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Flight behaviour of the black river turtle (Rhinoclemmys funerea)

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The flight behaviour of the Black River Turtle (*Rhinoclemmys funerea*) on the Caño Palma canal.

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Abstract

River turtle populations are declining on a worldwide basis due to habitat loss, environmental pollution, diseases and human disturbance. The black river turtle (*Rhinoclemmys funerea*) of Costa Rica is no exception on this matter. Due to the increase of eco-tourism in Costa Rica, *R. funerea* is facing an increase in human disturbance, in the form of boat traffic, while it is basking. This increase in boat traffic causes interruption of basking resulting in a number of negative effects like a decrease in body temperature and an increase in stress related hormones. These negative effects could cause the turtle populations to decline and eventually to disappear. To gain more knowledge on the flight behaviour in relation to boat traffic, a total of 56 surveys were conducted using either a kayak or a motorboat. The flight initiation distance (FID) of turtles, encountered on motorboat surveys, was greater than FID of turtles encountered on kayak surveys. But more unidentified splashes, most likely caused by turtles escaping into the water from a great distance, were observed on kayak surveys. This could be explained by the fact that turtles feel more threatened by slow moving boats. In narrow sections of the canal, where sunlight scarcely reaches basking spots, FID was higher than in wide sections with plenty of sunlight reaching the basking spots. It is possible that turtles were more inclined to display flight behaviour in those narrow sections, to make up for reduced performance caused by a lack of sunlight. Apart from a lack of basking turtles on rainy days, no significant relation was found between weather conditions and FID. This result might be due to the possibility that the encountered turtles already managed to acquire the appropriate body temperature. A change in the number of turtles encountered over the months might be explained by the change in seasonal condition of the weather and therefore the water level of the canal. As so little is known about *R. funerea*, this research might provide a number of leads for follow-up research. For example, radio telemetry could be of use to gain more knowledge about the seasonal distribution of *R. funerea*. More specialized research on the basking behaviour could provide information on reactions towards boat traffic on the Caño Palma canal. The motorboat surveys should continue over a longer time period to provide information about the abundance of *R. funerea* on the canal. It can be concluded that more research is necessary to find solutions to solidify the fine line between positive and negative contribution of eco-tourism in Costa Rica.

1. Introduction

On a worldwide basis, a concern is growing for the future of most species of river turtles. A great number of turtle populations is declining rapidly. This decline is due to a number of causes like invasive species, environment pollution, habitat loss, diseases, and human disturbance (Mittermeier *et al.*, 1992; Devine, 1998; Mack *et al*., 2000; Castaño-Mora, 2002; Converse *et al.*, 2005; Moore & Seigel, 2006). These factors can lead to a decrease in immunity, decrease in metabolic activity, and a lack of reproduction due to a high level of stress related hormones and other negativities (Mahmoud *et al*., 1989; Congdon *et al.*, 1994; Sapolsky *et al*., 2000). Most of these factors can be traced back to human influence on either the habitat, or the disturbance of the population of turtles itself (Mitchell & Clemens, 2000; Converse *et al.*, 2005). The populations of Black River Turtle (*Rhinoclemmys funerea*) of Costa Rica is no exception to this global problem, as it was classified Near Threatened in 1996 by the IUCN, however, the status of *R. funerea* needs revision (Tortoise & Freshwater Turtle Specialist Group, 1996).

The Black River Turtle (*Rhinoclemmys funerea*) is a semi-aquatic, primarily nocturnal, turtle of the family Geoemydidea. It is a moderate sized turtle, with a maximum body length of about 35 centimetres, with a dark coloured carapace (Acuña, 1998). It is found in and around rivers, swamps, ponds, and little streams of Atlantic lowlands from Honduras to Panama (Savage, 2002). During the day it can be found basking on logs and other debris, or foraging on the water's edge where it feeds mostly on vegetation and seeds (Moll & Legner, 1971). In captivity and in the wild they will accept meat or any other food source, which suggests they might be partial scavengers as well (Ernst, 1983; Personal observation).

R. funerea is known to play a role in the seed dispersal of some terrestrial plants like *Dieffenbachia, Ficus* and *Solanum* species (Moll & Jansen, 1994). As the turtle is foraging through different plant material, it defecates and disperses the seeds it has ingested. The defecated seeds do not tend to germinate better than regularly dispersed seeds, so *R. funerea* is not essential for the seeds germination. For the dispersal of seeds however, *R. funerea* is useful as it tends to disperse the seeds over greater distance. Moreover, the turtles seem to play a significant role in the dispersal and establishment of *Ficus insipida* (Moll & Jansen, 1994).

One of the mayor threats the species faces is human disturbance. An increase in boat traffic, due to increased eco-tourism in Costa Rica, might lead to decrease of basking activity (Czech *et al*., 2000; Selman *et al*., 2013). As aerial basking is of great importance to river turtles to maintain an optimum body temperature (Boyer, 1965). If boats get close to the basking turtles, the turtles drop into the water as they try to escape. The distance between a potential threat and the turtle, when it starts its flight behaviour, it known as the flight initiation distance (FID). A decrease in basking time might lead to a number of consequences like reduced digestive activity, decrease in dermal synthesis of vitamin D, and reduced reproductive fitness and growth (Boyer, 1965; Mahmoud *et al*., 1989; Congdon *et al.*, 1994; Sapolsky *et al*., 2000; Busch & Hayward, 2009).

The main objective of this study was to gain more knowledge on the flight behaviour of *R. funerea* in relation to boat traffic. The aim was to observe, on kayak and motorboat surveys, if there is variation in flight behaviour in relation to time of day, side and section of the canal, size classes, basking locations and weather conditions. It was hypothesized that individuals of *R. funerea* would display flight behaviour from a greater distance on kayak surveys because off the difference in speed (Moore & Seigel, 2006). It was also hypothesised that younger turtles, which are not habituated to human disturbance, show flight behaviour from a greater distance than mature individuals (Moore & Seigel, 2006). The type of basking spot might also be of importance, as more vegetated and camouflaged basking spots might feel safer to the turtle than open logs (López *et al*., 2005). Another hypothesis was the relation between weather conditions and flight behaviour, as it was expected that turtles would be less inclined to show flight behaviour on colder days (Boyer, 1965; Huey & Slatkin, 1976). A side objective of this study was to set up a motorboat survey on which the number of *R. funerea* on the Caño Palma canal could be assessed.

2. Methods

2.1. Study area

Kayak surveys were conducted from October 1 to December 28, 2014 on a 3.8 kilometre stretch of the Caño Palma canal which starts at Caño Palma Biological Station (E: 0223454, N: 1772185) and ends at the entrance of Turtle Beach Lodge (E: 0221482, N: 1175410). Motorboat surveys were conducted from September 29 to December 29, 2014 on a 4,6 kilometre stretch, of the same canal, which starts at Caño Palma Biological and ends at the entrance of Laguna Cuatro (E: 0221037, N: 1176150 (Figure 1). The Caño Palma canal is located within the Barra Del Colorado Wildlife Refuge. The area is covered by lowland Atlantic tropical wet forest and has an average temperature of about 26 degrees Celsius and an annual rainfall of about 4500 millimetres (Janzen, 1983).

2.2. Flight behaviour

The flight behaviour of *Rhinoclemmys funerea* was observed on 68 surveys. A total of 56 surveys were conducted from a kayak and 12 from a motorboat. Of the 56 kayak surveys, 28 surveys were conducted in the morning, 14 surveys while going north and 14 surveys while going south. A total of 28 surveys were conducted in the afternoon, 14 surveys while going north and 14 surveys while going south. The kayak surveys were conducted on random days. All motorboat surveys were conducted on Mondays in the afternoon, 6 while going north and 6 while going south. When a turtle was spotted on kayak or motorboat surveys, the distance between the turtle and the boat, when the turtle displayed its flight behaviour, was estimated using a global positioning system (GPS; Garmin GPSMAP 62S) as a control. The flight initiation distance (FID) was rounded up to the nearest multiple of five. Encountered turtles were categorized in three groups depending on their estimated size: TJ15 (Turtle juvenile <15 cm.), TY25 (Turtle young 15 – 25 cm.) and TM35 (Turtle mature >25 cm.). To estimate the size of the turtles, their basking spot was used as a reference point (Gallego-García & Castaño-Mora, 2008). The basking spots were categorized as "Open" (completely free of any cover) or "Covered" (partially or fully covered by vegetation). The coordinates of the basking spot were noted using a GPS (Garmin GPSMAP 62S) and the time was noted. The research stretch for FID, of both kayak and motorboat surveys, was divided into three sections of 1075 metres, using the latitudinal coordinates as a reference point, starting at Caño Palma Biological Station and ending at the entrance of Turtle Beach Lodge, to check for differences in FID between different sections of the canal.

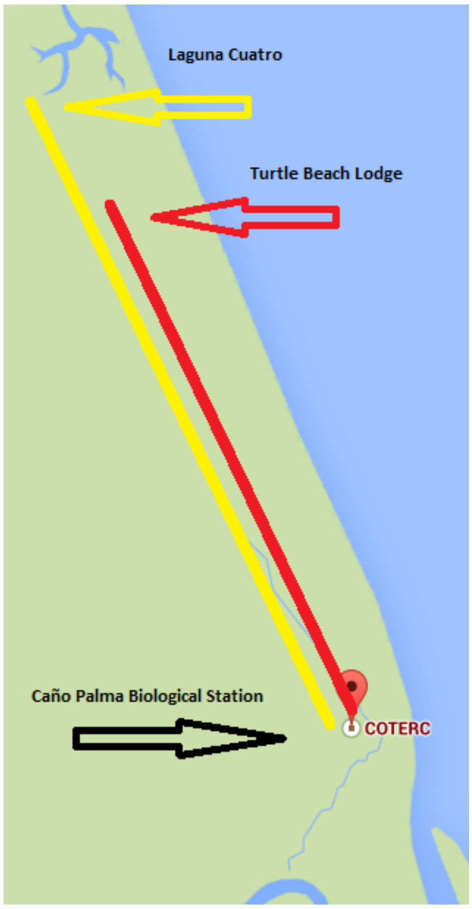

Figure 1. Map of the research area displaying survey stretches for Kayak (Red) and motorboat (Yellow) surveys and the three landmarks. (Reference: Google maps).

2.3. Human disturbance

On both kayak and motorboat surveys, any passing boat was noted. Boats were categorized as motorboat, kayak and other manually propelled boat. The direction of the boat and the time when it passed by was noted.

2.4. Number of turtles

The main goal of the motorboat surveys was, apart from FID research, to set up a long-term monitoring survey to estimate the abundance of *R. funerea* on the Caño Palma canal. Turtle counting was conducted while observing FID. For every encountered turtle, the basking spot, side of the canal, size group, time, and coordinates were recorded in the same manner as previously described. For the number of turtles, only data from surveys going north was used. The research stretch was divided into four sections, the first three being the same as the sections used in on kayak surveys, section 4 being the section between Turtle Beach Lodge and the entrance of Laguna Cuatro.

2.5. Basking spots

Once per month, an assessment of the number of possible basking spots on the canal was conducted. During this assessment, the research stretch of the kayak surveys was split in three sections using a global positioning system (GPS; Garmin GPSMAP 62S). The sections were split using latitudinal coordinates, each section consisted of 540 metres north starting at Caño Palma Biological Station. Both the east and west side of the canal were assessed. Possible basking spots consisted of any emerging material such as logs and root systems of palms, as long as the material formed a stable and easily accessible platform above the water so the turtle could readily escape when it felt threatened (Boyer, 1965).

2.6. Canal measurements

During the first two weeks of December, the width of the canal within the research stretch of kayak surveys was measured. Measurements were taken at 129 points using a global positioning system (GPS; Garmin GPSMAP 62S) and a 50 metres measuring tape. The measuring points were determined at 25 metres intervals using latitudinal coordinates as a reference.

2.7. Weather data

During both kayak and motorboat surveys, the cloud cover at the start of the survey was noted. The percentage of cloud cover was categorized in five groups: No cloud cover (0-10%), Light cloud cover (10-30%), Medium cloud cover (30-60%), Heavy cloud cover (60-90%) and Full cloud cover (90-100%). Temperature and rainfall data were provided by Caño Palma Biological Station.

2.8. Analysis

The data collected during the surveys was analysed and tested using Excel (2013) and IBM SPSS Statistics (Version 21). As the data were non-normally distributed (Shapiro-Wilk, $p < .05$), the Mann-Whitney U test ($\alpha = .05$) was used to test for differences between the FID, during kayak and motorboat surveys, for time of day, side of the canal, direction of the survey, basking spot and for the difference in FID between the kayak and motorboat surveys. The same test was used to test for differences between east and west in basking spot assessment data. The Kruskal-Wallis test ($\alpha = .05$) with a post hoc Mann-Whitney test ($\alpha = .05$), using a Bonferroni adjustment of *p*–value, was used to test for differences in FID, during kayak and motorboat surveys, between the sections of the canal, months of observation, cloud cover and the size groups of turtles. The same test was used to test for differences in the number of *R. funerea*, encountered on motorboat surveys, and differences in width, for different sections of the canal. As the number of basking spots was normally distributed (Shapiro-Wilk, $p > .05$), the One-Way ANOVA test was used to test for differences in the number of basking spots for different sections of the canal and the number of basking spots during different months. A negative binominal model ($\alpha = .05$) with log link function was used to test for correlation between FID and width of the canal, temperature at the time the turtle was encountered, temperature on the day before, rain on the survey day, rain on the day before the survey and the water level on the survey day.

3. Results

3.1. Flight initiation distance

During this study, a total of 247 displays of flight behaviour of *Rhinoclemmys funerea* were observed, where 171 displays were observed on kayak surveys and 76 on motorboat surveys. A significant difference in flight initiation distance (FID) was observed (U = 4302.50, Z = -4.331, p < .001), where FID was larger on motorboat surveys than FID on kayak surveys. No correlation was found between the FID and the width of the canal (Wald χ^2 = 1.380, P = .240), temperature on the encounter time (Wald χ^2 = .087, P = .768), temperature on the day before (Wald χ^2 = .174, P = .677), rain on the survey day (Wald χ^2 = 1.133, P = .287), rain on the day before the survey (Wald χ^2 = .088, P = .766) and the water level on the survey day (Wald χ^2 = .378, P = .538). No significant difference in FID was found for turtles encountered on the ways north or south on both kayak (Appendix 1.1) and motorboat (Appendix 1.2) surveys. Four turtles of the size group TJ15, 96 of TY25 and 71 of size group TM35 were encountered on kayak surveys, where only 43 turtles of TY25 and 33 of size group TM35 were encountered on motorboat survey. No significant differences in FID were found, on both kayak (χ^2(2, 171) = 2.42, P = .298) and motorboat (χ^2(1, 76) = 1.64, P = .201) surveys, between turtles of different size groups.

3.2. FID on kayak surveys

A difference in FID was found on kayak surveys for turtles in different sections of the canal (χ^2(2, 171) = 13.42, P = .001). A total of 145 displays of flight behaviour were observed in section 1, 15 in section 2 and 11 in section 3, where the FID was significantly greater in section 3 than in section 1 (U = 320.00 , Z = -3.423, p = .001). Between the different basking spots, a significant difference in FID was observed, where FID of turtles basking on open basking spots was greater than FID of turtles basking on covered basking spots (Appendix 1.1). No significant difference was found in FID between turtles encountered in the morning or the afternoon and no significant difference was found in FID between turtles on the east and west side of the canal (Appendix 1.1). A total of 43 displays of flight behaviour were observed during October, 60 displays during November and 68 displays during December. No significant difference in FID was found between the months (χ^2(2, 171) = 4.689, P = .096).

3.3. FID on motorboat surveys

A significant difference was found in FID of turtles basking on different basking spots, where the FID of turtles in open basking spots was greater than FID of turtles in covered basking spots (Appendix 1.2). No difference in FID was found between different sections of the canal on motorboat surveys (χ^2(2, 76) = 2.85, P = .240), where 47 displays of flight behaviour were observed in section 1, 11 in section 2 and 18 in section 3. No significant difference in FID was found between turtles basking on the East and West side of the canal and no significant difference was found between turtles who were observed in the morning or the afternoon (Appendix 1.2). During September, one display of flight behaviour was observed, 15 displays were observed in October, 21 in November and 39 in December. No significant difference in FID of the turtles was found between the months (χ^2(3, 76) = 1.48, P = .686).

3.4. FID and weather

Five kayak surveys and four motorboat surveys were conducted while it was raining, no turtles were encountered on those surveys. No significant difference was found, for both kayak (χ^2(4, 171) = 2.73,

P = .605) and motorboat (χ^2(2, 76) = .295, P = .863) surveys, in FID of turtles during different cloud covering.

3.5. Human disturbance

During 20 of the 56 kayak surveys, human disturbance caused by boat traffic occurred. A total of 35 motorboats, seven kayaks and four manually propelled boats were observed. A total of 22 motorboats were observed in the morning and 13 in the afternoon. All kayaks and manually propelled boats were encountered in the morning (Appendix 3).

3.6. Number of turtles

A total of 73 turtles were counted during motorboat surveys, of which 34 turtles were observed in section 1, nine in section 2, 17 in section 3 and 13 in section 4 (Appendix 2). No significant difference was found for the number of turtles between the different sections (χ^2(3, 39) = 3.97, P = .265).

3.7. Basking spots

The number of basking spots, on both sides of the canal, showed a significant difference (F(3, 44) = 9.67, p < .001) over the months, where the number of basking spots counted in September (*M*: 25.00, *SD*: 8.63) and December (*M*: 26.00, *SD*: 9.84) was higher than the number of basking spots counted in October (*M*: 17.50, *SD*: 4.27) and November (*M*: 12.25, *SD*: 4.56). No significant difference was found for the number of basking spots on the east and west side of the canal (U = 225.50, Z = -1.291, p = .197). Between section 1 (*M*: 21.94, *SD*: 10.64), section 2 (*M*: 21.94, *SD*: 8.86) and section 3 (*M*: 16.69, *SD*: 6.70), no significant differences were found in the number of basking spots (F (2, 45) = 1.87, p = .167).

3.8. Canal Width

A significant difference was found for the width of the canal in the different sections (χ^2(2, 129) = 64.88, P < .001). Section 1 was wider than section 2 (U = 228.00, Z = -6.020, p < .001) and section 3 (U = 103.50, Z = -7.100, p < .001). Section 2 was wider than section 3 (U = 520.00, Z = -3.503, p < .001).

4. Discussion

Individuals of *Rhinoclemmys funerea* who used a more covered basking spot were less inclined to escape into the water than turtles who used an open basking spot. This difference might be due to the protection a covered basking spot provides as turtles are less visible to predators. Therefore the turtle might decide to use a freeze response, rather than a flight response, while trusting on its camouflage in order to prevent predation (Hayes & Saiff, 1967; Martín & López, 2000; López *et al*., 2005). This phenomenon was observed a few times when turtles basking on covered spots did not display flight behaviour until intensely approached. It seems that FID of *R. funerea* was not altered when it faced the same threat, in this case the kayak or motorboat, within a relatively short time span because there were no differences between FID while surveys were going north or south. Therefore it is possible to use the FID data collected on surveys going both north and south.

The results showed that *R. funerea* displayed flight behaviour from a greater distance on motorboat surveys than turtles encountered on kayak surveys. The reason for this finding might be due to the difference in size of a motorboat compared to a kayak. Another reason might be the difference in vibrations caused by the motorboat. A different possibility might be that turtles were not encountered during kayak surveys because they displayed flight behaviour from a greater distance than could be observed properly. The reasons for this belief are 1) the difference in number of turtles encountered on kayak surveys compared to the number of turtles encountered on motorboat surveys, and 2) the number of unidentified splashes in the water during kayak surveys. These splashes were not included in the turtle data because it was not possible to determine what caused them, although it is quite likely they were caused by an escaping turtle. It may be possible that the difference in speed, between the kayak and motorboat, made turtles display flight behaviour before they were spotted on kayak surveys, because turtles seem to feel more threatened by slow moving boats (Moore & Seigel, 2006; Selman *et al*., 2013). This hypothesis is supported by observations on motorboat surveys when turtles did not show any flight behaviour when the boat passed by on the way back, at high speed. Another reason might be the amount of habituation towards motorboats as they frequently pass by at high speed, as well as low speed (Moore & Seigel, 2006; Selman *et al*., 2013). Boat data showed that the number of kayaks used on the canal was much lower than the number of motorboats. The lack of difference in FID between turtles of different size groups, and therefore probably of different age, could mean that the level of habituation is not strongly related to the age of the turtles. It could also mean that habituation is of less importance than the speed of the approaching boat because older individuals did not show any difference in FID compared to younger individuals.

The difference in FID of *R. funerea* in different sections of the canal might be due to a number of different reasons. As the sections differ in width, the amount of sunlight which reaches the possible basking spots is less in the sections that are narrower. The side of the canal which gets the most direct sunlight is the east side. As most turtles were encountered on that side, it is very likely that the amount of direct sunlight is the most decisive factor for the turtles to choose their basking spot, as there was no difference in the number of basking spots between the sides of the canal. In some parts of the canal, direct sunlight only reaches the possible basking spots in the early morning. It might be possible that the turtles who were encountered in narrow sections did not reach their optimal body temperature when they were encountered, so they displayed their flight behaviour earlier to make up for reduced performance like in some other reptiles (Rand, 1964; Smith, 1997; Cooper, 2000). The fact that no significant correlation between temperature and FID was found does not necessarily mean there is no correlation. The low number of *R. funerea* found during relatively colder days or the fact that the temperature data was not collected at the basking spot might explain the lack of significant results. Another possible reason might also be linked to the width of the canal in different sections. As turtles visually judge their exposure to possible predators, they might feel more threatened on narrow sections because a possible threat, in this case the kayak, is more likely to come close to the turtle than it would be in wider sections of the canal (Hayes & Saiff, 1967; López *et al*., 2005). This might also be the reason why most turtles were encountered in the first section of the canal as it is the widest part. Another reason might be the number of different food sources in the different sections of the canal, as *R. funerea* is known to feed on a number of local fruits and seeds (Moll & Jansen, 1994). The results, however, did not show any significant difference in the number of turtles between different sections of the canal. This might be due to the low number of successful motorboat surveys, as turtles were only spotted on seven motorboat surveys and on one of those surveys only one turtle was spotted.

During rainy days, turtles did not bask. The amount of rain on the day before survey, or on the day of survey, did not have an effect on the FID of the turtles. Neither did the amount of cloud cover or the time of day. This is not as was expected because a lack of basking time, caused by rain or heavy cloud cover, might result in failure in reaching the optimum body temperature which might lead to decreased metabolic activity (Boyer, 1965; Huey & Slatkin, 1976; Huey, 1982; Angilletta *et al*., 2002; Bulté & Blouin-Demers, 2010). Therefore it was expected that FID, of *R. funerea* encountered after periods of rain of heavy cloud cover, would decrease because the turtles needed the basking time to increase digestive activity (Parmenter, 1981; Edwards & Blouin-Demers, 2007; Dubois *et al*., 2009; Polo-Cavia *et al*., 2012). The same was expected when turtles were encountered in the morning. It might be possible that the encountered turtles had already been able to acquire the right body temperature, which would explain the lack of difference or correlation for different weather conditions. As the optimal body temperature for *R. funerea* is unknown, it might be possible that it is relatively low, which might also explain the lack of difference in FID for less warm weather conditions. This however, cannot be stated with any certainty because no research has been conducted on the optimum body temperature of the Black River Turtle.

During the different months, the FID did not significantly change, on both kayak an motorboat surveys. However, a change in the number of *R. funerea* occurred during motorboat surveys. During October, eight turtles were counted on both surveys, where on the last successful survey of December a total of 33 turtles were counted. This increase in number of turtles might have been caused by the flooding in November, when the river kept flowing north for a longer period of time. This flooding might also be the reason for the changing number of basking spots as the number of basking spots was lower when the water level was higher. Another possibility is seasonal migration of the turtles. As some river turtles were found on the beach by sea turtle patrols, it might be possible that *R. funerea* is forced to nest near or on the beach because of a lack of nesting beaches or other nesting spots on the canal. Seasonal migration has been observed in other river turtle species (Hurtado, 1973; Moll & Moll, 2000; Gallego-García & Castaño-Mora, 2008).

5. Conclusion

During this study, individuals of *R. funerea* were more likely to display flight behaviour from a greater distance when they used an open basking spot, probably because they were more visible and accessible to predators. Some of the turtles who were basking on covered basking spots did not even show flight behaviour until intensely approached. When turtles were approached more than once an a relatively short time span, the FID did not change. The flight behaviour of *R. funerea* encountered on motorboat surveys was different than the flight behaviour observed on kayak surveys. Even though data showed a greater FID on motorboat surveys, turtles probably displayed flight behaviour from a greater distance on kayak surveys because of the difference in speed of the vessel and the difference in habituation towards different types of boats. A difference in environmental factors on different sections of the canal were probably decisive for the difference in FID and the cheer number of turtles who were visible in the different sections of the canal. As basking time is related to rainfall and temperature, no turtles basked when it was raining. No other relations with weather conditions were found, so it might be possible that the basking time of *R. funerea* is not strongly linked to weather conditions. The conditions of the canal itself, as well as additional seasonal conditions might be strongly related to the number of turtles on the Caño Palma canal.

As information on *R. funerea* is scarcely available, it was not possible to find hard evidence to explain most findings. Therefore it is of utmost importance to continue the motorboat surveys to see if any changes occur in the population in relation to environmental factors. Radio telemetry could be very useful to gain knowledge on the seasonal movements of *R. funerea*, as it might explain the difference in number of turtles before and after the flooding of the canal. More detailed research on the basking behaviour should be conducted to gain more knowledge on that subject, as it is of great importance to the turtles metabolic activity and therefore eventually for reproduction fitness.

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Appendix 1

Appendix 1.1. Results of the Mann-Whitney U tests (α=0,05) on differences in FID of basking *R. funerea* for different grouping variables. Data was collected on kayak surveys (N=171).

Grouping variables		*n*:	*U* value	*Z* value	*p* value
Side of canal	East	154	1240.00	-.218	.713
	West	17			
Basking spot	Open	117	1840.50	-4.540	**<.001**
	Covered	54			
Direction of survey	North	88	3279.50	-1.189	.234
	South	83			
Time of day	Morning	69	3452.00	-.218	.827
	Afternoon	102			

Appendix 1.2. Results of the Mann-Whitney U tests (α=0,05) on differences in FID of basking *R. funerea* for different grouping variables. Data was collected on motorboat surveys (N=76).

Grouping variables		*n*:	*U* value	*Z* value	*p* value
Side of canal	East	68	246.50	-.439	.661
	West	8			
Basking spot	Open	60	277.00	-2.630	**.009**
	Covered	16			
Direction of survey	North	60	459.50	-.266	.791
	South	16			

Appendix 2

Appendix 1. Raw data on human disturbance, in the form of passing boats, collected on kayak surveys.

Date	Time	Direction boat	Type	Direction survey
7-10-2014	12.44	s	Motor	n
7-10-2014	12.52	n	Motor	n
7-10-2014	13.12	s	Motor	n
16-10-2014	9.12	s	Motor	n
16-10-2014	9.17	n	Motor	n
16-10-2014	9.33	s	Motor	n
18-10-2014	14.41	n	Motor	n
19-10-2014	8.57	s	Motor	n
21-10-2014	13.18	n	Motor	s
21-10-2014	13.52	n	Motor	s
22-10-2014	8.39	n	Boat	n
22-10-2014	9.13	s	Motor	n
22-10-2014	9.15	s	Motor	n
1-11-2014	13.27	n	Motor	n
1-11-2014	14.08	s	Motor	s
8-11-2014	13.09	n	Motor	n
19-11-2014	13.58	n	Motor	s
22-11-2014	12.33	s	Motor	n
22-11-2014	13.05	n	Motor	n
23-11-2014	9.23	s	Motor	n
29-11-2014	10.11	s	Motor	n
29-11-2014	11.12	n	Motor	s
15-12-2014	9.10	n	Boat	n
15-12-2014	10.26	n	Kayak	s
19-12-2014	10.01	s	Motor	n
19-12-2014	11.01	s	Motor	s
19-12-2014	11.22	n	Boat	s
20-12-2014	9.17	n	Motor	n
20-12-2014	9.18	s	Motor	n
20-12-2014	9.22	s	Motor	n
20-12-2014	10.29	s	Motor	s
22-12-2014	8.59	s	Motor	n
22-12-2014	9.02	s	Boat	n
22-12-2014	9.04	s	Motor	n
22-12-2014	9.39	n	Kayak	n
22-12-2014	9.39	n	Kayak	n
22-12-2014	9.39	n	Kayak	n
22-12-2014	10.31	n	Motor	s
22-12-2014	10.37	s	Motor	s
23-12-2014	13.20	n	Motor	n
23-12-2014	13.37	n	Motor	s

26-12-2014	13.06	s	Motor	n
28-12-2014	9.55	n	Motor	n
28-12-2014	11.04	n	Kayak	s
28-12-2014	11.04	n	Kayak	s
28-12-2014	11.09	n	Kayak	s