Rate of Osmotic Response in *Malaclemys terrapin terrapin* Under Varying Salinity Conditions

Abstract

Northern Diamondback Terrapins (*Malaclemys terrapin terrapin*) are unique in that they are the only species of turtle that lives in estuarine habitats. However, those habitats are being altered through climate change: as sea level rises, salty ocean water flows farther inland, raising the salinity of the estuaries. Terrapins can tolerate varying salinities through osmoregulation, and are to absorb or excrete water as conditions change. This is in order to maintain a constant osmotic pressure and solute concentration within their bodies. It was hypothesized that higher-salinity conditions (as a result of an influx of ocean water) would make water intake for the terrapins more difficult, because excess salt particles take up more space in the water and terrapins need to remove those high amounts of salt when taking in said water. This experiment had eighteen terrapins of varying ages and sizes be put into water-filled containers of certain salinities. One container had the average salinity of a terrapin's natural habitat (17-18 ppt), another had freshwater, and the last had a salinity higher than the average (30-32 ppt). The terrapins were massed before each trial and again at certain time intervals throughout each trial experiment. The masses in the trials were compared to the initial masses of the terrapins using statistical analysis. Applying the results found in this study would be useful to show how Diamondback Terrapins, already a species of special concern in New Jersey, would be affected by the inevitable changing climate in other ways than just habitat destruction.

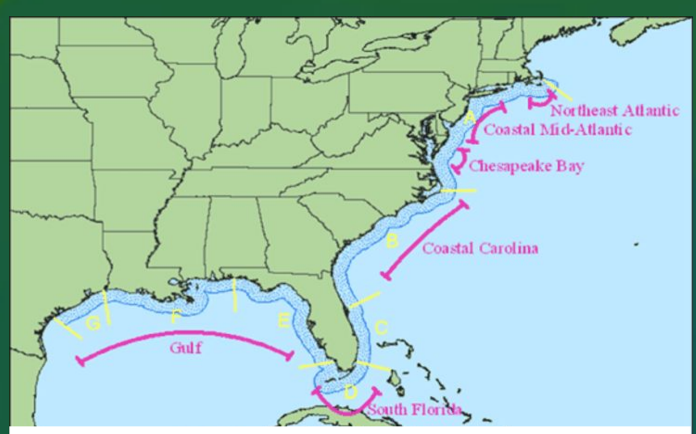

Figure 1: Map of the range of the seven Diamondback terrapin subspecies. Range A is the range of the Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*).

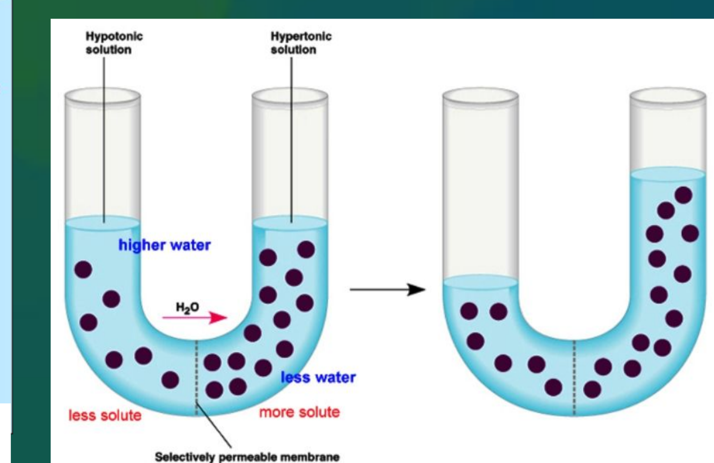

Figure 2: Diagram of osmosis process

Figure 3: One of the terrapins resting in its container.

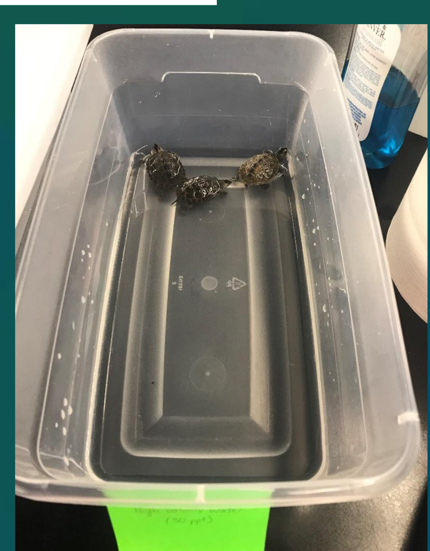

Figure 4: Hatchlings undergoing one of the trials.

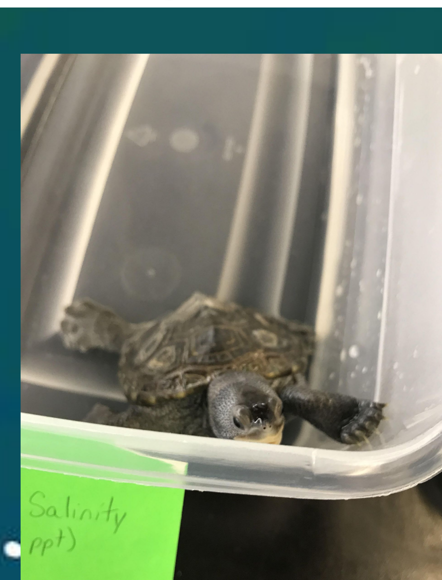

Figure 5: One of the terrapins crawling around the container.

Introduction

- Northern Diamondback Terrapins (*Malaclemys terrapin terrapin)* are known as the only species of turtle that spend their entire lives in the water
- Live in estuarine habitats: areas where rivers meet ocean, resulting in brackish water (mix of salt and fresh water), with salinities from 0.5 to 35 parts per thousand (ppt) (NOAA, 2018).
- Terrapins are adapted to live in "coastal salt marshes, estuaries and tidal creeks along the U.S. Atlantic and Gulf coasts from Cape Cod, Mass., to Corpus Christi, Texas, including the Florida Keys," (Cover, 2018) (**Figure 1**)
- Food for terrapins: mussels, clams, small crabs, marine worms, and any other hard-shelled organisms (Cover, 2018)
- Females are much larger than males (6-9 in. vs 4-5.5 in.) ("Northern Diamondback Terrapin," n.d.)
- Terrapins can tolerate various salinities through osmoregulation: the process of "regulating water potential in order to keep fluid and electrolyte balance within a cell or organism relative to the surrounding[s]" ("Osmoregulation," 2009)
- The osmotic response for terrapins is absorbing water, and expelling water and excess salts in order to maintain an ideal osmotic pressure and their bodies' solute concentration and body fluid amount ("Osmoregulation," 2009).
- Would likely take energy and cause weights to fluctuate
- Sea level rise leads to greater influx of saltwater in estuaries, raising estuaries overall salinity, and posing threats to species living there
- Salt particles take up more space in water, and since excess salt must be excreted, does saltier water make water intake more difficult?
- It is hypothesized that if a terrapin is soaked in high-salinity water, then it will take in less of that water because of the excess salt ions that take up space in the water and the need to reach equilibrium in the environment.

Objective

To determine the changes in weight terrapins undergo when exposed to freshwater, a normal salinity, and a high salinity to see how terrapins in the wild would undertake salinity changes due to climate change.

Methodology

- Obtaining terrapins
  - Get permission to use the terrapin hatchlings
  - Get permission to use captive terrapins and wild terrapins
- Set Up
  - Purchase/obtain six Tupperware containers, a refractometer, and salt
  - Fill three containers one fifth of the way (for hatchlings) or one third of the way (for adults) with water
  - Add salt to each container and frequently check salinity with refractometer
  - Add salt until one container is 10 ppt, one is 16-18 ppt, and on is 30 ppt.
- Experimentation
  - Mark and weigh each terrapin
  - Place one terrapin in each container, and record what salinity condition each terrapin is in
    - For hatchlings, multiple can be placed in the same container
  - Check each terrapin's weight after one hour, then return to the same containers (**Figure 12**)
  - Check again after the following hour, then return to same containers
  - Check weights once more after 24 hours
  - Repeat until each terrapin has undergone each condition
  - Repeat with different terrapins

Results

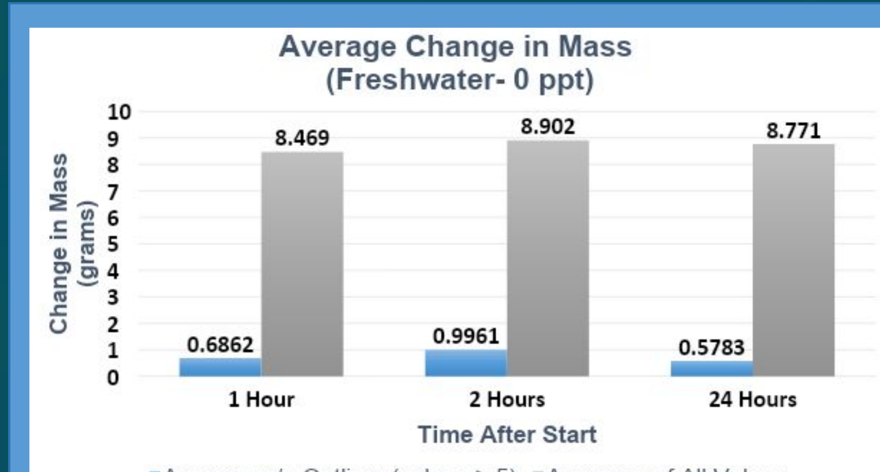

Figure 6: The average change in mass (in grams) from the initial mass of the terrapin over the course of the trials involving freshwater. Averages without outliers were calculated because they skewed the results heavily.

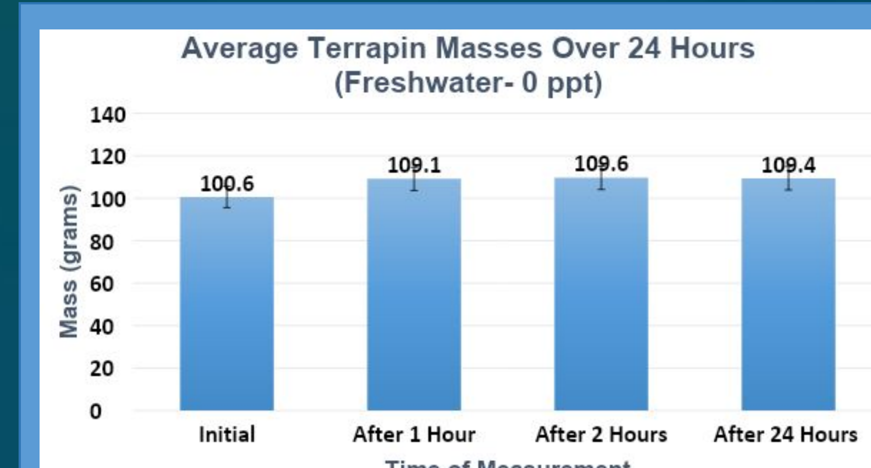

Figure 7: Average terrapin masses used in the freshwater trials. A T-Test was done, comparing the initial mass to each time a measurement was taken. No statistical difference was found, as shown by the overlapping error bars.

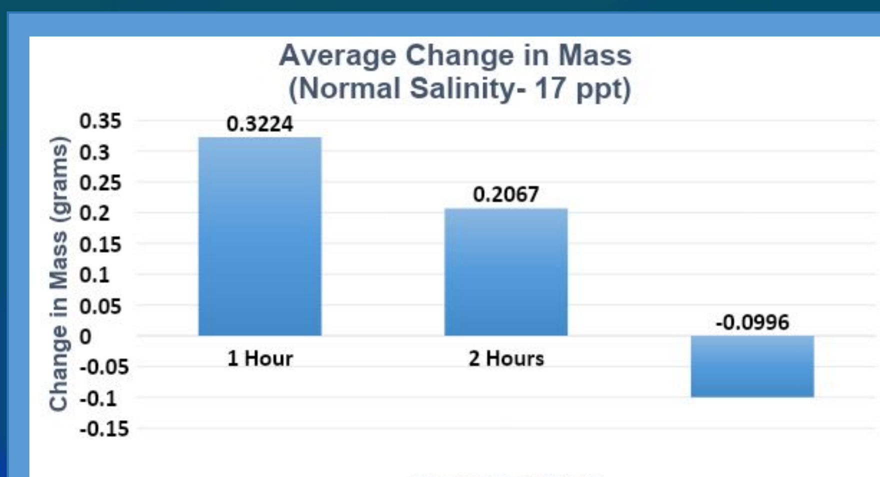

Figure 8: The average change in mass (in grams) from the initial mass of the terrapin over the course of the trials involving normal salinity water. In this case, there were no outliers to skew the results.

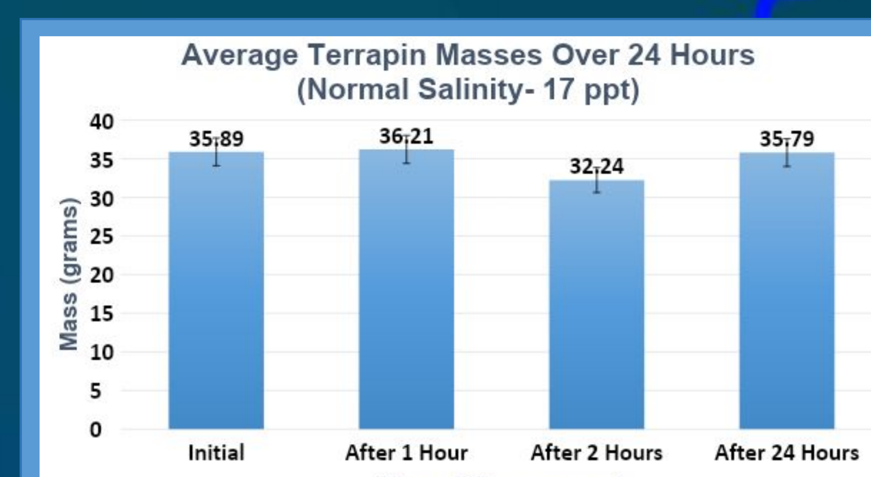

Figure 9: Average terrapin masses used in the normal salinity trials. A T-Test was done, comparing the initial mass to each time a measurement was taken. No statistical difference was found, as shown by the overlapping error bars.

Figure 10: The average change in mass (in grams) from the initial mass of the terrapin over the course of the trials involving high salinity water. Averages without outliers were calculated because they skewed the results heavily.

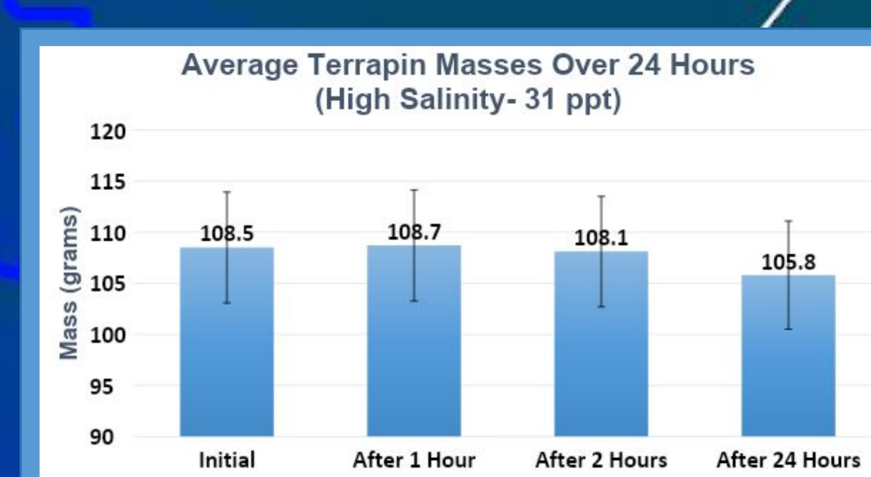

Figure 11: Average terrapin masses used in the high salinity trials. A T-Test was done, comparing the initial mass to each time a measurement was taken. No statistical difference was found, as shown by the overlapping error bars.

Discussion

- Hypothesis (if terrapins are subjected to high-salinity water, then they will take up less water weight) was not supported by the data
- No statistical differences found in the parameters
- Lack of results was likely because of how terrapins osmoregulate
- Terrapins are osmoregulators like most vertebrates, so they actively regulate internal osmotic pressure regardless of surroundings ("Osmoregulation Definition," 2019)
- Not osmoconformers like they were predicted- organisms that match internal osmotic pressure with their surroundings ("Osmoregulation Definition," 2019)
- Terrapins must also be euryhaline organisms (subcategory of osmoregulators that maintain an internal salinity between seawater salinity and freshwater), which can tolerate a wide range of salinities (Saladin, n.d.)
- Needed given their estuarine habitat which has fluctuating salinities given their estuarine habitat, which can tolerate
- Said classification would cause terrapins to not change their mass in response to surroundings
- Another reason could also be excretion of wastes: the deposit of urine or feces during the experiment would have contributed to mass gained or lost in order to establish internal equilibrium
- Methodology's design could have contributed as well: a longer experiment time and more frequent measurements could have given more significant results

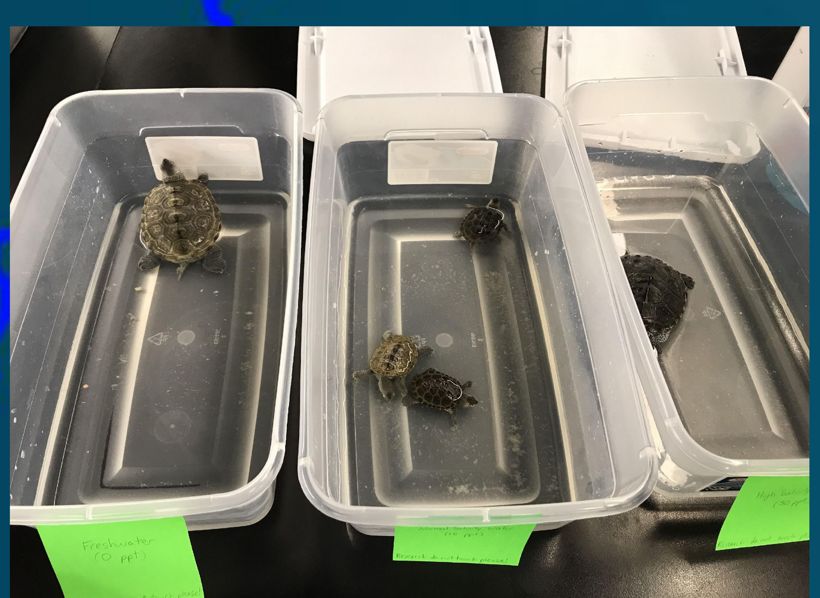

Figure 12: Setup for the trials.

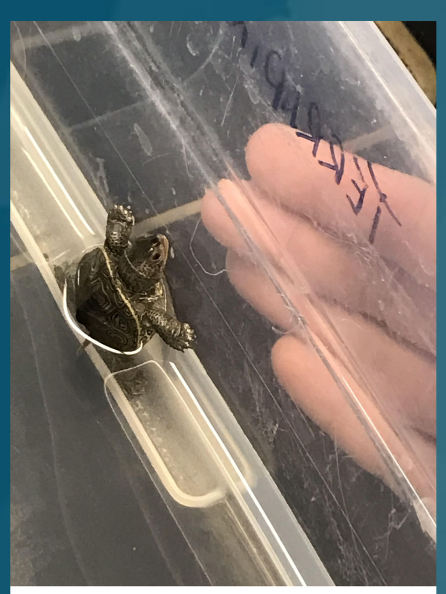

Figure 13: One of the smallest terrapins used (compared to my hand).

Conclusion

- Terrapins did not gain or lose a significant amount of mass when subjected to different salinity conditions
- Likely because of terrapins' method of osmoregulation, excretion of wastes
- Absence of significant results could lead to the assumption that the rise of salinity in estuaries due to climate change would not affect terrapins negatively
- Harmful effects on terrapins from climate change would be from other reasons such as habitat loss and food shortages
- Future research could investigate the effects that changes in salinity have on organisms that are prey to terrapins, in efforts to see how they would react to climate change

Acknowledgements

I would like to thank my advisors for guiding me throughout this project from start to finish and for providing me with the majority of the measuring tools I needed and a safe lab to conduct my experiments on. Lastly, I would like to thank my fellow students for giving me insight on this project when I stayed after school to conduct the trials.

Selected References

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