Ocean and Coastal Management 154 (2018) 26–33

Contents lists available at ScienceDirect

Ocean and Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

An evaluation of sea turtle strandings in the Fethiye-Göcek Specially Protected Area: An important foraging ground with an increasing mortality rate

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ARTICLE INFO

Keywords:
Stranding
Fethiye-Göcek specially protected area
Foraging ground
Caretta caretta
Chelonia mydas
Bycatch

ABSTRACT

The Fethiye-Göcek Specially Protected Area (SPA) is an important protected area in Turkey that includes important loggerhead turtle nesting beaches and marine habitats for sea turtles. Here, we analysed the number of stranded loggerhead and green sea turtles in the Fethiye-Göcek SPA, Turkey. A total of 139 dead sea turtles (102 loggerhead and 37 green turtles) were found between the years 2000 and 2016. The majority of stranded loggerheads were considered to be adults (77.45%), while the majority of stranded green turtles were immature individuals (86.49%). Mean annual strandings were 6.0 individuals for loggerhead turtles and 2.2 individuals for green turtles. The main cause of strandings was determined as incidental catch in fishing gear (51% for loggerhead turtle, 41% for green turtle) and marine vehicle collisions (23% for loggerhead turtle and 27% for green turtles). Strandings were encountered all year round. These results suggest that the Fethiye-Göcek SPA should not be only considered as a seasonal nesting ground for loggerhead turtles, but also a year-round feeding ground for both species. An increase in the number of stranded turtles in the study area suggests that negative anthropogenic effects on sea turtle populations are relatively high and that conservation and monitoring efforts on the nesting beaches are not sufficient to protect sea turtle populations. Research is required to identify the fisheries' segments and metiers responsible for sea turtle mortality in order to develop bycatch mitigation, prioritising the marine habitats of the Fethiye-Göcek SPA.

1. Introduction

Three sea turtle species occur regularly in the Mediterranean; Loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea*) (Baran and Kasparek, 1989; Taşkavak and Farkas, 1998; Casale et al., 2003; Türkozan and Kaska, 2010). Loggerhead and green turtles both breed in the Mediterranean, while leatherback turtles from the Atlantic use the region only for foraging (Kasparek et al., 2001; Margaritoulis et al., 2003; Camiñas, 2004). Loggerhead turtles are the most abundant sea turtle species in the Mediterranean (Broderick et al., 2002). The main loggerhead nesting areas are in Greece, Turkey, Cyprus and Libya (Kasparek et al., 2001; Margaritoulis et al., 2003; Canbolat, 2004; Casale and Margaritoulis, 2010) and the main foraging areas are along the North African, Adriatic and north-eastern Ionian continental shelves (Casale and Margaritoulis, 2010; Luschi and Casale, 2014; Stokes et al., 2015). Green turtle habitats are restricted, with a more easterly distribution. The main green turtle nesting areas are in Turkey, Cyprus and Syria (Kasparek et al., 2001; Canbolat, 2004; Rees et al., 2008; Casale and Margaritoulis, 2010) with discrete foraging areas on the coasts of Libya, Egypt, the Levant, Cyprus and Turkey (Stokes et al., 2015; Bradshaw et al., 2017).

Every species of sea turtle is protected by international regulations and conventions (Barcelona, 1976; Bern, 1979; Bonn, 1979). The known nesting species in Turkey are: the loggerhead turtle, which is listed as Least Concern (LC) as a conservation dependant regional subunit in the Mediterranean, and the green turtle, which is listed as Endangered (EN) by IUCN (IUCN, 2017). The main threats to sea turtle populations are coastal development (Ilgaz et al., 2007) and natural predation (Erk'akan, 1993; Broderick & Godley, 1996), incidental catch and intentional killings by fishers (Casale, 2011), and marine vehicle collision (Denkinger et al., 2013; Casale and Margaritoulis, 2010). Entanglement in plastic marine debris is likely a major source of mortality (Duncan et al., 2017). Incidental catch is considered to be the main

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https://doi.org/10.1016/j.ocecoaman.2018.01.003
Received 10 August 2017; Received in revised form 27 December 2017; Accepted 2 January 2018

threat in the Mediterranean and Casale (2011) estimated that over 132,000 sea turtles were captured, of which 44,000 die annually in the region.

Twenty-one nesting beaches were identified along the Mediterranean coast of Turkey (Türkozan and Kaska, 2010) and of these five have been declared as Specially Protected Areas (SPA). Of these specially protected areas, the Köyceğiz-Dalyan SPA, Fethiye-Göcek SPA and Göksu SPA include important marine habitats within their boundaries. Sea turtle research in Turkey has mainly focussed on nesting female populations and their reproductive outputs, with only a few studies conducted on marine habitat use and the factors that threaten them in marine habitats. The most comprehensive incidental catch reports were produced two decades ago from the eastern Mediterranean coast of Turkey and these studies suggested a high sea turtle incidental catch rate by bottom trawlers (Oruç et al., 1997; Oruç, 2001). Other studies have focussed on sea turtle strandings throughout the Turkish coasts of the Mediterranean and Aegean and provide information on the distribution of sea turtles in the Turkish waters of the Mediterranean, Aegean, Marmara and Black Sea (Baran and Kasparek, 1989; Godley et al., 1998; Oruç et al., 2011; Öztürk et al., 2011; Türkozan et al., 2013; Başkale et al., 2015; Tonay and Oruç, 2016). These studies suggest that Turkish coasts host different age classes of both loggerhead and green turtles, with recent haplotype analyses suggesting that the eastern Mediterranean coast hosts foraging turtles largely from Turkish and Cypriot rookeries (Türkozan et al., 2017).

In this context, stranding records of sea turtles are considered to be an accessible and important data source for demographics, temporal and spatial distribution of sea turtles (Poli et al., 2014). Strands can also provide information about key mortality sources toward mitigating anthropogenic factors (Casale et al., 2010). The Fethiye-Göcek SPA is an important nesting ground (Baran and Kasparek, 1989; Canbolat, 2004; Türkozan and Kaska, 2010; Başkale et al., 2016), and is considered to be a green turtle feeding ground (Türkozan and Durmuş, 2000). To determine the main temporal and spatial distribution of the mortalities and the cause of mortalities within the Fethiye-Göcek SPA, we recorded stranding information over 17 years. The study area includes an additional important sea turtle nesting beach, off which small-scale fisheries operate and where recreational marine traffic is high. The strandings are analysed alongside additional environmental factors, such as sea water temperatures, to assess the importance of the Fethiye-Göcek SPA as a suitable feeding ground for both species.

2. Materials and methods

2.1. Study area

The Fethiye-Göcek Specially Protected Area (SPA) in Muğla Province, Turkey includes important terrestrial and marine habitats (Fig. 1). Fethiye, an important nesting area (Baran and Kasparek, 1989; Canbolat, 2004; Türkozan and Kaska, 2010; Başkale et al., 2016), is also an important tourism centre and is the largest town in the area. Göcek is also a growing yacht tourism centre with six marinas. Sea traffic has relatively increased in the last two decades, since the establishment of marinas in the small bays of Göcek and Fethiye. Additionally, Fethiye has a modest fishing port with numerous small fishing boats that are mainly fishing in the region. The primary fishing method is gillnet with demersal longlines also being used.

2.2. Data collections

In this study, we used the term “stranding” only for dead turtles; injured turtles that have been taken to the rescue centre (DEKAMER) were not presented here. Stranding data was collected between 2000 and 2016 using two different methods. The recorded and reported stranding information was gathered from our direct observations of the sea turtle conservation and monitoring projects from May to September, during 2000, 2001, 2011, 2012, 2013 and 2016. Each stranding was investigated visually on site and morphological information was collected. Secondly, additional data was collected from project reports of other years, unpublished reports of NGO's, personal communication with observers, and the media. During data evaluation, unreliable measurements obtained by secondary and tertiary parties were excluded from the calculations.

During on-site observations, Curved Carapace Length (CCL) from the notch to the tip of the carapace was measured, using a soft millimetric tape measure (Bolten, 1999). The maturity and sex of the stranded sea turtles were determined by using tail length. Individuals with CCL > 85 cm and > 70 cm were considered to be adult for green turtles and loggerhead turtles, respectively, according to Türkozan et al. (2013). Previous studies showed similar results for nesting loggerhead females on Fethiye beach (the mean CCL = 74.6 ± 0.89) (Kaska et al., 2011, 2016; Başkale et al., 2012, 2013, 2016; Hoş et al., 2014; Yerli et al., 2015).

Cause of death was determined through necropsy and direct visual observations when necropsy was either not available or not required. Cause of death was categorized as follows: (1) Incidental catch: entanglement in nets, hook ingestions or fishing line detected in mouth, oesophagus, stomach or intestine, or fishing line entangled around body, (2) Intentional killings: strandings injured or pierced with heavy or sharp objects respectively (i.e., hammer, spear gun) (3) Marine debris: debris were detected in stomach and intestine of strandings, (4) Marine vehicle collision: Marine vehicle (speed boat or daily tour boats) directly crashed turtle carapace or; propeller cut to carapace or other body part, (5) Unknown mortality: no obvious cause of death was observable, due to the decomposed body of the stranding, no evidence of death following necropsy or data was obtained from observers via phone calls and/or e-mails, and the media. However, in most cases these will have drowned in set nets (Snape et al., 2013), but we did not include them in incidental catch as we could not find any evidence of drowning.

To assess the environmental factors, the monthly average sea water surface temperature records were taken from Meteorological Stations (Fethiye, Köyceğiz, Marmaris and Bodrum) between the years of 2000–2016.

2.3. Statistical analysis

The stranding data was normally distributed (Kolmogorov–Smirnov D test, all $P > .05$), thus allowing comparisons using parametric tests. We used Pearson's correlation to determine the relationship between the number of strandings and various parameters, such as time (years) and sea water surface temperatures. We used a one-way ANOVA, to see if temperature differed among the four locations in Muğla Province. We also used ANOVA tests to analyse the annual variations of CCL among the studied years in both species. We used Tukey's HSD post hoc test under one-way ANOVA tests when statistically significant differences were found. All statistical analyses were performed with SPSS ver. 20.0 (SPSS, 2011).

3. Results

A total of 139 strandings were found in the Fethiye - Göcek SPA between 2000 and 2016. Of these, 102 (73.4%) were loggerhead turtles and 37 (26.6%) were green turtles. There was a significant, positive correlation in the number of stranded loggerhead turtles (Pearson's correlation: $r^2 = 0.814$; $P < .001$) and stranded green turtles (Pearson's correlation: $r^2 = 0.328$; $P < .05$) among the years (Fig. 2).

The stranded loggerhead turtle data showed that all age classes and both sexes can be found in the Fethiye-Göcek SPA (Table 1). The majority of dead loggerheads were adult females (49.02%), while the proportion of adult males was (19.61%), immature individuals (22.55%) and undetermined adults (8.82%). For green turtles, a