

**MITIGATING ANTHROPOGENIC LIGHTING ON SEA
TURTLE NESTING BEACHES IN ANGUILLA:
RECOMMENDATIONS FOR A LIGHTING ORDINANCE IN A
TOURISM-BASED ECONOMY**

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ABSTRACT

Anguilla is a small island in the Caribbean with recovering nesting populations of hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) turtles. While there is currently a moratorium on sea turtle harvesting until 2020, the Department of Fisheries and Marine Resources is concerned about anthropogenic impacts on nesting habitat. These impacts relate to tourism pressures and include artificial beachfront lighting, largely unconstrained coastal development, and illegal sand mining for construction aggregate. Artificial lighting on beaches can deter gravid females from approaching nesting sites, disrupt and shorten nesting efforts, and inhibit sea-finding mechanisms in both turtles and hatchlings. The majority of light pollution in Anguilla emanates from beachfront tourism-related properties, the most rapidly expanding economic sector on the island. In addition to stakeholder interviews, field work included formal lighting assessments on three hotel properties located on nesting beaches and informal assessments of lighting and other anthropogenic effects on other potential nesting habitat on the island. The project provides recommendations for elements of a Lighting Ordinance, as well as tourism-oriented materials designed to help reduce the impact of the tourism industry on sea turtle nesting habitat in Anguilla.

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Author, DFMR staff and volunteers after successful sampling event on Scrub Island

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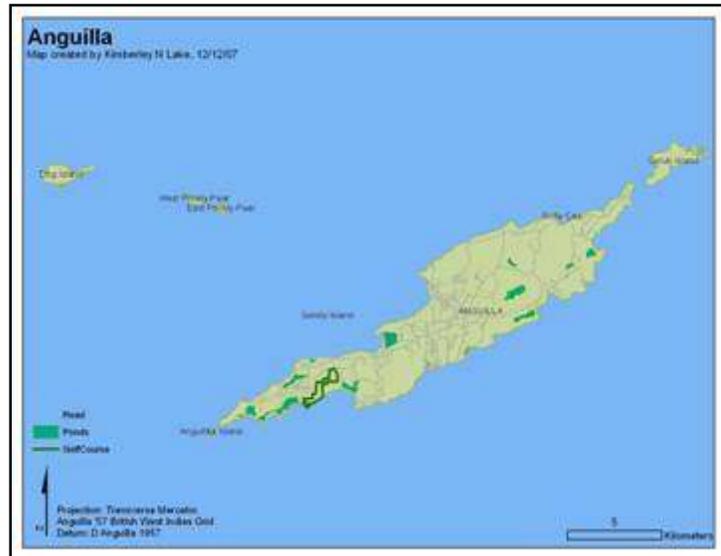
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INTRODUCTION

Anguilla is a small island territory (39.4 square miles) in the Caribbean Sea with a population of 13,677. The island is 16 miles long, end to end, and only 3 miles across at its widest point. In addition to the main island, the territory includes several small and mostly uninhabited islets.

Anguilla is an internally self-governing Overseas Territory of the United Kingdom. The United Kingdom is responsible for the island's external affairs; for example, defense and international agreements. Internal affairs, including legislation and enforcement related to fisheries and the environment, are the responsibility of the Anguillan government (Godley et al., 2004; Bräutigam & Eckert, 2006).



Map of Anguilla. (GIS Data from DFMR, Anguilla)

Anguilla has few natural resources, most of which are directly linked to the ocean, and poor soils that are unsuitable for a wide range of agriculture. Tourism makes up a large part of the income of the country. The tourism industry in Anguilla flourished in the 1980s and 1990s: the number of visitors to Anguilla increased seven-fold from 17,561 in 1982 to 125,780 in 1995 (Gell & Watson, 2000). In 2005, 143,186 visitors arrived in Anguilla, a 16% increase over 2004 arrivals (ATB, 2006). The clientele tends to be elite; this is often documented in travel magazines and the news (see for example Yancey, 2008). Accommodations range from small guesthouses to large and exclusive hotels and villas. The tourism industry is the major catalyst for development on the island, and beachfront construction has degraded (through impacts like light pollution), or eliminated nesting habitat for endangered sea turtles.

Protecting favorable habitat for nesting turtles is an important step to the recovery of a threatened marine turtle population (Bell et al, 2007). Frazer (1986) estimated that only one egg in 1,000 results in an adult sea turtle; therefore successful egg-laying and hatching, as well as protection of egg-laying adults, is critical to increasing the population of nesting turtles on Anguilla. However, the odds are reduced by disorientation and mortality of hatchlings due to artificial beachfront lighting.

Hatchlings rely almost exclusively on brightness cues to find their way to the ocean; when there is an excess of artificial lighting on the beach, hatchlings can become confused or orient themselves inland instead of to the water, resulting in increased predation or fatal

dehydration and/or fatigue. Managers of turtle populations can respond by eliminating the threats, reducing the risk through mitigation measures, relocating eggs to lower-lit areas, or doing nothing (Witherington, 1999).

“Doing nothing” in Anguilla is not a viable option for promoting sea turtle recovery. Coastal development on the island is expanding, meaning that major anthropogenic threats to nesting are not projected to decrease over time. Relocating eggs is also not an appropriate option for Anguilla. First, the risks associated with relocating nests could be counterproductive to Anguilla’s conservation goals: most beaches are not patrolled all night, meaning that eggs would be exhumed and reburied the following day. The relocation of eggs 12 hours or more after a nesting event has been shown to reduce hatching success by up to 67% (Limpus et al., 1979). Secondly, and more importantly, threats to nesting are not only on popular beaches. Sand mining, a serious threat to habitat on the island, occurs on some of Anguilla’s more remote beaches since remote locations reduce the risk to illegal miners of being caught. Therefore, relocating eggs to remote (un-lit) locations may not increase the probability of a successful nest. Moreover, exclusivity and remoteness draw the highest-paying tourists, meaning that development even in remote beaches is likely to increase. Captain’s Bay, a remote and extremely important nesting beach for green turtles on the eastern end of the island, is currently occupied by one villa; however, the floodlights on this one property are bright enough to light the entire beach. Therefore, in the long term, relocating nests is not a viable solution as Anguilla would quickly run out of suitable relocation sites. Eliminating, or at least minimizing, the impacts of anthropogenic lighting is likely to be the more practical, long-term option to meeting conservation targets.

With this in mind, the Department of Fisheries and Marine Resources requested the assistance of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) in performing a comprehensive assessment of the major threats to sea turtle habitat from coastal development, with a special focus on light pollution.

SEA TURTLES AND THEIR MANAGEMENT IN ANGUILLA

Anguilla has stunning and ecologically significant coral reefs and a rich marine life, including three species of sea turtles. The most abundant sea turtle is the colorful, reef-dwelling hawksbill (*Eretmochelys imbricata*), a species that is present in nearshore waters year round and comes ashore to nest between June and September (peaking in August).

Hawksbills rely on 19 of the 35 sandy beaches in Anguilla for nesting (Dow et al., 2007), the most important of these are Captain's Bay, Savannah Bay, Limestone Bay and Blackgarden Bay.

Leatherback turtles (*Dermochelys coriacea*), second in abundance, arrive seasonally (March to July) from high-seas foraging grounds to lay their eggs on the island's shores.



Green turtles (*Chelonia mydas*) *Green turtle tracks on Katouche Bay* are present in low numbers; nesting peaks during August and September and occurs primarily at Captain's Bay.

Although peak tourist season is the winter, this currently small overlap with nesting season does not negate the need for protection of habitat or for the mitigation of lighting. Low tourist levels does not necessarily lead to lower lighting; beachfront bars and other outdoor property lighting are often fully operational during peak and low tourist season.

LEGISLATION

Turtle meat has long been a part of the Caribbean culinary culture (Fleming, 2001). Anguilla has archaeological records that confirm over 1000 years of exploitation and use of sea turtles for food, domestic tools, and utilitarian items (Peterson & Crock, 2001).

According to Bräutigam & Eckert (2006), the exploitation of marine turtles in Anguilla has been formally regulated since 1948 when the Turtle Ordinance Cap. 99 established a four-month closed season on the take of turtles and eggs, and a minimum size limit for all species of 20 lb. These same provisions were incorporated into subsequent

regulations, the most recent of which were the Fisheries Protection Regulations of 1988, issued under the Fisheries Protection Ordinance No. 4 of 1986.

In 1995, the Fisheries Protection Regulations of 1988 were amended to close the open season entirely, bring into effect a moratorium on the capture of turtles and take of eggs for a period of five years. The amended Regulations also placed an indefinite ban on the use of gill nets, thereby reducing the risk of incidental take of sea turtles in fishery operations. The moratorium has since been renewed, and is scheduled to expire in 2020 (Bräutigam & Eckert, 2006).

Although the extensions of the moratorium were a step in the right direction as far as protecting the remaining sea turtle population, the recovery of nesting populations in Anguilla is still in jeopardy of habitat degradation and loss, especially of nesting beaches and mostly due to a dramatic rise in coastal development projects on the island.

The Department of Fisheries and Marine Resources (DFMR) is responsible for the improvement and management of Fisheries and Marine Parks, and all Coastal Zone Management. Anguilla has about 38 miles of coastline, and a territorial sea that extends 3 nm from shore. DFMR is responsible for enforcing all fisheries legislation within Anguilla's ca. 33,000 square-mile Exclusive Fisheries Zone, which extends 200 nm from shore. The DFMR can press charges against violators of the laws, but does not currently have the authority to arrest an offender. Special marine police, or, in their absence, regular police officers, have the authority to apprehend offenders.

DFMR is constrained by budget limits and a small staff; notwithstanding, the Department collects data on nesting, often with the help of calls from local residents and hotel staff, and supports an active program of tissue sampling in foraging areas with an aim to determine turtle abundance and distribution.



DFMR staff tagging a hawksbill turtle during a sampling event

INTERNATIONAL AGREEMENTS

Because Anguilla is an Overseas Territory of the United Kingdom, the island cannot participate in international treaties to which the United Kingdom is not Party. However, even if the United Kingdom participates in a treaty, Anguilla's membership is not automatic. Of the treaties the United Kingdom is party to that are relevant to marine turtle conservation, Anguilla only participates in the Convention on Wetlands of International Importance (Ramsar Convention on Wetlands) and the World Heritage Convention (Bräutigam & Eckert, 2006). The Ramsar Convention has 158 parties and focuses on the wise use of wetlands and their resources, while the World Heritage Convention has 170 parties and focuses on the preservation of sites of major cultural importance.



Educational brochures about ratifying multi-lateral agreements distributed by the Anguilla National Trust and Department of Environment

There are four multilateral agreements to which Anguilla is not Party that can significantly impact sea turtle conservation efforts on the island. Two have been signed by the United Kingdom, but do not extend to Anguilla. The first of these is the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973, ratified by the United Kingdom in 1975. Under CITES, international trade in certain species, including sea turtles, is strictly regulated¹. The second of these is the Convention on Migratory Species (Bonn Convention), 1979, ratified by

the United Kingdom in 1985. The convention calls for strict monitoring of endangered migratory species, multiparty conservation and management plans, and cooperative research.

The Protocol Concerning Specially Protected Areas and Wildlife (SPAW) to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention), 2000, has been signed but not ratified by the United Kingdom. Parties to this Protocol are required to ensure total protection and recovery of marine turtle species. Ratification of SPAW by the United Kingdom – and its extension to the Overseas Territories – depends on the Overseas Territories having supporting national legislation in place.

The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) is the sole international treaty that deals only with sea turtles, articulates protection and conservation goals both on land (nesting beaches) and at sea. It was entered into force in 2001, and has been ratified by 11 countries. It has been neither signed nor ratified by the United Kingdom, and therefore does not apply to Anguilla or to any other Overseas Territory of the United Kingdom.

¹ Exemptions can be made, and action can be taken against Parties in breach of the treaty.

RESEARCH METHODS

This study was performed between 21 June and 21 August 2007. The objectives were to identify and rank (High, Medium, Low) the threats to sea turtles in Anguilla resulting from coastal development; to conduct a coastal lighting assessment of beaches on Anguilla; to provide coastal residents of Anguilla and hoteliers with the best management practices for reducing the negative impacts to sea turtles on nesting beaches; and to recommend to the Government of Anguilla a Lighting Ordinance, to be incorporated into national environmental legislation, that would allow for greater protection of sea turtles on nesting beaches.

To achieve these objectives, I performed a variety of activities while on the island. First, I held initial meetings with stakeholders. The most important step in any legislation formulation is the inclusion of stakeholders in the policy process, not only for this sense of ownership but in order to create effective legislation (dei Marcovaldi et al, 1999). Therefore, I met with as many stakeholders as possible, including Government officials, police officers, fishermen, and other representatives from stakeholder organizations (e.g., the Anguillan Hotel and Tourism Association).



The author documenting beachfront lighting on Mead's Bay, Anguilla, during the summer of 2007.

I then assessed sea turtle nesting beaches associated with built development (see Appendix A), and ranked those developments based on the extent to which their lighting regimes had the potential to negatively affect turtles' selection of that beach for nesting, the ability of the nesting turtle to survive the nesting process (e.g., without being disoriented inland, away from the sea), and the ability of hatchlings to make their way to the sea. The assessment focused on several coastal development components, including buildings (e.g., hotels, bars, clubs) as well as roads and other types of supporting infrastructure present along nesting beaches.

The assessment was qualitative in nature because, without a full historical data set documenting sea turtle nesting, it was difficult to compare one type of activity to another quantitatively. Therefore, I visited each of the island's 31 nesting beaches (as identified by Mr. Gumbs of DFMR) and documented the types of activities that I saw on those beaches. My assessment is, therefore, based on these observations, my literature review, and my understanding of the potential effects of human activities on turtle nesting and hatchling survival.

I determined and ranked sources of artificial lighting on properties with recent nesting activity, by conducting daytime and nighttime lighting inspections with the cooperation of property managers. In a lighting assessment, collaboration with property managers is important because they have intimate knowledge of the purposes and timing of the lighting on the property. They also know which lights are under the control of the property, and which are controlled by the guests. Often the negative effects of property lighting can be mitigated in ways that are both creative and cost-effective, and in some cases may even present energy savings to the property. By collaborating directly with managers and owners from the start, they become directly involved in both the assessment and its recommendations.

Although daytime inspections allowed for the siting of potential sources, the nighttime inspections illuminated which of these jeopardized the integrity of the nesting habitat and the success of nesting and hatching turtles. The process of ranking was based on that outlined in Mr. English-Knowles' Master's Project – *In the Spotlight: An Assessment of Beachfront Lighting at Four Hotels and Recommendations for Mitigation Necessary to Safeguard Sea Turtles Nesting in Barbados, West Indies* – where he outlined a ranking system where “a rank of ‘1’ describes indirect light visible by an observer on the beach, but not likely to present a strong attraction to nesting or hatching turtles. A rank of ‘2’ describes direct light or a visible globe, glowing element, lamp, or reflector likely to disorient turtles. Both ‘1’ and ‘2’ ranking lights are not strong enough to cast a discernible shadow on the beach during a dark night. A rank of ‘3’ describes a light source strong enough to cast a shadow on the beach regardless of the illumination being direct or indirect. Ideally, a beach should not have any source of illumination to rank, revealing a score of zero and hence no need for an assessment. However, in context of reality a rank of ‘1’ is preferred over a rank of ‘2’ which is preferred over a rank of ‘3.’” (Knowles, 2006). By performing nighttime inspections at different times, one can observe the impacts of each kind of light during the normal transition from day- to night-time lighting at hotels, strengthening the assessment.

In all, full assessments were done on three properties (see Appendix B, C, D), and observation-only assessments done on other beaches on the island. The assessment process also allowed me to interact with hoteliers and coastal residents and discuss lighting pollution and light management practices.

THREATS TO TURTLES ON ANGUILLA

The heavy dependence of multiple industries and individuals on the coastal resources of Anguilla is immediately visible when one visits the island. However, although there are many stakeholders in the use of this resource, a shorter list of activities poses direct threats to the ability of sea turtles to successfully nest on the island. These include artificial lighting along the coastline, increasingly dense coastal development, sand mining (despite the fact that the Beach Protection Act, 2000, prohibits sand and gravel extraction within 200 feet of the foreshore on 18 protected beaches: Bräutigam & Eckert, 2006), and poaching of sea turtles and eggs. With sea turtle survival rates naturally low and Anguilla's turtle population having been heavily exploited (Godley et al., 2004), minimizing adverse anthropogenic impacts to the life cycle is critical to the recovery of the island's remnant populations.

ARTIFICIAL LIGHTING

The reduced success of hatchling sea-finding, and the reduced attractiveness of well lit beaches to nesting females are well documented; for an extensive review of research done on the effects of lighting and human activity on nesting behavior and hatchling emergence, see Witherington and Martin, 2000.



Maunday's Bay, lit by the outdoor and restaurant lighting of Cap Juluca Resort

then light pollution can be said to force some turtles into suboptimal nesting habitat. At suboptimal nesting beaches, the number of hatchlings produced and their survivorship may be compromised, and hatchling sex ratios may be affected. There is also the potential that turtles deterred from nesting may shed their eggs at sea.” (Witherington and Martin, 2000)

The adverse effects of artificial lighting on the ability of hatchling turtles to make their way to the sea are well documented (McFarlane, 1963; Witherington et al, 1990; Witherington, 1991; Tuxbury and Salmon, 2005; Salmon et al, 1995b). Emerging hatchlings align themselves with the brightest ambient cues (often described as the lowest, brightest

Sea turtles nest most successfully on dark, quiet beaches. Turtles have been shown to emerge from the water on darker stretches of beach, as opposed to well lit areas (Witherington, 1992; Salmon, 2003). In addition, if they see human activity or lights once they have emerged from the water, they can abandon the nesting effort altogether (resulting in a false crawl, or a beaching that does not result in the deposition of eggs). Therefore, “if we assume that sea turtles choose nesting sites based upon favorable conditions for safe nesting and the production of fit offspring,

horizon), which, on a dark beach, is the open horizon and reflective surface of the water, as opposed to the landward vegetation or dune line. This journey to the water must take place quickly or hatchlings become tired, dehydrated and/or easy meals for predators. However, on a lit beach, hatchlings can be drawn toward artificial light sources instead of to the water, where they can become disoriented and confused, wandering the beach for hours and oftentimes dying before making it to the ocean. The sensitivity of hatchling to light sources is incredible; one hotel manager in Anguilla recounts the personal experience of witnessing a hatching event, and described how the hatchlings would immediately align themselves to even the brief flashes of light from cameras.

Anguillan beaches are often well lit, as these are the most attractive sites for tourism-oriented businesses including restaurants, beach-bars, and hotels. Among the beaches observed to have significant light pollution were: Captain's Bay, Maunday's Bay, Mead's Bay, Shoal Bay East, Barnes Bay, and, to a lesser extent, Rendezvous Bay. Although these beaches represent the worst situations during the nights of my study, all developed beaches on the island have the potential to introduce light pollution into the coastal environment.

COASTAL DEVELOPMENT

During my eight weeks on-island, there were at least three large hotel construction projects underway, and billboards promising more in the coming year. One project in particular



Part of a new hotel being constructed on the island

extended from the main central road to the edge of the island (ca. 1.5 miles wide) and perhaps 0.5 miles along the road (pers. observ.). On an island 16 miles long and 3 miles wide, this is a substantially sized project. The high rate of development, on top of potentially causing run-off, increased traffic (including on the beaches), and other environmental problems, will exacerbate light pollution along the coast.

It is clear that the most obvious impact of

coastal development on turtle nesting is the placement of hotels and other buildings on sandy beaches. While Anguilla's planning legislation includes set-backs, the enforcement of these laws is inconsistent and I observed many buildings, ranging from large private residences to hotels, constructed directly on the beach.

In addition to the degradation or loss of habitat, hotels and other developmental activities increase the level of lighting visible from the beaches, and also increase the attractiveness of these beaches to tourists and residents. Therefore, even if a construction project followed coastal planning legislation requiring they be set back from the beaches, the indirect effects include increased human activity on the nearby beaches, making them potentially unattractive to nesting turtles.

ILLEGAL SAND MINING

Sand mining on beaches for construction materials affects nesting habitat directly, because the sand removal is often at higher rates than natural processes can replace it. Over time, the result is often a rocky beach unfit for sea turtle nesting. Because of the surge in construction on the island, there is high demand for construction materials, including aggregate.



Sile Bay, before being destroyed by sand mining. Courtesy DFMR



Pits resulting from illegal sandmining at Windward Point.

expeditions in the area. If this activity is not stopped, Windward Point is in danger of looking much like Sile Bay looks today.

Although there are legal quarrying sites, illegal sand mining provides a free source. Law enforcement is lax, and sand poachers do serious damage to the island's nesting beaches. An example is Sile Bay, once an important nesting beach, which is currently a wasteland of gravel and rock. The beach most threatened by this activity today is Windward Point. This beach is still an important sea turtle nesting and foraging site; however, on any given day, one can observe the pits left behind from illegal mining

POACHING

The removal of eggs from their nest for sale or consumption is another anthropogenic activity that directly impacts the recovery of the turtle population. While there is no official record of poaching of eggs on the island, and there seems to be an understanding of the importance of the turtle population recovery, it is not unheard of that someone who happens upon a turtle nest would take a few eggs home (personal communication, Katouche Bay resident). Again, culturally, turtles and their eggs are traditional fare, and while someone would hesitate to excavate an entire nest, they might not refrain from helping themselves to one or two eggs. There are differing perspectives and responses to this problem on the island. Some locals believe that people actively look for turtle tracks and therefore are very territorial of the beaches they live near, monitoring them once they know a nesting event has occurred, and policing the nest. Others believe that egg poaching is a thing of the past, and that most people, while they might joke about taking eggs, would not actually remove the eggs from the nest (personal communication, security guard, Mallihouana Hotel).

ANTHROPOGENIC LIGHTING ON ANGUILLA

On an island like Anguilla, with increasingly high levels of coastal tourism and development and where beaches cannot feasibly be dark and quiet year-round, it is vital that owners and managers of coastal properties be committed to creative lighting practices that minimize impacts on proximal sandy beaches.

The properties that line Anguilla's coasts are mainly tourism-based; however, within this category there



Cuisinart Resort and Spa on Rendezvous Bay

is variation in property size, type and management. These variations mean that each of these properties face different sets of challenges and advantages when it comes to lighting management. During the course of my study, I was able to capture much of this variation in the sampling of properties that I visited and studied, which included large and small hotels, managed and timeshare properties, large private villas and houses, and restaurants.

LARGE HOTELS

Anguilla's tourism industry serves a range of clientele, but leans mostly toward the elite. There are many large and spectacular hotel properties on Anguilla, most of which occupy the western end of the island. These large hotels in Anguilla are often characterized by outside ownership, with design decisions made to suit corporate guidelines designed to present consistency to the traveler, regardless of whether they are visiting Anguilla or Antwerp.

Sample Property: Cuisinart Resort and Spa

The Cuisinart Resort and Spa, with whom I was able to work during the course of my study², is a 5-star resort boasting Grecian-style architecture and constructed over much of the Rendezvous Bay coastline. The 93-room property has its own hydroponic farms and organic gardens, where it grows vegetables and produce used for cooking the meals at its restaurant. The least expensive room at this property can be had for \$400 a night in the low season, but can soar to over \$1,000 a night during peak visitation during which the most expensive accommodations can be enjoyed for \$5,280 per night.³

Mitigating Beachfront Lighting in Large Hotels

One benefit to mitigating light pollution at a large hotel, especially a chain hotel, is that there may be more (financial) resources available, suggesting that lighting changes to properties might be made relatively quickly. In addition, these properties may have larger advertising budgets than would a smaller hotel, suggesting that the hotel could advertise their 'green' decisions more broadly and possibly capitalize more quickly on lighting mitigation investments.

Several challenges face managers wishing to mitigate the effects of large hotels' lighting on sea turtle nesting beaches. Firstly, ownership by foreign companies can translate into less flexibility with mitigation options, especially if these relate to design elements. For example, changing the type of light fixture may depend on whether those fixtures can blend with the image of the hotel. Another mitigation option that may be difficult to implement is the increased use of foliage and natural vegetation. Depending on the landscape design for the hotel chain, modifying foliage type, density and/or height as lighting mitigation tools might not be possible.

The perception of safety and security is an important issue. For a large chain hotel, a mishap at one venue can affect the reputation of the entire chain and not just the local site. Although many studies have shown that lighting and security are not necessarily correlated, and that the benefits of excessive lighting are psychological (e.g., Ramsay & Newton, 1991), the event of an attack against a guest on a lower-lit beach might lead the public to perceive that the incident could have been prevented by more lighting. And, again, a tarnished reputation at one site could cause unwillingness for visitors to stay at other properties controlled by the same chain or management.

² See Appendix B for the full lighting assessment

³ <http://www.cuisinartresort.com/>; Accessed 1/16/2008

SMALL HOTELS

Smaller hotels are also well represented on the island, being situated at both the east and west ends of the island, and on the beaches in between. While many are locally owned, some are owned by foreigners.

Sample Property: Frangipani Beach Resort

The Frangipani Beach Resort is a small, intimate property on Meads Bay. A restaurant with an outdoor dining space offers a view of the sea, and is one of the property's most striking features. The hotel offers eight recently renovated and well appointed condominium-style suites; these suites come with private balconies, as well as modern entertainment systems.



Frangipani Beach Resort on Mead's Bay

The least expensive accommodation at the Frangipani advertises at \$250 per night in the low season, and \$450 during peak season. The penthouse suite is the most expensive: as much as \$2,400 per night in the peak season.⁴

Mitigating Beachfront Lighting in Small Hotels

Smaller properties, especially locally owned, have a couple of advantages with regards to lighting mitigation. First, unlike larger or foreign owned hotels, small and locally owned hotels have more control and potentially more flexibility with the 'look and feel' of the property. They are often not chain hotels, so this adds to their design individuality. Smaller hotels can also capitalize on the image of intimacy and seclusion with lower intensity lighting on the property. Notwithstanding, making large changes to the lighting infrastructure could be challenging for smaller hotels and their (presumed to be smaller) budgets. There is also a sentiment that removing lighting from the property, especially at night, makes a smaller property appear too desolate and remote.

TIMESHARE/MANAGED PROPERTIES

Another type of property on the island is the privately owned, but externally managed properties. They tend to be designed by the same architect, and therefore there is a sense of uniformity that lends these sites the look and feel of a resort or large hotel property.

⁴ <http://www.frangipaniresort.com/rates.php>, Accessed 1/23/2008

While the property may have several units available for rent, and are never owned by individuals, many of the units are owned and built to the specifications of the individual (almost exclusively foreign) owners. When the owner is ready to return to Anguilla (mostly during the winter months), the unit is appointed to the specifications of the client. For the bulk of the year, however, the units are either left empty or rented to others, depending on the wishes of the owner. The management of the beachfront and the property is therefore left to the manager of the property.

Sample Property: Covecastles

Covecastles is an example of a managed property on Anguilla. This very grand property is located on Shoal Bay West, a long and secluded stretch of beach on the western end of the island. With seclusion comes the security of motion sensors and guards that respond discreetly to any alert.



Covecastles, a managed property on Shoal Bay East

There is plentiful native foliage on the beachfront side of the property, which screens much of the light from occupied villas. There are also no permanent structures or seating on the beach. Walking along this beach at night, one can definitely enjoy the feeling of being the only person on the whole of Anguilla. For this privilege, one can pay as little as \$600 per night for a two bedroom unit in the low season.⁵ However, these prices rise fairly rapidly based on unit size and time of year; for one of the larger or better appointed units, one can pay just shy of \$6,400 per night during peak season.

Mitigating Beachfront Lighting in Managed Properties

There are clear advantages to managing lighting on a property like Covecastles; namely, the type of clientele and their needs. They pay for seclusion and for exclusivity; a well lit beach does not fit into that vision. Therefore, the intense foliage and dark beaches at Covecastles a symptomatic of the desires of an elite group of clients who want to feel like the only people on the island. This results in darker, more vegetated beaches than one would expect on a property of this size. Vegetative shielding of property lights have been shown to be effective in attracting turtles to developed sites (Salmon et al, 1995a); therefore, this is an example of how natural vegetation can work for the benefit of both property owners and natural wildlife.

⁵ <http://www.covecastles.com/rates.html>, Accessed 1/23/2008



Foliage at Covecastles blocking light from villas

Although the property is as large as some of the larger hotels, what makes mitigation easier on a managed property is that the units are highly individualized and managed as such. Much of the beach aspects are dealt with by the managers, and even more so when there are no occupants, or when the owners are away. Therefore, a manager of a property like this may enjoy a certain degree of authority to ensure that exterior lighting was managed in a ‘turtle friendly’ manner.

Drawbacks to mitigation at managed properties are associated with the special needs and privileges of high-paying guests: at over \$6,000 a night, “what the client wants, the client gets”. This could be a problem if clients reject initiatives to alter lighting schemes for the benefit of sea turtles. Another potential problem is similar to that of large hotels; namely, structure and design. These grand properties are celebrated for their architectural design and detail. If lighting elements are part of these details, as they most often are, making changes might be unpopular. Nevertheless, a creative manager should be able to incorporate the principles of reducing light pollution and create a scheme that works well with established architectures.

HOUSES/VILLAS

There are an increasing number of private properties in Anguilla’s coastal zone. These properties are often large and often seasonally unoccupied. Although there are coastal zone ordinances in place to prevent building very close to the shore, the enforcement of these regulations is weak. While this also creates other environmental problems, it definitely contributes to the growing number of well lit beaches.



Private house on Limestone Bay, with the construction of a new house in the background

Mitigating Beachfront Lighting in Personal Properties

Because beachfront mansions tend to be owned by more wealthy individuals, the cost of mitigating their outdoor lighting is small relative to the income generated by the rental property. In addition, because these are individually owned, there is more flexibility in finding lighting fixtures that both appeal to the homeowner as well as reduce the negative effects of beachfront lighting.

A disadvantage when seeking to mitigate lighting at these properties is lack of access to the owners, since they are rarely resident on-island. In addition, unlike a commercial property that can possibly exploit ‘turtle friendly’ lighting as a marketing tool, private owners have no real incentive to mitigate lighting other than their own beliefs about lighting. Therefore, a well enforced lighting policy might be the most effective tool with these types of properties.

RESTAURANTS



Restaurant on Shoal Bay East

There are many restaurants sprinkled over the island, serving the eastern and western beaches as well as those in between. The diversity of the ownership and clientele in the island’s tourism industry is best seen in the range of restaurant types, locations and price range. Some are free-standing (e.g. many on Shoal Bay East), but many are attached to hotels. Cusinart, Covecastles and Frangipani all have their own restaurants; however, Frangipani’s restaurant is the only one physically situated on the beach.

Beachfront restaurants serve a variety of clientele, and many are open on- and off-season. The ownership of the hotel varies from foreign owned to locally owned; both types are very successful with visitors to the island, as well as locals.

Mitigating Beachfront Lighting in Restaurants

The defined ‘hours of operation’ of most restaurants tends to help with light mitigation. For example, offending lights can be turned off during late night hours when the restaurant is closed and outside lighting can be managed to minimize excess lighting. However, while on Shoal Bay at night, many restaurants, although closed, had all their outdoor lights illuminated. By requesting (or mandating) that these lights be turned off, this particular nesting beach could be made significantly darker and more suitable for sea turtle nesting.

Smaller, local restaurants can also use the ‘intimacy factor’ to their advantage; e.g., smaller tables lend themselves to hurricane lamps or tea candle lighting, restricting the light to the immediate area it was meant to serve.

However, while electricity cost reductions could be convincing, the ‘intimacy’ benefits of mitigation are uncertain and legislation might be necessary to encourage owners to adopt recommended changes and to accept any additional costs.



Shoal Bay East lit by beachfront restaurants at night. The restaurants are closed.

In some cases, ‘wave-view’ restaurants attached to the hotel are part of the architectural vision, potentially limiting the use of lighting options that do not satisfy both sea turtles and marketing needs. Similarly, foliage as a mitigation option might not be viable, since it might interfere with the open air, ocean view, “sand in toes” aspects of beachfront dining.

PRINCIPLES FOR A POLICY-BASED SOLUTION

Several factors are important when considering policy-based solutions to beach-front lighting in tourism-based economies such as Anguilla. In order to create effective legislation, the needs – real and perceived – of stakeholders need to be taken into account. The stakeholders include, at a minimum, the DFMR, property owners and managers, residents of Anguilla, and paying guests.

A beachfront lighting policy adopted or implemented in Anguilla should satisfy the following five (5) criteria:

Increase nesting beach quality – This is in line with the conservation aims of DFMR, and other entities both local (e.g., Anguilla National Trust) and international (e.g., WIDECAS). Making the beaches more suitable for nesting is an important step in increasing (and safeguarding) habitat suitable for nesting and hatching sea turtles, thus encouraging the recovery of nesting populations. This is considered a threshold criterion; any policy that does not satisfy this criterion is considered unviable.

Maximize cost effectiveness – This criterion must take into account that two stakeholders ultimately bear the cost(s) of mitigation; i.e., DFMR and property owners. DFMR has a limited budget and a large mandate. Therefore, costs associated with the policy, including implementation and enforcement, should be carefully balanced with expected gains. Property owners also face costs, the most obvious of which is implementing the changes necessary for mitigation; other costs include disruption of business activity during implementation and potentially a loss of aesthetic appeal (and therefore future business) associated with reduced lighting.

No reduction in safety or security – Although there is much debate about whether lighting actually makes a location less prone to crime (e.g., Ramsay and Newton 1991), people tend to feel safer in well lit areas. Because some beachfront lighting is necessary for illuminating paths, stairways and entrances, it is imperative that the safety of the guests and other facility users is not jeopardized by the mitigation.



Pictures of a hatching event at Gwen's Reggae Grille, a popular restaurant on Shoal Bay East

Maximize enforceability – The potential for any mitigation mandated by a lighting ordinance to positively affect habitat quality hinges on enforcement. Without a proper enforcement strategy, the policy cannot achieve its objectives. Therefore the policy must take into account the size and capacity of the DFMR staff and budget, and/or provide for other enforcement authorities. Similarly, the ordinance should embrace incentives designed to strongly encourage stakeholder ‘buy-in’, thereby reducing the challenge of law enforcement.

Ensure flexibility to adapt to new scientific information – The sea turtle moratorium was enacted, in part, to provide DFMR with an opportunity to collect data suitable for determining population trends, patterns of habitat use, etc. at the nation’s nesting beaches and foraging grounds. Updated information on the ecology and life history of local – and regional – sea turtle populations will be useful in evaluating the effectiveness of conservation efforts. The policy should be flexible enough to allow adjustments based on new information.



DFMR staff measuring a juvenile green turtle during a sampling event on Scrub Island

COMPONENTS OF A LIGHTING ORDINANCE

Lighting ordinances can be extremely useful conservation and mitigation tools if they are fairly constructed and consistently enforced. To that end, Witherington and Martin (1996) suggest a basic framework for a lighting ordinance that includes descriptions of activities prohibited because of their disruption to turtle nesting, standards for new lighting, standards for mitigation existing lighting, and proposals for enforcement and monitoring. These, along with other general issues that should be addressed in a lighting ordinance are explored in this section, including the extent to which this framework can apply to Anguilla’s special needs and, finally, suggestions as to how these issues can be most effectively addressed.

IDENTIFY CRITICAL HABITAT

With an aim to characterize the status of the island’s sea turtle populations and active threats to their survival, the Department of Fisheries and Marine Resources has been collecting data on active nesting and foraging sites on the island since 1995. With the intention of encouraging recovery of nesting populations, the Department seeks to protect

beaches that are currently used for nesting, as well as those which have historically had nesting (James Gumbs, pers. comm., 2007). According to DFMR records, these beaches would include: Katouche Bay, Crocus Bay, Little Bay, Limestone Bay, Blackgarden Bay, Shoal Bay East, Island Harbour, Captain's Bay, Windward Point, Savannah Bay, Mimi's Bay, Sandy Hill Bay, Long Pond Beach, Forest Bay, Corito Bay, Elsie Bay, Little Harbour, Lockrum Bay, Old Woman's Bay, Sandy Point, Rendezvous Bay, Cove Bay, Maunday's Bay, Shoal Bay West, West End by the Sea, Barnes Bay, Mead's Bay, Long Bay, Road Bay, and Auntie Doo Bay. Of these, the most recently active site are (in order of activity): Captain's Bay, Windward Point, Savannah Bay, Long Bay, Limestone Bay, Blackgarden Bay, Mead's Bay, Shoal Bay West, Barnes Bay, Cove Bay, Crocus Bay, Katouche Bay, Junk's Hole, Mimi's Bay, Sandy Hill Bay, Shoal Bay East, and Road Bay (Godley et al., 2004).

PROHIBIT ACTIVITIES DISRUPTIVE TO MARINE TURTLES

A holistic approach should be taken, so that the positive effects of mitigating lighting are not lost due to the continued operation of other threats. To this end, the ordinance should provide standard guidelines and criteria concerning activities that should not be conducted near nesting beaches, especially during nesting and/or hatching seasons. For example, there should be no motorized vehicles allowed on the beach with the exception of vehicles deemed necessary for law enforcement or emergency response. If hotels 'comb' their beaches to remove debris, this should be confined to areas below the high tide line (where eggs, which can be crushed by the vehicle weight or punctured by the combs, are least likely to be incubating). Other debris removal during the nesting and hatching season should be accomplished by hand (e.g. by raking). Similarly, to protect the integrity of the beach and the safeguard the eggs incubating below the surface, bonfires and campfires should not occur on the beach during nesting and hatching seasons (see Witherington and Martin, 2003).

ADOPT MODEL STANDARDS FOR NEW LIGHTING

A model ordinance presented by Witherington and Martin (2000) includes several useful recommendations, but it was constructed for Florida and it makes consideration for features (e.g., dunes) that do not apply to Anguilla. Amendments to lighting should be enforced during all dark hours to ensure that no early or late emerging turtles are affected (Witherington et al, 1990). It should be kept in mind that properties can also have lighting impacts on beaches not directly adjacent to them (Philibosian, 1976).

Adapting their model to Anguilla, the following text is recommended:

1. Exterior lighting should be designed and located so that:
 - a. The source of light or any reflective surface of the light fixture is not directly visible from the nesting beach
 - b. The nesting beach is not indirectly illuminated by reflective surfaces near lights (for example, white walls, beach bar umbrellas, and umbrellas from seating areas)

2. Exterior artificial light fixtures visible from the beach are considered appropriate if they are:
 - a. Completely shielded downlit fixtures, louvered or recessed fixtures without reflective inner surfaces. These fixtures may use bulbs low wattages (<50) or turtle-friendly bulbs
 - b. Mounted as low as possible to the ground
3. Floodlights, uplights or spotlights for decorative and accent purposes that are directly visible from the beach, or which indirectly or cumulatively illuminate the beach, should not be used.
4. Exterior lights used expressly for safety or security purposes should be limited to the minimum number and configuration required to achieve their functional role(s). Where possible, use motion detector switches that turn lights on only when approached and for the shortest length of time possible.
5. Only low intensity lighting should be used in parking areas within line-of-sight of the beach, with lighting where the source of light is:
 - a. No higher than 48 inches off the ground; and
 - b. Positioned or shielded so that the light is cast downward and away from the beach, so that neither the light fixture nor reflective surfaces (e.g., walls) light the beach
6. Parking areas and roadways, including any paved or unpaved areas upon which motorized vehicles will park or operate, should be designed and located to prevent vehicular headlights from directly or indirectly illuminating the beach.
7. Vehicular lighting, parking area lighting, and roadway lighting should be shielded from the beach through the use of vegetation or other non-destructive ground-level barriers.
8. Tinted glass should be installed on all windows and glass doors of single or multi-story structures within line-of-sight of the beach.
9. With regard to high intensity lighting for security and parking lot lighting, appropriately shielded and directed low-pressure sodium-vapor lamps and fixtures should be used.

While this exact language is recommended, phrasing can be adjusted to harmonize the text of the ordinance with existing environmental legislation. These rules should also apply to temporary lighting of construction sites during the marine turtle nesting season. In addition, there should be personal explanations provided to stakeholders, and brochures or other visual representations should also be provided to hoteliers and homeowners to emphasize what is considered acceptable and unacceptable with regard to lighting regimes.

ADOPT MODEL STANDARDS FOR EXISTING LIGHTING

As far as the mitigation of existing lighting, many of Witherington and Martin's (2003) recommendations apply, and include adjusting or retrofitting existing light to meet the standards outlined above for new lighting. Again, while this exact language is recommended, phrasing can be adjusted to harmonize the text of the ordinance with existing environmental legislation. As far as how properties mitigate their lighting effects, it is important that the focus be on the intended result – i.e., on darkening the beaches as much as possible – and not on implementing specific technologies. This will allow different properties to mitigate in ways that are most cost-effective for the site.

Adapting their model to Anguilla, the following text is recommended:

1. Existing artificial light fixtures should be repositioned, modified, or removed so that:
 - a. The source of light or any reflective surface of the light fixture is not directly visible from the nesting beach
 - b. The nesting beach is not indirectly illuminated by reflective surfaces near lights (for example, white walls, beach bar umbrellas, and umbrellas from seating areas)
2. The following measures should serve as examples for how to reduce or eliminate the negative impacts of existing exterior artificial lighting. Owners should be allowed to mitigate in the ways most appropriate and cost effective to their property, as long as the beaches are appropriately darkened:
 - a. Reposition fixtures so that the point source of light or any reflective surface of the light fixture is no longer visible from the beach
 - b. Replace fixtures having an exposed light source with fixtures containing recessed light sources or shields
 - c. Replace traditional light bulbs with yellow, turtle friendly bulbs not exceeding 50 watts
 - d. Replace non-directional fixtures with directional fixtures that point down and away from the beach
 - e. Replace translucent fixture coverings with opaque shields so that the fixture or inner reflective surfaces are not visible from the beach
 - f. Replace pole lamps with low-profile, low-level lights so the fixture or inner reflective surfaces are not visible from the beach
 - g. Replace incandescent, fluorescent, and high intensity lighting with the lowest wattage, low pressure sodium-vapor lighting suitable for its purpose
 - h. Increase vegetation between lights and beaches to help screen light from the beach or construct a ground level barrier to shield light sources from the beach
 - i. Permanently remove or permanently disable any fixture which cannot be brought into compliance

3. The following measures should be taken to reduce or eliminate the negative effects of interior light (from doors and windows visible from the beach):
 - a. Apply window tint or film that meets the standards for tinted glass
 - b. Move lamps and other moveable fixtures away from windows
 - c. Use window treatments (e.g., blinds, curtains) to shield interior lights from the beach, and leave reminders for guests to close curtains at night during nesting season
 - d. Turn off unnecessary lights, and leave reminders for guests to turn lights off when not in use

PROPOSE ENFORCEMENT AND PENALTIES

When determining penalties, for example related to the timeframe within which properties must come into compliance or degrees of offence, many factors must be taken into consideration. For example, the fines must be sufficient to encourage compliance but reasonable enough so that authorities are willing to invoke them. Fines should escalate with iterative offences. When considering rental properties, consideration must be given to whether liability falls to the owner and/or to the occupant. Incentives for compliance should be considered, and the enforcement authority clearly defined.

CONSIDER MONITORING AND ENFORCEMENT

According to Witherington and Martin (2000), “making the public aware of light-pollution problems on sea turtle nesting beaches is a fundamental step towards darkening beaches for sea turtles. Many of those responsible for errant lighting are unaware of its detrimental effects and are generally willing to correct the problem voluntarily once they become aware.” Rupert Balgobin, Head Engineer at Cuisinart Resort and Spa, relates that guests are informed at check-in that the resort is “lucky to be on a nesting beach” and asked to kindly close their blinds when their lights are on, to turn lights off when not in use, and to refer to related information available in the rooms (pers. comm., 2007). Involving managers and guests in public awareness campaigns can emphasize the unique value (and vulnerability) of the sea turtles.



Hotel manager helping DFMR officer measure turtle tracks. This manager regularly cordons off nests and tracks on his beach until DFMR staff arrive on the site.

Although the new ordinance should be created to cover all (current and historic) documented nesting beaches, enforcement priority, in the context of limited resources, might logically be directed toward major nesting beaches and the most deleterious lighting regimes. For example, Captain's Bay not only has high numbers of sea turtles nesting, but an adjoining villa, Exclusivity, boasts intense flood-lights focused on the beach all night.

Therefore, Captain's Bay should be considered a high priority beach, both for mitigation and for enforcement of compliance.

OTHER CONSIDERATIONS

NEST REPORTING

Staff and resource limitations conspire to ensure that DFMR cannot unilaterally monitor sea turtle nesting island-wide or stay abreast of incidents of disorientation due to beachfront lighting, for example. Public participation in reporting sea turtle sightings is critical to understanding population trends and patterns of habitat usage, and how these might be affected by implementation of lighting mitigation schemes.

DFMR currently receives reports of nesting from some hotel managers, but not all hotel staff are aware of how to proceed after a turtle sighting. For example, while speaking with a grounds manager at Covecastles, I was told that he had seen nesting at his property but did not know whom to call. Since many property and grounds managers are on the beach during early morning and early evening hours, they could be an important asset in monitoring both nesting levels and lighting compliance. It is recommended that hotel managers be made aware of whom to call when they find evidence of a sea turtle nesting, successful (eggs laid) or not. A brochure explaining a simple protocol for hotel staff to follow would be extremely useful in cutting DFMR beach monitoring costs, as well as in encouraging the participation of hoteliers in conservation activities. A 24-hr *Sea Turtle Hotline* should be maintained for use by the public in reporting sightings, illegal activity, and emergencies.

OTHER COASTAL PROBLEMS

Coastal development tied to the tourism industry brings a host of challenges for management. Lighting is one such challenge, but there are many others. Dow et al. (2007) cite sand mining, frequent recreational beach equipment and other obstacles on hotel beaches, frequent beach driving, occasional loss of native



Debris accumulated on Lockerum Beach, Anguilla.

vegetation due to development, and occasional beach erosion and nourishment. Many hotel and villa beaches are tended and debris does not, therefore, tend to accumulate; however, debris associated with unoccupied beaches can reduce habitat quality: I observed this problem on Lockrum, Long Pond Beach and Sandy Hill Bay. These issues must be addressed if sea turtles are to enjoy healthy environs.



Weathered sea turtle 'body pit' identified by the grounds manager at Covecastles.

Based on my observations, the most pressing concern is sand mining. The beaches most readily mined are remote and difficult to access, and therefore difficult to enforce mining regulations. The remote and typically undeveloped nature of these beaches also makes them attractive to nesting sea turtles; therefore, by not enforcing sand mining regulations, sea turtle recovery efforts are also affected.

The intensity of sand mining is unlikely to decrease in the absence of consistent law enforcement, as development pressures and the need to build at competitive prices increase. Similarly, as long as strong development pressures exist, legislation requiring setbacks and other conditionalities is unlikely to be enthusiastically enforced. These issues are not only a matter of scarce human and financial resources, but also of political will and public awareness about the destructive impacts of development and related activities.

SUMMARY AND CONCLUSIONS

The British Overseas Territory of Anguilla is home to three species of Caribbean sea turtle. It is also home to a vibrant tourism industry, the demands of which are evident in the rapid development of Anguilla's coastlines. While beachfront development is directly implicated in habitat encroachment and loss, it also serves to exacerbate other habitat degrading effects, such as beachfront lighting. On a beach developed for tourism, sea turtle hatchlings are often attracted inland to artificial light sources instead of to the sea. Misorientation and disorientation reduce the hatchlings' chances of survival, and may discourage gravid females from approaching the beach in the first place.

When it became clear to the island's Department of Fisheries and Marine Resources that managing direct take of sea turtles (through a legislated moratorium) was unlikely, by itself, to result in population recovery, the Department reached out to WIDECAST in seeking an assessment of the role of tourism development in sea turtle survival. Specifically, there was an interest in mitigating the potentially negative effects of artificial lighting

associated with built development, and a solution was needed that would meet the needs of both the tourism industry and the sea turtle population.

Studies on the island revealed that the context of Anguilla posed several opportunities and challenges for protecting sea turtle habitat. One advantage is the timing of the peak tourism season, which is during the winter months. With turtle nesting most pronounced between March and September, there was an expectation that hoteliers might be more willing to implement a lighting ordinance designed to darken the beaches during their "off season". Another advantage is the exclusive tourism product that Anguilla represents, and the expectation that the coveted "only person on the island" feeling would not be expected to conflict with reduced lighting on the island's sandy beaches. Challenges, on the other hand, include safety concerns, the variety of property types that contribute to the problem, the lack of a national policy regarding beachfront lighting, and the difficulty hoteliers might experience in obtaining mitigating technologies.

The project was carried out in partnership with government, as well as selected property owners who were approached ahead of time and agreed to participate. Close collaboration between property owners and the lighting assessment team ensured both transparency and mutual respect. The outcomes of the project were formal written Lighting Assessment Reports for participating hoteliers and draft text for a national lighting ordinance in Anguilla. In the property assessment reports, the location, fixture type and rank of each light accompanied a picture of each lighting element, any special notes about the lights or property, and specific recommendations on how each light could be modified to ensure its least effect on nesting and hatching sea turtles. Each property assessment report was peer-reviewed by the property manager and other partners, and accepted. The legislation text focused on results, not technology, thus enabling different properties to mitigate in ways that were appropriate (and cost-effective) for them.

This project provides a useful contemporary example of how academic, private/commercial, nonprofit and government entities can work together to find management solutions to biodiversity threats in tourism-based economies. As many Caribbean countries support a coastal tourism product important to their economic health, and many of these same countries support remnant populations of sea turtles in need of conservation attention, the project can serve as a model for finding solutions to beachfront lighting (and other tourism-related habitat threats) in other destinations.

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<http://www.frangipaniresort.com/rates.php>
Last accessed 1/23/2008

The Inter-American Convention for the Protection and Conservation of Sea Turtles

<http://www.seaturtle.org/iac/convention.shtml>
Last accessed 3/10/2008

The World Heritage Convention

<http://www.environment.gov.au/heritage/worldheritage/convention.html>
Last accessed 3/7/2008

Yancey, K.B. "Where the elite retreat." USA Today 8 Jan. 2008, online ed.

**APPENDIX A:
LIGHTING ASSESSMENT FORM**

Lighting Evaluation Form	
Facility Name/Address:	_____
Light Location:	_____
Type of Observation (Circle):	Daytime Early Nighttime Late Nighttime Follow-up Nighttime
Date/Time of Observation:	_____
Observer(s):	_____
General Comments:	_____

Light Visible From Beach:	YES NO
Fixture Type:	_____ Photo #: _____
Rank:	1 2 3 OFF NOB
Comments:	_____

Recommended Modifications:	_____

Observed Modifications:	_____

Additional Modifications Required:	YES NO

APPENDIX B: LIGHTING ASSESSMENT REPORT FOR CUISINART RESORT AND SPA

Lighting Assessment Report

Prepared for:

CUISINART RESORT AND SPA



Rendezvous Bay Anguilla, BWI

Performed by:

Kimberley Lake, Duke University

In Partnership with:

The Department of Fisheries and Marine Resources, Anguilla
The Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

INTRODUCTION

Sea turtles are an important part of the ecological wealth of Anguilla, with three of the world's seven species nesting seasonally (April-November) on Anguillan beaches and four foraging in nearshore waters. Centuries of largely unmonitored exploitation have resulted in serious declines in local sea turtle populations (Godley et al. 2004). In an effort to restore their numbers, the Government of Anguilla has enforced a moratorium on the harvest of sea turtles and their eggs since 1995.

While safeguarding remnant stocks from unsustainable use is an important first step in population recovery, another critical factor is habitat quality. The presence of anthropogenic light sources on nesting beaches is detrimental to hatchlings and nesting turtles, and is commonly called "light pollution" (Witherington and Martin 2000). In an attempt to document this threat at known nesting beaches in Anguilla, formal lighting assessments were performed during July and August, 2007, in partnership with the Department of Fisheries and Marine Resources (DFMR) and The Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

Sea turtles nest most successfully on dark, quiet beaches. Emerging hatchlings align themselves with the brightest ambient cues (often described as the lowest, brightest horizon), which, on a dark beach, is the open horizon and reflective surface of the water, as opposed to the landward vegetation or dune line. This journey must take place quickly or hatchlings become tired, dehydrated and/or easy meals for predators. However, on a lit beach, hatchlings are drawn toward artificial light sources instead of to the water, whereupon they can become disoriented and confused, wandering the beach for hours and oftentimes dying before making it to the ocean.

On an island, such as Anguilla, with increasingly high levels of coastal tourism and development and where beaches cannot feasibly be dark and quiet year-round, it is vital that owners and managers of coastal properties use best lighting practices to minimize their impacts on proximal sandy beaches.

In a lighting assessment, collaboration with property managers is important because they have intimate knowledge of the purposes and timing of the lighting on the property. They also know which lights are under the control of the property, and which are controlled by the guests. Many times, the negative effects of the lights on the property can be mitigated in ways that are creative and low cost, and in some cases may even present energy savings to the property. By collaborating directly with managers and owners from the start, they become directly involved in both the assessment and its recommendations.

The Cuisinart Resort and Spa, along with three (3) other properties, graciously volunteered to have a lighting assessment performed on their property. In doing so, they have assumed a leadership role in the conservation and recovery of local sea turtle populations and provided an excellent example to other beachfront properties to follow.

Mr. Rupert Balgobin, Head Engineer (Cuisinart Resort and Spa), participated fully in all stages of the assessment, providing access to the property, information about the lights, and volunteering lighting mitigation ideas. This highly commendable action is the type of collaborative effort that can only help efforts to restore sea turtle nesting on the island to healthy levels. Since the resort is on one of the island's more active nesting beaches, this assessment has high potential to positively impact habitat quality on the island.

THE LIGHTING ASSESSMENTS

The assessments were performed by Kimberley Lake, a Coastal Environmental Management graduate student in The Nicholas School of the Earth and Environmental Sciences at Duke University, North Carolina. The lighting assessments occurred on July 2, 2007 in three parts: a daytime assessment at 3 p.m., an early nighttime assessment at 7:30 p.m., and a late night assessment at midnight. Because lights are often managed differently depending on time of day, these multiple assessments allowed the observer to capture the temporal aspects of lighting effects. As the purpose of the study was to assess these effects on marine turtles, all assessments were performed from the nesting beach. The only purpose for accessing the property behind the beach was for the observer to verify the source of an indirect light, or to verify the type of fixture.

Daytime Assessments

The purpose of the daytime lighting assessment was to document and record any light fixture that could be seen from the beach. The observer walked from one beachfront end of the property to the other, documenting the types of light fixtures, their locations and quantities across the beachfront. In addition, photographs of each fixture type were taken to facilitate off-property verification, and to facilitate identification in the reports. Once nighttime assessments were completed, a follow-up daytime walk along the property with Mr. Balgobin helped to verify and document the uses and importance of each of the light fixtures as well as the exact timing of their use.

Early Nighttime Assessments

The purpose of the early night time assessment was to determine the impact of each light fixture identified during the daytime assessment. Each light fixture was given a rank of 1 to 3, with 1 being the least disruptive and 3 being the most disruptive (to nesting females and their young).

A light with a rank of 1 is considered an indirect light, or one whose globe is not visible. These lights are not strong enough to cast a shadow on the beach. Light fixtures that were not observed during the day, but whose light is observed at night could also fall in this category. An example might be an indoor light; although these lights are not on the exterior of the building, they are often bright enough to be seen from the beach and have a disorienting effect. A light with a rank of 2 is one whose globe can be seen from the beach, but is not strong enough to cast a shadow on the beach. A light with a rank of 3 is strong enough to cast a shadow on the beach, whether the globe is visible or not.

In order to ensure that the specific lights were given their correct rankings, in some cases hotel personnel were asked to extinguish confounding lights while a specific fixture was being assessed.

Late Night Assessment

To capture the temporal aspects of the beachfront lighting at a particular property, a late night assessment (methodologically a repeat of the early night assessment) is crucial. For example, a restaurant may be well lit until 9 p.m., and these lights may be seen from the beach, but after midnight, these lights are extinguished and cease to exert a measurable impact on nesting or hatchling turtles.

THE LIGHTS OF CUISINART RESORT AND SPA: RANKINGS AND RECOMMENDATIONS

The following pages document the findings of the assessments, and the recommendations are a combined product of discussions with the Head Engineer, Mr. Balgobin and lighting recommendations found in Wintherington and Martin, 2000.

Light Location: Beach Bar

Fixture Type: Double Upward Pole Mounted Floodlight

Light Ranking: 3



Recommendations:

- a. Turn lights off when bar is not in use.
- b. When in use, point light fixtures downward to constrain illumination to the bar itself.
- c. Consider using lower wattage light fixtures.

Light Location: Access Pathways between villas

Fixture Type: Low pole mounted mushroom light

Light Ranking: 3



Notes: There is a lot of natural vegetation on the property, and most of these are hidden. The one directly observed from the beach was between Villas 8 and 9. The others however did contribute to a lot of first floor wall wash.



Recommendations:

- a. Replace mushroom cap with bollard with louvers to direct light onto the pathways and prevent spillage onto beach and nearby walls
- b. Replace compact fluorescent elements with lower wattage elements

Light Location: Main Property
Fixture Type: Floodlight
Light Ranking: 3



Notes: Mr. Balgobin informed me that this light should not be on, and is only used for special events. In any case, the light still has potential to be very distracting when in use.

Recommendations:

- a. Point downward and attach full visor when in use

Light Location: Bell towers at top of villas
Fixture Type: Unknown (probably spotlight)
Light Ranking: 3



Notes: These lights are for aesthetic purposes, and are important to the showcasing of the property.

Recommendations:

- a. Use much lower wattage bulb to reduce the intensity of the wall wash
- b. Turn lights off during nesting season

Light Location: Second and third floor balconies

Fixture Type: Wall mounted up/down lighting

Light Ranking: 2



Notes: These lights were good in their effort to prevent horizontal light spillage. However, since the sconce allowed light to go upward, the wall wash was very strong from this source. These lights were also present on the first floor but the foliage did a good job of shielding the lights.



Recommendations:

- a. Verbally remind guests upon check-in to be mindful of their lights and to turn off the balcony lights
- b. Attach a reflector or shield on the top of the sconce to cancel the up-lighting from the fixture
- c. Use a lower wattage element that will provide enough lighting for the balcony but will not be strong enough to spill to the beaches

Light Location: Beach bar stairway
Fixture Type: Wall mounted spotlight with visor
Light Ranking: 2



Notes: These lights were timed, so that the lights in the bend of the stairway were the only ones illuminated all night. However, the light could still be seen at angles. These lights are important for the safety of the guests.

Recommendations:

- a. Use a lower wattage “bug light”

Light Location: Second and third floor rooms
Fixture Type: Room lights
Light Ranking: 1



Notes: Cuisinart has reminders in the rooms to keep blinds drawn, and to turn lights off when not in use. That led to these lights being very well managed. However, a few rooms still were not shielded from the beach.

Recommendations:

- a. Verbally remind guests upon check-in to be mindful of their lights and to draw their curtains

ACKNOWLEDGEMENTS

I would like to thank Cuisinart Resort and Spa for giving me access to the property, their staff and for their security at night. I would specially like to thank Mr. Rupert Balgobin who was crucial to my understanding of the lights on this amazing property, as well as other fascinating aspects of the resort.

Special thanks are extended to Mr. James Gumbs, Director of the Department of Fisheries and Marine Resources (and WIDECAST Country Coordinator in Anguilla) and Farah Mukhida of the Anguilla National Trust, who personally escorted me during the nighttime assessments. Mr. Gumbs generously arranged, prior to my arrival, partnerships with the properties involved in my assessment and guided and encouraged my efforts throughout my stay in Anguilla. I would also like to thank the entire DFMR staff who was patient and very generous with their time and knowledge.

My academic advisor, Dr. Karen Eckert, has been my mentor while enrolled in Duke University's graduate program. I want to thank her for having faith in my abilities to complete this project successfully, and for ensuring success by guiding me through the entire process.

My training in lighting assessments I owe to John English Knowles, also a graduate student at Duke University, who, free of charge, traveled to Florida in order to teach me the basics of light assessments. He remained accessible to me while I was preparing for my research and while I was working in Anguilla; he kindly encouraged my efforts and reviewed my results.

I would also like to thank my landlord, Mr. Rhon Connor (Department of Environment, Government of Anguilla) and his family, who made my transition into life on Anguilla as seamless as possible, providing excellent accommodations and hand-picking service providers for my needs while on the island.

Lastly, I would like to thank my loving family and friends in Trinidad and in the United States for supporting me with visits and phone calls while I was performing my research.

LITERATURE CITED

Godley B. J., A. C. Broderick, L. M. Campbell, S. Ranger and P. B. Richardson. 2004. An Assessment of the Status and Exploitation of Marine Turtles in Anguilla, pp.39-77. *In*: An Assessment of the Status and Exploitation of Marine Turtles in the UK Overseas Territories in the Wider Caribbean. Final Project Report for the Department of Environment, Food and Rural Affairs and the Foreign and Commonwealth Office.

Witherington, B. E., and R. E. Martin. 2000. Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. 2nd ed. Rev. Florida Marine research Institute Technical Report TR-2. 73 p.

CONTACT INFORMATION

Please direct any comments or questions to Kimberley Lake (kimberley.lake@duke.edu) or James Gumbs, Director of Fisheries and Marine Resources, Anguilla (james.gumbs@gov.ai)

APPENDIX C: LIGHTING ASSESSMENT REPORT FOR THE FRANGIPANI RESORT

Lighting Assessment Report

Prepared for:

FRANGIPANI BEACH RESORT



**Meads Bay
Anguilla, BWI**

Performed by:
Kimberley Lake, Duke University

In Partnership with:
The Department of Fisheries and Marine Resources, Anguilla
The Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

INTRODUCTION

Sea turtles are an important part of the ecological wealth of Anguilla, with three of the world's seven species nesting seasonally (April-November) on Anguillan beaches and four foraging in nearshore waters. Centuries of largely unmonitored exploitation have resulted in serious declines in local sea turtle populations (Godley et al. 2004). In an effort to restore their numbers, the Government of Anguilla has enforced a moratorium on the harvest of sea turtles and their eggs since 1995.

While safeguarding remnant stocks from unsustainable use is an important first step in population recovery, another critical factor is habitat quality. The presence of anthropogenic light sources on nesting beaches is detrimental to hatchlings and nesting turtles, and is commonly called "light pollution" (Witherington and Martin 2000). In an attempt to document this threat at known nesting beaches in Anguilla, formal lighting assessments were performed during July and August, 2007, in partnership with the Department of Fisheries and Marine Resources (DFMR) and The Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

Sea turtles nest most successfully on dark, quiet beaches. Emerging hatchlings align themselves with the brightest ambient cues (often described as the lowest, brightest horizon), which, on a dark beach, is the open horizon and reflective surface of the water, as opposed to the landward vegetation or dune line. This journey must take place quickly or hatchlings become tired, dehydrated and/or easy meals for predators. However, on a lit beach, hatchlings are drawn toward artificial light sources instead of to the water, whereupon they can become disoriented and confused, wandering the beach for hours and oftentimes dying before making it to the ocean.

On an island, such as Anguilla, with increasingly high levels of coastal tourism and development and where beaches cannot feasibly be dark and quiet year-round, it is vital that owners and managers of coastal properties use best lighting practices to minimize their impacts on proximal sandy beaches.

In a lighting assessment, collaboration with property managers is important because they have intimate knowledge of the purposes and timing of the lighting on the property. They also know which lights are under the control of the property, and which are controlled by the guests. Many times, the negative effects of the lights on the property can be mitigated in ways that are creative and low cost, and in some cases may even present energy savings to the property. By collaborating directly with managers and owners from the start, they become directly involved in both the assessment and its recommendations.

The Frangipani Beach Resort, along with three (3) other properties, graciously volunteered to have a lighting assessment performed on their property. In doing so, they have assumed a leadership role in the conservation and recovery of local sea turtle populations and provided an excellent example to other beachfront properties to follow.

Mr. Esmond Richards, a member of the maintenance team at Frangipani Beach Resort, participated fully in all stages of the assessment, providing access to the property, information about the lights, and volunteering lighting mitigation ideas. This highly commendable action is the type of collaborative effort that can only help efforts to restore sea turtle nesting on the island to healthy levels. Since the resort is on one of the island's more active nesting beaches, this assessment has high potential to positively impact habitat quality on the island.

THE LIGHTING ASSESSMENTS

The assessments were performed by Kimberley Lake, a Coastal Environmental Management graduate student in The Nicholas School of the Earth and Environmental Sciences at Duke University, North Carolina. The lighting assessments occurred on July 3, 2007 in three parts: a daytime assessment at 1 p.m., an early nighttime assessment at 8 p.m., and a late night assessment at midnight. Because lights are often managed differently depending on time of day, these multiple assessments allowed the observer to capture the temporal aspects of lighting effects. As the purpose of the study was to assess these effects on marine turtles, all assessments were performed from the nesting beach. The only purpose for accessing the property behind the beach was for the observer to verify the source of an indirect light, or to verify the type of fixture.

Daytime Assessments

The purpose of the daytime lighting assessment was to document and record any light fixture that could be seen from the beach. The observer walked from one beachfront end of the property to the other, documenting the types of light fixtures, their locations and quantities across the beachfront. In addition, photographs of each fixture type were taken to facilitate off-property verification, and to facilitate identification in the reports. Once nighttime assessments were completed, a follow-up daytime walk along the property with Mr. Richards helped to verify and document the uses and importance of each of the light fixtures as well as the exact timing of their use.

Early Nighttime Assessments

The purpose of the early night time assessment was to determine the impact of each light fixture identified during the daytime assessment. Each light fixture was given a rank of 1 to 3, with 1 being the least disruptive and 3 being the most disruptive (to nesting females and their young).

A light with a rank of 1 is considered an indirect light, or one whose globe is not visible. These lights are not strong enough to cast a shadow on the beach. Light fixtures that were not observed during the day, but whose light is observed at night could also fall in this category. An example might be an indoor light; although these lights are not on the exterior of the building, they are often bright enough to be seen from the beach and have a disorienting effect. A light with a rank of 2 is one whose globe can be seen from the beach, but is not strong enough to cast a shadow on the beach. A light with a rank of 3 is strong enough to cast a shadow on the beach, whether the globe is visible or not.

In order to ensure that the specific lights were given their correct rankings, in some cases hotel personnel were asked to extinguish confounding lights while a specific fixture was being assessed.

Late Night Assessment

To capture the temporal aspects of the beachfront lighting at a particular property, a late night assessment (methodologically a repeat of the early night assessment) is crucial. For example, a restaurant may be well lit until 9 p.m., and these lights may be seen from the beach, but after midnight, these lights are extinguished and cease to exert a measurable impact on nesting or hatchling turtles.

THE LIGHTS OF FRANGIPANI BEACH RESORT: RANKINGS AND RECOMMENDATIONS

The following pages document the findings of the assessments, and the recommendations are a combined product of discussions with Mr. Esmond Richards and lighting recommendations found in Wintherington and Martin, 2000.

Light Location/Quantity: In front of restaurant patio

Fixture Type: Tree mounted flood light (1)

Light Ranking: 3



Notes: This light is very strong, mounted high and oriented so it illuminates a large portion of the beach.

Recommendations:

- a. Replace bulb with a “turtle friendly” element
- b. Rig light fixture to a motion sensor

Light Location/Quantity: Around the restaurant patio (6)
Fixture Type: Pillar mounted carriage light
Light Ranking: 3



Notes: These lights are extremely bright and were illuminated all night. These lights are extremely strong and right on the beach front, and their bright white color makes them potentially very distracting.



Recommendations:

- a. Turn lights off when patio is not in use
- b. Replace bulbs with low wattage, “turtle friendly” elements
- c. Replace fixtures with ones that direct light low and toward the property

Light Location/Quantity: Pathway to beach (9)
Fixture Type: Low level tiered lighting
Light Ranking: 3



Notes: These lights are necessary for patron safety. The fixture is designed well for the nesting beach, eliminating most horizontal light. However, the element is too bright.

Recommendations:

- a. Replace bulbs with lower wattage, “turtle friendly” elements

Light Location/Quantity: Entrance to Beachfront Grill (2)
Fixture Type: Large wall mounted carriage light
Light Ranking: 3



Recommendations:

- a. Turn lights off when not in use
- b. Replace bulbs with “turtle friendly” element
- c. Replace fixture with downlighting

Light Location/Quantity: At front of western end of guest house (3) and in front concierge house (3)

Fixture Type: Medium wall mounted carriage light

Light Ranking: 3



Notes: These lights are very bright. The ones at the western end of the property do not directly illuminate anything but the beach, and the concierge house is not used at night



Recommendations:

- a. Turn these light off during the nesting season

Light Location/Quantity: Either sides of doorframes on most guest house beachfront walls (28)

Fixture Type: Small wall mounted carriage light

Light Ranking: 3



Recommendations:

- a. Replace all bulbs with “turtle friendly” bulbs
- b. During nesting season, remind guests at check-in and place reminders in rooms to turn balcony lights off when not in use
- c. Replace all fixtures with downlighting

Light Location/Quantity: Concierge stand (1)

Fixture Type: Low pole mounted floodlight

Light Ranking: 3



Notes: This light was not on, and Mr. Richards informed me that the light is permanently unplugged. However, this light is troubling because it has the potential to be extremely distracting if turned on, accidentally or otherwise.

Recommendations:

- a. Remove light fixture completely

Light Location/Quantity: In front of beach bar (2) and on eastern end of property (1)

Fixture Type: Tree mounted double spotlight

Light Ranking: 3



Notes: These lights are normally turned on and also used for special events. However, these lights are aimed toward the beach and light a significant portion of it strongly, therefore very distracting to nesting turtles.



Recommendations:

- a. Replace these lights with “turtle friendly” lights
- b. Attach hoods on spotlights, so that light is directed down and toward the temporary bar, minimizing light spillage onto beach.

Light Location/Quantity: Along western boundary wall (2), parking area (1), and along the pool area (5)
Fixture Type: Pole mounted carriage light
Light Ranking: 2



Recommendations:

- a. Replace fixtures with downlighting
- b. Attach motion sensors to the fixtures by the pool so lights are on at night only when pool is in use
- c. Increase beachfront vegetation to shield beach from these lights

Light Location: Guests Rooms
Fixture Type: Indoor lights
Light Ranking: 1



Recommendations:

- a. During nesting season, remind guests at check-in and place reminders in rooms to turn lights off when not in use, and to pull blinds at night

Light Location: Restaurant
Fixture Type: Indoor lights
Light Ranking: 1

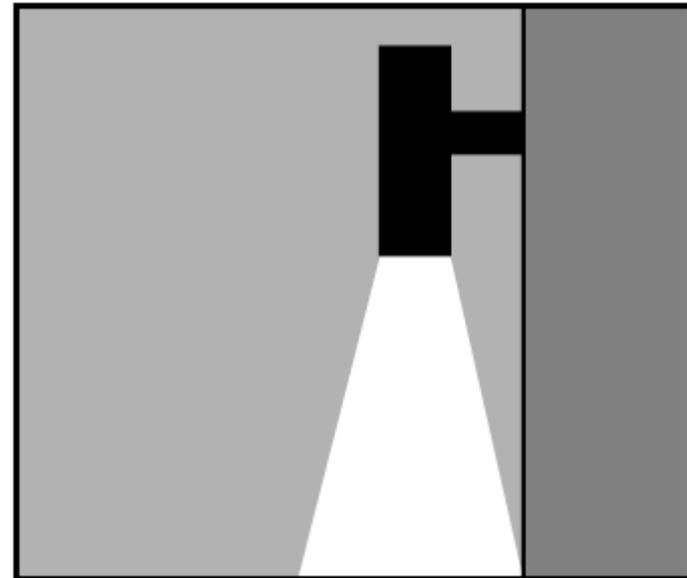


Recommendations:

- a. Replace restaurant lights with lower wattage, more intimate lighting

ADDITIONAL COMMENTS

Frangipani Beach Resort's impending remodel is the perfect opportunity for the resort to change many of their lighting fixtures to ones that are more appropriate for a nesting beach. Many of the recommendations include "turtle friendly" bulbs or elements, which are easily found at many outdoor lighting retailers on the internet, for example, Lighting Science (<http://store.lsgc.com/index.aspx>). The recommendations also call for "downlighting" which is a fixture that directs light downward, thus minimizing spillage onto the beach.



Witherington and Martin, 2000

These types of fixtures are also readily available at most lighting retailers.

ACKNOWLEDGEMENTS

I would like to thank Frangipani Beach Resort, especially Office Manager Susan Brookes, for giving me access to the property, their staff and for their security at night. I would specially like to thank Mr. Esmond Richards who was crucial to my understanding of the lights on this warm and inviting property.

Special thanks are extended to Mr. James Gumbs, Director of the Department of Fisheries and Marine Resources (and WIDECAST Country Coordinator in Anguilla) and Farah Mukhida of the Anguilla National Trust, who personally escorted me during the nighttime assessments. Mr. Gumbs generously arranged, prior to my arrival, partnerships with the properties involved in my assessment and guided and encouraged my efforts throughout my stay in Anguilla. I would also like to thank the entire DFMR staff who was patient and very generous with their time and knowledge.

My academic advisor, Dr. Karen Eckert, has been my mentor while enrolled in Duke University's graduate program. I want to thank her for having faith in my abilities to complete this project successfully, and for ensuring success by guiding me through the entire process.

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LITERATURE CITED

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CONTACT INFORMATION

Please direct any comments or questions to Kimberley Lake (kimberley.lake@duke.edu) or James Gumbs, Director of Fisheries and Marine Resources, Anguilla (james.gumbs@gov.ai)

APPENDIX D: LIGHTING ASSESSMENT REPORT FOR COVECASTLES

Lighting Assessment Report

Prepared for:

COVECASTLES



**Shoal Bay West
Anguilla, BWI**

Performed by:

Kimberley Lake, Duke University

In Partnership with:

The Department of Fisheries and Marine Resources, Anguilla
The Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

INTRODUCTION

Sea turtles are an important part of the ecological wealth of Anguilla, with three of the world's seven species nesting seasonally (April-November) on Anguillan beaches and four foraging in nearshore waters. Centuries of largely unmonitored exploitation have resulted in serious declines in local sea turtle populations (Godley et al. 2004). In an effort to restore their numbers, the Government of Anguilla has enforced a moratorium on the harvest of sea turtles and their eggs since 1995.

While safeguarding remnant stocks from unsustainable use is an important first step in population recovery, another critical factor is habitat quality. The presence of anthropogenic light sources on nesting beaches is detrimental to hatchlings and nesting turtles, and is commonly called "light pollution" (Witherington and Martin 2000). In an attempt to document this threat at known nesting beaches in Anguilla, formal lighting assessments were performed during July and August, 2007, in partnership with the Department of Fisheries and Marine Resources (DFMR) and The Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

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On an island, such as Anguilla, with increasingly high levels of coastal tourism and development and where beaches cannot feasibly be dark and quiet year-round, it is vital that owners and managers of coastal properties use best lighting practices to minimize their impacts on proximal sandy beaches.

In a lighting assessment, collaboration with property managers is important because they have intimate knowledge of the purposes and timing of the lighting on the property. They also know which lights are under the control of the property, and which are controlled by the guests. Many times, the negative effects of the lights on the property can be mitigated in ways that are creative and low cost, and in some cases may even present energy savings to the property. By collaborating directly with managers and owners from the start, they become directly involved in both the assessment and its recommendations.

Covecastles, along with three (3) other properties, graciously volunteered to have a lighting assessment performed on their property. In doing so, they have assumed a leadership role in the conservation and recovery of local sea turtle populations and provided an excellent example to other beachfront properties to follow.

Mr. Robert Murray (Covecastles) participated fully in all stages of the assessment, providing access to the property, information about the lights, and volunteering lighting mitigation ideas. This highly commendable action is the type of collaborative effort that can only help efforts to restore sea turtle nesting on the island to healthy levels. Since the resort is on one of the island's more active nesting beaches, this assessment has high potential to positively impact habitat quality on the island.

THE LIGHTING ASSESSMENTS

The assessments were performed by Kimberley Lake, a Coastal Environmental Management graduate student in The Nicholas School of the Earth and Environmental Sciences at Duke University, North Carolina. The lighting assessments occurred on July 17, 2007 in three parts: a daytime assessment at 8:30 a.m., an early nighttime assessment at 8 p.m., and a late night assessment at midnight. Because lights are often managed differently depending on time of day, these multiple assessments allowed the observer to capture the temporal aspects of lighting effects. As the purpose of the study was to assess these effects on marine turtles, all assessments were performed from the nesting beach. The only purpose for accessing the property behind the beach was for the observer to verify the source of an indirect light, or to verify the type of fixture.

Daytime Assessments

The purpose of the daytime lighting assessment was to document and record any light fixture that could be seen from the beach. The observer walked from one beachfront end of the property to the other, documenting the types of light fixtures, their locations and quantities across the beachfront. In addition, photographs of each fixture type were taken to facilitate off-property verification, and to facilitate identification in the reports. Once nighttime assessments were completed, a follow-up daytime walk along the property with Mr. Murray helped to verify and document the uses and importance of each of the light fixtures as well as the exact timing of their use.

Early Nighttime Assessments

The purpose of the early night time assessment was to determine the impact of each light fixture identified during the daytime assessment. Each light fixture was given a rank of 1 to 3, with 1 being the least disruptive and 3 being the most disruptive (to nesting females and their young).

A light with a rank of 1 is considered an indirect light, or one whose globe is not visible. These lights are not strong enough to cast a shadow on the beach. Light fixtures that were not observed during the day, but whose light is observed at night could also fall in this category. An example might be an indoor light; although these lights are not on the exterior of the building, they are often bright enough to be seen from the beach and have a disorienting effect. A light with a rank of 2 is one whose globe can be seen from the beach, but is not strong enough to cast a shadow on the beach. A light with a rank of 3 is strong enough to cast a shadow on the beach, whether the globe is visible or not.

In order to ensure that the specific lights were given their correct rankings, in some cases hotel personnel were asked to extinguish confounding lights while a specific fixture was being assessed.

Late Night Assessment

To capture the temporal aspects of the beachfront lighting at a particular property, a late night assessment (methodologically a repeat of the early night assessment) is crucial. For example, a restaurant may be well lit until 9 p.m., and these lights may be seen from the beach, but after midnight, these lights are extinguished and cease to exert a measurable impact on nesting or hatchling turtles.

THE LIGHTS OF COVECASTLES: RANKINGS AND RECOMMENDATIONS

The following pages document the findings of the assessments, and the recommendations are a combined product of discussions with Mr. Robert Murray and lighting recommendations found in Wintherington and Martin, 2000.

One of the most striking and commendable aspects of this property is the significant amount of natural vegetation on the beachfront side of the vilas. In some cases, there is even foliage on the beachside of security spotlights.



Natural vegetation on the property

By maintaining this large amount of natural foliage, Covecastles has significantly cut down on the effects of the porch lighting on the first floors of the property, and has also made the beach safer and more attractive to nesting turtles.



Natural vegetation blocking porch lights from the beach

This characteristic is worthy of special mention because the vegetation not only maintains the property's island charm and seclusion, but is an example of how natural vegetation can work for the benefit of both property owners and natural wildlife.

Light Location: Between villas

Fixture Type: Low pole mounted double spotlight with motion sensor

Light Ranking: 3



Notes: Although these fixtures are present between most villas, the only one functioning during the assessment was between Vilas 4 and 5. This light was on a motion sensor, which is commendable, but was very strong and not shielded to prevent horizontal light spillage.



Recommendations:

- a. Replace elements with low wattage, “turtle friendly” light bulbs.
- b. Aim fixture toward property and away from the beach
- c. Attach hood to prevent horizontal light spillage
- d. Grow foliage on beach side of fixture to shield beach from light

Light Location: Beachfront patios
Fixture Type: Ceiling mounted downlight
Light Ranking: 3



Notes: These lights are mostly shielded from the beach by the natural vegetation. However, these lights shine strongly through the pathways from the porch to the beach.



Recommendations:

- a. Replace elements with lower wattage, “turtle friendly” bulbs
- b. Remind guests at check in to turn lights off when not in use, especially during nesting season.
- c. Allow foliage to grow higher to shield upper half of porches

Light Location: Pathway to beach at side of Villa 1
Fixture Type: Spotlight
Light Ranking: 2



Recommendations:

- a. Turn away from the beach and onto property
- b. Replace element with lower wattage bulb

Light Location: Upper non-beachfront balcony
Fixture Type: Recessed ceiling light
Light Ranking: 2/1



Notes: All these lights create significant wall wash, and they all get a rank of at least a 1. However, on some villas, the actual bulb can be seen and these get a rank of 2.

Recommendations:

- a. Turn these lights off when not in use, especially during nesting season

Light Location: Villa Rooms

Fixture Type: Indoor lights

Light Ranking: 1



Recommendations:

- a. Remind guests at check-in to draw their curtains at night especially during nesting season
- b. If possible, move lamps away from beachfront sliding glass doors and windows

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