Neotropical river otter *(Lontra longicaudis)* in Costa Rica

Influence of available food resource on the choice of foraging spots

Author:
Marjolein Smolders

Supervisor Reserva Playa Tortuga:
Oscar Brenes
Supervisor HAS Den Bosch:
Karin van Dueren den Hollander

has university of applied sciences

2012

Neotropical river otter *(Lontra longicaudis)* in Costa Rica

Influence of available food resource on the choice of foraging spots

Research rapport commissioned by Reserva Playa Tortuga (RPT)

11-02-2013, Ojochal (Puntarenas, Costa Rica), Reserva Playa Tortuga

Supervisor RPT: ***Oscar Brenes***

Supervisor HAS Den Bosch: ***Karin van Dueren den Hollander***

HAS University

Applied biology

Marjolein Smolders

Preface

My name is Marjolein Smolders. I am a third year Applied Biology student at HAS University of Applied Sciences. During this year of my study I went to Costa Rica to do an internship research project at Reserva Playa Tortuga (RPT), Ojochal, Puntarenas. I had a wonderful time in Costa Rica and loved to work on this research project. This amazing experience would not have been able without the following people:
The person I am most thankful for all the time he spent on supervising me and helping me out wherever necessary is biologist Oscar Brenes. Thank you very much Oscar, I learned a lot from you. I would also like to thank Melissa Jimenez for her help and guidance especially during the first couple weeks of fieldwork. Thank you Alexia Maizel For giving me the chance to come to RPT at all and driving us around when we needed to go somewhere. Thank you Karin van Dueren den Hollander for supervising me from the Netherlands and thinking along when necessary. Last but not least I am also very grateful for Angela Chevez, Jorge and all the volunteers at RPT who have helped me collecting samples and taking measurements during the fieldwork. Thank you guys.

Table of contents

Summary

Lontra longicaudis (neotropical river otter) is with a distribution across all of Central America and most of South America the otter species with the widest distribution in this area but despite their range *Lontra longicaudis* is listed as an endangered species on the red list of the International Union for the Conservation of Nature (IUCN). This unfortunate status is meanly caused by human activities like deforestation, contamination and pollution of aquatic systems, agricultural activities, mining and damming, hunting and accidental capturing of otters during fishing activities. Between 1950 and 1970 *L. longicaudis* was loved for its fur which resulted in excessive hunting and local extinction of this otter species. By now the hunting is illegal and *Lontra longicaudis* is protected in most of the distribution area. However, the population is still declining

The aim of this study is to research if the neotropical river otter prefers using some spots in a river above other spots in the same river. The main focus during this study is to describe the available food resource (amount and species) at each of twelve sampling spots spread along the river. This was done through fishing at those spots and comparing the caught fish species with fish species found in otter feces. Those last ones are identified by comparing fish scales found in the feces with fish scales in a homemade database. Not only the fish, but also other characteristics (oxygen, water temperature, width and depth of the river, current, coverage with rocks and vegetation) of the spots were taken into account. This data has been compared with the fish diversity at each of the samplingspots to determine what characteristic would be the most important. The characteristics of the spots where evidence of otter presence (tracks, feces, sightings, photo's on "camera traps") was found where compared with each other to determine if they had similarities and which ones would be most important for the otter.

Based on the results of this study can be concluded that of the different river characteristics measured during this study depth of the river is most important for fish diversity, in that way that the deeper the river is, the more fishspecies can be found. This is positive for *L. longicaudis* because more than 2/3 of its diet consists of fish. Gobiidae…was found most in the otter feces and caught second most at the samplingspots. Which makes Gobiidae…. highly probable the favorite food of the otter. However only the presence of this fish species will not be enough for *Lontra longicaudis*. This otter strongly prefers a homerange in a natural environment with lots of vegetation on the river banks. It is not often seen in a human residential environment or close to plantations

1. Introduction

Lontra longicaudis (neotropical river otter) is with a distribution (as shown in figure 1) across all of Central America and most of South America the otter species with the widest distribution in this area (Larivière, 1999).

Figure 1: The yellow plane shows that *L. Longicaudis* is currently only present in Central America and most part of South America: from IUCN (2012).

Despite their range *Lontra longicaudis* is listed as an endangered species on the red list of the International Union for the Conservation of Nature (IUCN). Most important human threads include deforestation, contamination and pollution of aquatic systems, agricultural activities, mining and damming, hunting and accidental capturing of otters during fishing activities (IUCN, 2012). Not only humans are threatening the survival of *L. longicaudis*, also some natural preditors kill an otter now and then. They get preyed on by anaconda's, caimans, jaguars, dogs and birds. Between 1950 and 1970 *L. longicaudis* was loved for its fur which resulted in excessive hunting and local extinction of this otter species (IUCN, 2012; Larivière, 1999; Reid, 2009; Wainwright, 2007). The neotropical river otter is now protected in Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad, Tobago, Uruguay and Venezuela , but the population is still declining (IUCN, 2012). This decline might be contributed by the behavior and habitat choice of *L. longicaudis*. They are not afraid of humans and can adapt to changes in the environment. However, most otters of this species are seen in environments with low human density, low chemical- and organic pollution. Also an extensive aquatic network is important (Larivière, 1999) to mark territories which can range from 7 km until 80 km along a river or stream (Wainwright, 2007). *L. longicaudis* has different places to live, swim, hunt, shelter and raise their offspring, but has a broad preference about how to arrange these spots within their territory (Cho, Choi, Lee, & Park, 2009).
Otters prefer to mark their territory in a river which is in natural condition, just as the banks will have to be. Their favorite places are narrow, not more than five meters deep and covered with stones and vegetation on the bottom and on the bank of the river (Cho, et al, 2009). Stones and vegetation are used to find food underneath or in-between it (Wainwright, 2007), but they can also be used as

shelter- and refuge spots (Cho, et al, 2009). It is important that the water is clear because the main sense of *L. longicaudis* is its eyesight. At most places the water needs to be flowing fast (Larivière, 1999), but a (natural) weir is preferred at foraging spots in order to reduce the drift of water and prey (Cho, et al, 2009).
L. longicaudis are opportunistic feeders and feed most often on medium sized slow swimming fish like Cichlidae, Characidae, Synbranchidae, Loricariidae and Erythrinidae (Gori, Carpaneto, & Ottino, 2003). Also crustaceans form a significant part of the otter's diet and on some occasions an otter feeds on mollusks, birds, reptiles and small mammals (Gori, et al, 2003; IUCN, 2012; Larivière, 1999; Reid, 2009; Wainwright, 2007). Each otter has to eat almost 15% to 20% of their bodyweight a day. Foraging and feeding may occur throughout the day, however most time is spent on this activity in the (late) afternoon (Larivière, 1999). Though the neotopical river otter is a diurnal species, it might become (completely) nocturnal when hunted or disturbed by humans
The fish and crustaceans the otters eat are not only used for the nutrients they provide, but also for communication in the form of spraints (scent-marking with feces). Spraints are used to mark the territory and the scent let males know when a female is in heat (Larivière, 1999; Wainwright, 2007). Otters prefer solid, high and dry spots close to "deep" water to put their spraints on. Large flat rocks, logs, root systems and planks are examples of spots like these. If these are not available the otter may chose places which flood regularly or it uses a sandbank where it puts its feces in a hole up to 20 cm deep (Larivière, 1999). Another way for *L. longicaudis* to communicate with other individuals is through purring, whistling, screeching and chuckling at each other. When the otter feels threatened it might make grunting and hissing sounds (Wainwright, 2007) to warn its family members but most otters live solitary and are usually silent (Reid, 2009). However, a solitary male and female may form a breeding couple for one day.

In order to stop the population from declining any further and becoming extinct eventually there are two important aspects. The (by now illegal) hunting and the destruction of the otters habitat has to stop and it is important to gain and use knowledge of the habitat and diet of *L. longicaudis*. This study focuses on the second of those aspects. The aim is to research if the neotropical river otter prefers using some spots in a river above other spots in the same river. The main focus during this study is to describe the available food resource (amount and species) at each of twelve sampling spots spread along the river. This was done through fishing at those spots and comparing the caught fish species with fish species found in otter feces. Those last ones are identified by comparing fish scales found in the feces with fish scales in a homemade database. Not only the fish, but also other characteristics (oxygen, water temperature, wide and depth of the river, current, coverage with rocks and vegetation) of the spots were taken into account. The resultsgain from this study may play a significant role by determining the appropriate kind of river management in order to gain and/or preserve *L. longicaudis* in certain (parts of) lotic systems.

2. Materials and Methods

2.1 Study area

Fieldwork has been done from September 2012 until December 2012 in the lower part of the Balso River (Puntarenas, Costa Rica). The study area is 7 km long, starts at an altitude of 158 meters, near a waterfall and ends where the river flows into the ocean. This part of the river has been chosen as study area because *L. longicaudis* has been spotted in this area. Despite the fact that this part of the river would be equal to only the minimum size of the otters home range, it was not possible to extent the study area. The reason is that the part of the river which is upstream from the waterfall is really difficult to reach and walk through due to big rocks, fallen trees, many smaller waterfalls and the lack of a path close to the river. Balso river is from natural origin but undergoes changes by as well nature as men. The lowest part of the river (the last 200 meters before it enters the ocean) experiences a lot of changes due to natural causing's. Because of the changing tides and the huge amounts of water during and after rainfall, this last part of the river can change its course within some days till weeks. Further upstream it are mostly people who influence the river by building dams, changing the river course, or polluting the river. Most of the riverside is forest but at some places there are roads or residence at only dozens of meters away from the river. Those manmade constructions may influence the presence of the otter and possibly also of the fishes and crustacean species which the *Lontra longicaudis* consumes. Figure 2 shows what structures are present along the whole riverside (this figure presents data from before the start of this study).

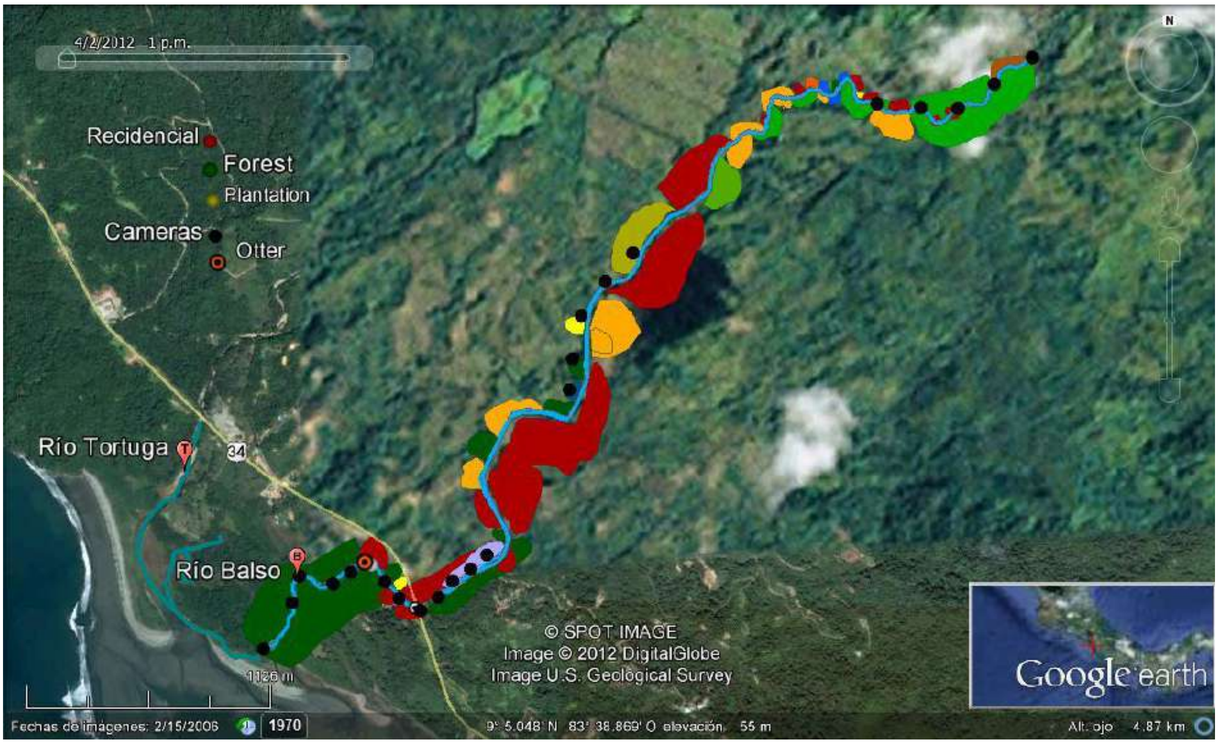


Figure 2: The Balso river and its surroundings. Red displays the residential areas, green is the forest, and yellow and orange are plantations. According to the figure, most forest is found at the top and at the bottom of the river, while a residence and plantations are mostly at the middle part of the river: from (Brenes, O., & Jimenez, M. K. (2012). Nutrias Oscar. *Otter proyect*) .

2.2 Sampling

2.3.1 Determining sampling spots

Lontra longicaudis prefers foraging at spots in the river with slowly to non flowing water (Cho, et al, 2009). In order to get a representative overview of what fish- and crustacean species are available for the otter during foraging, the sampling took place at spots like these (mostly pools/ponds in the river). These spots were determined within the first two weeks of fieldwork by walking through the river and marking every possible “otter hunting ground” with Global Positioning System (GPS) Garmin GPSmap 62sc. The data collected data was transposed to the computer program Garmin BaseCamp (Garmin LTD. or its subsidiaries, 2008-2012), which was used to refine the tracks and waypoints so a clear map could be made. This Basecamp file has been exported to Google Earth (Google-Software, 2012) in order to get a clear view of the river and its surroundings. The result is shown in figure...

As shown in figure... twelve samplingspots were chosen to collect fish samples and information about river characteristics. The number of twelve is chosen because not all marked pools could be sampled within the available time. By choosing twelve evenly spread samplingspots it was able to cover the whole study area with not more than a couple of hundred meters in between most consecutive spots. The only exception is the 1,5 kilometer long part between samplingspots 6 and 7 which arose because spot 7 looked to be more appropriate for this study compared to the other pools between samplingspots 6 and 8. The most important characteristic when determining if a pool would be used as one of the samplingspots was the availability of evidence of otter presence (feces, tracks, sightings, pictures). Samplingspots 1, 2 and 3 were chosen for this reason. The other spots were chosen because they resembled the best characteristics for otter foraging area (solid ground, many water plants, structured vegetation (Gori, et al, 2003), shallow, narrow areas of streams, banks covered with trees and bushes, reduced drift of water and fishes, natural type of riverbank (Cho, et al, 2009)).

2.3.2 Sampling times

At each sampling day two of the sampling spots were sampled. Together those spots form a couple which means they were always sampled at the same day and around the same time as each other. Sampling two spots at exactly the same time is not possible so that is why the spot sampled at first at one week, was sampled second at the next sampling day.
Each couple has been sampled twice within two weeks, both one time in the morning (starting at 7.00) and both one time in the afternoon (starting at 15.30) to compare if there is a difference in pray- species and numbers caught during these times of the day. If the weather and the availability of volunteers allowed it, the morning and afternoon sample of a spot were taken at the same day. Normaly fieldwork was done only three days a week to minimize the impact of human presence and possible disturbance in the home range of *Lontra longicaudis*. However, during some weeks when it was necessary, one or more extra days of fieldwork were added to the schedule.

2.3.3 Sampling technique

At each sampling spot fish samples were taken by fishing with a fishing line for half an hour. The bait used for fishing consisted of earthworms which were dug up from the ground not more than 12 hours before they were put on the hook (which had a size of...cm). Originally one sample from each caught fish species would be taken to the laboratory to take pictures of its scales so a fishscale data base could be created (.....Fishscale database). This database was used when fish scales were found in otter feces to determine which species it could have been. Scales of five different fishspecies were succesfull collected. The database plates made of scales are presented in attachment...
If not known, the name of the fish was determined to family level (or genus and species level when possible) by using the book: Peces de las aguas continentales de Costa Rica; Freshwater fishes of

Costa Rica (Bussing, 2002). When a fish was caught which was in the database already, the species and length were noted after which the fish was released at the spot where it was caught.

2.3.4 Sampling circumstances

The circumstances at which the fish were caught were noted in the form as shown in attachment …. The GPS was used to determine the current position (coordinates) and altitude. Width of the river was measured with a measure tape if possible or when not possible, an estimation of the width was made. Determination of the depth happened almost the same as with the width of the river, only now a long straight stick was used to put upright on the bottom of the river. When pulling the stick up again, the wet part was measured to determine the depth. This has been done at the right, middle and left side of the pool. Also the deepest part of the samplingspot was measured and noted. To measure the current, a measure tape, a stopwatch and a small floating object were used. Two persons each held one side of the measure tape, holding it strained while one stood upstream (making sure he/she would not block the current) and one stood downstream in the river. The person upstream let the floating object go at the beginning of the measure tape and started the stopwatch at the same time. Downstream the object was caught at the end of the tape and the time was stopped. This measurement has been done three times, from which the mean was taken to calculate the speed in meters per second. Oxigen and water temperature were measured by using the YSI 85 oxygen conductivity salinity temperature multi parameter. Percentages of stone, water plant and vegetation are determined by estimating how many percent of the river bottom or ground was covered by each of them.

2.4 Fish scale database

Fish brought back from the river were put in a container with ethanol to conserve the fish. Within 48 hours after capture the scale samples were taken by pulling scales out with tweezers. The appearance of scales varies dependent of the place on the body. For this reason three scales were taken from different places. One scale was taken from the side of the body, about 1/3 of the body length from the anterior and halfway dorsal and ventral. The second one was taken from the back, halfway anterior and posterior and the third one is from just in front of the tail halfway dorsal and ventral. When a scale was pulled, it was taken through blue acrylic paint which was diluted with water to make the structure of the scale better visible. Now the binocular microscope is used to take a couple of pictures of the scale. The scales dry within a couple of minutes which causes that they bend and influence the visibility of the shape and structure. To prevent this it was important to work quickly from the moment the scale was pulled, until the pictures were taken. Beside the pictures of the three different scales, pictures of the side of the fish were taken with a normal camera. To clarify the size of the fish this pictures were made with a measure tape underneath the animal to show its length. In case another side of the fish appears to be important for its identification (for instance the side of Gobiidae…) there were also pictures taken of this side. The pictures of the three scales and the picture of the fish itself were combined in a plate of that fish. These plates are displayed in attachment…..

2.2 Locating otters

Locating *Lontra longicaudis* to find out if it was using a certain spot happened with three different techniques. There are different ways which will be used to find out if *Lontra longicaudis* uses the concerned spot. The easiest one was looking for otter tracks along the riverside or looking for otter feces on flat rocks in the river. The whole river was searched bit by bit so it would be completed once in the two weeks. Pictures were taken of feces and tracks (with a measure tape to determine the size) when found. In case of feces, half of it was put in a bag examine the contents in the laboratory. The other half was left behind because of its function as scent-mark for *L. longicaudis*. The tracks of the front and hind paw have different shapes, like figure 3 shows and the spraints can be recognized on the granular structure with many fish bones and –scales in it.

Figure 3: front and hind footprints of the neotropical river otter: from (Wainwright, M. (2007). Neotropical River Otter: Lutra longicaudis. In M. Wainwright, *The Mammals of Costa Rica: a natural history and field guide* (pp. 318-322). China: A Zona Tropical Publication)

For the third method two water tight cameras (Bushnell Color Viewer) (so called “camera traps”) were placed at the riverside of sampling spots, facing the place of interest as best as possible. The possibilities to place the cameras depended on the presence of trees, which could be used to place the cameras in. The “traps” were set up so they would take three pictures every time movement was noticed. Besides that the trap was set to take three pictures every five minutes to keep track on things happening in the environment

2.5 Analyzing the results

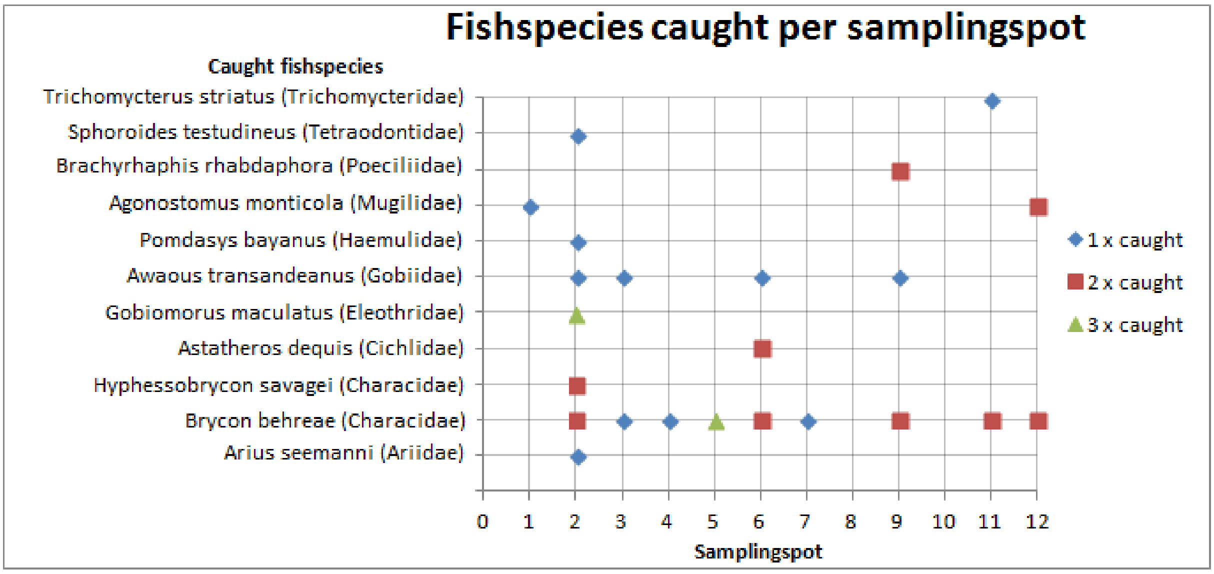
After all the data had been collected the river characteristics were compared with the fish diversity and the number of caught fish at each samplingspot. A diversity alpha-beta-gamma analysis of the computer program Species diversity (Pisces Conservation Ltd., 2009) was used to determine how many percent of the diversity or the number of caught fish was determined by that specific river characteristic. The program Species diversity has also been used to make a Shannon-Wiener plot to display how high the diversity of each spot was compared with those of the other samplingspots. A linear regression analysis of SPSS (,,,,) has been used to check if correlations found between one of the characteristics and the fish diversity or number of caught fish are significant. A logistic regression analysis with the same computer program was used to look for a correlation between one of the characteristics and the the spots at which evidence of otter presence was found.

3. Results

This chapter displays the most important results gain from analyzing caught fish, river characteristics and otter feces. Tables and figures will be discussed shortly just as the corresponding statistics. All the data of river characteristics displayed in this chapter is the mean from several measurements. Attachment... contains the full data gaddered during the research.

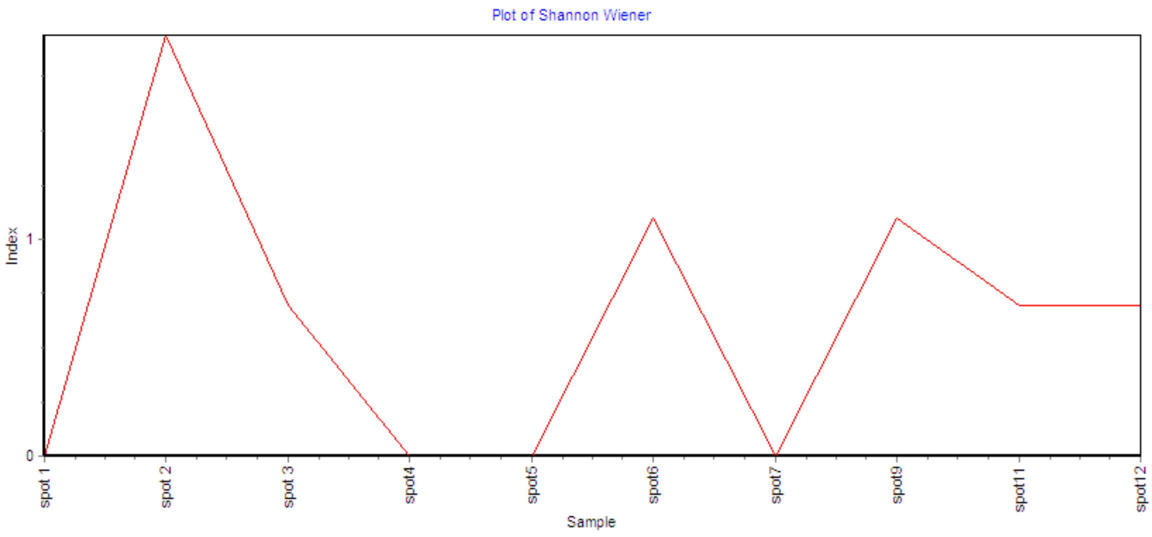
3.1 Sampling result

Figure...is a scattering plot which shows the amount of each fish species caught at each of the sampling spots.



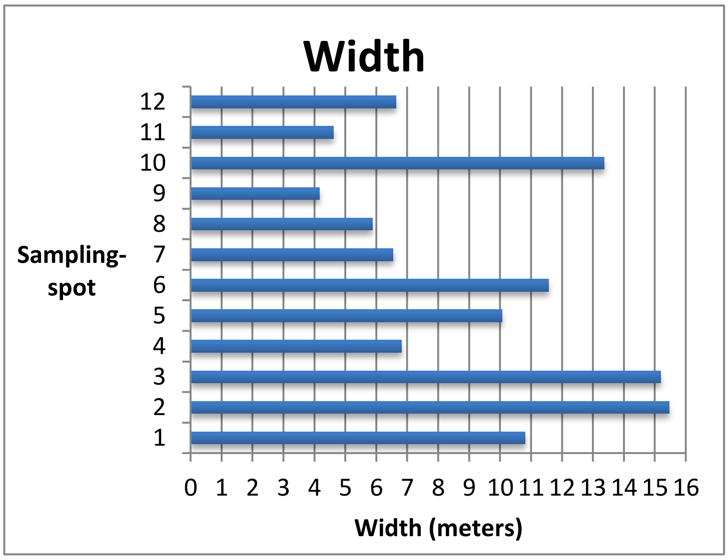
As is visible in figure..., samplingspot 2 had, with eleven fish caught, the highest catch-rate followed by spots 6 and 9 which each had a catch-rate of five fish. This in contrast to samplingspots 8 and 10 where none fish were caught. Figure..., also shows that the most caught fish species is Brycon behreae (Characidae) (sixteen times). Awaous transandeanus (Gobiidae) is with four times caught the second best caught fishspecies. Arius seemanni (Ariidae), Pomdasys bayanus (Haemulidae), Sphoroides testudineus (Tetraodontidae) and Trichomycterus striatus (Trichomycteridae) share the “last place” with a catch-rate of one fish of each of these species.

The Shannon Wiener plot (figure...), which gives a clue about the fishdiversity at each of the samplingspots, shows most diversity at samplingspot 2 (H = 1,946). The “second place” is shared by spot 6 (H = 1,099) and spot 9 (H = 1,099) and samplingspots 1, 4, 5 and 7 all have a H of zero. Remarkable is that samplingspots 8 and 10 are not even shown in the graph. The precise values of H and Variance H can be found in the table in attachment....

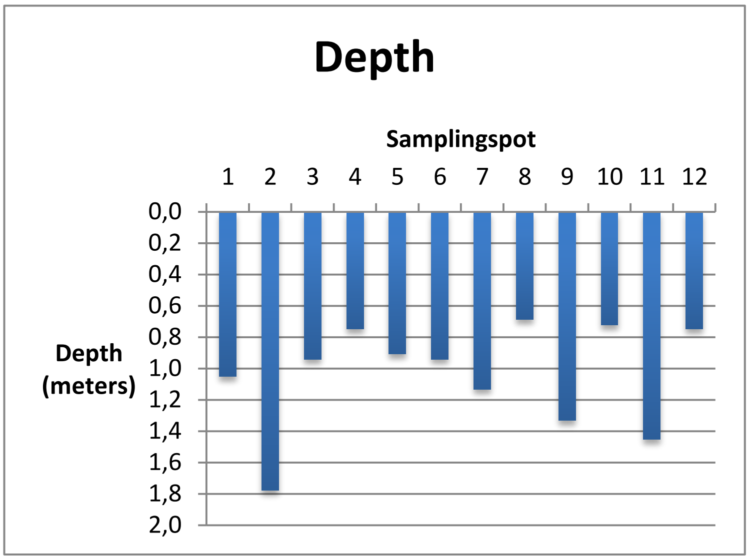


3.2 Sampling circumstances

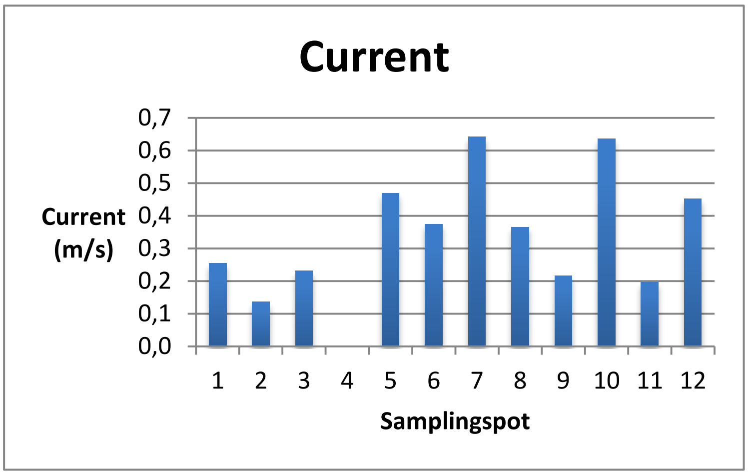
The most important characteristics and circumstances while sampling at each of the spots are displayed in the graphs and tables below. Figure... displays a graph of the width of the river. The top three widest spots are, in order from widest to narrower: samplingspot 2 (15,45 meter), samplingspot 3 (15,19 meter), samplingspot 10 (13,36 meter). On the opposite side there are the narrowest spots: samplingspot 9 (4,17 meter), samplingspot 11 (4, 61 meter) and samplingspot 8 (5,87 meter)



Samplingspot 2 is with 1,78 meter the deepest of the twelve spots, according to the graph in figure....It is followed by spot 11 with 1,46 meters and spot 9 with 1,33 meter. The sallowest spot is 8 with a depth of 0,69 meter. After samplingspot 8, spot 10 is the least deep (0,73 meter). The last two spots in the top three of sallowest spots are samplingspots 4 and 12 which both have a depth of 0,75 meter



The current (see figure...) is highest in both samplingspot 7 and 10 with a moving speed of 0,64 meter per second. Spot 5 is the place where the second highest current was found (0,47 meter per second) samplingspot 12 (0,45 meter per second) just behind it.
The top three spots where the water flow is the slowest are spot 2 (0,14 meter per second), spot 11 (0,20 meter per second) and spot 9 (0,22 meter per second). Remarkable is that spot 4 does not show any current at all.



A phenomenon which can be seen in figure.... is that half of the samplingspots (5, 6, 8, 9, 10, 12) show an oxygen level between 7,3 milligram per liter (mg/l) and 7,5 mg/l. Only spots 7 and 11 have with respectively 8,2 mg/l and 7,7 mg/l a higher oxygen level. The first four samplingspots stay with oxygen levels of 6,6 mg/l (spot 1), 7,0 mg/l (spot 2), 6,8 mg/l (spot 3) and 6,5 mg/l (spot 4) below the 7,3 mg/l

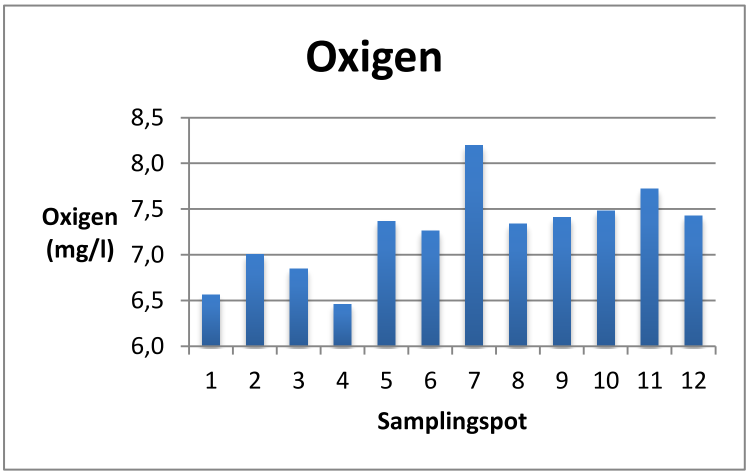
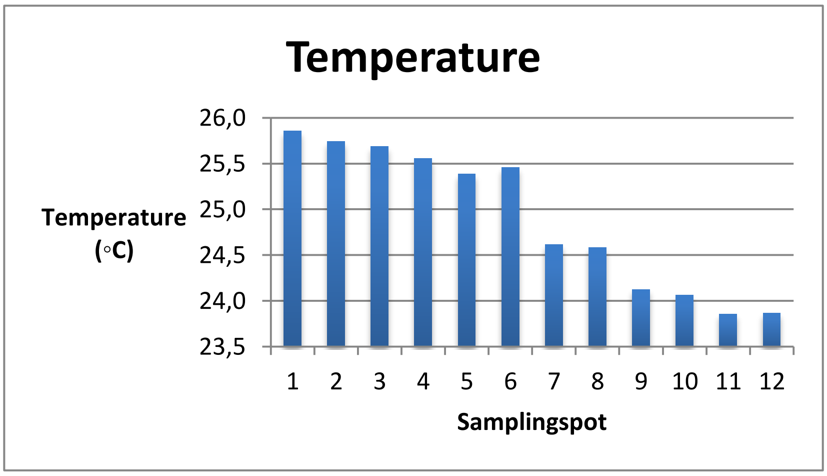
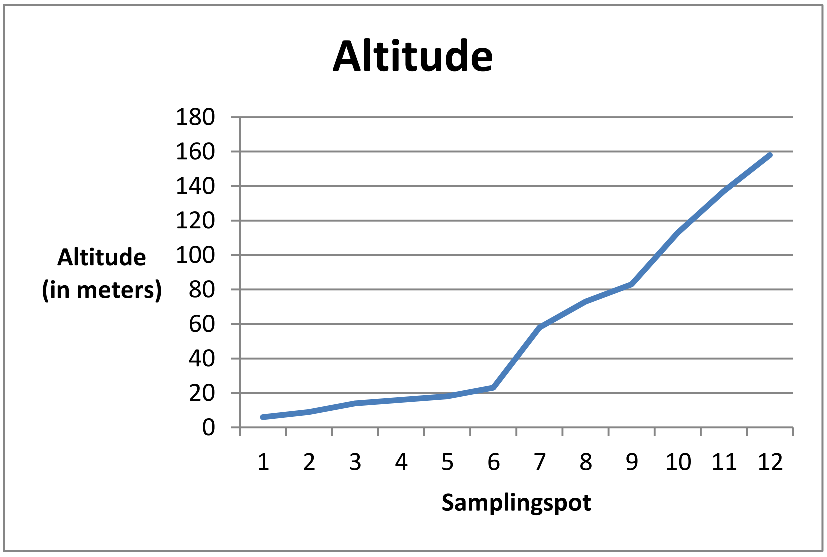


Figure... gives a view about the average water temperature at each of the samplingspots. Spot 1 has the highest temperature which is 25,86˚C. From there the temperature seems to go down steadily as the number of samplingspots get higher until 23,87˚C is reached at spot 12.
Three spots which make the decline of temperature a little less steady are spots 5, 6 and 7. At spot 6 the temperature lies a little above the one of samplingspot 5. There is also a temperature difference of 0,84˚C between samplingspot 6 (25,46˚C) and samplingspot 7 (24,62 ˚C). Most other difference between two consecutive spots however are not bigger than 0,21 ˚C (one exception: between spot 8 (24,58˚C) and spot 9 (24,13˚C) is a temperature difference of 0,45 ˚C).



The altitude at which each spot lays is presented in figure.... This graph shows that the first six sampling spots can all be found between the heights of six meter and 23 meter. A bigger difference (35 meter) in altitude can be noticed between spots 6 (23 meter) and 7 (58 meter). From spot 7 to spot 9 (83 meter) the change in altitude is with a difference of 25 meter a little more gradually but from samplingspot 9 there is a bigger increase in altitude again until spot 12 at 158 meter is reached. This means an increase of 75 meter in-between spot 9 and 12.



How many percent of the river bottom is covered with big stones/rocks or with waterplants? This is what figure .... shows. At spots 8, 10 and 12 80% of the riverbottom is covered with stones. Samplingspot 4 comes next with 75% of the bottom covered with stones, followed by 60% stone coverage at spot 7. The first three spots don't have any stones at all but after those the three lowest percentages are found at spots 6 and 9 (both 10% covered with stones), spot 11 (15% covered with stones) and spot 5 where 30% of the bottom was covered with stones. Water plants however were not found at any of the samplingspots.

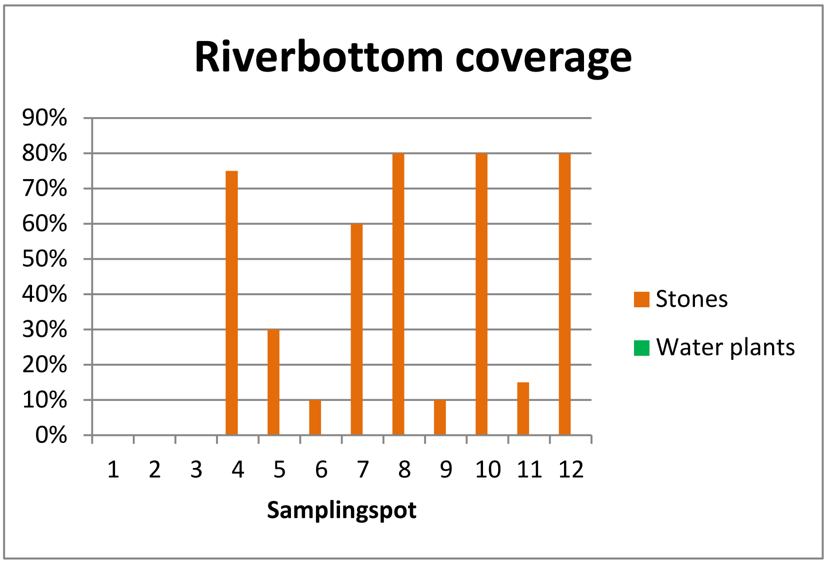
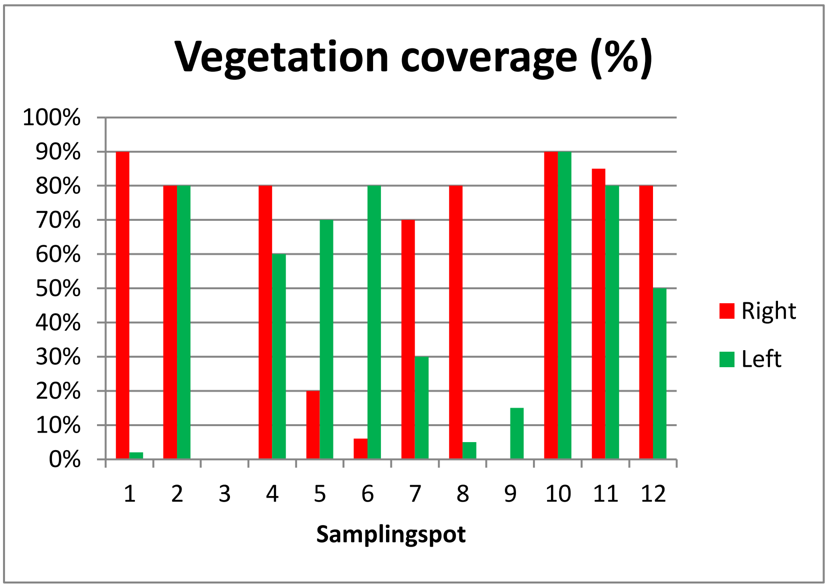


Figure... tells something about how well the right and the left side of the riverbank were covered with vegetation. On some of the spots the riverbanks at both sides were about evenly covered but in other cases there was quite a difference between the amount of coverage of the right side compared with the amount of coverage on the left side of the river. Looking at the total of both sides at each samplingspot there can be seen that spot 10 is covered most with 90% at both sides. The next "in line" is spot 11 with 85% coverage on the right, and 80% on the left side. Last one of the top three is samplingspot 2 with 80% vegetation coverage at both river banks. Two



remarkable results on this characteristic are gain at spots 3 and 9. With a total coverage of respectively 0% and 15% these spots are 85% and 70% under the third lowest spot in line of this vegetation coverage. This is samplingspot 6 with 5% vegetation coverage on the right side and 80% of it on the left side.

Of what kind of material the river bottom is composed is shown in table... The bottom of the first six spots contains only gravel, except for spot 2 were the river bottom is a mixture of gravel and sand. At the six spots upstream on the other hand the bottom is composed of both gravel and sand, with the exception of spot 10 which has a fully gravel bottom.

Riverbottom material		
	Sand	**Gravel**
1		x
2	x	x
3		x
4		x
5		x
6		x
7	x	x
8	x	x
9	x	x
10		x
11	x	x
12	x	x

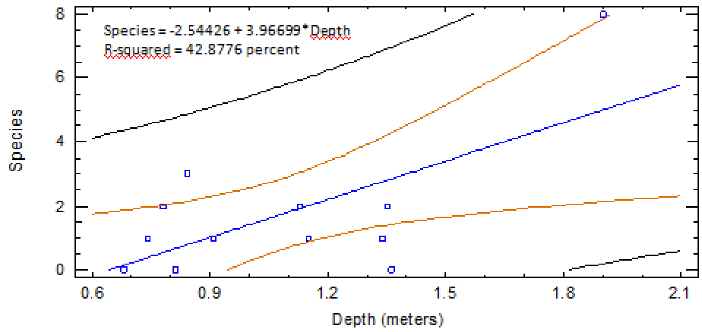
Table....displays if the river at each spot had a natural condition or the current was slowed down by a (natural or artificial) weir or if there had been human intervention by straitening the river (canalization). As the table shows, all spots but one where in natural condition except for spot three which appeared to be canalized.

River condition			
	Canalized	**Weir**	**Natural**
1			x
2			x
3	x		
4			x
5			x
6			x
7			x
8			x
9			x
10			x
11			x
12			x

The bank type of a river can be adapted or made by humans (artificial) or can be formed by natural causing's. As table...shows, most of the Balso river has a natural bank type but both banks of samplingspot 3 are artificial.

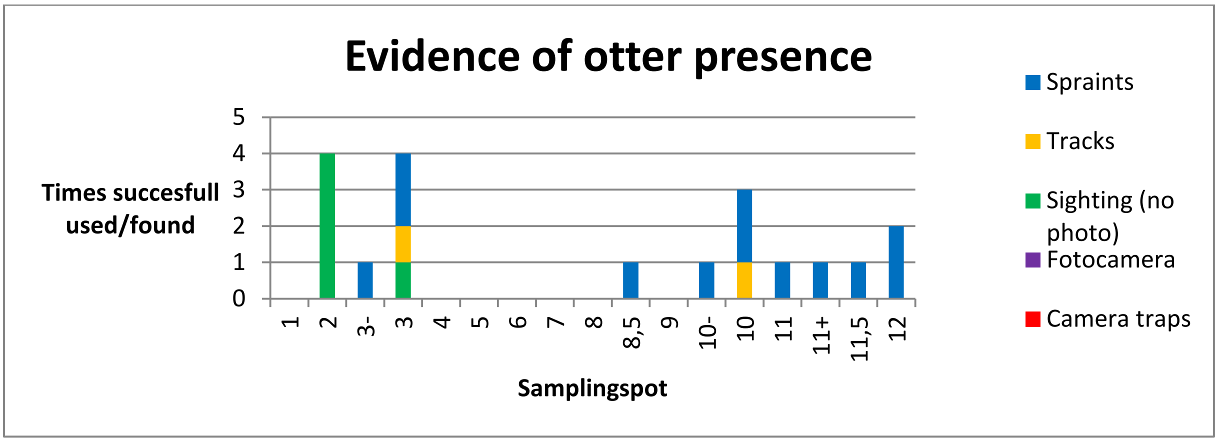
Bank type		
	Artificial	**Natural**
1		x
2		x
3	x	
4		x
5		x
6		x
7		x
8		x
9		x
10		x
11		x
12		x

Figure..... shows the graph presenting the correlation between the species diversity and the depth of the river. About 43% of the diversity can be explained by the depth. With p = 0,39 the correlation is significant.



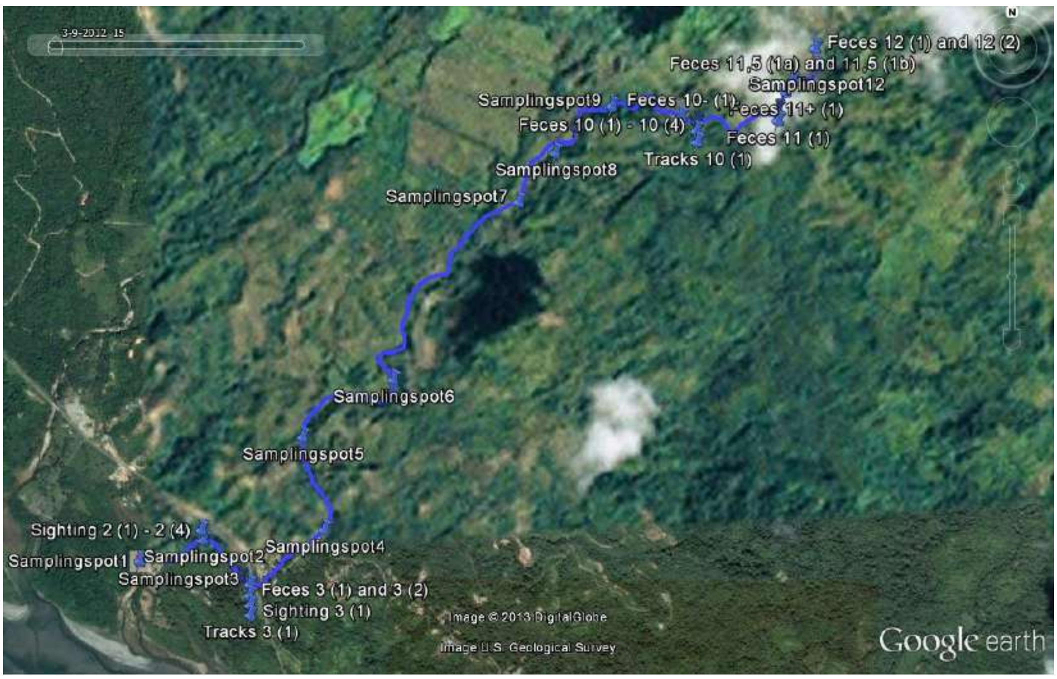
3.3 Evidence of otter presence

Figure... shows at what spots along the river evidence is found that the otter has been there. What is also visible in the graph is the amount of times that each type of evidence has been found during this study, at each of the samplingspots. However, evidence is not only found at the samplingspots but also about 50 meter downstream from spot 3 (3-), 100 meter downstream from spot 10 (10-), 50 meter upstream from spot 11 (11+) and about halfway spot 11 and 12 (11,5). Most evidence is found at spots 2 and 3, which are also the only places where the otter has actually been seen. At samplingspot 3 are except sightings, tracks and feces found. Feces is the most found evidence and at most spots (3-; 8,5; 10-; 11; 11+; 11,5; 12) also the only type of evidence found. Samplingspot 10 however also contained otter tracks. Remarkable is that, except for the one time feces at 8,5, all the evidence was found or in the upstream or in the downstream part of the river, but not in the middle.



3.4 feces and fish scale analysis

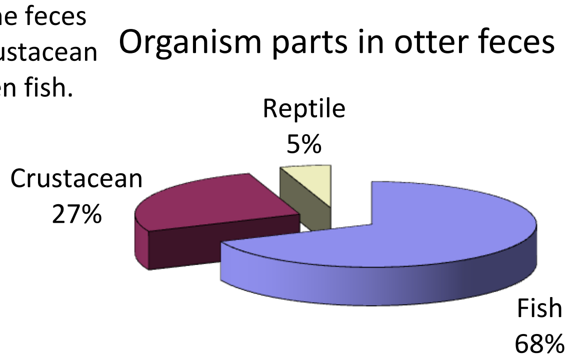
Figure.... displays where in the river feces has been found.



After drying the otter feces and searching it for animal part the results shown in table... were found.

Feces							
Sample	Fish	Crustacean	Mammal	Bird	Reptile	Other	Unknown
3- (1)	60%	40%	-	-	-	-	-
3 (1)	50%	50%	-	-	-	-	-
3 (2)	91%	9%	-	-	-	-	-
8,5 (1a)	-	100%	-	-	-	-	-
8,5 (1b)	-	-	-	-	-	-	100%
10- (1)	95%	5%	-	-	-	-	-
10 (1)	100%	-	-	-	-	-	-
10 (2)	97%	3%	-	-	-	-	-
10 (3)	100%	-	-	-	-	-	-
10 (4)	-	25%	-	-	75%	-	-
11 (1)	100%	-	-	-	-	-	-
11+ (1)	100%	-	-	-	-	-	-
11,5 (1a)	33%	67%	-	-	-	-	-
11,5 (1b)	-	100%	-	-	-	-	-
11,5 (2)	100%	-	-	-	-	-	-
12 (1)	100%	-	-	-	-	-	-

Studying table... it appears to be that most parts in the feces had been fish ones, reptiles were found least and crustacean parts were found more than reptile parts but less then fish. Figure... confirms this presumption.
The figure shows how many percentage of the total volume of feces is fish, crustacean and reptile. With 68% of the total volume fish was most common in the otter feces. 27% of the total feces volume consisted of crustacean parts. Reptiles represented 5% of the total volume



From the twelve samples which had fish parts in it, all different fishscales which could be found were studied under a microscope and compared with the fishscale database (attachment…). This lead to the results shown in table…. The table shows that each of the mentioned fish species is found only once except for Gobiidae of which the scales were found in four different samples. From seven samples from one or more "scaletypes" could not be determined what fish species it might have been.

Fishscales found in otter feces						
	Astatheros diquis (Cichlidae)	Brycon behreae (Characidae)	Brachyrhaphis rhabdaphora (Poeciliidae)	Awaous transandeanus (Gobiidae)	Agonostomus monticola (Mugilidae)	Unknown
3- (1)			x	x		
3 (1)				x		x
3 (2)				x		
10- (1)						x (no scales, only bones)
10 (1)					x	x
10 (2)	x					
10 (3)				x		
11 (1)						x (dirty)
11+ (1)						x (dirty)
11,5 (1a)		x				
11,5 (2)						x (dirty)
12 (1)						x (dirty)

4. Discussion

4.1 sampling results

Most of the fish caught during this study are from the Characidae family. Especially Brycon behreae was as well seen, as caught a lot at different samplingspots along the whole length of the river. There might be different reasons why this fish species was caught more easily than the other species. At first, Brycon behreae was, while snorkeling, at every samplingspot the most seen fishspecies. Unless there were great numbers of other species camouflaging and hiding through what they were not discovered Brycon behreae appears to be the most abundant fish species. Even if it was not the most abundant then maybe its bold character made them easier to catch than the shyer fish. Another possibility which might have had influence on the caught fish species is the bait used for fishing (in this case earthworms, dug up from the ground). Some species might have only been able to catch with another kind of bait. It has occurred sometimes that the fish were curious about the bait and kept swimming around it for a while, but they did not make an attempt to bite. Also the size of the hook probably played a role by giving a higher change catching "bigger" fish, rather than small samples since it was easier for the "big guys" to swallow the hook. Finally the species caught most was also determined by the fishing method which was used. The "classic" way of using a fishingline (holding the branch/spool with fishline in one hand and pulling back when a fishbite was felt) seemed to be most efficient for catching fish like Brycon behreae (Characidae), while catching bottom fish like (Gobiidae) went best by hanging the branch/spool in a tree with the hook hanging in the water. With this method the fish catches itself.

An interesting finding during this study was that the number of fish seen at each samplingspot changed over the weeks. For instance samplingspot 10. During the first samplingday at that spot there were lots of fish but during all the other samplingdays, there were no fish at all, or only a couple of small fish which had no interest in biting the worm. The opposite occurred at samplingspots 5, 7 and 8 where no fish were spotted at the start, but were seen about one month before the end of this study. This long time absence of fish has probably been a reason why no fish were caught at samplingspots 8 and 10.

The best place to catch fish appeared (according to figure….) to be samplingspot 2. The number of fish caught at this spot is about … times as high as the one from the spots with the second highest (samplingspots 6 and 9) catch-rate of five fish. This might be explained by the fact that samplingspot 2 laid within a couple of 100 meters from the reserve which made it the easiest spot to go for "recreative" fishing. Because of this there was about twice the amount of fishing time spent at spot 2 compared with the fishingtime spent at the other spots. Also, all the fish caught at this spot were caught outside the regular fishingtimes for this research.

When looking at fish diversity at the different spots, the top three also consisted of samplingspots, 2 (H = 1,946), 6 (1,099) and 9 (1,099). This result was to be expected since, the more fish has been caught, the higher the chance that there are multiple species. But when looking at the Shannon-Wiener index (= H), this study did not find particularly much fish diversity throughout the Balso river. H can range from 0 to 4,5 but the most realistic values lay between 1,5 and 3,5 at which 1,5 is relatively low and 3,5 relatively high diversity. The only samplingspot in the Balso river which lays above the lowest realistic boundary is spot 2 and even that one still has a relatively low diversity. This means that none of the samplingspots in the Balso river would be very stable within the meaning to adapt to (sudden) environmental changes. An example of this is the change from rain season to dry season. During the rain season all pools in the river are filled up with water and many of them contain fish. However, when the waterlevel drops in dry season the pools get smaller and swallower with as result that the fish "disappear" from some pools. This makes it harder for *Lontra longicaudis* to catch a nice fish meal so the otter is forced to look for more other kind of pray, which in most cases will be crustacean.

4.2 Sampling circumstances

With a width between 4,17 and 15,45 meter and a depth between 0,69 and 1,78 meter Balso river is not a particularly big river but one which does have quite some differences in speed of the water flow. This current appears to be related with the depth of the river in that way that at points where the river is deeper, the current is less strong, but when the river is shallow the current is strong. An explanation for this feature can be found with the water volume which has to be transported by the river. At a deep spot the water does not have to flow that quickly because it is like a reservoir which "stores" water. But if the same amount of water would have to pass a shallow part of the river, the current will have to increase. If this does not happen the water will find another way to get the same volume of water downwards. The most probable option is that the width of the river expends. In this study however, no correlation was found between the width and the current of the river.
Samplingspot 4 is with its depth of only 0,75 meter and without any current a special case. This pool lays about two meters aside from the river. It has one direct connection with the river itself on the bottom side of the pool but because water always looks for the lowest point the water flow does not flow from the river back into the pool. Samplingspot 4 also is not completely drained because it has a direct connection with the river so the waterlevel in both this pool and in the river will be the same. Spot 4 will only know a current when the waterlevel is high enough for the river to reach the pool from upstream.
When looking at the other river characteristics a pattern appears to be visible between the temperature of the water and the altitude of the spot. The higher the altitude, the lower the water temperature. This is probably caused by the low air temperature at higher altitude which occurs because less air density is not as capable as high air density to retain heat. When comparing the results of the temperature with those of the depth and the vegetation coverage, the last two appear to have (almost) no influence on the water temperature.
Oxygen levels seem to be related with as well the current as the temperature. Especially the first eight samplingspots show the same pattern in the graphs of current (figure…) and oxygen (figure…). The higher the current the more the water moves, so oxygen can be easier dissolved in the water creating a higher oxygen level. From samplingspot 8 to 12 there seem to be more of a correlation visible between the water temperature and the oxygen level. The lower the temperature the more oxygen the water can contain.

4.3 Evidence of otter presence

When looking at the graph "evidence of otter presence" figure… can be seen that some methods to locate the *L. longicaudis* worked better than others. During this study no photographs could be taken from the otter. The camera traps have been placed at least one time at each sampling spot for four days. If the otter was spotted or feces or tracks were found at a certain spot the cameras would be set up at that point the next time they were available. Despite this it was not possible to "catch" the otter on picture. This might have been due to the low number of available camera traps. Because only two of these traps could be used it was not possible to place them at all the samplingspots more than once which means they were setup at each spot for only a very short time. Except for insight on how it was best to place the camera's the chance to "capture" an otter was mostly based on luck. Luck that the otter would pass the camera at the moment it was set up, that it would pass within the range of the motion detection sensor and that the photo would be of a decent quality. It might be possible that the otter noticed the human smell left behind by putting up the camera traps, and because of this reason avoided that place for a couple of days.
Also with a normal hand camera no photos of the otter could be made. *L. longicaudis* has been seen a couple of times, but in most cases there was not camera to hand. The one time there was a camera the otter was gone already before a picture could be taken.
Looking for tracks was an easy method with a rather disappointing result. Tracks were found at only two places which is probably because at most places the conditions of the ground were not good

enough for tracks to be left. In most cases the ground was dry, consisted mainly of rocks or consisted of really tiny gravel. The last bottom type did contain footprints sometimes, but the ground particles were often too big to show details in the footprints so it could not be determined from which animal it could have been. Even if the otter would have left a good footprint behind, there was still the risk that it would be washed away by the water, something that also could happen to otterfeces. However, the risk of feces being washed away is smaller than in case of tracks. Because otters use the feces to mark their territory they defecate at a high, flat spot (mostly a rock) close to deep water. This made the feces the easiest and most found evidence that the otter had been at a certain spot. Remarkable is that (except for the feces found at spot 8,5), all the evidence is found or fully downstream at spots 2, 3- and 3, or fully upstream at spots from 10- and up. The feces found between samplingspots 11 and 12 was almost all found at the same day, however, after the fieldwork of this study was done, there was more feces found between those two spots.
According to Gori, et al (2003) *L. longicaudis* prefes to live in an area with solid ground, many water plants and structured vegetation. Cho, et al (2009) adds to this characteristics: shallow, narrow areas of streams, banks covered with trees and bushes, reduced drift of water and fishes and natural type of riverbank. With exception of the solid ground (which all the samplingspots had), none of these characeristics were shared by all the samplingsports where evidence of otter precense was found. A natural type of riverbank with good structued vegetation seemed to be the characteristics best shared by the "evidencespots" except for spot 3. This samplingspot had artifically made riverbanks without any vegetation. Compairing this data with the map showed in figure 2 there can be seen that the information of both complies with each other. As far as known the otter has been only twice in the middel part of the river where the environment is characterised by houses and plantations against 21 times upstream and downstream where there is mainly forest around the river. A good vegetation covered river bank not to close to humans seems to be a very important characteristic for the homerange of *Lontra longicaudis*.
Finding feces as wel upstream as downstream also arose a question. Since otters deficate mostly at the center of their territory, and the feces was found multiple times upstream and mulitple times downstream, it might mean that (despite the small range) there is more than one otter in the study area.

4.4 Feces and fish scale database

…,….,….all agree that the biggest part of an otter diet is composed of fish and crustacean take the "second place". That is the same result as what is found during this study. During an attempt to take a closer look at the feces in order to determine of what species the fishparts (fishscales) were a problem was discovered. Many of the fish scales in the samples where very dirty, or burned. Because of that it was not able to determine to what kind of fish these scales belonged. … had done a similar research at which otter feces was looked through in order to determine the organisms which the otter had been eating. …. Did not wrote about not being able to analyze animal parts because they were dirty. The most probable reason for this is that the feces were washed with…before drying them, a step not conducted in this study. The burned fish scales can be explained because they were in the same feces as the reptile was. Because pieces of the last one did not dry very well, the feces had been in the dryer cabinet for a couple of days and looked burned when it came out.
Of the feces samples which passed the drying process well could (in most cases) be determined what fishspecies the samples contained. The amount of them however in one sample is not to predict because it is not possible to see if two fishscales from the same species are from the same individual. Most found was the Gobiidae…… Besides this species also……,……,……,…… were found in the feces. Remarkable is that despite the great abundance of Brycon behreae this was not the species found most in the feces. There are two possible explanations for this finding. Brycon behreae is a relatively fast swimmer compared to Gobiidae…… and many of the other caught species. Since the otter is an opportunistic feeder, it will hunt the easiest preys, which are the slowest and the most abundant

once. After Brycon behreae Gobiidae…. was the fish caught most at the samplingspots. So with being slow, and more abundant than most of the other species, Gobiidae…. is the perfect prey for the otter. Another possibility is that the scales which were thought to be Gobiidae….. actually belonged to another species. Some scales from different species look a lot like each other and it also does not make it easier that the scales of one species differ in shape and drawing at the different bodyparts. So it is not impossible that some fish scales are said to be from another specie as which they actually are.

5. Conclusion

Based on the results of this study can be concluded that of the different river characteristics measured during this study depth of the river is most important for fish diversity, in that way that the deeper the river is, the more fishspecies can be found. This is positive for *L. longicaudis* because more than 2/3 of its diet consists of fish. Gobiidae…was found most in the otter feces and caught second most at the samplingspots. Which makes Gobiidae…. highly probable the favorite food of the otter. However only the presence of this fish species will not be enough for *Lontra longicaudis*. This otter strongly prefers a homerange in a natural environment with lots of vegetation on the river banks. It is not often seen in a human residential environment or close to plantations.

5.1 recommendations

It is recommended to conduct a long term study of several years and in multiple rivers at the same time on the otter diet and home range. This way it is possible to oversee if and how the diet differs during the seasons and in different rivers. An advice is to fish for periods longer than 30 minutes (1 or 1,5 hour for instance) to increase the chance of catching more fish. This might be combined with estimating how many fish of one family or genus can be seen by watching through the water. In order to locate the otter it is recommended to use more than two camera traps and place them on different spots along the river to increase the chance of “catching” one or maybe even more otters at the same time.

Literature

Bussing, W. A. (2002). *Peces de las aguas continentales de Costa Rica; Freshwater fishes of Costa Rica.* San Jose: Editorial de la Universidad de Costa Rica.

Cho, H.-S., Choi, K.-H., Lee, S.-D., & Park, Y.-S. (2009). Characterizing habitat preference of Eurasian river otter (Lutra lutra) in streams using a self-organizing map. *Limnology, 10* , 203-213.

Gori, M., Carpaneto, G. M., & Ottino, P. (2003). Spatial distribution and diet of the Neotropical otter Lontra longicaudis in the Ibera Lake (northern Argentina). *Acta Theriologica, 48* , (4), 495–504.

IUCN. (2012). *Lontra longicaudis*. Opgeroepen op September 25, 2012, van The IUCN Red List of Threatened Species: http://www.iucnredlist.org/details/12304/0

Larivière, S. (1999). *Mammalian species: Lontra longicaudis.* American Society of Mammalogists.

Reid, F. A. (2009). Neotropical river otter: Lontra longicaudis. In F. A. Reid, *A field guide to the mammals of Central America & Southeast Mexico* (pp. 271-272). Oxford New York: Oxford University Press.

Wainwright, M. (2007). Neotropical River Otter: Lutra longicaudis. In M. Wainwright, *The Mammals of Costa Rica: a natural history and field guide* (pp. 318-322). China: A Zona Tropical Publication.

Attachments

Attachment 1: Otter habitat (sampling spots) form

Otter habitat (sampling spots)

General:

Name:____

Date:_________________________________Time:____________________________

Season: Rain season / Dry season / Comments:____________________________________

Weather conditions:
Today:____

Yesterday/this morning:____

Part of the River:

Sampling spot:____

Coordinates (according to GPS): N:09◦____.______″ O083◦____.______″

Altitude:____

River width (estimation):____

River depth (estimation): Right:__________Middel:_____________Left:______________

Deepest spot:_______________________________________

Current: 1st: _________________2nd:_____________________3th:___________________

Oxigen (mg/l): Right:__________Middel:____________Left:__________Time:__________

Water temperature: Right:____________Middel:______________Left:_______________

Tide (important for segment 1): has been High / Low at:________(time)_____cm, will be High / Low at: _______(time)________(cm)

Evidence of otter presence: None / Camera Traps / Fotocamera /
Sighting (no photo) / Tracks / Spraints (feces) Date:___________________________
Coordinates (according to GPS)____

Habitat use: Unknown / Hunting and Eating / Resting / Den / Raising young

River condition: Canalized / Weir / Natural

Riverbottom material: Sand / Grid / Other:_______________________________________

Riverbottom coverage (%): Stone:_______________________________________

: Water plant:_______________________________________

Bank type: Artificial / Natural / Comment:_______________________________________

Vegetation coverage (%):_______________________________________

Comments:_______________________________________

____

Sampling results:

Fish:

Cichlidae (Cichlid family):_______________________________

*Cichlasom*____________:_____________________________

*Cichlasom*____________:_____________________________

*C. vittata (Moray eel):*_____________________________

____________________:_____________________________

____________________:_____________________________

____________________:_____________________________

Characidae (Characid family):_____________________________

*Astyanax bimaculatus (Twospot astyanax):*_________________

____________________:_____________________________

____________________:_____________________________

Synbranchidae (Swamp eel family):__________________________

*Synbranchus marmoratus (Mottled swamp eel):*_____________

____________________:_____________________________

____________________:_____________________________

Loricariidae (Armoured catfish family):_____________________

____________________:_____________________________

____________________:_____________________________

Erythrinidae (Trahiras family):_____________________________

*Hoplias malabaricus (Wolf- or Tigerfish):*_________________

____

*Rhamdia*__________________:_____________________________

*Rhamdia*__________________:_____________________________

*Eigenmannia*_______________:_____________________________

*Eigenmannia*_______________:_____________________________

Not identified:_____________________________________

__________________________:_____________________________

Crustaceans:

*Trichodactylus borellianus:*_____________________________

_________________________:_____________________________

_________________________:_____________________________

_________________________:_____________________________

Insects:

Belostomatidae (giant water bug family):_______________

_____________:_________

_____________:_________

Plant matter:

_____________:_________

_____________:_________

Molluscs:

Gastropoda (snails and slugs):_______________

___________:___________

___________:___________

Pelecypoda (Oysters, clams, scallops, mussels):_____________

___________:___________

___________:___________

Reptiles:

___________:___________

Birds:

___________:___________

Amphibians:

___________:___________

___________:___________

Mammals:

___________:___________

:

Attachment 2: Biodiversity: Shannon-Wiener

Sample	H	Variance H
spot 1	0	0
spot 2	1.946	0.06122
spot 3	0.6931	0.125
spot4	0	0
spot5	0	0
spot6	1.099	0.1111
spot7	0	0
spot9	1.099	0.1111
spot11	0.6931	0.125
spot12	0.6931	0.125

Attachment 3: Full data of river characteristics

River width (m)							
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Average**	**Total average**
1m	5,00	-	10,50	11,30	10,50	10,77	10,81
1a	10,50	5,00	-	-	11,25	10,88	
2m	-	20,00	13,00	15,00	13,80	15,45	15,45
2a	11,38	20,00	-	-	15,00	15,46	
3m	-	12,00	15,50	17,10	15,00	14,90	15,19
3a	18,00	13,50	15,20	-	-	15,57	
4m	15,00	15,00	6,20	6,60	6,73	6,51	6,81
4a	-	8,50	-	6,00	-	7,25	
5m	10,00	9,85	10,20	10,50	10,50	10,21	10,07
5a	-	-	9,50	10,05	9,93	9,83	
6m	10,00	11,50	-	12,70	10,50	11,18	11,57
6a	-	12,00	-	12,70	-	12,35	
7m	7,00	-	8,70	6,00	5,70	6,85	6,54
7a	-	-	-	5,86	6,00	5,93	
8m	5,30	-	5,35	6,30	6,00	5,74	5,87
8a	-	-	-	6,50	5,75	6,13	
9m	2,00	4,50	4,15	4,50	4,29	4,36	4,17
9a	-	-	-	-	3,40	3,40	
10m	15,00	14,50	12,00	12,60	13,34	13,49	13,36
10a	-	-	-	-	12,74	12,74	
11m	4,00	-	4,50	5,20	4,46	4,54	4,61
11a	-	-	4,87	-	-	4,87	
12m	5,00	8,00	-	5,78	10,20	5,39	6,64
12a	-	-	5,35	5,50	-	5,43	

River depth (m)							
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Average**	**Total average**
1m	0,78	-	1,33	0,85	1,03	1,18	1,05
1a	1,10	1,00	-	-	1,30	1,13	
2m	-	2,30	0,98	2,00	2,00	2,10	1,78
2a	1,40	2,00	-	-	-	1,70	
3m	-	0,51	1,28	1,25	1,28	1,27	0,94
3a	0,70	0,56	0,92	1,05	-	0,98	
4m	0,71	0,52	0,73	0,82	0,75	0,76	0,75
4a	-	0,66	-	0,79	-	0,73	
5m	0,82	0,88	1,06	0,97	0,91	0,93	0,91
5a	-	-	0,92	0,88	0,88	0,89	
6m	0,97	0,68	0,94	1,41	-	0,96	0,94
6a	-	0,72	-	-	-	0,72	
7m	1,28	-	0,66	1,38	1,33	1,33	1,14
7a	-	-	0,59	1,39	1,33	1,36	
8m	0,63	-	0,69	0,73	0,73	0,69	0,69
8a	-	-	-	0,69	0,69	0,69	
9m	1,28	1,20	1,47	1,26	1,36	1,31	1,33
9a	-	-	1,48	1,30	1,33	1,37	
10m	0,90	0,70	0,53	0,83	0,63	0,72	0,73
10a	-	-	-	-	0,76	0,76	
11m	1,73	-	1,34	1,47	1,46	1,42	1,46
11a	-	-	1,28	-	-	1,28	
12m	0,80	0,36	0,65	0,94	0,96	0,84	0,75
12a	-	-	0,64	0,91	-	0,77	

Current (m/s)							
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average	Total average
1m	0,24	-	0,23	0,32	0,27	0,26	0,25
1a	0,18	0,34	-	-	0,21	0,24	
2m	-	0,07	-	0,20	0,14	0,14	0,14
2a	0,16	0,11	-	-	-	0,13	
3m	-	0,22	0,30	0,21	0,27	0,25	0,23
3a	0,15	0,17	0,42	0,12	-	0,15	
4m	1,39	1,24	0,00	0,00	0,00	0,00	0,00
4a	-	0,00	-	0,00	-	0,00	
5m	0,17	0,34	0,67	0,32	0,90	0,33	0,47
5a	-	-	0,64	0,34	0,38	0,36	
6m	0,32	0,15	0,37	0,41	0,41	0,38	0,37
6a	-	0,65	-	0,31	-	0,31	
7m	0,78	-	0,72	0,60	0,59	0,67	0,64
7a	-	-	-	0,60	0,55	0,58	
8m	0,48	-	0,38	0,36	0,33	0,39	0,37
8a	-	-	-	0,44	0,21	-	
9m	0,16	0,18	0,28	0,11	0,33	0,21	0,22
9a	-	-	0,25	0,22	0,19	0,22	
10m	0,58	0,54	0,74	0,58	0,62	0,57	0,64
10a	-	-	-	-	0,75	0,75	
11m	0,24	-	0,17	0,16	0,20	0,16	0,20
11a	-	-	0,22	-	-	0,22	
12m	0,40	0,85	0,45	0,39	0,34	0,40	0,45
12a	-	-	0,43	0,31	-	0,37	

Oxigen (mg/l)							
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average	Total average
1m	-	-	7,56	7,00	6,56	7,04	6,56
1a	6,31	6,67	-	-	5,27	6,49	
2m	-	6,93	7,04	6,40	7,15	6,88	7,01
2a	-	8,01	-	-	6,50	6,50	
3m	-	7,80	7,63	6,40	6,48	7,17	6,85
3a	-	6,57	6,85	6,21	-	6,54	
4m	-	7,50	7,27	6,75	5,92	7,01	6,46
4a	-	6,50	-	5,87	-	6,19	
5m	-	8,09	7,08	7,12	7,57	7,26	7,37
5a	-	7,68	6,94	6,85	7,63	7,28	
6m	-	6,63	7,88	7,51	7,05	7,48	7,26
6a	-	-	-	7,25	-	7,25	
7m	-	-	8,46	8,39	8,33	8,39	8,20
7a	-	-	-	8,10	7,71	7,91	
8m	-	-	7,70	7,60	7,30	7,53	7,34
8a	-	-	-	6,90	7,21	7,06	
9m	7,14	7,64	7,18	7,77	7,00	7,35	7,41
9a	-	-	7,35	-	7,80	7,58	
10m	7,40	8,03	7,34	7,67	7,70	7,63	7,49
10a	-	-	-	-	6,77	6,77	
11m	7,67	-	7,88	8,06	7,63	7,81	7,72
11a	-	-	7,37	-	-	7,37	
12m	7,60	8,21	7,41	7,40	6,59	7,47	7,43
12a	-	-	7,48	7,29	-	7,39	

Water temperature (◦C)							
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average	Total average
1m	25,70	-	24,90	25,80	25,00	25,35	25,86
1a	26,30	26,50	-	-	26,80	26,53	
2m	-	24,70	25,20	25,10	25,60	25,15	25,74
2a	26,80	26,20	-	-	26,60	26,53	
3m	-	25,30	24,80	26,00	24,50	24,87	25,69
3a	26,60	26,30	25,90	26,10	-	26,23	
4m	25,00	24,90	24,20	25,20	25,40	25,13	25,56
4a	-	26,70	-	26,30	-	26,50	
5m	25,70	25,30	24,90	26,00	24,80	25,34	25,39
5a	-	-	25,40	25,80	25,20	25,47	
6m	25,10	24,80	25,40	24,90	24,90	25,02	25,46
6a	-	25,90	-	25,90	-	25,90	
7m	24,60	-	24,20	24,70	24,10	24,40	24,62
7a	-	-	-	24,90	25,20	25,05	
8m	24,50	-	24,30	24,30	24,50	24,40	24,58
8a	-	-	-	24,90	25,00	24,95	
9m	24,20	24,10	24,00	24,20	23,50	24,00	24,13
9a	-	-	24,80	-	24,10	24,45	
10m	24,40	23,50	24,70	23,70	23,70	23,63	24,07
10a	-	-	-	-	24,40	24,40	
11m	23,40	-	23,70	23,70	24,00	23,70	23,86
11a	-	-	24,50	-	-	24,50	
12m	23,80	23,50	23,90	23,40	24,00	23,72	23,87
12a	-	-	24,30	24,20	-	24,25	

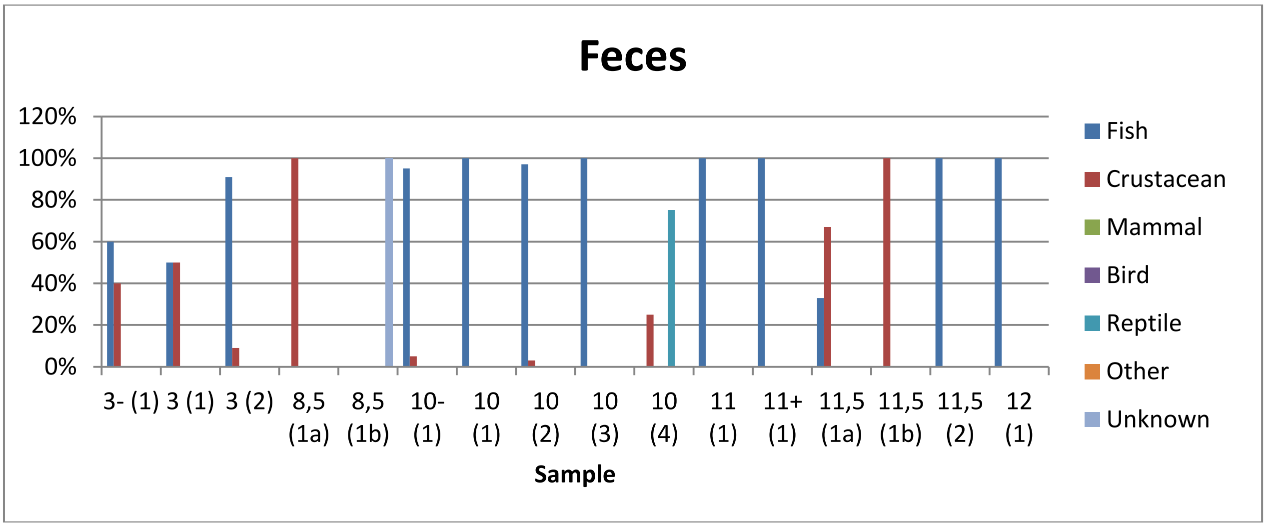
Altitude (m)	
	Altitude
1	6
2	9
3	14
4	16
5	18
6	23
7	58
8	73
9	83
10	113
11	137
12	158

Riverbottom coverage (%)		
	Stones	**Water plants**
1	0%	0%
2	0%	0%
3	0%	0%
4	75%	0%
5	30%	0%
6	10%	0%
7	60%	0%
8	80%	0%
9	10%	0%
10	80%	0%
11	15%	0%
12	80%	0%

Vegetation coverage (%)			
	Right	**Left**	**Average**
1	2%	90%	46%
2	80%	80%	80%
3	0%	0%	0%
4	80%	60%	70%
5	20%	70%	45%
6	6%	80%	43%
7	70%	30%	50%
8	80%	5%	43%
9	0%	15%	8%
10	90%	90%	90%
11	85%	80%	83%
12	80%	50%	65%

Evidence of otter presence					
	Camera traps	**Fotocamera**	**Sighting (no photo)**	**Tracks**	**Spraints**
1					
2			4		
3-					1
3			1	1	2
4					
5					
6					
7					
8					
8,5					1
9					
10-					1
10				1	2
11					1
11+					1
11,5					1
12					2

Attachment 4: Feces analysis



Sampling spot	Arius see-manni	Brycon behreae	Hyphesso-brycon savagei	Astat-heros dequis	Gobio-morus maculatus	Awaous transan-deanus	Pom-dasys bayanus	Agono-stomus monticola	Brachy-rhaphis rhabda-phora	Sphoroides testudineus	Tricho-mycterus striatus
1								1			
2	1	2	2		3	1	1			1	
3		1				1					
4		1									
5		3									
6		2		2		1					
7		1									
8											
9		2				1			2		
10											
11		2									1
12		2						2			

Sample	Fish	Crustacean	Reptile
3- (1)	60%	40%	-
3 (1)	50%	50%	-
3 (2)	91%	9%	-
8,5 (1a)	-	100%	-
8,5 (1b)	-	-	-
10- (1)	95%	5%	-
10 (1)	100%	-	-
10 (2)	97%	3%	-
10 (3)	100%	-	-
10 (4)	-	25%	75%
11 (1)	100%	-	-
11+ (1)	100%	-	-
11,5 (1a)	33%	67%	-
11,5 (1b)	-	100%	-
11,5 (2)	100%	-	-
12 (1)	100%	-	-
Totaal	1026%	399%	75%
% van totaal	68%	28%	5%

Attachment 5: Statistics

Explore

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Number of fish caught	10	100,0%	0	,0%	10	100,0%
Fish diversity	10	100,0%	0	,0%	10	100,0%
Width	10	100,0%	0	,0%	10	100,0%
Depth	10	100,0%	0	,0%	10	100,0%
Current	10	100,0%	0	,0%	10	100,0%
Oxigen	10	100,0%	0	,0%	10	100,0%
Temperature	10	100,0%	0	,0%	10	100,0%
Altitude	10	100,0%	0	,0%	10	100,0%
River bottom coverage (stones)	10	100,0%	0	,0%	10	100,0%
Vegetation coverage	10	100,0%	0	,0%	10	100,0%
Evidence of otter presence	10	100,0%	0	,0%	10	100,0%

Descriptives

			Statistic	Std. Error
Number of fish caught	Mean		3,60	,957
	95% Confidence Interval for Mean	Lower Bound	1,44	
		Upper Bound	5,76	
	5% Trimmed Mean		3,33	
	Median		3,00	
	Variance		9,156	
	Std. Deviation		3,026	
	Minimum		1	
	Maximum		11	
	Range		10	
	Interquartile Range		4	

	Skewness		1,772	,687
	Kurtosis		3,863	1,334
Fish diversity	Mean		2,30	,578
	95% Confidence Interval for Mean	Lower Bound	,99	
		Upper Bound	3,61	
	5% Trimmed Mean		2,11	
	Median		2,00	
	Variance		3,344	
	Std. Deviation		1,829	
	Minimum		1	
	Maximum		7	
	Range		6	
	Interquartile Range		2	
	Skewness		2,172	,687
	Kurtosis		5,415	1,334
Width	Mean		9,1845	1,28954
	95% Confidence Interval for Mean	Lower Bound	6,2673	
		Upper Bound	12,1016	
	5% Trimmed Mean		9,1148	
	Median		8,4361	
	Variance		16,629	
	Std. Deviation		4,07790	
	Minimum		4,17	
	Maximum		15,45	
	Range		11,29	
	Interquartile Range		6,41	
	Skewness		,431	,687
	Kurtosis		-1,121	1,334
Depth	Mean		1,1050	,10441
	95% Confidence Interval for Mean	Lower Bound	,8688	
		Upper Bound	1,3412	
	5% Trimmed Mean		1,0872	
	Median		,9950	
	Variance		,109	

	Std. Deviation		,33016	
	Minimum		,75	
	Maximum		1,78	
	Range		1,03	
	Interquartile Range		,49	
	Skewness		,994	,687
	Kurtosis		,450	1,334
Current	Mean		,2974	,05924
	95% Confidence Interval for Mean	Lower Bound	,1633	
		Upper Bound	,4314	
	5% Trimmed Mean		,2947	
	Median		,2432	
	Variance		,035	
	Std. Deviation		,18734	
	Minimum		,00	
	Maximum		,64	
	Range		,64	
	Interquartile Range		,28	
	Skewness		,375	,687
	Kurtosis		-,043	1,334
Oxigen	Mean		7,230	,1640
	95% Confidence Interval for Mean	Lower Bound	6,859	
		Upper Bound	7,601	
	5% Trimmed Mean		7,217	
	Median		7,350	
	Variance		,269	
	Std. Deviation		,5187	
	Minimum		6,5	
	Maximum		8,2	
	Range		1,7	
	Interquartile Range		,7	
	Skewness		,299	,687
	Kurtosis		-,071	1,334
Temperature	Mean		25,0180	,25637

	95% Confidence Interval for Mean	Lower Bound	24,4381	
		Upper Bound	25,5979	
	5% Trimmed Mean		25,0356	
	Median		25,4250	
	Variance		,657	
	Std. Deviation		,81070	
	Minimum		23,86	
	Maximum		25,86	
	Range		2,00	
	Interquartile Range		1,64	
	Skewness		-,588	,687
	Kurtosis		-1,659	1,334
Altitude	Mean		52,20	17,689
	95% Confidence Interval for Mean	Lower Bound	12,19	
		Upper Bound	92,21	
	5% Trimmed Mean		48,89	
	Median		20,50	
	Variance		3128,844	
	Std. Deviation		55,936	
	Minimum		6	
	Maximum		158	
	Range		152	
	Interquartile Range		84	
	Skewness		1,171	,687
	Kurtosis		-,061	1,334
River bottom coverage (stones)	Mean		28,00	10,061
	95% Confidence Interval for Mean	Lower Bound	5,24	
		Upper Bound	50,76	
	5% Trimmed Mean		26,67	
	Median		12,50	
	Variance		1012,222	
	Std. Deviation		31,815	
	Minimum		0	
	Maximum		80	

	Range		80	
	Interquartile Range		64	
	Skewness		,852	,687
	Kurtosis		-1,075	1,334
Vegetation coverage	Mean		49,00	8,793
	95% Confidence Interval for Mean	Lower Bound	29,11	
		Upper Bound	68,89	
	5% Trimmed Mean		49,83	
	Median		48,00	
	Variance		773,111	
	Std. Deviation		27,805	
	Minimum		0	
	Maximum		83	
	Range		83	
	Interquartile Range		38	
	Skewness		-,675	,687
	Kurtosis		-,282	1,334
Evidence of otter presence	Mean		1,10	,526
	95% Confidence Interval for Mean	Lower Bound	-,09	
		Upper Bound	2,29	
	5% Trimmed Mean		1,00	
	Median		,00	
	Variance		2,767	
	Std. Deviation		1,663	
	Minimum		0	
	Maximum		4	
	Range		4	
	Interquartile Range		3	
	Skewness		1,253	,687
	Kurtosis		-,037	1,334

Explore

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Number of fish caught (LN)	4	40,0%	6	60,0%	10	100,0%
Fish diversity (LN)	4	40,0%	6	60,0%	10	100,0%
Temperature (LN)	4	40,0%	6	60,0%	10	100,0%
Altitude (LN)	4	40,0%	6	60,0%	10	100,0%
Evidence of otter presence (LN)	4	40,0%	6	60,0%	10	100,0%

Descriptives

			Statistic	Std. Error
Number of fish caught (LN)	Mean		1,3940	,36358
	95% Confidence Interval for Mean	Lower Bound	,2369	
		Upper Bound	2,5511	
	5% Trimmed Mean		1,3772	
	Median		1,2425	
	Variance		,529	
	Std. Deviation		,72717	
	Minimum		,69	
	Maximum		2,40	
	Range		1,70	
	Interquartile Range		1,35	
	Skewness		1,113	1,014
	Kurtosis		1,576	2,619
Fish diversity (LN)	Mean		1,0063	,31319
	95% Confidence Interval for Mean	Lower Bound	,0096	
		Upper Bound	2,0031	
	5% Trimmed Mean		,9715	
	Median		,6931	

	Variance		,392	
	Std. Deviation		,62638	
	Minimum		,69	
	Maximum		1,95	
	Range		1,25	
	Interquartile Range		,94	
	Skewness		2,000	1,014
	Kurtosis		4,000	2,619
Temperature (LN)	Mean		3,2097	,02156
	95% Confidence Interval for Mean	Lower Bound	3,1411	
		Upper Bound	3,2783	
	5% Trimmed Mean		3,2097	
	Median		3,2094	
	Variance		,002	
	Std. Deviation		,04311	
	Minimum		3,17	
	Maximum		3,25	
	Range		,08	
	Interquartile Range		,08	
	Skewness		,002	1,014
	Kurtosis		-5,989	2,619
Altitude (LN)	Mean		3,7047	,74882
	95% Confidence Interval for Mean	Lower Bound	1,3216	
		Upper Bound	6,0878	
	5% Trimmed Mean		3,7130	
	Median		3,7795	
	Variance		2,243	
	Std. Deviation		1,49765	
	Minimum		2,20	
	Maximum		5,06	
	Range		2,87	
	Interquartile Range		2,72	
	Skewness		-,067	1,014
	Kurtosis		-5,526	2,619

Evidence of otter presence (LN)	Mean		,8664	,33182
	95% Confidence Interval for Mean	Lower Bound	-,1896	
		Upper Bound	1,9224	
	5% Trimmed Mean		,8857	
	Median		1,0397	
	Variance		,440	
	Std. Deviation		,66364	
	Minimum		,00	
	Maximum		1,39	
	Range		1,39	
	Interquartile Range		1,21	
	Skewness		-,855	1,014
	Kurtosis		-1,289	2,619

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,359[a]	,129	,020	,64069

a. Predictors: (Constant), Width

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,099	,522		,190	,854
	Width	,057	,052	,359	1,088	,308

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,247[a]	,061	-,057	,83639

a. Predictors: (Constant), Width

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,537	,681		,789	,453
	Width	,049	,068	,247	,720	,492

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,658[a]	,433	,362	,51703

a. Predictors: (Constant), Depth

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-,803	,600		-1,339	,217
	Depth	1,289	,522	,658	2,470	,039

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,531[a]	,282	,192	,73118

a. Predictors: (Constant), Depth

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-,457	,848		-,539	,604
	Depth	1,309	,738	,531	1,774	,114

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,299[a]	,089	-,025	,65511

a. Predictors: (Constant), Current

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,929	,404		2,301	,050
	Current	-1,032	1,166	-,299	-,885	,402

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,106[a]	,011	-,112	,85821

a. Predictors: (Constant), Current

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,126	,529		2,128	,066
	Current	-,459	1,527	-,106	-,300	,771

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,013[a]	,000	-,125	,68640

a. Predictors: (Constant), Oxigen

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,737	3,197		,230	,824
	Oxigen	-,016	,441	-,013	-,036	,972

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,125[a]	,016	-,107	,85625

a. Predictors: (Constant), Oxigen

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-,431	3,988		-,108	,917
	Oxigen	,196	,550	,125	,357	,730

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,046[a]	,002	-,123	,68573

a. Predictors: (Constant), Temperature

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,543	7,057		,219	,832
	Temperature	-,037	,282	-,046	-,130	,899

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,164[a]	,027	-,095	,85130

a. Predictors: (Constant), Temperature

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5,116	8,761		,584	,575
	Temperature	-,165	,350	-,164	-,471	,650

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,072[a]	,005	-,119	,68469

a. Predictors: (Constant), Altitude

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,579	,304		1,906	,093
	Altitude	,001	,004	,072	,203	,844

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,183[a]	,033	-,088	,84854

a. Predictors: (Constant), Altitude

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,851	,376		2,260	,054
	Altitude	,003	,005	,183	,525	,614

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,466[a]	,217	,120	,60726

a. Predictors: (Constant), River bottom coverage (stones)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,888	,262		3,389	,010
	River bottom coverage (stones)	-,009	,006	-,466	-1,491	,174

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,363[a]	,131	,023	,80429

a. Predictors: (Constant), River bottom coverage (stones)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,249	,347		3,600	,007
	River bottom coverage (stones)	-,009	,008	-,363	-1,101	,303

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,203[a]	,041	-,079	1,899

a. Predictors: (Constant), Vegetation coverage

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,645	1,267		1,298	,230
	Vegetation coverage	,013	,023	,203	,587	,573

a. Dependent Variable: Fish diversity

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,098[a]	,010	-,114	,85892

a. Predictors: (Constant), Vegetation coverage

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,849	,573		1,482	,177
	Vegetation coverage	,003	,010	,098	,277	,789

a. Dependent Variable: Number of fish caught (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,511[a]	,261	,168	,59016

a. Predictors: (Constant), Evidence of otter presence

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,366	,241		1,520	,167
	Evidence of otter presence	,640	,381	,511	1,680	,131

a. Dependent Variable: Fish diversity (LN)

Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,428[a]	,183	,081	,77999

a. Predictors: (Constant), Evidence of otter presence

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,720	,318		2,260	,054
	Evidence of otter presence	,674	,503	,428	1,339	,217

a. Dependent Variable: Number of fish caught (LN)

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

	Observed		Predicted		
			Evidence of otter presence		Percentage Correct
			0	1	
Step 0	Evidence of otter presence	0	6	0	100,0
		1	4	0	,0
	Overall Percentage				60,0

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,405	,645	,395	1	,530	,667

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	LN_fish_diversity	2,609	1	,106
	Overall Statistics		2,609	1	,106

Block 1: Method = Enter

Classification Table[a]

	Observed		Predicted		
			Evidence of otter presence		Percentage Correct
			0	1	
Step 1	Evidence of otter presence	0	4	2	66,7
		1	3	1	25,0
	Overall Percentage				50,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	LN_fish_diversity	2,108	1,508	1,955	1	,162	8,233
	Constant	-1,787	1,254	2,032	1	,154	,167

a. Variable(s) entered on step 1: LN_fish_diversity.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Predicted: Percentage Correct
Step 0	Evidence of otter presence	0	6	0	100,0
		1	4	0	,0
	Overall Percentage				60,0

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,405	,645	,395	1	,530	,667

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	LN_number_fish_caught	1,832	1	,176
	Overall Statistics		1,832	1	,176

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Predicted: Percentage Correct
Step 1	Evidence of otter presence	0	4	2	66,7
		1	2	2	50,0
	Overall Percentage				60,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	LN_number_fish_caught	1,313	1,055	1,549	1	,213	3,717
	Constant	-1,797	1,384	1,687	1	,194	,166

a. Variable(s) entered on step 1: LN_number_fish_caught.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			Evidence of otter presence		Percentage Correct
Observed			0	1	
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Width	1,858	1	,173
	Overall Statistics		1,858	1	,173

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 1	Evidence of otter presence	0	6	1	85,7
		1	2	3	60,0
	Overall Percentage				75,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Width	,224	,172	1,684	1	,194	1,251
	Constant	-2,453	1,775	1,911	1	,167	,086

a. Variable(s) entered on step 1: Width.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Depth	,714	1	,398
	Overall Statistics		,714	1	,398

Block 1: Method = Enter

Classification Table[a]

			Predicted		
			Evidence of otter presence		Percentage Correct
	Observed		0	1	
Step 1	Evidence of otter presence	0	6	1	85,7
		1	3	2	40,0
	Overall Percentage				66,7

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Depth	1,570	1,914	,672	1	,412	4,805
	Constant	-1,979	2,094	,893	1	,345	,138

a. Variable(s) entered on step 1: Depth.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Current	,000	1	,990
	Overall Statistics		,000	1	,990

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 1	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Current	-,039	3,127	,000	1	,990	,961
	Constant	-,323	1,189	,074	1	,786	,724

a. Variable(s) entered on step 1: Current.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted		
			Evidence of otter presence		Percentage Correct
			0	1	
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Oxigen	,019	1	,889
	Overall Statistics		,019	1	,889

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Predicted: Percentage Correct
Step 1	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Oxigen	,179	1,288	,019	1	,889	1,196
	Constant	-1,638	9,372	,031	1	,861	,194

a. Variable(s) entered on step 1: Oxigen.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Predicted: Percentage Correct
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Temperature	,989	1	,320
	Overall Statistics		,989	1	,320

Block 1: Method = Enter

Classification Table[a]

			Predicted		
			Evidence of otter presence		Percentage Correct
	Observed		0	1	
Step 1	Evidence of otter presence	0	6	1	85,7
		1	2	3	60,0
	Overall Percentage				75,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Temperature	-,797	,818	,949	1	,330	,451
	Constant	19,474	20,318	,919	1	,338	2,866E8

a. Variable(s) entered on step 1: Temperature.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Altitude	2,398	1	,121
	Overall Statistics		2,398	1	,121

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 1	Evidence of otter presence	0	6	1	85,7
		1	2	3	60,0
	Overall Percentage				75,0

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Altitude	,019	,014	2,064	1	,151	1,020
	Constant	-1,520	1,049	2,098	1	,147	,219

a. Variable(s) entered on step 1: Altitude.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted		
			Evidence of otter presence		Percentage Correct
			0	1	
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	River_bottom_coverage_stones	,021	1	,885
	Overall Statistics		,021	1	,885

Block 1: Method = Enter

Classification Table[a]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 1	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	River_bottom_coverage_stones	-,003	,017	,021	1	,885	,997
	Constant	-,245	,861	,081	1	,776	,783

a. Variable(s) entered on step 1: River_bottom_coverage_stones.

Logistic Regression

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted: Evidence of otter presence 0	Predicted: Evidence of otter presence 1	Percentage Correct
Step 0	Evidence of otter presence	0	7	0	100,0
		1	5	0	,0
	Overall Percentage				58,3

a. Constant is included in the model.

b. The cut value is ,500

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-,336	,586	,330	1	,566	,714

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Vegetation_coverage	1,638	1	,201
	Overall Statistics		1,638	1	,201

Block 1: Method = Enter

Classification Table[a]

			Predicted		
			Evidence of otter presence		Percentage Correct
	Observed		0	1	
Step 1	Evidence of otter presence	0	6	1	85,7
		1	1	4	80,0
	Overall Percentage				83,3

a. The cut value is ,500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Vegetation_coverage	,033	,028	1,434	1	,231	1,034
	Constant	-2,135	1,691	1,594	1	,207	,118

a. Variable(s) entered on step 1: Vegetation_coverage.