Many conservationists and wildlife managers have embraced ecotourism as an economic incentive for protecting species and ecosystems in developing countries (Laarman and Durst 1987, Boo 1990, Hill 1990, Ruschmann 1992). Ecotourism, also called ecological, nature-based, or natural history tourism, constitutes traveling to relatively undeveloped natural areas to enjoy and study the scenery and wildlife (Boo 1990). Dependent on using natural resources in a relatively undeveloped form, ecotourism is based on natural features, such as scenic vistas, pristine forests, and abundant wildlife, and requires maintaining the high quality of these resources. To many, ecotourism represents a potentially low consumption use of natural resources that may generate substantial economic return, thus fostering sustainable management of resources, from rain-

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unstable sources of income, degradation of water or air quality, and alteration or destruction of vegetation, also are ubiquitous (Mathieson and Wall 1982, Farrell and Runyan 1991). Much of the research on biological effects of tourism has been conducted in temperate areas. Boyle and Samson (1985) analyzed 166 studies of the effects of “non-consumptive” recreation on wildlife in North America, including changes in bird and mammal populations at campgrounds, disturbance of waterbird colonies and influences on nesting success, and changes in foraging behavior in large mammals. In contrast, effects of ecotourism on pristine tropical areas are poorly documented. Yet ecotourism destinations often involve extremely fragile ecosystems or endangered or threatened wildlife. Ecotourists, such as wildlife viewers and photographers, may be potentially more damaging to wildlife than other tourists because they actively seek and approach wildlife. Information is critically needed to identify, monitor, and mitigate the negative effects, both individual and cumulative, on the fauna and flora. Ecotourism can not be viewed as a benign, non-consumptive use of natural resources in the tropics.

Like many of Costa Rica’s renowned parks, Tortuguero National Park (TNP) lacks the basic infrastructure, such as trained guides, interpretive information, and visitor centers, needed to support tourism. In the past decade TNP experienced a 24-fold increase in visitors who were attracted by sea turtle nesting, sport fishing, and the area’s wild expanse of rivers and beaches. Tourism has been the primary industry of Tortuguero village since the 1980’s, however, infrastructure development had not kept pace with rising tourist numbers (Brown 1991, Place 1991). Biologists and TNP managers had become increasingly concerned about the impact of visitors attempting to observe the 1–2 hour nesting process of the 5,700–23,000 green sea turtles (Chelonia mydas) nesting on Tortuguero annually, the largest nesting site for green turtles in the western hemisphere.

As a step toward managing the natural resources of TNP more effectively, our study was designed to help develop a program to minimize potential tourist impacts on nesting turtles. Accordingly, data were derived from resource managers and scientists, hotel owners, community members, and tourists to determine human activity patterns on the nesting beach and to quantify the effects of high and low levels of human activity on the behavior of nesting turtles.

**STUDY AREA AND METHODS**

**Tortuguero National Park**

Located in northeastern Costa Rica, Tortuguero was first chronicled as a traditional nesting ground for sea turtles in 1592 (Boza and Mendoza 1981). During the 20th century, the exploitation of the turtles for their meat, calipee (used in making turtle soup), eggs, oil, and in one species, shell, led to their decline or extirpation in other regions. In 1954, Carr and Carr (1972) began a long-term, ongoing study of the green turtles nesting in Tortuguero. TNP was established in 1975, protecting the 35 km turtle nesting beach and 18,946 ha of surrounding swamp forests (classified as Tropical Wet Forest; Holdridge 1967) that encompassed most of the Tortuguero basin watershed. In addition to the 4 species of endangered marine turtles that nest on its beaches, the park protects 55 species of fish in the lagoons, over 350 species of birds, and some 140 species of mammals (Boza and Mendoza 1981). Rainfall averages 5.8 m annually (Myers 1981).

**Human Activities**

Human activity on the nesting beach was determined by nightly observations of tourist numbers and behaviors from 23–30 July 1990. All tourists, as well as park guards and researchers, were counted at the busiest section of beach (Mile 3–4). Data from hotel occupancy records, park entrance fee receipts, and tourist surveys also were used to indicate nightly use patterns and to document variations between weekday and weekend use from July–September 1990. This information also was used to develop a training program for tour guides to minimize human disturbance; these methods are reported elsewhere (Jacobson and Robles 1992).

**Turtle Nesting Activity**

Impact of human activity on turtle nesting behavior was analyzed in 2 ways. Nightly census data on number of turtle emergences and nesting attempts along a 7 km stretch of Tortuguero Beach were collected by Caribbean Conservation Corporation (CCC) researchers. They censused the beach 6–8 times between 2000–0400
recording number and location of (1) successful nests, indicating nesting emergence; (2) false nests, those that had been partially dug then abandoned, indicating incomplete emergence; and (3) unsuccessful nesting activity, where females had crawled onto the beach but returned to the ocean without any nest digging attempt, indicating a non-nesting emergence.

Proportion and total number of successful nests, false nests, and non-nesting emergences were compared between weekend nights (Friday and Saturday) and weekday nights (Monday and Tuesday) in July and August 1990. Influence of differential tourist visitation also was assessed by comparing turtle nesting behavior between 2 stretches of beach during July 1990. Successful nests, false nests, and non-nesting emergences along a 1.6 km beach area (Mile 3-4) fronting Tortuguero village, where the maximum amount of human activity and lights were present, were compared to a contiguous, visually homogenous 1.6 km beach area (Mile 4-5) where less human use occurred because of its greater distance from the town. Chi-square statistics were used in data analysis (Siegel 1988).

RESULTS

The maximum hotel capacity in Tortuguero of 287 people/night is severely limited by transportation, which depends on boats and chartered planes. Eighty percent of the tourists came on boats that transported people primarily on weekends. During peak months for 1989–1990, hotels were 10–75% full and in the lowest month, only 4–20% full. Green turtle nesting season, July–September, was considered a busy tourist season and during July 1990 hotels housed about 1,300 tourists. Visitors stayed primarily on weekends; thus, a Friday and Saturday night during this time received more than half of the entire week’s tourists. Maximum tourist numbers on the beach reached 90 visitors (minimum = 23) during a 90-minute interval/weekend night and a maximum of 5 and a minimum of 0 visitors/weekday night during observation periods from 23–30 July.

Presence and behavior of tourists on the beach during turtle nesting season had a variety of effects. Nesting turtles were observed being disturbed by the use of flashlights and flash cameras, physical blocking or touching of turtles arriving from or returning to the sea, digging and movement by tourists near nests, and handling and trampling of hatchlings. CCC researchers, park guards, and tourists reported that turtles were interrupted during emergence and turned around and returned to the ocean as a result of human disturbance. However, turtle nesting behavior—nesting, false nests, and non-nesting emergences—did not differ on low tourist visitation (weekday) nights versus high tourist visitation (weekend) nights ($X^2 = 1.01, 2$ df, $P = 0.60$; Fig. 1). Nor did nesting behaviors on sections of beach subjected to different amounts of human disturbance differ ($X^2 = 0.76, 2$ df, $P = 0.68$; Fig. 2). Yet, overall turtle activity on weekday versus weekend nights differed. Fifty percent more of all three types of nesting behavior occurred on weekday nights (180 emergences) than occurred on weekends (116 emergences; $X^2 = 13.84, 1$ df, $P < 0.005$).

DISCUSSION

The relationship between tourism and wildlife conservation can be: (1) parasitic—when the presence of tourism exploits and is detrimental to the natural environment; (2) coexistent—when there is relatively little contact or effect; or (3) symbiotic—when natural assets are conserved and people garner physical, aesthetic, cultural, scientific, educational, or, of course, economic, benefits through tourism (e.g., Budowski 1976). Ecotourism proponents stress the potential positive relationships: “... when the saving of an endangered species, a rain forest, or a wetland can be aided by cooperative strategies, this is ecotourism” (Farrell and Runyan 1991:34); yet these claims are largely unsubstantiated. Impact of human activities is dictated by many factors (Shelby and Heberlein 1987, Decker and Purdy 1988) that must be managed to create symbiotic or, at least, coexistent relationships between tourism and natural areas.

Ecotourism at TNP required careful management to mitigate negative impacts on nesting turtles. Before 1990, few regulations governed human activity on the nesting beach. Park managers and biologists reported frequent disturbances of turtles coming to shore
by tourists walking up and down the beach, shining flashlights, and taking flash pictures of turtles. Similar tourist behavior has been reported on sea turtle nesting beaches in Costa Rica and elsewhere (Herzog and Gerrand 1992). Reports by the tourists themselves of tourist disturbance of nesting turtles supported managers' concerns. Tourists from large tour groups gave significantly more negative responses about the deleterious impacts of tourism than other hotel guests (Jacobson and Robles 1992), implying that the lack of regulations influenced visitor satisfaction as well as affected the resource.

The extent and concentration of human activity influence the natural environment. Increased activity alters the behavior of waterfowl (Korschgen et al. 1985), raptors (Anderson et al. 1990), ungulates (Kuck et al. 1985, Ward 1985), canids (Gese et al. 1989), and other groups. However, impacts of human disturbance on turtle nesting behavior were difficult to quantify. Beaches subjected to different amounts of human disturbance did not reflect different levels of specific nesting activities (i.e., nesting, false nesting, and non-nesting emergences). However, differences in total nesting activity were significant. A third fewer incidents of all three types of nesting behaviors were recorded on weekend nights than weekday nights, corresponding to much higher tourist numbers. Long-term study would be necessary to completely eliminate variables other than tourist numbers as an explanation for this weekly phenomenon.

Experimental investigation also is required to understand how and if human disturbance influences turtle reproductive success. However, rapid annual increase in tourists, potential for relatively fewer turtle emergences on high tourist nights, and the anecdotal observations of CCC scientists, park guards, and tourists supported TNP staff's desire to begin to control human activity on the nesting beach. A pilot guide program was developed to help regulate tourism. Eight Tortuguero residents completed a 10-hour guide training program and established a cooperative to organize the guide program and rotate guide duties. TNP staff required tourists wishing to walk on the nesting beach at night to go in small groups and be accompanied by guides. Hypothetically, if it takes one person 3 minutes to traverse a segment of beach, then 90 people walk-
ing individually will represent 4.5 hours of beach contact, but people walking in groups of ten could traverse the area in less than 30 minutes. In addition to reducing human movement at the beach, the guides prohibited tourists from using flashlights and restricted flash photography. These regulations have been suggested for controlling human activity on other turtle nesting beaches (e.g., Fla. Dep. of Nat. Resour. Recommendations).

The portion of Tortuguero beach easily accessible to tourists represents only one-fifth of the total nesting beach; historically less than 10% of the turtles nest in this area (C. Luthin, CCC, Gainesville, Fla., 1991, pers. commun.). This site may become more significant with time as the relatively recent establishment of the park and new regulation of human activity may affect nesting in this section in the future. The 12 park managers and biologists working at TNP unanimously agreed that the guide program helped minimize tourist activity such as movement and lights on the beach. The program additionally helped increase park entrance fees TNP collected and added an additional cadre of people on the beach to report illegal activities.

Traditionally, as tourism increases, negative impacts on the natural resource base also increase (Mathieson and Wall 1982). Careful management is necessary to ensure that TNP, as a tourist attraction, does not become the "nonrenewable" resource that Butler (1980) described as the fate of so many tourist areas where environmental and social costs eventually exceeded benefits. In response to TNP management concerns, the Costa Rican government, in March 1991, decreed a 6-km tourist zone along the Tortuguero beach where tourists will be prohibited from using lights and will have to be accompanied by guides during the green turtle nesting season. Long-term monitoring of turtle reproductive success is needed to determine if the tour guide program is effective and sufficiently mitigates the disturbance.

Some species are more sensitive to disturbance because of their breeding patterns, colonial behavior, narrow distribution, habitat tolerance, restricted prey base, or other requirements (Boyle and Samson 1985). Resource managers must be able to determine what species may be most affected by which ecotourist activities and at what intensities and duration. The difficulty in quantifying impacts on an easily observed, 130+ kg turtle whose nesting population has been monitored for 35 years is an indication of the enormous task of understanding the effects of ecotourism on the other millions of species found in the tropics.

Wildlife managers in developing countries are faced with the challenge of establishing management priorities and developing programs to conserve biological diversity while addressing increasing numbers of ecotourists.

SUMMARY

Presence and behavior of tourists on the beach during green turtle nesting season resulted in disturbance of nesting turtles at Tortuguero National Park, Costa Rica. Tourist visitation was concentrated on weekends, correlating with the times that a third fewer turtles came to the beach. However, specific nesting behaviors, including successful nesting, incomplete nesting, and females emerging on the beach but returning to the ocean without digging a nest, did not differ on segments of the beach exposed to different levels of human disturbance. A tour guide program was developed to control tourist activity on the beach.

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