

What Does Climate Change Mean for Marine Turtles?

Lucy Hawkes

We now widely accept that our future climate will be radically different from conditions experienced in any of the several hundred thousand years before present. Major changes, including higher temperatures, altered precipitation patterns, increase in strength of extreme weather events (e.g., hurricanes) and sea level rise, are expected and will likely have huge ramifications, including negative effects on tourism, the global financial market, infrastructure, human health and food supplies, including fisheries and agriculture. A special issue of *Endangered Species Research* (Volume 7, Number 2) addresses the issues of how to incorporate climate change in endangered species conservation. In addition to reviewing the literature for birds, mammals, fishes and reptiles, the papers together highlight that much of our confidence in predicting the effects of climate change on endangered species is limited by a lack of data from which to extrapolate. In particular, for marine turtles many baseline data are not yet available.

For example, sex in marine turtles is not determined genetically, rather the temperature at which eggs incubate will determine the resulting proportions of females (warmer conditions) and males (cooler conditions). From limited published work, we now understand that natural sex ratios at many major rookeries appear to be female biased – as much as 99% female hatchlings. The threat of increasing temperatures should serve only to increase the proportion of female hatchlings, perhaps effectively extirpating male turtles altogether. However, it is unclear to what extent this is likely. Even at very hot beaches, some males

could still be produced at the cooler beginning and end of the nesting season, in deeper nests, and in smaller nests (due to reduced metabolic heating). Even so, for the majority of populations, we do not understand the current primary sex ratios that are being produced, how this translates to adult sex ratios and how many male hatchlings are required to ensure adequate fertilisation of the nesting population. Also key to this area is an understanding of the rate at which turtles could adapt to forecast change.

Sea turtles are long-lived, far-ranging species and therefore, arguably more important are the effects of climate change on populations of turtles at large in the Caribbean, Atlantic, Mediterranean, Indian and Pacific oceans. Satellite tracking combined with time-depth sensors and satellite derived environmental data, is beginning to give researchers a picture of the physical rules that govern where, how and why turtles occupy the particular pieces of the oceans.

These studies are limited by sample size but the collaborative sharing of existing data from multiple projects will go some way to help bridge this information gap. Recent work with green turtles in the Galapagos, and loggerhead turtles from the USA, Cape Verde islands and Japan, have highlighted that there may be greater flexibility in foraging and life history strategies than previous science has suggested and is an important research area for future work.

There exist no current data with which to predict the possible impacts of climate change on habitat and diet for any of the marine turtle species. The omnivorous loggerheads and olive ridleys are generally understood to have a wide choice of prey items, while most populations of green sea turtles only eat marine sea grasses, and hawksbill turtles are thought to forage only on sponges. Leatherback turtles are thought to consume only gelatinous prey items. The mechanisms by which climate change may alter

A leatherback sea turtle nests on a beach in Gabon, while excess natural gas burns from oil platforms offshore



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foraging habitat (e.g., sea grass pasture blowouts due to extreme weather events, altered reef competition due to coral bleaching events, different migration patterns for gelatinous prey) are starting to be understood. It may be that species with greater dietary flexibility are better able to adapt to such changes. An individual that can forage on a greater range of prey will undoubtedly have less difficulty gaining the resources (e.g., breeding) than a turtle with a narrower diet. Novel forensic techniques in this field, such as analysis of stable isotopes of Carbon and Nitrogen, can quickly yield much information about the

trophic width of a study animals diet, and are helping elucidate this key life history trait.

The review of the existing knowledge about climate change and marine turtles shows that there is an imperative need for more empirical data to understand how climate change might threaten sea turtles, particularly given that all seven species are of conservation concern. In order for any future management recommendations of any substance to be made, baseline data must be collected, integrated and shared from as wide a variety of geographic regions, species and populations as possible. Given that the combined threats

of climate change, through sea level rise, habitat alteration and altered thermal conditions may supersede all other known threats for turtles, this is a priority for future turtle research programs.

Originally published as:

Hawkes, L.A., A.C. Broderick, M.H. Godfrey and B.J. Godley. 2009. Climate change and marine turtles. *Endangered Species Research* 7(2): 137-154.

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The Quiet Revolution: How Rural Tanzanians are Winning Back the Rights to their Forests

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Quietly and beyond the glare of the newspaper headlines, across Tanzania, communities are slowly but surely claiming back their forests and putting them under local control. Already around 4.1 million hectares of forest land in over 2,300 villages are either under, or in the process of being transferred to, local communities across the country. This includes high value montane forests in the Eastern Arc Mountains biodiversity hotspot, coastal forests and mangroves and miombo woodlands that cover large swathes of Tanzania's sparsely populated western regions. These changes have been made possible by changes in the Tanzanian forestry laws in 2002, which, for the first time, recognise and legalise forests owned and managed by village councils and community groups.

Donors such as the Danish, Norwegian and Finnish governments as well as the World Bank have been working with the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism to support village level forestry activities. The law allows two systems of forest management. The first is where communities become owners and managers through their village councils. Forests and woodlands within the village area are declared by village governments, and then registered with the local district council as 'Village Land Forest Reserves'. Once a management plan has been drawn up and approved by the district, the villagers can start actively managing their own forests. The second system covers communities living close to larger

forests managed by either national or local government. Communities become joint managers by signing agreements with the government and in return for actively managing the forests, are able to share the benefits by accessing honey, fuelwood, poles and timber.

The changes in policy have been possible through Tanzania's unique system of local government. Communities in rural areas are divided into villages (of which there are over 10,500 on mainland Tanzania), which are managed by village councils. The councils are accountable to village assemblies consisting of all the adults living within the village area. This system dates back to the mid-1970s, when the socialist "ujamaa" programme of Tanzania's founding President Julius Nyerere gave villages a legal basis, largely as a way to fit scattered and poor rural communities into the country's socialist development agenda. Although unpopular at the time, this political initiative sowed the seeds for rural empowerment through village governments. The Local Government Act of 1982 strengthened