Green Turtles

AS SILENT SENTINELS OF POLLUTION IN THE GREAT BARRIER REEF

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Understanding the impact of chemical contaminants on turtles can inform turtle conservation and also can guide efforts to protect and conserve larger ecosystems. Northeastern Australian green turtles are excellent proxy indicators of the overall health of the Great Barrier Reef. Partners in WWF-Australia's Rivers to Reef to Turtles (RRT) project have spent the past four years studying the chemical profile and health impacts of pollutants found in green turtles in the hope of improving the way turtles and their habitats are monitored and conserved.

The Great Barrier Reef Marine Park, designated a UNESCO World Heritage site, covers 344,400 sq km (132,973 sq miles) along the coast of northeast Australia. It receives fresh water runoff from 35 river catchments from 424,000 sq km (163,707 sq miles) that transport sediments, nutrients, and chemical contaminants from agricultural, industrial, mining, and urban activities. Thousands of new chemicals are registered for use worldwide each year, often with minimal toxicological and environmental impact assessments. According to the Chemical Abstracts Service, a division of the American Chemical Society, 15,000 new chemicals are registered daily; that's one every 6 seconds, which makes maintaining up-to-date environmental contaminant databases incredibly challenging. The latest UNESCO report expresses "serious concern" for coral bleaching events on the Great Barrier Reef and highlights the role of water pollution as a key threat to the reef ecosystem. Whereas northeastern Australian waterways are monitored using water-quality and coral- and seagrass-cover assessments, currently, there is no mechanism to monitor the impacts of chemical contamination on wildlife. Green turtles are among the many iconic and vulnerable species found on the Great Barrier Reef, and they forage in coastal areas where they are exposed to complex mixtures of land-based pollutants.

Correlating environmental monitoring and biological samples from turtles is a major challenge. The relationships between external pollutant doses (for example, water, sediment, and seagrass), internal exposure (for example, blood concentrations), and subsequent toxicological and health effects in green turtles are poorly understood, yet establishing these links is critical to effectively inform Great Barrier Reef monitoring and management. The RRT project is a four-year collaboration among several university and research partners, led by WWF Australia with philanthropic support from Banrock Station Wines Environmental Trust. Now in its final year, RRT developed nontarget screening approaches combining environmental monitoring, turtle health, and toxicology to understand the effects of chemical contaminants on green turtles foraging in coastal Great Barrier Reef habitats adjacent to urban-industrial and agricultural-legacy mining activities. Turtles living in pristine offshore reefs served as a baseline for optimal turtle health.

During this study, coastal turtles were found to have elevated blood levels of multiple trace elements. Specifically, turtles from the agricultural site had cobalt levels up to 25 times higher than the healthy reference population and well within the range expected to cause acute toxicity. Additionally, a mixture of chemicals associated with human activities, including heart and gout medication, pesticides, and industrial sulfonic acids, were detected in coastal populations. Matched clinical results from the same animals showed signs of an active systemic disease in turtles from the urban-industrial site and a marked increase in inflammatory response in 44 percent of turtles from the agricultural site. Importantly, elevated cobalt, antimony, and manganese in the blood of these turtles were significantly correlated with clinical markers of acute inflammation and liver dysfunction. This finding was further supported by biomarkers of neuroinflammation and oxidative stress, including lipid peroxidation products. Ulcerative eye lesions were also observed in both coastal populations in years two and three.

Similarly, water-quality monitoring showed clear site-specific differences in metal and organic chemical profiles, but it only identified 13 pesticides, dominated by priority photosystem II inhibiting herbicides atrazine and diuron. Despite the suspected importance of incident sediment ingestion as a pollutant exposure source for foraging turtles, only trace levels of contaminants were detected in sediment.

Of importance was the wide range of exogenous compounds detected in turtle blood, thousands of which could not be identified. Of the compounds that could be identified, many were new chemicals and thus not included in routine Great Barrier Reef-monitoring programs. We currently know very little about the effects of these contaminants on the long-term health of green turtles. Moreover, the chemicals detected in water and sediment samples used for traditional (targeted) environmental monitoring were not reflected in the biological samples, and vice versa.

Green turtles have proven to be an accurate indicator of environmental health for their resident habitats in the Great Barrier Reef. Understanding the impact of chemical contaminants on marine turtles is paramount to effective species conservation, reef catchment

restoration, and the continued health of the Great Barrier Reef, especially as coastal development including urban and industrial land use, ports, and expansion of agricultural practices is expected to increase the sources and diversity of contaminants released into the sea. We question whether existing environmental monitoring programs that analyze only targeted contaminants are adequate to address the combined toxicity of chemicals entering the Great Barrier Reef and its wildlife. Sea turtles can be used alongside other environmental measures as environmental sentinels to provide a more holistic overview of ecosystem health and an objective measure of anthropogenic impacts on the Great Barrier Reef. That is why, as the RRT project continues, we are developing a green turtle biomonitoring tool for use as a proxy indicator of wildlife and ecosystem health in the Great Barrier Reef and other coastal regions worldwide. ■

THIS PAGE: A researcher collects sediment samples for the "Rivers to Reef to Turtles" study. © GÖKSEL DOGRUER / WWF-AUSTRALIA; AT LEFT: A green turtle is released at Howick Island in Australia's Great Barrier Reef Marine Park after sampling for "Rivers to Reef to Turtles" biomonitoring studies. © GÖKSEL DOGRUER / WWF-AUSTRALIA