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Is the protection of beach and dune vegetation compatible with tourism?

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HIGHLIGHTS

- Can coastal tourism be compatible with the protection of beach and dune vegetation?
- We analyzed changes in vegetation in beaches with low and medium tourism density.
- We found no significant differences before and after the three holiday seasons.
- Low and medium density tourism can be compatible with the protection of vegetation.

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ABSTRACT

The paradox of development vs. protection and conservation of the coasts highlights the need to determine if tourism and conservation can be compatible rather than opposite activities. We analyzed the spatial and temporal changes in vegetation cover, composition and diversity in three beaches located in the state of Veracruz (Mexico) with different levels of tourism activity (Natural, Trailer Park and Hotels). We calculated tourist density and evaluated vegetation cover, species richness and diversity and analyzed the changes before and after three holiday seasons (winter, spring and summer). The Natural site had the highest vegetation cover (42.8 m^2), species richness (14) and diversity (1.50), and Trailer Park the lowest (4.9 m^2, 8 species, and 0.897 respectively). The BACI (Before-After-Control-Design) analysis showed no significant differences before and after the holiday seasons. Our results show how low and medium density tourism can be compatible with the protection of beach and coastal dune vegetation.

1. Introduction

It has been widely recognized that coastal areas have many valuable attributes, evidence of which is the expanding economic development and an increasing human population near or at the coast (McGranahan, Balk, & Anderson, 2007; Nordstrom, 2008; Silva et al., 2014). Specifically, tourism has become an important activity with large economic benefits for many countries (Propín-Frejomil and Sánchez-Crispín 2007), and thus, the construction of high rise buildings, residential developments, resorts, cottages and recreation parks at the beach or on top of the dunes has been widely promoted (Faggi & Dadon, 2011). Such rapid development is also associated with intense environmental degradation that results from dune reshaping or flattening (Nordstrom, 2008), vehicle driving, trampling and beach cleaning, all with evident and immediate damage to the vegetation (Faggi & Dadon, 2011; Nordstrom & Jackson, 2013; Heslenfeld, Jungerius, & Klijn, 2004; Kutiel, Eden, & Zhevelev, 2000; Muñoz-Vallés, Gallego Fernández, & Dellafiore, 2011; Hesp, 2011). Native taxa are lost as the natural heterogeneity of vegetation and topography is modified and introduced exotics become successfully established (Labuz, 2004).

The rapid economic development of the coasts results in an increasing human encroachment with populations exposed to sea-level rise, increased storminess, and shoreline erosion. This generates a high-risk scenario in which human life, property and infrastructure are threatened. Engineering solutions such as the construction of jetties, groins and seawalls are frequently perceived

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as the best option to prevent flood risk and erosion. However, oftentimes it is evident that, besides the high-maintenance costs, these hard protection measures generally transfer the erosion problem down-drift by altering sediment dynamics. Consequently ecosystem-based coastal defense strategies have recently been recommended as better and more sustainable alternatives (Temmerman et al., 2013). This idea is becoming increasingly solid given the demonstrated positive role of vegetation and dunes in protecting the coast and preventing coastline retreat and dune erosion (Barone, McKenna, & Farrell, 2014; Costanza et al., 2008; Kobayashi, Gralher, & Do, 2013; Silva, Martínez, Odériz, Mendoza, & Feagin, 2016).

Similar to other countries with large coastal areas, sand and sun tourism contributes to this growing industry in Mexico which altogether (tourism in general) represents 8.6% of its GDP (http://www.inegi.org.mx/est/contenidos/proyectos/cn/tur/default.aspx). Every year, nearly 20 million tourists arrive, ranking Mexico in second place, in The Americas (first is USA), and among the twenty most visited countries worldwide (World Tourism Organization 2013). Popular coastal touristic destinations are located throughout the more than 11,000 km of coasts, and include the Pacific (Acapulco, Mazatlán, Los Cabos, Ensenada, Puerto Vallarta), the Caribbean (Cancun) and the Gulf of Mexico (Veracruz) (Propín-Frejomil and Sánchez-Crispín 2007; Secretaría de Turismo, 2002). Specifically, the state of Veracruz is amongst the ten most popular states for sand and sun tourism. This yields important economic revenues but also a highly degraded environment (Seingier, Espejel, & Almada, 2009).

The above shows the paradox of development vs. protection and conservation of the coasts. On one hand, intense economic development, tourism and urban sprawl are important drivers for changing land use. But on the other, the need to protect and restore the rapidly decaying beaches and coastal dunes is urgent in order to recover the resilience of these ecosystems as well as relevant ecosystem services such as protection, scenic beauty and recreation (Everard, Jones, & Watts, 2010). Given this scenario, it is necessary to ask if it is possible to enjoy the benefits that coastal dunes and sandy beaches provide for tourism without damaging the ecological structure and functioning of the natural ecosystems.

Against this background, the need to determine if and at what intensity can tourism and conservation be compatible rather than opposite activities is highlighted. This information is very relevant for future development projects on the coast, as well as for management and conservation plans and legal instruments such as Environmental Impact Assessment studies. Consequently, in this study we aimed at testing if low and medium density tourism can be compatible with the preservation of beach and coastal dune vegetation in terms of community composition and structure. To achieve this, we analyzed the spatial and temporal changes in vegetation cover, composition and diversity in low-to medium-density tourism destinations where natural vegetation was still growing on the beach and foredunes. Our working hypothesis was that plant cover and diversity would decrease after each vacationing period and, most contrastingly, when and where tourism was most intensive. We expected that species typical of the dune environment would be the most affected by human activities such as trampling, while exotics would become more abundant as tourism and disturbance increased (Castillo & Moreno-Casasola, 1998).

2. Methods

2.1. Study sites

The state of Veracruz is located midway along the Gulf of Mexico between Tamaulipas and Tabasco (Fig. 1) and occupies 3.7% of the total surface of Mexico. The shoreline of Veracruz (745 km) represents 6.42% of the national coastline (11,593 km) (INEGI, 2007; http://www.inegi.org.mx/est/contenidos/proyectos/cn/tur/default.aspx). Specifically, we focused our analyses on Costa Esmeralda (20° 29′ N and 97° 00' W), where low and medium density tourism activities take place, which means that infrastructure is not so dense and still allows natural vegetation to grow at the beach and on the dunes. Costa Esmeralda is a touristic corridor that covers 20.17 km of shoreline and encompasses 3 municipalities: Tecolutla, San Rafael and Nautla. Popular beaches in Costa Esmeralda are frequently visited by tourists (mostly national tourism and from nearby inland cities), but at varying densities, depending on the occurrence of infrastructure for tourism. Of the three municipalities that comprise the Costa Esmeralda region, Tecolutla is the one with the largest number of hotels (126) in comparison with San Rafael and Nautla (6 each) (www.inegi.gob.mx). The 138 hotels of Costa Esmeralda are distributed throughout four small localities: La Guadalupe, La Vigueta, Monte Gordo and mostly in Casitas (Fig. 1) and their services range from 1 to 4 stars. The highest hotel occupation takes place during the three vacationing periods, namely, winter (December), spring (April) and summer (July-August).

Study sites were selected according to the following criteria: presence of natural plant cover on the beach and foredunes; accessibility to the beach, and type of infrastructure available for tourists. As a result, our three sites were: a) without infrastructure; b) with trailer parks and c) with hotels and houses. The first sampling site (hereafter named "Natural") is located near Casitas (20° 14.953′ N, 96° 47.478′ W) at 2.4 m above sea level (m.a.s.l.). There are neither hotels nor commercial establishments in the area. Only a few suburban houses are found behind the foredune. The second sampling site (hereafter named "Trailerpark") is located between Casitas and Monte Gordo (20° 17.019′ N; 96° 49.536′ W) at 1.22 m.a.s.l. Besides the five trailer parks located behind the foredune, there are 20 houses, six hotels and two restaurants in the vicinity. Finally, the third sampling site (named "Hotels") is located in Monte Gordo (20° 18.243′ N, 096° 50.858' W), at 1.30 m.a.s.l. (Fig. 1). Here, 10 hotels, more than 25 houses, two restaurants and 5 trailer parks are built on top of the dune. The distances between the study sites were not shorter than 2 km or longer than 7, as is shown in the map (Fig. 1).

2.2. Tourist density

Recreational use of most of the coast is associated to the school vacations, namely December, spring, (during Easter holidays) and July. Thus, tourist density was calculated once in each site, during the peak of these vacationing periods: December 2007 (winter), Easter week in April 2008 (spring), and July-August 2008 (summer). Time elapsed between observations was: 36 days in winter, 26 in spring and 40 in summer. At each site and at the peak day and hours with highest tourist density (12-4pm), photographs covering the whole width of the beach were shot every 100 m until the whole area with visiting tourists was photographed. Photos were shot during the same day (no more than 30 min apart) and under similar weather conditions (bright sunny days) so that the number of tourists observed was not affected by weather conditions. Then, beach area occupied by visitors was measured on site with a 50m long measuring tape, and our calculations showed that the photographs covered a total of 3,000, 4000 and 3000 m^2 in each site (Natural, Trailer-park and Hotels) respectively. Later on, the number of people found at each site was counted (form the photographs) and we then calculated mean tourist density per site during one day at the peak of each season. The peak of each vacationing period (mostly weekends) was determined based on information from the