

Artisanal fishers help to map marine turtle distribution and bycatch: further evidence for an important foraging ground in Famagusta Bay, North Cyprus

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Introduction

Many marine turtle populations have suffered historic declines due to harvesting and fisheries bycatch. In the Mediterranean, approximately 2,000-3,000 loggerhead turtle (*Caretta caretta*) and 300-400 green turtle (*Chelonia mydas*) females nest annually (Broderick *et al.* 2002) in the eastern basin countries of Greece, Turkey, Cyprus and in the Levant. These populations are of elevated conservation concern (Wallace *et al.* 2011) due to their low numbers, geographic isolation and the combined threats acting upon them, including coastal development and pollution, but chiefly fisheries bycatch. It is estimated that at least 132,000 marine turtles are caught annually in the region of which 44,000 are thought to die (Casale 2011).

Bycatch by artisanal fisheries has the greatest impact on these vulnerable populations because they operate close to the coast due to limited vessel range. They thus selectively impact on large individuals which have completed the pelagic juvenile foraging phases that most marine turtle species undergo after hatching. Being closer to their optimal fecundity than smaller animals, and with higher natural survival probabilities, such large individuals are the population mainstay and their loss is felt hardest.

Artisanal fisheries are difficult to study. Vessels are numerous, fishing techniques varied and catch record keeping often limited. The scale of their bycatch is consequently difficult to assess. Artisanal fisheries are difficult to control and police because of their dispersed nature. On the other hand, they are often associated with economically poor communities where fishing provides important employment and a source of much needed food. The study described here was designed to improve understanding of the impact of artisanal fishing by developing a participatory methodology with fishers to help us understand the nature and distribution of marine turtle bycatch along the coast of North Cyprus. This is an area where bycatch in trammel nets (targeting siganid fish) is known to inflict a heavy toll on green and loggerhead turtles (Snape *et al.* 2013).

Methods

Compact waterproof cameras were distributed to the captains of 14 fishing vessels along the North Cyprus coast. The captains were well acquainted with the survey team through a previous bycatch study (Snape *et al.* 2013) and agreed to help, also giving permission for us to attach commercially available 'I Got U' GPS loggers (Mobile Action Technology, Inc.) to the canopies of their vessels. Loggers were programmed to record coordinates every three to four minutes; battery lifetime was typically three to six weeks. Fishers allowed us to board their boats when unattended in ports to access equipment (stored in an unlocked kit box). Camera SD cards were downloaded, batteries serviced and loggers replaced. Vessels were visited at roughly two-month intervals between May 2013 and November 2014.

Fishers were asked to photograph all marine turtle bycatch and, where possible, to include photos of specimens during hauling in or alongside the gear in which they were caught, thus enabling us to determine the site of capture, the gear type responsible for their capture, the approximate mesh size of nets and the extent of turtle entanglements. From some photos we were also able to determine the physical state of the entangled turtle. Turtles' sex was sometimes determinable due to the presence/absence of an elongated tail, while for nearly all photos the size of the turtle (carapace length, CL) was categorised into size classes of small (<40cm), medium (40-60cm) and large (>60cm). Logger data were examined using the programme @trip (Mobile Action Technology, Inc.). Where turtles were obviously photographed during or shortly after hauling, the location coordinates with the nearest time stamp to the time recorded in the photograph metadata were assigned to mark the capture location. Where the turtle was photographed after hauling during return to port, the trammel net set that had occurred immediately prior to the time recorded in the photograph metadata was assumed to be the set in which the turtle was caught and a coordinate was selected from the mid-point of the set as a best estimate for point of capture. All sets were parallel to bathymetric contours, so the error of these estimates along an axis perpendicular to the coast is likely to be low. However, net sets are 0.5-3.0km in length so these estimates could have an error of ± 1.5 km along an axis parallel to the coast. Logger data were also used to derive soak times of those sets which resulted in turtle bycatch. This was done by calculating the interval between net deployment and the start of net hauling.

Results and Discussion

Turtles

Sixty marine turtles (31 green, 29 loggerhead) were caught and photographed by fishers. In general green turtles were small (<40cm CL) whereas loggerhead turtles were large (>60cm CL; Fig. 1). This finding is consistent with published

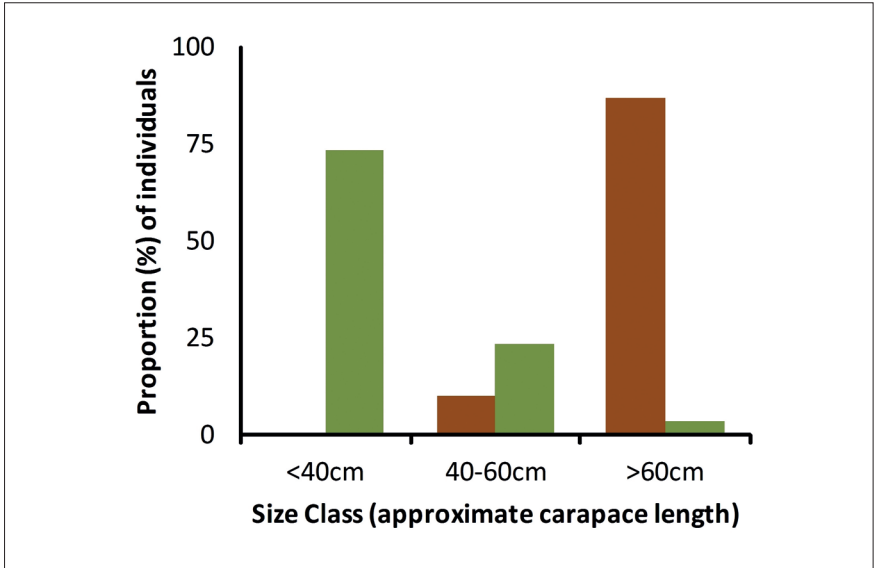


Fig. 1. Approximate sizes (carapace lengths) of loggerhead (brown) and green (green) turtles caught during this study.

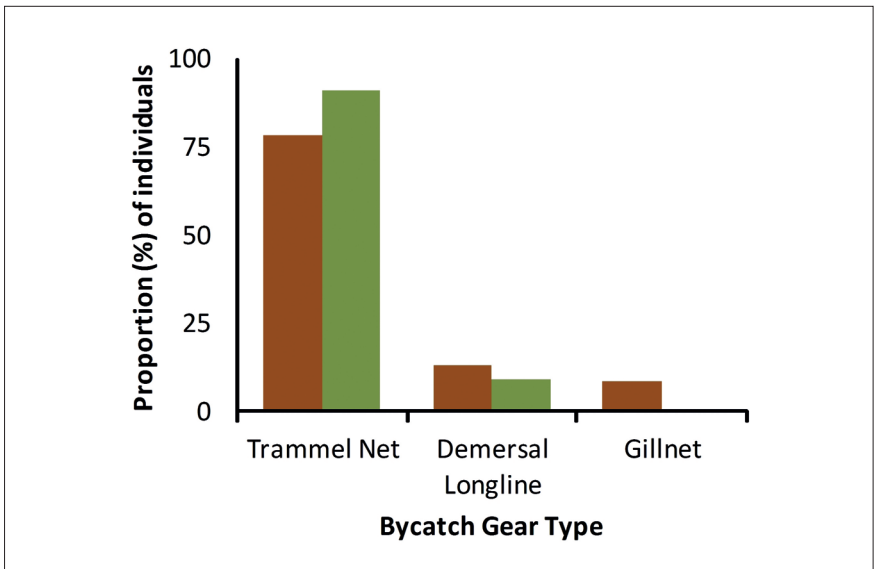


Fig. 2. Gear types responsible for bycatch of loggerhead (brown) and green (green) turtles during this study.

data for bycatch registration and stranded turtles logged in North Cyprus (Snape *et al.* 2013). This finding is important because, although green turtles in the Mediterranean as a whole are fewer than loggerheads and are particularly vulnerable (Broderick *et al.* 2006), in North Cyprus it appears that only small juvenile greens are caught by the fishery. From a conservation viewpoint this is of less concern than the entanglement of large juvenile and adult loggerhead turtles which are of greater reproductive value.

Gears

By far the most turtles were caught in trammel nets. Some green and some loggerheads were also caught on demersal longlines and some loggerheads were caught in gillnets (Fig. 2). Trammel nets were typically ~30mm internal mesh used to target siganid and sparid fish. Where turtles were caught in gillnets the nets had large 100mm meshes and were used for catching greater amberjack (*Seriola dumerili*). Trammel nets were soaked for 12.5 hours (mean). These results are consistent with results published from bycatch registration and anthropological surveys (Snape *et al.* 2013).

Fishers complain that turtles damage their gears and are the cause of great amounts of handling time and this was evidenced by the state of entanglement of some of the turtles, effectively writing off considerable sections of longline and trammel net gears (Fig.3). Both loggerheads and greens were attracted to octopus and squid baited longlines and it seems plausible that complaints from fishers about turtles feeding on fish caught in nets reflect justified economic concerns.

Spatial distribution

We were able to assign location data to 49 of the 60 bycatch turtles and, of these, 49% of locations were derived when the turtle was photographed during hauling (thus providing greater accuracy of the real position of capture) and 51% were assigned from midpoints of sets. Both loggerhead and green turtles were recorded on all coasts, but the majority were caught in Famagusta Bay where two fishers (14% of the total) recorded 42 (70%) turtles (Fig. 4). Satellite tracking data from other studies show that, while the majority of adult female loggerhead turtles that nest in North Cyprus travel to foraging grounds away from Cyprus (as far as Tunisia), 20% stay close to the island (Godley *et al.* 2003; Broderick *et al.* 2007) and 60% of those that stay forage in Famagusta Bay (Snape *et al.*, in prep).



Fig. 3. Examples of equipment damage caused during entanglement in a) trammel nets and b) longlines.

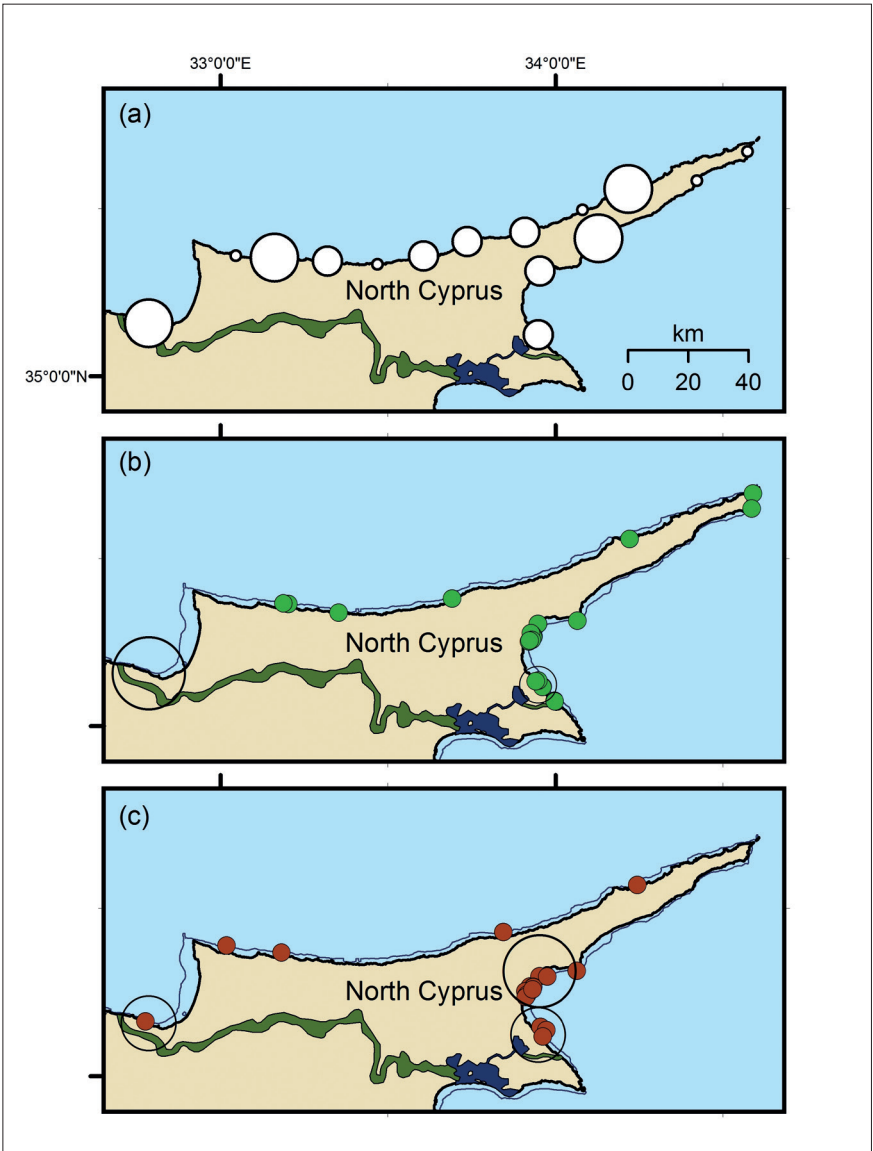


Fig. 4. a) Distribution of ports in North Cyprus and number of participating fishermen per port where small circle=0, medium circle=1 and large circle=2. b) Spatial distribution of green turtle captures where green circles are known or estimated points of capture and large open circles are where turtles were photographed but where no spatial data was available (large circle=1, small circle=3). c) Spatial distribution of loggerhead turtle captures where brown circles are known or estimated points of capture and large open circles are where turtles were photographed but where no spatial data was available (large circle=3, small circle=2).

Temporal distribution

The temporal distribution of turtle captures mirrors published stranding data for North Cyprus (Snape *et al.* 2013), with most bycatch turtles being caught in May, June and July and with a slightly earlier onset of bycatch for loggerheads than for green turtles (Fig. 5). Lower levels of bycatch were recorded during winter months. These results likely reflect trends in seasonal fishing effort, combined with variations in activity patterns of turtles which are affected by water temperatures. Highest rates of dormancy occur in December, January, February and March (Broderick *et al.* 2007). Seventy-six per cent of loggerhead turtle and 61% of green turtle bycatch occurred during the months of May, June and July.

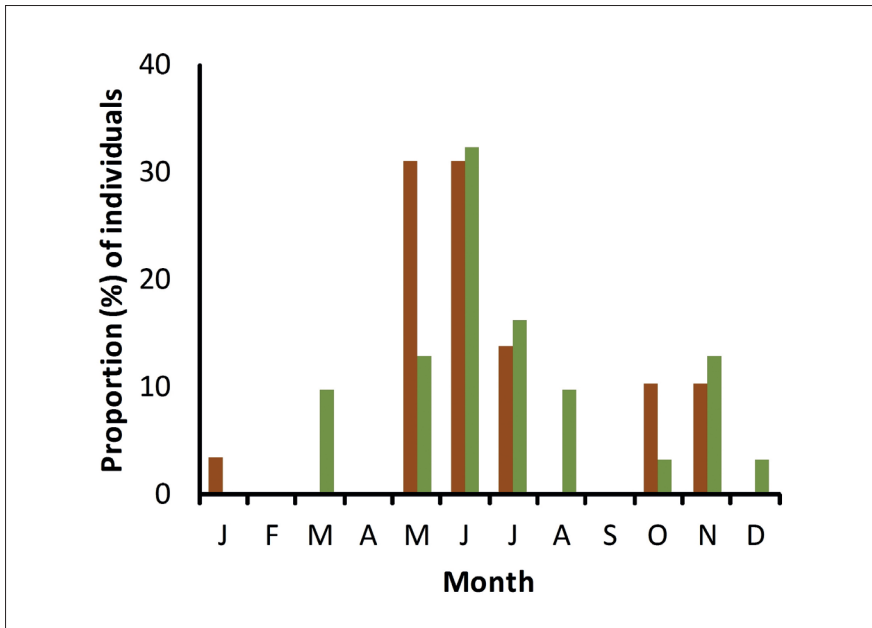


Fig. 5. Temporal distribution of loggerhead (brown) and green (green) turtle bycatch during this study.

Conclusions

This study demonstrates an excellent methodology for triaging marine turtle bycatch in artisanal fisheries which is transferable to other artisanal fisheries worldwide where sufficient levels of cooperation and participation can be established with fishers. The method is relatively cheap, which is an important consideration when it is considered that many artisanal fisheries, particularly those for which data are not available, are in less economically developed

countries and economically marginalised rural communities. The cost of fitting out individual boats is around 160 US dollars with additional monthly service costs for battery (2*AAA) changes and download of data.

Rates of bycatch by fishermen operating from ports in Famagusta Bay are high when compared with fishers elsewhere in the study area, with fishers in these ports reporting the majority of captures. This result reinforces our satellite telemetry studies which show that the area is an important foraging ground for loggerhead turtles. Mortality rates are likely greater than 60% as post-release survivals are not well quantified (Snape *et al.* 2013).

Our results are preliminary, but further studies using the same methodology and incorporating more fishers, with more visits to harbours over more seasons, could be used to produce data of higher resolution at modest cost. More expensive satellite telemetry studies targeting resident foraging turtles in Famagusta Bay, in particular green turtles which have so far not been tracked during foraging in the region, as well as aerial surveys, could also be used to better delimit and prioritise those areas where greatest turtle densities lie, thus optimising the fishable area for fishers and minimising the economic impact of area closures or enforced mitigation.

To reduce bycatch, attention should focus on Famagusta Bay during the months of May, June and July, when a seasonal reduction in the use of trammel nets to target siganids could significantly reduce the toll of the North Cyprus fishery on marine turtles.

Ironically, siganids are invasive non-native fish which colonised the Mediterranean from the Red Sea via the Suez Canal ('Lessepsian migration'). Siganids are known to impact on benthic biodiversity, creating benthic 'barrens' devoid of biomass; Sala *et al.* (2011) encouraged active siganid fishing on the Turkish coast to offset this phenomenon. However, alternative fishing methods that have the potential to catch siganids but impact on fewer turtles could be trialled. In the Lebanon, for example, wire traps are baited with algae in June and July to trap siganids selectively (Sacchi & Dimech 2011). Reducing trammel net soak times could also prove effective in allowing for some siganid fishing whilst reducing marine turtle bycatch and mortality rates. Some success has also been reported from studies where lights are attached to set nets to reduce marine turtle bycatch (Wang *et al.* 2010, 2013).

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