IN THE SPOTLIGHT:

An Assessment of Beachfront Lighting at Four Hotels in Barbados, with Recommendations for Reducing Threats to Sea Turtles

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WIDECAST
Wider Caribbean Sea Turtle Conservation Network

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Karen L. Eckert
Julia A. Horrocks

2009

Tourism Development Corporation

Barbados Sea Turtle Project, University of the West Indies

Columbus Zoo and Aquarium

Pew Fellows Program in Marine Conservation

PREFACE AND INTENT

For more than two decades, the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), with Country Coordinators resident in more than 40 Caribbean nations and territories, has linked scientists, conservationists, natural resource users and managers, policy-makers, industry groups, educators, and other stakeholders together in a collective effort to develop a unified management framework, and to promote a region-wide capacity to design and implement science-based sea turtle conservation actions.

As a Partner Organization of the UNEP Caribbean Environment Programme and its Regional Programme for Specially Protected Areas and Wildlife (SPAW), WIDECAST is designed to address research and management priorities at national and regional levels, both for sea turtles and for the habitats upon which they depend. We focus on bringing the best available science to bear on contemporary management and conservation issues, empowering stakeholders to make effective use of that science in the policy-making process, and providing an operational mechanism and a framework for cooperation within and among nations.

Network participants are committed to working collaboratively to develop their collective capacity to manage shared sea turtle populations. By bringing people together and encouraging inclusive management planning, WIDECAST is helping to ensure that utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival in the long term. However, the recovery of remnant populations of Caribbean sea turtles will require more than a precautionary approach to sustainable use, it will also require thoughtful attention to both acute and chronic threats to important nesting and foraging habitats.

Artificial beachfront lighting is a widespread and oft-fatal threat to sea turtle hatchlings and adult females at the nesting grounds. Barbados, the easternmost Caribbean island, exhibits particularly severe light pollution on its south and west coasts, which also host some of the largest hawksbill sea turtle, *Eretmochelys imbricata,* rookeries in the Caribbean Sea.

Beachfront hotels can be a significant source of artificial lighting. At a 2000 national workshop entitled, "Sea Turtles and Beachfront Lighting: An Interactive Workshop for Industry Professionals and Policy-Makers in Barbados," the nation's hotel representatives pledged to undertake lighting assessments and to implement 'turtle friendly' lighting regimes "as soon as practicable," with an aim to reduce the threat posed to endangered sea turtles.

In furtherance of this commitment, four leading hotels participated in a six-month voluntary lighting assessment in 2006. The results of these assessments, which included detailed recommendations for reducing light pollution at major nesting beaches, were presented to each hotel and, with their permission, have been collected for publication and dissemination in this Technical Report.

The coast-based hospitality sector in the Wider Caribbean Region has a large and growing impact on sea turtle habitat. In this study we focus on artificial lighting, which is well known to deter or disrupt the nesting process and confuse sea-finding behavior, but other threats include deforestation, seawalls and other obstacles to nesting, sand mining, increased erosion, introduction of non-native predators, inadequate waste disposal, and so on. Property owners must assume a degree of responsibility for these threats. Reducing light pollution is a straightforward exercise that yields large dividends; therefore, involving property owners and managers in reducing beachfront lighting is fundamentally important to the successful management of Caribbean sea turtle populations. This study, and the willingness of major beachfront hotels to participate, provides a replicable model.

It is our hope that participating hotels will take these recommendations to heart, and that other hotels, condominiums, and villas in Barbados will follow suit, thereby significantly reducing the impact the tourism industry has on sea turtles nesting on the island's beautiful beaches. In addition, we hope that Government will incorporate a progressive national Lighting Ordinance into the island's regulatory framework, setting an example for other nations to follow.

Karen L. Eckert, Ph.D.
Executive Director
WIDECAST

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We would also like to express our appreciation to Ms. Jennifer Harding at the Fairmont Royal Pavilion for accommodating trainers Erik Martin and Karen Eckert during their 2006 visit. Equally important, this assessment would not have been possible without the foresight, encouragement, and financial support of the Tourism Development Corporation of Barbados.

Finally, we would like to recognize the tireless efforts of the Barbados Sea Turtle Project (BSTP), based at the University of the West Indies, and especially Dr. Julia Horrocks, Barry Krueger, and the 2006 seasonal staff. The professional work of the BSTP sets a high standard for biodiversity research and conservation in Barbados and throughout the Caribbean region. Without their collaboration, including providing JEK with housing, training, access to data and other technical information, and the opportunity to contribute to their important field work, which was so professionally and personally enriching to him, this study and the lighting assessments that contribute to it, could not have been accomplished.

This WIDECAST Technical Report is based on a thesis (Knowles 2007) submitted to the Master of Environmental Management degree program at Duke University. The senior author is grateful to Dr. Karen Eckert, Executive Director of WIDECAST and his academic advisor in the Duke University Nicholas School of the Environment, for her encouragement of his efforts and her leadership in Caribbean sea turtle conservation issues in general; to Mr. Erik Martin of Ecological Associates Inc. (EAI), for his kindness and patience in training in the protocols of professional beachfront lighting assessments, a field in which he is well-recognized; and to Dr. Julia Horrocks for hosting his summer internship and allowing him to participate in the work of the Barbados Sea Turtle Project.

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We dedicate this study and its recommendations to the hospitality industry in Barbados, and we hope that the initiative shown by the four properties profiled herein will fuel both their own mitigation efforts as well as those of other beachfront properties in the country.

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INTRODUCTION

Artificial beachfront lighting contributes to the degradation of sea turtle nesting grounds because the natural light intended to guide nesting females and their young back to the sea is diminished by light pollution from beachfront properties and other coastal infrastructure. The resulting disorientation (loss of bearings) and misorientation (incorrect orientation) is especially acute in the hatchling stage, and the consequences can be fatal (e.g., Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Philibosian 1976; Witherington and Bjorndal 1991a,b; Witherington and Martin 2003; Tuxbury and Salmon 2005). Working towards a solution to this pervasive problem, we describe light pollution assessment and mitigation procedures at four hotels in Barbados, West Indies.

Over the course of the last century, human activity on ocean shores has reduced the reproductive success of sea turtles in the Caribbean Sea and elsewhere (for Caribbean reviews, see Fleming 2001; Reichart et al. 2003; Godley et al. 2004; Bräutigam and Eckert 2006; for more general reviews, see Bjorndal 1982; Witherington and Bjorndal 1991a,b; MTSG 1995; Lohmann et al. 1996; Lutcavage et al. 1996; UNEP/CMS 2000; Witherington and Martin 2003; Shanker and Choudhury 2006; Hamann et al. 2006).

As a result of coastal land use patterns, and centuries of largely unmanaged exploitation, incidental capture, and international trade, sea turtles are recognized as depleted and endangered species by international law (Frazier 2002) and are fully protected by 70% of all Wider Caribbean governments (Dow et al. 2007), including Barbados. Caribbean-occurring sea turtle species are classified as Vulnerable, Endangered, or Critically Endangered (this category includes the hawksbill sea turtle, *Eretmochelys imbricata*) on IUCN's *Red List of Threatened Species*, either because of reduced range of habitat, recent declines in population size, or both (Pritchard 1996; WWF 2004; IUCN 2004, 2007a,b).

The hawksbill sea turtle has further been affected by widespread over-exploitation for traditional crafting industries reliant on the animal's keratinized carapace scutes, known as tortoiseshell (e.g., Parsons 1972; King 1982; Mack et al. 1982; Milliken and Tokunaga 1987; Groombridge and Luxmoore 1989; Hemley 1994; Meylan and Donnelly 1999; Kemf et al. 2000; León and Bjorndal 2002; Bräutigam and Eckert 2006; Reuter and Crawford 2006; IUCN 2007a). Notwithstanding, signs of contemporary population increases are evident at protected hawksbill nesting sites, including Barbados (Krueger et al. 2003; Beggs et al. 2007).

In furtherance of national conservation policies in Barbados, where, as in many other nations, threats persist even after the adoption of protective legislation and the ratification of international treaties (see Bräutigam and Eckert 2006 for a summary of legislation and treaty obligations in Barbados), the objective of this study was to assess and quantify one of the nation's dominant sea turtle survival threats (beachfront lighting), and to offer recommendations for mitigation that define practical incentives and solutions.

Artificial beachfront lighting results in death to thousands of sea turtle hatchlings every year in Barbados (Horrocks 1992; Eckert and Horrocks 2002). Artificial light is often associated with built development – including hotels, private homes, condos and villas, recreational facilities, and roadways – near nesting beaches. Depending on the location, certain property types dominate the landscape; in Barbados, large hotels tend to have the most significant effect, with regard to light pollution, on the beaches they abut.

Tackling light pollution in large hotels might seem daunting due to the scale of the built environment, but scale sometimes holds an advantage. For example, correcting light pollution at a single large hotel can have a positive effect along a significant portion of coastline, as well as surrounding areas. Moreover, the financial capacity of these hotels (e.g., see PKF 2006) may enable change in the management regimes of adjacent beaches at a faster pace than is likely to occur with similar regimes at beachside roads and parks managed by Government (McConney et al. 2003). When hotels are organized under an industry representative that can encourage replication of successful mitigation, further advantages accrue. Finally, hotels are often critiqued by third party evaluation/certification entities, as well as by guests and clients, and each of these can provide due recognition for progressive policies adopted by individual hotels.

BARBADOS IN THE SPOTLIGHT

Beachfront properties on the south and west coasts of Barbados advertise Caribbean beaches that slope gently to an emerald sea, attracting tourists as well as hawksbill sea turtles. The overlap has resulted in the degradation of turtle nesting grounds due to artificial beachfront lighting that affects, in a negative way, the behavior of both hatchlings and nesting females. Various problems, including light pollution and beach erosion associated with highly built coastlines, have worsened over time in the Caribbean region and elsewhere (e.g., Horrocks and Scott 1991; Cambers 1996; Potter 1996; Fletcher et al. 1997; Bryant et al. 1998; Clark 1998; Steinitz et al. 1998; Witherington and Martin 2003; Burke and Maidens 2004; Danielsen et al. 2005; Choi and Eckert 2009).

In 2000, the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), the Barbados Sea Turtle Project, and the Tourism Development Corporation of Barbados sponsored an event entitled, "Sea Turtles and Beachfront Lighting: An Interactive Workshop for Industry Professionals and Policy-Makers in Barbados" (Eckert and Horrocks 2002). The workshop culminated in several recommendations and pledges by the hotel industry that demonstrated the sector's concern for and commitment to the survival of vulnerable populations of sea turtles (Appendix I).

Among the pledges made was to "undertake a lighting assessment and investigate our individual hotel and villa capacities to participate in 'turtle friendly' lighting schemes; and implement, as soon as practicable, 'turtle friendly' lighting on all beaches" (Eckert and Horrocks 2002). A formal lighting assessment provides the most effective foundation by which specific lighting issues, recurring along the coast, can be addressed. Lighting assessments also provide vital information to individual property mangers seeking to prioritize, implement, and evaluate lighting improvements made over time.

Formalized lighting assessments were pioneered in the US in response to strict laws and policies, particularly along the southeast coast, that lights be prohibited from shining on sea turtle nesting beaches. Assessment techniques focus on identifying the most serious light pollution problems and making recommendations concerning the most effective means to reduce the amount of light that reaches the beach. Such recommendations are often articulated in three "Golden Rules": keep it *low*, keep it *shielded*, keep it *long* [referring to the wavelength emitted by the lamp] http://www.myfwc.com/wildlifehabitats/SeaTurtle_index.htm. The three "Golden Rules" are not substitutes for lights that can safely be *turned off* at night during the nesting season: an absence of light is always the best policy where sea turtles are concerned.

Mitigating light pollution is sensible and straight-forward, but often overlooked as a useful contributor to healthy beach and coastal environments. As a result, many beach communities come to recognize the negative impacts of artificial lighting only after sea turtle nesting habitat has been degraded. Once this point has been reached, legislative intervention is helpful because unilateral action by one or two properties is unlikely to be sufficient in a densely developed landscape. Some governments have responded by adopting and enforcing coastal lighting ordinances and other appropriate laws. The US is a leader in this field and, especially in Florida, many municipalities and communities have passed lighting ordinances in compliance with state mandates (see Witherington and Martin 2003 for background and model text; see Lake and Eckert 2009 for Caribbean-adapted text).

Like most countries in the Caribbean, Barbados does not have specific regulations concerning beachfront lighting. As a result, many thousands of hawksbill hatchlings are fatally disoriented every year, posing a serious threat to the survival of the colony and undermining other conservation efforts on their behalf (Horrocks 1992; Eckert and Horrocks 2002). There are also numerous cases of nesting females finding their way into backyard swimming pools and drains (Barry H. Krueger, BSTP, personal communication, 2006). As the number of these incidences grow, it is clear that the issue must be addressed through stakeholder-led processes whereby hotels, hospitality industry representatives, government agencies, and community leaders work together to effectively mitigate the threat on a national basis.

Our hope is that this report, including methodologies and recommendations offered, will serve to catalyze this much-needed effort, and will set a helpful example for others to follow.

PARTICIPATING HOTELS

With a view to evaluating the extent to which hotels had implemented the pledges made at the 2000 hotelier workshop (Eckert and Horrocks 2002), the Barbados Sea Turtle Project initiated, in 2006, a partnership with WIDECAST to conduct formal lighting assessments at four prominent beachfront hotels located in the Caribbean island nation of Barbados. These properties were: the Fairmont Royal Pavilion, Sandy Lane Hotel, Turtle Beach Resort, and Southern Palms Beach Club (see Appendices for Lighting Assessment Reports submitted to each property).

The four hotels were chosen because of their leadership in environmental consciousness, their location on critical sea turtle nesting habitat, and their past efforts and/or interests in mitigating unresolved beachfront lighting problems. The hotels differ in ownership, clientele, architecture, and degree of light pollution. Each was asked, and kindly agreed, to participate in a voluntary lighting assessment in 2006 and to have the results made publicly available.

The selected hotels are not to blame for the lighting problems in Barbados, even if they do hold some degree of responsibility. Also, they do not represent the worst case scenarios, for there are many beaches with high levels of artificial lighting. Finally, adopting 'turtle friendly' lighting alternatives at these four hotels will not fully solve the national problem; however, their willingness to participate in the assessment, to devote staff time to the process, and to give explicit attention to the challenge will contribute in significant ways to the survival of endangered sea turtles in Barbados.

Aware that Barbados lacks a formal lighting policy, we hope that this study and its attendant recommendations will not only spur participating hotels to make significant progress towards more 'turtle friendly', energy-efficient, and safe lighting alternatives, but that it will also encourage Government to debate and adopt a national Lighting Ordinance, and serve as a replicable model of success in stakeholder participation in resolving important conservation issues.

Fairmont Royal Pavilion –

The Fairmont Royal Pavilion hosts 72 deluxe oceanfront rooms along 1000 feet of beach. The cost of the most expensive room exceeds US$1,000 per night. The hotel is couples-oriented and will not book families with children under the age of 13 during peak season (November to April). The property is managed under Fairmont Hotels and Resorts, "the largest luxury hotel company in North America", ensuring consistency to its clientele by applying strict company standards with regard to property amenities (see www.fairmont.com/royalpavilion).

Sandy Lane Hotel –

Preferred Hotels and Resorts certifies Sandy Lane through their Standards of Excellence program, since they offer only the highest quality of service. Of the 112 luxury rooms and suites, totaling about 116,000 square feet (and extending along 1000 feet of beach), 79 of these rooms view the sea. Room rates range from US$450-$900 per night, with a luxury villa fetching US$4,000-plus per night during peak season. A varied clientele consists of families, honeymoon couples, and niche corporate and incentive groups (see www.sandylane.com/introduction/index.html).

Turtle Beach Resort –

With a nightly rate upwards of US$1,000, the Turtle Beach Resort is the only all-inclusive hotel assessed. The property features 166 spacious suites, many with panoramic ocean views. This four star hotel is managed by Elegant Hotels Group Barbados, caters to families, and offers a variety of activities for all ages. The hotel extends along 1500 feet of sandy beach (see www.turtlebeachresortbarbados.com).

Southern Palms Beach Club –

Of the four participating hotels, the Southern Palms Beach Club offers the least expensive rooms, with the most costly reaching US$360 per night. According to the official website, the hotel "welcomes the young who want to do it all, the couple that just wants to enjoy each other's company in the tranquil beauty of the island, or the family with children", while making "a firm commitment to meet the highest international standards in regards to the environment, conservation and corporate responsibility." Southern Palms Beach Club has 92 rooms, of which 53 view the ocean. The property is situated along 1000 feet of sandy beach (see www.southernpalms.net).

OVERVIEW OF METHODOLOGY

The basic procedure for conducting a lighting assessment is simple: walk the beach, identify and characterize all visible light sources (during both day and night periods), and document these sources on a standardized Lighting Evaluation Form (Appendix II). We adapted our data form from that used in Florida (US) by Ecological Associates Inc. (original evaluation form courtesy of Erik Martin, EAI).

Each Assessment Report features an introduction (reminding readers of the effects of beachfront lighting on endangered sea turtles, and why hotels play such a critical role in mitigation), a survey method section (detailing the systematic nature and timing of the assessment process), an explanation of the ranking scale (based on light intensity) that was used to evaluate fixtures, and detailed recommendations for reducing the negative effects of lighting on sea turtles.

Our ranking scale, adapted from that used by Ecological Associates Inc., was as follows:

- Rank of "1" described indirect light visible by an observer on the beach, but not likely to present a strong attraction to nesting or hatching sea turtles

- Rank of "2" described direct light or a visible globe, glowing element, lamp, or reflector likely to disorient sea turtles [*note*: neither "1" nor "2" lights were strong enough to cast a discernible shadow on the beach on a dark night]

- Rank of "3" (most problematic to sea turtles) described a light source strong enough to cast a discernible shadow on the beach, regardless of the illumination being direct or indirect

Ideally, a sea turtle nesting beach should not have any source of illumination to rank, revealing a score of "0" and hence no need for mitigation. When visible light is present, a rank of "1" is preferred over a rank of "2", which is preferred over a rank of "3."

Three important aspects of the ranking scale are its simplicity, objectivity, and reproducibility. The scale is readily understood by maintenance personnel who, most likely, will implement and evaluate any mitigation effort, and also by senior management making lighting scheme decisions during construction or renovation phases, increasing the likelihood that 'turtle friendly' lighting options will be selected. The ranking scale is also objective, meaning this it is designed to maximize the probability that a particular light fixture will receive the same ranking regardless of who conducts the assessment. This consistency aids in reproducibility, providing a baseline for hotels to track the success of mitigation action over time.

The recommendations featured in each stand alone Assessment Report (see Appendices V to VIII) make use of photographs, illustrations, and standardized icons. Each report features a different inventory of light sources because each property is unique, but many of the recommendations are shared. After defining the various illustrations and icons, each report offers advice for mitigating the effect(s) of specific fixture types: a labeled photograph is followed by the fixture's assigned rank, location(s), and icon-led recommendations. A comment section provides additional detail.

The fixture type evaluations are ordered based on the degree of rank (1, 2 or 3) as the primary tier. Since a rank of "3" indicates the most problematic light, these are listed first, followed by "2", then "1". Within the primary tier, order is based on the number of fixtures of that kind, color, creativity involved in resolving the lighting problem, the attention required, and the cost of implementation. Within the primary tier, the order is arguably more subjective because precise quantification of the impact to sea turtles of any particular light fixture, in isolation, is not possible.

In summary, the format of each Assessment Report is intended to direct a hotel's focus to the most problematic lights as defined by an easy-to-understand, illustrated suite of ranked recommendations. Each Assessment Report concludes by commending the hotel on past and present efforts in beachfront light reduction, while reaffirming the importance of executing the report's recommendations. An "Internet Resources" section features select industry websites where certain bulbs or fixtures mentioned in the Assessment Report can be reviewed and purchased. The original Assessment Reports, as submitted to each participating hotel, also included a CD of lighting products, vendors, and security information.

The Fairmont Royal Pavilion has implemented several sea turtle conservation measures, including supporting umbrellas on a flat base (*versus* poles thrust into the sand) and stacking beach chairs each night, reducing the chance that egg-laden females will encounter obstacles during nesting. In addition, beachfront spotlights are hooded, reducing glare and emphasizing the beautiful night sky. The most significant sources of light pollution at this property are balcony lights, and lights associated with a beachfront restaurant. Photographs taken during the day and at night (see inserts below) illustrate the challenge of reducing light spilling out onto the nesting beach from the restaurant's open arches.

At Sandy Lane Hotel, the majority of light fixtures obscure the bare bulb, a pleasing scenario for guests and sea turtles alike. Other measures that aid in the conservation of sea turtles include lush vegetation along the seawall (which both reduces light leakage and provides shelter to nesting females) and the stacking of beach chairs each night, easing the overland journey for both egg-laden adults and their hatchlings. The most significant threat to sea turtle survival at this property is the presence of large, tree-mounted floodlights emitting short wavelength light (e.g., violet). These lights overwhelm the property at night, resulting in severe sea turtle disorientation on site, as well as luring hatchlings (which safely reached the sea from nearby beaches) *back* to the beach!

Southern Palms Beach Club uses yellow bulbs in its spotlights, which is an improvement for sea turtles. In addition, ceramic sconces soften balcony lighting, which is very important (from the standpoint of sea turtle conservation) in a multi-story hotel. As with any structure built directly on the sandy beach platform, mitigating light pollution can be a real challenge. In this case, the most significant dilemma is presented by restaurant lighting during evening hours (below left) and pole-mounted courtyard lighting (below right) installed to provide ambient light for security cameras. In the Property Assessment conducted for this property, we discuss alternatives in both cases.

The Turtle Beach Resort has some of the best lighting (for sea turtles) of any property in Barbados. Landscaping emphasizes native vegetation, the watersports stand boasts no exterior lighting at all, and certain beachfront spotlights are left off during nesting season. 'Turtle friendly' fixtures are installed on all balconies, but guests need to remember to play their role and draw the curtains at night during the nesting season (compare open *versus* drawn, below left); common areas (e.g., stairwells) also need to be addressed. The big challenge to this resort is that even single lights (below right) can have a profound effect on the nesting habitat at night.

MANAGEMENT ISSUES

Hatchling Arena Assays –

Hatchling arena assays can demonstrate the effect of light on sea-finding behavior (Salmon and Witherington 1995; EAI 2002). In Barbados, we performed such an experiment on the beach in front of Hotel "A" and Hotel "B". The assay is a staged hatching event inside a designated circular arena defined by a 1 m radius divided into 36 equal sections. A shallow trench defined the arena's perimeter. Each of the 36 sections, representing 10 degrees of a circle, was divided off using cardboard slots, each separated by a 17.5 cm arc length (adapted from Salmon and Witherington 1995). Two arenas were positioned directly in front of Hotel A (Sites 1, 2) and Hotel B (Sites 1, 2). Hotel B had two additional peripheral arenas, one 25 m north of the property (Site 3) and one 25 m south of the property (Site 4).

Hatchlings used in the arena assays were collected from hotels where they had emerged earlier that night and been disoriented inland to artificial lights. Twelve hatchlings were placed in the center of the circular arena, facing the sea, and released one at a time (cf. Salmon and Witherington 1995). Two rounds were performed in each arena. The first round was performed with lights on, as they would be during normal hours of operation. The second round was carried out with all "3" ranking lights turned off. The data recorded for each hatchling included its final position at the perimeter, the length of its track, and the time needed to reach the arena boundary.

We used a Watson-Wilson test to determine any significant differences between the two rounds (Zar 1984). Orientation for each experiment did differ significantly from random, and all (lights on – lights off) pairs were significantly different with the exception of Site 2 at Hotel B ($P>0.25$), where one floodlight (with a rank of "3") was unable to be turned off (see Figure 1).

The results of this analysis reinforce the importance of reducing beachfront lighting. The results obtained from the peripheral arenas at Hotel B demonstrate that lights can negatively affect more than the area of beach they directly illuminate. The broadcast of some fixtures can affect an entire bay by drawing hatchlings from darker sections of beach out of the water and back to the beach (JEK, personal observation).

Common Issues among Properties –

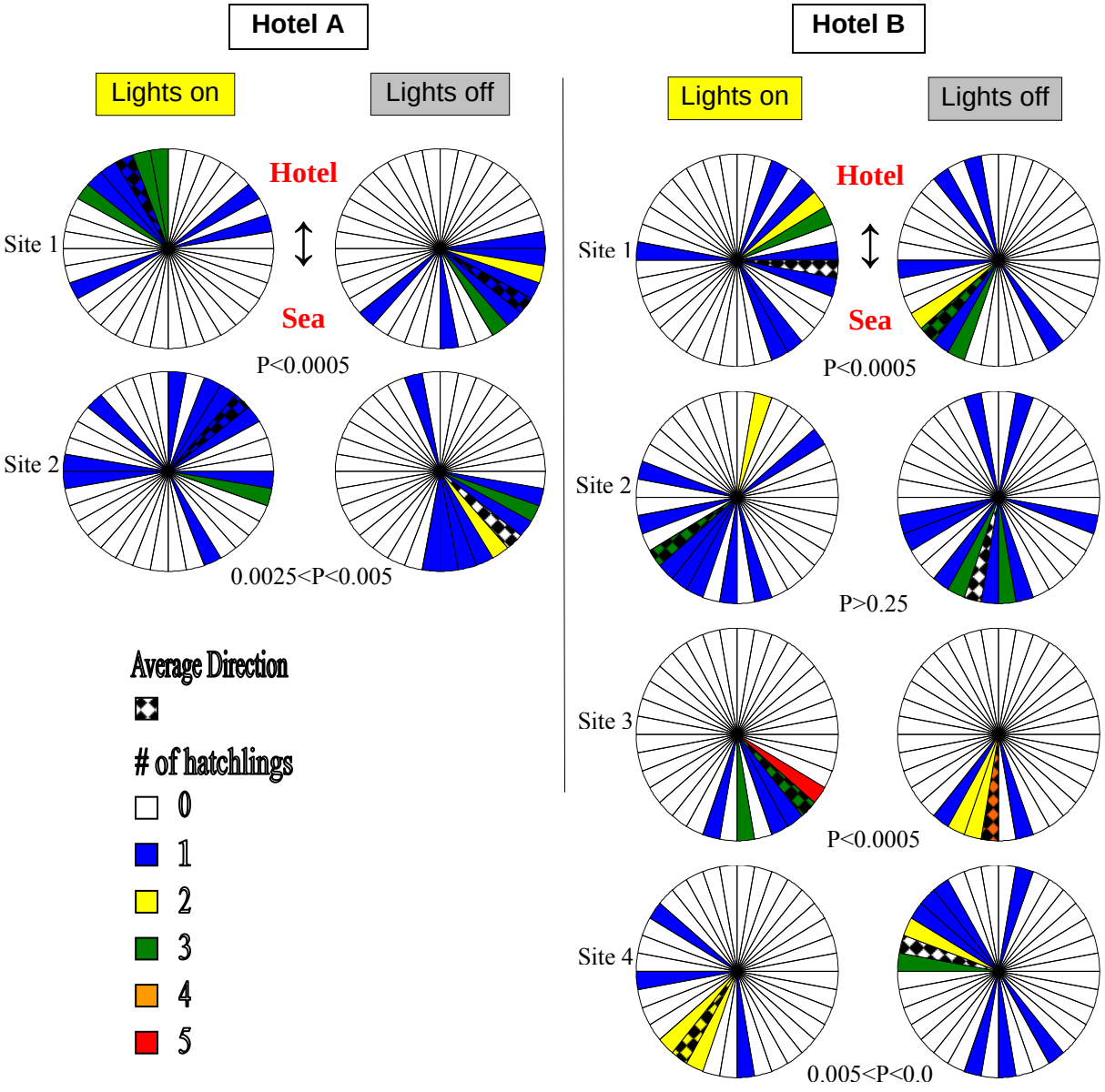
Most beachfront hotels provide similar services; for example, dining, entertainment, well-appointed rooms including balconies and windows-with-a-view, security, and so on. These services can result in unintended consequences, including negative effects on local endangered species due to lighting, activity, and highly modified landscapes.

One common problem observed at all four participating hotels was the issue of beachfront restaurants. In most cases there was no intentional illumination of the beach associated with the restaurants. Ceiling- and wall-mounted fixtures were the main source of broadcast light (recommendations focus on shielding and concealing these, respectively), and these were designed to illuminate the table setting and the space where people walk. One general solution is to lower these light fixtures behind opaque objects. Louvered foot lights installed into restaurant walls are an excellent example of successful mitigation; creative landscaping is another option. As for illuminating the table area, table lamps with shades and LED candles are an energy-efficient way to illuminate the space without broadcasting light beyond the restaurant.

Purely decorative lighting was also an issue shared among the featured properties. This is (or should be) one of the easier categories of lighting to mitigate since it serves only to enhance mood and ambiance, providing little or no functional or security purpose. The recommendation in this case is to eliminate the lighting. However, this type of lighting is popular in creating a unique or festive atmosphere, and eliminating it can be a difficult decision. One option is restrict such lighting to non-nesting periods: managers should contact local conservation organizations to confirm the timing of the annual nesting effort.

We hope that, with greater awareness, hotels will be willing to reserve decorative lighting for areas not visible from the beach, and choose to extinguish light that is "much more harmful to sea turtles than it is useful to people" (Witherington and Martin 2003:21).

Figure 1. Hatchling arena assays demonstrate the effect of varying degrees on light on the sea-finding ability of sea turtles. Two circular arenas were positioned directly in front of Hotel "A" (Sites 1, 2) and Hotel "B" (Sites 1, 2). Hotel B had two additional peripheral arenas, one 25 m north of the property (Site 3) and one 25 m south of the property (Site 4). Assays (staged hatching events) performed on the beach in front of Hotel A and Hotel B clearly illustrate the negative effects of beachfront lighting on the sea-finding ability of sea turtles, and the positive effects of turning off all rank "3" lights (the most problematic for sea turtles). Orientation for each experiment did differ significantly from random and all (lights on – lights off) pairs were significantly different except for one. The exception was Site 2 at Hotel B (P>0.25), where one floodlight with a rank of "3" could not be turned off. Results obtained from the peripheral arenas at Hotel B (Sites 3, 4) demonstrate that lights can affect more than the area of beach that they directly illuminate – the broadcast of some fixtures can affect an entire shoreline, even unlit portions.



Mitigating light sources that serve multiple purposes can be problematic. Two commonly paired categories – security and area lighting – are often served by high intensity spotlights. Security lighting includes lights that illuminate a perimeter or area for the sole purpose of preventing crime. An area light is defined as a source of illumination for spaces such as walkways, patios, or steps. When it comes to mitigation, separating light sources by function is helpful. Lights placed primarily for security are often best handled by the installation of motion detectors. For area lighting, 'turtle friendly' alternatives include louvered bollards and path lighting concealed by opaque objects. Area lighting should not include portions of sandy beach.

In addition to a plethora of multi-purpose lighting fixtures, the expansive length, depth, and height of a large hotel complex can be daunting when conducting a lighting assessment because of the number and types of fixtures to be evaluated. The hotels participating in this study each include 1000 feet or more of built beachfront. In addition, Sandy Lane Hotel and Turtle Beach Resort extend significantly landward from the beach, illustrating the complexities of the depth factor. Difficulties arise when forward lights are corrected, but the effects are undermined by uncorrected lights from behind. An accurate assessment relies on hotel management to extinguish the brighter forward lights so that the contribution of lights further inland can be evaluated. Height was not a significant issue for participating hotels. One advantage of a comparatively low profile is that landscaping can be an effective and pleasing option; i.e., the use of (preferably native) vegetation as a buffer between lights and the beach.

Finally, a challenge held in common among beachfront hotels, including those participating in this study, is that lights become more disruptive to sea turtles the closer the hotel (and its lighting regime) is to the ocean. The Fairmont Royal Pavilion and the Southern Palms Beach Club are closest to the beach, and most lights at these properties scored poorly with regard to their potential effect on sea turtles. Worth noting is the fact that construction setbacks are an important factor in sustainable coastal development in general, significantly reducing the risk of property damage due to shoreline erosion (e.g., Cambers 1997, Clark 1996, 1998, McKenna et al. 2000, Cambers et al. 2008, Choi and Eckert 2009), in addition to minimizing the negative effects of light pollution on sea turtles.

Distinct or Unique Issues among Properties –

Just as some lighting problems are shared broadly among beachfront hotels, it is also the case that some challenges are uncommon, perhaps even unique to a particular property.

Beachfront restaurants can present a major threat to sea turtles due to their close proximity to nesting sites and hours of operation. The Palm Terrace Restaurant at the Fairmont Royal Pavilion is no exception, with evening hours of operation (1900-2145 hr) and an advertising campaign describing the Caribbean sea as being "so close that it almost reaches the table" (www.fairmont.com/royalpavilion). Moreover, an open dining space is separated from the outside by large, wide arches, broadcasting light to the beach.

A distinct issue for the Palm Terrace Restaurant is that spotlights located at the wall and ceiling junctions create "wall wash" (reflected light), while others illuminate the dining space but are still highly visible from the beach. The general recommendation for this scenario relied on removing existing fixtures and repositioning their replacements. When management was reluctant to remove them, a "next-best" solution, tailored to the site, included lowering and shielding these lights to help conceal their emissions from the beach. Use of vegetation was also recommended. Typically a buffer would be planted in the space between the restaurant and the beach, but, because no such space exists at this site, it was suggested that potted palms within the dining area be positioned to block the high-mounted spotlights. Finally, we recommended that the arches be "landscaped" in to reduce the space from which light could leave the dining area, while preserving ocean views for diners.

At Sandy Lane Hotel, which in general ranked favorably with regard to its lighting regime, a distinct issue arose with respect to four tree-mounted floodlights designed to bathe the entire beachfront (dusk to 0200 hr) in violet-blue light. As sea turtles are most strongly disoriented by bright, short-wavelength light, these fixtures posed an extreme challenge. In addition, their height (being tree-mounted) broadcast light across the adjoining bay to peripheral beaches. As the lights are purely aesthetic, we recommended their removal. When this was rejected by management, we suggested restricting their use to *non-nesting*, peak tourism months (December to April).

Finally, at the Southern Palms Beach Club, the waterfront is lined with yellow spotlights. This particular situation improved following the 2000 "Sea Turtle and Beachfront Lighting Workshop" (Eckert and Horrocks 2002), when wattage was reduced and the original white spotlights were replaced by yellow spotlights. Notwithstanding, nearly *every* hatch of a sea turtle nest on this beach is characterized by disoriented hatchlings (JEK, personal observation). The lights are valued by management as security assets and are associated with security cameras. In reality, however, the light emitted by these fixtures and others is not sufficient to provide a clear image for the cameras. With this in mind, we (i) recommended alternative security measures and (ii) noted that because the human eye readily adjusts to low ambient light (Hecht 2001), sufficient safety in navigating walkways and steps to the beach could be provided by, for example, tube lights with red LEDs.

Lighting and Crime Misconceptions –

The issue of lighting and crime continues to concern the hotel sector, and "the perceived issues of guest security have been a major impediment to light reduction on Barbados' beaches" (Eckert and Horrocks 2002). The concern is widespread, and important. Witherington and Martin (2003:69) respond this way:

"How can the sacrifice of human safety and security to save a few sea turtles be justified? Thankfully, no such choice is necessary. The safety and security of humans can be preserved without jeopardizing sea turtles. The goal of any program to reduce sea turtle harassment and mortality caused by lighting is to manage light so that it performs the necessary function without reaching the nesting beach. Still, some may contend that any inconvenience at all is too much and that the concerns of humans should always outweigh those for turtles. People insistent on this generalization should not ignore the large and resolute constituency that values sea turtles. Sea turtles are valuable to people both ecologically and for pure enjoyment. In many ways, the protection of sea turtles is in our own best interests."

The ecological argument is a strong one in Barbados, where many thousands of hawksbill sea turtle hatchlings are threatened by lighting every year. Indeed, an estimated one-third of all hatchlings born on the island are affected (Eckert and Horrocks 2002), and with Barbados hosting one of the largest remaining nesting colonies for this species in the Western Hemisphere (Beggs et al. 2007; Dow et al. 2007), these losses have profound implications for the survival of the species. Fortunately, security and dark beaches can exist in harmony. Security need not rely on continuous beachfront lighting. Efficient and cost-effective alternatives include motion detectors that provide instant area illumination when an intruder is present, giving shadowed security staff the advantage (e.g., visit www.darksky.org). Well-trained guards with flashlights and an active patrol schedule are another proven alternative to high-energy, broadcast light that can lull security staff into complacency.

Witherington and Martin (2003:68) also addressed the perception that crime will increase if the beach is unlit. They concluded, "Generally, beaches are not areas where there is a great need for crime prevention. Very little valuable property is stored on beaches and there is seldom much nighttime human activity to require security. Fortunately, areas adjacent to nesting beaches where people reside, work, recreate, and store valuables can be lighted for protection without affecting turtles on the nesting beach. Where this type of light management was legislated in Florida coastal communities, the Florida State Attorney's Office has found no subsequent increase in crime."

Similarly, studies by the UK Home Office Crime Prevention Unit on street lighting and crime conclude that improvements in street lighting do little to prevent crime and criminals are less often deterred by light (Ramsay and Newton 1991), and that increasing the intensity of street lighting does not correspond to decreasing levels of criminal activity (Atkins et al. 1991). While these crime prevention studies did not look at beach lighting in particular, and generally examined areas with crime rates much higher than those observed in Barbados or elsewhere in the insular Caribbean, their results are revealing (Nuttall 2000).

Volusia County in Florida (US) provides a compelling and relevant case study. The county has one of the strictest coastal lighting ordinances in the state. When the Lighting Ordinance was passed in 1989, local businesses feared losses and worried about rising incidents of crime. As it turns out, no such loss or rise in crime materialized (Lelis 2003; William "Bill" Sorrentino Sr., Zoning Compliance Division, Daytona Beach, personal communication, 2006).

DISCUSSION AND NEXT STEPS

Other than recommended implementation actions at specific properties (see Appendices V to VIII), there are several next steps to be considered by the industry and its representatives (e.g., Barbados Hotel and Tourism Association, Tourism Development Corporation), as well as by Government, NGOs, and relevant experts. These next steps include, *inter alia*, regular follow-up lighting assessments, examinations of other beachfront properties and civil infrastructure (e.g., roadways, parking lots, tennis courts), energy audits and economic analyses, legislative action, and public awareness and participation campaigns.

Assessment and Ongoing Evaluation –

Each property situated on a sea turtle nesting beach (see Dow et al. 2007; contact Prof. Julia Horrocks <julia.horrocks@cavehill.uwi.edu> for detailed locations) should conduct a formal lighting assessment using a standardized ranking scale (see "Overview of Methodology"), and implement recommendations. Attention to the initial assessment should suffice in resolving threats to sea turtles associated with existing lighting, but because of routine changes associated with repair, renovation, landscaping, etc., annual inspections should be conducted just prior to the nesting season. Hotels, condominiums, and villas should be reminded on an annual basis to evaluate lighting regimes and to make needed adjustments.

Properties with the most significant lighting issues should receive priority attention in terms of training and assistance, mitigation, and evaluation. Training is available through the Barbados Sea Turtle Project (BSTP) at the University of the West Indies; contact Prof. Julia Horrocks, WIDECAST Country Coordinator, at <julia.horrocks@cavehill.uwi.edu>.

Environmental Management Systems (EMS) –

Hotel managers participating in the 2000 forum, "Sea Turtles and Beachfront Lighting: An Interactive Workshop for Industry Professionals and Policy-Makers in Barbados," pledged to adopt a Sea Turtle Policy Statement regarding the protection of sea turtles on hotel grounds, and to revise standard operating procedures to implement the policy (Eckert and Horrocks 2002). Choi and Eckert (2009) articulated such a policy (see Appendix III), and provided a comprehensive "check list" of best management practices to assist beachfront properties in doing their part to "ensure the survival of endangered sea turtles and their young" (see Appendix IV).

All beachfront hotels in Barbados (and elsewhere) are encouraged to adopt a Sea Turtle Policy Statement that includes a commitment to conduct "regular lighting assessments", as well as to implement a variety of other measures aimed at improving environmental performance. Notable is the fact that efforts to reduce light pollution are not separate from equally necessary efforts to improve energy efficiency, decrease costs, and model sustainable architectural designs. Lighting is the second most significant daily expenditure for Caribbean hotels (Tourism Global Inc. 2006), and energy-efficient lighting supports industry goals to neutralize carbon emissions from the tourism sector (CHA/CTO 2007).

An energy audit was not performed at the four participating hotels to demonstrate cost savings inherent in embracing 'turtle friendly' lighting alternatives. However, reducing wattage, turning lights off, and emphasizing light emitting diode (LED) technologies, low pressure sodium (LPS) and compact fluorescent lamps, timers, motion-detectors, and fixtures that direct light more efficiently (i.e., only where needed), are sure to reduce operational expenditures in a region where energy costs are high (http://climatelab.org/Small_Island_Developing_States). New technologies, including LED and CFL fixture types, among others, are making energy-efficient options more widely available and affordable than ever before. At the same time, some analysts are suggesting that energy efficient lighting translates into "elegance" (www.lrc.rpi.edu) and, potentially, into increased revenue since sophisticated lighting attracts a sophisticated traveler (Sabedra et al. 2004; Ruffino 2007).

Sustainable policies also seek to support local products and vendors. For example, in Barbados, 'turtle friendly' fixtures, including ceramic sconces and other products that can be adapted to both shield light and to enhance design and ambiance, are manufactured locally by Earthworks Pottery. "Buying local" fosters essential economic development (Witter et al. 2002; Duval 2004; Pattullo 2005; Tourism Global Inc. 2006; Travelwatch 2006) and delights guests with authentic

presentation (MacCannell 1973; Poon 2003; Tourism Global Inc. 2006). This recommendation may be more readily implemented by locally owned and smaller hotels and resorts, while hotels owned by large international corporations often have strict company-wide standards that apply to architectural elements, including lighting fixture options. Notwithstanding, managers in every context should emphasize local business partnerships as integral to a sustainable business model.

The benefits of supporting locally owned businesses are well documented and include reducing environmental impact, receiving better service, creating jobs at home, satisfying travelers' desires for distinctive local charm, and fostering local prosperity. "Several studies have shown that when you buy from an independent, locally owned business, significantly more of your money is used to make purchases from other local businesses, service providers and farms – continuing to strengthen the economic base of the community" (http://sustainableconnections.org/thinklocal/why).

Progress toward sustainable operating procedures is rewarded by industry certifications such as Green Globe (http://www.greenglobeint.com/), a benchmarking and certification program that promotes sustainable tourism worldwide by providing a framework for environmental and social performance improvement. Based on Agenda 21 and the principles endorsed at the United Nations Rio de Janeiro Earth Summit in 1992, Green Globe Standards provide participants with a framework to measure their environmental impact, and then develop and implement strategies to reduce that impact. The Caribbean Alliance for Sustainable Tourism (CAST) lists the "top 10 benefits of certification" as reduced water and energy consumption, lower operational costs, improved staff morale and productivity, increased staff creativity, increased customer satisfaction, reduced employee conflict, increased employee retention, improved community relationships and benefits, and improved business and shareholder value (http://www.cha-cast.com/).

Regulatory Action –

By adopting light management legislation, government makes a long-term commitment to protect sea turtles from the harmful effects of light pollution. In addition to providing a public mandate, legislation can establish specific criteria for determining which artificial light sources constitute a problem and how these light sources should be modified in order to solve the problem (Witherington and Martin 2003). Lighting legislation also helps to ensure that consistent action is taken nationwide, strengthening the success of individual efforts that might not otherwise occur on a scale necessary to safeguard endangered sea turtle populations.

Effective lighting legislation should have a clearly stated purpose, set standards for both new and existing developments, and be mandatory. Existing properties may be allowed to "phase in" appropriate lighting designs, while any new construction should be required to implement 'turtle friendly' policies from the start. Ideally, lighting legislation should be embedded in a holistic national conservation strategy, and comprehensive coastal zone management plan.

According to Lake and Eckert (2009), several factors are important when considering light management legislation, and effective policies should embrace the needs – real and perceived – of stakeholders, including government agencies, property owners and managers, residents, and paying guests. With this in mind, these authors suggest that a national Lighting Ordinance should satisfy at least the following five criteria: increase the quality of sea turtle nesting habitat; maximize cost-effectiveness for property owners and regulators; maximize public safety and security; maximize enforceability; and ensure flexibility to adapt to new scientific information. Model lighting ordinances are found in Witherington and Martin (2003).

Public Outreach and Participation –

The BSTP operates a 24-hour national *Sea Turtle Hotline* to facilitate public involvement in the reporting of sea turtle nesting or hatching events, including incidents of turtles being disoriented inland, away from the sea. Hotel staff, security guards, and even guests routinely call the *Hotline* if turtles are disoriented due to property lighting. BSTP staff also document hatchling disorientation not reported by the *Hotline* but observed during their nightly research and monitoring efforts. The participation of hotel staff and (supervised) guests can meaningfully extend a nation's capacity for monitoring and responding to sea turtles in trouble. By paying attention to the cause(s) of the disorientation, lighting problems can be identified and resolved.

Responding to Disoriented Turtles –

According to Phelan and Eckert (2006) hatchlings traveling away from sea, clearly entrained by artificial lighting, should be collected and released immediately. Hatchlings have limited internal yolk stores, which are needed to provide sufficient "fuel" for their swim frenzy into the open ocean immediately after departing from the nesting beach. Each day a hatchling is held captive, drawing on its internal food stores, makes it more likely that it will deplete its yolk and be forced to stop, prematurely, to feed in predator-rich coastal waters.

If hatchlings are rescued during the heat of the day, they should be kept until late afternoon or evening in a lightly covered cooler or bucket. The procedure is described by Phelan and Eckert (2006) as follows:

- Place a few inches of damp beach sand in a cooler. If the sand is too dry, the young turtles may desiccate (dry out); if too wet, energy will be wasted in swimming, and weak hatchlings may be unable to hold their heads above the water to breathe.
- Cover the cooler or box and place it in the shade until late afternoon or nightfall. Supervise the container to avoid the unwanted attention of dogs, predators, and onlookers.
- At the time of release, keep predators (e.g., dogs, birds, crabs) away from the hatchlings as they cross the beach. Select an unlit stretch of beach (preferably the beach where the eggs were laid) to release the hatchlings; if the beach is well lit, ask the landowner/ hotelier to turn off the lights briefly as the hatchlings crawl to the sea. To encourage natural sea-finding, use minimum light and prohibit flash photography during hatchling releases.
- Never toss newborn hatchlings directly into the sea, or "ferry" them into deeper water. The natural progression of the hatchling from the nest, across the beach, through the coastal zone, and into the open sea is important and should not be unduly disrupted.

Remember that it is *illegal to handle and possess sea turtles,* which are protected by law in Barbados. The BSTP should be contacted for guidance in any efforts to assist post-nesting females in orienting correctly to the sea, or attempts to rescue and release hatchlings.

Concluding Remarks –

Widespread mortality to endangered sea turtle hatchlings due to bright coastal lighting, which distracts the newborn turtles during their journey from the nest to the sea, is well documented in Barbados (Horrocks 1992; Eckert and Horrocks 2002). In search of a solution, four prominent beachfront hotels, with support from local (Barbados Sea Turtle Project) and regional (WIDECAST) NGOs, as well as international experts (Ecological Associates Inc.), voluntarily committed to a lighting assessment of their properties and publication of the resulting recommendations. Each Assessment Report (see Appendices) provides a simple and objective ranking scheme, based on light fixture intensity, which can be used to reduce the harmful effects of artificial lighting on nesting beaches at these properties and, we hope, throughout Barbados and elsewhere. The Assessment Reports also establish a baseline for these specific properties, against which to evaluate progress made. Finally, the reports can be viewed as reference documents for general recommendations, products and vendors, and other information broadly useful for addressing problematic lighting observed at hotels, condominiums, and villas.

Hotels, condominiums, and villas are natural focal points for efforts to reduce "light pollution" originating on the coast, since they encompass a significant portion of beachfront property. Their individual efforts should be encouraged and rewarded in the context of industry certifications, such as Green Globe, that recognize sustainable policies. Government also has a role to play in securing the national benefits of light reduction, which include improving the quality of sea turtle nesting habitat (without compromising safety and security), lowering energy costs, and emphasizing a science-based approach to coastal zone management issues. By enacting regulations requiring 'turtle friendly' lighting schemes, the burden of mitigation falls equally on all beachfront properties and civil infrastructure (e.g., roadways).

Finally, residents and guests play a vital role in reporting sea turtle nesting and hatching events, including disorientation and mortality; in advocating for stronger conservation policies and reporting violations; in obeying requests to turn lights off when not in use and engaging in other helpful behaviors; and in taking time to learn about sea turtles and their important role in Caribbean ecology, economy, and culture.

Have Hatchling Turtles Come Calling At Night?

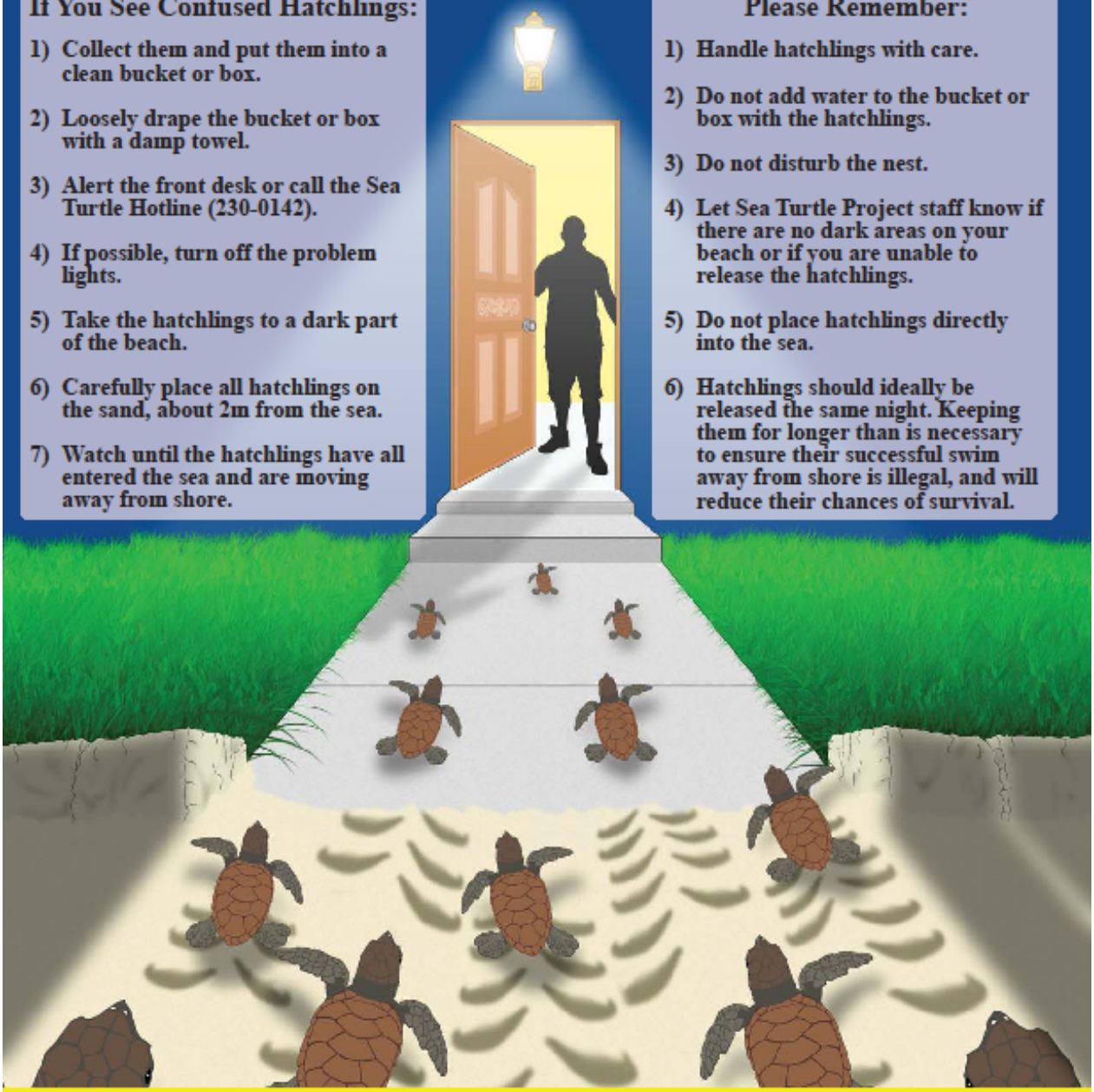
When the beachfront is dark, sea turtle hatchlings can easily locate the sea without our assistance. Artificial lights from coastal properties and roads often confuse hatchlings causing them to crawl inland. This can prove fatal for hatchlings since they may be preyed upon by crabs or domestic animals, run over by vehicles or die from dehydration.

If You See Confused Hatchlings:

1) Collect them and put them into a clean bucket or box.
2) Loosely drape the bucket or box with a damp towel.
3) Alert the front desk or call the Sea Turtle Hotline (230-0142).
4) If possible, turn off the problem lights.
5) Take the hatchlings to a dark part of the beach.
6) Carefully place all hatchlings on the sand, about 2m from the sea.
7) Watch until the hatchlings have all entered the sea and are moving away from shore.

Please Remember:

1) Handle hatchlings with care.
2) Do not add water to the bucket or box with the hatchlings.
3) Do not disturb the nest.
4) Let Sea Turtle Project staff know if there are no dark areas on your beach or if you are unable to release the hatchlings.
5) Do not place hatchlings directly into the sea.
6) Hatchlings should ideally be released the same night. Keeping them for longer than is necessary to ensure their successful swim away from shore is illegal, and will reduce their chances of survival.



For additional information on sea turtles and how to make a donation for sea turtle conservation in Barbados,
See www.barbadosseaturtles.org or call the Sea Turtle Hotline (230-0142).
The Barbados Sea Turtle Project, Dept. of Biological and Chemical Sciences,
University of the West Indies, Cave Hill Campus, St. Michael, Barbados
Tel: (246) 417-4320, Fax: (246) 417-4325.
Arrangement by Darren Browne & Asanchia Harewood. Art by Darren Browne.

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APPENDIX I: RESOLUTIONS, PLEDGES & RECOMMENDATIONS

Source: Eckert and Horrocks (2002)

RESOLUTION OF THE MEETING

RECOGNISING that Caribbean sea turtles species are classified either as Endangered or Critically Endangered by international authorities, and are fully protected in Barbados under the Fisheries (Management) Regulations, 1997;

CONCERNED that sea turtle populations in Barbados have declined dramatically over the course of the 20th century, due to threats both domestic and foreign;

AWARE that natural sandy beach habitat is essential to the survival of the tourism industry in Barbados, as well as to the survival of our sea turtles;

ALARMED that the majority of sea turtle hatchlings emerging from the beaches of Barbados are confused and disoriented by artificial lighting and that, as a result, thousands of them die every year;

SENSITIVE to the impact the modern tourism industry, including coastal construction and artificial beachfront lighting, has on the plight of sea turtles;

ENLIGHTENED, based on the results of this workshop, about how the coast-based tourism industry can participate in sea turtle conservation and protection; and

COMMITTED to taking effective action, both as individuals and as an industry, to ensure the survival of sea turtles in Barbados –

WE PLEDGE TO:

ADOPT a Policy Statement regarding the protection of sea turtles on hotel grounds;

REVISE Standard Operating Procedures (SOPs) to implement the Sea Turtle Policy Statement and further encourage reporting and protecting nesting turtles and hatchlings by hotels and other beachfront properties;

SEEK to ensure that funding is available to support annual training (by the Barbados Sea Turtle Project) of support staff in those departments that are responsible for actualisation of the Sea Turtle Policy Statement;

UNDERTAKE a lighting assessment (following the guidance of Witherington and Martin, 2000) and investigate our individual hotel and villa capacities to participate in "turtle friendly" lighting schemes; and

IMPLEMENT, as soon as practicable, "turtle friendly" lighting on all beaches (e.g., replace HPS lights with LPS alternatives, install motion-sensitive security lights, turn off purely aesthetic lights at 9:00 PM during peak nesting and hatching seasons).

RECOMMENDATIONS OF THE MEETING:

TO PROMOTE full implementation of the RESOLUTION, we recommend that the Tourism Development Corporation, in consultation with the Barbados Sea Turtle Project and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and in collaboration with other local (BHTA) and regional (CAST) industry coalitions:

PROVIDE the hoteliers, villa rental agencies, Ministries and other relevant agencies in Barbados with a draft to be adopted and implemented by the hotel and villa rental community nation-wide, with each establishment ensuring that its SOPs are revised as necessary;

PROVIDE the hoteliers and villa rental agencies in Barbados with standard guidelines and criteria for implementing the Sea Turtle Policy Statement; and

PROVIDE coastal hoteliers and landowners with emergency numbers for reporting sea turtle sightings and violations, and a calendar noting the nesting and hatching months of local sea turtle species.

APPENDIX II: 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 III: SEA TURTLE POLICY STATEMENT

Source: Choi and Eckert (2009)

Aware that sea turtles contribute in significant ways to the ecology, culture, and economy of the Wider Caribbean Region;

Concerned that sea turtles are severely depleted from their historical abundance; and

Acknowledging that while the large majority of Caribbean nations protect sea turtles, population recovery will not be possible without greater attention to the conservation of essential nesting and feeding habitats,

We Pledge To:

- Encourage a commitment to environmental responsibility among employees and guests;
- View sea turtle protection as an opportunity for civic engagement in biodiversity issues;
- Be vigilant and aware of any risks to the environment which may occur within or outside our development area as a result of our activities;
- Assess environmental impacts of all activities, planned and ongoing, as they relate to the conservation of sea turtles and their habitats;
- Provide employees and contractors with information and instruction to enhance their awareness of relevant environmental issues, and to ensure effective management of environmental impacts, including impacts on sea turtles and their habitats;
- Identify and collaborate with local experts in designing, implementing and evaluating our sea turtle program to ensure that it fits within national sea turtle conservation priorities, policies, and ongoing initiatives;
- Make continual improvements in operations and management oversight to increase the effectiveness and reliability of our sea turtle conservation program;
- Comply with environmental legislation and local best practice policies related to turtles and their habitats (sandy beaches, seagrass, coral reefs) and encourage others to do so;
- Promote setbacks, and maintain vegetated buffer zones between sandy beaches and all buildings, patios, and other built structures;
- Implement measures to minimize waste, including applying monitoring procedures to ensure that the nesting beach and nearshore waters remain free of debris and pollution;
- Conduct regular (at least annual) lighting assessments to identify sources of light pollution, and strive to eliminate artificial light visible from the beach during nesting season;
- Implement a system that removes potential obstacles to sea turtle nesting, including sun beds and recreational equipment, from the beach each night during nesting season;
- Discourage vehicles on the nesting beach, require hand-raking of debris and seaweed;
- Support local sea turtle conservation and research, including offering financial or in-kind support, as practicable; and
- Report all incidents of sea turtle harassment or harm to the proper authorities.

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

CAST
Caribbean Alliance for Sustainable Tourism

APPENDIX IV: CHECK LIST OF BEST MANAGEMENT PRACTICES

Sea turtles are ancient creatures, living mostly unseen in the world's oceans. At certain times of the year, egg-bearing females must come ashore to lay eggs deep in the warm sand of tropical beaches. The nesting process can be threatened by various aspects (e.g., deforestation, lights, sand mining, roads and construction, noise, activity, recreation) associated with beachfront development. Fortunately, an informed property manager can help ensure the survival of endangered sea turtles by implementing the following check list, including committing to reducing light pollution that can be fatal to nesting females and their young. *Source*: Choi and Eckert (2009).

Activity	Sea Turtle Protection BMPs
Pre-Construction Phase	➢ Know whether (and when) sea turtles nest on beaches near your property ➢ Be aware of laws and policies protecting sea turtles and their eggs ➢ Support the development and implementation of an independent Environment Impact Assessment ➢ Evaluate – and commit to minimizing – impacts to the nesting beach from access roads, vegetation removal/burning, excavation, erosion, lights and activity associated with work crews, etc. ➢ Schedule construction during non-nesting periods ➢ Identify and collaborate with local sea turtle experts to monitor the effects of construction ➢ Support formation of a local Advisory Board for transparency, information-exchange, oversight ➢ Adopt a *Sea Turtle Policy Statement* (see Appendix III)
Construction Setbacks	➢ Do not construct permanent buildings, snack bars, pools, etc. on the sandy beach platform ➢ To protect both the nesting beach and coastal infrastructure, establish reasonable setbacks between the ocean and any permanent buildings ➢ Inform contractors and partners of the importance of these setbacks, and of preserving native vegetation within a buffer zone
Exterior Lighting	➢ Commit to reducing "light pollution" that can be fatal to nesting females and their young ➢ Conduct lighting inspections, at least annually, and respond promptly to recommended corrective measures ➢ All exterior fixtures – anywhere on the property – that produce light visible from the nesting beach should be shielded, directed only where light is needed, generally placed as low as practicable, and use long wavelength lamps (e.g., red/amber LEDs, low pressure sodium) and black baffles ➢ Avoid bright white light, such as metal halide, halogen, fluorescent, mercury vapor, and incandescent lamps – and never use where such light could be visible from the beach ➢ Turn off balcony lights when not in use ➢ Use ornamental vegetation to block and reduce light leakage to the nesting beach ➢ Emphasize timers and motion sensitive lights to reduce beachfront lighting and operational costs ➢ Prohibit bonfires or fire pits on the beach or in line-of-sight of the beach during nesting season

Activity	Sea Turtle Protection BMPs
Glass Windows and Doors Visible from the Beach	➢ Commit to reducing the amount of light that reaches the nesting beach from hotel rooms, restaurants, and other interior spaces ➢ When possible, use blackout curtains or shade-screens – if glass tinting is an option, apply film with a visible light transmittance value of 45% or less to all windows and doors within line-of-sight of the beach ➢ Turn off lights when not in use!
Beach Sand Mining	➢ Know the law with regard to sourcing construction aggregate ➢ Avoid using sand mined from coastal beaches ➢ Report violations of sand mining laws
Obstacles on the Nesting Beach	➢ Remove furniture and recreational equipment (kayaks, small sailboats) from the beach nightly ➢ Stack and arrange furniture off-beach ➢ Use a permanent umbrella holder or sleeve – never thrust an umbrella (or other penetrating object) into a nesting beach ➢ Consider signage (if egg poaching is not a problem) alerting visitors to nest locations and asking that they stay 2m (6ft) from the nest site
Litter and Debris	➢ Implement policies to keep grounds and adjoining beach areas clean ➢ Hand-rake beach debris (vs. using a tractor) to avoid harming eggs incubating below the surface ➢ Partner with local youth or conservation groups to conduct Beach Clean-Ups, especially just prior to the nesting season
Beach Stabilization and Restoration	➢ Seek alternatives to coastal armoring/seawalls ➢ Protect beachfront property through enforced construction setbacks, mixed-species (preferably native) vegetation buffers, and dune protection ➢ If beach restoration/rebuilding is unavoidable, replacement sand should be similar (grain size, organic content) to the original beach sand, thereby maintaining the suitability of the beach for egg incubation ➢ Beach restoration should never take place during the nesting/hatching season
Vehicles on the Beach	➢ With the exception of authorized patrol or emergency vehicles (which should drive below the high tide line), motorized vehicles should be prohibited from driving on sandy beaches ➢ Smooth-out tire tracks – ruts trap emerging hatchlings, prevent them from reaching the sea
Protecting Beach Vegetation	➢ Know the law regarding removal and restoration of coastal vegetation and maritime forest ➢ Incorporate established vegetation into architectural plans – minimize removal of beachfront vegetation, restore what has been lost ➢ Emphasize the use of native plant/tree species ➢ Construct raised walkways over sensitive areas ➢ Consider planting “beach gardens” to help restore nesting habitat for hawksbill sea turtles

Activity	Sea Turtle Protection BMPs
Protecting Seagrass and Coral	➢ Prohibit actions that damage seagrass or coral ➢ Require all marine vessels be moored or docked ➢ Restrict anchoring to non-sensitive marine areas ➢ Demarcate a no-wake Swim Zone offshore the nesting beach ➢ Eliminate sedimentation and pollution – e.g., manage wastewater effluent, recycle graywater, maintain high standards for sewage treatment, emphasize low doses of landscape chemicals ➢ Educate divers and snorkelers about appropriate behavior underwater
Boats, Personal Watercraft	➢ Commit to reducing the impact of recreational boating on sensitive marine ecosystems ➢ Enforce a slow speed or no-wake zone offshore the nesting beach ➢ Encourage the use of propeller guards to reduce injury to marine life, including sea turtles ➢ Ensure that staff and guests know and understand all relevant rules and restrictions
Educating Staff and Guests	➢ Regularly train/evaluate staff in environmental management systems and sea turtle protocols ➢ Involve guests in sea turtle protocols; e.g., close curtains at night when interior lights are lit ➢ Make conservation fun! Host a Sea Turtle Summer Camp or Story Hour, sponsor a Beach Clean-Up, invite a local expert to give a Sea Turtle Talk, organize Nature Tours, recognize staff efforts ➢ Partner with a local conservation group to offer professionally guided Turtle Watches, if sea turtle species and habitats are conducive to viewing ➢ Use signage/in-room materials to inform guests of sea turtle (and other conservation) issues ➢ Always report nesting and hatching events

APPENDIX V: FAIRMONT ROYAL PAVILION ASSESSMENT REPORT

National Assessment of Beachfront Lighting and its Effect on the Survival of Endangered Marine Turtles in Barbados, West Indies

Property Assessment:

The Fairmont Royal Pavilion

Respectfully submitted
John English Knowles

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

Tourism DEVELOPMENT CORPORATION

INTRODUCTION

In partnership with the Barbados Sea Turtle Project (BSTP), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), and the Tourism Development Corporation in Barbados, a formal lighting assessment was conducted at the Fairmont Royal Pavilion as part of a follow-up initiative to implement recommendations made at a national "Sea Turtles and Beachfront Lighting" workshop held in Barbados in 2000 (Eckert and Horrocks 2002). The evaluation of lighting associated with the Fairmont Royal Pavilion property attests to the efforts and dedication of the hotel industry, its representatives, and the BSTP in reducing artificial lighting along the nation's sandy beaches.

Artificial lighting is well known to be detrimental both to nesting sea turtles and to their hatchlings because the natural light intended to guide the turtles back to the sea is diminished by light pollution from beachfront properties and other coastal infrastructure. The resulting disorientation (loss of bearings) and misorientation (incorrect orientation) is especially acute in the hatchling stage, and the consequences can be fatal (e.g., Mrosovsky and Shettleworth 1968; Philibosian 1976; Witherington and Bjorndal 1991a,b; Witherington and Martin 2003; Tuxbury and Salmon 2005).

The Fairmont Royal Pavilion has identified itself as a leader in addressing the lighting problem by voluntarily participating in this assessment. The property – along with three other beachfront hotels – was chosen because it plays a crucial role in maintaining high quality sea turtle nesting habitat. The intent of the lighting assessment was to evaluate current conditions, and to propose solutions and recommendations for each light identified as contributing to the nocturnal illumination of adjoining nesting grounds.

Reducing nocturnal illumination of nesting grounds is critical in the survival of the hawksbill sea turtle, *Eretmochelys imbricata*, a critically endangered species worldwide (IUCN 2004, 2007). Barbados plays a uniquely important role in the survival of this species, as the island's western coast is identified as one of the most important nesting grounds remaining in the Wider Caribbean Region (Dow et al. 2007).

Artificial and detrimental beachfront lighting, characterized as "light pollution" by Witherington and Martin (2003), is the most serious contemporary threat to the survival of sea turtles in Barbados (Eckert and Horrocks, 2002). Sea turtles are most sensitive to shorter wavelengths (what humans generally see as blue and green, but these wavelengths are strongly emitted by bright white light, as well), which they use in sea-finding. Based on the best available science, Witherington and Martin (2003:23) suggest using as few lights as practicable and, for the remaining fixtures, adjusting wavelength and/or intensity:

> *"We have no reliable formula that can be used to calculate how much each light source will affect sea turtles. We do know, however, that if spectral emissions are equivalent, reducing intensity will reduce effects, and if intensities are similar, substituting less attractive sources (like yellow bug or red lights) will also reduce effects. A sound strategy, therefore, would be to reduce effects on sea turtles by manipulation both intensity and color. As few lights as practicable should be used and, for lighting deemed essential, long wavelength light sources should replace more disruptive light sources and intensity should be reduced by using lamps of minimal wattage that are housed within well-directed fixtures aimed down and away from the beach."*

In summary, direct light on the beach can be highly disruptive to both adult sea turtles and hatchlings, and eliminating sources of direct light reaching the beach is preferred over all other light conservation alternatives.

Where eliminating light sources – either by turning them off or by removing the fixtures altogether – is not practical, alternatives are available which direct light more efficiently and/or shield the source from the beach.

In the case of indirect light, which can also be highly disruptive, Witherington and Martin (2003:21) reiterate that "luminaires should not be directed onto … any object visible from the beach," including walls, ceilings, and vegetation. Intentional indirect lighting often takes the form of decorative lighting, which "has limited use for any purpose other than aesthetic enhancement [and when] near nesting beaches may be much more harmful to sea turtles than it is useful to people" (Witherington and Martin 2003:20-21). Fixtures are available that will minimize or eliminate "wall wash" (the illumination of the side or façade of a building); see "Internet Resources".

Interior lighting is also a source of light pollution. Witherington and Martin (2003:22) note that the criteria for identifying problems caused by indoor lighting are the same as those for identifying problems caused by outdoor lighting; i.e., indoor light is a problem if it is visible from the nesting beach.

> *"Indoor lighting from buildings that are close to the beach, are very tall, or have large sea-side windows causes the greatest problem for sea turtles. Because indoor lighting is usually not meant to light the outdoors, the unwanted effects of indoor lighting can easily be eliminated without compromising the intended function of the light."*

Reducing light broadcast from occupied rooms requires cooperation from residents and guests. Indoor hotel light can be reduced by informing guests at Check-in, and reminding them through the use of in-room materials, to close opaque curtains during evening hours when room lights are on.

In the sections that follow, methods, results and recommendations, and a brief summary are provided. In general, immediate action should be taken to implement recommendations associated with rank "3" lights; in other words, light fixtures with the potential to have the most significant negative effect on endangered sea turtles. Lower priority actions can be budgeted over time. In keeping with the decisions of the 2000 "Sea Turtles and Beachfront Lighting" workshop, recommendations are based on best practices and current science as articulated by Witherington and Martin (2003).

METHODS

Daytime Lighting Survey –

A baseline daytime lighting survey was conducted on foot on 3 June 2006 by observing lighting fixtures and bulbs directly visible from the sandy beach. The entire property was accessed to clarify, identify, and enumerate (count) each visible fixture. All exterior lights within line-of-sight of the Assessor [John English Knowles] were described with respect to fixture type and location. The function of each light was preliminarily deduced by the Assessor; however, subsequent meetings with hotel management staff ensured that the correct function was documented in every case. Light fixtures with lamps (light bulbs) visible from the beach, as well as those that were designed or positioned so that they would likely illuminate the beach, were considered to be potentially problematic, and each was ranked and scored during a nighttime survey.

Nighttime Lighting Survey –

In coordination with hotel management, a nighttime lighting survey was conducted on foot on 23 July 2006. During the nighttime survey, each light identified during the daytime survey was located and evaluated with respect to its potential effect on sea turtles. Lights unseen during the day, but visible when emitting light, were also evaluated. Each light was ranked and scored on a scale of "1" to "3" (see "Ranking Individual Fixtures and Lamps").

The nighttime survey involved two inspections, one before midnight (2400 hr) and one after midnight, allowing for an accurate ranking of each individual light source in the context of changing background illumination as lighting conditions and intensities change throughout the night. Because particularly bright lights lessen the degree or the actual brightness of the lights behind them, and because some lights are extinguished late at night under normal operating procedures, the Assessor was able to use the sequential inspecttions to more accurately characterize the lighting landscape.

Ranking Individual Fixtures and Lamps –

The most disruptive lamps received a rank of "3"; whereas the least disruptive, a rank of "1". Specifically, a rank of "1" described indirect light visible to the Assessor while standing on the beach, but not likely to present a strong attraction to nesting or hatching sea turtles. A rank of "2" described a visible globe, glowing element, lamp, or reflector likely to disorient a sea turtle, but not strong enough to cast a shadow on the beach. A rank of "3" described a visible globe, glowing element, or lamp strong enough to cast a shadow on the beach regardless of whether the illumination was direct or indirect.

Even the smallest light could rank "3" if it cast a shadow on the beach because its close proximity (to the beach) or its particular vertical positioning could be just as disorientating as that of a more powerful light further away.

The "3" ranking lights are placed first in the assessment because of their potentially more serious effect(s) on sea turtles. The focus of corrective actions should begin with these lights, as their mitigation will have the most significant impact on the quality of nesting beach habitat.

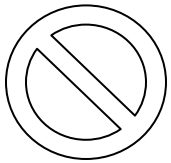
Within each rank – 1, 2, 3 – fixtures listed first are expected to require the greatest attention either in number, financial expense, or creativity. The list continues through fixtures deemed progressively simpler and/or less expensive to mitigate. For each light the number of fixtures visible from the beach, the fixture type, location, rank, comments (if any), function, photograph and pertinent recommendations are documented.

Each recommendation is specific to an individual light, and may include one or more explanatory remarks. Some recommendations pertain to modifying the fixture in some way, while other recommendations seek to replace the fixture with an alternative. "Recommendations" refer to fixes that will address the more serious issue(s), but in some cases may not completely eliminate the problem. "Ultimate Recommendations" refer to the best possible approach, and often suggest replacing (or removing) the fixture altogether.

RECOMMENDATIONS

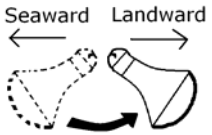
Illustrations and Icons –

Permanently eliminate fixture; some cases are specific to the number of fixtures.

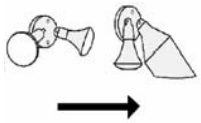


Reposition fixture to the landward side of the tree or object.

Aim (re-direct) the fixture away from the nesting beach.



or



Replace existing fixture with a more directed and functional path light that is positioned as to not directly or indirectly illuminate the beach.

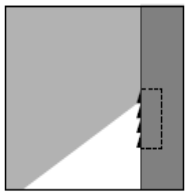
Replace the existing fixture with a more directed and functional bollard with external louvers.

Install low wattage (50 watts or less) yellow bug light bulb.

Install compact fluorescent “Turtle Safe Lighting” lamps (light bulbs). See “Internet Resources”.

Replace the existing fixture with a more directed and functional downlight (e.g., http://www.thomaslighting.com/catalog/proddetail.asp?cno=SL9270-8)

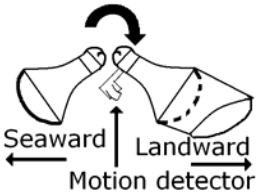
Replace the existing fixture with a more directed, more functional step light positioned to eliminate any direct (or indirect) illumination of the beach.



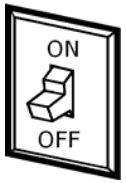
Reduce the intensity of the light, or lower the wattage.

Plant, landscape, or improve native vegetation buffer so that light is effectively screened (i.e., not directly visible) from the beach.

Install a hood, aim the light away from the nesting beach, and connect the fixture to a motion detector.

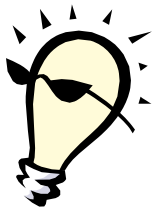


Keep lights off when not in use, especially lights closest to the beach. Inform guests via “table tents”, door hangers, or other educational, advertising or informative hotel materials about fixtures under their control.

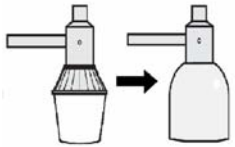


Install a shield or mask of sufficient size to cover an arc of 180° on the ocean side. *Note*: This recommendation is associated with broadcast light (generally in restaurants or porches) spilling out onto the nesting beach. The shield is intended to maintain the diffuse broadcast light effect, but eliminate any spillover. The shield can be anything placed in front of the light at any distance, as long as it blocks light from reaching the beach.

Shade arches; this recommendation refers to installing drop-down shades from the arches in the restaurant.

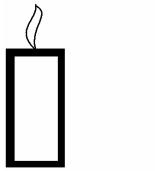


Install a Hubbell Skycap, or similar shield.



For security, install a motion detector to turn the fixture on only when an intruder is on the beach. *Note*: a motion detector can be disengaged when not needed.

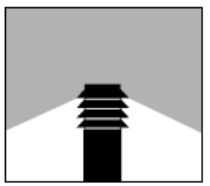
Eliminate fixtures and use low table lamps (e.g., Aurelle LED Candle Series or Maxxima MLC-01 LED Flameless Candle) or candles to illuminate the table without unintended broadcast from the restaurant.

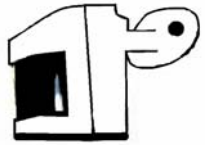


Palm-mounted hooded spotlight

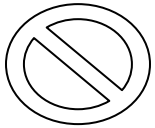
Rank: 3
Light Location: Coconut palm at the Water Sports Centre (southern end of property)
Number of fixtures: 2
Comments: Currently, the light is directed toward the boat ramp and steps. A much better alternative in illuminating these steps would be to install small foot/ step lights emitting a pure red light and connected to a motion detector (so they only come on when needed). If these lights are needed for security, low-profile, louvered bollards with beach-side shields would be an acceptable alternative. To minimize the effects of these lights on sea turtles, the bollards could be connected to a motion detector and feature low-pressure sodium (LPS) vapor lamps or yellow bug lights.

Recommendation:


or

with


Ultimate recommendation:

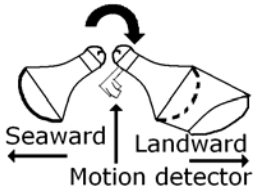


Bare spotlight (view 1)

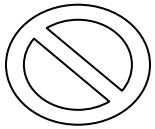
Bare spotlight (view 2)

Rank: 3
Light Location: On the roof of the Water Sports Centre
Number of fixtures: 2

Recommendation:



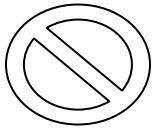
Ultimate recommendation:



Floodlight

Rank: 3
Light Location: North beach by the vender stalls
Number of fixtures: 1

Recommendation:



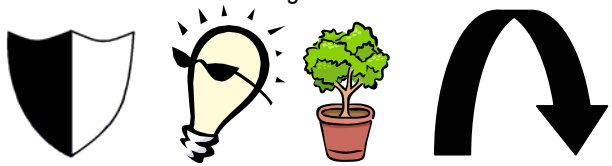
Large spotlights for the stage

Smaller, palm-mounted spotlight

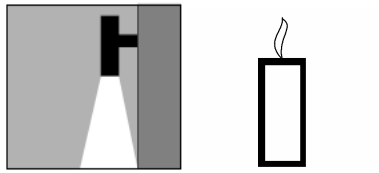
Smaller, ceiling-mounted spotlight

Rank: 3
Light Location: Palm Terrace Restaurant
Number of fixtures: 4 larger spotlights for stage (2 orange, 2 white) and 21 smaller spotlights
Comments: The restaurant presents a unique challenge because it is directly on the beach. Using wall-mounted downlights, step lights, and/or other directional fixtures in combination with small, low-level table lights will minimize the amount of light leaving the restaurant. The downlights should be mounted low enough so that they do not illuminate the nesting beach. Consideration should be given to planting vegetation *inside* the arches in such a way as to limit the amount of light passing through them, but, ideally, not obstructing the view of seated guests (a schematic is presented on the next page). Some fixtures also contribute to "wall wash," but because wall wash from a pure yellow or pure red light is less disruptive than wall wash from a full-spectrum white light, yellow bug lights or other 'turtle friendly' lamps should be used. By following these recommendations, neither this unique dining experience nor the behavior of sea turtle hatchlings will be compromised.

Recommendations on existing fixtures:



Ultimate recommendations:



With regard to the recommendation (above) that planting vegetation inside the arches could limit the amount of light reaching the beach, while at the same time preserving the ocean view for seated guests, the following landscaping options may be effective

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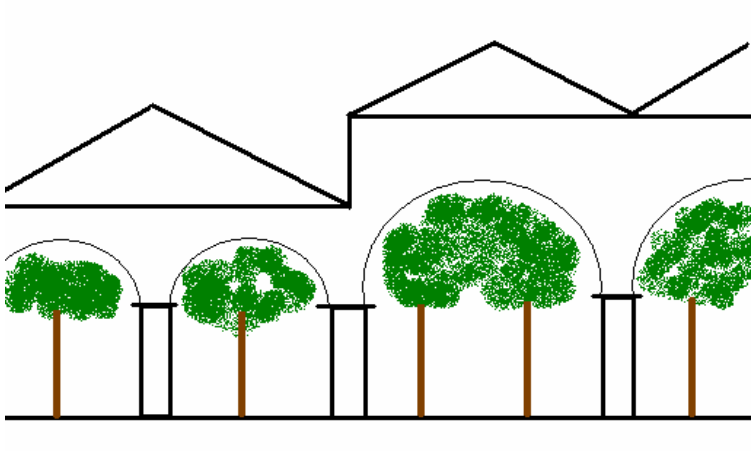
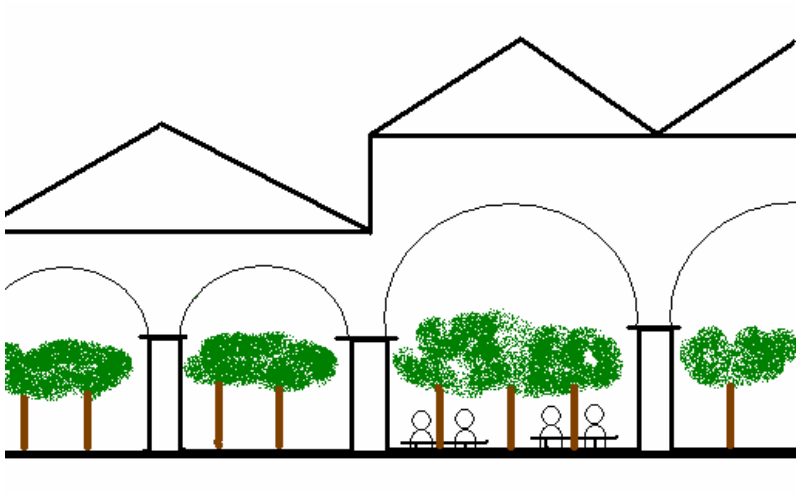


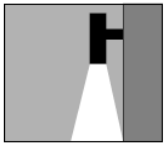


Wall-mounted candle holder fixture

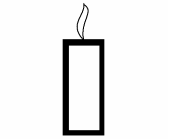
Rank: 3
Light Location: Café Taboras
Number of fixtures: 6
Comments: Café Taboras presents a unique case that can be easily mitigated. Because the current fixtures are a source of direct light shining on the beach, a replacement fixture that shields the light bulb from the beach (as well as eliminates the unsightly glare that currently greets customers) is preferred. One option would be to replace the glass chimney with an opaque one, concealing the bulb. Earthworks Pottery could possibly design such a fixture, thereby increasing the quality of the nesting beach, the ambiance of the restaurant, and strengthening a local vendor.

Recommendation on existing fixtures:





Ultimate recommendations:



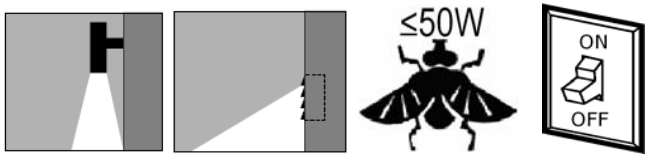
Wall-mounted, shell-shaped balcony sconce

Balcony light, period style

Rank: 3
Light Location: First, second, and third floor balconies of North and South buildings
Number of fixtures: 138
Comments: Pending installation of 'turtle friendly' fixtures, the detrimental effects of these lights can be reduced (but not eliminated) by shielding or tinting the glass on the current fixtures. Because the shell sconce helps shield the bare bulb from the beach, it is preferred to the period light; however, considerable light from the sconce is reflected off the balcony wall towards the beach ("wall wash"). The bulbs should be replaced with a low-wattage yellow bug lights or Turtle Safe Lighting lamps. Small, portable book lights could be provided in every room for guests that prefer to read on the balcony at night.

Recommendations on the existing fixtures, especially the period light:

Ultimate recommendation:

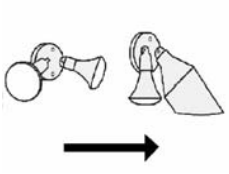


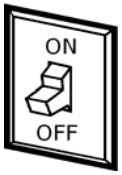
Small spotlights (view 1)

Small spotlights (view 2)

Rank: 3
Light Location: Café Taboras
Number of fixtures: 13

Recommendations:





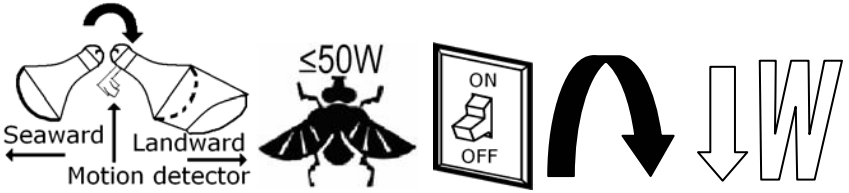
Palm-mounted hooded spotlight

North Beach illuminated at night

Rank: 3
Light Location: North Beach
Number of fixtures: 10
Comments: These spotlights, located directly on the beach, exemplify the worst possible conditions for endangered sea turtles nesting at this location. Ideally, these fixtures would be removed or timed to turn off after sunset, at least during nesting and hatching season. If they are required for dining or entertainment events, then having them on for short durations on random nights is preferred over having them on all the time. If all of these lights cannot be removed or turned off, the number of lights (currently 10) should be reduced as practicable and the wattage of each lamp reduced (e.g. through the use of low pressure sodium (LPS) or yellow bug light bulbs). A 'turtle friendly' CF PAR-38 filter is available (see "Internet Resources").

Recommendation:

Recommendations for the remaining fixtures:

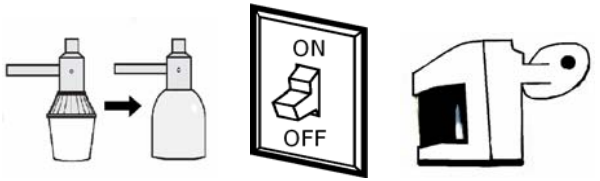


Ultimate recommendation:

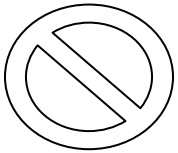
Dusk-to-dawn security light

Rank: 3
Light Location: North Beach
Number of fixtures: 1
Comments: The best recommendation and preferred option is to eliminate this fixture. If its necessary purpose is to illuminate dining or entertainment, then it should be shielded (aiming light downward) and turned off when not needed. If its purpose is to illuminate the beach so that security staff can view potential trespassers, then a more effective and economical means might be to install a motion detector so that security staff are alerted only when someone approaches the property. Provide security staff with flashlights. Studies show (see "Management Issues: Lighting and Crime Considerations") that such changes do not result in higher crime rates.

Recommendations on existing fixture:



Ultimate recommendation:

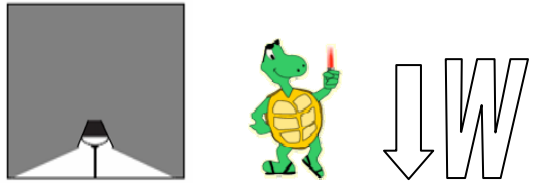


Up-directed hooded spotlight at palm tree base

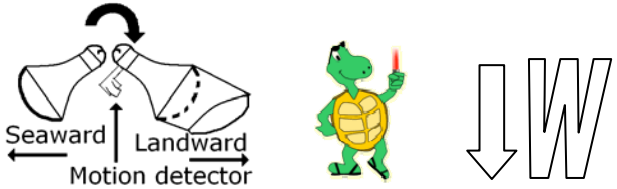
Tree-mounted, down-directed, hooded spotlight

Rank: 3
Light Location: "Garden area" in front of the Palm Terrace Restaurant, where two upward-directed spotlights at secured at the base of a coconut palm and one downward-directed spotlight is mounted high in the palm tree.
Number of fixtures: 3
Comments: The high-mounted, downward directed fixture casts a great deal of direct light onto the nesting beach and, of these three spotlights, would certainly be the most disruptive to the sea-finding behavior of sea turtles. To retain the ambiance of this lighting, the tree-mounted spotlight could be directed inland and upward, with the wattage reduced by a low pressure sodium (LPS) or yellow bug light bulb.

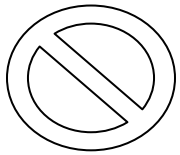
Recommendation (low-mounted):



Recommendation (high-mounted):



Ultimate recommendation:

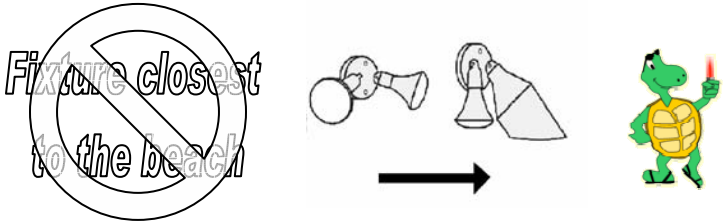


Palm-mounted, hooded spotlight

Mahogany tree-mounted, hooded spotlight

Rank: 3
Light Location: Coconut palm and mahogany trees between Café Taboras and South building
Number of fixtures: 2
Comments: A common recommendation to correct lighting problems is to lower the light fixture to the point where its light is not visible from the beach. In this situation, the purpose of the lights is to illuminate the terrace/patio of Café Taboras. This purpose can be achieved *without* high-mounted tree fixtures, which increase stray light reaching the beach. The preferred alternative is to lower and shield these lights, such as by placing the fixtures behind an opaque object. In this case, simply repositioning the lights on the landward side of wall might be sufficient. Vegetation can also be useful in minimizing the light that reaches the beach. Both options (lowering the fixtures and more creative use of landscaping) would be expected to increase the quality of the environment for sea turtles on the beach and dinning guests on the terrace.

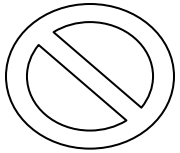
Recommendations:



Palm-mounted, hooded spotlight closest to beach

Rank: Off at the time of assessment (3?)
Light Location: Coconut palm just south of North building
Number: 1
Comments: This light was not operational during the assessment, and therefore could be not evaluated directly. However, given its height and location, it would be expected to be very disruptive to the sea-finding behavior of sea turtles.

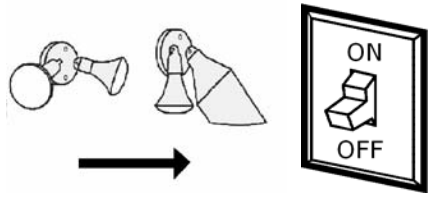
Recommendation:



Palm-mounted, hooded spotlight furthest from beach

Rank: 2
Light Location: Coconut palm just south of North building
Number: 2
Comments: This light should be repositioned away from the beach, directed away from the beach, and turned off when not in use.

Recommendations:



SUMMARY

The improvements already made by the Fairmont Royal Pavilion do not go unnoticed. The hotel constantly strives for a more suitable nesting beach environment, which only increases its quality as a luxury resort. Fairmont Royal Pavilion is praised for supporting umbrellas with a flat base, instead of models that spike the post directly into the sand. This, as well as the property's commitment to stacking beach chairs each night, help to ensure that incubating eggs are not damaged and nesting females are not obstructed from crawling on the beach. Another obvious consideration in seaside ambience is the hooding of beachfront spotlights to reduce glare and improve the stunning night sky for guests and other visitors.

Improvement can still be made with regard to the impact of evaluated light fixtures, including spotlights. This is a challenge for management, but one which we believe can be met. The Fairmont Royal Pavilion beach side property is elongated, and situated directly on the beach with little or no setback. The result is that even a small light bulb can be problematic, and this is also why nearly all fixtures are categorized as being potentially very disruptive to sea turtles (= rank "3").

Even when directed inland and shielded, such as with a hood, a spotlight situated directly on the nesting beach can cause an egg-bearing female to turn away from suitable nesting habitat and, if eggs are successfully laid, fatally disorient her young (see "Barbados in the Spotlight").

The cumulative effect of multiple balcony lights also has a significant and negative impact on sea turtles. Ideally, sea-facing balcony lights should be off at all times during the nesting season. A more practical recommendation may be to shield the bulbs (to minimize both direct light and wall wash), utilize 'turtle friendly' lamps, lower the wattage, and/or provide guests with candles or small reading lights for use on the balconies. Information available at Check-in and in each individual room will remind guests of the importance of these changes, and encourage them to do their part.

The two on-site restaurants also pose a challenge in reducing light pollution, since they, too, are situated directly on the nesting beach. Any solution must meet the needs both of dining guests and of sea turtles, since the restaurants' evening hours of operation overlap with the emergence of most hatchlings. Mitigation options require commitment and creativity, and a clear understanding of the principles of light mitigation with regard to sea turtles. We hope that, in involving managers directly in this assessment, the requisite technical knowledge has been imparted.

By taking full advantage of creative landscaping and 'turtle friendly' lighting schemes, as well as diligence in turning lights off when they are not in use, we are confident that this beautiful property can coexist more harmoniously with egg-laying sea turtles.

These recommendations, once implemented, will not only improve beach conditions for sea turtles, but will contribute to the existing sophisticated theme of the resort's lighting ambiance while, at the same time, reducing operational expenses (lower energy use).

To encourage lighting improvements and assist in implementation, the Tourism Development Corporation of Barbados is available to purchase fixtures and specialty lamps (e.g., Compact Fluorescent [CF] bug lights) in bulk, reducing the cost of retrofitting and innovation.

Along with an improved beachfront (in terms of light pollution), comes a parallel responsibility for conservation-minded coastal management in general. Fairmont Royal Pavilion plays an essential role in the survival of the endangered sea turtles that use its beaches, and is well positioned to serve as a model for "sea turtle friendly" environmental management systems elsewhere in Barbados and beyond.

INTERNET RESOURCES

'Turtle Friendly' Lighting Products –

FFWCC Wildlife Certified Fixtures and Bulbs – http://myfwc.com/Conservation/Conservation_LivingWith_Wildlifelighting_fixtures.htm

Turtle Safe Lighting – www.turtlesafelighting.com

Turtle Safe Products – www.turtlesafeproducts.com

Starry Night Lights – http://store.starrynightlights.com/tufrli.html

International Dark-Sky Association – http://www.darksky.org/

www.philips.com > Lighting > Browse Literature > Product Bulletins > Compact Fluorescent

CF PAR 38 –

www.philips.com > Lighting > Online Catalog > Lamps > Keyword Search "212407" [product number]

www.gelighting.com/na/ > Commercial Products > Compact Fluorescent > Self-Ballasted > PAR38

R30 Amber Bug Light –

Lighting Science – http://www.laminaceramics.com (e.g., http://products.lsgc.com/product/soltm_r30/)

Amber Gold 3.5 – www.turtleslighting.com

Path and Landscape Lighting –

Ruud Lighting – http://www.ruudlighting.com/literature/landscape_family.asp?mscssid=&conid=&dc=9&vt=12

FX Luminaire – www.fxl.com

Architectural Bollards –

LSI Industries – http://www.lsi-industries.com/lighting_product.asp?ID=5777

Lithonia Lighting – http://www.acuitybrandslighting.com/library/PSG/LL/Outdoor%20Lighting/Site%20Lighting/Bollards/KBD.pdf

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I am deeply indebted to the staff and management of the Fairmont Royal Pavilion, including Nicholas Emery (General Manager) and Andre Berube (Chief Engineer), for their collaboration in this assessment. They were extraordinarily kind in accommodating my requests, which often involved their working off-hours, including late at night.

Equally important, the assessment would not have been possible without the foresight and financial support of the Tourism Development Corporation of Barbados, WIDECAST, the Columbus Zoo and Aquarium, and the Collaborative Project Fund of the Pew Fellows Program in Marine Conservation/ The Pew Charitable Trusts.

I would also like to recognize the tireless efforts of the Barbados Sea Turtle Project (BSTP), especially Dr. Julia Horrocks, Barry Krueger and their 2006 seasonal field staff. The professional work of the BSTP sets a high standard for research and conservation in Barbados and throughout the Wider Caribbean Region. Without their collaboration, including providing me with housing, training, access to data and other technical information, and the opportunity to contribute to their important field work, which has been professionally and personally enriching for me, this lighting assessment could not have been accomplished.

Finally, I am grateful to Dr. Karen Eckert, Executive Director of WIDECAST and my academic advisor at Duke University's Nicholas School of the Environment, for her encouragement of my efforts and her leadership in Caribbean sea turtle conservation issues in general, and to Erik Martin of Ecological Associates, Inc. (co-author of Witherington and Martin 2003) for his kindness and patience in training me in the protocols of professional beachfront lighting assessments, a field in which he is well-recognized.

APPENDIX VI: SANDY LANE HOTEL ASSESSMENT REPORT

National Assessment of Beachfront Lighting and its Effect on the Survival of Endangered Marine Turtles in Barbados, West Indies

Property Assessment:

Sandy Lane Hotel

Respectfully submitted
John English Knowles

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

Tourism DEVELOPMENT CORPORATION

INTRODUCTION

In partnership with the Barbados Sea Turtle Project (BSTP), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), and the Tourism Development Corporation in Barbados, a formal lighting assessment was conducted at the Sandy Lane Hotel as part of a follow-up initiative to implement recommendations made at a national "Sea Turtles and Beachfront Lighting" workshop held in Barbados in 2000 (Eckert and Horrocks 2002). The evaluation of lighting associated with the Sandy Lane property attests to the efforts and dedication of the hotel industry, its representatives, and the BSTP in reducing artificial lighting along the nation's sandy beaches.

Artificial lighting is well known to be detrimental both to nesting sea turtles and to their hatchlings because the natural light intended to guide the turtles back to the sea is diminished by light pollution from beachfront properties and other coastal infrastructure. The resulting disorientation (loss of bearings) and misorientation (incorrect orientation) is especially acute in the hatchling stage, and the consequences can be fatal (e.g., Mrosovsky and Shettleworth 1968; Philibosian 1976; Witherington and Bjorndal 1991a,b; Witherington and Martin 2003; Tuxbury and Salmon 2005).

The Sandy Lane Hotel has identified itself as a leader in addressing the lighting problem by voluntarily participating in this assessment. The property – along with three other beachfront hotels – was chosen because it plays a crucial role in maintaining high quality sea turtle nesting habitat. The intent of the lighting assessment was to evaluate current conditions, and to propose solutions and recommendations for each light identified as contributing to the nocturnal illumination of adjoining nesting grounds.

Reducing nocturnal illumination of nesting grounds is critical in the survival of the hawksbill sea turtle, *Eretmochelys imbricata*, a critically endangered species worldwide (IUCN 2004, 2007). Barbados plays a uniquely important role in the survival of this species, as the island's western coast is identified as one of the most important nesting grounds remaining in the Wider Caribbean Region (Dow et al. 2007).

Artificial and detrimental beachfront lighting, characterized as "light pollution" by Witherington and Martin (2003), is the most serious contemporary threat to the survival of sea turtles in Barbados (Eckert and Horrocks, 2002). Sea turtles are most sensitive to shorter wavelengths (what humans generally see as blue and green, but these wavelengths are strongly emitted by bright white light, as well), which they use in sea-finding. Based on the best available science, Witherington and Martin (2003:23) suggest using as few lights as practicable and, for the remaining fixtures, adjusting wavelength and/or intensity:

> *"We have no reliable formula that can be used to calculate how much each light source will affect sea turtles. We do know, however, that if spectral emissions are equivalent, reducing intensity will reduce effects, and if intensities are similar, substituting less attractive sources (like yellow bug or red lights) will also reduce effects. A sound strategy, therefore, would be to reduce effects on sea turtles by manipulation both intensity and color. As few lights as practicable should be used and, for lighting deemed essential, long wavelength light sources should replace more disruptive light sources and intensity should be reduced by using lamps of minimal wattage that are housed within well-directed fixtures aimed down and away from the beach."*

In summary, direct light on the beach can be highly disruptive to both adult sea turtles and hatchlings, and eliminating sources of direct light reaching the beach is preferred over all other light conservation alternatives.

Where eliminating light sources – either by turning them off or by removing the fixtures altogether – is not practical, alternatives are available which direct light more efficiently and/or shield the source from the beach.

In the case of indirect light, which can also be highly disruptive, Witherington and Martin (2003:21) reiterate that "luminaires should not be directed onto … any object visible from the beach," including walls, ceilings, and vegetation. Intentional indirect lighting often takes the form of decorative lighting, which "has limited use for any purpose other than aesthetic enhancement [and when] near nesting beaches may be much more harmful to sea turtles than it is useful to people" (Witherington and Martin 2003:20-21). Fixtures are available that will minimize or eliminate "wall wash" (the illumination of the side or façade of a building); see "Internet Resources".

Interior lighting is also a source of light pollution. Witherington and Martin (2003:22) note that the criteria for identifying problems caused by indoor lighting are the same as those for identifying problems caused by outdoor lighting; i.e., indoor light is a problem if it is visible from the nesting beach.

> *"Indoor lighting from buildings that are close to the beach, are very tall, or have large sea-side windows causes the greatest problem for sea turtles. Because indoor lighting is usually not meant to light the outdoors, the unwanted effects of indoor lighting can easily be eliminated without compromising the intended function of the light."*

Reducing light broadcast from occupied rooms requires cooperation from residents and guests. Indoor hotel light can be reduced by informing guests at Check-in, and reminding them through the use of in-room materials, to close opaque curtains during evening hours when room lights are on.

In the sections that follow, methods, results and recommendations, and a brief summary are provided. In general, immediate action should be taken to implement recommendations associated with rank "3" lights; in other words, light fixtures with the potential to have the most significant negative effect on endangered sea turtles. Lower priority actions can be budgeted over time. In keeping with the decisions of the 2000 "Sea Turtles and Beachfront Lighting" workshop, recommendations are based on best practices and current science as articulated by Witherington and Martin (2003).

METHODS

Daytime Lighting Survey –

A baseline daytime lighting survey was conducted on foot on 23 July 2006 by observing lighting fixtures and bulbs directly visible from the sandy beach. The entire property was accessed to clarify, identify, and enumerate (count) each visible fixture. All exterior lights within line-of-sight of the Assessor [John English Knowles] were described with respect to fixture type and location. The function of each light was preliminarily deduced by the Assessor; however, subsequent meetings with hotel management staff ensured that the correct function was documented in every case. Light fixtures with lamps (light bulbs) visible from the beach, as well as those that were designed or positioned so that they would likely illuminate the beach, were considered to be potentially problematic, and each was ranked and scored during a night-time survey.

Nighttime Lighting Survey –

In coordination with hotel management, a nighttime lighting survey was conducted on foot on 23 July 2006. During the nighttime survey, each light identified during the daytime survey was located and evaluated with respect to its potential effect on sea turtles. Lights unseen during the day, but visible when emitting light, were also evaluated. Each light was ranked and scored on a scale of "1" to "3" (see "Ranking Individual Fixtures and Lamps").

The nighttime survey involved two inspections, one before midnight (2400 hr) and one after midnight, allowing for an accurate ranking of each individual light source in the context of changing background illumination as lighting conditions and intensities change throughout the night. Because particularly bright lights lessen the degree or the actual brightness of the lights behind them, and because some lights are extinguished late at night under normal operating procedures, the Assessor was able to use the sequential inspecttions to more accurately characterize the lighting landscape.

Ranking Individual Fixtures and Lamps –

The most disruptive lamps received a rank of "3"; whereas the least disruptive, a rank of "1". Specifically, a rank of "1" described indirect light visible to the Assessor while standing on the beach, but not likely to present a strong attraction to nesting or hatching sea turtles. A rank of "2" described a visible globe, glowing element, lamp, or reflector likely to disorient a sea turtle, but not strong enough to cast a shadow on the beach. A rank of "3" described a visible globe, glowing element, or lamp strong enough to cast a shadow on the beach regardless of whether the illumination was direct or indirect.

Even the smallest light could rank "3" if it cast a shadow on the beach because its close proximity (to the beach) or its particular vertical positioning could be just as disorientating as that of a more powerful light further away.

The "3" ranking lights are placed first in the assessment because of their potentially more serious effect(s) on sea turtles. The focus of corrective actions should begin with these lights, as their mitigation will have the most significant impact on the quality of nesting beach habitat.

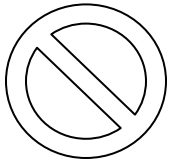
Within each rank – 1, 2, 3 – fixtures listed first are expected to require the greatest attention either in number, financial expense, or creativity. The list continues through fixtures deemed progressively simpler and/or less expensive to mitigate. For each light the number of fixtures visible from the beach, the fixture type, location, rank, comments (if any), function, photograph and pertinent recommendations are documented.

Each recommendation is specific to an individual light, and may include one or more explanatory remarks. Some recommendations pertain to modifying the fixture in some way, while other recommendations seek to replace the fixture with an alternative. "Recommendations" refer to fixes that will address the more serious issue(s), but in some cases may not completely eliminate the problem. "Ultimate Recommendations" refer to the best possible approach, and often suggest replacing (or removing) the fixture altogether.

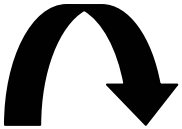
RECOMMENDATIONS

Illustrations and Icons –

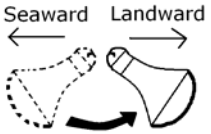
Permanently eliminate fixture; some cases are specific to the number of fixtures.



Reposition fixture to the landward side of the tree or object



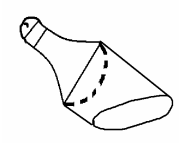
Aim (re-direct) the fixture away from the nesting beach.



Install a shield or mask of sufficient size to cover an arc of 180° on the ocean side. The shield can be anything placed in front of the light at any distance, as long as it blocks light from reaching the beach.

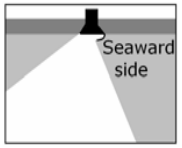
Install low wattage (50 watts or less) yellow bug light bulb.

Install hood of sufficient depth and width.

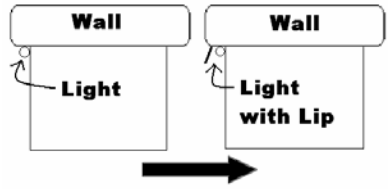


Reduce the intensity of the light, or lower the wattage.

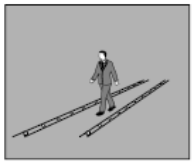
Shield seaward side of fixtures that are visible from the beach.



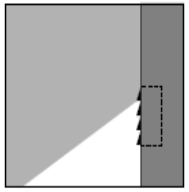
Position lip over rope lighting to conceal bare bulbs.



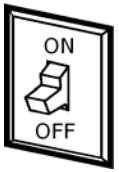
Replace with red LED rope lighting.



Replace the existing fixture with a more directed, more functional step light positioned to eliminate any direct (or indirect) illumination of the beach.



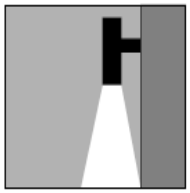
Keep lights off when not in use, especially lights closest to the beach. Inform guests via “table tents”, door hangers, or other educational, advertising or informative hotel materials about fixtures under their control.



Remove light when not in use.

Extinguish when not in use.

Replace the existing fixture with a more directed and functional downlight (e.g., http://www.thomaslighting.com/catalog/proddetail.asp?cno=SL9270-8)

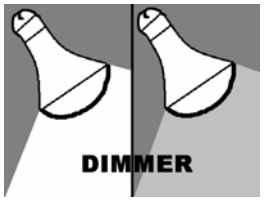


Replace existing fixture with a more directed and functional path light that is positioned as to not directly or indirectly illuminate the beach.

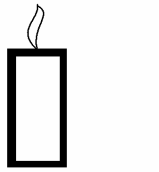
Install compact fluorescent “Turtle Safe Lighting” lamps (light bulbs). See “Internet Resources”.

Install red LED bulb.

Use dimmer to lessen the effect of indirect light leaving the dining area.

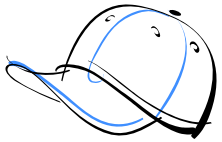


Eliminate fixtures and use low table lamps (e.g., Aurelle LED Candle Series or Maxxima MLC-01 LED Flameless Candle) or candles to illuminate the table without unintended broadcast from the restaurant.



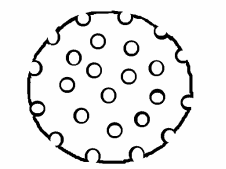
Place a small lamp shade over bare bulbs to prevent their being visibile from the beach.

Cap or cover top of fixture to prevent up-lighting and “wall wash.”



Replace the existing fixture with a more directed and functional bollard with external louvers.

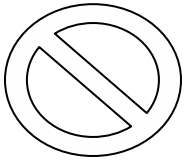
Install a filter that emits a pure red wavelength (this is different from a filter that simply appears red to the human eye).



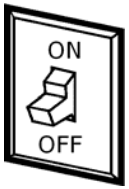
Very large tree-mounted floodlight

Rank: 3
Number of fixtures: 4
Light Location: Trees along the beachfront
Comments: These high intensity blue floodlights are extremely disruptive to sea-finding behavior in turtles, so much so that they attract hatchlings (which had successfully entered the sea from darker stretches of beach) back to land (personal observation, JEK). These lights should be turned off during the nesting and hatching season (May to November).

Recommendations:



or



Tree-mounted, hooded spotlight

Rank: 3
Number of fixtures: 14
Light Location: Beachside trees along property
Comments: To light walking paths, use low-profile lights or bollards.

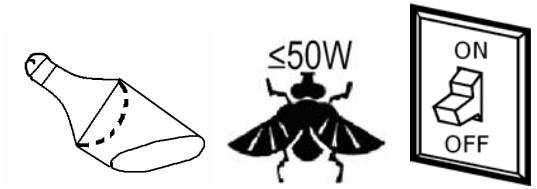
Recommendations:

Ultimate recommendation:
:

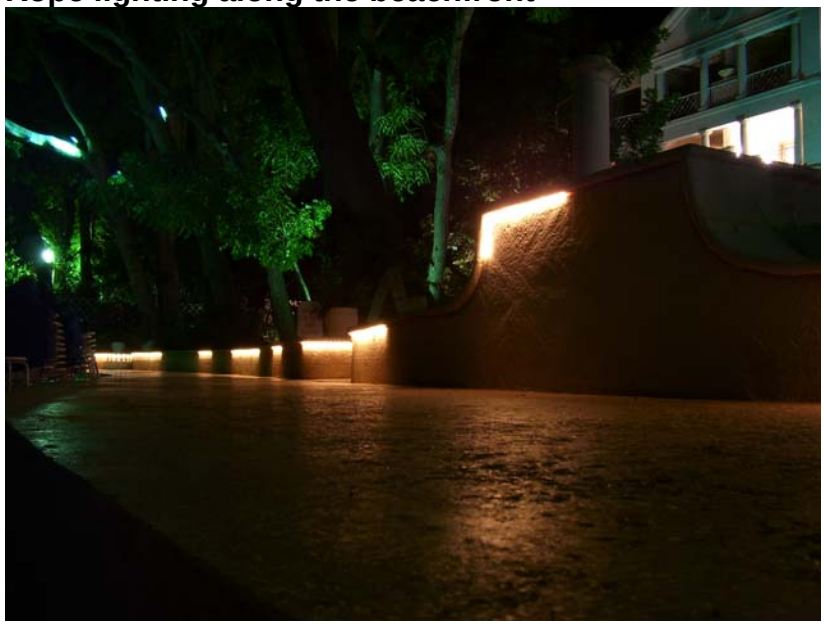
Bare spotlight

Rank: 3
Number of fixture: 7
Light Location: Tree on north end of property (pictured tree near the north gazebo, Bajan Blue Restaurant tree
Comments: These lights are used on special occasions. Installing a hood over the bulbs will increase the aesthetics for guests, while at the same time directing the light in a more efficient manner.

Recommendations:

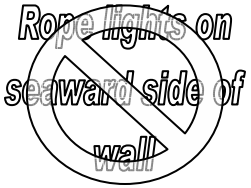


Rope lighting along the beachfront

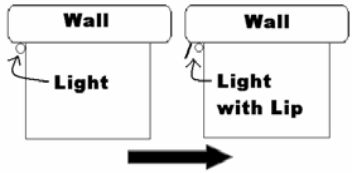


Rank: 3
Length of rope lighting: 233 meters
Light Location: Along beachside wall
Comments: Although less intense than some floodlights, continuous strings of small white lights placed low on the horizon represent a real obstacle to sea turtle hatchlings, especially on dark nights. Even short strips emit enough light to lead hatchlings inland, away from the sea (personal observation, JEK).

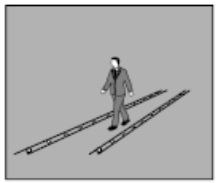
Recommendation on location of rope lighting:



Recommendation for existing fixtures:



Replacement Recommendation:

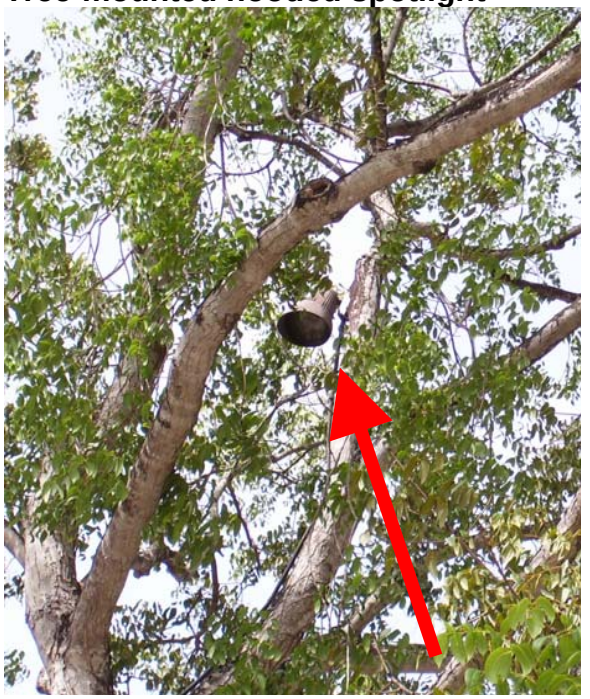


Large torch with open flame

Rank: 3
Number of fixtures: 2
Light Location: On beach, center property

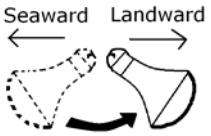
Recommendation:

Tree-mounted hooded spotlight



Rank: 2
Number of fixtures: 2
Light Location: Trees in lower terrace

Recommendation:

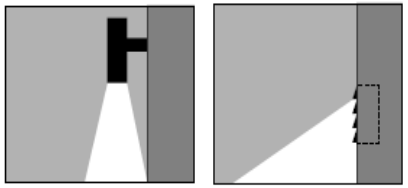


Wall-mounted candle-holding fixture

Rank: 2
Number of fixtures: 176
Light Location: Balconies of north and south wings

Recommendations for existing fixtures:

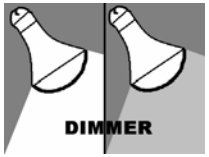
Ultimate recommendation:



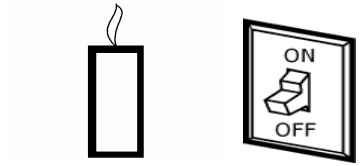
Umbrella-mounted spotlights

Rank: 2
Number of fixtures: 20
Light Location: Bajan Blue Restaurant
Comments: Even though these rank as moderate ("2") for potentially disrupting sea-finding behavior, these lights cause a significant broadcast of indirect light. Bouncing light off the umbrella illuminates the dining area … and beyond, including the nesting beach. Highly directed, low-profile lights could be used to effectively illuminate the beachfront dining area.

Recommendations for existing fixtures:



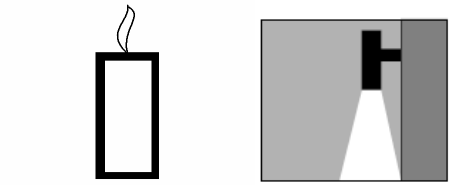
Ultimate recommendation:



Column-mounted candle lights

Rank: 2
Number of fixtures: 14
Light Location: Bajan Blue Restaurant
Comments: The Bajan Blue Restaurant presents a unique case that can be easily mitigated. The current lights are a source of direct light on the nesting beach, and their replacement with a progressive alternative is highly recommended. A fixture, such a decorative sconce, that successfully shields the light bulb from the beach (as well as from restaurant guests) would be much preferred over the existing bare bulb lights.

Recommendations:



Up-directed, hooded spotlight (in lawn, groundcover)

Up-directed, hooded spotlight (tree base)

Rank: 2
Number of fixtures: 16
Light Location: Grassy lawns in front of the first floor rooms (north and south wings)
Comments: Luminaires should not be directed onto any object visible from the beach. Glowing beachfront vegetation is highly disruptive to the sea-finding behavior of sea turtle hatchlings, especially on moonless nights. These lights have only an aesthetic purpose; consideration should be given to removing (at least during nesting season) or redirecting the light such that it is not visible from the beach.

Recommendations on the number of fixtures:

Recommendations on remaining fixtures:

Ultimate recommendation:

Wall-mounted candle light

Rank: 2
Number of fixtures: 2
Light Location: Upper terrace, just outside lobby

Recommendations:

Examples of acceptable fixtures:

Wall-mounted wick

Rank: 2
Number of fixtures: 28
Light Location: L'acajou

Recommendation:

Recessed step lights

Rank: 2
Number of fixtures: 52
Light Location: Terrace stairway
Comments: Use of a 'turtle friendly' wavelength (e.g., yellow or red LED) would be helpful here.

Recommendations:

Chandelier (with bare bulbs)

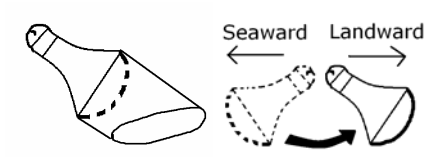
Rank: 2
Number of fixtures: 1 (including 3 bulbs)
Light Location: Lobby
Comments: Visible from the beach, it would be helpful to try and conceal or shade these bare bulbs in some way.

Recommendations:

Ceiling-mounted spotlight (lobby front desk)

Rank: 2
Number of fixtures: 2
Light Location: Lobby

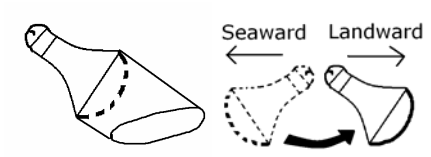
Recommendations:



Small, ceiling-mounted spotlight

Rank: 2
Number of fixtures: 11
Light Location: Bajan Blue Restaurant

Recommendations:



Tiki torch with open flame

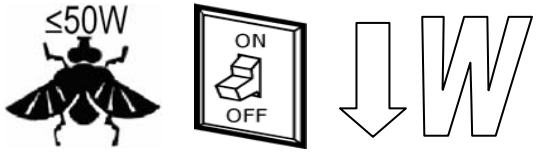
Rank: 2
Number of fixtures: 13
Light Location: On beach, in front of Bajan Blue Restaurant, Lower terrace

Recommendations:

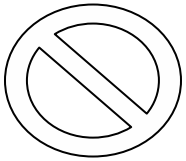
Balcony up-light

Rank: 1
Number of fixtures: 344
Light Location: Balconies
Comments: The balcony rooms at Sandy Lane have three different fixture types on each balcony: (i) candle-type fixtures have the greatest potential to disrupt sea-finding behavior in sea turtles – if these fixtures are replaced with a 'turtle friendly' alternative, they become less problematic; (ii) up-lit fixtures (pictured) are moderately disruptive, mainly because of "wall wash" which occurs despite the concealed bulb – these fixtures should be installed with low wattage bug lights or 'turtle friendly' lamps, and if other lighting is made available (e.g., opaque globes, mounted low to the floor), up-lights on beachfront balconies can be eliminated; (iii) finally, lamps are used but these are minimally disruptive to sea turtles.

Recommendations on the existing fixtures:



Ultimate recommendation when other adequate lighting is installed:

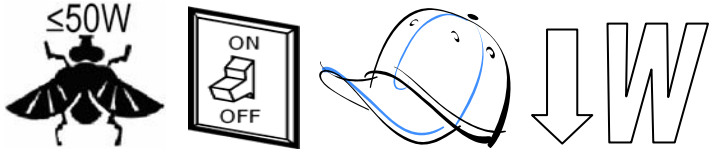


Wall-mounted clay covered fixture

(bottom view)

Rank: 1
Number of fixtures: 18
Light Location: Upper and lower terrace

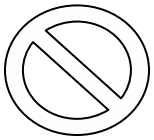
Recommendations:



Up-directed, hooded spotlight on ground

Rank: 1
Number of fixtures: 13
Light Location: Lower terrace (below trees in natural area)

Recommendations on the number of fixtures:



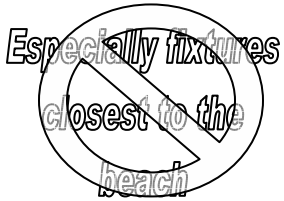
Recommendations on existing or remaining fixtures:

Ultimate recommendation:

Ground-recessed spotlight

Rank: 1
Number of fixtures: 10
Light Location: Beachside grassy areas
Comments: Luminaires should not be directed onto any object visible from the beach. Glowing beachfront vegetation is highly disruptive to the sea-finding behavior of sea turtle hatchlings, especially on moonless nights. These lights have only an aesthetic purpose; consideration should be given to removing (at least during nesting season) or redirecting the light such that it is not visible from the beach.

Recommendations on the number of fixtures:



Recommendations on existing or remaining fixtures:

Ultimate recommendation:

Table lamp

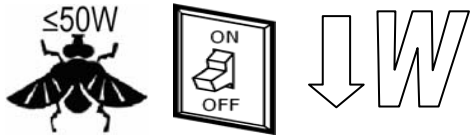
Rank: 1
Number of fixtures: 75
Light Location: Balcony tables, north and south wings

Recommendations:

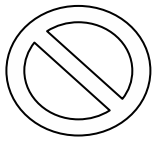
Wall-mounted, up-directed sconce

Rank: 1
Number of fixtures: 4
Light Location: Upper and lower terrace
Comments: Fixture contributes to “wall wash”.

Recommendations on the existing fixtures:



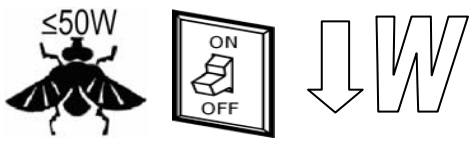
Ultimate recommendation (when other adequate lighting is installed):



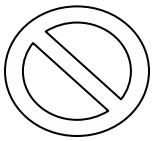
Wall-mounted up-light

Rank: 1
Number of fixtures: 6
Light Location: Lower terrace
Comments: Fixture contributes to “wall wash

Recommendations on the existing fixtures:



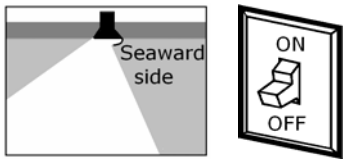
Ultimate recommendation (when other adequate lighting is installed):



Recessed ceiling light (restaurant)

Rank: 1
Number of fixtures: 70
Light Location: Bajan Blue Restaurant
Comments: Not all fixtures are visible from beach.

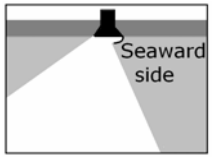
Recommendations:



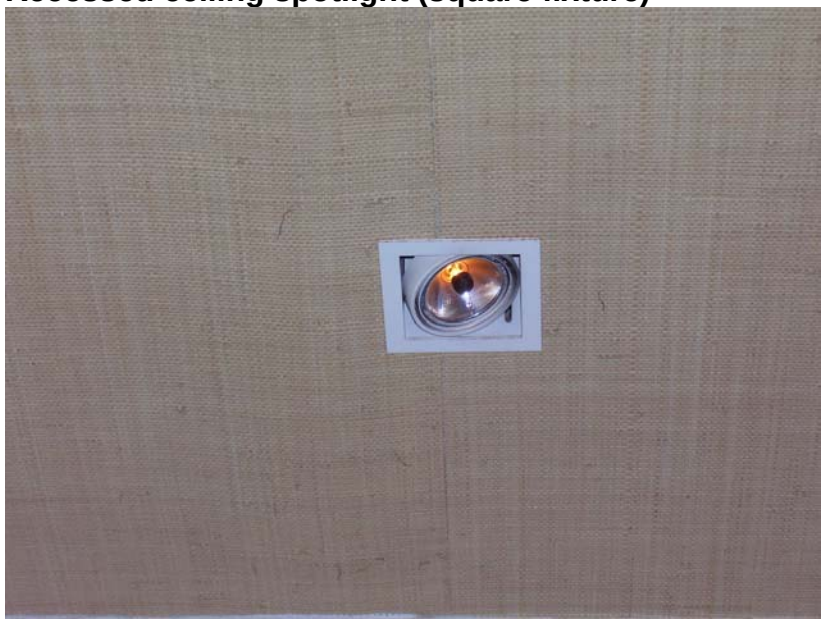
Recessed ceiling light (stairwell)

Rank: 1
Number of fixtures: 59
Light Location: North wing stairwell; third floor of both north and south wings
Comments: Not all fixtures are visible from beach.

Recommendations:

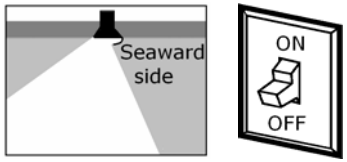


Recessed ceiling spotlight (square fixture)



Rank: 1
Number of fixtures: 55
Light Location: Ceiling of L'acajou Restaurant
Comments: Not all fixtures are visible from the beach.

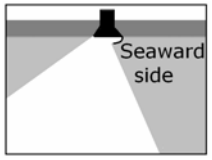
Recommendations:



Recessed circular light

Rank: 1
Number of fixtures: 21
Light Location: Ceiling of owner's penthouse
Comments: Not all fixtures are visible from beach.

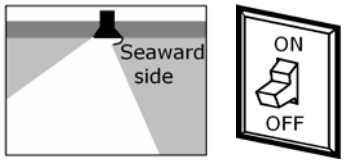
Recommendations:



Large recessed ceiling light (lobby)

Rank: 1
Number of fixtures: 6
Light Location: Lobby
Comments: Not all fixtures are visible from beach. The number given is the number of fixtures visible from the beach

Recommendations:



Recessed ceiling spotlights (gazebos)

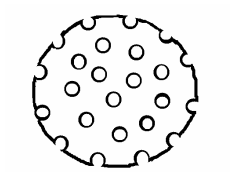
Rank: 1
Number of fixtures: 24
Light Location: Ceiling of both gazebos
Comments: Gazebo employees claim that these spotlights are too hot, suggesting that lower wattage or other alternative would be acceptable.

Recommendations:

Floodlight (gazebo)

Rank: 1
Number of fixtures: 2
Light Location: Above the rafters in both gazebos
Comments: Minimally disruptive to sea turtles; filtering would be ideal.

Recommendations:



Chandelier

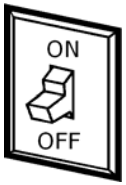
Rank: 1
Number of fixtures: 5
Light Location: Lower terrace
Comments: Not all fixtures are visible from the beach.

Recommendations:

Underwater recessed spotlight (base of the fountain)

Rank: 1
Number of fixtures: 2
Light Location: North wing fountain

Recommendation:



SUMMARY

As a premier luxury establishment, it is not coincidental that most of the lights at the Sandy Lane Hotel rank comparatively low in terms of their potential to disrupt and disorient endangered marine turtles.

The majority of fixtures conceal the actual luminaire or bulb. A bare bulb can be jarring and garish for humans and sea turtles alike, but the majority of the conditions at Sandy Lane are nothing less than very pleasing. The atmosphere of low light levels and tasteful fixtures only enhances the tourism experience one receives at Sandy Lane, and the resort is commended for its architectural design.

Sandy Lane Hotel also contributes directly to the survival of marine turtles in other ways, including stacking beach chairs at night, in an effort to prevent the entanglement of egg-bearing female turtles crawling on the beach.

That said, the relatively few rank "3" lights are present at very high and disturbing intensities. Removing tree-mounted floodlights (see photo insert) and string lighting along the beachfront will greatly improve the survival success of sea turtles nesting on the adjoining beach, as well as improve reproductive success on nearby beaches, as hatchlings already at sea are attracted *back to land* as a result of Sandy Lane's shoreline floodlights. Acting on this recommendation, and letting guests know why the lights were removed (at least during nesting season, which, quite fortuitously, does not coincide with high holiday visitation), will only increase Sandy Lane's quality, providing it yet another competitive edge against other privately owned luxury hotels in the Caribbean and elsewhere.

The recommendations described in this assessment, when implemented, will not only improve beach conditions for sea turtles, but will enhance the sophisticated and elegant theme of the resort's lighting ambiance while reducing operational expenses (lower energy use). Information available at Check-in and in each individual room will remind guests of the importance of these changes, and encourage them to do their part.

To encourage lighting improvements and assist in implementation, the Tourism Development Corporation of Barbados is available to purchase fixtures and specialty lamps (e.g., Compact Fluorescent [CF] bug lights) in bulk, reducing the cost of retrofitting and innovation.

Along with an improved beachfront (in terms of light pollution), comes a parallel responsibility for conservation-minded coastal management in general. The Sandy Lane Hotel plays an essential role in the survival of the endangered sea turtles that use its beaches, and is well positioned to serve as a model for "sea turtle friendly" environmental management systems elsewhere in Barbados and beyond.

INTERNET RESOURCES

'Turtle Friendly' Lighting Products –

FFWCC Wildlife Certified Fixtures and Bulbs – http://myfwc.com/Conservation/Conservation_LivingWith_Wildlifelighting_fixtures.htm

Turtle Safe Lighting – www.turtlesafelighting.com

Turtle Safe Products – www.turtlesafeproducts.com

Starry Night Lights – http://store.starrynightlights.com/tufrli.html

International Dark-Sky Association – http://www.darksky.org/

www.philips.com > Lighting > Browse Literature > Product Bulletins > Compact Fluorescent

CF PAR 38 –

www.philips.com > Lighting > Online Catalog > Lamps > Keyword Search "212407" [product number]

www.gelighting.com/na/ > Commercial Products > Compact Fluorescent > Self-Ballasted > PAR38

R30 Amber Bug Light –

Lighting Science – http://www.laminaceramics.com (e.g., http://products.lsgc.com/product/soltm_r30/)

Amber Gold 3.5 – www.turtleslighting.com

Path and Landscape Lighting –

Ruud Lighting – http://www.ruudlighting.com/literature/landscape_family.asp?mscssid=&conid=&dc=9&vt=12

FX Luminaire – www.fxl.com

Architectural Bollards –

LSI Industries – http://www.lsi-industries.com/lighting_product.asp?ID=5777

Lithonia Lighting – http://www.acuitybrandslighting.com/library/PSG/LL/Outdoor%20Lighting/Site%20Lighting/Bollards/KBD.pdf

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Witherington, B.E. and K.A. Bjorndal. 1991a. Influences of wavelength and intensity on hatchling sea turtle phototaxis: implications for sea-finding behavior. Copeia 1991(4):1060-1069.

Witherington, B.E. and K.A. Bjorndal. 1991b. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biological Conservation 55:139-149.

Witherington, B.E. and R.E. Martin. 2003. Understanding, Assessing, and Resolving Light Pollution Problems on Sea Turtle Nesting Beaches. Third Edition, Rev. Florida Marine Research Inst. Tech. Report TR-2. Tallahassee, FL. 73 pp. http://research.myfwc.com/publications/publication_info.asp?id=39080

ACKNOWLEDGMENTS

I am deeply indebted to the staff and management of Sandy Lane Hotel, including Michael Pownall (Chief Executive Officer), Paula Yarde (Chief Engineer), Lawrence Cumberbatch (Director of Engineering), and Leo Blackman and the rest of the engineering department for their collaboration in this assessment. They were extraordinarily kind in accommodating my requests, which often involved their working off-hours, including late at night.

Equally important, the assessment would not have been possible without the foresight and financial support of the Tourism Development Corporation of Barbados, WIDECAST, the Columbus Zoo and Aquarium, and the Collaborative Project Fund of the Pew Fellows Program in Marine Conservation/ The Pew Charitable Trusts.

I would also like to recognize the tireless efforts of the Barbados Sea Turtle Project (BSTP), especially Dr. Julia Horrocks, Barry Krueger and their 2006 seasonal field staff. The professional work of the BSTP sets a high standard for research and conservation in Barbados and throughout the Wider Caribbean Region. Without their collaboration, including providing me with housing, training, access to data and other technical information, and the opportunity to contribute to their important field work, which has been professionally and personally enriching for me, this lighting assessment could not have been accomplished.

Finally, I am grateful to Dr. Karen Eckert, Executive Director of WIDECAST and my academic advisor at Duke University's Nicholas School of the Environment, for her encouragement of my efforts and her leadership in Caribbean sea turtle conservation issues in general, and to Erik Martin of Ecological Associates, Inc. (co-author of Witherington and Martin 2003) for his kindness and patience in training me in the protocols of professional beachfront lighting assessments, a field in which he is well-recognized.

APPENDIX VII: SOUTHERN PALMS BEACH CLUB ASSESSMENT REPORT

National Assessment of Beachfront Lighting and its Effect on the Survival of Endangered Marine Turtles in Barbados, West Indies

Property Assessment:

Southern Palms Beach Club

Respectfully submitted
John English Knowles

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

Tourism DEVELOPMENT CORPORATION

INTRODUCTION

In partnership with the Barbados Sea Turtle Project (BSTP), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), and the Tourism Development Corporation in Barbados, a formal lighting assessment was conducted at the Southern Palms Beach Club as part of a follow-up initiative to implement recommendations made at a national "Sea Turtles and Beachfront Lighting" workshop held in Barbados in 2000 (Eckert and Horrocks 2002). The evaluation of lighting associated with the Southern Palms Beach Club property attests to the efforts and dedication of the hotel industry, its representatives, and the BSTP in reducing artificial lighting along the nation's sandy beaches.

Artificial lighting is well known to be detrimental both to nesting sea turtles and to their hatchlings because the natural light intended to guide the turtles back to the sea is diminished by light pollution from beachfront properties and other coastal infrastructure. The resulting disorientation (loss of bearings) and misorientation (incorrect orientation) is especially acute in the hatchling stage, and the consequences can be fatal (e.g., Mrosovsky and Shettleworth 1968; Philibosian 1976; Witherington and Bjorndal 1991a,b; Witherington and Martin 2003; Tuxbury and Salmon 2005).

Southern Palms Beach Club has identified itself as a leader in addressing the lighting problem by voluntarily participating in this assessment. The property – along with three other beachfront hotels – was chosen because it plays a crucial role in maintaining high quality sea turtle nesting habitat. The intent of the lighting assessment was to evaluate current conditions, and to propose solutions and recommendations for each light identified as contributing to the nocturnal illumination of adjoining nesting grounds.

Reducing nocturnal illumination of nesting grounds is critical in the survival of the hawksbill sea turtle, *Eretmochelys imbricata*, a critically endangered species worldwide (IUCN 2004, 2007). Barbados plays a uniquely important role in the survival of this species, as the island's western coast is identified as one of the most important nesting grounds remaining in the Wider Caribbean Region (Dow et al. 2007).

Artificial and detrimental beachfront lighting, characterized as "light pollution" by Witherington and Martin (2003), is the most serious contemporary threat to the survival of sea turtles in Barbados (Eckert and Horrocks, 2002). Sea turtles are most sensitive to shorter wavelengths (what humans generally see as blue and green, but these wavelengths are strongly emitted by bright white light, as well), which they use in sea-finding. Based on the best available science, Witherington and Martin (2003:23) suggest using as few lights as practicable and, for the remaining fixtures, adjusting wavelength and/or intensity:

> *"We have no reliable formula that can be used to calculate how much each light source will affect sea turtles. We do know, however, that if spectral emissions are equivalent, reducing intensity will reduce effects, and if intensities are similar, substituting less attractive sources (like yellow bug or red lights) will also reduce effects. A sound strategy, therefore, would be to reduce effects on sea turtles by manipulation both intensity and color. As few lights as practicable should be used and, for lighting deemed essential, long wavelength light sources should replace more disruptive light sources and intensity should be reduced by using lamps of minimal wattage that are housed within well-directed fixtures aimed down and away from the beach."*

In summary, direct light on the beach can be highly disruptive to both adult sea turtles and hatchlings, and eliminating sources of direct light reaching the beach is preferred over all other light conservation alternatives.

Where eliminating light sources – either by turning them off or by removing the fixtures altogether – is not practical, alternatives are available which direct light more efficiently and/or shield the source from the beach.

In the case of indirect light, which can also be highly disruptive, Witherington and Martin (2003:21) reiterate that "luminaires should not be directed onto … any object visible from the beach," including walls, ceilings, and vegetation. Intentional indirect lighting often takes the form of decorative lighting, which "has limited use for any purpose other than aesthetic enhancement [and when] near nesting beaches may be much more harmful to sea turtles than it is useful to people" (Witherington and Martin 2003:20-21). Fixtures are available that will minimize or eliminate "wall wash" (the illumination of the side or façade of a building); see "Internet Resources".

Interior lighting is also a source of light pollution. Witherington and Martin (2003:22) note that the criteria for identifying problems caused by indoor lighting are the same as those for identifying problems caused by outdoor lighting; i.e., indoor light is a problem if it is visible from the nesting beach.

> *"Indoor lighting from buildings that are close to the beach, are very tall, or have large sea-side windows causes the greatest problem for sea turtles. Because indoor lighting is usually not meant to light the outdoors, the unwanted effects of indoor lighting can easily be eliminated without compromising the intended function of the light."*

Reducing light broadcast from occupied rooms requires cooperation from residents and guests. Indoor hotel light can be reduced by informing guests at Check-in, and reminding them through the use of in-room materials, to close opaque curtains during evening hours when room lights are on.

In the sections that follow, methods, results and recommendations, and a brief summary are provided. In general, immediate action should be taken to implement recommendations associated with rank "3" lights; in other words, light fixtures with the potential to have the most significant negative effect on endangered sea turtles. Lower priority actions can be budgeted over time. In keeping with the decisions of the 2000 "Sea Turtles and Beachfront Lighting" workshop, recommendations are based on best practices and current science as articulated by Witherington and Martin (2003).

METHODS

Daytime Lighting Survey –

A baseline daytime lighting survey was conducted on foot on 25 July 2006 by observing lighting fixtures and bulbs directly visible from the sandy beach. The entire property was accessed to clarify, identify, and enumerate (count) each visible fixture. All exterior lights within line-of-sight of the Assessor [John English Knowles] were described with respect to fixture type and location. The function of each light was preliminarily deduced by the Assessor; however, subsequent meetings with hotel management staff ensured that the correct function was documented in every case. Light fixtures with lamps (light bulbs) visible from the beach, as well as those that were designed or positioned so that they would likely illuminate the beach, were considered to be potentially problematic, and each was ranked and scored during a nighttime survey.

Nighttime Lighting Survey –

In coordination with hotel management, a nighttime lighting survey was conducted on foot on 25 July 2006. During the nighttime survey, each light identified during the daytime survey was located and evaluated with respect to its potential effect on sea turtles. Lights unseen during the day, but visible when emitting light, were also evaluated. Each light was ranked and scored on a scale of "1" to "3" (see "Ranking Individual Fixtures and Lamps").

The nighttime survey involved two inspections, one before midnight (2400 hr) and one after midnight, allowing for an accurate ranking of each individual light source in the context of changing background illumination as lighting conditions and intensities change throughout the night. Because particularly bright lights lessen the degree or the actual brightness of the lights behind them, and because some lights are extinguished late at night under normal operating procedures, the Assessor was able to use the sequential inspecttions to more accurately characterize the lighting landscape.

Ranking Individual Fixtures and Lamps –

The most disruptive lamps received a rank of "3"; whereas the least disruptive, a rank of "1". Specifically, a rank of "1" described indirect light visible to the Assessor while standing on the beach, but not likely to present a strong attraction to nesting or hatching sea turtles. A rank of "2" described a visible globe, glowing element, lamp, or reflector likely to disorient a sea turtle, but not strong enough to cast a shadow on the beach. A rank of "3" described a visible globe, glowing element, or lamp strong enough to cast a shadow on the beach regardless of whether the illumination was direct or indirect.

Even the smallest light could rank "3" if it cast a shadow on the beach because its close proximity (to the beach) or its particular vertical positioning could be just as disorientating as that of a more powerful light further away.

The "3" ranking lights are placed first in the assessment because of their potentially more serious effect(s) on sea turtles. The focus of corrective actions should begin with these lights, as their mitigation will have the most significant impact on the quality of nesting beach habitat

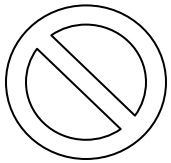
Within each rank – 1, 2, 3 – fixtures listed first are expected to require the greatest attention either in number, financial expense, or creativity. The list continues through fixtures deemed progressively simpler and/or less expensive to mitigate. For each light the number of fixtures visible from the beach, the fixture type, location, rank, comments (if any), function, photograph and pertinent recommendations are documented.

Each recommendation is specific to an individual light, and may include one or more explanatory remarks. Some recommendations pertain to modifying the fixture in some way, while other recommendations seek to replace the fixture with an alternative. "Recommendations" refer to fixes that will address the more serious issue(s), but in some cases may not completely eliminate the problem. "Ultimate Recommendations" refer to the best possible approach, and often suggest replacing (or removing) the fixture altogether.

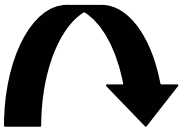
RECOMMENDATIONS

Illustrations and Icons –

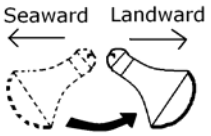
Permanently eliminate fixture; some cases are specific to the number of fixtures.



Reposition fixture to the landward side of the tree or object.



Aim (re-direct) the fixture away from the nesting beach.



Install low wattage (50 watts or less) yellow bug light bulb.

Install a shield or mask of sufficient size to cover an arc of 180° on the ocean side. The shield can be anything placed in front of the light at any distance, as long as it blocks light from reaching the beach.

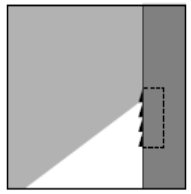
Replace the existing fixture with a bollard with external louvers.

Replace existing fixture with a more directed and functional path light that is positioned as to not directly or indirectly illuminate the beach.

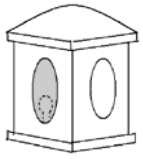
Install compact fluorescent “Turtle Safe Lighting” lamps (light bulbs). See “Internet Resources”.

Replace the existing fixture with a more directed and functional downlight (e.g., http://www.thomaslighting.com/catalog/proddetail.asp?cno=SL9270-8)

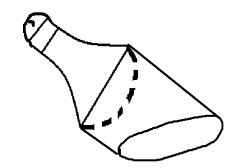
Replace the existing fixture with a more directed, more functional step light positioned to eliminate any direct (or indirect) illumination of the beach.



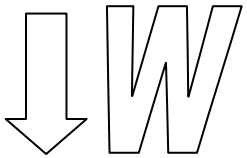
Install covers or filters across beach-facing sides of fixture to eliminate any direct (or indirect) illumination of the beach.



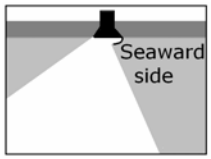
Install hood of sufficient depth and width.



Reduce the intensity of the light, or lower the wattage.

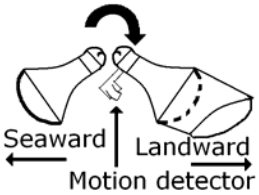


Shield the seaward side of fixtures visible from the beach.



Plant, landscape, or improve native vegetation buffer so that light is effectively screened (i.e., not directly visible) from the beach.

Install a hood, aim the light away from the nesting beach, and connect the fixture to a motion detector.



Keep lights off when not in use, especially lights closest to the beach. Inform guests via “table tents”, door hangers, or other educational, advertising or informative hotel materials about fixtures under their control.

White, un-hooded spotlight

Rank: 3
Number of fixtures: 17
Light Location: Coconut palms from just east of Capri to the eastern end of the property; Lady Smith; Khus Khus Bar (roof); Garden Terrace; off the bar in the main pool area
Comments: These lights serve to illuminate the beach for security cameras

Recommendations on the number of fixtures:

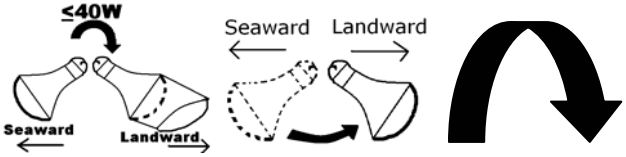
Recommendations on existing or remaining fixtures:

Yellow, un-hooded spotlight

Rank: 3
Number of fixtures: 16
Light Location: Seaward side of trees located from the western end to the center of the property

Recommendations on the number of fixtures:

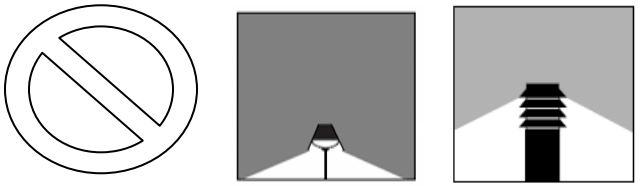
Recommendations on existing or remaining fixtures:



Post-mounted quadruple globe

Rank: 3
Number of fixtures: 15
Light Location: Landward side of the beach wall; beach side of the Carlisle rooms; Palm Court and around the main pool area in front of the lobby. One is visible between Lady Smith and the Banyan Court Building
Comments: These fixtures attempt (largely unsuccessfully) to provide sufficient light for security cameras located on the property during the evening hours (see "Summary"). Our recommendations address only the secondary purpose of these lights, which is to illuminate the courtyard during the evening for crossing on foot. This purpose is easily served with lower levels of light, and the seawall provides an excellent opaque object to conceal more energy-efficient and 'turtle friendly" low-profile lighting.

Recommendations:



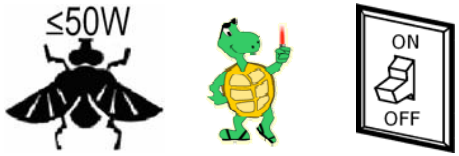
Wall-mounted ceramic sconce

Wall-mounted ceramic sconce (side view)

Wall-mounted sconce with rain shield

Rank: 3
Number of fixtures: 70
Light Location: Present on most balconies
Comments: These ceramic fixtures shield their bare bulbs from the beach, which is preferred over all other balcony lights and wall-mounted lights on the property. Of these 70 fixtures, those with rain shields are the most 'turtle friendly' because wall-wash above the fixture is eliminated.

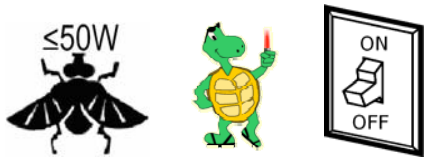
Recommendations:



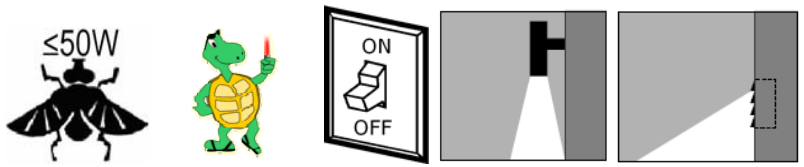
Wall-mounted downlight

Rank: 3
Number of fixtures: 4
Light Location: Second floor balcony rooms, eastern portion of the Carlisle Rooms Building

Recommendations for existing fixtures:



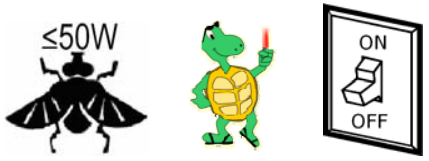
Ultimate recommendation:



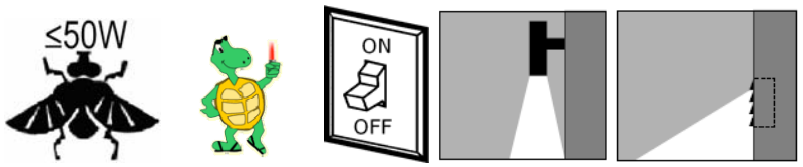
Wall-mounted uplight

Rank: 3
Number of fixtures: 4
Light Location: First floor rooms, eastern end of the Carlisle Rooms Building

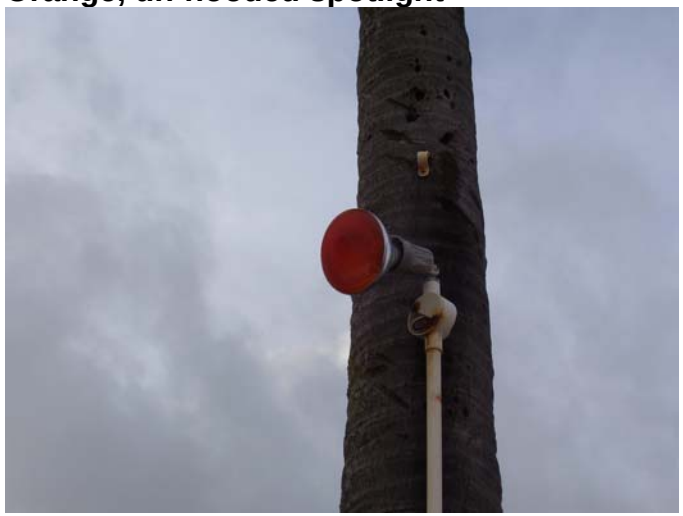
Recommendations for existing fixtures:



Ultimate recommendation:

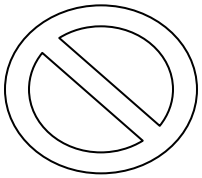


Orange, un-hooded spotlight



Rank: 3
Number of fixtures: 3
Light Location: Coconut palms in main pool area, east face of Banyan Court Building
Comments: An orange wavelength is less disruptive than a pure white light (white light emits all wavelengths, including those most disruptive to turtles).

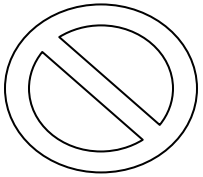
Recommendation:



Single globe

Rank: 3
Number of fixtures: 1
Light Location: Hedge on the beach side of the Palm Court Building

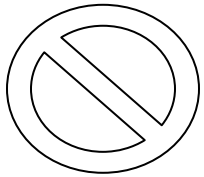
Recommendation:



Arch-mounted incandescent light

Rank: 3
Number of fixtures: 1
Light Location: Walkway arch between Lady Smith and Banyan Court buildings

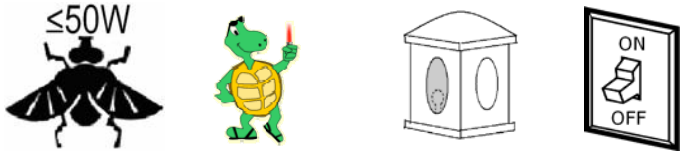
Recommendation:



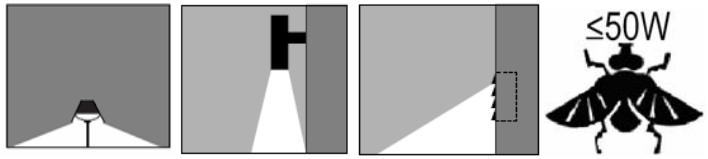
Column-mounted clay fixture (incandescent bulb)

Rank: 3
Number of fixtures: 2
Light Location: Circle Terrace
Comments: Recessed bulbs are preferred over bare and fully visible bulbs in beachfront lighting fixtures.

Recommendations for existing fixtures:



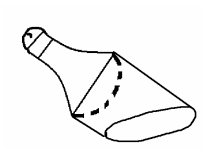
Ultimate recommendation:



White, un-hooded incandescent spotlights

Rank: 3
Number of fixtures: 7
Light Location: Jasmine Court Building; tree-mount just west of Banyan Court Building; Sundecks of Crescent Beach Building; Lady Smith; Hair-dressing Salon Building

Recommendations:



Ceramic sconce uplight **Ceramic sconce downlight**

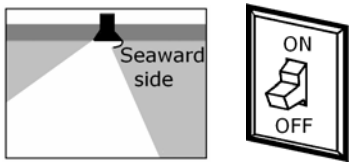
Rank: 3
Number of fixtures: 9
Light Location: Balconies on the west face of Palm Court Building
Comments: The current position of these fixtures creates wall wash. It would be an improvement if the fixtures were to be reversed (directed downward).

Recommendations:

Small recessed ceiling spotlight

Rank: 3
Number of fixtures: 100
Light Location: Lobby ceiling; Khus Khus Bar; Rondelle Restaurant; Garden Terrace Restaurant; off the Bar area
Comments: Not all fixtures are visible from the beach, the ones that are visible are so at sharp angles from high up on the beach.

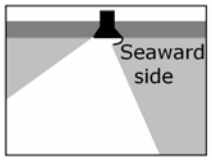
Recommendations:



Small recessed ceiling fixture (incandescent bulb)

Rank: 3
Number of fixtures: 17
Light Location: Terrace Restaurant; Khus Khus Bar
Comments: Not all fixtures are visible from the beach. Fixtures at the Khus Khus Bar are visible only at sharp angles from high up on the beach; a low overhang on the roof provides good cover.

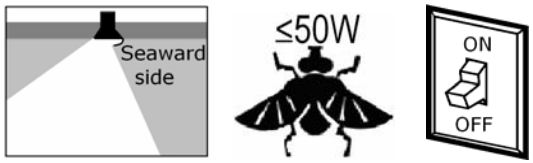
Recommendations:



Larger recessed ceiling fixture (incandescent bulb)

Rank: 3
Number of fixtures: 3
Light Location: West end of Khus Khus Bar
Comments: These lights are on three nights each week (i.e., during performances).

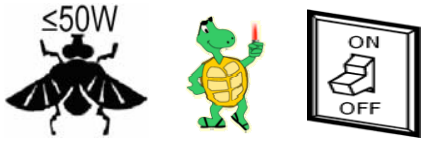
Recommendations:



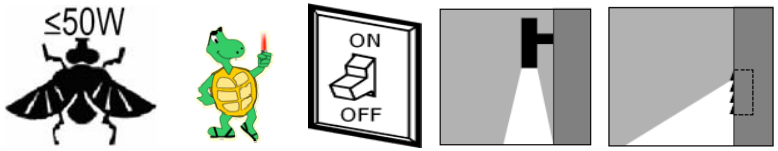
Wall mounted globe light

Rank: Lights were off, but probably rank as a "3" when illuminated
Number of fixtures: 3
Light Location: Second floor beachfront balcony of Carlisle Rooms Building; third floor of Jasmine Court Building
Comments: 25 watt (yellow 'bug light') to 40 watt bulbs are encouraged

Recommendations for existing fixtures:



Ultimate recommendation:



Room lights (interior)

Rank: 3 (rooms closest to the beach); 2 (other beachfront rooms)
Number of rooms visible from the beach: 53
Light Location: Beach-facing rooms

The following recommendations are from Witherington and Martin (2003) on the subject of "Minimizing beach lighting from indoor sources" –

1. Turn off lights in rooms that are not in use. Reminder notices should be placed on light switches in oceanfront rooms.

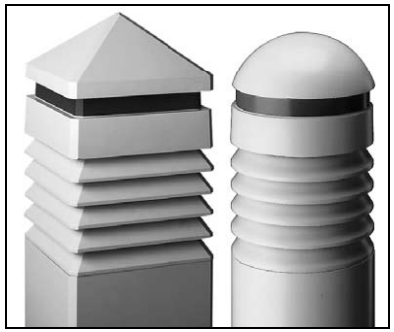
2. Relocate moveable lamps away from windows that are visible from the beach.

3. Tint or apply window treatments to windows that are visible from the beach so that light passing from inside to outside is substantially reduced. A good tinted glass or window-tinting treatment will reduce visible light from the inside to 45% or less (transmittance ≤45%). Window glass may be either tinted during its manufacture, or tinted later with an applied film. Window treatments (shading materials) are less permanent and can reduce light transmittance more than tints and films. A complete blocking of light is ideal.

4. Close opaque curtains or blinds after dark to completely cover windows that are visible from the beach. This is an inexpensive solution because most windows already have curtains or blinds to provide privacy to occupants.

Green path light

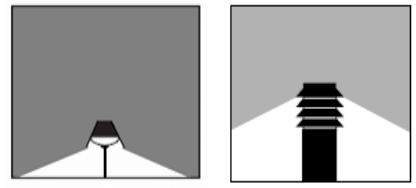
Architectural bollards with external louvers



Rank: 2
Number of fixtures: 2
Light Location: Main pool area
Comments: The purpose of illuminating the walking path by these lights is compromised by brighter lights surrounding the main pool area. However, these louvered path lights are highly recommended – they are low to the ground and they efficiently direct light to where it is needed, reducing unintended broadcast. If desired, there are other styles of path lighting available with turtle friendly designs (see "Internet Resources"). Another choice of 'turtle friendly' lighting is a bollard with external louvers (see insert). Whether the existing path lights or new bollard-style lights are used, all path lighting should have recessed, low-wattage (e.g., buy-type) bulbs and hidden reflectors.

Recommendations on existing fixture and under existing light conditions:

Recommendations under darker lighting conditions:



Ceiling-mounted light

Rank: 2
Number of fixtures: 4
Light Location: Walkway between the kitchen building and Crescent Beach Building
Comments: Only two of these fixtures are visible from the beach.

Recommendations:

Small black path light

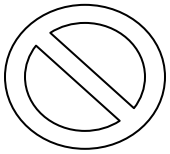
Rank: 1
Number of fixtures: 9
Light Location: Courtyard of Palm Court and Lady Smith Building. They are also present in the main pool area. In addition, two are located in front of north face of Palm Court Building.

Recommendation:

Spotlight

Rank: Light off
Number of fixtures: 3
Light Location: These fixtures are placed at the base of statues in the court-yards of Palm Court, Jasmine Court, and Capri buildings
Comments: Fixtures are not in use and only one bulb is present.

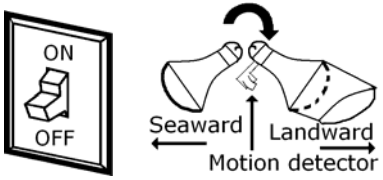
Recommendation:



White, un-hooded wall-mounted spotlight

Rank: Light off
Number of fixtures: 1
Light Location: North end of the wall of the hairdressing salon

Recommendations:



SUMMARY

The efforts of the Southern Palms Beach Club to constantly improve their conservation measures are laudable. Managers are to be commended on the installation of yellow spotlights, and the placement of ceramic sconces that soften balcony lighting. These improvements increase the quality of nesting habitat for sea turtles, as well as provide a first-rate vacation destination for guests.

The biggest challenge at this property, which extends along approximately 1,000 feet of shoreline, is that it is situated directly on the sandy beach platform. This places limitations on strategic landscaping, and increases the potentially negative effects of even the smallest lights. Solutions are available to meet the needs of both guests and endangered sea turtles – but implementing these solutions requires both creativity and a clear understanding of (and commitment to) reducing light pollution property-wide.

The number of lights, their placement relative to the beach, and their emitted wavelength are all important. Fewer lights are preferred over many lights; low-level, directional lights are preferred over high-mounted spotlights; and long wavelengths (e.g., yellow or "bug type" lamps) are preferred over short (blue, violet) or mixed (white) wavelengths. Filters can be useful if properly chosen and installed: there are many yellow-hue lights and filters that are not monochromatic, meaning that while they might appear yellow to the human eye, sea turtles might perceive them differently.

Southern Palms Beach Club is one of the few hotels in Barbados to operate beachfront cameras at night. Bright, post-mounted white lights attempt to provide sufficient lighting for the cameras to operate. These lights are highly disruptive to sea turtles. The emphasis on security and safety is important, and alternatives to the current system must be carefully considered. Because research demonstrates that more light does not necessarily correlate to more security (i.e., less crime), successful alternatives to the present scenario might include investments that give an advantage to security staff and alert them when the property line has been crossed. For example, strategic placement of motion detecting lights both startle intruders and alert security staff to the breach. Infrared sensors (see www.optexeurope.com) can also be a potent security tool.

Eliminating nighttime use of beachfront cameras and associated lighting does not mean that the areas of concern are plunged into darkness. The courtyards can be effectively lit by low-profile landscape lights, path lights, and/or bollards. The seawall provides the ideal opaque screen to conceal low-profile lighting from the nesting beach. According to Witherington and Martin (2003:21), it is possible to have both a 'turtle friendly' beach in terms of lighting *and* a secure property: "light illuminance levels necessary for safety and security are rather low (0.2-1.0 footcandles or 2-11 lux, are recommended for fence [or perimeter] security and parking areas)."

These recommendations, once implemented, will not only improve beach conditions for sea turtles, but will enhance the sophisticated and elegant theme of the resort's lighting ambiance while reducing operational expenses (lower energy use). Information available at Check-in and in each individual room will remind guests of the importance of these changes, and encourage them to do their part. To encourage lighting improvements and to assist in implementation, the Tourism Development Corporation of Barbados is available to purchase fixtures and specialty lamps (e.g., Compact Fluorescent [CF] bug lights) in bulk, reducing the cost of retrofitting and innovation.

Along with an improved beachfront in terms of lighting comes a parallel responsibility for conservation-minded coastal management in general, including, for example, stacking beach chairs to ensure that egg-laden females are not obstructed during their crawl to and from the water. The Southern Palms Beach Club plays an essential role in the survival of the endangered sea turtles that use its beaches, and is well positioned to serve as a model for "sea turtle friendly" environmental management systems elsewhere in Barbados and beyond.

INTERNET RESOURCES

'Turtle Friendly' Lighting Products –

FFWCC Wildlife Certified Fixtures and Bulbs – http://myfwc.com/Conservation/Conservation_LivingWith_Wildlifelighting_fixtures.htm

Turtle Safe Lighting – www.turtlesafelighting.com

Turtle Safe Products – www.turtlesafeproducts.com

Starry Night Lights – http://store.starrynightlights.com/tufrli.html

International Dark-Sky Association – http://www.darksky.org/

www.philips.com > Lighting > Browse Literature > Product Bulletins > Compact Fluorescent

CF PAR 38 –

www.philips.com > Lighting > Online Catalog > Lamps > Keyword Search "212407" [product number]

www.gelighting.com/na/ > Commercial Products > Compact Fluorescent > Self-Ballasted > PAR38

R30 Amber Bug Light –

Lighting Science – http://www.laminaceramics.com (e.g., http://products.lsgc.com/product/soltm_r30/)

Amber Gold 3.5 – www.turtleslighting.com

Path and Landscape Lighting –

Ruud Lighting – http://www.ruudlighting.com/literature/landscape_family.asp?mscssid=&conid=&dc=9&vt=12

FX Luminaire – www.fxl.com

Architectural Bollards –

LSI Industries – http://www.lsi-industries.com/lighting_product.asp?ID=5777

Lithonia Lighting – http://www.acuitybrandslighting.com/library/PSG/LL/Outdoor%20Lighting/Site%20Lighting/Bollards/KBD.pdf

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Eckert, K.L. and J.A. Horrocks (Editors). 2002. Proceedings of "Sea Turtles and Beachfront Lighting: An Interactive Workshop for Industry Professionals and Policy-Makers in Barbados", 13 October 2000. Sponsored by the Wider Caribbean Sea Turtle Conservation Network, Barbados Sea Turtle Project, and the Tourism Development Corporation of Barbados. WIDECAST Technical Report No. 1. 43 pp. http://www.widecast.org/Resources/Pubs.html

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Witherington, B.E. and R.E. Martin. 2003. Understanding, Assessing, and Resolving Light Pollution Problems on Sea Turtle Nesting Beaches. Third Edition, Rev. Florida Marine Research Inst. Tech. Report TR-2. Tallahassee, FL. 73 pp. http://research.myfwc.com/publications/publication_info.asp?id=39080

ACKNOWLEDGMENTS

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Equally important, the assessment would not have been possible without the foresight and financial support of the Tourism Development Corporation of Barbados, WIDECAST, the Columbus Zoo and Aquarium, and the Collaborative Project Fund of the Pew Fellows Program in Marine Conservation/ The Pew Charitable Trusts.

I would also like to recognize the tireless efforts of the Barbados Sea Turtle Project (BSTP), especially Dr. Julia Horrocks, Barry Krueger and their 2006 seasonal field staff. The professional work of the BSTP sets a high standard for research and conservation in Barbados and throughout the Wider Caribbean Region. Without their collaboration, including providing me with housing, training, access to data and other technical information, and the opportunity to contribute to their important field work, which has been professionally and personally enriching for me, this lighting assessment could not have been accomplished.

Finally, I am grateful to Dr. Karen Eckert, Executive Director of WIDECAST and my academic advisor at Duke University's Nicholas School of the Environment, for her encouragement of my efforts and her leadership in Caribbean sea turtle conservation issues in general, and to Erik Martin of Ecological Associates, Inc. (co-author of Witherington and Martin 2003) for his kindness and patience in training me in the protocols of professional beachfront lighting assessments, a field in which he is well-recognized.

APPENDIX VIII: TURTLE BEACH RESORT ASSESSMENT REPORT

National Assessment of Beachfront Lighting and its Effect on the Survival of Endangered Marine Turtles in Barbados, West Indies

Property Assessment:

Turtle Beach Resort

Respectfully submitted
John English Knowles

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

Tourism DEVELOPMENT CORPORATION

INTRODUCTION

In partnership with the Barbados Sea Turtle Project (BSTP), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), and the Tourism Development Corporation in Barbados, a formal lighting assessment was conducted at the Turtle Beach Resort as part of a follow-up initiative to implement recommendations made at a national "Sea Turtles and Beachfront Lighting" workshop held in Barbados in 2000 (Eckert and Horrocks 2002). The evaluation of lighting associated with the Turtle Beach Resort property attests to the efforts and dedication of the hotel industry, its representatives, and the BSTP in reducing artificial lighting along the nation's sandy beaches.

Artificial lighting is well known to be detrimental both to nesting sea turtles and to their hatchlings because the natural light intended to guide the turtles back to the sea is diminished by light pollution from beachfront properties and other coastal infrastructure. The resulting disorientation (loss of bearings) and misorientation (incorrect orientation) is especially acute in the hatchling stage, and the consequences can be fatal (e.g., Mrosovsky and Shettleworth 1968; Philibosian 1976; Witherington and Bjorndal 1991a,b; Witherington and Martin 2003; Tuxbury and Salmon 2005).

Turtle Beach Resort has identified itself as a leader in addressing the lighting problem by voluntarily participating in this assessment. The property – along with three other beachfront hotels – was chosen because it plays a crucial role in maintaining high quality sea turtle nesting habitat. The intent of the lighting assessment was to evaluate current conditions, and to propose solutions and recommendations for each light identified as contributing to the nocturnal illumination of adjoining nesting grounds.

Reducing nocturnal illumination of nesting grounds is critical in the survival of the hawksbill sea turtle, *Eretmochelys imbricata*, a critically endangered species worldwide (IUCN 2004, 2007). Barbados plays a uniquely important role in the survival of this species, as the island's western coast is identified as one of the most important nesting grounds remaining in the Wider Caribbean Region (Dow et al. 2007).

Artificial and detrimental beachfront lighting, characterized as "light pollution" by Witherington and Martin (2003), is the most serious contemporary threat to the survival of sea turtles in Barbados (Eckert and Horrocks, 2002). Sea turtles are most sensitive to shorter wavelengths (what humans generally see as blue and green, but these wavelengths are strongly emitted by bright white light, as well), which they use in sea-finding. Based on the best available science, Witherington and Martin (2003:23) suggest using as few lights as practicable and, for the remaining fixtures, adjusting wavelength and/or intensity:

> *"We have no reliable formula that can be used to calculate how much each light source will affect sea turtles. We do know, however, that if spectral emissions are equivalent, reducing intensity will reduce effects, and if intensities are similar, substituting less attractive sources (like yellow bug or red lights) will also reduce effects. A sound strategy, therefore, would be to reduce effects on sea turtles by manipulation both intensity and color. As few lights as practicable should be used and, for lighting deemed essential, long wavelength light sources should replace more disruptive light sources and intensity should be reduced by using lamps of minimal wattage that are housed within well-directed fixtures aimed down and away from the beach."*

In summary, direct light on the beach can be highly disruptive to both adult sea turtles and hatchlings, and eliminating sources of direct light reaching the beach is preferred over all other light conservation alternatives.

Where eliminating light sources – either by turning them off or by removing the fixtures altogether – is not practical, alternatives are available which direct light more efficiently and/or shield the source from the beach.

In the case of indirect light, which can also be highly disruptive, Witherington and Martin (2003:21) reiterate that "luminaires should not be directed onto … any object visible from the beach," including walls, ceilings, and vegetation. Intentional indirect lighting often takes the form of decorative lighting, which "has limited use for any purpose other than aesthetic enhancement [and when] near nesting beaches may be much more harmful to sea turtles than it is useful to people" (Witherington and Martin 2003:20-21). Fixtures are available that will minimize or eliminate "wall wash" (the illumination of the side or façade of a building); see "Internet Resources".

Interior lighting is also a source of light pollution. Witherington and Martin (2003:22) note that the criteria for identifying problems caused by indoor lighting are the same as those for identifying problems caused by outdoor lighting; i.e., indoor light is a problem if it is visible from the nesting beach.

> *"Indoor lighting from buildings that are close to the beach, are very tall, or have large sea-side windows causes the greatest problem for sea turtles. Because indoor lighting is usually not meant to light the outdoors, the unwanted effects of indoor lighting can easily be eliminated without compromising the intended function of the light."*

Reducing light broadcast from occupied rooms requires cooperation from residents and guests. Indoor hotel light can be reduced by informing guests at Check-in, and reminding them through the use of in-room materials, to close opaque curtains during evening hours when room lights are on.

In the sections that follow, methods, results and recommendations, and a brief summary are provided. In general, immediate action should be taken to implement recommendations associated with rank "3" lights; in other words, light fixtures with the potential to have the most significant negative effect on endangered sea turtles. Lower priority actions can be budgeted over time. In keeping with the decisions of the 2000 "Sea Turtles and Beachfront Lighting" workshop, recommendations are based on best practices and current science as articulated by Witherington and Martin (2003).

METHODS

Daytime Lighting Survey –

A baseline daytime lighting survey was conducted on foot on 26 July 2006 by observing lighting fixtures and bulbs directly visible from the sandy beach. The entire property was accessed to clarify, identify, and enumerate (count) each visible fixture. All exterior lights within line-of-sight of the Assessor [John English Knowles] were described with respect to fix-ture type and location. The function of each light was preliminarily deduced by the Assessor; however, subsequent meetings with hotel management staff ensured that the correct function was documented in every case. Light fixtures with lamps (light bulbs) visible from the beach, as well as those that were designed or positioned so that they would likely illuminate the beach, were considered to be potentially problematic, and each was ranked and scored during a night-time survey.

Nighttime Lighting Survey –

In coordination with hotel management, a nighttime lighting survey was conducted on foot on 26 July 2006. During the nighttime survey, each light identified during the daytime survey was located and evaluated with respect to its potential effect on sea turtles. Lights unseen during the day, but visible when emitting light, were also evaluated. Each light was ranked and scored on a scale of "1" to "3" (see "Ranking Individual Fixtures and Lamps").

The nighttime survey involved two inspections, one before midnight (2400 hr) and one after midnight, allowing for an accurate ranking of each individual light source in the context of changing background illumination as lighting conditions and intensities change throughout the night. Because particularly bright lights lessen the degree or the actual brightness of the lights behind them, and because some lights are extinguished late at night under normal operating procedures, the Assessor was able to use the sequential inspecttions to more accurately characterize the lighting landscape.

Ranking Individual Fixtures and Lamps –

The most disruptive lamps received a rank of "3"; whereas the least disruptive, a rank of "1". Specifically, a rank of "1" described indirect light visible to the Assessor while standing on the beach, but not likely to present a strong attraction to nesting or hatching sea turtles. A rank of "2" described a visible globe, glowing element, lamp, or reflector likely to disorient a sea turtle, but not strong enough to cast a shadow on the beach. A rank of "3" described a visible globe, glowing element, or lamp strong enough to cast a shadow on the beach regardless of whether the illumination was direct or indirect.

Even the smallest light could rank "3" if it cast a shadow on the beach because its close proximity (to the beach) or its particular vertical positioning could be just as disorientating as that of a more powerful light further away.

The "3" ranking lights are placed first in the assessment because of their potentially more serious effect(s) on sea turtles. The focus of corrective actions should begin with these lights, as their mitigation will have the most significant impact on the quality of nesting beach habitat.

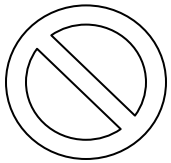
Within each rank – 1, 2, 3 – fixtures listed first are expected to require the greatest attention either in number, financial expense, or creativity. The list continues through fixtures deemed progressively simpler and/or less expensive to mitigate. For each light the number of fixtures visible from the beach, the fixture type, location, rank, comments (if any), function, photograph and pertinent recommendations are documented.

Each recommendation is specific to an individual light, and may include one or more explanatory remarks. Some recommendations pertain to modifying the fixture in some way, while other recommendations seek to replace the fixture with an alternative. "Recommendations" refer to fixes that will address the more serious issue(s), but in some cases may not completely eliminate the problem. "Ultimate Recommendations" refer to the best possible approach, and often suggest replacing (or removing) the fixture altogether.

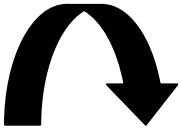
RECOMMENDATIONS

Illustrations and Icons –

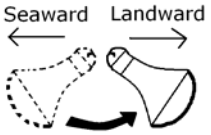
Permanently eliminate fixture; some cases are specific to the number of fixtures.



Reposition fixture to the landward side of the tree or object



Aim (re-direct) the fixture away from the nesting beach.



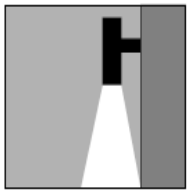
Replace the existing fixture with a more directed and functional bollard with external louvers.

Replace existing fixture with a more directed and functional path light that is positioned as to not directly or indirectly illuminate the beach.

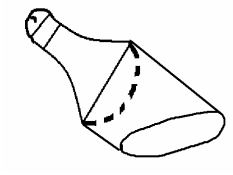
Install low wattage (50 watts or less) yellow bug light bulb.

Install compact fluorescent “Turtle Safe Lighting” lamps (light bulbs). See “Internet Resources”.

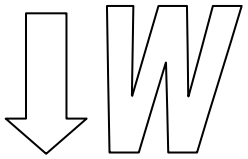
Replace the existing fixture with a more directed and functional downlight.



Install hood of sufficient depth and width.



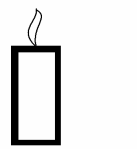
Reduce the intensity of the light, or lower the wattage.



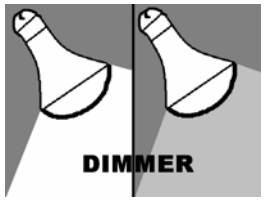
Plant, landscape, or improve native vegetation buffer so that light is effectively screened (i.e., not directly visible) from the beach.

Keep lights off when not in use, especially lights closest to the beach. Inform guests via “table tents”, door hangers, or other educational, advertising or informative hotel materials about fixtures under their control.

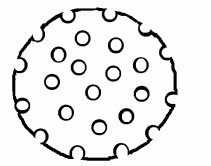
Eliminate fixtures and use low table lamps (e.g., Aurelle LED Candle Series or Maxxima MLC-01 LED Flameless Candle) or candles to illuminate the table without unintended broadcast from the restaurant.



Use dimmer to lessen the effect of indirect light leaving the dining area.



Install a filter that emits a pure red wavelength (this is different from a filter that simply appears red to the human eye).

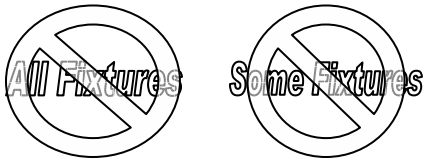


Extinguish when not in use.

Tree-mounted hooded spotlight

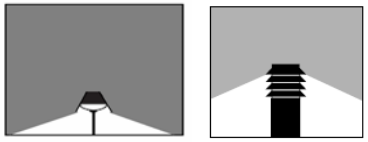
Rank: 3
Number of fixtures: 21
Light Location: Mounted on coconut palms/casuarinas beginning at B block and continuing east to the end of the property
Comments: The best option is to eliminate the light, either by turning them all off or removing the fixtures. If all lights cannot be removed or turned off, then it is recommended that the number of lights (currently 21) and wattage of each lamp be reduced. Some lights could also be lowered. The installation of yellow bug lights is also recommended. Lights that point directly towards the beach should be repositioned. For the purpose of illuminating the hotel grounds in this area, low profile lights are preferred.

Recommendations on the number of fixtures:



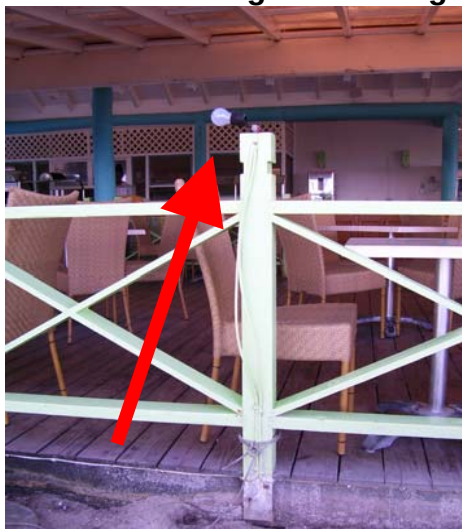
Recommendations on existing or remaining fixtures:

Ultimate recommendation:



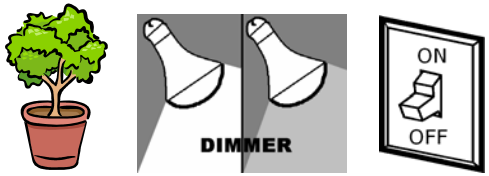
Post-mounted globe light

Post-mounted light without globe fixture

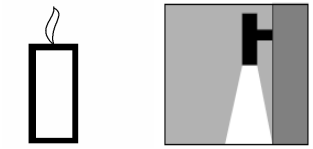


Rank: 3
Number of fixtures: 16
Light Location: Waterfront Restaurant
Comments: During the few nights a week of operation, the Waterfront Restaurant presents a unique case that can be easily mitigated. The current lights are a source of direct light on the beach and their replacement with a modern alternative is encouraged. Earthworks could possibly design such a fixture thereby increasing the quality of the beach, the restaurant, and supporting the local economy. In addition, strategic landscaping can be employed to conceal the current fixtures from the beach, a task seemingly well employed by the Turtle Beach Resort with its lush hotel grounds.

Recommendations on existing fixtures:



Ultimate recommendations:



Ceiling-mounted colored stage light

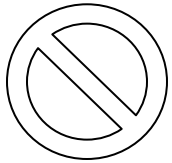
Rank: 3
Number of fixtures: 1
Light Location: Overhand of restaurant
Comments: When the light is on (during a performance) it does reach the beach. Strategic landscaping could help conceal light; a good example of this is the native vegetation that surrounds the Jacuzzi area.

Recommendations:

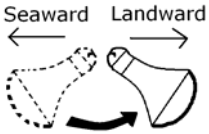
Ceiling-mounted colored spotlight

Rank: 3
Number of fixtures: 4
Light Location: Ceiling of Waterfront Restaurant
Comments: These fixtures broadcast a lot of light to the nesting beach; fortunately, they are rarely used. If they are redirected away from the sea, a filter that emits a pure red wavelength (this filter is superficially red, but does not eliminate other wavelengths) should be employed.

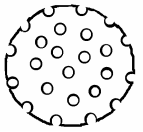
Recommendations:



or,



with



Wall-mounted downlight

Rank: 2
Number of fixtures: 62
Light Location: Balconies of C block
Comments: The fixture offsets the bulb from the wall, reducing the amount of "wall wash" that can occur with fixtures flush to the wall. Installing a yellow bug light bulb will significantly reduce the chance of disrupting the sea-finding behavior of sea turtles, and is not visible to most insects. Guests need to be reminded to turn lights off when not in use.

Recommendations:

Fluorescent and incandescent bulbs covered by perforated wood box

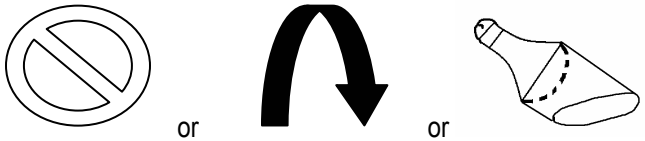
Rank: 2
Number of fixtures: 16
Light Location: Waterfront Restaurant, Bathrooms at Waterfront Restaurant
Comments: The number of fixtures given (16) is the total number on hotel grounds; however, the only fixture visible from the beach is the one located at the women's bathroom. In general these fixtures are encouraged because the bare bulb is concealed and the light is directed downward; however, a yellow bug light in the women's bathroom fixture is preferred over the existing white incandescent bulb.

Recommendations:

Small, bare spotlight

Rank: 2
Number of fixtures: 3
Light Location: Hanging above Restaurant

Recommendations:



Room lights (interior)

Rank: 1
Number of balconies visible from the beach: 172
Light Location: Ocean view rooms

Recommendations are adapted from Witherington and Martin (2003:22):

1. Turn off lighting in rooms that are not in use. Reminder notices placed on light switches located in oceanfront rooms are helpful.
2. Relocate, away from windows, moveable lamps visible from the beach.
3. Tint or apply window treatments to windows visible from the beach so that light passing from inside to outside is substantially reduced. A good tinted glass or window-tinting treatment will reduce visible light from the inside to 45% or less (transmittance ≤ 45%). Window glass may be tinted either during its manufacture, or later with an applied film. Window treatments (shading materials) are less permanent and can reduce light transmittance more than a tint or film. Complete blocking of light is ideal.
4. Close opaque curtains or blinds after dark to completely cover windows visible from the beach. Fortunately, most windows already have curtains or blinds to provide privacy to occupants.

Wall-mounted downlight (view 1)

Wall-mounted downlight (view 2)

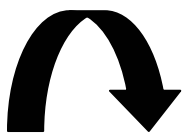
Rank: 1
Number of fixtures: 128
Light Location: Balconies of A, B, D and E Blocks

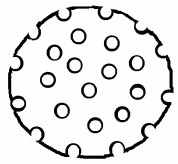
Recommendations:

Small, recessed ceiling spotlight

Rank: 1
Number of fixtures: 40
Light Location: Above doors in E block
Comments: These lights cause a significant amount of "wall wash" in the corridor between D Block and E Block, as well as along the back of D Block. Cumulatively, they are potentially disruptive. The number of fixtures given (40) equals the number of fixtures that are causing "wall wash" clearly visible from the beach. One option is to install a R30 amber bug light, or something similar (see "Internet Resources" for vendors).

Recommendations:

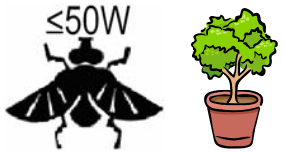




Pathway light (green)

Rank: 1
Number of fixtures: 6
Light Location: Sidewalk to E block

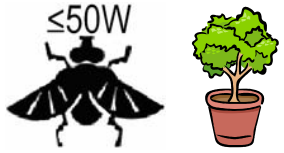
Recommendations:



Pathway light

Rank: 1
Number of fixtures: 6
Light Location: Around pool area in front of C Block, and along the path from the kids' pool to D Block and E Block.
Comments: Not all fixtures are visible from beach.

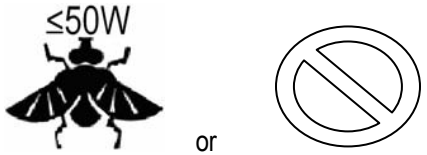
Recommendations:



Hooded spotlight

Rank: 1
Number of fixtures: 2
Light Location: Grass area in front of E block
Comments: Although the light is directed downward and its purpose appears to be for illuminating the lawn in front of E Block, it contributes to wall wash.

Recommendations:

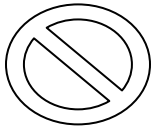


Up-directed hooded spotlight

Rank: 1
Number of fixtures: 3
Light Location: Ground-level, Jacuzzi area
Comments: None

Recommendation on existing fixtures:

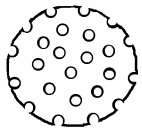

Ultimate recommendations:


or

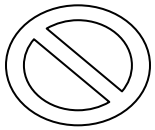

Floodlight, green light

Rank: 1
Number of fixtures: 2
Light Location: Jacuzzi area
Comments: Strategic landscaping could ensure that decorative lighting was not visible from the beach.

Recommendation on existing fixtures:



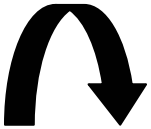
Ultimate recommendation:



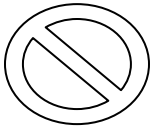
Downlight

Rank: 1
Number of fixtures: 1
Light Location: Restaurant rafters

Recommendations:



Ultimate recommendation:



"Tiki torch" with open flame

Rank: Unable to rank, torches were not lit during the assessment
Number of fixtures: 10
Light Location: Surrounding the Waterfront Restaurant at the edge of the vegetation and along the main entrance to the beach
Comments: The number of fixtures given (10) was the number of torches that were posted and visible during the assessment.

Recommendation:

SUMMARY

The Turtle Beach Resort is commended for having some of the best lighting conditions (i.e., least disruptive to endangered sea turtles) observed at any beachfront hotel in Barbados.

'Turtle friendly' fixtures have been installed on all balconies – these fixtures are ideal because the bare bulb is recessed and concealed, preventing direct light reaching the nesting beach. In addition, these fixtures are offset from the wall, reducing the amount "wall wash." Other progressive features include native vegetation that screens and reduces the amount of artificial light reaching the beach; a watersports stand with no exterior lights at all; and the fact that some tree-mounted spotlights were disconnected with the specific intention of reducing the disorientation of sea turtle hatchlings.

Notwithstanding, there is still room for improvement. For instance, strategic landscaping could further reduce beachfront lighting at some locations. Bug lights (which emit a wavelength that is less attractive both to sea turtles and to mosquitoes) should be installed in all balcony fixtures. The number of tree-mounted spotlights should be reduced, and the remaining fixtures re-directed and lowered with the intention of directing light only where it is needed and reducing light broadcast to the beach. The illumination of hotel grounds can easily be accomplished by low-profile pathway lighting.

As far as decorative lighting is concerned, true (monochromatic) red light is preferred over blue, green or white light (e.g., rope/tube lighting along the pool bridges). Finally, all beachfront lights should be turned off when not in use, including soda machines, televisions, and decorative lighting (e.g., lights strung over the band stand).

These relative minor recommendations, once implemented, will not only improve beach conditions for sea turtles, but will enhance the sophisticated and elegant theme of the resort's lighting ambiance while reducing operational expenses (lower energy use). Information available at Check-in and in each individual room will remind guests of the importance of these changes, and encourage them to do their part.

To encourage lighting improvements and assist in implementation, the Tourism Development Corporation of Barbados is available to purchase fixtures and specialty lamps (e.g., Compact Fluorescent [CF] bug lights) in bulk, reducing the cost of retrofitting and innovation.

Along with an improved beachfront (in terms of light pollution), comes a parallel responsibility for conservation-minded coastal management in general, including, for example, stacking beach chairs to ensure that egg-laden adult female sea turtles are not obstructed during their crawl to and from the water.

Turtle Beach Resort plays an essential role in the survival of the endangered sea turtles that use its beaches, and is well positioned to serve as a model for "sea turtle friendly" environmental management systems elsewhere in Barbados and beyond.

INTERNET RESOURCES

'Turtle Friendly' Lighting Products –

FFWCC Wildlife Certified Fixtures and Bulbs – http://myfwc.com/Conservation/Conservation_LivingWith_Wildlifelighting_fixtures.htm

Turtle Safe Lighting – www.turtlesafelighting.com

Turtle Safe Products – www.turtlesafeproducts.com

Starry Night Lights – http://store.starrynightlights.com/tufrli.html

International Dark-Sky Association – http://www.darksky.org/

www.philips.com > Lighting > Browse Literature > Product Bulletins > Compact Fluorescent

CF PAR 38 –

www.philips.com > Lighting > Online Catalog > Lamps > Keyword Search "212407" [product number]

www.gelighting.com/na/ > Commercial Products > Compact Fluorescent > Self-Ballasted > PAR38

R30 Amber Bug Light –

Lighting Science – http://www.laminaceramics.com (e.g., http://products.lsgc.com/product/soltm_r30/)

Amber Gold 3.5 – www.turtleslighting.com

Path and Landscape Lighting –

Ruud Lighting – http://www.ruudlighting.com/literature/landscape_family.asp?mscssid=&conid=&dc=9&vt=12

FX Luminaire – www.fxl.com

Architectural Bollards –

LSI Industries – http://www.lsi-industries.com/lighting_product.asp?ID=5777

Lithonia Lighting – http://www.acuitybrandslighting.com/library/PSG/LL/Outdoor%20Lighting/Site%20Lighting/Bollards/KBD.pdf

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WIDECAST

Wider Caribbean Sea Turtle Conservation Network

"Working together to build a future where all inhabitants of the Wider Caribbean Region, human and sea turtle alike, can live together in balance."

The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) is a regional coalition of experts and a Partner Organization to the U.N. Environment Programme's Caribbean Environment Programme. WIDECAST was founded in 1981 in response to a recommendation by the IUCN/CCA *Meeting of Non-Governmental Caribbean Organizations on Living Resources Conservation for Sustainable Development in the Wider Caribbean* (Santo Domingo, 26-29 August 1981) that a "Wider Caribbean Sea Turtle Recovery Action Plan should be prepared ... consistent with the Action Plan for the Caribbean Environment Programme."

WIDECAST's vision for achieving a regional recovery action plan has focused on bringing the best available science to bear on sea turtle management and conservation, empowering people to make effective use of that science in the policy-making process, and providing a mechanism and a framework for cooperation within and among nations. By involving stakeholders at all levels and encouraging policy-oriented research, WIDECAST puts science to practical use in conserving biodiversity and advocates for grassroots involvement in decision-making and project leadership.

Emphasizing initiatives that strengthen capacity within participating countries and institutions, the network also develops and replicates pilot projects, provides technical assistance, enables coordination in the collection, sharing and use of information and data, and promotes strong linkages between science, policy, and public participation in the design and implementation of conservation actions. Finally, working closely with local communities and resource managers, WIDECAST develops standard management guidelines and criteria that emphasize best practices and sustainability, ensuring that current utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival over the long term.

With Country Coordinators in more than 40 Caribbean nations and territories, WIDECAST is uniquely able to facilitate complementary conservation action across range States, including strengthening legislation, encouraging community involvement, and raising public awareness of the endangered status of the region's six species of migratory sea turtles. As a result, most Caribbean nations have adopted a national sea turtle management plan, poaching and illegal product sales have been dramatically reduced or eliminated at key sites, many of the region's largest breeding colonies are monitored on an annual basis, alternative livelihood models are increasingly available for rural areas, and citizens are mobilized in support of conservation action. You can join us! Visit www.widecast.org for more information.

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