AVANCES
EN CIENCIAS E INGENIERÍAS
ARTÍCULO/ARTICLE SECCIÓN/SECTION B

Population density, abundance estimates, habitat preference and social structure of Amazon River dolphins (*Inia geoffrensis*) in the Cuyabeno Reserve, Ecuador

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Editado por/Edited by: C. Zambrano, Ph.D.
Recibido/Received: 02/23/2010. Aceptado/Accepted: 01/10/2010.
Publicado en línea/Published on Web: 12/08/2010. Impreso/Printed: 12/08/2010.

Abstract

Population density, abundance, habitat preference, home range and social structure of Amazon River dolphins or Boto (*Inia geoffrensis*) were studied in the Cuyabeno Reserve in Ecuador from 1996 to 1998. The study area the Cuyabeno and Lagartococha Rivers are two blackwater tributaries, to the Aguarico River a white ater river. While the Cuyabeno river is flowing through tierra firme forest with numerous oxbow lakes on the 111km stretch surveyed, the Lagartococha river was surveyed on 86,7kms passing through varzea. The maximum population density of 0.39 Botos/km river is fairly low in comparison to other study areas in the lower Amazon basin and depends significantly on season and habitat. Most animals tend to be close to the river mouth during the low water season and in Lagoons with Igapó and Grasslands during the high water season. Behaviour was most divers in Lagoons with Igapó and Grasslands, while shallow river sections with beaches are only used as migration passages. Although Botos are considered solitary animals, observations in the Cuyabeno Reserve confirm a high amount of groups from two to eight animals with calves living in groups of three or four animals rather than mother calf pairs. According to Photo ID studies, home range of Botos in the Cuyabeno Reserve extended over different rivers and travelling distances of more than 200kms within the Lagartococha to the Cuyabeno River were recorded. However, most of the dolphins identified according to natural marks on their dorsal fin or back, remained within 50kms, which shows overlapping home ranges of different groups or single animals.

Keywords. Amazon riverdolphin, *Inia geoffrensis*, population density, abundance, social structure, Group size, habitat use, behaviour, homerange.

Abstract

La densidad poblacional, abundancia y preferencia de hábitat del delfín Amazónico o Boto (*Inia geoffrensis*) en la Reserva Cuyabeno, Ecuador fue estudiado entre 1996 y 1998. El área de estudio se ubicó en el río Cuyabeno y en el río Lagartococha, dos tributarios de aguas negras los cuales desembocan al rio Aguarico. El río Cuyabeno en sus 111 km estudiados fluye a través de bosques de tierra firme con numerosas lagunas meandricas, mientras que el río Lagartococha a lo largo de los 86,7 km que fueron estudiados se encuentra en un sistema de bosques inundados. La máxima densidad poblacional de 0,39 Botos/km río es bastante bajo en comparación con otras áreas de estudio de la Amazonía baja y depende significativamente de la estación del año y el hábitat. En la época seca, la mayoría de los animales tienden a mantenerse cerca de las desembocaduras de los ríos, mientras que en la época lluviosa suben a las lagunas con Igapó y Varzea. Existe mayor diversidad de comportamientos en lagunas con Igapó y Varzea, mientras que los delfines usan las secciones de río de poca profundidad y playas solamente como pasos migratorios. A pesar de que los Botos se consideran animales solitarios, observaciones en la Reserva Cuyabeno confirman un gran porcentaje de grupos de dos a ocho animales. Cuando hay crías, generalmente el tamaño del grupo es de tres a cuatro animales. El ámbito hogareño de los Botos en la Reserva Cuyabeno, según los estudios de foto identificación, se extiende a través de varios ríos entre el río Lagartococha y el río Cuyabeno con una extensión de más de 200 km, sin embargo, la mayoría de los delfines se mantuvo en un rango de 50km en sobre posición con otros grupos o delfines solitarios.

Palabras Clave. Delfín Amazónico, *Inia geoffrensis*, densidad poblacional, abundancia, estructura social , tamaño grupal, uso de hábitat, comportamiento, ámbito hogareño.

ISSN 1390-5384

Introduction

The Amazon River Dolphin or Boto (*Inia geoffrensis*) inhabits the Amazon and Orinoco River basin [1]. In Ecuador, they are distributed in the Pastaza, Curaray, Napo and Aguarico River systems but information is limited to studies, in the Lagartococha River in the North of the Cuyabeno Reserve [2, 3]. River dolphins are restricted to freshwater where they may be found in a variety of habitats [4, 5] such as confluence areas [6], flooded forests [4], main river channels, lagoons and below rapids [1]. So far, studies on habitat use did not consider behaviour in different habitats and are restricted to censuring dolphins in different habitats such as lagoons, rivers and secondary channels [7] or as river sections with or without curves used by Henningsen [8]. Tagging experiments of Botos in the central Amazon have shown that they are apparently sedentary [9]. Area extent of Botos is not known, but individuals may remain in the same area for over a year [10]. Direct evidence of long-range migrations like that for one individual that migrated 2000 km from near Tefé in Brazil to the Samirias River in Perú [8] are scarce and Best and da Silva [9] suggest that long-distance migrations are not frequent. Even though all cetaceans are , social to some extent, Botos are rather solitary or gather in pairs [8]. Thus, in the Central Amazon of Brazil agregations of up to 20 dolphins only have been observed for hours or for a few days [8]. However, in the Brazilian or Peruvian Amazon [11, 7] most Botos were seen in groups than singly. Here I report abundance estimates of Amazon River dolphins for their entire range in the Cuyabeno Reserve using strip transects and photo identification. Group composition and group size frequency in different types of habitat also was part of this study.

Methodology

Study area

The study area is part of the Aguarico river system (Figure 1), situated in the Cuyabeno Faunistic Reserve in the province of Sucumbios in the north east of the Ecuadorian Amazon. Surveys were conducted in the Cuyabeno and the Lagartococha River, two blackwater affluents to the Aguarico River with an average width of 30 m. The Cuyabeno River was studied along 89 km including the Laguna Grande and the Lagartococha River on an 87 km stretch from its mouth to Garzacocha. The Cuyabeno River flows through *terra firme* forest, and is connected to a system of several lagoons with Igapó, the Lagunas Grandes, while grasslands, patches of Igapó forest and numerous lagoons characterize the course of the Lagartococha River. During the dry season, from December to March, the Lagunas Grandes run completely dry and the Cuyabeno River almost dries out in its upper course but still has water in the lower 20 kms. In the Lagartococha River system, neither the river nor the lagoons, such as Garzacocha and Imuya run completely dry. The rainy season (high water season) begins in March and by

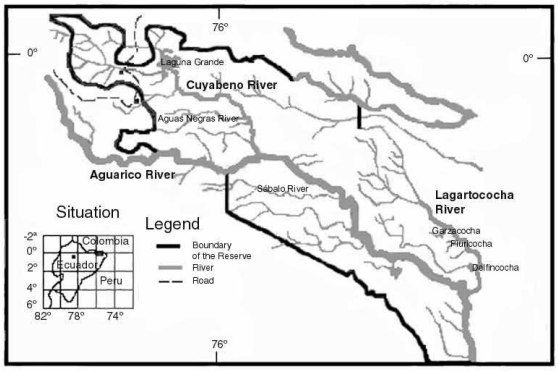

Figure 1: Study area in the Cuyabeno Faunistic Reserve

Habitat	Code	# of surveys conducted
Lagoons with Igapó	LIG	66
Lagoons or river with grassland	HER	58
Whitewater river	WWR	18
Blackwater river mouth with whitewater river	RMA	110
River wide parts and beaches	RWB	27
River wide parts and Igapó	RWI	61
River with oxbow lakes	ROL	101
River narrow parts with steep shores	RNS	75

Table 1: Habitat systems in the study area and effort in each habitat.

June all lagoons and rivers are at their maximum water levels with 5m depth in the Lagunas Grandes. During the rainy and dry seasons water level vary dramatically. During the rainy season, the Cuyabeno River may still run dry occasionally and during the dry season, occasional heavy rainfalls may result in almost maximum water levels in the rivers and lagoons during short periods.

From May 1996 to June 1998 rivers were surveyed from a 12 m dugout canoe with a 25 hp out-board motor. The speed of the canoe with 10 to 15 km/h was adjusted to the 14 km/h maximum swimming speed of Inia [10]. Two observers surveyed the river, one looking ahead and one looking behind the canoe. For each sighting, time of day, river section, sighting duration, number of individuals and size-class of each individual was recorded. A group was defined as the total number of animals seen in the immediate vicinity of a sighting. For group composition, animals were classified into three age-classes according to size: individuals with up to 1 m total body length were considered as calves (*c*), from 1 m to 2 m as intermediates (females and immature) (*i*) and dolphins larger then 2 m as adults (*a*). Besides size, age-classes were also distinguished by their appearance and behaviour such as the short beak and mostly greyish colour of calves. Adults are light grey or pink and

very often covered with scratches, nicks and patches of dark and light pigmentations. Sighting density was measured by strip transects [12] in the river channel. In the Aguarico River sighting conditions are poor because of the width and structure of this river. Therefore sightings on these transects were occasional and therefore excluded from sighting density and abundance estimates. Sighting density (D^*) was computed separately for each season and river section dividing the number of dolphins (n) seen on each transect by the length of the transect (L_{trans}).

$$D^* = \frac{n}{L_{trans}} \quad (1)$$

The strip transect method assumed that all animals within a strip either side of the survey craft are detected [12]. Therefore only surveys during low water conditions are used for abundance estimates. Abundance (N) on each river was calculated by multiplying the average density (D_a) of the Cuyabeno and Lagartococha River during the low water season, with the total length (L) of the river surveyed.

$$N = D_a \cdot L \quad (2)$$

Photographs for Photo Identification studies were taken with a Nikon F3 35mm camera and a Sigma 400mm/5.6 lens on 200 and 100 ASA colour slide films. Out of 3.564 pictures, 353 were processed with Adobe Photoshop and analysed for different marks or combinations of marks such as slight and deep scratches, nicks and pigmentation patterns. All marks used for this study remained for at least three years and hence were feasible for population estimates and home range analysis throughout the study period [13]. Only pictures of very good quality were used for population estimates. Since current information suggests that Boto populations remain in defined areas, closed population models [14] were used using Bailey's [15] modification of the Petersen two sample model for sampling with replacement:

$$N_1 = \frac{n_1 (n_2 + 1)}{m_2 + 1} \quad (3)$$

(N_1= population size; n_1=animals identified in the first sample, n_2=animals identified in the second sample, m_2= animals recaptured in the second sample). Since all animals should have equal "catchability" at all sampling units used for the estimate [16], only excursions during the low water season in December 1996 and 1997 were used in order to keep sighting and capture heterogeneity as small as possible. For habitat use studies, the study area was classified into different types of habitats (Table 1). Because of poor visibility only surface behaviours were considered according to Table 2. The number of observations, number of animals, average group size, presence of calves and the frequency of different behavioural categories in different habitats was analysed in relation to the effort spent in each habitat and in each season (Table 1). Home range was studied based on maximum travel distances using photographically identified individuals observed in different river sections. Even though natural marks such as nicks, scars and pigmentations are commonly used to identify whales and dolphins by photo identification [17], this technique so far has found little attention for river dolphin studies, even though Trujillo [18] mentioned that photo identification is a promising tool to study social structure and migrations of both Boto and Sotalia (*Sotalia fluviatilis*). Maximum travel distances were classified into distance groups such as 0 -10 km, 10 –50 km, 50 – 100 km, 100 – 200 km and more than 200 km.

Behavior	**Definition**
Milling	One or more dolphins are surfacing regularly and in different directions in the same area.
Feeding	Fast movements on or underneath the surface mostly directed to the shore or against bushes, mostly fishes are jumping on the surface.
Travelling	Directional swimming with regular surfacing intervals and at a moderate speed.
Socializing	Any interaction of two or more animals that are involved in the same behaviour within a limited area and manipulation of objects.
Resting	Non-directional swimming with regular surfacing intervals at a low speed. Or surfacing on more or less the same spot without any abrupt or fast movement.

Table 2: Ethogram for surface behaviour of *Inia geoffrensis*

Social structure of Boto was examined analysing group size, group composition and group size frequencies in different types of habitat. Group composition was classified as singletons with single intermediate sized or adult animals, pairs and mother calf pairs, triplets of adults and intermediate sized animals and mother calf(ves) escort groups with 3 and more animals including calves and finally groups with four and more animals without calves. The frequency for all types of groups was calculated by the amount of sightings from each group size to the total number of sightings (n = 499) and according to effort in each type of habitat. Size class composition was calculated in reference to all sightings and as frequency for each group size.

Results

Abundance estimates were higher for the Cuyabeno River (79 dolphins in 1996/97 and 45 dolphins in 1997/98) than for the Lagartococha River (15 dolphins in 1997/98).

Area/season	96/97	97/98
Cuyabeno River	79	45
Lagartococha River		15
Study area strip transects		60
Study area Population estimate		61,2

Table 3: Boto (*Inia geoffrensis*) abundance estimates (dolphins/km river) and Population estimate in the Cuyabeno Reserve.

In 1997/98 a total of 60 dolphins were estimated to inhabit both river systems using the strip transect method and 61. 2 animals estímate. (Table 3).

The number of animals found differed significantly from one season to another (χ^2 = 20.14; DF=4, p < 0.01-). In the Cuyabeno River, density of Botos was highest during the low water season (D = 0.08 Botos/km river; SD = 0.03) In the mouth of the Cuyabeno River, no animals were seen during the high and rising water season, but the density of Botos on the 20km transect to the mouth was strikingly high during the low water season (D = 0.39 Botos/km river; SD = 0.20). In the Lagartococha River, during the low water season Boto density was higher on transects to the mouth (D = 0.25 Botos/km river; SD = 0.15) than on transects to the upper part of the river (D = 0.09 Botos/km river; SD = 0.03) (Figure 2).

The amount of animals sighted depends significantly on habitat and season (χ^2= 405, DF = 7, p<0.1-). During the high water season most animals remain in lagoons with Igapó forest (*lig* = 39%) or within grasslands (*her* = 30%). During the falling water season they migrate downstream to the river mouth (*rma* = 35%), however, some animals stay in the lagoons (*lig* = 13%) and grasslands (*her* = 18%). During the low water season, most Botos were seen in river sections with oxbow lakes (*rol* = 47%) and in the mouth of the river (*rma* = 22%). During the rising water season, they migrate back to the lagoons with Igapó (*lig* = 12%) or to grasslands (*her* = 26%) and some remain in the river mouth (*rma* = 24%) or in river sections with oxbow lakes (*rol* = 22%) (Figure 3).

The behaviour depends significantly on the habitat (χ^2 = 240; FG = 7; p < 0.01, Pearsons Coefficient of Contingency = 0.56). In grasslands Botos are mainly feeding (fe = 0,2/h) or milling (mi = 0.9/h), while lagoons with Igapó were used for resting (re = 0.7/h). In the river mouth and in river sectors with oxbow lakes, the main behaviour was travelling (rma: tr = 0.3/h; rol: tr = 0.5/h) and. milling (rma: mi = 0.4/h; rol: mi = 0.6/h). In wide sectors of the river only travelling (tr = 0.1/h) and occasionally milling could be observed, while narrow sectors of the river and sectors with Igapó forest were also used for milling (rnas: mi = 0.1/h; rwi: mi = 0.2/h) and feeding (rns/rwi: fe = 0.1/h). Another predominant activity in these sectors was travelling (rns/ rwi: tr = 0.1). Whitewater Rivers however were rather used for feeding (fe = 0.1/h) and milling (mi = 0.2/h) than for travelling.

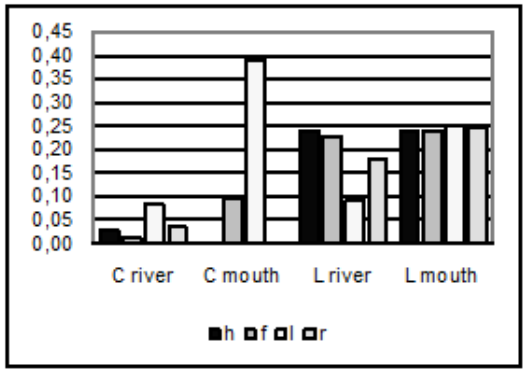

Figure 2: Boto (*Inia geoffrensis*) sighting density on transects in the Cuyabeno Reserve. Legend: *C*: Cuyabeno River; *C mouth*: Mouth of the Cuyabeno River; *L river*: Lagartococha River; *L mouth:* Mouth of the Lagartococha River; *h*: high water season; *f*: falling water season; *l:* low water season; *r*: rising water season.

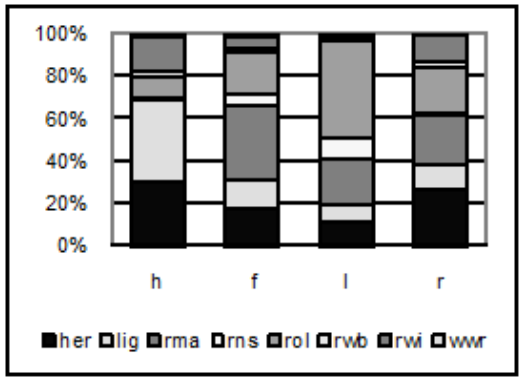

Figure 3: Proportion of Boto (*Inia geoffrensis*) seen in different habitats during different seasons (n = 956). Legend: *her*: herbazales; *lig*: lagoons with Igapó forest; *rma*: river mouth; *rns*: narrow sectors of the river; *rol*: river sectors with oxbow lakes; *rwb*: wide sectors of the river with beaches; *rwi*: wide sectors of the river with Igapó forest; *wwr*: white water river; *h*: high water season, *f*: falling water season; *l*: low water season; *r*: rising water season.

Social behaviour has only been observed in small portions in grasslands, lagoons with Igapó forest, in river sectors with oxbow lakes and in the river mouth (Figure 4).

In order to define homerange, of 29 animals identified, 17% (left Side of dorsal fin) or 7% (right side of dorsal fin) of identified animals have been observed within a range of 200 km and more, migrating from one river to another. As many animals have been seen within a 100 – 150 km range as within a 0 – 50 km range (37% left ID; 38% right ID) (Figure 5).

The number of Botos seen at each sighting differed from 1 to 9 animals. Most of them appeared in groups of two or more animals but still 29 % were singletons and 13% pairs. Most of the groups with three and more animals were mother calf(ves) escort groups (32 %) mother/calf groups comprised 16% of the sightings. Surprinsingly 5% of the sightings were single calves and 2% calf pairs (Figure 6).

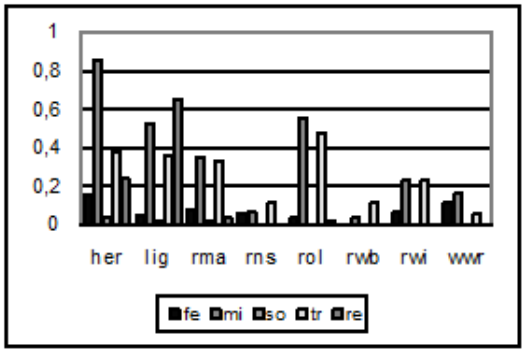

Figure 4: Behaviour frequencies of Boto (*Inia geoffrensis*) in different types of habitat in the Cuyabeno Reserve (n = 435)Legend: *her*: herbazales; *lig*: lagoons with Igapó forest; *rma*: river mouth; *rns*: narrow sectors of the river; *rol*: river sectors with oxbow lakes; *rwb*: wide sectors of the river with beaches; *rwi*: wide sectors of the river with Igapó forest; *wwr*: white water river.

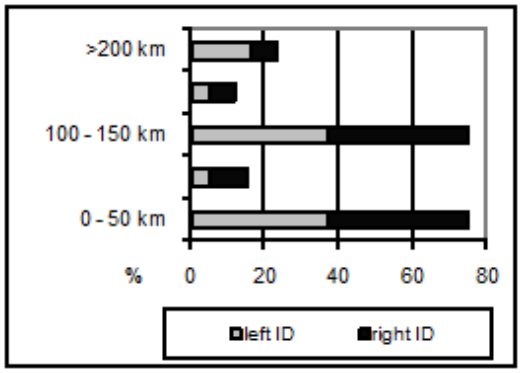

Figure 5: Home range of Boto in the Cuyabeno Reserve using photographically identified animals according to marks on the left side (*left ID*) and right side (*right ID*) of their dorsal fin (n = 29)

Concerning group structure, intermediate sized animals were mostly seen in groups of two (28%), three (27%) or four and more animals (26%). Adults seemed to prefer groups of three animals (33%) and were rarely seen alone (14%). Even though calves remained basically in groups of four or more animals (35%), still 7 % of all calves sighted were actually seen on their own. (Figure 8). Most of the animals sighted were of intermediate size, and only 12% of the sightings were adults and 30% calves (Figure 7).

Discussion

During the study period from 1996 to 1998, approximately 60 Botos inhabited the Cuyabeno and Lagartococha river systems in the Cuyabeno Reserve. Population density throughout these years remained stable but differed significantly within seasons and habitat. During high water seasons for example, dolphins preferred the upper parts of the rivers, where they stay in lagoons and Igapó forests. During the falling and low water season they migrate towards the mouth of the river. During the high water seasons, most fish species hide in Igapó forests, within grasslands and along steep shores, where they find shelter from the sun and predators. During the low water season the fish has to migrate to deeper areas,

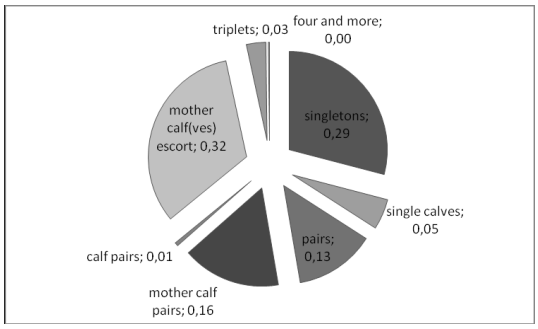

Figure 6: Boto (*Inia geoffrensis*) group size frequency (n = 499))

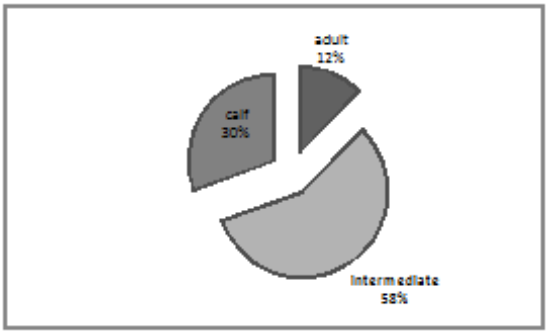

Figure 7: Boto (*Inia geoffrensis*) size class composition (n = 1130 animals)

such as the main riverbed, and the lower sections of the rivers (Barriga pers. com). Therefore Boto densities in the river bed are higher during the low and falling water season. McGuire and Winemiller [7] in the Cinaruco River, in Venezuela, also observed dolphins more frequently during the falling than during the rising water period.

In general Boto densities in the Cuyabeno River are fairly low in comparison to other areas of the Amazon basin. In the Amazon River, population density ranges from 1.7 Botos/km in the upper part at the border of Peru and Colombia [4] to 0.19 Botos/km in the mid Amazon [5], and 0.22 Botos/km from Manaus to Peru [9]. In smaller side streams in Peru population densities ranged from 0.45 to 0.68 Botos/km in the Samiria River and 0.73 to 1.46 Botos/km in the Tapiche River [8]. However, few of these studies are long-term studies and the methodology, such as survey speed is not standardised. Henningsen [8], for example, used a travelling speed of 4 –6 km/h, which may account for higher densities in his study area, since more animals are missed travelling at a speed of 10-15 km/h as used in the present study and by Best and da Silva [9]. On the other hand double counts may be avoided as Botos travel with a speed of 2.4 to 5.1 km/h and bursts up to 22.5 km/h [1]. More animals were seen in Blackwater Rivers than in Whitewater Rivers. Even though, Best and Da Silva [9] observed that population density is higher in Whitewater than in Blackwater Rivers since primary production in Blackwater Rivers is low and hence there are fewer fish to prey upon. Nevertheless, 36 of the 45 prey species of Inia according to Best and da Silva [19]

can be found in Blackwater Rivers of the Cuyabeno Reserve, where they prefer lagoons and canyons (Barriga pers. com.). Despite of observations from Best and Da Silva [9] and Henningsen [8], that Boto prefers the mouth of rivers, in the Cuyabeno Reserve, fewer animals were seen in the mouth than in grasslands and lagoons with Igapó. According to the amount of animals and the high proportion of calves seen in grasslands and lagoons with Igapó, these habitats seem to be especially important as breeding areas. Different habitats are used in different ways as the behaviour varies significantly with the habitat. Behaviours correlated with feeding occur in all habitats, which is probably due to the wide variety of prey fish [9]. Only in wide areas of the river with beaches few observations of feeding were made even though on several occasions McGuire and Winemiller [7] found Botos feeding on beaches. In the Cuyabeno Reserve, the dolphins basically use this habitat for travelling. Possibly, wide shallow areas of the river are dangerous since the water level can change from one day to another and dolphins could become trapped. Socializing was only observed in grasslands, lagoons with Igapó, river sections with oxbow lakes or in the mouth of black water rivers. Again this indicates that grasslands and Igapó forests are important habitats for this species. Most of the animals observed in the Cuyabeno Reserve have a home range of 0 -50 km or 100 – 150 km. As each river was surveyed on a stretch of about 80 km, dolphins rather seem to remain in an extended river section of up to 50 km. These findings support overlapping of home ranges as suspected by Best and da Silva [9]. The high number of animals seen within a 100 – 150 km range is due to the migrations within the Cuyabeno and Lagartococha River where they travelled at least 100 km. Migrations may be caused by seasonal flood cycles since the Cuyabeno River can run dry, while the Lagartococha River has enough water for dolphins throughout the year. On the other hand, Botos ranged within 150 km or more, which is supported by the relatively high percentage of animals seen within more than 200 km in this study and the individual that travelled from Brazil to Peru observed by Henningsen [8].

Even though Boto is considered a solitary animal [1] [20], in the Cuyabeno Reserve sightings of groups were more frequent than single animals. McGuire and Winemiller [7] found groups of two to eight individuals in the Cinaruco River in Venezuela and Henningsen et al. [11] observed only 2 % of all Boto and Sotalia (*Sotalia fluviatilis*) singly while most of his sightings consisted of pairs or small groups of three to four animals. In Brazil Best and Da Silva [1] on the other hand observed 51 – 81 % of Botos on their own and 12 - 26 % in pairs most of which were mother and calf pairs. According to the results obtained within the present study and by other researchers at least in some regions of the Amazon basin, Botos appear to be social animals. As expected, most of these animals seen were of intermediate size, as

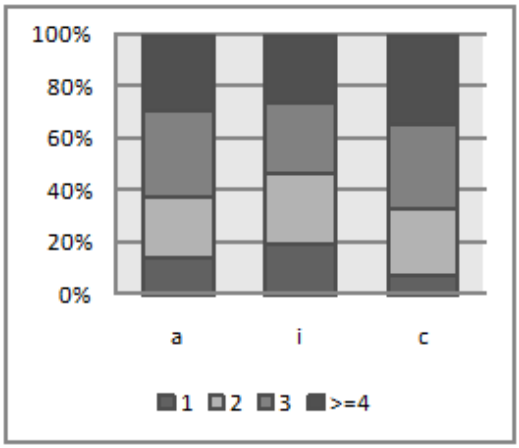

Figure 8: Boto (*Inia geoffrensis*) proportion of group size in each size class (n = 1130 animals). Legend: *a*: adults; *i*: intermediate sized animals; *c*: calves

this size class comprises a variety of age classes considering that females mature at a body length of 1.80 m and males mature at a body length of 1.90 m [19] [20]. Still it is surprising that there are more calves than full-grown adults. Maybe most of the animals in the adult size class were actually mature males, given that males grow bigger than females [9]. On the other hand, the high amount of calves might be due to the difficulty of estimating the size of Botos, as most of their body is submerged, even when breathing. Though, with an estimated error of 20cm, animals judged as calves are definitely younger than 2 years and the fact that every third animal seen was a calf or a youngster with less than 2 years indicates that the Cuyabeno Reserve is an important area for upbringing. Most calves were seen in groups of 3 to 4 animals, which coincide with observations by Henningsen [8]. Probably older offsprings remain with the mothers for several years. Nevertheless 25 % of the calves were seen in pairs, possibly mother calf pairs or an effect of loose bonding with older offsprings or other group members as observed in Bottlenose dolphins (*Tursiops truncatus*) by Shane and Wells [21].

Acknowledgements

My special thanks go Dr. Walter Traunspurger and Prof. Dr.Fritz Trillmich for supervising my thesis at Bielefeld University, Germany; to Eugenio Ortiz, Rafael Aguinda, Gonzalo Meza, Susanne Thaler and Patricio Donoso for their assistance in the field during several months and years. INEFAN (now Ministerio de Ambiente) and the staff from the Cuyabeno Reserve gave host and transport. Prof. L. Albuja and Prof. R. Barriga from the Escuela Politecnica Nacional in Quito, and Kelly Swing gave helpful comments. The project was initiated by Dr. Lorenzo von Fersen and financed by Yaqu Pacha (Organization for the Conservation of South American Aquatic Mammals). This study forms part of a PhD at Bielefeld University, Germany with a grant from the DAAD (German Academic Exchange program).

References

[1] Best, R. and Da Silva, V. 1993. "Inia Geoffrensis". *Mammalian Species*. 426, 1–8.

[2] Herman, L., Von Fersen, L., and Solangi, M. 1996. "The Bufeo Inia Geoffrensis in the Rio Lagartococha of the Ecuadorian Amazon". *Marine Mammal Science*. 12, 118–125.

[3] Utreras, V. 1996. "Estimación de la Abundancia, Aspectos Ecológicos y Etológicos del Delfín Amazónico Inia Geoffrensis Geoffrensis (Cetacea: Iniidae) en el Río Lagartococha, Amazonia Ecuatoriana". *Pontificia Universidad Católica del Ecuador, Faculdad de Ciencias de la Educación*. 1.

[4] Layne, J. 1958. "Observations on Freshwater Dolphins in the Upper Amazon". *Journal of Mammalogy*. 39, 1–22.

[5] Magnussen, W., Best, R., and Da Silva, V. 1980. "Numbers and Behaviour of Amazon Dolphins, Inia Geoffrensis and Sotalia Fluviatilis, in the Rio Solimões, Brasil". *Aquatic Mammal Science*. 8, 27–32.

[6] Pilleri, G. and Gihr, M. 1977. "Observations on the Bolivian (Inia Geoffrensis d'orbigny 1834) and the Amazonian Bufeo (Inia Geoffrensis de Blainville 1817) with Description of a New Subspecies (Inia Geoffrensis Humboldtiana)". *Investigations on CETACEA*. 8, 11–76.

[7] Mc Guire, T. and Winemiller, K. 1998. "Occurrence Patterns, Habitat Associations and Potential Prey of the River Dolphin, Inia Geoffrensis in the Cinaruco River, Venezuela". *Biotropica*. 30, 625–638.

[8] Henningsen, T. 1998. "Zur Verbreitung, Habitatwahl und Verhaltensökologie der Delphine Inia Geoffrensis und Sotalia Fluviatilis im Oberlauf des Amazonas". *Dissertation zur Erlangung des Doktorgrades des Fachbereichs Biologie der Universität Bremen*. 1, 139.

[9] Best, R. and Da Silva, V. 1989a. "Biology, Status and Conservation of Inia Geoffrensis in the Amazon and Orinoco River Basin". *Occasional papers of the Species Survival Comission (SSC)*. 3, 23–33.

[10] Best, R. and Da Silva, V. 1989b. "Amazon River Dolphin, Boto Inia Geoffrensis". *Handbook of Marine Mammals*. 4, 1–23.

[11] Henningsen, T., Knickmeier, K., and Lotter, G. 1995. "Behavioural Ecology of the Dolphins Inia Geoffrensis and Sotalia Fluviatilis in the Upper Region of the Amazon, Peru". *Proceedings of the ninth annual conference of the European Cetacean Society*. 1.

[12] Caughley, G. 1977. "Analysis of Vertebrate Populations". *Wiley and Sons*. 1, 234.

[13] Denkinger, J. 2001. "Demographic Studies of the Amazon River Dolphin (Inia Geoffrensis) in the Cuyabeno Reserve, in Ecuador". *PhD thesis*. 1, 143.

[14] Hammond, P. 1986. "Estimating the Size of Naturally Marked Whale Populations Using Capture-recapture Techniques". *Rep. Int. Whal. Commn.*. 8.

[15] Bailey, N. 1951. "On Estimating the Size of Mobile Populations from Capture-recapture Data". *Biometrika*. 38, 293–306.

[16] Seber, G. 1982. "The Estimation of Animal Abundance and Related Parameters". *Griffin, London*. 1, 654.

[17] Hammond, P., Mizroch, S., and Donovan, G. 1990. "Individual Recognition of Cetaceans: Use of Photoidentification and Other Techniques to Estimate Population Parameters". *Report of the International Whaling Commission*. 12.

[18] Trujillo, F. 1994. "The Use of Photoidentification to Study the Amazon River Dolphin, Inia Geoffrensis, in the Colombian Amazon". *Marine Mammal Science*. 10, 348–353.

[19] Best, R. and Da Silva, V. 1984. "Preliminary Analysis of Reproductive Parameters of the Boutu, Inia Geoffrensis, and the Tucuxi, Sotalia Fluviatilis, in the Amazon River System". *Species Survival Comission (SSC)*. 1.

[20] Brownell, R. 1984. "Review of Reproduction in Platanistid Dolphins". *Rep. Int. Whal. Commn.*. 6, 149–158.

[21] Shane, S. and Wells, R. 1986. "Ecology, Behaviour and Social Organization of the Bottlenose Dolphin: A Review". *Marine Mammal Science*. 2, 34–36.