



CITIZEN SCIENCE CONTRIBUTIONS TO SEA TURTLE RESEARCH AND CONSERVATION

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Public participation in scientific research, an emerging research tool commonly referred to as citizen science, enables research programs to collect large amounts of data over wide geographical areas and long periods of time. Such programs are very cost-effective and have a complementary effect of increasing community awareness about the research species, area and/or discipline (reviewed by Hudgins *et al.*, 2017; Long & Azmi, 2017; Williams *et al.*, 2017). Three recent sea turtle research and conservation projects that involved citizen scientists in the region demonstrate the potential of this approach to increasing our knowledge about nesting and foraging sea turtle populations.

Hudgins, J.A., E.J. Hudgins, K. Ali & A. Mancini. 2017. Citizen science surveys elucidate key foraging and nesting habitat for two endangered marine turtle species within the Republic of Maldives. *Herpetology Notes* 10: 463-471.

A recent project in the Maldives involved citizen scientists in the collection of data about sea turtles in their nesting and feeding grounds. In 2016, a 10-year ban on catching and/or killing marine turtles expired (Zahir, 2010) and the new legislation under consideration required quantitative data that measured the effectiveness of the previous policy. The Maldives comprise ~1,192 islands spread over 90,000km², including coral reefs that exceed 4,500 km²; the urgent need to collect information from such a large area inspired development of the citizen-science based monitoring programme Turtle Watch Maldives (TWM). The Maldives Marine Research Centre (MRC) developed two protocols for TWM. The in-water protocol allowed snorkellers, divers or in-boat observers to collect information about turtles in their feeding grounds using either a simple or in-depth version. The nesting protocol collected information about successful and unsuccessful ('false crawls') nesting attempts by asking participants to count tracks on local beaches. Both protocols first underwent trial

assessment with 12 marine biologists, who later trained citizen scientists (including tourists and dive and snorkel guides) in the data collection methods. Participants kept records or all their surveys- whether turtles were observed or not- and sent them to TWM monthly.

A total of 16 participants completed 2,216 in-water surveys between January - September 2015, with at least one survey completed at 12.5% of the islands in the Maldivian archipelago. A total of 1,293 hawksbill turtle, 704 green turtle, and 6 unknown turtle species observations were recorded, predominantly of female turtles. Four participants completed 48 nesting surveys to record 28 successful and 18 unsuccessful nesting attempts. The records increased sea turtle data for the Maldives by ~2,000%, and identified a green turtle foraging hotspot the authors suggest is an area of importance for sea turtles that requires conservation action and an atoll, already a UNESCO Biosphere Reserve, demonstrating a high rate of juvenile hawksbill recruitment that potentially indicates recovery from exploitation of the species. The surveys also provided evidence to support the common perception that more green turtles than hawksbill turtles nest in the Maldives, and provided initial data on green turtle nests incubation duration and hatching success.

Despite the limited or inaccurate data on turtle size or maturity stage collected by citizen scientists participating in TWM, the project was deemed a success and Hudgins *et al.* (2017) conclude that the approach was effective in collecting a large volume of data quickly from a wide area, in addition to engaging the public with sea turtle conservation. They suggest that further training and data quality checks could overcome limitations in the type of observations recorded by citizen scientists, and recommend the approach when collecting similar data in other countries. Results of the study were used by the Maldivian government to create legislation that bans the capture and killing of sea turtles and harvest of turtle eggs throughout the entire archipelago.

Long, S.L. & N.A. Azmi. 2017. Using photographic identification to monitor sea turtle populations at Perhentian Islands Marine Park in Malaysia. *Herpetological Conservation and Biology* 12: 350-366.

Citizen scientists were also engaged in recent surveys on foraging and nesting sea turtles in Malaysia, but a different approach to data capture was implemented. Long & Azmi (2017) used photographic-identification (photo-ID) to estimate the number of feeding and nesting turtles in Perhentian Island Marine Park, comparing photographs submitted by trained interns and volunteers with Perhentian Turtle Project (PTP) to those submitted through email and social media by members of the public.

Records required photographs of the left and/or right sides of the turtle head (taken from a minimum of 1.5m in distance) that showed facial scutes and a dorsal image of in-water turtles. PTP trained its members in appropriate photography of sea turtles observed during snorkel surveys and beach monitoring, while public citizen scientists were informed by posters and other information displayed in public spaces such as the mainland jetty. Of the 1,826 turtle sightings submitted during the study period of 2009-2015, 1,182 originated from members of PTP and 644 from members of the public. Images were analysed using the software NaturePatternMatch to estimate the number of unique individuals observed in the study area as between 120-131 green turtles and 20-23 hawksbill turtles. The range of potential individuals results from incomplete image sets for some observations. Of the total sightings, <5% of the photographic records were of insufficient quality to identify the individual. Image geodata and date/time stamp and flipper tags applied to nesting turtles were used to distinguish between in-water and nesting sea turtle populations.

The study was able to describe preferred habitat and strong site fidelity among feeding green turtles in the study site, and the first short-distance breeding migration (~30km) of a green turtle in the region. The number of injured (n=8) and dead (n=2) turtles with injuries resulting from interactions with boat traffic during the

study period was also recorded. Photographs submitted by public citizen scientists were as useful in identifying individual turtles as those collected by PTP members, so long as the image was not blurred and turtle facial scutes were visible. However, location names submitted by the former group, especially from tourists to the area, were sometimes inaccurate and date/time stamps on images could indicate that of the citizen scientists home country and not the actual date and time at the study site. Data on survey effort was also unavailable. Long & Azim (2017) concluded that citizen scientist contributions to photo-ID studies of in-water sea turtles was likely to be effective, but that specific training in how and when to photograph nesting sea turtles might be required.

The potential limitations in the use of citizen scientists to collect data about in-water and nesting sea turtles does not detract from the volume of information gathered in the two studies described above, or the contribution of the studies to greater understanding of sea turtle biology, informing policy development, and raising public awareness of threats to sea turtle populations. The research approach may be of use to other projects throughout the Indian Ocean and Southeast Asia, and its varied application can be understood further by reading other recent examples involving citizen scientists in sea turtle research, including those below.

Hof, C.A.M., E. Smallwood, J. Meager & I.P. Bell. 2017. First citizen-science population abundance and growth rate estimates for green sea turtles *Chelonia mydas* foraging in the northern Great Barrier Reef, Australia. *Marine Ecology Progress Series* 574: 181-191.

Williams, J.L., S.J. Pierce, M.P.B. Fuentes & M. Hamann. 2015. Effectiveness of recreational divers for monitoring sea turtle populations. *Endangered Species Research* 26: 209-219.

Williams, J.L., S.J. Pierce, C.A. Rohner, M.M.P.B. Fuentes & M. Hamann. 2017. Spatial distribution and residency of green and loggerhead sea turtles using coastal reef habitats in southern Mozambique. *Frontiers of Marine Science* 3: 288. doi: 10.3389/fmars.2016.00288.