# Human Impact on Giant Otters in Lake Tres Chimbadas

Karen Dehnert

Tambopata Summer Research Opportunity, Tambopata, Peru
Stanford University

2003

**Abstract**

The endangered giant otter (*Pteronura brasiliensis*) faces daily threats associated with human encroachment on its aquatic habitat in the Amazon rainforest. This study examines the impacts of the growing ecotourism industry on otters in Peru through a case study of otter behavior in Lake Tres Chimbadas. During a two month period from June to August, 2003, I observed otter behavior and use of different parts of the lake when boats were present and absent. In 40% of their encounters with boats, otters exhibited alarm behavior before retreating to a distance of at least 250 m to resume more relaxed fishing behaviors. When boats were on the lake, otters avoided certain areas and spent half as much time fishing and less time resting on logs as when boats were absent. These findings indicate that boats do impact otter behavior and use of the lake. If boat users were more sensitive to the otters' need for space or, better yet, if observation towers were used for all tourist visits to the lake, human impact could be reduced. An understanding of how boats currently impact otters will help ecotourism agencies minimize these impacts for the benefit of endangered otters and interested tourists alike.

## Introduction

The giant otter, *Pteronura brasiliensis,* is one of the most endangered species in the world and the most endangered mammal in the Amazons. Lake Tres Chimbadas in southeastern Peru is the home of a few of these rare individuals, whose continued survival depends on an enhanced understanding of their health and needs in an environment with a significant – and growing – human presence.

These otters comprise a major ecotourism attraction in the area, and people from all over the world visit their habitat. While these visitors provide income that helps ensure the conservation of the rainforest and the survival of endangered species like the river otter, they also impact sensitive populations as they travel through prime habitat. Tourist boats visit Lake Tres Chimbadas every day, occupying the otters' territory and often coming close to the otters themselves. In this study, I monitored the lake's giant otter population, consisting of one lone otter and a family of seven otters, investigating the impact boats and human activities have on otter behavior and use of the lake. I observed the otters throughout the day, both in the presence and absence of boats, in order to determine how the otters alter their activities, movements, and vocalizations when humans are present.

A better understanding of the impacts of human activity on the otter population in Lake Tres Chimbadas may help ecotourism companies like Rainforest Expeditions reduce these impacts. An ecotouristic approach with an emphasis on sensitivity would establish the optimal balance between conservation and ecotourism, allowing visitors to observe the otters in the most natural environment possible.

### *Tropical Rainforests*

The diversity and complexity of rainforest ecosystems make them both interesting to study and important to protect. It is estimated that about half of the species in the world live in tropical rainforests, even though these forests occupy less than ten percent of the world's land area (Whitmore, 1998). However, the increasing human presence in rainforests around the world disrupts this system, threatening the balance between native species and their environments.

In the past century, rainforests were destroyed at a rapid rate as trees were removed by the timber industry and land was cleared for agriculture. Since World War II, the development of more reliable machines has made cutting trees, bulldozing land, hauling logs, and building roads much easier (Whitmore, 1998). The result of this new technology has been the loss of rainforest at a rate of about 13 million hectares per year, nearly 1%. In the Brazilian Amazon in particular, approximately 1.5 million hectares are lost or degraded per year (Whitmore, 1998). In addition, the rainforest that is left is of poorer quality because roads break up remaining forest into fragments.

Bodies of water are especially sensitive to changes in the rainforest. Erosion of lake and river beds, and increased runoff from logging and other deforestation activities, result in poor water quality (Moss, 1998). This affects entire populations of fish as well as the species, like otters, that depend on them.

Responses to these changes have been varied. Since the United Nations Conference on the Environment at Stockholm in 1972, efforts to reduce human impacts on the natural environment have increased (Whitmore, 1998). Many countries have areas of forest that are protected in, for example, National Parks, UNESCO Biosphere Reserves, and World Heritage Areas. Most countries also have institutions to manage the environment. Non-governmental organizations,

such as the World Conservation Union, the Worldwide Fund for Nature, Friends for the Earth, Greenpeace, and World Resource Institute, are also working to conserve the remaining forest.

Other, more local conservation efforts include reforestation, sustainable agriculture, and other attempts at managing human use (Bruenig, 1996). Some timber companies, such as the Costa Rican PORTICO company, carefully manage their forests' health and invest in the research of new production methods (Hartshorn, 1995). Community-based timber companies, including the Yánesha Forestry Cooperative in Peru, give local people more control over the use of their forests and the regeneration of native trees (Hartshorn, 1995). The production of nontimber products from the forests, such as the harvesting of brazil nuts, is another option for communities (Hartshorn, 1995). However, conservation efforts like these can be complicated by social and political issues. For example, poverty in many parts of the Amazon leads inhabitants to further degrade the environment because they need the income that agriculture and natural resources can bring, even if it causes destruction (Bruenig, 1996). In addition, political bodies sometimes do not recognize their responsibility to promote sustainability and conservation, and instead allow the private sector to degrade or destroy habitat (Bruenig, 1996).

Attempts at conservation can have very different effects on various segments of the environment. The rainforest ecosystem is so complex that what conserves one component of biodiversity many actually adversely affect others (Redford and Richter, 1999). In fact, Redford and Richter assert that all the components of biodiversity can be preserved only in areas that have not been altered by humans to any appreciable extent. They recommend that areas with great biodiversity be protected as much as possible.

Ecotourism is one approach to conservation that often focuses on areas of great biodiversity. Though relatively new, the ecotourism industry has grown very rapidly to become an important economic and conservationist force that depends on and therefore promotes the maintenance of healthy plant and animal populations. Income from tourism also gives local communities an economic incentive to protect their surrounding environment, especially the most pristine areas (Bookbinder et al, 1998). Furthermore, areas with great biodiversity are those most valuable to this industry, so these areas are preferentially protected, benefiting an especially large number of species (Myers, 1996). Because giant otter live in pristine habitat with hundreds of other species, protecting the otters and their home ranges also helps maintain overall biodiversity and protect other endangered and threatened animals, such as the black caiman (Frankfurt Zoological Society, 2003).

Tourists themselves can directly contribute to conservation. The revenue they bring supports protected areas and species, ensuring future survival (Giannecchini, 1993). Most ecotourism ventures also educate tourists about the value of nature and the importance of conservation, inspiring greater attentiveness to these issues. However, tourists also inevitably impact the environments they visit, overusing and abusing many natural settings around the world (Giannecchini, 1993). The infrastructure of lodges and roads disturbs the rainforest, and the increased human presence can affect individual animal species.

Clearly ecotourism can be a very powerful force, for both the protection and the destruction of the rainforest, so a balance must be established between these beneficial and potentially harmful effects of human activities. This study attempts to provide more information about the complex interactions between humans and rainforest species in a threatened environment.

*Giant Otter*

Otter populations around the world have been persecuted for centuries and are currently at serious risk. Historically, otters have been hunted and killed as "vermin," sometimes for bounties. They have also been hunted for their beautiful fur, as valuable pelts can bring in considerable income, especially in poorer areas. The runoff from industrial wastes and chemicals used in agriculture has poisoned many of the waters that otters depend on, and streambeds have been stripped of vegetation (Mason and Macdonald, 1986). As rivers, wetlands, and coastal environments are destroyed, otters around the world are left with little habitat and an uncertain future.

Giant otter once lived throughout much of South America, but poaching has greatly reduced their populations. They are currently seriously endangered in most of South America because of overhunting in the past half century. Between 1946 and 1973, Peru exported 23,980 otter pelts, putting a serious strain on otter populations from which they are still recovering (Mason and Macdonald, 1986). Giant otter are especially vulnerable to hunting by humans because they are active during the day, live in groups, and have a naturally curious nature. When they hear unusual noises, otters will lift their heads out of the water, and males often even charge boats, making them especially easy targets (Mason and Macdonald, 1986).

Hunting of otters, which was outlawed in the 1970s, is no longer the biggest threat to the population. As a result of new trade laws, otters are seldom killed for their pelts today. However, they are sometimes killed by fishermen, who see them as direct competition for the supply of fish in streams and lakes (Kruuk, 1995). Local people also sometimes capture otter cubs to sell or keep as pets, splitting up the close family units (Frankfurt Zoological Society, 2003). Furthermore, otters sometimes drown in nets and traps set up to catch fish (Frankfurt Zoological Society, 2003).

Otter populations are especially vulnerable to humans because of their small home ranges relative to other large predators. Each family lives in a lake less than one square kilometer in area (Dauphine, 2000). The small size of their home range means that they are usually unable to simply travel somewhere else when faced with disturbances. As top predators, they are very dependent on the health of all the populations below them on the food chain, so reductions in fish stocks can have drastic effects on otter populations. Pollution of lakes and exploitation of fish populations by local fishermen can lead to poor health and even starvation of otters (Kruuk, 1996). Because otters spend so much time in cool water, they have a high energy requirement and have to consume a lot of food, up to 4 kg of fish per day (Kruuk, 1996). As a result, polluted waters and fluctuations in fish populations can have serious impacts on otter health.

Habitat degradation and loss comprise the primary threat to the species. Giant otter need habitats with shallow water, gently sloping banks, suitable patches for fish, and plenty of nutrients (Kruuk, 1996). Already uncommon, these are areas that are frequently settled by humans and degraded over time. The removal of biomass from rainforests and the reduction of water quality have greatly reduced habitat suitable for otters.

Human presence can also have direct and very dramatic effects on giant otters. Past studies have shown that the primary effects of human disturbance are on lactation and the rearing and weaning of young (Mason and Macdonald, 1986). Mothers under significant stress due to human presence sometimes stop producing milk, which can result in the starvation of the pups (Dauphine, 2000). In addition, various researchers have suggested that tourist groups can cause otter families to catch fewer fish, change their denning activities, and even abandon habitat altogether (Mason and Macdonald, 1986). More direct and obvious evidence that otters are disturbed by humans comes in the form of elaborate territory-defending displays, in which otters

lift their bodies up out of the water (deemed "periscoping"), show their teeth, and make "alarm snorts" and other warning cries (Mason and Macdonald, 1986).

At the same time, otters attract tourists because of both their aesthetic appeal and their interesting and diverse behaviors. They are large, attractive animals that are easy to observe in the wild because they are very social and active during the day, from approximately 6:30 a.m. to 6:30 p.m.. In a 1985 study of otters in Peru, Martha Brecht-Munn found that otters primarily feed in the morning, rest and groom during midday, and feed and play in the late afternoon (Mason and Macdonald, 1986). Giant otter are found in families of a few individuals who live and feed together, hunting in groups by herding fish into shallow water (Mason and Macdonald, 1986). Otters also play and wrestle with each other, communicate from across the water by loud whistles and cries, and lounge and groom themselves on logs by the lake's edge. For these reasons, otters are usually very popular with tourists who prefer to see them at as close a range as possible.

*Conservation Efforts in Peru*

The Frankfurt Zoological Society, an organization dedicated to protecting biodiversity around the globe, began the Giant Otter Project in Peru in 1990. This project has directed research, monitoring, and conservation efforts to protect the giant otter families left in the country (Groenendijk et. al, 2001). In many protected areas, ecotourism is the only economic activity permitted by law, so the reduction of its negative impacts is essential. With this goal in mind, the Frankfurt Zoological Society promotes increased education, refuge areas for animals, better trail design, tighter control of boats, and replacement of boat use with observation towers and platforms (Hajek and Groenendijk, 2001). In the rainforest, ecotourism activity is concentrated in and along rivers and lakes because of the natural beauty, great wildlife, and facility of movement in these areas. However, otters need large bodies of water like these to fish and raise their young; areas with high shores and undisturbed vegetation in particular are essential for den sites (Hajek and Groenendijk, 2001). Many of these areas can no longer support otter populations because of human use for fishing, hunting, mining, and development. When shores are modified by construction of lodges, ports, or trails, for example, otters abandon dens and latrine sites. Development and motor boat travel along rivers like the Tambopata prevent otters from using these areas are permanent habitats. The ongoing loss of rainforest makes it essential that current microhabitats like Lake Tres Chimbadas remain suitable for otters.

In order to protect the otters' home in Lake Tres Chimbadas, the Frankfurt Zoological Society has composed a management plan for the lake. Unlike nearby national parks, the lake does not lie within a legally protected area, and compliance with this plan is only voluntary. The management plan includes a daily monitoring component, which involves recording the number, location and behavior of otters. The management plan also advocates changes in human use of the lake. Before 1999, people fished and hunted in the entire lake, and boats had free range. Under this plan, hunting has been eliminated altogether, and fishing and boating are restricted to the eastern half of the lake. Catamarans follow a single circular route along the southeastern shore no farther than the halfway point of the lake and then return along the northeastern shore. In this way, the western half, which has high shores suitable for den and latrine sites, is off limits to people. In theory, this gives otters a refuge from human impact.

However, despite this plan, there is significant encroachment upon otter habitat in the lake. A lodge and trails on the southern shore of the lake are within 50 meters of the water's edge, so otters cannot use this land for campsites. Canoes from the lodge take their visitors to the

protected western area. To the north of the lake, the road from Cuzco to Puerto Maldonado and the agricultural lands near it threaten the otters' habitat. In addition, people in the area continue to extract natural resources from both the lake and surrounding forests. As a result, efforts to reduce human impacts must continue.

## Methods

*Study Population and Site*

Lake Tres Chimbadas is in the Department of Madre de Dios in southeastern Peru. It is located 1.5 km west of the Tambopata River, south of the regional capital of Puerto Maldonado. The land to the northwest is owned by the state and contains agricultural lands along the road between Puerto Maldonado and Cuzco. These farms spread closer to the lake every year. To the north of the lake are lands owned and protected by the native Ese'eja community of Infierno, which with Rainforest Expeditions co-owns Posada Amazonas Lodge. The lands to the south are owned by the Bocangel family, which runs a farm and a small lakeshore lodge where tourists occasionally stay.

Tres Chimbadas is an oxbow lake, two kilometers long and less than 300 meters wide, formed in an L-shape when the Tambopata River changed course. It is in an area of lowland rainforest that gets two meters of rainfall each year and has an average temperature of 25-26˚C. This environment supports a wide range of plant and animal life, including the endangered black caiman, four species of piranha, catfish, turtles, a diversity of bird species, and aquatic and semi-aquatic vegetation, including floating marsh grass and palm species. Fallen tree trunks and large branches stick up out of the lake as partially submerged logs. Each day, tourists from Posada Amazonas visit the lake for a few hours, walking from the river at dawn. They observe the lake from a large catamaran, composed of a four by three meter platform spanning two canoes, very slowly propelled by large oar. Rainforest Expeditions owns two of these catamarans, and on a busy day, each may carry up to 15 passengers. Occasional visitors at the Bocangel lodge usually visit the lake at dawn, traveling in a seven meter long canoe. Sometimes a third lodge will use one of the catamarans to bring a few tourists onto the lake around midday.

The lake is home to one family of giant otters. At the time of my study, I observed a group of seven otters as well as one solitary otter, probably a young adult searching for a mate. I did not see any otter cubs during my study, as during the period from June to early August, cubs are too young to leave the den area. I could not tell the ages or sexes of any of the otters, but I assume the family to be typical in consisting of a mating pair and its young. The solitary otter was seen arriving at the lake from the direction of the river, and it stayed for the full two months of my study. On two occasions, it appeared to fight with the otter family, though it often swam and fished near the family without any commotion.

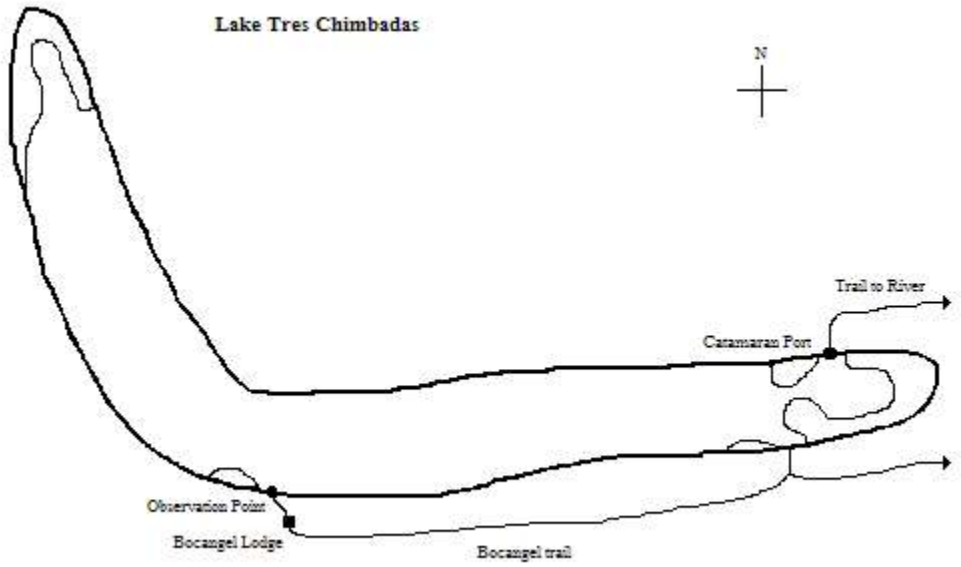
*Procedures*

My study extended from June 19 to August 14, 2003. During this time, I spent 14 full days and 11 half days at Lake Tres Chimbadas, for a total of 93 hours and 46 minutes in position to observe the otters. Of this time, the otters were in sight for just over half (53%) of the time. This gave me 49 hours and 57 minutes to directly observe the otters' behaviors. Most of this observation was in the presence of boats (37 hours total), though a significant amount (14 hours)

was in their absence, making it possible to compare and contrast the otters' behaviors under these two conditions.

My observations were made from the south shore, where the lake bends and just east of the floating grass and the boundary marking the protected half of the lake. From this position, the view of the lake, deemed the "observable area", included all but the two ends of the lake. At the northwest end, where the otters' den is located, marsh grass obscured my view of the water. At the eastern end, where the catamaran port is, marsh grass partially encloses a section of water that was also obscured from view. In this section, I could only see the otters when they swam or fished near the mouth of the grass enclosing this end. Figure 1 shows a map of the lake (not to scale).

**Figure 1. Map**




When making observations, I sat on a log by the water's edge, under a tree with low-hanging branches that partially hid me from view. I tied my small canoe to this tree, and sometimes sat or lay down in it to get a better view when the otters were far away. I used binoculars for all my observations.

I came to the lake in the morning with the tourists, leaving Posada Amazonas at 5:30 a.m., traveling upriver to the trailhead via boat, and walking 30 minutes to the lake. Once at the lake, while the tourists boarded the catamaran, I took a canoe and paddled to my observation spot. I could usually begin my observations by 7:00 a.m.. When I could stay at the lake for the day, I usually ended my observations at 1:00 p.m. in order to be back at the river in time to be picked up by a boat with a group of ecotourists returning from another activity. I deemed this a "full day" of observation, as it involved 10 hours round-trip. When no boat was available to take me in the afternoon, I returned with the tourists to the lodge in the morning. During these "half days," I had to make my observations from the catamaran, from which I had a view of little more than half the lake. Nevertheless, when otters emerged, I got a very good look at their direct responses to the catamaran. On these days, I spent two and a half hours on the lake.

I recorded my observations on a data sheet with both notes and map components. At the top of the data sheet, I recorded the day's weather, including temperature, wind, cloud cover, and

precipitation data. As the weather changed throughout the day, I recorded those changes. Observation periods with heavy precipitation were removed from the data set, both for fear that rain itself may alter otter behavior and because it made seeing otters and accurately recording their behavior nearly impossible even at moderate distances.

I watched the lake continuously, recording observations on the data sheets when behaviors and locations changed. The data sheet had five columns: time, number of otters, otter behavior, otter location, and behavior and location of boats. Observation time was recorded to the nearest minute. The number of otters column recorded the number of visible otters. Since otters swim and fish underwater, popping up occasionally to breathe or to eat, it could be difficult to accurately count the number of otters. I recorded the largest number I could see with their heads out of water at the same time.

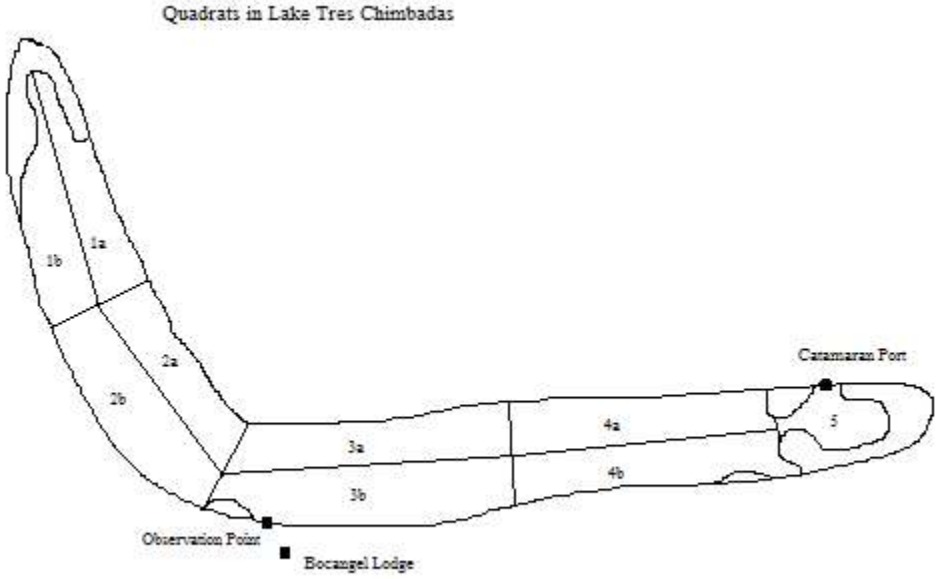
I established a simple code for each fundamental otter behavior that I recorded in the otter behavior column. The seven codes I used were:

E = eating
F = fishing (diving motion)
P = periscoping (heads high out of water so necks are visible)
R = resting/grooming (on logs)
S = swimming
AC = alarm cry
TC = territorial cry
SC = squeaky cry (young asking for food)
L = disappeared on land

In the behavior column I also described any unusual or complex behaviors that could not be simply noted by a code. These included, for instance, how otters responded to boats when they got too close, and interactions between otters (e.g. fights, or sharing food). When the otters retreated onto land, I noted the time and departure location, with a second entry recording when and where they returned to the water. Since the otters swam and fished together as a family, each behavior could usually be described for the whole group; when it could not, I noted the different behaviors of different members of the family.

I also described the location of the otters in the lake. This was done in three ways. First, I described the location of the otters on the data sheet under the "otter location" column. Second, I put a dot on the map that corresponded to this location, with the time next to it. I connected these dots with lines to indicate the path the otters took between points. Third, I recorded the quadrat of the lake the otters were in. To do this, I divided the lake into five main quadrats (1-5), numbered from the northwest end to the eastern end. For each of these quadrats (except for 5, which was largely obscured by marsh grass), I labeled the far shore (north or east shore) "a" and the near shore (south or west) "b". This gave me a total of nine quadrats, each about 400 m long and 125 m wide. The quadrats were divided according to what I considered fairly stable and visible natural markers in the lake. These markers included partially submerged logs (between quadrats 3 and 4), distinctive trees (between 1 and 2), and large patches of marsh grass (between 2 and 3 and between 4 and 5). Figure 2 shows how the lake was divided into quadrats.

**Figure 2. Quadrat design**




The final column of the data sheet was filled with observations of the boats on the lake. I recorded the number and types of boats on the lake at all times. I also both described and mapped their location (with an X and the time next to it). In this column I described any notable observations, such as whether the boats were crowded, loud, going very fast, approaching or drawing away from the otters, and so forth. I recorded and mapped the times at which they entered the lake, entered the observable area of the lake (moving past the marsh grass from quadrat 5 into quadrat 4), and left the observable area of the lake, along with which quadrats they were in at all times.

The bottom of each data sheet had the map of the lake in which I could record the locations of the otters and boats in each quadrat. This also allowed me to record visually the paths of both by connecting the dots (for otters) and Xs (for boats) with their times. In this way, I could show their locations (especially their locations relative to each other) more accurately than I would be able to describe them in words. Although I was generally so far away from the otters that the locations were only estimates, it was always clear which quadrat they were in.

## Results and Discussion

*Times on the Lake*

In general, the Posada Amazonas catamaran(s) entered the observable area of the lake, from quadrat 5 to quadrat 4b, sometime between 6:45 and 7:30 a.m., with an average entry time of 7:11 a.m.. Before entering the observable area, the catamarans usually spent half an hour circling quadrat 5. Once they entered the observable area, they would move slowly down the south shore of the lake, then cross to the other side of the lake and head back along the north shore. The general path, therefore, was a circle through quadrats 5, 4b, 3b, 3a, 4a, and then back to 5 and the port. The catamarans usually left the observable area again sometime between 8:15 and 9:30, at an average time of 9:04 a.m.. The boats would spend another 5 or 10 minutes in quadrat 5 to

reach the port and unload. Each morning, the catamarans spent an average of just under two hours in the observable area of the lake, and two and half hours in the lake overall. Therefore, the catamarans constituted a significant daily presence in the eastern half of the lake.

The Bocangel canoe was seen on the lake seven times. On six of these occasions, it traveled to the northwest side of the lake early in the morning, before I arrived at 7:00, then returned to its port (my observation point) around 7:30 a.m.. [The seventh time, it was seen in the afternoon.] On three of these mornings, the otters did not even appear until afternoon; perhaps they had been scared into their den by the boat. On the other three mornings, the otters did come out into the lake and exhibited fairly normal fishing behavior.

Of the 25 days I spent at the lake, the otters were seen by tourists on the catamarans 19 times, for a "success rate" of 76%. For the months of July and August, according to abbreviated data sheets filled out by the rowers of the catamarans, otters were seen at a rate of 68%, just over two-thirds of the time, the rate Rainforest Expeditions publishes. I saw the otters at least once each of my full days at the lake.

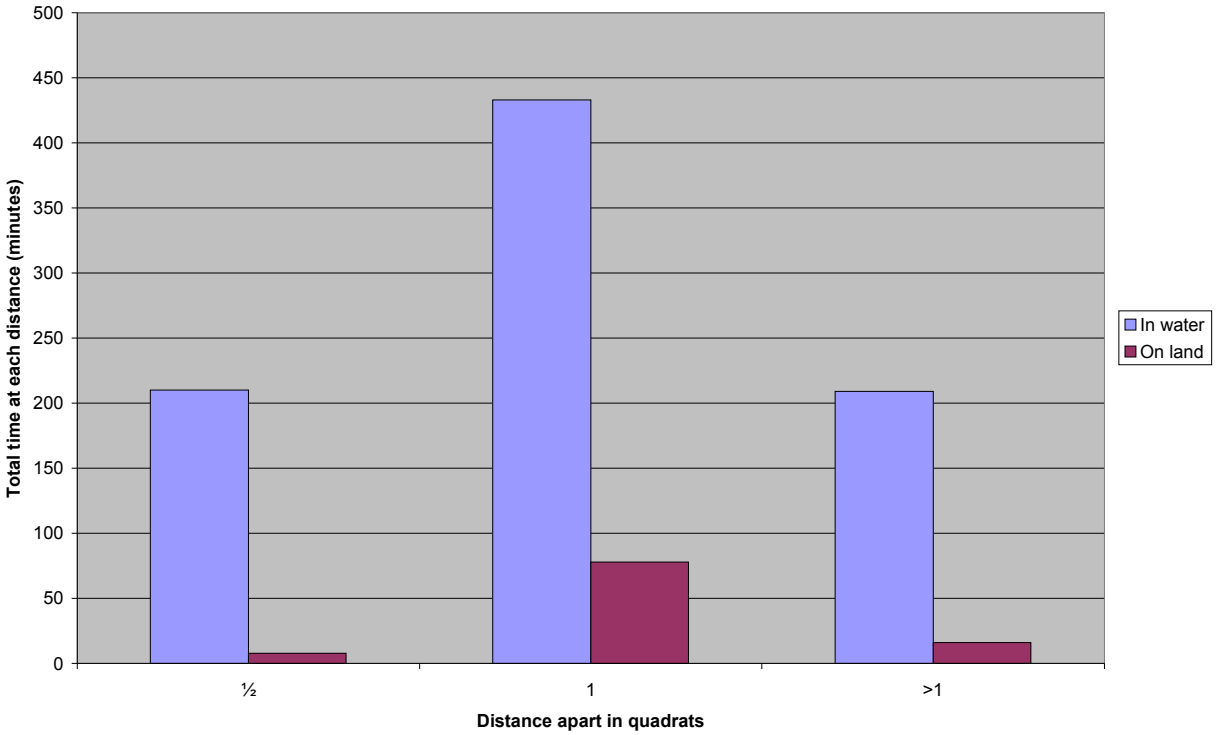
When the otters did come out into the lake so that tourists could see them, they appeared at an average time of 7:26 a.m., could be observed for a full hour, and then disappeared into the other end of the lake or onto shore at an average time of 8:27. Usually the otters were seen in a group ranging in size from four to eight otters, with a mean and median size of six members. Occasionally, the lone otter would be seen, usually fairly near the otter family, though sometimes on its own.

*Immediate Responses*

The most immediately identifiable way otters responded to the presence of boats was through characteristic alarm behavior. This included lifting their heads out of the water, an action called "periscoping" that shows the markings on their necks, and making loud alarm noises. Sometimes the otters approached the boat while making this display, while other times they performed it in one spot and then retreated. On the days I was at the lake, the otters exhibited such alarm behavior eight times out of the twenty they were in the presence of boats, or 40% of the time. From July to August, the Rainforest Expeditions monitoring sheets recorded alarm behavior on 4 out of 25 days, for a lower rate of only 16% overall. This is likely because these sheets were from different days than the ones I observed, so our data sets were different.

In general, when the otters were near the boats, they first brought their heads out of the water and looked at the boats. If they were very close to the boat or had been startled by it, they would show alarm behavior, lifting their heads high out of the water and making alarm calls. If they did not seem to feel threatened, they did not usually retreat immediately, but rather observed the boat from where they were. Once they had a good look at the boat, they would return to fishing at a distance they considered safe. This was usually on the opposite shore of the lake, about one quadrat away. Figure 3 shows the distance maintained between otters and boats in terms of quadrats. All times are cumulative for the two months of data.

**Figure 3. Distance between otters and boats**




As the figure shows, the otters swam and fished within half a quadrat of the boat only 25% of the time, and more than one quadrat away (but within view) another 25% of the time, but about one quadrat (300 – 400 m) away 50% of the time. The trend is the same for otters on shore but within view of the boat (on logs, etc.).

A more striking trend is shown by the shore on which the otters usually fished. Of 17 times otters were observed in the presence of boats, they fished on the opposite shore of the lake 14 times and by the same shore the boat was on only twice. In addition, when they fished on the opposite shore, only once were they directly opposite the boat; usually they fished on the opposite side and down the shore another 100 meters or so. This practice allowed them to maintain a distance of at least 250 m from the boat, the distance also observed through the quadrat measurements.

Perhaps the otters maintained a distance of about 250 – 400 m in order to stay far enough from the boat to feel safe but close enough to keep an eye on it. Indeed, when the otters first saw the boat in the morning, they usually swam away from it, but not all the way to their northwest half of the lake. When they fished in the vicinity of the boat, they occasionally lifted their heads out of the water in the direction of the boat, appearing to look at it but not exhibiting alarm calls or other alarm behavior.

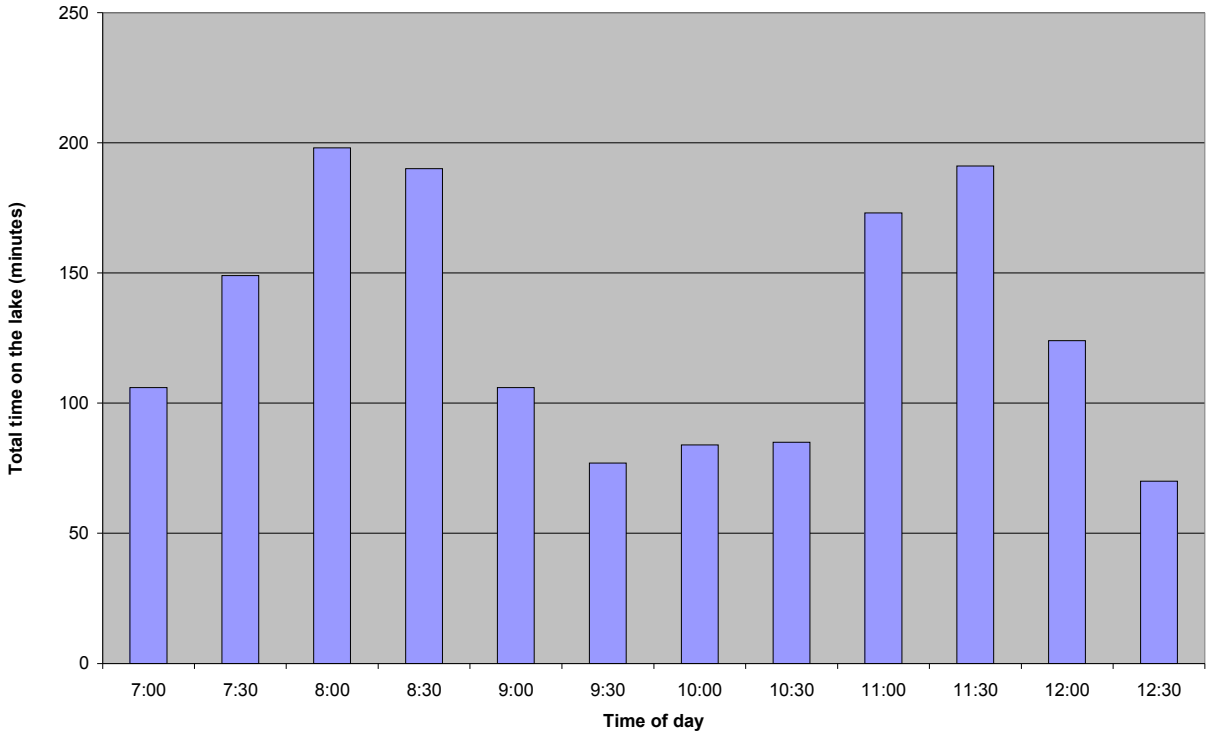
Although the otters usually exhibited fairly relaxed behavior when boats were stationed on the other side of the lake, they often stopped fishing and returned to the northwest end of the lake when the boat started to move again or began to cross the lake. On multiple occasions, the boat would stop and observe the otters for half and hour or more, without seeming to bother them, but when it started to move back to the port, even if not in the direction of the otters, they would

leave. Perhaps this sudden movement startled them or reminded them that the boat was still there and might approach, and this caused them to retreat.

*Time Distribution*

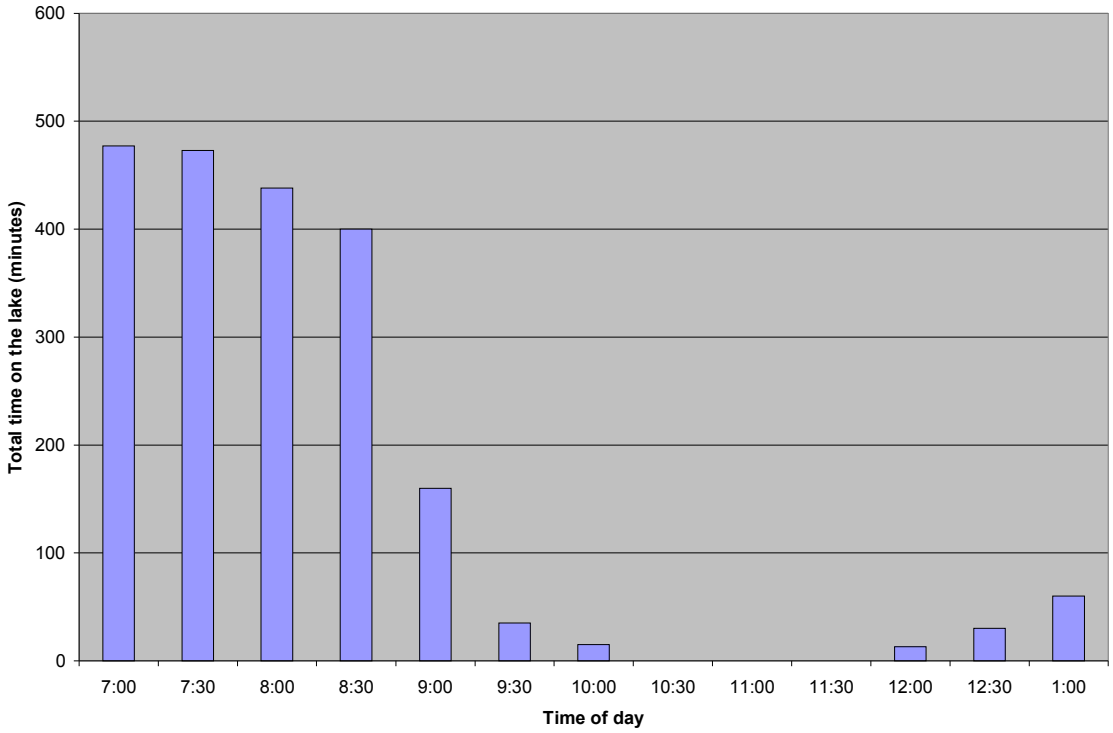
The otters maintained a fairly consistent daily schedule in terms of the times they spent in water and on land. On average, they emerged from the north end of the lake (where their den is located) at 7:25 a.m. and swam to the east side to fish. Approximately one hour later, they disappeared again, either back to their den at the north end or onto land at one of their campsites at the east end. They often emerged again between 11:00 a.m. to 12:00 p.m. for another fishing session. Although the otters did spend significant amounts of time on the lake at other times, these two periods were the most common times for fishing. Figure 4, based entirely on data from full days at the lake, shows this trend.

**Figure 4. Total time otters spent in the lake by time of day**




This time distribution for the otters shows the two peak times during the morning that the otters spent in the water. The time distribution for boats in the lake shows that early morning – before 9:00 – has the most boat activity, and for the rest of the morning the lake is virtually boat-free. Figure 5 shows that boats are usually absent from the lake after 9:30 a.m..

**Figure 5. Total time boats were on the lake by time of day**



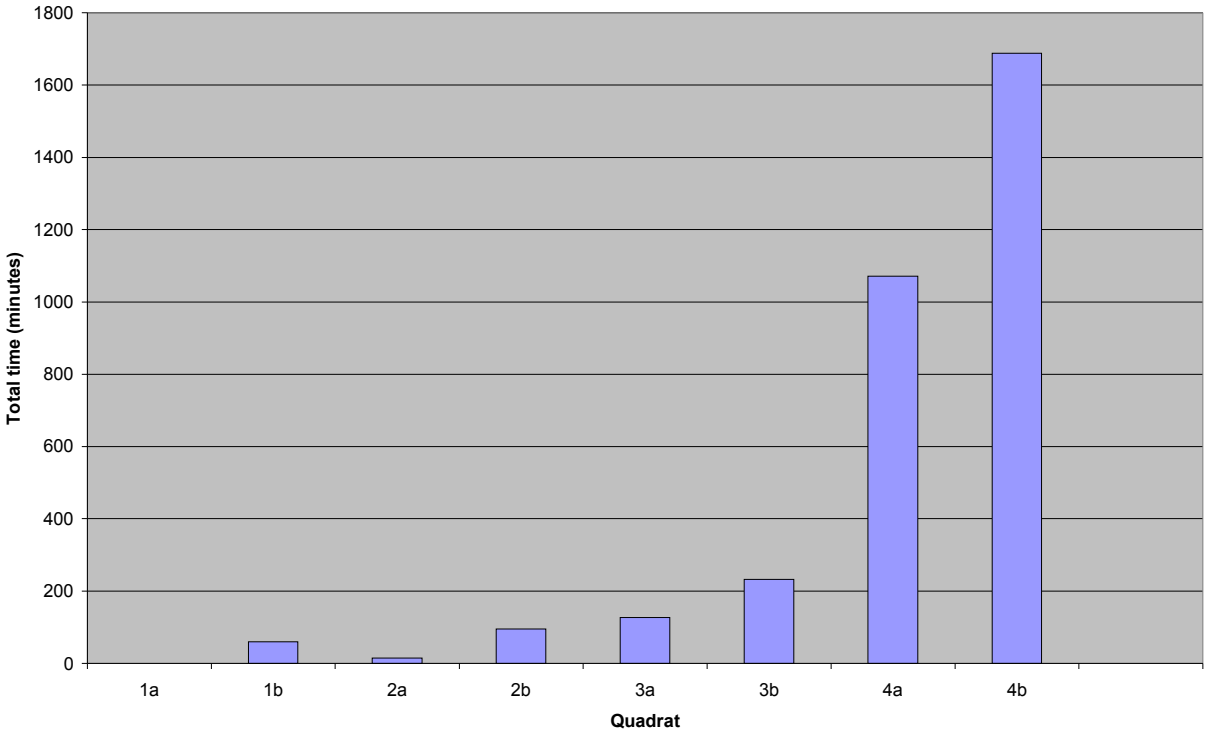

The boat time distribution does not seem correlated with the time distribution of otters. The highest points of boats in the lake are between 7:00 and 9:00, while the lowest are between 10:30 and 12:00. The boat high and low map almost directly onto the two otter high periods, suggesting that the presence of boats is not the determining factor for when otters fish. Rather, this may be biologically determined by the otters' energy requirements; they need to eat at the beginning of the day, then again a few hours later. As a result, they fish at these times regardless of whether the boats are present.

*Parts of the Lake*

The parts of the lake the otters preferred were also not determined solely by the presence of boats, as evidenced by observations that otters did not avoid quadrats commonly used by catamarans.

In their circular path around the lake, the catamarans spent time in quadrants 4a, 4b, 3a, and 3b. The Bocangel canoe took tourists into quadrats 1b, 2a, and 2b, the ones on the protected northwest half of the lake. Figure 6 summarizes the trends of the amount of time boats spent in each quadrat overall. (Quadrat 5 was not included in the graph because it is not included in the observable area).

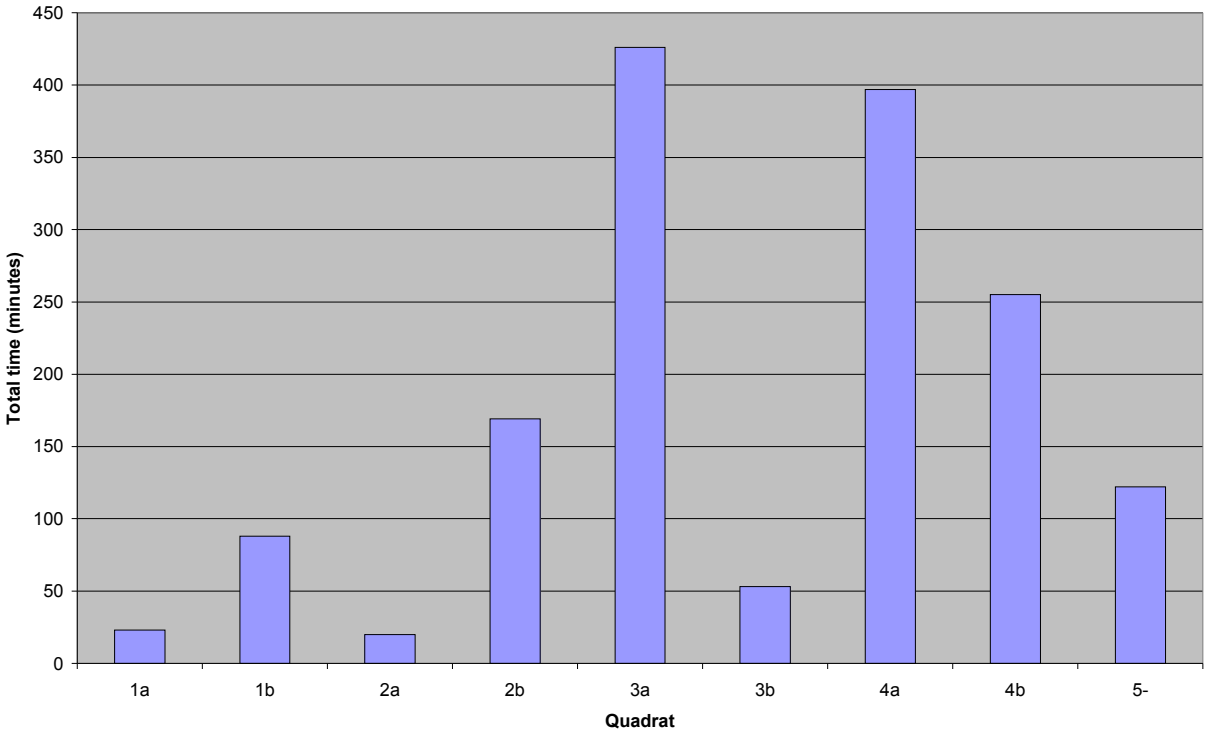
**Figure 6. Time boats spent in each quadrat**




In general, the catamarans traveled more slowly on the south shore of the lake (because there were many stops during this first half of their lake tour) and therefore spent more time in quadrats 4b and 3b than their north-shore counterparts 4a and 3a. In addition, the catamarans often did not proceed much farther than quadrats 4b and 4a, so more time was spent in them than quadrats 3a and 3b. The Bocangel canoe usually traveled along the west side of the lake (quadrats 2b and 1b) because that is the side of the lake their lodge is on, although it was once seen briefly returning on the northeast side (through quadrat 2a).

The otters' preferences for parts of the lake did not show such a simple trend as their paths were not nearly as predictable as the boats'. Otters were observed primarily on the north side of the eastern half of the lake, as Figure 7 shows.

**Figure 7. Time otters spent in the lake by quadrat**




The otters spent the most time in quadrat 3a, which may be partially due to its location in the lake. The shortest path from the north end to the west end of the lake is directly through quadrat 3a since it is located at the lake's bend. Every time the otters made this trip (which they did nearly every day), they went through this quadrat, often stopping to fish on the way. In addition, quadrat 3a has a set of partially submerged logs where the otters often rested and ate large fish. One of their campgrounds was also on land adjacent to this quadrat. All these factors may have contributed to making this quadrat the one in which the otters spent the most time, whether fishing, eating, resting, or playing.

Quadrat 4a was the other quadrat preferred by the otters. It also has partially submerged logs on which the otters could rest and eat, as well as play and fish. In addition, it has a small creek system running off from it, into which otters often disappeared; a campsite may have been present here as well. Quadrat 4b was also a frequently visited quadrat, and otters also often disappeared into the brush and more reedy parts of the lake in this area. Quadrat 2b was a rather large quadrat frequented by the otters; it also had a campsite and partially submerged logs that may have attracted the otters to fish in that area. The otters also spent a long time fishing in quadrat 5 in the late morning, after tourists departed.

Quadrat 3b was surprisingly not one in which otters spent very much time, especially compared to neighboring quadrats 2b, 3a, 4a, and 4b. This may have been due to a combination of natural factors and human impacts. The quadrat does have a few small partially submerged logs that the otters fished around and rested on a few times. However, the shore along 3b has a trail used to travel from the river to the Bocangel lodge that prevents the otters from using the land for campsites. This quadrat has more human presence than others because both my observation point and the Bocangel lodge are located right before its border with 2b. Twice the

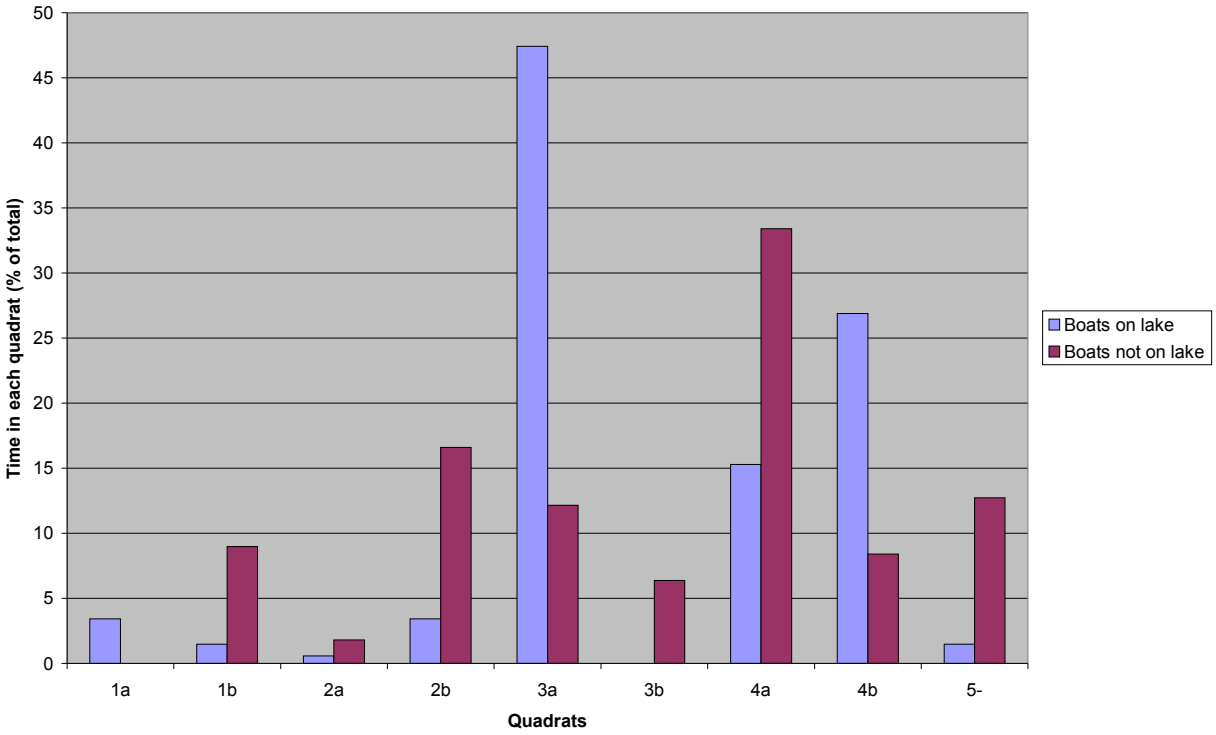
otters noticed my presence and exhibited alarm behaviors, including calls and periscoping. On two other occasions, the otters clearly looked my way and seemed to avoid the area – quadrat 3b – as a result. In addition, the Bocangel lodge overlooks this quadrat, so the area sometimes had guests (whose voices carried to the water) and usually had a canoe stationed in the water. On one day in particular, tourists at the lodge observed the otters in quadrat 3b and made so much noise that the otters immediately stopped swimming, lifted their heads out of the water, and then retreated back to the north shore. On another occasion, people sat in the very end of the canoe stationed at the lodge, hanging out over the water when otters were nearby and scaring the otters away. Individual events like these may have had a large enough cumulative effect to reduce the overall time otters were observed in this quadrat during my study.

Finally, it is interesting to note how little time the otters were observed in quadrats 1a and 2a. This is surprising because these quadrats are near the otters' dens and (supposedly) off-limits to boats, yet the otters did not fish in them very much. This may be a reflection of the quality of fishing in these quadrats, or may be due to the lack of campsites along these shores. It is also possible that I simply did not observe the otters in these quadrats as much as in others because my angle made them harder to see or because I only observed in the mornings, when these quadrats were shaded and perhaps not good for fishing.

These complicated trends show that time distribution is probably determined by a variety of factors, especially the presence of partially submerged logs in the water and campsites on shore. It is clear, however, that the otters do not completely avoid certain parts of the lake because they are areas boats visit, as the three quadrats the otters spent the most time in(3a, 4a, and 4b) were also the ones boats visited most.

However, otters did show certain differences in what parts of the lake they spent time in when boats were present and absent. This is shown by Figure 8, which is based on data from full days at the lake.

**Figure 8. Quadrats otters were in when boats were present and absent**




When people were on the lake, the otters spent essentially no time in quadrat 5 (they were once observed right when the tourists arrived at the lake, but immediately left the area), but when the tourists were gone, they fished there extensively. Because the catamaran comes from quadrat 5, it easily scares any otters out of it in the early morning, and otters would not want to be trapped in it when the catamaran returned to the port.

Although quadrats 4a and 4b were roughly equivalent in terms of how much time boats spent in each, otters spent less time in 4a when boats were on the lake, as might be expected, but actually more time in 4b in the presence of boats. Perhaps this can be explained by the path the catamarans always follow. By 7:30 when the otters usually swim over to the east side of the lake, the catamaran has moved partway through quadrat 4b. This leaves space for the otters to fish in the area the catamaran has vacated. As the catamaran travels in its circular path around the lake, it returns along the north shore (through quadrat 4a), not through 4b again. If the otters had a sense of the route the catamaran always takes, they might see quadrat 4b as the safest place to fish, knowing that once the catamaran has traveled through the easternmost parts of this quadrat, it will not come back through them. In addition, quadrat 4b has small inlets between sections of grass where the otters frequently fished; the catamaran never entered these dead-end areas.

A somewhat surprising trend is also seen with quadrat 3a; the otters spent proportionally much more time in this quadrat when boats were present than when they were not. This may be because the otters felt that this was a fairly safe quadrat because the boats often returned to the port before reaching this quadrat. In addition, if the catamaran did enter this quadrat and get too close to the otters, it would be very easy for them to retreat back into the safe northwest half of the lake.

Overall, these data suggest that the presence of boats certainly does not prevent otters from fishing in the eastern half of the lake, where boat traffic is heaviest. The otters continue to fish in this half of the lake nearly every morning. The differences in the preferred quadrats when boats are present and absent may be due to a number of factors, or may not even be statistically significant, since only the 14 full days of observation were included here.

*Length of Resting and Fishing Sessions*

Otters exhibited relaxed behaviors like resting on logs by the shore even when boats were present. In both the presence and absence of boats, otters rested on logs on about two-thirds of their trips around the lake. The amount of time otters rested on logs varied greatly, however, from day to day, ranging from one minute to 37 minutes. However, on average, otters rested on logs for longer periods when boats were absent than when they were present, with an average of 11.5 minutes when boats were around and 17.3 minutes when they were not. This may be the result of a generally more relaxed attitude in the absence of boats.

The presence of boats had an even more significant effect on the length of time otters spent fishing. Here, I defined a "fishing session" as a period of time otters spent in the water that included fishing. When the otters fished, then swam to a new site, then began fishing again, and so on, I counted this as one continuous fishing session; similarly, if an otter stopped fishing for a few minutes to eat a large fish on a log and then returned to the water to fish more, I counted this as a continuous session. However, when otters returned to their den or got out of the water to rest on logs or in a campsite, I counted this as the end of the fishing session.

When boats were absent, otters fished for an average of 63 minutes continuously. In contrast, when boats were present, fishing sessions lasted for an average of only 36 minutes, just over half as long. While the length of fishing sessions did vary considerably when boats were both present and absent, these averages are significant. In addition, the longest fishing sessions when boats were present were 90 and 96 minutes, while the longest in the absence of boats were 150 and 160 minutes, again almost twice as long.

Fishing sessions had a slightly different character when boats were present than when they were absent. In the absence of boats, otters usually spent more time fishing in one location, and only changed locations once or twice during the session. About half of the fishing sessions were spent in one location, and most of the rest were spent in only two or three locations. When boats were around, on the other hand, otters tended to change location more frequently. They only fished in one location for about one third of their sessions, and changed locations frequently for another third of their sessions. This may be because when the otters were fairly near the boats, they would lift their heads out of the water to see where the boat was. Occasionally they would then move to a new location in response to the movements of the boat.

It appears, therefore, that the fishing sessions are of different length and quality when boats are present and absent. In the absence of boats, the otters generally have longer and more continuous fishing sessions, which means more time actually fishing and less time swimming around the lake.

## Conclusions

The observations made during this study show the various effects that boats have on giant otter behavior and use of the lake. These effects reflect how the current management plan and ecotouristic approaches on Lake Tres Chimbadas are working and suggest ways in which human

impacts can be further reduced. With a few more improvements in the relationship between tourists and otters, and with further and more complete studies, a balance can ultimately be established that will provide a healthy environment for otters and an exciting nature experience for tourists.

*Evaluation of the Current Ecotouristic Approach on the Lake*

Although the presence of boats on the lake does affect otters in certain ways, from eliciting alarm behavior to shortening fishing sessions, overall, the management plan is being successfully implemented to reduce human impacts. Otters swim, fish, relax, and use campsites on the east side of the lake on a regular basis, even when boats are there. In the presence of boats, otters usually feel comfortable enough not to exhibit alarm behavior, but rather maintain a safe distance, usually on the opposite shore on the lake, and exhibit relatively relaxed behavior. Because the catamarans travel along the shores, they give the otters plenty of space to go around them. The catamarans' fixed route may also help the otters anticipate where the boats will go next, so they avoid certain areas (e.g. quadrat 5, where the port is), and spend more time in others (e.g. quadrat 3a, which the boats enter less often). Two catamarans do not appear to impact the otters any more than one catamaran does, as long as they travel together and do not make additional noise. Fishing, when restricted to eastern half of the lake, does not seem to prevent the otters from catching plenty of fish.

It remains important that tourists, guides, and rowers be sensitive to the needs of the otters. All should stay quiet and still in the boat. In addition, when the boats begin to move suddenly, it often scares the otters away, so boats should avoid abruptly changing directions, crossing the lake, or approaching the otters. They should maintain a distance of at least 250 m, about the width of the lake, and not approach any further, even if the otters are exhibiting relaxed fishing behavior.

In addition, while consistently following the same catamaran route is important in allowing the otters to anticipate the actions of the boat, it may be even more important to adjust this route when appropriate. If otters are fishing on the north shore of the lake, it may be better to return to the port along the south shore. On a few occasions when the otters were out fishing for an hour and the tourists were finished observing them, the boat headed straight back to the port without being as careful of the otters as it might have been had the otters just appeared. In conditions like these, it remains important for the boat to travel slowly and quietly and maintain an appropriate distance from the otters even when viewing the animals is no longer the focus of attention.

Unfortunately, not all the recommendations set out in the management plan are being followed. On the south shore, the lodge and trails are too close to the water, preventing the otters from using these lands for campsites and also possibly reducing their use of the water along this shore, as exhibited by the relatively low rates of use of quadrat 3b. The noise made by guests at the lodge can also disturb otters and should be minimized.

Perhaps even more problematic is that the canoe never follows the established boat route, but rather brings tourists deep into the northwest end of the lake, the area meant to be a refuge for the otters. Following otters to their den in this way puts stress on them, which past research has shown can negatively affect reproductive rates and the successful raising of young. Though it appears that otters and boats can successfully coexist in the same parts of the lake, otters retreat when approached by the boat. They need a refuge they can safely retreat to when feeling threatened. Following the otters back to their den can also reduce the chances of other tourists being able to see them.

As the impacts of boats on the lake are evaluated, monitoring efforts should continue, as these data are important to follow the health and behavior of the otters in Lake Tres Chimbadas. For the months of July and August, monitoring sheets at Posada Amazonas were only filled out for about half the days at the lake. The sheets for the other half of the days, however, were very accurate. Recorded times were usually within five or ten minutes of the actual times the boats and otters arrived and left, and the recorded number of otters seen was always within one of the number I counted. Maps were also very accurate. The behavior recordings were the ones that were most often incomplete, though usually similar to the behaviors I observed. Only once did I observe alarm behavior that was not noted on a data sheet.

These data sheets are essential and filling them out on a daily basis should be a priority. It is still important to monitor the otters because boats continue to affect otter behavior in measurable ways. In the presence of boats, otters use different parts of the lake, rest on logs for shorter periods of time, fish for significantly less time, and change fishing sites more often. These effects are ameliorated by the fact that boat use in the lake is, for the most part, confined to early morning. As a result, otters are more free to use the lake as they please during the majority of the day, catching additional fish then as necessary. Just as it is important to grant the otters a physical area that is free of boats, it is important to establish a period of time in the day when boats are absent from the whole of the lake.

Of course, eliminating boats on the lake altogether would reduce these impacts even further. Building an observation tower for tourists to use might be a good solution. This would allow tourists to see the otters in an even more natural setting, as the water would be empty of boats and the otters would ideally not notice any human presence at all. An observation tower at the bend of the lake, on either shore, would give tourists a good view of both ends of the lake. It would be important to build this tower slightly set back from the water and also to design trails leading away from the lake, rather than along it, so as not to disturb campsite areas. The otters currently spend the most time in their campsite on the north shore of the lake, so this area in particular should be carefully avoided. When using the tower, tourists would have to remain quiet and still even though they would be hidden from the water. Overall, otters would not be affected nearly as much by tourists in a tower as they are by boats moving through their territory, so this would be a very effective way of minimizing human impact.

*Limitations of the Study and Possible Future Research*

Any changes made in the approach to tourism on Lake Tres Chimbadas should be evaluated based on their impacts on the otters. Additional studies would provide a more complete picture of the full range of impacts caused by human use of the lake, including boats, trails, fishing, and the lodge. The primary limitation of this study was the relatively short time period over which it was conducted. I was only in Peru for two months, and while I was working with an assistant from the community, I was further limited by the days he could work. I was also unable to count rainy days in my analyses because the weather impacted otter behavior and visibility. Another limitation was my reliance on tourist boats for transportation to and from the lake. On certain days I had to return to the lodge with the tourists in the morning, so I could only observe otters for a couple of hours, if they appeared at all. Even on days I was not picked up until afternoon, I spent almost as much time getting to and from the lake as I did actually observing the otters. I left the lodge every morning at 5:30 and did not return until 3:30 in the afternoon. In this ten hour day, I was usually only at the lake in a position to observe otters for about six hours, from

7:00 a.m. to 1:00 p.m. If I had not needed to depend on boats for transportation, I would have been able to spend more time at the lake and collect more data.

My observational abilities were also limited by the lake's oxbow shape, which prevented me from being able to see some of the otters' territory. The otters spent a large proportion of their time outside my field of view, at the ends of the lake or on land. The lake's shape also made it difficult to see much of the otters' behavior since they were so far away much of the time. As a result, I could only use rough behavioral codes, grouping water behavior into only swimming or fishing, for instance. It was also very difficult for me to judge distances on the lake, as I could not put up physical markers for my quadrats, but rather had to use rough estimates based on natural markers.

Because this research is based on observations in the field, there were many variables I could not control. I tried to deal with this problem by not basing my quantitative analyses on data that was likely influenced by special conditions or circumstances like the weather. Although helpful for collecting data, carrying out the study only in the dry season, before the new cubs came out of the den with their parents, is a further limitation. A yearlong study would show a wider range of behaviors, as otters may well act differently around boats when they have young cubs to protect.

Finally, my own human presence may have had an additional impact on the otters. I know the otters did notice my presence on a few occasions, and they may have on other occasions as well. I tried to stay still, quiet, and hidden under the branches of the tree, but the canoe and I could both be seen from the water. When my presence elicited periscoping behaviors, I was careful to retreat from the water's edge until the otters continued on. Nevertheless, the time the otters spent in that general area in quadrat 3b may have been influenced by my presence as well as that of the catamaran and lodge. A more complete blind, raised from the water and well-camouflaged, would work better.

*Significance*

Despite its limitations, I hope this research contributes to a better understanding of both the complex behavioral patterns of giant otter and the impact of human activities on these behaviors. The great biodiversity of the Amazon rainforest is one of its essential features, and the endangered giant otter is a very important part of this complex ecosystem. A better understanding of these incredible creatures and how to reduce the threats they face is therefore essential to maintaining the overall health of their population and the rainforest as a whole.

Since ecotourism is an emerging industry, it is important to determine its ecological effects. As a sensitive yet visible species, the giant otter is a perfect candidate for determining effects ecotourism can have on the environment it aims to protect. I hope this research will contribute to an understanding of, and reduction in, the impact of human activity on otters. The ultimate goal would be a sensitive approach that allows tourists to experience the wonders of the rainforest while giving otters plenty of undisturbed space both in the water and on land. This type of approach would benefit both otters and tourists, who should come away from the experience with a better sense of the importance of conservation.

Conservation and the survival of endangered species have certainly grown more important to me personally through the time I spent in Peru. In addition, this research helped me explore my own interest in biology and gain valuable experience designing and carrying out a project in the field. Furthermore, it gave me the opportunity to contribute to a cause that I am really passionate about – the conservation of the rainforest and one of its most endangered species –

and fulfill one of my lifelong dreams of living in the Amazon. I believe it is important for people to see incredible rainforest species like the giant otter in order to understand the importance of their continued survival. I hope this research will contribute to the development of a means through which a healthy coexistence of humans and otters can continue well into the future.

## Acknowledgements

First and foremost, I thank Rainforest Expeditions for offering the Tambopata Summer Research Opportunity, for providing everything I needed in Peru, including room, board, transportation, and other support, and for introducing me to the people and rainforest that made this experience a highlight of my life. I also thank all the individuals at Stanford and in Peru who helped me with my project along every step of the way, especially Professor Bill Durham for providing so much support for this program; Constanza Ocampo-Raeder for her invaluable wisdom and guidance as I prepared my project; Oscar Mishaja for his assistance at the lake and for sharing his incredible knowledge of wildlife in the Amazon; and Raphael Notin and the Frankfurt Zoological Society for teaching me so much about giant otters in Peru and for giving me suggestions on my project proposal. Last but certainly not least, I thank the Wyn Family for the Undergraduate Research Opportunity funding that made my research in Peru possible.

## Bibliography


Otters

Dauphine, David. 2001. *The Giant River Otter: Ecotourism, Biodiversity, and Wildlife Ecology in the Amazon Rainforest*.

Frankfurt Zoological Society. 2003. *The Peruvian Giant Otter Research and Conservation Project*. <http://www.giantotters.com/>.

Groenendijk, Jessica, Frank Hajek, Christof Schnek, Elke Staib. 2001. "Moritoreo del Lobo de Río (*Pteronura brasiliensis*) en la Reserva de Biosfera del Manu: Metodologías y Resultados."

Hajek, Frank, and Jessica Groenendijk. 2001. "Manejo del Turismo de Naturaleza en Hábitat del Lobo de Río (*Pteronura brasiliensis*) en el Sureste del Perú."

Hajek, Frank, Jessica Groenendijk, and Raphael Notin. 2003. *Manejo y Monitoreo del Turismo en Hábitat del Lobo de Río (*Pteronura brasiliensis*): el Caso de Cocha Tres Chimbadas*.

Hershkovitz, Philip. 1969. "The Recent Mammals of the Neotropical Region: A Zoogeographic and Ecological Review." *The Quarterly Review of Biology*, Vol. 44, No. 1.

Kruuk, Hans. 1995. *Wild Otters: Predation and Population*. Oxford: Oxford University Press.

Mason, C.F. and S.M. Macdonald. 1986. *Otters: ecology and conservation*. Cambridge: Cambridge University Press.

Ecology and Conservation

Bookbinder, Marnie, Eric Dinerstein, Arun Rijal, Hank Cauley, and Arup Rajouria. 1998. "Ecotourism's Support of Biodiversity Conservation." *Conservation Biology*, Vol. 12, No. 6.

Bruenig, Eberhard F. 1996. *Conservation and Management of Tropical Rainforests: An integrated approach to sustainability*. Wallingford, UK: CAB International.

Giannecchini, Joan. 1993. "Ecotourism: New Partners, New Relationships." Conservation Biology, Vol. 7, No. 2.

Hartshorn, Gary S. 1995. "Ecological Basis for Sustainable Development in Tropical Forests." *Annual Review of Ecology and Systematics*, Vol. 26.

Moss, Brian. 1998. *Ecology of Freshwaters: Man and Medium, Past to Future*, 3rd ed. London: Blackwell Sciences Ltd.

Myers, Norman. 1996. "Environmental Services of Biodiversity." *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 93, No. 7.

Redford, Kent and Brian Richter. 1999. "Conservation of Biodiversity in a World of Use." *Conservation Biology*, Vol. 13, No. 6.

Whitmore, T.C. 1998. *An Introduction to Tropical Rain Forests*, 2nd ed. New York: Oxford University Press.

Research Techniques

Krebs, Charles J. 1999. *Ecological Methodology*, 2nd ed. Menlo Park, CA: Benjamin Cummings.

Sutherland, William J. 1996. *Ecological Census Techniques: A Handbook*. Cambridge: Cambridge University Press.