MEXICO DISSERTATION/THESIS PROJECT

MEX-M01 Abundance of immature green turtles in relation to seagrass biomass 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*). Sea turtles spend over 90% of their time far out to sea where they are largely inaccessible. Consequently, little is known about their behaviour, diet and habitat preferences. Green turtles (*Chelonia mydas*) are generally herbivorous with sea grass and algae as the main components of their diet (Lopez-Mendilaharsu et al., 2005) although data from animal-borne video cameras suggests that ctenophores and jellyfish are also important components of their diet (Heithaus et al., 2002). The diet and behaviour of green turtles are reported to change from the juvenile to adult life stages, with a more varied diet in adult turtles, whereas juveniles and sub-adults feed exclusively on sea grasses (Arthur et al., 2008).

Large numbers of immature green turtles can aggregate around the same feeding ground and remain until the abundance of their preferred food sources have become depleted (Lopez-Mendilaharsu et al., 2005). A study of immature green turtle stomach contents indicated that over 80% of the diet consisted of sea-grasses with the majority being from the *Thalassia* genus (Mortimer, 1981). As with all grazing animals, turtles show a strong preference for younger parts of the plants that have a higher nutritional content and are more easily digested due to the low lignin content (Bjorndal, 1980). Continuous grazing of turtles on the same sea grass patches maximises the nitrogen and protein content in the grass and decreases the lignin content by around 50% resulting in a nutritious and easily digestible food source (Bjorndal, 1980; Moran & Bjorndal, 2005). However, if seagrass patches are overgrazed due to a high density of individuals and thus food supply is depleted, turtles are expected to leave in search of new feeding grounds.

Due to the abundant sea grasses in Akumal, there is a large population of juvenile and sub-adult green turtles in Akumal Bay. There are three species of seagrass in Akumal Bay (*Thallassia testudinum, Syringodium filiforme* and *Halodule wrightii*) and seagrass monitoring data has indicated that *Thallassia testudinum* in particular appears to be heavily grazed by the turtles and the abundance of this sea grass is declining (Hernández & van Tussenbroek, 2014). There are other bays containing small patches of seagrass, but the turtles do not appear to use them. Due to an influx of Sargassum macroalgae in the Yucatan Peninsula in 2015, many of the seagrass habitats in the region died, meaning that Akumal is one of only a small handful of suitable feeding grounds for immature turtles. Over 80 individuals have been recorded in the seagrasses of Akumal Bay, but several years of unregulated snorkel tours with these turtles resulted in a decline in the health of the turtle population and considerable damage to the seagrasses. As Akumal Bay is now a marine protected area, the hope is that the turtle population will recover. Snorkel tours with turtles have been restricted to a set route around the bay and the use of snorkel fins is prohibited in order to allow seagrasses chance to recover. As the turtles preferentially graze in different areas each year, the distribution of seagrasses in the bay change over time and the location of the designated snorkel route needs to change in line with this to ensure the continued recovery of the ecosystem.

The aim of this project is to investigate the abundance and distribution of immature green turtles in Akumal Bay in relation to the abundance and distribution of seagrasses *Thallassia testudinum, Syringodium filiforme* and *Halodule wrightii* and in relation to the distribution of tourists. The project will also investigate the intensity and distribution of turtle grazing on seagrasses. Collectively, these data may be used to determine the ideal location of snorkel tour routes in the bay relative to restricted areas designated to turtle foraging. Data from the project will determine the extent of overgrazing of seagrasses and the sustainability of the resident turtle population.

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 became 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.

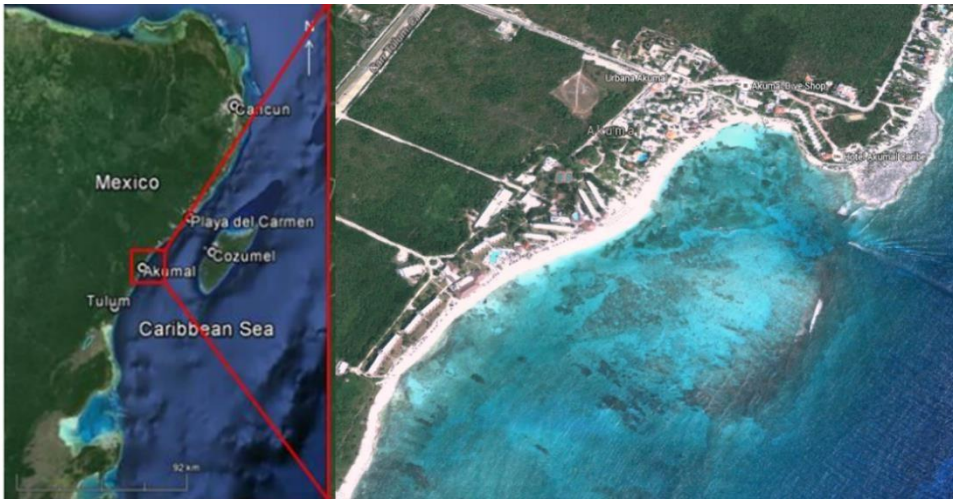
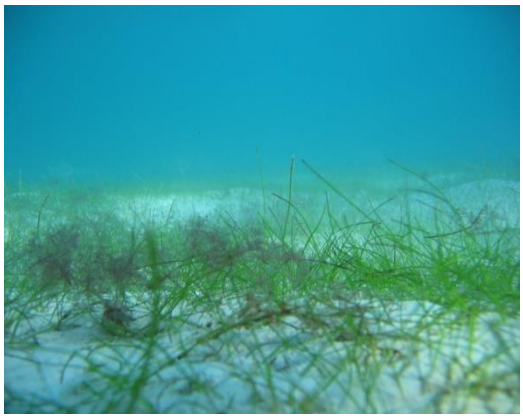


Figure 1: Map of the Riviera Maya showing location of Akumal and map of Akumal Bay where the resident immature green turtles are located (adapted from Google Maps).

Data will be collected on the seagrasses and resident green turtle (*Chelonia mydas*) population in Akumal Bay. Akumal Bay contains three different species of seagrass: *Thalassia testudinum* (Figures 2a and 2b) and faneróga ma filiformes (*Syringodium filiforme* and *Hadolule wrigthii* Figure 3a and 3b). The area closest to the shore does not exceed 2 meters in depth, and is strongly affected by waves that stir up sediment and impair visibility. However, these waves are rarely large waves because the bay is protected by the coral reef. Areas closer to the reef have depths between 2-3 meters with better visibility as the waves are almost undetectable.


Figures 2a and 2b: *Thalassia testudinum* in Akumal Bay




Figures 3a and 3b: *Halodule wrightii* and *Siryngodium filiforme* in Akumal Bay

The relative abundance of each type of seagrass (*Thallassia testudinum, Siryngodium filiforme* and *Halodule wrightii*) in Akumal Bay will be assessed. To do this, a series of quadrats, each 1m^2, with 20cm sub-divisions (i.e. 25 small squares inside the quadrat) will be located in a grid system across the bay (Figure 3). In each quadrat, the number of small squares that are covered by each type of sea grass or bare sand will be recorded using Braun-Blanquet method with the following categories:

- R = rare
- + = few individual specimens
- 1 = Various individuals but <5% coverage
- 2 = Many individuals, coverage 5-25%
- 3 = Coverage 25-50%
- 4 = Coverage 50-75%
- 5 = Coverage 75-100%

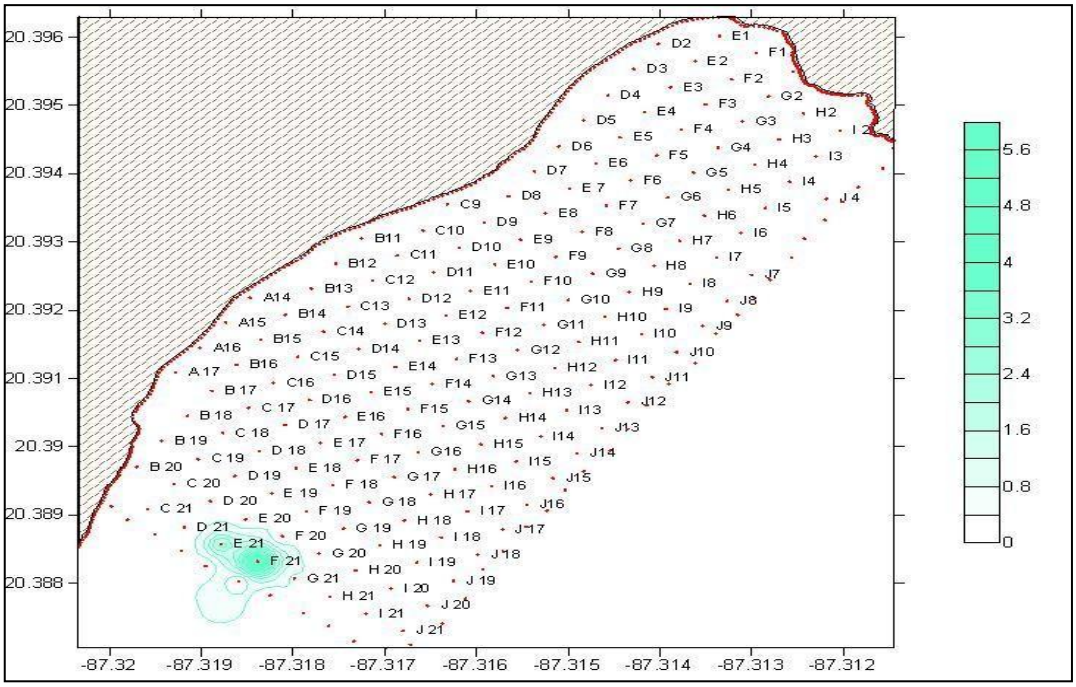


Figure 3: Grid system for seagrass surveys in Akumal Bay

Investigation of turtle movement patterns in relation to the distribution of seagrasses and the number of tourists in the bay will involve belt transects throughout the bay that coincide with the numbered rows 1 – 21 of the seagrass monitoring grid system. The number of turtles and tourists encountered along each transect will be recorded so that turtle abundance may be related to mean seagrass abundance across plots along the transect and the total number of tourists encountered on the transect.

Recommended Reading

Arthur, K.E., Boyle, M.C. & Limpus, C.J. 2008. Ontogenetic changes in diet and habitat use in green sea turtle (*Chelonia mydas*) life history. *Marine Ecology Process Series* 362: 303-311.

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