Symbiotic Beachfront Design:
Sharing Southeast Florida's Coast with Sea Turtles

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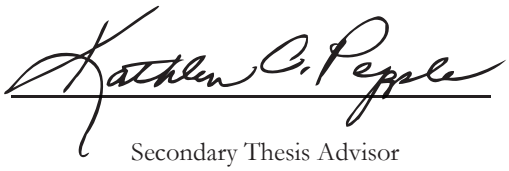

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Abstract

This urban beachfront design project is a unique approach to sustainable beachfront design development because it focuses on creating a symbiotic relationship between humans and a sensitive turtle habitat, rather than relying solely on traditional habitat conservation. Through research of the nesting and living habits of the loggerhead, green, and leatherback sea turtles this project shows how to develop a place for human beach activity that also serves as a safer coastal nesting ground for sea turtles. Designing to variables that can affect the sea turtles, while maintaining beach access for people presents a challenge, but the results may have worldwide application.

Statement of Intent

Although there are many wildlife habitats at risk across the globe, coastline and beachfront sites are of greatest concern because of their growing popularity for human development and tourism (Cox 2011). They may also be viable habitats for endangered and threatened sea turtle species. Traditional habitat preservation is not usually applicable in urban areas, where the habitat has already been destroyed. In this thesis I plan to explore a new conservation technique that educates people how to share beaches sustainably with threatened nesting sea turtles in a "non-traditional" conservation zone.

Urban beachfronts with nesting sea turtle populations can be rejuvenated to create more viable habitat for turtles while also enhancing the beachfront aesthetically and providing more opportunity for human investment. This paper will show how beneficial it is to rejuvenate the beachfront for sea turtles, as this will help create a unique experience for people who visit the beach through education, interaction, and preservation.

Boca Raton, Florida presents an ideal site location for this project because it has a large population of nesting turtles as well as numerous people that use the beach for recreation. The sea turtles that nest on the

Boca Raton beach include loggerhead (threatened), green (endangered), and leatherback (critically endangered). Because of sensitivity to human development on the shores, most species of sea turtles have seen dramatic losses in population in just the short amount of time that humans have populated the globe; sea turtles have been around for hundreds of millions of years, out-dating dinosaurs (Perrine 2003). By researching the nesting and living habits of these turtles in Boca Raton, this project shows how to develop a comfortable place for humans while also continuing to function as a safer nesting ground for the loggerhead, green, and leatherback sea turtles. Among variables that affect the turtles are:

- Artificial lighting
- Sand dune health
- Predatory animals
- Human activity

Resources such as books, magazines, journals, documentaries, and interviews will help guide this project in regards to turtle biology, turtle behavior, nesting habitat, Boca Raton culture, coastal weather patterns, legal issues, and numerous other variables that will impact the design solution. Outreach to professionals with similar interests in this sensitive interaction will also help guide this project to a design solution.

Overall, this thesis will make people more aware of the affect that human development has on sea turtles in Boca Raton, Florida. The project brings to light how landscape architecture can inspire innovative preservation and rejuvenation of these critical habitats; this is essential if people intend to save sea turtles from extinction. People will be more inclined to change when they see how this project benefits humans, loggerhead, green, and leatherback sea turtles through urban beachfront rejuvenation and preservation.

Typology

- Urban beachfront park
- Symbiotic beachfront design
- Urban ecological planning
- Interactive and educational design

The Symbiotic Beachfront Design: Sharing Southeast Florida's Coast with Sea Turtles is a pioneer urban rejuvenation project. The beach will be used for passive and active recreation, while maintaining a natural aesthetic. Visiting the beach will be an interactive and educational experience, leaving people with a sense of awareness and pride about sea turtle biology and preservation.

Research Questions

- Why should people be concerned with the safety of sea turtle nesting sites?
- How many sea turtles nest on the Boca Raton Beach in a given season?
- What is the amount of light that disorients nesting/hatching sea turtles on the beach?
- What recreation is currently occurring on the beach? Does it pose a threat to sea turtles?
- What design techniques can be used to keep people off the dunes and nesting zones?
- Are there ways to block the sky glow and other artificial light disturbances that occur further in the city of Boca Raton, Florida?
- How will the design help create awareness and educate people about the endangered sea turtles?
- How will the rejuvenation of the beach benefit both people and sea turtles?
- What lower impact lighting techniques will allow the beach to be safe at night and also respond to the sea turtle's instincts?
- Who will use the site? Gain the most from it?

- What are the biological or instinctual habits of sea turtles regarding their nesting and surviving?
- How will this project be more beneficial to the community of Boca Raton as well as the sea turtles that utilize the sandy beach to nest?
- What is considered viable nesting habitat for sea turtles?
- Are there similar projects that have been designed? Are they successful?

Research Hypothesis

By redeveloping the urban beachfront of Boca Raton with sea turtle preservation in mind, a valuable symbiotic relationship will be created between people and turtles. By responding to the sea turtle's nesting habitat and instincts by designing a more interactive, aesthetic, and shared beach, the project will bring more value to the beach and preserve sea turtles in the long term. By creating better nesting habitat for sea turtles, the beach will in turn become better for human activities as well. Not only will the beach be naturally beautiful, but it will help spread awareness and concern for other urban beaches that may have shared use between people and a marine species.

Critical Analysis

This symbiotic beachfront design project proposes to rejuvenate an urban marine habitat on the beach of Boca Raton, Florida, by responding to loggerhead turtle nesting instincts as well as human recreation and education through sustainable symbiotic design approaches. Boca Raton, Florida in the United States is a prime example of an urban coastline that has had an adverse effect on sensitive habitat and the sea turtles that nest there. By introducing beachfront design that responds directly to the sea turtle's nesting instincts, to human activity, and to the relationship between people and turtles this project will create safer, more viable nesting habitat for the sea turtles; while functioning as a better beachfront for the community of Boca Raton, Florida, through the process of symbiotic beachfront design.

As the global human population grows exponentially, more and more animal habitats are being developed and altered. This can create conflict between human use and animal use, but people often do not need the particular habitat to survive. It is important to begin thinking about these conflict zones in an innovative way that will allow different species to thrive and share a specific habitat. Using landscape architecture as the pioneer design process, humans can begin to redevelop places that respond more sustainably to sensitive habitats and specific animal species. The state of Florida has some of the largest nesting populations of sea turtles in the world including loggerheads (threatened), green (endangered), and leatherback (critically endangered) (Rusenko 2014). By investigating these sea turtles and their nesting locations, human design development may respond in ways that it never has before when dealing with sensitive beachfront adjacent to urban areas. Not only will this process benefit the turtles, but it can benefit the local community, while creating more awareness about threatened sea turtle species and sensitive beachfront preservation (Sea Turtle Conservancy 2014).

Symbiotic beachfront design is a rarely used design approach in landscape architecture. It is based on the symbiotic relationship that humans and sea turtles can have in an urban setting. "Ecologists and

conservation biologists have long recognized that the vast majority of species neither occur in nor will be conserved in protected or conservation areas but instead must also be conserved in non-reserve lands"(Groves 2008), such as the Boca Raton beachfront in Florida. The site for this design project lies on an urban coastline that currently has a substantial nesting population of loggerhead (threatened), green (endangered), and leatherback (critically endangered) turtles which is what makes it a unique and relevant design project. In addition:

> These non-reserve lands—both public and private lands that are not being specifically or solely managed for their biological resources—are becoming increasingly urbanized and this urbanization is impacting land-use patterns in unanticipated ways. In 1950, only 29 percent of the world's population lived in urban areas; today [2008], that figure is 49 percent and is expected to reach 60 percent by 2030. This trend presents both challenges and opportunities for conserving biodiversity (Groves 2008).

The worldwide opportunities for projects such as this are growing more and more numerous as the human population grows. If successful, rejuvenation of urban beachfronts for biodiversity and conservation of species will stand as an example for other urban areas to follow, thereby spreading global ecological awareness and sustainability. Overall, I hope that this project will successfully display an innovative, sustainable, and responsible way to rejuvenate urban beachfronts with an ecological awareness that benefits the endangered loggerhead, green, and leatherback turtles while improving the beachfront environment of Boca Raton, Florida.

In a 2008 issue of *Landscape Journal,* James R. Miller writes an article entitled "Conserving Biodiversity in Metropolitan Landscapes: A Matter of Scale (But Which Scale?)", which is about landscape ecology in the urban setting. As an ecologist, Miller has a strong bias for introducing more ecological planning into metropolitan areas, something he thinks promotes safer, healthier, and more valuable cities. He also writes about the topic of scale, and how previous thinking about landscape ecology seemed to suggest that larger is better; however, Miller argues that better quality habitats, even though fragmented and small, can be just as

beneficial to animal species. The article goes on to address "win-win" scenarios in which not only does the habitat and animal benefit, but humans benefit as well: "…'win-win' ecology, in essence seeks to design places dedicated to human uses so that they also can be used by other species" (Miller 2008). His scenario, a symbiosis of sorts, involves turtles relying on people to keep the beach a viable place to nest; and people relying on turtles to provide a sense of nature. This idea is at the core of this thesis project. Nature impacts people in positive ways such as "higher-order cognitive function…" as well as "enhancing observational skills and the ability to reason" (Miller 2008), providing a basis for an appreciation of the human relationship and interdependence with the natural world including sea turtles. If this project can also promote overall sustainability, aesthetics, and social needs for Boca Raton, Florida, it may receive more support from the community (Mller 2008).

Miller also discusses the use of native plant species when thinking about habitat restoration, but not in the way one would expect. Miller points out "that a strict focus on native plants may be inappropriate" (Miller 2008), and goes on to describe situations in which some exotic plants have been around long enough to accommodate the needs of animal species in certain areas. Just because the exotic plant is not "historically" native does not mean that it is not a viable option for certain animal species. However, for this project, I intend to use mostly native Florida plants, due mostly to the fact that they are adapted to the harsh weather events associated with hurricanes, can withstand the tropical Florida climate, are disease and parasite resistant, and their ability to maintain beach dunes from eroding wind, tide, and wave action. Also, some exotic plants harbor predators and diseases that are otherwise not found in the native landscape, and which could be detrimental to sea turtle survival. This paper will not yet explore the planting palette of the site in Boca Raton, Florida, but it is important to note why more native plantings will be used. Natural rejuvenation is at the forefront of the symbiotic beachfront design, among other alternative preservation and conservation techniques.

In his book *Sustainable Urbanism: Urban Design with Nature,* Douglas Farr (2008) writes about habitat biodiversity, conservation and preservation. Farr argues for more conservation and preservation of habitat,

and it is clear that he has a conservationist's bias when talking about the subject. The Boca Raton project however, is not focusing on traditional conservation and preservation methods, but rather habitat rejuvenation and the sharing of a habitat that can be used by humans as well as nesting sea turtles. His argument helps justify the project however, because it is important to keep the current turtle beachfront habitat intact and begin to rejuvenate some of the more disturbed parts of the beach where human activity, artificial lighting, or lack of sand dunes are among some of the problems for turtles. According to Farr, one "should maximize habitat patch size, minimize the degree of isolation among existing habitat patches, and optimize the natural connectivity of the landscape using habitat corridors…" (Farr 2008). Connecting undeveloped parts of the beach with developed parts of the beach through habitat rejuvenation will make more of an impact on where sea turtles can nest, creating a higher quality nesting beach site. People can still go about their activities and enjoy the beach too. This project presents a more challenging approach as opposed to Farr's traditional views because the urban setting poses more threats to nesting turtles and their habitats. There is other research however, that has focused on the urban beachfront's effect on nesting turtles.

One of the biggest impacts that an urban area has on sea turtle nesting sites is introducing artificial light onto the beach. Michael Solomon and Blair E. Witherington, of the *American Society of Ichthyologists and Herpetologists (*"Artificial Lighting and Seafinding by Loggerhead Hatchlings: Evidence for Lunar Modulation", 931-938) discuss the effect of both artificial and natural light on sea turtle hatchlings along Florida's southeast coast. The study looks at hatchlings and their disorientation due to artificial lighting, which can cause the turtles to crawl away from the sea and possibly be run over by vehicles or more susceptible prey (Solomon and Witherington 1995). The process in which nocturnally active animals are disoriented by artificial light is known as "light trapping", which is a very real problem for turtle hatchlings and other animals living adjacent to urban areas; especially animals that use their eyesight to get around. Most scientists would agree that coastal development has been occurring very rapidly in recent years, and beachfronts are becoming more and more flooded with artificial light; therefore, sea turtle hatchlings are becoming more and more disoriented. Over time, this will decrease sea turtle's overall survival rate. The article goes on to explain the effect that

natural light, such as a lunar event, has on the orientation of the sea turtle hatchlings: "our data suggest that lunar background illumination, and not the moon itself, counters the light trapping effect" (Solomon and Witherington 1995). At first, the researchers thought that the sea turtle hatchlings were simply attracted to the brightest light in the sky, but this is not the case, because even when the moon was in the south or west sky the turtles oriented eastward toward the sea. However, when there was no natural (moon) light, the sea turtle hatchlings had a higher percentage of disorientation due to artificial lights being located on the land (opposite the sea). Before artificial light, sea turtle hatchlings almost always oriented their crawling efforts toward the ocean, because it is naturally the brightest horizon. Florida has been one of the most progressive states in the United States when it comes to lighting ordinances for the health of sea turtles; however, their global populations have been steadily declining. In designing this project, I will need to balance the effects artificial and natural lights have on sea turtle nesting success, amongst other beachfront variables.

In addition to the welfare of sea turtles, this project needs to be planned for human needs as well, as southeast Florida has "consistently grown more rapidly than the nation" (Scott 2008). With more people in the area of the turtles' nesting sites, these animals will face more disruption when they come to shore to nest, which is putting a strain on the species' overall health and stability. In a 2008 issue of *Landscape Journal,* Paul Odpam and Eveliene Steingrover write an article about landscape planning and ecological sustainability. They argue that ecological sustainability is a relatively new idea for driving landscape planning and is not the only variable when planning these landscapes, so it is often omitted because designers and planners tend to put it on the "back-burner". The authors argue for more biodiversity, which means more use of ecological sustainability in landscape planning. Odpam and Steingrover also urge project decision-makers to consider that the "landscape keep its potential to deliver ecological services and values to present and future generations" (Odpam and Steingrover 2008). This notion is very important when thinking about symbiotic beachfront design, because the beach is being used by humans and turtles presently, so in the future it should continue to be used by humans and sea turtles. In order for the two species to cohabit the beachfront, an ecologically sustainable design must be implemented to keep both parties happy. This particular article also reinforces the idea that because the current human generation has had a chance to interact, study, and cherish

these sea turtles, there is an obligation to help the turtle species survive so that future generations of humans can also appreciate these amazing animals. It would truly be a shame to watch a prehistoric species of turtle become extinct because of irresponsible human development on beachfronts, especially since sea turtles have been using Earth's beaches for hundreds of millions of years (Frazier 2003). Also, the biology and nesting habits of the loggerhead, green, and leatherback sea turtles needs to be examined as this will determine whether or not coastal planting will directly affect the survival of nests and hatchlings.

To begin to understand the Boca Raton site, one must first look into general sea turtle instincts and the life cycle of the turtles. Sea turtles usually mate in waters adjacent to the nesting beach with about one month between the actual mating and the nesting. Symbiotic beachfront design focuses on how the beach functions, especially at night because most sea turtles do their nesting nocturnally (Hamann, Limpus, and Owens 2003). "Sea turtles nest at night, reducing the possibility of lethal overheating and lessening the risk that daytime predators will find the nest and eat the eggs" (Perrine 2003). One of the most interesting female sea turtle nesting instincts is to select a beach based on where they themselves hatched and crawled into the ocean. This selection may also depend on other factors such as:

- Accessibility
- Beach slope and width
- High tide
- Physical characteristics of the sand
- Amount of vegetation
- Presence of predators
- Beach development
- Human activity (especially artificial light)

Sometimes after a turtle has crawled out of the ocean and onto the beach, noises, lights, and obstacles can cause the female to retreat back to the ocean without nesting, known as a "false crawl" (Perrine 2003). Boca

Raton, Florida, has consistent nesting activity from loggerhead, green, and leatherback sea turtles beginning in May and ending in November (Rusenko 2014). This is a critical time period for the project site because this is when the turtles will be crawling onto the beach to lay their eggs; it is important to note that the turtles of Boca Raton do not nest for the entire year, however they use the beach during the summer there is the highest amount of human activity (Rusenko 2014). The book *Sea Turtles of the World* states most incubation time for sea turtle eggs is one and a half to three months depending on the temperatures; it is also interesting that once the mother nests and the eggs hatch, "this tiny reptile is ready to face life's challenges with no help from its parents. Sea turtles depend more on preprogrammed behaviors, and less upon learned responses" (Perrine 2003). This is somewhat disturbing because of the fact that humans are altering turtle nesting habitats faster than the turtles can adapt, which is why artificial light and other beachfront developments are so hazardous to them. Finally, hatchlings break out of their eggs and begin digging based on temperature fluctuations, an embedded instinct ensuring that they have a better chance of emerging from the nest during the night; then it is survival of the fittest: "On average, only one hatchling from a nest of about 100 will survive the first year, and only one in 1,000 will survive to adulthood and return to reproduce in the same area" (Perrine 2003). The life of sea turtles is extremely complex. For instance, within the first year of a turtle's life, it may travel upwards of 10,000 miles in the open ocean foraging for food; with a lifespan of 50 plus years, the turtles take a long time to develop into mature, reproducing adults (Perrine 2003). The life cycles of the sea turtles that are nesting on the beach in Boca Raton, Florida, are very complex and need to be taken into consideration throughout the entire design process.

The book *Turtle Conservation*, edited by Michael Klemens, addresses traditional conservation efforts that do not deal with urban beachfront variables. The contributors of this book argue for turtle conservation, because they believe it is important that these complex animals do not go extinct under people's watch. If humans do not try to preserve turtle populations, "without active intervention and management, sea turtle populations are expected to continue to decline to extinction" (Klemens, 2000). There are strategies that non-government conservation groups promote which include:

- Research and monitoring
- Integrated research and management of sea turtles and their habitats
- Capacity for conservation, research, and management
- Public awareness and education
- Community participation
- Regional and international cooperation
- Evaluation of the status of marine turtles
- Preservation

Landscape architecture has the ability to implement (1) integrated management of sea turtle nesting habitat, (2) public awareness and education, and (3) community participation through design implementations. By redeveloping the Boca Raton beachfront as a shared habitat for endangered sea turtles and humans, this project naturally creates a positive interaction between the two species.

Anchoring or hardening beachfronts is utilized along coasts to prevent erosion, and is one of the leading causes in the destruction of sea turtle nesting habitat. "The threat posed to nesting turtles by vertical cement on the beach is obvious and familiar, revetments, rockpiles, and buried sandbags also represent barriers that prevent turtles from nesting" (Klemens, 2000). Beach armoring is especially prevalent in regions with high tide and strong wind activity. For instance in 1991, 21% of Florida's, 10% of Georgia's, and 10% of South Carolina's beaches were armored (Klemens, 2000), and one can only expect that those percentages are currently higher. Because of Florida's location on the globe, it has hurricane weather events from mid-May until late November, which can cause extensive damage and erosion to beachfront property and habitat depending upon the severity of the hurricane. Besides sea walls and human built infrastructure, there are natural ways to prevent erosion and hurricane swale damage to beaches and adjacent properties. Sand dunes are natural beach features that can help block damaging wave action from destroying property, as well as provide nesting habitat for many marine sea turtles. It is important to implement protective infrastructure that not only benefits property owners

along the beach, but also provides critical habitat for nesting sea turtles. There are adverse effects to restoring sand dunes due to:

- Sand compaction (difficult for hatchlings to emerge)
- Steep slope (difficult for mother's to lay eggs)
- Altered microclimates for incubation of eggs
- Timing of re-nourishing sand dunes which disturbs nests and nesting habits

There are a lot of variables that go into creating natural sand dunes for sea turtles. Some beaches have struggled with perfecting the method, for instance some places will use native sands from offshore locations however this can lead to depletion of native sands. In Florida, some dunes are nourished with non-native sand such as aragonite, which has led to lower incubation temperatures (Klemens, 2000). Something as simple as adding non-native sands to the beach in Boca Raton, Florida, may have huge implications for sea turtles nesting on the beaches here because determination of sea turtle sex is based on incubation temperature. "All sea turtles examined to date appear to have a male-female pattern in which cooler incubation temperatures produce males and warmer incubation temperatures produce females" (Wibbels 1997). Known as temperature dependent sex determination, changing the microclimate of nesting locations can disrupt the balance of sea turtle hatchling sex and potentially have a negative impact on the population of sea turtles using the Boca Raton beach to nest. Overall, the project will have to look at ways in which to prevent accidental microclimate alterations that may skew the loggerhead, green, and leatherback sea turtle populations. Creating viable and healthy sand dunes without altering the natural sex determination in sea turtles is essential to the success of this project.

Besides the impact to the sea turtles nesting at Boca Raton, another concern or limitation of symbiotic beachfront design is how the project and design will benefit the community or stakeholders. For instance, what are the economic repercussions of creating a safer habitat for sea turtles on Boca Raton's beachfront? The answer is derived from a published study found in the 2010 journal, *Proceedings of the National Academy of Sciences of the United States of America (PNAS),* which looks at the socioeconomic repercussions that

protected habitats have on local communities in Costa Rica and Thailand. Although the study focuses on the impact of these areas in developing countries, one can expect similar or even more apparent results in a developed location such as Boca Raton, Florida, because the economy is much more developed. The conclusion of the study was that in a 15 year period after the establishment of a protected area, the adjacent community's poverty was reduced, generating a positive correlation between protected areas and socioeconomic improvement (Andam 2010). The study supports similar ecological planning in other countries, and has been successful in decreasing poverty and increasing the overall quality of life for communities adjacent to the protected areas. One of the criticisms of this study is that this economic growth could have happened naturally within the 15 years, with or without the introduction of protected areas, as well as the many other factors used to define poverty and wellbeing. Overall, the article supports the idea that this project will benefit the community of Boca Raton, Florida, in several measurable ways including economic, social, and environmental components. The community of Boca Raton will not likely invest in the planning and development of the project without knowing that there will be a return on its investment. In the example below a marine park project in Greece has been unsuccessful because the local communities did not invest in the project. Had they been made aware of the economic benefits of the conservation project, the results might have been different.

Case Study

Zakynthos National Marine Park, Greece

Project Name: Zakynthos National Marine Park

Location: Laganas Bay, Island of Zakynthos, Greece

Date Established/Planned: Marine park established in 1999 followed six months later by a management agency

Construction Completed: Ongoing management

Construction Cost: N/A

Size: 52 square miles

Landscape Architect(s): N/A

Client/Developer: European Union, Greece, Sea Turtle Protection Society, World Wildlife Fund-Greece, and the Mediterranean Association to Save the Sea Turtles

Consultants/Architects: European Union and Greek Government

Managed By: Sea Turtle Protection Society (STPS), World Wildlife Fund (WWF)-Greece, and Mediterranean Association to Save the Sea Turtles (MEDASSET), and Greece

Context

Zakynthos is the southernmost Greek island in the Ionian Sea. This island is home to critical nesting sites for the loggerhead sea turtle, *Caretta caretta*, which inspired the conservation initiative that became the Zakynthos National Marine Park. The marine park is located on the southwest side of the island, encompassing a majority of the Laganas Bay. The island of Zakynthos is a popular European tourist destination, with a majority of the tourist activity being along the Laganas Bay where the loggerhead sea turtles happen to nest. Tourist activity is most prominent during the months that the turtle uses the beach to nest (May-August), which creates a conflict of interest for the local economy.

Ecologists and property owners do not share the same opinions on the conservation regulations of this nesting beach which has been a consistent nesting habitat for the loggerhead sea turtle. Land and business owners are of the opinion that the beach conservation regulations will have a negative impact on the tourism economy that is prevalent on Zakynthos. Because a majority of the business and property owners are opposed to following the regulations set by the Greek government for the marine park, it has been hard to enforce and reprimand the violators.

Some of the major conservation restrictions include no access to the beach at night, beach furniture kept only to small areas, no vehicles on the beach, and artificial light regulations. The Greek government has not offered any economic incentives for the communities on Zakynthos to comply with these regulatory efforts, and has done very little enforcing of regulations due to lack of funds and poor financial management. Current efforts are strengthening, however, as more planning and research is being done on how to keep all the stakeholders happy while maintaining the nesting beach for the loggerhead sea turtles.

Site Analysis

With a mild Mediterranean climate, Zakynthos has always been a popular place for European tourists. The island is home to 40,000 residents, but will host 50-60,000 tourists on a daily basis, especially during the peak tourism season (Melidou, 2001). This huge number of tourists drives an inflated tourism economy that has been unresponsive to the restrictions set in place by the formation of the national marine park. The large numbers of people coming to the island of Zakynthos can harm the loggerhead sea turtle nesting sites in the following ways:

- The numerous people on the beach during the day may deter mother turtles who scan the beach looking for a viable place to make their nests at night.
- Beach garbage may find its way out to the ocean, where some turtles mistake it for food which can cause the turtle to die or have other health issues.

- Umbrellas and day beds can obstruct a female turtle from nesting, which is why these things should be removed from the beach at night.
- Artificial beach lighting can deter females from coming to shore, but also it causes disorientation of hatchlings who rely on lighting cues to find the open ocean, which they rely upon for survival.

Overall, the impact from local tourism has not shown a significant detrimental impact on the loggerhead sea turtle's nesting numbers. However, if community development along the popular Laganas Bay continues to ignore the needs of the nesting loggerhead sea turtle, their population will undoubtedly see a negative impact.

The beach in Laganas Bay is the most utilized loggerhead nesting site in the Mediterranean Sea with an average of over 1,200 nests every season. If the beach is impacted negatively by tourism development on Zakynthos, the entire population of Mediterranean loggerhead sea turtles will drop. Most of the tourist activities are passive in the sense that they are not necessarily physically destroying the turtle nesting habitat. People visit the Greek island of Zakynthos because of its clear water, sandy beaches, and abundance of sun. Swimming, sunbathing, and relaxing are common activities during the day at the beach. At night, the beaches along Laganas Bay close and people head away from the coast for night life activities. However, the artificial lights and loud noises of night activity can scare the loggerhead turtles back into the water without successfully nesting. Even the airport on Zakynthos is closed at night, because the noise from planes arriving late at night is proven to scare the turtles from nesting.

Project Background and History

In the 1980s, several of the beaches along the Laganas Bay of Zakynthos, Greece, were identified as important nesting sites of the loggerhead sea turtle (*Caretta caretta*). This was one of the first steps in creating the Zakynthos National Marine Park; the idea of the park was solidified by Greece during the 10th CITES (Convention on the International Trade of Endangered Species) meeting held in Zimbabwe

in 1997. During the CITES meeting, nations discussed the topic of unconditional protection versus sustainable use, with sustainable use having support from a majority of those in attendance. However the national marine park was not officially formed until 1999 when the European Union and Greece concluded how important it was to protect the nesting beaches of the threatened loggerhead sea turtle. At the same time awareness of sea turtles grew in Zakynthos so did the tourism campaign which created the conflict of interest we see today. Six months after the establishment of the Zakynthos National Marine Park, a management agency was formed to help with enforcing of regulations and engaging the hesitant community in the conservation process.

Genesis of the Project

Currently there is still a lack of cooperation between conservation efforts and local land owners; this has been the case for more than twenty years. New regulations have been in the planning process for years, but not much has been accomplished (Melidou 2001). For instance, land owners who have been designated as owning property within the Zakynthos National Marine Park have not been offered any compensation measures for their cooperation with conservation regulations. The head of environmental management of the park K. Katselidis has suggested that this problem is due to Environmental Law 1650/86, which defines compensation as measures provided for the acquisition of land contrary to the park's plan to let the locals maintain ownership of their property (Melidou 2001).

Also, because of the lack of policy enforcement from Greece for over 20 years, local mentality is well established; "it is acceptable to ignore the law" (Melidou 2001). Depending on which local community of Laganas Bay government officials talk to, there are huge differences in attitudes. For instance, some land owners in Dafani, Greece, simply refuse to cooperate and even negotiate with Greek officials. They have built and operated illegal tourist establishments for years within designated marine park lands, due to the fact that they have not been offered any compensation measures to comply with conservation efforts.

However, other communities such as Kalamaki are much more cooperative even without compensation (Melidou 2001).

Another problem is that there has not been very good organization between the Greek government and non-governmental organizations (NGOs) such as the Sea Turtle Protection Society. There has even been detrimental competition between the government and NGOs which has led to duplication of efforts as well as less communication of information between NGOs and the Greek government. For example, there are numerous beach guards on Laganas Bay that help enforce beach restrictions; however, there is a lack of signs, brochures, and other communication that would help inform tourists about restrictions prior to spending time in the marine park.

Currently, the local population has been disassociated from the Zakynthos National Marine Park. There is no ecological monitoring station on the island; the conservation efforts seem foreign because ecologists come from the universities of Athens and Thessaloniki bringing people from across the globe to help in the loggerhead nesting observations (Melidou 2001). There are plans to create an ecological conservation outpost on the island, which would help spark better community interactions on Zakynthos.

Planning in response to the marine park has only been accomplished on a small area of the island, and physical implementations have been just a fraction of that. With communities not seeing any physical implementations being made or paid for by the Greek government, they are not being motivated to make any changes to their properties.

Design/Development Process

The Greek government wrote the legislation that defined and designated the Zakynthos National Marine Park in 1999, but did not have a management plan in place until six months later. There has been a

lack of enforcement, compensation, and planning efforts from the Greek government since day one. Overall, the development and design process for the marine park has been lacking every step of the way.

Role of Landscape Architect(s)

I have been unable to find anything written about the role of a landscape architect in the planning process for this project. However, this could help explain why the Greek government has failed to implement successful conservation efforts on Zakynthos. A landscape architect may have the ability to think about the interaction between the local communities on Zakynthos and the loggerhead sea turtles, while taking into account both of their needs and coming up with a solution that helps both.

Program Elements

The Zakynthos National Marine Park was established in 1999 to provide maximum protection to the loggerhead sea turtle nesting populations adjacent to Laganas Bay. The goal of the marine park is to help preserve the beaches and waters that the loggerhead turtles use along with other animal species that live near the Greek island of Zakynthos. Although landscape architecture and design has not been used to think about the solution to this problem, some restrictions were set by Greece in a government designated 52 square mile area on the south side of the island. These restrictions include:

- No access to the beaches at night
- Limited beach furnishings
- No motorized vehicles allowed
- Artificial light reductions
- No fishing within designated marine park boundaries

These restrictions were set in place so that people would not disturb the sea turtles coming on the beach at night to nest. Also, the project coincides with ongoing research on the nesting habits of the loggerhead and how people are effecting their reproduction and hatchling success. Overall, one of the main program elements of the marine park is to create awareness about the threatened loggerhead sea turtle, and how people can begin to help preserve them.

Maintenance and Management

The marine park is maintained and managed by the Greek government alongside NGOs such as the World Wildlife Fund-Greece. The government and NGOs help patrol the beaches along Laganas Bay enforcing rules and informing tourists of conservation measures while scientists within these organizations are researching the marine life in the park. The Greek government is currently still looking for more viable approaches to maintaining the tourism economy on Zakynthos while not compromising the protection provided by the marine park.

User/Use Analysis

The island of Zakynthos is a major European tourist destination, with the economy being constantly driven by the demand of tourist business. People come to the Greek island for sand, sun and relaxation which is most prevalent in the summer months of May through August; the same time when loggerhead nesting activity is the highest.

People who visit Zakynthos often do not even realize that there is a national marine park located on the south side of the island, so they often are not aware of the restrictions put in place by the Greek government. This can sometimes cause surprise when beach patrols approach tourists to make them aware of the restrictions that they unknowingly violate.

A lot of the activity in the Laganas Bay area of Zakynthos includes passive recreation such as swimming, walking the beach, and relaxing in the sand which does not raise a terrible amount of concern for the health of the loggerhead sea turtles. However local businesses in the tourist industry are known to ignore restrictions along the beach, because they feel the marine park regulations would decrease their income from the booming tourist economy. In the long run, local attitude toward the conservation efforts in the area may have a detrimental impact on the loggerhead turtles.

Peer Reviews

Most conservationists agree that it is hard to say if the Zakynthos National Marine Park in Greece has been successful or not. Although the legislation is there, working with the local community has not worked. This is mostly due to the poor planning on the Greek government's part in order to compensate land owners and make sure the beaches can be still be used by the tourist economy as well as the loggerhead sea turtles. Data on nesting and hatching success has not suggested that the tourism activity has yet had a negative impact on the loggerheads, but if the lack of cooperation between locals and the Greek government continues, conservationists agree that a negative impact will be seen; there needs to be a more holistic solution to conservation efforts in human populated areas (Melidou 2001).

Criticism

There has been an abundance of criticism about the Zakynthos National Marine Park mostly due to the lack of cooperation between local Zakynthians, the Greek government, and non-governmental organizations. Although the project focused on conservation of an important species, the loggerhead sea turtle, it did not look at the overall sustainability. "Sustainability expresses the balance between economy, society and the environment has not been achieved and that could compromise conservation in the long

term" (Melidou 2001). Most of this criticism stems from the fact that the Greek government has not made the local's wants and needs the priorities, like it has done with the marine park conservation efforts. Local attitudes have reflected this neglect, creating distance between them and the management, maintenance, and planning efforts that they should be a part of. Overall, most people agree that something needs to change in order for this project to be successful.

Significance and Uniqueness of Project

The significance of this project is the fact that it was the first marine park in the country of Greece, and a milestone conservation effort for the European Union as the sea turtles were the primary reason for the marine park. The most unique part of this project is that the park is located adjacent to local communities and human dwellings, with human activities occurring in the same habitat that loggerhead sea turtles nest. Also, the marine park site is located on the largest known loggerhead nesting sites in the Mediterranean Sea. Overall this is a unique project with unique opportunities and limitations, its significance will become more apparent as the project continues to evolve.

Limitations

There has been little apparent success with the Zakynthos National Marine Park project other than the fact that a marine park, first of its kind in Greece, was established. Because of a lack of local investment in the project, there has been little to no enforcement of regulations in the park. Local business owners continue to illegally develop tourism related businesses along the beach that in the long term could have a detrimental impact on the Mediterranean loggerhead sea turtle population.

Generalizable Features and Lessons

The key features of the Zakynthos National Marine Park are the restrictions laid out in the written document that defines the laws and boundaries of the marine park; however the lack of planning and enforcement of regulations has made the project lose credibility as an example of appropriate conservation planning. The project has potential to function as a traditional marine park; however, because of the proximity to local Zakynthos communities it becomes an atypical conservation park. This means that an atypical planning and development approach should have been used when considering the Zakynthos National Marine Park, which may explain why it has not been successful.

Future Issues/Plans

The future issues of this project lie in the relationship between the local Zakynthos communities and the Greek government. Obviously the current relationship is strained because the locals do not see the benefit in cooperating with conservation and the marine park regulations. Future plans are to better manage the conservation efforts so that they benefit both local communities and nesting loggerhead turtles on the island. Overall, the project has some potential to become very successful for the Greek island of Zakynthos, but it will take some more thoughtful planning and effort to do so.

Bibliography and Project Citations or References

See bibliography at the end of paper.

Methodology

Approach to Research

Boca Raton, Florida has a population of nesting loggerhead, green, and leatherback sea turtles that utilize the short stretch of urban beach on an annual basis. Because of the beach's close proximity to the urban population of Boca Raton, there have been detrimental effects to the population of local sea turtles. The project clients are the community and Gumbo Limbo nature center, both of which should benefit greatly from this symbiotic beachfront design project. Researchers, the public, and sea turtles will use the site for biological research, recreation, and nesting habitat. All of these activities peak during the same few months of the year, which is why it is so important for humans to share the beach responsibly with the nesting sea turtles.

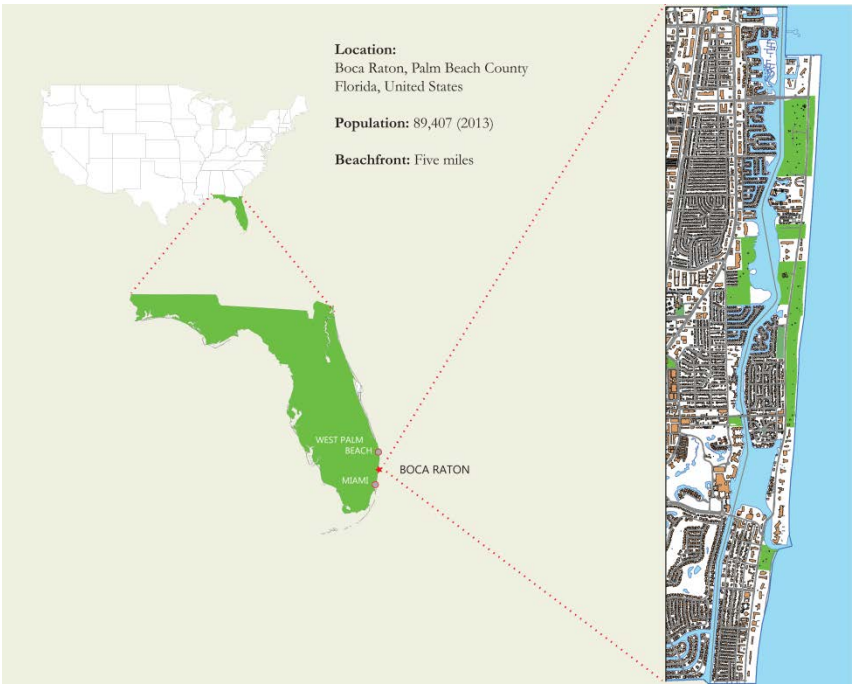
In order for the symbiotic beachfront design project to be a successful landscape architecture project, numerous data measures will help guide the design development of the site. Data measures include:

- Number of turtle nesting sites
- Sand dune health (pertaining to sea turtle usage)
- Amount of artificial light and effect on sea turtles
- Age range of people who are more open to ecological education, interaction, and awareness
- Length of Boca Raton beach for both private and public properties
- Plant material that can withstand hurricane-force winds and the Floridian climate
- Width of beach and tidal fluctuations

Each data measure will help guide more specifically how and where a successful design should be implemented along the Boca Raton beachfront.

Site Introduction

Boca Raton, Florida, is located on the southeast (Atlantic) side of the state between Miami and West Palm Beach. The research area for this thesis project extends five miles along the entire Boca Raton beachfront. The beachfront has public, private, and commercial zoning. However is mostly dominated by public parks and high-density residential zoning.



Strengths

- Large sea turtle nesting population
- Urban beachfront
- Human population growth and investment
- Local conservation efforts
- Stakeholder support

Limitations

- Light pollution
- Separating human and turtle activities
- Beach maintenance

Boca Raton, West Palm Beach County, Florida

Southeast Florida's population has been growing exponentially for the past decade. It is critical to explore opportunities on how to save nesting beaches, as this coast provides habitat for tens of thousands of nesting sea turtles. As human development will continue to grow in this area, more stress is being put on nesting females and hatchlings which is driving down sea turtle populations.

Client/User Description

The client for the symbiotic beachfront design project is the City of Boca Raton, Florida. The city will be working in collaboration with the Gumbo Limbo Nature Center, which is located directly on the proposed site. With the help of the Gumbo Limbo Nature Center, the sea turtle nests can be monitored and researched and the results of the symbiotic beachfront design can be thoroughly studied. The City of Boca Raton is the main client because they will be able to make the changes to zoning laws that will implement this beachfront rejuvenation project. Also, the city has the most interest in the success of the beachfront rejuvenation and how it impacts the community, economy, and ecology. By rejuvenating the Boca Raton beach, the health of the nesting site will be restored creating a more viable site for sea turtles to lay their eggs successfully.

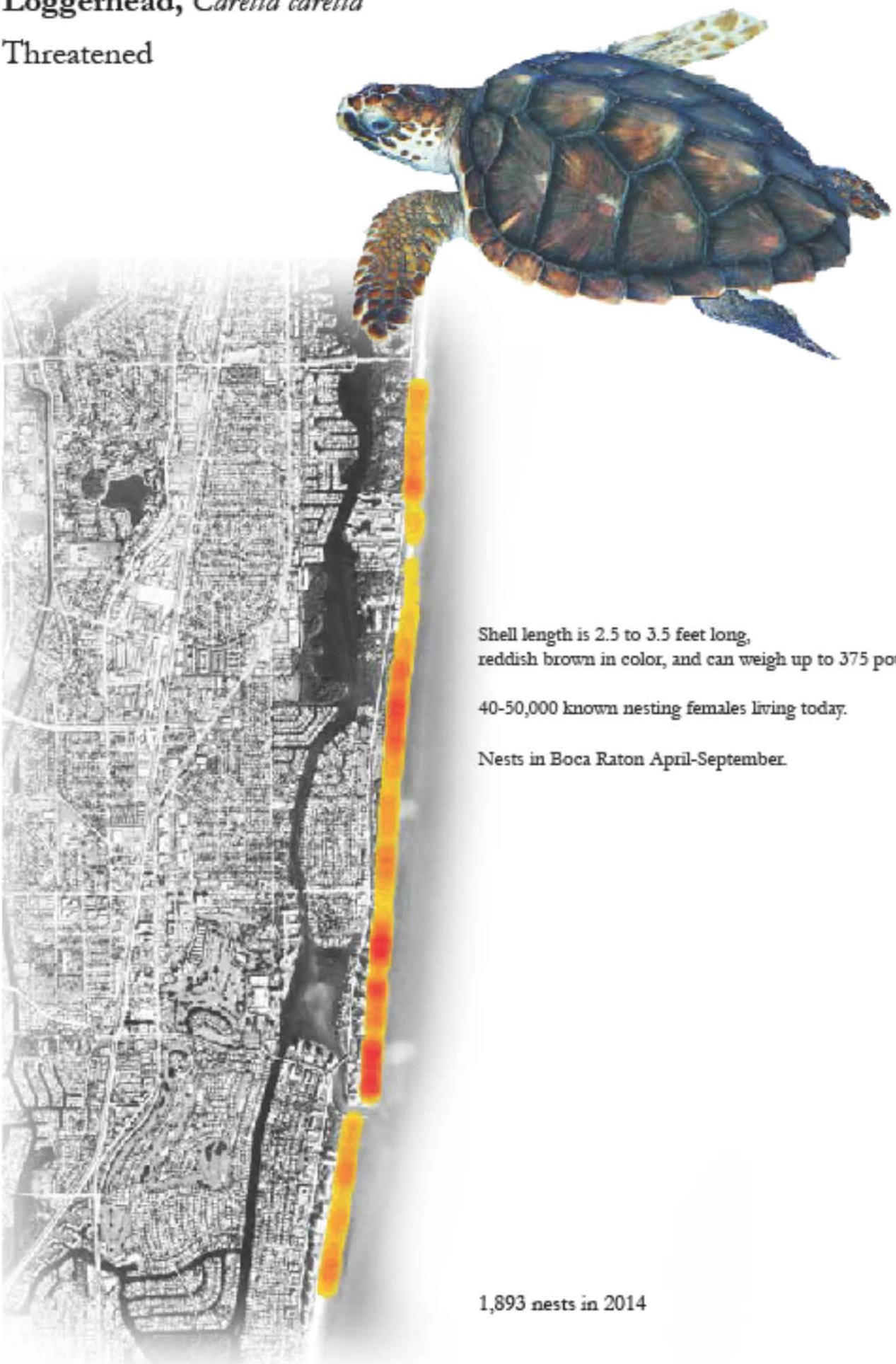
There are two clients that the symbiotic beachfront design project will have to take into consideration, (1) people and (2) sea turtles. Sea turtles use the beachfront for a single purpose, to lay their eggs. The people using the beach in Boca Raton are local community members and visitors, who use the site in various ways including:

- Passive activities such as sunbathing
- Active activities such as jogging
- In water activities such as swimming

Because there is a wide variety of beach activity conducted by people, this thesis will have to develop different areas of the beach for different activities, so humans can still utilize the beach for their pleasure, while sea turtles can use the beach for their survival.

Loggerhead, *Caretta caretta*

Threatened



Shell length is 2.5 to 3.5 feet long,
reddish brown in color, and can weigh up to 375 pounds.

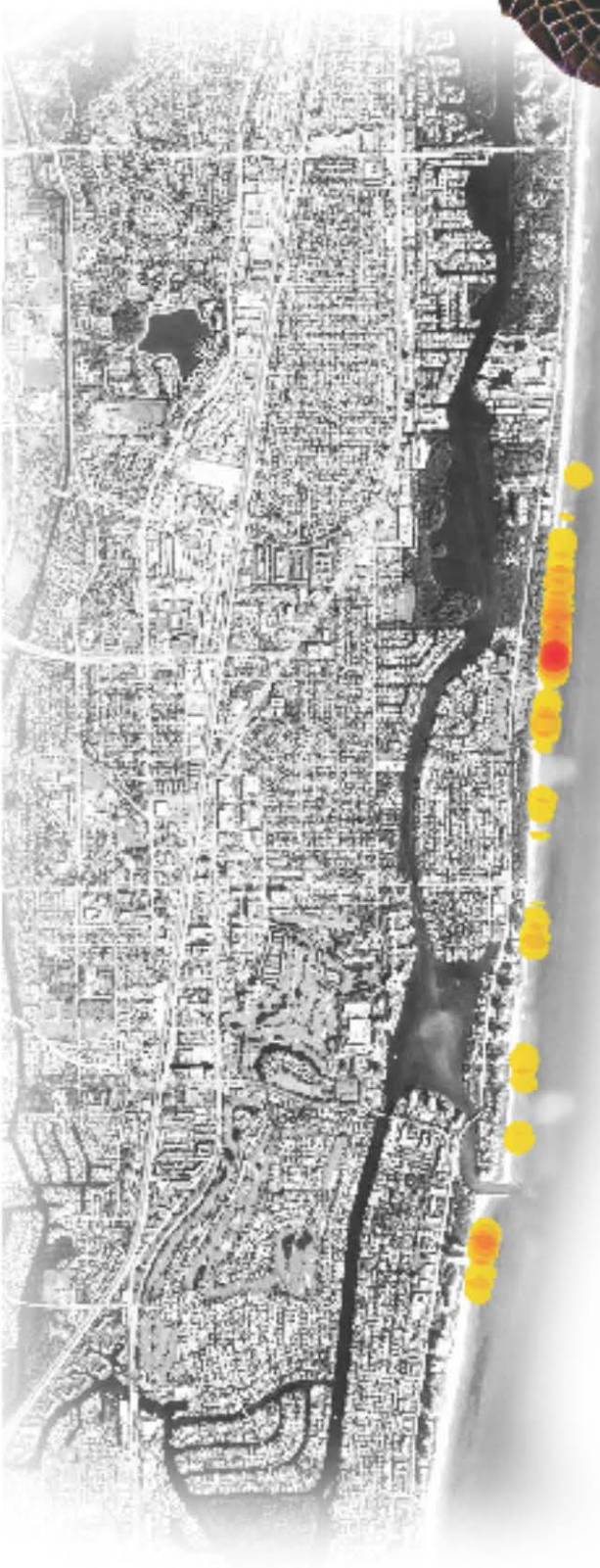
40-50,000 known nesting females living today.

Nests in Boca Raton April-September.

1,893 nests in 2014

Green, *Chelonia mydas*

Endangered



Shell length is 3-4 feet long,
pale/dark green or yellow color, and weighs 240-420 pounds.

85-90,000 known nesting females living today.

Nests in Boca Raton June-August.

135 nests in 2014

Leatherback, *Dermochelys coriacea*
Critically Endangered

Shell length is 4-6 feet long,
gray/black with white spots and weighs 660-1,100 pounds.

34-36,000 known nesting females living today.

Nests in Boca Raton April-October.

22 nests in 2014

Data Measures

One of the quantitative data measures that will drive the design of this Boca Raton site is the number of sea turtle nesting sites and their locations along the five mile beach of Boca Raton. This information will be found through Gumbo Limbo Nature Center sea turtle research and literature that they have been accruing for several years. This will help determine where the densest areas of nesting activity are along the beach, as these may help determine where more drastic preservation techniques should be used and less human activity should take place.

A key qualitative data measure for this thesis project will be the sand dune health, as this is essential to the nesting success of sea turtles. Research, literature, and nesting data will provide guidelines in how to rejuvenate dunes for the nesting sea turtles on Boca Raton beach. If this design is to preserve and rejuvenate sea turtle habitat, sand dune health will be a determining factor to the success of the project. By determining what constitutes viable sand dunes for sea turtle nests, the dunes can be ranked by which are the healthiest and which will need to be rejuvenated along the beachfront.

Artificial light is also an important quantitative data measure for this project because of its proven detrimental effects on sea turtle nesting success. The Gumbo Limbo Research Center in Boca Raton has done extensive research on how artificial light plays a role in the hatchling success in finding the ocean. By measuring the amount of light along the five mile stretch of beach, it will become clear which places along the beach will be most successful for sea turtle nesting, and where artificial lighting should be reduced. This data measure will be one of the largest influences to the design of the symbiotic beachfront design project.

One qualitative data measure that will have influence on this design project is what demographic, age range, or group of people respond most positively to interactive and educational signage. Finding literature and research on this topic will help determine how to design the signage on site in order to create the most effective awareness. By providing signage specifically for this particular group of people, more awareness

about sea turtles will be created and information about the project will be spread thereby increasing positive attitudes about the preservation of these prehistoric creatures.

Another important data measure is the linear footage of public and private properties currently along the Boca Raton beachfront. The amount of beachfront will be found through personal observation. It is important in determining where the design will respond to different interests along the beach, access points, and other variables that go along with the different zoning along the beach. For instance public areas may have different levels of artificial lighting than a private property. Also, if more sea turtles are nesting along private beachfront they may be less protected than a turtle nesting on public beachfront (or vice versa). This data measure will help determine where the best design solutions can be implemented.

Plant material is a qualitative data measure that will help determine what plants will survive the Florida climate. This is especially important when plant materials are added to the site because they will need to be aesthetically pleasing, but also need to withstand the hurricane force winds and other climatic events associated with the southeast Florida coast. By finding literature on Florida plant material, the project will be able to make sure that the beach is healthy for sea turtles as well as the other users.

One of the last quantitative data measures includes the width of the beach and tidal fluctuations. By understanding the width of beach turtles typically nest on, important preservation areas will be established. Tidal fluctuations throughout the seasons will also determine the height of sand dunes that should be rejuvenated along the beach, and where critical areas of erosion occur. Overall, this data measure will help guide where more dunes should be made, and where there may be erosion or sea swell concerns.

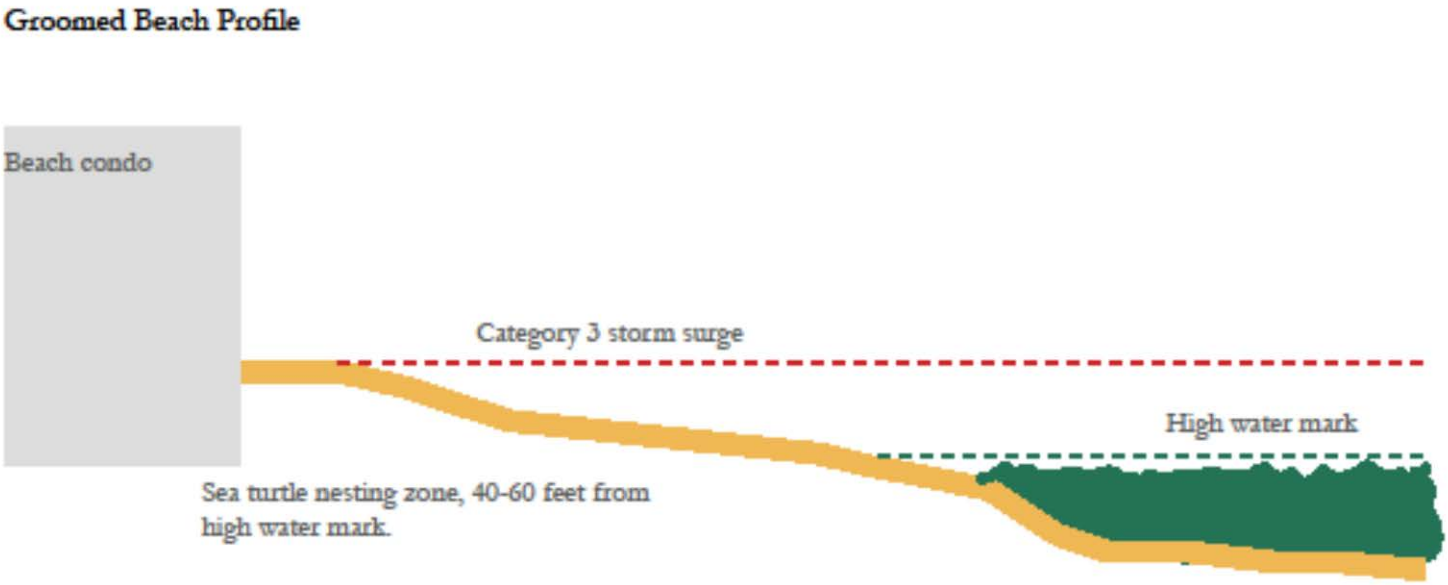
To conclude, all of these data measures will help add up to a well-planned design approach. Based on the outcomes of this research, different areas of the beach will begin to receive different measures of preservation. The research will help point out which areas are most critical, and allow for the successful cohabitation of people and sea turtles on Boca Raton beach in Florida.

Results

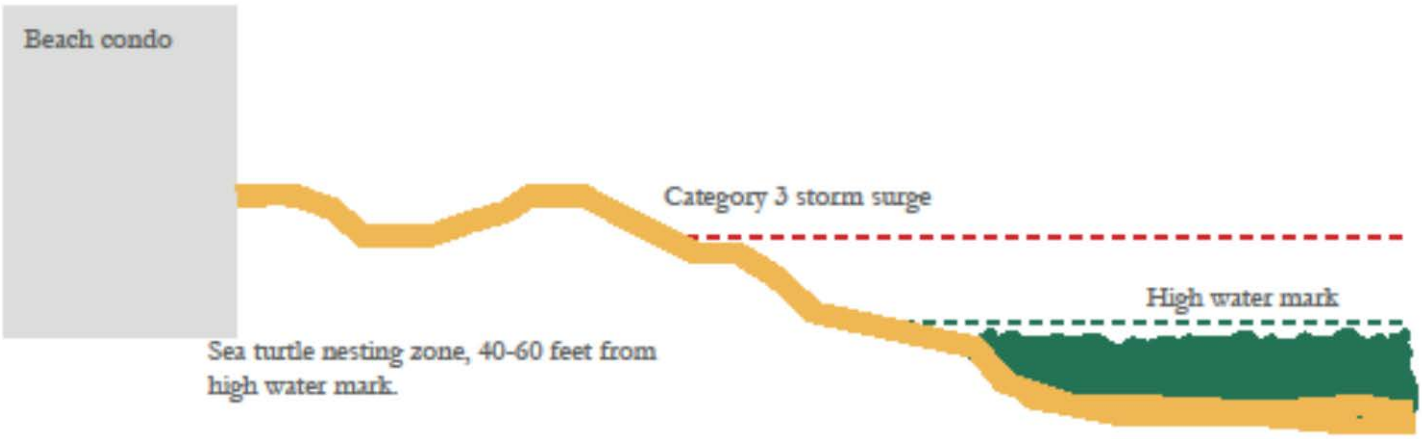
Sand Dune Health

Sand dune health is essential to nesting success on the beach of Boca Raton, Florida. For instance Dr. Kirt Rusenko of the Gumbo Limbo Nature Center describes the following factors:

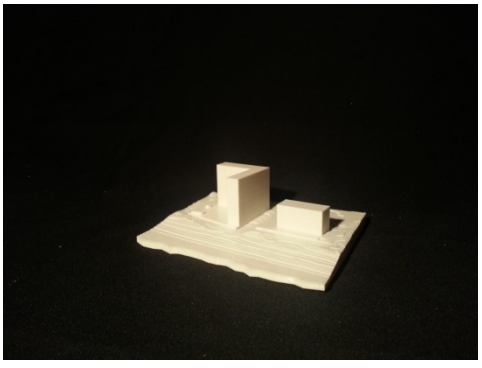
- **Height**—the highest dune on the beach is favored by sea turtles.
- **Beach width**—the narrowest section of the beach from offshore is favored by sea turtles.
- **Amount of vegetation**—the more vegetation, the healthier the dune.
- **Presence of sea walls**—sea walls replace dunes and eliminate nesting habitat.
- **Nourishment projects**—adds sand to the dune creating wider distances for turtles to crawl.

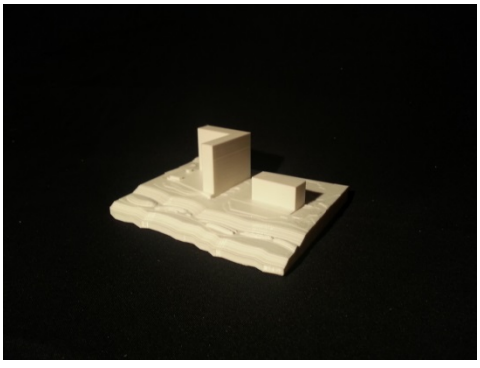


High Energy Beach Profile



Due to human use, the groomed beach profile is much flatter. This is because of loss of dune vegetation which traps sand that blows toward the shore, as well as beach grooming which keeps the sand flat causing it to erode faster. Boca Raton is naturally a high energy beach which defines it as a narrow beach with dune vegetation beginning 50 feet from the shore, right in the sea turtle nesting zone. Not only would a natural beach be aesthetically pleasing, it would provide for lower maintenance and storm protection.





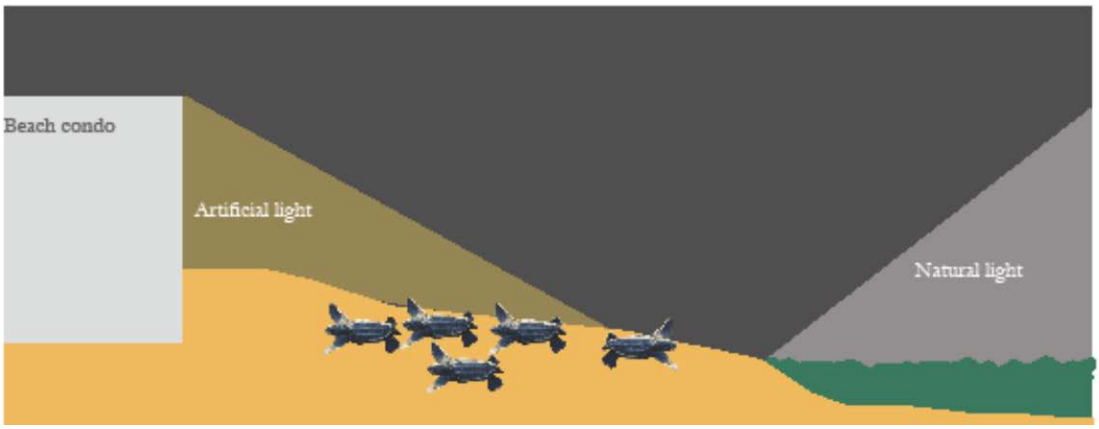
Dune Rejuvenation

Artificial Light

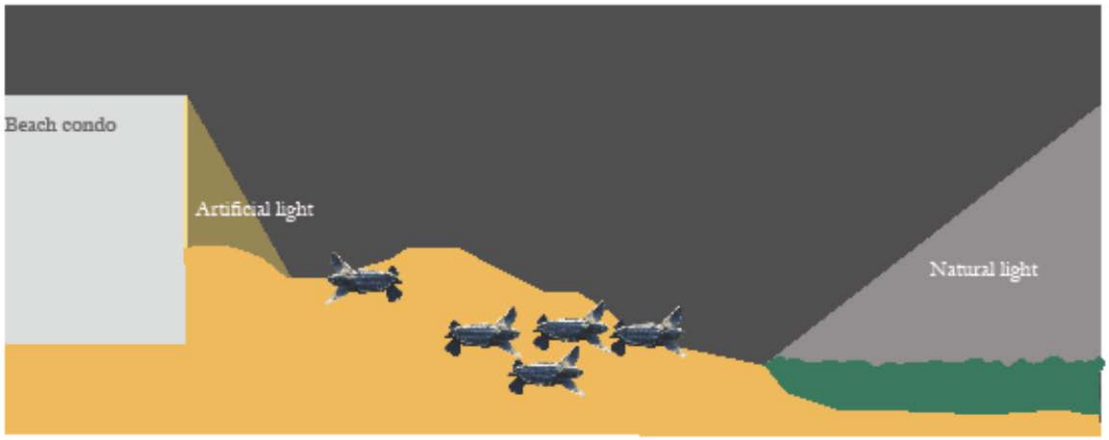
Artificial light is well known to have a negative correlation with sea turtle nesting numbers on Boca Raton beach. With more artificial light, less nesting occurs. Artificial light is especially prevalent in southeast Florida, as one can see from the images to the right.

Sky glow from Boca Raton is what causes most of the detrimental impacts on the nesting sea turtles. There is also an indication that tall vertical objects such as trees or condos can block this glow, shadowing the beach at night and increasing the likelihood of turtle nests (Rusenko, 2014).

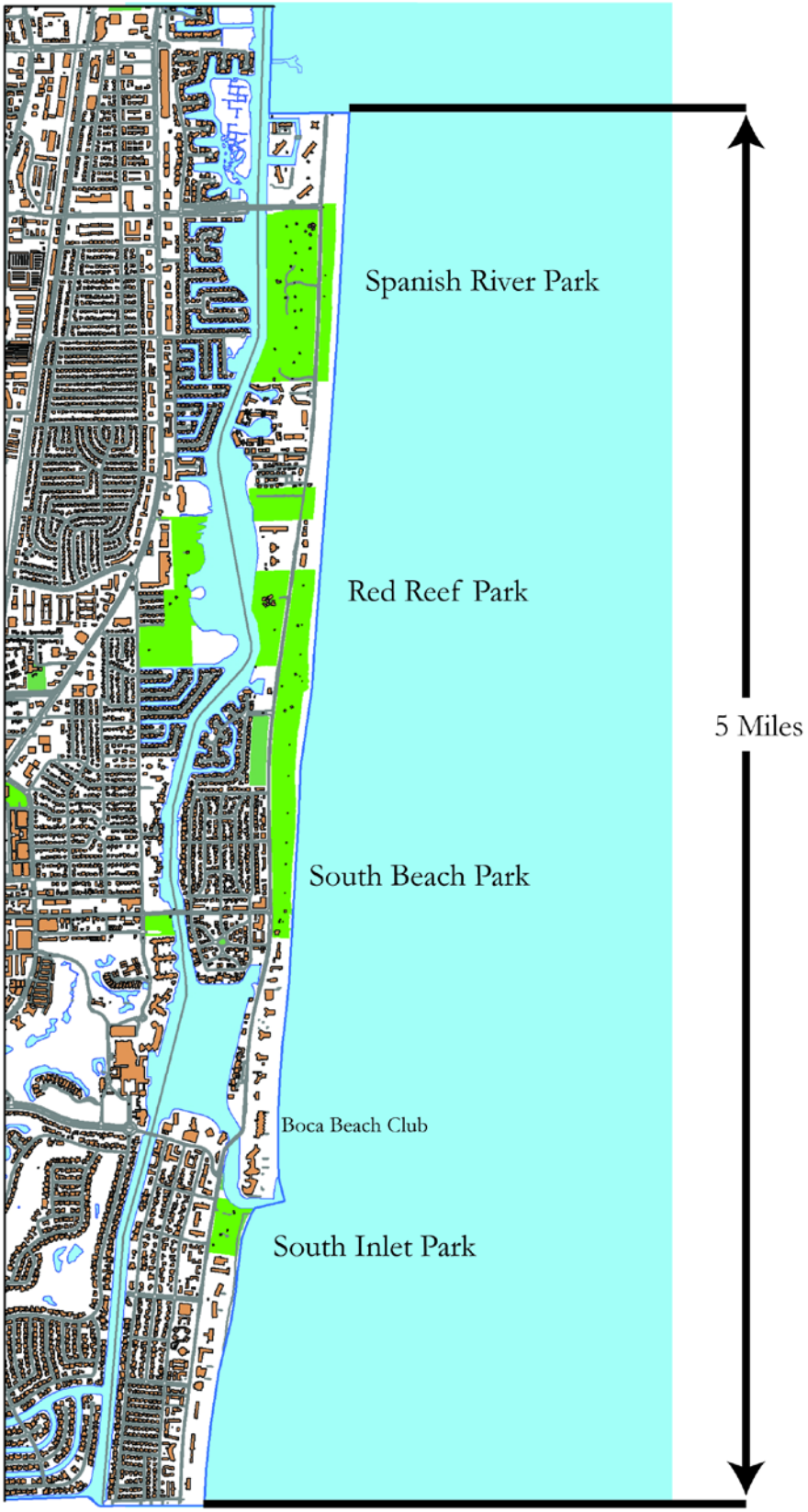
Artificial lighting



Sea turtle friendly lighting



Artificial lighting is very detrimental for sea turtles, because they instinctually nest at night. Not only does it deter females from nesting successfully, hatchlings will crawl toward the brightest horizon, which naturally would be the ocean, however because of human development the hatchlings crawl in the opposite direction often never reaching the ocean at all. This is a very important piece of this project because all lighting introduced needs to be turtle friendly, however it is very important for my design to allow people to experience the beach at night.



Public and Private Beachfront

Boca Raton's beachfront is unique compared to other southeast Florida municipalities because it is five miles long, over half of its length being public parks at approximately 2.6 miles long.

The remaining beachfront is residential buildings, with one property being zoned for commercial use.

Tide Charts and Beach Type

The beach along Boca Raton, Florida is considered a high energy beach, which means it is a long narrow (40-50 feet) stretch of beach with strong wave action. These beaches are also relatively flat with large sand dunes found behind them. Wave action usually dissipates slowly without creating strong rips as found on a low energy beach (Brander, 2007). The following Boca Raton tide charts show how the water level can change up to three feet within a day, with the highest tides occurring during winter when sea turtles do not come to shore to nest.

January 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Wed 1		2:34 AM EST / -0.66 ft	8:33 AM EST / 2.89 ft	3:07 PM EST / -0.27 ft	8:44 PM EST / 2.76 ft	New Moon	7:08 AM EST	5:39 PM EST
Thu 2		3:26 AM EST / -0.72 ft	9:23 AM EST / 2.93 ft	3:58 PM EST / -0.36 ft	9:38 PM EST / 2.78 ft		7:08 AM EST	5:40 PM EST
Fri 3		4:18 AM EST / -0.69 ft	10:13 AM EST / 2.91 ft	4:50 PM EST / -0.40 ft	10:32 PM EST / 2.74 ft		7:08 AM EST	5:41 PM EST
Sat 4		5:11 AM EST / -0.58 ft	11:04 AM EST / 2.82 ft	5:43 PM EST / -0.38 ft	11:27 PM EST / 2.64 ft		7:08 AM EST	5:41 PM EST
Sun 5		6:05 AM EST / -0.42 ft	11:56 AM EST / 2.69 ft	6:37 PM EST / -0.32 ft			7:09 AM EST	5:42 PM EST
Mon 6	12:24 AM EST / 2.51 ft	7:00 AM EST / -0.21 ft	12:50 PM EST / 2.53 ft	7:34 PM EST / -0.23 ft			7:09 AM EST	5:43 PM EST
Tue 7	1:25 AM EST / 2.37 ft	7:59 AM EST / 0.00 ft	1:46 PM EST / 2.36 ft	8:33 PM EST / -0.13 ft		First Quarter	7:09 AM EST	5:43 PM EST
Wed 8	2:28 AM EST / 2.25 ft	9:01 AM EST / 0.19 ft	2:45 PM EST / 2.21 ft	9:33 PM EST / -0.06 ft			7:09 AM EST	5:44 PM EST
Thu 9	3:33 AM EST / 2.16 ft	10:05 AM EST / 0.32 ft	3:44 PM EST / 2.10 ft	10:34 PM EST / -0.03 ft			7:09 AM EST	5:45 PM EST
Fri 10	4:36 AM EST / 2.13 ft	11:07 AM EST / 0.38 ft	4:42 PM EST / 2.03 ft	11:31 PM EST / -0.03 ft			7:09 AM EST	5:46 PM EST
Sat 11	5:34 AM EST / 2.13 ft	12:05 PM EST / 0.38 ft	5:37 PM EST / 2.01 ft				7:09 AM EST	5:46 PM EST
Sun 12		12:22 AM EST / -0.06 ft	6:25 AM EST / 2.17 ft	12:56 PM EST / 0.34 ft	6:26 PM EST / 2.02 ft		7:09 AM EST	5:47 PM EST
Mon 13		1:09 AM EST / -0.10 ft	7:10 AM EST / 2.21 ft	1:41 PM EST / 0.28 ft	7:11 PM EST / 2.04 ft		7:09 AM EST	5:48 PM EST
Tue 14		1:51 AM EST / -0.14 ft	7:51 AM EST / 2.25 ft	2:22 PM EST / 0.21 ft	7:52 PM EST / 2.08 ft		7:09 AM EST	5:49 PM EST
Wed 15		2:31 AM EST / -0.18 ft	8:28 AM EST / 2.28 ft	3:00 PM EST / 0.14 ft	8:31 PM EST / 2.10 ft	Full Moon	7:09 AM EST	5:50 PM EST
Thu 16		3:08 AM EST / -0.20 ft	9:04 AM EST / 2.30 ft	3:37 PM EST / 0.08 ft	9:09 PM EST / 2.12 ft		7:09 AM EST	5:50 PM EST
Fri 17		3:45 AM EST / -0.19 ft	9:39 AM EST / 2.29 ft	4:13 PM EST / 0.05 ft	9:47 PM EST / 2.12 ft		7:09 AM EST	5:51 PM EST
Sat 18		4:21 AM EST / -0.15 ft	10:13 AM EST / 2.26 ft	4:48 PM EST / 0.02 ft	10:25 PM EST / 2.10 ft		7:09 AM EST	5:52 PM EST
Sun 19		4:58 AM EST / -0.09 ft	10:48 AM EST / 2.21 ft	5:24 PM EST / 0.01 ft	11:03 PM EST / 2.07 ft		7:09 AM EST	5:53 PM EST
Mon 20		5:35 AM EST / -0.00 ft	11:23 AM EST / 2.15 ft	6:01 PM EST / 0.01 ft	11:45 PM EST / 2.03 ft		7:09 AM EST	5:53 PM EST
Tue 21		6:15 AM EST / 0.09 ft	12:01 PM EST / 2.08 ft	6:42 PM EST / 0.01 ft			7:08 AM EST	5:54 PM EST
Wed 22	12:30 AM EST / 1.98 ft	7:00 AM EST / 0.19 ft	12:43 PM EST / 2.02 ft	7:28 PM EST / -0.00 ft			7:08 AM EST	5:55 PM EST
Thu 23	1:21 AM EST / 1.95 ft	7:50 AM EST / 0.27 ft	1:31 PM EST / 1.98 ft	8:20 PM EST / -0.03 ft			7:08 AM EST	5:56 PM EST
Fri 24	2:19 AM EST / 1.95 ft	8:48 AM EST / 0.32 ft	2:28 PM EST / 1.96 ft	9:20 PM EST / -0.09 ft		Last Quarter	7:08 AM EST	5:57 PM EST
Sat 25	3:23 AM EST / 1.99 ft	9:53 AM EST / 0.30 ft	3:31 PM EST / 1.99 ft	10:24 PM EST / -0.20 ft			7:07 AM EST	5:57 PM EST
Sun 26	4:29 AM EST / 2.09 ft	10:59 AM EST / 0.21 ft	4:36 PM EST / 2.08 ft	11:27 PM EST / -0.35 ft			7:07 AM EST	5:58 PM EST
Mon 27	5:31 AM EST / 2.23 ft	12:03 PM EST / 0.04 ft	5:40 PM EST / 2.22 ft				7:07 AM EST	5:59 PM EST
Tue 28		12:28 AM EST / -0.52 ft	6:29 AM EST / 2.40 ft	1:02 PM EST / -0.16 ft	6:40 PM EST / 2.37 ft		7:06 AM EST	6:00 PM EST
Wed 29		1:25 AM EST / -0.69 ft	7:24 AM EST / 2.56 ft	1:58 PM EST / -0.37 ft	7:37 PM EST / 2.53 ft		7:06 AM EST	6:00 PM EST

Thu 30		2:20 AM EST / -0.82 ft	8:16 AM EST / 2.68 ft	2:50 PM EST / -0.55 ft	8:32 PM EST / 2.64 ft	New Moon	7:05 AM EST	6:01 PM EST
Fri 31		3:12 AM EST / -0.88 ft	9:05 AM EST / 2.75 ft	3:41 PM EST / -0.67 ft	9:24 PM EST / 2.69 ft		7:05 AM EST	6:02 PM EST

February 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Sat 1		4:03 AM EST / -0.86 ft	9:54 AM EST / 2.75 ft	4:31 PM EST / -0.72 ft	10:16 PM EST / 2.66 ft		7:04 AM EST	6:03 PM EST
Sun 2		4:54 AM EST / -0.76 ft	10:43 AM EST / 2.68 ft	5:21 PM EST / -0.69 ft	11:09 PM EST / 2.57 ft		7:04 AM EST	6:03 PM EST
Mon 3		5:45 AM EST / -0.58 ft	11:31 AM EST / 2.54 ft	6:12 PM EST / -0.60 ft			7:03 AM EST	6:04 PM EST
Tue 4	12:02 AM EST / 2.43 ft	6:36 AM EST / -0.36 ft	12:21 PM EST / 2.37 ft	7:04 PM EST / -0.46 ft			7:03 AM EST	6:05 PM EST
Wed 5	12:57 AM EST / 2.26 ft	7:30 AM EST / -0.12 ft	1:13 PM EST / 2.18 ft	7:58 PM EST / -0.30 ft			7:02 AM EST	6:06 PM EST
Thu 6	1:55 AM EST / 2.10 ft	8:27 AM EST / 0.10 ft	2:08 PM EST / 2.00 ft	8:56 PM EST / -0.15 ft		First Quarter	7:02 AM EST	6:06 PM EST
Fri 7	2:57 AM EST / 1.97 ft	9:29 AM EST / 0.27 ft	3:07 PM EST / 1.87 ft	9:56 PM EST / -0.05 ft			7:01 AM EST	6:07 PM EST
Sat 8	4:01 AM EST / 1.90 ft	10:33 AM EST / 0.35 ft	4:07 PM EST / 1.79 ft	10:56 PM EST / -0.00 ft			7:00 AM EST	6:08 PM EST
Sun 9	5:02 AM EST / 1.89 ft	11:34 AM EST / 0.36 ft	5:06 PM EST / 1.77 ft	11:52 PM EST / -0.01 ft			7:00 AM EST	6:08 PM EST
Mon 10	5:56 AM EST / 1.92 ft	12:28 PM EST / 0.31 ft	5:59 PM EST / 1.81 ft				6:59 AM EST	6:09 PM EST
Tue 11		12:42 AM EST / -0.06 ft	6:42 AM EST / 1.99 ft	1:15 PM EST / 0.22 ft	6:47 PM EST / 1.88 ft		6:58 AM EST	6:10 PM EST
Wed 12		1:27 AM EST / -0.12 ft	7:24 AM EST / 2.06 ft	1:56 PM EST / 0.11 ft	7:30 PM EST / 1.96 ft		6:58 AM EST	6:11 PM EST
Thu 13		2:07 AM EST / -0.19 ft	8:01 AM EST / 2.13 ft	2:34 PM EST / 0.01 ft	8:09 PM EST / 2.04 ft		6:57 AM EST	6:11 PM EST
Fri 14		2:46 AM EST / -0.23 ft	8:37 AM EST / 2.18 ft	3:10 PM EST / -0.08 ft	8:47 PM EST / 2.10 ft	Full Moon	6:56 AM EST	6:12 PM EST
Sat 15		3:22 AM EST / -0.26 ft	9:11 AM EST / 2.21 ft	3:44 PM EST / -0.15 ft	9:24 PM EST / 2.15 ft		6:56 AM EST	6:13 PM EST
Sun 16		3:58 AM EST / -0.24 ft	9:45 AM EST / 2.21 ft	4:19 PM EST / -0.20 ft	10:01 PM EST / 2.17 ft		6:55 AM EST	6:13 PM EST
Mon 17		4:34 AM EST / -0.20 ft	10:18 AM EST / 2.19 ft	4:53 PM EST / -0.23 ft	10:39 PM EST / 2.16 ft		6:54 AM EST	6:14 PM EST
Tue 18		5:10 AM EST / -0.13 ft	10:52 AM EST / 2.15 ft	5:30 PM EST / -0.23 ft	11:19 PM EST / 2.13 ft		6:53 AM EST	6:15 PM EST
Wed 19		5:49 AM EST / -0.04 ft	11:29 AM EST / 2.10 ft	6:10 PM EST / -0.22 ft			6:53 AM EST	6:15 PM EST
Thu 20	12:02 AM EST / 2.09 ft	6:32 AM EST / 0.06 ft	12:12 PM EST / 2.05 ft	6:56 PM EST / -0.20 ft			6:52 AM EST	6:16 PM EST
Fri 21	12:52 AM EST / 2.04 ft	7:22 AM EST / 0.16 ft	1:01 PM EST / 2.00 ft	7:49 PM EST / -0.17 ft			6:51 AM EST	6:16 PM EST
Sat 22	1:50 AM EST / 2.00 ft	8:20 AM EST / 0.23 ft	1:59 PM EST / 1.96 ft	8:51 PM EST / -0.16 ft		Last Quarter	6:50 AM EST	6:17 PM EST
Sun 23	2:55 AM EST / 2.00 ft	9:26 AM EST / 0.24 ft	3:06 PM EST / 1.97 ft	9:58 PM EST / -0.19 ft			6:49 AM EST	6:18 PM EST
Mon 24	4:03 AM EST / 2.06 ft	10:37 AM EST / 0.16 ft	4:17 PM EST / 2.05 ft	11:07 PM EST / -0.29 ft			6:48 AM EST	6:18 PM EST
Tue 25	5:09 AM EST / 2.18 ft	11:44 AM EST / 0.00 ft	5:25 PM EST / 2.19 ft				6:47 AM EST	6:19 PM EST
Wed 26		12:12 AM EST / -0.43 ft	6:10 AM EST / 2.34 ft	12:45 PM EST / -0.21 ft	6:28 PM EST / 2.37 ft		6:46 AM EST	6:19 PM EST
Thu 27		1:11 AM EST / -0.58 ft	7:05 AM EST / 2.50 ft	1:41 PM EST / -0.43 ft	7:25 PM EST / 2.54 ft		6:45 AM EST	6:20 PM EST
Fri 28		2:06 AM EST / -0.70 ft	7:57 AM EST / 2.63 ft	2:33 PM EST / -0.61 ft	8:18 PM EST / 2.67 ft		6:44 AM EST	6:21 PM EST

March 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Sat 1		2:57 AM EST / -0.75 ft	8:45 AM EST / 2.70 ft	3:22 PM EST / -0.73 ft	9:09 PM EST / 2.73 ft	New Moon	6:43 AM EST	6:21 PM EST
Sun 2		3:46 AM EST / -0.73 ft	9:33 AM EST / 2.70 ft	4:10 PM EST / -0.77 ft	9:59 PM EST / 2.72 ft		6:42 AM EST	6:22 PM EST
Mon 3		4:34 AM EST / -0.63 ft	10:18 AM EST / 2.64 ft	4:57 PM EST / -0.71 ft	10:47 PM EST / 2.63 ft		6:41 AM EST	6:22 PM EST
Tue 4		5:22 AM EST / -0.47 ft	11:04 AM EST / 2.51 ft	5:44 PM EST / -0.59 ft	11:36 PM EST / 2.48 ft		6:40 AM EST	6:23 PM EST
Wed 5		6:10 AM EST / -0.25 ft	11:50 AM EST / 2.34 ft	6:32 PM EST / -0.41 ft			6:39 AM EST	6:23 PM EST
Thu 6	12:27 AM EST / 2.30 ft	6:59 AM EST / -0.02 ft	12:39 PM EST / 2.15 ft	7:22 PM EST / -0.21 ft			6:38 AM EST	6:24 PM EST

Fri 7	1:20 AM EST / 2.13 ft	7:52 AM EST / 0.20 ft	1:30 PM EST / 1.98 ft	8:16 PM EST / -0.03 ft			6:37 AM EST	6:24 PM EST
Sat 8	2:17 AM EST / 1.98 ft	8:50 AM EST / 0.37 ft	2:27 PM EST / 1.83 ft	9:14 PM EST / 0.12 ft		First Quarter	6:36 AM EST	6:25 PM EST
Sun 9	4:18 AM EDT / 1.89 ft	10:53 AM EDT / 0.46 ft	4:29 PM EDT / 1.76 ft	11:16 PM EDT / 0.20 ft			7:35 AM EDT	7:26 PM EDT
Mon 10	5:20 AM EDT / 1.86 ft	11:56 AM EDT / 0.47 ft	5:32 PM EDT / 1.75 ft				7:34 AM EDT	7:26 PM EDT
Tue 11		12:15 AM EDT / 0.21 ft	6:17 AM EDT / 1.90 ft	12:53 PM EDT / 0.40 ft	6:29 PM EDT / 1.82 ft		7:33 AM EDT	7:27 PM EDT
Wed 12		1:09 AM EDT / 0.16 ft	7:06 AM EDT / 1.97 ft	1:41 PM EDT / 0.29 ft	7:19 PM EDT / 1.92 ft		7:32 AM EDT	7:27 PM EDT
Thu 13		1:56 AM EDT / 0.08 ft	7:49 AM EDT / 2.06 ft	2:23 PM EDT / 0.16 ft	8:03 PM EDT / 2.04 ft		7:31 AM EDT	7:28 PM EDT
Fri 14		2:39 AM EDT / -0.01 ft	8:28 AM EDT / 2.15 ft	3:01 PM EDT / 0.03 ft	8:43 PM EDT / 2.16 ft		7:30 AM EDT	7:28 PM EDT
Sat 15		3:18 AM EDT / -0.08 ft	9:04 AM EDT / 2.23 ft	3:38 PM EDT / -0.09 ft	9:22 PM EDT / 2.27 ft		7:29 AM EDT	7:29 PM EDT
Sun 16		3:56 AM EDT / -0.12 ft	9:39 AM EDT / 2.28 ft	4:13 PM EDT / -0.19 ft	9:59 PM EDT / 2.35 ft	Full Moon	7:28 AM EDT	7:29 PM EDT
Mon 17		4:33 AM EDT / -0.14 ft	10:13 AM EDT / 2.31 ft	4:48 PM EDT / -0.26 ft	10:37 PM EDT / 2.39 ft		7:27 AM EDT	7:30 PM EDT
Tue 18		5:09 AM EDT / -0.12 ft	10:48 AM EDT / 2.32 ft	5:25 PM EDT / -0.30 ft	11:16 PM EDT / 2.40 ft		7:26 AM EDT	7:30 PM EDT
Wed 19		5:47 AM EDT / -0.06 ft	11:25 AM EDT / 2.30 ft	6:03 PM EDT / -0.30 ft	11:57 PM EDT / 2.38 ft		7:25 AM EDT	7:31 PM EDT
Thu 20		6:28 AM EDT / 0.01 ft	12:04 PM EDT / 2.26 ft	6:45 PM EDT / -0.27 ft			7:24 AM EDT	7:31 PM EDT
Fri 21	12:41 AM EDT / 2.33 ft	7:12 AM EDT / 0.11 ft	12:49 PM EDT / 2.21 ft	7:33 PM EDT / -0.21 ft			7:23 AM EDT	7:32 PM EDT
Sat 22	1:31 AM EDT / 2.26 ft	8:03 AM EDT / 0.20 ft	1:41 PM EDT / 2.14 ft	8:28 PM EDT / -0.12 ft			7:22 AM EDT	7:32 PM EDT
Sun 23	2:29 AM EDT / 2.19 ft	9:03 AM EDT / 0.27 ft	2:42 PM EDT / 2.10 ft	9:31 PM EDT / -0.05 ft		Last Quarter	7:21 AM EDT	7:33 PM EDT
Mon 24	3:34 AM EDT / 2.16 ft	10:10 AM EDT / 0.28 ft	3:52 PM EDT / 2.09 ft	10:41 PM EDT / -0.03 ft			7:19 AM EDT	7:33 PM EDT
Tue 25	4:43 AM EDT / 2.18 ft	11:21 AM EDT / 0.20 ft	5:05 PM EDT / 2.17 ft	11:52 PM EDT / -0.08 ft			7:18 AM EDT	7:33 PM EDT
Wed 26	5:50 AM EDT / 2.27 ft	12:28 PM EDT / 0.04 ft	6:15 PM EDT / 2.31 ft				7:17 AM EDT	7:34 PM EDT
Thu 27		12:57 AM EDT / -0.19 ft	6:51 AM EDT / 2.40 ft	1:28 PM EDT / -0.16 ft	7:16 PM EDT / 2.49 ft		7:16 AM EDT	7:34 PM EDT
Fri 28		1:57 AM EDT / -0.30 ft	7:46 AM EDT / 2.54 ft	2:23 PM EDT / -0.36 ft	8:12 PM EDT / 2.65 ft		7:15 AM EDT	7:35 PM EDT
Sat 29		2:50 AM EDT / -0.40 ft	8:36 AM EDT / 2.64 ft	3:13 PM EDT / -0.52 ft	9:04 PM EDT / 2.76 ft		7:14 AM EDT	7:35 PM EDT
Sun 30		3:40 AM EDT / -0.44 ft	9:23 AM EDT / 2.70 ft	4:01 PM EDT / -0.61 ft	9:52 PM EDT / 2.81 ft	New Moon	7:13 AM EDT	7:36 PM EDT
Mon 31		4:28 AM EDT / -0.42 ft	10:08 AM EDT / 2.69 ft	4:47 PM EDT / -0.62 ft	10:39 PM EDT / 2.79 ft		7:12 AM EDT	7:36 PM EDT

April 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Tue 1		5:13 AM EDT / -0.33 ft	10:52 AM EDT / 2.63 ft	5:31 PM EDT / -0.55 ft	11:24 PM EDT / 2.70 ft		7:11 AM EDT	7:37 PM EDT
Wed 2		5:58 AM EDT / -0.19 ft	11:36 AM EDT / 2.51 ft	6:15 PM EDT / -0.41 ft			7:10 AM EDT	7:37 PM EDT
Thu 3	12:10 AM EDT / 2.57 ft	6:43 AM EDT / -0.01 ft	12:20 PM EDT / 2.36 ft	6:59 PM EDT / -0.23 ft			7:09 AM EDT	7:38 PM EDT
Fri 4	12:56 AM EDT / 2.41 ft	7:29 AM EDT / 0.18 ft	1:05 PM EDT / 2.19 ft	7:46 PM EDT / -0.03 ft			7:08 AM EDT	7:38 PM EDT
Sat 5	1:44 AM EDT / 2.24 ft	8:19 AM EDT / 0.36 ft	1:54 PM EDT / 2.03 ft	8:35 PM EDT / 0.17 ft			7:07 AM EDT	7:39 PM EDT
Sun 6	2:36 AM EDT / 2.10 ft	9:13 AM EDT / 0.50 ft	2:48 PM EDT / 1.91 ft	9:30 PM EDT / 0.32 ft			7:06 AM EDT	7:39 PM EDT
Mon 7	3:33 AM EDT / 2.00 ft	10:11 AM EDT / 0.57 ft	3:49 PM EDT / 1.84 ft	10:30 PM EDT / 0.42 ft		First Quarter	7:04 AM EDT	7:40 PM EDT
Tue 8	4:32 AM EDT / 1.96 ft	11:12 AM EDT / 0.57 ft	4:53 PM EDT / 1.84 ft	11:32 PM EDT / 0.44 ft			7:03 AM EDT	7:40 PM EDT
Wed 9	5:29 AM EDT / 1.98 ft	12:09 PM EDT / 0.50 ft	5:52 PM EDT / 1.91 ft				7:02 AM EDT	7:41 PM EDT
Thu 10		12:29 AM EDT / 0.40 ft	6:20 AM EDT / 2.04 ft	12:59 PM EDT / 0.38 ft	6:44 PM EDT / 2.03 ft		7:01 AM EDT	7:41 PM EDT
Fri 11		1:19 AM EDT / 0.32 ft	7:06 AM EDT / 2.12 ft	1:43 PM EDT / 0.24 ft	7:31 PM EDT / 2.17 ft		7:00 AM EDT	7:42 PM EDT
Sat 12		2:04 AM EDT / 0.23 ft	7:47 AM EDT / 2.22 ft	2:24 PM EDT / 0.08 ft	8:13 PM EDT / 2.32 ft		6:59 AM EDT	7:42 PM EDT
Sun 13		2:46 AM EDT / 0.14 ft	8:26 AM EDT / 2.31 ft	3:02 PM EDT / -0.07 ft	8:53 PM EDT / 2.45 ft		6:58 AM EDT	7:43 PM EDT
Mon 14		3:26 AM EDT / 0.06 ft	9:03 AM EDT / 2.38 ft	3:40 PM EDT / -0.20 ft	9:33 PM EDT / 2.55 ft		6:57 AM EDT	7:43 PM EDT
Tue 15		4:05 AM EDT / 0.02 ft	9:41 AM EDT / 2.44 ft	4:18 PM EDT / -0.29 ft	10:12 PM EDT / 2.62 ft	Full Moon	6:56 AM EDT	7:44 PM EDT
Wed 16		4:45 AM EDT / 0.00 ft	10:20 AM EDT / 2.46 ft	4:58 PM EDT / -0.34 ft	10:54 PM EDT / 2.64 ft		6:55 AM EDT	7:44 PM EDT
Thu 17		5:26 AM EDT / 0.02 ft	11:01 AM EDT / 2.46 ft	5:40 PM EDT / -0.34 ft	11:37 PM EDT / 2.62 ft		6:54 AM EDT	7:45 PM EDT
Fri 18		6:10 AM EDT / 0.07 ft	11:45 AM EDT / 2.43 ft	6:26 PM EDT / -0.29 ft			6:54 AM EDT	7:45 PM EDT
Sat 19	12:25 AM EDT / 2.56 ft	6:58 AM EDT / 0.13 ft	12:34 PM EDT / 2.37 ft	7:17 PM EDT / -0.19 ft			6:53 AM EDT	7:46 PM EDT
Sun 20	1:16 AM EDT / 2.48 ft	7:52 AM EDT / 0.20 ft	1:30 PM EDT / 2.30 ft	8:14 PM EDT / -0.07 ft			6:52 AM EDT	7:46 PM EDT
Mon 21	2:14 AM EDT / 2.39 ft	8:52 AM EDT / 0.25 ft	2:34 PM EDT / 2.25 ft	9:18 PM EDT / 0.04 ft			6:51 AM EDT	7:47 PM EDT
Tue 22	3:18 AM EDT / 2.33 ft	9:58 AM EDT / 0.25 ft	3:44 PM EDT / 2.24 ft	10:28 PM EDT / 0.10 ft		Last Quarter	6:50 AM EDT	7:47 PM EDT
Wed 23	4:25 AM EDT / 2.33 ft	11:06 AM EDT / 0.17 ft	4:56 PM EDT / 2.30 ft	11:37 PM EDT / 0.09 ft			6:49 AM EDT	7:48 PM EDT
Thu 24	5:29 AM EDT / 2.37 ft	12:11 PM EDT / 0.04 ft	6:03 PM EDT / 2.41 ft				6:48 AM EDT	7:48 PM EDT
Fri 25		12:42 AM EDT / 0.04 ft	6:29 AM EDT / 2.45 ft	1:10 PM EDT / -0.13 ft	7:03 PM EDT / 2.55 ft		6:47 AM EDT	7:49 PM EDT
Sat 26		1:40 AM EDT / -0.04 ft	7:23 AM EDT / 2.53 ft	2:03 PM EDT / -0.28 ft	7:58 PM EDT / 2.67 ft		6:46 AM EDT	7:49 PM EDT

Sun 27		2:33 AM EDT / -0.10 ft	8:13 AM EDT / 2.59 ft	2:53 PM EDT / -0.39 ft	8:47 PM EDT / 2.75 ft		6:45 AM EDT	7:50 PM EDT
Mon 28		3:22 AM EDT / -0.12 ft	8:59 AM EDT / 2.62 ft	3:39 PM EDT / -0.45 ft	9:34 PM EDT / 2.78 ft		6:45 AM EDT	7:50 PM EDT
Tue 29		4:07 AM EDT / -0.10 ft	9:44 AM EDT / 2.60 ft	4:22 PM EDT / -0.44 ft	10:18 PM EDT / 2.76 ft	New Moon	6:44 AM EDT	7:51 PM EDT
Wed 30		4:51 AM EDT / -0.04 ft	10:26 AM EDT / 2.54 ft	5:05 PM EDT / -0.37 ft	11:01 PM EDT / 2.68 ft		6:43 AM EDT	7:51 PM EDT

May 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Thu 1		5:34 AM EDT / 0.05 ft	11:08 AM EDT / 2.44 ft	5:47 PM EDT / -0.24 ft	11:44 PM EDT / 2.58 ft		6:42 AM EDT	7:52 PM EDT
Fri 2		6:17 AM EDT / 0.17 ft	11:50 AM EDT / 2.32 ft	6:29 PM EDT / -0.09 ft			6:41 AM EDT	7:52 PM EDT
Sat 3	12:26 AM EDT / 2.45 ft	7:01 AM EDT / 0.30 ft	12:34 PM EDT / 2.19 ft	7:12 PM EDT / 0.08 ft			6:41 AM EDT	7:53 PM EDT
Sun 4	1:11 AM EDT / 2.31 ft	7:47 AM EDT / 0.42 ft	1:20 PM EDT / 2.06 ft	7:58 PM EDT / 0.25 ft			6:40 AM EDT	7:53 PM EDT
Mon 5	1:57 AM EDT / 2.19 ft	8:36 AM EDT / 0.51 ft	2:12 PM EDT / 1.96 ft	8:49 PM EDT / 0.40 ft			6:39 AM EDT	7:54 PM EDT
Tue 6	2:48 AM EDT / 2.09 ft	9:30 AM EDT / 0.56 ft	3:09 PM EDT / 1.90 ft	9:44 PM EDT / 0.50 ft		First Quarter	6:39 AM EDT	7:55 PM EDT
Wed 7	3:42 AM EDT / 2.04 ft	10:26 AM EDT / 0.55 ft	4:09 PM EDT / 1.90 ft	10:43 PM EDT / 0.54 ft			6:38 AM EDT	7:55 PM EDT
Thu 8	4:36 AM EDT / 2.02 ft	11:21 AM EDT / 0.48 ft	5:09 PM EDT / 1.96 ft	11:41 PM EDT / 0.53 ft			6:37 AM EDT	7:56 PM EDT
Fri 9	5:28 AM EDT / 2.06 ft	12:12 PM EDT / 0.37 ft	6:03 PM EDT / 2.07 ft				6:37 AM EDT	7:56 PM EDT
Sat 10		12:35 AM EDT / 0.46 ft	6:17 AM EDT / 2.12 ft	12:59 PM EDT / 0.21 ft	6:53 PM EDT / 2.22 ft		6:36 AM EDT	7:57 PM EDT
Sun 11		1:24 AM EDT / 0.37 ft	7:02 AM EDT / 2.21 ft	1:43 PM EDT / 0.04 ft	7:38 PM EDT / 2.37 ft		6:35 AM EDT	7:57 PM EDT
Mon 12		2:10 AM EDT / 0.26 ft	7:45 AM EDT / 2.31 ft	2:25 PM EDT / -0.13 ft	8:22 PM EDT / 2.51 ft		6:35 AM EDT	7:58 PM EDT
Tue 13		2:54 AM EDT / 0.16 ft	8:28 AM EDT / 2.40 ft	3:08 PM EDT / -0.28 ft	9:05 PM EDT / 2.63 ft		6:34 AM EDT	7:58 PM EDT
Wed 14		3:37 AM EDT / 0.07 ft	9:11 AM EDT / 2.48 ft	3:51 PM EDT / -0.39 ft	9:49 PM EDT / 2.72 ft	Full Moon	6:34 AM EDT	7:59 PM EDT
Thu 15		4:22 AM EDT / 0.01 ft	9:55 AM EDT / 2.53 ft	4:36 PM EDT / -0.45 ft	10:34 PM EDT / 2.75 ft		6:33 AM EDT	7:59 PM EDT
Fri 16		5:07 AM EDT / -0.02 ft	10:41 AM EDT / 2.55 ft	5:22 PM EDT / -0.45 ft	11:21 PM EDT / 2.74 ft		6:33 AM EDT	8:00 PM EDT
Sat 17		5:55 AM EDT / -0.02 ft	11:30 AM EDT / 2.52 ft	6:11 PM EDT / -0.39 ft			6:32 AM EDT	8:01 PM EDT
Sun 18	12:10 AM EDT / 2.69 ft	6:46 AM EDT / 0.01 ft	12:24 PM EDT / 2.47 ft	7:05 PM EDT / -0.28 ft			6:32 AM EDT	8:01 PM EDT
Mon 19	1:03 AM EDT / 2.60 ft	7:42 AM EDT / 0.04 ft	1:22 PM EDT / 2.40 ft	8:03 PM EDT / -0.14 ft			6:31 AM EDT	8:02 PM EDT
Tue 20	2:01 AM EDT / 2.51 ft	8:41 AM EDT / 0.07 ft	2:26 PM EDT / 2.34 ft	9:06 PM EDT / -0.00 ft			6:31 AM EDT	8:02 PM EDT
Wed 21	3:02 AM EDT / 2.42 ft	9:45 AM EDT / 0.07 ft	3:34 PM EDT / 2.31 ft	10:13 PM EDT / 0.10 ft		Last Quarter	6:30 AM EDT	8:03 PM EDT
Thu 22	4:04 AM EDT / 2.37 ft	10:50 AM EDT / 0.02 ft	4:43 PM EDT / 2.33 ft	11:20 PM EDT / 0.15 ft			6:30 AM EDT	8:03 PM EDT
Fri 23	5:07 AM EDT / 2.36 ft	11:52 AM EDT / -0.06 ft	5:48 PM EDT / 2.39 ft				6:30 AM EDT	8:04 PM EDT
Sat 24		12:23 AM EDT / 0.15 ft	6:06 AM EDT / 2.37 ft	12:50 PM EDT / -0.16 ft	6:47 PM EDT / 2.47 ft		6:29 AM EDT	8:04 PM EDT
Sun 25		1:21 AM EDT / 0.12 ft	7:00 AM EDT / 2.40 ft	1:43 PM EDT / -0.26 ft	7:41 PM EDT / 2.55 ft		6:29 AM EDT	8:05 PM EDT
Mon 26		2:14 AM EDT / 0.10 ft	7:50 AM EDT / 2.42 ft	2:31 PM EDT / -0.32 ft	8:30 PM EDT / 2.59 ft		6:29 AM EDT	8:05 PM EDT
Tue 27		3:02 AM EDT / 0.08 ft	8:36 AM EDT / 2.42 ft	3:17 PM EDT / -0.35 ft	9:15 PM EDT / 2.61 ft		6:28 AM EDT	8:06 PM EDT
Wed 28		3:47 AM EDT / 0.08 ft	9:20 AM EDT / 2.40 ft	3:59 PM EDT / -0.33 ft	9:58 PM EDT / 2.59 ft	New Moon	6:28 AM EDT	8:06 PM EDT
Thu 29		4:30 AM EDT / 0.10 ft	10:01 AM EDT / 2.35 ft	4:40 PM EDT / -0.27 ft	10:39 PM EDT / 2.54 ft		6:28 AM EDT	8:07 PM EDT
Fri 30		5:11 AM EDT / 0.15 ft	10:43 AM EDT / 2.29 ft	5:20 PM EDT / -0.18 ft	11:19 PM EDT / 2.47 ft		6:28 AM EDT	8:07 PM EDT
Sat 31		5:52 AM EDT / 0.20 ft	11:24 AM EDT / 2.21 ft	6:01 PM EDT / -0.07 ft	11:58 PM EDT / 2.38 ft		6:27 AM EDT	8:08 PM EDT

June 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Sun 1		6:33 AM EDT / 0.26 ft	12:06 PM EDT / 2.12 ft	6:41 PM EDT / 0.06 ft			6:27 AM EDT	8:08 PM EDT
Mon 2	12:39 AM EDT / 2.29 ft	7:16 AM EDT / 0.33 ft	12:50 PM EDT / 2.03 ft	7:24 PM EDT / 0.20 ft			6:27 AM EDT	8:09 PM EDT
Tue 3	1:21 AM EDT / 2.19 ft	8:01 AM EDT / 0.38 ft	1:37 PM EDT / 1.95 ft	8:10 PM EDT / 0.32 ft			6:27 AM EDT	8:09 PM EDT
Wed 4	2:06 AM EDT / 2.10 ft	8:48 AM EDT / 0.40 ft	2:29 PM EDT / 1.90 ft	9:00 PM EDT / 0.42 ft			6:27 AM EDT	8:10 PM EDT

Thu 5	2:53 AM EDT / 2.04 ft	9:38 AM EDT / 0.39 ft	3:25 PM EDT / 1.90 ft	9:55 PM EDT / 0.49 ft		First Quarter	6:27 AM EDT	8:10 PM EDT
Fri 6	3:43 AM EDT / 2.00 ft	10:30 AM EDT / 0.34 ft	4:22 PM EDT / 1.94 ft	10:52 PM EDT / 0.51 ft			6:27 AM EDT	8:11 PM EDT
Sat 7	4:34 AM EDT / 2.01 ft	11:22 AM EDT / 0.23 ft	5:19 PM EDT / 2.03 ft	11:48 PM EDT / 0.47 ft			6:27 AM EDT	8:11 PM EDT
Sun 8	5:26 AM EDT / 2.06 ft	12:13 PM EDT / 0.09 ft	6:12 PM EDT / 2.16 ft				6:27 AM EDT	8:11 PM EDT
Mon 9		12:42 AM EDT / 0.38 ft	6:16 AM EDT / 2.14 ft	1:02 PM EDT / -0.08 ft	7:03 PM EDT / 2.31 ft		6:26 AM EDT	8:12 PM EDT
Tue 10		1:33 AM EDT / 0.27 ft	7:06 AM EDT / 2.24 ft	1:51 PM EDT / -0.26 ft	7:52 PM EDT / 2.46 ft		6:27 AM EDT	8:12 PM EDT
Wed 11		2:22 AM EDT / 0.14 ft	7:55 AM EDT / 2.36 ft	2:39 PM EDT / -0.42 ft	8:39 PM EDT / 2.60 ft		6:27 AM EDT	8:13 PM EDT
Thu 12		3:11 AM EDT / 0.01 ft	8:44 AM EDT / 2.46 ft	3:27 PM EDT / -0.55 ft	9:27 PM EDT / 2.70 ft		6:27 AM EDT	8:13 PM EDT
Fri 13		4:00 AM EDT / -0.11 ft	9:34 AM EDT / 2.54 ft	4:16 PM EDT / -0.62 ft	10:16 PM EDT / 2.76 ft	Full Moon	6:27 AM EDT	8:13 PM EDT
Sat 14		4:49 AM EDT / -0.19 ft	10:25 AM EDT / 2.58 ft	5:07 PM EDT / -0.62 ft	11:05 PM EDT / 2.77 ft		6:27 AM EDT	8:14 PM EDT
Sun 15		5:40 AM EDT / -0.24 ft	11:18 AM EDT / 2.58 ft	5:59 PM EDT / -0.56 ft	11:55 PM EDT / 2.73 ft		6:27 AM EDT	8:14 PM EDT
Mon 16		6:33 AM EDT / -0.25 ft	12:13 PM EDT / 2.54 ft	6:53 PM EDT / -0.44 ft			6:27 AM EDT	8:14 PM EDT
Tue 17	12:48 AM EDT / 2.65 ft	7:27 AM EDT / -0.23 ft	1:11 PM EDT / 2.46 ft	7:50 PM EDT / -0.28 ft			6:27 AM EDT	8:14 PM EDT
Wed 18	1:43 AM EDT / 2.54 ft	8:25 AM EDT / -0.19 ft	2:13 PM EDT / 2.38 ft	8:50 PM EDT / -0.11 ft			6:27 AM EDT	8:15 PM EDT
Thu 19	2:41 AM EDT / 2.43 ft	9:26 AM EDT / -0.16 ft	3:18 PM EDT / 2.32 ft	9:54 PM EDT / 0.04 ft		Last Quarter	6:27 AM EDT	8:15 PM EDT
Fri 20	3:41 AM EDT / 2.33 ft	10:28 AM EDT / -0.15 ft	4:24 PM EDT / 2.28 ft	10:58 PM EDT / 0.15 ft			6:28 AM EDT	8:15 PM EDT
Sat 21	4:41 AM EDT / 2.26 ft	11:29 AM EDT / -0.16 ft	5:29 PM EDT / 2.28 ft				6:28 AM EDT	8:15 PM EDT
Sun 22		12:01 AM EDT / 0.20 ft	5:40 AM EDT / 2.22 ft	12:28 PM EDT / -0.18 ft	6:29 PM EDT / 2.31 ft		6:28 AM EDT	8:16 PM EDT
Mon 23		1:00 AM EDT / 0.22 ft	6:36 AM EDT / 2.20 ft	1:21 PM EDT / -0.22 ft	7:23 PM EDT / 2.35 ft		6:28 AM EDT	8:16 PM EDT
Tue 24		1:54 AM EDT / 0.21 ft	7:26 AM EDT / 2.20 ft	2:10 PM EDT / -0.25 ft	8:12 PM EDT / 2.38 ft		6:29 AM EDT	8:16 PM EDT
Wed 25		2:43 AM EDT / 0.19 ft	8:13 AM EDT / 2.20 ft	2:55 PM EDT / -0.26 ft	8:56 PM EDT / 2.40 ft		6:29 AM EDT	8:16 PM EDT
Thu 26		3:27 AM EDT / 0.17 ft	8:58 AM EDT / 2.20 ft	3:37 PM EDT / -0.25 ft	9:37 PM EDT / 2.41 ft		6:29 AM EDT	8:16 PM EDT
Fri 27		4:09 AM EDT / 0.15 ft	9:39 AM EDT / 2.19 ft	4:17 PM EDT / -0.22 ft	10:15 PM EDT / 2.39 ft	New Moon	6:29 AM EDT	8:16 PM EDT
Sat 28		4:48 AM EDT / 0.14 ft	10:19 AM EDT / 2.17 ft	4:56 PM EDT / -0.17 ft	10:53 PM EDT / 2.36 ft		6:30 AM EDT	8:16 PM EDT
Sun 29		5:27 AM EDT / 0.15 ft	10:59 AM EDT / 2.13 ft	5:34 PM EDT / -0.09 ft	11:30 PM EDT / 2.32 ft		6:30 AM EDT	8:16 PM EDT
Mon 30		6:06 AM EDT / 0.16 ft	11:39 AM EDT / 2.09 ft	6:13 PM EDT / 0.00 ft			6:30 AM EDT	8:17 PM EDT

July 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Tue 1	12:07 AM EDT / 2.25 ft	6:44 AM EDT / 0.19 ft	12:21 PM EDT / 2.04 ft	6:53 PM EDT / 0.11 ft			6:31 AM EDT	8:17 PM EDT
Wed 2	12:45 AM EDT / 2.18 ft	7:24 AM EDT / 0.21 ft	1:04 PM EDT / 1.99 ft	7:35 PM EDT / 0.22 ft			6:31 AM EDT	8:17 PM EDT
Thu 3	1:25 AM EDT / 2.11 ft	8:06 AM EDT / 0.23 ft	1:51 PM EDT / 1.95 ft	8:20 PM EDT / 0.33 ft			6:31 AM EDT	8:17 PM EDT
Fri 4	2:07 AM EDT / 2.04 ft	8:52 AM EDT / 0.23 ft	2:41 PM EDT / 1.93 ft	9:10 PM EDT / 0.42 ft			6:32 AM EDT	8:17 PM EDT
Sat 5	2:53 AM EDT / 2.00 ft	9:41 AM EDT / 0.19 ft	3:37 PM EDT / 1.95 ft	10:04 PM EDT / 0.46 ft		First Quarter	6:32 AM EDT	8:16 PM EDT
Sun 6	3:45 AM EDT / 1.99 ft	10:35 AM EDT / 0.12 ft	4:35 PM EDT / 2.01 ft	11:03 PM EDT / 0.46 ft			6:33 AM EDT	8:16 PM EDT
Mon 7	4:39 AM EDT / 2.02 ft	11:30 AM EDT / 0.01 ft	5:33 PM EDT / 2.11 ft				6:33 AM EDT	8:16 PM EDT
Tue 8		12:02 AM EDT / 0.39 ft	5:36 AM EDT / 2.10 ft	12:26 PM EDT / -0.14 ft	6:29 PM EDT / 2.25 ft		6:34 AM EDT	8:16 PM EDT
Wed 9		12:59 AM EDT / 0.27 ft	6:33 AM EDT / 2.22 ft	1:21 PM EDT / -0.31 ft	7:24 PM EDT / 2.41 ft		6:34 AM EDT	8:16 PM EDT
Thu 10		1:55 AM EDT / 0.11 ft	7:29 AM EDT / 2.36 ft	2:15 PM EDT / -0.47 ft	8:16 PM EDT / 2.57 ft		6:34 AM EDT	8:16 PM EDT
Fri 11		2:48 AM EDT / -0.06 ft	8:24 AM EDT / 2.50 ft	3:08 PM EDT / -0.60 ft	9:06 PM EDT / 2.70 ft		6:35 AM EDT	8:15 PM EDT
Sat 12		3:40 AM EDT / -0.22 ft	9:18 AM EDT / 2.61 ft	4:00 PM EDT / -0.69 ft	9:57 PM EDT / 2.79 ft	Full Moon	6:35 AM EDT	8:15 PM EDT
Sun 13		4:31 AM EDT / -0.35 ft	10:11 AM EDT / 2.69 ft	4:52 PM EDT / -0.70 ft	10:47 PM EDT / 2.83 ft		6:36 AM EDT	8:15 PM EDT
Mon 14		5:23 AM EDT / -0.43 ft	11:05 AM EDT / 2.71 ft	5:44 PM EDT / -0.64 ft	11:37 PM EDT / 2.80 ft		6:36 AM EDT	8:15 PM EDT
Tue 15		6:15 AM EDT / -0.45 ft	12:00 PM EDT / 2.67 ft	6:37 PM EDT / -0.51 ft			6:37 AM EDT	8:15 PM EDT
Wed 16	12:28 AM EDT / 2.72 ft	7:08 AM EDT / -0.42 ft	12:56 PM EDT / 2.59 ft	7:32 PM EDT / -0.33 ft			6:37 AM EDT	8:14 PM EDT
Thu 17	1:22 AM EDT / 2.60 ft	8:04 AM EDT / -0.34 ft	1:54 PM EDT / 2.48 ft	8:30 PM EDT / -0.12 ft			6:38 AM EDT	8:14 PM EDT
Fri 18	2:17 AM EDT / 2.46 ft	9:02 AM EDT / -0.25 ft	2:56 PM EDT / 2.37 ft	9:30 PM EDT / 0.08 ft		Last Quarter	6:38 AM EDT	8:14 PM EDT
Sat 19	3:14 AM EDT / 2.32 ft	10:02 AM EDT / -0.15 ft	4:00 PM EDT / 2.27 ft	10:33 PM EDT / 0.24 ft			6:39 AM EDT	8:14 PM EDT
Sun 20	4:14 AM EDT / 2.21 ft	11:03 AM EDT / -0.08 ft	5:05 PM EDT / 2.22 ft	11:37 PM EDT / 0.34 ft			6:39 AM EDT	8:13 PM EDT
Mon 21	5:14 AM EDT / 2.13 ft	12:02 PM EDT / -0.05 ft	6:06 PM EDT / 2.21 ft				6:40 AM EDT	8:13 PM EDT
Tue 22		12:38 AM EDT / 0.38 ft	6:12 AM EDT / 2.10 ft	12:58 PM EDT / -0.04 ft	7:02 PM EDT / 2.24 ft		6:40 AM EDT	8:12 PM EDT
Wed 23		1:33 AM EDT / 0.38 ft	7:05 AM EDT / 2.10 ft	1:49 PM EDT / -0.05 ft	7:51 PM EDT / 2.28 ft		6:41 AM EDT	8:12 PM EDT
Thu 24		2:22 AM EDT / 0.34 ft	7:53 AM EDT / 2.13 ft	2:34 PM EDT / -0.07 ft	8:34 PM EDT / 2.32 ft		6:41 AM EDT	8:11 PM EDT

Fri 25		3:05 AM EDT / 0.29 ft	8:37 AM EDT / 2.16 ft	3:16 PM EDT / -0.08 ft	9:14 PM EDT / 2.35 ft		6:42 AM EDT	8:11 PM EDT
Sat 26		3:46 AM EDT / 0.23 ft	9:18 AM EDT / 2.20 ft	3:55 PM EDT / -0.08 ft	9:50 PM EDT / 2.38 ft	New Moon	6:42 AM EDT	8:10 PM EDT
Sun 27		4:23 AM EDT / 0.19 ft	9:57 AM EDT / 2.22 ft	4:33 PM EDT / -0.06 ft	10:26 PM EDT / 2.38 ft		6:43 AM EDT	8:10 PM EDT
Mon 28		5:00 AM EDT / 0.15 ft	10:35 AM EDT / 2.24 ft	5:10 PM EDT / -0.01 ft	11:01 PM EDT / 2.37 ft		6:43 AM EDT	8:09 PM EDT
Tue 29		5:35 AM EDT / 0.14 ft	11:13 AM EDT / 2.23 ft	5:46 PM EDT / 0.06 ft	11:35 PM EDT / 2.33 ft		6:44 AM EDT	8:09 PM EDT
Wed 30		6:11 AM EDT / 0.15 ft	11:52 AM EDT / 2.21 ft	6:23 PM EDT / 0.16 ft			6:44 AM EDT	8:08 PM EDT
Thu 31	12:10 AM EDT / 2.28 ft	6:48 AM EDT / 0.16 ft	12:32 PM EDT / 2.17 ft	7:02 PM EDT / 0.26 ft			6:45 AM EDT	8:07 PM EDT

August 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Fri 1	12:46 AM EDT / 2.22 ft	7:27 AM EDT / 0.18 ft	1:15 PM EDT / 2.14 ft	7:44 PM EDT / 0.38 ft			6:45 AM EDT	8:07 PM EDT
Sat 2	1:26 AM EDT / 2.17 ft	8:10 AM EDT / 0.20 ft	2:02 PM EDT / 2.11 ft	8:30 PM EDT / 0.47 ft			6:46 AM EDT	8:06 PM EDT
Sun 3	2:10 AM EDT / 2.12 ft	8:58 AM EDT / 0.20 ft	2:56 PM EDT / 2.10 ft	9:24 PM EDT / 0.54 ft		First Quarter	6:46 AM EDT	8:05 PM EDT
Mon 4	3:02 AM EDT / 2.11 ft	9:53 AM EDT / 0.17 ft	3:55 PM EDT / 2.13 ft	10:24 PM EDT / 0.56 ft			6:47 AM EDT	8:05 PM EDT
Tue 5	4:01 AM EDT / 2.13 ft	10:54 AM EDT / 0.11 ft	4:58 PM EDT / 2.21 ft	11:28 PM EDT / 0.51 ft			6:47 AM EDT	8:04 PM EDT
Wed 6	5:05 AM EDT / 2.20 ft	11:56 AM EDT / -0.00 ft	6:00 PM EDT / 2.34 ft				6:48 AM EDT	8:03 PM EDT
Thu 7		12:32 AM EDT / 0.38 ft	6:09 AM EDT / 2.33 ft	12:58 PM EDT / -0.15 ft	6:59 PM EDT / 2.50 ft		6:48 AM EDT	8:03 PM EDT
Fri 8		1:31 AM EDT / 0.19 ft	7:10 AM EDT / 2.50 ft	1:56 PM EDT / -0.31 ft	7:54 PM EDT / 2.68 ft		6:49 AM EDT	8:02 PM EDT
Sat 9		2:27 AM EDT / -0.01 ft	8:08 AM EDT / 2.68 ft	2:51 PM EDT / -0.45 ft	8:46 PM EDT / 2.83 ft		6:49 AM EDT	8:01 PM EDT
Sun 10		3:21 AM EDT / -0.21 ft	9:03 AM EDT / 2.83 ft	3:44 PM EDT / -0.54 ft	9:37 PM EDT / 2.94 ft	Full Moon	6:50 AM EDT	8:00 PM EDT
Mon 11		4:12 AM EDT / -0.36 ft	9:56 AM EDT / 2.93 ft	4:36 PM EDT / -0.55 ft	10:26 PM EDT / 2.99 ft		6:50 AM EDT	7:59 PM EDT
Tue 12		5:03 AM EDT / -0.44 ft	10:49 AM EDT / 2.96 ft	5:27 PM EDT / -0.49 ft	11:15 PM EDT / 2.97 ft		6:51 AM EDT	7:59 PM EDT
Wed 13		5:54 AM EDT / -0.45 ft	11:42 AM EDT / 2.93 ft	6:18 PM EDT / -0.35 ft			6:51 AM EDT	7:58 PM EDT
Thu 14	12:05 AM EDT / 2.89 ft	6:45 AM EDT / -0.38 ft	12:35 PM EDT / 2.82 ft	7:11 PM EDT / -0.14 ft			6:52 AM EDT	7:57 PM EDT
Fri 15	12:56 AM EDT / 2.75 ft	7:38 AM EDT / -0.25 ft	1:31 PM EDT / 2.68 ft	8:05 PM EDT / 0.09 ft			6:52 AM EDT	7:56 PM EDT
Sat 16	1:48 AM EDT / 2.58 ft	8:33 AM EDT / -0.09 ft	2:29 PM EDT / 2.53 ft	9:03 PM EDT / 0.32 ft			6:53 AM EDT	7:55 PM EDT
Sun 17	2:44 AM EDT / 2.41 ft	9:31 AM EDT / 0.08 ft	3:31 PM EDT / 2.39 ft	10:04 PM EDT / 0.51 ft		Last Quarter	6:53 AM EDT	7:54 PM EDT
Mon 18	3:43 AM EDT / 2.27 ft	10:32 AM EDT / 0.21 ft	4:35 PM EDT / 2.30 ft	11:09 PM EDT / 0.62 ft			6:53 AM EDT	7:53 PM EDT
Tue 19	4:46 AM EDT / 2.19 ft	11:34 AM EDT / 0.30 ft	5:38 PM EDT / 2.28 ft				6:54 AM EDT	7:52 PM EDT
Wed 20		12:12 AM EDT / 0.67 ft	5:46 AM EDT / 2.16 ft	12:32 PM EDT / 0.33 ft	6:35 PM EDT / 2.30 ft		6:54 AM EDT	7:52 PM EDT
Thu 21		1:08 AM EDT / 0.64 ft	6:42 AM EDT / 2.19 ft	1:25 PM EDT / 0.31 ft	7:24 PM EDT / 2.35 ft		6:55 AM EDT	7:51 PM EDT
Fri 22		1:57 AM EDT / 0.58 ft	7:31 AM EDT / 2.25 ft	2:11 PM EDT / 0.28 ft	8:07 PM EDT / 2.42 ft		6:55 AM EDT	7:50 PM EDT
Sat 23		2:40 AM EDT / 0.49 ft	8:15 AM EDT / 2.33 ft	2:52 PM EDT / 0.24 ft	8:45 PM EDT / 2.48 ft		6:56 AM EDT	7:49 PM EDT
Sun 24		3:18 AM EDT / 0.41 ft	8:56 AM EDT / 2.41 ft	3:31 PM EDT / 0.22 ft	9:21 PM EDT / 2.53 ft		6:56 AM EDT	7:48 PM EDT
Mon 25		3:54 AM EDT / 0.33 ft	9:34 AM EDT / 2.48 ft	4:08 PM EDT / 0.21 ft	9:55 PM EDT / 2.56 ft	New Moon	6:57 AM EDT	7:47 PM EDT
Tue 26		4:29 AM EDT / 0.28 ft	10:10 AM EDT / 2.53 ft	4:44 PM EDT / 0.23 ft	10:29 PM EDT / 2.57 ft		6:57 AM EDT	7:46 PM EDT
Wed 27		5:03 AM EDT / 0.25 ft	10:47 AM EDT / 2.55 ft	5:19 PM EDT / 0.29 ft	11:02 PM EDT / 2.55 ft		6:58 AM EDT	7:45 PM EDT
Thu 28		5:38 AM EDT / 0.24 ft	11:24 AM EDT / 2.54 ft	5:55 PM EDT / 0.37 ft	11:36 PM EDT / 2.52 ft		6:58 AM EDT	7:44 PM EDT
Fri 29		6:13 AM EDT / 0.25 ft	12:02 PM EDT / 2.52 ft	6:32 PM EDT / 0.47 ft			6:58 AM EDT	7:43 PM EDT
Sat 30	12:11 AM EDT / 2.47 ft	6:51 AM EDT / 0.28 ft	12:43 PM EDT / 2.48 ft	7:13 PM EDT / 0.58 ft			6:59 AM EDT	7:41 PM EDT
Sun 31	12:51 AM EDT / 2.42 ft	7:34 AM EDT / 0.32 ft	1:30 PM EDT / 2.43 ft	7:59 PM EDT / 0.68 ft			6:59 AM EDT	7:40 PM EDT

September 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Mon 1	1:36 AM EDT / 2.38 ft	8:23 AM EDT / 0.37 ft	2:23 PM EDT / 2.40 ft	8:53 PM EDT / 0.75 ft			7:00 AM EDT	7:39 PM EDT
Tue 2	2:31 AM EDT / 2.35 ft	9:21 AM EDT / 0.40 ft	3:24 PM EDT / 2.39 ft	9:55 PM EDT / 0.78 ft		First Quarter	7:00 AM EDT	7:38 PM EDT
Wed 3	3:35 AM EDT / 2.36 ft	10:26 AM EDT / 0.38 ft	4:30 PM EDT / 2.44 ft	11:03 PM EDT / 0.72 ft			7:01 AM EDT	7:37 PM EDT

Thu 4	4:44 AM EDT / 2.44 ft	11:34 AM EDT / 0.31 ft	5:36 PM EDT / 2.56 ft				7:01 AM EDT	7:36 PM EDT
Fri 5		12:11 AM EDT / 0.58 ft	5:52 AM EDT / 2.58 ft	12:39 PM EDT / 0.18 ft	6:37 PM EDT / 2.72 ft		7:01 AM EDT	7:35 PM EDT
Sat 6		1:12 AM EDT / 0.37 ft	6:56 AM EDT / 2.77 ft	1:40 PM EDT / 0.03 ft	7:33 PM EDT / 2.89 ft		7:02 AM EDT	7:34 PM EDT
Sun 7		2:09 AM EDT / 0.14 ft	7:54 AM EDT / 2.97 ft	2:36 PM EDT / -0.11 ft	8:26 PM EDT / 3.05 ft		7:02 AM EDT	7:33 PM EDT
Mon 8		3:02 AM EDT / -0.07 ft	8:49 AM EDT / 3.14 ft	3:28 PM EDT / -0.19 ft	9:16 PM EDT / 3.16 ft	Full Moon	7:03 AM EDT	7:32 PM EDT
Tue 9		3:52 AM EDT / -0.21 ft	9:41 AM EDT / 3.24 ft	4:18 PM EDT / -0.21 ft	10:04 PM EDT / 3.20 ft		7:03 AM EDT	7:31 PM EDT
Wed 10		4:42 AM EDT / -0.28 ft	10:31 AM EDT / 3.27 ft	5:08 PM EDT / -0.14 ft	10:51 PM EDT / 3.18 ft		7:03 AM EDT	7:30 PM EDT
Thu 11		5:30 AM EDT / -0.26 ft	11:22 AM EDT / 3.21 ft	5:57 PM EDT / 0.00 ft	11:39 PM EDT / 3.08 ft		7:04 AM EDT	7:29 PM EDT
Fri 12		6:19 AM EDT / -0.15 ft	12:12 PM EDT / 3.09 ft	6:47 PM EDT / 0.20 ft			7:04 AM EDT	7:27 PM EDT
Sat 13	12:28 AM EDT / 2.93 ft	7:09 AM EDT / 0.02 ft	1:04 PM EDT / 2.93 ft	7:38 PM EDT / 0.43 ft			7:05 AM EDT	7:26 PM EDT
Sun 14	1:18 AM EDT / 2.75 ft	8:01 AM EDT / 0.23 ft	1:59 PM EDT / 2.75 ft	8:33 PM EDT / 0.66 ft			7:05 AM EDT	7:25 PM EDT
Mon 15	2:12 AM EDT / 2.57 ft	8:56 AM EDT / 0.44 ft	2:58 PM EDT / 2.59 ft	9:33 PM EDT / 0.84 ft		Last Quarter	7:05 AM EDT	7:24 PM EDT
Tue 16	3:11 AM EDT / 2.42 ft	9:56 AM EDT / 0.61 ft	4:00 PM EDT / 2.48 ft	10:37 PM EDT / 0.95 ft			7:06 AM EDT	7:23 PM EDT
Wed 17	4:14 AM EDT / 2.34 ft	10:59 AM EDT / 0.72 ft	5:02 PM EDT / 2.44 ft	11:40 PM EDT / 0.97 ft			7:06 AM EDT	7:22 PM EDT
Thu 18	5:18 AM EDT / 2.32 ft	12:00 PM EDT / 0.76 ft	6:00 PM EDT / 2.46 ft				7:07 AM EDT	7:21 PM EDT
Fri 19		12:37 AM EDT / 0.93 ft	6:15 AM EDT / 2.38 ft	12:54 PM EDT / 0.74 ft	6:50 PM EDT / 2.52 ft		7:07 AM EDT	7:20 PM EDT
Sat 20		1:26 AM EDT / 0.84 ft	7:06 AM EDT / 2.47 ft	1:42 PM EDT / 0.68 ft	7:33 PM EDT / 2.59 ft		7:08 AM EDT	7:18 PM EDT
Sun 21		2:08 AM EDT / 0.72 ft	7:50 AM EDT / 2.58 ft	2:24 PM EDT / 0.62 ft	8:12 PM EDT / 2.67 ft		7:08 AM EDT	7:17 PM EDT
Mon 22		2:46 AM EDT / 0.61 ft	8:30 AM EDT / 2.69 ft	3:04 PM EDT / 0.56 ft	8:48 PM EDT / 2.74 ft		7:08 AM EDT	7:16 PM EDT
Tue 23		3:22 AM EDT / 0.51 ft	9:07 AM EDT / 2.79 ft	3:40 PM EDT / 0.53 ft	9:22 PM EDT / 2.78 ft		7:09 AM EDT	7:15 PM EDT
Wed 24		3:56 AM EDT / 0.43 ft	9:44 AM EDT / 2.86 ft	4:16 PM EDT / 0.53 ft	9:56 PM EDT / 2.81 ft	New Moon	7:09 AM EDT	7:14 PM EDT
Thu 25		4:31 AM EDT / 0.37 ft	10:21 AM EDT / 2.90 ft	4:52 PM EDT / 0.55 ft	10:29 PM EDT / 2.80 ft		7:10 AM EDT	7:13 PM EDT
Fri 26		5:06 AM EDT / 0.35 ft	10:58 AM EDT / 2.91 ft	5:29 PM EDT / 0.61 ft	11:04 PM EDT / 2.78 ft		7:10 AM EDT	7:12 PM EDT
Sat 27		5:42 AM EDT / 0.36 ft	11:36 AM EDT / 2.88 ft	6:07 PM EDT / 0.69 ft	11:42 PM EDT / 2.74 ft		7:10 AM EDT	7:11 PM EDT
Sun 28		6:22 AM EDT / 0.40 ft	12:18 PM EDT / 2.83 ft	6:49 PM EDT / 0.78 ft			7:11 AM EDT	7:09 PM EDT
Mon 29	12:24 AM EDT / 2.69 ft	7:06 AM EDT / 0.46 ft	1:05 PM EDT / 2.77 ft	7:37 PM EDT / 0.86 ft			7:11 AM EDT	7:08 PM EDT
Tue 30	1:12 AM EDT / 2.64 ft	7:58 AM EDT / 0.55 ft	1:59 PM EDT / 2.71 ft	8:32 PM EDT / 0.93 ft			7:12 AM EDT	7:07 PM EDT

October 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Wed 1	2:10 AM EDT / 2.60 ft	8:58 AM EDT / 0.62 ft	3:00 PM EDT / 2.67 ft	9:36 PM EDT / 0.94 ft		First Quarter	7:12 AM EDT	7:06 PM EDT
Thu 2	3:18 AM EDT / 2.60 ft	10:06 AM EDT / 0.65 ft	4:08 PM EDT / 2.69 ft	10:46 PM EDT / 0.87 ft			7:13 AM EDT	7:05 PM EDT
Fri 3	4:31 AM EDT / 2.67 ft	11:16 AM EDT / 0.61 ft	5:14 PM EDT / 2.78 ft	11:53 PM EDT / 0.71 ft			7:13 AM EDT	7:04 PM EDT
Sat 4	5:41 AM EDT / 2.81 ft	12:23 PM EDT / 0.50 ft	6:16 PM EDT / 2.91 ft				7:14 AM EDT	7:03 PM EDT
Sun 5		12:55 AM EDT / 0.49 ft	6:44 AM EDT / 3.00 ft	1:24 PM EDT / 0.37 ft	7:13 PM EDT / 3.06 ft		7:14 AM EDT	7:02 PM EDT
Mon 6		1:51 AM EDT / 0.27 ft	7:42 AM EDT / 3.19 ft	2:20 PM EDT / 0.25 ft	8:05 PM EDT / 3.19 ft		7:15 AM EDT	7:01 PM EDT
Tue 7		2:43 AM EDT / 0.08 ft	8:34 AM EDT / 3.34 ft	3:11 PM EDT / 0.17 ft	8:54 PM EDT / 3.27 ft		7:15 AM EDT	7:00 PM EDT
Wed 8		3:32 AM EDT / -0.05 ft	9:25 AM EDT / 3.42 ft	4:00 PM EDT / 0.16 ft	9:41 PM EDT / 3.30 ft	Full Moon	7:15 AM EDT	6:59 PM EDT
Thu 9		4:19 AM EDT / -0.09 ft	10:13 AM EDT / 3.43 ft	4:48 PM EDT / 0.22 ft	10:27 PM EDT / 3.25 ft		7:16 AM EDT	6:58 PM EDT
Fri 10		5:06 AM EDT / -0.04 ft	11:01 AM EDT / 3.36 ft	5:35 PM EDT / 0.34 ft	11:13 PM EDT / 3.15 ft		7:16 AM EDT	6:57 PM EDT
Sat 11		5:52 AM EDT / 0.08 ft	11:48 AM EDT / 3.24 ft	6:22 PM EDT / 0.51 ft	11:59 PM EDT / 3.00 ft		7:17 AM EDT	6:56 PM EDT
Sun 12		6:39 AM EDT / 0.27 ft	12:36 PM EDT / 3.07 ft	7:11 PM EDT / 0.70 ft			7:17 AM EDT	6:55 PM EDT
Mon 13	12:47 AM EDT / 2.82 ft	7:28 AM EDT / 0.48 ft	1:27 PM EDT / 2.89 ft	8:02 PM EDT / 0.88 ft			7:18 AM EDT	6:54 PM EDT
Tue 14	1:39 AM EDT / 2.65 ft	8:20 AM EDT / 0.70 ft	2:21 PM EDT / 2.73 ft	8:58 PM EDT / 1.03 ft			7:18 AM EDT	6:53 PM EDT
Wed 15	2:35 AM EDT / 2.51 ft	9:16 AM EDT / 0.88 ft	3:18 PM EDT / 2.61 ft	9:58 PM EDT / 1.11 ft		Last Quarter	7:19 AM EDT	6:52 PM EDT
Thu 16	3:38 AM EDT / 2.42 ft	10:17 AM EDT / 1.00 ft	4:18 PM EDT / 2.55 ft	11:00 PM EDT / 1.12 ft			7:19 AM EDT	6:51 PM EDT
Fri 17	4:42 AM EDT / 2.41 ft	11:19 AM EDT / 1.04 ft	5:15 PM EDT / 2.54 ft	11:57 PM EDT / 1.06 ft			7:20 AM EDT	6:50 PM EDT
Sat 18	5:41 AM EDT / 2.47 ft	12:16 PM EDT / 1.02 ft	6:06 PM EDT / 2.59 ft				7:21 AM EDT	6:49 PM EDT
Sun 19		12:47 AM EDT / 0.95 ft	6:33 AM EDT / 2.57 ft	1:06 PM EDT / 0.95 ft	6:51 PM EDT / 2.65 ft		7:21 AM EDT	6:48 PM EDT
Mon 20		1:30 AM EDT / 0.82 ft	7:18 AM EDT / 2.70 ft	1:51 PM EDT / 0.87 ft	7:32 PM EDT / 2.73 ft		7:22 AM EDT	6:47 PM EDT
Tue 21		2:10 AM EDT / 0.68 ft	7:59 AM EDT / 2.83 ft	2:32 PM EDT / 0.79 ft	8:10 PM EDT / 2.80 ft		7:22 AM EDT	6:46 PM EDT
Wed 22		2:47 AM EDT / 0.55 ft	8:39 AM EDT / 2.94 ft	3:10 PM EDT / 0.72 ft	8:46 PM EDT / 2.86 ft		7:23 AM EDT	6:45 PM EDT
Thu 23		3:23 AM EDT / 0.43 ft	9:17 AM EDT / 3.03 ft	3:48 PM EDT / 0.68 ft	9:22 PM EDT / 2.90 ft	New Moon	7:23 AM EDT	6:44 PM EDT
Fri 24		4:00 AM EDT / 0.35 ft	9:55 AM EDT / 3.08 ft	4:26 PM EDT / 0.67 ft	9:59 PM EDT / 2.92 ft		7:24 AM EDT	6:44 PM EDT

Sat 25		4:38 AM EDT / 0.30 ft	10:34 AM EDT / 3.10 ft	5:05 PM EDT / 0.68 ft	10:38 PM EDT / 2.91 ft		7:25 AM EDT	6:43 PM EDT
Sun 26		5:17 AM EDT / 0.30 ft	11:15 AM EDT / 3.08 ft	5:46 PM EDT / 0.71 ft	11:20 PM EDT / 2.88 ft		7:25 AM EDT	6:42 PM EDT
Mon 27		6:00 AM EDT / 0.34 ft	11:59 AM EDT / 3.03 ft	6:31 PM EDT / 0.76 ft			7:26 AM EDT	6:41 PM EDT
Tue 28	12:06 AM EDT / 2.83 ft	6:47 AM EDT / 0.42 ft	12:47 PM EDT / 2.95 ft	7:21 PM EDT / 0.81 ft			7:26 AM EDT	6:40 PM EDT
Wed 29	12:58 AM EDT / 2.77 ft	7:41 AM EDT / 0.53 ft	1:41 PM EDT / 2.87 ft	8:19 PM EDT / 0.85 ft			7:27 AM EDT	6:40 PM EDT
Thu 30	1:59 AM EDT / 2.71 ft	8:42 AM EDT / 0.63 ft	2:42 PM EDT / 2.81 ft	9:22 PM EDT / 0.84 ft		First Quarter	7:28 AM EDT	6:39 PM EDT
Fri 31	3:07 AM EDT / 2.70 ft	9:50 AM EDT / 0.69 ft	3:47 PM EDT / 2.79 ft	10:30 PM EDT / 0.76 ft			7:28 AM EDT	6:38 PM EDT

November 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Sat 1	4:19 AM EDT / 2.75 ft	11:00 AM EDT / 0.69 ft	4:53 PM EDT / 2.83 ft	11:36 PM EDT / 0.61 ft			7:29 AM EDT	6:37 PM EDT
Sun 2	4:29 AM EST / 2.86 ft	11:07 AM EST / 0.63 ft	4:55 PM EST / 2.91 ft	11:37 PM EST / 0.43 ft			6:30 AM EST	5:37 PM EST
Mon 3	5:31 AM EST / 3.01 ft	12:08 PM EST / 0.53 ft	5:51 PM EST / 3.00 ft				6:30 AM EST	5:36 PM EST
Tue 4		12:33 AM EST / 0.24 ft	6:28 AM EST / 3.16 ft	1:04 PM EST / 0.44 ft	6:43 PM EST / 3.09 ft		6:31 AM EST	5:36 PM EST
Wed 5		1:24 AM EST / 0.09 ft	7:20 AM EST / 3.27 ft	1:54 PM EST / 0.37 ft	7:32 PM EST / 3.14 ft		6:32 AM EST	5:35 PM EST
Thu 6		2:12 AM EST / -0.01 ft	8:09 AM EST / 3.32 ft	2:42 PM EST / 0.35 ft	8:19 PM EST / 3.14 ft	Full Moon	6:32 AM EST	5:34 PM EST
Fri 7		2:58 AM EST / -0.03 ft	8:55 AM EST / 3.31 ft	3:28 PM EST / 0.39 ft	9:03 PM EST / 3.09 ft		6:33 AM EST	5:34 PM EST
Sat 8		3:43 AM EST / 0.02 ft	9:40 AM EST / 3.24 ft	4:14 PM EST / 0.46 ft	9:48 PM EST / 2.99 ft		6:34 AM EST	5:33 PM EST
Sun 9		4:27 AM EST / 0.13 ft	10:25 AM EST / 3.13 ft	4:58 PM EST / 0.57 ft	10:32 PM EST / 2.86 ft		6:34 AM EST	5:33 PM EST
Mon 10		5:11 AM EST / 0.30 ft	11:09 AM EST / 2.99 ft	5:44 PM EST / 0.70 ft	11:18 PM EST / 2.71 ft		6:35 AM EST	5:32 PM EST
Tue 11		5:56 AM EST / 0.48 ft	11:55 AM EST / 2.83 ft	6:32 PM EST / 0.82 ft			6:36 AM EST	5:32 PM EST
Wed 12	12:06 AM EST / 2.56 ft	6:43 AM EST / 0.67 ft	12:42 PM EST / 2.68 ft	7:22 PM EST / 0.92 ft			6:36 AM EST	5:31 PM EST
Thu 13	12:58 AM EST / 2.43 ft	7:35 AM EST / 0.84 ft	1:33 PM EST / 2.56 ft	8:16 PM EST / 0.98 ft			6:37 AM EST	5:31 PM EST
Fri 14	1:56 AM EST / 2.34 ft	8:30 AM EST / 0.96 ft	2:27 PM EST / 2.48 ft	9:12 PM EST / 0.99 ft		Last Quarter	6:38 AM EST	5:30 PM EST
Sat 15	2:57 AM EST / 2.32 ft	9:29 AM EST / 1.02 ft	3:21 PM EST / 2.44 ft	10:08 PM EST / 0.93 ft			6:39 AM EST	5:30 PM EST
Sun 16	3:57 AM EST / 2.36 ft	10:28 AM EST / 1.02 ft	4:14 PM EST / 2.45 ft	10:59 PM EST / 0.83 ft			6:39 AM EST	5:30 PM EST
Mon 17	4:52 AM EST / 2.45 ft	11:22 AM EST / 0.96 ft	5:02 PM EST / 2.49 ft	11:46 PM EST / 0.68 ft			6:40 AM EST	5:29 PM EST
Tue 18	5:40 AM EST / 2.57 ft	12:11 PM EST / 0.88 ft	5:47 PM EST / 2.56 ft				6:41 AM EST	5:29 PM EST
Wed 19		12:29 AM EST / 0.53 ft	6:26 AM EST / 2.70 ft	12:56 PM EST / 0.77 ft	6:29 PM EST / 2.63 ft		6:42 AM EST	5:29 PM EST
Thu 20		1:10 AM EST / 0.37 ft	7:08 AM EST / 2.82 ft	1:39 PM EST / 0.67 ft	7:11 PM EST / 2.71 ft		6:43 AM EST	5:28 PM EST
Fri 21		1:51 AM EST / 0.22 ft	7:49 AM EST / 2.93 ft	2:20 PM EST / 0.58 ft	7:51 PM EST / 2.78 ft		6:43 AM EST	5:28 PM EST
Sat 22		2:32 AM EST / 0.10 ft	8:30 AM EST / 3.01 ft	3:02 PM EST / 0.51 ft	8:33 PM EST / 2.82 ft	New Moon	6:44 AM EST	5:28 PM EST
Sun 23		3:14 AM EST / 0.03 ft	9:13 AM EST / 3.05 ft	3:44 PM EST / 0.46 ft	9:17 PM EST / 2.84 ft		6:45 AM EST	5:28 PM EST
Mon 24		3:57 AM EST / 0.00 ft	9:56 AM EST / 3.04 ft	4:29 PM EST / 0.43 ft	10:03 PM EST / 2.83 ft		6:45 AM EST	5:28 PM EST
Tue 25		4:44 AM EST / 0.04 ft	10:43 AM EST / 3.00 ft	5:17 PM EST / 0.43 ft	10:53 PM EST / 2.79 ft		6:46 AM EST	5:27 PM EST
Wed 26		5:34 AM EST / 0.12 ft	11:32 AM EST / 2.93 ft	6:09 PM EST / 0.44 ft	11:48 PM EST / 2.72 ft		6:47 AM EST	5:27 PM EST
Thu 27		6:29 AM EST / 0.24 ft	12:26 PM EST / 2.83 ft	7:06 PM EST / 0.45 ft			6:47 AM EST	5:27 PM EST
Fri 28	12:49 AM EST / 2.66 ft	7:29 AM EST / 0.36 ft	1:24 PM EST / 2.74 ft	8:08 PM EST / 0.44 ft			6:48 AM EST	5:27 PM EST
Sat 29	1:55 AM EST / 2.61 ft	8:34 AM EST / 0.46 ft	2:26 PM EST / 2.68 ft	9:12 PM EST / 0.39 ft		First Quarter	6:49 AM EST	5:27 PM EST
Sun 30	3:05 AM EST / 2.62 ft	9:42 AM EST / 0.52 ft	3:30 PM EST / 2.65 ft	10:17 PM EST / 0.30 ft			6:50 AM EST	5:27 PM EST

December 2014

Day	High	Low	High	Low	High	Moon	Sunrise	Sunset
Mon 1	4:13 AM EST / 2.67 ft	10:49 AM EST / 0.51 ft	4:32 PM EST / 2.66 ft	11:18 PM EST / 0.18 ft			6:50 AM EST	5:27 PM EST
Tue 2	5:17 AM EST / 2.76 ft	11:50 AM EST / 0.47 ft	5:29 PM EST / 2.70 ft				6:51 AM EST	5:27 PM EST
Wed 3		12:14 AM EST / 0.05 ft	6:14 AM EST / 2.85 ft	12:47 PM EST / 0.41 ft	6:23 PM EST / 2.73 ft		6:52 AM EST	5:27 PM EST
Thu 4		1:06 AM EST / -0.06 ft	7:06 AM EST / 2.92 ft	1:38 PM EST / 0.35 ft	7:12 PM EST / 2.75 ft		6:53 AM EST	5:27 PM EST

Fri 5		1:54 AM EST / -0.12 ft	7:53 AM EST / 2.95 ft	2:26 PM EST / 0.32 ft	7:59 PM EST / 2.75 ft		6:53 AM EST	5:27 PM EST
Sat 6		2:39 AM EST / -0.13 ft	8:38 AM EST / 2.94 ft	3:11 PM EST / 0.31 ft	8:43 PM EST / 2.71 ft	Full Moon	6:54 AM EST	5:28 PM EST
Sun 7		3:23 AM EST / -0.10 ft	9:21 AM EST / 2.89 ft	3:54 PM EST / 0.33 ft	9:26 PM EST / 2.64 ft		6:55 AM EST	5:28 PM EST
Mon 8		4:04 AM EST / -0.02 ft	10:02 AM EST / 2.82 ft	4:36 PM EST / 0.38 ft	10:08 PM EST / 2.55 ft		6:55 AM EST	5:28 PM EST
Tue 9		4:45 AM EST / 0.10 ft	10:43 AM EST / 2.71 ft	5:18 PM EST / 0.44 ft	10:51 PM EST / 2.44 ft		6:56 AM EST	5:28 PM EST
Wed 10		5:27 AM EST / 0.24 ft	11:23 AM EST / 2.59 ft	6:00 PM EST / 0.50 ft	11:35 PM EST / 2.33 ft		6:57 AM EST	5:28 PM EST
Thu 11		6:09 AM EST / 0.39 ft	12:05 PM EST / 2.47 ft	6:45 PM EST / 0.56 ft			6:57 AM EST	5:29 PM EST
Fri 12	12:22 AM EST / 2.22 ft	6:55 AM EST / 0.53 ft	12:49 PM EST / 2.36 ft	7:31 PM EST / 0.60 ft			6:58 AM EST	5:29 PM EST
Sat 13	1:13 AM EST / 2.14 ft	7:43 AM EST / 0.65 ft	1:35 PM EST / 2.26 ft	8:21 PM EST / 0.61 ft			6:59 AM EST	5:29 PM EST
Sun 14	2:08 AM EST / 2.10 ft	8:37 AM EST / 0.74 ft	2:25 PM EST / 2.19 ft	9:13 PM EST / 0.58 ft		Last Quarter	6:59 AM EST	5:30 PM EST
Mon 15	3:06 AM EST / 2.10 ft	9:34 AM EST / 0.78 ft	3:17 PM EST / 2.16 ft	10:06 PM EST / 0.50 ft			7:00 AM EST	5:30 PM EST
Tue 16	4:03 AM EST / 2.15 ft	10:32 AM EST / 0.76 ft	4:09 PM EST / 2.17 ft	10:58 PM EST / 0.38 ft			7:01 AM EST	5:30 PM EST
Wed 17	4:58 AM EST / 2.25 ft	11:27 AM EST / 0.69 ft	5:00 PM EST / 2.23 ft	11:47 PM EST / 0.23 ft			7:01 AM EST	5:31 PM EST
Thu 18	5:48 AM EST / 2.38 ft	12:18 PM EST / 0.58 ft	5:49 PM EST / 2.31 ft				7:02 AM EST	5:31 PM EST
Fri 19		12:35 AM EST / 0.05 ft	6:36 AM EST / 2.52 ft	1:06 PM EST / 0.44 ft	6:37 PM EST / 2.42 ft		7:02 AM EST	5:32 PM EST
Sat 20		1:21 AM EST / -0.12 ft	7:22 AM EST / 2.65 ft	1:53 PM EST / 0.29 ft	7:24 PM EST / 2.52 ft		7:03 AM EST	5:32 PM EST
Sun 21		2:07 AM EST / -0.27 ft	8:07 AM EST / 2.76 ft	2:39 PM EST / 0.15 ft	8:12 PM EST / 2.61 ft	New Moon	7:03 AM EST	5:33 PM EST
Mon 22		2:54 AM EST / -0.37 ft	8:53 AM EST / 2.83 ft	3:26 PM EST / 0.03 ft	9:00 PM EST / 2.67 ft		7:04 AM EST	5:33 PM EST
Tue 23		3:42 AM EST / -0.42 ft	9:39 AM EST / 2.86 ft	4:13 PM EST / -0.05 ft	9:50 PM EST / 2.69 ft		7:04 AM EST	5:34 PM EST
Wed 24		4:31 AM EST / -0.41 ft	10:27 AM EST / 2.84 ft	5:03 PM EST / -0.10 ft	10:43 PM EST / 2.67 ft		7:05 AM EST	5:34 PM EST
Thu 25		5:22 AM EST / -0.33 ft	11:16 AM EST / 2.78 ft	5:55 PM EST / -0.11 ft	11:38 PM EST / 2.61 ft		7:05 AM EST	5:35 PM EST
Fri 26		6:16 AM EST / -0.20 ft	12:08 PM EST / 2.68 ft	6:50 PM EST / -0.10 ft			7:06 AM EST	5:35 PM EST
Sat 27	12:37 AM EST / 2.52 ft	7:13 AM EST / -0.04 ft	1:04 PM EST / 2.56 ft	7:48 PM EST / -0.07 ft			7:06 AM EST	5:36 PM EST
Sun 28	1:40 AM EST / 2.44 ft	8:15 AM EST / 0.11 ft	2:03 PM EST / 2.45 ft	8:50 PM EST / -0.06 ft		First Quarter	7:06 AM EST	5:36 PM EST
Mon 29	2:47 AM EST / 2.38 ft	9:21 AM EST / 0.23 ft	3:05 PM EST / 2.36 ft	9:54 PM EST / -0.06 ft			7:07 AM EST	5:37 PM EST
Tue 30	3:54 AM EST / 2.36 ft	10:27 AM EST / 0.30 ft	4:08 PM EST / 2.30 ft	10:56 PM EST / -0.10 ft			7:07 AM EST	5:38 PM EST
Wed 31	4:59 AM EST / 2.38 ft	11:31 AM EST / 0.30 ft	5:08 PM EST / 2.29 ft	11:56 PM EST / -0.16 ft			7:07 AM EST	5:38 PM EST

Hurricane Resistant Plants

Boca Raton is in southeast Florida, which means the beach must be able to withstand hurricane weather events. Hurricanes cause erosion, flooding, and extensive damage to beachfront properties in many places across the globe including the Gulf of Mexico, Atlantic Ocean, and Pacific Ocean. According to FEMA, the Atlantic hurricane season begins in June, and ends in November; which correlates with the nesting times of the Loggerhead, Green, and Leatherback sea turtles in Boca Raton. Here is a breakdown what the different categories of hurricanes cause according to the South Florida Water Management District:

Category One:

- Winds 74-95 mph
- Storm surge 4-5 feet above normal
- Damage to unsecure structures
- Limited inland flooding

Category Two:

- Winds 96-110 mph
- Storm surge 6-8 feet above normal
- Limited roof, window, and door damage
- Coastal and inland flooding possible
- Some trees blown down

Category Three:

- Winds 111-130 mph
- Storm surge 9-12 feet above normal
- Some structural damage to small buildings
- Coastal and inland flooding possible
- Most tree vegetation blown off
- Wind tolerant trees may survive depending upon soil

Categories Four and Five:

- Winds 131-155 mph
- Storm surge 13-18 feet above normal
- Many roof and building structure failures
- Coastal and inland flooding probable
- Most trees and vegetation sustain extensive damage
- Little vegetation survives the highest winds
- The South Florida Water Management District also provides a great list of what plant species can withstand storm events, and which plants to remove from areas impacted by frequent hurricanes.

Storm tolerant plants include:

Plant Species	Wind Tolerance	Flooding Tolerance	Salt Tolerance	Mature Size
Paurotis Palm	High	High	High	20'x5'
Florida Thatch Palm	High	Medium	High	20'x3'
Coconut Palm	High	Medium	High	60'x5'
Cypress	Medium	High	Low	80'x25'
Live Oak	High	Medium	Low	60'x40'
Gumbo Limbo	Medium-High	Medium	High	40'x35'
Sea Grape	Medium-High	Medium	High	30'x25'
Strangler Fig	High	High	Medium	50'x50'
Cocoplum	Medium	High	High	12'x10'
Mastic	Medium-High	Medium	Medium	45'x30'
Cabbage Palm	High	High	High	40'x5'
Dahoon Holly	Medium	High	Low	25'x15'
Pond Apple	Medium	High	Low	20'x15'
Black Ironwood	High	Medium	Medium	25'x10'
Stoppers spp.	High	Medium	Medium	25'x10'
Buttonwood	High	High	High	20'x25'
Red Bay	Medium	High	Low	40'x30'
Royal Palm	High	High	Medium	80'x7'
Jamaican Caper	Medium	Medium	High	10'x4'

Plants to remove:

- Australian Pine
- Yellow Tabebuia
- Norfolk Island Pine
- Black Olive
- Weeping Fig
- Queen Palm
- Carrotwood
- Royal Poinciana
- Silk Oak
- Java Plum
- Hong Kong Orchid
- Jacaranda
- Earleaf Acacia
- Eucalyptus
- Javanese Bishopwood
- Washington Fan Palm

All of the following plants cause danger and more clean-up after storm events because they easily topple. Depending on the size of the specific plant, they can cause extensive damage and threaten other property features such as buildings, fences, etc.

Applicable Site Values

This research will help guide the Symbiotic Beachfront Design project immensely by pinpointing what factors need to be taken into account. For instance by locating where sand dune health is bad along the Boca Raton beach, coastal plants and grasses can be added to help form healthier more durable dunes which will help increase nesting success. Another important factor is understanding where the most light pollution is coming from, and how the design can begin to block the sky glow to make the beach darker for sea turtles at night; in turn creating more beach area for successful nesting.

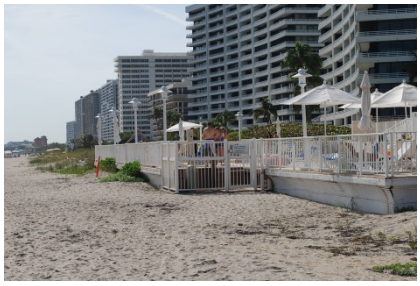
Understanding where the densest nesting is occurring by species will also begin to illustrate key areas where human/turtle interaction should be kept to a minimum. In coordination with the site visit, this will help me determine what existing factors are contributing to the most/least successful nesting areas along the beach. It is also interesting to note that some of the densest nesting sites are not occurring along the public beachfront, where artificial lights are kept to a minimum. Examining the difference between public versus private properties will help determine where problems are occurring, and why.

Another key piece to the puzzle is understanding what vegetation can be included. If I want to shadow the beach from sky glow with natural vegetation such as trees, it is important to note if the trees can even withstand a hurricane weather event. If this project is to be sustainable, the plant material must be able to survive some of these extreme weather conditions associated with Boca Raton, Florida. Cross examining tidal charts with beach width, topography, and dune health, it will become more clear where the Symbiotic Beachfront Design project should focus.

Overall, the results of the research will help make it clear where and how this design project should be implemented. By having a solid idea of what is going on along the beach, the project will be able to respond to the many variables that will make the Boca Raton beachfront a successful cohabitated urban development.

Site Photos











Photos courtesy of Luke Champa. Notice the current dune vegetation and large condo units along the site. It is also important to note that access is very limited to the beach and circulation occurs very close to the water itself.

Project Area

The project area for this design is 24.6 acres with a mix of public park and high density residential fronting on the Atlantic Ocean. The beach width varies from 100- 170 feet, from water to current dune vegetation and the site has a total of .60 miles of beachfront.

Pedestrian access to the beach in this area is limited to South Inlet Park. Circulation through the project area occurs on the inland side of Ocean Boulevard and on the beach; which can be detrimental to sea turtle nesting habitat.

Turtle Nesting Habitat

The turtles do not use all of the beach in fact they will crawl 40-60 feet from the high water mark for nesting and then return to the Atlantic to mate and feed.

Zoning

The zoning of this part of the project is important because it indicates how much artificial light can be expected on the beach at night. In the map green is zoned for park use and orange is medium- high residential.

Ocean Boulevard

Ocean boulevard is a collector street within the city of Boca Raton, it provides access to the private condos and public parking at South Inlet Park

Design Goals

Academic

- Think outside the box to design a project that is unlike any other thesis done by myself or my peers.
- Learn every day that I spend working on the project; whether it's about turtle biology, beachfront design, or my own personal interests.
- Compile previous knowledge from class curriculum into a project that shows I have academically grown immensely during my 5 years at North Dakota State University.

Professional

- Create an innovative design solution that can be applied to beachfronts across the globe.
- Talk to working design professionals about the project and establish relationships that may go past graduation from NDSU.
- In the long term I want this design to thrust me into the world of urban beachfront design and lead to job opportunities with firms that work on projects like these.

Personal

- I want to learn and use successful time management to complete this project on time.
- I want this project to stick out as a fun and unique approach to urban beachfront design.
- Graphically, I want this project to be my best work; something that can be used in my portfolio.

Project Goals

1) Rejuvenate healthier sea turtle habitat along the Boca Raton Beachfront.
    - Dune vegetation
    - Beach renourishment
2) Create an urban park that helps control and strengthen human access and activity along the beach.
    - Physically separate human and turtle habitat
    - Unique spaces and experiences
3) Inspire sea turtle conservation and awareness
    - Aesthetic design
    - Public conservation involvement

Program Elements

Urban dune rejuvenation creates an exciting unique experience.

- New beach spaces helps people circulate around the nesting habitat to find a more comfortable area to enjoy the beach

Using turtle friendly lighting creates a safer beach environment at night; for humans and more importantly, the sea turtles.

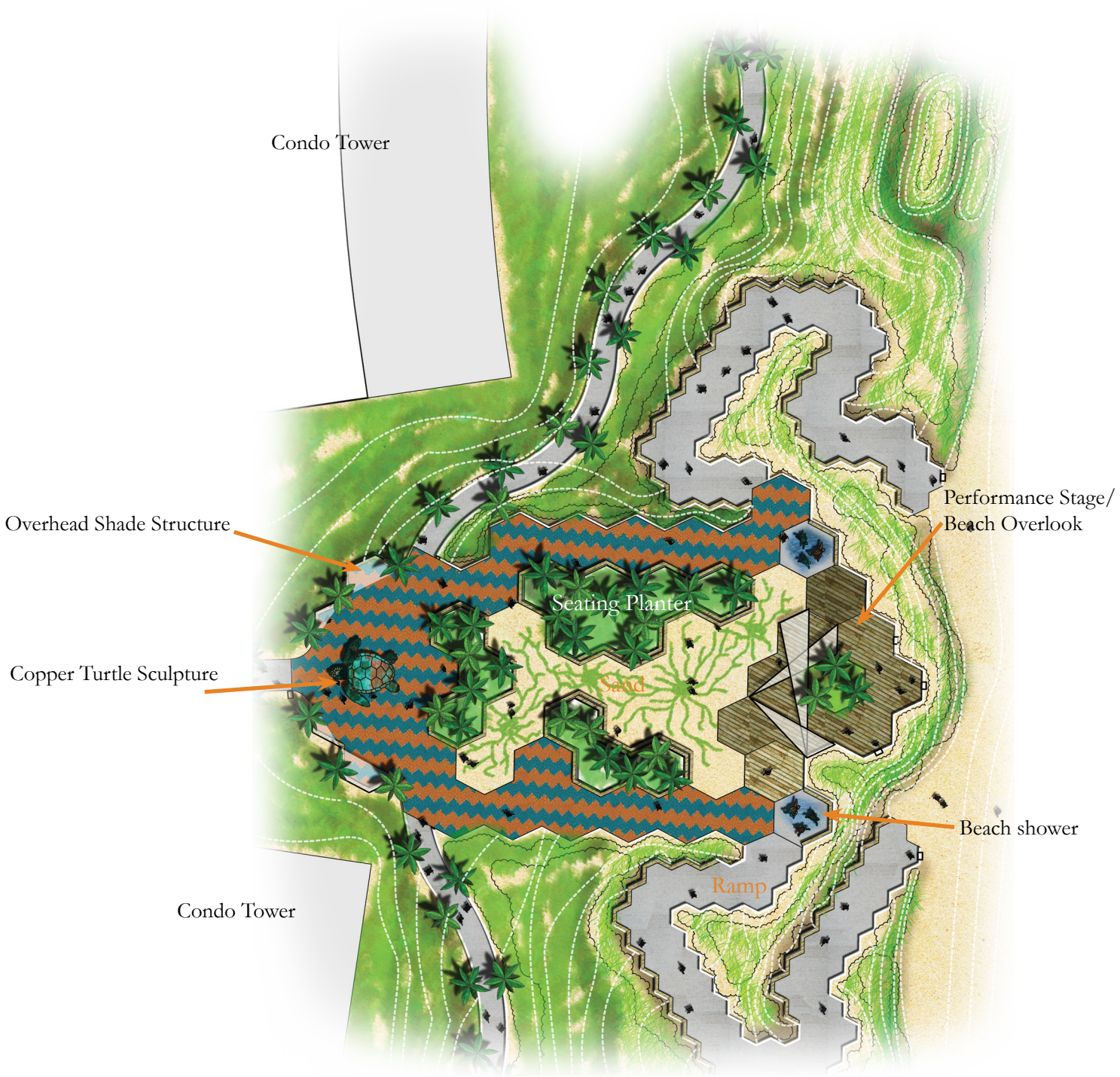
- Natural approach to storm protection and lower maintenance costs, as dunes strengthen and grow over time.

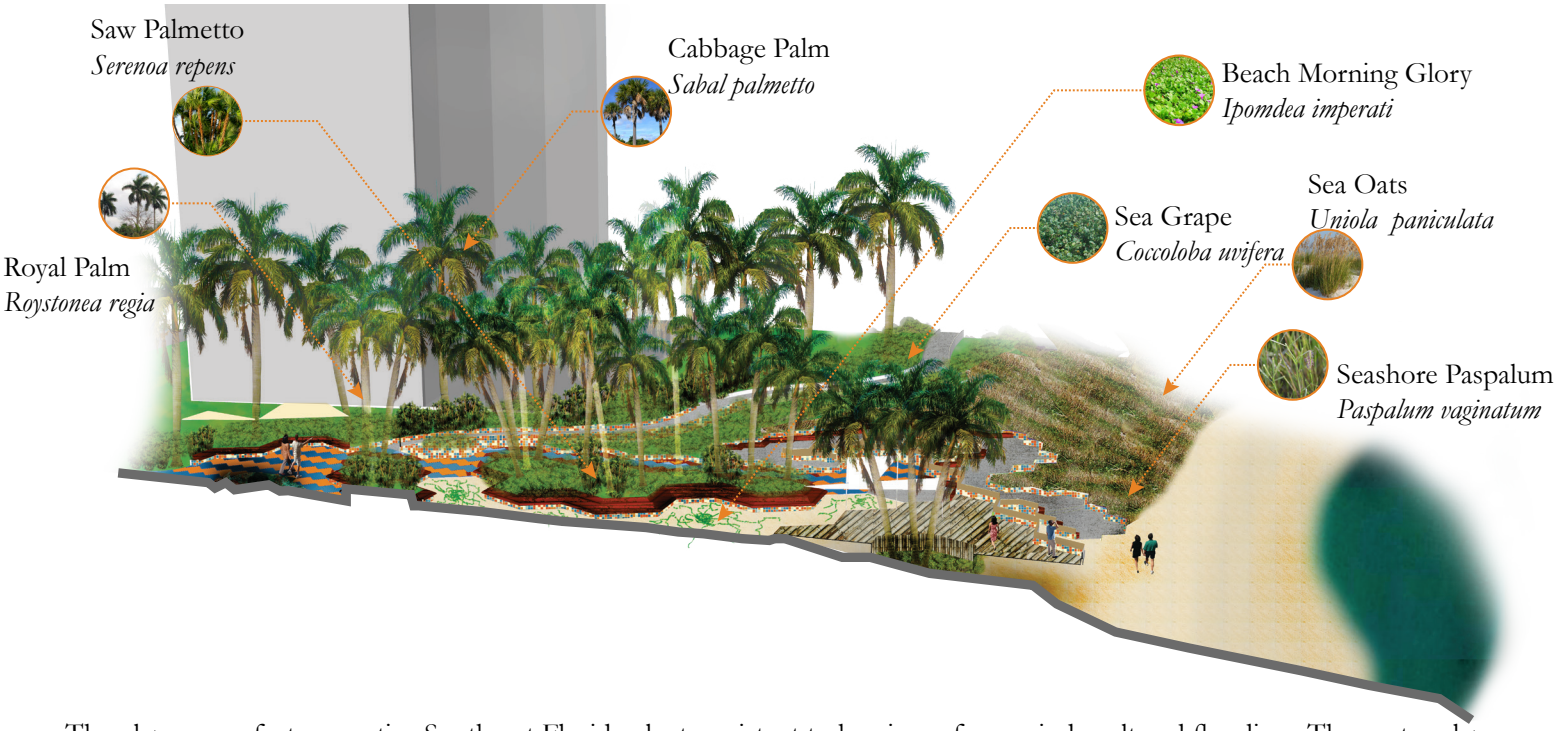
The turtle rehabilitation center and turtle sculptural elements give people the opportunity to physically interact with these often ignored or forgotten animals.

- Programs that allow people to get involved in sea turtle conservation and see how these animals interact with the Boca Raton beachfront and Atlantic Ocean.

Master Plan

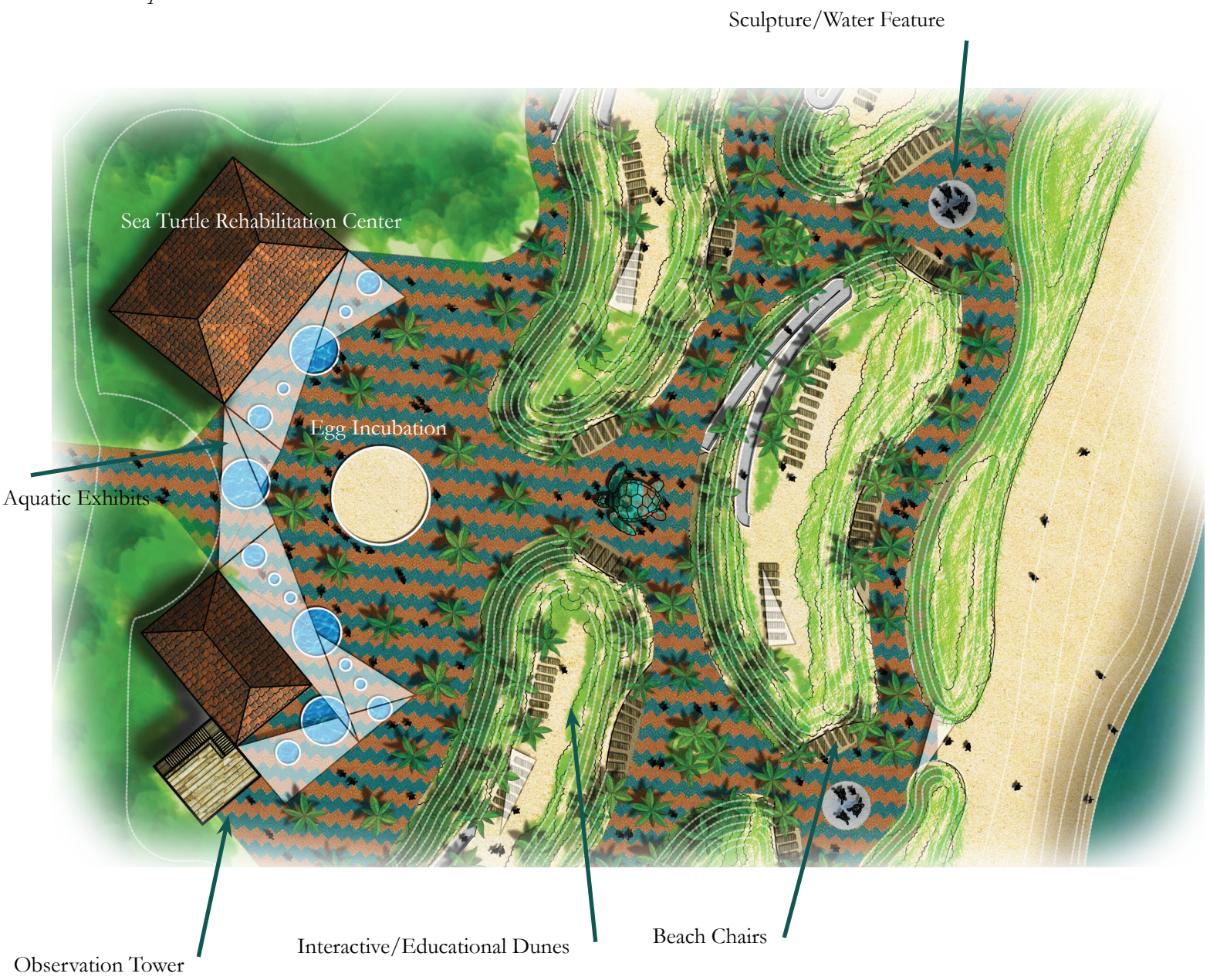

"Dune Experience"
Sea Turtle Rehabilitation Center
Pedestrian Circulation Path
"Dune Room"
Overlook/Node Space
"Turtle Plaza"
Beach Overlook
Street/Beach Access
"Dune Room"
Educational Experience
Atlantic Ocean
100'
300'
500'
N


Condo Tower
Overhead Shade Structure
Performance Stage/
Beach Overlook
Seating Planter
Copper Turtle Sculpture
Sand
Beach shower
Ramp
Condo Tower
N
30'
60'
90'



The plaza space features native Southeast Florida plants resistant to hurricane force winds, salt and flooding. The center plaza softscape is a native substitute to turf grass, and even provides a flowering aesthetic. These plant materials will help decrease maintenance costs, especially during a tropical storm event. The Plaza is a major node along the site, providing access to the street and the beach.

The plaza space has sea turtle friendly lighting such as indirect light as seen under the benches, and on the shore side of the palm trees. The blue lighting is solar activated, inlayed when the paving pattern was layed.


Sculpture/Water Feature
Sea Turtle Rehabilitation Center
Egg Incubation
Aquatic Exhibits
Observation Tower
Interactive/Educational Dunes
Beach Chairs

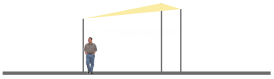

N


30'
60'
90'

"Dune Experience"

Aquatic turtle exhibit for face to face turtle interaction.

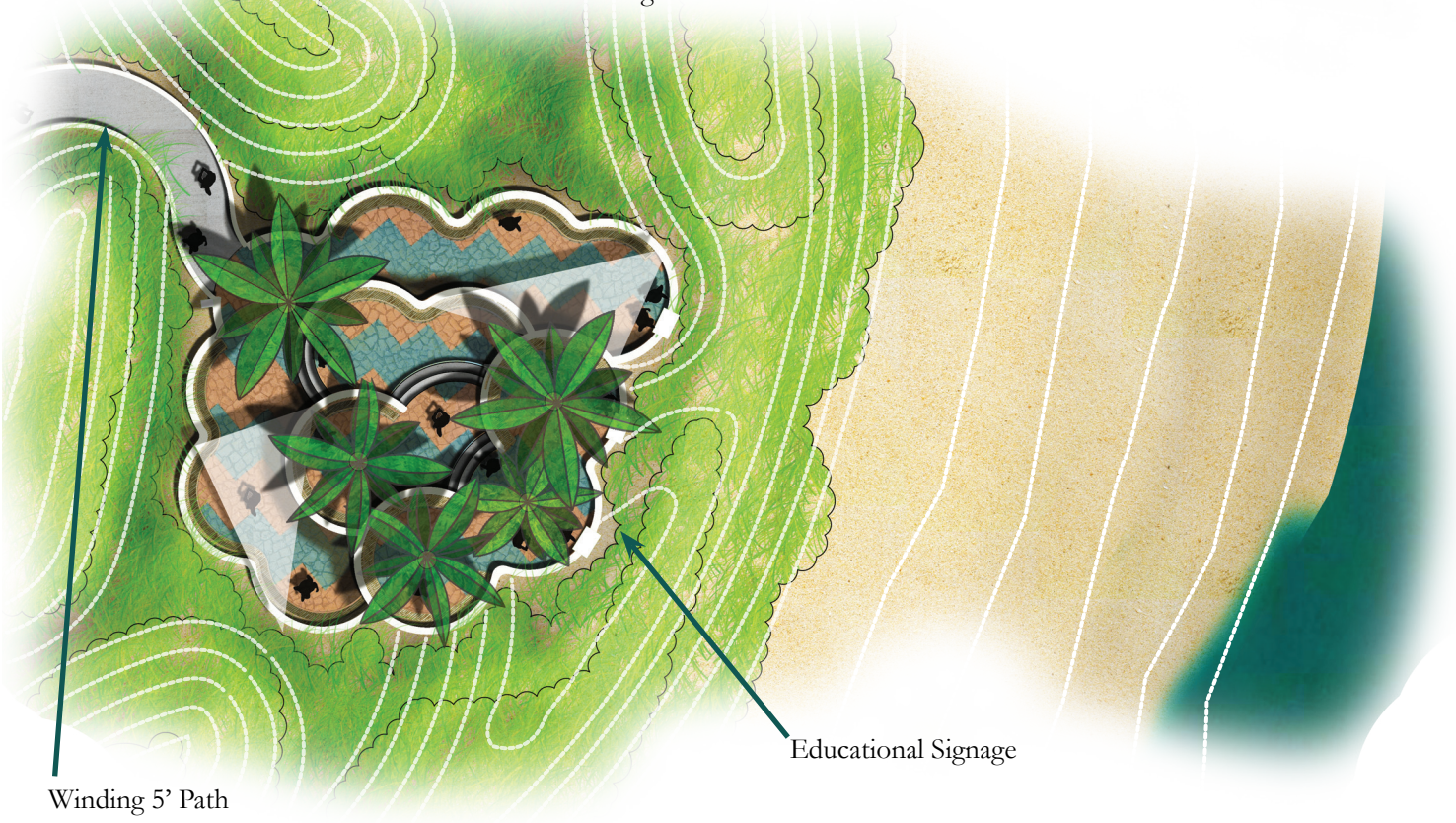
Large copper structure for patina and scale.



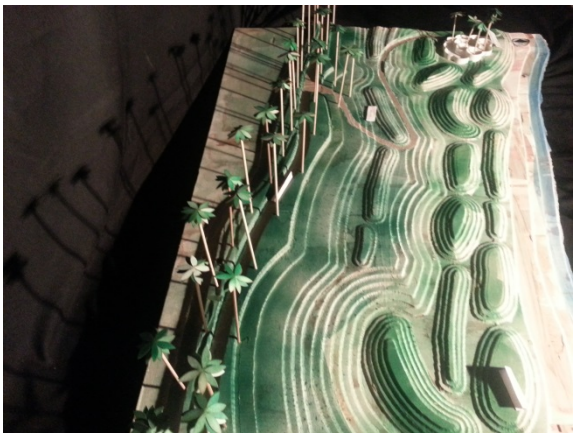
Shade structures made of durable fabric and aluminum supports.

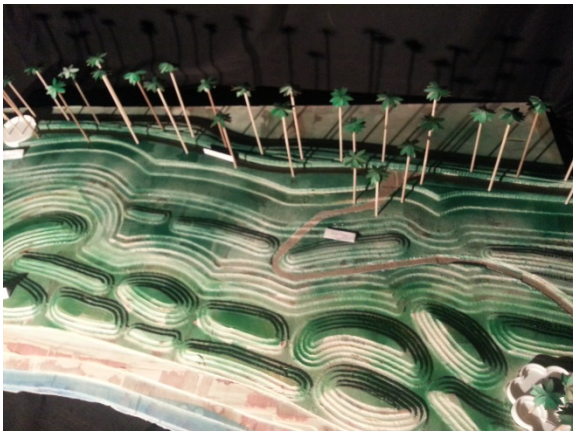
The dune experience and turtle rehabilitation center is the main access for the public onto the beach in this area and will inspire sea turtle awareness and conservation. It will also give people the opportunity to become involved, whether it's a night nesting tour or live hatchling exhibit.

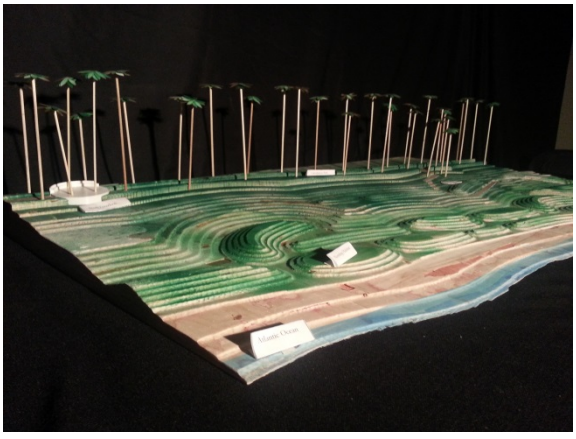
This intimate space is intended to be a place of observation, awareness, and education. The space is nestled within the dunes; inspired by the egg chambers that female turtles lay each year, becoming a quiet zone of self reflection and thought.



Dune Room model







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Appendix

Boca Raton tide charts will go in this section.