Sargassum accumulation may spell trouble for nesting sea turtles

Thigh-high mounds of sargassum seaweed line the northern section of a beach on Long Island, Antigua – an island in the West Indies – that hosts nesting hawksbill sea turtles (*Eretmochelys imbricata*) every summer. A meter offshore – although it is difficult to tell where the shore begins and the sea ends – the seaweed is crisp, even crunchy underfoot. We plod through it to skirt a mangrove tree during nightly patrols for nesting hawksbills, but the thick seaweed soup makes wading slow and difficult. The mass of seaweed varies with the prevailing winds and currents but often stretches over 10 m into the water. Closer to shore, it is a warm, fly-infested mush in various states of stinking decay. It collects on the beach to form a low but substantial wall, at times approaching 1 m in height and well over 2 m in width (Figure 1). And the sargassum keeps coming. Unfortunately, this image of sargassum is becoming widespread across much of the Caribbean region.

Sargassum, a genus of macroalgae that has garnered much research attention in recent years, has been dubbed the "floating rainforest" of the sea (Laffoley *et al.* 2011). The primary reason for this attention and the nickname lies in the middle of the North Atlantic Subtropical Gyre: the Sargasso Sea, where predominant ocean currents create a vortex that amasses huge quantities of the seaweed. This unique habitat is essential for a diverse array of fauna (Laffoley *et al.* 2011); for instance, open-ocean sargassum mats provide important nurseries for sea turtles such as loggerheads (*Caretta caretta*; Mansfield *et al.* 2014). But, over the past half-decade, sargassum has been proliferating in unprecedented quantities and is affecting areas far from the Sargasso Sea. Massive amounts have appeared on coasts from Florida to South America, even reaching western Africa. As a result, sargassum is generating substantial interest among the travel and tourism sectors, commercial enterprises seeking to harvest the seaweed, and conservation organizations (Smetacek and Zingone 2013). There is some speculation as to the source of all of this biomass, but evidence from a peak year in 2011 points to a possible origin off the coast of Brazil, north of the Amazon River mouth (Gower *et al.* 2013).

This coastal influx begs the question: what does all this seaweed mean for the region's populations of nesting sea turtles? Although sargassum in the open sea is a critical nursery ground, how will coastal accumulation affect Caribbean nesting beaches? The wider Caribbean region hosts numerous nesting sites for six of the seven extant marine turtle species (Dow *et al.* 2007); globally, these six species are categorized from Vulnerable to Critically Endangered by the International Union for Conservation of Nature (IUCN 2015).

The benefits of sargassum are largely recognized among members of the conservation community. As mentioned, oceanic sargassum is a key habitat for neonatal and juvenile sea turtles (Mansfield *et al.* 2014), and increased prevalence may improve prospects of survival for these age classes. When washed onto nesting beaches, seaweed may serve to stabilize against erosion. It also represents a mechanism for the transport of marine nutrients to terrestrial ecosystems (Polis and Hurd 1996), which further enhances stabilization by promoting the growth of sand-holding plants. These are important functions, given that healthy nesting beaches are critical components of population recovery efforts, and especially considering that only an estimated 1 in 1000 sea turtle eggs hatch and survive the decade or more required to reach maturity (Frazer 1986).

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Figure 1. *Immense quantities of sargassum have been washing ashore on Long Island, around Antigua, and across the Caribbean in waves over the past 5 years.*

Based on recent experiences at our study site on Long Island, Antigua, however, we suspect that sargassum may pose an emerging threat on some nesting beaches, where it can act as a barrier. Crescent-shaped Pasture Bay, the primary nesting beach on Long Island, is windward facing (in contrast to many other hawksbill beaches) and oriented north–northeast. This positioning makes it an ideal area for accrual of sand and a choice landing spot for female hawksbills seeking a nesting site. Unfortunately, the geography and the typical prevailing currents also mean it is a perfect sargassum trap.

Nearly 90 individual hawksbills laid

eggs at >310 nests on Long Island in 2014, with the majority deposited along the 650-m-long Pasture Bay. Such high nesting densities make every section of suitable habitat valuable, and over the past three decades, the northern portion of Pasture Bay has been among the sites most intensively used by hawksbills. During 2015, however, in those north stretches where massive amounts of sargassum have accumulated (~10% of Pasture Bay's shoreline), there has been virtually no nesting activity. We have recorded little nesting activity in sections with more variable presence of sargassum (an additional 10–15% of the Bay's coastline). These findings suggest that dense sargassum can hinder or altogether preclude access to preferred nesting locations, effectively shrinking the primary nesting beach by as much as 25%. If the sargassum persists, already high nesting densities will climb higher in those areas unaffected by sargassum, increasing the chances of nesting hawksbills digging into previously laid nests. Such destruction of in situ clutches has been observed here for more than a decade, even without the sargassum further concentrating nests.

M Watkins-Gilkes

Figure 2. *Hatchlings, such as this neonatal hawksbill turtle that succumbed in the nearshore waters of eastern Antigua, may struggle through the dense mats of sargassum as they attempt to begin offshore migrations.*

Impeded access to nesting sites is not the only potential problem for sea turtles. We hypothesize that seaweed that is pushed over incubating nests by waves on particularly narrow beaches (such as northern Pasture Bay) or by beach cleaners may create an anoxic and contaminated incubation environment when it decomposes, and may alter thermal conditions (our preliminary data suggest a cooling effect, which could result in the production of more male hatchlings since gender is temperature-dependent in this taxon). Hatchlings that successfully emerge from nests along sargassum-affected stretches of shoreline will face further obstructions both on land and at sea (Figure 2), and their use of wave direction to navigate during the initial offshore migration (Salmon and Lohmann 1989) may be compromised. These factors, in turn, may increase mortality through hyperthermia, exhaustion, drowning, and vulnerability to predation.

Sea turtles face a multitude of threats, including harvesting, degradation of key foraging and nesting sites, and bycatch in the fisheries industries (Lutcavage *et al.* 1997; Bräutigam and Eckert 2006). Although most threats are well understood, mass seaweed stranding is a new phenomenon, especially in the eastern Caribbean, and its direct impacts on sea turtle nesting remain largely unexplored. While sargassum may enhance beach stability, we do not view widespread coastal accumulation as an overwhelming ecological positive. Indeed, the direct consequences of sargassum accumulation on beaches may be a detriment to nesting sea turtles and their offspring in some areas. Sea turtles are ancient relics that have withstood the test of time, and their high reproductive output can buffer against the occasional poor nesting season. Nevertheless, new and sustained threats can have severe consequences for populations that are already imperiled.

On Long Island, we have borne witness to a nearly threefold increase in nesting numbers since the inception of our monitoring program in 1987. This is encouraging news for a critically endangered species (Mortimer and Donnelly 2008). However, the altered nesting behavior we have observed and the postulated impacts of sargassum on nests and hatchlings are concerning.

Unanswered questions about the current sargassum strandings make for an unpredictable future. Sargassum may wash out with storms, and the rafts of seaweed may cease to appear in nearshore waters, providing a respite to the region's beaches and sea turtles. Yet, any reprieve may be short-lived; some scientists suggest that sargassum influxes may reflect larger-scale climatic changes, so high concentrations of seaweed may be a new reality that the Caribbean region will have to contend with in the years to come.

Acknowledgements

The Jumby Bay Hawksbill Project is generously supported by the Jumby Bay Island Company and is a member of the Wider Caribbean Sea Turtle Conservation Network. J Horrocks provided useful comments on an earlier version of this text.

References

Please see WebReferences

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