Inia geoffrensis (de Blainville, 1817)

English: Amazon river dolphin, Boto, Inia
German: Amazonas-Delphin
Spanish: Bufeo
French: Dauphin de l'Amazon

Family Iniidae

1. Description

The boto is the largest of the river dolphins. Males reach a maximum body length of 255 cm and a mass of 185 kg, the smaller females reach 215 cm and 150 kg. The body is corpulent and heavy but extremely flexible: the head can be moved in all directions. The flukes are broad and triangular, the dorsal fin is low, keel-shaped long, extending from the midbody to the caudal peduncle. The flippers are large, broad and paddle-like. Whereas swimming speed is not very high, botos are capable of manoeuvring very well between trees in the flooded forest. The rostrum and mandible are long and robust and the melon is small and flaccid. Its shape can be muscularly controlled. Whereas young animals are dark grey, older botos are completely pink or blotched pink and may have a darker back (da Silva, 2002).

2. Distribution

http://www.iucnredlist.org/apps/redlist/details/10831/0/rangemap

General distribution of Inia geoffrensis *in the Amazon-Orinoco river systems (Reeves et al. 2008; © IUCN).*

The boto has a very wide distribution and can be found almost everywhere it can physically reach without venturing into marine waters (da Silva, 2002). There are three morphologically distinguishable populations, which are best recognised at the subspecific level (Rice, 1998):

I. g. humboldtiana (Pilleri and Gihr, 1978): ranges in the Orinoco River system, including the Apure and Meta rivers, upstream as far as the rapids at Puerto Ayacucho (Rice, 1998). Contact between this race and the next is restricted, at least during low water, by waterfalls on the upper Rio Negro, by the rapids on the Orinoco river between Samariapo and Puerto Ayacucho, and by the Casiquiare Canal itself (da Silva and Martin, 2000).

I. g. geoffrensis: found throughout most of the Amazon River and its tributary rivers (below an elevation of about 100 m), including the Tocantins, the Araguaia, the lower Xingu up to the rapids at Altamira, the lower Tapajós up to the rapids at Sao Luis, the Madeira as far as the rapids at Porto Velho, the Purús, the Juruá, the Ica, the Japura, the Branco, and up the Negro through the Canal Casiquiare into the headwaters of the Orinoco, from whence in ranges as far downstream as San Fernando de Atabapo, including its tributary the Guaviare (Rice, 1998).

I. g. boliviensis (d'Orbigny, 1834): occurs in the upper Rio Madeira drainage in Bolivia, where it is confined to the Rio Mamoré and its main branch the Rio Iténez (= Rio Guaporé), including lower reaches of their larger tributaries (at an elevation of 100-300m). There are no

credible reports from the Rio Beni or any of its tributaries above Riberalta. This subspecies appears to be isolated from the previous one by 400km of rapids from Porto Velho on the Rio Madeira in Brazil upstream to Riberalta on the Rio Beni in Bolivia. However, *Inias* of undetermined subspecies live in the Rio Abuna and its tributary the Rio Negro, which enters the Madeira/Beni an the border between Brazil and Bolivia (Rice, 1998 and references therein). Botos in the Beni system may, in fact, constitute a separate species (da Silva 1994).

Although, at present, a single species is recognised, Banguera-Hinestroza et al. (2002) compared samples from specimens in the Orinoco basin (four rivers), the Putumayo River, a tributary of the Colombian Amazon and the Mamoré, and the Tijamuchy and Ipurupuru rivers in the Bolivian Amazon. From mitochondrial DNA and mitochondrial cytochrome b gene analysis, a subdivision of the *Inia* genus was proposed into at least two evolutionarily signifcant units: one connected to the Bolivian river basin and the other widely distributed across the Amazon and Orinoco basins. However, the IWC sub-committee (IWC, 2000) and more recently, da Silva (2009) recognised that this was still an unresolved issue.

3. Population size

The boto is the most common river dolphin and population densities appear to be relatively high throughout much of its range (IWC, 2000). Its current distribution and abundance apparently do not differ from the past, although relative abundance and density are highly seasonal and appear to vary among rivers (da Silva, 2002, 2009). Overall population size, however, is unknown and precise data on trends are insufficient for any of the three subspecies.

Differences in density exist between different river systems. Pilleri and Gihr (1977) report an average of one dolphin per 4 km over 130 km on Rio Ichilo, one per 0.9 km on Rio Ipurupuru, and one per 1.0 km on Rio Ibare. On the Amazon River bordering Colombia, Peru, and Brazil Vidal et al. (1997) found that *Inia* density was highest in tributaries with 4.8 dolphin/km, followed by areas around islands 2.7 dolphin/km and along main banks 2.0 dolphin/km.

Aliaga-Rossel et al. (2006) investigated encounter-rates in the Mamore River of the Bolivian Amazon and four of its tributaries during the low water season. *Inia* encounter rates were in the range 1.6-5.8 km^{-1} and are the highest recorded anywhere in its broad geographic range. Mean group size was greatest in the Tijamuchi River (3.3 +- 2.96) and smallest in theYacuma River (1.8 +- 0.75).

In absolute numbers, Aliaga-Rossel (2002) counted 208 bufeos in the Tijamuchi River of Bolivia. Surveys in a 1,200 km section of the Amazon River between Manaus and Santo Antonio de Ica yielded estimates averaging 332 dolphins (Best and da Silva, 1989). Martin and da Silva (2004a) found the boto population of the central Amazon, to be structured on the basis of floodplain lake systems, with extensive animal movement between systems. They estimate that 13,000 botos occur in the 11,240 km² Mamiraua Sustainable Development Reserve, which covers an estimated 11%- 18% of varzea habitat in Brazil.

4. Biology and Behaviour

Habitat: The Amazon river dolphin is an exclusively fresh-water species. In the Orinoco and Amazon basins, the species is found in a variety of riverine habitat types, including rivers, small channels and lakes, excepting the estuaries and strong rapids and waterfalls.

Concentrations occur mainly at the mouth of rivers, below rapids and smaller channels running parallel to the main river. During the high-water season dolphins may utilize both the flooded forest and grasslands, throughout most of Amazon River and its tributary rivers (Reyes, 1991).

Martin and daSilva (2004b) investigated habitat use in and around the Mamiraua Reserve, Brazil. Largely forested with numerous channels and lakes, Mamiraua comprises a variety of seasonal floodplain habitats known collectively as varzea. The annual cycle of flooding in this region (amplitude 11-15 m) dominates all life. Profound seasonal differences in dolphin density between habitats were consistent with known fish movements, in turn dictated by changes in water level and dissolved oxygen. An exodus of botos from floodplains to river at low water prevents dolphins being trapped in areas that become entirely dry. Densities of botos in floodplain channels were seasonally higher (up to 18 per km²) than reported for any cetacean worldwide. Adults were largely segregated by sex except at low water. Some 80% of botos occurring on rivers were within 150 m of the margins. The reliance of adult females and calves on varzea in a region with exceptional dolphin densities demonstrates the importance of floodplain habitats for the boto, and may be the key determinant of this species' distribution.

In Peru's Pacaya-Samiria National Reserve McGuire (2002) found that boto encounter rates were highest in confluences, intermediate in lakes, and lowest in rivers. Encounter rates for botos in rivers and lakes did not differ among seasons. During low water, boto persisted longer in the confluences throughout the sampling day, and occurred in higher densities than in any other season; the reverse pattern was observed during high water.

Schooling: Although rarely seen in groups of four or more, *Inia* is most often observed as a solitary individual. Loose aggregations have been observed at feeding areas. Most groups of two are apparently mothers and calves. In the survey done by Magnusson et al. (1980), from Manaus to Tefé 81% of the sightings were of a single individual and only 3% of sightings were of four or more animals. Of 407 sightings made from Manaus to Tabatinga, 69% were of one animal and 3% were of four or more. In surveys from Leticia, 58% of sightings were of one animal while 14% were of four or more (Best and da Silva, 1989). In the Tijamuchi River, Beni, Bolivia 42% of observations were of solitary dolphins, 32% were of pairs, and maximum group size was 19. Calves were seen most often during falling and low waters (Aliaga-Rossel , 2002). In Peru's Pacaya-Samiria National Reserve, botos were seen most often as single animals and seasonal differences in group size were not detected (McGuire, 2002).

Although more often a solitary feeder, *Inia* sometimes form loose groups that fish in a coordinated fashion to herd and attack shoals. These groups may also include the tucuxi (*Sotalia fluviatilis*) and the giant otter (*Pteronura brasiliensis*). Similar group relationships can develop with man in his fishing canoe. Fishermen, on their part, use dolphins to localise shoals of fish and the dolphins use the human fishing operation as a means of disrupting the shoal to their advantage (Best and da Silva, 1989).

Food: *Inias* may frequent shallow waters primarily for feeding (Best and da Silva, l989). About 50 species of fish have been reported as the food of Amazon river dolphins in the central Amazon. Sciaenids, cichlids and characins are the preferred prey; some of them are of commercial value (Best and da Silva, l989).

Reproduction: Reproduction of Amazon River Dolphins, based on observations of live dolphins from the Orinoco, Amazon, and Mamore river basins (in Venezuela, Peru and Bolivia, respectively) indicate that reproduction in *Inia* often occurs year-round, with seasonal peaks varying according to geographic location. *Inia* neonates in Peru and Bolivia were seen in all seasons, and were observed most often in falling water (season was defined by relative water level). Conversely, neonates in Venezuela were seen at the end of low water and in rising water, yet were never observed during falling water. *Inia* mating behavior in Peru was observed in all seasons, while mating was observed only during falling and low water in Bolivia (McGuire and Aliaga-Rossel 2007). The authors suggest variation in reproductive seasonality, with year-round reproduction in some areas. Seasonality of peaks in births varies according to study area, and may be more closely associated with local environmental and prey conditions than with taxonomic relatedness, relative seasonal differences in water levels, or broad geographic distribution. Gestation lasts 10-11 months (Best and da Silva, 1989).

5. Migration

McGuire and Henningsen (2007) used photo-identification to recognize *Inia* from scars, cuts, nicks, pigmentation patterns, and abnormal beaks in Peru's Pacaya-Samiria Reserve. 72 *Inia* were identified, and 25 were resighted between 1991 and 2000. Sighting histories ranged from 1 d to 7.6 y. Maximum range of movement was 220 km, with a mean range of 60.8 km. The greatest rates of movement observed were 120 km/d for *Inia* , with a mean rate of movement of 14.5 km/d. Identified dolphins were always observed within the same tributary system. 90% of all *Inia* resighted in one river system were seen in the same lake at least once, and 33% of dolphins resighted in the lake were never seen outside of the lake. This confirms earlier work by Da Silva and Martin (2000) in the central Amazon of Brazil, where most animals moved only a few tens of kilometres between high and low water seasons. Of more than 160 marked animals, however three had been resighted more than 100 km from the tag site.

Seasonal migrations seem to represent slight extensions of more or less stable home ranges. Some of these migrations, mostly during flood seasons, are known to cross international boundaries: in the Casiquiare Canal and Upper Rio Negro (Venezuela, Colombia and Brazil); in the Rio Madeira-Guapore system (Brazil and Bolivia); in the Takatu River (Brazil and Guyana) and at Leticia (Peru, Colombia and Brazil) (Best and da Silva, 1989).

6. Threats

Direct Catch: Parts of stranded or incidentally caught dolphins may be sold as love charms. In the Beni district, Bolivia, hunting with rifles and nets was previously reported (Pilleri, 1969; Pilleri and Gihr, 1977). Da Silva and Best (1996) conducted interviews with fishermen in boats, in the fishmarket and in the shops supposedly selling dolphin products in an attempt to quantify the overall incidental kill attributed to commercial fisheries operations. The results showed that in the Central Amazon, dolphin catches are incidental and only a very small number of these carcasses are used for commercial purposes. In the Colombian Amazon some fishermen have killed Inia (including harpooning, shooting and deliberate poisoning) to deter gear interactions. In the Orinoco system and Peruvian Amazon there are also reports of some deliberate killings apparently due to interactions with fisheries (IWC, 2000).

Incidental catches:

Deliberate killing: Amazon river dolphins have learned to take advantage of some fishing activities. They may tear fish from nets (in particular from lampara seine nets) causing considerable loss of fish catch and damage to fishing gear. Also, these dolphins congregate to eat fish stunned by dynamite used illegally by some fishermen. In both instances, fishermen may decide to kill the dolphins. Best and da Silva (1989) mention that at least two reports of harpooned dolphins exist, probably due to this interference with fishing operations.

Overfishing: According to da Silva and Best (1996) the use of nylon gill nets in the Amazon fishery is widely spread throughout the whole region, and with increasing fisheries pressure the potential for dolphin/fisheries interactions is much greater. Competition between man and dolphin for commercial fish, however, is still minimal in the Central Amazon. Dietary analysis has shown that only 43% of 53 identified prey species are of commercial value and that the dolphins generally prey on size-classes of fish below those of commercial interest.

Habitat degradation: Human populations are expanding rapidly in many areas of the boto´s range, especially in Colombia and Brazil. Such population increases result in increased agriculture, deforestation, cattle ranching and the establishment of plantations (IWC, 2000). Deforestation in flood plains for agriculture and the timber industry affects the hydrological cycle and the riverine ecosystem as a whole. One of the major effects of deforestation is the reduction of fish productivity, and hence reduction of food supply for river dolphins and other aquatic animals. Hydroelectric development is at present not a great threat, but several dams are projected for the next few years in the river systems of both Brazil and Venezuela (Best and da Silva, 1989, IWC, 2000). Dams may prevent migrations, breaking the populations into very small units with insufficient genetic variability, and reduce food supply (Ralls, 1989, in Reyes, 1991). Strandings in the Formosa River have been reported as resulting from changes in the water level produced by the deviation of waters for irrigation (Best and da Silva, 1989). Furthermore, the water areas behind dams provide an impoverished environment for *Inia*, with lower oxygen concentrations, lower pH levels and fewer fish (IWC, 2000).

Recently (IWC, 2000) oil exploration and production were also identified as a potential threat to *Inia*. In Colombia there had been many oil spills in recent years as a result of the ongoing guerrilla war in the upland regions. Some of these had been very extensive, and represented a potential threat that has not yet been quantified. Anecdotal accounts of a decline in numbers were reported in Ecuador. These reported declines were linked to oil spills in the region, though the subcommittee noted that fluctuations in numbers would also be expected due to water level fluctuations.

Pollution: According to Reyes (1991), large quantities of pesticides are being used increasingly in agriculture in the Amazon and Orinoco Basins. Pollution by heavy metals in the Amazon comes from gold mining and associated indiscriminate use of mercury. Effluents from pulp mills are also a potential source of pollution (Best and da Silva, 1989). However, Rosas and Lethi (1996) report that the mercury concentration (176 ng/ml) found in the milk of a lactating *Inia* caught in the Amazon River near Manaus, Brazil was very close to the minimum level of methylmercury toxicity for non-pregnant human adults. This suggests that at least in this part of the river system, contamination is low.

7. Remarks

Range states (Reeves et al. 2008):
Bolivia; Brazil; Colombia; Ecuador; French Guiana; Peru; Venezuela

Inia geoffrensis is categorised as "Data defficient" by the IUCN (Reeves et al. 2008). The species was previously listed as “Vulnerable” but is now considered Data Deficient due to the limited amount of current information available on threats, ecology, and population numbers and trends. However, the IWC (2008) has expressed concern over the capture of boto for bait in the central Brazilian Amazonas, which is considered to be an emergent, but already large-scale, problem (Reeves et al. 2008).

The species is listed in appendix II of CITES and it is also listed in Appendix II of CMS.

According to an evaluation by the Scientific Committee of the IWC (2000), populations of the boto appear to be large and, at present, there is little or no evidence of any decrease in numbers or range. The sub-committee noted the increasing human pressures on the region, and recognised that future anthropogenic effects are to be expected, with declines in range and population fragmentation the most likely consequences. The Asian river dolphins provide a model for the possible effects of increased human populations and dam construction. The subcommittee therefore agreed that there is a need for appropriate monitoring schemes and formulated its recommendations accordingly.

The IWC sub-committee (IWC, 2000) recommended:

• that work on stock structure of *Inia* be conducted and existing studies should be brought to publication as soon as possible,

• that a registry of the distribution of this species should be established, recording in which waterways botos are present, and that the locations of all existing and proposed dams and other large-scale engineering works should be included. Information on other potential threats, such as the scale of fishing operations and the locations of oil pipelines might also usefully be included where practicable,

• that for each population, research should be directed towards detecting trends in abundance or any diminution of range, and identifying causes of any declines. Trends in abundance should be documented by making repeatable, statistically rigorous estimates of density in a range of regions and habitats.

The most significant anthropogenic impact on this species at present appears to be mortalities in fishing operations. These are either entirely incidental (entanglement) or to a greater or lesser extent deliberate, as fishermen are reportedly poisoning botos with baited fish, to limit net depredation, and also shooting and otherwise killing animals found in or near to nets. The sub-committee recommends that information should be collected to allow evaluation of the relative levels of mortality, both indirect and direct, associated with different fishing methods (IWC, 2000).

The management of renewable natural resources in developing countries has been hampered by a mix of socioeconomic and political difficulties that in turn have resulted in insufficient scientific knowledge, limited environmental awareness and education, and limited commitment to conservation (Vidal, 1993). Aquatic mammals provide good examples. Because many aquatic mammal populations are shared by several Latin American countries, international co-operation is critical to ensuring their long-term conservation.

8. Sources

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