 m^2 (Duplaix, 1980; Laidler, 1984; S.K. Carter & F.C.W. Rosas, personal observation). Campsites are generally clustered around feeding areas within territories, with each family group maintaining one cluster of three to eight campsites and possibly a few outliers (Laidler, 1984). They are most often constructed on shaded level ground which has little ground cover and easy access to small forest

Fig. 9. Giant Otter campsite. Xixuaú Creek, Brazil (Photo by S.K. Carter).

creeks, swampy areas, or shallower waters of larger rivers (Duplaix, 1980; Laidler, 1984; S. K. Carter & F. C. W. Rosas, personal observation). High banks which seldom or never flood are preferred over lower areas and low human disturbance is also important in site selection (Duplaix, 1980; Laidler, 1984). In Suriname, approximately half of the sites were perennial (Duplaix, 1980), while the present authors found that in their study site on the Xixuaú Creek of the lower Jauaperi River in northern Amazônia, 20 of 22 campsites used during the study period had been used in previous years.

Giant Otters also build dens in the banks of rivers and lakes within their home range. These dens are used regularly for sleeping in most areas, although they may be used only temporarily during cub rearing in others (Laidler, 1984). In northern Amazônia, the authors found that dens consist of one to seven entrances (generally 0–4.2 m above the current water mark) which are ∪⊇0.43 m wide (range 0.18–1.10 m) by 0.28 m high (range 0.12–0.90 m). Other studies have found that den entrances average 0.2–0.4 m in diameter, with older dens having the larger entrances (Duplaix, 1980; Schweizer, 1992). Tunnels 0.3–3.6 m in length lead from each entrance to one or more chambers ∪⊇1.2–1.8 m in diameter and 0.4–0.7 m high (Duplaix, 1980). In the Amazon, dens may also have several smaller air holes (∪⊇0.26 m wide by 0.18 m high) higher up on the bank (S. K. Carter & F. C. W. Rosas, personal observation). Dens are commonly located under root systems or fallen trees (Mondolfi, 1970; Duplaix, 1980; Schweizer, 1992; S. K. Carter & F. C. W. Rosas, personal observation). In the authors' study site on Xixuaú Creek, 15% of 46 dens were found to be adjacent to campsites and 17% of 46 dens were adjacent to latrines. In addition, 96% of 44 dens were located in areas with at least 50% tree cover and 90% of 31 dens used during the study were perennial.

BEHAVIOUR

Giant Otters generally live in groups of three to nine consisting of a mated pair and one or two litters. Group size varies with region, habitat and season. Occasionally supergroups of 12–20 individuals are observed, which may be a result of grouping around plentiful food sources or groups temporarily travelling together (Mondolfi, 1970; Duplaix, 1980; Laidler, 1984).

Individuals not living in family groups are referred to as transients. Transients may be subadults recently split from their family group or adults which have lost a mate. They lack established territories and are usually shy and difficult to sight. Associations observed between transients and family groups with subadults nearing dispersal age may indicate a preliminary form of mate selection (Laidler, 1984; Schweizer, 1992).

Giant Otters are exclusively diurnal. Family groups may travel over 17 km daily, alternately fishing and patrolling their territories (Laidler, 1984). In their natural habitat, these otters spend approximately half of their time hunting, travelling and patrolling their territories and half resting and marking ashore (Duplaix, 1980; Schweizer, 1992). In captivity, Salvo Souza & Best (1982) found that 39–46% of daylight is spent active in the water, 12–17% in terrestrial activities, 8% eating and 34–36% resting; activity peaked in the early morning and afternoon. Recent observations by the authors of a captive adult female at the National Institute of Amazon Research showed that 42.9% of daylight hours were spent in aquatic activities, 26.2% in terrestrial activities, 5.5% eating and 26.3% resting. Aquatic activity peaked in early morning and again mid afternoon and terrestrial activity remained fairly constant throughout the day at a level nearly twice that observed by Salvo Souza & Best (1982). Resting peaked at noon, between the scheduled morning and mid-afternoon feeding periods (Fig. 10). Fishing activity in wild Giant Otters in Guyana peaked in the morning (Laidler, 1984), while in Peru peaks were observed in both the morning and afternoon (Fugger, 1981). No specific activity peaks were evident in otters of Kaboeri Creek, Suriname (Duplaix, 1980).

Giant Otter groups are highly cohesive: group members rest, play, sleep, travel and fish together, and mated pairs are often observed allogrooming. Group defence is cooperative with the male

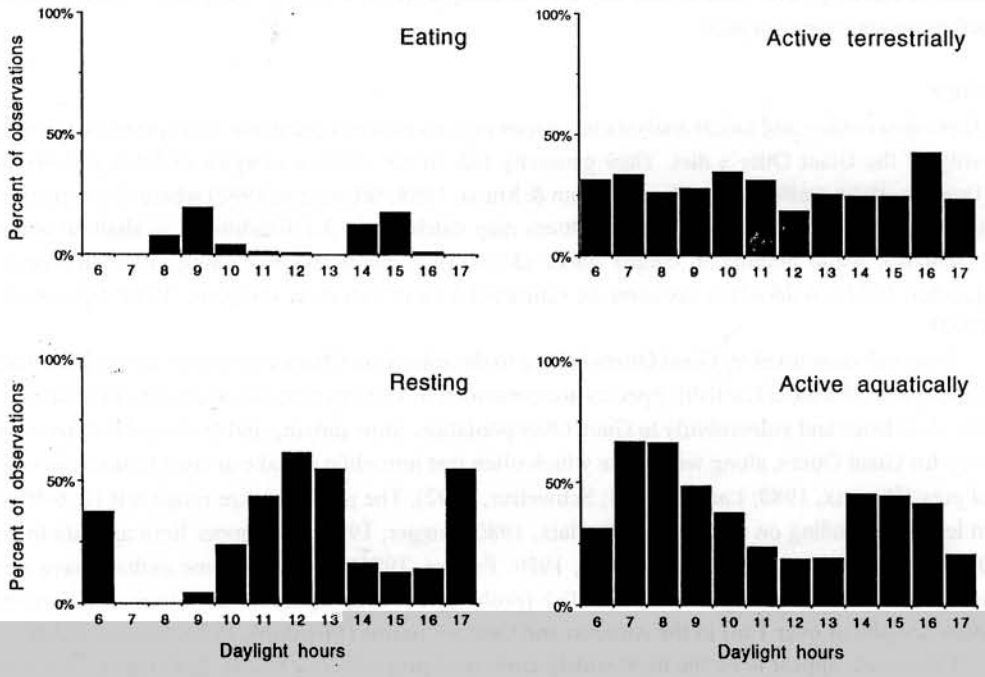

Fig. 10 Summary of principle diurnal activities of a Giant Otter (*Pteronura brasiliensis*) at the National Institute of Amazon Research, Manaus, Brazil. A total of 1554 observations were made at 10 minute intervals during 60 days in the period of January 1993–February 1994. Number of observations per hour ranges from 68 to 158.

generally taking the front line, while females may determine other group movements and activities (Trebbau, 1972; Duplaix, 1980; Laidler, 1984; Brecht-Munn & Munn, 1988; Schweizer, 1992). Hunting appears to be cooperative only in circumstances where the prey species is too large to be subdued by a single otter (e.g. large Anacondas *Eunectes murinus* and Black Caimans *Melanosuchus niger*; Brecht-Munn & Munn, 1988). Supposed cooperation observed in other cases (Hershkovitz, 1969) may be an incidental result of group members fishing individually but in close proximity. Food sharing is common among captive Giant Otters, but it has only been observed in two field studies (Brecht-Munn & Munn, 1988; Schweizer, 1992). To date no aggression within Giant Otter family groups has been observed and at least one case of altruistic behaviour involving a pair and their cubs has been documented (Schweizer, 1992).

Giant Otters appear actively to avoid direct agonistic encounters with other groups. Intergroup communication and territory defence is mainly indirect through the construction and scent marking of campsites; vocal communication may play a smaller role in territorial demarcation (Duplaix, 1980; Schweizer, 1992). In areas of high otter density, range expansion often involves territorial fights (Schweizer, 1992).

Giant Otters vocalize frequently using variations and combinations of the nine basic calls described by Duplaix (1980) and Laidler (1984). The HAH! and snort express alarm or warning to the group and the growl is a low-pitched threat. The di- or trisyllabic contact call is given frequently when travelling and fishing. Adults convey aggression, defence, or high excitement in the caterwaul or wavering scream, while cubs caterwaul to beg for food or express frustration. The hum is a reassurance close-contact sound which may be interspersed with coos when used by mated pairs or parents and their cubs. Newborns squeak during their first few days to communicate fear, hunger,

location and/or general discomfort; they later develop a whine to beg for food and express general defensive annoyance or pain.

DIET

Direct observation and faecal analysis in various regions have revealed that fish constitute the majority of the Giant Otter's diet. They generally fish in the shallow margins of lakes and rivers (Duplaix, 1980; Defler, 1983; Brecht-Munn & Munn, 1988; Schweizer, 1992) where fish density is high (Lowe-McConnell, 1975). Giant Otters may catch up to 3.2 fish/h/otter in shallow water (< 0.60 m), while hunting in deeper water (3–10 m) is much less rewarding (1.8 fish/h/otter) (Laidler, 1984). Wild adults consume an estimated 3 kg of fish daily (Duplaix, 1980; Schweizer, 1992).

Most fish consumed by Giant Otters belong to the suborders Characoidei (characins), Percoidei (perch) and Siluroidei (catfish). Species are consumed in varying amounts according to their relative abundance and vulnerability to Giant Otter predation. Slow moving and nocturnal fish are easy prey for Giant Otters, along with those which often rest immobile on lake or river bottoms in wait of prey (Duplaix, 1980; Laidler, 1984; Schweizer, 1992). The preferred size range is 0.10–0.40 m in length depending on the species (Duplaix, 1980; Fugger, 1981). The upper limit appears to be 0.60 m in most circumstances (Duplaix, 1980; Fugger, 1981), although some authors have observed Giant Otters eating enormous catfish (probably *Pseudoplatystoma fasciatum* which easily attain lengths of over 1 m) in the Amazon and Orinoco basins (Mondolfi, 1970; Santos, 1984).

Characoids appear to be the most widely consumed prey of Giant Otters. In Guyana, 73.5% of spraints contained remains of the characoid *Hoplias malabaricus* (Erythrinidae) and approximately half of the catches observed in Suriname were of this species (Duplaix, 1980; Laidler, 1984). In north central Amazônia, F. C. W. Rosas, J. A. S. Zuanon & S. K. Carter (unpublished data) found characoids in 86.5% of samples; Best (1984) found the characoid *Schizodon* sp. (Anostomidae) was the most commonly consumed species, with *Hoplias* spp. taken less frequently. Other frequently eaten characoids are members of the families Serrasalmidae, Characidae and Curimatidae (Duplaix, 1980; Laidler, 1984; Benetton, Rosas & Colares, 1990).

Siluroids and percoids also make up a substantial portion of the Giant Otter diet. Cichlids (suborder Percoidei) were consumed more frequently (present in 96.8% of spraint samples) and in greater bulk than any other prey in Guyana (Laidler, 1984) and were present in 97.3% of samples from north central Amazônia (F. C. W. Rosas *et al.*, unpublished data), although they were less important in other regions (Duplaix, 1980; Fugger, 1981). *Plagioscion auratum* (Sciaenidae) made up about one third of the diet in a Peruvian study (Fugger, 1981). Siluroid remains were present in at least 34% of faeces samples from Guyana and one area of north central Amazônia (Laidler, 1984; Benetton *et al.*, 1990), however, only 5.4% of faeces sampled from Yuruá Creek contained siluroid remains (F. C. W. Rosas *et al.*, unpublished data). Siluroids constituted 22% of the catches observed by Duplaix (1980) in Suriname.

In only one study did an invertebrate species occur in a significant portion of spraints: Duplaix (1980) found crab remains in 40% of analysed samples. Most of these samples were single spraints (rather than communal latrines) which appeared to be deposited outside the core areas of home ranges, tentatively suggesting that crab may have been a prey item consumed on seasonal visits to [illegible] of the home range. Invertebrates, mammal, amphibian, reptile, bird, crustacean and mollusc remains were rare (generally < 2%) in faeces samples (Laidler, 1984; Benetton *et al.*, 1990; F. C. W. Rosas *et al.*, unpublished data). Other vertebrates consumed in various locations include Anacondas under 3 m, other snakes under 2 m, Black Caimans under 1.5 m and turtles (*Podocnemis unifilis* and *Hydromedusa tectifera*) (Laidler, 1984; Brecht-Munn & Munn, 1988; Schenck & Staib, 1992; Martuscelli, in press).

In captivity, Giant Otters are generally fed a variety of fish supplemented with vitamins and sometimes vegetable oil. They have also been given other meats (poultry, beef, horse and donkey meat) and bread soaked in milk and egg (Zeller, 1960; Trebbau, 1972). In the Brasília zoo, Giant Otters frequently catch herons which gather in their enclosure to feed on leftover fish (C. L. Magalhães, personal communication). The present authors found that a captive adult consumed 10.0% (range 6.0–16.0%) of its body weight daily and a subadult consumed 13.4% (range 8.0–18.9%). These results are similar to studies by Zeller (1960) and Best (1985) which reported daily food consumption by adults and subadults is 7.0–9.6% and 12.9% of their body weight, respectively. Schweizer (1992) reported a higher consumption rate of 25% of the total body weight for one subadult.

PREDATION AND COMPETITION

Adult Giant Otters living in family groups have no known important natural predators, but there are some records of Black Caimans in Peru and Spectacled Caimans *Caiman yacare* in the Pantanal preying on Giant Otters (Brecht-Munn & Munn, 1988; Schweizer, 1992). Solitary animals and unattended cubs may be vulnerable to attacks from various mammals and reptiles including Anacondas and Jaguars *Panthera onca*, which are known to prey on *Lutra* sp. (Duplaix, 1980; Laidler, 1984). White-lipped Peccaries *Tayassu pecari* have also been suggested as predators of cubs (Schenck & Staib, 1992).

The Neotropical Otter *Lutra longicaudis*, sympatric in much of *Pteronura*'s range, is the Giant Otters' most significant competitor, but several factors appear to minimize direct competition. First, the Giant Otter usually frequents larger rivers and their oxbow lakes, while the Neotropical Otter inhabits smaller creeks, lakes and swampy areas further from the main rivers (Duplaix, 1980; Schweizer, 1992). Second, the latter species apparently does not need dens on 'terra firma' (land above the seasonal flood mark) to raise its young (Schweizer, 1992) and Neotropical Otters often use natural openings in rocky areas as shelter, which are not used by the Giant Otter (Blacher, 1987; Olímpio, 1992). Third, the Neotropical Otter preys on smaller fish than the Giant Otter as well as having a much wider diet which, besides fish, includes crustaceans (especially freshwater shrimp), small mammals, amphibians, reptiles and birds (Blacher, 1987; Olímpio, 1992; Parera, 1992a; Schweizer, 1992). Finally, the Neotropical Otter is nocturnal or crepuscular in some areas unlike the strictly diurnal Giant Otter (Duplaix, 1980; Blacher, 1992).

Other animals which consume only or mainly fish in habitats fully or partially overlapping that of the Giant Otter include some caimans (*Melanosuchus niger*, *Caiman yacare* and *C. crocodylus*), large piscivorous siluroids, characoids and gymnotoids (Duplaix, 1980; Laidler, 1984; Schweizer, 1992) and the river dolphins (*Sotalia fluviatilis* and *Inia geoffrensis*) which inhabit the Amazon and Orinoco Basins. We suggest that competition by both dolphin species is minimal because of spatial separation and dietary preferences. *Sotalia* generally frequents large open bodies of water and consumes mainly diurnal pelagic fish (da Silva, 1983), which would appear to minimize both habitat and dietary overlap with the Giant Otter. *Inia* may exploit the shallow water of the flooded forest during the rainy season (Best & da Silva, 1989) and its diet is more varied with a less pronounced preference for diurnal pelagic fish (da Silva, 1983). This could indicate higher habitat and dietary overlap with the Giant Otter. However, both dolphin species consume mainly small fish (< 20 cm) which are on the low end of the size range preferred by Giant Otters. Defler (1983) observed associations between *Pteronura* and *Inia* and suggested that the dolphins may benefit by fish fleeing from the Giant Otters.

REPRODUCTION AND CUB DEVELOPMENT

Information on the reproductive characteristics of Giant Otters is scanty and primarily derived from captive observations of a few animals. Giant Otters are estimated to be sexually mature at 2 years (Laidler & Laidler, 1983). The 21-day oestrous cycle continues year round (Laidler, 1984) and numerous authors have found females to be receptive from 3 to 10 days during this cycle. Zeller (1960) differed, finding the heat period to be 14 days during January and April. Nipples and vulva swell during the receptive period and females may be more aggressive and display less desire for food and play (Zeller, 1960; Laidler, 1984), although Trebbau (1978) observed no change in behaviour. Copulation takes place in the water and has been described by Autuori & Deutsch (1977) and Trebbau (1978). Breeding is apparently possible year round and peak birthing occurs during the dry season in environments with marked flooded and dry seasons (Duplaix, 1980; Brecht-Munn & Munn, 1988; Schweizer, 1992). Records of captive births show no peak.

One to five (average two) cubs are born following a 52–70-day gestation period (Autuori & Deutsch, 1977; Trebbau, 1978; Brecht-Munn & Munn, 1988; Schweizer, 1992). Survival rate in captivity is less than 30%: common causes of mortality are accidents, parents eating their young, gastroenteritis and epileptic attacks/convulsions (Trebbau, 1972; Trebbau, 1978; Autuori & Deutsch, 1977; Salvo Souza & Best, 1982; Lima & Lima, 1984). In captivity, the interlitter period may be as little as 77 days when all cubs of the previous litter are lost. If at least one cub survives, captive interlitter period is ∪⊇9 months, while intervals of 21 and 33 months were observed in the field (Laidler, 1984).

At birth, Giant Otters weigh ∪⊇0.20 kg and measure 0.33 m (Autuori & Deutsch, 1977). Cubs are cared for by both parents and siblings; older siblings may leave the group temporarily when the new cubs are born, returning 6–8 weeks later (Duplaix, 1980; Brecht-Munn & Munn, 1988; Schenck & Staib, 1992). Cubs are kept within the family den for 2–3 weeks before being introduced to the water by their parents. At one month their eyes open and they are able to swim (Autuori & Deutsch, 1977). By 6 weeks cubs regularly follow their parents out of the den and play around the den's entrance with supervision from parents or subadult siblings, but they do not begin hunting and travelling with the family until they are 3–4 months old (Duplaix, 1980; Laidler, 1984; Brecht-Munn & Munn, 1988). Cubs are weaned by 9 months and after 10 months they hunt as successfully as their parents and can no longer be distinguished from adults in the wild (Laidler, 1984; Brecht-Munn & Munn, 1988). Juveniles begin marking on their parents' campsites at about 1 year of age and remain with the family group for approximately 2 years (Laidler, 1984; Schweizer, 1992).

PHYSIOLOGY

Few physiological studies of Giant Otters exist. Marsicano *et al.* (1986) described anaesthesiology of a captive adult with ketamine hydrochloride, finding effective dosages of 10.0–10.6 mg/kg, depending on the animal's condition. Colares & Best (1991) described haematological and chemical blood parameters which are similar to those of the Sea Otter, and Rosas & Lehti (1992) found Zn, Na, Cu, Mg, Mn, Fe and Ca levels in fur to be comparable with those of other carnivores. Digestive efficiency is ∪⊇75% and passage time through the digestive tract in captivity ranges from 35 min to about 2 h (Duplaix, 1980; Best, 1985). Field observations by Schweizer (1992) indicate a passage time of ∪⊇1 h.

Laidler (1984) observed low heat tolerance in captive otters, which may be a result of the elevated metabolic rates of mustelids in general (Iversen, 1972) combined with the high ambient temperatures found throughout most of the Giant Otter's range.

STATUS

Since 1978 the Otter Specialist Group of the World Conservation Union (IUCN) has considered *Pteronura brasiliensis* the most endangered otter species in the world. The species, however, is classified as 'vulnerable' by IUCN (1990). It has also been listed on Appendix I (species threatened with extinction) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This convention, enacted in 1973 and now ratified by all South American countries, authorizes international trade only in exceptional circumstances. However, CITES does not regulate domestic trade nor enforce habitat protection. Giant Otters are also protected by national laws within all South American countries (with the possible exception of French Guiana), but trade bans did not come into effect in some countries until the mid 1970s and enforcement is nearly impossible.

PAST AND PRESENT THREATS

Before large-scale settlement of the Amazon Basin began in the early 1960s, pelt hunters were the main threat to Giant Otter populations. Remaining populations of Giant Otters now face severe pressure from increasing colonization and exploitation of natural resources such as hydroelectric power, minerals and fossil fuels which contaminate or destroy formerly pristine tropical forests and water systems.

Hunting

Giant Otters can be easily located because of their noisy diurnal habits and conspicuous campsites. These characteristics, combined with the high value of their pelts ($US 27–90 or more) (Doughty & Myers, 1971; Donadio, 1978; Ayres & Best, 1979), led to extensive uncontrolled hunting in the 1950s and 1960s. Official statistics indicate that over 40 663 pelts were exported from Brazil alone from 1960 to 1967 (Best, 1984). This is probably a gross underestimation of the actual number of Giant Otters killed because (i) 60% of animals sink before they can be recovered by hunters (Coimbra-Filho, 1972); (ii) any dependent cubs are effectively killed with the death of a parent; and (iii) the sale of many skins never appears on official records because of smuggling or under-invoicing by exporters (Donadio, 1978). Trade is now banned and pelt prices have dropped significantly ($US10–20), but Giant Otters continue to be hunted for their pelts (Duarte & Rebêlo, 1985; Emory, 1990; Schenck & Staib, 1992; Bisbal, 1993). Before the implementation of CITES, the USA and Europe (particularly West Germany and the UK) were the main importers of Giant Otter pelts (Doughty & Myers, 1971). In 1981, West Germany imported 1007 pelts from Italy, with Paraguay the reported country of origin (Fitzgerald, 1989), and in 1982, 547 pelts were confiscated in Brazil (Duarte & Rebêlo, 1985). Small numbers of Giant Otters are also hunted for meat by Amerindians in Colombia and Guyana (Laidler & Laidler, 1983; Defler, 1986), captured for the zoo trade (Schweizer, 1992) and robbed by locals from their dens as cubs to be sold or kept as pets (Duplaix, 1980; S. K. Carter & F. C. W. Rosas, personal observation). However, the current effect on the overall population from direct capture or killing of animals is minor compared with the increasing threat to existing populations from habitat loss and degradation.

Colonization and deforestation

The increasing development and subsequent human invasion of vast tracts of tropical forest is rapidly making many areas incapable of supporting Giant Otter populations. Colonization of the Amazon Basin has historically been limited to the areas along navigable waterways, but recently many roads have been built by logging and mining companies and for government projects. This opens up large areas to invasion by hunters and settlers and consequently more people must depend on the river for food, as fish is their principal source of animal protein (Santos, Ferreira & Zuanon,

1991). This leads to conflict with resident otters, which are highly visible, often feared and consume large quantities of fish. Also, the nutrient-poor soil in the Amazon Basin will support agricultural crops and cattle pasture for only 3–4 and 10 years, respectively, which leads to further clearing and burning of the forest. Fearnside (1993) estimated that as of 1990, 10.5% of the Brazilian Amazon had been deforested.

Hydroelectric dams

Hydroelectric dams have been constructed on rivers throughout the Amazon, Orinoco and La Plata basins. The majority of rivers selected for damming are black or clear water (Junk & Nunes de Mello, 1987), the favoured habitat of the Giant Otter. Thus the fate of aquatic fauna in these reservoirs and their future suitability as Giant Otter habitat is of key importance.

Dams have flooded a current total of 5429 km^2 in the Brazilian Amazon and this may soon be increased to 11 060 km^2 by another eight dams in the final stages of planning (Nunes de Mello, 1993). Dams make formerly inaccessible areas accessible, leading to the indiscriminate exploitation of natural resources in the area and potential invasion by hunters (Junk & Nunes de Mello, 1987). They also profoundly affect fish populations by interrupting migratory routes and drastically changing hydrological and water-quality conditions (Junk, 1983; Petts, 1990; Leite & Bittencourt, 1991). Preliminary studies show that there is a temporary boom in the number of predatory fish, particularly *Serrasalmus* spp., after filling (Leite & Bittencourt, 1991), but populations of many migratory species are greatly reduced or disappear in and above the reservoir (Ferreira, 1984; Junk & Nunes de Mello, 1987). Three years after damming the Tocantins River at Tucuruí (Brazil), the fish population remained unstable and biomass and species diversity were significantly decreased (Leite & Bittencourt, 1991). In Suriname, the Brokopondo reservoir was still relatively poor in aquatic fauna and flora after 20 years (Junk & Nunes de Mello, 1987).

Mining

Gold mining is common in areas of the Orinoco and upper Paraguai River basins, on the Saramacca and Marowijne Rivers in Suriname and on rivers throughout the Amazon Basin including the Madre de Dios, Madeira, Negro, Branco and Tapajós, all of which are or were inhabited by Giant Otters. Gold is mined from these rivers by dredging. This produces large amounts of suspended particulate matter in the water, which interferes with light penetration, buries bottom-dwelling algae species and asphyxiates fish (Alho, Lacher & Gonçalves, 1988). Once sludge is removed, mercury is used to separate and amalgamate the gold particles. Approximately 1.3–4.0 kg of mercury are released into the surrounding environment for each 1.0 kg of gold produced (Mallas & Benedicto, 1986; Pfeiffer & de Lacerda, 1988) and as much as 45–60% of this mercury flows directly into the water (Pfeiffer & de Lacerda, 1988). Recent research by Forsberg *et al.* (in press) has shown that mercury contamination is especially critical in black-water rivers, which promote naturally high mercury concentrations because of their low pH and conductivity and high content of dissolved organic material.

Once in the aquatic ecosystem, metallic mercury may be changed to its more dangerous organic form (methylmercury) and transferred through the food chain, magnifying at successive trophic levels (biomagnification). Predatory fish accumulate significantly higher tissue mercury concentrations than herbivorous and omnivorous species from the same area of the Amazon (Martinelli *et al.*, 1988; Forsberg *et al.* in press; C. R. Padovani, B. R. Forsberg & T. P. Pimentel, unpublished data) and Kucera (1983) found that North American River Otters accumulate 10 times more mercury than predatory fish. Bioaccumulation has been demonstrated in otters as well: Kruuk & Conroy, (1991) and Mason & Madsen (1992) found higher mercury levels in adult otters than in juveniles and subadults.

Mercury accumulates in the hair, liver, kidney, muscle and brain tissues of otters, causing progressive central nervous system deterioration and death in laboratory tests (O'Conner & Nielsen, 1980; Kucera, 1983; Wren, 1986). O'Conner & Nielsen (1980) predicted that mercury poisoning would occur in wild otter populations in watersheds where fish regularly contain 2 parts per million (wet weight) methylmercury. Sublethal effects on reproduction, growth and behaviour may occur at lower concentrations (Wren, Stokes & Fischer, 1986). As predatory fish in some areas of the Amazon have mercury tissue concentrations of up to 2.63 p.p.m. (Forsberg *et al.* in press) and there is no sign of a decrease in gold mining, it is possible that Giant Otter populations could be affected by mercury poisoning in the future. Mercury poisoning in humans has been confirmed in several areas of the Amazon Basin (Homewood, 1991).

The most dangerous consequence of mining of other mineral resources such as bauxite, iron ore and coal in the Amazon may be the accompanying development which results in large areas of forest being disturbed, cleared or settled. This is particularly evident in the Serra dos Carajás where development projects related to the exploitation of iron ore and other minerals are expected to destroy almost all of the forest east of the Tocantins River by the end of the century (Johns, 1988).

Fossil fuels

Oil is currently exploited in the Orinoco and far western Amazon basins and recently large deposits of oil and natural gas have been discovered in the Urucú and Juruá River basins in the western Amazon of Brazil (Johns, 1988). The road building involved in oil exploration often leads to invasion of these areas by settlers, as happened in the Cuyabeno Wildlife Reserve and will likely happen in Yasuní National Park, both legally protected areas in Ecuador inhabited by Giant Otters (Collins, 1990). During drilling and recovery, there is the risk of a spill or blow-out along with further contamination of water systems from oil, effluents and drilling mud (a mixture of clay, water, chemicals and sometimes oil) (IUCN, 1991). Contamination is extensive in Ecuador where ruptures in one main pipeline have spilled over 16 million gallons of oil into the water system in the last 20 years. Ten thousand gallons are spilled weekly from secondary lines. Further damage is caused by the more than 4.3 million gallons of untreated toxic waste the petroleum industry dumps into the watershed daily (Kane, 1994).

Industrial pollution

Industrial pollution in the more developed Paraguai, Orinoco and La Plata basins has also affected aquatic fauna. Alcohol distilleries in the Pantanal produce large amounts of stillage, a by-product of the sugar cane distillation process. The distilleries' widespread discharge of stillage into water courses causes eutrophication and deoxygenation of water, alters its temperature and pH and has been linked to numerous fish kills (Alho *et al.*, 1988). In the Orinoco, the heavy use of pesticides in the Portuguesa and Cojedes subbasins has caused fish mortality (Colonnello, 1990), and the new industrial development project in the basin includes plans for a wood pulp processing plant and a large crude oil refinery which would likely increase pollution in other areas. Changes have also been observed in fish species of the lower La Plata basin, a system polluted with agricultural and industrial toxic substances and altered by various hydroelectric dams (Quiros, 1990).

RECOMMENDATIONS

As with other Neotropical species, protection of quantity and quality of habitat is required to ensure the survival of the Giant Otter. This may best be carried out through the development of long-term sustainable development projects combined with the establishment and fiscalization of adequately located and sized protected areas. In addition, we recommend elevating the status of the Giant Otter in the *IUCN Red Data Book* from 'vulnerable' to 'endangered' and further studies on the effects of natural resource harvest and extraction.

Reevaluation of Red List status

We believe that the status of the Giant Otter should be changed from 'vulnerable' to 'endangered' according to the new criteria for the Red List Categories in Version 2.2 of IUCN (1994). The species has been decimated in the southern portion of its original distribution. Pelt export statistics indicate that Giant Otters were heavily exploited in much of the remainder of their historical range through at least the 1960s. The remaining scattered populations in South America face immediate and increasing threats to the quantity and quality of their habitat. Based on this information, the species has experienced a severe decline over the last five generations in extent of occurrence, area of occupancy and quality of habitat and thus should be considered 'endangered' under criterion A1 of endangered species of IUCN (1994).

Habitat protection

Long-term studies by independent researchers on the ecological effects of hydroelectric dams, mining and oil exploration are needed. Of particular importance to Giant Otter conservation are studies on the effects of large dams on the diversity and abundance of fish populations and the extent to which animals at the top of the aquatic food chain are affected by biomagnification and bioaccumulation of mercury in the ecosystem.

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