MEXICO DISSERTATION/THESIS PROJECT

ME72 Effect of tourism on immature green turtle behaviour in Akumal Bay

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All sea turtles in the Caribbean are listed by the IUCN (2012) as endangered (green turtle, *Chelonia mydas* and loggerhead turtle, *Caretta caretta*) or critically endangered (hawksbill turtle, *Eretmochelys imbricate*, and leatherback turtle, *Dermochelys coriacea*). The diet and behaviour of green turtles are reported to change from the juvenile to adult life stages, with juveniles and sub-adults feeding exclusively on sea grasses, with large numbers of turtles aggregating around the same feeding ground (Lopez et al., 2005; Arthur et al., 2008). These concentrations of turtles in shallow water close to shore are very accessible for swim and snorkel based tourism. Sea turtles are increasingly popular as a form of wildlife tourism, but little is known about the effect of tourism on turtle behaviour (Tisdell & Wilson, 2002). Data from other wild species suggests that if tourism is not correctly managed, interactions with tourists can lead to behavioural changes and increased anxiety in the target animals (Constantine, 2001; Stensland & Bergren, 2007). If these animals are not in a captive setting and have control over their ranging patterns, long-term exposure to increased anxiety associated with tourism could cause the animals to abandon their home range in favour of an area with less disturbance (Bedjer et al., 2006).

Fibropapillomatosis (FP) is a debilitating neoplastic disease that is characterized by the presence of epithelial fibropapillomas (cutaneous tumours) and internal fibromas (benign tumours that are composed of fibrous or connective tissue. Sea turtles appear most susceptible to FB following recruitment to seagrass ecosystems close to shore (Ene et al., 2005). Seagrass habitats tend to have relatively shallow water resulting in warmer temperatures and in developed tourist destinations, close proximity to shore often results in environmental pollutants, biotoxins and bacteria, all of which are reported to contribute to advancement of FP (Van Houtan et al., 2010). In addition, physiological factors such as stress and immunologic status are reported to be associated with FP. Studies of glucocorticoid stress hormones and Heterophil/Lymphocyte blood parameters in wild *Chelonia mydas* in Hawaii have indicated FP infected turtles were immunosuppressed and chronically stressed (Work et al., 2001). Chelonid fibropapilloma-associated herpesvirus (CFPHV) is believed to be the aetiological agent of FP, meaning that turtles infected with the herpesvirus then start to develop FP tumours. However, the CFPHV herpesvirus has been found in turtles free from FP (Alfaro-Nuñez et al., 2014) and this suggest that the FP progression is multifactorial and involves a tumour-promoting phase triggered by a range of factors. Thus, it appears that turtles living in polluted coastal environments with high nitrogen-footprints are more susceptible to FP and the virus develops at a faster rate if the turtles are also subjected to chronic stress resulting in immunosuppression.

Due to the abundant sea grasses in Akumal Bay, there is a large population of juvenile and sub-adult green turtles, and as a result of this Akumal Bay has become increasing popular for snorkel based tourism. In 2013, Operation Wallacea created a photographic database for the identification of turtles in Akumal Bay, which has been updated each year. The reported number of cases of FP tumours has been stadily increasing, but most tumours are relatively small suggesting a high probability of recovery

in the turtles if the causes of the infection can be mitigated in the immediate future. As the availability of seagrasses in the Akumal region is limited, the resident turtles in Akumal Bay do not have the option of migrating to a new area the escape from the tourism. Consequently, sustainable management of tourism is paramount to the welfare of the turtles.

The aim of this project is to investigate the movement patterns, activity budgets and rates of evasive behaviour in immature green turtles in Akumal Bay in relation to snorkel based tourism. The project aims to investigate the relationship between the number of tourist and behaviour of tourists on turtle behaviour and likely stress levels, and use the findings of the study to produce guidelines for the regulation of snorkel based tourism in Akumal Bay.

Methods

Akumal (meaning "home of the turtles") is a small coastal town located approximately a 1.5-hour drive south from the major tourist destination of Cancun. Akumal Bay (Figure 1) is a key foraging area for immature green turtles due to the abundant sea grasses. The local population in the bay fluctuates, with as many as 80 individual turtles present at a time. Although sea turtles have always been present in Akumal, the resident population arrived relatively recently. Prior to 2005 there were no seagrasses in Akumal Bay, but in November of 2005, hurricane Wilma hit the coastline the waves essentially pulled most of the beach into the water, creating shallow water with a sandy bed; the perfect conditions for seagrasses to grow. By 2008 there was a growing population of green turtles in the bay and by 2010, snorkel tours with turtles because the primary tourist attraction in Akumal. With unregulated excessive numbers of tourist snorkelling in the bay, tourism began to take its toll on the turtles and seagrasses, but in 2017, Akumal was declared a marine protected area to ensure more sustainable management of tourism and the gradual recovery of the ecosystem.

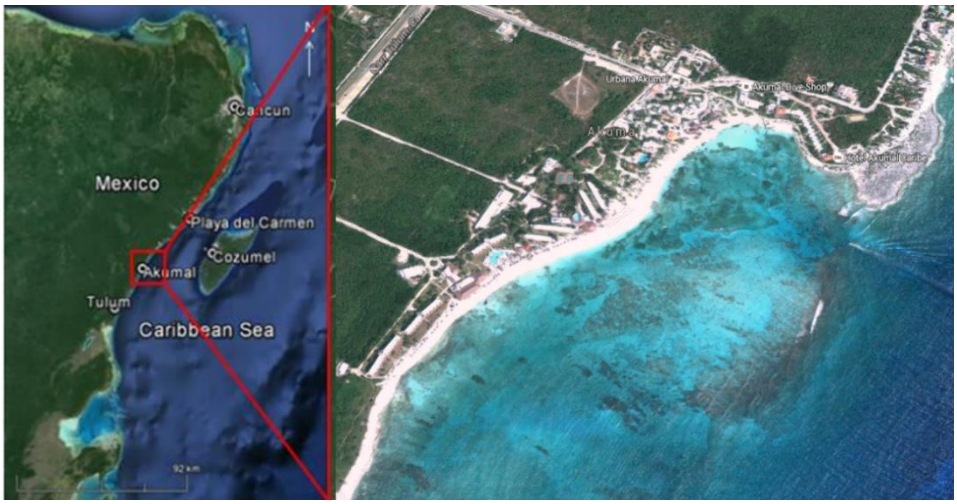

Figure 1: Map of the Riviera Maya showing location of Akumal and map of Akumal Bay where the resident immature green turtles are located (adapted from Google Maps).

Data will be collected on the resident green turtle (*Chelonia mydas*) population in Akumal Bay. There are approximately 80 juvenile and sub-adult individuals living in the bay and each turtle can be identified based on unique markings on the scales. Behavioural observations of turtles will be broken

down into a series of 2-hour periods between 7am and 7pm resulting in 6 different time slots in total. Three time slots will be used each day and rotated to ensure that equal quantities of data are collected for each time of day (e.g. day 1: 7am-9am, 11am-1pm, 3pm-5pm then day 2: 9am-11am, 1pm-3pm, 5pm-7pm). When a turtle is located photographs of the head and back of the turtle and a zoomed photograph of the numbered tag on the turtle will be recorded for use in the existing turtle ID database.

Figure 2: Example photographs used for Identification of individual green turtles in Akumal Bay. These photos are of "Apollo" with tag number "?? 531"

Data will be collected while snorkelling in the bay using focal animal sampling with continuous recording (Altmann, 1974) whereby each student will follow a different individual turtle for a 20-minute period and will record their behaviour in real time based on pre-defined behavioural categories (Table 1). The aim is to complete two 20-minute focal samples per hour with the remaining time spent locating and identifying each turtle. The number of tourists within a 5-meter radius of the turtle will be recorded throughout the sample. Any attempts of tourists to approach or interact with the turtle will be recorded based on the pre-defined categories in Table 2. When the focal turtle is feeding, the type of sea grass will be recorded (*Thallassia testudinum, Syringodium filiforme* and *Halodule wrightii*). If the turtle moves out of view for up to 3 minutes, then their behaviour should be recorded as "out of view" and the data collection resumed as soon as the turtle is visible again. If the turtle remains out of view for longer than 3 minutes, then the sample should be abandoned. Focal less than 5 minutes in duration should be abandoned, but anything longer than 5 minutes should be kept and the exact duration of the sample recorded.

Table 1: Ethogram of turtle behaviour

Behaviour	Code	Description
Feed	FE	Turtle masticates food while food is in its mouth or is foraging on prey items
Swim	SW	Turtle moves through the water at a steady pace in restively horizontal position
Rest	RE	Turtle is stationary and is not engaged in any other behaviour

Surface	SU	Turtle swims in a roughly vertical position towards the water surface to breathe
Dive	DI	Turtle swims quickly in a roughly vertical downward position
Evasive	EV	Turtle quickly changes direction and/or swims rapidly to avoid approaching human observer
Other	OT	All forms of behaviour not listed above, including all social interactions with one or more other turtles

Table 2: Ethogram of tourist behaviour

Behaviour	Code	Description
Acceptable	AC	Tourists maintain the 3-5m distance from the turtle, do not crowd around the turtle to prevent escape routes and do not attempt to interact with the turtle in any way
Crowd	CR	Two or more tourists move around the turtles in such a way that they block its travel path and potential escape routes. This behaviour can occur even if the 3-5m distance barrier is maintained
Chase	CH	Tourist continually follows turtle, despite its attempts to escape causing constant movement of the turtle away from the following tourist. This behaviour can occur even if the 3-5m distance barrier is maintained
Approach	AP	Tourist moves within 3m of turtle and deliberately swims towards it and invades it space. This is usually to take a photograph or to get in front of the turtle to photograph/film their face
Touch	TO	Tourist physically touches the turtle

Recommended Reading

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