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Evaluating St. Catherines Island's Shoreline, Vegetation Line, and the Locations of Loggerhead Sea Turtle Nests

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EVALUATING ST. CATHERINES ISLAND’S SHORELINE, VEGETATION LINE, AND THE LOCATIONS OF LOGGERHEAD SEA TURTLE NESTS

by

SYDNEY DAVIS

(Under the Direction of Chester Jackson)

ABSTRACT

St. Catherines Island is a highly dynamic barrier island on the Georgia coast that is also a federally listed critical nesting habitat for loggerhead sea turtles. Understanding how St. Catherines’ shoreline and vegetation is changing over time is geographically important as a potential template for other barrier islands. Measuring sea turtle nest locations will provide insight into their natural patterns and how they adjust those locations on a changing barrier island. Analyzing Moving Boundaries Using R (AMBUR) is implemented in this research to assess the movement of the vegetation and shorelines from 2005-2017 using the End Point Rate (EPR) and Linear Regression Rate (LRR) methods of calculation. In this study, the distances from each loggerhead sea turtle nest were measured to the vegetation and shoreline of the respective year using the near distance tool in ArcGIS Pro. The vegetation line was found to be eroding at a faster rate than the shoreline across the island (mean LRR=-4.98 m/yr vs -3.99m/yr). The average distance from a sea turtle nest to the vegetation and shoreline was very similar across the island, despite different sections of the beach experiencing different patterns of erosion and accretion. The average distance to the shoreline from a loggerhead nest was 19.41m on the Northern Section and 19.02m on the Southern Section The average distance to the vegetation line was 27.07m on the Northern Section and 26.98m on the Southern Section. Linear regressions confirmed that the rates of change of the vegetation and shoreline influence the distance between sea turtle nests and these physical markers, although much variation is present in the dataset (all p-value < 0.01, $R^2 < 0.08$).

INDEX WORDS: Shoreline change, Barrier island, Coastal Georgia, AMBUR, GIS, R project, ArcGIS Pro, Loggerhead sea turtles, Sea turtle nest sites, Vegetation line

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by

SYDNEY DAVIS

B.S., Georgia Southern University, 2017

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MASTER OF SCIENCE

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SYDNEY DAVIS

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DEDICATION

This project is dedicated to St. Catherines Island, a place that changed my life in more ways than I can count. St. Catherines taught me an incredible amount about the coast and about myself. This research is also dedicated to my friends and family, who were always overwhelmingly supportive of my odd interests. I love you all.

Thank you to my mom, Becky Sanders, for teaching me how to follow what I love. Even when I didn’t know what I was doing, you’ve believed in me to make the right choices, and your love knows no bounds.

Thank you to my dad, Jeff Davis, for being my academic driver and hard reset button. You taught me to always see the big picture. Without that mentality, I don’t know that I would have been the person for this project!

To my partner, JT Edgar, I would also like to say thank you. Whether it was out on the beach or at my desk, you were always willing to lend a hand however you could. I value your support more than I can say.

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CHAPTER 1

INTRODUCTION

1.1 Purpose of the Study

In 2014, the U.S. Fish and Wildlife Services (USFWS) designated 38 marine areas as critical nesting habitats for loggerhead sea turtle (*Caretta caretta*) nesting (USFWS, 2014). Critical habitat is defined as a geographic area with a physical feature that may need additional protection and is vital to the conservation of a species (USFWS, 2017). One of these stretches of critical nesting habitat includes St. Catherines Island, off the coast of Georgia.

St. Catherines Island is a transgressive barrier island that is considered an erosional hotspot (Jackson, 2010). St. Catherines Island is one of the most erosional beaches on the Georgia coast and may be representative of a worst-case scenario for other barrier islands (Jackson, 2010). The island is exhibiting an overall shortening and thinning over time, with sediment depletion being one part of a complex web of causes. (Jackson, 2010; Meyer, 2013). This sediment depletion is attributed to the island's position in a sediment deprived coastal compartment (Jackson, 2010; Meyer, 2013). However, St. Catherines is a popular location for loggerhead sea turtles to nest and has been continuously monitored since 1989.

Understanding the many variables that determine where a sea turtle chooses to nest has been identified as a global research priority for sea turtle conservation (Hamman et al., 2010). The distance to the shoreline from a nest is one of these variables, which can impact overall hatch success through increased risks of washoever events and inundation (Fuentes et al., 2009). In this study, the shoreline refers to a digitized wet/dry line based on aerial photography. The distance to the vegetation line from a sea turtle nest is another nesting metric that has been measured in other studies, with decreased distances on narrowing beaches reported (Fujisaki et al., 2017; Patricio et al., 2018). Vegetation can impact incubating sea turtle nests through their roots or shade, potentially influencing temperature and moisture control in a nest (Kamel, 2013). In this study, the digitized vegetation line was identified as the dense and stable vegetation near the dune area, distinguishable from the seaward area mainly occupied by scattered vegetation (South Carolina DHEC, 2019). No study has evaluated and compared the movement of the shoreline and vegetation line on a Georgia barrier island. Much of the literature that measures and compares sea turtle nesting occurs on armored, developed ocean fronts, and understanding those distances (and their potential change over time) on a natural, unarmored barrier island is important for understanding sea turtle ecology.

The objectives in this study are to: 1) measure the shoreline and vegetation line change rates on St. Catherines Island from 2005-2017 2) calculate the distances between Loggerhead sea turtle nests and the vegetation and shoreline and 3) analyze the relationship between these variables. The research questions addressed are 1) how does the vegetation line change when compared to the shoreline? 2) is there a relationship between shoreline change rates and sea turtle nest locations? and 3) is there a relationship between vegetation line change and sea turtle nest locations?

By accomplishing these goals, a better understanding of sea turtle nest location dynamics on an underdeveloped beach will emerge. Also, updating the shoreline change records of St. Catherins Island will add to the collective understanding of erosion and accretion on the Georgia coast. In order to examine St. Catherines Island’s shoreline and vegetation line in detail, their change was calculated using AMBUR (Analyzing Moving Boundaries Using R) along three distinct sections of the beach. AMBUR calculates the linear regression rate (LRR) of change, which will look at each vegetation and shoreline year to year, and the end point rate (EPR), which evaluates the change from the oldest and youngest vegetation and shorelines. The study period covers 2005-2017 using eight years of data.

In order to analyze the relationship between sea turtle nest locations and the moving vegetation and shoreline, the distance between each nest and each line type was measured for each year of data. This was accomplished using the Near function in ArcGIS Pro. Analyzing the change in those distances as the vegetation and shoreline move will provide insight into those relationships. A linear regression was used to compare the distance to the vegetation and shoreline using the different change rate calculations. Dry beach width was calculated per section of beach. Comparing these values over time will provide insight into how sea turtle nests are moving on an underdeveloped barrier island.

1.2 Background

Barrier islands, important locations for sea turtle nesting, are highly dynamic environments. Understanding how barrier islands have transformed and will change in the future is important for coastal planning and conservation practices. The rate of global sea-level rise has been consistently increasing since 1880, with a current estimated rate of +3.4mm/yr (GSFC, 2021). Shoreline change is notably influenced by anthropogenic alterations, increased rates of sea-level rise, and increased erosion and deposition from storms (Meyer et al., 2015; Morton and Sallenger, 2003). These anthropogenic alterations include dams and armored shorelines, which significantly affect the distribution of sediments that feed and alter beachfronts (Meyer, 2013). While St. Catherines Island does not have any of these structures, the influence of these changes upstream to sediment distribution and shoreline change rates has been previously noted (Meyer et al., 2015).

Due to the reproductive cycle of sea turtles (with multiple-year intervals between nesting), these species are naturally suited to high rates of habitat disturbance (Dewald and Pike, 2013). Loggerhead sea turtles demonstrate nest site fidelity (Carr and Carr, 1972). Nest site fidelity means that sea turtles return to nest in areas that they have nested in before (Carr and Carr, 1972). Natal homing and nest-site fidelity are evolutionarily advantageous behaviors that help to ensure a nesting site will successfully produce offspring (Switzer, 1993). No species of sea turtle exhibit maternal care after they nest, and nest location has been shown to be imperative as to how many offspring are successfully hatched (Godfrey and Barreto 1995; Whitmore and Dutton, 1985). The location of a nest site can influence incubating sea turtle eggs susceptible to temperature, moisture, salinity, and gas exchange (Booth, 2017; Miller et al., 2003; Poloczanska, 2009).

CHAPTER 2:
LITERATURE REVIEW

2.1 Sea Turtle Nest Site Selection

Sea turtles use the magnetic field of the Earth as their guide over lengthy migrations between foraging sites and nesting sites, sometimes spanning thousands of kilometers over open ocean (Avens and Lohmann, 2003; Brothers and Lohmann, 2018; Lohmann and Lohmann, 2019). Early in the field, it was established that sea turtles have ‘site fixity,’ which is modernly called nest site fidelity (Carr and Carr, 1972). Nest site fidelity means that sea turtles return to nest in areas that they have previously nested in before (Carr and Carr, 1972). Avens and Lohmann (2003) previously illustrated that loggerhead sea turtles are capable of maintaining orientation through visual or geomagnetic means, which supports the concept of sea turtle nest site selection requiring both local and global level cues. Global magnetic field cues may first return loggerhead sea turtles to their past laid nests or natal beach, who then use a variety of local cues to choose the specific point on the beach to nest (Lohmann and Lohmann, 2019). There are many potential variables that sea turtles could be evaluating in the nearshore environment, including waves breaking and refracting waves around islands or the presence of chemical gradients (Lamont and Houser, 2014; Lohmann and Lohmann, 2019).

Another potential local cue may be the use of vision by sea turtles to determine the distance to the vegetation line. Vegetation can impact the temperature of an incubating nest through the shade, which is important due to the sex of sea turtles being temperature-dependent (Kamel, 2013). In recent years, distance to the vegetation line has been a metric used in sea turtle nest site selection studies, with significant results indicating that vegetation is a contributing factor in selecting sea turtle nest locations (Fujisaki et al., 2017; Patricio et al., 2018). Fujisaki et a. (2017) evaluated two years of nesting data 10 years apart, with no detail given as to how they defined their vegetation line or what type of vegetation it consisted of. Patricio et al (2018) gave each nest they evaluated a designation-‘forest,’ ‘forest border,’ and ‘open sand,’ but this is the closest the vegetation line comes to being defined or the type of vegetation explained. Gross anatomy studies that have attempted to discern the acuity and strength of the eyes of sea turtles have only noted that they are designed to maximize vision underwater (Bartol and Musick, 2003). Another consideration is that loggerhead sea turtles nest at night. Sixteen years of observing sea turtle crawlways that make contact or avoid obstructions on the beaches of St. Catherines Island strongly suggests the amount of moonlight plays a significant role in visual acuity upon accessing the beach to nest (R.K. Vance, personal communication, 2021). Although the extent of a sea turtle's vision may not be known, the potential effects of vegetation on dune stability, salinity, moisture, and other variables that can impact incubating eggs, make this metric an important addition.

Loggerhead sea turtles (*Caretta caretta*) and green sea turtles (*Chelonia mydas*), the two most common species that nest on St. Catherines Island, are listed by the International Union for Conservation of Nature as vulnerable and endangered, respectively (IUNC, 2021). Certain characteristics of sea turtles make them more vulnerable than other species, including their slow maturation (35 years to sexual maturity in females) and temperature-dependent sex determination in hatchlings. However, nest site maintenance and nest predator control are attributes that conservation efforts can directly impact (Avens et al., 2015; Mrosovsky and Yntema 1980).

Many studies employ GIS, R programming language, and light detection and ranging (LiDAR) datasets to analyze their study sites, allowing them to assess the various spatial aspects of sea turtle nesting (Fuentes et al, 2010; Patricio et al, 2018; Witherington et al, 2009). LiDAR data has been valuable in regard to sea turtle nesting studies due to the importance of slope as an inundation risk and nest preference variable (Wood and Bjorndal, 2000). Numerous existing studies have called for further research that combines the use of GIS with a larger temporal scale, which is especially useful in regard to the conservation and management of a species with a long lifespan and slow rate of maturity (Poloczanska et al., 2009; Yamamoto et al., 2015).

When a sea turtle emerges from the ocean and does not successfully nest, a false crawl is the other type of nesting activity commonly recorded (Rumbold et al., 2001). There are many potential causes of a false crawl, whether that be a predatory threat or an unmet nesting parameter. Little exists in the literature that has tried to quantify this on beaches that do not have seawalls or other physical barriers to nesting (Long et al., 2011; Rumbold et al., 2001).

2.2 Sea Turtle Nesting Site Threats

Due to a potential increase in nest density, loggerhead sea turtle nesting is affected by narrowing beaches (Mazaris et al., 2009). The higher concentration of nests could allow for easier predation and disease transmission (Mazaris et al., 2009; Sarmiento-Ramirez et al., 2014). The most common predator on St. Catherines Island is feral hogs, which resulted in an estimated loss of 24,279 loggerhead sea turtle eggs in the 2016 and 2017 nesting seasons on the island (Butler et al., 2020). Pathogenic fungal species, such as *Fusarium falciforme* and *Fusarium keratoplasticum*, are transmitted between nests and can both kill over 90% of embryos present (Sarmiento-Ramírez et al., 2014). The need for further research to evaluate the spatial structure of nesting habitats is high (Hamman et al., 2010; Mazaris et al., 2009).

Another potential problem that stems from narrowing beaches is the increased likelihood of inundation. As sea levels continue to rise, the threat of inundation is also increasing, which has been shown to significantly increase egg mortality (Poloczanska et al., 2009; Fuentes et al., 2010; Varela et al., 2018). Inundated nests have also been shown to have higher rates of fungal infections, many of which can have catastrophic effects on hatch rates (Sarmiento-Ramírez et al., 2014). Sea turtle eggs can survive in a certain amount of salinity and moisture, being most vulnerable just after being laid and just before hatching. However, when an inundation event occurs, a decrease in hatchling success has been found in both loggerheads (Foley et al., 2006) and leatherbacks (Caut et al., 2010). Foley et al. (2006) found that loggerhead nests at their study site in Southwestern Florida with no inundation events had an 84.4% mean hatch success, while nests inundated by groundwater 15 cm below the sand’s surface had a mean hatch success of 20.5%. Time, frequency, and depth of inundation were all shown to negatively affect hatch success in leatherback sea turtle eggs (Caut et al., 2010).

The nearshore environment is a significant local cue for sea turtles, and disruption to it could potentially affect nesting success (Poloczanska et al., 2009). The nearshore environment influences erosion and depositional changes, including current orientations, prevailing wind angle, and wave heights (Lamont and Carthy, 2007). Another potential threat to sea turtle nesting from erosion is a change in beach slope. Studies have found that steeper slopes and higher beach elevation correlate with sea turtle nesting success (Poloczanska et al., 2009; Santos et al., 2017; Wood and Bjorndal, 2000). These features help to prevent inundation events and improve drainage. Green sea turtles have been shown to prefer inclines ranging from -2° to 8° (Santos et al., 2017). Beach slope has also been shown to correlate with hatchling success, a valuable metric to conservation efforts (Wood and Bjorndal, 2000).

Tropical storms and hurricanes greatly influence erosion and accretion. In the last four decades, 97% of sea turtle nesting beaches in the northeastern Pacific and northwestern Atlantic were impacted by hurricanes (Dewald and Pike, 2013). Global climate modeling suggests that the devastation hurricanes wreak on coastal areas will only increase over time (Emanuel, 2005; Mann and Emanuel, 2006). Studies have noted the negative impacts that a mid-season hurricane can have on sea turtle nesting success by reducing the quality of the environment through storm surges and beach erosion (Dewald and Pike, 2014; Milton et al., 1994). In a ten-year study on an uninhabited stretch of Florida beach, both loggerhead and green turtle nests had significantly lower hatching success after seawater inundation from storm surges (two-way ANOVA, $F = 221.1$, $P < 0.001$) (Pike and Stiner, 2007). Another Florida study on a sea turtle nesting beach reported 100% egg mortality following Hurricane Ivan, less than 20 miles from the eye of the storm (Milton et al., 1994).

While beach nourishment and beach recovery programs are well-intentioned in their attempts to remedy erosion and narrowing beaches, they are not long-term solutions and have been shown to be potentially harmful to sea turtle nesting attempts (Long et al., 2011; Rumbold et al., 2001). Through the use of LiDAR data and multiple regression models, it has been illustrated that loggerhead sea turtles have a significant negative ($R^2 = 0.16$, $P < 0.01$) correlation with nesting success on a beachfront before and after restoration (Long et al., 2011). Seawalls can negatively impact the nesting and the eggs by preventing a sea turtle from attempting to nest and increasing the likelihood that nests laid in front of seawalls are washed out during storm events (Rizkalla and Savage, 2010).

2.3 Shoreline Change Analysis

The wet/dry line is a commonly used feature by coastal erosion studies to approximate the mean high water line (Crowell et al., 1991; Pajak and Leatherman, 2002; Moore, 2000). The wet/dry line is a visibly discernible feature, where the dry, lighter-colored sand meets the darker sand that is still wet from the previous high tide and repeated saturation (Crowell et al., 1991). In this study, this line was simply referred to as the shoreline. The vegetation line refers to the line that separates the stable, dense vegetation of the dune area from the scattered vegetation of the seaward area. This shoreline proxy has been recognized by the South Carolina Department of Health and Environemtnal Control's Office of Ocean and Coastal Resource Management (DHEC OCRM) (South Carolina DHEC, 2019). The vegetation line has recently been used in coastal studies as a shoreline proxy (Pollard et al., 2020; Toure et al., 2019).

AMBUR (Analyzing Moving Boundaries Using R) is a package for the R programming environment (R Core Team, 2021) that is capable of measuring changing shorelines over time using a unique transect method (Jackson et al., 2012). Traditionally, shoreline erosion is measured by transects that are drawn perpendicularly to the user set baseline, with change measured across each transect to the historical shorelines (Crowell et al., 1997; Dolan et al., 1978). AMBUR improves on this method and can additionally draw "near" transects, which originate at the outer baseline and cast to the nearest point on the inner baseline (Jackson et al., 2012). Near transects can then be converted into "filtered" transects, which have been modified to reduce gaps and reduce overshoot. These methods eliminate most transect crossovers, allowing for more accurate measurements of highly curved features (Jackson et al., 2012). AMBUR is open source and can be used with any commercial or publicly available GIS software, making it more accessible than other currently available shoreline analyses (Jackson et al., 2012).

AMBUR also generates a wide array of quantitative values and figures (Jackson et al., 2012; Sankar et al., 2018). The end-point-rate (EPR) of change between the oldest and youngest shorelines and linear regression rate (LRR) are the two outputs that are most commonly reported in the literature. The EPR divides the total movement by the time elapsed. The LRR is the slope of the line that is the least-squares distance to the vegetation and shoreline. This slope estimates the change rate. While EPR is useful when analyzing historical imagery or long-term studies, all variation between the first and last shorelines is not captured (Genz et al., 2007; Jackson et al., 2012). Conversely, LRR takes all shoreline data into account and is more statistically precise when multiple shorelines are available (Dolan et al., 1991; Jackson et al., 2012; Sankar et al., 2018)

Burns, Alexander, and Alber (2021) used AMBUR to evaluate the changing edge of a salt marsh on the coast of the eastern United States using 70 years of imagery and data. The authors attributed the transect drawing methods present in AMBUR as the key reason it was employed in the study, due to the highly curved marsh perimeter and interior, and found that two of their three study sites were experiencing high rates of both shoreline advance and retreat (Burns, Alexander, and Alber, 2021). Another study evaluating shoreline change used various shoreline proxies that were evaluated with AMBUR (Pollard et al., 2020). Pollard et al. (2020) found that the HWL (in this study, the wet/dry line present in aerial photography) retreated 14.56 m (9.79m-19.33 m) from 1992 to 2016 at their study site at Blakeney Point, on the eastern side of the United Kingdom. In that same time period, the vegetation line retreated 21.93 m (20.62m-23.24m).

CHAPTER 3:

METHODOLOGY

3.1 Study Site

St. Catherines Island, one of Georgia's fifteen barrier islands, is bordered by St. Catherine's Sound to the north, the Atlantic Ocean to the east, Sapelo Sound to the south, and tidal marshes to the west (Figure 3-1). The two NOAA tide stations flanking St. Catherines island- Fort Pulaski, Georgia (Station ID: 8670870) and Fernandina Beach, Florida (Station ID: 8720030) - report current sea level trends of +3.39 (±0.27 mm/yr) and +2.18 (±0.17 mm/yr) respectively (NOAA, 2021). These stations are the most available accurate proxies- there is no long term tide data for St. Catherines Island specifically. As this is a 12 year study from 2005-2017, sea level did consistently rise across the period, with global satellite data showing 41.4 (+/-4mm) of sea height variation in 2005, compared to 85.8 (+/-4mm) in 2017.

Figure 3-1: Location map of St. Catherines Island

The geology of the island begins with its Pleistocene (2.58 million – 11,700 years ago) core, located towards the western side of the island, and rising as high as 5m to 7m above mean sea level (Meyer, 2013). This core is surrounded by Holocene ridge and swale terrain (Rich et al., 2014). Ridges on the northern and southern beaches have been reported to be as tall as 3.3m above the high tide line, with swales that varied from 1.5m to 2.1m (Meyer, 2013). St. Catherines Island has approximately 16km of beach.

When discussing the geomorphology of St. Catherines Island, it is important to distinguish that different parts of the island experience different rates of accretion and erosion due to placement and geomorphological features (Figure 3-2). This has been noted in the few studies of St. Catherines shoreline over the years, including the work of Jackson (2010), Langley et al. (2003), Meyer (2013), and Meyer et al. (2015).

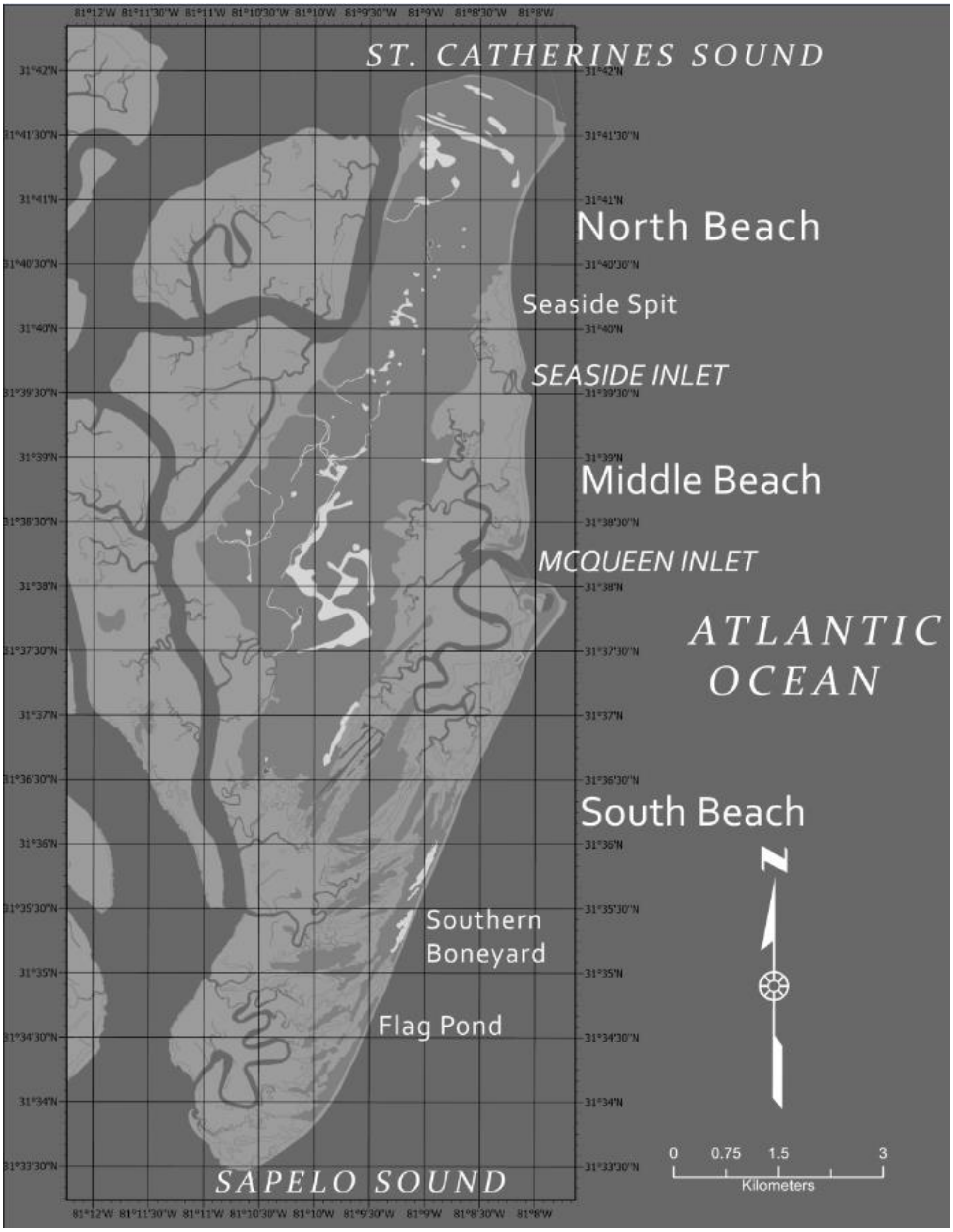


Figure 3-2: Feature map of St. Catherines Island.

A study that evaluated St. Catherines Island from approximately 1880-1920 found that erosion rates on the island varied greatly with location, reporting rates ranging from -1.6 m to -

10.1 m per year depending on location (Langley et al., 2003). Accretion has been previously noted on the northeastern tip of St. Catherines due to a large ebb-tidal delta in St. Catherines Sound providing sediment and altering wave refraction (Langley et al., 2003; Jackson, 2010; Meyer et al., 2015). In Langley's 2003 work, the northeastern tip was the only section measured on the island that illustrated any significant accretion, gaining 1.7m/year over the 58 years studied. Distinctions have previously been made regarding erosion and accretion near McQueen Inlet, with more variation in rates of change and a larger overall change north of the inlet when compared to south of the inlet (Jackson, 2010). Based on this and other research, the St. Catherine's beach was divided into three distinct sections for evaluation (Figure 3-2).

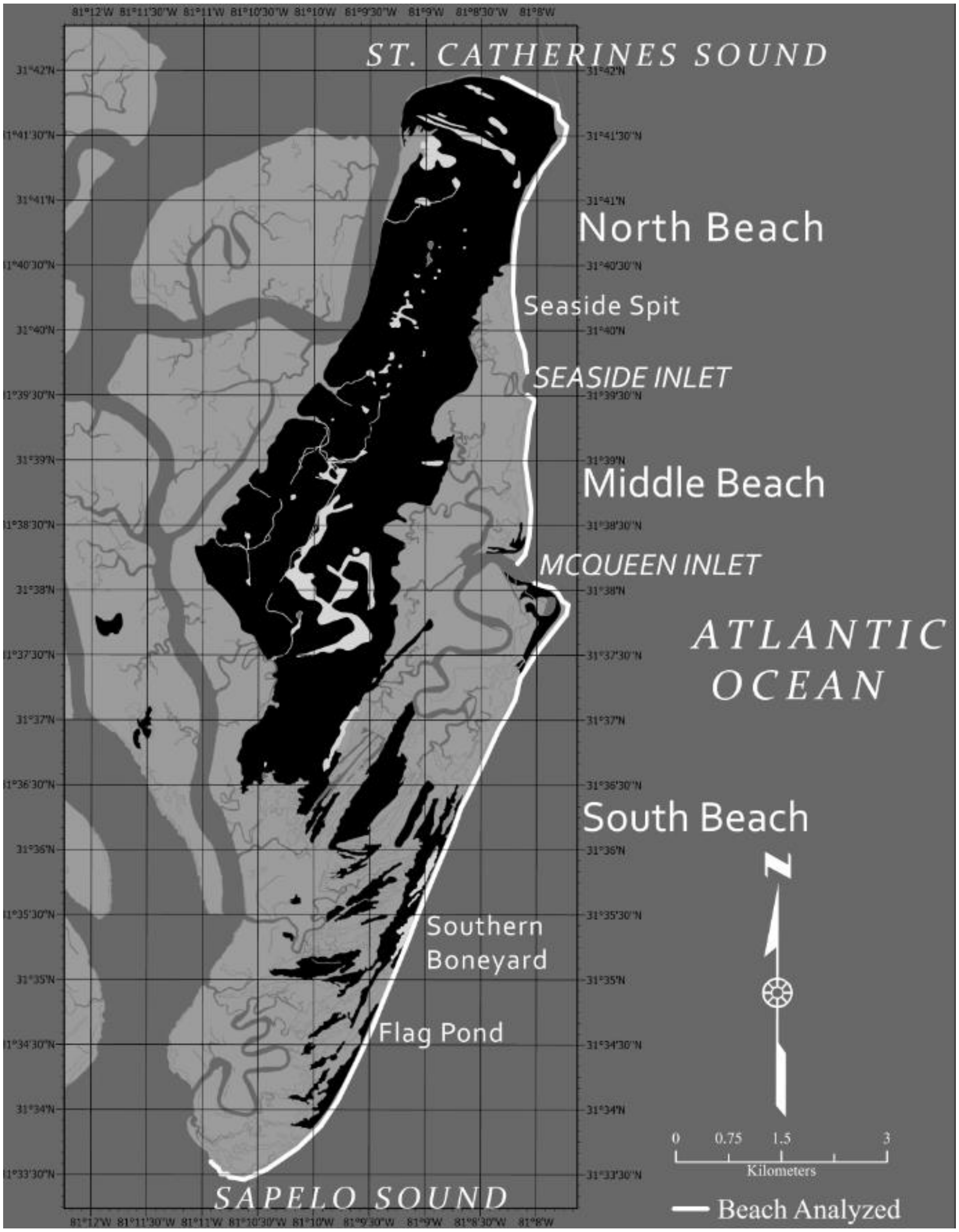


Figure 3-3: Delineated sections of the study.

The first section, Northern Section, begins on the northern end of the island (facing St. Catherines Sound) and consists of mature ridge and swale landforms that wrap around the northeastern point (Meyer, 2013). These landforms exist on the seaward border of the higher

Pleistocene core of the island (Personal Communication, R.K Vance, 2021). Moving south along the section, the beach narrows against Yellow Banks Bluff. Yellow Banks Bluff is an active scarp that presents as a vertical exposure of the Pleistocene core, with Holocene cover (Linsely et al., 2008; Personal Communication, R.K Vance, 2021). South of Yellow Banks Bluff, Seaside Spit begins, consisting of Holocene salt marsh, with low beach ridges built on top (Personal Communication, R.K Vance, 2021). Finally, the Northern Section ends at Seaside Inlet.

The second section, Middle Section, is the stretch of beach between Seaside Inlet and McQueen Inlet. This wave dominated shoreline is highly erosional and relic marsh systems have been exposed there (Linely et al., 2008).

The third section, Southern Section, begins south of McQueen Inlet, where there is an extensive accreting dune field (Meyer, 2013). South of the dune field, the beach narrows on a spit, with the shoreline built upon Holocene salt marsh (Personal Communication, R.K Vance, 2021). South of the spit, almost halfway down the section, the shoreline transitions to cutting into maritime forest built on Holocene accretional ridge and swale complexes (Meyer 2013). The study area ends where the sea turtle nests do, on the Sapelo Sound facing portion of the shoreline on the southern tip, which consists of younger marshes.

Vegetation also varies across the beaches of the island. The northern oceanfront follows the vegetation patterns of a prograding dune field, in the form of younger dunes near the shoreline being vegetated with sea oats (*Uniola paniculata*), and older dunes further landward being vegetated with shrubs and trees, such as loblolly pine (*Pinus taeda*) (Meyer, 2013.). The southern end of the island is dominated by grasses, including saltmarsh cordgrass (*Spartina alterniflora*), spike grass (*Distichlis spicata*), saltwort (*Salsola kali*), and beach hogwart (*Croton punctatus*) (Meyer, 2013). No vegetation has specifically been attributed to the middle of the island in the literature. Much of south beach has eroded into the maritime forest or is beach built against salt marshes, something also seen around Seaside Inlet (Personal Communication, R.K Vance, 2021).

Georgia Southern personnel's monitoring of sea turtles on St. Catherines Island began in 1989, along with the first version of the Georgia Southern University Sea Turtle Program. From 2008-2018, this program documented 1945 total nests, 2872 non-nesting crawls, and completed 1255 relocations of potentially doomed nests, averaging 66.7% of total nests on the island being relocated (GSU Sea Turtle Program, 2021). For context, in 2018, 27.1% of all sea turtle nests laid on the Georgia coast were relocated, while St. Catherine's Island relocated 59.4% of nests laid that same year (GSU Sea Turtle Program, 2021). The Georgia Department of Natural Resources (DNR) sets its own relocation management criteria for determining whether a sea turtle nest needs to be relocated or not, which is a part of the training each personnel member receives each nesting season. This includes taking into account factors like slope, erosion in the area, and distance to the spring high tide line.

There are some biological influences on St. Catherines that are noteworthy. St. Catherines Island is home to a wide variety of animals that are potential nest predators, including feral pigs, ghost crabs, armadillos, raccoons, otters, snakes, fire ants, and coyotes. The beaches of St. Catherines Island are primarily used by loggerhead sea turtles (*Caretta caretta*), with green sea turtles (*Chelonia mydas*) being the second most common sea turtle, based off of the dataset. Leatherback (*Dermochelys coriacea*) and Kemp’s Ridley (*Lepidochelys kempii*) sea turtles are present in this area but rarely nest on St. Catherines Island as per the dataset.

Due to the temporal overlap of the sea turtle nesting season in the southeastern United States (April- October) and hurricane season (June- November), sea turtle nests are vulnerable to the effects of hurricanes and tropical storms (Milton et al., 1994). St. Catherines Island regularly experiences these events, primarily during nesting season (Table 3-1). St. Catherines Island has been known to be heavily modified by hurricanes before, such as accretion due to sediment movement following Hurricane Hugo in 1989 (Meyer, 2013).

Table 3-1: Hurricane and tropical storm activity during the study period. Data gathered from the National Hurricane Center (NHC) hurricane season records (NHC, 2021). Storm surges are reported from the Fort Pulaski and Fernandina Beach tide gauges. NR values were not reported.

Name	Classification	Start Date	End Date	Fort Pulaski Storm Surge (ft)	Fernandina Beach Storm Surge (ft)
Tammy	Tropical Storm	10/05/05	10/06/05	4.2	3.2
Alberto	Tropical Storm	06/10/06	06/14/06	0.98	NR
Ernesto	Hurricane	08/24/06	09/01/06	NR	NR
Andrea	Subtropical Storm	05/09/07	05/11/07	NR	2.64
Debby	Tropical Storm	06/01/07	06/02/07	NR	NR
Cristobal	Tropical Storm	07/19/08	07/23/08	NR	NR
Josephine	Tropical Storm	09/02/08	09/06/08	NR	NR
Irene	Hurricane	08/21/11	08/28/11	1.15	1.85
Alberto	Tropical Storm	05/19/12	05/22/12	NR	NR
Beryl	Tropical Storm	05/26/12	05/30/12	2.93	NR
Debby	Tropical Storm	06/23/12	06/27/12	2.76	3.21
Sandy	Hurricane	10/22/12	10/29/12	2.89	2.95
Andrea	Tropical Storm	07/05/13	07/07/13	1.55	1.29
Arthur	Hurricane	07/01/14	07/05/14	NR	1.79
Ana	Tropical Storm	05/08/15	05/11/15	1.65	1.88
Bonnie	Tropical Storm	05/27/16	06/04/16	1.42	1.66
Colin	Tropical Storm	06/05/16	06/07/16	1.53	1.31
Hermine	Hurricane	08/28/16	09/03/16	1.64	1.3
Julia	Tropical Storm	09/13/16	09/18/16	NR	NR
Matthew	Hurricane	09/28/16	10/09/16	7.7	6.91
Irma	Hurricane	08/30/17	09/12/17	5.63	7.78

As a minimally developed island with little human occupation, St. Catherines Island offers a rare opportunity to evaluate natural shoreline dynamics without the presence of shoreline hardening or erosion control structures (Meyer et al., 2015). There is little direct human contact with sea turtles and no barriers or sea walls exist that could prevent nesting. It is important that St. Catherines Island be evaluated as a loggerhead sea turtle nesting habitat, not only to gain a better understanding of sea-turtle nesting science, but also to assist coastal managers and scientists. As previously stated, St. Catherines Island has also been listed as a critical nesting habitat for the loggerhead sea turtle by the USFWS (USFWS, 2014).

3.2 Data Sources

Aerial photography and color infrared orthophotography were obtained from the United States Department of Agriculture Farmer Service Agency (USDA/FSA). Additional color infrared orthophotography was obtained from the National Oceanic and Atmospheric Association (NOAA) (Table 3-2). Horizontal accuracies were obtained from the digital metadata provided with the imagery.

Table 3-2: Imagery Sources and Additional Information

Year	Agency	Source Type	Date Taken	Horizontal Accuracy (+/- meters)
2005	USDA/FSA	Aerial photography	10/05/2005	3
2006	USDA/FSA	Aerial photography	09/15/2006	5
2007	USDA/FSA	Aerial photography	09/25/2007	5
2009	USDA/FSA	Aerial photography	09/29/2009	5
2010	USDA/FSA	Color infrared orthophotography	10/06/2010	5
2013	USDA/FSA	Color infrared orthophotography	11/28/2013	6
2015	USDA/FSA	Color infrared orthophotography	12/18/2015	6
2017	USDA/FSA	Color infrared orthophotography	10/26/2017	6

Georgia Southern University personell gathered sea turtle nest site data during the study period. Generally conducted at dawn, there was some temporal variation in data collection surveys due to tide dependent beach access. All surveys were conducted on (ATV) by members of the program, who were trained to identify sea turtle crawl ways and nests following the protocols of the Georgia Department of Natural Resources. Upon finding evidence of a sea turtle nest, the GPS location is recorded, and the species is identified based on the crawlway. In order to distinguish between what sea turtle activity has been documented, ATVs are driven over crawl ways after the data is collected to reduce potential human error.

There are instances when a sea turtle will emerge from the ocean onto the beach without laying a nest, commonly referred to as a ‘false crawl’ (Rumbold et al., 2001). These activities are also recorded on St. Catherines island and are presented in the results.

3.3 Methods

Aerial photography and color infrared orthophotography were used in this study. The 2015 and 2017 LiDAR data were collected using Leica ADS-100 and Leica ADS-80SH82 digital sensors (USDA-FSA, 2015; USDA-FSA, 2017). The ADS 100 has the following band specifications: red 619nm-651nm, green 525nm-585nm, blue 435nm-495nm, and near-infrared 808nm-882nm (USDA-FSA, 2015). The ADS 80 has the following band specifications: pan 465nm-676nm, red 604nm-664nm, green 533nm-587nm, blue 420nm-492nm, and near-infrared 833nm-920nm(USDA-FSA, 2017). Due to the emphasis placed on the vegetation and wet/dry line, no tide corrections were performed on the imagery. All data used was projected to the same GIS coordinate reference system, NAD83 UTM Zone 17N, and in distance units of meters. After clipping the imagery to the same extent, both the shoreline and vegetation line were manually digitized at a 1:1000 scale in ArcGIS Pro (Version 2.7.1) for each year of available imagery (Table 3-1). Error associated with manual digitzation is contained in the error produced by

AMBUR after performing that analyses, based on entered accuracies and confidence intervals (Jackson et al, 2012). These entered accuracies are the horizontal accuracies taken from the metadata of the imagery (Table 3-2) and the confidence interval was set to 95%. The digitization was accomplished by creating a polyline feature and marking the wet/dry line for shorelines and the dense, landward vegetation for the vegetation lines (Figure 3-1). The shapefiles containing the polylines were imported into AMBUR and the inner and outer baseliens were identified, creating the change envelope the program would analyze.

Figure 3-4: Digitization example. 2013 imagery at a 1:1000 scale from the southern section before and after the vegetation and shoreline were manually digitized.

Using these digitized lines, transects were then drawn every 50m. The “original” transect casting method and transects cast using the AMBUR’s “near method” function are available in Figure 3-4. The differences between these casting methods is most apparent on the curves of the shoreline and near the inlets. The transects were then filtered using AMBUR’s “filtertran” function to produce transects with orientations best suited for the curved, digitized lines. These resulting transects were used for all analyses, as they are best fit to all of the digitized lines over the study period, 2005-2017.

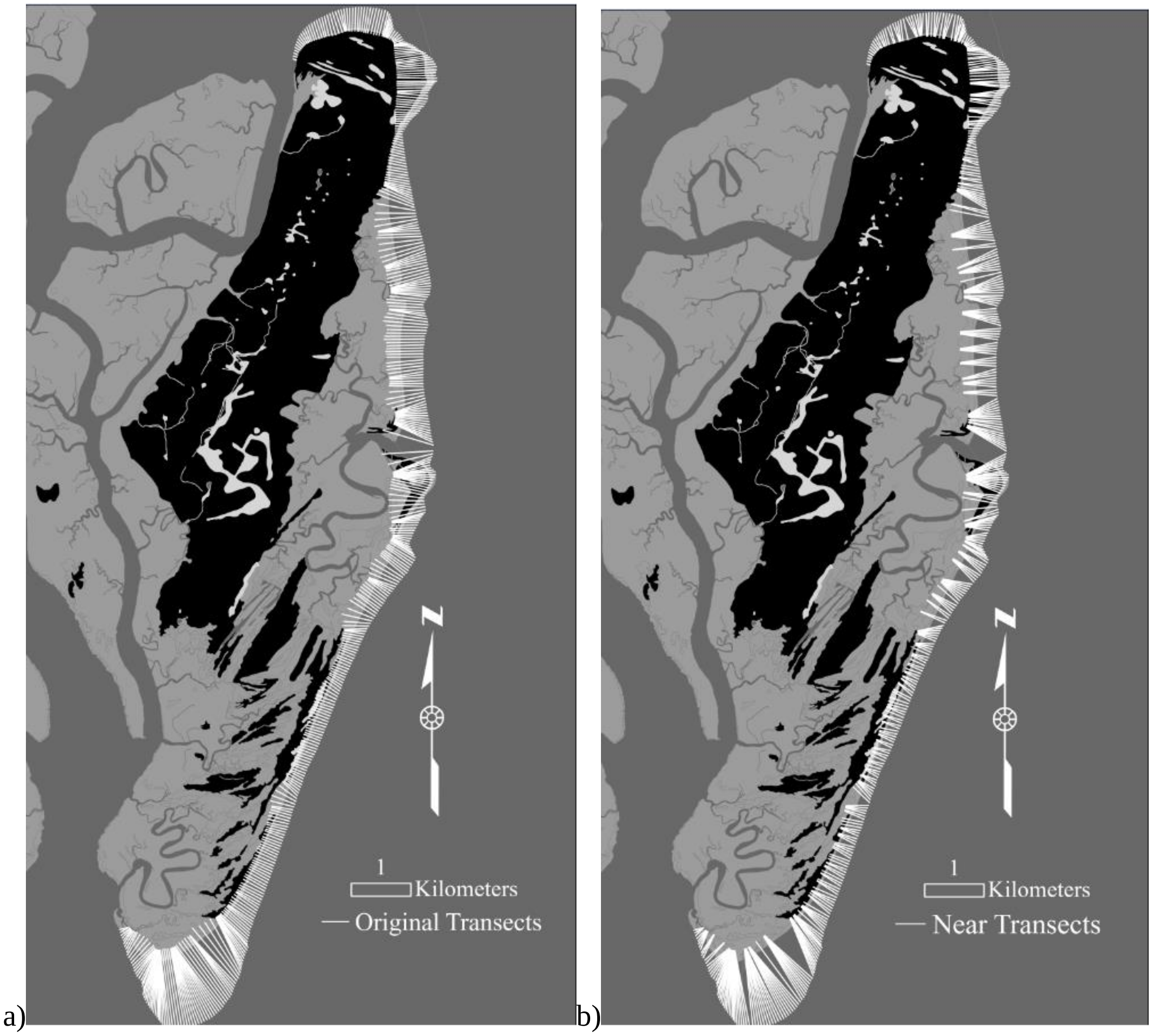


Figure 3-5: Original (a) and near (b) transects for St. Catherines Island.

Using the ‘Near’ analysis tool in ArcGIS Pro, the distance from each sea turtle nest location to the vegetation and shoreline was measured for each year of data. The Near tool works by analyzing an input feature and measuring the near distance to a selected ‘near feature.’ No search radius is set in these analyses, and it is executed using the planar method within the tool settings. This tool modifies the input data, adding a specific field to calculate the near distance for each feature.

Statistics

AMBUR automatically performs certain statistics within the program when calculating the various change rates, such as the LRR. This is the calculated linear regression rate, which is the slope of the line that is the least-squares distance to the vegetation and shoreline. This slope estimates the change rate. This, along with EPR and Era Change, are how the shoreline and vegetation line change were measured across the study.

Once the near distances, shoreline change rates, and vegetation line change rates were compiled, a series of simple linear regressions were performed within the R software enviornment (R Core Team, 2021). This is how the relationship between the location of sea turtle nests and change rates were analyzed. A total of 6 were performed, 2 each (one for the vegetation line and one for the shoreline) for the EPR, LRR, and Era Change. This was used to compare each nest distance with the associated change along the nearest transect to the nest.

CHAPTER 4:

RESULTS

4.1 AMBUR Preparation Results

St. Catherines island’s digitized vegetation and shorelines were composed of a number of polylines (Table 4-1). The vegetation line generally had more line sements than the shoreline. The final digitized shorelines and vegetation lines are displayed in Figures 4-1 and 4-2.

Table 4-1: Number of line segments digitized per year

	Shoreline	**Vegetation Line**
2005	31	64
2006	42	70
2007	48	94
2009	33	59
2010	34	10
2013	24	33
2015	24	89
2017	17	39

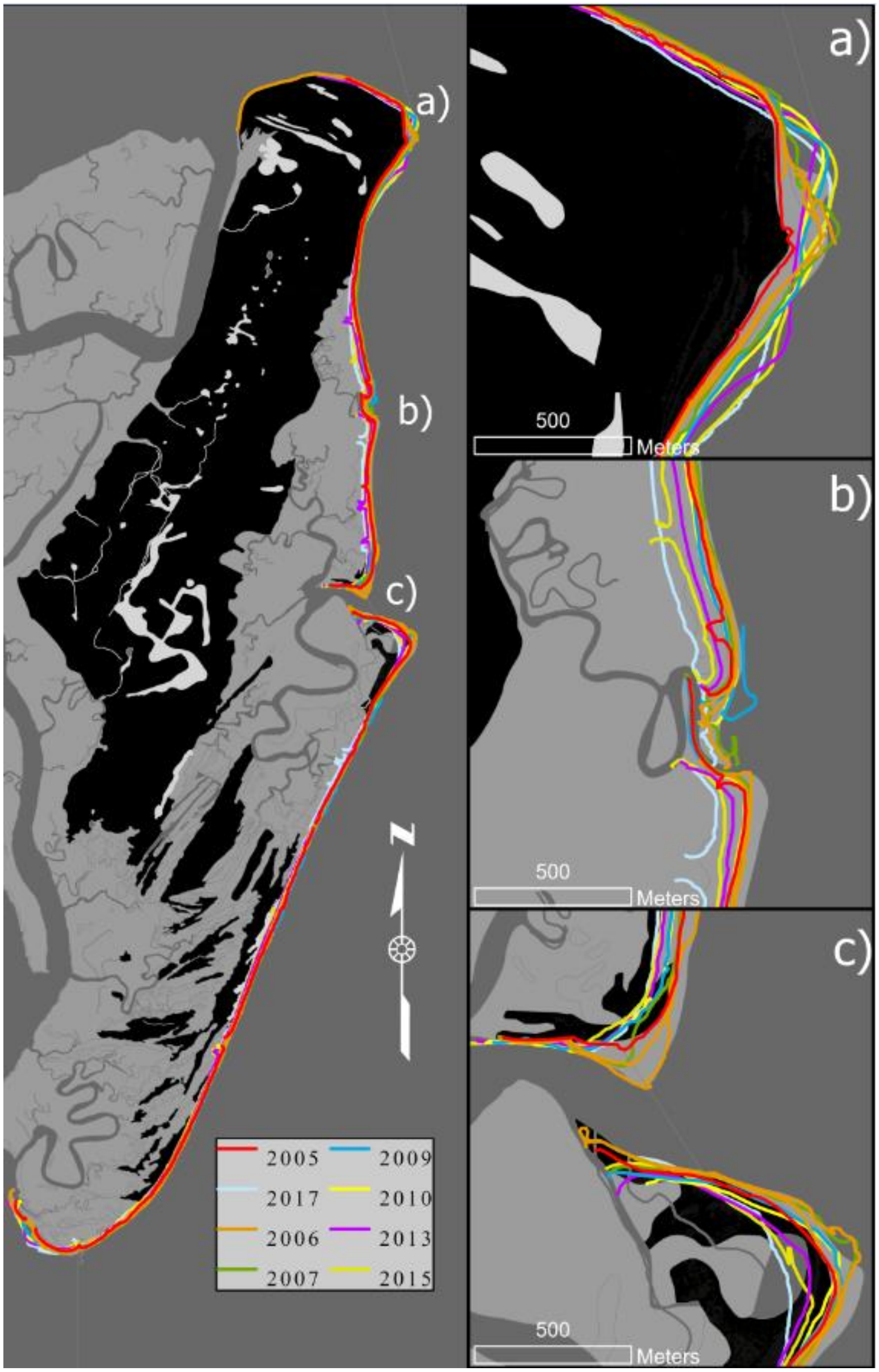


Figure 4-1: Digitized shorelines for each year.

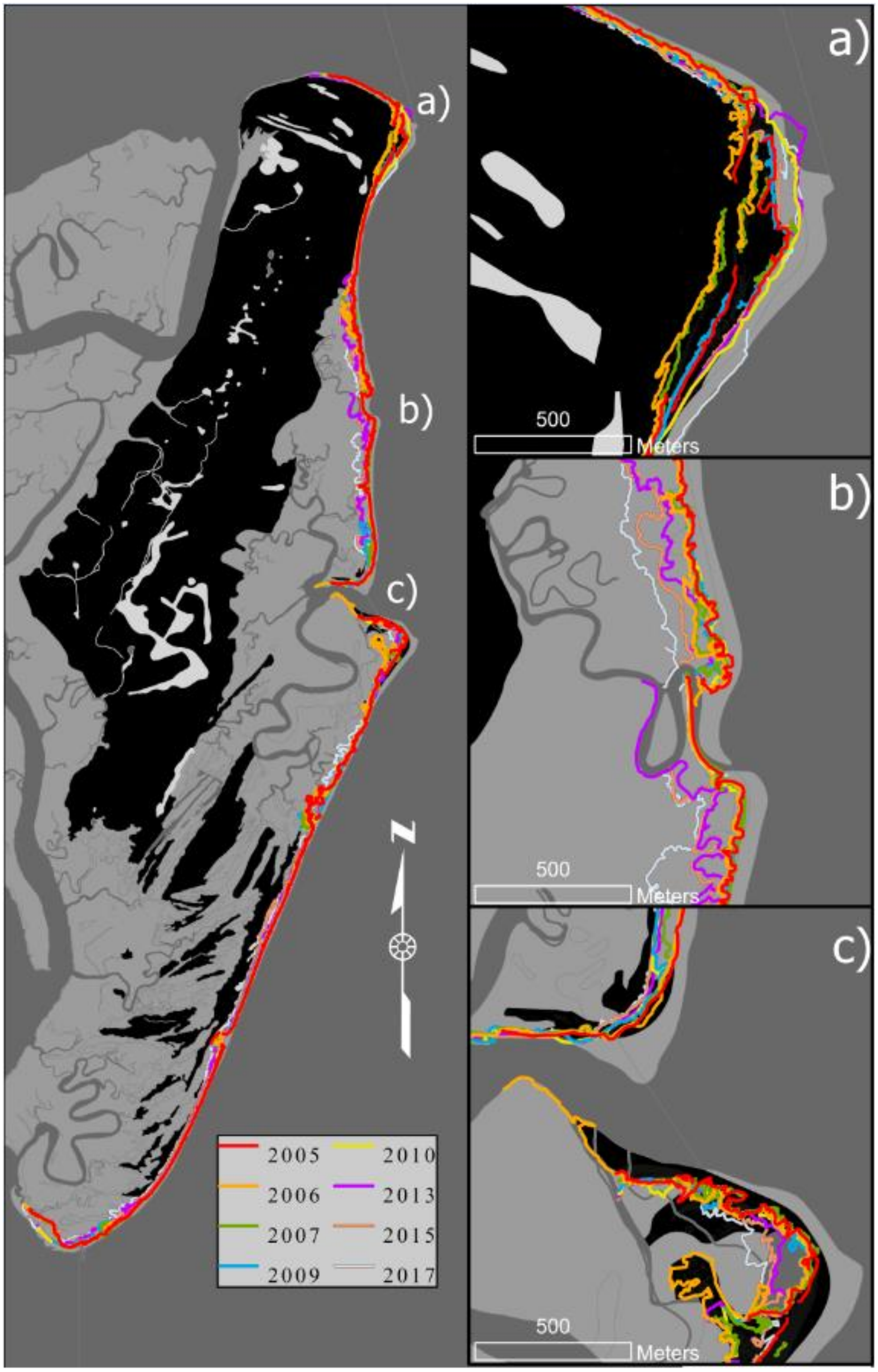


Figure 4-2: Digitized vegetation lines for each year.

The shapefiles containing the digitized shorelines and vegetation lines were imported into AMBUR, and the inner and outer baselines were identified. This is the change envelope that was analyzed by the program (Figure 4-3).

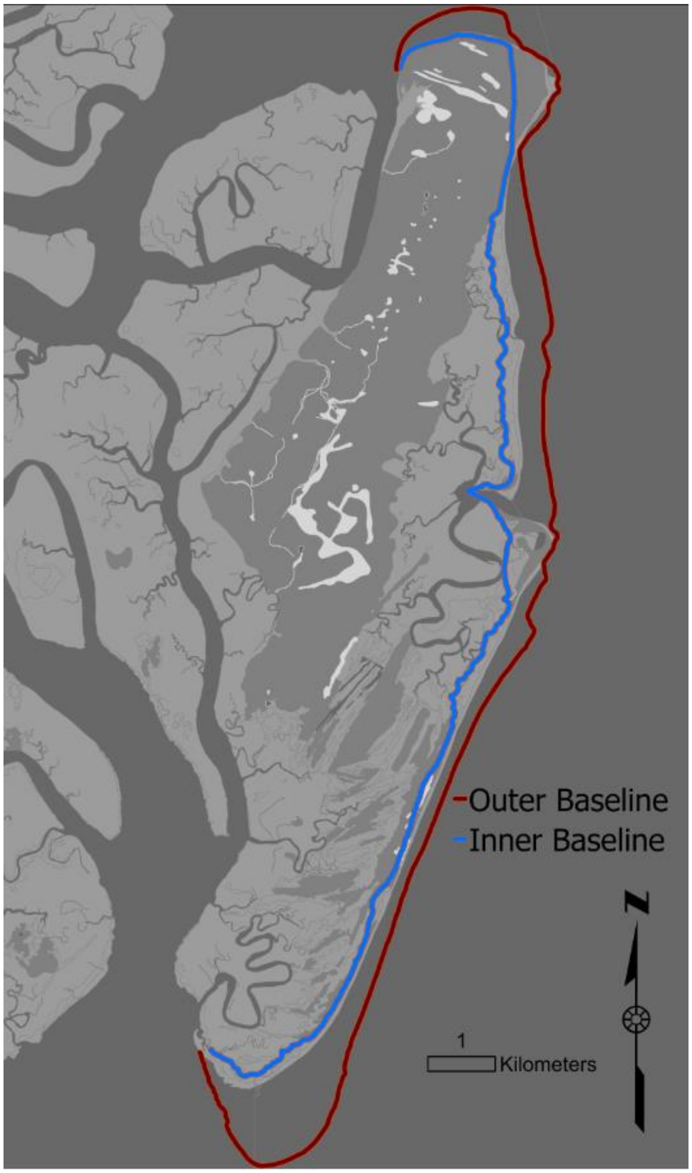


Figure 4-3: The change envelope. This envelope is based on the inner and outermost baselines.

Transects were then drawn every 50m using the previously detailed methods, resulting in the final filtered transects seen in Figure 4-4.

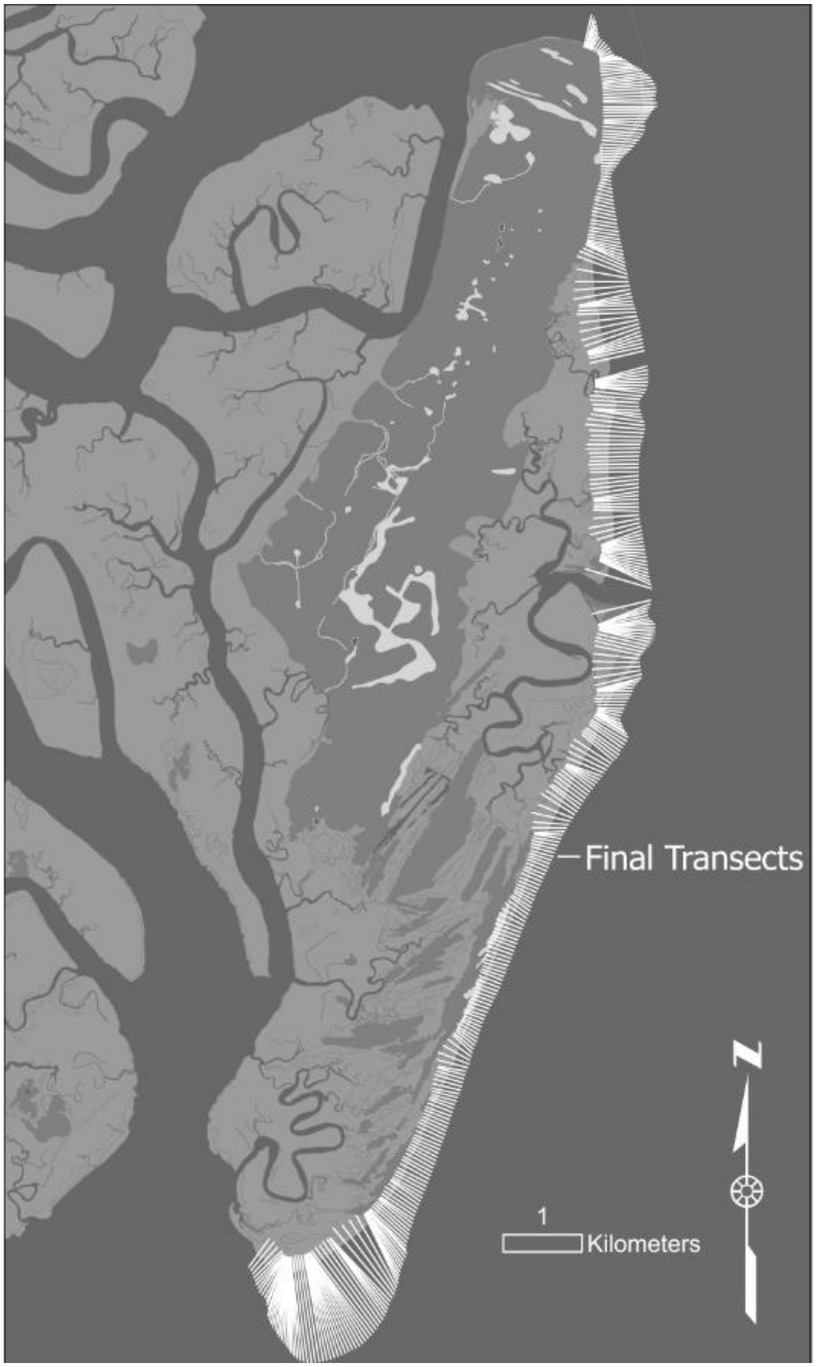


Figure 4-4: Final filtered transects

AMBUR analyzes the shoreline and vegetation line change along these transects and generates a stamped file containing all of the outputs. Due to the focus of the study, specific transects were then identified for the different, inlet delineated sections of the beach being compared (Table 4-2). Each section was designated based off of it's position, creating the

Northern Section, Middle Section, and Southern Section. The transects that make up each section are displayed in Figure 4-5.

Table 4-2: The transect breakdown of each section. These were the transects used over the study period, for each analysis from 2005-2017.

Section	**First Transect**	**Last Transect**	**Total Transects**
Northern	327	427	101
Middle	268	317	50
Southern	11	265	255

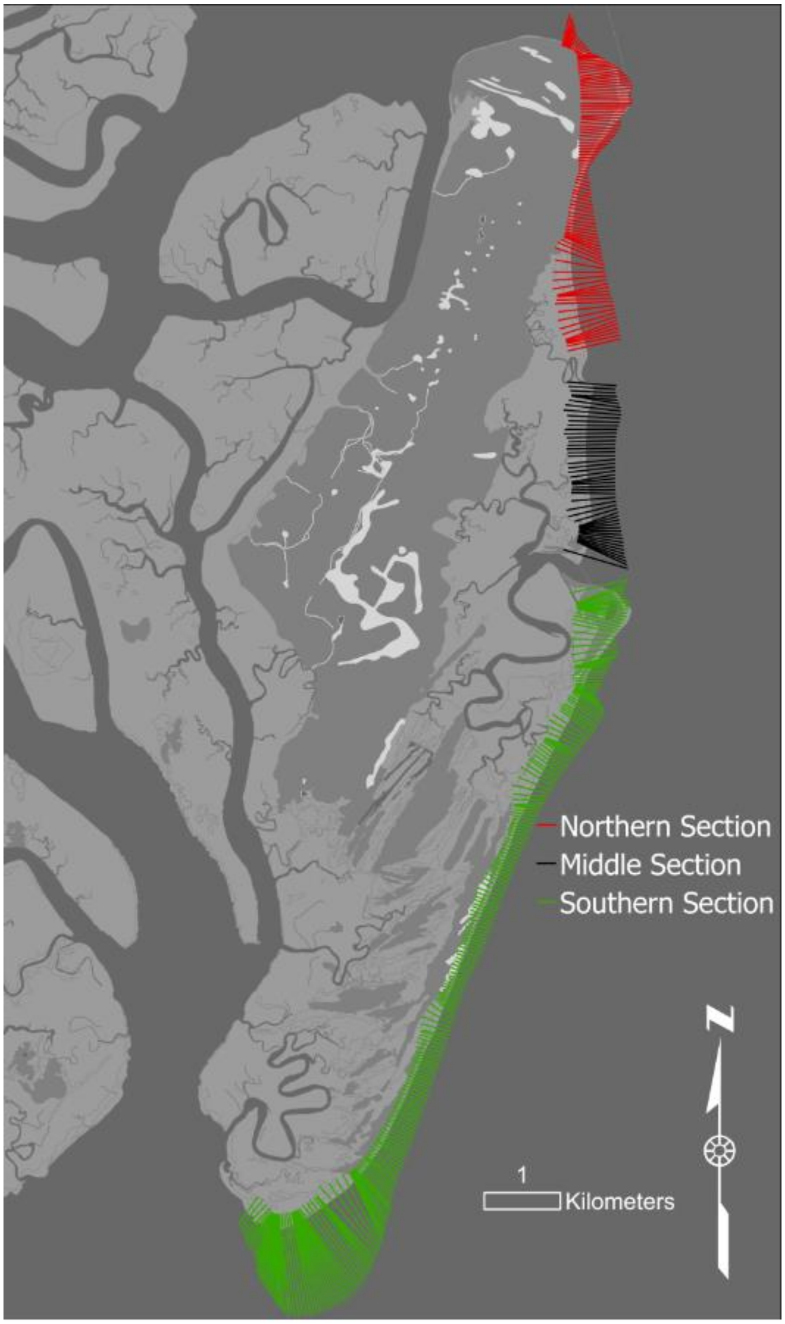


Figure 4-5: The three sections of the beach, delineated by transect. These transects were used in each analysis conducted over the study period.

4.2 Recorded Nests

The number of nests located for each year analyzed is summarized per section in Table 4-3. The Northern Section had 225 nests recorded over the study period. The Middle Section, which covers Middle Beach, was not regularly monitored during the study period due to beach access. Only 15 nests were observed here over the study period. The Southern Section of the island had the most over the study period, at 848 nests.

Table 4-3: Loggerhead nests recorded on each section.

	Northern	Middle	Southern	Total
2005	22	4	79	*105*
2006	19	4	83	*106*
2007	10	1	39	*50*
2009	25	4	69	*98*
2010	19	0	130	*149*
2013	31	1	157	*189*
2015	52	0	139	*191*
2017	47	1	152	*201*
Total	*225*	*15*	*848*	

There are instances when a sea turtle will emerge from the ocean onto the beach without laying a nest, commonly referred to as a ‘false crawl’ (Rumbold et al., 2001). The falsecrawl data collected for St. Catherines Island over the study period is available in Table 4-4.

Table 4-4: False crawls recorded on each section.

	Northern	Middle	Southern	Total
2005	40	4	133	*177*
2006	24	4	116	*144*
2007	39	3	100	*142*
2009	39	12	184	*235*
2010	42	0	216	*258*
2013	29	2	188	*219*
2015	82	0	228	*310*
2017	40	1	198	*239*
Total	*335*	*26*	*1363*	

2015 had the most false crawls on the Northern and Southern Sections of the island, followed by 2010. The least false crawls were recorded in 2007 for the Southern Section and in 2006 for the Northern Section. The data is summarized in Table 4-5 as percentages.

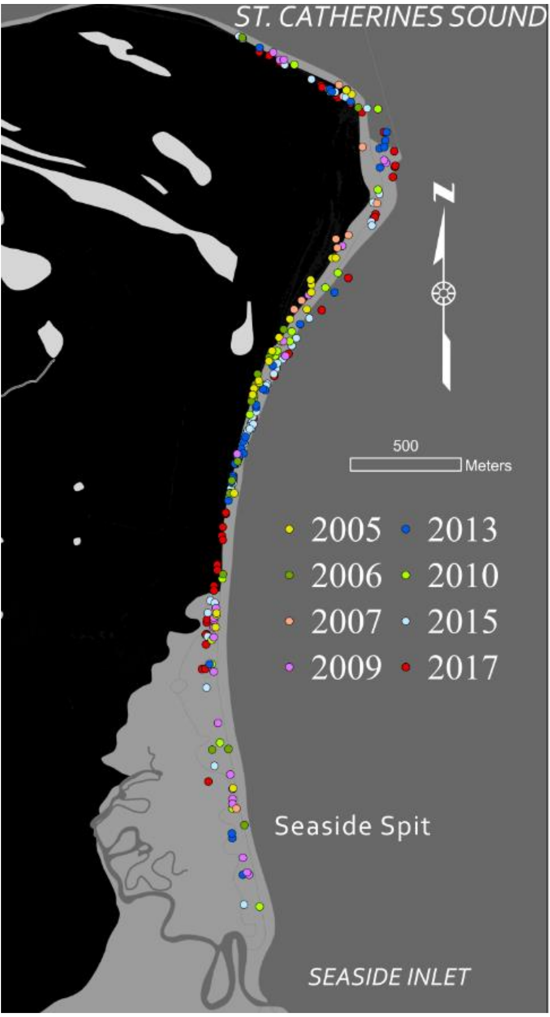
Table 4-5: Total nesting activity percentages.

	Total records	Nests	False crawls
Northern	560	40.18%	59.82%
Middle	41	36.59%	63.41%

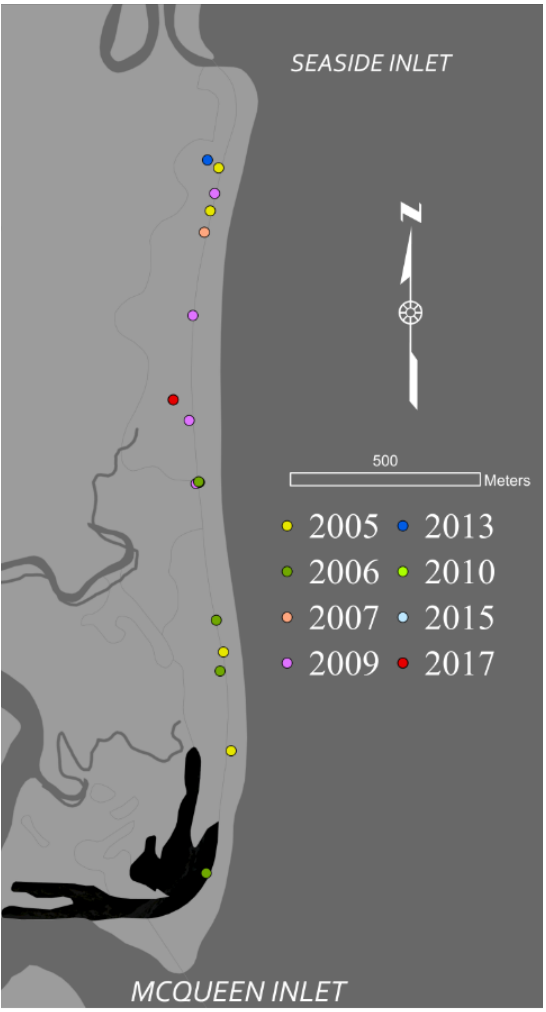
Southern	2211	38.35%	61.65%
Total	2812	38.37%	61.63%

The Middle Section has the highest percentage of false crawls, but only a fraction of nesting events recorded compared to the other sections. Loggerhead sea turtles do not have a verified ratio of nests to false crawls, although it is commonly thought to be approximately a 1:1 ratio. The location of the various sea turtle nests per section are illustrated in Figure 4-6.

a)


ST. CATHERINES SOUND
500
Meters
● 2005
● 2006
● 2007
● 2009
● 2013
● 2010
● 2015
● 2017
Seaside Spit
SEASIDE INLET

b)


SEASIDE INLET
500
Meters
● 2005
● 2006
● 2007
● 2009
● 2013
● 2010
● 2015
● 2017
MCQUEEN INLET

c)

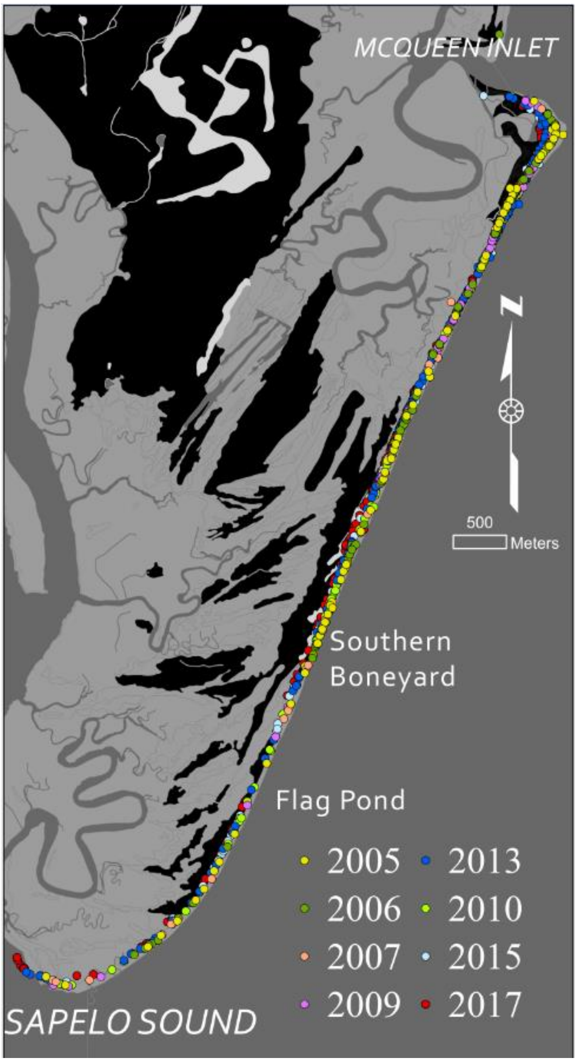


Figure 4-6. Loggerhead sea turtle nest locations on each section. These are all recorded nests from 2005-2017 on a) Northern Section, b) Middle Section, and c) Southern Section.

These locations varied across the years, likely as the beach itself changed over time. This is most evident on the Northern accreting tip of the island, where only more reent nests are present, and on the Southern tip of the island, where newer nests are laid more landward.

4.3 AMBUR Analysis Results

The Era Change (raw change in meters) measured by AMBUR is reported per section and period in Table 4-6 for the shoreline and 4-7 for the vegetation line. These values are averages across all transects in a section. Most of the analyses in this study use rate calculations that evaluate the data from 2005-2017 as a whole, but looking at the year-to-year changes in the vegetation and shoreline change rate highlight changes that may be lost in a broad scale approach.

Table 4-6: The average shoreline change rate (m/yr) per era.

	05-06	06-07	07-09	09-10	10-13	13-15	15-17
Northern Section Mean	25.44	25.08	-10.15	-6.82	-11.45	7.94	-17.41
Northern Section St. Dev	25.35	14.57	30.57	14.55	28.64	27.67	21.49
Middle Section Mean	25.84	-3.46	-14.47	-7.87	-31.76	-8.65	-23.37
Middle Section St. Dev	21.78	17.07	11.76	8.58	19.04	17.27	19.4
Southern Section Mean	16.65	13.91	0.79	-20.16	-16.54	-6.98	-2.6
Southern Section St. Dev	18.75	12.89	19.41	12.71	17.15	11.61	25.81

Table 4-7: The average vegetation line change rate (m/yr) per era.

	05-06	06-07	07-09	09-10	10-13	13-15	15-17
Northern Section Mean	-35.64	19.86	8.5	15.11	-23.88	-15.27	4.06
Nothern Section St. Dev	45.32	39.87	39.53	29.47	43.96	30.96	44.72
Middle Section Mean	-6.89	3.54	-18.75	-0.33	-40.46	-20.42	-32.85
Middle Section St. Dev	10.34	30.00	18.68	15.28	48.61	19.29	63.38
Southern Section	-10.21	11.92	-14.95	2.78	-13.66	-11.01	-29.39
Southern Section St. Dev	25.18	22.85	26.75	13.04	27.39	27.67	38.26

The Era Change tables illustrate how different sections experienced net erosion or net accretion over the same time period. It also allows for the isolated raw movements of the vegetation and shoreline to be compared, with no discernable pattern evident between the two lines movement.

AMBUR also calculated the end point rate (EPR) of each transect for vegetation and shoreline from 2005-2017. The EPR calculates the change from the oldest to the youngest line available, divided by elapsed time. A positive EPR value indicates accretion over the study period, while a negative EPR value indicates erosion.

The linear regression rate (LRR) of each transect were generated by AMBUR for both the shoreline and vegetation line. LRR is the slope of the regression line and assesses the change from year to year, using each available shoreline, producing a change rate (m/yr). Just like the EPR, a negative value indicates erosion, whereas a positive value indicates accretion. The values presented here are for the entire study period, 2005-2017.

The Northern Section

On the Northern Section, the shoreline and vegetation line both had erosional and accretional EPR transects (Table 4-8). The Northern Section was the only section analyzed that produced an accretional mean EPR, for the shoreline at 0.03 m/yr (+/-7.2m). The Northern Section shoreline EPR values are displayed in Figure 4-7. The vegetation line was accretional for fewer transects and at a slower rate (where accretional) when compared to the shoreline, with a mean EPR of -2.32 (+/-6.76m). The Northern Section vegetation line EPR values are displayed in Figure 4-8.

Table 4-8: The average EPR (m/yr) for the Northern Section

	Mean EPR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	0.03	7.2	13.36	-11.33
Vegetation	-2.32	6.76	11.42	-18.45

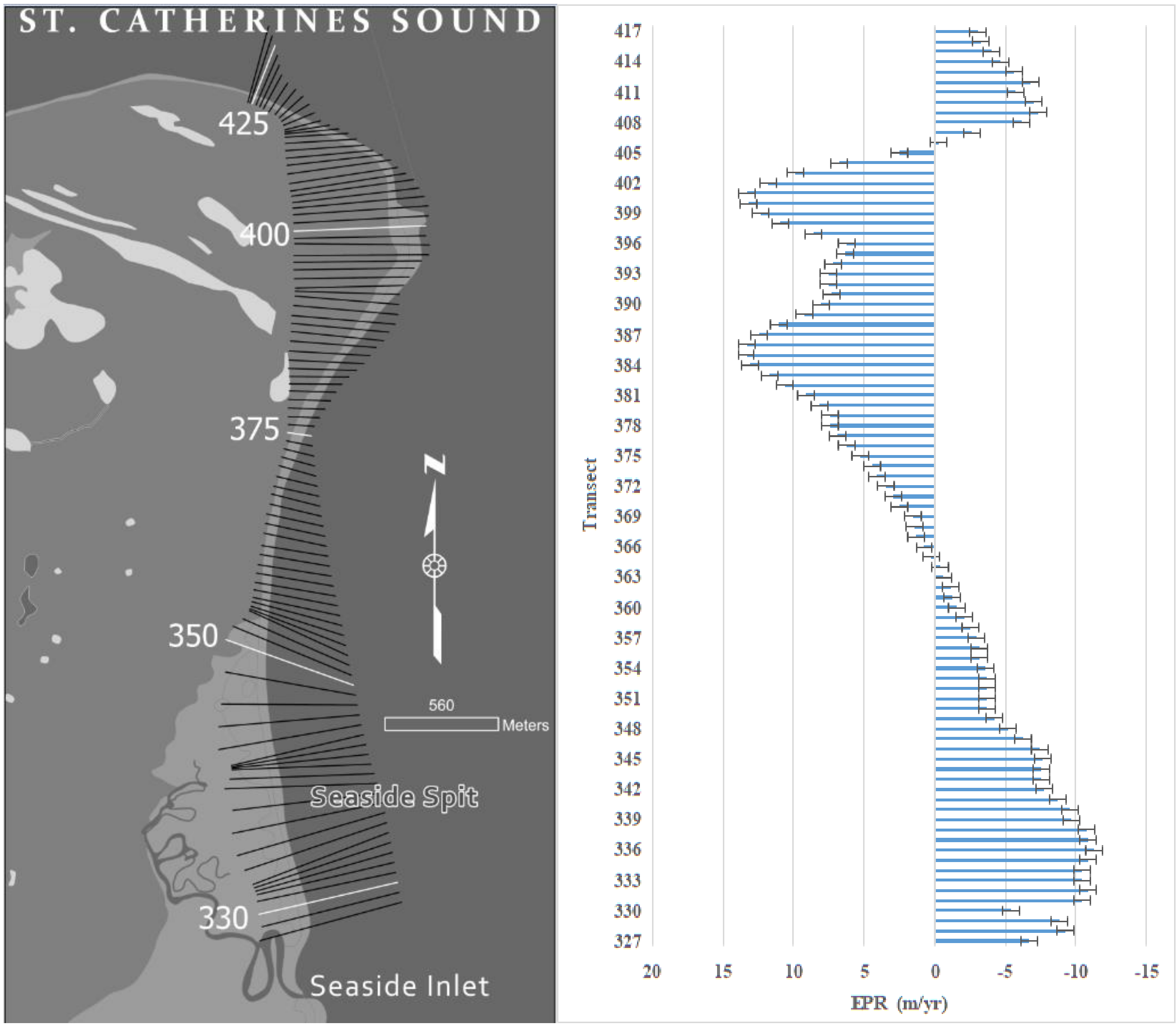


Figure 4-7: Northern Section shoreline EPR(m/yr). Error bars are equal to the standard deviation of the transect analyzed.

All accretional values are clustered towards the middle of the section, between transects #365 and #405. Transect #385 reported the highest accretion rate, at +13.36 m/yr. North and south of the accreting point, the shoreline experienced erosion from 2005-2017. The highest rate of erosion was on transect #336, at -11.33 m/yr.

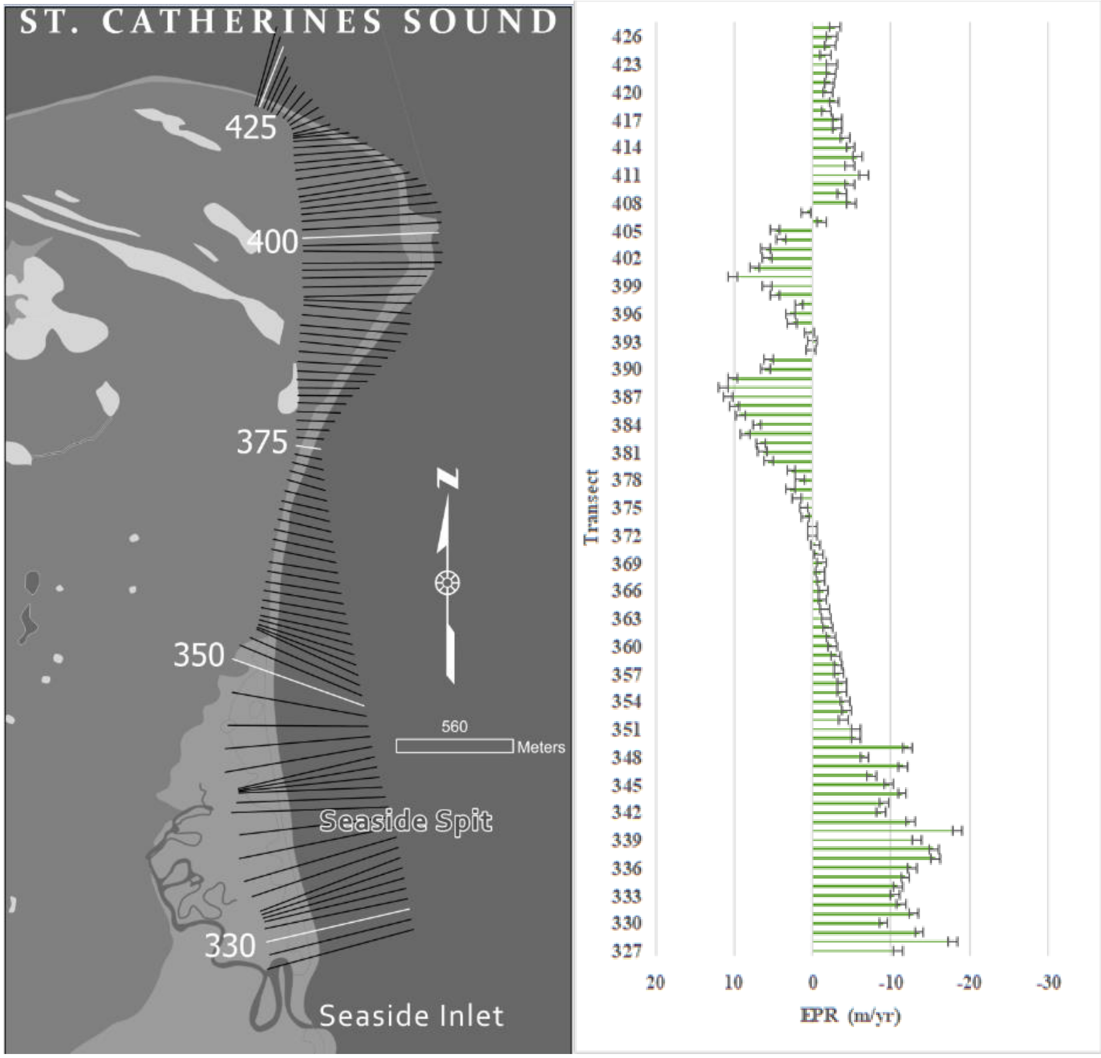


Figure 4-8: Northern Section vegetation line EPR(m/yr). Error bars are equal to the standard deviation of the transect analyzed.

The vegetation line followed a pattern similar to the shoreline, only accreting in a clustered zone near the accretional northeastern point, on transects #371 through #407. This accretion was less than the reported shoreline EPR values, with a maximum of +11.42m/yr on transect #388. All other transects eroded over the study period on the Northern Section, with transect #340 having the maximum erosion rate recorded for the section at -18.45m/yr.

The linear regression rate (LRR) of each transect was generated by AMBUR for both the shoreline and vegetation line (Table 4-9). Recall that this calculation method takes all digitized lines into account, not just the change from oldest to youngest, like the EPR method of calculation. For the LRR method, the mean shoreline rate was -0.95m/yr (+/- 6.95m) (Figure 4-9). This was less erosional than the reported mean vegetation line LRR, -1.27m/yr (+/- 7.61m) (Figure 4-10). The vegetation line had higher reported maximum accretion and erosion rates along a single transect than the shoreline.

Table 4-9: The average shoreline and vegetation LLR (m/yr) for the Northern Section

	Mean LRR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	-0.95	6.95	13.61	-11.47
Vegetation	-1.27	7.61	14.49	-22.69

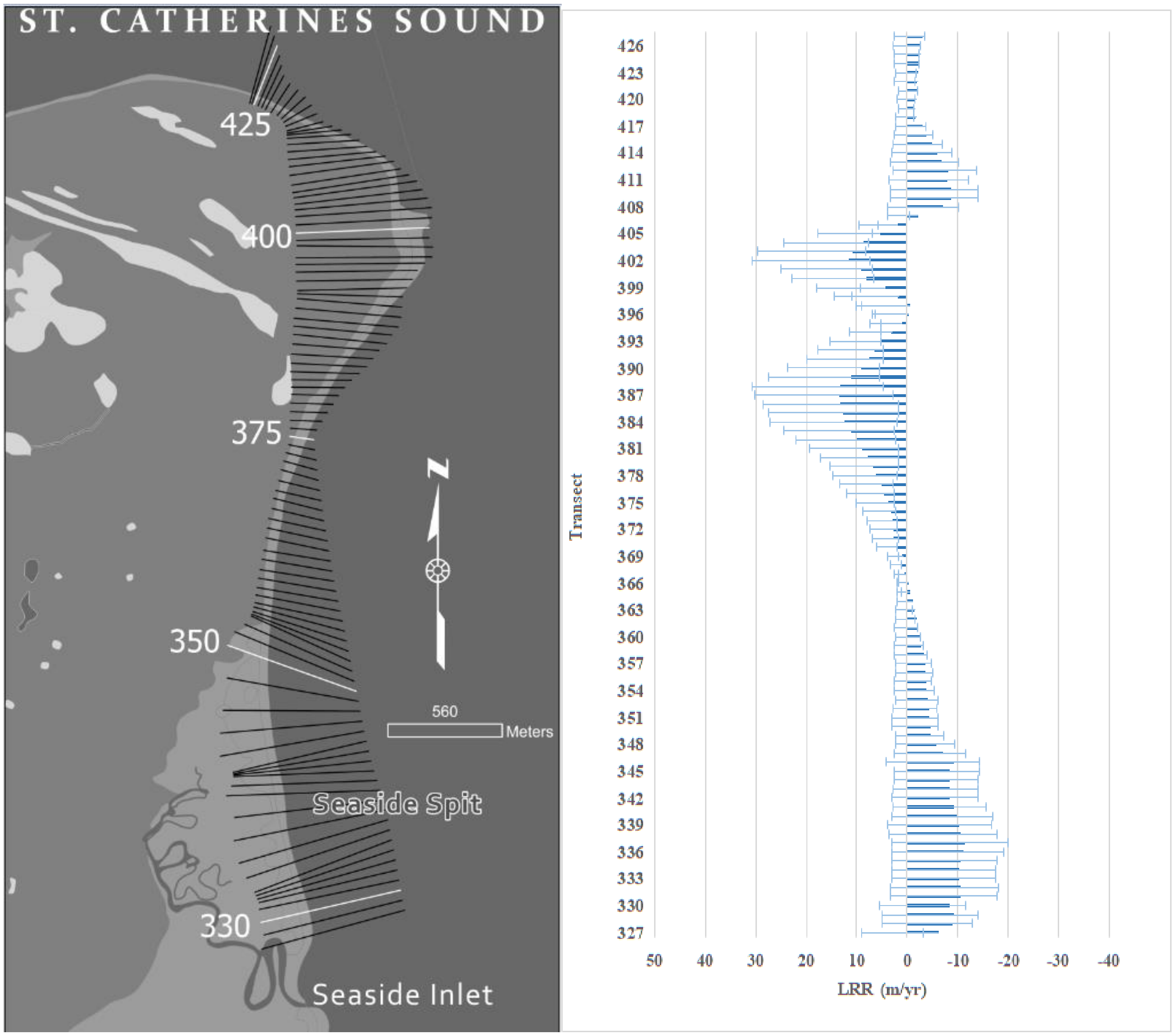


Figure 4-9: Northern Section Shoreline LRR (m/yr). Error bars are set at a 95% confidence interval.

The LRR calculated for the shoreline transects also shows accretion around the northeastern portion, specifically from transects #367 to #395 and #398 through #406. This is 4 less transects overall than the EPR calculations for the shoreline, but also includes 2 erosional transects between the accretional areas. The most erosional rate on a single transect was reported on #337, at -11.47 m/yr.

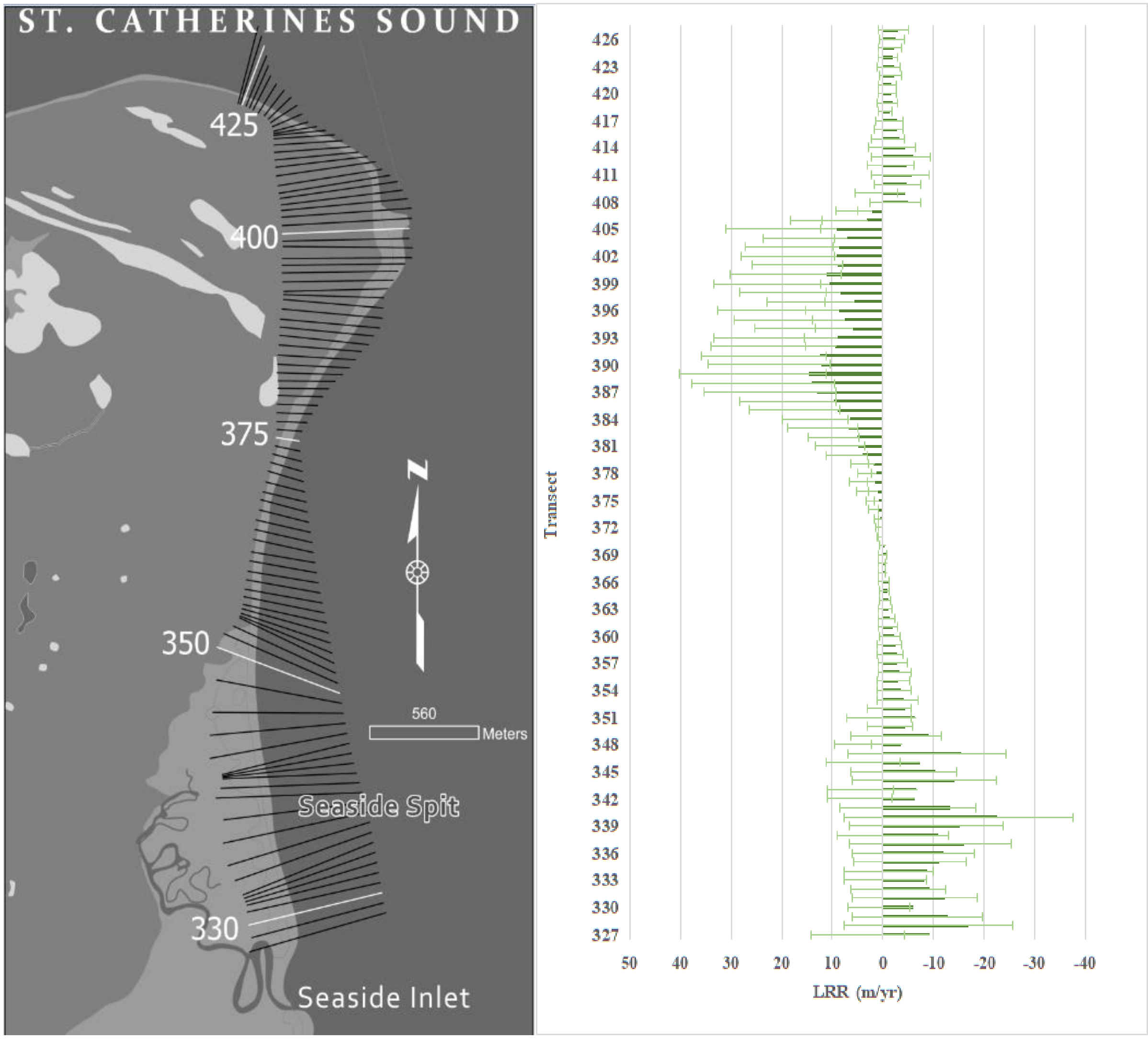


Figure 4-10: Northern Section vegetation line LRR (m/yr). Error bars are set at the upper and lower 95% confidence intervals.

The Northern Section's accreting vegetation line transects are also clustered along the middle of the section, although less completely than the EPR. Vegetation line LRR accretion was recorded on transects #372 through #392, #394 through #405, & #407. All other transects on the Northern Section were eroding, with the highest reported erosion rate on transect #340, at -22.69 m/yr.

To summarize the Northern Sections results, the shoreline EPR and LRR noted the most erosional transect at #336 and #337 respectively. Both EPR and LRR for the vegetation line noted the most erosional transect at #340. Shoreline accretion (EPR) was noted on transects #356 through #405, and, using the LRR, was found on transects #367 through #395 and #398 through #406. Vegetation line accretion was found on transects #371 through #407 based on EPR, and on transects #372 through #392, #394 through #405, and #407 based on the LRR results.

The Middle Section

The Middle Section had no accretional EPR values on any transect. The highest erosion rates along a single transect on St. Catherines Island were found in the Middle Section (Table 4-10). The shoreline had a mean EPR of -6.52m/yr (+/-1.8m), with most transects reporting a similar rate (Figure 4-11). The vegetation line had a mean EPR of -9.63m/yr (+/-4.52m), with more variation in reported rates than the shoreline (Figure 4-12).

Table 4-10: Average EPR (m/yr) for the Middle Section

	Mean EPR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	-6.52	1.8	N/A	-13.65
Vegetation	-9.63	4.52	N/A	-21.35

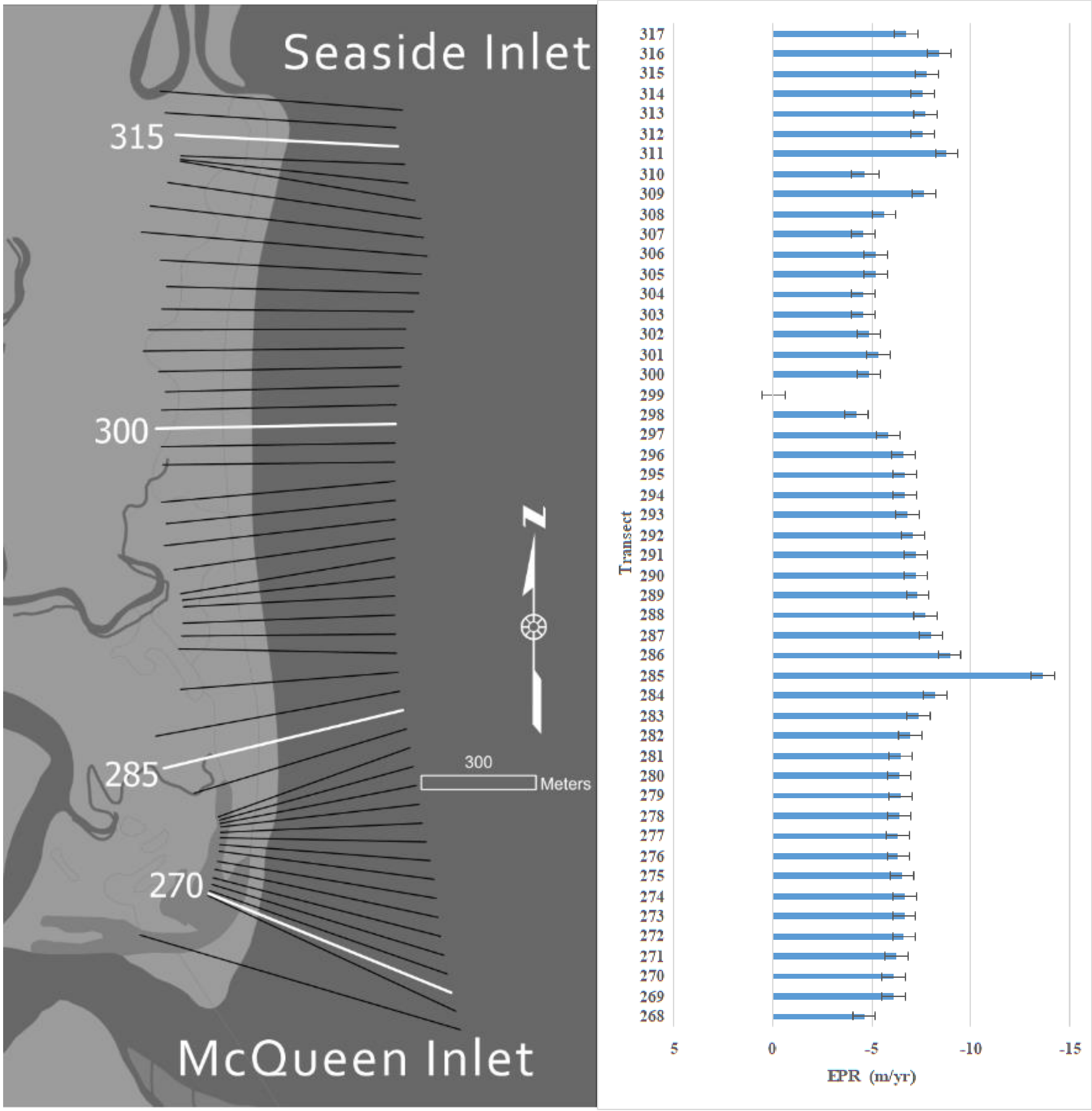


Figure 4-11: Middle Section shoreline EPR (m/yr). Error bars are equal to the standard deviation of the transect analyzed.

All but 2 transects on the Middle Section reported erosional EPRs between -4m/yr and -9m/yr. Transect #299 was the closest rate to accretion reported on the Middle Section, at -0.04m/yr. This transect is just north of the middle of this section. Transect #285 was the most erosional and produced an EPR of -13.65m/yr, located towards the southern end of the section.

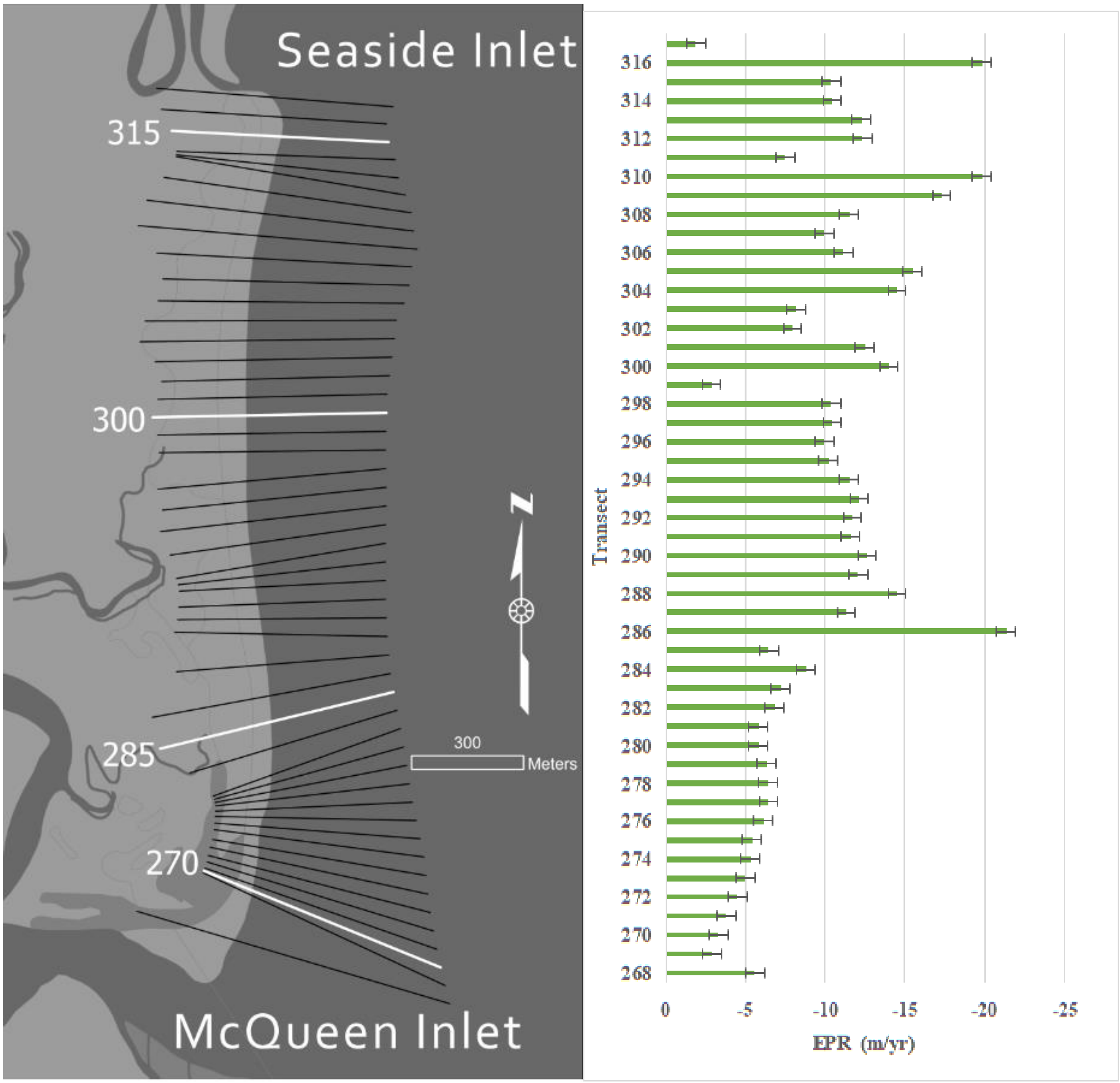


Figure 4-12: Middle Section vegetation line EPR (m/yr). Error bars are equal to the standard deviation of the transect analyzed.

The calculated vegetation line EPR was also exclusively erosional, but had a greater range than the shoreline EPR calculations. The most erosional transect was #286, with an EPR of -21.35 m/yr. In contrast, the lowest erosion rate was reported at transect #317 at -1.9m/yr. Both the vegetation and shoreline generally exhibit lower erosion on the southern end of the section.

The linear regression rate (LRR) of each transect was generated by AMBUR for both the shoreline and vegetation line on the Middle Section (Table 4-11). The Middle Section of St.

Catherines Island again had exclusively erosional transects when calculated using the LRR method for both the vegetation and shoreline. The shoreline produced a mean LRR of -7.56m/yr (+/-1.72m) (Figure 4-13). The vegetation line had a higher mean LRR, at -9.43m/yr (+/-4.49m) (Figure 4-14). The vegetation line also had a higher maximum erosion rate along a single transect.

Table 4-11: Average LRR (m/yr) for the Middle Section

	Mean LRR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	-7.56	1.72	N/A	-12.19
Vegetation	-9.43	4.49	N/A	-23.58

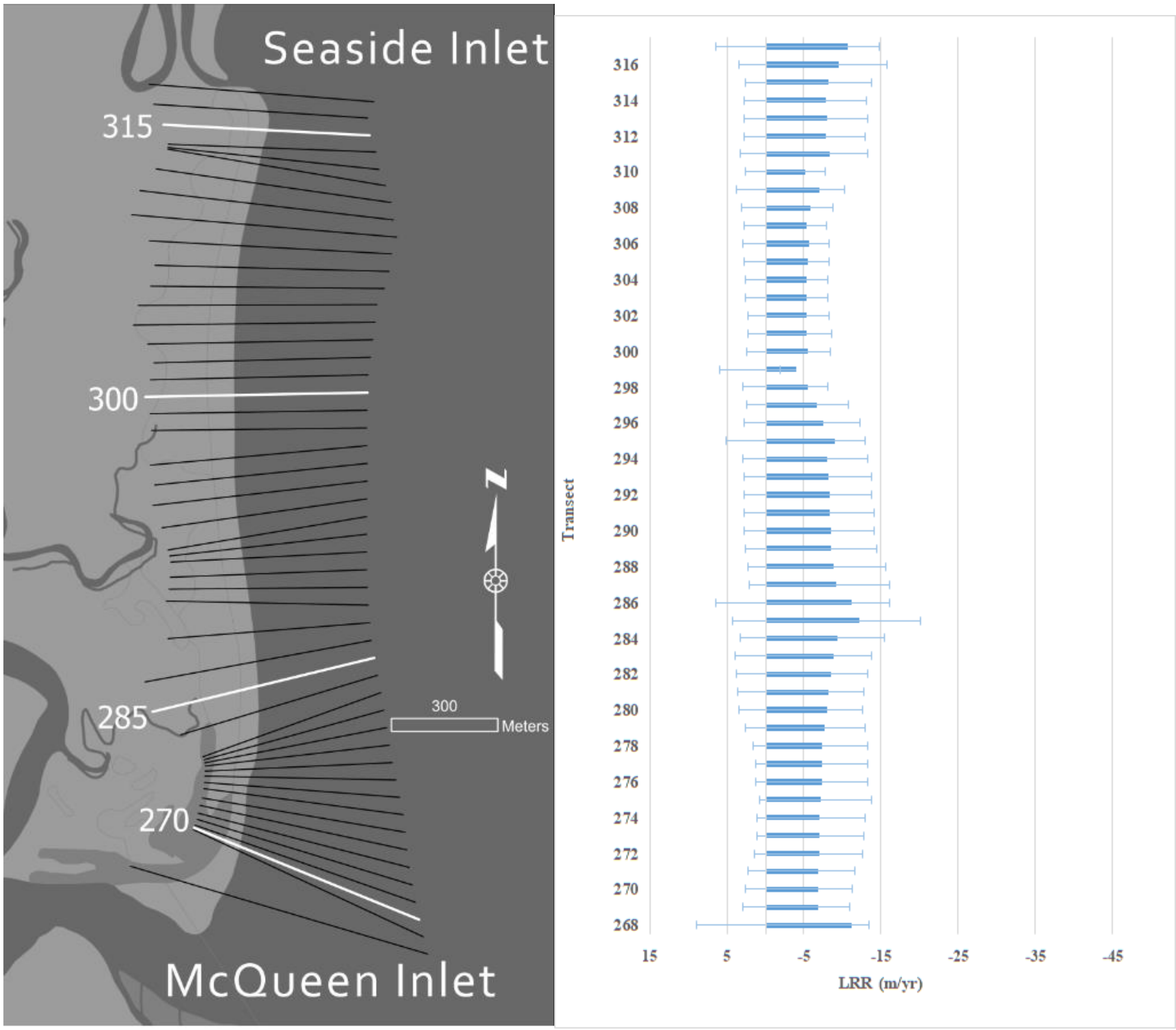


Figure 4-13: Middle Section shoreline LRR (m/yr). Error bars are set at the upper and lower 95% confidence intervals.

The shoreline LRRs are more erosional than the reported EPRs for the Middle Section. When looking at specific transects, the highest erosional LRR was on transect #285 at -12.19m/yr. The second highest was right next to it, on transect #286 at -11.22m/yr. The lowest shoreline erosional LRR reported for the Middle Section was on transect #299 at -3.97m/yr.

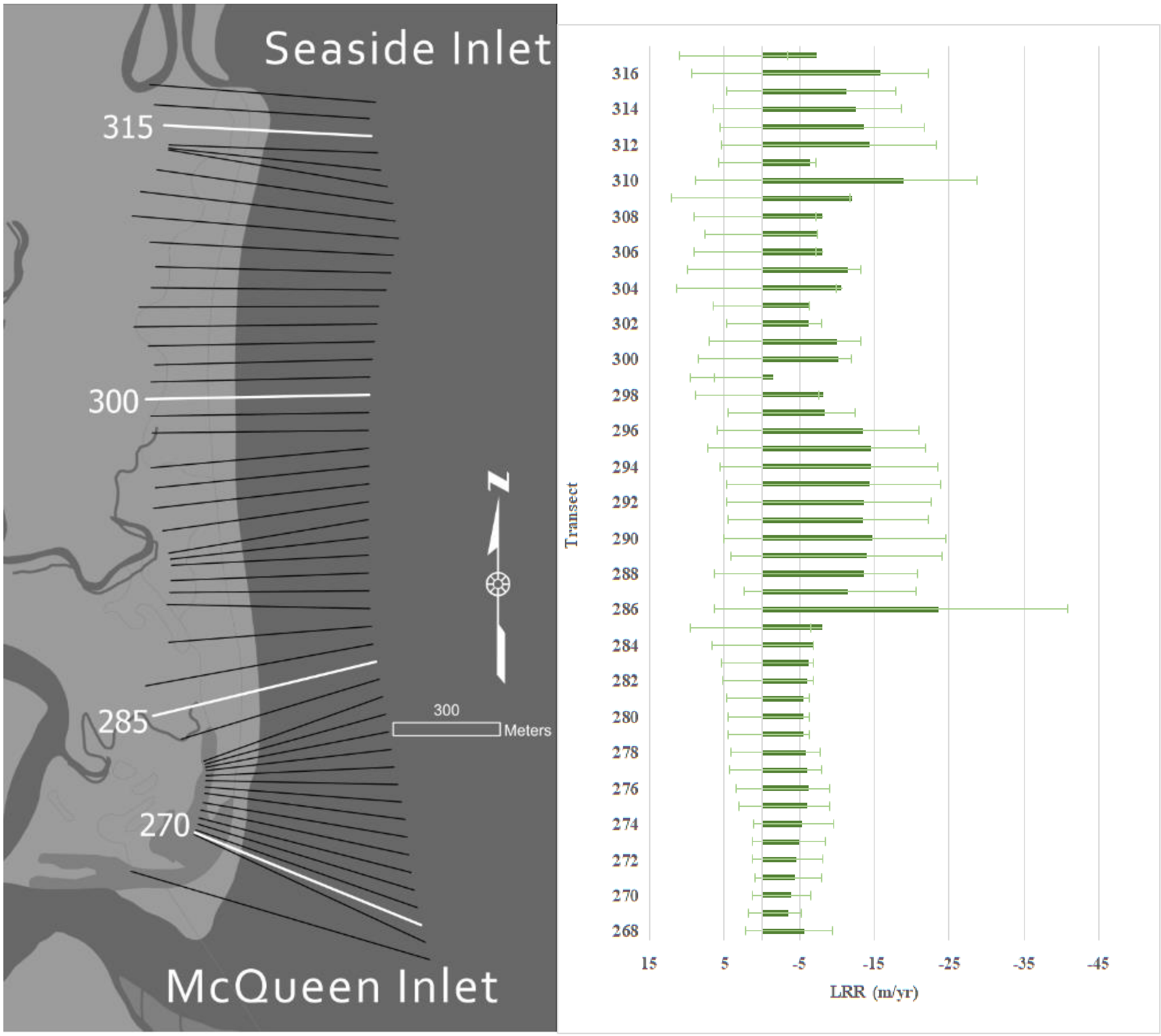


Figure 4-14: Middle Section vegetation line LRR (m/yr). Error bars are set at the lower and upper 95% confidence intervals.

The highest rates of erosion found on the vegetation line occurred as singular transects, particularly along #310, #316, and the highest #286 (-23.58 m/yr). The lowest erosion rate, transect #299, reported a LRR of -1.55m/yr. This section also had the highest average vegetation line LRR among the sections at -9.43 m/yr (+/4.49m).

To summarize the Middle Section results, no accretional values were reported for either line using either rate calculation method. The shoreline, from both the EPR and LRR results, reported the most erosional transect as #285. The vegetation line also had the next transect, #286, reported as the most erosional through both calculation methods. Transect #299 was reported as the least erosional transect in the section for the shoreline (EPR and LRR methods) and for the vegetation line using the LRR method of rate calculation. Transect #317 was the least erosional for the vegetation line using the EPR method.

The Southern Section

The Southern Section had a mean shoreline EPR of -2.38m/yr (+/- 3.06m) (Figure 4-15). The vegetation line had a greater mean EPR, at -5.14m/yr (+/-3.91) (Figure 4-16). Both the vegetation and shoreline had accretional and erosional values reported, but the vegetation line had greater maximum accretion and erosion rates reported along a single transect (Table 4-12).

Table 4-12: Average EPR (m/yr) for the Southern Section

	Mean EPR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	-2.38	3.06	12.59	-12.86
Vegetation	-5.14	3.91	15.4	-16.96

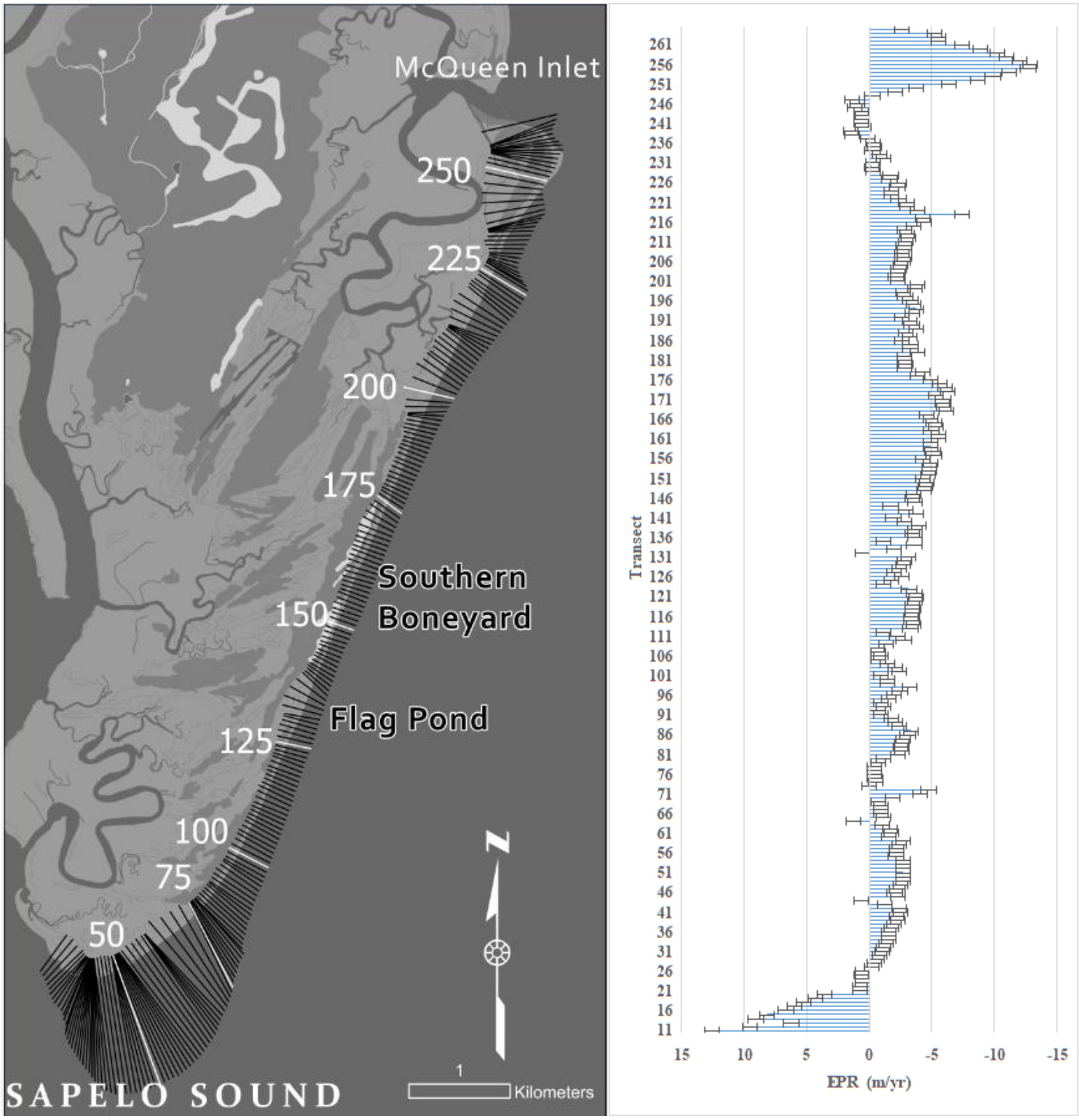


Figure 4-15: Southern Section shoreline EPR (m/yr). Error bars are equal to the standard deviation of the transect analyzed.

The Southern Section had mostly erosional shoreline EPRs, but with large accretion present on the southern tip of the Island (transect #11 through #26) and slight accretion south of McQueen Inlet (transect #237 and #247) (Figure 4-). The greatest accretion rate was found on transect #11 , at +12.59m/yr. The most erosional EPR was reported on transect #256 at -12.86m/yr and was flanked by the second and third most erosional transects, #255 and #257.

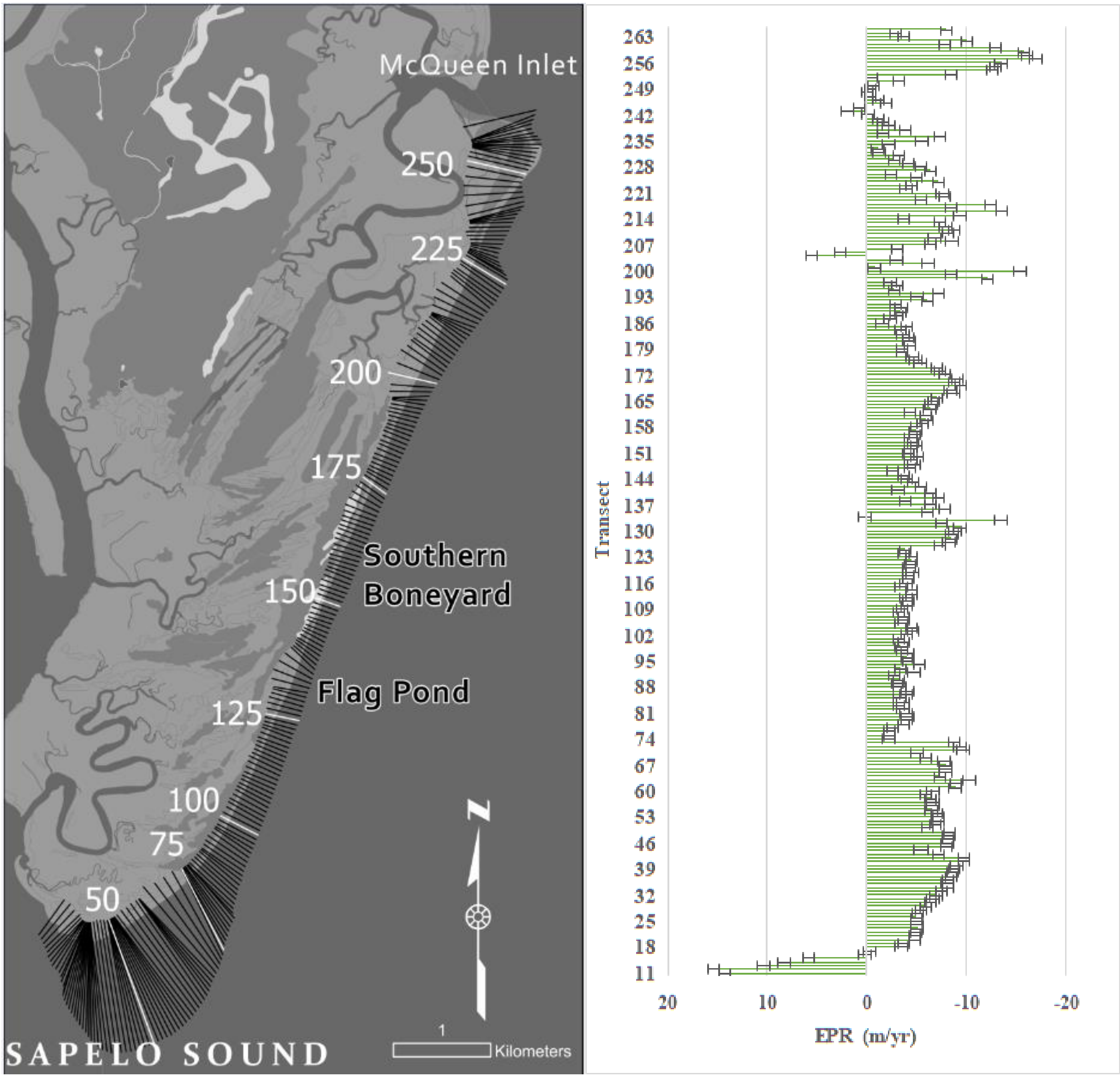


Figure 4-16: Southern Section vegetation line EPR (m/year). Error bars are equal to the standard deviation of the transect analyzed.

Much like the shoreline, the southern end of the Southern Section did produce accretional EPRs for the vegetation line, but only for transects #11 through #16. Unlike the shoreline, there were only 2 transects (#243 and #244) reporting accreting values on the northern end of the section, south of McQueen Inlet. The maximum accretion transect, #12, had a rate of +15.4m/yr. The maximum erosion rate on a single transect was recorded on #257, at -16.96 m/yr. Transects #258 and #259 were the second and third most erosional transects.

The linear regression rate (LRR) of each transect was generated by AMBUR for both the shoreline and vegetation line (Table 4-13). The Southern Section's shoreline reported a mean LRR of -3.47m/yr (+/- 3.01m) (Figure 4-17). The vegetation line reported a mean LRR of -4.24m/yr (+/- 3.65m) (Figure 4-18).

Table 4-13: Average LRR (m/yr) for the Southern Section

	Mean LRR	Standard Deviation	Maximum Accretion Rate	Maximum Erosion Rate
Shoreline	-3.47	3.01	10	-15.77
Vegetation	-4.24	3.65	11.86	-16.96

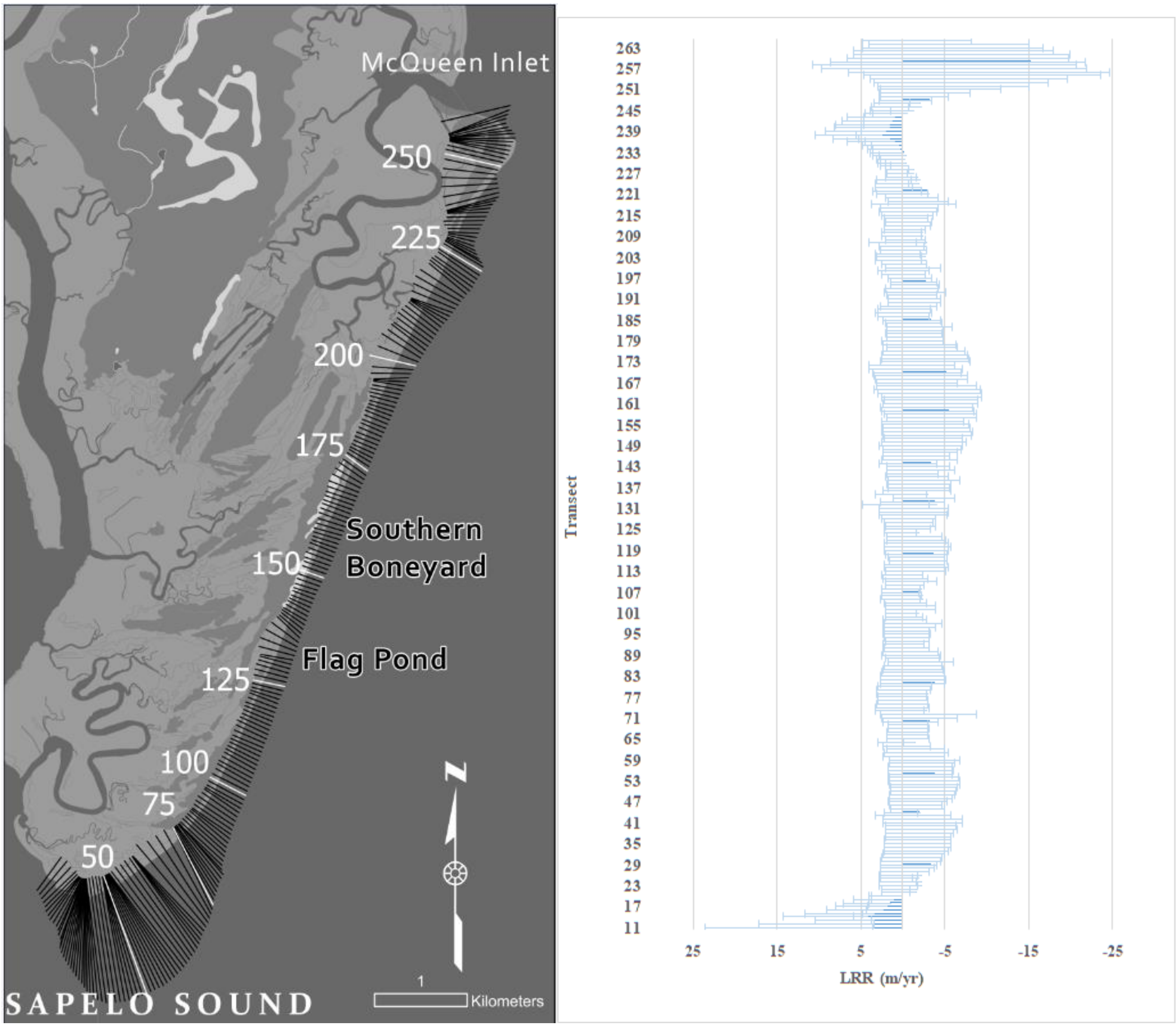


Figure 4-17: Southern Section Shoreline LRR (m/yr). Error bars are set at a 95% confidence interval.

Erosional and accretional LRRs were reported for the shoreline on the Southern Section. Accretion was reported on the southern end of this section, at transects #11 through #20. Transect #11 had the single highest reported accretion rate on the Southern Section, at +10 m/yr. Accretion was also present south of McQueen Inlet, at transects #234 through #243. Other than the referenced transects, all other transects on the Southern Section were eroding, peaking at transect #257 at a rate of -15.77 m/yr.

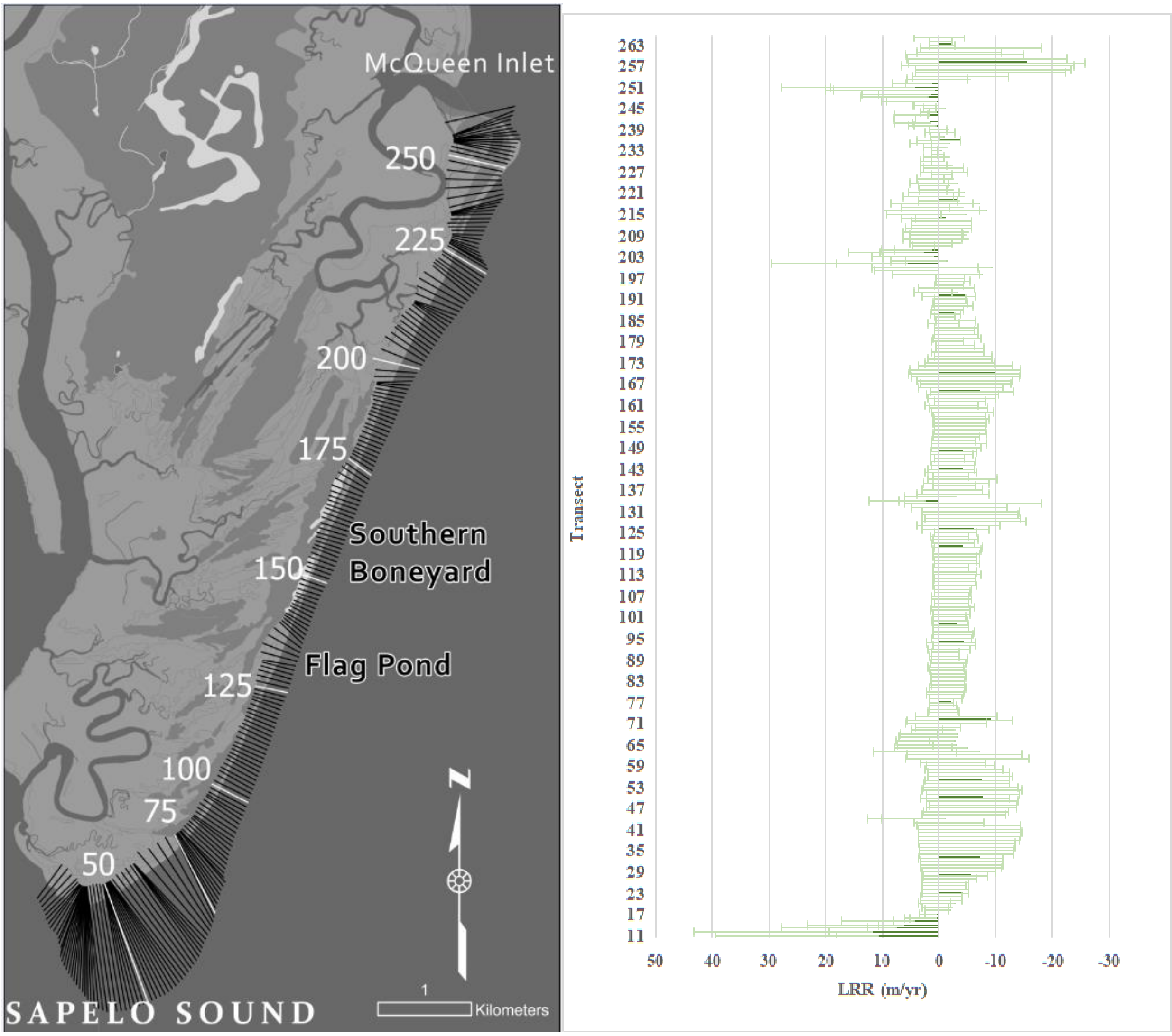


Figure 4-18: Southern Section vegetation line LRR (m/yr). Error bars are set at the upper and lower 95% confidence intervals.

The vegetation line on the Southern Section also had both accreting and eroding LRRs reported. However, accretion occurred on less transects measuring the LRR of the vegetation line than the shoreline. On the southern tip of the island, accretion was only reported for transects #11 through #16. The area south of McQueen Inlet was also only accreting on transects #243 and #244. The maximum accretion was reported on transect #12, at +15.4 m/yr. The maximum erosion rate recorded on a single transect for the vegetation line was on transect #257, at -16.96m/yr.

To summarize the results of the Southern Section, the shoreline was shown to be accreting on transects #11 through #26 and #237 through #247 using the EPR method. The LRR method showed accretion on transects #11 through #20 and transects #234 through #243. The shoreline had the greatest accretion on transect #11, for both calculation methods. The most erosional transect for the shoreline in this section was #256 and #257, for the EPR and LRR respectively. Both rate calculation methods also produced the same transect of maximum accretion, #257, for the vegetation line. The vegetation line reported the same accretion on the southern and northern end of the Southern Section using both methods, through transects #11 through #16 and at #243 and #244. The vegetation line had the greatest accretion on transect #12, for both calculation methods.

Overall, the Middle Section has the highest rate of erosion, the Southern Section has the second highest with some accretion, and the Northern Section has the lowest erosion with the highest accretion for both the vegetation and shoreline. However, all of the average vegetation values are higher than the average shoreline values.

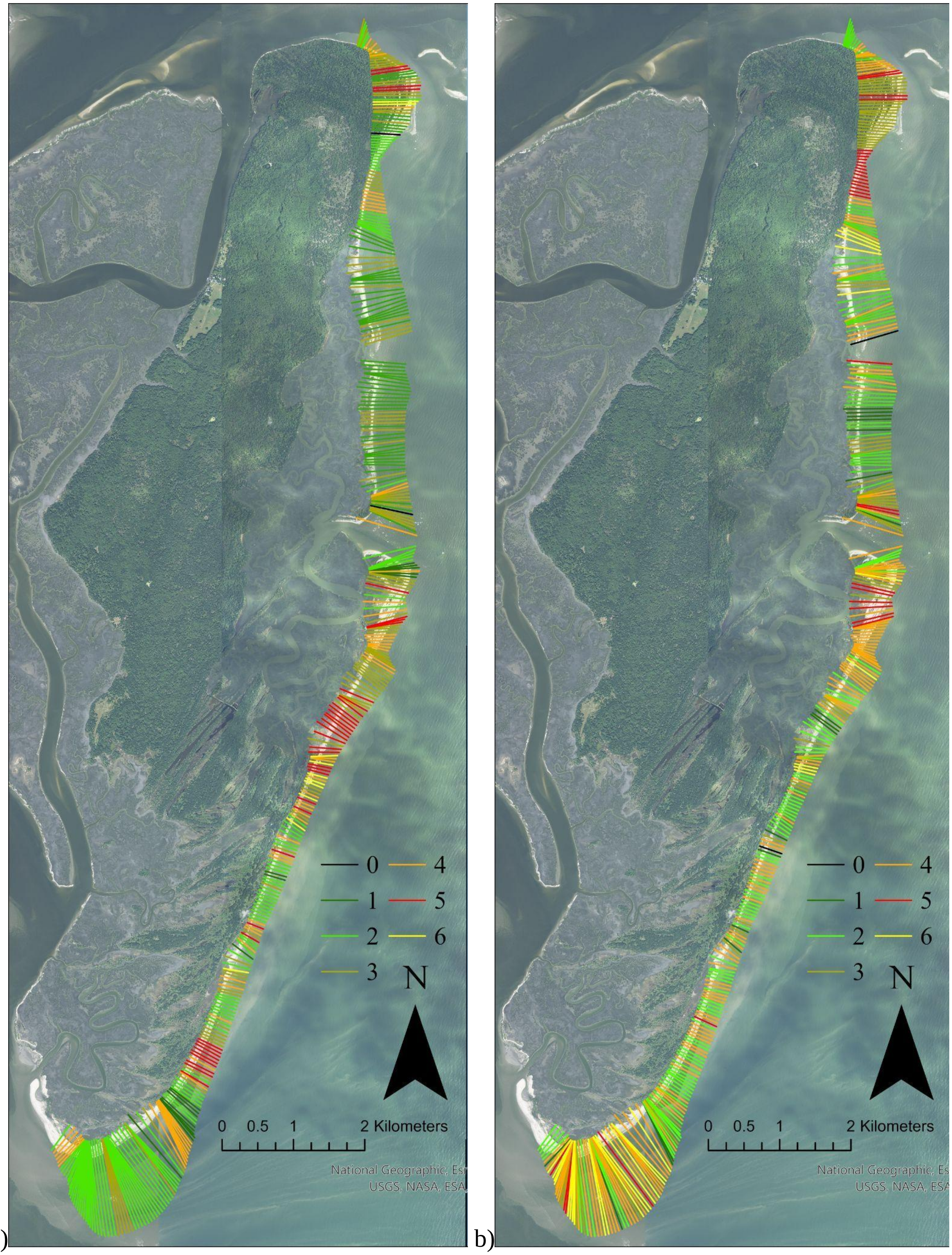
Chronic Processes

To better examine how the vegetation and shoreline are changing over time, AMBUR also identifies whether each transect is exhibiting a “chronic process” of moving the same direction each year analyzed. Most of the transects experienced both erosion and accretion over the study period, with only 4 transects out of the 812 analyzed (accounting for both the shoreline and vegetation line) in the sections exhibiting a chronic process. Both the shoreline and the vegetation line had 2 transects with chronic processes (Figure 4-19). For the shoreline, the chronically eroding transect (#274) was located on the Middle Section, north of McQueen Inlet. The other chronic process noted on the shoreline, chronically accreting transect #385, was on the accreting northeastern portion of the Northern Section. For the vegetation line, transect #167 was noted as a chronically eroding, which is located north of Flag Pond on the Southern Section. The other chronically erosional vegetation line transect, #327, borders the northern side of Seaside Inlet and is the southern boundary for the Northern Section.

Figure 4-19: Chronic processes transects.

Oscillations

Another statistic that AMBUR produces is the number of oscillations experienced by each transect across the study period. An oscillation refers to a transect rate changing from positive, to negative, and back to positive (or vice versa). This would indicate a large amount of variability on a transect with a high number of oscillations, and less on a transect with a lower number. Oscillations ranged from zero to six over the study period. Figure 4-20 is a map of the number of oscillations along with the vegetation and shoreline. The results are summarized in Table 4-14, both overall and per section.



a) b)

Figure 4-20: The a)shoreline and b)vegetation line number of oscillations per transect observed by AMBUR.

The vegetation and shoreline oscillation transects followed different patterns across the island in most locations. The vegetation line experienced a more varied number of oscillations on the southern tip of the island. Many transects near McQueen Inlet share similar rates of oscillations. The transects near Seaside Inlet experience different numbers of oscillations between the vegetation and the shoreline. There are some similarities in the number of oscillations on the Northern accreting tip between the two lines, with 5 oscillations being commonly cited.

Table 4-14: Oscillations overall and per section

Oscillations	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Overall								
Vegetation Line	2	18	132	58	135	33	28	406
Shoreline	2	74	124	102	56	38	10	406
Northern Section								
Vegetation Line	1	0	28	26	22	19	5	101
Shoreline	1	28	25	32	9	4	2	101
Middle Section								
Vegetation Line	0	7	19	13	8	3	0	50
Shoreline	1	29	1	16	3	0	0	50
Southern Section								
Vegetation Line	1	11	85	19	105	11	23	255
Shoreline	0	17	98	54	44	34	8	255

The majority (55.66%) of the shoreline transects experienced 2-3 oscillations over the study period (Figure 4-21). The shoreline only had two transects that experienced no oscillations, illustrating the two noted chronic processes.

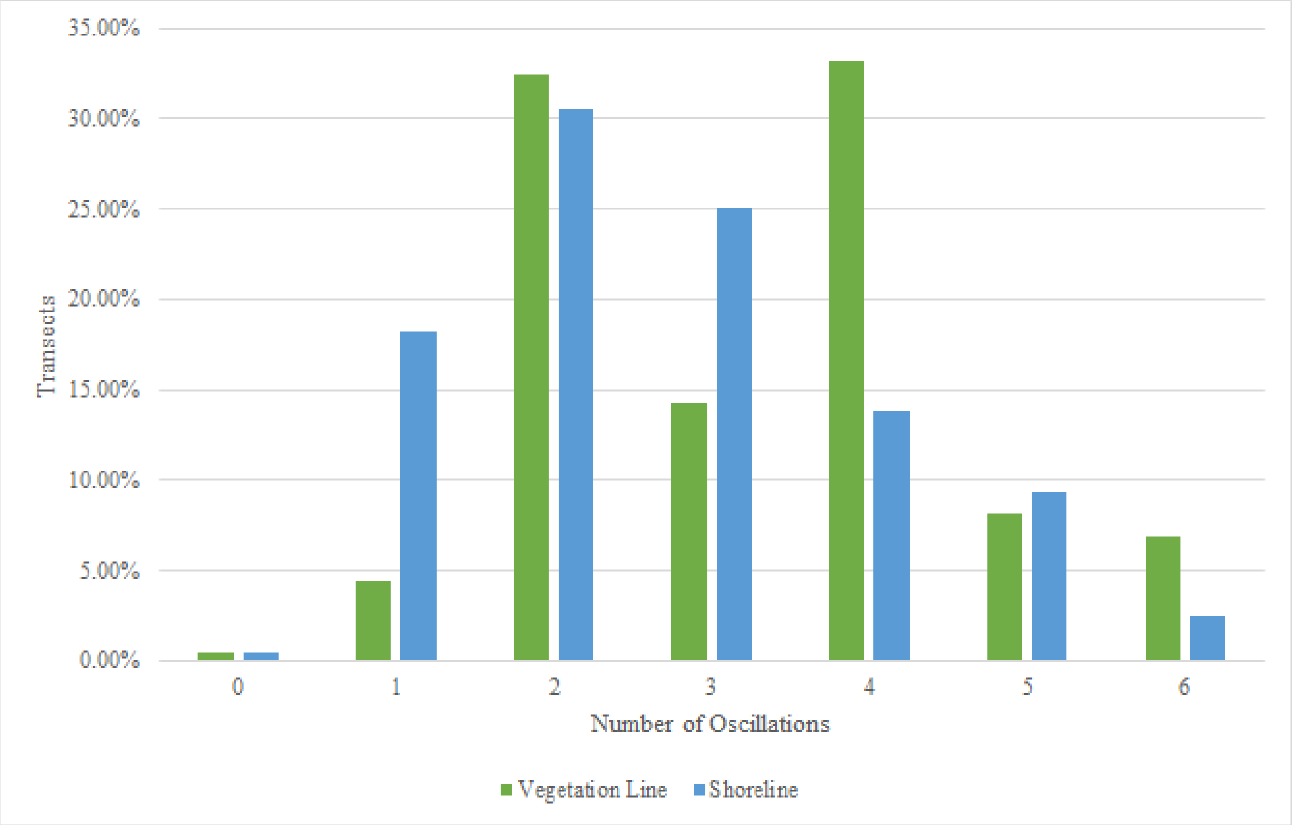


Figure 4-21: The percentage of transects in the vegetation and shoreline that experienced each number of oscillations.

The vegetation line had a different arrangement of oscillation, with 2 and 4 oscillations being the majority of transects across the study period (65.76%). Again, the two chronic processes are noted with “0” oscillations. The second-lowest number of oscillations recorded on a transect was 1.

When comparing these, 15.02% of the transects measured had the same number of oscillations across the vegetation and shorelines (Figure 4-22). All transects in common were in the Southern and Middle Sections.

Figure 4-22: Transects with the same oscillations between the vegetation and shoreline

Dry Beach Width

Over the study period, the Northern Section had the widest dry beach on average at 56.82m (+/-40.46m). The average dry beach widths are plotted in Figure 4-23. Average dry beach width was calculated for each section based on the distance between the shoreline and the vegetation line along each transect from 2005-2017 (Table 4-15).

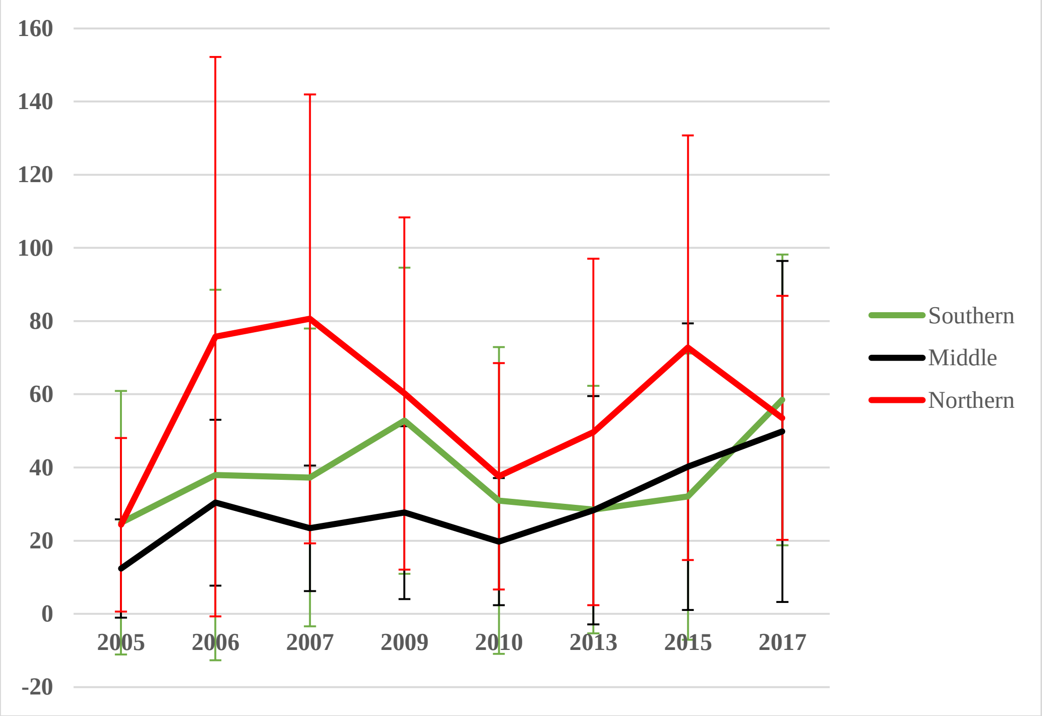


Figure 4-23: The dry beach width plotted over the study period per section. Error bars are set to the standard deviation of each year's measurements.

The Northern Section had the widest average beach for 6 of the 8 years evaluated, only being narrower than the Southern Section by less than 5m in 2005 and 2017. The Middle Section had the narrowest dry beach across the study period, with an average width of 28.99m (+/-26.4m).

Table 4-15: Average dry beach width(m) per section annually.

Section	2005	2006	2007	2009	2010	2013	2015	2017	Average	St. Dev.
Northern	24.38	74.78	80.61	60.23	37.6	49.7	72.73	53.56	56.82	40.46
Middle	12.37	30.38	23.38	27.67	19.71	28.34	40.23	49.83	28.99	26.4
Southern	24.87	37.93	37.28	52.78	30.97	28.5	32.07	58.5	37.86	47.4

Overall	20.54	47.7	47.09	46.89	29.43	35.51	48.34	53.96

Additionally, the initial beach width was subtracted from the final beach width to illustrate the average change of the beach width from 2005-2017 per each section (Table 4-16). The average beach width change was greatest on the Middle Section at 36.46m (+/-47.68m). The standard deviations were extremely large over each section of St. Catherines Island, being greater than the associated means, likely due to the extreme changes seen between certain eras in the dataset.

Table 4-16: Average beach width change(m) over the study period.

Section	Average Width Change	Standard Dev.
Northern	27.08	31.07
Middle	36.46	47.68
Southern	33.82	37.09

4.4 Sea Turtle Nest Distance Results

Using the Near tool in ArcGIS Pro, the distance from each sea turtle nest was measured to both the vegetation and shoreline (Tables 4-17 and 4-18). Over the study period, the average distance from a loggerhead sea turtle nest to the shoreline was 19.41m (+/-17.43m) on the Northern Section, 14.17m (+/-15.29m) on the Middle Section, and 19.02m (+/-16.83) on the Southern Section.

Table 4-17: Sea turtle nest near distances to the shoreline

Year	Mean(m)	Median(m)	Standard Dev.	Nest Count
Northern Section				
2005	10.26	8.31	8.53	22
2006	15.33	14.03	17.3	19
2007	55.58	51.91	23.28	10
2009	24.37	22.01	13.67	25
2010	15.54	14.39	7.87	19
2013	8.83	7.42	5.58	31
2015	16.03	14.19	8.17	52
2017	9.35	7.14	8.41	47
Overall Mean	19.41	17.43	11.6	28.13
Middle Section				
2005	3.8	2.27	3.7	4
2006	15.4	15.6	2.7	5
2007	25.46	N/A	N/A	1
2009	24.3	28	12.3	5
2010	N/A	N/A	N/A	0
2013	7.15	N/A	N/A	1
2015	N/A	N/A	N/A	0
2017	8.91	N/A	N/A	1
Overall Mean	14.17	15.29	6.23	2.83
Southern Section				
2005	12.47	10.78	11.56	79
2006	15.71	14.08	9.6	83
2007	34.66	30.63	19.91	39
2009	36.68	35.33	17.64	69
2010	16.69	16.43	9.9	130
2013	12.02	10.84	8.46	157
2015	9.98	8.45	8.86	139
2017	14.45	7.9	14.72	153
Overall Mean	19.02	16.83	12.58	106.13

The average rates per year were plotted against each section in Figure 4-24 for the shoreline. No significant trend lines could be fitted to the change in distance to the shoreline over time. The Northern and Southern Sections had very similar overall averages, although the distances from year to year do differ. The few nests on middle beach have very different distances, with a lower average being reported.

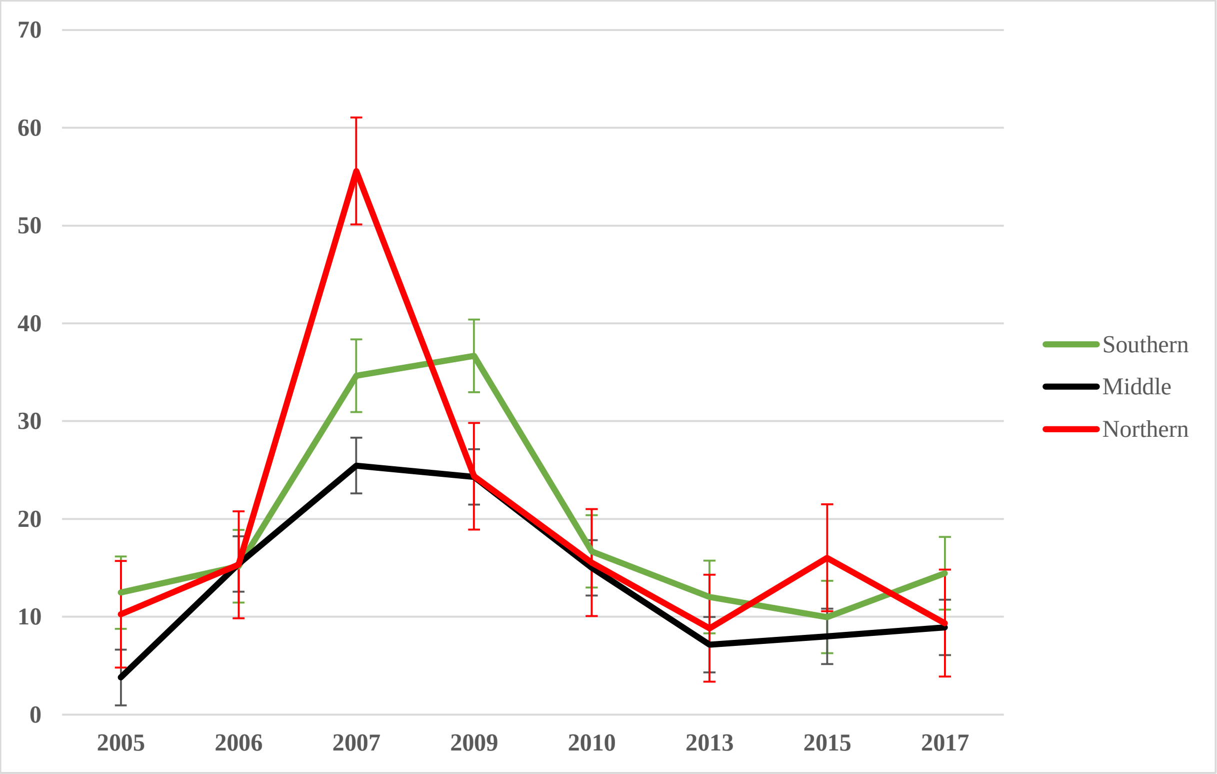


Figure 4-24: Average distance to the shoreline from sea turtle nests. Note that no data exists for the Middle Section in 2010 or 2015 because no nests were recorded.

As Figure 4-24 shows, nests on the Middle Section consistently had the shortest distance to the shoreline. The Northern and Southern Sections are both fairly similar in 2005 and 2006. In 2007, the distance on the Northern Section more than tripled. In 2010, all distances to the shoreline are fairly similar again across the island, with comparatively minor variation for the rest of the study period.

The average distance from a loggerhead sea turtle nest to the vegetation line was measured using the same technique. Over the study period, the average distance from a loggerhead sea turtle nest to the shoreline was 27.07 (+/-25.61m) on the Northern Section, 19 (+/-4.8m) on the Middle Section, and 26.98 (+/-32.14m) on the Southern Section.

Table 4-18: Sea turtle nest near distances to the vegetation line

Year	Mean(m)	Median(m)	Standard Dev.	Nest Count
Northern Section				
2005	24.49	15.56	24.14	22
2006	16.05	10.74	17.9	19
2007	48.74	45.18	37.56	10
2009	20.55	6.44	32.5	25
2010	22.21	17.69	21.64	19
2013	21.42	15.74	22	31
2015	32.03	24.15	24.51	52
2017	31.09	28.4	24.64	47
Overall Mean	27.07	20.49	25.61	28.13
Middle Section				
2005	4.6	3.5	3.5	4
2006	4.3	1.93	4.9	5
2007	10.41	N/A	N/A	1
2009	7.3	8.1	6	5
2010	N/A	N/A	N/A	0
2013	14.36	N/A	N/A	1
2015	N/A	N/A	N/A	0
2017	73.04	N/A	N/A	1
Overall Mean	19	4.51	4.8	2.83
Southern Section				
2005	22.27	5.87	29.74	79
2006	30.79	13.1	35.66	83
2007	22.68	11.33	24.6	39
2009	35.39	11.57	44.34	69
2010	27.11	7.48	39.86	130
2013	22.73	8.59	28.98	157
2015	25.13	9.86	28.35	139
2017	29.74	27.25	25.62	153
Overall Mean	26.98	11.88	32.14	106.13

No significant trend lines could be fitted to the change in distance to the vegetation line over time when the means were compared (Figure 4-25).

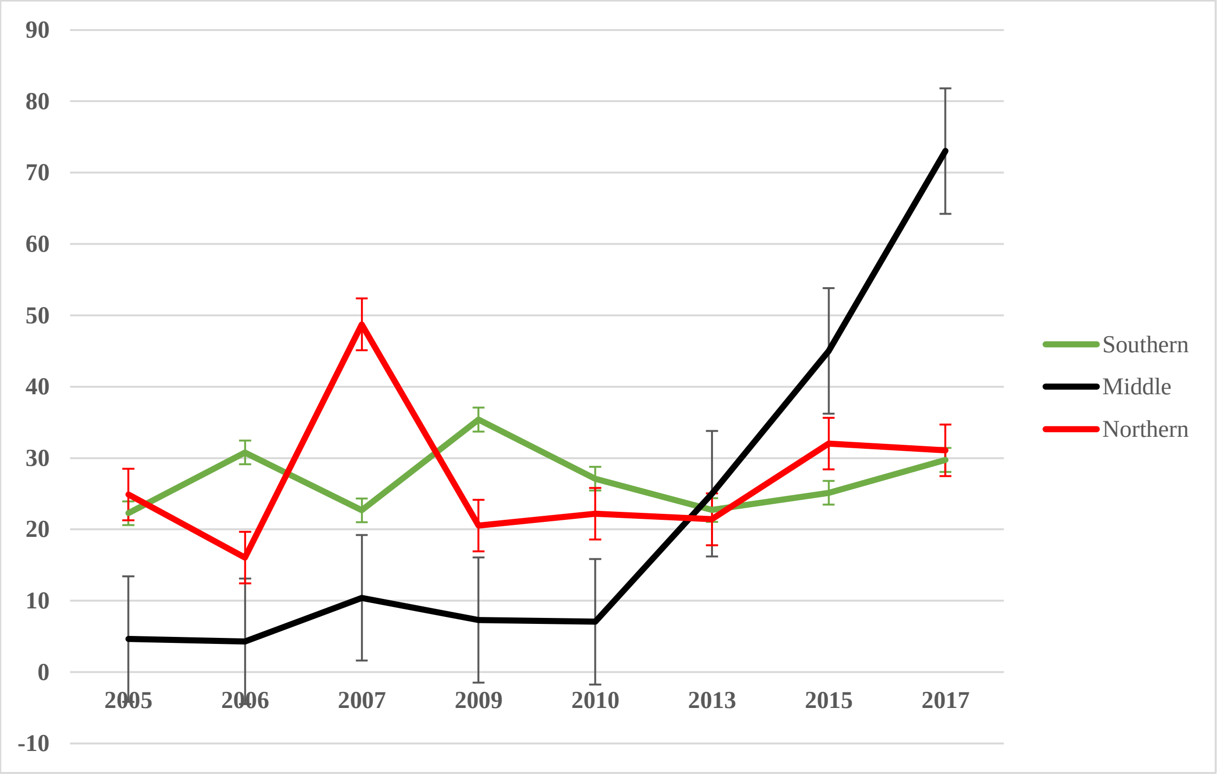


Figure 4-25: Average distance to the vegetation line from sea turtle nests. Note that no data exists for the Middle Section in 2010 or 2015 because no nests were recorded.

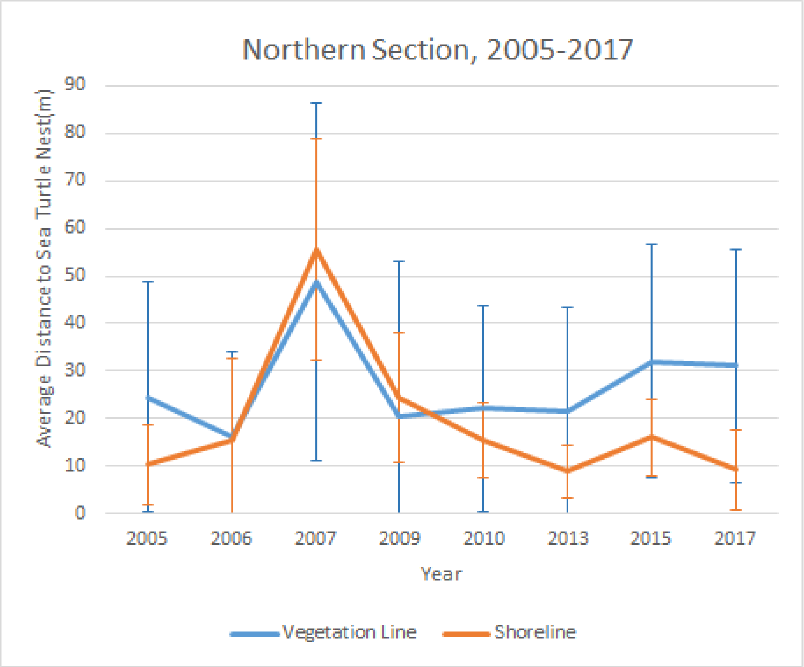
As Figure 4-25 illustrates, the Northern and Southern Section distance to the vegetation line start at similar distances. Much like the distance to the shoreline, in 2007, the Northern Section distance increases three fold and begin to trend more similarly with the Southern Section after 2010. Unlike the distances to the shoreline, the Middle Section is not consistent, increasing dramatically in 2017. However, without nests recorded in 2015, this increase shows the change from a single nest in 2013 at 14.36m from the vegetation line to a single nest in 2017, at 73.04m. No standard deviations can be provided, as these were the only data points for those years. This is why the Middle Beach data must be evaluated with its limited sample size in mind.

The averages of the vegetation and shoreline distances to sea turtle nests are compared in Table 4-19 and visually shown in Figures 4-26 for each section.

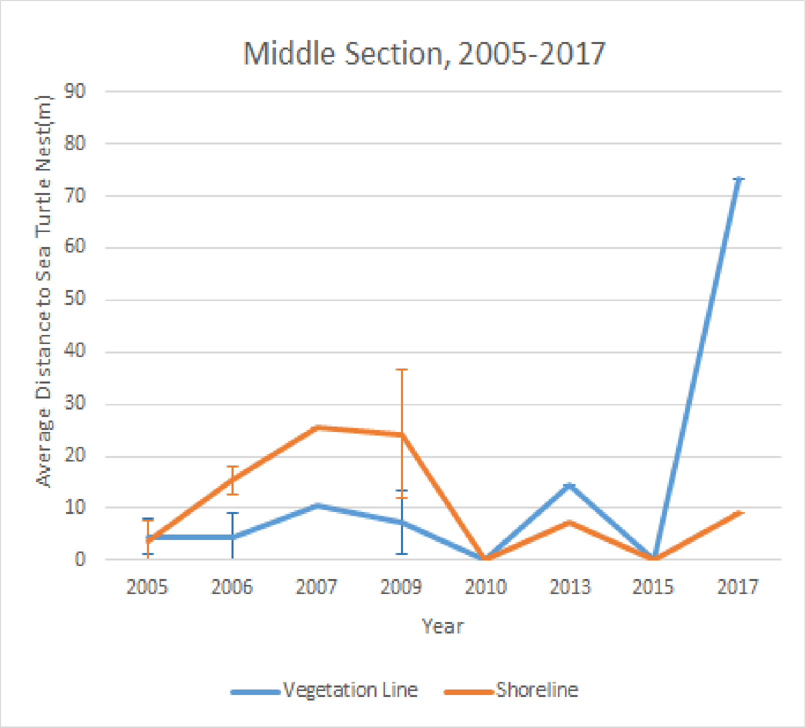
Table 4-19: Average nest distances(m) to the vegetation and shoreline annually. Middle Section had years where 0 or 1 nest were recorded, hence the N/A values.

Year	Shoreline		Vegetation Line	
Northern Section	Mean	St. Dev	Mean	St. Dev
2005	10.26	8.53	24.49	24.14
2006	15.33	17.3	16.05	17.9
2007	55.58	23.28	48.74	37.56
2009	24.37	13.67	20.55	32.5
2010	15.54	7.87	22.21	21.64
2013	8.83	5.58	21.42	22
2015	16.03	8.17	32.03	24.51
2017	9.35	8.41	31.09	24.64
Overall Mean	19.41	11.6	26.7	25.61
Middle Section				
2005	3.8	3.7	4.6	3.5
2006	15.4	2.7	4.3	4.9
2007	25.46	N/A	10.41	N/A
2009	24.3	12.3	7.3	6
2010	N/A	N/A	N/A	N/A
2013	7.15	N/A	14.36	N/A
2015	N/A	N/A	N/A	N/A
2017	8.91	N/A	73.04	N/A
Overall Mean	14.17	6.23	19	4.8
Southern Section				
2005	12.47	11.56	22.27	29.74
2006	15.17	9.6	30.79	35.66
2007	34.66	19.91	22.68	24.6
2009	36.68	17.64	35.39	44.34
2010	16.69	9.9	27.11	39.86
2013	12.02	8.46	22.73	29.98
2015	9.98	8.86	25.13	28.35
2017	14.45	14.72	29.74	25.62
Overall Mean	19.02	12.58	26.98	32.14

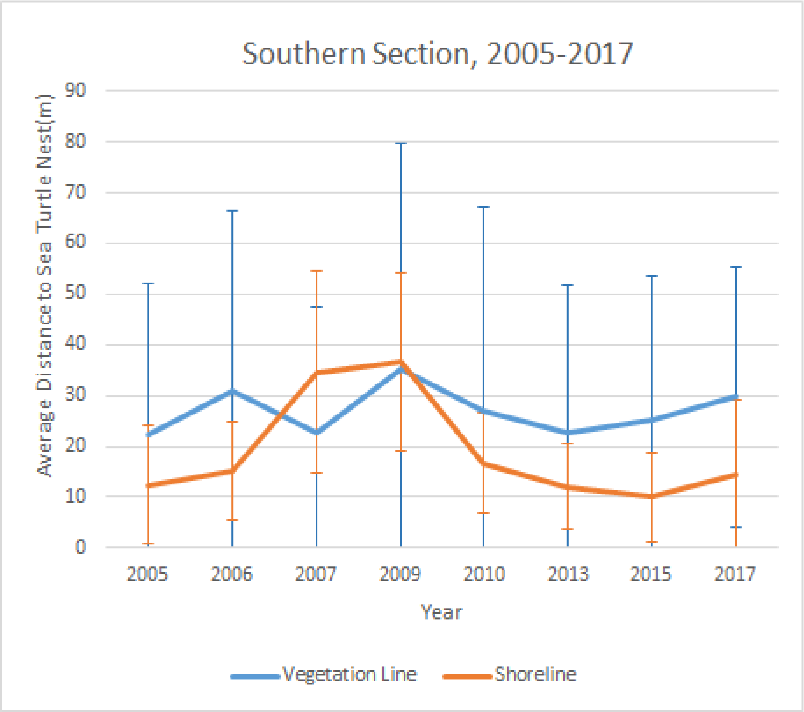
Dry beach width was compared to the vegetation and shorelines for each section.


Northern Section, 2005-2017
Average Distance to Sea Turtle Nest(m)
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2009
2010
2013
2015
2017
Year
Vegetation Line
Shoreline

a)


Middle Section, 2005-2017
Average Distance to Sea Turtle Nest(m)
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2009
2010
2013
2015
2017
Year
Vegetation Line
Shoreline

b)



c)

Figure 4-26. Graphed distances from nests to the vegetation and shoreline. Points without error bars did not have a standard deviation due to only one nest being recorded that year in that section.

A simple linear regression was performed between the near distances and the affiliated EPR, LRR, and era change values. These tables are available in the Appendix, separated by shoreline and vegetation (A-1, A-2). Table 4-20 lists the associated p-value and R^2 values for each pair of analyses. While all of the p-values were significant statistically, each pair covered a different percent of the explored population, presented as the R^2 value. The distance to the shoreline had the most data explained by the Era Change. The distance to the shoreline had the most data explained by the calculated LRR.

Table 4-20: Linear regression results for each pair of data.

	p-value	R^2	St. Dev
EPR			
Distance to the shoreline	<0.01	0.04	19.70
Distance to the vegetation line	<0.01	0.01	30.29
LRR			
Distance to the shoreline	<0.01	0.01	19.45

Distance to the vegetation line	<0.01	0.07	29.84
Era Change			
Distance to the shoreline	<0.01	0.06	19.38
Distance to the vegetation line	<0.01	0.02	24.42

CHAPTER 5:

DISCUSSION

5.1 Study Limitations

The imagery for this study was captured in September, October, November, or December of the different years (Table 3-2). This introduces a potential temporal error since the shorelines and vegetation lines may not be precisely where they were during the sea turtle nesting season.

Also, hurricane and tropical storm activity introduce a source of error due to their potentially large impact on the imagery between nesting events and the recorded vegetation and shorelines (Table 3-1). Only one tropical storm, Tammy on October 5th, 2005, technically occurred after the imagery was recorded for the corresponding year of sea turtle nesting data. Interestingly, based on the metadata provided by the imagery, the imagery was recorded the same day NOAA recognized Tammy in the Bahamas and Florida, where it spent October 5th traveling north along the eastern coast of Florida (NOAA, 2021). Due to a lack of comparable pre and post storm imagery, the amount of variation in the vegetation and shorelines from the time of nesting to the recording of the imagery is unknown.

Sea turtle nest data collection on Middle Beach was not consistent due to difficulties with beach access. Only 15 loggerhead sea turtle nests were recorded on this section over the study period, and the extremely small sample size must be taken into account when comparing it to the Northern and Southern sections of the beach, which had 225 and 848 nests respectively (Figure 4-6). Another potential source of error could be in the collection of nest locations. While it is uncertain what specific handheld GPS units were used over the study period, they were not likely mapping or survey grade.

Manual digitization also produces a degree of error since digitization can vary from operator to the operator (Dolan et al., 1991; Meyer, 2013). Automating digitizing the shoreline and vegetation line would be ideal, allowing for more consistent and replicable analysis.

5.2 Interpretation

St. Catherines Island has historically had varying rates of shoreline erosion, depending on geographic location (Langley, 2003; Jackson, 2010; Meyer, 2013) (Figure 5-1). The results of this study support this idea, as well as noting the even more tumultuous nature of the vegetation line.

The EPR calculations follow the same general trend as the LRR rates across the sections- with the Northern Section having the least erosional mean rate (or the singular accretional rate for EPR), the Southern Section having the middle rate, and the Middle Section having the greatest erosional mean rate in regard to both the vegetation and shoreline (Table 4-8, Table 4-10, Table 4-12).

When the EPR method was employed to calculate the rate of vegetation and shoreline change across the sections, all but the shoreline on the Northern Section had negative mean rates of change. All sections of St. Catherines Island analyzed had negative mean LRRs for both the vegetation and shoreline (Tables 4-9, 4-11, and 4-13). This indicates that from 2005-2017, the shoreline of the Northern Section did experience accretion, but the LRR, which takes all digitized lines into account, caught the year to year variation and produced a negative change rate overall.

Using both methods of change rate calculation, the vegetation line had a greater rate of change across all three sections when compared to the shoreline. Using the LRR method, the vegetation line had a mean change rate of -1.27m/yr on the Northern Section, -9.43m/yr on the Middle Section, and -4.24m/yr on the Southern Section. The respective equivalent shoreline values are -0.95m/yr, -7.56m/yr, and -3.47m/yr. From a biological perspective, it does make sense that vegetation would be unable to accrete in areas that were not consistently above the wet/dry line, limiting it to the extent of the shoreline to a degree. When comparing the oscillations of the transects, the average shoreline transect experienced 2.73 (+/-1.31) oscillations while the average vegetation line transect experienced 3.27 (+/-1.33) oscillations over the study period (Table 4-14). This supports the concept of greater variability in the vegetation line, likely the result of washover fans and sudden storm events, with the vegetation taking a longer time to recover than an equivalently placed shoreline. A study on barrier islands recently noted that the impact of storms on oceanfront vegetation can cause land cover changes that last approximately four years (Velasquez-Montoya et al., 2021).

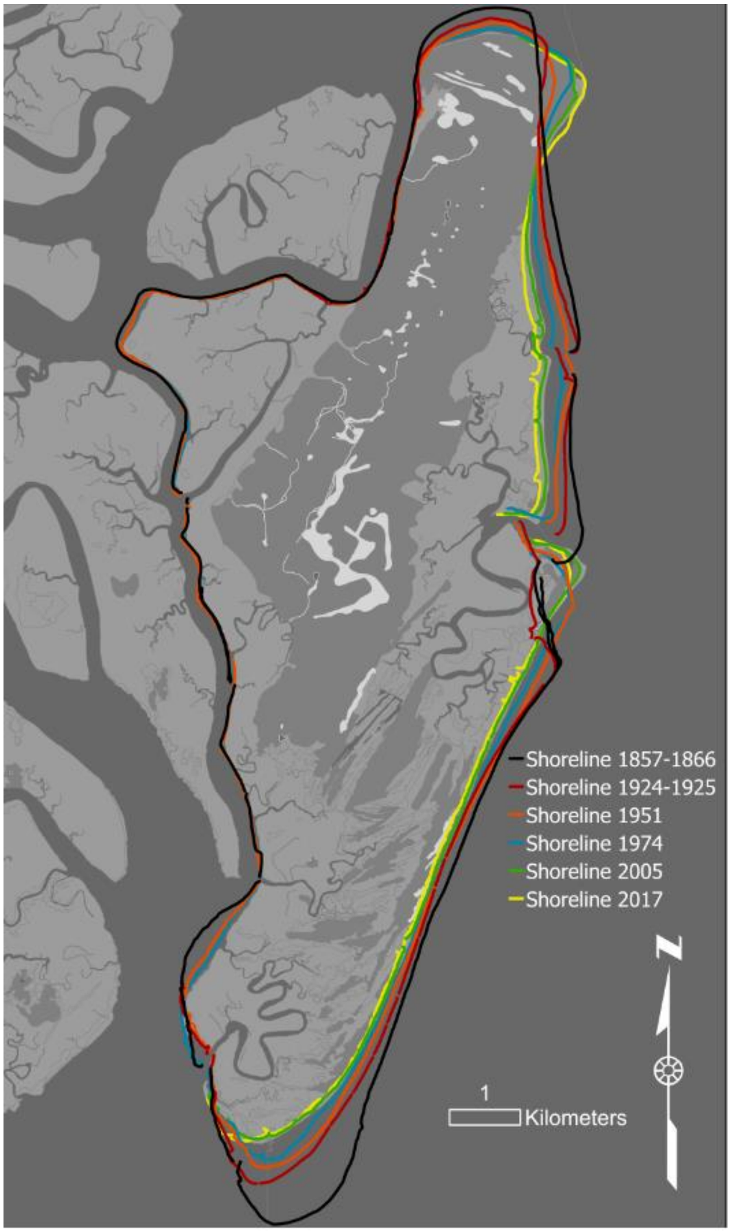


Figure 5-1. Historical shorelines of St. Catherines Island, with the addition of the 2005 and 2017 shorelines from this study.

The Northern Section

The Northern Section had the lowest rate of shoreline and vegetation line erosion (EPR and LRR) when compared to the other sections, even producing an accretional value for the shoreline (EPR). This reflects the historical trend of accretion on St. Catherines' northeastern ocean-facing point (Langely et al., 2003; Jackson, 2010; Meyer et al., 2015) (Figure 5-1).

However, this is not simply the accretion disrupting the average of an erosional beach- even where the Northern Section is eroding, the erosion rates are lower compared to the other sections of the island. This is supported by the presence of accretionary features on this section, like the mature ridge and swale landforms. Northern Section had no transects between the vegetation and the shoreline that experienced the same number of oscillations across the study period, but interestingly does contain two transects with chronic processes. It was originally hypothesized that the Northern Section would have a large number of chronic processes, due to the known accretion on the northeastern portion, but only one transect returned as chronically accreting. This supports the differing results from the mean rates produced by the EPR and LRR calculation methods, as only a single transect exclusively experienced accretion over the study period. Another chronic process was noted on the southernmost transect of the Northern Section, but this one was erosional for the vegetation line.

The Northern Section shoreline EPR and LRR noted the most erosional transect at #336 and #337 respectively. The chronically eroding vegetation line transect is the southernmost transect, bordering Seaside Inlet. This, with the other surrounding transect values AMBUR produced taken into consideration, indicates that the area of beach from Seaside Spit to Seaside Inlet is the most erosional portion of the Northern Section for both the vegetation and shoreline. The shoreline transects north of Seaside Inlet range primarily from one to three oscillations over the study period, indicating these are slightly more consistent on average (2.51 oscillations) than the shoreline average for the island (2.73 oscillations). These transects of high erosion and oscillations occur on Seaside Spit, as the accretionary landforms on the Northern Section end at Yellow Banks Bluff. This erosion may be due to the inlet dynamics surrounding Seaside Inlet, in combination with the northern portion of the section accreting through sediment transport. The

Northern Section’s accretion is all clustered on the northeastern portion for both the vegetation and shoreline. The accretion on the northeastern portion is the greatest recorded accretion on the St. Catherines Island in this study. This accretion has been attributed to the greater sediment dynamics of St. Catherines Sound, including a local sediment supply and wave refraction due to a large ebb tidal delta (Meyer et al., 2015). The oscillations present on this area differ between the vegetation and shoreline (Figure 4-22). The shoreline has a high number of oscillations on the accreting point (max 6), that lessen moving southward (Figure 4-20a). The vegetation line has a high number of oscillations on the accreting point (max 5), but maintains that high number until halfway down the Middle Section. This may be due to shoreline there consistently receiving some sediment from the accreting portion of the Northern Section, whereas the vegetation line has no environmental support.

Middle Section

The Middle Section had the most erosional vegetation and shoreline when compared to the other sections of St. Catherines Island. The Middle Section had no accretion reported for the either line over the study period. This agrees with the erosional trend presented in the work of Jackson (2010), which found that a length of St. Catherines (stretching from the accretion noted on the Northern Section to McQueen Inlet) produced a potential maximum shoreline change rate of -5.79m/yr from 1865-2004. This study, which isolated the Middle Section as the stretch of beach from McQueen Inlet to Seaside Inlet, found a potential maximum shoreline change rate of -8.32m/yr (EPR) and -9.28m/yr (LRR) from 2005-2017. Meyer et al. (2015) also noted the erosion present on the Middle Section, with that part of the island having the greatest erosion rates presented in that study (>8m/yr (EPR)).

However, only one transect was found to be chronically eroding on the shoreline there: #274, north of McQueen Inlet. This is in close proximity to transect #285, which both the EPR and LRR calculations noted as their most erosional rate along a single transect. Transect #286 was deemed the most erosional for both calculation methods for the vegetation line. Transect #299 was the least erosional rate reported for shoreline (EPR and LRR) and for the vegetation line (LRR), whereas transect #317 was the least erosional for the vegetation line for the EPR calculation. For the shoreline, 60% of the transects had 1-2 oscillations. 52% of the vegetation transects had 1-2 oscillations. There is consistent erosion north of McQueen Inlet, in both the vegetation and shoreline.

The first 14 shoreline transects (~650m) south of Seaside Inlet experienced 1 oscillation over the study period. Based on the produced AMBUR rates, the shoreline south of Seaside Inlet is consistently erosional. The vegetation line is not as consistent south of the inlet, with transect #317 (the border transect) experiencing five oscillations. However, #317 was also reported as the least erosional transect the EPR vegetation line calculations, indicating that this high number of oscillations could be linked to Seaside Inlet for the vegetation line, and may be slowing the erosion experienced by other portions of the Middle Section.

North of McQueen Inlet, on the southern end of the Middle Section, the number of oscillations reported is more varied and higher for the shoreline than south of Seaside Inlet. The vegetation line is also higher and more varied comparatively.

Southern Section

The Southern Section reported areas of both accretion and erosion from 2005-2017. The work of Meyer et al. (2015), which calculated the shoreline change rate from 1968-2011 reported no accretion over that time period (EPR or LRR), although this may be due to the divisions of the beach that were averaged, as the importance of location on St. Catherines island cannot be understated. Langely et al. (2003) also only reported erosional rates from 1856-1924, by measuring four transects that pass through the Southern Section. However, transect “St C5”, was cast just south of McQueen Inlet and produced a shoreline change rate of just -0.1m/yr (Langely et al., 2003). It should be noted that neither Langely et al. (2003) or Meyer et al. (2015) went below the ocean facing portion of the southern tip of the island. The variation on the Southern section of the island is also noted in the work of Jackson (2010), which indicated the area south of McQueen Inlet was not chronically eroding, unlike much of the Southern Section. One part of the Southern Section noted as “chronically eroding” from 1855-2004 by Jackson (2010) contains the only transect exhibiting a chronic process on this section: #167 for the vegetation line, north of Flag Pond.

Due to the study area of this research, the southernmost transects of the Southern Section face Sapelo Sound. This allowed for accretion to be recorded here, on transects #11 through #20 for the vegetation line (EPR and LRR) and on transects #11 through #26 (LRR) and #11 through #20 (LRR) for the shoreline. Sapelo Sound may be influencing sediment deposition on the south and southwest of St. Catherines Island. The shoreline and vegetation line produced the same most accretional transect regardless of calculation method, at #11 and #12 respectively. These are the only reported accretional rates until the northern end of the section. Erosion on the southern, ocean facing end of the island has been previously attributed to the large distance from a sediment source (Langely et al., 2003). The vegetation and shoreline near Flag Pond and the Southern Boneyard are consistently eroding, through both rate calculation methods.

At the northern end of the Southern Section, the shoreline was noted as accreting on transects #237 through #247 (EPR) and transects #234 through #243 (LRR). The vegetation line reported accretional rates on transects #243 and #244, using both calculation methods. The vegetation line experienced accretion on fewer transects and at slower rates than the shoreline. The accretional area seen in the transects is south of McQueen Inlet, but does not directly border it, instead occurring ~670m south of the inlet when measured to the northernmost shoreline accretional transect (#247). This may be what Jackson refers to as an ‘inlet bulge’, which is the presence of accretion below an inlet on a shoreline (C.W. Jackson Jr., personal communication, 2021).

Although the Southern Section was the largest geographically, it only had one chronic transect. 76.85% of the shoreline transects experienced 2-4 oscillations over the study period (81.98% of the vegetation transects). Large variation is present in this section, with it also reporting the highest percentage of 6 oscillations (the maximum) over the study period, at 9.01 oscillations for the vegetation line. This is most likely due to the wide variety of geomorphological features present in this section, ranging from inlets and ponds to boneyards and spits.

At the northern end of the Southern Section, there was much variation in oscillations in the shoreline. The same was true for the vegetation line, although the number of oscillations were higher on average. Much like the dynamic in oscillations seen north and south of Seaside Inlet, the transects north of McQueen Inlet are experiencing higher numbers of oscillations when compared to those south of McQueen Inlet. Traveling southward, there were many areas near the Southern Boneyard and Flag Pond that had clusters of transects with the same oscillations between the vegetation and shoreline. This could be due to the narrower beaches present on these sections of the island, meaning that both vegetation and shoreline may be more equally impacted by a sudden storm or washover event.

On the southern tip of St. Catherines Island, the shoreline formed sections of consistent oscillations (Figure 4-20a). The vegetation line mirrors this effect until the area of beach near Flag Pond, when the transects rapidly increase in oscillation number, reporting almost entirely transects with four to six oscillations. That is, until the last four transects, #11 through #14, which are facing Sapelo Sound. These transects only have two oscillations, including the transect (#12) with the most accretion rate reported for the Southern Section's vegetation line.

When trying to compare St. Catherines Islands to the shoreline change being experienced on other Georgia barrier islands (as no other vegetation line movement studies are known to exist for the Georgia coast), the highly erosional nature of the island is highlighted. Ossabaw Island, the island on the northern side of St. Catherines Sound, was reported as accreting at a rate of 3.34 m/yr (+/- 0.30 m/yr) along its northern shore and at 1.09 m/yr (+/- 0.30 m/yr) near the sound on the southern end in 2004 (Jackson, 2010). St. Catherine's oceanfront, in the same study, was reported as having an average rate per era of approximately -2.21 m/yr (+/- 0.06 m/yr) (Jackson, 2010). Wassaw Island, the next island to the north, was reported as having a range of -1.2 to 6.0 m/yr, compared to St. Catherines -1.6m/yr to -10.1 m/yr from 1856-1924 (Langely et al., 2003). The islands north of St. Catherines do not appear to be experiencing erosion at such a high rate, comparatively.

When looking south of St. Catherines Island, across Sapelo Sound, the next islands are Blackbeard and Sapelo. Both islands exhibited accretion when evaluated on a long term scale, from 1855-2004, with Blackbeard producing an oceanfront accretional rate of 1.13 (+/- 0.06 m/yr) and Sapelo producing a rate of 1.34 m/yr (+/- 0.07 m/yr) (Jackson, 2010). Net accretion is a concept unfamiliar to St. Catherines Island, although the variation in erosion and accretion presented on these islands is more akin to what St. Catherines is experiencing when compared to the islands north of it. Jackson (2010) proposed that there was a ‘middle compartment’ of the Georgia Coast, from St. Catherines Island to Wolf Island (south of Sapelo), that experienced increased oceanfront erosion, surrounded by areas of accretion. While this may be true as a broad statement, St. Catherines is a uniquely changing island, and future research into vegetation movments on other barrier islands would make for interesting comparisons to bolster the shoreline variation that has been previously noted on the Georgia coast.

Sea Turtle Nest Comparisons

Fujisaki et al., (2017), which observed shifts in sea turtle nest locations on an eroding Florida barrier island, found that from 2002 to 2004, loggerhead sea turtle nests moved closer to vegetation line at 9 m/yr at their west site and 5.8 m/yr at their east site. The barrier island they evaluated experienced dramatic beach loss, but, much like St. Catherines Island, it was also accreting in certain areas (Fujisaki et al., 2017). The west site had a shoreline change rate of -10.9 (+/- 9.9)m/yr, and their east site experienced -2.8 (+/-4.9) m/yr. In the case of Fujisaki et al., it makes sense that sea turtle nests would have to move closer to the vegetation line as the beach became more narrow. However, in the case of St. Catherines Island, the dry beach width available for nesting is not on a consistent trend of narrowing due to the movement of both the vegetation and shoreline (Figure 4-26).

While dry beach width did vary across the study period and had high standard deviations, each section did trend upwards, with each beach being wider at the end of the twelve years than in the beginning. The Northern Section had the widest beach in almost every year evaluated, with an average of 56.82 (+/-40.46)m of the dry beach. The Middle Section had the narrowest beach every year, with an average of 28.99 (+/-26.4)m. The Southern Section had a mean width of 37.86 (+/-47.4)m. Average width change had an extremely high standard deviation, indicating that the year-to-year changes are varied and are lost when summarized.

The average distance from a loggerhead sea turtle nest to the shoreline on the Northern and Southern sections were similar, at 19.41m (+/-17.43m) and 19.02m (+/-16.83) respectively. Comparing the vegetation line distances had an even narrower margin of 0.09m, with the Northern Section having an average of 27.07m(+/-20.49m) and the Southern Section averaging 26.98 (+/-11.88m). The Middle Section of St. Catherines Island had an average near distance from a sea turtle nest to the shoreline of 14.17 (+/-6.23m) and the distance to the vegetation line was 19 (+/-4.8m). These distances to the vegetation line are far greater than the 6.7 (+/-11.7m) reported on a study of Green sea turtles on Poilao Island, although some variation among species is to be expected (Patricio et al., 2018).

One spike in the data that must be addressed is the increase in nest distances from 2006 to 2007 on the Northern Section. Between these years, the distance between a sea turtle nest and the shoreline jumped from an average of 15.33m to 55.58m. The average distance between a sea turtle nest and the vegetation line also extended from 16.05m to 48.74m. However, instead of a larger dry beach width, similar sizes were reported, with a 74.78m width in 2006 and 80.62m width in 2007. The dry beach width actually increased from 2005 to 2006, with the original width of 24.38m almost tripling in size to the 2006 measurements. This is due to the date of the imagery being taken-September 15th, 2006, after all reported tropical storm activity for that year had occurred. Tropical storm activity can make significant changes to the geomorphology of a beach, through washover events and other sediment shifting processes on St. Catherines Island (Meyer, 2013). The Northern Section recorded in the imagery had been modified by events like Tropical Storm Alberto and Hurricane Ernesto since the sea turtle nests recorded for 2006, most likely explaining why the sea turtle nest distances increased without the dry beach width changing. Imagery reflective of beach conditions sea turtles are faced with during nesting season would be ideal and ensure the accuracy of research into sea turtle nesting patterns.

The linear regression of the distance from a sea turtle nest to the shoreline and the shoreline change LRR, EPR, and Era values all returned significant P values (Table 4-20). The same is true for the vegetation line distances, which all had significant P values in relation to the LRR, EPR, and Era values. The significant p values presented across the data, combined with the low R^2 values (ranging from 0.01 to 0.07) and high standard deviations, suggest that while there is much variability in the data, a relationship exists between the shoreline and vegetaton line movment and the distance to loggerhead sea turtle nests from those lines.

5.3 Conclusion

When comparing the sections of St. Catherines Island, the Northern Section is the least erosional regarding the shoreline and vegetation line over the study period. Although the overall averages for most of the change analyses of the Northern Section indicate erosion over the study period, accretion has been shown to historically occur on the northeastern portion over time (Langely et al., 2013; Jackson, 2010; Meyer et al., 2015) and by the LRR calculations of the shoreline. However, the lack of chronic transects and differences between the rate calculation methods indicate that change on this portion of the island is not consistent year to year. The presence of mature ridge and swale terrain on this portion of the island does reinforce that overtime, the Northern Section is experiencing accretion on the northeastern point. If the northeastern point were to be evaluated separately, it would have a net accretion, but the section includes Yellow Banks Bluff and Seaside Spit, which are highly erosional.

Seaside Inlet, which divided the Northern and Middle Sections, had differing effects on the shoreline of those sections. Transects north of Seaside Inlet experienced three oscillations over the study period. The most erosional shoreline transects over the entire Northern Section, as well as a chronically eroding vegetation transect, occur north of Seaside Inlet. This, along with the rates of the surrounding transects produced by AMBUR, indicate that there is much variation and erosion north of Seaside Inlet. South of the Inlet, the first ~650m of shoreline transects experienced one oscillation. The area directly south of the Seaside Inlet did produce erosional rates and these are consistently erosional based on the number of oscillations recorded. The vegetation line was not as consistent, potentially due to high variation based on the narrowness of the beach.

The Middle Section had the highest mean vegetation and shoreline erosion compared to the other sections, using the EPR and LRR methods. This aligns with the shoreline change analysis of Jackson (2010) and Meyer (2013). The Middle Section vegetation transects had an average of 2.62 oscillations, while the shoreline had an average of 1.78 oscillations, indicating that the vegetation line experienced more changes between erosion and accretion than the shoreline.

North of McQueen Inlet, both the vegetation and shoreline were more highly varied and had higher oscillations than the rest of the Middle Section. The shoreline did produce a chronically eroding transect north of McQueen Inlet as well. As with all of the Middle Section, both the vegetation and shoreline were eroding north of the inlet. South of McQueen Inlet, the shoreline had fewer oscillations compared to north of the inlet, although much variation occurred between individual transects. However, ~670m south of McQueens, there is a cluster of accretional transects for the shoreline (EPR and LRR). The vegetation line also has two accreting transects here. This has been referred to as an ‘inlet bulge’ due to the accretion occurring south of the inlet, but not directly (C.W. Jackson Jr., personal communication, 2021). This aligns with the noted accreting dune field near McQueen Inlet (Meyer, 2013).

The middle portion of the Southern Section was primarily erosional, with both the vegetation and shoreline having the same number of oscillations in many clustered sections near the Southern Boneyard and Flag Pond. This is the section of the beach that begins to cut into maritime forest, which may be influencing the number of oscillations here. The prescnese of established maritime forest could potentially cause the shoreline and vegetation line to behave more similarly, as a storm event required to push back that line would have to be more severe than other beach vegetation, such as sea oats or spike grass. The southern ocean facing portion of the section had the some of the highest oscillations reported on the vegetation line, although the number of oscillations quickly drops when the beach begins to face southwest, where both the vegetation and shoreline reported accretion. Due to the accretion on the southern tip of the island not being widely explored in the literature, the influence of Sapelo Sound on St. Catherines Island is not known. This accretion could also be due to sediment dynamics occurring northward on the island.

The distance between a loggerhead sea turtle nest and the vegetation and shoreline is likely dependent on the available nesting habitat. In a habitat with a narrowing beach, the need to move closer to the vegetation line to find dry ground may be the only viable nesting option- or it could motivate a sea turtle to perform a false crawl and ultimately not nest. This would need to be tested on a narrowing beach, which is not what St. Catherines Island is experiencing over time, despite the changes undergoing the vegetation and shoreline. St. Catherines Island has a higher occurrence of false crawls than nests, with 61.63% of all nesting activity being false crawls, although, without a statistical standard for the species, it is difficult to quantitate.

The distances between sea turtle nests and the vegetation and shoreline varied between the years but had strikingly similar averages between the Northern and Southern Sections of the beach. The Northern Section and Southern Section had less than a tenth of a meter difference (0.09m) between the average distance to the vegetation line. The shoreline had only a 0.39m gap between the average distances on the Northern and Southern Sections.

The consistency presented in the Southern Section sea turtle distances stands in contrast to the differences seen in the vegetation and shoreline along the Southern Section of the beach. The largest increases in the near distances are seen on the Southern Section, with the average distance to the shoreline showing a 120.62% increase from 2006-2007. Hurricane Ernesto hit towards the end of the nesting season in late August of 2006. Subtropical storm Andrea and Tropical storm Debby impacted St. Catherines Island mid-season in 2007 (Table 3-1). However, the vegetation line does not reflect a significant change in the same time period. The near distances could be found to follow no overall specific trend over time or trend in association with dry beach width, although this may be due to the dating of imagery, as noted in regard to 2005-2006 previously.

Since the available dry beaches of St. Catherines Island are not narrowing, sea turtles still have a range of available nesting areas, in spite of the overall erosion being experienced by the vegetation and shoreline across the beach. The vegetation line averaged a higher distance to sea turtle nests than the shoreline, between 7.66m-7.9m more on the Northern and Southern Sections. While the understanding of a loggerhead sea turtle's nest site decision-making is not yet fully understood, the distance to the vegetation line could serve as an indicator as to the health of the nesting habitat, if a normal range could be established.

The linear regressions that were conducted to gauge the relationship between shoreline and vegetation line change and the distance from a nest to the vegetation or shoreline both produced significant results. This indicates that the movement of the vegetation line is impacting the distance to the vegetation line, and likewise in regard to the shoreline. This also confirms that the placement of sea turtle nests is not random in regard to the vegetation and shoreline. However, the results from the linear regression, while significant, explain very little of the data. Much like the large standard deviations reported for many of the analyses, there is an extremely high amount of variation presented in the original dataset.

St. Catherines Island is a complex environment of inlet dynamics and sediment transportation, which leads to very location specific patterns of accretion and erosion. As a USFWS critical nesting habitat, monitoring how loggerhead sea turtles adapt to the changing beach is essential to future conservation efforts (USFWS, 2014). Future research into this hypothesis would require other known variables that influence sea turtle nest site selection, such as slope, temperature, and sediment composition, to be considered (Poloczanska et al., 2009;Wood and Bjorndal, 2000). The emphasis on the vegetation line in this study has not been previously performed and compared on the Georgia coast, which is valuable information, due to the use of the vegetation line as a shoreline proxy legally in South Carolina (South Carolina DHEC, 2019). Vegetation surveys would be advantageous in future research, as understanding the type of vegetation present on each section could provide insight into why certain areas of the island are changing differently. Future studies that approach the change on St. Catherines should also incorporate a more long term analysis that considers the potential impact of sea level rise.

The impacts of sea level rise have been shown to be exacerbated on sandy beaches and serves as a large source of potential uncertainty for future shoreline projections (Le Cozannet et al., 2019). Understanding how St. Catherines island is eroding and accreting is also important to coastal management, as a barrier island in Georgia, but also simply as a highly dynamic barrier island.

The purposes of this study were to evaluate the locations of loggerhead sea turtle nests and measure the changes seen in the vegetation and shoreline on St. Catherines Island from 2005-2017. The locations were evaluated by measuring the distance from a sea turtle nest to the shoreline and vegetation line. The vegetation line and shoreline were analyzed in detail, through calculated change rates, chronic processes, The research questions addressed were 1) how does the vegetation line change when compared to the shoreline? 2) is there a relationship between shoreline change rates and sea turtle nest locations? and 3) is there a relationship between vegetation line change and sea turtle nest locations? After comparing the vegetaion line and shoreline movements through multiple methods, the vegetation line was found to be eroding at a faster rate than the shoreline across every section of the island. Based on the results of the linear regression, there is a relationship between shoreline change and the distance to a loggerhead sea turtle nest, as the p values indicate significance. The same is also true of the vegetation line, with each measure of change indicating significant results in relation to sea turtle nest distances to the vegetation. Further research is needed to understand how specifically sea turtles are making their nesting decisions, but this research does conclude that sea turtles are somehow factoring in the location of the vegetation and shoreline when choosing where to place their nests.

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APPENDIX A

Table A-1: Shoreline data for all nests evaluated over the study period, with the closest transect noted, shoreline EPR, shoreline LRR, nest distance to the shoreline, and the associated change from the era the imagery was taken.

NestID	Year	Transect	EPR	LRR	Nest Distanc	Era
2	2006	259	-15.74	-14.13	20.58	41.78
3	2006	244	0.77	0.67	33.76	49.41
4	2006	211	-8.81	-5.73	19.75	20.21
5	2006	190	-3.44	-2.95	20.15	-9.26
6	2006	244	0.77	0.67	24.42	49.41
7	2006	257	-16.96	-15.18	8.92	-6.07
8	2006	374	0.92	0.93	10.92	1.63
9	2006	144	-4.00	-3.76	4.25	-8.54
10	2006	253	-8.48	-5.39	30.99	44.20
11	2006	205	2.72	1.22	28.28	27.87
12	2006	376	2.02	1.16	12.03	11.83
13	2006	365	-1.26	-0.95	2.82	-12.79
14	2006	203	-2.98	1.01	40.93	37.41
15	2006	177	-4.53	-4.20	7.88	-28.15
17	2006	379	2.71	1.77	17.46	3.34
18	2006	148	-4.73	-4.16	5.55	-19.55
19	2006	250	-0.69	0.71	23.92	39.73
20	2006	240	-1.61	0.57	0.04	18.56
21	2006	147	-4.30	-3.70	2.53	-17.39
22	2006	143	-4.60	-4.04	4.34	-5.24
23	2006	382	6.68	5.05	14.08	11.24
24	2006	375	1.14	0.80	16.36	6.01
26	2006	68	-7.72	-3.32	25.83	21.92
27	2006	165	-6.66	-7.29	33.08	-17.69
28	2006	78	-3.64	-3.00	19.32	33.12
29	2006	242	-0.09	1.99	8.42	31.32
30	2006	250	-0.69	0.71	18.07	39.73
31	2006	376	2.02	1.16	18.24	11.83
32	2006	102	-3.97	-3.37	3.68	-17.48
33	2006	168	-8.37	-8.46	0.24	-54.55
34	2006	197	-2.33	-2.51	11.72	-7.26
35	2006	232	-1.23	-0.56	8.86	-4.31
36	2006	71	-9.64	-7.12	13.40	-1.59
37	2006	216	-13.52	-8.35	7.11	16.99
38	2006	256	-13.46	-13.77	13.09	35.11
39	2006	246	-1.18	0.08	28.51	32.98
40	2006	366	-1.40	-1.00	4.38	-9.66
41	2006	270	-3.30	-3.95	13.52	33.88
42	2006	376	2.02	1.16	20.36	11.83
43	2006	221	-7.56	-4.51	10.96	15.23

44	2006	255	-12.95	-13.19	25.67	30.15
45	2006	379	2.71	1.77	16.03	3.34
46	2006	244	0.77	0.67	26.80	49.41
47	2006	218	-12.44	-7.22	13.36	3.79
48	2006	142	-5.39	-4.53	7.41	-19.25
50	2006	192	-6.12	-4.73	27.36	15.89
51	2006	244	0.77	0.67	28.57	49.41
52	2006	368	-1.00	-0.71	5.83	-12.32
53	2006	248	-0.05	2.11	20.40	36.20
54	2006	234	-2.20	-1.25	0.26	-3.04
55	2006	190	-3.44	-2.95	15.70	-9.26
56	2006	208	-8.52	-5.19	19.34	21.59
57	2006	177	-4.53	-4.20	9.96	-28.15
58	2006	377	2.84	1.65	31.42	10.49
59	2006	188	-2.95	-2.82	18.52	-4.24
60	2006	70	-5.03	-3.89	14.25	33.35
61	2006	338	-15.39	-10.90	1.14	10.35
62	2006	223	-4.45	-1.86	18.72	17.61
63	2006	236	-7.35	-3.82	14.08	-11.78
64	2006	244	0.77	0.67	17.37	49.41
65	2006	256	-13.46	-13.77	11.87	35.11
66	2006	344	-11.40	-14.18	79.27	17.94
67	2006	406	-1.20	3.13	14.56	25.92
68	2006	344	-11.40	-14.18	5.69	17.94
70	2006	70	-5.03	-3.89	15.09	33.35
71	2006	151	-4.15	-3.78	1.90	-16.92
72	2006	165	-6.66	-7.29	9.65	-17.69
73	2006	236	-7.35	-3.82	11.96	-11.78
74	2006	165	-6.66	-7.29	1.82	-17.69
75	2006	191	-2.88	-2.73	10.15	0.44
76	2006	374	0.92	0.93	14.03	1.63
77	2006	203	-2.98	1.01	37.66	37.41
78	2006	296	-9.98	-13.48	15.61	16.38
79	2006	296	-9.98	-13.48	17.46	16.38
80	2006	288	-14.50	-13.61	11.91	11.82
81	2006	286	-21.35	-23.58	18.45	2.59
82	2006	235	-5.52	-1.89	3.71	-9.87
83	2006	247	-0.33	0.46	24.09	38.30
85	2006	87	-4.09	-3.12	11.08	-5.87
86	2006	164	-6.48	-6.34	14.11	-17.43
87	2006	145	-3.66	-4.02	5.67	-13.15
88	2006	240	-1.61	0.57	11.15	18.56
89	2006	236	-7.35	-3.82	6.51	-11.78
91	2006	186	-1.54	-1.82	16.24	3.64
92	2006	244	0.77	0.67	30.78	49.41

93	2006	232	-1.23	-0.56	6.68	-4.31
95	2006	194	-7.14	-4.89	11.87	-2.08
96	2006	188	-2.95	-2.82	22.46	-4.24
97	2006	222	-3.93	-2.49	6.46	20.41
99	2006	256	-13.46	-13.77	19.04	35.11
100	2006	162	-4.33	-4.43	14.48	-23.34
101	2006	163	-6.33	-6.06	19.21	-6.82
102	2006	254	-12.54	-8.50	19.14	51.55
103	2006	246	-1.18	0.08	21.39	32.98
104	2006	420	-1.94	-1.69	5.98	3.10
105	2006	187	-2.31	-2.63	13.61	-8.89
106	2006	214	-3.71	-1.14	27.90	15.38
107	2006	145	-3.66	-4.02	3.94	-13.15
108	2006	356	-3.79	-3.29	0.61	-21.92
109	2006	71	-9.64	-7.12	10.76	-1.59
110	2006	191	-2.88	-2.73	25.28	0.44
111	2006	240	-1.61	0.57	5.56	18.56
112	2006	169	-9.43	-9.61	0.37	-28.47
114	2006	185	-4.01	-3.59	14.60	2.64
116	2006	194	-7.14	-4.89	1.51	-2.08
117	2006	183	-3.62	-3.82	9.69	-11.07
119	2006	254	-12.54	-8.50	25.50	51.55
2	2007	171	-9.08	-9.75	19.66	3.49
3	2007	204	5.55	2.83	26.18	0.00
4	2007	133	-13.48	-12.06	28.63	4.10
5	2007	259	-15.74	-14.13	58.97	-39.71
6	2007	191	-2.88	-2.73	22.96	-4.88
7	2007	177	-4.53	-4.20	11.65	1.69
8	2007	73	-8.76	-7.24	40.03	0.28
9	2007	208	-8.52	-5.19	18.98	-0.50
10	2007	392	0.15	9.35	66.40	38.48
11	2007	208	-8.52	-5.19	21.30	-0.50
12	2007	139	-7.23	-5.85	20.84	-9.64
13	2007	15	5.89	4.51	28.48	-18.18
14	2007	250	-0.69	0.71	30.31	-13.55
15	2007	374	0.92	0.93	54.06	19.76
16	2007	71	-9.64	-7.12	40.53	2.23
17	2007	215	-9.32	-4.78	118.66	0.00
18	2007	73	-8.76	-7.24	47.18	0.28
19	2007	391	5.55	12.30	78.00	33.96
20	2007	253	-8.48	-5.39	36.95	-14.25
21	2007	70	-5.03	-3.89	35.14	4.91
22	2007	16	0.20	0.47	43.05	-1.26
23	2007	384	7.09	6.51	48.43	18.67
24	2007	95	-4.19	-3.52	14.34	0.18

	25	2007	256	-13.46	-13.77	54.80	-2.82
	26	2007	163	-6.33	-6.06	36.28	-4.43
	27	2007	202	-6.13	-1.42	13.67	-2.15
	28	2007	244	0.77	0.67	49.68	26.88
	29	2007	402	5.71	9.20	55.35	2.99
	30	2007	201	-0.76	5.66	25.85	-4.39
	31	2007	140	-6.36	-6.07	16.07	-1.89
	32	2007	234	-2.20	-1.25	30.41	6.61
	33	2007	70	-5.03	-3.89	39.63	4.91
	34	2007	308	-11.49	-8.15	25.46	-6.48
	35	2007	259	-15.74	-14.13	65.15	-39.71
	36	2007	250	-0.69	0.71	33.63	-13.55
	37	2007	338	-15.39	-10.90	39.19	12.41
	38	2007	247	-0.33	0.46	47.24	3.79
	39	2007	385	9.18	8.93	40.96	15.08
	40	2007	130	-8.88	-8.46	30.04	-6.46
	41	2007	396	2.83	8.70	49.77	33.72
	42	2007	409	-3.67	-4.27	19.36	6.91
	43	2007	72	-9.35	-9.31	30.63	-3.10
	44	2007	261	-7.83	-7.42	60.24	3.05
	45	2007	44	-5.38	-1.19	1.45	-3.00
	46	2007	194	-7.14	-4.89	17.78	-1.92
	47	2007	150	-5.05	-4.81	23.62	6.62
	48	2007	244	0.77	0.67	48.14	26.88
	49	2007	392	0.15	9.35	104.31	38.48
	50	2007	132	-7.47	-8.38	31.85	-0.74
	51	2007	254	-12.54	-8.50	31.72	-12.44
1		2009	254	-12.54	-8.50	33.75	-6.49
10		2009	304	-14.50	-10.66	18.94	-4.31
100		2009	182	-4.18	-3.56	40.94	6.89
101		2009	254	-12.54	-8.50	30.17	-6.49
11		2009	233	-1.08	-0.46	64.22	21.57
12		2009	189	-3.33	-3.45	55.27	12.97
13		2009	244	0.77	0.67	52.94	-7.49
14		2009	310	-19.85	-18.82	5.49	-4.48
17		2009	246	-1.18	0.08	50.74	-4.76
18		2009	132	-7.47	-8.38	38.62	-4.33
19		2009	237	-1.67	-0.91	81.73	32.78
2		2009	236	-7.35	-3.82	71.46	28.01
20		2009	215	-9.32	-4.78	35.81	1.73
21		2009	334	-10.81	-8.81	11.11	-15.67
22		2009	299	-2.89	-1.55	34.54	-3.80
23		2009	299	-2.89	-1.55	34.54	-3.80
24		2009	190	-3.44	-2.95	46.22	5.78
25		2009	400	10.13	10.95	19.11	8.37

26	2009	208	-8.52	-5.19	32.17	2.38
27	2009	334	-10.81	-8.81	16.52	-15.67
28	2009	210	-8.13	-5.11	31.79	6.37
29	2009	350	-5.46	-4.43	25.66	-15.60
3	2009	216	-13.52	-8.35	24.24	-1.16
30	2009	177	-4.53	-4.20	44.14	3.68
31	2009	194	-7.14	-4.89	23.65	4.41
32	2009	254	-12.54	-8.50	25.41	-6.49
33	2009	351	-5.45	-6.37	26.50	-15.15
34	2009	74	-2.15	-2.76	28.96	-6.40
35	2009	184	-3.32	-2.74	40.64	8.87
36	2009	187	-2.31	-2.63	61.35	18.91
37	2009	127	-8.23	-7.24	38.93	3.96
38	2009	226	-2.45	-1.70	26.85	-0.97
39	2009	229	-4.14	-2.31	41.52	6.81
4	2009	386	9.95	9.59	50.64	12.93
40	2009	149	-4.43	-4.28	45.73	7.83
41	2009	30	-6.35	-7.06	1.40	-10.90
42	2009	254	-12.54	-8.50	38.47	-6.49
43	2009	256	-13.46	-13.77	27.32	-17.07
44	2009	234	-2.20	-1.25	65.41	20.27
45	2009	391	5.55	12.30	68.68	5.53
46	2009	212	-7.90	-5.28	23.36	1.20
47	2009	149	-4.43	-4.28	45.73	7.83
48	2009	256	-13.46	-13.77	23.97	-17.07
49	2009	244	0.77	0.67	36.92	-7.49
5	2009	244	0.77	0.67	44.94	-7.49
50	2009	204	5.55	2.83	62.29	15.25
51	2009	245	-1.97	-1.17	42.41	2.34
52	2009	247	-0.33	0.46	17.87	-10.90
53	2009	215	-9.32	-4.78	30.34	1.73
54	2009	409	-3.67	-4.27	5.97	-15.97
55	2009	244	0.77	0.67	36.93	-7.49
56	2009	263	-3.67	-2.34	8.57	-18.97
57	2009	336	-12.66	-12.09	16.88	-19.40
58	2009	400	10.13	10.95	31.47	8.37
59	2009	223	-4.45	-1.86	22.67	-0.31
6	2009	339	-13.29	-15.17	29.48	-12.89
60	2009	379	2.71	1.77	9.53	8.67
61	2009	177	-4.53	-4.20	32.32	3.68
62	2009	194	-7.14	-4.89	14.64	4.41
63	2009	224	-7.16	-3.35	24.47	-3.37
64	2009	348	-6.63	-3.66	22.01	-4.08
65	2009	231	-3.24	-1.76	55.92	16.74
66	2009	350	-5.46	-4.43	23.39	-15.60

67	2009	263	-3.67	-2.34	18.62	-18.97
68	2009	246	-1.18	0.08	12.71	-4.76
69	2009	203	-2.98	1.01	44.66	15.23
7	2009	193	-5.04	-3.31	39.98	5.35
71	2009	339	-13.29	-15.17	35.67	-12.89
72	2009	204	5.55	2.83	60.03	15.25
73	2009	203	-2.98	1.01	43.67	15.23
74	2009	217	-8.41	-4.17	28.30	3.16
75	2009	53	-7.23	-8.38	21.61	-5.30
76	2009	340	-18.45	-22.69	8.03	-18.52
77	2009	206	-3.10	-1.97	42.11	12.73
78	2009	16	0.20	0.47	3.22	5.18
79	2009	350	-5.46	-4.43	20.34	-15.60
8	2009	256	-13.46	-13.77	33.31	-17.07
80	2009	238	-3.86	-2.70	80.27	32.21
81	2009	416	-3.13	-2.86	12.47	-11.38
82	2009	368	-1.00	-0.71	22.94	-2.01
83	2009	112	-3.93	-3.70	35.33	3.69
84	2009	351	-5.45	-6.37	22.01	-15.15
85	2009	251	-3.17	4.41	18.76	-12.03
86	2009	339	-13.29	-15.17	14.62	-12.89
87	2009	249	-0.35	1.42	30.75	-8.69
88	2009	248	-0.05	2.11	12.82	-1.73
89	2009	414	-4.83	-4.52	20.17	-14.12
9	2009	262	-10.06	-10.71	16.87	-22.26
91	2009	178	-3.48	-3.30	48.43	9.74
92	2009	346	-7.56	-7.28	32.65	-7.26
93	2009	380	5.68	4.13	34.32	9.74
94	2009	218	-12.44	-7.22	15.81	-3.43
95	2009	296	-9.98	-13.48	27.98	-1.81
96	2009	250	-0.69	0.71	22.57	-10.43
98	2009	201	-0.76	5.66	31.92	8.85
99	2009	238	-3.86	-2.70	79.79	32.21
1	2010	250	-0.69	0.71	22.31	0.24
10	2010	256	-13.46	-13.77	41.34	-5.95
100	2010	109	-3.54	-3.26	11.55	-19.29
101	2010	162	-4.33	-4.43	24.96	-13.58
102	2010	63	-10.29	-7.26	6.28	-15.00
103	2010	146	-2.55	-2.74	12.36	-25.67
105	2010	405	4.73	9.29	7.80	50.68
106	2010	230	-2.77	-0.90	6.26	-29.91
107	2010	182	-4.18	-3.56	9.67	-29.78
109	2010	124	-3.68	-3.27	7.94	-20.07
11	2010	177	-4.53	-4.20	8.82	-33.14
110	2010	204	5.55	2.83	4.74	-43.38

111	2010	253	-8.48	-5.39	28.57	-19.95
112	2010	25	-4.93	-3.89	1.56	-8.87
113	2010	225	-4.96	-2.45	14.49	-26.13
114	2010	262	-10.06	-10.71	5.59	-34.73
115	2010	222	-3.93	-2.49	5.80	-46.44
116	2010	33	-7.53	-7.37	5.30	-7.05
117	2010	154	-4.63	-4.55	21.19	-21.57
118	2010	209	-6.79	-4.63	10.35	-25.82
119	2010	356	-3.79	-3.29	9.06	-3.39
12	2010	210	-8.13	-5.11	11.98	-26.78
120	2010	409	-3.67	-4.27	7.19	-24.30
121	2010	246	-1.18	0.08	24.21	-1.54
122	2010	379	2.71	1.77	23.99	-11.87
123	2010	345	-9.79	-10.45	12.03	-22.31
124	2010	20	-4.80	-2.93	4.77	-9.97
125	2010	254	-12.54	-8.50	30.17	-24.18
126	2010	248	-0.05	2.11	26.93	-4.40
127	2010	174	-7.00	-5.69	7.87	-37.27
129	2010	250	-0.69	0.71	18.52	0.24
13	2010	263	-3.67	-2.34	3.93	-33.10
130	2010	199	-8.49	0.05	16.79	-35.45
131	2010	187	-2.31	-2.63	9.04	-47.63
132	2010	156	-4.84	-4.76	16.12	-21.75
133	2010	241	-1.15	1.57	7.13	-5.07
134	2010	146	-2.55	-2.74	4.35	-25.67
135	2010	16	0.20	0.47	8.67	-22.04
136	2010	103	-4.60	-3.43	16.89	-16.21
137	2010	168	-8.37	-8.46	14.32	-40.99
138	2010	191	-2.88	-2.73	6.46	-26.35
139	2010	124	-3.68	-3.27	21.75	-20.07
14	2010	115	-3.44	-3.15	15.51	-26.03
140	2010	172	-7.77	-8.28	23.69	-56.35
141	2010	413	-5.65	-5.90	5.80	-15.82
142	2010	147	-4.30	-3.70	25.08	-13.53
143	2010	152	-4.43	-4.10	18.89	-24.16
144	2010	152	-4.43	-4.10	18.89	-24.16
145	2010	330	-9.02	-5.99	14.39	-1.73
146	2010	265	-8.01	-4.41	1.00	-31.70
147	2010	154	-4.63	-4.55	20.51	-21.57
148	2010	163	-6.33	-6.06	15.04	-17.33
149	2010	338	-15.39	-10.90	24.45	-8.02
15	2010	186	-1.54	-1.82	4.31	-44.59
150	2010	155	-4.37	-4.49	21.21	-20.59
151	2010	215	-9.32	-4.78	21.85	-13.01
152	2010	70	-5.03	-3.89	7.89	-23.01

16	2010	20	-4.80	-2.93	7.72	-9.97
17	2010	265	-8.01	-4.41	6.02	-31.70
18	2010	185	-4.01	-3.59	21.93	-31.55
19	2010	387	10.86	13.05	20.27	10.42
2	2010	202	-6.13	-1.42	8.11	-44.84
20	2010	15	5.89	4.51	27.32	-13.41
21	2010	250	-0.69	0.71	18.52	0.24
22	2010	203	-2.98	1.01	2.08	-42.28
23	2010	217	-8.41	-4.17	0.83	-15.77
24	2010	256	-13.46	-13.77	41.34	-5.95
25	2010	254	-12.54	-8.50	37.32	-24.18
26	2010	247	-0.33	0.46	31.61	0.42
27	2010	108	-3.20	-3.08	13.53	-19.65
28	2010	154	-4.63	-4.55	16.15	-21.57
29	2010	380	5.68	4.13	29.75	-14.48
3	2010	139	-7.23	-5.85	18.56	-16.75
30	2010	154	-4.63	-4.55	16.15	-21.57
31	2010	157	-4.88	-4.80	21.44	-11.05
32	2010	231	-3.24	-1.76	19.39	-35.23
33	2010	255	-12.95	-13.19	40.72	-23.03
34	2010	112	-3.93	-3.70	26.28	-21.28
35	2010	170	-8.75	-9.81	16.83	-38.22
36	2010	244	0.77	0.67	38.94	14.00
37	2010	381	6.33	4.87	3.39	-14.17
38	2010	164	-6.48	-6.34	19.20	-26.00
39	2010	172	-7.77	-8.28	6.66	-56.35
4	2010	244	0.77	0.67	28.60	14.00
40	2010	250	-0.69	0.71	25.93	0.24
41	2010	398	4.74	8.47	6.80	-10.67
42	2010	150	-5.05	-4.81	9.19	-28.33
43	2010	225	-4.96	-2.45	9.85	-26.13
44	2010	244	0.77	0.67	21.38	14.00
45	2010	232	-1.23	-0.56	12.36	-39.09
46	2010	185	-4.01	-3.59	9.61	-31.55
47	2010	61	-8.86	-10.84	9.37	-13.43
48	2010	151	-4.15	-3.78	18.95	-19.50
49	2010	210	-8.13	-5.11	8.52	-26.78
5	2010	255	-12.95	-13.19	32.29	-23.03
50	2010	374	0.92	0.93	27.89	-11.07
51	2010	222	-3.93	-2.49	5.80	-46.44
52	2010	186	-1.54	-1.82	17.23	-44.59
53	2010	250	-0.69	0.71	30.87	0.24
54	2010	131	-9.34	-8.54	42.66	-22.96
55	2010	207	-6.42	-3.73	18.02	-55.55
56	2010	388	11.42	14.07	21.41	20.02

57	2010	85	-3.29	-3.09	13.79	-8.00
58	2010	261	-7.83	-7.42	13.70	-17.54
59	2010	163	-6.33	-6.06	23.64	-17.33
6	2010	207	-6.42	-3.73	5.13	-55.55
60	2010	253	-8.48	-5.39	24.12	-19.95
61	2010	215	-9.32	-4.78	20.45	-13.01
62	2010	186	-1.54	-1.82	9.03	-44.59
63	2010	379	2.71	1.77	20.49	-11.87
64	2010	382	6.68	5.05	13.66	-10.74
65	2010	254	-12.54	-8.50	25.06	-24.18
66	2010	198	-12.07	-7.71	8.17	-37.48
67	2010	250	-0.69	0.71	25.74	0.24
68	2010	247	-0.33	0.46	23.87	0.42
69	2010	171	-9.08	-9.75	10.20	-54.97
7	2010	349	-12.10	-9.03	17.73	-11.28
70	2010	350	-5.46	-4.43	16.04	-12.23
71	2010	197	-2.33	-2.51	11.57	-20.83
72	2010	255	-12.95	-13.19	23.85	-23.03
73	2010	255	-12.95	-13.19	23.85	-23.03
74	2010	181	-4.23	-3.87	3.97	-34.34
75	2010	232	-1.23	-0.56	2.26	-39.09
76	2010	174	-7.00	-5.69	7.56	-37.27
77	2010	157	-4.88	-4.80	27.21	-11.05
78	2010	53	-7.23	-8.38	6.10	-15.88
79	2010	175	-5.34	-5.10	17.31	-34.63
8	2010	147	-4.30	-3.70	22.55	-13.53
80	2010	15	5.89	4.51	16.70	-13.41
81	2010	14	8.33	6.23	22.81	6.13
82	2010	198	-12.07	-7.71	20.89	-37.48
83	2010	91	-2.71	-2.46	20.94	-13.39
84	2010	13	10.38	7.57	25.06	3.78
85	2010	197	-2.33	-2.51	11.57	-20.83
86	2010	246	-1.18	0.08	44.23	-1.54
87	2010	255	-12.95	-13.19	32.29	-23.03
88	2010	246	-1.18	0.08	21.11	-1.54
89	2010	372	0.09	0.32	13.17	-13.13
9	2010	250	-0.69	0.71	22.31	0.24
90	2010	158	-4.93	-4.49	14.38	-13.27
91	2010	265	-8.01	-4.41	6.02	-31.70
92	2010	182	-4.18	-3.56	6.88	-29.78
93	2010	152	-4.43	-4.10	17.21	-24.16
94	2010	179	-3.48	-2.78	2.70	-40.09
95	2010	214	-3.71	-1.14	12.73	-4.24
96	2010	236	-7.35	-3.82	18.80	-36.89
97	2010	249	-0.35	1.42	30.36	-0.42

98	2010	232	-1.23	-0.56	12.36	-39.09
99	2010	109	-3.54	-3.26	11.55	-19.29
1	2013	251	-3.17	4.41	71.64	-13.75
10	2013	194	-7.14	-4.89	0.38	-3.94
100	2013	198	-12.07	-7.71	2.02	-1.82
101	2013	178	-3.48	-3.30	7.81	-5.79
102	2013	265	-8.01	-4.41	11.88	-2.80
103	2013	176	-4.86	-4.61	1.24	-7.19
105	2013	198	-12.07	-7.71	2.82	-1.82
106	2013	221	-7.56	-4.51	16.89	-2.94
107	2013	98	-3.56	-3.20	3.46	-3.39
108	2013	247	-0.33	0.46	70.91	-8.13
109	2013	402	5.71	9.20	1.46	-11.75
11	2013	409	-3.67	-4.27	3.71	-11.88
110	2013	91	-2.71	-2.46	8.21	-4.09
111	2013	238	-3.86	-2.70	61.18	0.97
112	2013	152	-4.43	-4.10	0.47	-8.30
113	2013	105	-3.45	-3.00	2.67	-3.77
114	2013	162	-4.33	-4.43	6.26	-9.80
115	2013	216	-13.52	-8.35	1.48	-3.93
116	2013	232	-1.23	-0.56	3.31	1.88
117	2013	375	1.14	0.80	2.95	1.91
119	2013	242	-0.09	1.99	106.10	-0.58
12	2013	367	-1.06	-0.68	14.87	1.02
120	2013	238	-3.86	-2.70	60.39	0.97
121	2013	217	-8.41	-4.17	8.87	-3.10
122	2013	247	-0.33	0.46	66.27	-8.13
123	2013	65	-7.93	-3.08	7.53	-3.41
124	2013	247	-0.33	0.46	75.16	-8.13
125	2013	217	-8.41	-4.17	14.20	-3.10
126	2013	205	2.72	1.22	1.80	-3.15
127	2013	337	-15.66	-16.00	5.27	-12.40
128	2013	262	-10.06	-10.71	11.22	-14.87
129	2013	265	-8.01	-4.41	7.17	-2.80
13	2013	370	-0.69	-0.38	6.68	3.02
130	2013	147	-4.30	-3.70	8.29	-8.19
131	2013	265	-8.01	-4.41	9.94	-2.80
132	2013	184	-3.32	-2.74	3.86	-6.82
133	2013	158	-4.93	-4.49	4.54	-8.38
134	2013	215	-9.32	-4.78	1.11	-2.83
135	2013	257	-16.96	-15.18	71.20	-31.62
136	2013	247	-0.33	0.46	69.49	-8.13
137	2013	244	0.77	0.67	71.43	-8.55
138	2013	214	-3.71	-1.14	1.13	-3.00
139	2013	159	-5.63	-5.34	7.85	-9.15

14	2013	214	-3.71	-1.14	4.71	-3.00
140	2013	202	-6.13	-1.42	9.34	-1.60
141	2013	417	-3.22	-2.73	6.36	-2.23
142	2013	162	-4.33	-4.43	10.97	-9.80
143	2013	194	-7.14	-4.89	2.78	-3.94
144	2013	13	10.38	7.57	46.72	1.61
145	2013	402	5.71	9.20	22.13	-11.75
146	2013	366	-1.40	-1.00	8.37	-0.65
147	2013	231	-3.24	-1.76	9.21	1.75
148	2013	121	-4.34	-4.21	7.48	-4.87
149	2013	403	5.91	8.69	5.00	-8.54
15	2013	240	-1.61	0.57	51.20	1.19
150	2013	387	10.86	13.05	8.10	19.22
151	2013	71	-9.64	-7.12	3.46	-1.27
152	2013	195	-2.72	-2.44	4.33	-3.88
153	2013	364	-1.56	-1.16	5.27	-1.55
155	2013	231	-3.24	-1.76	8.06	1.75
156	2013	171	-9.08	-9.75	5.52	-5.11
157	2013	249	-0.35	1.42	94.02	-11.80
158	2013	215	-9.32	-4.78	0.68	-2.83
159	2013	71	-9.64	-7.12	6.80	-1.27
16	2013	195	-2.72	-2.44	3.58	-3.88
160	2013	87	-4.09	-3.12	4.36	-5.53
161	2013	253	-8.48	-5.39	31.20	-16.85
162	2013	258	-16.13	-15.46	26.16	-31.68
163	2013	165	-6.66	-7.29	18.94	-11.95
164	2013	77	-2.59	-2.15	9.38	3.00
165	2013	230	-2.77	-0.90	1.84	1.23
166	2013	375	1.14	0.80	14.27	1.91
167	2013	216	-13.52	-8.35	2.04	-3.93
168	2013	369	-1.19	-0.76	8.95	1.92
169	2013	188	-2.95	-2.82	0.70	-5.44
17	2013	400	10.13	10.95	3.22	-6.73
170	2013	126	-7.38	-6.00	2.67	-7.22
171	2013	135	-6.06	-3.00	8.59	-6.27
172	2013	402	5.71	9.20	2.12	-11.75
173	2013	241	-1.15	1.57	51.88	0.33
174	2013	96	-3.97	-3.48	8.09	-5.31
175	2013	235	-5.52	-1.89	45.04	0.12
176	2013	368	-1.00	-0.71	7.42	2.06
177	2013	136	-7.78	-6.44	3.18	-9.09
178	2013	96	-3.97	-3.48	9.16	-5.31
179	2013	199	-8.49	0.05	1.00	-0.31
18	2013	161	-5.90	-4.77	12.36	-8.71
180	2013	202	-6.13	-1.42	10.36	-1.60

181	2013	197	-2.33	-2.51	0.72	-5.01
182	2013	13	10.38	7.57	43.55	1.61
183	2013	209	-6.79	-4.63	1.01	-0.58
184	2013	214	-3.71	-1.14	0.83	-3.00
185	2013	265	-8.01	-4.41	7.58	-2.80
186	2013	258	-16.13	-15.46	39.37	-31.68
187	2013	215	-9.32	-4.78	1.28	-2.83
188	2013	190	-3.44	-2.95	3.59	-4.17
189	2013	213	-7.38	-5.35	7.96	-2.42
19	2013	409	-3.67	-4.27	9.52	-11.88
190	2013	202	-6.13	-1.42	13.64	-1.60
192	2013	256	-13.46	-13.77	36.62	-28.18
2	2013	192	-6.12	-4.73	0.59	-3.64
20	2013	256	-13.46	-13.77	70.04	-28.18
21	2013	174	-7.00	-5.69	2.14	-6.90
22	2013	247	-0.33	0.46	77.60	-8.13
23	2013	247	-0.33	0.46	75.47	-8.13
24	2013	175	-5.34	-5.10	4.83	-7.74
25	2013	311	-7.49	-6.46	7.15	-9.33
26	2013	370	-0.69	-0.38	6.62	3.02
27	2013	173	-7.39	-6.17	4.29	-7.30
28	2013	198	-12.07	-7.71	2.79	-1.82
29	2013	254	-12.54	-8.50	37.69	-18.36
3	2013	164	-6.48	-6.34	1.15	-9.91
30	2013	337	-15.66	-16.00	6.94	-12.40
31	2013	232	-1.23	-0.56	0.53	1.88
32	2013	190	-3.44	-2.95	2.10	-4.17
33	2013	217	-8.41	-4.17	6.86	-3.10
34	2013	223	-4.45	-1.86	10.94	-1.93
35	2013	349	-12.10	-9.03	7.66	-6.48
36	2013	247	-0.33	0.46	65.74	-8.13
37	2013	234	-2.20	-1.25	12.94	0.52
38	2013	246	-1.18	0.08	59.90	-8.38
39	2013	12	15.40	11.86	92.00	6.52
4	2013	190	-3.44	-2.95	5.41	-4.17
40	2013	162	-4.33	-4.43	18.50	-9.80
41	2013	222	-3.93	-2.49	14.65	-1.53
42	2013	219	-5.48	-3.45	14.91	-5.80
43	2013	67	-7.90	-3.41	12.32	-3.48
44	2013	249	-0.35	1.42	105.00	-11.80
45	2013	230	-2.77	-0.90	5.78	1.23
46	2013	106	-3.70	-3.48	4.06	-2.68
47	2013	368	-1.00	-0.71	15.72	2.06
48	2013	407	0.82	2.16	10.83	-15.37
49	2013	250	-0.69	0.71	125.24	-13.94

5	2013	71	-9.64	-7.12	10.87	-1.27
50	2013	70	-5.03	-3.89	10.52	-3.24
51	2013	202	-6.13	-1.42	10.72	-1.60
52	2013	224	-7.16	-3.35	4.03	-2.53
53	2013	383	8.61	6.81	18.83	6.91
54	2013	161	-5.90	-4.77	1.09	-8.71
55	2013	136	-7.78	-6.44	13.30	-9.09
56	2013	149	-4.43	-4.28	3.47	-6.92
57	2013	188	-2.95	-2.82	0.52	-5.44
58	2013	200	-15.37	-9.37	6.07	-4.79
59	2013	373	0.00	0.40	10.35	2.99
6	2013	14	8.33	6.23	28.42	-2.06
60	2013	247	-0.33	0.46	79.67	-8.13
61	2013	135	-6.06	-3.00	13.54	-6.27
62	2013	134	0.19	2.59	48.43	-6.74
63	2013	260	-12.91	-10.26	6.87	-29.72
64	2013	334	-10.81	-8.81	3.28	-9.79
65	2013	250	-0.69	0.71	115.34	-13.94
66	2013	166	-6.98	-7.44	5.00	-10.02
67	2013	217	-8.41	-4.17	15.29	-3.10
68	2013	163	-6.33	-6.06	0.82	-10.41
69	2013	189	-3.33	-3.45	5.92	-4.40
7	2013	233	-1.08	-0.46	0.46	0.86
70	2013	234	-2.20	-1.25	17.68	0.52
71	2013	366	-1.40	-1.00	6.27	-0.65
72	2013	189	-3.33	-3.45	1.35	-4.40
73	2013	114	-4.46	-3.81	7.16	-3.55
74	2013	238	-3.86	-2.70	62.94	0.97
75	2013	177	-4.53	-4.20	3.69	-3.93
76	2013	136	-7.78	-6.44	2.43	-9.09
77	2013	374	0.92	0.93	14.54	2.87
78	2013	378	1.67	1.33	22.88	6.18
79	2013	199	-8.49	0.05	24.93	-0.31
8	2013	366	-1.40	-1.00	9.12	-0.65
80	2013	210	-8.13	-5.11	7.54	-0.74
81	2013	251	-3.17	4.41	46.30	-13.75
82	2013	263	-3.67	-2.34	23.73	-11.52
83	2013	221	-7.56	-4.51	3.51	-2.94
84	2013	200	-15.37	-9.37	5.61	-4.79
85	2013	369	-1.19	-0.76	5.09	1.92
86	2013	258	-16.13	-15.46	28.34	-31.68
87	2013	102	-3.97	-3.37	16.73	-4.71
88	2013	254	-12.54	-8.50	51.31	-18.36
89	2013	210	-8.13	-5.11	0.94	-0.74
9	2013	63	-10.29	-7.26	10.82	-2.23

90	2013	11	14.30	10.69	109.24	11.94
91	2013	74	-2.15	-2.76	9.24	3.81
92	2013	254	-12.54	-8.50	51.31	-18.36
93	2013	258	-16.13	-15.46	41.11	-31.68
94	2013	253	-8.48	-5.39	38.37	-16.85
95	2013	224	-7.16	-3.35	44.87	-2.53
96	2013	248	-0.05	2.11	74.10	-10.28
97	2013	246	-1.18	0.08	69.98	-8.38
98	2013	240	-1.61	0.57	43.20	1.19
99	2013	184	-3.32	-2.74	5.57	-6.82
1	2015	242	-0.09	1.99	12.98	-0.37
10	2015	378	1.67	1.33	21.01	12.70
100	2015	194	-7.14	-4.89	14.49	5.28
101	2015	408	-4.86	-4.97	12.51	4.11
102	2015	411	-6.59	-5.74	10.89	3.63
103	2015	101	-3.25	-2.84	4.88	-5.32
104	2015	104	-4.49	-3.71	0.83	-8.83
105	2015	408	-4.86	-4.97	9.69	4.11
107	2015	254	-12.54	-8.50	21.54	5.45
108	2015	190	-3.44	-2.95	14.59	3.97
109	2015	187	-2.31	-2.63	1.05	1.74
11	2015	396	2.83	8.70	41.88	19.50
111	2015	211	-8.81	-5.73	12.10	4.13
112	2015	212	-7.90	-5.28	15.18	2.80
113	2015	252	-0.48	1.23	34.76	10.83
114	2015	250	-0.69	0.71	10.87	10.32
115	2015	247	-0.33	0.46	34.35	-5.92
116	2015	366	-1.40	-1.00	33.02	4.86
117	2015	99	-3.43	-3.13	4.37	-3.50
118	2015	238	-3.86	-2.70	1.88	1.25
119	2015	135	-6.06	-3.00	16.06	-0.64
12	2015	197	-2.33	-2.51	17.89	7.34
120	2015	199	-8.49	0.05	0.97	5.38
121	2015	185	-4.01	-3.59	1.63	4.40
122	2015	182	-4.18	-3.56	8.65	1.18
123	2015	352	-4.02	-4.30	4.62	-2.84
124	2015	371	-0.31	0.11	11.26	4.33
125	2015	372	0.09	0.32	19.34	5.50
126	2015	381	6.33	4.87	27.19	17.88
127	2015	394	0.34	5.94	9.34	7.10
128	2015	420	-1.94	-1.69	10.73	6.91
129	2015	233	-1.08	-0.46	1.11	-2.33
13	2015	182	-4.18	-3.56	7.57	1.18
130	2015	103	-4.60	-3.43	1.09	-6.19
131	2015	201	-0.76	5.66	6.21	2.99

132	2015	184	-3.32	-2.74	10.59	4.67
133	2015	226	-2.45	-1.70	6.22	0.22
134	2015	99	-3.43	-3.13	3.16	-3.50
135	2015	244	0.77	0.67	1.90	-3.34
136	2015	112	-3.93	-3.70	1.59	-9.48
137	2015	364	-1.56	-1.16	12.04	3.43
138	2015	256	-13.46	-13.77	6.42	-20.76
139	2015	202	-6.13	-1.42	12.05	1.30
14	2015	202	-6.13	-1.42	8.66	1.30
140	2015	210	-8.13	-5.11	17.69	3.66
141	2015	148	-4.73	-4.16	0.67	-4.76
142	2015	244	0.77	0.67	7.09	-3.34
143	2015	409	-3.67	-4.27	19.41	5.76
144	2015	99	-3.43	-3.13	3.80	-3.50
145	2015	197	-2.33	-2.51	13.71	7.34
146	2015	101	-3.25	-2.84	4.26	-5.32
147	2015	408	-4.86	-4.97	10.10	4.11
149	2015	373	0.00	0.40	12.61	5.55
15	2015	348	-6.63	-3.66	16.34	4.39
150	2015	408	-4.86	-4.97	7.71	4.11
151	2015	370	-0.69	-0.38	11.24	4.50
152	2015	366	-1.40	-1.00	16.02	4.86
153	2015	244	0.77	0.67	8.66	-3.34
154	2015	188	-2.95	-2.82	12.69	1.85
155	2015	366	-1.40	-1.00	11.23	4.86
156	2015	230	-2.77	-0.90	8.92	-2.44
159	2015	179	-3.48	-2.78	5.24	0.08
160	2015	202	-6.13	-1.42	17.92	1.30
161	2015	127	-8.23	-7.24	10.04	1.66
162	2015	180	-4.28	-4.15	10.62	2.66
163	2015	149	-4.43	-4.28	0.34	-5.65
164	2015	234	-2.20	-1.25	5.17	-3.24
165	2015	371	-0.31	0.11	4.84	4.33
166	2015	219	-5.48	-3.45	4.78	2.95
167	2015	371	-0.31	0.11	3.88	4.33
168	2015	175	-5.34	-5.10	4.50	-0.20
169	2015	380	5.68	4.13	21.48	15.09
170	2015	246	-1.18	0.08	3.22	-6.53
171	2015	244	0.77	0.67	11.41	-3.34
172	2015	244	0.77	0.67	9.17	-3.34
173	2015	247	-0.33	0.46	5.79	-5.92
174	2015	236	-7.35	-3.82	12.62	2.17
175	2015	204	5.55	2.83	10.30	4.75
176	2015	179	-3.48	-2.78	4.48	0.08
177	2015	190	-3.44	-2.95	14.34	3.97

178	2015	371	-0.31	0.11	10.30	4.33
18	2015	225	-4.96	-2.45	20.15	3.02
180	2015	238	-3.86	-2.70	9.24	1.25
182	2015	253	-8.48	-5.39	25.25	7.98
183	2015	193	-5.04	-3.31	17.11	2.39
184	2015	406	-1.20	3.13	7.40	-14.86
185	2015	413	-5.65	-5.90	13.85	3.76
186	2015	238	-3.86	-2.70	9.72	1.25
188	2015	223	-4.45	-1.86	10.23	3.35
189	2015	212	-7.90	-5.28	12.97	2.80
19	2015	105	-3.45	-3.00	7.41	-6.41
190	2015	74	-2.15	-2.76	11.62	-12.99
191	2015	265	-8.01	-4.41	63.00	5.99
192	2015	179	-3.48	-2.78	1.65	0.08
193	2015	191	-2.88	-2.73	0.54	3.43
194	2015	247	-0.33	0.46	2.62	-5.92
195	2015	247	-0.33	0.46	6.37	-5.92
196	2015	196	-3.07	-3.01	13.06	5.42
197	2015	197	-2.33	-2.51	15.64	7.34
198	2015	244	0.77	0.67	7.72	-3.34
199	2015	129	-8.52	-8.49	24.90	1.69
2	2015	370	-0.69	-0.38	16.15	4.50
200	2015	244	0.77	0.67	4.70	-3.34
201	2015	216	-13.52	-8.35	9.56	0.30
202	2015	246	-1.18	0.08	10.00	-6.53
203	2015	215	-9.32	-4.78	8.01	0.91
205	2015	261	-7.83	-7.42	6.51	-8.40
206	2015	128	-8.43	-9.17	12.55	2.23
208	2015	247	-0.33	0.46	5.53	-5.92
209	2015	202	-6.13	-1.42	14.15	1.30
21	2015	258	-16.13	-15.46	3.48	-11.83
22	2015	97	-4.10	-3.57	5.43	-5.19
23	2015	71	-9.64	-7.12	2.27	-12.59
24	2015	246	-1.18	0.08	2.46	-6.53
25	2015	394	0.34	5.94	16.82	7.10
26	2015	194	-7.14	-4.89	20.08	5.28
27	2015	179	-3.48	-2.78	4.65	0.08
28	2015	196	-3.07	-3.01	16.92	5.42
29	2015	105	-3.45	-3.00	2.51	-6.41
3	2015	350	-5.46	-4.43	14.74	-3.48
30	2015	93	-3.39	-3.75	5.94	-5.24
31	2015	133	-13.48	-12.06	23.83	3.39
32	2015	366	-1.40	-1.00	15.01	4.86
33	2015	371	-0.31	0.11	10.42	4.33
34	2015	180	-4.28	-4.15	8.86	2.66

35	2015	194	-7.14	-4.89	17.13	5.28
36	2015	377	2.84	1.65	18.30	8.91
37	2015	107	-3.69	-3.24	0.94	-6.51
38	2015	379	2.71	1.77	19.43	14.64
39	2015	367	-1.06	-0.68	13.26	2.86
4	2015	366	-1.40	-1.00	14.54	4.86
40	2015	244	0.77	0.67	8.71	-3.34
41	2015	101	-3.25	-2.84	12.28	-5.32
42	2015	109	-3.54	-3.26	3.22	-7.24
43	2015	378	1.67	1.33	27.69	12.70
44	2015	371	-0.31	0.11	15.16	4.33
45	2015	108	-3.20	-3.08	3.35	-7.92
46	2015	180	-4.28	-4.15	9.09	2.66
47	2015	181	-4.23	-3.87	6.53	1.33
48	2015	330	-9.02	-5.99	20.17	-11.09
49	2015	182	-4.18	-3.56	11.25	1.18
5	2015	341	-12.46	-13.42	10.32	-9.47
50	2015	167	-8.67	-7.94	0.57	-7.40
51	2015	376	2.02	1.16	22.55	9.52
52	2015	209	-6.79	-4.63	9.64	2.59
53	2015	206	-3.10	-1.97	13.07	3.32
54	2015	180	-4.28	-4.15	9.09	2.66
56	2015	384	7.09	6.51	43.11	28.62
57	2015	170	-8.75	-9.81	8.61	-14.52
58	2015	250	-0.69	0.71	22.63	10.32
59	2015	248	-0.05	2.11	9.44	-4.24
6	2015	205	2.72	1.22	18.82	4.82
60	2015	201	-0.76	5.66	9.72	2.99
61	2015	409	-3.67	-4.27	12.24	5.76
62	2015	372	0.09	0.32	13.48	5.50
63	2015	101	-3.25	-2.84	2.55	-5.32
64	2015	98	-3.56	-3.20	4.60	-6.08
66	2015	397	1.73	5.72	36.52	26.40
67	2015	216	-13.52	-8.35	5.92	0.30
68	2015	379	2.71	1.77	23.89	14.64
69	2015	193	-5.04	-3.31	10.04	2.39
7	2015	179	-3.48	-2.78	8.41	0.08
70	2015	251	-3.17	4.41	31.91	9.99
71	2015	246	-1.18	0.08	8.54	-6.53
72	2015	217	-8.41	-4.17	6.61	0.84
73	2015	246	-1.18	0.08	3.54	-6.53
74	2015	351	-5.45	-6.37	22.39	-2.98
75	2015	352	-4.02	-4.30	16.45	-2.84
76	2015	365	-1.26	-0.95	13.34	4.27
77	2015	105	-3.45	-3.00	1.00	-6.41

78	2015	244	0.77	0.67	4.25	-3.34
79	2015	208	-8.52	-5.19	13.90	3.03
8	2015	24	-5.03	-4.19	4.58	-2.83
80	2015	235	-5.52	-1.89	6.20	-0.74
81	2015	365	-1.26	-0.95	11.64	4.27
82	2015	186	-1.54	-1.82	9.96	1.91
83	2015	155	-4.37	-4.49	1.84	-7.40
84	2015	201	-0.76	5.66	12.03	2.99
85	2015	420	-1.94	-1.69	15.42	6.91
86	2015	249	-0.35	1.42	43.82	7.82
87	2015	218	-12.44	-7.22	7.19	1.09
88	2015	186	-1.54	-1.82	5.84	1.91
90	2015	376	2.02	1.16	22.89	9.52
91	2015	234	-2.20	-1.25	2.43	-3.24
92	2015	217	-8.41	-4.17	11.34	0.84
94	2015	195	-2.72	-2.44	14.83	5.03
95	2015	247	-0.33	0.46	5.01	-5.92
96	2015	196	-3.07	-3.01	11.40	5.42
97	2015	244	0.77	0.67	7.11	-3.34
98	2015	107	-3.69	-3.24	0.60	-6.51
99	2015	198	-12.07	-7.71	16.34	6.37
1	2017	414	-4.83	-4.52	1.14	-12.47
10	2017	395	2.53	7.64	21.39	9.95
100	2017	408	-4.86	-4.97	5.08	-21.41
101	2017	254	-12.54	-8.50	3.06	-36.91
102	2017	242	-0.09	1.99	1.35	-21.39
103	2017	399	5.79	10.62	16.97	-1.28
104	2017	242	-0.09	1.99	4.71	-21.39
105	2017	395	2.53	7.64	18.18	9.95
106	2017	349	-12.10	-9.03	3.15	-11.30
107	2017	187	-2.31	-2.63	6.38	-6.37
108	2017	149	-4.43	-4.28	10.43	-5.45
109	2017	363	-1.73	-1.27	7.89	-2.23
110	2017	167	-8.67	-7.94	13.89	0.42
111	2017	170	-8.75	-9.81	17.58	-4.84
112	2017	186	-1.54	-1.82	7.58	-6.07
113	2017	187	-2.31	-2.63	7.60	-6.37
114	2017	372	0.09	0.32	16.99	2.56
115	2017	166	-6.98	-7.44	23.66	0.19
116	2017	166	-6.98	-7.44	20.79	0.19
117	2017	198	-12.07	-7.71	16.50	-15.35
118	2017	235	-5.52	-1.89	7.66	-14.41
119	2017	340	-18.45	-22.69	8.91	-19.21
12	2017	203	-2.98	1.01	6.55	-14.84
120	2017	247	-0.33	0.46	52.60	19.26

121	2017	105	-3.45	-3.00	35.16	9.90
122	2017	198	-12.07	-7.71	1.91	-15.35
123	2017	236	-7.35	-3.82	2.45	-17.89
124	2017	158	-4.93	-4.49	5.53	-5.35
125	2017	240	-1.61	0.57	14.86	-25.24
126	2017	234	-2.20	-1.25	4.73	-10.64
127	2017	416	-3.13	-2.86	1.45	-14.23
128	2017	204	5.55	2.83	7.37	-15.12
129	2017	233	-1.08	-0.46	6.67	-13.71
13	2017	185	-4.01	-3.59	3.24	-10.54
130	2017	244	0.77	0.67	3.41	-12.08
131	2017	244	0.77	0.67	9.30	-12.08
132	2017	349	-12.10	-9.03	4.23	-11.30
133	2017	164	-6.48	-6.34	32.19	-5.67
134	2017	184	-3.32	-2.74	0.58	-7.21
135	2017	406	-1.20	3.13	3.09	-24.44
136	2017	111	-4.12	-3.62	23.22	2.58
137	2017	242	-0.09	1.99	5.72	-21.39
138	2017	184	-3.32	-2.74	0.08	-7.21
139	2017	168	-8.37	-8.46	18.59	-7.00
14	2017	41	-9.70	-8.99	59.25	10.87
140	2017	150	-5.05	-4.81	8.57	-4.50
141	2017	218	-12.44	-7.22	15.36	-40.92
142	2017	184	-3.32	-2.74	7.85	-7.21
143	2017	176	-4.86	-4.61	11.59	-3.25
144	2017	185	-4.01	-3.59	8.63	-10.54
145	2017	371	-0.31	0.11	6.62	3.05
146	2017	350	-5.46	-4.43	0.76	-12.45
147	2017	230	-2.77	-0.90	1.20	-10.66
148	2017	150	-5.05	-4.81	10.32	-4.50
149	2017	94	-5.30	-4.36	30.64	5.69
15	2017	403	5.91	8.69	14.73	-24.43
150	2017	361	-2.35	-1.87	6.99	-3.22
151	2017	135	-6.06	-3.00	7.15	-12.80
152	2017	70	-5.03	-3.89	11.86	-1.36
153	2017	168	-8.37	-8.46	70.54	-7.00
154	2017	197	-2.33	-2.51	4.68	-12.12
155	2017	231	-3.24	-1.76	2.74	-8.88
156	2017	253	-8.48	-5.39	1.51	-33.62
157	2017	234	-2.20	-1.25	0.38	-10.64
158	2017	187	-2.31	-2.63	6.36	-6.37
159	2017	176	-4.86	-4.61	9.94	-3.25
16	2017	182	-4.18	-3.56	0.92	-3.10
161	2017	157	-4.88	-4.80	1.73	-4.92
162	2017	245	-1.97	-1.17	17.69	1.84

163	2017	155	-4.37	-4.49	6.03	-2.45
164	2017	172	-7.77	-8.28	2.32	-9.05
165	2017	154	-4.63	-4.55	5.28	-5.00
166	2017	234	-2.20	-1.25	3.72	-10.64
167	2017	106	-3.70	-3.48	38.06	9.93
168	2017	251	-3.17	4.41	2.38	-21.46
169	2017	253	-8.48	-5.39	0.91	-33.62
17	2017	228	-5.47	-3.49	11.06	-12.47
170	2017	161	-5.90	-4.77	0.88	-8.51
171	2017	350	-5.46	-4.43	0.30	-12.45
172	2017	407	0.82	2.16	3.58	-20.11
173	2017	247	-0.33	0.46	38.38	19.26
174	2017	255	-12.95	-13.19	13.65	-25.09
175	2017	255	-12.95	-13.19	7.88	-25.09
176	2017	252	-0.48	1.23	7.76	-28.89
177	2017	360	-2.49	-2.09	1.39	-3.00
178	2017	416	-3.13	-2.86	3.72	-14.23
179	2017	101	-3.25	-2.84	25.87	8.72
18	2017	251	-3.17	4.41	9.42	-21.46
180	2017	198	-12.07	-7.71	1.48	-15.35
182	2017	197	-2.33	-2.51	6.72	-12.12
183	2017	365	-1.26	-0.95	12.12	-0.99
184	2017	74	-2.15	-2.76	35.58	9.28
185	2017	105	-3.45	-3.00	31.41	9.90
186	2017	180	-4.28	-4.15	2.04	-4.19
187	2017	165	-6.66	-7.29	27.85	-2.39
188	2017	148	-4.73	-4.16	5.47	-7.54
189	2017	350	-5.46	-4.43	2.30	-12.45
19	2017	410	-4.73	-4.66	7.36	-20.10
190	2017	253	-8.48	-5.39	4.86	-33.62
191	2017	101	-3.25	-2.84	26.77	8.72
192	2017	183	-3.62	-3.82	1.86	-7.90
193	2017	218	-12.44	-7.22	29.54	-40.92
194	2017	184	-3.32	-2.74	5.71	-7.21
196	2017	246	-1.18	0.08	27.15	11.54
197	2017	244	0.77	0.67	1.00	-12.08
198	2017	408	-4.86	-4.97	1.61	-21.41
2	2017	140	-6.36	-6.07	22.38	0.58
20	2017	388	11.42	14.07	14.08	-17.85
201	2017	254	-12.54	-8.50	6.85	-36.91
202	2017	45	-8.01	-7.28	36.26	7.15
204	2017	253	-8.48	-5.39	7.76	-33.62
205	2017	174	-7.00	-5.69	7.98	-8.51
206	2017	247	-0.33	0.46	51.47	19.26
207	2017	153	-4.97	-4.69	12.26	-3.43

21	2017	240	-1.61	0.57	12.75	-25.24
22	2017	158	-4.93	-4.49	0.88	-5.35
23	2017	112	-3.93	-3.70	22.11	10.24
24	2017	358	-3.25	-2.65	2.53	-4.82
25	2017	349	-12.10	-9.03	12.03	-11.30
26	2017	413	-5.65	-5.90	0.86	-16.76
27	2017	133	-13.48	-12.06	41.11	10.57
28	2017	181	-4.23	-3.87	15.10	-2.01
29	2017	177	-4.53	-4.20	17.97	0.41
3	2017	238	-3.86	-2.70	0.37	-18.85
30	2017	367	-1.06	-0.68	20.14	2.10
31	2017	233	-1.08	-0.46	3.32	-13.71
33	2017	353	-4.40	-4.00	0.32	-7.65
34	2017	407	0.82	2.16	0.96	-20.11
35	2017	368	-1.00	-0.71	14.49	0.75
36	2017	263	-3.67	-2.34	37.35	11.51
37	2017	163	-6.33	-6.06	15.31	-6.00
38	2017	73	-8.76	-7.24	36.17	20.77
39	2017	182	-4.18	-3.56	15.59	-3.10
4	2017	377	2.84	1.65	18.16	11.32
40	2017	234	-2.20	-1.25	4.76	-10.64
41	2017	236	-7.35	-3.82	8.01	-17.89
42	2017	417	-3.22	-2.73	7.58	-15.92
45	2017	244	0.77	0.67	12.36	-12.08
46	2017	193	-5.04	-3.31	0.30	-12.76
47	2017	242	-0.09	1.99	2.48	-21.39
49	2017	253	-8.48	-5.39	4.31	-33.62
5	2017	143	-4.60	-4.04	19.29	-2.00
50	2017	253	-8.48	-5.39	3.56	-33.62
51	2017	165	-6.66	-7.29	19.87	-2.39
52	2017	186	-1.54	-1.82	1.21	-6.07
53	2017	244	0.77	0.67	1.54	-12.08
54	2017	246	-1.18	0.08	22.05	11.54
55	2017	385	9.18	8.93	40.58	5.78
56	2017	353	-4.40	-4.00	7.14	-7.65
57	2017	236	-7.35	-3.82	14.70	-17.89
58	2017	94	-5.30	-4.36	24.95	5.69
59	2017	400	10.13	10.95	16.44	-2.66
6	2017	198	-12.07	-7.71	3.08	-15.35
60	2017	184	-3.32	-2.74	3.86	-7.21
61	2017	409	-3.67	-4.27	1.46	-21.12
62	2017	357	-3.40	-2.86	2.33	-4.99
63	2017	191	-2.88	-2.73	1.83	-12.01
64	2017	165	-6.66	-7.29	14.27	-2.39
65	2017	191	-2.88	-2.73	4.28	-12.01

66	2017	185	-4.01	-3.59	4.49	-10.54
67	2017	197	-2.33	-2.51	2.55	-12.12
68	2017	363	-1.73	-1.27	7.01	-2.23
7	2017	244	0.77	0.67	1.24	-12.08
70	2017	350	-5.46	-4.43	3.54	-12.45
71	2017	247	-0.33	0.46	47.98	19.26
72	2017	242	-0.09	1.99	3.58	-21.39
73	2017	362	-1.96	-1.52	9.28	-2.86
74	2017	70	-5.03	-3.89	2.84	-1.36
75	2017	172	-7.77	-8.28	16.17	-9.05
76	2017	158	-4.93	-4.49	12.58	-5.35
77	2017	379	2.71	1.77	25.27	4.61
78	2017	186	-1.54	-1.82	4.57	-6.07
79	2017	232	-1.23	-0.56	1.42	-13.30
8	2017	369	-1.19	-0.76	10.92	0.48
80	2017	158	-4.93	-4.49	7.86	-5.35
82	2017	401	7.44	8.96	18.36	-9.57
83	2017	168	-8.37	-8.46	18.40	-7.00
86	2017	252	-0.48	1.23	6.59	-28.89
87	2017	179	-3.48	-2.78	12.89	-2.89
88	2017	250	-0.69	0.71	13.30	-12.51
89	2017	103	-4.60	-3.43	7.89	1.77
9	2017	185	-4.01	-3.59	2.98	-10.54
90	2017	263	-3.67	-2.34	38.14	11.51
91	2017	395	2.53	7.64	21.42	9.95
92	2017	136	-7.78	-6.44	19.39	-11.65
93	2017	244	0.77	0.67	7.56	-12.08
94	2017	400	10.13	10.95	14.50	-2.66
95	2017	174	-7.00	-5.69	6.84	-8.51
96	2017	164	-6.48	-6.34	27.97	-5.67
97	2017	169	-9.43	-9.61	11.35	-8.77
98	2017	174	-7.00	-5.69	9.69	-8.51
99	2017	100	-3.69	-3.12	29.08	5.67

APPENDIX B

Table B-1: Vegetation line data for each nest over the study period, with the closest transect noted, vegetation line EPR, vegetation line LRR, nest distance to the vegetation line, and the associated change from the era the imagery was taken.

NestID	Year	Transect	EPR	LRR	Nest Distance	Era
2	2006	259	-15.74	-14.13	13.10	-11.47
3	2006	244	0.77	0.67	72.55	7.63
4	2006	211	-8.81	-5.73	1.87	-4.19
5	2006	190	-3.44	-2.95	2.72	-8.66
6	2006	244	0.77	0.67	54.06	7.63
7	2006	257	-16.96	-15.18	25.51	-12.57
8	2006	374	0.92	0.93	10.19	-9.20
9	2006	144	-4.00	-3.76	1.36	-1.30
10	2006	253	-8.48	-5.39	94.31	-10.46
11	2006	205	2.72	1.22	24.40	69.63
12	2006	376	2.02	1.16	17.81	-11.98
13	2006	365	-1.26	-0.95	7.13	-10.87
14	2006	203	-2.98	1.01	63.91	-100.43
15	2006	177	-4.53	-4.20	0.54	-9.13
17	2006	379	2.71	1.77	3.54	-12.74
18	2006	148	-4.73	-4.16	3.68	-1.30
19	2006	250	-0.69	0.71	106.03	-164.28
20	2006	240	-1.61	0.57	60.45	-21.24
21	2006	147	-4.30	-3.70	2.31	-7.88
22	2006	143	-4.60	-4.04	6.50	1.02
23	2006	382	6.68	5.05	34.35	-15.74
24	2006	375	1.14	0.80	10.74	-12.37
26	2006	68	-7.72	-3.32	31.57	-52.13
27	2006	165	-6.66	-7.29	19.90	-4.02
28	2006	78	-3.64	-3.00	6.21	-1.16
29	2006	242	-0.09	1.99	54.46	-19.07
30	2006	250	-0.69	0.71	146.99	-164.28
31	2006	376	2.02	1.16	12.40	-11.98
32	2006	102	-3.97	-3.37	0.23	-10.64
33	2006	168	-8.37	-8.46	9.96	-6.50
34	2006	197	-2.33	-2.51	4.61	-3.97
35	2006	232	-1.23	-0.56	3.08	-11.93
36	2006	71	-9.64	-7.12	4.35	-0.72
37	2006	216	-13.52	-8.35	19.90	-6.07
38	2006	256	-13.46	-13.77	69.74	-36.18
39	2006	246	-1.18	0.08	108.15	-12.29
40	2006	366	-1.40	-1.00	7.05	-12.10
41	2006	270	-3.30	-3.95	12.03	14.79

42	2006	376	2.02	1.16	6.48	-11.98
43	2006	221	-7.56	-4.51	30.05	-14.30
44	2006	255	-12.95	-13.19	79.06	-27.32
45	2006	379	2.71	1.77	2.81	-12.74
46	2006	244	0.77	0.67	83.21	7.63
47	2006	218	-12.44	-7.22	12.83	-9.96
48	2006	142	-5.39	-4.53	9.70	2.07
50	2006	192	-6.12	-4.73	0.87	-1.24
51	2006	244	0.77	0.67	50.99	7.63
52	2006	368	-1.00	-0.71	14.53	-12.05
53	2006	248	-0.05	2.11	114.24	-101.59
54	2006	234	-2.20	-1.25	20.68	-29.90
55	2006	190	-3.44	-2.95	2.13	-8.66
56	2006	208	-8.52	-5.19	6.16	-4.06
57	2006	177	-4.53	-4.20	5.64	-9.13
58	2006	377	2.84	1.65	0.58	-10.33
59	2006	188	-2.95	-2.82	3.23	-11.51
60	2006	70	-5.03	-3.89	15.68	-12.65
61	2006	338	-15.39	-10.90	35.21	-35.85
62	2006	223	-4.45	-1.86	14.27	-12.90
63	2006	236	-7.35	-3.82	25.47	-43.66
64	2006	244	0.77	0.67	46.98	7.63
65	2006	256	-13.46	-13.77	71.36	-36.18
66	2006	344	-11.40	-14.18	21.65	-4.03
67	2006	406	-1.20	3.13	78.49	-34.67
68	2006	344	-11.40	-14.18	18.46	-4.03
70	2006	70	-5.03	-3.89	4.12	-12.65
71	2006	151	-4.15	-3.78	1.91	-3.49
72	2006	165	-6.66	-7.29	2.81	-4.02
73	2006	236	-7.35	-3.82	27.85	-43.66
74	2006	165	-6.66	-7.29	8.36	-4.02
75	2006	191	-2.88	-2.73	7.75	-6.34
76	2006	374	0.92	0.93	5.44	-9.20
77	2006	203	-2.98	1.01	75.48	-100.43
78	2006	296	-9.98	-13.48	1.93	-9.49
79	2006	296	-9.98	-13.48	0.10	-9.49
80	2006	288	-14.50	-13.61	1.39	-7.01
81	2006	286	-21.35	-23.58	6.09	1.56
82	2006	235	-5.52	-1.89	35.51	-70.03
83	2006	247	-0.33	0.46	65.72	-23.35
85	2006	87	-4.09	-3.12	1.03	-4.60
86	2006	164	-6.48	-6.34	0.68	-8.31
87	2006	145	-3.66	-4.02	0.83	-6.71
88	2006	240	-1.61	0.57	49.39	-21.24
89	2006	236	-7.35	-3.82	33.04	-43.66

91	2006	186	-1.54	-1.82	8.09	0.52
92	2006	244	0.77	0.67	38.44	7.63
93	2006	232	-1.23	-0.56	6.21	-11.93
95	2006	194	-7.14	-4.89	3.02	-9.93
96	2006	188	-2.95	-2.82	2.04	-11.51
97	2006	222	-3.93	-2.49	32.92	-4.86
99	2006	256	-13.46	-13.77	79.31	-36.18
100	2006	162	-4.33	-4.43	3.94	-2.14
101	2006	163	-6.33	-6.06	0.45	-5.67
102	2006	254	-12.54	-8.50	111.03	-61.10
103	2006	246	-1.18	0.08	98.47	-12.29
104	2006	420	-1.94	-1.69	6.62	-13.28
105	2006	187	-2.31	-2.63	10.54	-7.65
106	2006	214	-3.71	-1.14	43.89	-3.74
107	2006	145	-3.66	-4.02	1.50	-6.71
108	2006	356	-3.79	-3.29	11.50	-9.76
109	2006	71	-9.64	-7.12	5.71	-0.72
110	2006	191	-2.88	-2.73	1.99	-6.34
111	2006	240	-1.61	0.57	54.97	-21.24
112	2006	169	-9.43	-9.61	4.63	-3.93
114	2006	185	-4.01	-3.59	1.82	-9.68
116	2006	194	-7.14	-4.89	21.82	-9.93
117	2006	183	-3.62	-3.82	0.29	-4.52
119	2006	254	-12.54	-8.50	105.20	-61.10
2	2007	171	-9.08	-9.75	0.84	-4.54
3	2007	204	5.55	2.83	19.90	3.04
4	2007	133	-13.48	-12.06	2.07	-12.09
5	2007	259	-15.74	-14.13	7.72	19.40
6	2007	191	-2.88	-2.73	8.64	5.13
7	2007	177	-4.53	-4.20	3.51	1.34
8	2007	73	-8.76	-7.24	0.37	8.59
9	2007	208	-8.52	-5.19	1.50	11.15
10	2007	392	0.15	9.35	49.30	5.82
11	2007	208	-8.52	-5.19	2.69	11.15
12	2007	139	-7.23	-5.85	6.87	-0.34
13	2007	15	5.89	4.51	75.56	-4.71
14	2007	250	-0.69	0.71	31.04	189.10
15	2007	374	0.92	0.93	3.25	7.18
16	2007	71	-9.64	-7.12	18.63	7.61
17	2007	215	-9.32	-4.78	35.75	-2.84
18	2007	73	-8.76	-7.24	7.28	8.59
19	2007	391	5.55	12.30	118.06	4.11
20	2007	253	-8.48	-5.39	84.54	16.78
21	2007	70	-5.03	-3.89	16.44	34.54
22	2007	16	0.20	0.47	50.77	2.94

23	2007	384	7.09	6.51	55.70	12.99
24	2007	95	-4.19	-3.52	9.66	5.82
25	2007	256	-13.46	-13.77	60.61	19.46
26	2007	163	-6.33	-6.06	5.38	5.62
27	2007	202	-6.13	-1.42	45.35	63.32
28	2007	244	0.77	0.67	38.96	14.82
29	2007	402	5.71	9.20	40.50	8.10
30	2007	201	-0.76	5.66	48.19	7.70
31	2007	140	-6.36	-6.07	4.98	7.35
32	2007	234	-2.20	-1.25	6.72	31.66
33	2007	70	-5.03	-3.89	13.87	34.54
34	2007	308	-11.49	-8.15	10.41	36.67
35	2007	259	-15.74	-14.13	1.23	19.40
36	2007	250	-0.69	0.71	36.02	189.10
37	2007	338	-15.39	-10.90	12.21	8.09
38	2007	247	-0.33	0.46	49.65	24.88
39	2007	385	9.18	8.93	76.46	15.98
40	2007	130	-8.88	-8.46	11.33	13.73
41	2007	396	2.83	8.70	41.07	200.13
42	2007	409	-3.67	-4.27	3.48	70.39
43	2007	72	-9.35	-9.31	3.59	10.20
44	2007	261	-7.83	-7.42	12.08	31.05
45	2007	44	-5.38	-1.19	12.77	
46	2007	194	-7.14	-4.89	3.64	5.51
47	2007	150	-5.05	-4.81	9.30	3.40
48	2007	244	0.77	0.67	37.77	14.82
49	2007	392	0.15	9.35	87.37	5.82
50	2007	132	-7.47	-8.38	7.84	26.83
51	2007	254	-12.54	-8.50	91.28	16.05
1	2009	254	-12.54	-8.50	74.42	-8.02
10	2009	304	-14.50	-10.66	8.06	-3.57
100	2009	182	-4.18	-3.56	1.56	-5.56
101	2009	254	-12.54	-8.50	91.82	-8.02
11	2009	233	-1.08	-0.46	2.77	-5.94
12	2009	189	-3.33	-3.45	3.54	-7.66
13	2009	244	0.77	0.67	58.04	-7.01
14	2009	310	-19.85	-18.82	1.64	-2.35
17	2009	246	-1.18	0.08	131.05	-7.06
18	2009	132	-7.47	-8.38	0.91	-10.98
19	2009	237	-1.67	-0.91	28.52	-7.49
2	2009	236	-7.35	-3.82	19.16	-1.61
20	2009	215	-9.32	-4.78	3.61	19.05
21	2009	334	-10.81	-8.81	9.99	5.89
22	2009	299	-2.89	-1.55	13.04	-4.69
23	2009	299	-2.89	-1.55	13.04	-4.69

24	2009	190	-3.44	-2.95	0.20	-7.43
25	2009	400	10.13	10.95	117.02	19.16
26	2009	208	-8.52	-5.19	0.36	-4.33
27	2009	334	-10.81	-8.81	6.44	5.89
28	2009	210	-8.13	-5.11	13.98	-4.65
29	2009	350	-5.46	-4.43	0.65	-0.47
3	2009	216	-13.52	-8.35	4.64	-4.24
30	2009	177	-4.53	-4.20	8.90	-6.43
31	2009	194	-7.14	-4.89	3.80	-5.10
32	2009	254	-12.54	-8.50	80.04	-8.02
33	2009	351	-5.45	-6.37	1.76	-3.99
34	2009	74	-2.15	-2.76	2.38	-3.24
35	2009	184	-3.32	-2.74	1.68	-7.85
36	2009	187	-2.31	-2.63	2.57	-4.12
37	2009	127	-8.23	-7.24	5.47	-8.99
38	2009	226	-2.45	-1.70	7.68	-6.87
39	2009	229	-4.14	-2.31	6.76	-9.46
4	2009	386	9.95	9.59	56.73	19.72
40	2009	149	-4.43	-4.28	1.13	-7.59
41	2009	30	-6.35	-7.06	19.76	-4.89
42	2009	254	-12.54	-8.50	67.08	-8.02
43	2009	256	-13.46	-13.77	65.55	-11.26
44	2009	234	-2.20	-1.25	12.18	-12.66
45	2009	391	5.55	12.30	26.45	40.64
46	2009	212	-7.90	-5.28	6.36	-4.70
47	2009	149	-4.43	-4.28	1.13	-7.59
48	2009	256	-13.46	-13.77	60.63	-11.26
49	2009	244	0.77	0.67	49.28	-7.01
5	2009	244	0.77	0.67	67.46	-7.01
50	2009	204	5.55	2.83	10.27	14.88
51	2009	245	-1.97	-1.17	90.93	-14.08
52	2009	247	-0.33	0.46	153.93	-50.77
53	2009	215	-9.32	-4.78	3.14	19.05
54	2009	409	-3.67	-4.27	14.37	-34.50
55	2009	244	0.77	0.67	76.89	-7.01
56	2009	263	-3.67	-2.34	59.25	-6.70
57	2009	336	-12.66	-12.09	4.83	4.70
58	2009	400	10.13	10.95	108.59	19.16
59	2009	223	-4.45	-1.86	19.32	-5.53
6	2009	339	-13.29	-15.17	4.46	-3.07
60	2009	379	2.71	1.77	67.52	-1.36
61	2009	177	-4.53	-4.20	3.71	-6.43
62	2009	194	-7.14	-4.89	4.10	-5.10
63	2009	224	-7.16	-3.35	9.70	-7.50
64	2009	348	-6.63	-3.66	0.57	44.33

65	2009	231	-3.24	-1.76	4.10	-6.71
66	2009	350	-5.46	-4.43	7.81	-0.47
67	2009	263	-3.67	-2.34	49.28	-6.70
68	2009	246	-1.18	0.08	139.47	-7.06
69	2009	203	-2.98	1.01	10.38	21.58
7	2009	193	-5.04	-3.31	1.36	-2.70
71	2009	339	-13.29	-15.17	3.98	-3.07
72	2009	204	5.55	2.83	5.43	14.88
73	2009	203	-2.98	1.01	2.11	21.58
74	2009	217	-8.41	-4.17	17.86	-3.07
75	2009	53	-7.23	-8.38	11.57	-12.85
76	2009	340	-18.45	-22.69	5.80	-8.03
77	2009	206	-3.10	-1.97	6.20	6.32
78	2009	16	0.20	0.47	58.81	20.26
79	2009	350	-5.46	-4.43	10.62	-0.47
8	2009	256	-13.46	-13.77	51.94	-11.26
80	2009	238	-3.86	-2.70	31.04	-12.99
81	2009	416	-3.13	-2.86	8.01	-15.25
82	2009	368	-1.00	-0.71	5.14	-3.41
83	2009	112	-3.93	-3.70	4.51	-8.06
84	2009	351	-5.45	-6.37	3.85	-3.99
85	2009	251	-3.17	4.41	94.09	-46.74
86	2009	339	-13.29	-15.17	3.46	-3.07
87	2009	249	-0.35	1.42	146.74	-48.01
88	2009	248	-0.05	2.11	154.25	-48.37
89	2009	414	-4.83	-4.52	8.51	-23.01
9	2009	262	-10.06	-10.71	22.80	-16.66
91	2009	178	-3.48	-3.30	3.96	-3.52
92	2009	346	-7.56	-7.28	2.98	41.28
93	2009	380	5.68	4.13	33.64	2.35
94	2009	218	-12.44	-7.22	0.51	7.41
95	2009	296	-9.98	-13.48	0.53	-7.96
96	2009	250	-0.69	0.71	153.79	-98.61
98	2009	201	-0.76	5.66	2.20	82.08
99	2009	238	-3.86	-2.70	53.14	-12.99
1	2010	250	-0.69	0.71	98.84	24.10
10	2010	256	-13.46	-13.77	49.34	3.27
100	2010	109	-3.54	-3.26	3.08	-0.51
101	2010	162	-4.33	-4.43	4.46	3.49
102	2010	63	-10.29	-7.26	5.16	6.71
103	2010	146	-2.55	-2.74	4.62	2.63
105	2010	405	4.73	9.29	79.30	103.17
106	2010	230	-2.77	-0.90	13.29	11.20
107	2010	182	-4.18	-3.56	2.45	1.32
109	2010	124	-3.68	-3.27	2.45	2.94

11	2010	177	-4.53	-4.20	2.65	-4.56
110	2010	204	5.55	2.83	7.76	-0.95
111	2010	253	-8.48	-5.39	62.86	1.66
112	2010	25	-4.93	-3.89	9.98	10.78
113	2010	225	-4.96	-2.45	3.20	1.94
114	2010	262	-10.06	-10.71	28.09	-14.63
115	2010	222	-3.93	-2.49	24.14	4.14
116	2010	33	-7.53	-7.37	2.17	1.86
117	2010	154	-4.63	-4.55	0.37	-2.92
118	2010	209	-6.79	-4.63	1.18	5.92
119	2010	356	-3.79	-3.29	14.52	-1.02
12	2010	210	-8.13	-5.11	1.39	9.77
120	2010	409	-3.67	-4.27	18.62	4.46
121	2010	246	-1.18	0.08	152.42	1.55
122	2010	379	2.71	1.77	24.13	6.53
123	2010	345	-9.79	-10.45	1.64	-4.27
124	2010	20	-4.80	-2.93	33.54	6.72
125	2010	254	-12.54	-8.50	61.67	6.13
126	2010	248	-0.05	2.11	137.67	6.52
127	2010	174	-7.00	-5.69	0.19	1.76
129	2010	250	-0.69	0.71	95.08	24.10
13	2010	263	-3.67	-2.34	41.72	-2.21
130	2010	199	-8.49	0.05	4.71	10.34
131	2010	187	-2.31	-2.63	6.82	-0.67
132	2010	156	-4.84	-4.76	9.14	0.63
133	2010	241	-1.15	1.57	91.91	7.39
134	2010	146	-2.55	-2.74	4.26	2.63
135	2010	16	0.20	0.47	36.67	1.24
136	2010	103	-4.60	-3.43	6.35	-3.97
137	2010	168	-8.37	-8.46	5.13	4.83
138	2010	191	-2.88	-2.73	1.94	2.33
139	2010	124	-3.68	-3.27	9.78	2.94
14	2010	115	-3.44	-3.15	3.79	0.75
140	2010	172	-7.77	-8.28	36.88	-3.60
141	2010	413	-5.65	-5.90	4.05	-7.63
142	2010	147	-4.30	-3.70	0.29	-4.59
143	2010	152	-4.43	-4.10	6.21	0.33
144	2010	152	-4.43	-4.10	6.21	0.33
145	2010	330	-9.02	-5.99	27.39	
146	2010	265	-8.01	-4.41	10.79	-5.26
147	2010	154	-4.63	-4.55	1.98	-2.92
148	2010	163	-6.33	-6.06	6.98	0.06
149	2010	338	-15.39	-10.90	2.91	3.51
15	2010	186	-1.54	-1.82	12.03	1.05
150	2010	155	-4.37	-4.49	1.56	2.68

151	2010	215	-9.32	-4.78	8.02	4.62
152	2010	70	-5.03	-3.89	0.75	2.77
16	2010	20	-4.80	-2.93	26.14	6.72
17	2010	265	-8.01	-4.41	8.03	-5.26
18	2010	185	-4.01	-3.59	1.50	-6.91
19	2010	387	10.86	13.05	52.86	61.16
2	2010	202	-6.13	-1.42	2.13	-2.43
20	2010	15	5.89	4.51	13.03	3.81
21	2010	250	-0.69	0.71	95.08	24.10
22	2010	203	-2.98	1.01	7.70	-0.79
23	2010	217	-8.41	-4.17	23.14	13.05
24	2010	256	-13.46	-13.77	49.34	3.27
25	2010	254	-12.54	-8.50	44.33	6.13
26	2010	247	-0.33	0.46	144.14	3.08
27	2010	108	-3.20	-3.08	0.23	-4.04
28	2010	154	-4.63	-4.55	7.26	-2.92
29	2010	380	5.68	4.13	18.35	3.02
3	2010	139	-7.23	-5.85	5.39	0.65
30	2010	154	-4.63	-4.55	5.57	-2.92
31	2010	157	-4.88	-4.80	0.31	-0.81
32	2010	231	-3.24	-1.76	2.51	4.39
33	2010	255	-12.95	-13.19	35.71	3.47
34	2010	112	-3.93	-3.70	11.28	2.99
35	2010	170	-8.75	-9.81	3.17	-1.64
36	2010	244	0.77	0.67	42.27	14.18
37	2010	381	6.33	4.87	55.11	4.87
38	2010	164	-6.48	-6.34	5.76	-0.13
39	2010	172	-7.77	-8.28	6.34	-3.60
4	2010	244	0.77	0.67	118.27	14.18
40	2010	250	-0.69	0.71	141.20	24.10
41	2010	398	4.74	8.47	7.88	73.66
42	2010	150	-5.05	-4.81	1.43	-9.27
43	2010	225	-4.96	-2.45	1.72	1.94
44	2010	244	0.77	0.67	63.81	14.18
45	2010	232	-1.23	-0.56	11.28	6.78
46	2010	185	-4.01	-3.59	4.96	-6.91
47	2010	61	-8.86	-10.84	8.66	2.46
48	2010	151	-4.15	-3.78	3.16	-0.10
49	2010	210	-8.13	-5.11	0.99	9.77
5	2010	255	-12.95	-13.19	43.32	3.47
50	2010	374	0.92	0.93	1.29	8.88
51	2010	222	-3.93	-2.49	24.14	4.14
52	2010	186	-1.54	-1.82	2.26	1.05
53	2010	250	-0.69	0.71	94.40	24.10
54	2010	131	-9.34	-8.54	0.40	-3.21

55	2010	207	-6.42	-3.73	8.12	0.38
56	2010	388	11.42	14.07	41.42	67.70
57	2010	85	-3.29	-3.09	1.45	4.44
58	2010	261	-7.83	-7.42	19.68	5.77
59	2010	163	-6.33	-6.06	2.97	0.06
6	2010	207	-6.42	-3.73	6.64	0.38
60	2010	253	-8.48	-5.39	68.73	1.66
61	2010	215	-9.32	-4.78	4.72	4.62
62	2010	186	-1.54	-1.82	6.24	1.05
63	2010	379	2.71	1.77	17.69	6.53
64	2010	382	6.68	5.05	34.52	15.42
65	2010	254	-12.54	-8.50	72.88	6.13
66	2010	198	-12.07	-7.71	1.65	-0.49
67	2010	250	-0.69	0.71	104.52	24.10
68	2010	247	-0.33	0.46	145.68	3.08
69	2010	171	-9.08	-9.75	3.68	-2.90
7	2010	349	-12.10	-9.03	4.91	1.04
70	2010	350	-5.46	-4.43	7.39	4.18
71	2010	197	-2.33	-2.51	0.13	0.77
72	2010	255	-12.95	-13.19	51.56	3.47
73	2010	255	-12.95	-13.19	51.56	3.47
74	2010	181	-4.23	-3.87	2.48	-1.20
75	2010	232	-1.23	-0.56	19.74	6.78
76	2010	174	-7.00	-5.69	1.15	1.76
77	2010	157	-4.88	-4.80	4.97	-0.81
78	2010	53	-7.23	-8.38	11.67	3.70
79	2010	175	-5.34	-5.10	10.12	-5.14
8	2010	147	-4.30	-3.70	5.60	-4.59
80	2010	15	5.89	4.51	28.57	3.81
81	2010	14	8.33	6.23	21.70	
82	2010	198	-12.07	-7.71	10.67	-0.49
83	2010	91	-2.71	-2.46	1.77	-5.24
84	2010	13	10.38	7.57	34.00	
85	2010	197	-2.33	-2.51	0.13	0.77
86	2010	246	-1.18	0.08	129.03	1.55
87	2010	255	-12.95	-13.19	43.32	3.47
88	2010	246	-1.18	0.08	155.25	1.55
89	2010	372	0.09	0.32	7.97	5.66
9	2010	250	-0.69	0.71	98.84	24.10
90	2010	158	-4.93	-4.49	4.73	2.39
91	2010	265	-8.01	-4.41	8.03	-5.26
92	2010	182	-4.18	-3.56	0.98	1.32
93	2010	152	-4.43	-4.10	0.53	0.33
94	2010	179	-3.48	-2.78	3.51	-1.59
95	2010	214	-3.71	-1.14	1.43	4.58

96	2010	236	-7.35	-3.82	45.27	7.16
97	2010	249	-0.35	1.42	133.80	5.75
98	2010	232	-1.23	-0.56	11.28	6.78
99	2010	109	-3.54	-3.26	3.08	-0.51
1	2013	251	-3.17	4.41	64.28	9.95
10	2013	194	-7.14	-4.89	14.58	-1.82
100	2013	198	-12.07	-7.71	10.16	-0.76
101	2013	178	-3.48	-3.30	9.68	-3.42
102	2013	265	-8.01	-4.41	8.98	1.21
103	2013	176	-4.86	-4.61	12.03	-4.58
105	2013	198	-12.07	-7.71	2.06	-0.76
106	2013	221	-7.56	-4.51	14.03	-1.02
107	2013	98	-3.56	-3.20	11.51	-2.12
108	2013	247	-0.33	0.46	4.61	25.54
109	2013	402	5.71	9.20	37.81	0.49
11	2013	409	-3.67	-4.27	4.43	-4.11
110	2013	91	-2.71	-2.46	17.42	-1.47
111	2013	238	-3.86	-2.70	8.85	-0.24
112	2013	152	-4.43	-4.10	0.97	-2.11
113	2013	105	-3.45	-3.00	11.16	-1.62
114	2013	162	-4.33	-4.43	10.02	-5.01
115	2013	216	-13.52	-8.35	6.56	-1.00
116	2013	232	-1.23	-0.56	10.00	1.89
117	2013	375	1.14	0.80	48.93	-4.00
119	2013	242	-0.09	1.99	25.56	18.11
12	2013	367	-1.06	-0.68	1.89	1.10
120	2013	238	-3.86	-2.70	43.84	-0.24
121	2013	217	-8.41	-4.17	12.85	0.15
122	2013	247	-0.33	0.46	8.44	25.54
123	2013	65	-7.93	-3.08	17.06	-11.37
124	2013	247	-0.33	0.46	12.96	25.54
125	2013	217	-8.41	-4.17	11.54	0.15
126	2013	205	2.72	1.22	0.63	-3.37
127	2013	337	-15.66	-16.00	36.73	-25.48
128	2013	262	-10.06	-10.71	5.40	-10.81
129	2013	265	-8.01	-4.41	4.22	1.21
13	2013	370	-0.69	-0.38	15.21	0.08
130	2013	147	-4.30	-3.70	11.52	-0.55
131	2013	265	-8.01	-4.41	8.18	1.21
132	2013	184	-3.32	-2.74	0.48	-4.54
133	2013	158	-4.93	-4.49	8.13	-3.48
134	2013	215	-9.32	-4.78	5.09	-1.92
135	2013	257	-16.96	-15.18	10.41	-29.66
136	2013	247	-0.33	0.46	17.93	25.54
137	2013	244	0.77	0.67	13.09	-1.82

138	2013	214	-3.71	-1.14	33.10	-5.13
139	2013	159	-5.63	-5.34	10.60	-2.59
14	2013	214	-3.71	-1.14	21.74	-5.13
140	2013	202	-6.13	-1.42	9.53	-5.33
141	2013	417	-3.22	-2.73	4.33	-0.65
142	2013	162	-4.33	-4.43	15.19	-5.01
143	2013	194	-7.14	-4.89	1.76	-1.82
144	2013	13	10.38	7.57	22.36	-2.46
145	2013	402	5.71	9.20	15.74	0.49
146	2013	366	-1.40	-1.00	2.28	0.61
147	2013	231	-3.24	-1.76	8.67	2.44
148	2013	121	-4.34	-4.21	13.91	-2.68
149	2013	403	5.91	8.69	31.35	6.77
15	2013	240	-1.61	0.57	4.52	13.67
150	2013	387	10.86	13.05	104.36	-2.35
151	2013	71	-9.64	-7.12	12.15	-2.37
152	2013	195	-2.72	-2.44	6.78	-0.96
153	2013	364	-1.56	-1.16	2.76	0.43
155	2013	231	-3.24	-1.76	9.86	2.44
156	2013	171	-9.08	-9.75	5.35	-2.86
157	2013	249	-0.35	1.42	11.38	-0.55
158	2013	215	-9.32	-4.78	18.41	-1.92
159	2013	71	-9.64	-7.12	12.07	-2.37
16	2013	195	-2.72	-2.44	6.82	-0.96
160	2013	87	-4.09	-3.12	10.84	-2.05
161	2013	253	-8.48	-5.39	9.17	-0.62
162	2013	258	-16.13	-15.46	19.18	-26.26
163	2013	165	-6.66	-7.29	9.81	-12.78
164	2013	77	-2.59	-2.15	9.36	-2.49
165	2013	230	-2.77	-0.90	13.23	2.10
166	2013	375	1.14	0.80	37.84	-4.00
167	2013	216	-13.52	-8.35	6.13	-1.00
168	2013	369	-1.19	-0.76	24.86	1.12
169	2013	188	-2.95	-2.82	6.56	-3.37
17	2013	400	10.13	10.95	4.20	1.18
170	2013	126	-7.38	-6.00	0.27	-5.73
171	2013	135	-6.06	-3.00	3.56	3.51
172	2013	402	5.71	9.20	34.46	0.49
173	2013	241	-1.15	1.57	11.62	15.22
174	2013	96	-3.97	-3.48	14.92	-1.68
175	2013	235	-5.52	-1.89	8.64	-0.61
176	2013	368	-1.00	-0.71	10.64	0.68
177	2013	136	-7.78	-6.44	11.87	-0.53
178	2013	96	-3.97	-3.48	16.80	-1.68
179	2013	199	-8.49	0.05	9.32	29.16

18	2013	161	-5.90	-4.77	11.32	-3.69
180	2013	202	-6.13	-1.42	12.12	-5.33
181	2013	197	-2.33	-2.51	3.28	-4.81
182	2013	13	10.38	7.57	19.94	-2.46
183	2013	209	-6.79	-4.63	19.45	-2.21
184	2013	214	-3.71	-1.14	7.93	-5.13
185	2013	265	-8.01	-4.41	10.00	1.21
186	2013	258	-16.13	-15.46	14.83	-26.26
187	2013	215	-9.32	-4.78	22.68	-1.92
188	2013	190	-3.44	-2.95	9.28	-1.24
189	2013	213	-7.38	-5.35	11.05	-7.73
19	2013	409	-3.67	-4.27	4.60	-4.11
190	2013	202	-6.13	-1.42	10.24	-5.33
192	2013	256	-13.46	-13.77	11.96	-30.77
2	2013	192	-6.12	-4.73	10.91	-5.17
20	2013	256	-13.46	-13.77	7.79	-30.77
21	2013	174	-7.00	-5.69	2.93	-5.89
22	2013	247	-0.33	0.46	22.65	25.54
23	2013	247	-0.33	0.46	1.70	25.54
24	2013	175	-5.34	-5.10	7.40	-6.18
25	2013	311	-7.49	-6.46	14.36	1.10
26	2013	370	-0.69	-0.38	16.11	0.08
27	2013	173	-7.39	-6.17	5.32	-3.50
28	2013	198	-12.07	-7.71	10.04	-0.76
29	2013	254	-12.54	-8.50	2.31	-9.87
3	2013	164	-6.48	-6.34	4.19	-2.14
30	2013	337	-15.66	-16.00	43.17	-25.48
31	2013	232	-1.23	-0.56	18.89	1.89
32	2013	190	-3.44	-2.95	4.28	-1.24
33	2013	217	-8.41	-4.17	21.62	0.15
34	2013	223	-4.45	-1.86	10.38	-0.52
35	2013	349	-12.10	-9.03	9.11	-15.86
36	2013	247	-0.33	0.46	10.81	25.54
37	2013	234	-2.20	-1.25	14.77	5.50
38	2013	246	-1.18	0.08	14.39	17.55
39	2013	12	15.40	11.86	22.27	-0.57
4	2013	190	-3.44	-2.95	14.55	-1.24
40	2013	162	-4.33	-4.43	21.64	-5.01
41	2013	222	-3.93	-2.49	16.86	1.51
42	2013	219	-5.48	-3.45	4.56	0.68
43	2013	67	-7.90	-3.41	15.95	-12.05
44	2013	249	-0.35	1.42	4.45	-0.55
45	2013	230	-2.77	-0.90	13.55	2.10
46	2013	106	-3.70	-3.48	18.29	-1.18
47	2013	368	-1.00	-0.71	2.43	0.68

48	2013	407	0.82	2.16	0.48	-5.25
49	2013	250	-0.69	0.71	23.33	-6.63
5	2013	71	-9.64	-7.12	18.29	-2.37
50	2013	70	-5.03	-3.89	17.84	-5.62
51	2013	202	-6.13	-1.42	4.06	-5.33
52	2013	224	-7.16	-3.35	5.87	2.78
53	2013	383	8.61	6.81	52.98	-0.59
54	2013	161	-5.90	-4.77	0.76	-3.69
55	2013	136	-7.78	-6.44	9.90	-0.53
56	2013	149	-4.43	-4.28	3.84	-4.36
57	2013	188	-2.95	-2.82	9.50	-3.37
58	2013	200	-15.37	-9.37	11.70	-1.56
59	2013	373	0.00	0.40	21.98	0.36
6	2013	14	8.33	6.23	11.59	-2.76
60	2013	247	-0.33	0.46	12.42	25.54
61	2013	135	-6.06	-3.00	0.51	3.51
62	2013	134	0.19	2.59	10.98	0.74
63	2013	260	-12.91	-10.26	7.76	-5.64
64	2013	334	-10.81	-8.81	31.67	-14.99
65	2013	250	-0.69	0.71	6.95	-6.63
66	2013	166	-6.98	-7.44	14.30	-0.85
67	2013	217	-8.41	-4.17	6.04	0.15
68	2013	163	-6.33	-6.06	4.24	-5.08
69	2013	189	-3.33	-3.45	13.48	-2.47
7	2013	233	-1.08	-0.46	17.64	2.71
70	2013	234	-2.20	-1.25	1.94	5.50
71	2013	366	-1.40	-1.00	5.13	0.61
72	2013	189	-3.33	-3.45	13.22	-2.47
73	2013	114	-4.46	-3.81	16.67	-2.59
74	2013	238	-3.86	-2.70	19.37	-0.24
75	2013	177	-4.53	-4.20	6.31	-3.01
76	2013	136	-7.78	-6.44	15.04	-0.53
77	2013	374	0.92	0.93	18.82	-0.95
78	2013	378	1.67	1.33	28.27	0.55
79	2013	199	-8.49	0.05	3.33	29.16
8	2013	366	-1.40	-1.00	2.31	0.61
80	2013	210	-8.13	-5.11	5.65	-2.44
81	2013	251	-3.17	4.41	6.85	9.95
82	2013	263	-3.67	-2.34	0.96	-0.11
83	2013	221	-7.56	-4.51	10.24	-1.02
84	2013	200	-15.37	-9.37	13.21	-1.56
85	2013	369	-1.19	-0.76	9.18	1.12
86	2013	258	-16.13	-15.46	24.96	-26.26
87	2013	102	-3.97	-3.37	24.86	0.63
88	2013	254	-12.54	-8.50	5.86	-9.87

89	2013	210	-8.13	-5.11	12.67	-2.44
9	2013	63	-10.29	-7.26	8.24	24.72
90	2013	11	14.30	10.69	35.45	-1.70
91	2013	74	-2.15	-2.76	30.81	-4.49
92	2013	254	-12.54	-8.50	15.17	-9.87
93	2013	258	-16.13	-15.46	12.67	-26.26
94	2013	253	-8.48	-5.39	23.94	-0.62
95	2013	224	-7.16	-3.35	13.00	2.78
96	2013	248	-0.05	2.11	35.11	17.33
97	2013	246	-1.18	0.08	16.67	17.55
98	2013	240	-1.61	0.57	7.76	13.67
99	2013	184	-3.32	-2.74	2.24	-4.54
1	2015	242	-0.09	1.99	57.91	-15.97
10	2015	378	1.67	1.33	51.26	-3.03
100	2015	194	-7.14	-4.89	2.13	1.73
101	2015	408	-4.86	-4.97	8.85	-18.76
102	2015	411	-6.59	-5.74	3.59	-7.90
103	2015	101	-3.25	-2.84	3.73	-3.59
104	2015	104	-4.49	-3.71	3.33	-3.55
105	2015	408	-4.86	-4.97	13.34	-18.76
107	2015	254	-12.54	-8.50	41.83	1.42
108	2015	190	-3.44	-2.95	0.88	-2.01
109	2015	187	-2.31	-2.63	25.06	-9.75
11	2015	396	2.83	8.70	21.39	0.85
111	2015	211	-8.81	-5.73	8.64	-1.35
112	2015	212	-7.90	-5.28	2.86	-1.22
113	2015	252	-0.48	1.23	47.45	-5.38
114	2015	250	-0.69	0.71	18.97	56.78
115	2015	247	-0.33	0.46	54.97	-3.21
116	2015	366	-1.40	-1.00	36.12	-4.60
117	2015	99	-3.43	-3.13	5.45	-4.25
118	2015	238	-3.86	-2.70	83.88	-1.31
119	2015	135	-6.06	-3.00	21.18	-7.41
12	2015	197	-2.33	-2.51	0.18	-0.94
120	2015	199	-8.49	0.05	46.09	-0.59
121	2015	185	-4.01	-3.59	18.89	-1.91
122	2015	182	-4.18	-3.56	1.55	-3.12
123	2015	352	-4.02	-4.30	33.74	0.77
124	2015	371	-0.31	0.11	32.40	-2.95
125	2015	372	0.09	0.32	27.98	-5.21
126	2015	381	6.33	4.87	86.67	-1.07
127	2015	394	0.34	5.94	80.94	-1.75
128	2015	420	-1.94	-1.69	16.68	-1.31
129	2015	233	-1.08	-0.46	28.15	-4.97
13	2015	182	-4.18	-3.56	0.71	-3.12

130	2015	103	-4.60	-3.43	4.46	-5.10
131	2015	201	-0.76	5.66	28.87	-3.15
132	2015	184	-3.32	-2.74	4.64	-3.34
133	2015	226	-2.45	-1.70	10.31	-0.47
134	2015	99	-3.43	-3.13	3.34	-4.25
135	2015	244	0.77	0.67	85.83	2.08
136	2015	112	-3.93	-3.70	6.30	-6.91
137	2015	364	-1.56	-1.16	12.42	-3.97
138	2015	256	-13.46	-13.77	56.54	-3.92
139	2015	202	-6.13	-1.42	17.46	-3.67
14	2015	202	-6.13	-1.42	19.29	-3.67
140	2015	210	-8.13	-5.11	7.37	-0.77
141	2015	148	-4.73	-4.16	0.71	-2.67
142	2015	244	0.77	0.67	87.10	2.08
143	2015	409	-3.67	-4.27	1.66	-0.85
144	2015	99	-3.43	-3.13	6.02	-4.25
145	2015	197	-2.33	-2.51	1.58	-0.94
146	2015	101	-3.25	-2.84	6.64	-3.59
147	2015	408	-4.86	-4.97	10.47	-18.76
149	2015	373	0.00	0.40	35.95	-2.55
15	2015	348	-6.63	-3.66	39.45	-2.63
150	2015	408	-4.86	-4.97	13.26	-18.76
151	2015	370	-0.69	-0.38	22.89	-2.09
152	2015	366	-1.40	-1.00	14.71	-4.60
153	2015	244	0.77	0.67	89.40	2.08
154	2015	188	-2.95	-2.82	10.30	-3.26
155	2015	366	-1.40	-1.00	16.77	-4.60
156	2015	230	-2.77	-0.90	1.20	1.21
159	2015	179	-3.48	-2.78	5.93	-5.05
160	2015	202	-6.13	-1.42	12.21	-3.67
161	2015	127	-8.23	-7.24	22.11	11.15
162	2015	180	-4.28	-4.15	8.37	-10.38
163	2015	149	-4.43	-4.28	0.83	-5.39
164	2015	234	-2.20	-1.25	23.87	-10.62
165	2015	371	-0.31	0.11	36.51	-2.95
166	2015	219	-5.48	-3.45	24.77	-7.36
167	2015	371	-0.31	0.11	43.33	-2.95
168	2015	175	-5.34	-5.10	8.43	-3.20
169	2015	380	5.68	4.13	75.55	-1.92
170	2015	246	-1.18	0.08	69.26	-29.91
171	2015	244	0.77	0.67	66.00	2.08
172	2015	244	0.77	0.67	71.41	2.08
173	2015	247	-0.33	0.46	65.95	-3.21
174	2015	236	-7.35	-3.82	63.15	-2.51
175	2015	204	5.55	2.83	11.89	-6.97

176	2015	179	-3.48	-2.78	6.68	-5.05
177	2015	190	-3.44	-2.95	3.57	-2.01
178	2015	371	-0.31	0.11	30.71	-2.95
18	2015	225	-4.96	-2.45	32.73	-0.86
180	2015	238	-3.86	-2.70	71.65	-1.31
182	2015	253	-8.48	-5.39	46.12	-1.59
183	2015	193	-5.04	-3.31	0.80	2.76
184	2015	406	-1.20	3.13	77.10	-68.40
185	2015	413	-5.65	-5.90	10.16	-12.79
186	2015	238	-3.86	-2.70	70.62	-1.31
188	2015	223	-4.45	-1.86	19.68	7.83
189	2015	212	-7.90	-5.28	5.53	-1.22
19	2015	105	-3.45	-3.00	12.59	-5.75
190	2015	74	-2.15	-2.76	8.55	-4.84
191	2015	265	-8.01	-4.41	21.33	-0.46
192	2015	179	-3.48	-2.78	2.73	-5.05
193	2015	191	-2.88	-2.73	14.69	0.50
194	2015	247	-0.33	0.46	69.62	-3.21
195	2015	247	-0.33	0.46	65.45	-3.21
196	2015	196	-3.07	-3.01	2.51	-2.78
197	2015	197	-2.33	-2.51	0.14	-0.94
198	2015	244	0.77	0.67	88.81	2.08
199	2015	129	-8.52	-8.49	25.25	-2.39
2	2015	370	-0.69	-0.38	21.90	-2.09
200	2015	244	0.77	0.67	92.51	2.08
201	2015	216	-13.52	-8.35	2.37	-1.91
202	2015	246	-1.18	0.08	58.59	-29.91
203	2015	215	-9.32	-4.78	13.96	-12.58
205	2015	261	-7.83	-7.42	3.73	-8.12
206	2015	128	-8.43	-9.17	41.78	-2.42
208	2015	247	-0.33	0.46	64.62	-3.21
209	2015	202	-6.13	-1.42	16.40	-3.67
21	2015	258	-16.13	-15.46	34.85	-10.16
22	2015	97	-4.10	-3.57	4.42	-6.29
23	2015	71	-9.64	-7.12	2.46	-11.04
24	2015	246	-1.18	0.08	66.67	-29.91
25	2015	394	0.34	5.94	69.65	-1.75
26	2015	194	-7.14	-4.89	3.24	1.73
27	2015	179	-3.48	-2.78	5.56	-5.05
28	2015	196	-3.07	-3.01	1.62	-2.78
29	2015	105	-3.45	-3.00	4.10	-5.75
3	2015	350	-5.46	-4.43	7.64	1.10
30	2015	93	-3.39	-3.75	5.29	-7.23
31	2015	133	-13.48	-12.06	0.45	-2.53
32	2015	366	-1.40	-1.00	15.06	-4.60

33	2015	371	-0.31	0.11	30.51	-2.95
34	2015	180	-4.28	-4.15	8.08	-10.38
35	2015	194	-7.14	-4.89	0.17	1.73
36	2015	377	2.84	1.65	43.90	-0.86
37	2015	107	-3.69	-3.24	3.34	-5.06
38	2015	379	2.71	1.77	62.11	-1.79
39	2015	367	-1.06	-0.68	16.89	-4.81
4	2015	366	-1.40	-1.00	14.02	-4.60
40	2015	244	0.77	0.67	72.26	2.08
41	2015	101	-3.25	-2.84	1.57	-3.59
42	2015	109	-3.54	-3.26	0.46	-7.25
43	2015	378	1.67	1.33	42.87	-3.03
44	2015	371	-0.31	0.11	25.41	-2.95
45	2015	108	-3.20	-3.08	7.60	-6.17
46	2015	180	-4.28	-4.15	9.86	-10.38
47	2015	181	-4.23	-3.87	1.44	-3.55
48	2015	330	-9.02	-5.99	44.48	-11.18
49	2015	182	-4.18	-3.56	1.36	-3.12
5	2015	341	-12.46	-13.42	22.27	35.12
50	2015	167	-8.67	-7.94	8.71	-23.79
51	2015	376	2.02	1.16	56.28	-1.85
52	2015	209	-6.79	-4.63	15.70	-3.14
53	2015	206	-3.10	-1.97	9.03	-9.10
54	2015	180	-4.28	-4.15	9.86	-10.38
56	2015	384	7.09	6.51	108.99	-16.49
57	2015	170	-8.75	-9.81	62.33	-46.44
58	2015	250	-0.69	0.71	70.65	56.78
59	2015	248	-0.05	2.11	61.98	0.06
6	2015	205	2.72	1.22	5.41	-3.00
60	2015	201	-0.76	5.66	1.36	-3.15
61	2015	409	-3.67	-4.27	4.89	-0.85
62	2015	372	0.09	0.32	34.49	-5.21
63	2015	101	-3.25	-2.84	3.88	-3.59
64	2015	98	-3.56	-3.20	4.57	-6.33
66	2015	397	1.73	5.72	28.29	-1.36
67	2015	216	-13.52	-8.35	5.51	-1.91
68	2015	379	2.71	1.77	65.48	-1.79
69	2015	193	-5.04	-3.31	6.05	2.76
7	2015	179	-3.48	-2.78	3.01	-5.05
70	2015	251	-3.17	4.41	55.28	51.51
71	2015	246	-1.18	0.08	61.16	-29.91
72	2015	217	-8.41	-4.17	13.83	-0.18
73	2015	246	-1.18	0.08	70.08	-29.91
74	2015	351	-5.45	-6.37	10.58	27.70
75	2015	352	-4.02	-4.30	13.17	0.77

76	2015	365	-1.26	-0.95	14.61	-4.63
77	2015	105	-3.45	-3.00	5.20	-5.75
78	2015	244	0.77	0.67	86.57	2.08
79	2015	208	-8.52	-5.19	5.38	-0.35
8	2015	24	-5.03	-4.19	4.37	-1.84
80	2015	235	-5.52	-1.89	51.10	-2.45
81	2015	365	-1.26	-0.95	14.71	-4.63
82	2015	186	-1.54	-1.82	9.59	-2.75
83	2015	155	-4.37	-4.49	6.74	-8.04
84	2015	201	-0.76	5.66	10.79	-3.15
85	2015	420	-1.94	-1.69	7.42	-1.31
86	2015	249	-0.35	1.42	105.56	37.59
87	2015	218	-12.44	-7.22	10.16	-6.10
88	2015	186	-1.54	-1.82	10.50	-2.75
90	2015	376	2.02	1.16	53.30	-1.85
91	2015	234	-2.20	-1.25	39.45	-10.62
92	2015	217	-8.41	-4.17	9.02	-0.18
94	2015	195	-2.72	-2.44	1.05	-3.24
95	2015	247	-0.33	0.46	66.46	-3.21
96	2015	196	-3.07	-3.01	26.24	-2.78
97	2015	244	0.77	0.67	82.62	2.08
98	2015	107	-3.69	-3.24	2.92	-5.06
99	2015	198	-12.07	-7.71	0.45	-0.85
1	2017	414	-4.83	-4.52	4.14	-3.25
10	2017	395	2.53	7.64	41.56	17.55
100	2017	408	-4.86	-4.97	17.02	-0.43
101	2017	254	-12.54	-8.50	85.98	-38.76
102	2017	242	-0.09	1.99	44.39	-6.23
103	2017	399	5.79	10.62	74.87	32.14
104	2017	242	-0.09	1.99	46.61	-6.23
105	2017	395	2.53	7.64	47.12	17.55
106	2017	349	-12.10	-9.03	92.50	-58.77
107	2017	187	-2.31	-2.63	8.35	2.52
108	2017	149	-4.43	-4.28	0.80	-8.99
109	2017	363	-1.73	-1.27	9.61	-1.52
110	2017	167	-8.67	-7.94	35.55	-15.13
111	2017	170	-8.75	-9.81	36.36	8.28
112	2017	186	-1.54	-1.82	3.70	-2.27
113	2017	187	-2.31	-2.63	7.31	2.52
114	2017	372	0.09	0.32	31.52	2.95
115	2017	166	-6.98	-7.44	9.41	-11.25
116	2017	166	-6.98	-7.44	28.19	-11.25
117	2017	198	-12.07	-7.71	0.06	-72.26
118	2017	235	-5.52	-1.89	37.18	-22.15
119	2017	340	-18.45	-22.69	73.04	0.73

12	2017	203	-2.98	1.01	49.38	-21.30
120	2017	247	-0.33	0.46	27.92	9.57
121	2017	105	-3.45	-3.00	4.63	-6.55
122	2017	198	-12.07	-7.71	34.40	-72.26
123	2017	236	-7.35	-3.82	48.94	-28.23
124	2017	158	-4.93	-4.49	1.74	-8.64
125	2017	240	-1.61	0.57	62.75	-6.27
126	2017	234	-2.20	-1.25	30.32	-0.56
127	2017	416	-3.13	-2.86	4.22	-5.46
128	2017	204	5.55	2.83	46.06	-29.15
129	2017	233	-1.08	-0.46	14.88	-2.45
13	2017	185	-4.01	-3.59	8.40	-7.07
130	2017	244	0.77	0.67	58.28	-6.48
131	2017	244	0.77	0.67	58.28	-6.48
132	2017	349	-12.10	-9.03	50.12	-58.77
133	2017	164	-6.48	-6.34	7.44	-3.86
134	2017	184	-3.32	-2.74	8.94	-1.84
135	2017	406	-1.20	3.13	48.90	0.34
136	2017	111	-4.12	-3.62	5.05	-5.93
137	2017	242	-0.09	1.99	50.38	-6.23
138	2017	184	-3.32	-2.74	9.55	-1.84
139	2017	168	-8.37	-8.46	28.80	-5.35
14	2017	41	-9.70	-8.99	29.05	-19.81
140	2017	150	-5.05	-4.81	2.97	-9.39
141	2017	218	-12.44	-7.22	44.06	-70.52
142	2017	184	-3.32	-2.74	0.51	-1.84
143	2017	176	-4.86	-4.61	2.64	-1.33
144	2017	185	-4.01	-3.59	2.01	-7.07
145	2017	371	-0.31	0.11	28.40	2.18
146	2017	350	-5.46	-4.43	30.90	-21.54
147	2017	230	-2.77	-0.90	12.00	-23.41
148	2017	150	-5.05	-4.81	2.07	-9.39
149	2017	94	-5.30	-4.36	24.24	-19.39
15	2017	403	5.91	8.69	35.63	42.14
150	2017	361	-2.35	-1.87	10.78	-3.70
151	2017	135	-6.06	-3.00	68.47	-44.29
152	2017	70	-5.03	-3.89	40.61	-25.68
153	2017	168	-8.37	-8.46	122.79	-5.35
154	2017	197	-2.33	-2.51	4.89	-1.86
155	2017	231	-3.24	-1.76	10.71	-20.39
156	2017	253	-8.48	-5.39	59.87	-48.79
157	2017	234	-2.20	-1.25	40.75	-0.56
158	2017	187	-2.31	-2.63	4.78	2.52
159	2017	176	-4.86	-4.61	3.45	-1.33
16	2017	182	-4.18	-3.56	18.87	-8.99

161	2017	157	-4.88	-4.80	3.50	-5.03
162	2017	245	-1.97	-1.17	57.16	-0.61
163	2017	155	-4.37	-4.49	2.68	-2.55
164	2017	172	-7.77	-8.28	34.35	-0.04
165	2017	154	-4.63	-4.55	4.79	-4.61
166	2017	234	-2.20	-1.25	33.08	-0.56
167	2017	106	-3.70	-3.48	2.83	-5.63
168	2017	251	-3.17	4.41	30.47	2.12
169	2017	253	-8.48	-5.39	62.35	-48.79
17	2017	228	-5.47	-3.49	27.25	-22.31
170	2017	161	-5.90	-4.77	21.07	-22.08
171	2017	350	-5.46	-4.43	29.10	-21.54
172	2017	407	0.82	2.16	28.61	-2.64
173	2017	247	-0.33	0.46	39.33	9.57
174	2017	255	-12.95	-13.19	63.58	-15.84
175	2017	255	-12.95	-13.19	69.66	-15.84
176	2017	252	-0.48	1.23	39.97	-25.31
177	2017	360	-2.49	-2.09	16.74	-4.48
178	2017	416	-3.13	-2.86	1.80	-5.46
179	2017	101	-3.25	-2.84	9.00	-8.65
18	2017	251	-3.17	4.41	36.99	2.12
180	2017	198	-12.07	-7.71	1.78	-72.26
182	2017	197	-2.33	-2.51	3.15	-1.86
183	2017	365	-1.26	-0.95	11.66	0.90
184	2017	74	-2.15	-2.76	28.86	-6.17
185	2017	105	-3.45	-3.00	8.55	-6.55
186	2017	180	-4.28	-4.15	12.34	-3.56
187	2017	165	-6.66	-7.29	7.99	-4.89
188	2017	148	-4.73	-4.16	5.53	-15.11
189	2017	350	-5.46	-4.43	47.78	-21.54
19	2017	410	-4.73	-4.66	13.48	-6.18
190	2017	253	-8.48	-5.39	51.66	-48.79
191	2017	101	-3.25	-2.84	5.84	-8.65
192	2017	183	-3.62	-3.82	10.92	-4.22
193	2017	218	-12.44	-7.22	33.58	-70.52
194	2017	184	-3.32	-2.74	2.28	-1.84
196	2017	246	-1.18	0.08	41.81	1.49
197	2017	244	0.77	0.67	79.39	-6.48
198	2017	408	-4.86	-4.97	11.78	-0.43
2	2017	140	-6.36	-6.07	15.65	-18.84
20	2017	388	11.42	14.07	37.43	53.99
201	2017	254	-12.54	-8.50	89.48	-38.76
202	2017	45	-8.01	-7.28	39.01	-23.78
204	2017	253	-8.48	-5.39	63.27	-48.79
205	2017	174	-7.00	-5.69	27.70	-22.65

206	2017	247	-0.33	0.46	28.69	9.57
207	2017	153	-4.97	-4.69	3.87	-8.42
21	2017	240	-1.61	0.57	69.78	-6.27
22	2017	158	-4.93	-4.49	1.78	-8.64
23	2017	112	-3.93	-3.70	3.50	-5.57
24	2017	358	-3.25	-2.65	11.49	-5.96
25	2017	349	-12.10	-9.03	82.61	-58.77
26	2017	413	-5.65	-5.90	6.90	2.13
27	2017	133	-13.48	-12.06	83.84	-28.99
28	2017	181	-4.23	-3.87	0.10	-7.99
29	2017	177	-4.53	-4.20	4.42	-6.89
3	2017	238	-3.86	-2.70	73.51	-16.88
30	2017	367	-1.06	-0.68	11.04	0.86
31	2017	233	-1.08	-0.46	7.28	-2.45
33	2017	353	-4.40	-4.00	14.12	-9.62
34	2017	407	0.82	2.16	26.14	-2.64
35	2017	368	-1.00	-0.71	16.90	1.55
36	2017	263	-3.67	-2.34	25.13	-12.40
37	2017	163	-6.33	-6.06	10.16	-10.41
38	2017	73	-8.76	-7.24	44.65	-35.61
39	2017	182	-4.18	-3.56	3.16	-8.99
4	2017	377	2.84	1.65	31.46	23.28
40	2017	234	-2.20	-1.25	23.54	-0.56
41	2017	236	-7.35	-3.82	48.31	-28.23
42	2017	417	-3.22	-2.73	2.09	-3.45
45	2017	244	0.77	0.67	71.00	-6.48
46	2017	193	-5.04	-3.31	54.74	-34.85
47	2017	242	-0.09	1.99	47.81	-6.23
49	2017	253	-8.48	-5.39	61.83	-48.79
5	2017	143	-4.60	-4.04	5.22	-18.47
50	2017	253	-8.48	-5.39	74.25	-48.79
51	2017	165	-6.66	-7.29	12.81	-4.89
52	2017	186	-1.54	-1.82	11.39	-2.27
53	2017	244	0.77	0.67	44.06	-6.48
54	2017	246	-1.18	0.08	43.43	1.49
55	2017	385	9.18	8.93	35.02	66.80
56	2017	353	-4.40	-4.00	10.57	-9.62
57	2017	236	-7.35	-3.82	69.01	-28.23
58	2017	94	-5.30	-4.36	9.74	-19.39
59	2017	400	10.13	10.95	71.94	39.44
6	2017	198	-12.07	-7.71	2.94	-72.26
60	2017	184	-3.32	-2.74	14.41	-1.84
61	2017	409	-3.67	-4.27	7.15	-16.70
62	2017	357	-3.40	-2.86	14.21	-6.10
63	2017	191	-2.88	-2.73	3.38	-5.68

64	2017	165	-6.66	-7.29	21.72	-4.89
65	2017	191	-2.88	-2.73	13.38	-5.68
66	2017	185	-4.01	-3.59	8.62	-7.07
67	2017	197	-2.33	-2.51	2.37	-1.86
68	2017	363	-1.73	-1.27	10.20	-1.52
7	2017	244	0.77	0.67	41.55	-6.48
70	2017	350	-5.46	-4.43	44.08	-21.54
71	2017	247	-0.33	0.46	31.95	9.57
72	2017	242	-0.09	1.99	38.32	-6.23
73	2017	362	-1.96	-1.52	8.91	-2.63
74	2017	70	-5.03	-3.89	57.29	-25.68
75	2017	172	-7.77	-8.28	32.84	-0.04
76	2017	158	-4.93	-4.49	9.11	-8.64
77	2017	379	2.71	1.77	32.40	23.34
78	2017	186	-1.54	-1.82	16.85	-2.27
79	2017	232	-1.23	-0.56	4.89	-4.12
8	2017	369	-1.19	-0.76	21.12	1.20
80	2017	158	-4.93	-4.49	2.27	-8.64
82	2017	401	7.44	8.96	84.12	30.05
83	2017	168	-8.37	-8.46	33.04	-5.35
86	2017	252	-0.48	1.23	40.66	-25.31
87	2017	179	-3.48	-2.78	1.93	-5.54
88	2017	250	-0.69	0.71	40.28	16.62
89	2017	103	-4.60	-3.43	11.11	-11.85
9	2017	185	-4.01	-3.59	7.76	-7.07
90	2017	263	-3.67	-2.34	24.60	-12.40
91	2017	395	2.53	7.64	45.56	17.55
92	2017	136	-7.78	-6.44	35.02	-36.81
93	2017	244	0.77	0.67	51.58	-6.48
94	2017	400	10.13	10.95	74.26	39.44
95	2017	174	-7.00	-5.69	25.12	-22.65
96	2017	164	-6.48	-6.34	2.58	-3.86
97	2017	169	-9.43	-9.61	44.25	-4.90
98	2017	174	-7.00	-5.69	25.34	-22.65
99	2017	100	-3.69	-3.12	7.98	-9.42