

22 February 2007

Dear Volunteers,

I would like to express my sincere gratitude for all the help you provided with the projects at Lago Preto and Samiria. This year we have had the most successful field season ever. More data were collected than we anticipated and new discoveries were made, with your help. We now understand much better the animal populations in the Lago Preto Conservation Concession and the Samiria river basin of the Pacaya-Samiria National Reserve. The crew of the Ayapua and the Peruvian biologists send their warm wishes to you all. They always tell me how great the Earthwatch volunteers are and they remember each one of you. As you will read in this report, our understanding of Amazonian wildlife populations made significant advances this year, and will influence the community-based and protected area conservation of the Peruvian Amazon, largely because of your help. It warms my heart to know that there are dedicated people like you willing to take time and effort to help with our projects.

With many thanks.

Yours sincerely,

Richard E. Bodmer, PhD, DSc
Reader in Conservation Ecology

Project Title: Amazon Riverboat Exploration: Report on Wildlife Monitoring in the Samiria River Basin.

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Position/Affiliations: Durrell Institute of Conservation and Ecology (DICE)
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Collaborations: The Earthwatch project was conducted in collaboration with the Wildlife Conservation Society, the Durrell Institute of Conservation and Ecology, The World Wildlife Fund – Peru Office, the National University of the Peruvian Amazon (UNAP), the National Institute of Natural Resources – Peru (INRENA), the Pacaya-Samiria National Reserve Authority and the British Schools Exploring Society.

Research Site(s) (geographic location, include coordinates if known, e.g. Lat/Long):
UTM 536643 E y 9423977 N

Local Management Status of the Research Site(s) (e.g. National Park, RAMSAR Site, World Heritage Site, IBA etc.): National Reserve

Scientific names of primary species being studied:

Primates:

Ateles chamek, Alouatta seniculus, Cebus albifrons, Cebus apella, Lagothrix lagotricha, Pithecia monachus, Saguinus fuscicollis, Saimiri sciureus

Terrestrial mammals:

Dasyprocta fuliginosa, Sciurus spp., Mymecophaga tridactyla, Tamandua tetradactyla, Bradypus variegatus, Eira barbara, Nasua nasua, Leopardus pardalis, Mazama americana, Tayassu pecari, Tayassu tajacu

Aquatic mammals:

Trichechus inunguis, Inia geoffrensis, Sotalia fluviatilis, Pteromura brasiliensis

Game birds:

Penelope jacquacu, Pipile cumanensis, Psophia leucoptera, Tinamus spp.

Macaws:

Ara ararauna, Ara macao, Ara severa, Orthosittaca manilata

Wading birds:

Phalacrocorax olivaceus, Casmerodius alba

Caimans and river turtles:

Caiman niger, Caiman crocodylus, Paleosuchus trigonatus, Podocnemis unifilis

Key Research Objectives:

The overall objective was to evaluate the effects of conservation actions on wildlife populations in the Pacaya-Samiria National Reserve.

Specific objectives include:

- How primate population dynamics and community structure respond to decreasing hunting pressure
- How terrestrial mammal populations respond to changes in hunting pressure
- How manatee and giant river otter populations are recovering in the Samiria river

- How Amazon river dolphins are using the Samiria hydroscape
- How key game bird species are responding to changes in hunting pressure
- How macaw populations are using the Samiria river basin landscape
- How key wading birds are seasonally using the land and hydroscares at the mouth of the Samiria river basin
- How the caiman and river turtles are responding to conservation actions
- How economically important fish populations are using the Samiria hydroscape.

Date this report was completed: 22 February 2007

Introduction

The Pacaya-Samiria National Reserve is the largest protected area in Peru spanning over 2,000 km² of tropical rainforest. The two major rivers that bound the reserve are the Ucayali and Marañon rivers that join to form the Amazon proper, right at the point where the reserve begins. The huge floodplains of these majestic rivers have produced low-lying flooded forests with 92% of the reserve being white water flooded forest habitat known as varzea. The Pacaya-Samiria National Reserve is a refuge for the high diversity assemblages of aquatic and terrestrial wildlife, including large populations of river dolphins, recovering populations of manatees and giant river otter, 12 species of primates, and a wide range of terrestrial rainforest mammals (Aquino et al. 2001). Macaws, wading birds, and game birds are abundant (Gonzalez 2004), as are populations of caimans and river turtles. The hydroscape of the reserve has a great diversity of fish and abounds with economically important species (Ortega & Vari 1986).

The Pacaya-Samiria National Reserve has approximately 95,000 people living in villages and towns along its boundary (INRENA 2000). Some of the villages lie just inside the reserve, however there are no human settlements within the core area. Most of the inhabitants are Cocama-Cocamilla Indians (Puertas et al. 2000). The Cocama-Cocamilla people are renowned for their mobility with families continually moving between villages (Newing & Bodmer 2004). They have always adapted well to other societies and integrated well with the influx of European customs beginning with the missionaries, and then through the rubber boom and twentieth century.

The Pacaya-Samiria National Reserve has gone through a major shift in its management policies over the past two decades, from an area of strict protection where local people were excluded from the reserve to an area where the local indigenous people participate with the reserve management. This drastic shift in conservation policy has led to a reduction in hunting pressure and an increase in wildlife populations (Bodmer & Puertas 2007). When the park administration changed and the reserve began to incorporate the local communities in the management of the area, attitudes of the local people also changed (Puertas et al. 2000). Local management groups were given areas to manage and were no longer considered poachers. They were able to use a limited amount of resources legally and with reserve administration approval. Many of the local people changed their attitude towards the reserve and began to see the long-term benefits of the reserve for their future. The reserve became part of their future plans and there was increasing interest in getting involved with the reserve. Many local people can now see the socio-economic benefits of the reserve and are themselves helping to conserve the area. Hunting has decreased substantially, both due to the poachers now becoming managers, and because the local people are keeping the other poachers out of their management areas.

Many animal populations are recovering in the Samiria river basin during the past decade. The aims of this report are to document how the population dynamics, community structure and land/hydroscape use of the wildlife are being effected by the successful

conservation actions of the reserve. A range of terrestrial and aquatic wildlife taxa were monitored to understand the changes, including mammalian, avian, reptilian and fish species.

Methods

The Samiria river basin was sub-divided into three sections to evaluate the populations, community structure and land and hydroscape use of key wildlife species. These areas included the region around the mouth, the mid-section of the river, and two sections up river, near up river and far up river (Map 1). All of the sections are approximately equal distances apart with an average of 28 km straight line distance between them. The area encompassing the mouth of the Samiria river has a varied hydroscape of channels, lakes, islands and flooded forest. This area floods to a greater extent than the forests further up the river basin, due to its proximity to the Marañon river. There are numerous Cocama-Cocamilla villages at the mouth of the Samiria river and this area has had much greater resource exploitation than the landscapes further inside the reserve.

During the decade of the 1990's the mid-section of the Samiria river had extensive wildlife exploitation from illegal poachers. More recently, hunting and fishing in this area has decreased and the wildlife population have rebounded (Bodmer & Puertas 2007). The mid-section of the Samiria river has several large oxbow lakes and numerous smaller lakes and channels.

The up river section of the Samiria is the core conservation area of the reserve and has been impacted the least from illegal poachers over the decades. This is a strictly protected area and more isolated from indigenous communities due to its distance up river. The oxbow lakes are generally smaller in this section of the river and there are a greater number of levees that do not flood during average years.

Terrestrial and aquatic wildlife were censused in the three river sections, the mouth, the mid-section and the up river section. Terrestrial wildlife, including the primates, terrestrial mammals and game birds were censused along transects cut in the forest. There were a total of 14 transects with four to five cut in each river section, and with an average length of 3.5 km. The total distance censused was 565 km, with 89 km at the mouth, 142 km in the mid-section and 334 km in the up river section. Each transect was censused on several occasions, and the DISTANCE sampling technique was used (Buckland et al. 1993). Results of the 2006 censuses were compared to previous years, including 2001 and 2004.

Censuses of manatees, giant river otters and turtles were carried out along the river, lakes and channels. The manatee and giant river otter census included 34 km of river transect, and the turtle census included 104 km. Censuses were conducted without the boat engines and usually were done by floating down the river or with the aid of a paddle. Dolphin censuses were also carried out using aquatic censuses along the river, lakes and channels, however, the engine of the boat was often used to keep the vessel moving at 1-2 km per hour. A total of 161 km of dolphin censuses were conducted.

Caimans were surveyed during nocturnal censuses along the edge of the river, lakes and channels. Censuses were conducted between 9 pm and 1 am. Spot lights were used to observe the caimans, determine species and a representative sample was caught to take morphometric measurements. A total of 150 km were censused during the caiman surveys.

Macaws were surveyed using point counts at 500m along the river during the mornings (5:30-9 am) and afternoons (4:30-7 pm). A total of 331 fifteen minute point counts were surveyed, 54 points at the mouth, 82 points at the mid-section and 195 points up river. Wading birds were surveyed along the islands at the mouth of the Samiria along a 3.5 km transect.

The abundance of economically important fish were determined using catch per unit effort. The effort involved standard nets set for hourly intervals. In total there were 307 hours of netting, with 109 hours around the mouth of the Samiria River, 28 hours in the mid-section and 170 hours up river.

Results

Primates:

Conservation actions in the Samiria River basin have had a positive effect on the primate populations, with primate numbers increasing, especially around the mouth of the river. However, the effects of these increases have resulted in community level changes to primate populations, apparently through competition between species. This has resulted in changes in the primate community structure at the mouth of the river and distinctive primate communities between the mid and up river sections of the basin.

The diversity of primates is greatest at the mid-section of the basin with a Shannon H' of 1.62, followed by the up river section with a Shannon H' of 1.60. The lowest diversity is at the mouth of the Samiria where the primate community has a Shannon H' of 1.39. The lower diversity at the mouth is a result of both fewer species and a greater unevenness in their density distribution (Fig. 1). The overall density of primates is greatest at the mid followed by the upper sections and least at the mouth (156 ind/km², 130 ind/km² and 108 ind/km², respectively) ($X^2=8.79$, $p=0.012$).

The primate density and biomass have increased at the mouth of the Samiria between 2001 and 2006. Interestingly, the biomass has increased greater than the overall density, due to the recovery of the larger bodied species, including the howler monkey (*Alouatta seniculus*) and the black capuchin monkey (*Cebus apella*). Howler monkeys have increased with an e^r of 1.16 and a rate of increase (r) of 0.15, whilst black capuchin monkeys have increased with an e^r of 1.11 and an r of 0.10. In 2001 the density of howler monkey at the mouth was 2 ind/km² and by 2006 has increased to 12 ind/km². We calculated the carrying capacity (K) of howler monkeys in the Samiria river to be 29 ind/km² in the absence of woolly monkeys. We predict that the howler monkey population at the mouth can still increase further. In 2001 the density of black capuchin monkey at the mouth was 9 ind/km², and by 2006 this has increased to 20 ind/km². We calculate the K of black capuchin to be 22 ind/km² in the Samiria basin, which means that this species is close to its K around the mouth of the river.

Both the howler monkey and black capuchin monkey have been hunted in the recent past, and are considered as a bush meat species for the local Cocama-Cocamilla indigenous people. However, the smaller squirrel monkey (*Samiri sciureus*) and saddled back tamarins (*Saguinus fuscicollis*) are generally not hunted. The squirrel monkey population has doubled in the mouth region of the Samiria river from a density of 25 ind/km² in 2001 to 57 ind/km² in 2006, with an e^r of 1.11 and an r of 0.10. In contrast the tamarin population has decreased in the mouth region from a density of 44 ind/km² in 2001 to 5 ind/km² in 2006, with an e^r of 0.88 and an r of -0.13 . This decreasing population appears to be a result of competition from other primate species.

Indeed, competition appears to be a major factor determining the primate communities along the Samiria river basin. Whilst squirrel monkeys are the most abundant species in all three sections of the Samiria basin, biomass reflects ecological dominance. Howler monkeys and capuchin monkeys have similar biomasses in the mouth region, whereas howler monkeys dominate the mid-section and woolly monkeys (*Lagothrix lagotricha*) dominate up river (Fig. 2). Using censuses from 2001, 2004 and 2006 it is clear that the howler monkeys and woolly monkeys are in a Lotka-Volterra competitive interaction, with woolly monkeys winning up river and howler monkeys winning in the mid section. The total K of both species appears to be around 30 ind/km². Other species also appear to have Lotka-Volterra interactions, but sample sizes do not currently show significant relationships.

These results have important implications for conservation strategies and management policies. The conservation actions of reducing hunting clearly are helping to increase the populations of large bodied primates, but at the expense of small bodied species. Also, the

dominance of one species will impact the population of other species. For example, if woolly monkeys or howler monkeys begin to dominate an area of the Samiria basin, this will decrease the population of the competing species.

Terrestrial Mammals:

The populations of terrestrial mammals in the Samiria basin is confounded by both hunting and habitat types. The area around the mouth of the Samiria is flooded more intensively than the forests in the mid section, and up river is flooded the least. There is also greater hunting of terrestrial mammals closer to the mouth and less hunting up river. The terrestrial mammals show a clear relationship with distance from the mouth, and species have greater densities and biomasses further up river. For example, terrestrial mammals had a total density of 2.4 ind/km² at the mouth, 4.2 ind/km² at the mid section and 10.2 ind/km² up river and their populations in an 100km² area are greater in the up river sections of the basin ($X^2=595$, $p<0.001$)(Fig. 3). Similar to previous surveys very few ungulates occur in the mouth region and have increasing populations further up the basin. The peccary biomass dominates the up river sections of the Samiria river.

In contrast, the aboreal Amazon squirrels (*Sciurus* spp.) have a greater density at the mouth (8.5 ind/km²), compared to the mid and upper sections (2.2 and 2.5 ind/km² respectively). Likewise, the arboreal sloth (*Bradypus variegatus*) has greater densities at the mouth (1.1 ind/km²) compared to the mid section (0.5 ind/km²).

These results suggest that the extensive flooding around the mouth of the Samiria river basin is limiting the populations of terrestrial mammals. During high water periods terrestrial mammals retreat to levees or floodplain islands to wait out the floods. Levees are more common up river and in turn these areas support greater populations of terrestrial mammals.

Manatee and Giant River Otter:

The Pacaya-Samiria National Reserve is an important refuge for both the Amazon manatee (*Sotalia fluviatilis*) and giant river otter (*Pteromura brasiliensis*) and their populations have been recovering along the Samiria basin. The Amazon manatee populations have been surveyed since 2003 in the mid and upper sections of the river basin. The population of manatee in 2003 and 2004 only recorded an average of 1.5 ind/ 2 week survey. In 2005 the average rose to 2 ind. and in 2006 jumped to 8 individuals. The rate of growth (r) is increasing and demonstrates a small population that is still attaining a r_{max} (Fig. 4). The r has a large variance and is ranging between 0.69 and 1.38.

The giant river otter shows a similar trend as the manatee. The number of sightings during two week censuses has steadily increased over the years. During censuses in 1996 and 2000 no giant river otters were sighted. Then in 2005 the otters began to be seen and in 2006 they were seen more frequently (Fig. 5). The r is ranging between 0.4 and 0.5 for the giant river otter.

Both the manatee and the giant river otter are flagship species for the Pacaya-Samiria National Reserve. Whilst their numbers are still low, the increasing trends in the populations is very positive. However, their small population size will make them vulnerable to changes in mortality rates, such as a reoccurrence of hunting pressure.

Dolphins:

The pink river dolphin (*Inia geoffrensis*) and the grey river dolphin (*Sotalia fluviatilis*) are used to evaluate the general health of the Samiria river basin. These two dolphins are not hunted in the basin due to strong taboos by the local indigenous people. Very occasionally they are killed in fish nets, and in 2006 there was one pink dolphin accidentally killed in a fish net. The dolphin populations should respond to the aquatic ecosystem in terms of fish abundance and water quality.

There were 987 river dolphin sightings in 2006. The age composition of pink and grey dolphins is similar with around 60% adults, 30% juveniles and 10% young (Fig. 6). Overall, the

pink river dolphin had a greater density than the grey river dolphin in the Samiria river basin (41 ind/km² and 26 ind/km², respectively). The pink and grey river dolphins use the Samiria hydroscape differently ($X^2=246, p<0.001$) (Fig. 7). The pink river dolphin uses the region of the mouth to a much greater extent than the grey river dolphin. Both species use the near up river region extensively, and use the mid-section less frequently and the far up river section the least.

There does not appear to be a competitive relationship between the two dolphin species, and they can co-exist in the same river sections, as was evident in the near up river section. The pink river dolphin density reflects the overall abundance of fish, with the mouth region having over twice the fish abundance of the mid-section, and the far up river section the least. In contrast, the density of grey river dolphin does not vary in relation to overall fish abundance and is likely reflecting the presence of specific fish species or sizes (Fig. 8).

Game Birds:

Game birds become increasingly more common from the mouth of the Samiria to the up river sections. Game birds are generally rare at the mouth, with only the *Tinamus* spp. sighted along the transects. In the mid-section the *Tinamus* spp. became even more abundant and the *Pipile cumanensis* were also sighted. The up river section has the greatest density and species richness for the game birds (Fig. 9). The game birds have not recovered to the same extent as the primates, and are still at relatively low numbers, especially around the mouth of the basin.

Macaws:

The larger species of macaws were used for the pet trade in the past, especially Blue and gold macaw (*Ara ararauna*). In recent years the extraction of Macaws for the pet trade has decreased substantially. In total there were 1,418 macaws sighted during the 2006 censuses. The community composition of macaw species varies along the Samiria basin. Overall, there are greater numbers of macaws sighted at point samples around the mouth with 11 macaws/point, fewer in the mid-section with 6 macaws/point, and still fewer up river with 3 macaws/point.

There is a change in the community composition of macaws along the river basin, with *Ara ararauna* being most common around the mouth, decreasing in abundance in the mid-section and having an even lower abundance up river. Similarly, the Red-bellied macaw (*Orthopsittaca manilata*) is most common at the mouth and decreases up the Samiria basin. (Fig. 10). The species of Chestnut-fronted macaw (*Ara severa*), Scarlet macaw (*Ara macao*), and Red-and-green macaw (*Ara chloroptera*) are generally rarer in the Samiria river basin and occur in the up river sections. There appears to be a Lotka-Volterra interaction between *Ara ararauna* and *Ara Severa*. Censuses from 2003, 2004 and 2006 show an increasing population of *Ara ararauna* and a decreasing population of *Ara severa*, with *Ara ararauna* appearing to outcompete *Ara severa*.

Wading Birds:

Wading birds flock to the mouth of the Samiria river during the low water season to exploit the fish migration out of the Samiria and into the Marañon river. Censuses were conducted on Neotropic cormorant (*Phalacrocorax olivaceus*) and Great egret (*Casmerodius alba*) and a total of 48,051 birds were recorded. These wading birds flock intensively on the largest island in the mouth of Samiria and during the month of August there were an average of 4,362 *Phalacrocorax olivaceus* and 442 *Casmerodius alba* flocking at the island each day. In December during higher water neither of these species were present on the island.

Turtles:

The Pacaya-Samiria National Reserve has implemented a turtle conservation program based on head starting for a number of years, where eggs of Yellow-spotted Amazon River Turtle (*Podocnemis unifilis*) and Giant Amazonian River Turtle (*Podocnemis expansa*) have been removed from their wild nests, replanted at guard stations, hatched, and released back into the

river. This conservation strategy has been set up to overcome the intensive poaching of turtle eggs during the laying season. River turtle numbers are recovering along the Samiria river basin as a result of the head starting program.

The abundance of *Podocnemis unifilis* was determined by turtles sunning along the riverbanks, whereas *Podocnemis expansa* does not sun along the banks and was not censused. Very few turtles were sighted around the mouth of the Samiria river basin. In the mid-section an average of 84 *Podocnemis unifilis* ind/km were recorded compared to up river where 218 ind/km were recorded (Fig 11).

Since 1996 a total of around 865,864 turtle hatchlings have been released in the head starting program, with an annual average of 73,507 *Podocnemis unifili* and 16,348 *Podocnemis expansa* (Fig. 12).

Caiman:

Three species of caimans occur in the Pacaya-Samiria National Reserve, the black caiman (*Caiman niger*), the common caiman (*Caiman crocodylus*) and the dwarf caiman (*Paleosuchus trigonatus*). The black caiman was intensively overhunted during the 1950's – 1970's and has been recovering in the Samiria river over the past decades.

The abundance of caimans varies along the Samiria river basin. All three species were rare around the mouth of the Samiria river (0.4 ind/km) and were more common in the intermediate zone between the mouth and the mid-section (1.4 ind/km). Caimans were most abundant at the mid section (2.7 ind/km) and the beginning of the up river section (2.2 ind/km), and then decreased at the upper reaches of the Samiria (1.4 ind/km) ($X^2=18$, $p<0.001$) (Fig. 13).

The population of black caiman increased slowly between 1981 to 1996 with an er of 1.02 and an r of 0.02. Between 1996 and 2004 the population increased slightly faster with an er of 1.08 and an r of 0.08. The black caiman population has increased considerably faster since 2004 from 0.5 ind/km to 1.4 ind/km in 2006, with an er of 1.64 and an r of 0.49 (Fig. 14).

The black and common caiman appear to be in a Lotka-Voltera competitive interaction, with the black caiman winning over the common caiman. Indeed, the common caiman was very abundant in 1981 with over 8 ind/km, but has been decreasing as the black caiman populations have increased to the current abundance of 0.5 ind/km. Therefore, the conservation actions to recover the black caiman populations have led to a decrease in common caiman numbers over the years.

Fish:

A total of 1,475 fish were caught during the surveys, which included 44 species from 14 families. This catch represents 16.4 % of the 256 species found in the Samiria river basin. The most commonly caught fish species was Common Pleco (*Liposarcus pardalis*), followed by Black prochilodus (*Prochilodus nigricans*), *Hypostomus emarginatus* and Red-Bellied Piranha (*Serrasalmus nattereri*) (Fig. 15). The greatest diversity of fish was around the mouth of Samiria with a Shannon H' value of 0.158. The mid section had a smaller Shannon diversity ($H' = 0.141$), which was similar to Cocha Laga up river with Shannon H' values of 0.147. Overall river channels had the greatest diversity with a Shannon H' of 0.155, followed by lakes with a Shannon H' of 0.155 and channels with a Shannon H' of 0.13.

Catch per unit effort was used to evaluate the abundance of fish in the Samiria river basin. The area around the mouth of the Samiria had the greatest abundance of fish with a CPUE of 22.7 fish/hr, followed by the mid-section with a CPUE of 11.3 fish/hr. The area with the smallest abundance of fish was the up river section with a CPUE of 2.0 fish/hr. Likewise the greatest biomass of fish was around the mouth with a CPUE of 7.3 kg/hr, followed by the mid-section with a biomass CPUE of 2.8 kg/hr, and the up river area with a biomass CPUE of 0.6 kg/hr.

Overall, fish abundance was greatest in the main river and river channels with CPUE's of 8.9 ind/hr and 10.2 ind/hr, respectively. The lakes had fewer fish with a CPUE of 3.0 ind/hr. However, rivers had a greater biomass of fish with a CPUE of 3.2 kg/hr, followed by the channels with a biomass CPUE of 2.4 kg/hr. Again, the smallest biomass of fish was in the lakes with a CPUE of 0.9 kg/hr.

Management Groups:

The Pacaya-Samiria Reserve incorporates participation of the local Cocama-Cocamilla indigenous population through a program of management groups. These management groups collaborate with protecting a specified section of the reserve, and managing the natural resources under approved management plans. The project is providing technical assistance to 8 management groups from the communities of Bolivar, San Martin, Nueva Arica, Parinari, and Santa Clara. Assistance includes help with elaborating management plans, monitoring wildlife resource populations in management areas, and organising workshops and training courses. The natural resources in the management areas has seen a steady increase. For example in the management area of Cocha Wiuri the freshwater Piache fish (*Arapaima gigas*) has increased from 0.3 ind/ha in 2000 to 16 ind/ha in 2006 (Fig 16).

Significance/Benefits of Research

The results of the research show that many animal populations have recovered along the Samiria river basin over the past decades. This has been due in large part to the change in management policy of the Pacaya-Samiria National reserve, from an area of strict protection to an area that incorporates local indigenous people in the reserve management. The level of poaching was much greater during the period of strict control and hunting pressure was considerably greater. Local people saw no future in the reserve and considered the reserve administration as an enemy who took away their access to natural resources in their traditional lands. In the late 1990's the strict policies of the reserve were changed and local people became involved with reserve management. This has permitted them to change their views of the reserve and move from being poachers to managers. With the decrease in poaching activities and an increased involvement of local people in the management of the reserve the animal populations have increased. There are now larger populations of most of the wildlife species than in the recent past.

The success of the reserve has seen recovering populations of key wildlife species, such as the large-bodied primates, the blue and gold macaws, the Amazonian river turtles, and the black caiman. However, the research clearly shows that species are often in Lotka-Volterra competitive interactions, and recovery of one species will actually impact the population of other species. For example, large-bodied primates appear in competition with each other, and outcompete smaller species. As the blue and gold macaw numbers increase, the chestnut fronted macaw is in decline. Likewise, the recovery of the black caiman is resulting in a decline of common caiman. The local management policies of the reserve need to take into account the results of being successful. It may lead to an increase in the species being conserved, an in turn lead to a change in the animal community structure and a decrease in competing species.

The Pacaya-Samiria National Reserve is the largest protected area in the north eastern Peruvian Amazon and is key to biodiversity conservation of the western Amazon basin. The results of this study clearly show that the reserve is conserving biodiversity. The results also show that having a reserve administration that involves local people in park management has a positive effect on biodiversity conservation.

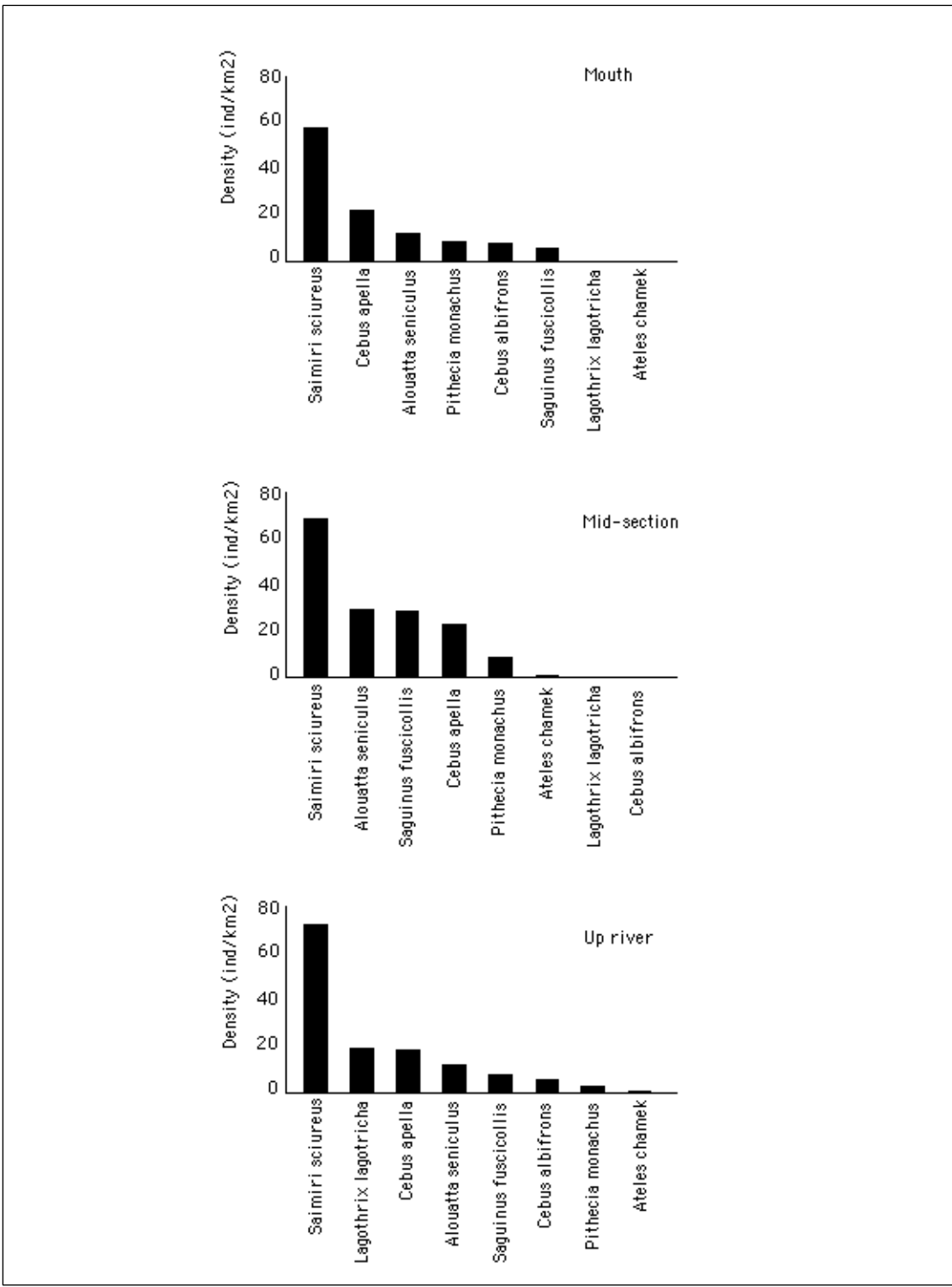


Figure 1. Density of primates in the different river sections of the Samiria basin.

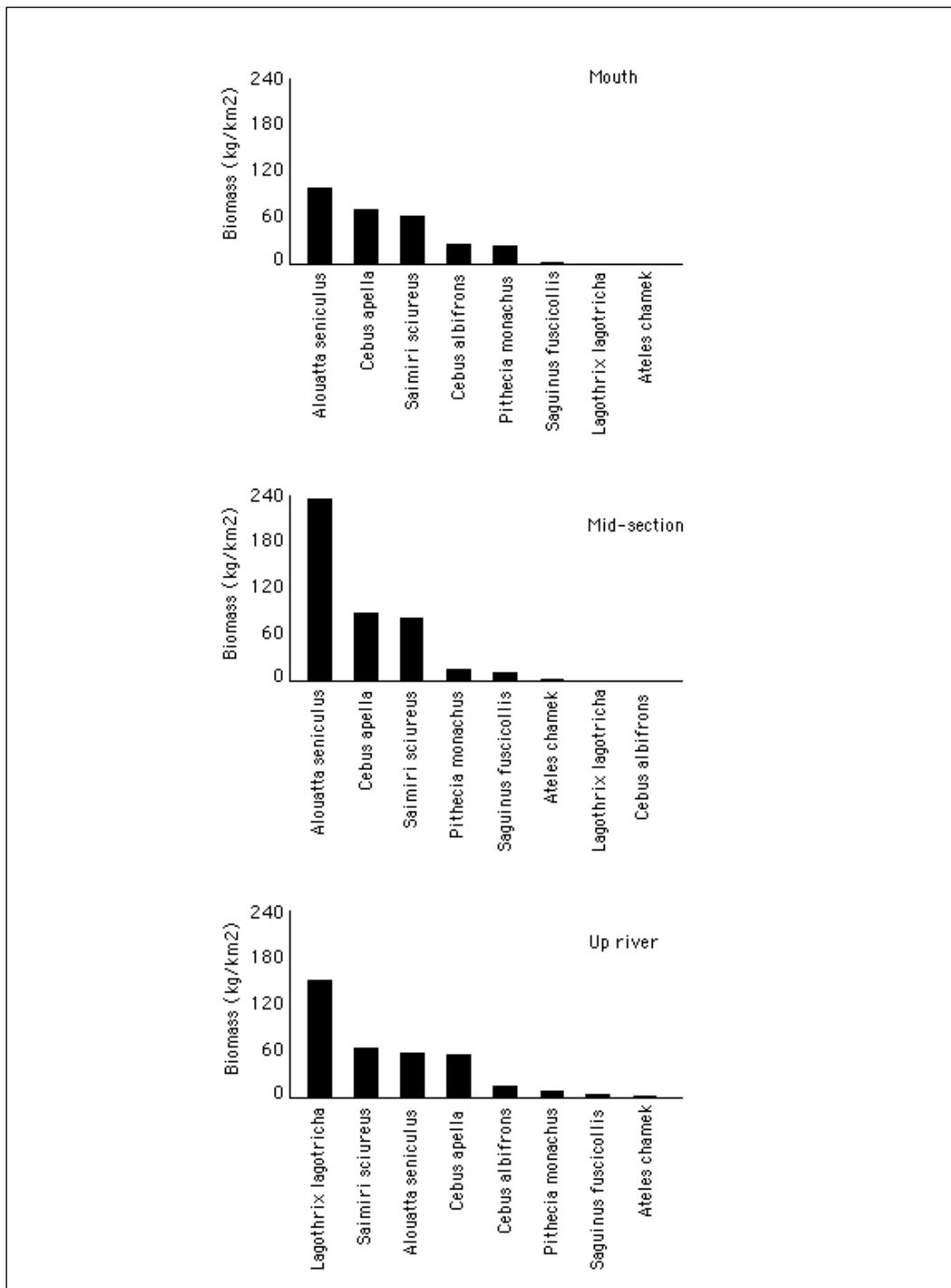


Figure 2. Primate biomass in the different river sections of the Samiria river basin.

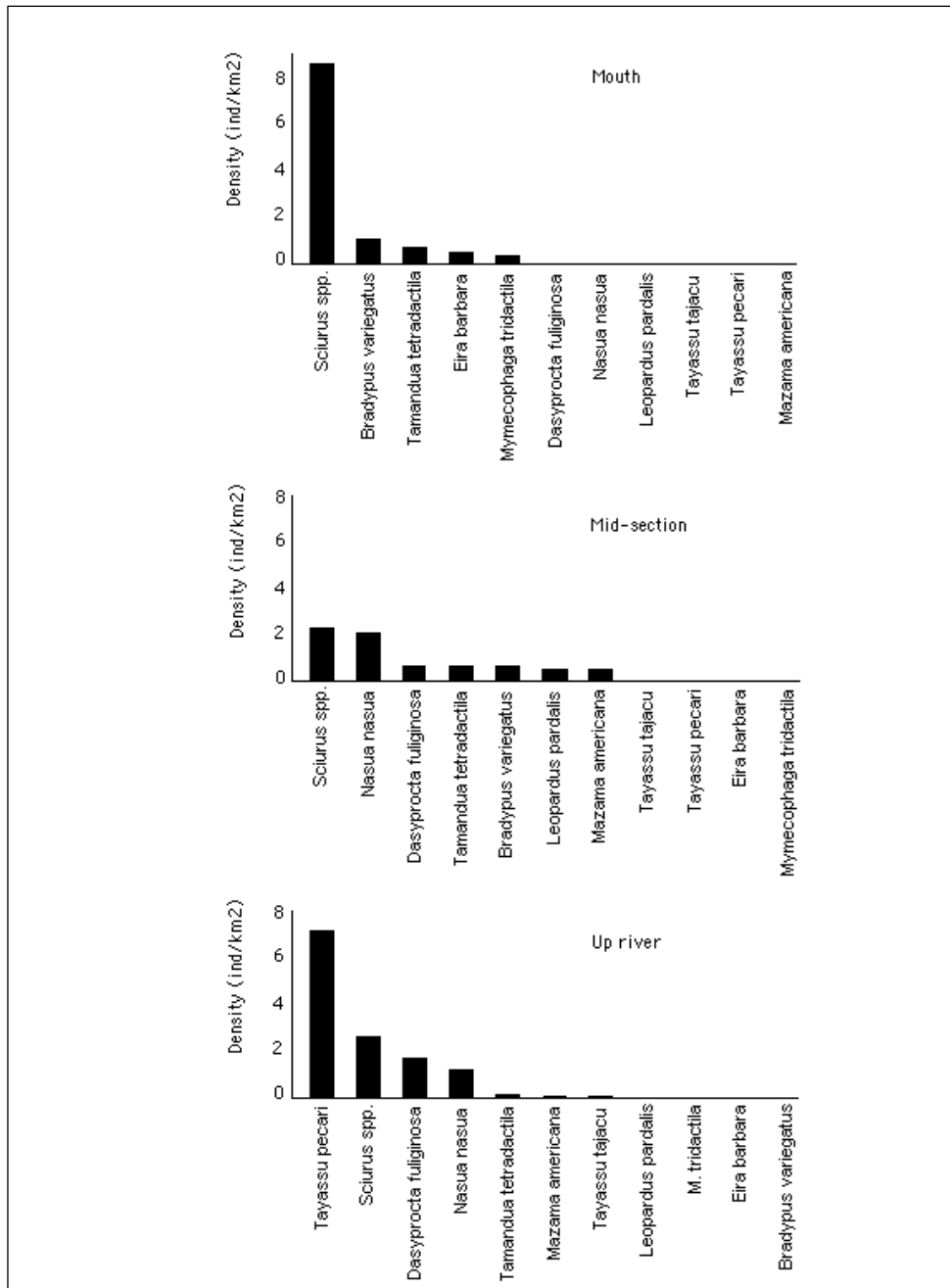


Figure 3. Densities of terrestrial mammals in different sections of the Samiria river basin.

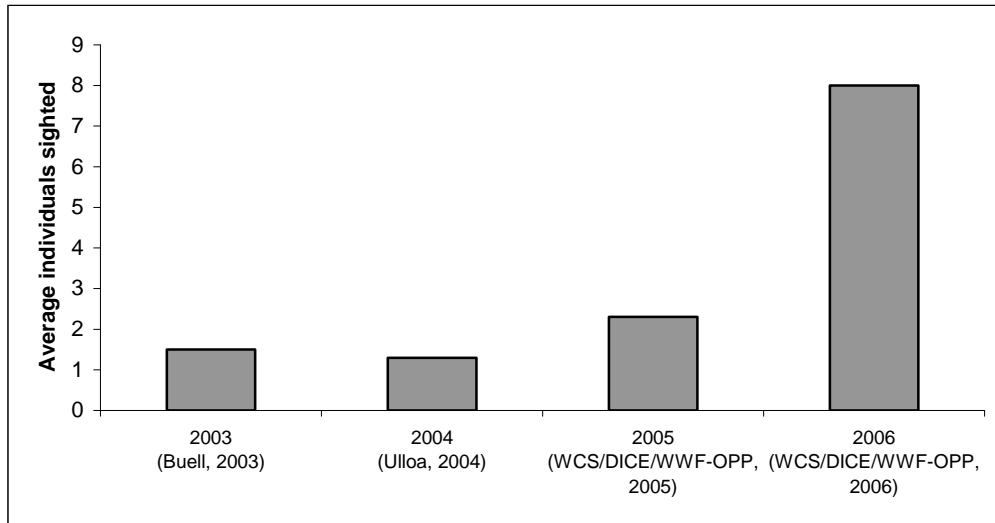


Figure 4. Abundance of Amazon manatees in the Samiria river basin between 2003-2006.

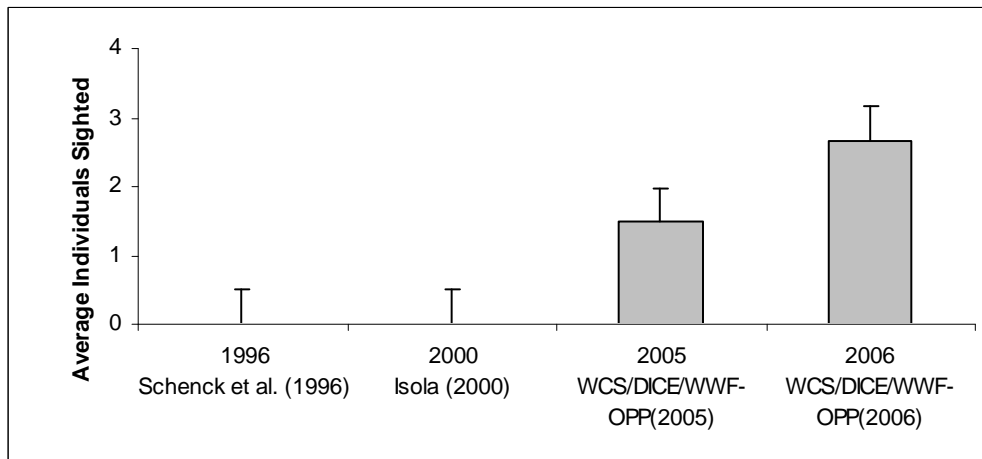


Figure 5. Abundance of giant river otter in the Samiria river between 1996 and 2006.

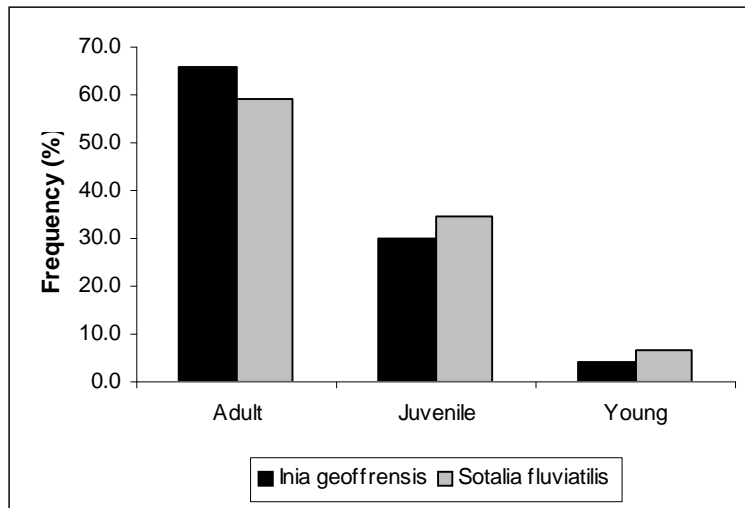


Figure 6. Age structure of pink dolphin (*Ina geoffrensis*) and grey river dolphin (*Sotalia fluviatilis*) in the Samiria river.

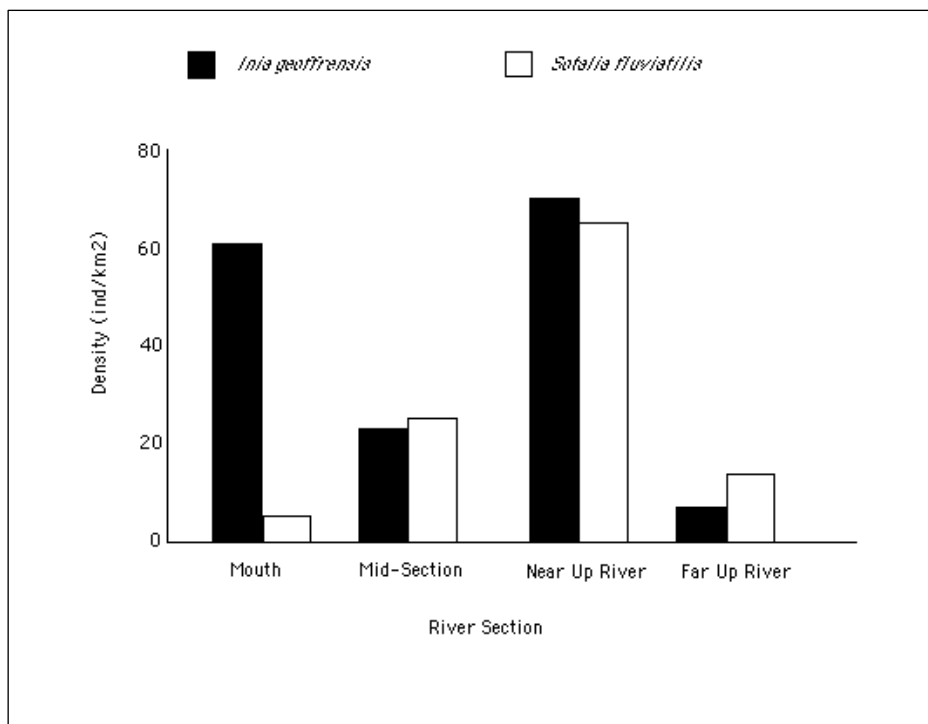


Figure 7. Densities of pink dolphin (*Ina geoffrensis*) and grey river dolphin (*Sotalia fluviatilis*) along the Samiria river.

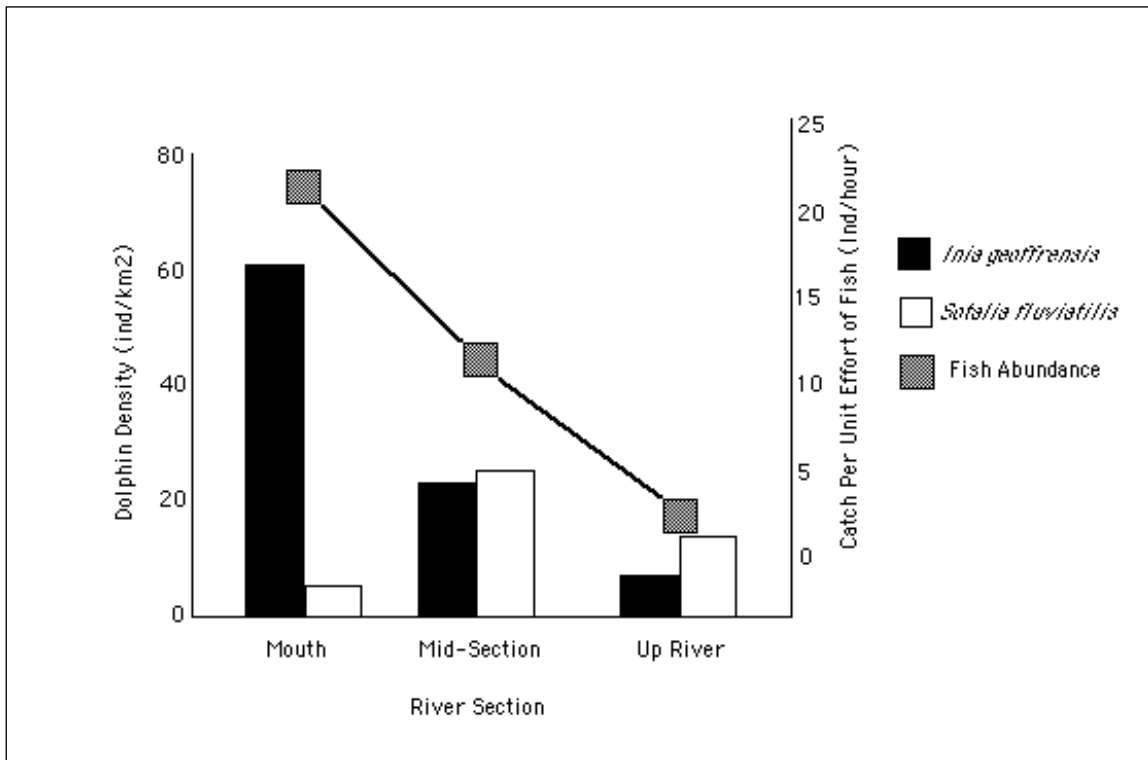


Figure 8. Relationship between river dolphin density and fish abundance, measured as Catch per Unit Effort.

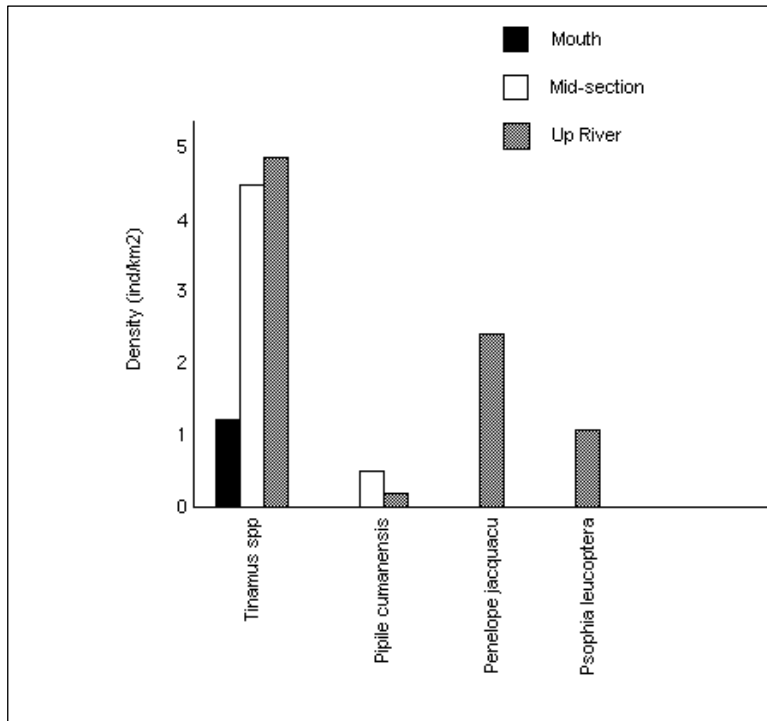


Figure 9. Density of game birds in different sections of the Samiria river basin.

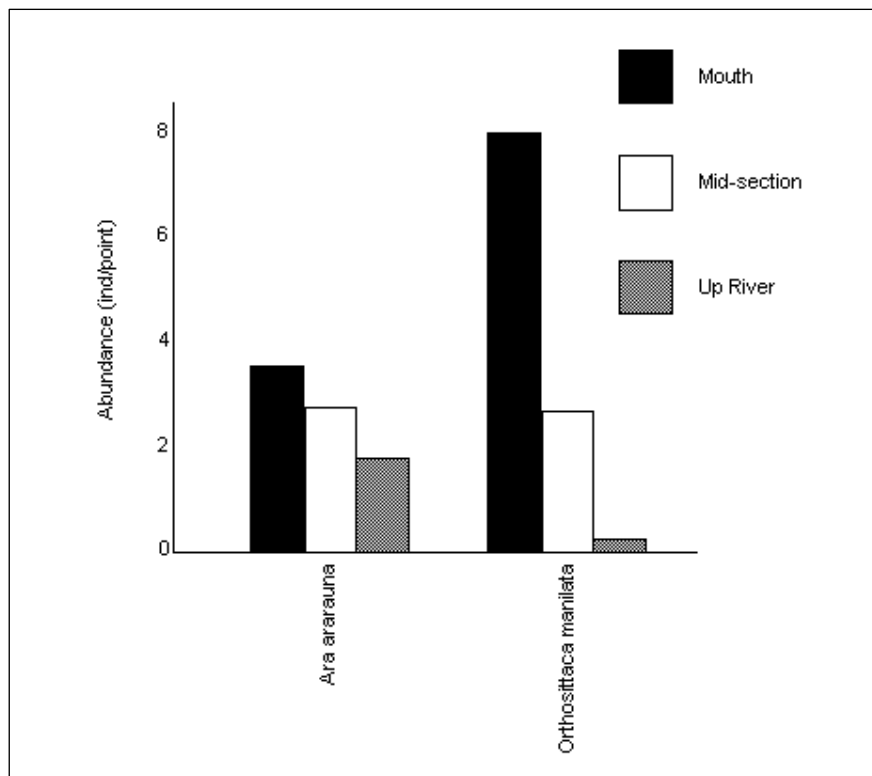


Figure 10. Abundance of macaws along different sections of the Samiria river basin.

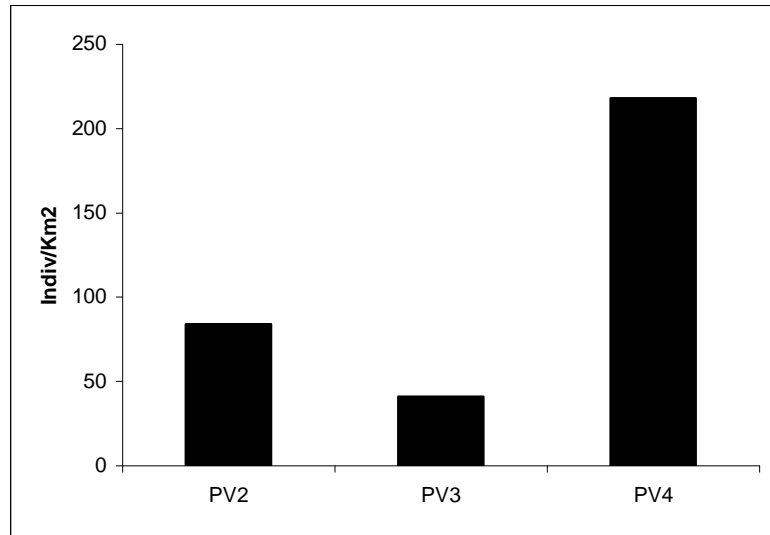


Figure 11. Density of *Podocnemis unifilis* along the Samiria river. PV2 is the mid-section, PV3 the near up river section and PV4 the far up river section.

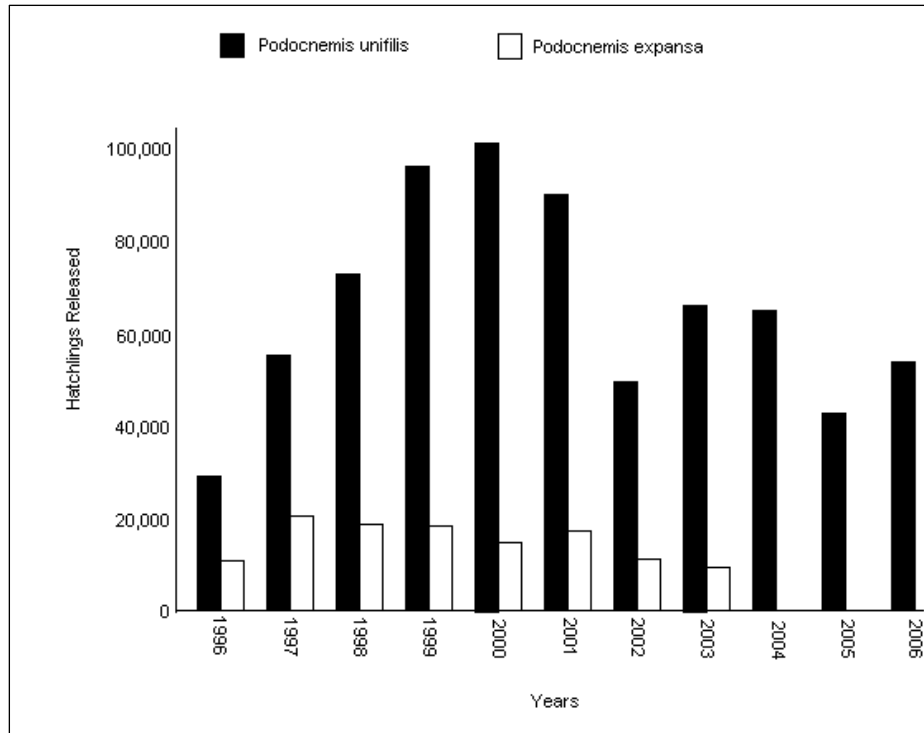


Figure 12. The number of hatchling turtles released during the head starting program.

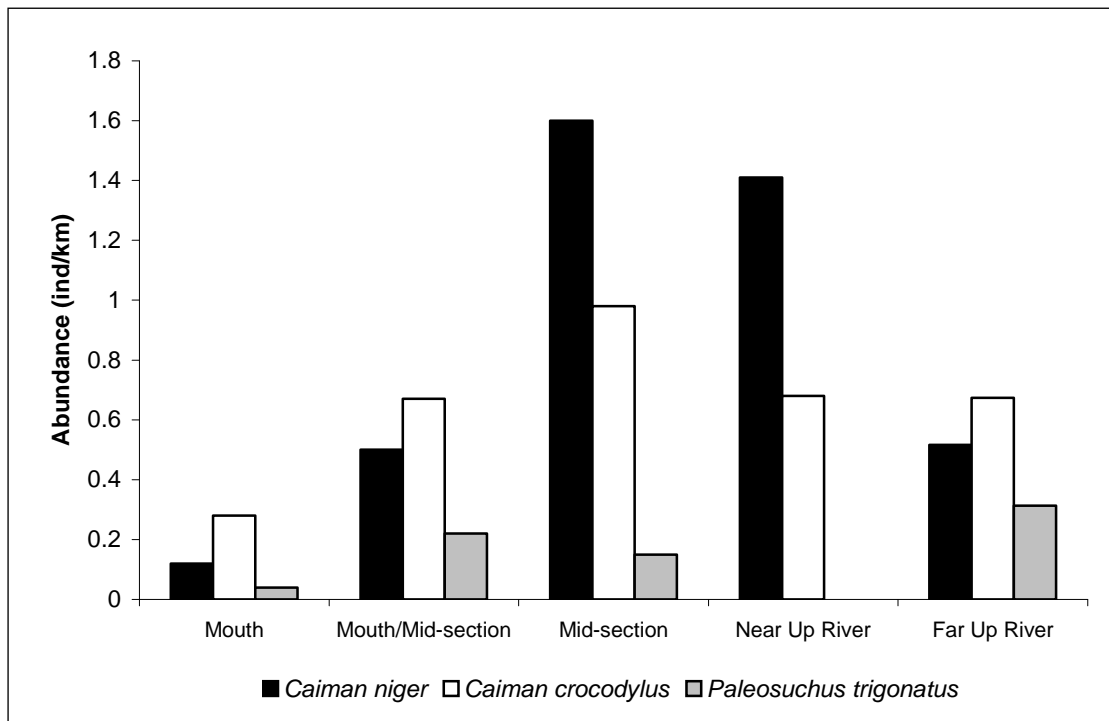


Figure 13. The abundance of caimans in different sections of the Samiria river.

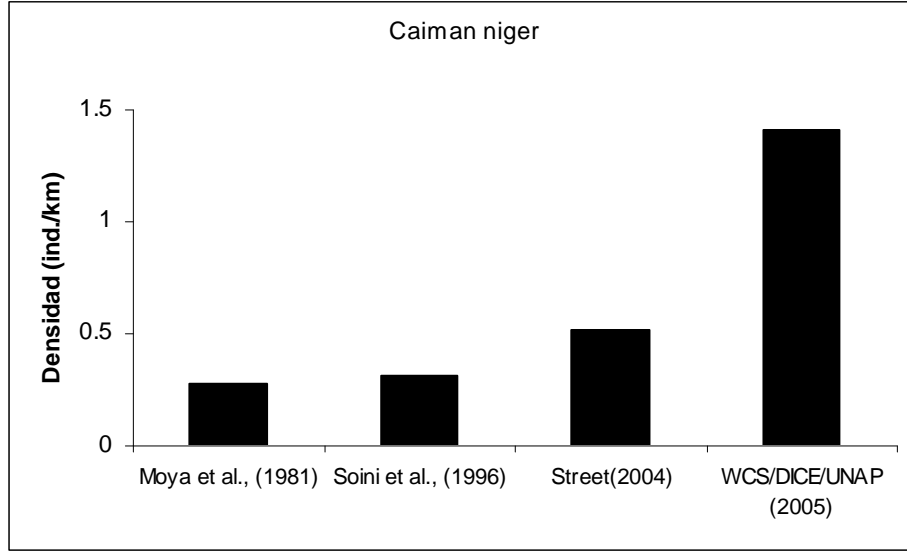


Figure 14. Abundance of black caiman in the up river section of the Samiria between 1981 and 2005.

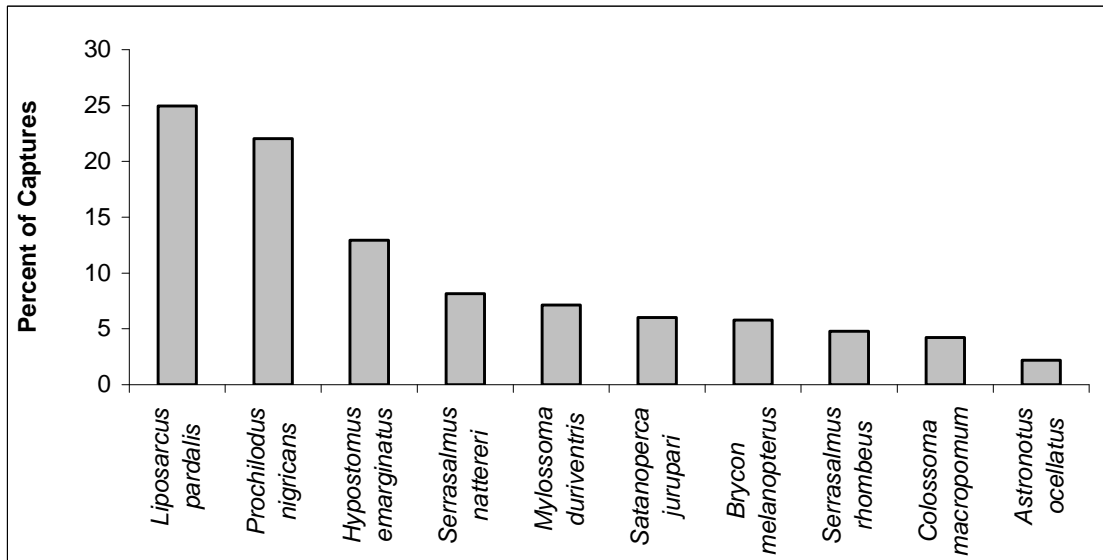


Figure 15. The most common fish species captured during the fish surveys.

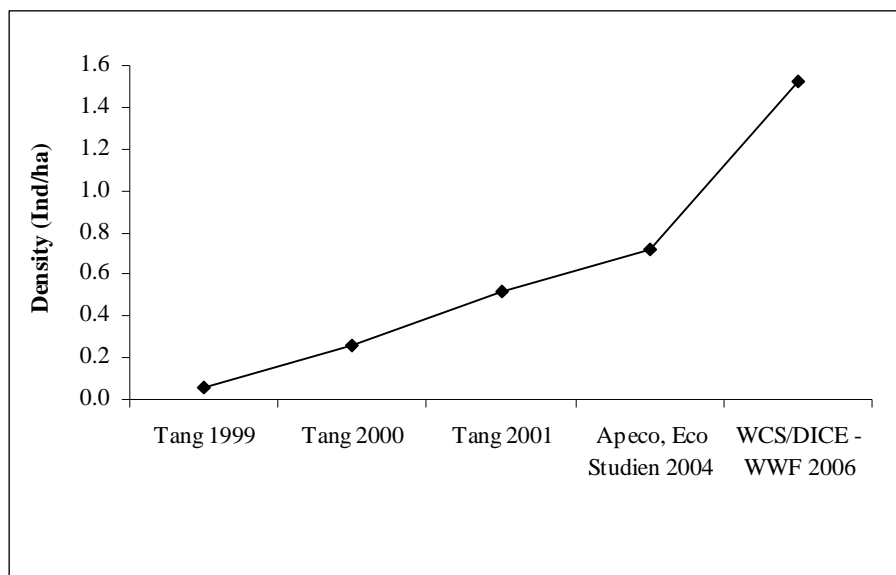


Figure 16. Density of the Piache fish in the community managed lake of Cocha Wiuri between 1999 and 2006.

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Volunteer Tasks and Accomplishments

The volunteers were truly helpful in monitoring the wildlife populations. More data were collected than originally anticipated, and the amount of information collected exceeded our expectations. In addition, new areas of research were initiated with the help of the volunteers, including a wading bird survey and mist netting. But, it was the assistance that many volunteers provided to the local communities that was truly unexpected. Many volunteers provided health and education materials to the local communities who are involved with community-based conservation.

The volunteers help with monitoring terrestrial wildlife populations, including primates, terrestrial mammals and game birds. They also helped monitor aquatic mammals, including dolphins, manatees and giant river otter. Avian censuses included macaws and wading birds. The reptilian fauna included censuses of turtles and caimans. Fish were also censused using catch-per-unit-effort. The volunteers censused 754 km of terrestrial transects, 265 km of aquatic mammal censuses, 138 km of caiman surveys, 98 km of turtle surveys, 280 points of macaw surveys, 168 hours of fish surveys.

Project Development

The first Earthwatch expedition that we ran was not only the first time we incorporated Earthwatch volunteers in the project, but it was also the first time we operated the boat “Ayapua”. We encountered many logistical and operational difficulties on this first trip, both with the boat and with understanding the expectations of Earthwatch and the volunteers. The suggestions provided by the volunteers and Earthwatch staff were very useful in evaluating the expedition and incorporating necessary changes. The subsequent four expeditions ran according to plan for the most part. However, we continued to incorporate suggestions from the volunteers. There are still a few areas that need improvement, and we expect to implement these changes for the 2007 season. Below is a list of the major suggestions that have been implemented during the past season.

- VHF Radio communication with auxiliary boats
- Bow and stern tie up of auxiliary boats
- Improved English of Peruvian biologists
- Improved food service
- Improved briefing by Peruvian biologists prior to each census
- Improved plumbing system
- Improved data entry by volunteers
- Change of engines in the Ayapua
- Alternating laundry service
- Improved PA system
- Installation of new auxiliary generator

The monitoring activities will be continued and will incorporate additional surveys on the wading birds in the Samiria River. The introductory sessions will incorporate the results from the 2006

field season to show the volunteers how the results are being used for sustainable resource use by local people and helping to better manage the protected areas.

Educational Opportunities

Many local communities are involved with our projects on community-based conservation. The information on wildlife populations collected by the volunteers helps in developing better community-based management programs. The project provides technical assistance to local communities in the development of wildlife and fisheries management plans, the setting of non-hunted source areas, and in managing wildlife habitat.

Capacity building of Peruvian and non-Peruvian students is an important aspect of the project. Most of the student field courses are held on other research boats, and not during Earthwatch expeditions.

The Management Authorities of the Pacaya-Samiria National Reserve and the Lago Preto Conservation Concession will use the results of the research to improve the protected area management plans.

Local communities require natural resources to meet their subsistence and financial needs. These resources will only be available to meet these needs over the long-term if the resources are used sustainably. The project is helping the local communities set up more sustainable use of their natural resources, especially for wildlife and fisheries. Likewise, the project is working with the national and regional governments to set up more sustainable policies of wildlife and fisheries use in the Peruvian Amazon. The project is also working with the protected areas authorities to set up more sustainable protected areas that incorporate the local people in reserve management.

Our project has helped with 10 BSc projects, 2 MSc projects and one PhD project during 2006. Most of our activities involving students are conducted on our other research boats and not during Earthwatch expeditions.

Partnerships

The Earthwatch project was conducted in collaboration with the following institutions: The Wildlife Conservation Society (WCS), the Durrell Institute of Conservation and Ecology (DICE), The World Wildlife Fund – Peru Office (WWF-Peru), Darwin Initiative, the National University of the Peruvian Amazon (UNAP), the National Institute of Natural Resources – Peru (INRENA), the Pacaya-Samiria National Reserve Authority, the British Schools Exploring Society (BSES) and FundAmazonia.

WCS has large foundation support for project and together with DICE is the base for our operations in Loreto, Peru. WCS maintains an office in Iquitos, and employs numerous field staff. DICE funds the salary of the lead PI. The overall objectives of the project were developed through joint WCS/DICE/WWF projects. WCS manages the Lago Preto Conservation Concession. WCS/DICE manage the community-based conservation activities, and WWF is collaborating with the conservation activities in the Samiria river basin. The Darwin Initiative and WCS jointly fund the Peccary Pelt Certification Program, and WCS funds the Cross Cutting Program on Wildlife Management in the Amazon. Students and staff from UNAP are involved with the conservation activities and participate with the capacity building field courses, run in part by BSES. INRENA collaborates with all aspects of the research and conservation activities, and the Pacaya-Samiria National Reserve collaborates with all aspects of the work in the Samiria river basin. FundAmazonia manages funds for projects not managed by WCS

The projects in the Peruvian Amazon of Loreto are made possible by numerous collaborating institutions. The different projects will receive project reports, and some of the information will overlap between projects. Publications will acknowledge the appropriate institutions. Reports are submitted on a 6 month or annual basis depending on the institution.

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