SEA TURTLE FRIENDLY LIGHTING IN FLORIDA: A MULTI LEVEL EVALUATION OF POLICY IMPLEMENTATION AND EFFECTIVENESS

By

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To my parents, the most ardent supporters of my dreams
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Lighting ordinances to protect endangered sea turtles in Florida have been in existence for three decades with no comprehensive reviews of the effectiveness of these policies. There are currently 82 lighting ordinances passed by local governments in Florida. The integrated implementation model posits that the performance outputs of a policy are determined by the written policy and the enforcement behavior of the agents who daily interact with those who are being regulated. The three studies in this dissertation use the integrated implementation model as a framework for analyzing lighting ordinances for sea turtle protection.

The first study assesses policy design using a theory-based evaluation comparing the current lighting ordinances with the ideal model lighting ordinance for sea turtle protection written by the Florida Department of Environmental Protection. The results of the theory-based evaluation show that failure to incorporate mandates, penalties and information provisions into an ordinance can lead to an ineffective policy.

The second study analyzes the structure of the 82 ordinances via a content analysis. Fixed effects models were used to predict hatchling disorientation rates in
each ordinance jurisdiction from 2000-2010. The presence of a lighting ordinance, and increasing management requirements are associated with significant decreases in hatchling disorientations.

The third study investigates lighting ordinance implementation by analyzing enforcement styles of frontline agents in Florida. Four styles, based on an agents’ degree of accommodation and formalism, were identified: assistive legalistic enforcers, persuasive enforcers, accommodative enforcers and flexible enforcers. When predicting performance output, such as time spent on night inspections, enforcement style serves as a moderator.

These findings demonstrate that while Florida ordinances have helped to protect sea turtles, efforts vary across the state. The studies also highlight the importance of including management activities like compliance inspections and education campaigns. If ordinances mandate management activities the effect of an agents’ enforcement style will matter less when predicting performance outputs. As lighting ordinances for the protection of sea turtles are being adopted by other states, and new revisions are taking place in Florida, this work represents a step toward improving the legislation and delivery of these laws.
CHAPTER 1
INTRODUCTION

Florida, with its 1,197 miles of coastline and 663 miles of beaches, hosts the greatest number of nesting sea turtles in the continental United States (Butler, 1998). These same beaches sea turtles use to lay their eggs help attract the 112.3 million people that visited Florida in 2016 (VISIT FLORIDA Research, 2017). One of the consequences of having more people at the coast is the increase of artificial light during the night. Artificial light on a nesting beach negatively impacts sea turtles at both the adult and hatchling stage (Witherington and Martin, 1996). It has been shown that beaches exposed to artificial lighting have lower nesting densities (Salmon, 2006). Light pollution can also interfere with the ability of hatchlings to locate the ocean (Witherington and Bjomdal, 1991). In general, hatchlings are strongly attracted to the shorter, violet to green wavelengths. Incorrect orientation negatively impacts hatchling survival by directly increasing mortality on the beach and indirectly decreasing fitness by reducing the store of yolk energy that should be used for offshore migration during the night (Salmon, 2006).

There are 27 counties in Florida that have beaches where sea turtles nest, all but five (Duval County, Miami-Dade County, Manatee County, Pinellas County, and Okaloosa County) have passed lighting ordinances to reduce the impact of artificial coastal lighting on marine turtles, in order to improve nesting habitats and increasing successful nesting activity and production of hatchlings. Sea turtle volunteer groups and environmental NGOs champion the passage of lighting ordinances as integral to lowering hatchling disorientation. Additionally, lighting ordinances have been required by the federal government for locations seeking permits for beach renourishment.
projects to mitigate the increase in disoriented hatchlings that occurs following completion of renourishment projects (Brock et al., 2009). Still, existing lighting ordinances have not been reviewed to determine whether they are successful in contributing to favorable nesting and hatching conditions for sea turtles.

The first lighting ordinance was passed on the local level in 1982 in the city of Naples in Collier County, Florida. Today there are 82 such laws in existence throughout Florida where sea turtle nesting beaches occur and only. In the past 34 years, a comprehensive review of these laws has not been conducted.

The three studies in this dissertation use the integrated implementation model shown in Figure 1-1 (Winter, 1990, 2012a) as a framework for analyzing lighting ordinances for sea turtle protection. This model focuses on the interaction of the policy and implementation processes with each other and the outcomes (Sabatier, 1986).

In the first study I start by elucidating the policy process in “A Theory-Based Evaluation of Three Decades of Lighting Ordinances for Sea Turtle Protection in Florida.” Here I use logic models to illustrate the sequence of activities described in the law and use evidence based research from social science literature to determine the likelihood that conducting these activities will lead to achieving the desired result.

The second study, “An Analysis of the Impact of Technical and Management Language of Florida’s Beach Lighting Ordinances on Hatchling Disorientation Rates,” examines the individual laws that have been passed and analyzes the policy design of each of the local laws to see which of the important technical and managerial elements are included in the statutes. I then use generalized linear mixed models to determine the impact of the laws on the rate of hatchling disorientation over a 10-year period.
The third study, “Impacts Of Frontline Agent Regulatory Style On Sea Turtle Lighting Regulation Performance Outputs And Perceptions Of Effectiveness” further investigates the implementation process. Here, I move beyond what activities are carried out by agents to analyzing regulatory style, defined as regulators’ approaches to gaining compliance with the law as they interact with regulated entities (May and Winter, 2000; Mcallister, 2010). I develop a theoretical conception of regulatory style that is based on the degrees of accommodation and formalism in agents’ interactions (May and Winter, 2000; May and Wood, 2003). Next, I examine the ways in which agents’ regulatory styles relate to their enforcement actions and the outcomes of policy objectives.

Together, these three studies serve as a blueprint for the evaluation of environmental laws. The studies reveal critical information about how the policy and implementation process impact the ultimate goal of improving sea turtle nesting beaches, a key habitat for the survival of an endangered species. As lighting ordinances for the protection of sea turtles are being adopted by other states, and new revisions are taking place in Florida, this work represents an important step toward improving the legislation and delivery of these laws.
Figure 1-1. The Integrated Implementation Model (Winter, 1990) applied to lighting ordinances.
CHAPTER 2
A THEORY-BASED EVALUATION OF THREE DECADES OF LIGHTING ORDINANCES FOR SEA TURTLE PROTECTION IN FLORIDA

Background

Lighting ordinances to protect endangered sea turtles in Florida have been in existence for three decades with no comprehensive reviews of the policies. As recent population viability analyses indicate that the effect of increased night lighting is to decrease the time to extinction for sea turtles (Brei et al., 2016), it is important to review the laws that seek to reduce this contamination. In this paper, theory based evaluation is used to analyze laws that regulate nighttime lighting in coastal areas of Florida where sea turtle nesting occurs. Theory based evaluation (TBE) is a technique that allows for systematic analysis of policy documents and applies what has been learned from other policies with a similar context (Apostolopoulou and Pantis, 2009; Stem et al., 2005). This paper represents the first TBE for lighting ordinances in Florida and lays the groundwork for increased effectiveness of lighting ordinances in the future.

Impacts of Light Pollution on Sea Turtles

Artificial light on a nesting beach negatively impacts sea turtles at both the adult and hatchling stage (Witherington and Martin, 1996). It has been shown that beaches exposed to artificial lighting have lower nesting densities (Salmon, 2006). Light pollution can also interfere with the ability of hatchlings to locate the ocean (Witherington and Bjorndal, 1991). In general, hatchlings are strongly attracted to the shorter, violet to green wavelengths that in nature are most strongly found in the direction of the ocean (Mrosovsky and Shettlesworth, 1968; Rivas et al., 2015; Witherington and Bjorndal, 1991). Artificial lights that appear white also produce the wavelengths that are attractive to sea turtles at a stronger intensity than those found in the direction of the ocean, which
causes hatchlings to head away from the ocean towards buildings, roads, or street lights (Salmon et al., 1992). Incorrect orientation negatively impacts hatchling survival by directly increasing mortality on the beach by predators. Incorrect orientation also indirectly decreases fitness by reducing the store of yolk energy that should be used for offshore migration during the night and using the energy instead to wander along the shore (Salmon, 2006).

**Development of Lighting Regulations**

Florida, with its 1,197 miles of coast line and 663 miles of beaches hosts the greatest number of nesting sea turtles in the continental United States (Butler, 1998). There are 27 counties and 63 municipalities who govern areas that include sea turtle nesting beaches. The initial mandate to protect endangered species came from the federal level with the Endangered Species Preservation Act 1966; sea turtles were first listed in 1970. Section 9 of the 1973 Endangered Species Act (ESA) strictly prohibits a “take” of these species by any person (16 U.S.C. § 1538(1)(B) (2012)). In the ESA, the term *take* includes the harassment and harm of protected wildlife (50 C.F.R. §17.3 (2012)). To “harm” means an act that kills or injures wildlife, such as significant habitat modification that actually kills or injures wildlife by *significantly impairing essential behavior patterns, including breeding, feeding, or sheltering* (50 C.F.R. § 17.3 (2013) (emphasis added)). There has been scientific evidence since the 1960’s showing that artificial lighting on beaches disrupts sea turtle breeding patterns, which is specifically prohibited under the ESA. In one Florida case, *U.S. v. The Breakers Condominiums*, the federal government sued a condominium association after lighting associated with the condominium caused a high number of loggerhead turtle hatchling deaths. The case
eventually settled, with the association agreeing to pay a $15,000 fine and correct the lighting situation.

The Beach and Shore Preservation Act (1984) administered by the Florida Department of Environmental Protection was first to protect sea turtles on the state level with the Coastal Construction Control Line (CCCL) Program. The purpose of the program “is to preserve and protect (Florida’s beaches) from imprudent construction which can jeopardize the stability of the beach-dune system, accelerate erosion, provide inadequate protection to upland structures, endanger adjacent properties, disrupt wildlife habitat, or interfere with public beach access” (161.053(1)(a), F.S.). The Coastal Construction Control Line represents the area of the beach-dune system vulnerable to surge or storm waves due to a 100-year storm; any construction or related activities seaward of this area requires special permitting (62B-33.002(12), F.S.). The DEP recognizes that artificial lighting causes detrimental behavioral changes in sea turtles and requires a review of lighting plans of any activities as part of the CCCL permitting process. However, the CCCL permits are only required of new construction and do not address all development that contributes to illumination of the beach at night. Existing development and development inland of the CCCL are not part of this permitting process.

To regulate those structures not addressed in the CCCL, the Florida Legislature tasked the DEP with adopting by rule “guidelines for local government regulations that control beachfront lighting to protect hatching sea turtles." (Fla. Stat. § 161.163 (2012)). In response, DEP enacted rule 62B-55 F.A.C. in 1993, the Model Lighting Ordinance for Marine Turtle Protection (MLO). The goals of the MLO are to “protect hatching marine
turtles from the adverse effects of artificial lighting, provide overall improvement in
nesting habitat degraded by light pollution, and increase successful nesting activity and
production of hatchlings" (62B-55 F.A.C.). Typical of most policy instruments (Abdul-
Manan et al., 2015; Harmelink et al., 2006), the policy-theory governing lighting
ordinances is implicit; that is, how the policy makers believe the items contained in the
policy will lead to the desired outcomes is not explicitly described. This TBE identifies
whether the conditions are present in the design of lighting ordinances for obtaining the
desired effects, and provides information on the components that, according to scientific
literature, should be added to improve the intervention’s impact (Brousselle and
Champagne, 2011; Chen and Rossi, 1989).

**Methods**

This TBE is implemented in a four step process: (1) Gather all source information
(Renger, 2010). The official lighting ordinances for each local jurisdiction were acquired
via county websites, the Florida Municode Library, scanned documents from
municipalities, and the Florida Department of Environmental Protection website. (2)
Identify the policy intent, the factors the policy is trying to change such as behavioral
conditions and environmental factors. The source documents were systematically
examined for clues about the antecedent conditions the program is trying to change. (3)
Create a logic model to visually represent “assumptions” on the way the policy is
expected to lead to the targeted effects” (Abdul-Manan et al., 2015). Ordinances from
each locality were compared to the logic model of the activities outlined by the MLO. (4)
Evaluate the validity of the cause-effect chains within the logic model using evidence-
based research from social science literature (Abdul-Manan et al., 2015; Birckmayer and Weiss, 2000; Brousselle and Champagne, 2011).

**Results and Discussion**

**Step 1: Gather and Review Source Information**

Of the 90 jurisdictions with sea turtle nesting beaches 83 have passed beach lighting ordinances to reduce the impact of artificial light on sea turtles and their nesting habitat. The first lighting ordinance for sea turtle protection was passed in 1982 in the city of Naples in Collier County, Florida. Other local governments followed suit with 42 ordinances already entered into law by 1993 when the Model Lighting Ordinance (MLO) was finalized (Figure 2-1). Since the DEP enacted the MLO, 78 ordinances have been passed or updated (Figure 2-1). The beach lighting laws currently on the books in local governments follow a similar structure to the MLO though they do not include all of the major activities.

**Step 2: Policy Intent**

The main objective of beach lighting ordinances in Florida is to create nesting beach environments favorable for sea turtles with the goals of increasing nesting on beaches, and decreasing adult and hatchling disorientations. The laws regulate the allowable structure of external lights on buildings and the behavior of individuals with respect to the use of window treatments to block interior light from the beach. These ordinances target a wide variety of stakeholder groups, from corporations to individuals by using command and control and compliance strategies.

**Step 3: Create a Logic Model & Causal Chain Description**

The MLO includes three major activities: a lighting plan review, lighting inspections, and a public awareness campaign (Figure 2-2). However local
governments were not required to adopt the MLO in its entirety so the activities mandated by each local ordinance vary (Table 2-1). The majority, 57%, of local ordinances do not include any of the activities listed in the MLO but instead only provide technical requirements for lighting that will not interfere with sea turtle behavior.

**Activity 1: Lighting Plan Review**

The first activity outlined by the MLO is the review of lighting plans for new development (Figure 2-2). Only 29% of lighting ordinances within localities require a lighting plan review.

The DEP model lighting ordinance (62B-55.004) suggests “local governments develop a system for receiving copies of permits issued by DEP or the US Army Corps of Engineers for any coastal construction within the local government's jurisdiction”. This inter-governmental agreement would allow lighting plans to be reviewed for compliance with the local government’s lighting ordinance. As an example, in Palm Beach County:

Any applicant for new development shall submit a complete Sea Turtle Lighting Plan (“STLP”) to the city for review, which shall be reviewed at the same time as the application for the building permit. The STLP must include the following information: complete electrical, building, and landscape plans showing profile and plan views with all exterior, highlighted landscape and pool light fixture locations, all windows within sight of the beach, the elevations of proposed and existing structures, proposed and existing vegetation, beach/dune profiles with building elevations depicted, and any pertinent topographical information. Prior to the issuance of a certificate of occupancy, the lighting must be completed in accordance with the approved plan. (Palm Beach County, 2009)

As part of the lighting plan review new construction may have to pass a lighting inspection, which includes a night survey with all beachfront lighting turned on, before the certificate of occupancy will be issued. The inspector may be from the local
government or a certified electrical engineer and may submit a written report verifying compliance.

**Activity 2: Lighting Inspections**

The second major activity outlined by the MLO is for agents to conduct lighting inspections (Figure 2-3). Lighting inspections identify structures that do not adhere to beachfront lighting standards, and they also identify “interior light emanating from doors and windows within line-of-sight of the beach” (62B-55.004). The MLO suggests the lighting inspection process “should include at least one compliance inspection of the beach conducted at night prior to the commencement of the main portion of the marine turtle nesting season and one compliance inspection conducted during the marine turtle nesting season” (62B-55.004). This type of inspection is a proactive lighting inspection. Reactive lighting inspections are initiated when the compliance agent investigates a report of noncompliance.

When violations are found during a lighting inspection, a written notice of violation is sent to the noncompliant properties, which includes information on the rules and regulations and a length of time during which the violation must be corrected. In the event a violation has not been corrected, violators can be penalized when follow-up inspections are done.

**Activity 3: Public Awareness Campaign**

The third activity outlined by the MLO is the public awareness campaign. Public awareness activities required by lighting ordinances can be separated into two categories: the distribution of educational material and lighting workshops. The DEP model lighting ordinance recommends that “any person submitting an application for coastal construction activities within the jurisdictional boundaries of the local
government should be informed” of the lighting ordinance and its requirements. In this instance local governments by and large have set out a more inclusive approach to the public awareness campaign as seen in Figure 2-4. The goals of educational campaigns are to increase stakeholder knowledge; that is, property owners, renters, and visitors, about the existence of the lighting ordinance, acceptable behaviors, and building requirements. Educational material like door hangers, newspaper articles, and public service announcements serve to communicate information to the general public.

Step 4: Validity of the Causal Chain

Activity 1: Lighting Plan Review

Completing a lighting plan review process provides a check for compliance before construction has started and gives property owners the chance to make necessary adjustments during the planning stages so they don’t have to pay multiple times for fixtures, bulbs, and installation. Withholding the certificate of occupancy until the lighting at the new construction has been shown to adhere to the approved plan, has been shown to increase the outcomes of compliant properties (Peter J. May, 2005).

Activity 2: Lighting Inspections

Inclusion of deterrent activities, like inspection and fines are integral to achieving compliance. The model lighting ordinance suggests that the “penalties for noncompliance should be sufficient to discourage violations.” This line of thinking is based on deterrence theory, which suggests that people’s actions follow a strict cost-benefit calculation so that they will want to avoid the fines imposed by the ordinance. Therefore, they will come into compliance (Lee, 2010; Schneider and Ingram, 2012).
The penalties for non-compliance imposed by local governments are fines and or jail time. Maximum jail time ranges from 60 to 180 days (Table 2-2). However most, 54% of ordinances do not include jail time as a penalty. All but one ordinance includes fines as a penalty. Maximum fines range from $100- $15,000 with 58% of ordinances having a maximum penalty of $500 (Table 2-3). In Indialantic if the code enforcement board or special magistrate finds the violation to be irresponsible or irreversible in nature a fine of $15,000 per violation is levied (Indialantic, 1986).

The town of Orchid in Indian River County may correct the violation itself if the responsible person or agent does not complete such measures within a time specified by the order (Orchid, 1993). The subsequent cost is leveled as a lien on the property until paid. In Palm Beach County, triple application fees for sea turtle lighting plans are imposed for lighting violators and any monies collected as civil penalties are deposited in the pollution recovery trust fund (Palm Beach County, 2009).

For existing construction, like resorts or private homes, coming into compliance can involve a substantial output of money upfront. It can cost $15,000 to retrofit large condominiums and resorts though the expense of compliance may be partially mitigated by cost savings through lower utility bills (Karen Shudes, personal communication). In places where cost savings from noncompliance is significant, officials have difficulty obtaining compliance. For example, in North Carolina, where developers save an average of $8,000 on a project by failing to install or maintain sediment control devices, only 36% of sites have met the standard mandated by law (Burby and Paterson, 1993). Certainty of punishment for noncompliance has been shown to be more important than speed of enforcement or severity of sanctions in general (Burby and Paterson, 1993;
Gunningham, 2015; Peter J May, 2005; Wu, 2009). Earnhart (2004) analyzed the response of large wastewater municipal facilities in Kansas to inspections and penalties and found that inspection and enforcement-related deterrence activities significantly induce better performance. Therefore, it is important for lighting ordinances to include the mechanism for identifying instances of noncompliant lighting as a mandated activity. And while not as important for all sectors, research indicates that indicates large penalties penetrate corporate consciousness in a way that other penalties do not (Thornton et al., 2005).

**Activity 3: Public Awareness Campaign**

An expectation is present that an increase in knowledge will result in an increase in compliant properties and an increase in stakeholders conducting sea turtle friendly behaviors. The logic driving this suite of activities is the knowledge deficit model, which posits that increasing knowledge will translate into a change in behavior (Schultz, 2002). Lack of knowledge is an important barrier to overcome, particularly when the basic understanding of how to conduct the behavior is missing (De Young, 1993; Gatersleben et al., 2002; Monroe, 2003). For example, the public awareness campaign may be the first contact visitors and new residents have with information about regulations related to sea turtles and artificial lighting. If education programs are not required, these populations are unaware of correct behaviors like lights on beaches and closing window shades at night. However, gaining procedural knowledge to influence behavior in and of itself is not sufficient to produce behavioral goals (Brousselle and Champagne, 2011; Frick et al., 2004; Kollmuss and Agyeman, 2002; Schultz, 2002; Stern, 2000).
Conclusion

The policy design of the MLO provides a blueprint for achieving compliant properties through mandates, penalties, and information provisions. However, current local ordinances do not incorporate the full suite of activities (Figure 2-5). Using TBE I show that failure to incorporate all activities into an ordinance can lead to an ineffective policy. Laws without a lighting plan review may have new construction that is immediately non-compliant. If inspections are not conducted certainty of punishment for noncompliance is missing which has been shown to be curtail for increasing compliance. A public education campaign is important to make new visitors and the transient tourist populations aware of laws but alone education is not sufficient to achieve high levels of compliance. As lighting ordinances are updated they should be reviewed to make sure they have all the statutes necessary to create an effective policy.
Figure 2-1. Number of passed and updated laws (1980-2015)
Table 2-1. Maximum incarceration for violating local sea turtle lighting ordinances.

<table>
<thead>
<tr>
<th>Jail Time (days)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>54</td>
</tr>
<tr>
<td>60</td>
<td>24</td>
</tr>
<tr>
<td>90</td>
<td>3</td>
</tr>
<tr>
<td>180</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2-2. Maximum monetary penalty for violating local sea turtle lighting ordinances.

<table>
<thead>
<tr>
<th>Maximum Penalty (dollars)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
</tr>
<tr>
<td>250</td>
<td>1</td>
</tr>
<tr>
<td>500</td>
<td>68</td>
</tr>
<tr>
<td>1000</td>
<td>1</td>
</tr>
<tr>
<td>5000</td>
<td>5</td>
</tr>
<tr>
<td>15000</td>
<td>3</td>
</tr>
</tbody>
</table>
Figure 2-2. Model lighting ordinance logic model
Figure 2-3. Logic model: Lighting inspections process
Figure 2-4. Logic model: Public awareness campaign process
Figure 2-5. The percentage of existing sea turtle ordinances that have enforcement and education components.
CHAPTER 3
AN ANALYSIS OF THE IMPACT OF TECHNICAL AND MANAGEMENT LANGUAGE
OF FLORIDA’S BEACH LIGHTING ORDINANCES ON HATCHLING
DISORIENTATION RATES

Background

Coastal areas have grown steadily over the last decades, this growth has been accompanied by rising pollution problems which imperils the characteristically rich coastal biodiversity (Brei et al., 2016; Fuentes et al., 2016). One hundred and twenty three million people populated U.S. coastal shoreline counties in 2010. Florida has the third highest coastal population. By 2020, according to one estimate, the residential population will reach 16 million residents in Florida’s coastal counties (Crossett et al., 2014). Regarding the tourist population, domestic and international tourists grew 5.4% in 2016 to 112.3 million (VISIT FLORIDA Research, 2017). The growing population means more artificial lights adding to the present overabundance of light pollution (Brock et al., 2009). Light pollution is the “degradation of the photic habitat by artificial light.” (Verheijen, 1985). Florida has a high number of coastal properties that have already been developed and in the future is predicted to have even more development.

Pollution from lighting at night has a negative impact on hatching sea turtles. It is a very important problem in Florida because 90% of the U.S. nesting turtles live there, and there needs to be a balance between protecting them and developing the land in the face of a growing residential population and tourists. Because successful nesting is key to their survival local and state ordinances have been enacted to artificial light on the beach. However, the total effect on sea turtles of nighttime lights has not has not yet been examined on a broad geographical level; the only investigations that have been done are only of certain beaches (Kaska et al., 2010; Witherington and Frazier, 2003).
Mazor et al. (2013) alone measured satellite-measured nighttime light effects on sea turtles nesting in Israeli coasts. None of these studies conducted analyzed long term effects.

In this study I review local lighting ordinances in Florida. The ordinances are broken down into indexes of three key features: technical requirements, required management actions, and the degree of detail in an ordinance for light regulations. Next I investigate one of the long-term goals of lighting ordinances, the decrease in number of hatchling disorientations. Using data from 2000-2010, I use a negative binomial regression models to determine the average policy effect of passing a lighting ordinance. I also test how the composition of law, via the indices, impacts the hatchling disorientation rate. Understanding how the composition of ordinances impact a targeted outcome will allow policy makers to better meet the challenges of balancing rising development with the conservation of ecological landscapes in the future.

**Biological behavior and technological solutions:** Artificial beach lighting at night can interfere with the normal behavior of adult and hatchling sea turtles. Light level is a strong cue for nest site selection, as adult turtles prefer darker beaches to those with more light. Consequently, beaches with high light levels often have lower nesting densities or no nests at all (Witherington, 1992). Only in the rare dark areas can nests be located on beaches that employ artificial lighting. When the nests are thus highly concentrated, it becomes easier for predators to find their prey (Salmon, 2006). When excessive artificial light is present, then adult sea turtles may not find their way when going back to the ocean, which is a phenomenon called "disorientation" or "misorientation" (Salmon and Witherington, 1995). Such lighting on the beach can
interfere with the ability of hatchlings as well to use instinctive cues to return to the sea. Among the cues are brightness (Witherington and Bjorndal, 1991) horizon shape (Witherington and Martin, 1996), wavelength (Horch et al., 2008), slope (Salmon et al., 1992), continuity (Witherington and Martin, 1996) and silhouette (Salmon et al., 1992). When their orientation is disrupted, then their chances of survival as newly hatched turtles sharply rises, when in a disoriented state, they are more vulnerable to being killed by traffic, predators on land, high temperatures after dawn, exhaustion or dehydration, and swimming pools (Witherington and Martin, 1996). Minimizing light exposure can include low mounted light fixtures with the least number of lumens to meet lighting needs and use the lowest amount of lumens (light) needed for the task. The same fixtures should have light shields or lenses that glow to minimize beach visibility (Witherington et al., 2014). The Florida Wildlife Conservation Commission (FWC) has resources that show which fixtures are appropriate and who manufactures appropriate lights.

Horch et al. (2008) showed in a behavioral study that newly hatched sea turtles are drawn the most strongly to shorter light wavelengths. These include 360 nanometer near-ultraviolet light (Horch et al., 2008). The same young turtles are the least sensitive to 580 nanometer or more wavelengths (Witherington, 1997). The latter appear as amber or red in the spectrum of light. As a result hatchling are drawn to land instead of the water when they find themselves in too much artificial lighting that is not in a wavelength band considered acceptable by researchers. They become not only disoriented but also with lowered survival probabilities. To lower the risks of artificial light, long wavelength sources of light are recommended (Witherington et al., 2014).
Recommended lighting for the most minimal impact on sea turtles are light-emitting diode (LED) lamps (580 nm or more) and low-pressure sodium (LPS) lighting (Witherington et al., 2014).

Methods

Analysis of Documents

To better understand how continued disorientations of sea turtles may be related to the current local lighting ordinances around the state, a content analysis was conducted on the 82 available local sea turtle lighting ordinances. Content analysis is a way to evaluate text objectively, quantitatively, and systematically, including legal information, both valid for data inferences and replicable (Krippendorff, 2014). A survey was developed using categories from DEP Rule 62B-55 F.A.C. (the old model ordinance), DEP Proposed Marine Turtle Lighting Guidelines, on the ground lighting retrofit experience from experts at the Sea Turtle Conservancy, the best available technology.

A team made up of graduate students from the Department of Wildlife Ecology and Conservation, the School of Forest Resources and Conservation, and second and third year law students at the University of Florida Levin College of Law were trained to evaluate, score and code the 82 available ordinances using the content analysis survey. These “coders” participated in a Lighting Workshop where they learned relevant sea turtle biology and lighting technology. All coders then completed a training survey based on a pre-selected local government ordinance. Coders were retrained on questions where less than 80% of the coders answered the question correctly. Coders were then assigned ordinances to score individually. To account for the high variability in interpretation of legal documents, two coders separately reviewed each ordinance.
Descriptions of Indexes

I developed a series of indexes that break lighting ordinances into three categories: the Management Index (MI), the Technical Index (TI), and the Specificity Index (SI). The MI measures how many management activities were included in each ordinance. The TI measures the amount of technology included in each ordinance. The SI measures how many specific topics are regulated in each ordinance. While some items within an index might play more of a role in ordinance strength, an item’s relative weight is difficult to determine (Wald and Hostetler, 2010). For example, does a public education clause confer more ordinance strength than a requirement for compliance inspections or does requiring lights to be long wavelength have more weight than requiring lights to be shielded? Placing each component on the same scale assigns equal weight to each component maintaining consistency in the statistical results. It also eliminates the question of which component should be given more weight. Finally, the total policy score was calculated by adding the scores for each component for a possible maximum score of 100.

The 17 questions regarding favorable sea turtle lighting conditions, based on sea turtle biology, were collapsed into Technical Index (TI) (Chronbach’s α= 0.84) (Table 3-1). Chronbach’s α is a measure of scale reliability and internal consistency (Acock, 2010). In this section statements in the survey were compared to statements in the ordinance and scored on a scale of 0 to 3. Where 0= concept not mentioned, 1= concept addressed but vague, 2= concept addressed but less stringent (wording provides loopholes), 3= addressed with the same strength.

There were 10 statements that catalogued the management actions required by the ordinance (Table 3-2). The 10 items relating to compliance and enforcement were
collapsed into the Management Index (MI) (Chronbach’s α= 0.63). In the MI questions, ordinances scored one point for every topic they addressed. In the Specificity index ordinances received one point for every topic they addressed (Table 3-3). Only the TI and MI were used to create the total policy score.

Scores for the TI and MI were calculated using four steps (Brody, 2003). First, the sum of the items within each component was taken. Second, the item sum was divided by the total possible score (BI = 17 items x 3 points = 51; IC = 10 items x 1 point each = 10 points). Third, the fractional score was multiplied by 50, placing each component on a 0-to-50 scale. A 50-point scale was used for ease of discussion. Fourth, because each ordinance was scored twice, the mean was taken of the two scores to arrive at a single component score for each ordinance. Specificity index scores are the sum of all topics addressed.

**Hatchling Disorientation Models**

Data on hatchling disorientations were gotten from the FWC Disorientation Database (2014). Disorientation data represent the number of sea turtle disorientation events reported to the FWC by Permit Holders across the state. The number of nests laid in each area was derived from FWC nesting data by beach. GPS boundary descriptions were used to determine the county or municipalities in which each survey was located. When multiple surveys were conducted within a jurisdiction, the resulting nesting numbers were combined to form a grand total.

The response I was interested in is the number of hatchlings that disorient in a given area. Modeling the absolute number of disorientation events would not be satisfactory because any comparison depends on the size of the group that generated the observations; in the model this would be incorporated as the number of nests laid.
To allow for comparison between areas, the disorientation rate was modeled. Because a rate of occurrence of some event cannot be negative and standard linear regression model could yield predicted rates that are negative, a logarithmic transformation was used (Fitzmaurice, Laird, and Ware, 2004). Log-linear, also referred to as Poisson regression, models are widely used for the analysis of counts in relationship to a set of covariates (Fitzmaurice et al., 2004). In many applications, biomedical, epidemiological, and ecological count data have variability that exceeds that predicted by the Poisson distribution, a condition known as over dispersion. This problem can be addressed by using the negative binomial distribution, which can be thought of as a generalization of the Poisson distribution with an additional parameter allowing the variance to exceed the mean (Waterman, 2016).

Fixed effects models were used to predict hatchling disorientation rates in each ordinance jurisdiction from 2000-2010. Human population (HP) is included as a covariate to capture the level of development in an area. Region (R) is included as a covariate to capture similarities in environmental factors like cloud cover, storm events, and beach profile (Table 3-5). The first model investigates the effect of having an ordinance on hatchling disorientation. Here we model log(# of hatchlings disoriented/ # nests laid) = ordinance presence + HP + R. The second models looks deeper into how the clauses that make up the ordinance affect the disorientation rate by evaluating the effect of the technical index, management index, specificity index. Here we model log(# of hatchlings disoriented/ # nests laid) = TI + MI + SI + HP + R. Negative binomial regression models were run using the STATA package (version 13) xtnbreg with a fixed variance. In each model, I accounted for the longitudinal structure of the data using
STATA’s “xtset” with location identified as the panel variable and year as the time variable.

Limitations

While the observational and ecological nature of this study means confounding variables may persist because of an inability to account for all factors that might distort the observed associations, the longitudinal design does account for some of the geographic and yearly variability. Evidence of disorientation events is difficult to capture. Permit holders usually complete surveys of nesting beaches during daylight morning surveys and the actual number of animals in each disorientation event cannot be verified. It should be noted that this protocol is not standardized and in some locations, volunteer groups record nighttime disorientations. Disorientation reporting is not mandatory and reporting efforts may vary across years and survey areas. Another important issue is the ease with which evidence of hatchling disorientation can be erased due to weather. To capture a more accurate picture of disorientation rates, it would be helpful for the state to institute a program like the Florida index beach nesting surveys (http://myfwc.com/research/wildlife/sea-turtles/nesting/monitoring). This effort would provide scientists and managers with a standardized collection method and an account of the effort so comparisons between locations could be made with increased confidence.

Results

Technical Statutes

The current ordinances enacted by local county and municipality governments are most often divided into sections with regulations that specifically regulate new development (96% of ordinances) and sections that regulate existing development (93%
of ordinances). Those responsible for the remaining ordinances chose not to
differentiate.

With respect to incorporating sea turtle friendly lighting technologies, very few
ordinances mandated low lumens (8% of existing development and 5% of new
development; Figure 3-1). However, 89% of ordinances required lights in existing
development to be shielded, and 92% of ordinances required that lights in new
development to be shielded (Figure 3-1). The general requirement that lights must not
be “visible from the beach” was found in 44% of ordinances as a requirement for
existing development and 90% included this stipulation for new development (Figure 3-
1). No ordinance requires lights to be exclusively long wavelengths, although 5% of
ordinances reference long wavelength light for existing development and 6% for new
development (Figure 3-1). The vast majority of ordinances mandate that exterior
artificial light for existing and new development must not be visible from the beach: 95%
and 96% respectively (Figure 3-41.

Management Statutes
Only 15% of ordinances mandate compliance inspections before the nesting
season begins, while 9% have compliance inspections during the nesting season
(Figure 3-1). Approximately 20% of the ordinances have provisions for educating the
general public. Approximately 15% have provisions for educating the affected public. In
Charlotte County, for example, “the community development department shall develop a
process whereby any individual submitting a site plan or building plan for construction
within the nesting zone is made aware of all instructions, requirements, and guidelines
contained herein” (Charlotte County, 2012)
Locality Index Scores

Technical index scores (TI) ranged from 0 to 35 with a mean of 18.0 SD 8.6 (Table 3-4). Juno Beach (0) had the lowest TI score followed by Highland Beach (3). Miami Beach (35) had the largest TI score followed by Venice, and St. Pete Beach (34) (Table 3-4).

Management index scores (MI) ranged from 0 to 40 with a mean of 15.9 and a standard deviation of 9.7 (Table 3-4). Vero Beach (40) had the highest MI score followed by the City of Sarasota (39) while Naples, Indian harbor Beach, and Melbourne Beach had the lowest scores (0) (Table 3-4).

The specificity index scores (SI) ranged from 0 to 17 with a mean of 8.4 and a standard deviation of 3.2 Juno Beach had the lowest SI score (0) followed by Highland Beach (2) Walton County had the highest SI score (17) followed by Ft. Lauderdale (16).

The total policy scores (TP) were computed as a sum of the TI and MI scores and ranged from 8 to 67, out of a possible 100, with a mean of 33.7 and a standard deviation of 15.5 (Table 3-4). Venice had the highest total score (67) followed closely by Sarasota (66). Naples, Gulf Stream, and Juno Beach had the lowest scores (8) (Table 3-4).

A Spearman’s correlation was run to assess the relationship between the year an ordinance was passed and the indexes. There was a weak positive correlation between the year an ordinance was passed and MI, which was statistically significant, \( r_s = 0.2208, p = 0.0462 \). There was a weak positive correlation between the year an ordinance was passed and TI, which was statistically significant, \( r_s = 0.2870, p = 0.0089 \). The correlation between the year an ordinance was passed and the SI was not significant, \( r_s = 0.0783, p = 0.4845 \).
Hatchling Disorientation Rates

Table 3-6 provides disorientation rate ratios associated with the presence or absence of a lighting ordinance. According to the model, the presence of a lighting ordinance was associated with a significant decrease in hatchling disorientation rates ($\beta = -1.151$, $p \leq 0.01$). Table 3-7 provides disorientation rate ratios associated with the technical (TI), management (MI), and specificity indexes (SI). According to the model the MI is associated with a significant decrease in hatchling disorientation rate ($\beta = -.065$, $p \leq 0.01$).

Discussion

The results of the content analysis indicate that there have only been minor changes to lighting ordinances as years have progressed. The slight improvement in management scores over time indicate that later ordinances are more likely to explicitly mandate management activities, However, the overall low scores on the management index indicate most ordinances are missing key management activities, like compliance inspections and educational requirements that are necessary to logically accomplish the stated goals of the ordinance.

The results show that increasing management requirements significantly decreases hatchling disorientations. Therefore when ordinances are updated is most important to include management activities. While most ordinances are still lacking these mandates there are some examples of statutes that could be added. For example, St. John’s County, states that “each year this Ordinance is in effect, the County shall conduct a community education effort to support the goal of protecting Marine Turtles against Artificial Light hazards” (St. Johns County, 2012).
The slight improvement of scores on the technical index over time indicates that new technology is being included in ordinances, albeit slowly. The low total technical index scores demonstrate a need for improvements in sea turtle friendly lighting requirements and guidelines for Florida’s coastal counties. Technology that addresses the biological sensitivity of sea turtles is currently available on the open market. The Florida Wildlife Conservation Commission (FWC) webpage (Fixtures and Bulbs, 2017) provides links to bulbs and fixtures that have been through a Wildlife Lighting Certification process. However, lighting ordinances may not include clauses that mandate the use of the most up-to-date technology. Many lighting ordinances that have been passed by local governments do not require use of current technology that provides access to light bulbs that only emit light in the wavelengths least disruptive to sea turtles. The omission of this new technology is in many cases because the laws have not been updated; only 15 locations have updated their ordinances since 2000. However, even newer ordinances may continue to include outdated technology alongside modern technology. For example, the Bay County ordinance that was updated in 2009 requires lights for existing and new development to be a “turtle lamp” or be disconnected during the nesting season (Bay County, 2012). However, this definition of turtle lamp includes incandescent bug lamps, which emit a full spectrum of light. This inclusion of older technology with new may be why there is a weak correlation between the strength of the technical index and the year an ordinance was passed.

In many ordinances, the requirements for existing development and new development were similar, though requirements for existing development have tended to be less restrictive. The vast majority of ordinances mandate that exterior artificial light
for existing and new development must not be visible from the beach, 95% and 96% respectively, which include some of the following caveats:

Lights shall not directly or indirectly illuminate the beach during the sea turtle nesting season except, in order to insure public safety, spill-over and reflective lighting onto the beach will be permitted to the extent necessary to meet the minimum safe lighting standards for particular property uses as published in the IES Lighting Handbook by the Illuminating Engineering Society of North America. (Volusia County, 1999)

Only applies if any portion of a developed property is located within a three-hundred-foot radius measured directly from the actual site of a sea turtle nest as verified by a person holding a Florida Marine Turtle permit (Jacksonville Beach, 2000)

While ordinances drafted in later years are more likely to include the latest technology, and to explicitly mandate public awareness campaigns and lighting inspections this study shows that overall the language in the current ordinances is weak. Even with these weak ordinances the models show that in areas where an ordinance has passed hatchling disorientation decreases. It is important to pass ordinances in the few Florida locations that have not yet passed an ordinance. Furthermore, it is most important to include management language in any new or updated ordinances for maximum effectiveness.
Table 3-1. Questions used for the content analysis Technical Index (TI) and summed results indicating affirmative responses for all Florida counties with lighting ordinances for sea turtle protection.

<table>
<thead>
<tr>
<th>Technical Index (20 items)</th>
<th>Counties (N = 82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Nighttime is defined as the locally effective time period between sunset and sunrise.</td>
<td>30 (37%)</td>
</tr>
<tr>
<td>2 Nesting season is defined as the period from May 1 through October 31 of each year for all counties except Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward. Nesting season for Brevard, Indian River, St. Lucie, Martin, and Palm Beach and Broward counties means the period from March 1 through October 31 of each year.</td>
<td>68 (82%)</td>
</tr>
<tr>
<td>3 All windows and glass doors visible from the beach shall be designed to have a light transmittance value of 15% or less</td>
<td>62 (76%)</td>
</tr>
<tr>
<td>4 Does the ordinance require exterior light to be a certain wavelength (ex. 580 nm or greater)?</td>
<td>6 (7%)</td>
</tr>
<tr>
<td>5 Exterior artificial light for existing development must be downward directed.</td>
<td>45 (55%)</td>
</tr>
<tr>
<td>6 Exterior artificial light for existing development must be full cut off (ex. no light emitted above 90 degree angle).</td>
<td>27 (33%)</td>
</tr>
<tr>
<td>7 Exterior artificial light for existing development must be low lumens.</td>
<td>5 (6%)</td>
</tr>
<tr>
<td>8 Exterior light for existing development must be shielded.</td>
<td>75 (91%)</td>
</tr>
<tr>
<td>9 Exterior artificial light for new development must be downward directed.</td>
<td>48 (59%)</td>
</tr>
<tr>
<td>10 Exterior artificial light for new development must be full cut off (ex. no light emitted above 90 degree angle).</td>
<td>36 (44%)</td>
</tr>
<tr>
<td>11 Exterior artificial light for new development must be low lumens.</td>
<td>6 (7%)</td>
</tr>
<tr>
<td>12 Exterior light for new development must be shielded.</td>
<td>76 (93%)</td>
</tr>
<tr>
<td>13 Exterior light for new development must be long wavelength.</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>14 The building of campfires or bonfires shall be prohibited during the nesting season.</td>
<td>31 (38%)</td>
</tr>
<tr>
<td>15 Areas seaward of the crest of the frontal dune are not cumulatively illuminated.</td>
<td>33 (40%)</td>
</tr>
<tr>
<td>16 Areas seaward of the frontal dune are not to be directly illuminated.</td>
<td>69 (84%)</td>
</tr>
<tr>
<td>17 Areas seaward of the frontal dune are not to be indirectly illuminated.</td>
<td>52 (63%)</td>
</tr>
<tr>
<td>18 The nighttime operation of motorized vehicles (excluding emergency or other official purposes) shall be prohibited.</td>
<td>29 (35%)</td>
</tr>
<tr>
<td>19 Exterior artificial light for existing development must not be visible from the beach.</td>
<td>78 (95%)</td>
</tr>
<tr>
<td>20 Exterior artificial light for new development must not be visible from the beach.</td>
<td>79 (96%)</td>
</tr>
</tbody>
</table>

a Mean scores standardized (standard deviation in parentheses).
Table 3-2. Questions used for the content analysis Management Index (MI) and summed results indicating affirmative responses for all Florida counties with lighting ordinances for sea turtle protection

<table>
<thead>
<tr>
<th>Management Index (10 items)</th>
<th>Counties (N = 82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Does the ordinance require a lighting plan to be reviewed before a permit will be issued?</td>
<td>23 (28%)</td>
</tr>
<tr>
<td>2  Does the ordinance require a property to pass a lighting inspection as a condition of occupancy?</td>
<td>24 (29%)</td>
</tr>
<tr>
<td>3  Does the ordinance provide for the education of the affected public (ex. those submitting an application for construction)?</td>
<td>18 (22%)</td>
</tr>
<tr>
<td>4  Does the ordinance provide for the education of the general public?</td>
<td>21 (26%)</td>
</tr>
<tr>
<td>5  Is a provision made for a compliance inspection before the nesting season begins?</td>
<td>13 (16%)</td>
</tr>
<tr>
<td>6  Is a provision made for a compliance inspection during the nesting season?</td>
<td>12 (16%)</td>
</tr>
<tr>
<td>7  Does the ordinance provide for a pre-enforcement warning?</td>
<td>32 (39%)</td>
</tr>
<tr>
<td>8  Does the ordinance provide for a notice of violation?</td>
<td>40 (49%)</td>
</tr>
<tr>
<td>9  Does ordinance regulate behavior? (Examples include requiring shades to be drawn, lights to be moved)</td>
<td>70 (85%)</td>
</tr>
<tr>
<td>10 Shall each day of any violation constitute a separate and distinct offense?</td>
<td>57 (70%)</td>
</tr>
</tbody>
</table>

*a Mean scores standardized (standard deviation in parentheses).*
Table 3-3. Questions used for the content analysis Specificity Index (SI) and summed results indicating affirmative responses for all Florida counties with lighting ordinances for sea turtle protection.

<table>
<thead>
<tr>
<th>Specificity Index (20 items)</th>
<th>Counties (N = 82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Does the ordinance specifically regulate emergency response activities?</td>
<td>16 (20%)</td>
</tr>
<tr>
<td>2 Does the ordinance address interior courtyard lights?</td>
<td>4 (5%)</td>
</tr>
<tr>
<td>3 Does the ordinance specifically regulate landscape lighting?</td>
<td>47 (57%)</td>
</tr>
<tr>
<td>4 Does the ordinance indicate the level of lumens to be used in any situation?</td>
<td>7 (9%)</td>
</tr>
<tr>
<td>5 Does the ordinance specifically regulate multi-family construction?</td>
<td>32 (39%)</td>
</tr>
<tr>
<td>6 Does the ordinance apply to new development?</td>
<td>80 (98%)</td>
</tr>
<tr>
<td>7 Does the ordinance specifically regulate pier lighting?</td>
<td>17 (21%)</td>
</tr>
<tr>
<td>8 Does the ordinance specifically regulate pool lighting?</td>
<td>9 (11%)</td>
</tr>
<tr>
<td>9 Does the ordinance specifically regulate public facility construction?</td>
<td>52 (63%)</td>
</tr>
<tr>
<td>10 The ordinance has a preamble, purpose, intent or objective that specifically protects sea turtles and their habitat from the adverse effects of artificial lighting.</td>
<td>69 (84%)</td>
</tr>
<tr>
<td>11 Does the ordinance specifically regulate single-family construction?</td>
<td>29 (35%)</td>
</tr>
<tr>
<td>12 Does the ordinance specifically regulate parking and roadway lighting?</td>
<td>73 (89%)</td>
</tr>
<tr>
<td>13 Does the ordinance specifically regulate the lighting of signs?</td>
<td>28 (34%)</td>
</tr>
<tr>
<td>14 Does the ordinance specifically regulate special events?</td>
<td>10 (12%)</td>
</tr>
<tr>
<td>15 Does the ordinance specifically regulate temporary lighting of construction areas?</td>
<td>49 (60%)</td>
</tr>
<tr>
<td>16 Does the ordinance indicate the level of wattage to be used in any situation?</td>
<td>45 (55%)</td>
</tr>
<tr>
<td>17 Does the ordinance specifically regulate light on beach access points?</td>
<td>50 (61%)</td>
</tr>
<tr>
<td>18 Does the ordinance specifically regulate commercial construction?</td>
<td>35 (43%)</td>
</tr>
<tr>
<td>19 Does the ordinance specifically regulate dune crossovers?</td>
<td>50 (61%)</td>
</tr>
<tr>
<td>20 Does the ordinance provide specific guidance for how to retrofit existing development?</td>
<td>79 (96%)</td>
</tr>
</tbody>
</table>

*a Mean scores standardized (standard deviation in parentheses).*
Table 3-4. Technical index, management index, and total policy scores from highest to lowest for locations in Florida

<table>
<thead>
<tr>
<th>Location</th>
<th>Technical Index</th>
<th>Management Index</th>
<th>Total Policy Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarasota, Venice</td>
<td>34</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>Sarasota County</td>
<td>28</td>
<td>38</td>
<td>66</td>
</tr>
<tr>
<td>Indian River, Vero Beach</td>
<td>25</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>Sarasota, City of Sarasota</td>
<td>26</td>
<td>35</td>
<td>61</td>
</tr>
<tr>
<td>Bay, Mexico Beach</td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>St. Johns County</td>
<td>27</td>
<td>32</td>
<td>59</td>
</tr>
<tr>
<td>Okaloosa, Destin</td>
<td>26</td>
<td>33</td>
<td>59</td>
</tr>
<tr>
<td>Franklin County</td>
<td>30</td>
<td>28</td>
<td>58</td>
</tr>
<tr>
<td>Martin County</td>
<td>21</td>
<td>35</td>
<td>56</td>
</tr>
<tr>
<td>Duval, Neptune Beach</td>
<td>23</td>
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<td>Walton County</td>
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<td>55</td>
</tr>
<tr>
<td>Pinellas, St. Pete Beach</td>
<td>34</td>
<td>20</td>
<td>54</td>
</tr>
<tr>
<td>Miami-Dade, Miami Beach</td>
<td>35</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Lee County</td>
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<td>Broward, Ft. Lauderdale</td>
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<td>Gulf County</td>
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<td>23</td>
<td>48</td>
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<tr>
<td>Manatee, Anna Maria Island</td>
<td>25</td>
<td>23</td>
<td>48</td>
</tr>
<tr>
<td>Miami-Dade, Village of Key Biscayne</td>
<td>33</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Nassau, Fernandina Beach</td>
<td>27</td>
<td>20</td>
<td>47</td>
</tr>
<tr>
<td>Indian River, Indian River Shores</td>
<td>18</td>
<td>28</td>
<td>46</td>
</tr>
<tr>
<td>Manatee, Brandenton Beach</td>
<td>20</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Volusia County</td>
<td>16</td>
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<td>44</td>
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<tr>
<td>Lee, Sanibel</td>
<td>28</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>Flagler, Flagler Beach</td>
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<td>28</td>
<td>42</td>
</tr>
<tr>
<td>Brevard County</td>
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<td>10</td>
<td>42</td>
</tr>
<tr>
<td>Broward, Hollywood</td>
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<td>13</td>
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</tr>
<tr>
<td>Location</td>
<td>Technical Index</td>
<td>Management Index</td>
<td>Total Policy Score</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Lee, Bonita Springs</td>
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<td>Charlotte County</td>
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<td>Monroe, Key West</td>
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<td>Miami-Dade, Golden Beach</td>
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<tr>
<td>Bay, Panama City Beach</td>
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<td>39</td>
</tr>
<tr>
<td>St. Johns, St. Augustine Beach</td>
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<td>38</td>
</tr>
<tr>
<td>St. Lucie County</td>
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<td>20</td>
<td>36</td>
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<tr>
<td>Monroe, Marathon</td>
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<td>Monroe County</td>
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<td>5</td>
<td>35</td>
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<tr>
<td>Pinellas, North Redington Beach</td>
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<td>35</td>
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<tr>
<td>Flagler County</td>
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<tr>
<td>Bay County</td>
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<td>33</td>
</tr>
<tr>
<td>Volusia, New Smyrna Beach</td>
<td>15</td>
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<td>33</td>
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<tr>
<td>Broward, Hallandale Beach</td>
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<td>8</td>
<td>33</td>
</tr>
<tr>
<td>Pinellas, Indian Shores</td>
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<td>18</td>
<td>32</td>
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<tr>
<td>Indian River County</td>
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<tr>
<td>Pinellas, Redington Beach</td>
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<tr>
<td>Brevard, Cocoa Beach</td>
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<td>Broward County</td>
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<td>Sarasota, Longboat Key</td>
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<td>Technical Index</td>
<td>Management Index</td>
<td>Total Policy Score</td>
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<td>St. Lucie, Ft. Pierce</td>
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<td>Broward, Deerfield Beach</td>
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<td>Palm Beach, Boca Raton</td>
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<td>10</td>
<td>21</td>
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<tr>
<td>Pinellas, Treasure Island</td>
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<td>20</td>
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<tr>
<td>Pinellas, Clearwater</td>
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<td>20</td>
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<tr>
<td>Broward, Lauderdale By The Sea</td>
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<td>10</td>
<td>20</td>
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<tr>
<td>Martin, Town of Jupiter Island</td>
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<td>Nassau County</td>
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<td>5</td>
<td>19</td>
</tr>
<tr>
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<td>10</td>
<td>18</td>
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<tr>
<td>Manatee, Holmes Beach</td>
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<td>17</td>
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<tr>
<td>Lee, Ft. Myers Beach</td>
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<td>8</td>
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<tr>
<td>Brevard, Satellite Beach</td>
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<td>13</td>
</tr>
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<td>Palm Beach, Delray Beach</td>
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<td>Brevard, India Harbour Beach</td>
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<tr>
<td>Collier, Naples</td>
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<tr>
<td>Palm Beach, Gulf Stream</td>
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<tr>
<td>Palm Beach, Juno Beach</td>
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</tbody>
</table>
Table 3-5. Counties by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>Escambia&lt;br&gt;Santa Rosa&lt;br&gt;Okaloosa&lt;br&gt;Walton&lt;br&gt;Bay&lt;br&gt;Gulf&lt;br&gt;Franklin</td>
</tr>
<tr>
<td>Southwest</td>
<td>Pinellas&lt;br&gt;Hillsborough&lt;br&gt;Manatee&lt;br&gt;Sarasota&lt;br&gt;Charlotte&lt;br&gt;Lee&lt;br&gt;Collier&lt;br&gt;Monroe</td>
</tr>
<tr>
<td>Northeast</td>
<td>Nassau&lt;br&gt;Duval&lt;br&gt;St. Johns&lt;br&gt;Flagler&lt;br&gt;Volusia</td>
</tr>
<tr>
<td>Southeast</td>
<td>Brevard&lt;br&gt;Indian River&lt;br&gt;St. Lucie&lt;br&gt;Martin&lt;br&gt;Palm Beach&lt;br&gt;Broward&lt;br&gt;Miami Dade</td>
</tr>
</tbody>
</table>
Table 3-6. Results from modeling hatchling disorientation rates predicted by ordinance presence or absence from 2000-2010

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Standard Error</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinance Presence/Absence</td>
<td>-1.151*</td>
<td>.135</td>
<td>-1.416, -0.887</td>
</tr>
<tr>
<td>Population</td>
<td>-1.52e-06*</td>
<td>3.27e-07</td>
<td>-2.16e-06, -8.75e-07</td>
</tr>
<tr>
<td>Region Southwest</td>
<td>.021</td>
<td>.217</td>
<td>-.405, .447</td>
</tr>
<tr>
<td></td>
<td>-.217</td>
<td>.292</td>
<td>-.789, .447</td>
</tr>
<tr>
<td></td>
<td>-2.630*</td>
<td>.200</td>
<td>-3.021, -2.236</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.329*</td>
<td>.176</td>
<td>-3.674, -2.985</td>
</tr>
</tbody>
</table>

*.01>p

Table 3-7. Results from modeling hatchling disorientation rates predicted by ordinance index strength from 2000-2010

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Standard Error</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Index</td>
<td>.009</td>
<td>.008</td>
<td>-.007, .045</td>
</tr>
<tr>
<td>Management Index</td>
<td>-.065*</td>
<td>.008</td>
<td>-.082, -.048</td>
</tr>
<tr>
<td>Specificity Index</td>
<td>.027</td>
<td>.024</td>
<td>-.020, .074</td>
</tr>
<tr>
<td>Population</td>
<td>-1.50e-06*</td>
<td>3.25e-07</td>
<td>-2.133e-06, -8.60e-07</td>
</tr>
<tr>
<td>Region Southwest</td>
<td>-.315</td>
<td>.241</td>
<td>-.787, .157</td>
</tr>
<tr>
<td></td>
<td>-.234*</td>
<td>.299</td>
<td>-.819, .352</td>
</tr>
<tr>
<td></td>
<td>-2.987*</td>
<td>.214</td>
<td>-3.407, -2.567</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.333</td>
<td>.185</td>
<td>-3.696, -2.970</td>
</tr>
</tbody>
</table>

*.01>p
Figure 3-1. The four main technical requirements of a sea turtle lighting ordinance and the percentage of existing ordinances that include those requirements.
Background

The “front-line agents” who work hand-in-hand with the public to meet compliance standards with environmental laws play an important role influencing policy outcome and output (Elmore, 1978; Lipsky, 1980; Pautz, 2009; Sevä and Jagers, 2013). These individuals have high demand work that includes educational programs, technical assistance, and implementing sanctions regarding laws. Agents often have discretion in how they address their job. They balance time and resource constraints by rationing their services, prioritizing cases and applying different levels of client control in an effort to maximize success (Meyers and Nielsen, 2012; Sevä and Jagers, 2013; Winter, 2012). How this balance manifests itself in the day to day interactions of inspectors when dealing with those who are being regulated is know as enforcement style (May and Winter, 2000; May and Wood, 2003). The integrated implementation model (Figure 1-1) theorizes that the performance outputs of a policy are determined by the written policy and the individual enforcement style of the agent as the policy is implemented (Winter, 1990, 2012a). I apply this model to the implementation of lighting ordinances for the protection of sea turtles. In this study I define enforcement style as the character of the day to day interactions of inspectors when dealing with those who are being regulated (May and Winter, 2000; May and Wood, 2003).

Lighting ordinances to protect sea turtles have the goal of decreasing the amount of light pollution along the beach at night by regulating how coastal buildings are illuminated externally and internally. The laws require inspections, and enforcement
staff in addition to a set of sanctions (Winter, 2012). This study analyzes the structure of front-line agents’ enforcement style and the relationships between enforcement styles and performance outputs. Performance outputs include the activities compliance agents are mandated to do by the ordinance, such as conducting building inspections for light pollution at night, distributing educational material and providing written notice of non-compliance. I hypothesize that different types of enforcement style will lead to differences in (a) the number of hours spent conducting nighttime compliance inspections, (b) time spent conducting all other implementation actions, (c) best practices and (d) recommended ordinance changes.

Enforcement strategy can be conceptualized as the contrast between coercive, threatening, fining inspectors and those who are accommodative and see themselves as consultants stressing communication of the law (Lo et al., 2009; May and Wood, 2003; Tang et al., 2003). Early studies theorized that enforcement styles varied along one dimension, formalism, which is related to how strictly enforcers conform to the written policy rules being implemented (Kagan, 1994; Reiss, 1984). Later studies differentiated between how formally the law was interpreted and an agents’ enforcement strategy (Gormley, 1998; Lo et al., 2009; May and Winter, 2000; May and Wood, 2003; McAllister, 2010; Tang et al., 2003). The majority of studies identify two dimensions: deterrence and cooperation (Kagan, 1994; Reiss, 1984); formalism and coercion (May and Winter, 2000); formalism and facilitation (May and Wood, 2003). Other enforcement style theories define multiple dimensions. McAllister (2010) proposes four dimensions: formalism, coercion, degree of autonomy, and degree of capacity. Tang et al. (2003) propose five dimensions: formalism, coercion, education, prioritization, and external
influence. There is no consensus on the underlying dimensions of enforcement style, which may be due to the wide variation in types of laws being implemented, agencies represented, and the low number of empirical studies of frontline agent enforcement style. This study will provide an empirical analysis of the underlying dimensions of enforcement style of frontline agents in Florida.

I use the variation in the use of formalism and accommodation to categorize enforcement styles. Consistent with May and Wood (2003), I define formalism as the rigidity with which rules are interpreted and applied. I define accommodation as the willingness of inspectors to help regulates through technical assistance and education. I adapted the May and Wood (2003) definition of facilitation to incorporate the emphasis that the model lighting ordinance places on education.

Pairing accommodation and formalism as the two underlying dimensions of enforcement style (Figure 4-1) is a variation of the model proposed by May and Winter (2000). In the original model the label coercion, defined as the willingness to issue threats, is used instead of accommodation. I use the description of enforcement types posited by May and Winter (2000), which lead to the following categorization of enforcement style types. Rule bound enforcers are those agents with high degrees of formalism yet with low degrees of coercion (p. 150). This is consistent with the depiction of book enforcement described in McAllister (2010). On the other end of the spectrum are agents who display low levels of formalism. The token enforcement style is used to describe enforcement that requires low effort, low stringency, and haphazard enforcement.
Those agents who display mid-range levels of formalism practice flexible enforcement (May and Winter 2000). This style requires high effort, moderate stringency and targeted enforcement. The variants of the flexible style in this study also differ in degrees of accommodation. Insistent enforcers emphasize specific limits to flexibility and display lower levels of accommodation, while persuasive enforcers are more patient and display higher levels of accommodation. In the original model no enforcement style labels are found where the highest level of one dimension is paired with a low level of the other dimension, however with the emphasis of the model lighting ordinance on education I introduce an additional label, assistive legalists. Agents in this category may have high scores on accommodation and while still being highly formalistic.

**Methods**

The characterization of enforcement styles is based on data I collected as part of a phone survey administered in 2013 to front-line agents. Of the 82 localities with sea turtle lighting ordinances in Florida, four localities use police departments to implement the sea turtle lighting ordinances and were not included in the phone survey. The initial list of frontline agent names and contact numbers was obtained from the Florida Wildlife Conservation Commission website. Internet searches were used to determine the contact’s e-mail address and if an e-mail was found, a first contact letter was sent to set a time for a phone interview. In the event there was no e-mail available for the listed contact person, a phone call was made to the locality’s frontline agent, and if the contact was unavailable, a message was left. Each enforcement officer was contacted at least three times to try to schedule a phone interview. Like other studies with small populations (May and Winter, 2000), the data are based on complete enumeration of
localities, rather than on a statistical sample making statistical tests of inference unnecessary. The main intent of this work is to find broader patterns in the data that relate to the hypotheses.

I developed a semi structured interview (Appendix A) based on the model lighting ordinance implementation theory. Before the final survey was launched, a group of survey experts reviewed the survey for clarity. A cognitive interview was conducted with a frontline agent responsible for implementing lighting ordinances for sea turtle protection from South Carolina. Table 4-1 summarizes the items that make up the measures of enforcement style, which were based on work by Lo et al. (2009) and Tang et al. (2003) with categorizations based on May and Wood (2003). Frontline agents were asked to indicate their agreement with statements on a five-point scale with 1 representing strong disagreement and 5 indicating strong agreement. These items were constructed to reflect different aspects of enforcement style and to correspond with measures employed by formalism and accommodation. Responses to these items were used to establish the underlying structure and types of code enforcement styles. Additional survey items included 2 items asking agents for their recommendations for improving the ordinances as well as opinions about existing sections of the ordinance that are effective in achieving compliance (Table 4-1).

A principal component analysis (PCA) is used to identify the underlying structure of enforcement styles by determining the number of dimensions. The PCA identifies the dimensions that explain variation among the nine items so that the dimensions are uncorrelated (May and Winter, 2000).
The integrated implementation model hypothesizes that the performance outputs of a policy are determined by the written policy and the behavior of frontline agents as they implement it. I use the score of the lighting ordinance on the management index (see Table 2-2 and 2-4) to represent the policy design variable and the enforcement style of the frontline agent to represent the implementation process. I use linear regression to analyze the significance of the strength of the ordinance, and the enforcement style of frontline agents on two performance outputs: (a) the average number of hours spent conducting nighttime inspections per month and (b) the average number of hours spent conducting lighting ordinance related duties per month.

Results

Underlying Dimensions of Enforcement Style

In all, 42 frontline agent agents from 10 counties and 28 municipalities across Florida were interviewed. Of the 71 agents contacted, 10 contacts were incorrect, meaning individuals no longer held positions as agents. The agents interviewed represent a cooperation rate of 60%. The agents responsible for administering the lighting ordinance are found in natural resource departments, code enforcement, and public administration offices.

The best fit for the principal component analysis is obtained by a two-dimensional solution. It explains 50% of overall variation in the nine items measuring enforcement style. Both underlying components meet the statistical criteria for retention with eigenvalues above one. The results of the principal component analysis showing the correlation between each of the items measuring enforcement style and the two underlying components are shown in Table 4-2. The first dimension consists of items characterizing interactions that focus on education and technical assistance which are
consistent with “accommodation” ($\alpha = 0.64$). The second dimension is composed of items that reflect the degree to which agents adhere to a consistent legally defined process when applying the law, these items are consistent with “formalism” ($\alpha = 0.39$). A Fisher-Hayter pairwise comparisons reveals two significantly different groups are present connected to the dimension of accommodation. A Fisher-Hayter pairwise comparison shows the formalism dimension is composed of four significantly different groups.

**Description of Enforcement Styles**

Frontline agents were assigned an enforcement style by plotting their accommodation and formalism scores and then conducting a cluster analysis (Figure 4-2). The 35% of front line agents who have high accommodation scores and high formalism scores are labeled as being assistive legalistic enforcers. The 20% of agents who have high accommodation scores and mid level formalism scores are persuasive enforcers. The 27.5% of agents who have high accommodation scores and low formalism scores are accommodative enforcers. The 17.5% of agents who have mid level accommodation and formalism scores are flexible enforcers. Table 4-3 lists the mean values of accommodation and formalism for each enforcement style.

**Impact Of Enforcement Style On Performance Outputs**

The main effects regression model including ordinances management score and frontline agent’s enforcement styles explain 38.7% of the variance of time spent conducting night inspections (Table 4-4). When the regression model includes the interaction between management score and enforcement style, the model explains 52.6% of the variance (Table 4-5). Neither the main effects nor the interaction models
for time spent conducting compliance activities other than lighting inspections are significant.

**Recommended Ordinance Changes and Implementation Practices**

There are no differences in best practices or recommended changes made by frontline agents with respect to agent enforcement style. Table 4-6 shows recommendations by frontline agents of best practices when implementing the ordinances. One frontline agent explained a best practice for ordinance implementation:

> Well, the thing that works the best is to have a conversation with the owner and explain to them and educate to them why it’s important, to not have the lights attract the turtles off the beach instead of just sending letters or threatening them with fines I think education is the most important part of the job there. And once people understand why it’s a privilege to work on the beach it’s not just their right it’s part of their privilege to live on the beach, they have to, they can’t just keep their lights on like everybody else can when they live on the beach. And you start having these conversations and more people understand and that ends up with a better result.

Table 4-7 shows recommendations by frontline agents for changes to the ordinance. Illustrative quotes of recommended ordinance changes are as follows:

> Yeah we haven’t revised our ordinance since we started it in 2001. It is overdue. We have 25 watt yellow bug lights as our standard light that’s recommended, so we know now, we now know that it gives off a variety of wavelengths, some of which the turtles can see. So our number one change would be to change that to low watt LED amber, red, or orange light. (Frontline agent)

> We do need to do an amendment to update some of the more recent changes in technology for lighting and types of bulbs because currently we require a 25 watt yellow bulb and those are getting obsolete. So we’re moving towards the amber LEDs and that’s what we’re doing a planned review but it’s not specified in the ordinance. So if anyone wanted to argue about it could be. Not specifically addressed and the same with pool lighting which seems to be an issue at the moment because it doesn’t specifically say what is expected. So those kinds of amendments could
certainly help being more specific. Like new construction and how to correct lightings and things like that. (Frontline agent)

I would have to say yes I think it would be good if some information some pictures of bulbs of lamps for the wildlife lighting ordinance if we have that. I have some handouts from the conservancy and fish and wildlife and federal agencies that have been real helpful. If that could be incorporated into the ordinance that would be nice for someone to look over it and look at certain pictures and then if they wanted to get that particular picture that there would be a list of suppliers and distributors just basically making it easier or the individual to accept the ordinance. (Frontline agent)

Discussion

This study provides an understanding of the administration of local environmental policies by analyzing the enforcement styles of frontline agents in Florida administering lighting ordinances to protect endangered sea turtles. The agents in Florida are trying to achieve compliance in areas heavily dominated by tourism where the beach and coastal area serve as the main attraction. During the interviews, agents expressed concern that if they act like cops, there would be a negative economic impact for the communities they serve. In Florida, front-line agents charged with implementation of coastal lighting ordinances rarely fine regulated entities or use the threat of fines, so the usual enforcement style categories that are based on coercion do not apply. This type of regulation is known as “reasonable regulation” where the goal is to achieve compliance without recourse to the legal process (Braithwaite et al., 1987 p. 324). I found that frontline agents in Florida rely on techniques of persuasion and negotiation and make use of education and provide technical assistance in order to implement lighting ordinances. Evidence of this is the high scores for the accommodation element and the majority of agents that suggested educational tactics for improving implementation.

This research adds empirical support for theories about enforcement style that have multiple dimensions. I show that frontline agents enforcement styles are best
depicted as having two dimensions—the degree of accommodation and the degree of formalism that they exercise when implementing lighting ordinances. For these data, the accommodation dimension is dominant, explaining a larger percentage of variation than the formalism dimension. The dominance of accommodation differs from other studies, which shows how heavily the cultural context can impact how agents go about implementing the law.

While there is variation within each of the four styles identified, as illustrated by the cloud of scatter points for each category (Figure 4-2), these patterns are more clearly defined than in previous research concerning variation in enforcement patterns by May and Winter (2000).

Enforcement style was associated with the effort spent on inspections. The moderator enforcement style changes the association from negative to positive between time spent on night inspections for those agents with an assistive legalistic enforcement style. Assistive legalists spend more time on night inspections when there are more management requirements. Frontline agents with persuasive and flexible enforcement styles more time conducting night inspections than those with assistive legalistic and accommodative style when paired with laws that require more management actions. This situation may be because night inspections often fall outside of many frontline agents’ regular work hours. Agents may be more inclined to find ways to alter their schedules to facilitate working at night. This may explain why there is no difference in the number of hours spent conducting other regulatory activities related to implementing the lighting ordinance as those activities can occur during the regular course of a workday.
Front-line agents recommendations for changes to the lighting ordinance are mostly bureaucratic. The focus on expanding what areas they have influence over suggests there is light pollution reaching the beach negatively impacting sea turtles coming from sources not regulated by the ordinance. Their recommendations for effective implementation focus on persuasive avenues to achieve compliance. Educational activity was cited by the most agents, irrespective of enforcement style, as helpful in achieving compliance. Since most ordinances do not mandate any educational activity, revisions to ordinances should include this element.
Figure 4-1. Hypothesized styles of enforcement displayed along two dimensions based on May and Winter (2000). Ideal type categories are displayed in bold.
Table 4-1. Questions used to measure regulatory enforcement styles, actions, and recommendations

<table>
<thead>
<tr>
<th>Enforcement Style</th>
<th>Action</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formalism</strong></td>
<td>I emphasize paperwork rather than direct conversation.</td>
<td>Are there any parts of the ordinance you find particularly effective?</td>
</tr>
<tr>
<td></td>
<td>I emphasize law enforcement rather than consultation.</td>
<td>Can you think of any changes to the ordinance that would help you in your job?</td>
</tr>
<tr>
<td></td>
<td>The degree of light pollution is an important consideration in each case I approach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The ability to pay is an important factor I consider in each case.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I emphasize consistency rather than flexibility.</td>
<td></td>
</tr>
<tr>
<td><strong>Accommodation</strong></td>
<td>I emphasize educating the public when seeking enforcement.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I emphasize educating businesses when seeking enforcement.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I emphasize providing technical assistance to help properties become compliant.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I have enough discretion to handle each case flexibly.</td>
<td></td>
</tr>
</tbody>
</table>
Table 4-2. Dimensions of enforcement style

<table>
<thead>
<tr>
<th>Character of interactions</th>
<th>Loadings for Enforcement Style Dimensions&lt;sup&gt;a&lt;/sup&gt;</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasize paperwork rather than direct conversation</td>
<td>-0.3124</td>
<td>0.3381</td>
<td></td>
</tr>
<tr>
<td>Emphasize law enforcement rather than consultation</td>
<td>-0.2887</td>
<td>0.3124</td>
<td></td>
</tr>
<tr>
<td>Degree of light pollution is important</td>
<td>0.2627</td>
<td>0.3165</td>
<td></td>
</tr>
<tr>
<td>Ability to pay is an important factor</td>
<td>0.0879</td>
<td>0.6515</td>
<td></td>
</tr>
<tr>
<td>Emphasize consistency rather than flexibility</td>
<td>-0.0755</td>
<td>0.3517</td>
<td></td>
</tr>
<tr>
<td>Emphasize educating the public</td>
<td>0.4857</td>
<td>0.1787</td>
<td></td>
</tr>
<tr>
<td>Emphasize educating businesses</td>
<td>0.4341</td>
<td>0.2300</td>
<td></td>
</tr>
<tr>
<td>Emphasize educating the public</td>
<td>0.4059</td>
<td>-0.0393</td>
<td></td>
</tr>
<tr>
<td>Discretion to handle each case flexibly</td>
<td>0.3841</td>
<td>-0.2311</td>
<td></td>
</tr>
</tbody>
</table>

Model Statistics

| Variance Explained | 33% | 17% |

Note:

<sup>a</sup> Cell entries are Pearson correlations between items measuring the character of interactions and the dimensions of enforcement style based on a principal component analysis with an orthogonal varimax rotation. Items shown in bold are those used to label each dimension. Each item is measured on a five point scale where higher scores indicate stronger agreement with the statement.
Figure 4-2. Classification of enforcement styles for Florida's sea turtle lighting ordinance frontline agents
Table 4-3. Attributes of different enforcement styles

<table>
<thead>
<tr>
<th>Dimensions of Enforcement Style</th>
<th>Assistive Legalists</th>
<th>Persuasive</th>
<th>Accommodative</th>
<th>Flexible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodative</td>
<td>4.732143</td>
<td>4.71875</td>
<td>4.795455</td>
<td>3.607143</td>
</tr>
<tr>
<td>Formalistic</td>
<td>4.035714</td>
<td>3.25</td>
<td>2.5</td>
<td>3.607143</td>
</tr>
<tr>
<td>Attributes of Enforcement Style&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emphasize paperwork rather than direct conversation</td>
<td>1.714286</td>
<td>1.5</td>
<td>1</td>
<td>2.285714</td>
</tr>
<tr>
<td>Emphasize law enforcement rather than consultation</td>
<td>2.428571</td>
<td>1.5</td>
<td>1</td>
<td>2.428571</td>
</tr>
<tr>
<td>Degree of light pollution is important</td>
<td>4.928571</td>
<td>4.75</td>
<td>3.909091</td>
<td>4</td>
</tr>
<tr>
<td>Ability to pay is an important factor</td>
<td>2.857143</td>
<td>2</td>
<td>1.181818</td>
<td>1.857143</td>
</tr>
<tr>
<td>Emphasize consistency rather than flexibility</td>
<td>4.214286</td>
<td>3.25</td>
<td>2.909091</td>
<td>3.857143</td>
</tr>
<tr>
<td>Emphasize educating the public</td>
<td>5</td>
<td>4.875</td>
<td>4.909091</td>
<td>4.142857</td>
</tr>
<tr>
<td>Emphasize educating businesses</td>
<td>4.857143</td>
<td>4.75</td>
<td>4.818182</td>
<td>4</td>
</tr>
<tr>
<td>Emphasize educating the public</td>
<td>4.642857</td>
<td>4.625</td>
<td>4.636364</td>
<td>3.285714</td>
</tr>
<tr>
<td>Discretion to handle each case flexibly</td>
<td>4.428571</td>
<td>4.625</td>
<td>4.818182</td>
<td>3</td>
</tr>
<tr>
<td>Cluster Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Compliance Agents</td>
<td>14</td>
<td>8</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Percent of Total</td>
<td>35</td>
<td>20</td>
<td>27.5</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Note:
<sup>a</sup> Cell entries are the mean values of designated items
<sup>b</sup> Scores for the dimensions of enforcement style based on the principal component analysis shown in Table 4-2.
<sup>c</sup> Items employed for the cluster analysis. Each item is measured on a five point scale with higher scores indicating stronger agreement with the statement.
Table 4-4. Number of hours spent conducting night inspections as predicted by enforcement style and ordinance management requirements

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>p</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Index</td>
<td>0.6393</td>
<td>0.1762</td>
<td>0.001</td>
<td>(0.2804, 0.9982)</td>
</tr>
<tr>
<td>Enforcement Style</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persuasive</td>
<td>6.5745</td>
<td>4.3353</td>
<td>0.139</td>
<td>(-2.2563, 15.4053)</td>
</tr>
<tr>
<td>Accommodative</td>
<td>0.6814</td>
<td>4.1828</td>
<td>0.872</td>
<td>(-7.8388, 9.20152)</td>
</tr>
<tr>
<td>Flexible</td>
<td>4.6968</td>
<td>4.6508</td>
<td>0.320</td>
<td>(-4.7765, 14.1702)</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.4051</td>
<td>3.7829</td>
<td>0.375</td>
<td>(-11.1105, 4.3004)</td>
</tr>
</tbody>
</table>
Table 4-5. Number of hours spent conducting night inspections as predicted by the interaction of enforcement style and ordinance management requirements.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>p</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style*Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistive Legalists</td>
<td>0.3755</td>
<td>0.1787</td>
<td>0.044</td>
<td>(0.0115, 0.7394)</td>
</tr>
<tr>
<td>Persuasive</td>
<td>0.9291</td>
<td>0.1912</td>
<td>0.000</td>
<td>(0.5396, 1.3186)</td>
</tr>
<tr>
<td>Accommodative</td>
<td>0.3403</td>
<td>0.2224</td>
<td>0.139</td>
<td>(-0.1166, 0.7971)</td>
</tr>
<tr>
<td>Flexible</td>
<td>1.1142</td>
<td>0.2802</td>
<td>0.000</td>
<td>(0.5435, 1.6851)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.3173</td>
<td>2.5105</td>
<td>0.900</td>
<td>(-5.4310, 4.7964)</td>
</tr>
</tbody>
</table>
Table 4-6. Frontline agent recommendations for implementing sea turtle lighting ordinances

<table>
<thead>
<tr>
<th>Implementation recommendations</th>
<th>Number of Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase education</td>
<td>25</td>
</tr>
<tr>
<td>Educate</td>
<td></td>
</tr>
<tr>
<td>Partner with outside groups</td>
<td></td>
</tr>
<tr>
<td>Send preseason reminder</td>
<td></td>
</tr>
<tr>
<td>Use door hangers</td>
<td></td>
</tr>
<tr>
<td>Websites with recommended lights and fixtures</td>
<td></td>
</tr>
<tr>
<td>Increase personal contact with target groups</td>
<td>4</td>
</tr>
<tr>
<td>Show people lights on buildings</td>
<td></td>
</tr>
<tr>
<td>Work with property managers</td>
<td></td>
</tr>
<tr>
<td>Enforcement effort</td>
<td>4</td>
</tr>
<tr>
<td>Conduct lighting inspections</td>
<td></td>
</tr>
<tr>
<td>Consistent effort throughout year</td>
<td></td>
</tr>
<tr>
<td>Increase available agent resources</td>
<td>11</td>
</tr>
<tr>
<td>Take advantage of grants</td>
<td></td>
</tr>
<tr>
<td>More personnel</td>
<td></td>
</tr>
<tr>
<td>Use new technology for faster inspections</td>
<td></td>
</tr>
</tbody>
</table>
Table 4-7. Frontline agent recommendations for changes to improve sea turtle lighting ordinances

<table>
<thead>
<tr>
<th>Change to ordinance</th>
<th>Number of Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand ordinance scope</td>
<td>11</td>
</tr>
<tr>
<td>- Regulate lights not on buildings</td>
<td></td>
</tr>
<tr>
<td>- Regulate interior light</td>
<td></td>
</tr>
<tr>
<td>- Regulate lights beyond beachfront</td>
<td></td>
</tr>
<tr>
<td>- Regulate existing construction</td>
<td></td>
</tr>
<tr>
<td>Provide detailed information</td>
<td>15</td>
</tr>
<tr>
<td>- Technical specifications</td>
<td></td>
</tr>
<tr>
<td>- Include new technology</td>
<td></td>
</tr>
<tr>
<td>Change how non-compliance is handled</td>
<td>4</td>
</tr>
<tr>
<td>- Option of writing a ticket or scheduling a hearing</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 5
CONCLUSION

Lighting technology has advanced since Florida counties first implemented lighting ordinances, and since the DEP drafted the model lighting ordinance (F.S. 62B-55) in 1998. Recently available technology has been shown to significantly decrease the impacts of artificial light on sea turtles. The content analysis revealed that most local ordinances are not adequate to protect sea turtles. They do not reference the newly available commercial technology nor do they have sufficient implementation statutes.

Interviews with the frontline agents responsible for implementing the lighting ordinances illustrated that what is written in statute will often differ from the activities that occur within a locality. These interviews also highlighted the need for ordinances to be written to provide continuity and resilience as staff change. The staff necessary to effectively fulfill these activities may require more resources than are budgeted by local governments. Additional funds may be secured by including language in the lighting ordinance that takes the fines collected and puts them into a sea turtle fund instead of into the general budget.

This dissertation provides the basis for several future studies. Additional studies should investigate whether providing statutes with fine scale specificity increases the ease of implementation for frontline agents and compliance by residents. There is also a need to connect initial and long-term outcomes with lighting ordinance legal strength and implementation. This dissertation also can serve as a model for conducting a theory-based evaluation of environmental regulation, thus improving scholarship in this important arena.
## APPENDIX A
### PENALTIES FOR ORDINANCE VIOLATION

<table>
<thead>
<tr>
<th>County Name</th>
<th>Municipality Name</th>
<th>Maximum Penalty (dollars)</th>
<th>Each Day of Violation a Separate Offense?</th>
<th>Jail Time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay</td>
<td></td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Bay</td>
<td>Mexico Beach</td>
<td>500</td>
<td>Yes</td>
<td>60</td>
</tr>
<tr>
<td>Bay</td>
<td>Panama City Beach</td>
<td>100</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Brevard</td>
<td>Town of Indiantantic</td>
<td>15000</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Brevard</td>
<td></td>
<td>500</td>
<td>Yes</td>
<td>180</td>
</tr>
<tr>
<td>Brevard</td>
<td>Cape Canaveral</td>
<td>500</td>
<td>Yes</td>
<td>60</td>
</tr>
<tr>
<td>Brevard</td>
<td>Cocoa Beach</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Brevard</td>
<td>Satellite Beach</td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Brevard</td>
<td>Indian Harbor Beach</td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Brevard</td>
<td>Melbourne Beach</td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Broward</td>
<td></td>
<td>500</td>
<td>Yes</td>
<td>60</td>
</tr>
<tr>
<td>Broward</td>
<td>Dania Beach</td>
<td>500</td>
<td>No</td>
<td>90</td>
</tr>
<tr>
<td>Broward</td>
<td>Hillsboro Beach</td>
<td>500</td>
<td>No</td>
<td>90</td>
</tr>
<tr>
<td>Broward</td>
<td>Hollywood</td>
<td>500</td>
<td>Yes</td>
<td>60</td>
</tr>
<tr>
<td>Broward</td>
<td>Deerfield Beach</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Broward</td>
<td>Ft. Lauderdale</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Broward</td>
<td>Hallandale Beach</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Broward</td>
<td>Lauderdale by the Sea</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Broward</td>
<td>Pompano Beach</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Charlotte</td>
<td></td>
<td>1000</td>
<td>Yes</td>
<td>90</td>
</tr>
<tr>
<td>Collier</td>
<td></td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Collier</td>
<td>Marco Island</td>
<td>500</td>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Collier</td>
<td>Naples</td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Duval</td>
<td>Neptune Beach</td>
<td>500</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Duval</td>
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Hello Interviewer: What is your name?

What location are you interviewing? (Ex. Bay County; St. Augustine)
  County Name (ex. Volusia County)
  Municipality Name (ex. New Smyrna)

This is _____________ speaking. I am a part of a graduate student research project at the University of Florida who is looking to understand different perspectives on sea turtle lighting legislation. (If you sent and e-mail) I sent you an email in the past few days asking to schedule a time to talk. Would you have time to spend about 30 minutes with me to answer some questions about the lighting ordinance and your experience with it? (If no e-mail was available) You were listed on the Florida Fish and Wildlife Conservation Commission website as the code enforcement contact for this issue in your area. Would you have time to spend about 30 minutes with me to answer some questions about the lighting ordinance and your experience with it?

First I have to give you some information about participating in this survey as required by the University of Florida. During the survey you may decline to answer any questions that you choose, and may discontinue your participation in the interview at any time without consequence. This research survey has been approved by the University of Florida Institutional Review Board (IRB). If you have any questions about this research protocol please contact the project coordinator Jame McCray at jmccray@ufl.edu. Questions or concerns about your rights as a research participant may be directed to the IRB02 office at the University of Florida phone number (352) 392-0433.

Are you still with me? There are no anticipated risks, compensation or other direct benefits to you as a participant in this interview. However, with your expert insight this project will be able to provide examples of successful implementation and quality recommendations to help improve lighting ordinances in Florida. With your permission I would like to record this interview for data accuracy. Only my research team will have access to the recording, which will be transcribed, removing any identifiers from the transcript. Your identity will be kept confidential to the extent provided by law and your identity will not be revealed in any reports associated with this interview. May I proceed with the interview and recording? [START RECORDING IF PERSON AGREES] (Did person agree to the recording?)

☐ Yes
☐ No

Thank you for agreeing to have this call recorded.
Since we will be discussing lighting ordinances for the protection of sea turtles I’d first like to ask:

Have you ever seen a sea turtle nesting or hatching as part of your work duties? If so would you briefly describe the encounter. (DO NOT READ CHOICES)
☑ Yes
☑ No

(Notes)

The next few questions focus on how your county implements the lighting ordinance

Do you recall what year your area began enforcing the sea turtle lighting ordinance? (DO NOT READ CHOICES) (Check all that apply)
☑ Yes ________________
☑ No
☑ Don't know

Are you the only person who enforces the sea turtle lighting ordinance in your area?
☑ Yes
☑ No

How many other people assist in the lighting ordinance implementation?

What are their names?

Of the people in your office, do you spend the most time on lighting ordinance matters?
☑ Yes
☑ No

(Prompt If no) Who would you say spends the most time working on lighting ordinance issues?

Are there any parts of the ordinance that you find particularly effective? (DO NOT READ CHOICES)
☑ Yes
☑ No

(Prompt if yes) Would you describe what you find effective?

(Prompt if no) Are you sure there isn't anything in the ordinance that you find effective?
Can you think of any changes to the ordinance that would help you in your job? (DO NOT READ CHOICES)

☐ Yes
☐ No

(Prompt if yes) Would you describe those changes?

(Prompt if no) Are you sure there isn't anything in the ordinance that you would like to change if you could?

The next set of questions focuses on lighting inspections:

Do you conduct nighttime lighting inspections during the sea turtle nesting season? (DO NOT READ CHOICES) (Check all that apply)

☐ Yes
☐ No

How often do you conduct lighting inspections? (DO NOT READ CHOICES) (Check all that apply)

☐ Monthly
☐ When I'm notified of a potential violation
☐ Both
☐ Other (please specify): ____________________

Do you remember what year the county began conducting lighting inspections? (DO NOT READ CHOICES)

☐ Yes ____________________
☐ No

Do you recall what prompted the county to begin conducting lighting inspections? (DO NOT READ CHOICES)

☐ Yes ____________________
☐ No

Think about a typical week during the current sea turtle nesting season. How many hours do you spend conducting lighting inspections? (READ ANSWER CHOICES)

☐ None
☐ 1-5 hours
☐ 6-10 hours
☐ 11-20 hours
☐ more than 20 hours
How many hours do you spend on lighting enforcement duties other than lighting inspections? (READ ANSWER CHOICES)
- None
- 1-5 hours
- 6-10 hours
- 11-20 hours
- more than 20 hours

Sometimes there are other activities related to the sea turtle lighting ordinance:

Does your department give presentations about the sea turtle lighting ordinance? (DO NOT READ CHOICES)
- Yes
- No
- Not sure

Are these presentations about any of the following topics? (READ ANSWER CHOICES) (Check all that apply)
- Sea turtle biology
- How to make buildings comply with the ordinance
- Is there anything else? ____________________

Does your department offer public educational materials related to the lighting ordinance? (DO NOT READ CHOICES)
- Yes
- No
- Not sure

Which of the following types of educational materials does your department provide? (READ ANSWER CHOICES) (Check all where they indicate yes)
- Do you provide written material?
- Do you provide signs?
- Do you provide public service announcements via radio?
- Do you provide public service announcements via television?
- Is there anything else? ____________________
Which of the following topics do the educational materials cover? (READ ANSWER CHOICES) (Check all where they indicate yes)
- Does the material cover sea turtle biology?
- Does it cover nesting season dates?
- Does the material cover lighting regulations?
- Does it cover the effects of artificial lighting on sea turtles?
- Does it cover technical information on property compliance?
- Does the material cover appropriate sea turtle friendly behaviors?
- Are there other topics the educational materials cover? ____________________

Does your department work with outside groups to implement the lighting ordinance? (DO NOT READ CHOICES)
- Yes
- No
- Not sure

What are some examples of the groups you work with?

Thank you for your patience. We are halfway through the survey.

Now I'd like to discuss how you deal with noncompliance.

Do you give pre-enforcement warnings? (DO NOT READ CHOICES)
- Yes
- No
- Not Sure

How do you issue these warnings? (DO NOT READ CHOICES)
- Oral warning
- Written warning
- Other (please specify): ____________________

Do you provide technical assistance to noncompliant properties? (DO NOT READ CHOICES)
- Yes
- No
- Not Sure

In regards to the sea turtle lighting ordinance, about how many warnings were issued during the last nesting season?

In regards to the sea turtle lighting ordinance, about how many violations were issued during the last nesting season?
How many convictions occurred during the last sea turtle nesting season?

How is the money collected from fines used? (DO NOT READ CHOICES)
- Response ____________________
- Not sure

At the beginning of last nesting season, what percentage of properties were compliant with sea turtle lighting regulations?

By the end of last nesting season, what percentage of properties were compliant with sea turtle lighting regulations?

At the beginning of this nesting season, what percentage of properties were compliant with sea turtle lighting regulations?

By the end of this nesting season, what percentage of residences do you expect to be compliant with sea turtle lighting regulations?

Now I’d like to ask a few questions about your time as a code enforcement officer.

How long have you been a code enforcement officer?

During this time, have you ever attended any training sessions about sea turtle biology in general? (DO NOT READ CHOICES) (Check all that apply)
- Yes
- No

(If Yes) Do you remember who held the session?

Have you ever attended any training sessions that were specifically about sea turtle friendly lighting? (DO NOT READ CHOICES) (Check all that apply)
- Yes
- No

Do you remember who held the session?

Are there any groups in your area that have been vocal about their views of the sea turtle lighting ordinance?

We are almost finished, this is the last section of the interview. Thank you for bearing with me. This section has a slightly different format. After I read a statement please say how much you agree or disagree with the statement on a scale of 1 to 5. In this scale 1= strongly disagree; 2= disagree; 3= neither agree nor disagree; 4= agree; and 5= strongly agree. The first set of statements deals with your interactions with the public and businesses.
When enforcing the sea turtle lighting ordinance..

I emphasize paperwork rather than direct conversation. (DO NOT READ CHOICES)
- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Agree nor Disagree
- 4 = Agree
- 5 = Strongly Agree
- Refuses to answer (DO NOT READ)

I emphasize law enforcement rather than consultation. (DO NOT READ CHOICES)
- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Agree nor Disagree
- 4 = Agree
- 5 = Strongly Agree
- Refuses to answer

I emphasize legal requirements rather than personal attitudes. (DO NOT READ CHOICES)
- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Agree nor Disagree
- 4 = Agree
- 5 = Strongly Agree
- Refuses to answer

I emphasize consistency rather than flexibility. (DO NOT READ CHOICES)
- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither Agree nor Disagree
- 4 = Agree
- 5 = Strongly Agree
- Refuses to answer
I use the threat of fines rather than avoid the threat of fines in enforcement. (DO NOT READ CHOICES)
- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree
- Refuses to answer

The next set of questions asks about how you prioritize tasks related to the sea turtle ordinance.

Remember in this scale 1= strongly disagree; 2= disagree; 3= neither agree nor disagree; 4= agree; and 5= strongly agree. Here is the last set of statements: On a scale of 1-5

I emphasize educating the public when seeking enforcement. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

I emphasize educating businesses when seeking enforcement. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

I emphasize providing technical assistance to help properties become compliant. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree
I have enough discretion to handle each case flexibly. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

The degree of light pollution is an important consideration in each case I approach. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

The ability to pay is an important factor I consider in each case. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

Overall, my unit effectively implements the sea turtle lighting regulations. (DO NOT READ CHOICES)
- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

That was the final question. Would you like to provide any final comments about the sea turtle ordinance?

Thank so much for participating in this study.

Have a good day

END
REFERENCE LIST


Gunningham, N., 2015. Compliance, Deterrence and Beyond (No. 87).


BIOPGRAPHICAL SKETCH

Jame McCray was born and raised in Brooklyn, NY. She graduated with a B.S. in Biology from the University of Maryland Baltimore County in 2002. She earned a M.A. in Marine Affairs and Policy from the Rosensteil School of Marine and Atmospheric Science at the University of Miami in 2004. During her time in Miami she worked as a biological technician for the National Park Service.

In 2006, Jame joined the Peace Corps and served in Samoa until 2008. While in Samoa she worked for both the Ministry of Natural Resources Environment as their marine statistician and the National University as a chemistry lecturer.

An interdisciplinary ecologist working at the intersections between ecology, human behavior and the performing arts, Jame collaborates on theater and dance projects grounded in scientific research. These projects serve to increase scientific literacy and bring diverse groups of people into dialogue on contemporary environmental issues. Jamē has developed arts integrated science education programs for a wide variety of audiences, from K-16 students to adults. Currently she works as an environmental social scientist for Delaware Sea Grant and is an associate artist with the Dance Exchange and Superhero Clubhouse.