THE HEAT IS ON

Flatbacks and a changing climate

Flatback sea turtles (*Natator depressus*) are special, nesting only on the beaches of northern Australia, with a number of key rookeries in Western Australia. A study is underway to assess the effects of climate change on flatback nesting sites in Western Australia's North West Shelf.

by Malindi Gammon and Carolyn Thomson-Dans

We are lying face-forward on the beach at Thevenard Island, off Onslow, still and quiet. Just in front of us, a female flatback gently rocks back and forth, releasing her glistening white eggs one by one into a perfectly formed egg chamber. Sea turtles have been around for 100 million years and witnessing the culmination of this—the nesting process—makes the exhaustion and occasional frustration of turtle research worth every sleep-deprived second.

Despite their persistence over evolutionary time-scales, today six of the world's seven species of sea turtle are internationally listed as Endangered or Critically Endangered by the IUCN. The only exception is the flatback turtle, which is classified as Data Deficient. The flatback is the only marine turtle with no oceanic stage in its early life history—it grows to maturity in the shallow waters of Australia's continental shelf. The flatback has the smallest geographic range of all sea turtle species, so it is particularly important to understand whether its nesting sites are vulnerable to the effects of a changing climate.

A study by PhD student Malindi Gammon, from The University of Western Australia, aims to provide crucial information to prioritise conservation actions for flatback turtles in the face of a changing climate. The project is part of the North West Shelf Flatback Turtle Conservation Program, which aims to improve flatback turtle conservation, management and research. This major long-term study of flatbacks that nest along the North West Shelf is funded through the Gorgon Joint Venture and managed by DBCA.

RISING OCEANS, HOT SAND

The nests of all sea turtle species are sensitive to climate change, due to increases in beach temperature, sea level and storm frequency. Sea turtle eggs develop in underground nest chambers on coastal beaches, where they can't avoid climatic effects such as flooding or suboptimal temperatures.

Previous page
Main Flatbacks produce smaller clutches than other sea turtle species, but their eggs are bigger and produce larger hatchlings with better swimming abilities and greater energy reserves, which presumably allow them to be better able to avoid predators in coastal shallow waters.
Photo – Malindi Gammon
Background Turtles leave distinctive tracks in the sand.
Photo – DBCA
Inset Adult female flatbacks can weigh 50–120 kilograms.
Photo – Jiri Lochman

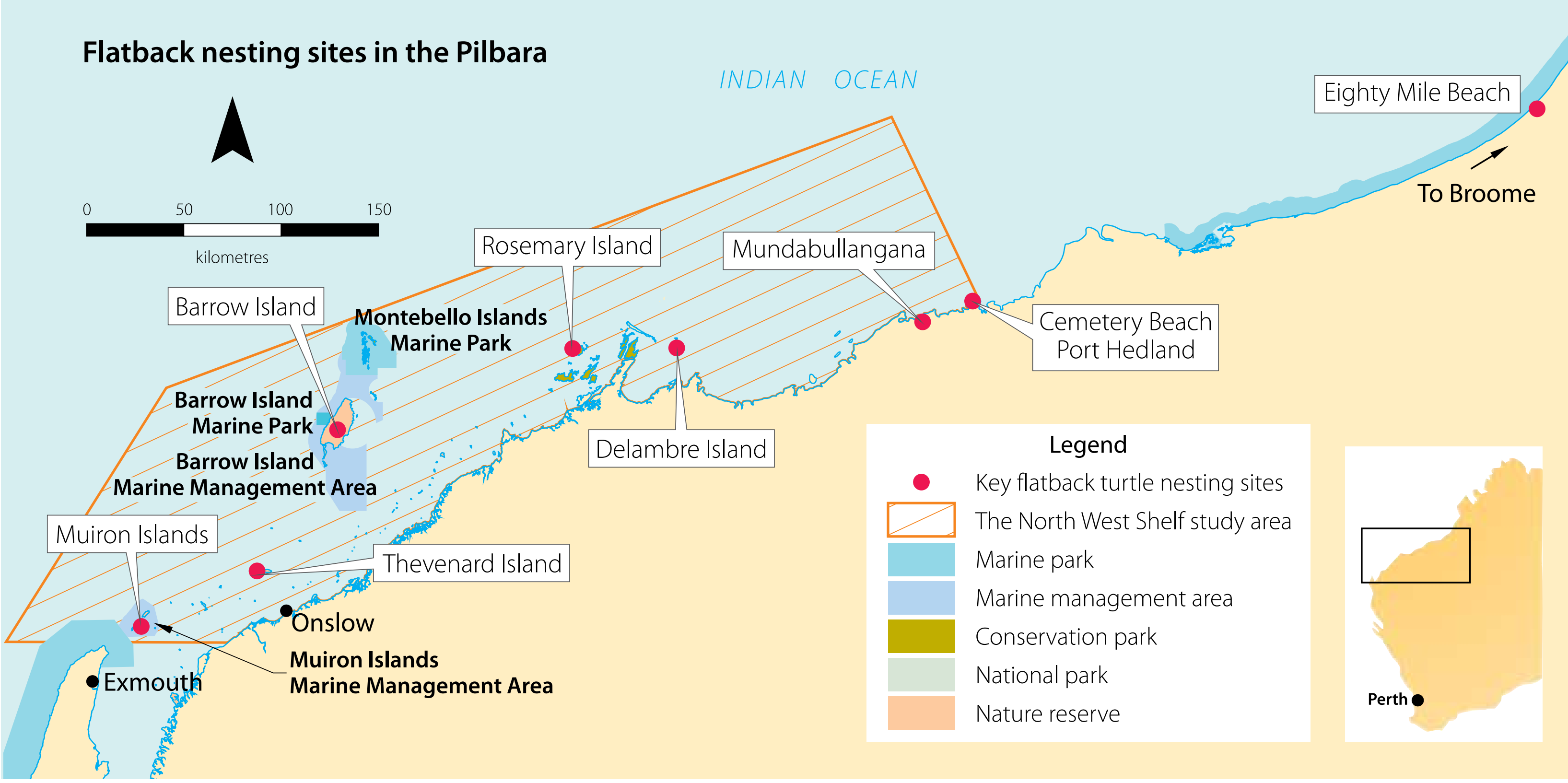
Above Female flatback laying eggs.
Photo – Andrea Whiting

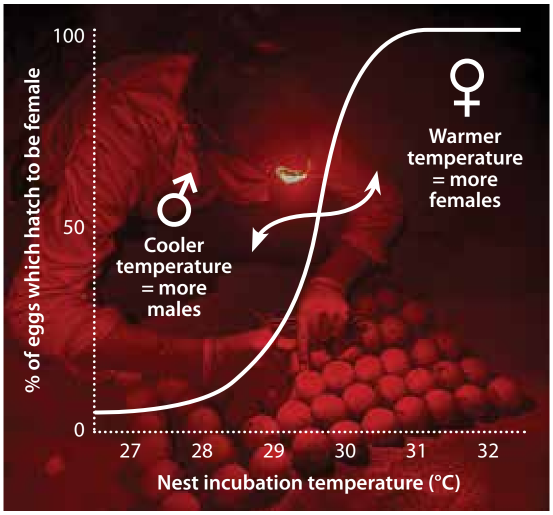
Right Flatback hatchlings have dark margins around their carapace scutes, giving their carapace a honeycomb appearance.
Photo – Kevin Crane/DBCA

Incubation temperature influences everything from nest hatchling success to the sex of hatchlings, and even hatchling fitness and their chances of making it to the ocean. For the eggs to successfully hatch, a nest must remain above the high-water mark and stay within a narrow temperature range. Cooler temperatures produce males, while females develop at warmer temperatures. The temperature effect on sex varies in different genetic stocks, so population-specific data are needed to accurately predict the impacts of climate change on specific populations.

If climate change continues unabated, widespread feminisation of turtle populations is likely, and many nesting beaches could become too hot for turtle embryos to survive. A changing climate induced by human activity is also predicted

"The nests of all sea turtle species are sensitive to climate change due to increases in beach temperature, sea level and storm frequency."





to increase the mean global sea level and storm frequency, which would expose nesting beaches to flooding, erosion, and more extreme storm events. Nesting females return to the same region from which they hatched, so may not be able to respond to these changes by moving their nesting sites.

DIGGING FOR DATA

To study the effect of sand temperature on the success of a turtle nest, timing is everything. Malindi must be on the beach at the exact moment a female turtle starts to lay. Each egg is delicately removed in a specific order, counted and a random sample of the eggs measured, weighed and marked. The eggs are then gently replaced in the nest in the same position from which they were removed, with temperature loggers deployed at the bottom, middle and top of the nest. Malindi then covers the nest with sand, taking great care to camouflage it in the same way a turtle does. To ensure no impact on nest survival, this process must be completed within an hour of laying. The researchers return once the eggs have hatched (approximately 50 days later) to record hatching success, and download data from the temperature loggers, which enables Malindi to analyse

Above left Graph showing how nest incubation temperature impacts sex of hatchlings.

Above left background Malindi Gammon excavating a flatback nest.

Above Thevenard Island jetty and beach—a key flatback nesting area.
Photos – Carolyn Thomson-Dans

Discover more about flatback turtles

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.

NO GLOW, MOVE SLOW, STAY LOW

If you are lucky enough to see a turtle emerging from the ocean STOP, DROP AND ACT LIKE A ROCK and ensure you are 15 metres away with no torch light. Turtles are easily spooked and can return to the ocean if they see movement on the beach. To understand the nesting process and the associated viewing rules check out DBCA's 'Turtle Watching Code of Conduct' and other information at flatbacks.dbca.wa.gov.au

the effect of temperature on hatchling success rates.

Volunteers and researchers with the North West Shelf Flatback Turtle Conservation Program play an important role in this work. To date, with the help of many hands, Malindi has excavated 45 nests over three seasons. This work is carried out at various rookeries throughout the North West Shelf, including Thevenard and Delambre islands, and Cemetery Beach at Port Hedland (administered by Care for Hedland). This builds a picture of incubation temperature and hatch success variation across the stock, with about 400 nests excavated in the past five years.

INNER WARMTH

Predicting incubation temperatures 10, 50 or even 100 years from now quickly gets complicated when embryos also produce their own heat.

Although sand temperature is often used as a proxy for nest temperature, the temperature of a sea turtle nest is not driven by sand temperature alone. Sea turtle eggs themselves generate heat as the embryo grows and develops. While the heat produced by a sea turtle egg is low, sea turtle nests contain 50–120 eggs depending on the species, and the heat produced by all eggs within a nest (metabolic heat) collectively drives nest temperature well above that of the surrounding sand. This variable makes it harder to accurately predict incubation temperatures, highlighting the need to account for it.

Malindi aims to fill this gap by creating a biodigital model of the sea turtle nest, which demonstrates how multiple drivers, including climate and metabolic heat, interact to produce an embryo's microclimate. This model will advance our ability to predict the impact of climate change on sea turtle populations, and improve our understanding of the variables influencing the nest microclimate. Small differences in temperature can have a large impact on hatchling success. For example, if nest temperature is already at the upper limit for flatback eggs to successfully hatch (33–35 degrees Celsius) and metabolic heat

Above Green turtles also nest on Thevenard Island and can often be seen returning to the ocean in the early morning.
Photo – Carolyn Thomson-Dans

Above right Flatback turtle hatchling.
Photo – Andrea Whiting

increases incubation temperature by just two degrees Celsius, this could lead to a very high mortality rate within the nest.

Malindi's model is being developed using flatback turtles, but she aims to develop an approach that can be applied to other sea turtle species.

THE PATH AHEAD

Around the world, researchers are assessing how vulnerable various sea turtle nesting sites are to our changing climate. Such assessments provide data to inform and prioritise management interventions such as beach shading to reduce sand temperature.

Malindi's project will undertake a vulnerability assessment for flatback turtles. She will use the information collected in her study to assess the vulnerability of flatback nesting sites in the North West Shelf to the predicted changes in sea level, storm frequency and temperature. This will allow both wildlife managers and industry to prioritise management actions to protect Australia's only endemic sea turtle.

Top Adult flatback turtles can be identified by their smooth carapace with upturned edges.
Photo – DBCA

Above left A rare sighting of a turtle nesting during daylight, with Malindi keeping a respectful distance.
Photo – Malindi Gammon

Above Red lights are used at night to limit any disturbance to turtles.
Photo – Carolyn Thomson-Dans

Right Flatback Turtle.
Illustration – Mandy Neilsen/DBCA

Malindi Gammon is a PhD Candidate at the School of Biological Sciences UWA.She can be contacted at malindi.gammon@research.uwa.edu.au

Carolyn Thomson-Dans is a former *LANDSCOPE* editor with DBCA and volunteers for the North West Shelf Flatback Turtle Conservation Program. She can be contacted at carolyn.thomsondans@gmail.com.

To get involved with the North West Shelf Flatback Turtle Conservation Program visit flatbacks.dbca.wa.gov.au

As this article was going to print, photographer and long-time LANDSCOPE *contributor Kevin Crane sadly passed way. The authors and* LANDSCOPE *team send their condolences to Kevin's family.*