

Katie Wilkinson Research Scholarship Report

Hot Males and Sex in the Sun. The Human Impact on Sea Turtle Sex Ratios on the Osa Peninsular, Costa Rica.

For my undergraduate project I have a great deal of people to thank, from the volunteers and researchers at Osa Conservation to the university staff who mentored my work. But nothing would have been possible without the belief and support of the Katie Wilkinson Research Scholarship. The generous donation the foundation provided enabled a study that will hopefully play a role in ensuring the continued presence of several magnificent species of sea turtle on the Osa Peninsula.



Piro beach, the main location of the study on the Osa Peninsula, Costa Rica.

The Osa Peninsula is a phenomenal natural redoubt, this small 800km² section of Costa Rica is estimated to be home to a remarkable 2.5% of the world's species (more than the entire continental United States) and it is frequently cited as the most biodiverse location on Earth. Its capacity for life is continued offshore as reefs, marine parks and one of just 4 tropical fjords worldwide adjoin the peninsula. In terms of conservation, despite continued threats, the region is generally viewed as a rare success. Corcovado, the national park that dominates much of the area is described as the 'jewel' in the nation's crown and the pioneering work of ecotourism has, despite some faults, provided the most successful framework by which members of the local population can escape the poverty ingrained in one of the most marginalised districts of the country.

For the local population the presence of sea turtles is incredibly important for ecological, cultural and economic reasons. The mysterious, ancient, perfectly spherical, stone-balls found in the area that form the Palmar-Sur UNESCO World Heritage Site are suspected to be depictions of turtle eggs, showing how their role within indigenous culture traces back to time *immemorial*. While their global status as symbols of peace, biodiversity and environmentalism has meant their image can be found invoked throughout the area, from 5 star ecolodges to surf shops. The opportunity for volunteerism with turtles has become a particularly important tourist draw and acts as a substantial source of funding for local conservation organisation's work. To some extent, this trend has precariously tied their and other animals' conservation efforts to their continued presence.

Unfortunately the nesting numbers of the four species found on the peninsula have dramatically decreased over the past few decades. Locals describe a past where mass nesting events with tens of thousands of females arriving on a beach were a common site (known as an '*arribada*' – Spanish for 'arrival'). Now however, the most seen on any night of the year on the local beaches rarely exceeds 100. The causes for this collapse are widely suspected to reflect those of classic conservation cases, with a combination of habitat-loss, pollution and poaching, the most likely reasons. Ultimately however, this is uncertain as quantifying the many pressures has been difficult. Aspects of the animal's lifecycles have proved very challenging to study and a lack of funding in the Eastern-Pacific, where population decreases have been particularly acute, has exacerbated these issues. Yet thanks to the commitment of many of the local population and funding from research organisations, some of these issues can begin to be explored.

Species	<i>Binary Nomenclature</i>	IUCN Conservation Status
Olive Ridley	<i>Lepidochelys olivacea</i>	Vulnerable
Green	<i>Chelonyas mydas</i>	Endangered
Leatherback	<i>Dermochelys coriacea</i>	Critically Endangered
Hawksbill	<i>Eretmochelys imbricate</i>	Critically Endangered

IUCN Conservation Statuses of the East-Pacific sea turtle populations found nesting on the Osa.



The Osa Conservation sea turtle hatchery on Piro beach. Nests laid in vulnerable locations along the beach that are judged unlikely to survive are relocated here to boost hatchling numbers.

Sea turtles possess a remarkable evolutionary artefact that is unique to a few members of the class *Reptilia*, in that their sex is determined, not by a combination of chromosomes such as X and Y in humans, but by the temperature of the nest during development. The discovery in the early 70s that warmer nests will produce more females not only challenged central tenets of reproductive theory but revealed additional vulnerabilities these species faced. Studies have increasingly warned of the growing risk posed to sea turtle populations from a warming world due to climate change. The narrow-temperature range between which a nest will produce a combination of either sex means that in many regions just a small increase in ambient temperature risks new generations of sea turtle hatchlings that are mostly or exclusively female. Such population feminisation could be catastrophic for sea turtle health and numbers.

A less studied human-induced impact on temperatures is the alteration of vegetation on nesting beaches. Sea turtles generally have a strong preference for nesting at the top of a beach under vegetation and, although widely presumed, the specific impact of the removal of this vegetation and its shading has rarely been quantified. A single study performed in the French-Caribbean found a 2 degree impact on ground temperatures at nest depth and this appears to be the sole published investigation to specifically address the issue. In contrast, personal experience suggested this could be a severe underestimation when

compared to conditions experienced on the black-sanded, equatorial beaches of the Osa.



A Green Female returns to the sea after laying a nest against the vegetation on Piro beach, note the arrival nesting track in the background.

By strategically placing temperature dataloggers, purchased with funds from Osa Conservation, personal finances and a large contribution from the Katie Wilkinson Research Scholarship, along common nesting areas on Piro beach that were judged to be representative of regional nesting sites, I could assess how vegetation changes affected the ground temperatures at nest depth on the Osa. By then comparing this data to established sex-temperature relationships for the native sea turtle species and nesting activity data on the local beaches gathered during the study period by local researchers and volunteers, I could create a fairly comprehensive picture of the status of hatchling sex ratios of sea turtles produced on the beach in its natural state. By then comparing temperatures between the beach and those found in a local sea turtle 'hatchery' and with local air temperature I could also assess how humans were and could impact hatchling sex-ratios. Temperatures were collected over a 6 month period on Piro beach with the kind help of Manuel Sanchez, the sea turtle conservation program manager at Osa Conservation.



Placing the dataloggers at two of the transects (left, undisturbed primary forest and right, artificial palm) accompanied by some curious researchers and students.

The results of the study were mixed, the removal of vegetation, when compared to natural forest, was shown to have almost twice the impact on nest temperatures ($+3.9^{\circ}\text{C}$) than that seen in the Caribbean and it was found that local beaches in their natural state most likely produced a very low number of males for all four species. Moreover, the type of vegetation change typical for beachside development in the area (removing forest and replacing it with sparse coconut palms) and conservative forecasts for the local impacts of climate change were expected to ensure that essentially all hatchlings produced on the beach were female or even that nests would fail altogether. On the other hand there was evidence that sufficient nests laid along areas of the beach backed by dense forest probably caused a significant numbers of males to be born and, surprisingly, the use of a local conservation hatchery appeared to increase the number of males produced by the beach 10 fold.

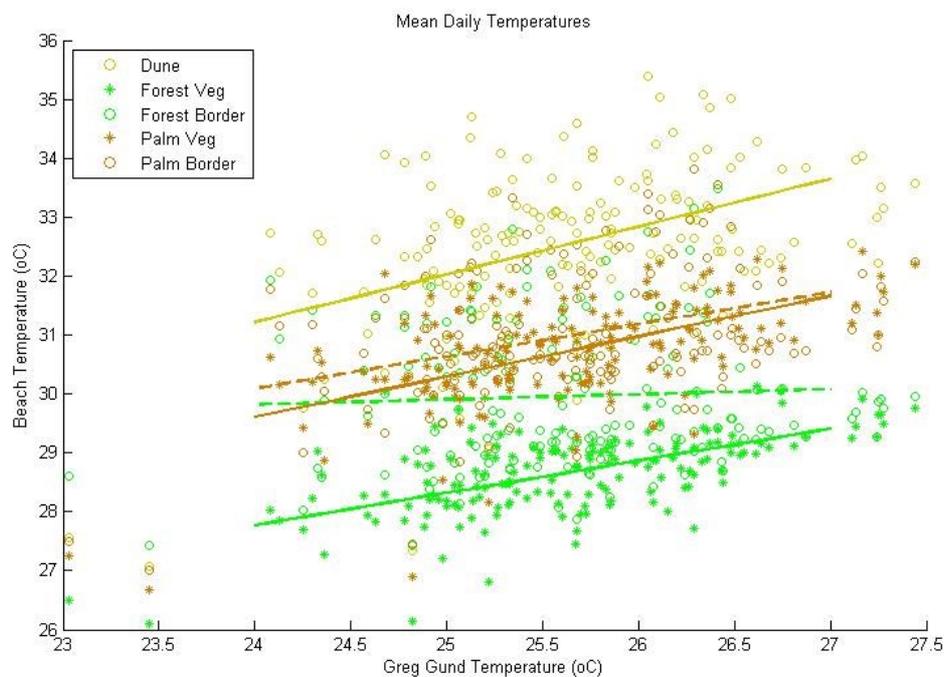


Figure showing the relationship between local air temperature (x-axis) and ground temperature (y-axis) that was used to infer the potential impacts from climate change. Note also the significantly different mean temperatures experienced for each vegetation profile [Dune=no vegetation, Forest= unspoiled primary forest, Palm = artificial palm].

The study provided some clear conclusions. Firstly that the number of males produced on the beach was already low and then that vegetation cover on these beaches has a dramatic effect on ground temperatures. This effect is so significant that it probably plays an important role in producing nests with viable numbers of males and goes some way to explaining some curious nesting habits of local sea turtles. We can also confidently conclude that human impacts on vegetation composition and from climate change have the potential to dramatically reduce the sex ratio of hatchlings produced. It was important to note that the beach in question was chosen partially so that these findings could be applied to other local nesting areas, suggesting that the local population could be facing severe stress from a low number of males.

However, as is often the case, the study raised even more questions. Some of the more obvious ones included; how reliable were the sex-temperature relationships used for the local population? How representative of the beaches further along the East-Pacific were those examined here? And what are the implications of producing so many males artificially in the hatchery? Fortunately, raising such questions was the original aim of the study and it is where I believe its value lies as a piece of research. It revealed the important questions that need to be answered by local organisations and researchers, such as Osa Conservation and myself, so that effective conservation choices can be made. By providing us with the tools to begin researching these issues the Katie Wilkinson Research Scholarship have set us on an important path to help ensure that sea turtles remain present on the Osa and beyond.



An Olive Ridley hatchling returning to sea (Photos courtesy: Manuel Sanchez, Lina Jerra).