Turtle Population Assessment at Parque Natural Metropolitano

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Introduction

Context

Parque Natural Metropolitano (PNM) is a park located in the province of Panamá, the neighborhood of Ancon, and between the roads Ascanio Villalaz and Juan Pablo II. The park is a protected area that was created with Law 8 of July 1985. Since its inauguration, PNM has promoted recreation, education, and ecosystem management as a major tourist attraction. Known as the "Pulmón de la Ciudad de Panamá", the park is an important conservation region for Panama City. PNM is the only protected area in Central America located within city boundaries, making it a unique place for both habitat protection and tourism (PNM, 2010).

PNM is characterized for having both tropical rainforest and tropical dry forest, which have ecosystems inhabited by a variety of species of flora and fauna. Within the 232 hectares are a recorded 284 species of trees, 45 species of mammals and 254 species of birds, reptiles, and amphibians. Since 1998, a rescue and rehabilitation program for many kinds of animals has been implemented at the park. This includes aiding injured, displaced, or orphaned animals with the goal to return them to their natural habitat (PNM, 2010).

Objectives

The project that was presented by PNM involved the current turtle population in the small pond along the El Roble trail and involved rapid population growth of unidentified turtle species. Throughout the years, non-native turtles had been introduced in the park and this led to an observable overpopulation of the pond. The park has not implemented a management strategy because more information was necessary in order to make an informed decision. Therefore, the aim of this project was to assess the turtle population and present strategies for population control and management. The park wanted to obtain the following information: the number of

turtles and their classification, the reproductive rate and lifespan, their source of food, and if the size of the pond was sufficient for the present turtle population. Along with a summary of pertinent information, the park wanted an interpretive guide containing information on the species of turtles found there, which would be given to park visitors for educational purposes.

Background Information

The small freshwater pond that is the focus of this project, otherwise known as "La Lagunita", is located 145 meters from the start of the primary trail of PNM called El Roble. It is considered an easy walk because it is 700 meters in length and involves no steep terrain. Due to this factor, the trail is well-traveled by park visitors and the pond is often the first stop (PNM, 2010).

The pond was artificially created in 2001 under a former collaborator for the protected area of the park, Sixto Mequizama. The area was completely covered by "paja canalera" (*Saccharum spontaneum)*, an introduced species of grass that was found to slow the process of forest regeneration after the park area became protected. It was decided that the straw grass needed to be removed and, after this was completed, collaborators like Mequizama observed that the area was very humid and pooled water easily (Castillo, 2015). This is what led to the creation of the pond.

As the Lagunita is artificial, all of the inhabitants were introduced since the pond's establishment. The fish that were introduced include tilapia, catfish, sardines, and hogfish. As for reptiles, there is the Jesus lizard or "meracho", which is a lizard that runs rapidly on the water to avoid predators. The pond predators include a variety of bird and mammal species that can be observed in the surrounding area. The pond is very small; its length along the trail is 10.1 meters and at its widest point is approximately 5 meters. The water originates from several springs that

are behind the pond. The rainy season is what helps maintain the pond depth at around 4 meters. The water is murky; the coloration is due to iron-filled sediment as well as the movement of aquatic animals and fallen leaves and branches (Castillo, 2015).

According to Jeraldyn Castillo's assessment of the Lagunita in 2015, there are a few common turtle species present with *Trachemys scripta*, or the Red-Eared Slider, as the most common. While its population had increased due to reproduction, the majority of the introductions were due to park visitors who brought their pet turtles that they no longer wanted to care for. Because of this and the overpopulation that was observed, it became established at PNM that visitors were not allowed to release their turtles (Castillo, 2015).

The current manager of the faunal rehabilitation and release program at PNM, Elias Estrada, had experience with handling the turtles in recent years. In fact, in December 2016 he relocated 70 turtles from the Lagunita to a lagoon near the Miraflores locks of the Panama Canal in Camino de Cruces National Park. Before the removal, he had estimated that the Lagunita held 150 turtles. The pond in PNM was clearly over capacity, which was why he had resorted to a more permanent measure in efforts to mitigate the overpopulation which had occurred. Before this, however, there was evidence that turtles were held in the rehabilitation center for observation. In 2005, the Programa de Rescate y Rehabilitation de Fauna Silvestre (PRRFS) recorded the presence of: one hatchling, five juveniles, and ten adults, all of the species *Rhynodemmys annulata,* or Brown Wood Turtle. Furthermore, in the PRRFS data it was noted that two juvenile *R. annulata* were bred in captivity, with one having the descriptive term "red ear" (PNM, 2006). In addition, it stated that two adult *R. annulata* were "displaced" (PNM, 2006). This illustrates that there was confusion about the classification of these species, as Brown Wood Turtles do not have a red marking characteristic of Red-Eared Sliders.

Furthermore, individual turtles had been raised by the park as well as removed in the year 2006. This was the only record of any turtle presence or relocation that the park had kept.

Methodology

Literature Search

I conducted my literature search using the McGill University Library Database, Google Scholar, and the STRI Library Database. Common search terms I used for determining the methodology to use and to obtain background information included “freshwater turtle capture”, “species abundance”, “Red-Eared Slider”, “pet turtle release”, “Parque Natural Metropolitano tortuga”, and “freshwater turtles”.

Turtle Handling

From my initial observations, the Lagunita appeared to be dominated by turtles. As you approach the pond, turtles swim up along the shore and observe you. In the park, the turtles are used to visitors feeding them bits of food, despite the fact that the park explicitly states not to feed them. The turtles have become sociable with park visitors and are not shy to swim close.

To capture individual turtles, I used chicken as bait, fishing line with a hook, and a homemade commercial-sized hoop net. Captured turtles were marked in order to know whether the individual had been previously captured and measured. The method for marking was obtained from Yorks (2015); a Swiss Army knife was used to cut an “X” shape into the furthest right posterior plastron scute. The plastron is the underside of the turtle shell is divided into large scales that are called scutes. The equipment for measurement was provided by PNM and included gloves, an animal cage, a hoop net, and measuring tape.

Data Collection and Analysis

Individual characteristics. Individuals were captured and measured to obtain quantitative measurements of body size and record common species characteristics. Furthermore, the life stage of the turtle was estimated from these observations. This methodology is common in papers that observe and capture freshwater turtles (i.e. Reidle et al., 2008). Straight-line carapace length and straight-line carapace width were measured in accordance with the protocol of Paez et al. (2015). Life stage estimations were made using carapace length (CL) measurements outlined by Shine and Iverson (1995); the concrete measurements provided were for CL at hatching, CL at sexual maturation, and maximum CL recorded for each species. Data for each species of interest from this publication are summarized in Table 2 (Appendix I). There is no single method for determining life stage of freshwater turtles. For simplicity, the turtles that were captured and measured were placed into two categories: juvenile or adult. A turtle was labelled juvenile if it was between the measurements of CL at hatching and CL at maturity, whereas if the turtle surpassed CL at maturity then it was deemed an adult.

Turtle abundance. To determine the abundance of turtles in the pond, I conducted basking surveys. This involves counting the number of turtles at the surface of the pond, on the shore, or on rocks and branches when they are basking in the sun for warmth. This is one method that researchers use to estimate relative abundance of semiaquatic turtles in an environment (Paez et al., 2015; Gallego-Garda and Castano-Mora, 2008; Restrepo et al., 2008; Gonzalez-Zarate, 2010). Another way to estimate relative abundance is with the Capture-Recapture Method, which involves capturing individual turtles using bait and nets and then marking the turtle before releasing it back into the pond. Then, at the next time of capture, record how many turtles that were captured had already been marked. From this you can estimate the number of turtles in the

pond. I followed the Lincoln-Petersen Method for a simple calculation on relative abundance based on capture data (Seber, 1982).

Identification of turtle species. I used the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Identification Guide for Turtles and Tortoises (CITES 1999) and followed the Dichotomous Key for classification. The characteristics to determine the species of an individual include but are not limited to: shape of limbs, number of claws, shape of carapace (top of shell), number of scales on plastron (bottom of shell), head shape, number of carapace marginal scales, number of keels (elevation of carapace), and serration of carapace (CITES, 1999).

Creation of Educational Material

The interpretive guide was modeled after the brochure for a guide of services. The guide contains an introduction on turtles and their ecology and follows with photos and descriptions of the species of turtles that can be found at the pond.

Limitations

Determining sex. I was not able to measure tail length of the individual turtles I caught because it was difficult to handle them and maneuver the turtles for our needs. I attempted to compare tail lengths between turtles of same species based on photos, however in order to accurately compare between two turtles they had to be of the same size and maturity. Due to these constraints, I was not able to determine the sex of the turtles that I captured. For this reason I did not collect that data and instead focused on the dimensions of the carapace. If the park wanted to obtain this information, I suggest either having an expert to observe the collected data and photographs, or to capture individual turtles and hold them for a longer period so that the measurements can be taken.

Estimating turtle abundance. In doing research I found it difficult to find one estimation or equation that would be appropriate to use for the data I have collected. This is because the sample size is small, so assumptions that are made for different methods used by researchers would not make sense for my data. In the Results section, I present a couple of different calculations based on different methodologies. I feel most confident based on my methods and data collected that a visual estimate is the best approximation of population size.

Record of turtles at the park. A major obstacle to this project was the lack of data surrounding the history of the turtle population at the park. It would have been helpful to have had a record of how many pet turtles were accepted by the park before they banned this practice, as well as which species the individuals were. Because of this, it was difficult to establish an understanding of population dynamics, for example in terms of growth over time and how the population became established.

Expertise on freshwater turtles. As there was no available record of turtles at the park, a strong background in understanding freshwater turtle populations was necessary in order to understand the population dynamics present in the Lagunita. It was difficult to research population dynamics of non-native pet turtle species in the context of a natural environment. Due to these constraints, I was not able to obtain information regarding the ages and sexes of the individuals, which prevented me from establishing reproductive rates or quantify population growth. This would have been very useful to the park for determining a strategy for management; my final suggestions should be viewed with this in mind.

Code of Ethics Certification

All research was carried out following the *Code of Ethics* of McGill University (see Appendix III for certificate).

Results

Literature Search

Freshwater turtles. For most turtle species, the life history strategy is characterized by slow population growth rates (Doak et al., 1994; Heppell, 1998). Other common characteristics include slow body growth, requirement of multiple habitats, constant and relatively high rates of survival in sub-adult and adult stages, and temperature-dependent sex determination, with more females produced at higher temperatures (Paez et al., 2015). Collisions with vehicles on roads are a source of mortality in turtles; this may even be biased towards adult females due to their searches for nest sites (Marchand and Litvaitis, 2004; Steen and Gibbs, 2004; Aresco, 2005; Gibbs and Steen, 2005). Turtles move often and at relatively great distances.

The Red-Eared Slider. As the Red-Eared Slider was deemed the most common turtle found in the Lagunita, it is important to understand their ecology. First, their reproductive biology is highly variable. Males mature anywhere from 2 to 5 years, while females mature at 8 years. In the United States, females nest between April and July (Lambert et al., 2013). Females can lay anywhere from 1-30 eggs in one clutch and can lay between 1-5 clutches in a year (Lambert et al., 2013). Red-Eared Sliders can grow up to 35 centimeters in length, however they are generally 12.5-20 centimeters long (Csurhes and Hankamer, 2012). Maximum lifespan is generally 20-30 years, but some sources claim that the maximum age can be up to 75 years (Feldman, 2005; Dundee and Rossman, 1989). Red-Eared Sliders can walk up to 9 kilometers from water to find a suitable habitat, a mate, or to lay eggs (Department of Agriculture and Food, 2009). Nests can be dug up to 1.6 kilometers away from water (Department of Agriculture and Food, 2009). Females can produce viable eggs for up to 5 years after mating (O'Keefe, 2005). Time to hatching is approximately 68-70 days (Dundee and Rossman, 1989). Like other turtle

species, Red-Eared Sliders exhibit temperature-dependent sex determination. Incubation temperature of 28.3 °C will produce some females in the clutch (Cadi et al., 2004). If incubation temperature is greater than 30.6 °C, it will produce all females (Feldman, 2005). They do not feed at body temperatures lower than 10 degrees Celsius, and prefer water bodies that are eutrophic, 1-2 deep, with dense vegetation and supports high densities of aquatic invertebrates that it feeds on (Parmenter, 1980; Morreale and Gibbons, 1986). Red-Eared Sliders consume tadpoles, aquatic insects, fish, and amphibians. They are omnivorous but shift from carnivorous at the juvenile stage to herbivorous during their growth to adulthood (Prévot-Julliard et al, 2007).

The Common Slider, *T. scripta*, has been traded worldwide since the 1950s. It is a popular pet because at the time it was cheap and seemed relatively easy to take care of. There are three subspecies of *T. scripta: Trachemys scripta scripta, T.s. elegans,* and *T.s. troostii* (Bonin et al., 2006). The most widely traded of the three is *T.s. elegans,* or the Red-Eared Slider. Over 30 million Red-Eared Sliders were exported from the United States to 58 countries from 1994 to 1997, which led to species establishment in both temperate and tropical zones around the world (Salzberg, 1998; Spinks et al., 2003). In Europe it was very popular until 1997 when importing of the species was banned due to high risk of biological invasion (Scalera, 2007). The trade of the other two subspecies increased following this ban. Young sliders are sold at a small size, only a few centimeters in length, but they grow very quickly which is why some owners end up releasing them. This problem has been well-documented in the US and Europe (Ficetola, 2012).

T. s. elegans is native to the eastern United States and northeastern Mexico. It has been introduced worldwide and individuals have been reported in 73 countries (Lever, 2003; Pupins, 2007; Kraus, 2009; Pendlebury, 2009; Scalera, 2009; Kikillus et al, 2010). This species has been deemed invasive. They become dominant due to their size in comparison to other freshwater

turtles; they can compete for and dominate basking sites and are generally more aggressive (Macchi, 2008; Macchi et al, 2008, Polo-Cavia et al, 2010b, Spinks et al, 2003, Cadi and Joly, 2004). Presence of these sliders can affect whole freshwater communities (Lever, 2003; Teillac-Deschamps and Prevot-Julliard, 2006; Prévot-Julliard et al, 2007; Pérez-Santigosa et al, 2011).

The International Union for Conservation of Nature (IUCN) listed the Red-Eared Slider as one of 100 of the world's worst invasive species. For example, in Australia they have become a big problem for several ecosystems of the country. The IPA Risk Assessment of 2016 determined that there was High Risk because of the organism's history as a major pest worldwide, its broad geographic range, generalist diet, high fecundity, and its suitability for the climate of Australia. Naturalized populations were reduced to low levels over the last eight years due to an intensive eradication campaign with ongoing surveillance and control (Csurhes and Hankamer, 2012). The full ecological impact of Red-Eared Sliders is unknown (Ramsay et al., 2007; Bringsoe 2006).

The classification of the Red-Eared Slider has a confused history, and because of this makes it difficult to place the identified turtles into a class or genus. Taxonomy is still unclear. The common slider is given the taxonomic name of *Trachemys scripta* in the United States and Australia. But it may also be placed under the genera Chrysemys or Pseudemys. To further complicate things, hybrids of Red-Eared Sliders (*T. s. elegans*) with Yellow-bellied sliders (*T. s. scripta*) have been reported in the southern U.S. Hybridization is common in closely related freshwater turtle species (Csurhes and Hankamer, 2012).

Population Abundance

Overall, I made 20 basking survey counts over four months. The highest number I counted at one time was 37 on January 31st, and was confirmed again on April 10th. The lowest

count I made was 17, on March 13th. For my days of capture, the day that I captured the most turtles was on February 20th, where I caught 11. For other days, however, I averaged around a capture of 3-5 new turtles. In total, I caught 21 turtles and measured their carapace length and width (Table 1). From basking surveys I conclude that the population size of the Lagunita is at least 37 turtles.

Following the Capture-Recapture Method for an alternative measure of abundance, the number of turtles in the first capture (February 20th) was 11, the number of turtles in the second capture (February 22th) was 5, and the number of marked turtles in the second capture was 3 (Table 1). The resulting population size from this calculation is approximately 18 turtles (see Appendix II).

As for life stages of the individuals present in the population, it was determined based on carapace length measurements that, of the 21 turtles captured, there are 7 juveniles and 14 adults (Table 1). If the ratio were to be extrapolated to the estimated size of the population (37 individuals), approximately 33% of that population are juveniles and 67% are adults (Fig. 2).

Species Abundance

Of the 21 turtles captured, I identified 8 Red Eared Sliders, 2 Painted Turtles, 1 White-Lipped Mud Turtle, and 10 Yellow-Bellied Sliders (Fig. 1). All species identified in the pond are common pet turtle species.

For all intents and purposes, I have categorized all slider-type turtles that did not possess the red stripe, which is indicative of Red-Eared Sliders, as Yellow-Bellied Sliders. It is sometimes difficult to discern which species an individual turtle belongs to due to factors such as hybridization and species variance. For example, not all Red-Eared Sliders retain the characteristic red marking over their entire lifetime (Csurhes and Hankamer, 2012). In addition,

there may be hybrids of the two subspecies present in the Lagunita, but it is no possible to determine this without genetic testing and close observation. Because of this, my classifications may not be correct; however, I categorized individuals to the best of my ability by following the CITES Identification Guide.

An important note to mention is the lack of consistency in reference to the correct species of turtle not only at PNM but in publications as well. In the Introduction under the section about the history of "La Lagunita", the paper by Castillo (2015) referred to the Red-Eared Slider as *T. scripta*, which I have categorized in the literature review as the species of common Slider, while Red-Eared Sliders are the subspecies *T. s. elegans.* Furthermore, in the PNM Management Plan of 2006 they referred to the Red-Eared Slider as *Rhynnodemys annulata,* which is actually the Brown Wood Turtle. This illustrates the continued challenge of proper classification of these turtles, which may lead to future confusion in terms of monitoring the population.

Management Strategies

Different publications on slider turtles like the Red-Eared Slider have different opinions on how best to manage populations of such invasive species. The problem is complicated by the fact that people continue to purchase them as pets due to limited education and information about how these turtles can alter natural landscapes. The following information presents a variety of strategies in different countries as they attempt to address a similar problem to what has been outlined in this project.

According to Dodd, Jr., reptiles that are considered pests, "because they have unwanted effects on humans or native ecosystems, or because they are invasive," should be managed through removal of the unwanted individuals (Dodd, Jr., 2016). The author specifically mentioned Red-Eared Sliders, stating:

> "For example, the Red-eared Slider (*Trachemys scripta elegans*) invades many parts of the world, and may outcompete local turtle species (Klemens, 2000; Moll and Moll, 2004)… management of invasive species usually attempts to reduce population size or even completely eradicate these species… many introduced reptile populations are difficult or impossible to eradicate because of their secretive nature, high fecundity, and difficulty capturing all life stages." (Dodd, Jr., 2016)

While the author highlighted the issue of invasive species in contrast with other animals, there was no detailed method for removal of the species.

At California State University Northridge (CSUN), in May 2016 they created a Pond Renovation project on their property. Their project update stated the following:

> "Due to the overpopulation of domestic turtles at the pond, some turtles will be relocated by a reptile consultant to other areas that do not impact the native turtle populations in naturally occurring Southern California waterways. This turtle population reduction is intended to create and stabilize a sustainable turtle population at the pond. A shaded turtle enclosure has been constructed to house between 80-100 turtles that will be rereleased back into the pond after renovation." (CSUN, 2016)

The CSUN project demonstrates an alternative strategy for management, as they have seemed to develop a method to keeping most turtles in their pond and planning relocation of other individuals with concern for the natural waterways in the surrounding area.

Recently, I discussed with Elias Estrada, the manager of the faunal rehabilitation program at PNM, possible management strategies for the turtle population. Before the population abundance estimate was made, he suggested that the pond held 80 turtles. However, in counting at most 37 turtles in the Lagunita, he believed that it was plausible that turtles left the pond to

find a new habitat. The turtle population is self-regulated by emigration and, more significantly, by predation on turtle eggs by animals in the park such as the “gatos solos”, or Coatis. Because of this, if the current population size is around 40 turtles, in his opinion it is manageable to keep them at PNM. Close monitoring would be a necessary part of management, however relocation would not be required at this time.

Targeted culling, or the elimination of these turtles by the park, would not be a possible strategy. According to the reforms to the Code that were enforced starting in 2008, it is a criminal offense to kill domestic animals without authorization of a veterinary doctor. This is under Article 406-A of the Code and follows provisions concerning crimes against wildlife that were proposed by animal activists. Article 406-B imposes penalties of arrest from six months to one year for intentionally injuring a pet (Tu Política Panama, 2017). If PNM were to explore the option of eradication of the turtles, they would need to correspond with the National Government of Panama in order to comply with the law.

Conclusion

The findings from the survey of the turtle population in PNM demonstrate that the Lagunita hosts approximately 40 turtles of varying species commonly found as pets. The basking survey counts are what has been used to estimate the population size. The majority of the individuals are adults, or at least at the size of sexual maturity, which may indicate that there is potential for population growth. However, there is an element of population regulation due to predation on eggs limiting the hatchling survival rates.

While prevention of turtle introduction in the park would be the most idealist approach to the problem, it does not address all aspects of the issues with turtles like Red-Eared Sliders being introduced into nature. From what is understood about the turtles in the Lagunita, once they grow

too large, they are likely to leave PNM in attempts to find a new habitat. While there is high risk of death by vehicles for these turtles that leave, due to the establishment of the Biological Corridor the turtles may reach these locations (PNM, 2010). The Biological Corridor connects PNM to two national parks, Camino de Cruces and Soberania, which are much larger in scale than PNM and are also protected areas (Centro de Reserva Panama, 2010). There is a risk associated with turtles from PNM reaching these parks because, as was presented in the literature review of this paper, Red-Eared Sliders and Yellow-Bellied Sliders are subspecies that have the ability to establish populations in areas all over the world. Their presence in two major national parks of Panama may threaten wild species in ways that have not yet been studied in Panama. Due to these factors, determining a final solution for the turtle population at PNM is more complex and requires an integration of current knowledge of the situation.

My concluding thoughts focus on the opinion of Elias Estrada, as he has had the most experience with the turtles at the park and would subsequently be involved in implementing a management strategy. The fact that the current size of the population is manageable indicates that the current focus should not be on eradication or relocation, but rather on education. There seems to be no direct effect that the turtles have on this pond; furthermore, the pond itself was artificially created and there are no natural inhabitants to protect. The turtles have also become an attraction for tourists, as they enjoy being able to observe the turtles up close and to see "wild" animals in a park. The slider turtle population therefore presents an opportunity for learning and engagement with the Panama City community and its visitors. As Red-Eared Sliders have established populations all over the world, it may interest tourists to learn more about this aspect at PNM. However, it is important to keep close watch over these turtles, as they can outcompete endemic turtle species.

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Appendix I – Tables and Figures

Table 1. Capture Data for Turtle Species in La Lagunita of PNM.

Turtle Number	Date of First Capture	Date of Second Capture (and more if any)	Straight-Line Carapace Length (cm)	Straight-Line Carapace Width (cm)	Life Stage	Species	Common Name
1	2/2/17	2/3/17, 2/20/17, 2/22/17	20	15	Adult	*Trachemys scripta scripta*	Yellow-bellied slider
2	2/20/17		13	11	Juvenile	*T.s. scripta*	Yellow-bellied slider
3	2/20/17		18	15	Adult	*T.s. scripta*	Yellow-bellied slider
4	2/20/17		15	11	Adult	*Kinosternon Leucostomum*	White-lipped Mud Turtle
5	2/20/17		9	9	Juvenile	*T.s. elegans*	Red-eared slider
6	2/20/17		11	9.5	Juvenile	*T.s. scripta*	Yellow-bellied slider
7	2/20/17	2/22/17	14	11	Juvenile	*T.s. elegans*	Red-eared slider
8	2/20/17		28	23	Adult	*T.s. elegans*	Red-eared slider
9	2/20/17		11	9.5	Juvenile	*T.s. scripta*	Yellow-bellied slider
10	2/20/17	2/22/17	21	15	Adult	*T.s. elegans*	Red-eared slider
11	2/20/17		16	13	Juvenile	*T.s. scripta*	Yellow-bellied slider

12	2/21/17		21.5	16	Adult	*T.s. elegans*	Red-eared slider
13	2/21/17		16	13.5	Juvenile	*T.s. scripta*	Yellow-bellied slider
14	2/21/17		19	17.5	Adult	*T.s. elegans*	Red-eared slider
15	2/22/17		18	15	Adult	*T.s. scripta*	Yellow-bellied slider
16	2/22/17		24	18	Adult	*T.s. scripta*	Yellow-bellied slider
17	2/23/17		17.5	14	Adult	*T.s. elegans*	Red-eared slider
18	2/3/17	2/23/17	21	16	Adult	*Chysemys picta*	Painted turtle
19	2/23/17		25	18	Adult	*T.s. scripta*	Yellow-bellied slider
20	2/23/17		21	18	Adult	*C. picta*	Painted turtle
21	2/3/17	2/23/17	19	16.5	Adult	*T.s. elegans*	Red-eared slider

Table 2. Summary of Carapace Length (CL) Data from Shine and Iverson, 1995

Turtle Species	CL at hatching (cm)	CL at maturation (cm)	Maximum CL (cm)
Kinosternon subrubrum	2.2	7	10.5
Chrysemys picta	2.5	16	21.1
Trachemys scripta	3.1	17.2	25.8

Note: *K. subrubrum* was used for life stage determination because it is similar to *K. leucostomum* and of the same genus. *T. scripta* was used for both *T. s. elegans* and *T. s. scripta* individuals that were captured at PNM.

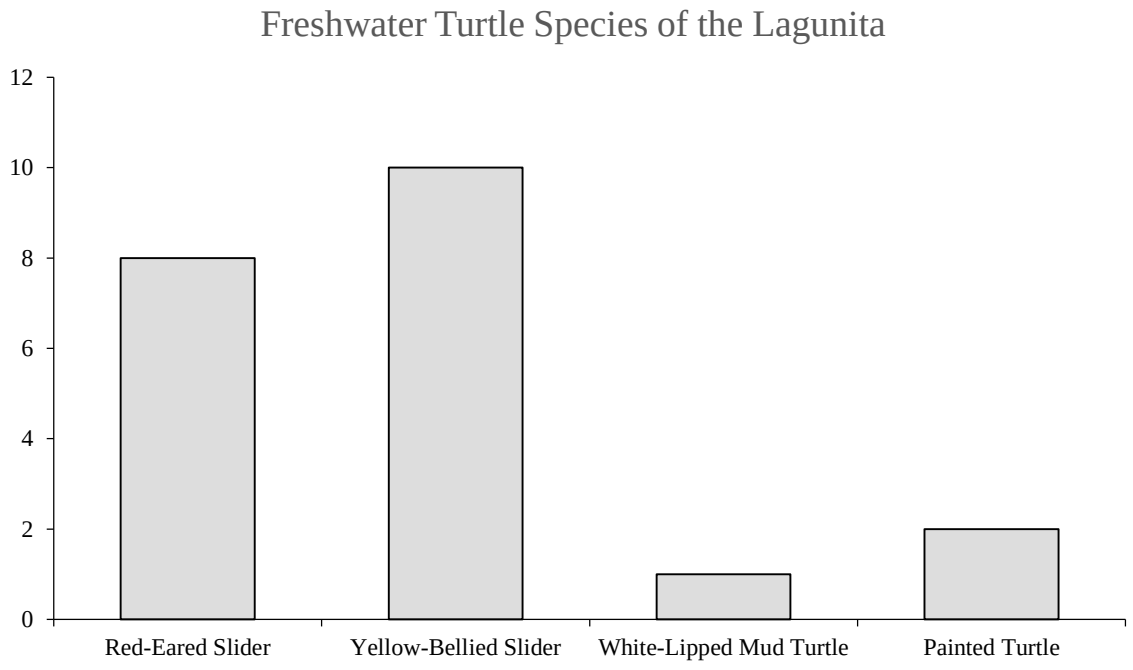

Figure 1. Number of identified turtle species present in the Lagunita at PNM as of April 2017; based on capture data of 21 turtles (Table 1).

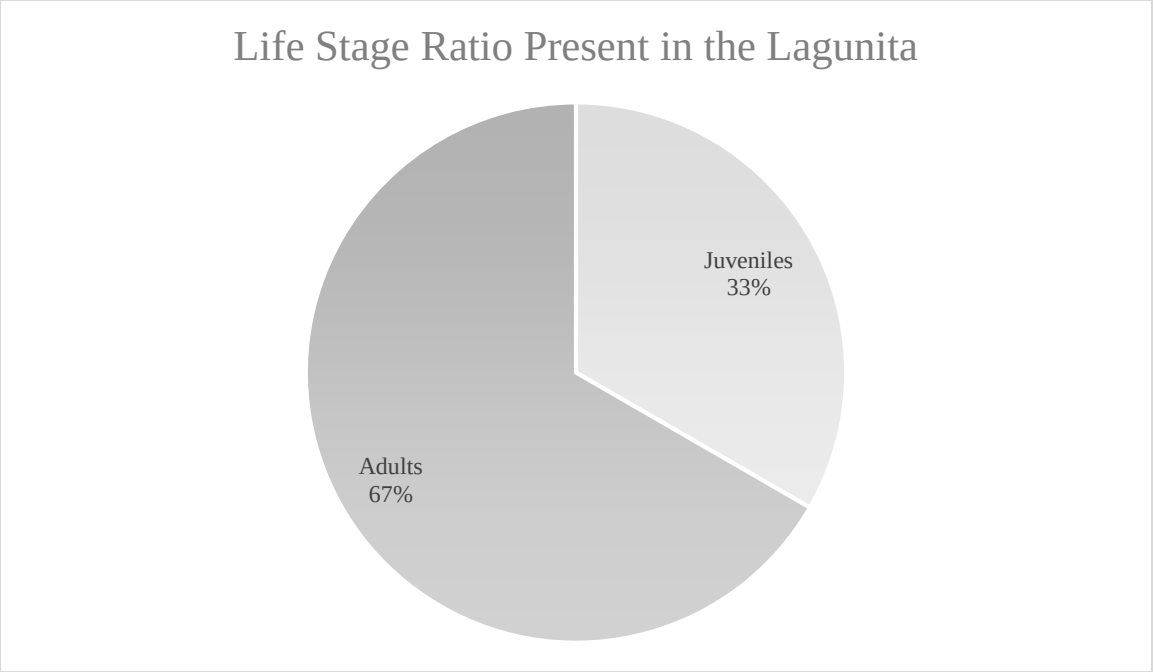

Figure 2. Ratio of adult to juvenile turtles in the Lagunita; data of carapace length and width which was used to determine relative life stage of each turtle is presented in Table 1.

Appendix II – Calculations

Capture-Recapture Method Calculations (following the Lincoln-Petersen Method):

$$N = \frac{MC}{m}$$

N = population size
M = sample of animals marked after first capture
C = sample of animals from second capture
m = number of marked animals in second capture

$$N = \frac{11 \times 5}{3} = \frac{55}{3} = 18.3333$$

Appendix III – Code of Ethics

PANEL ON
RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Allyson DeMerlis

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

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