North American Marsh Bird Monitoring

Technical Report No. 2010-001

Ecosystem Science Program, Guana Tolomato Matanzas National Estuarine Research Reserve

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Photo by Tom Barry

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Introduction

Marshes, both fresh and tidal, are sensitive ecosystems that face constant threats from developmental pressures and sea level rise. Marsh birds, simply by nature of the habitat in which they choose to live, are excellent indicators of these ecosystems. Unfortunately, they are also hard to study because of their secretive nature. North American Marsh Bird Monitoring takes this into account and uses a callback survey method, which allows for greater detection of these secretive marsh birds. Using this data allows the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM Research Reserve) to build a baseline dataset of an understudied group of birds, while also allowing the GTM Research Reserve to document the ecological health of wetlands.

Background

The North American Marsh Bird Monitoring protocol was conceived at a Marsh Bird Monitoring workshop hosted by the United States Geological Society and United States Fish and Wildlife Service at Patuxent Research Reserve in 1998. The protocol was written largely by Dr. Courtney Conway from the University of Arizona, and has been refined multiple times since then to keep up to date with the most recent science. Dr. Mark Woodrey brought the concept to the National Estuarine Research Reserve national meeting in the fall of 2006 as a proposal to join in this national effort.

Effort to Date

Marsh Bird monitoring was performed in the Research Reserve’s tidal marshes in the spring of 2009 and in both tidal and freshwater marshes in 2008. The primary species, as determined from the North American Marsh Bird Monitoring protocol, was the Clapper Rail; secondary species included Common Moorhens, Pied-billed Grebes, Soras, King Rails, Saltmarsh Sparrows, and Marsh Wrens.

Concerns

There are several environmental concerns that make the study of marsh birds important. A few of the most important considerations are prey availability and health of habitat. All the species we studied use macroinvertebrates as a major food source. Impacts to the food source could quickly impact the marsh bird populations. Also, for the *Rallidae* family members, hunting is still a potential concern. Accurate take numbers for these species is entirely unknown, and while estimates tend to be relatively low, there is enough uncertainty around the numbers to need more accurate information to assess how much of a concern hunting represents. Development is also always a concern, as it causes a direct habitat loss. The final, and perhaps largest concern, is the potential effects of climate change and sea level rise. These could be the most grave of all impacts to these birds, as marshes change in response to the climate. Monitoring of this aspect alone could prove to be extremely useful data over time.

Results and Discussion

Distance sampling was used on the data from 2009 to estimate densities of breeding birds, and returned a number of 5.0 Clapper Rails per hectare, with a 95% confidence interval range of 2.0 to 12.4. The confidence interval was very wide, as expected, due to a limited number of samples. As the monitoring continues, data will give a more accurate idea of densities. The limited number of samples came from a variety of issues relating to the national protocol. It was very difficult to adhere strictly to the national protocol, which gives very general directions. Some of the specific issues of the national protocol for our area included access to sites, relative abundance of appropriate habitat and how to randomly sample that habitat, and what species to monitor.

No comparable data analyses from the Southeast were available. However, as long as data is being collected, future comparison is always a possibility.

Conclusions and Recommendations

Overall, it appeared that the number of Clapper Rails found in our area was relatively high, though without much to compare to it is difficult to assess. A very interesting bit of side data was that the St. Augustine Christmas Bird Count, which encircles much of the GTM Research Reserve, returned the highest Clapper Rail count in the country in 2008. In order to draw more local conclusions, this project must continue into the future. Local results may become apparent in just a few years, but trends and more specific analysis will likely require more time. Some of the primary initial questions and goals of this project, including use of marsh birds as environmental indicators and measuring breeding marsh bird population trends, will only be answered and assessed as data continues to be gathered. In addition to continuing monitoring efforts, questions to address in the future may include how the density of wintering rails compares to the density of breeding birds, and how our populations compare to other sites, once other sites have data to compare to.

INTRODUCTION

Emergent wetlands are an ecosystem of concern for coastal communities in Northeast Florida. They have declined precipitously in the past century (Tiner 1984), and continue to decline in recent years, especially in coastal areas (Stedman 2008). There are many species of birds that rely on these wetlands for their survival, and many of these appear to be declining (Tate 1986, Eddleman et al. 1988, Conway et al. 1994, Conway and Sulzman 2007, Conway 2008). Studying these species of birds that are dependent on emergent wetlands may prove to be important not only for those particular species, but also as indicators of wetland health. Because birds are highly mobile, if characteristics important to successful reproduction in an ecosystem decline precipitously, the population is likely to reduce rapidly as birds leave to find more favorable habitats. Along with drastic changes, subtle declines can also be indicated by certain species such as Clapper Rails. Clapper Rails have relatively high site fidelity, and also feed on benthic organisms, illustrating a direct link with the marsh environment. If heavy metals, polychlorinated biphenyl, or other environmental contaminants are present, Clapper Rails can accumulate these toxins through a majority of their food selection. These contaminants can affect DNA strand breaks and eggshell integrity, both of which can cause population declines over time (Novak, 2006).

Another quality of an environmental indicator is having the ability to be measured. Unfortunately, standard bird surveys such as the Breeding Bird Survey and the Christmas Bird Count do not adequately detect inconspicuous birds such as rails. For these reasons, the North American Marsh Bird Monitoring program was instituted at the Guana Tolomato Matanzas National Estuarine Research Reserve in order to determine baseline data for marsh birds, monitor long term population trends, and to use these investigations—along with ecological linkages—to develop a possible indicator of ecosystem health.

STUDY SITE

The Guana Tolomato Matanzas National Estuarine Research Reserve (hereafter referred to as GTM Research Reserve or the Research Reserve) is located in Northeast Florida, situated along the coast of St. Johns and Flagler Counties. Because of the coastal location, a large portion of the GTM Research Reserve—approximately 21,000 acres—is comprised of tidal marsh, dominated primarily by smooth cordgrass (*Spartina alterniflora)* and black needlerush (*Juncus roemerianus)*. The concern over marsh health is well justified, as emergent wetlands face threats from development, dredging, climate change, and sea level rise (Stedman 2008). The North American Marsh Bird Monitoring program will be one component the Research Reserve will use to track trends in ecosystem health.

BACKGROUND

The North American Marsh Bird Monitoring protocol was conceived at a Marsh Bird Monitoring Workshop hosted at Patuxent Research Refuge in 1998 by the U. S. Fish and Wildlife Service (USFWS) and the U. S. Geological Survey (USGS), because the need to begin studying marsh birds had been recognized. Many of these birds, commonly called "secretive marsh birds," are thought to be rare or in decline, including several state and federally listed species (Conway 2008). The USFWS, recognizing the need for more data, has participated in this program from the outset. Because of the large amount of emergent vegetation managed by the USFWS under the National Wildlife Refuge system, a large quantity of data was collected in a few years. While this was a very good start to the program, because there is so much variation in marsh bird populations and habitats, information from more sites is needed to improve these data. The protocol used for this survey has been refined several times since the outset, with the most recent updates as of January, 2008. These revisions were made in response to the National Marsh Bird Monitoring Annual Conferences, in order to keep current with the most up to date science, and to clarify the protocols in order to achieve uniform data collection. The goal of the North American Marsh Bird Monitoring program is to estimate breeding populations of "secretive marsh birds" as accurately as possible.

A proposal for the National Estuarine Research Reserve System to implement North American Marsh Bird Monitoring was submitted by Mark Woodrey in the fall of 2006. The proposal was for each NERR site to begin monitoring in order to meet the goals of the North American Marsh Bird Monitoring Program, specifically to

1. Determine the population status and breeding distribution of marsh birds
2. Determine species-habitat associations of marsh birds
3. Determine population trends of marsh birds at local (NERR site), regional, and national geographic scales as well as various temporal scales
4. Determine the environmental factors that influence distribution of marsh birds

5. Increase local volunteer (birders or birdwatchers) participation in research and monitoring programs

A few Research Reserves have begun monitoring due to Woodrey's proposal, including GTM Research Reserve in the spring of 2008. Woodrey also provided guidance in planning the tidal marsh survey for the 2009 season. As more NERRs become involved with the North American Marsh Bird Monitoring, there will be more opportunities for data comparison and greater regional and national assessment capabilities.

The primary species of interest for this program include the Rallidae and Ardeidae, Rails and Bitterns. At GTM Research Reserve, the primary species of interest included Clapper Rails and Least Bitterns, but many secondary species are also of interest, including American Bitterns, King Rails, Virginia Rails, Soras, and Common Moorhens. Also, simply because of being in the right place at the right time, we record observations of Marsh Wrens and Saltmarsh Sparrows, though they are not included in the callback. The classification of these species that utilize the salt marsh is shown in Figure 1.

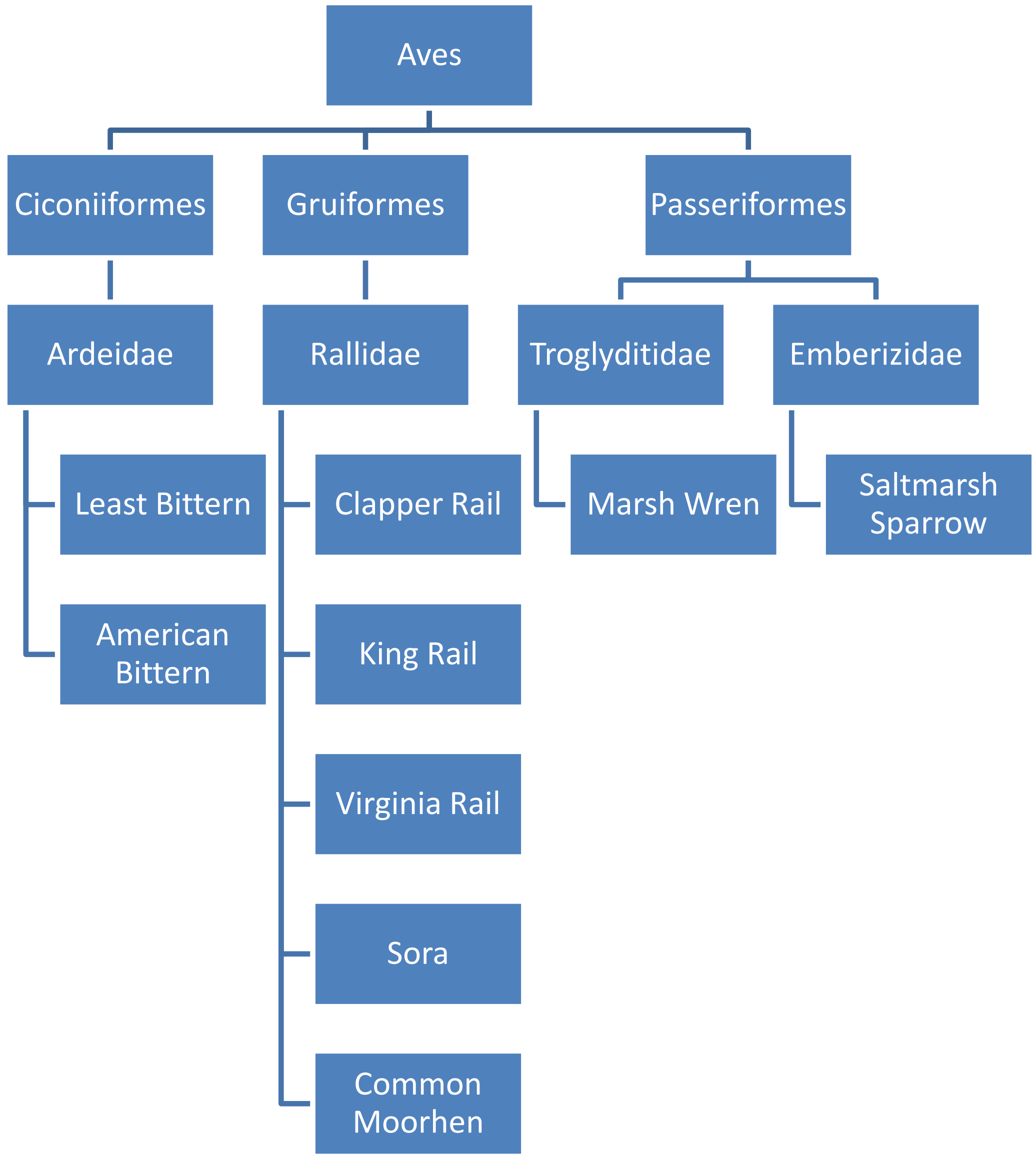

Figure 1: Taxonomic classification of target species

EFFORT TO DATE

GTM Research Reserve initiated the North American Marsh Bird Monitoring program in the spring of 2008. Initial sites were chosen using vegetation data derived from the Florida Natural Areas Inventory mapping project of the Guana River Wildlife Management Area and the Emergent Marsh mapping project for the GTMNERR by the St. Johns River Water Management District. Many of the randomly selected study sites were found in ground truthing to be dominated by upland vegetation, so even though there was also emergent vegetation present, habitat was not suitable for marsh birds. This issue was not well documented in the North American Marsh Bird Monitoring protocol available during the preparation of the 2008 survey (Conway 2005). Surveys were conducted in these areas, with very limited results. Many of the original points and routes were discarded in 2009 after deeming much of the habitat unsuitable for marsh birds (see Figure 2).

In 2009, the program was to concentrate on GTM Research Reserve's dominant emergent vegetation habitat, tidal marsh, and then expand to other emergent vegetation habitats in future years. Of the 75,000 acres in the management boundary of the GTM Research Reserve, approximately 21,000 acres consist of tidal marsh, making it by far the dominant emergent vegetation habitat type (Dahl 2009). Because these marshes are well flushed and nearly marine in salinity, Clapper Rails were the primary survey target. The tidal marsh data set will be useful for initial baseline data and population trends in the future. The points from 2008 that were retained were the sites in the Guana River transect, south of the Guana River dam, because of their suitability for marsh birds.

Figure 2: Survey site 9A, Route 10, 2008 (left), compared to Survey site 02, TM, from 2009 (right)

LIFE HISTORY ACCOUNTS

Clapper Rail

Clapper Rails (*Rallus longirostris*) and Least Bitterns (*Ixobrychus exilis*), as the primary representative marsh birds of the tidal and freshwater marshes in the GTM Research Reserve, are the two species of primary concern for monitoring and trend analysis at GTM Research Reserve. Clapper Rails of Northeast Florida (*R. l. waynei*) are a bird of the salt marsh, spending their entire lives there (Stevenson and Anderson 1994). Clapper Rails belong to the family *Rallidae,* in the order *Gruiformes.* There are seven common subspecies of Clapper Rails in North America, the Northern Clapper Rail (*R. l. crepitans*), Wayne Clapper Rail (*R. l. waynei*), Mangrove Clapper Rail (*R. l. insularum*), Florida Clapper Rail (*R. l. scottii*), Louisiana Clapper Rail (*R. l. saturates*), Light-footed Clapper Rail (*R. l. levipes*), Yuma Clapper Rail (*R. l. yumanensis*) and California Clapper Rail (*R. l. obsoletus*). Wayne Clapper Rails are the breeders in Northeast Florida, while Mangrove Clapper Rails, Louisiana Clapper Rails, and Florida Clapper Rails are breeders in southern Florida, the panhandle, and western (Gulf Coast) Florida, respectively (Lewis 1983). Florida is also the wintering grounds for Northern Clapper Rails. The three Clapper Rails that do not occur in Florida are the western U. S. subspecies, the Yuma, California, and Light-footed Clapper Rails.

Like many other marsh birds, Clapper Rails feed primarily on small crustaceans and insects. They forage along the water's edge, opportunistically capturing and eating nearly anything in view and reach, as well as probing into the marsh mud for more sedentary invertebrates. Lewis lists their food selection as parasitic worms (*Ascaridae*), clam worms (*Nereis* spp.), snails (*Molulidae*), crabs (*Sesarma* spp., *Uca* spp.), insects, spiders (*Lycosa* spp., *Clubiona* spp.), fish (*Poeciliidae*, *Fundulus* spp.) and plant material (Lewis 1983). This food selection, due to its benthic nature, could result in the accumulation of environmental contaminants, a reason in itself to monitor this species (Odom 1975, Conway 1995).

Clapper Rails are ground nesters. They build nest platforms in *S. alterniflora* with vegetation ramps to try to avoid tidal flooding, but still in close proximity to water. On tidal creeks in Georgia, Clapper Rail nest locations averaged 3-8 meters from the water's edge (Lewis 1983). Because of this nesting habitat selection near water, high tides from a single storm event can eradicate an entire population's nesting attempts. In the same way, sea level rise over a long period of time could be detrimental to marsh birds, reducing habitat availability (Wilson, personal communication). Clapper rails must rebuild their nest platforms every year, as the unstable environment removes them on at least an annual cycle (Gaines 2003). Even a very slight increase in magnitude or frequency of high tides and storm events could have a drastic impact on rail nesting success.

Least Bittern

Least Bitterns belong to the family *Ardeidae*, in the order *Ciconiiformes*. While sharing some habits with Clapper Rails, Least Bitterns have some distinct differences. Least Bitterns are more often found in freshwater areas, especially in cattail marshes. Their breeding range in North America covers approximately the eastern half of the United States and the southern edge of eastern Canada. In the fall, most Least Bitterns migrate around the gulf, wintering in southern Central America and northern South America. In central and south Florida, however, Least Bitterns are present year-round.

Figure 3: Least Bittern, photo by Donna Bear-Hull

Least Bitterns are very adept at foraging above deeper water by clinging to reeds and grasses, moving from stalk to stalk, without ever stepping on solid ground. This allows them to effectively use a deeper water area not used by most of the other herons and marsh birds (Gibbs 1992). Least Bitterns feed primarily on fish, salamanders, tadpoles, frogs, leeches, slugs, crayfish, dragonflies, other insects, and occasionally shrews and mice, taken primarily from the surface or near surface of the water (NYNHP 2009).

Least Bitterns weave their nests into the vegetation from six to 24 inches above water level. Nests often sink to rest on the water's surface as the young take on mass. Nests are typically located adjacent to a patch of open water, in most cases less than 20 feet away (Weller 1961). Some of these aspects of Least Bittern nesting habits, in conjunction with choosing freshwater marshes for their breeding habitat, protect them from some of the dangers faced by birds breeding in tidal marshes. However, freshwater marshes have been in decline over the past century, due largely to development pressures, and still continue to decline in recent years (Stedman and Dahl 2008). Also, some sea level rise models show significant impacts on coastal freshwater marshes. High salinity water inundation could cause conversions from freshwater marshes to tidal marshes (Ning 2003). This conversion would cause a decline in breeding habitat for Least Bitterns.

Secondary species

Species of lower monitoring priority, as defined by the North American Marsh Bird Monitoring protocol, but which are still included in our survey, include Soras (*Porzana carolina*), American Bitterns (*Botaurus lentiginosus*), Common Moorhens (*Gallinula chloropus*), and Pied-billed Grebes (*Podilymbus podiceps*). Soras and Common Moorhens are in the *Rallidae* family (order *Gruiformes*), while American Bitterns share the *Ardeidae* family (order *Ciconiiformes*) with Least Bitterns, egrets and herons. Pied-billed Grebes are in the order *Podicipediformes,* family *Podicipedidae*.

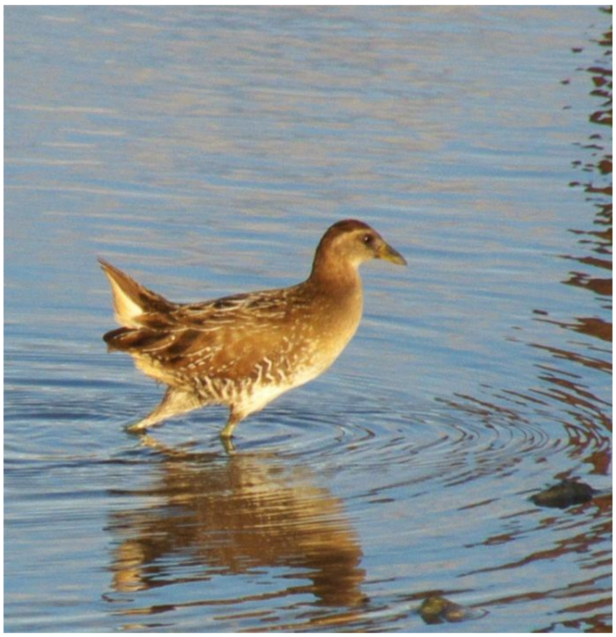

Figure 4: Sora, photo by Andrew Thornton

Sora and American Bittern

Soras and American Bitterns are on the list due to general recommendations from the program manager, Dr. Conway, of the North American Marsh Bird Monitoring program. Neither of these species is likely to breed in our survey area, and since the North American Marsh Bird Monitoring program is aimed at recording breeding populations, they will be removed in the future. However, removal will not happen before the 2010 survey, as in 2009 no freshwater marshes (where Soras and American Bitterns would be found) were surveyed. If no Soras or American Bitterns are recorded in the freshwater surveys of 2010, they will be removed from the 2011 surveys.

Common Moorhen and Pied-billed Grebe

Common Moorhens and Pied-billed Grebes are both primarily found breeding in freshwater marshes. As such they face the same issues as Least Bitterns, primarily habitat loss. Pied-billed Grebes and Common Moorhens both build nests of floating vegetation, which can be lost in seasonal flooding. Common Moorhens feed primarily on vegetation and snails, sometimes foraging underwater but primarily feeding from the surface. Pied-billed Grebes feed on fish and aquatic invertebrates, especially crayfish, diving for long periods to catch both, often taking prey from the benthos. Common Moorhens breed over the eastern United States, wintering in Florida and Central America, while Pied-billed Grebes breed throughout the United States, and winter virtually anywhere surface water remains unfrozen. Both of these species are common and currently of low conservation concern, though Pied-billed Grebes do seem to be declining on the edges of their range (Muller 1999, Bannor 2002).

Other recorded species

Marsh Wrens (*Cistothorus palustris*) and Saltmarsh Sparrows (*Ammodramus caudacutus*) are also recorded, both of which are species of the salt marsh and face many of the same threats to their populations as Clapper Rails. Their songs are not broadcast, however, and they are only recorded as present or absent.

Saltmarsh Sparrows

Saltmarsh Sparrows are in the family *Emberizidae,* in the order *Passeriformes*. They are on the National Audubon Society's top 20 watch list for imperiled species. They, like Clapper Rails, nest on the intertidal ground and their success is highly dependent on re-nesting success after high tide events (DiQuinzio 2002). In Maine, a study was done on mercury contamination in sharp-tailed sparrows that found Saltmarsh Sparrows had higher concentrations of mercury in their blood than other species using identical habitat. One hypothesis of why Saltmarsh Sparrows had this higher concentration was due to food selection (Shriver 2002). Saltmarsh Sparrows have a larger, more powerful bill than other passerines in the marsh, and therefore may be going after larger prey. If this hypothesis is correct, prey availability, which could be affected by sea level rise and human impacts, could impact different species of marsh birds in varying intensities. If the larger prey Saltmarsh Sparrows prefer are no longer available, their populations could crash while others in the same marsh could continue to prosper. Whether the prey selection difference is true in our area, and how that affects their long-term population, is unknown, but should be of concern. More detailed studies will be planned or promoted if trends in the presence/absence of this species exhibits significant declines.

Marsh Wrens

Marsh Wrens are also *Passeriformes*, but in the *Troglodytidae* family. They weave spherical nests in reeds and grass, usually a good distance above the water, making their breeding success less dependent upon high tide events (Kroodsma 1997). They eat almost exclusively insects and spiders found in the marsh grasses, primarily Beetles (*Coleoptera*), Flies (*Diptera*), True bugs (*Hemiptera*), and Dragonflies and Damselflies (*Odonata*). Marsh Wrens are both bigamous and monogamous, males defending larger territories of higher densities of marsh grasses seem to attract more females to mate, perhaps due to the higher food and nesting habitat availability (Gutzwiller 1987). Also, site fidelity is fairly low, with only approximately 10% of male Marsh Wrens returning to nesting areas from the previous year. This allows for individuals to select the best habitat every year, but it also creates intense population shifts when habitats change. Previously drained wetlands that have been restored can be an important breeding habitat for these adaptable birds (Zimmerman 2002). Worthington's Marsh Wrens (*C. p. griseus*), the subspecies found in our survey area, is state listed as a species of special concern by the Florida Fish and Wildlife Conservation Commission. Their range is primarily north of the St. John's River, extending to South Carolina along the Atlantic coast, but several individuals were documented on our survey. It is possible the southern edge of their range is not well understood. Continued monitoring of this subspecies in the GTM Research Reserve's boundary could offer valuable observations for the southern limit of this species' range.

Future Recorded Species

King Rail

King Rails (*Rallus elegans)* are closely related to Clapper Rails in the Rallidae family, but unlike the Clapper Rails of Florida, King Rails are primarily found breeding in freshwater marshes. Identification between the two is extremely tricky, with some individuals so intermediate that sure identification is not always possible in the field. For the purposes of marsh bird monitoring, differentiation is less important than in collecting the data for both species, so all King/Clapper Rail types that respond during breeding season in the freshwater marsh will be recorded as King Rails. As no freshwater marshes were surveyed in 2009, King Rails were not on the list. They were not on the list in 2008, either, based on recommendations from the National Marsh Bird Monitoring Protocol. However, they are known to breed locally, so they will be added to the survey list for 2010 freshwater marsh surveys.

There is only one known subspecies of King Rail in Florida, *R. e. elegans*, which breeds over most of Florida. In the United States, their breeding range extends south and east from Southeastern North Dakota over to Maryland and Florida, not including most of the Appalachians (Meanley 1992). King Rails forage in much the same way as Clapper Rails do, in shallow water or on shore, eating crustaceans, mollusks, small fishes, insects, seeds, and other plant matter (Stevenson, 1994). They build their nests in a similar fashion to Clapper Rails, although their choice of habitat remains freshwater marshes as opposed to tidal marshes. The vegetation mat nest is often resting just on or above the water, and typically a ramp is built up into the nest. This also leaves them susceptible to flooding, though in this case from storm events as opposed to high tides. Just like all the marsh nesting birds, King Rails' productivity is directly linked to their ability to quickly renest after flood events.

CONCERNS

One concern that spans all the species included in this survey is prey availability. All the species mentioned use insects as part of their diet: the presence or absence of this important prey could be a determining factor in population changes. One interest at the GTM Research Reserve is in the effects of mosquito control on the invertebrate populations. Concurrent studies are ongoing in the freshwater marshes of the GTM Research Reserve to determine baseline invertebrate species list and population abundances. If these studies detect changes in aquatic invertebrate population composition, these changes will be compared to the marsh bird information gathered from this monitoring effort, with additional investigation into prey availability in the tidal marsh habitat communities of the GTM Research Reserve.

Another concern for all the populations of the members of the *Rallidae* family is harvest from hunting. Florida allows hunting of most rail species, including Soras, Clapper, King, and Virginia Rails, Common Moorhens, and American Coots. Clapper Rails, King Rails, Common Moorhens, and American Coots limits are all 15 per day, 30 in possession. Soras and Virginia Rails are 25 for daily and total possession (FFWCC 2009). Sample size from the Harvest Information Program has been too small to reliably report data for migratory bird take while at the same time Sora, Virginia Rail, and King Rail are all known to be in decline (Sauer 2007). In 2006, the National Survey of Fishing, Hunting, and Wildlife-related Recreation conducted by the U. S. Fish and Wildlife Service found that in the state of Florida there were 236,000 hunters that hunted for a total of 3,769,000 days. A rough estimate of 47,000 rails taken was given, though it was based on limited survey results (USDoI 2007). In the 2008-2009 seasons, again survey results were not considered to be from a large enough sample size, but the U. S. Fish and Wildlife Service extrapolated hunting numbers from a five-year average (2003-2007). Results from this data analysis was considered very inaccurate, but estimates for the Atlantic Flyway (which includes Florida, Georgia, North Carolina and South Carolina) for 2007 for Sora, Virginia, Clapper, and King Rails take are 15,700 +/- 47%, and for 2008 estimates are 33,100 +/- 52%. There were no numbers derived for American Coots, and numbers for Common Moorhens were less robust than the other rails. Nearly all (2,900 of 3,000) of the harvest of Common Moorhens in the Atlantic Flyway from 2008 was considered to be from Florida, though the data collected is a very rough estimate: 2,900 +/- 151% (Raftovich 2009). The possibility of intensive hunting is a conservation concern for populations of marsh birds that appear to be in decline from current national assessments, and which the take from recreational hunting is roughly estimated at best.

The combination of Clapper Rails and Least Bitterns as our species of primary focus presents a timing challenge that many other survey sites do not face. Clapper Rails begin breeding in our area in early March and use tidal marsh, while Least Bitterns do not begin breeding until May and use freshwater marshes. To adequately survey for both species, our survey would span from early March through the end of May, 75 days instead of the 45 day time span of most sites. Because the protocol does not provide the option for two different callback methods between routes, we used the same sound file for all survey sites. This makes a longer list of species being played than most other survey sites in the national program, which means our surveyors spend more time at each survey point: one minute of settling after the boat engine is off, five minutes of silence, and six minutes of calls, resulting in 12 minutes of actual survey time at each site. Spending 12 minutes at each site limits the number of points which can be surveyed on each route, which in turn requires more routes, and thus more effort days, in order to reach the suggested number of survey points. Several options are being reviewed in an attempt to solve these issues to ensure statistically valid sampling for the experimental design. The most likely option would be to split tidal and freshwater marsh habitats into two completely separate survey sets, and use different playback lists for each.

METHODS

The methods for conducting the North American Marsh Bird Monitoring in 2009 were taken directly from the most recent protocols, updated January of 2008 (Conway 2008). However, the setting up of the survey, while generally described in the protocol, required much more planning than provided for in that document. For site selection, the protocols require survey points to be 400 meters apart on the intersection of emergent vegetation and either uplands or water. However, this stipulation does not include planning for access or random selection. Access is very important in terms of the amount of time each survey route takes, and random selection is vital for creating reasonable population estimates for the GTM Research Reserve. Solving these issues turned out to be a particular challenge for our area, as exhibited by the 2008 survey where survey routes took place in upland habitat with some emergent vegetation, and some were only able to access 4 points before meeting the time limit criteria.

The primary source of vegetation community information came from the National Wetlands Inventory Conterminous United States wetland polygon feature class, a GIS layer from the U.S. Fish & Wildlife Service (Dahl 2009). The attribute "tidal marsh" was selected and clipped in order to find the salt marsh habitat. The majority of the tidal marsh within the Research Reserve's boundary was found to be adjacent to the Intracoastal Waterway, so it was decided to approach these surveys by boat, allowing the sites to be tidal marsh bordering on water, as opposed to tidal marsh bordered by uplands, the two options allowed by the protocol. Three routes were created by randomly selecting a route origin point, the Tolomato North, Tolomato Middle, and Tolomato South routes. Tolomato South was discarded due to time constraints, to leave the Tolomato North and Middle routes, along with the previously created Guana Route, as the three routes used for the tidal marsh survey in 2009.

For the Tolomato routes, where travel over the course of the route was several miles, a motorized boat was needed. A 16-foot Wahoo with a 50 horsepower Mercury motor was used for those two routes. In the earlier protocols, boat use for access was not allowed. However, in the most current (2008) protocol, boat access is allowed with the stipulation of including a one-minute settling period before beginning the five minutes of silence. There was no settling period for the Guana route, as it was accessed by canoe and not motorized boat. Upland access had been a great difficulty in the past, with some routes from 2008 only reaching four sites within the allowed time frame. Using boat access, routes on the Tolomato were able to encompass 8 and 9 points. Conversations with more experienced biologists ascertained that this would be the best way to reach the largest number of points on the marsh interface, and consequently allow for the largest sample set of survey sites for the marsh, and better statistical power of determining population statistics (M. Woodrey, personal communication, 2008).

A canoe was used for the Guana River route because there was no close access to a boat ramp and it is a very shallow water system with a high tidal range. The canoe was launched from the south side of the Guana River Dam and paddled south approximately one mile. This route begins with the southern-most point and progresses northward. This route, because of the shallow water system, has its own unique challenge. At low tide, it is sometimes impossible to navigate the canoe closer than 50 feet to the point. To avoid this problem as much as possible, surveys were scheduled for high tides.

The Tolomato routes were created by generating three random points using the random point tool in ArcMap 9.3 (Environmental Systems Research Institute, 2008) on the boundary between the water body shapefile, from the St. Johns Water Management District, and the emergent vegetation shapefile, from the National Wetlands Inventory. The resulting random points were used as the starting point of each survey route, which were named Tolomato North, Tolomato Middle, and Tolomato South. Routes were built by placing additional points in no less than 400 meter intervals, as determined by appropriate habitat and accessibility by boat. The website www.random.org was used to create a random spreadsheet of ones and twos. Which side of the Tolomato the next survey point in the sequence fell on was determined by this random number set. A two meant the point would be placed on the West side, a one meant the East side. The number of sites within each survey was determined by the total time it took to reach the initial survey site from the boat ramp and the time the survey itself would run at each point. The end time of 10:00 am was chosen in 2008, and was adhered to in 2009 as well. The number of points per survey was chosen based on the shortest day of the surveying season. All surveys began at sunrise, and lasted for approximately three hours. Choosing an end time is important in terms of detection rates. The marsh birds on the survey tend to be most active and most vocal in the morning. Ending the survey in mid-morning ensures uniform detection across all sites (Nadeau 2008).

The random origin point for Tolomato North was created approximately 1 kilometer south of the Palm Valley boat ramp, off of State Road 210. Tolomato Middle origin was created just north of Pine Island, and Tolomato South was created on the west side of the Intracoastal approximately halfway along the Guana peninsula. The third route, Tolomato South, was never successfully surveyed due to weather conflicts with scheduling. Due to the probable weather conflicts that would arise in future years, and for statistical strength, it was decided to concentrate on getting three replications of each of the three routes surveyed successfully (Tolomato North, Tolomato Middle, and Guana) rather than sacrificing some replications of each route attempting to achieve surveys over a broader area (L. Sachs, personal communication, 2009).

The carrying out of the survey followed the North American Marsh Bird Monitoring Protocol (2008). A very important feature of the North American Marsh Bird Monitoring protocol is the use of call-broadcast surveys. Call-broadcast surveys are used to elicit responses from otherwise hard to detect birds, increasing the probability of vocalization (Conway and Nadeau 2006) without decreasing the probability of observation (Nadeau 2008).

The survey itself is fairly simple. Prior to the call broadcast portion of the survey, there is a period of silence, during which any detections are also recorded. This portion of the survey allows us to estimate detection probability and analyze the data without the biases associated with the call-broadcast technique.

Our call broadcast survey sequence used in 2009 was the following:

5 minutes of silence
30 seconds of Least Bittern calls
    30 seconds of silence
30 seconds of Sora calls
    30 seconds of silence
30 seconds of Clapper Rail calls
    30 seconds of silence
30 seconds of American Bittern calls
    30 seconds of silence
30 seconds of Common Moorhen calls
    30 seconds of silence
30 seconds of Pied-billed Grebe calls
    30 seconds of silence

Figure 5: SansaClip mp3 player and Genius SP-i200 speakers

Species were chosen based on both the National Marsh Bird Monitoring program's website (http://ag.arizona.edu.arnr/research/coop/azfwru/NationalMarshBird) and local breeding bird information (Stevenson 1994). The original call sequence from 2008 included Virginia rail. Virginia rail does not breed in our area, however, so it was removed after the first year. Soras and American Bitterns, still on our call list, probably do not breed in our area either, even though they are common as wintering birds. They will continue to be included in the survey for 2010, but if responses are limited and birds do not appear to be breeding, they will be removed.

Saltmarsh Sparrows and Marsh Wrens were also recorded, though they are not on the call broadcast list. They are not listed among the primary species of concern from the National Marsh Bird Monitoring program, but they are listed as secondary species. Both of these species are of concern for other reasons, so they will continue to be recorded.

Equipment used for broadcasting calls was a SansaClip mp3 player, connected to Genius SP-i200 speakers (see Figure 5). This combination is light-weight at just over 300 grams, and still provides adequate volume. The volume turned up to maximum on both mp3 player and speakers varies between 80-85 dB read at 1 meter distance. The national protocol requires sound pressure to be 80-90 dB at 1 meter, and because both volumes are simply set to max, there should be no variability between users. Speaker volume was tested on a regular basis using a Schosche SPL1000 decibel reader. The speakers were placed at the bow of the vessel being used (either the 16-foot Wahoo or a canoe) and pointed in the appropriate direction, perpendicular to the marsh edge facing into the marsh.

A 2008 Trimble GeoXT with ArcPad 7.1 was used for navigating to the survey points. Prior to the start of the survey, PVC markers were installed at these points to facilitate finding sites. The markers were approximately 1 meter of ½" diameter PVC, with a T-connector on top painted with a route color and then the site number. Tolomato North is yellow, Tolomato Middle is red, and Guana is white. The PVC was installed over a five-foot section of steel rebar for better stability (see Figure 6). This facilitated the finding of the exact location of each survey point.

Figure 6: Installing PVC over steel rebar

Estimating distance is very important for estimating density. By estimating distance to every bird detected, distance sampling can be used to estimate population density by habitat type. Distance was noted on the data sheet for every bird detected. No aids for estimating distance were used: rangefinders do not function well in the salt marsh, and markers require more time and effort than was available before the survey season began, with questionable improvement of estimation. Markers would improve visual distance estimation, but in marsh bird monitoring surveyors are performing audible distance estimation.

Use of the data sheet by volunteers for data recording required a significant amount of training effort. The date is recorded in the format of day-month-year, with month being written as a 3-letter abbreviation to avoid confusion (e.g. 17-JUN-2009). The unique route name is recorded, along with the replicate number for the current year. All observers present are recorded, to track potential observer bias. Weather information (temperature, wind speed, cloud cover, and precipitation) is recorded from the weather station at the Research Reserve's Environmental Education Center prior to going on a survey, and information for the end of the survey is recorded from the same source. When arriving at a survey point, the unique identifying mark is written down along with the time when the survey was started. If a bird is detected, either a 1, S, or 1S is recorded in the appropriate time slot (before, silent minutes 1-5, Least Bittern, Sora, Clapper Rail, American Bittern, Common Moorhen, and Pied-billed Grebe call broadcasts). A 1 is used if the bird is only heard, S if the bird is only seen, and 1S if a bird is both seen and heard.

The type of call heard is recorded (see Figure 7 for a list of calls associated with each target species), along with direction and distance from survey point. Background noise is noted as often as it changes, and a comment section is often used for noise sources (see Appendix A for an example of the survey data sheet).

Species	Standardized Call Name	Sibley name	BNA name	Possible function
AMBI	pump-er-lunk	bloonk-adoonk	pump-er lunk and dunk-a-doo	mate attraction, territorial signal
AMBI	chu-peep	chu-peep	chu-peep	during copulation ceremony
AMBI	kok	kok-kok-kok	kok-kok-kok or haink	when flushed
CLRA	clatter	clapper	Clapper or Clatter; chock-chock ; caccac-cac or jupe-jupe-jupe	mate communication
CLRA	kek	ket	kek-kek-kek, kik-kik-kik, bup-bup-bup	mate attraction
CLRA	kek-burr	ket-ket-karr	kek-burr	
CLRA	kek-hurrah	grunting	kek-hurrah	
CLRA	hoo		Hoo; oom-oom-oom	
CLRA	squawk		Screech or Shriek; Chase Squeal or kak	alarm call, territorial disputes
CLRA	prrr		purr; agitated purrrr; churr	
COMO	cackle	pep-pep-pehr-peehr		cackle – ka-ka-ka-ka-ka-kee-kree-kree kree
COMO	keek	kulp, keek	squawk, yelp, cluck	
COMO	kr-r-ruk			
LEBI	coo	poopoopoo	coo or cooing ; tut-tut-tut	mate attraction
LEBI	kak	rick-rick-rick	gack-gack	mate communication, alarm call
LEBI	ert	kuk	tut-tut-tut; quoh, hah or cackle	alarm call
LEBI	ank-ank	0	ank-ank	when flushed
PBGR	donkey bray	ge ge gadum gadum gwaaaaow	series of wut, whut or kuk notes followed by 4-20 kaow or cow notes	courtship, communication btw pair, territorial
PBGR	chatter	chatter	ek-ek-ek, hn-hn-hn	greeting call
SORA	whinny	whinny	decending whinny	territorial defense, mate communication
SORA	per-weep	kooEE	per-weep; ker-wee; ter-ee	mate attraction?
SORA	kee	keek	kee or weep	alarm call

Figure 7: Call types of marsh birds on broadcast list

Surveys were not conducted in periods of sustained rain or heavy fog, as well as when wind speeds were over 20 km/hr. If a survey was initiated and conditions deteriorated, the survey was called off and data was discarded. Only data from completed surveys were used. The goal for surveys at the beginning of the season was to complete 5 survey replications, in the time periods March 20-31, April 1-10, April 11-20, May 1-10, and May 11-20. This encompasses the entire known breeding timeframe for the all marsh birds in our area (Stevenson 1994). Future time periods will be set in 15 day increments, to correspond with the National database. More time for achieving replications will also be useful in ensuring all replications are made, increasing the quality and quantity of the data collected from year to year. The time frames in 2010 will be March 16-31, April 1-15, and April 16-30 for the tidal marsh surveys, and April 16-30, May 1-15 and May 16-31 for the freshwater marsh surveys.

As each survey was completed, data was entered into the Marsh Birds Population Assessment and Monitoring Project Database, hosted by the Patuxent Wildlife Research Center at http://www.pwrc.usgs.gov/point/mb/ . Data was quality checked after it was entered. After all data for the year was collected, analysis for Clapper Rails was performed using Distance 6.0 release 2, a free statistical software program for estimating density based on distance estimates (Thomas et al, 2010). Data was downloaded from the Marsh Birds Population Assessment and Monitoring Project Database as a MS 2007 Access database. A query was run for all data from the 2009 season, and converted to a MS Excel 2007 spreadsheet. The raw data download comes in the format of one individual line for each Clapper Rail detection, as well as for each survey point where no detections were recorded. This is the layout required for the program Distance 6.0, but is not very useful for graphing applications. Data was condensed in the Excel spreadsheet to reflect total number of Clapper Rail detections per point, per replicate, which allowed for a variety of visual representations of the data.

For the Distance analysis, data from the spreadsheet was converted into a .txt file, with the basic table format of Route, Site, and Distance as the header row, and then each individual survey site replication, plus each individual clapper rail detection, as the rows. For 2009, 143 Clapper Rails were detected at 62 site replicates, with 17 sites having no detections, resulting in a table of 161 lines (including the header). See Appendix B for a table of the raw data. Sites were labeled with a three number identifier, where the first two numbers are the site ID, and the third number is the replicate ID. For example, for Guana site 02 for the second replicate, the label would be G022.

Entering the data into Distance is a fairly complex process in which an understanding of the analytical processes is required. The book *Introduction to Distance Sampling*: *Estimating abundance of biological populations* (Buckland et al, 2001) was a vital resource in setting up the initial analysis. Each individual step in the process was checked through this resource, in the attempt to perform the most valid analysis. See Appendix C for a list of step-by-step instructions on setting up the Distance project and entering data. Essentially, the data was analyzed as a typical Point count transect, with truncation at 200 meters, grouping of the data in 50 meter intervals, and survey effort modified by each individual point based on the percentage of marsh habitat within a 200 meter radius circle. The survey effort was found by creating a 200 meter buffer ring around each point, then analyzing each point's habitat based on the Emergent Vegetation Scheme shapefile for St. Johns County, provided by the St. Johns River Water Management District. The habitat of "Tidal Marsh" was chosen for what could be hosting breeding Clapper Rails, from which a percentage was found for each survey site's 200 meter radius area. See Appendix D for a list of tidal marsh percentages per site.

The actual Distance analysis is simple to use. For the marsh bird survey, the numbers were right truncated at 200 meters, and data was grouped with four intervals, 0-50, 51-100, 101-150, and 151-200 meters. This grouping was done in order to overcome some heaping issues (observers tending to round distance estimation to a large whole number) with the data. After grouping, goodness of fit test was checked and found to be acceptable for our data analysis.

Other than Distance, a variety of charts and graphs were made in MS 2007 Excel to visually represent different aspects of the data. These various graphics are displayed and discussed in the results and discussion.

RESULTS

Data from 2009 were provided to the national database via the Patuxent Wildlife Research Center's (under USGS) website (http://www.pwrc.usgs.gov/point/mb/) and then downloaded at the end of the season as a MS 2007 Access database for site specific analysis. Of the 20 surveys planned, 8 surveys were conducted between March 10th and May 31st, with a total of 143 birds recorded. As expected, a high percentage (136/143, 95%) of the birds recorded were Clapper Rails, the target species of our 2009 survey. Also recorded were 3 Marsh Wrens and 4 Saltmarsh Sparrows, both secondary species. The analysis program Distance 6.0 release 2 was used to analyze population densities, which gave an estimate of 5.0 clapper rails per hectare of tidal marsh, with a 95% confidence interval (CI) of 2.0 to 12.4 (Thomas 2010). Total ideal habitat within the Northern boundary of the Research Reserve equals 4268 hectares, resulting in a gross abundance of 21,340 Clapper Rails (CI 8,536-52,923). Comparing these data to information found in the North American Waterbird Conservation Plan, GTM Research Reserve had a fairly average density. Georgia reported 2.2 and 4.7 individuals/ha (from two different studies), New Jersey 3.2/ha, 8.4/ha in Virginia, and 9.95/ha in Mississippi (Kushlan 2002). However, these numbers have unknown analyses behind them, and may not have had comparable survey methods to GTM's survey. But these are some of the only comparable data readily available. By showing GTM's known confidence interval, it is possible to see our data's upper and lower end of the confidence interval encompasses both the minimum and maximum densities compared to the data from *Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan* (Kushlan 2002).

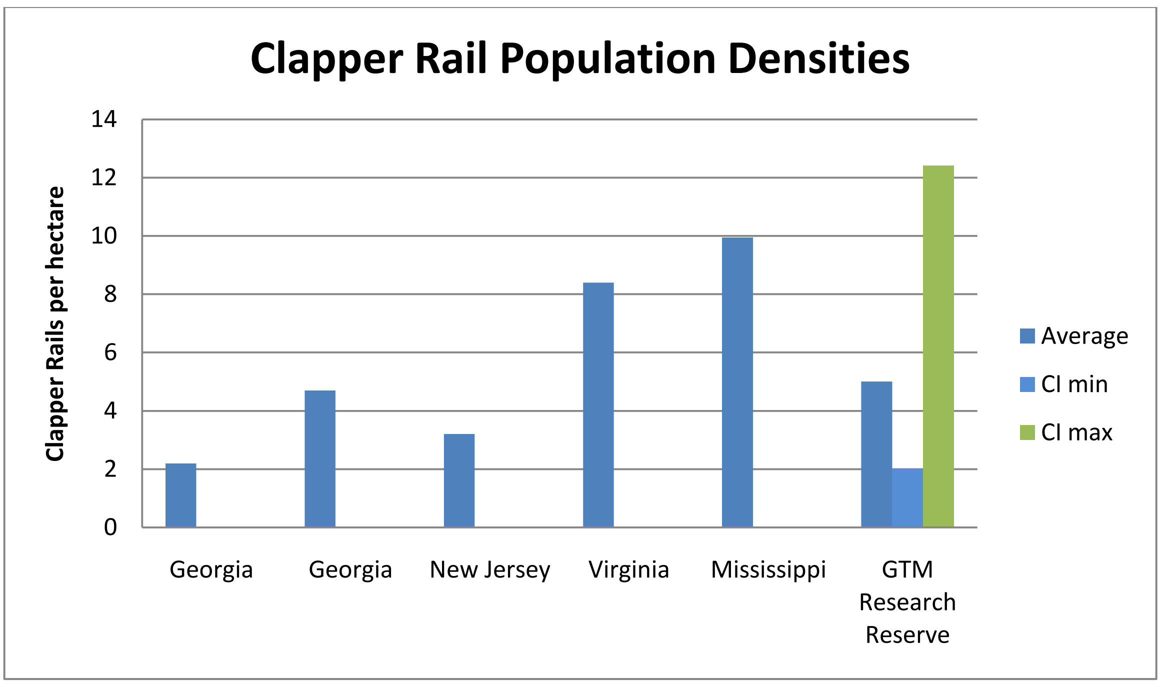

Figure 8: Clapper Rail Population Density comparisons

The southern component of the Research Reserve has approximately the same amount of estuarine wetlands (4,600 hectares) based on the Conterminous United States (CONUS) wetland survey (Dahl 2009). Although no surveys were done in the southern component, the habitat is likely to be fairly similar, although more mangroves are present, as the reserve encompasses the northern extent of the black mangrove (*Avicennia germinuns*). If numbers for the southern component can be extrapolated from the surveys done in the northern component, the Clapper Rail population of the entire Research Reserve boundary would be 44,340 birds (CI 17,736-109,963).

Eleven other sites from Florida, Georgia, Alabama, South Carolina, and North Carolina are conducting North American Marsh Bird Monitoring. Data from each site was pursued for comparative analysis; however, none of the other sites are conducting site specific data analysis. Two sites have shared their raw data, but abundance and species diversity varies widely even within Florida, making the data relatively incomparable. At Hungeryland Wildlife Management Area, the primary species recorded are Sandhill Cranes and Purple Gallinules, neither of which breeds within the Research Reserve boundary. At the Florida Panther and Ten Thousand Islands National Wildlife Refuge, surveys are conducted in the summer, and encompass primarily King Rails and Purple Gallinules. In future years, as we add freshwater marsh habitats, we hopefully will record King Rails in our area, and be able to compare our breeding population densities to those of Florida Panther NWR.

Individual survey counts for the sites are another source of possible interest, especially in terms of identifying areas that may show population change over time. A few sites stick out as high or low right away, though many of the highest numbers come from Tolomato Middle, and this route has only two visits. G03 and TN06 both show up as low sites, with zeroes for all three visits. This table (Figure 9) also shows some of the dramatic variation between surveys. For example, looking at the first survey for Guana, the first four sites all had zeroes. However, with the six count from the last site, this entire survey becomes similar in total to the other two surveys for the Guana route. It is important to note how variable the detections for each point are before attempting to draw conclusions from these data.

Site		Count	
	Survey 1	Survey 2	Survey 3
G00	0	1	3
G01	0	1	1
G02	0	2	5
G03	0	0	0
G04	6	2	3
TM00	6	5	n/a
TM01	2	2	n/a
TM02	2	4	n/a
TM03	1	1	n/a
TM04	3	2	n/a
TM05	3	8	n/a
TM06	2	4	n/a
TM07	7	9	n/a
TN00	2	0	0
TN01	2	0	0
TN02	6	2	0
TN03	1	0	0
TN04	3	0	4
TN05	2	5	5
TN06	0	0	0
TN07	5	1	7
TN08	4	6	3

Figure 9: Raw Count Data per Survey Site

There are three graphs related to these numbers in Appendix E, all of which further illustrate possible differences in Clapper Rail detections by individual sites. These graphs illustrate the number of Clapper Rails detected per survey site, per replicate, with each graph showing one route: Guana (G), Tolomato North (TN), or Tolomato Middle (TM).

The following graph (Figure 10) represents the minimum, maximum, and average counts per site within each survey, arranged chronologically. There do seem to be some differences to note, such as the relatively high medians and maximums of the Tolomato Middle surveys. The accompanying graph (Figure 11), shows the same data but arranged by route first, then chronologically. This adds another interesting detail, in that the Tolomato Middle and Guana Routes both seem to increase in detections later in the survey season, while Tolomato North increases from the second to third survey, but the highest survey was the first of the season. Looking at this data may help us to find the peak detection time specific to our area.

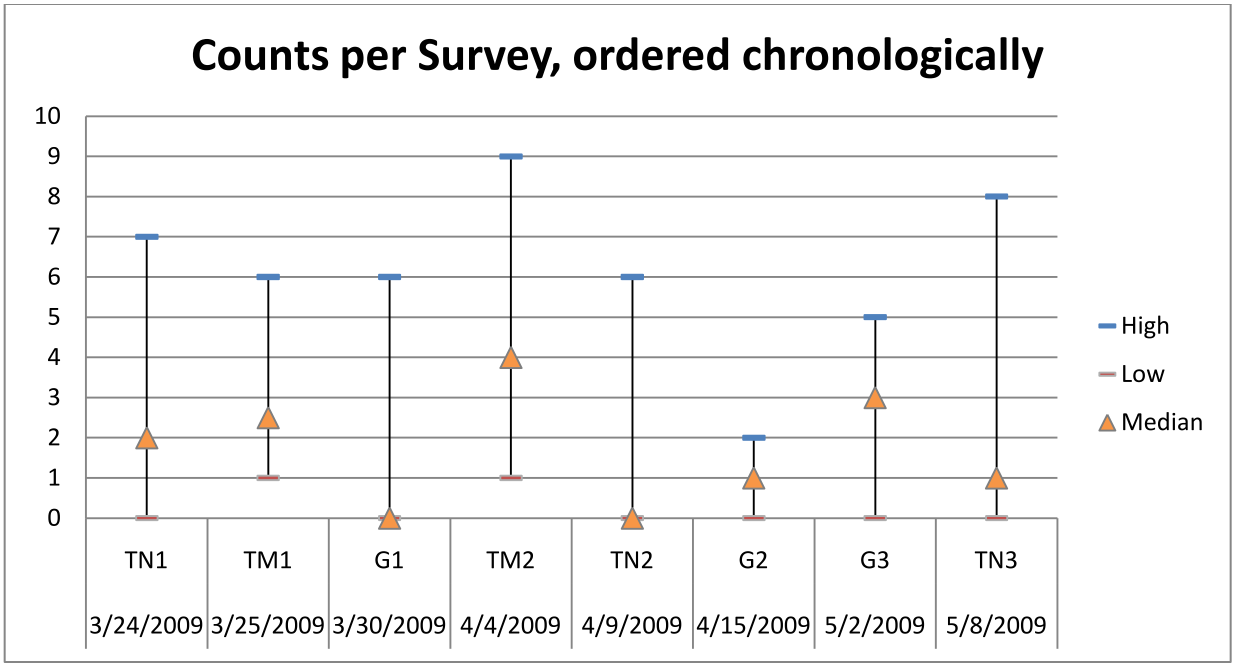

Figure 10: Clapper Rail counts per survey, chronological

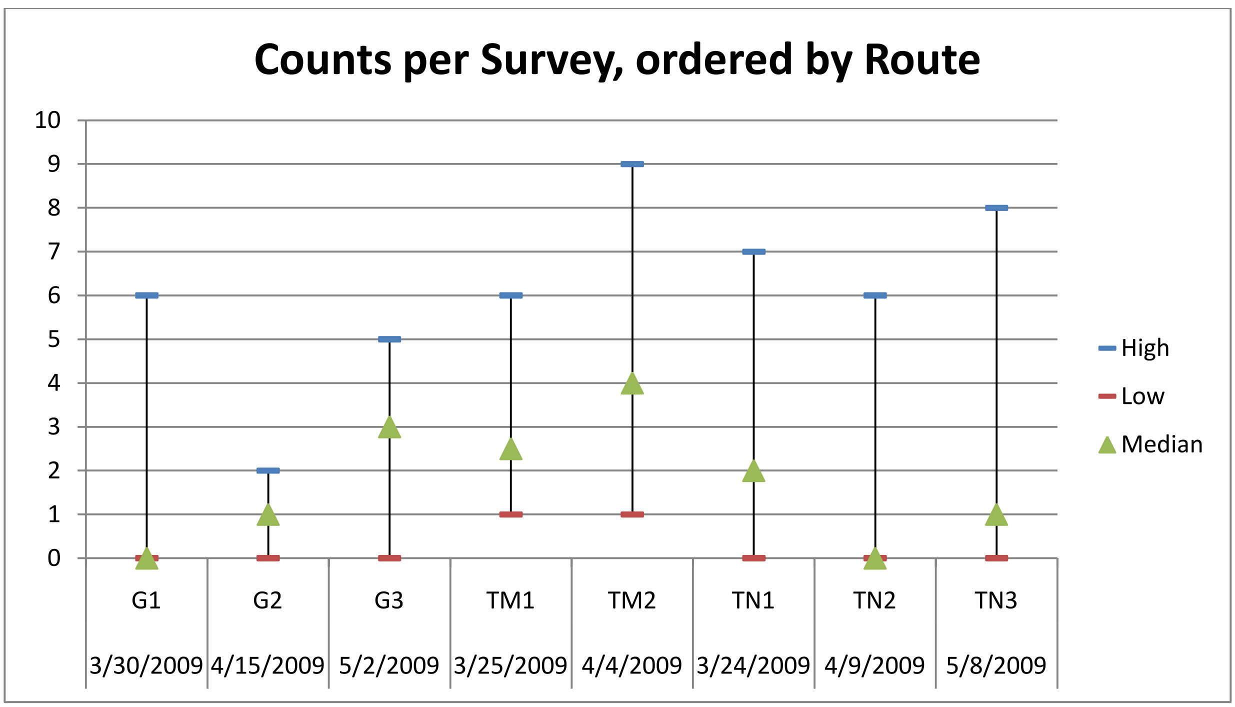

Figure 11: Counts per survey, by Route

This next graph (Figure 12) follows the same structure as figures 10 and 11 in representing the minimum and maximum counts per site, but in this figure it is left at individual site representation, and due to fewer numbers per points, average was used instead of median. Using median resulted in many zeroes for the sites with few surveys. Tolomato Middle has two data points per site, while the Tolomato North and Guana have three. Possibly the most interesting aspect of this graph is the relatively high counts from Tolomato Middle.

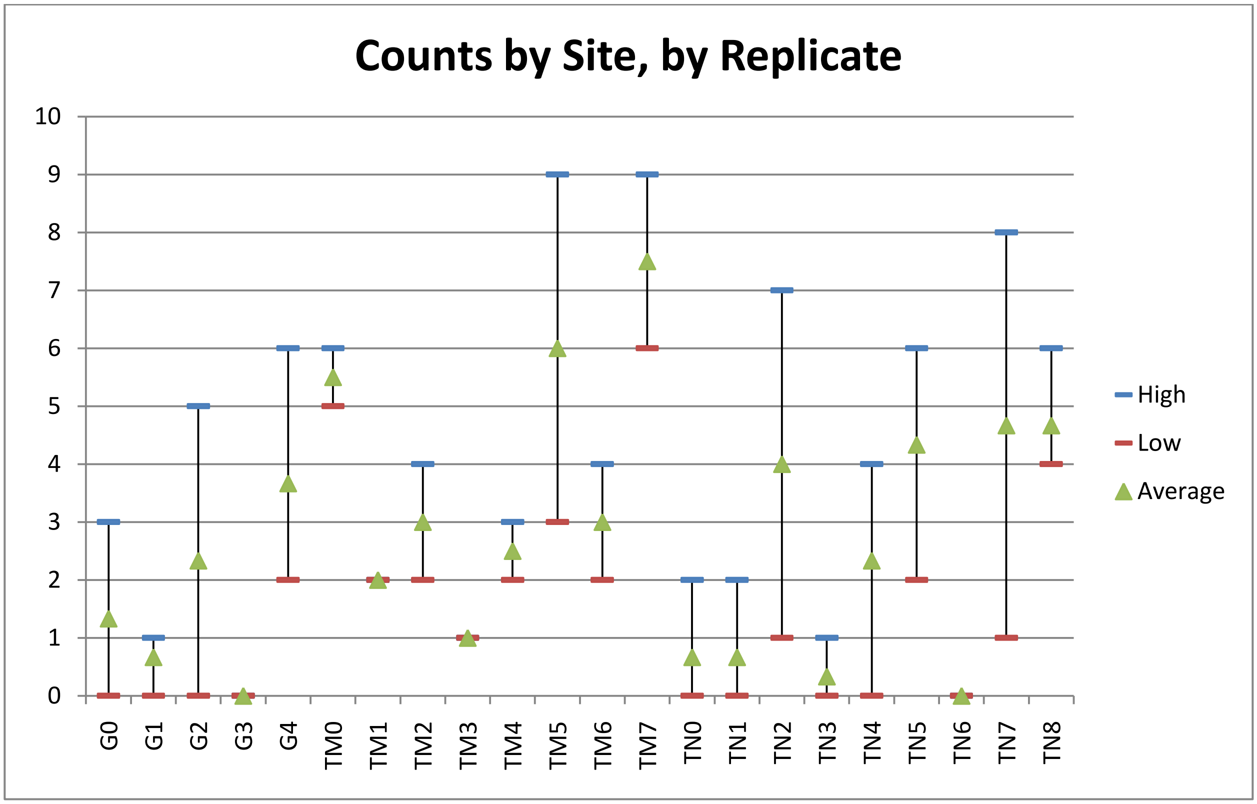

Figure 12: Count high, low, and average by site

It is possible that in the future, averages for each site can be used to illustrate differences in habitat preference. However, the original theory behind selecting these sites was that they were relatively uniform, so showing a significant difference would be unexpected. These graphs may be most useful in isolating points that are inappropriate for surveys.

DISCUSSION

By the close of the season it was apparent that there were several issues with strictly adhering to the 2008 National Marsh Bird Monitoring protocol. One of these issues was the sample size goal for the survey of 50 sites. As mentioned briefly in the methods, Tolomato South was never successfully surveyed. This led to the question of which would be more useful in determining population trends in the Research Reserve: to survey a greater area with decreased likelihood of completing all surveys due to weather and rescheduling, or to survey a smaller area with greater consistency of data collection. After consultation with a statistician, it was thought that it would be more statistically powerful to have regular repetitions for individual survey routes than to inconsistently survey a larger area (L. Sachs, personal communication, 2009). Due to this consultation, the Tolomato South will not be surveyed in 2010, leaving three routes with 22 survey sites.

Another issue was the timing of the replications. The protocol called for three replications in 15 day increments, but in the 2008 survey the windows were set in 10 day increments. Through an oversight, we continued the 10 day increments in 2009, which was found to be difficult to complete due to weather cancellations. The protocol calls for the survey to be called off and the data thrown out if wind speed ever gets above 20 kilometers per hour, or if there is heavy fog or rain. Springtime in Northeast Florida has a low percentage of favorable condition days for surveys. Attempting to complete four surveys in each ten day period, all the while adhering to the weather protocol, proved to be impossible. The total completion of 8 out of 20 surveys shows this difficulty. In the month of May alone, Northeast Florida experienced two solid weeks of rain, which canceled 6 surveys. Extending each period by 50% will help ensure all replications are completed, as well as make our methods match the National protocol.

Surveys conducted in 2008 were done in areas where the habitat could be described as wet, but was often not dominated by emergent vegetation, as is the requirement for the North American Marsh Bird Monitoring protocol. Because of this habitat selection, detection rates were much lower in 2008 than in 2009. However, limiting habitat selection to tidal marsh only solved part of the problem. The 2009 season only included tidal or saltwater marsh habitats (see Appendix F for a map of the survey routes from 2008 and Appendix G for the 2009 survey routes). Different species of marsh birds choose marsh habitat depending on the salinity content, and other corresponding factors (Weller 1994). In 2009, Clapper Rails were the primary species surveyed for. This focus worked well in detecting Clapper Rails, but other emergent marsh habitats were not included. Because of this, no freshwater species were recorded, and species diversity was lower. Future surveys will be planned to include freshwater emergent vegetation habitat, with a focus on least bitterns. The majority of freshwater marshes are on the northern reaches of the Guana River Impoundment in the Guana River Wildlife Management Area, so most of these surveys will likely take place in that area of the GTM Research Reserve.

In 2010, the initial plan will be to create an entire new survey, focused on freshwater habitats. Surveying freshwater marshes as well as tidal marshes will add diversity to the study, as well as monitoring another important habitat which is still in decline. While freshwater marshes do not face many of the same threats tidal marshes face, they are still at risk due to development and from tidal marsh expansion (Stedman 2008 and Ning 2003). After performing a power analysis, numbers of survey sites per year was found to need to be around 25 in order to be able to reach statistical significance in a few years time. The current survey has 22 sites, which will remain and will be consistently surveyed as the tidal survey, and a new survey will be set up in freshwater marsh areas only, with an initial goal of 25 survey sites. This may be harder to set up, as the emergent vegetation within the boundary of the Research Reserve is skewed largely towards saltwater marshes. Using a more specific classification of freshwater emergent vegetation habitat than that used for the 2008 survey, there will be a smaller area available to survey for the 2010 season. However, the smaller area will be a result of more strict guidelines which will more closely match the requirements of breeding habitat selection of freshwater marsh birds.

The process of setting up a survey specifically for the freshwater marshes brings into question what species should be included in the call broadcast. With two separate habitats being surveyed, it becomes reasonable to split the freshwater marsh survey from the saltwater survey, reporting data and performing analysis separately. This would solve another problem mentioned earlier, that of spending 12 minutes at each survey site because of the broad range of marsh birds in the callback list. Separating the surveys into tidal and freshwater habitats allows the use of two separate callback sequences. For the tidal marshes, potential species to include are Clapper Rails, American Bitterns, and Pied-billed Grebes. For the freshwater marshes, Sora, Least Bittern, American Bittern, Common Moorhen, and Pied-billed Grebe would be used. This would reduce the total time of the tidal surveys to 9 minutes, and the total time for the freshwater surveys would be 10 minutes. Lessening the total time spent at each site may allow for more sites to be surveyed in the normal course of the morning, resulting in more data per effort day. While we will be splitting the surveys in the future, it will become impossible to strictly follow the National Marsh Bird Monitoring protocol. The protocol requires that all sites play identical callback lists. However, we can report the data from each set as separate surveys, satisfying the protocol requirements for each marsh type. It is likely that most sites do not survey in both tidal and freshwater marsh areas, making the situation at the Research Reserve fairly unique.

After solving most issues with the initial protocol, this survey will begin to run regularly after the 2010 season. Part of the issues from 2008 and 2009 stemmed from having different staff in charge of the survey. After having two set working surveys in effect for 2010, it should be simple to repeat this survey in subsequent years. Having two survey years that were so different in scope and process also made comparing the data between 2008 and 2009 very difficult. The best comparisons are probably in terms of birds recorded per survey effort, as this shows the changes in improved habitat selection for the surveys. For 2008, there were 6 birds per survey route, and in 2009 there were 16. Unfortunately, over half the scheduled surveys in 2009 were cancelled due to weather, so even though the detections per effort increased, total number of birds was not very different from 2008. The approach to data analyses in the future will probably be to discard most of the data from 2008, with the exception of the Guana Route, which will continue to be surveyed.

Another interesting aspect of the Clapper Rail response was how often they responded as pairs. This survey was structured as a breeding survey, and both Clapper Rails of a pair will vocalize, which is what our data seem to reflect. These next three graphs (Figures 13-15) illustrate the distance of detections relative to each point. Clapper Rails that are the same distance and direction away from the observer are noted with a yellow highlighted border. Other observations may be Clapper Rails that are not yet paired, one of a pair responding while the other avoids detection, or one of a pair responding while the other is not in the immediate vicinity. Also, aside from showing the frequency of paired responses, individual points may show statistical differences over time, based on the relative amount of appropriate habitat type per point. For example, perhaps TN00 may not have detections over 50 meters away because of how narrow the tidal marsh habitat is at that point, while TN02 may overlook a large area of marsh, explaining how there are more detections further away. One difference that shows up between the three routes is that the distances from the Guana Route seem to be overall less than the other two routes. There are two likely explanations for this: one is that the marsh of the Guana Route is smaller, and therefore appropriate habitat does not extend as distantly from the observer as the other routes. Another is that the Guana Route is very near the ocean, and in almost all circumstances, noise levels were high on the Guana Route because of the surf. These are conjectural explanations, but more data may strengthen these explanations. Over time this study may be able to explore possible theories more thoroughly.

Analysis to this point has entailed using the program Distance 6.0 to get density estimates. In addition, various graphs have been created to show different aspects of the data, as outlined and discussed earlier in this paper. No trends have been statistically analyzed at this stage, only interesting aspects noted. In future years, after multiple years of survey data collected, trends will be analyzed.

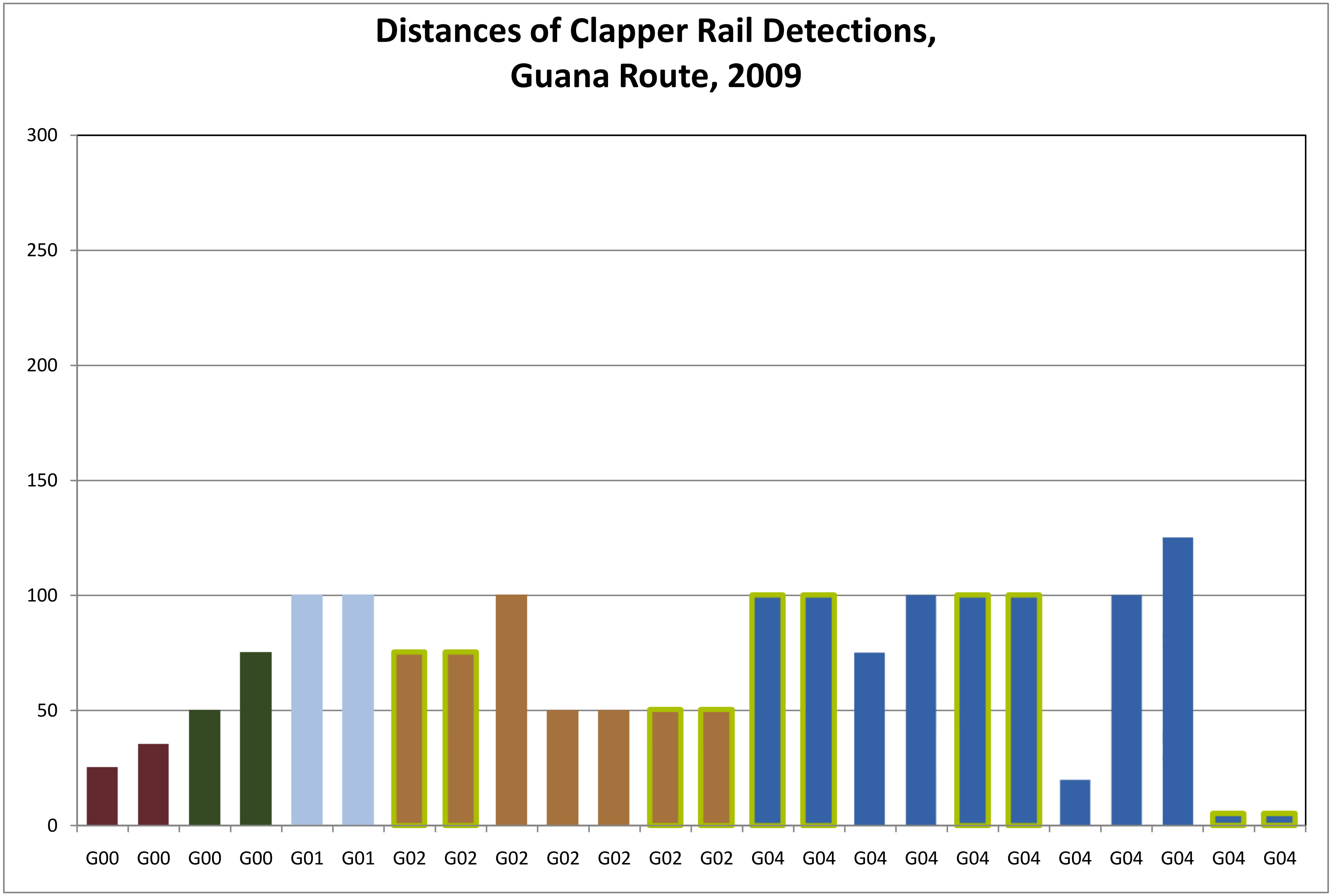

Figure 13: Distances to Clapper Rail Detections, Guana Route

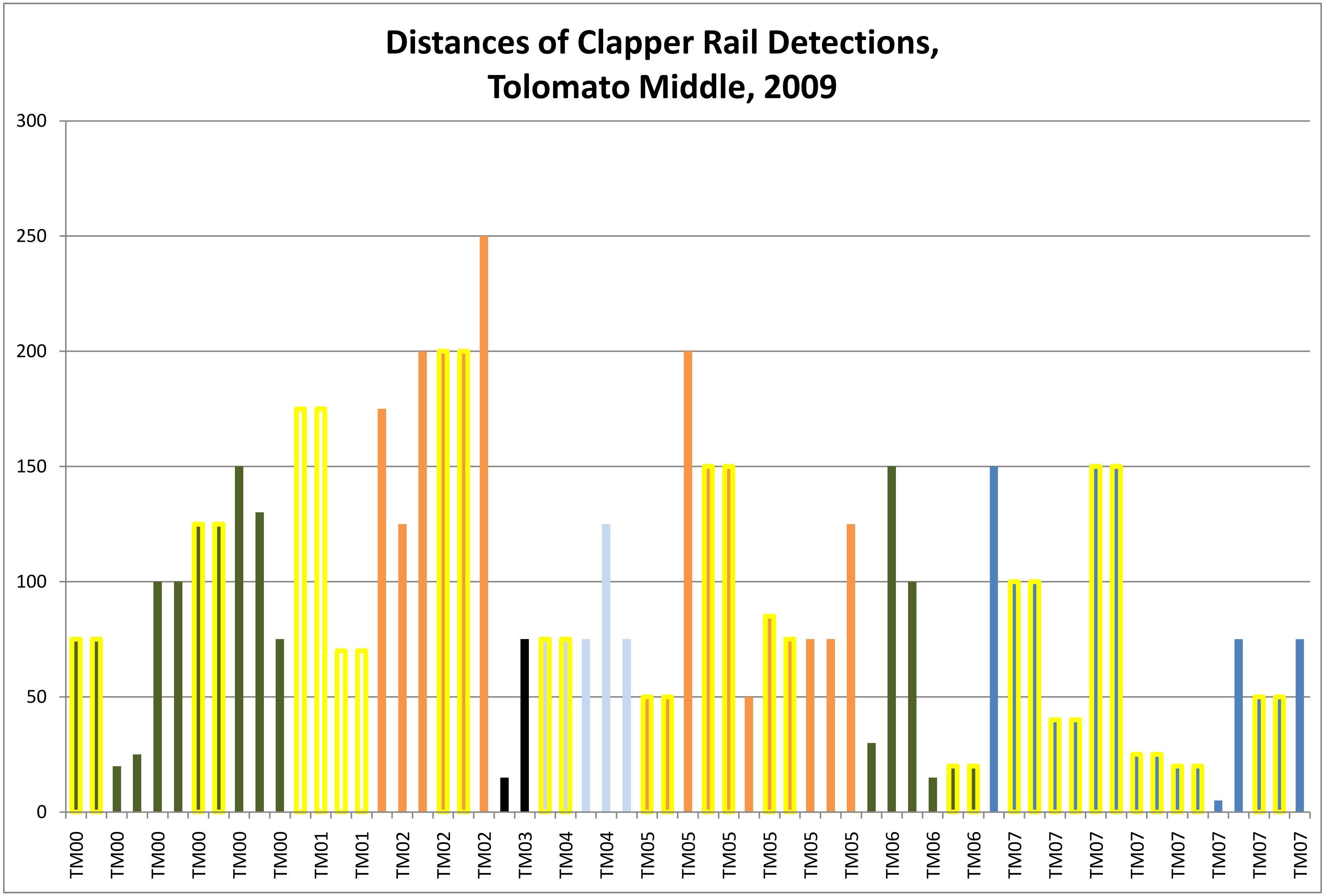

Figure 14: Distances to Clapper Rail detections, Tolomato Middle route

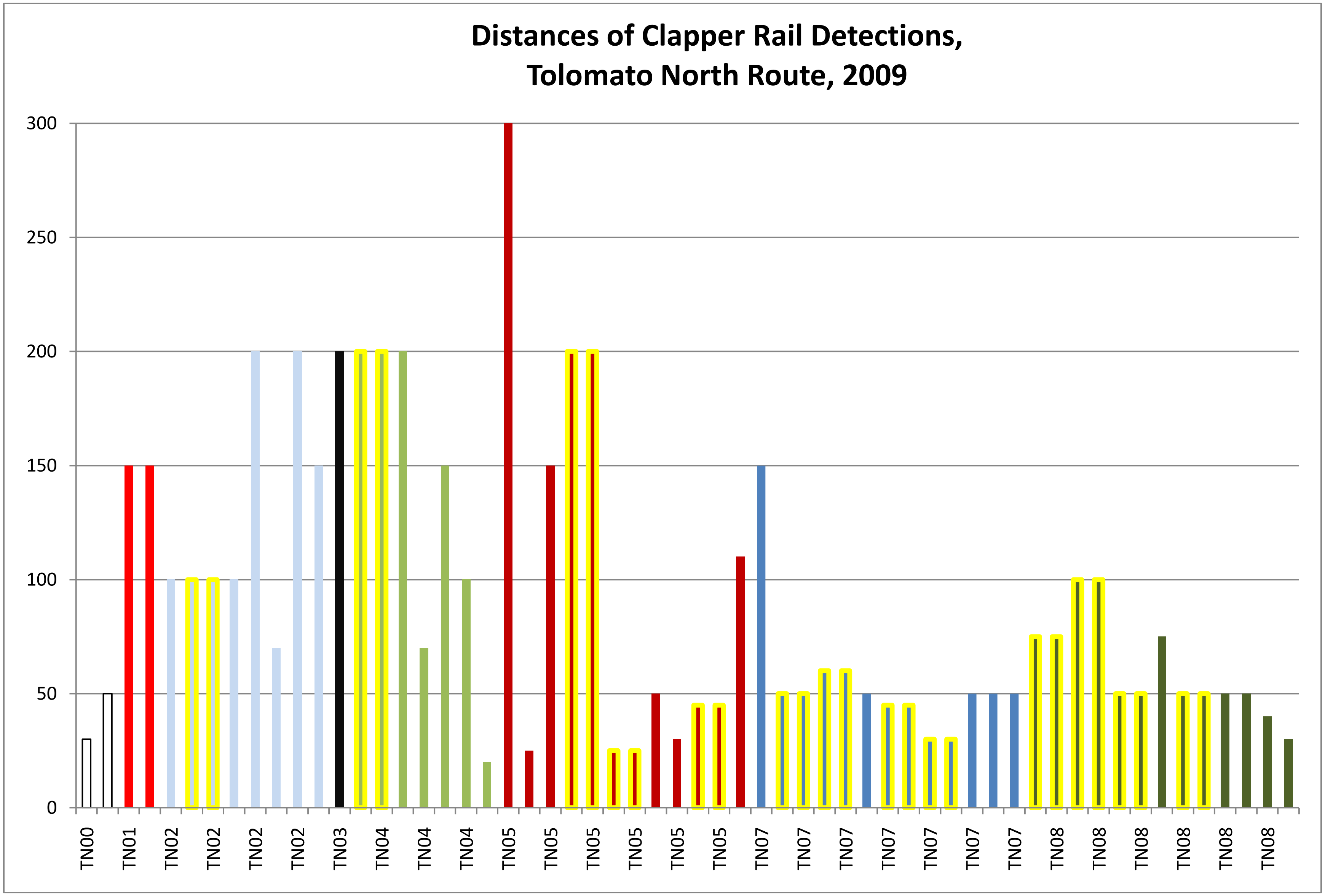

Figure 15: Distances to Clapper Rail detections, Tolomato North route

Comparing the Research Reserve's data to other sites proved to be a challenge due to the lack of data available. Of the eleven other sites in the Southeast United States, none are performing site specific data analysis, and one did not even report their data this past year. The only comparisons offered were found in the North American Waterbird Conservation Plan, as shown in Figure 8 (Kushlan 2002). These comparisons showed the differences in raw breeding population numbers, but did not include habitat type, survey method, or analysis method. As it is, the comparison chart shows our average to be fairly middling overall, while the confidence interval ranges beyond the rest of the data in both directions. It is hard to say from this where our area fits in compared to other sites that record breeding Clapper Rails. Data from the Christmas Bird Count (CBC) seems to imply we have a high density, as the St. Augustine CBC reports the highest number of Clapper Rails in the country (Ortega 2009). Part of this may be due to wintering rails as opposed to breeding rails, since the CBC takes place in late December. A winter density survey may prove to yield interesting results.

There are some major threats to tidal marshes that could quickly make changes to even a robust Clapper Rail population. One is an ongoing issue which nearly all habitats face: that of development. While development of emergent vegetation habitats has decreased in recent years, it is still ongoing (Stedman 2008). However, a much larger threat is that of climate change, specifically sea level rise. A study in the Chesapeake Bay region showed that major impacts would be felt in terms of drastic population declines of marsh-dependent birds, including Clapper Rails, with even low-range sea level rise estimates (M. Wilson, personal communication). One estimate of decline for Clapper Rails was an overall population decline of 35-42% from sea level rise of 0.39 meters over the next 100 years. The higher the estimates of sea level rise, the faster the decline of the population.

By monitoring the marsh bird populations of our area over time, information will be gathered that can be used to estimate ecosystem health and to observe any significant changes. While there are many challenges in monitoring these secretive birds, the value of recording this data is very high. In the future, as the North American Marsh Bird Monitoring continues to grow, our data will become even more useful and valuable in documenting the biological response of the estuary to climate change and other impacts to the estuarine habitats.

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Appendix A: Survey Data Sheet example

National Marsh Bird Monitoring Program Survey Data Sheet

		Before	After
Date:			
Name of Marsh/Route:	**Temperature (°F):**		
Observer(s) *:	**Windspeed (mph):**		
Survey Replicate #:	**Cloud Cover (%):**		
	Precipitation (see below):		

* list all observers in order of their contribution to the data collected

Put an "S" in the appropriate column if the bird was seen, a "1" if the bird was heard, and "1S" if both heard and seen

				Responded During:																	
Station #	Start Time	Background Noise	Species	Before	Silent Minute 1	Silent Minute 2	Silent Minute 3	Silent Minute 4	Silent Minute 5	LEBI 5-6	SORA 6-7	CLRA 7-8	AMBI 8-9	COMO 9-10	PBGR 10-11	After	Call Type(s)	Direction	Distance (meters)	Detected at a Previous Point	Comments

Precipitation: light rain, rain, heavy rain, light snow, snow, heavy snow, fog, none

Background noise: 0- no noise, 1- faint noise, 2- moderate noise (can't hear some birds beyond 100m), 3- loud noise (can't hear some birds beyond 50m), 4- intense noise (can't hear some birds beyond 25m)

Windspeed: 0- smoke rises vertically; 1-wind direction shown by smoke drift; 2- wind felt on face, leaves rustle; 3- leaves/twigs in constant motion; 4- raises dust, moves small branches; 5- small trees sway; whitecaps

Additional Comments:

Appendix B: Table of raw data .txt file for Distance Program

Route	PtName	SurveyStartDate	VisitNum	AlphaCode	Distance
Guana Route	G001	30-Mar-09	1		
Guana Route	G002	15-Apr-09	2	CLRA	25
Guana Route	G003	02-May-09	3	CLRA	35
Guana Route	G003	02-May-09	3	CLRA	50
Guana Route	G003	02-May-09	3	CLRA	75
Guana Route	G014	30-Mar-09	4		
Guana Route	G015	15-Apr-09	5	CLRA	100
Guana Route	G016	02-May-09	6	CLRA	100
Guana Route	G024	30-Mar-09	4		
Guana Route	G025	15-Apr-09	5	CLRA	75
Guana Route	G025	15-Apr-09	5	CLRA	75
Guana Route	G026	02-May-09	6	CLRA	100
Guana Route	G026	02-May-09	6	CLRA	50
Guana Route	G026	02-May-09	6	CLRA	50
Guana Route	G026	02-May-09	6	CLRA	50
Guana Route	G026	02-May-09	6	CLRA	50
Guana Route	G034	30-Mar-09	4		
Guana Route	G035	15-Apr-09	5		
Guana Route	G036	02-May-09	6		
Guana Route	G044	30-Mar-09	4	CLRA	100
Guana Route	G044	30-Mar-09	4	CLRA	100
Guana Route	G044	30-Mar-09	4	CLRA	75
Guana Route	G044	30-Mar-09	4	CLRA	100
Guana Route	G044	30-Mar-09	4	CLRA	100
Guana Route	G044	30-Mar-09	4	CLRA	100
Guana Route	G045	15-Apr-09	5	CLRA	20
Guana Route	G045	15-Apr-09	5	CLRA	100
Guana Route	G046	02-May-09	6	CLRA	125
Guana Route	G046	02-May-09	6	CLRA	5
Guana Route	G046	02-May-09	6	CLRA	5
Tolomato Middle	TM001	25-Mar-09	1	CLRA	75
Tolomato Middle	TM001	25-Mar-09	1	CLRA	75
Tolomato Middle	TM001	25-Mar-09	1	CLRA	20
Tolomato Middle	TM001	25-Mar-09	1	CLRA	25
Tolomato Middle	TM001	25-Mar-09	1	CLRA	100
Tolomato Middle	TM001	25-Mar-09	1	CLRA	100
Tolomato Middle	TM002	04-Apr-09	2	CLRA	125
Tolomato Middle	TM002	04-Apr-09	2	CLRA	125
Tolomato Middle	TM002	04-Apr-09	2	CLRA	150
Tolomato Middle	TM002	04-Apr-09	2	CLRA	130
Tolomato Middle	TM002	04-Apr-09	2	CLRA	75
Tolomato Middle	TM011	25-Mar-09	1	CLRA	175

Tolomato Middle	TM011	25-Mar-09	1	CLRA	175
Tolomato Middle	TM012	04-Apr-09	2	CLRA	70
Tolomato Middle	TM012	04-Apr-09	2	CLRA	70
Tolomato Middle	TM021	25-Mar-09	1	CLRA	175
Tolomato Middle	TM021	25-Mar-09	1	CLRA	125
Tolomato Middle	TM022	04-Apr-09	2	CLRA	200
Tolomato Middle	TM022	04-Apr-09	2	CLRA	200
Tolomato Middle	TM022	04-Apr-09	2	CLRA	200
Tolomato Middle	TM022	04-Apr-09	2	CLRA	250
Tolomato Middle	TM031	25-Mar-09	1	CLRA	15
Tolomato Middle	TM032	04-Apr-09	2	CLRA	75
Tolomato Middle	TM041	25-Mar-09	1	CLRA	75
Tolomato Middle	TM041	25-Mar-09	1	CLRA	75
Tolomato Middle	TM041	25-Mar-09	1	CLRA	75
Tolomato Middle	TM042	04-Apr-09	2	CLRA	125
Tolomato Middle	TM042	04-Apr-09	2	CLRA	75
Tolomato Middle	TM051	25-Mar-09	1	CLRA	50
Tolomato Middle	TM051	25-Mar-09	1	CLRA	50
Tolomato Middle	TM051	25-Mar-09	1	CLRA	200
Tolomato Middle	TM052	04-Apr-09	2	CLRA	150
Tolomato Middle	TM052	04-Apr-09	2	CLRA	50
Tolomato Middle	TM052	04-Apr-09	2	CLRA	85
Tolomato Middle	TM052	04-Apr-09	2	CLRA	75
Tolomato Middle	TM052	04-Apr-09	2	CLRA	75
Tolomato Middle	TM052	04-Apr-09	2	CLRA	75
Tolomato Middle	TM052	04-Apr-09	2	CLRA	150
Tolomato Middle	TM052	04-Apr-09	2	CLRA	125
Tolomato Middle	TM061	25-Mar-09	1	CLRA	30
Tolomato Middle	TM061	25-Mar-09	1	CLRA	150
Tolomato Middle	TM062	04-Apr-09	2	CLRA	100
Tolomato Middle	TM062	04-Apr-09	2	CLRA	15
Tolomato Middle	TM062	04-Apr-09	2	CLRA	20
Tolomato Middle	TM062	04-Apr-09	2	CLRA	20
Tolomato Middle	TM071	25-Mar-09	1	CLRA	150
Tolomato Middle	TM071	25-Mar-09	1	CLRA	100
Tolomato Middle	TM071	25-Mar-09	1	CLRA	100
Tolomato Middle	TM071	25-Mar-09	1	CLRA	40
Tolomato Middle	TM071	25-Mar-09	1	CLRA	40
Tolomato Middle	TM071	25-Mar-09	1	CLRA	150
Tolomato Middle	TM071	25-Mar-09	1	CLRA	150
Tolomato Middle	TM072	04-Apr-09	2	CLRA	25
Tolomato Middle	TM072	04-Apr-09	2	CLRA	20
Tolomato Middle	TM072	04-Apr-09	2	CLRA	20
Tolomato Middle	TM072	04-Apr-09	2	CLRA	5
Tolomato Middle	TM072	04-Apr-09	2	CLRA	75

Tolomato Middle	TM072	04-Apr-09	2	CLRA	25
Tolomato Middle	TM072	04-Apr-09	2	CLRA	50
Tolomato Middle	TM072	04-Apr-09	2	CLRA	50
Tolomato Middle	TM072	04-Apr-09	2	CLRA	75
Tolomato North	TN001	24-Mar-09	1	CLRA	30
Tolomato North	TN001	24-Mar-09	1	CLRA	50
Tolomato North	TN002	09-Apr-09	2		
Tolomato North	TN003	08-May-09	3		
Tolomato North	TN011	24-Mar-09	1	CLRA	150
Tolomato North	TN011	24-Mar-09	1	CLRA	150
Tolomato North	TN012	09-Apr-09	2		
Tolomato North	TN013	08-May-09	3		
Tolomato North	TN021	24-Mar-09	1	CLRA	100
Tolomato North	TN021	24-Mar-09	1	CLRA	100
Tolomato North	TN021	24-Mar-09	1	CLRA	100
Tolomato North	TN021	24-Mar-09	1	CLRA	100
Tolomato North	TN021	24-Mar-09	1	CLRA	200
Tolomato North	TN021	24-Mar-09	1	CLRA	70
Tolomato North	TN022	09-Apr-09	2	CLRA	200
Tolomato North	TN022	09-Apr-09	2	CLRA	150
Tolomato North	TN023	08-May-09	3		
Tolomato North	TN031	24-Mar-09	1	CLRA	200
Tolomato North	TN032	09-Apr-09	2		
Tolomato North	TN033	08-May-09	3		
Tolomato North	TN041	24-Mar-09	1	CLRA	200
Tolomato North	TN041	24-Mar-09	1	CLRA	200
Tolomato North	TN041	24-Mar-09	1	CLRA	200
Tolomato North	TN042	09-Apr-09	2		
Tolomato North	TN043	08-May-09	3	CLRA	70
Tolomato North	TN043	08-May-09	3	CLRA	150
Tolomato North	TN043	08-May-09	3	CLRA	100
Tolomato North	TN043	08-May-09	3	CLRA	20
Tolomato North	TN051	24-Mar-09	1	CLRA	300
Tolomato North	TN051	24-Mar-09	1	CLRA	25
Tolomato North	TN052	09-Apr-09	2	CLRA	150
Tolomato North	TN052	09-Apr-09	2	CLRA	200
Tolomato North	TN052	09-Apr-09	2	CLRA	200
Tolomato North	TN052	09-Apr-09	2	CLRA	25
Tolomato North	TN052	09-Apr-09	2	CLRA	25
Tolomato North	TN053	08-May-09	3	CLRA	50
Tolomato North	TN053	08-May-09	3	CLRA	30
Tolomato North	TN053	08-May-09	3	CLRA	45
Tolomato North	TN053	08-May-09	3	CLRA	45
Tolomato North	TN053	08-May-09	3	CLRA	110
Tolomato North	TN061	24-Mar-09	1		

Tolomato North	TN062	09-Apr-09	2		
Tolomato North	TN063	08-May-09	3		
Tolomato North	TN071	24-Mar-09	1	CLRA	150
Tolomato North	TN071	24-Mar-09	1	CLRA	50
Tolomato North	TN071	24-Mar-09	1	CLRA	50
Tolomato North	TN071	24-Mar-09	1	CLRA	60
Tolomato North	TN071	24-Mar-09	1	CLRA	60
Tolomato North	TN072	09-Apr-09	2	CLRA	50
Tolomato North	TN073	08-May-09	3	CLRA	45
Tolomato North	TN073	08-May-09	3	CLRA	45
Tolomato North	TN073	08-May-09	3	CLRA	30
Tolomato North	TN073	08-May-09	3	CLRA	30
Tolomato North	TN073	08-May-09	3	CLRA	50
Tolomato North	TN073	08-May-09	3	CLRA	50
Tolomato North	TN073	08-May-09	3	CLRA	50
Tolomato North	TN081	24-Mar-09	1	CLRA	75
Tolomato North	TN081	24-Mar-09	1	CLRA	75
Tolomato North	TN081	24-Mar-09	1	CLRA	100
Tolomato North	TN081	24-Mar-09	1	CLRA	100
Tolomato North	TN082	09-Apr-09	2	CLRA	50
Tolomato North	TN082	09-Apr-09	2	CLRA	50
Tolomato North	TN082	09-Apr-09	2	CLRA	75
Tolomato North	TN082	09-Apr-09	2	CLRA	50
Tolomato North	TN082	09-Apr-09	2	CLRA	50
Tolomato North	TN082	09-Apr-09	2	CLRA	50
Tolomato North	TN083	08-May-09	3	CLRA	50
Tolomato North	TN083	08-May-09	3	CLRA	40
Tolomato North	TN083	08-May-09	3	CLRA	30

Appendix C: Step-by-step instructions on setting up Distance and entering data

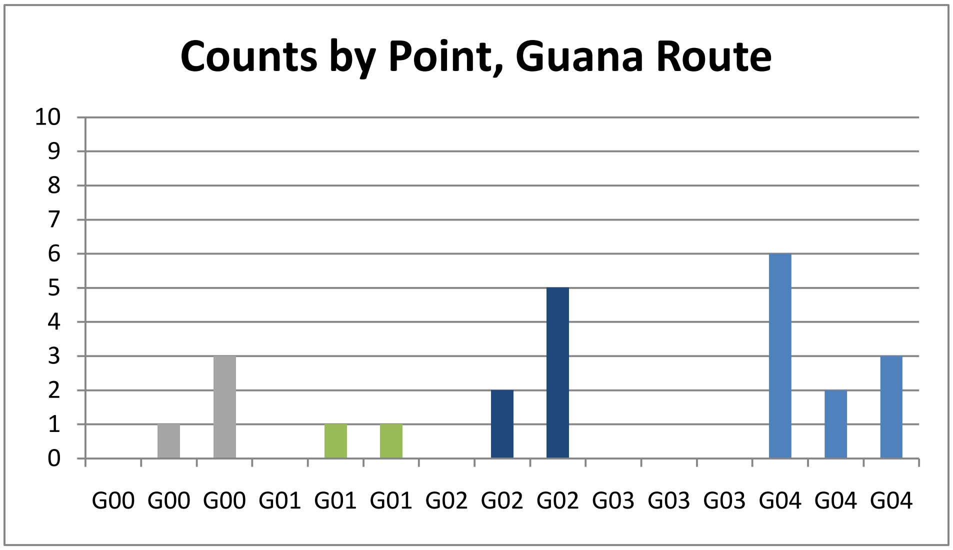
To bring the data into Distance: first, open the New Project Setup Wizard by going to File > New Project, and saving the project in the appropriate location (currently, projects are saved in Z:\EcoSystem Science Shared\Plants & Wildlife\Birds\Secretive Marsh Birds\ and then the appropriate year's data folder). Now, select "Analyze a new survey that has been completed" and click next. This may bring up an introductory screen with no options, if it does, just click next again. Now the top of the box should read "Step 3: Survey Methods." For "Type of Survey," select "Point transect." "Observer configuration" should be default on "Single observer," "Distance measurements" should be set on "Radial distance," and "Observations" should be "Single objects." Click next: the box should now be "Step 4: Measurement Units." For the "Distance" drop-down box, select "Meter," for the area drop-down select "Hectare." Click next. Setting up the Distance Analysis is finished, check the "Proceed to Data Import Wizard" option and click finish.

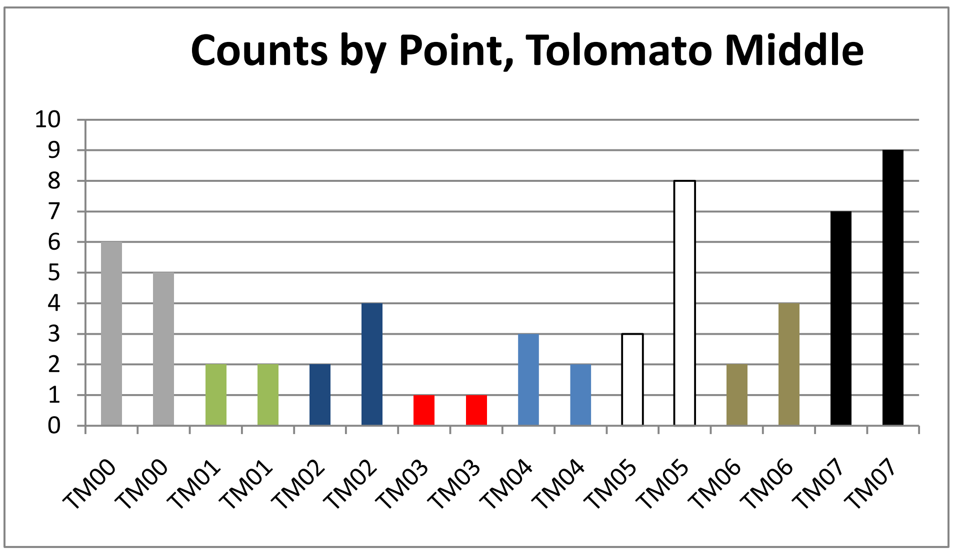
This may bring up an introductory screen, if it does just click next to get to Step 2. To bring in the data from 2009, navigate to Z:\EcoSystem Science Shared\Plants & Wildlife\Birds\Secretive Marsh Birds\2009Data, and choose the correct file. For Clapper Rail detections in 2009, the .txt file is 2009CLRA_seperatedbyvisit.txt. Once the correct .txt file is chosen you will be no Step 3: Data Destination. From the "Lowest data layer" drop-down choose "Observation," from the "Highest data layer" drop-down choose "Region," and then make sure "Add all new records under the first record in the parent data layer" and "Create one new line for each line of the import file" are selected and click next. Now the Step 4: Data File Format box is up, check to make sure the data is arranged in a table in a manner that allows each record to have its own line. Choose the "Do not import first row" option and click next. The table of raw data remains up for Step 5: Data File Structure. Above the "Route" column, click on the word "Ignore." A drop-down box will come up, select "Region" from this box. Click the box below this and choose "Label," and make sure the box below that also shows "Label." Now click on the "Ignore" above the PtName column, and choose "Point Transect," again choosing "Label" for the two boxes below. Lastly, click the "Ignore" above the "Distance" column, and choose "Observation." In the box below "Observation," select "Radial Distance," and in the box below this select "Decimal." Any other columns of data that might be in the table can be ignored for the purposes of this analysis. Click next, if this is new data being imported to an existing project, choose "Add to existing data," otherwise leave it on "Overwrite existing data" and then click finish. The data is now in a working Distance project. Now survey effort needs to be modified for each point, as we conduct surveys on the edge of marsh habitats, not from the middle. Navigate to the "Tools" menu and select "Data Entry Wizard." Click next three times until the "Point Transect" column shows up. The sub-column of "Survey Effort" is what will need to be edited. It is set as default at 1, use Appendix D to find the decimal percentage for each individual point, and enter this data. Click next twice more, then Finish. Navigating back to the data tab and clicking the "Observation" level will now show all the survey effort numbers that were just entered. Finally, the analysis is ready to be run. This part has been saved, so all that needs to be done is to select the "Grouped_Truncated 200" Analysis, and click the "run" button. The analysis should only take a few seconds. Scroll through the results drop-down box to find the density estimates.

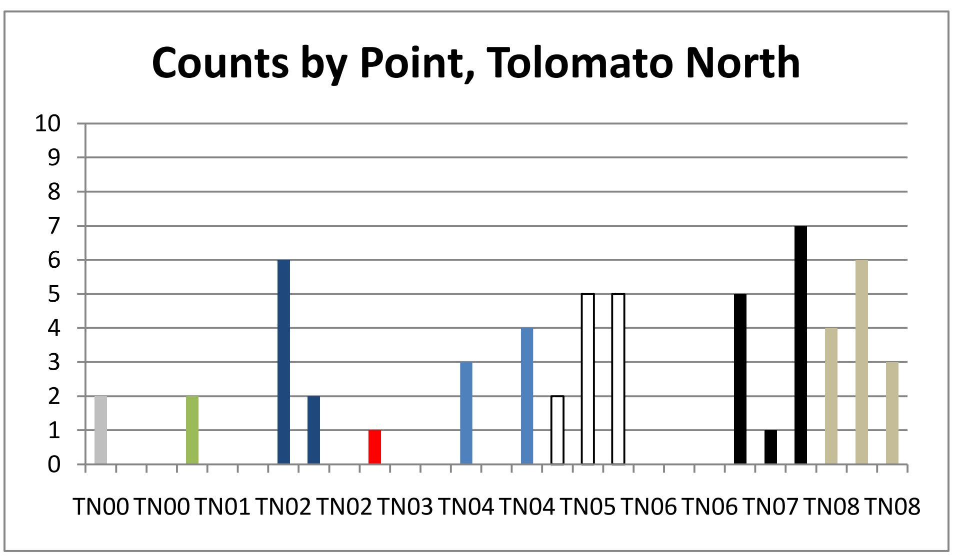
Appendix D: Tidal Marsh habitat percentages by site

Site	Percentage
G00	47.8
G01	42.7
G02	35.3
G03	12.0
G04	31.7
TM00	34.5
TM01	23.0
TM02	29.8
TM03	41.2
TM04	41.1
TM05	44.0
TM06	58.0
TM07	40.6
TN00	41.8
TN01	32.9
TN02	31.9
TN03	25.2
TN04	18.0
TN05	40.1
TN06	52.8
TN07	44.2
TN08	47.3

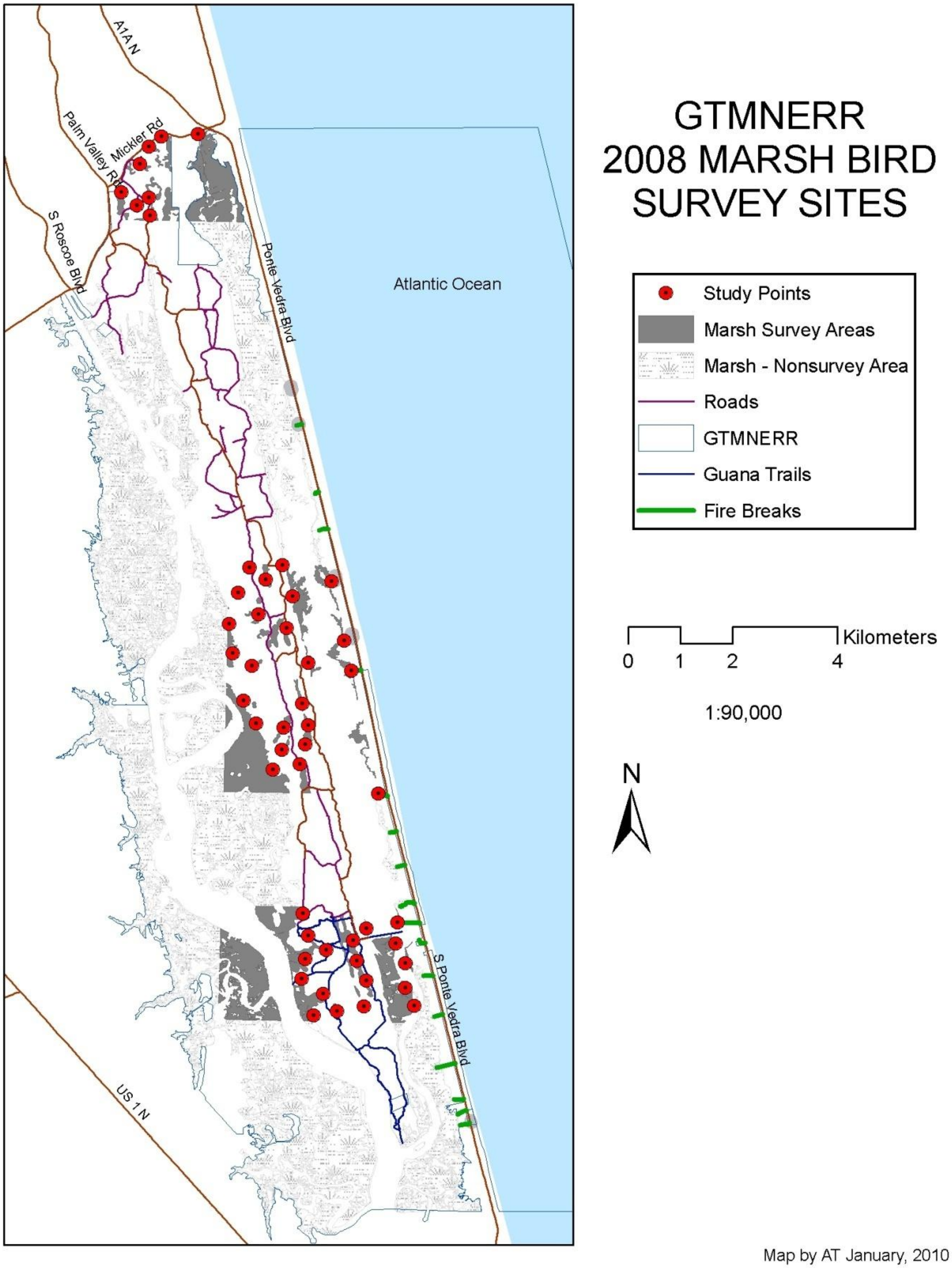
Appendix E: Graphs of Counts per Site, per Survey







Appendix F: Map of 2008 Survey Points



Appendix G: Map of 2009 Survey Points