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Feeding-Related Behavioral Changes of Green Sea Turtle *Chelonia mydas* in Mersin Bay, Northeastern Mediterranean

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Research Article

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Abstract

This study was conducted to identify the turtles and their frequency of visiting at the Çamlıbel Fishing Shelter in Mersin Bay (northeastern Mediterranean) between October 2023 and January 2024. During this period, green sea turtle *Chelonia mydas*, typically herbivorous, were observed feeding on bycatch species discarded from fishing nets and fish waste from restaurant boats for the first time. The change in feeding behavior of green sea turtles introduced to the area was confirmed through visual recordings and interviews with restaurant staff and fisherman. The study also reported the arrival of the loggerhead sea turtle *Caretta caretta* and the Nile softshell turtle *Trionyx triunguis* in the area. Habitat destruction in Mersin Bay, caused by anthropogenic factors such as intensive fisheries and tourism activities, has prompted sea turtles to adopt opportunistic feeding strategies, potentially disrupting their ecological balance and survival. This shift highlights the adaptability of green sea turtles to environmental changes and underscores the need to monitor how human impacts affect the feeding and migration of sea turtles to improve conservation efforts.

Keywords: *Green sea turtle, Chelonia mydas, feeding shift, Mersin Bay, northeastern Mediterranean.*

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Introduction

Across the world's oceans, sea turtles are represented by seven species belonging to two families: Cheloniidae and Dermochelyidae. Six species (*Caretta caretta*, *Chelonia mydas*, *Ertmochelys imbricata*, *Lepidochelys kempii*, *Lepidochelys olivacea*, and *Natator depressus*) are classified within family Cheloniidae, whereas family Dermochelyidae contains only *Dermochelys coriacea*. Although five of these species (*C. caretta*, *C. mydas*, *D. coriacea*, *E. imbricata*, and *L. kempii*) are distributed throughout the Mediterranean, *C. caretta*, *C. mydas*, and *D. coriacea* are the ones most regularly observed (Caminas, 2004; Casale et al., 2018). However, only *C. caretta* and *C. mydas* nest in the Mediterranean (Canbolat, 2004; Casale, 2010).

The green sea turtle *Chelonia mydas* (Linnaeus, 1758) is an important marine reptile species distributed in tropical and some subtropical waters of the Atlantic, Pacific and Indian Oceans, and Mediterranean Sea (Kasparek et al., 2001; Scott et al., 2012). Green sea turtles nest routinely in the Mediterranean, with their primary nesting areas include Türkiye, Cyprus and Syria, while they nest less frequently in Israel, Lebanon and Egypt (Türkozan et al., 2013; Casale et al., 2018). It is estimated that there are an average of 2204 green sea turtle nests along the entire Mediterranean coast (Casale et al., 2018). Approximately 60% of these nests (1331 nests per year) have been reported along the Turkish coast (Özdilek et al., 2020; Turan et al., 2021). They are recognized for their highly migratory patterns, ability to navigate various habitats, long lifespans, and diverse migration behaviors (Aguirre and Tabor, 2004; Poloczanska et al., 2009). *C. mydas*, despite their importance, are classified as Endangered (EN) by the IUCN Red List criteria due to numerous human-induced and environmental threats (Seminoff, 2023).

Green sea turtles embark on long migrations between their birthplaces, pelagic habitats, and coastal feeding areas, navigating through several distinct stages of life, from hatchling to juvenile, subadult, and adult (Read et al., 2014). During breeding migrations, they arrive at nesting beaches; increases in testosterone in males and both testosterone and estrogen in females are important physiological stimuli that initiate this process. Turtles only come ashore to spawn and spend the majority of their lives at sea (Witherington, 2006; Wyneken et al., 2013). Feeding migrations involve returning to and moving between feeding grounds after breeding (Tanabe et al., 2023). They travel long distances to reach different feeding grounds in this process (Mancini et al., 2018). Migrations play a critical role both in maintaining the health of turtles and in transferring nutrients and genetic diversity between ecosystems (Witherington, 2006).

The diet of green sea turtles evolves over time, starting as primarily carnivorous with small invertebrates during the hatchling phase, and shifting to mainly herbivorous, feeding on seagrasses (especially *Thalassia* sp., *Syringodium filiforme*, and *Halodule* sp.) and macroalgae (such as *Polysiphonia* sp., *Rhizoclonium* sp., *Ulva* sp., *Sargassum* sp.) as adults (Devaux and De Wetter, 2000; Houghton and Hays, 2003). However, geographical differences and anthropogenic factors may alter these feeding behaviors (Fukuoka et al., 2016). The feeding behavior of green sea turtles helps maintain the balance of the marine ecosystem (Godley et al., 2008). Throughout their lives, green sea turtles face various challenges that impact their health, including changes in water temperature and quality, food availability, and habitat degradation. Additionally, exposure to pollutants, pathogens, and climate change poses significant risks to their overall well-being and lifespan (Arienzo, 2023).

The green sea turtle is a critically important species facing numerous threats, including habitat loss, pollution, climate change, and poaching. Its natural migration and feeding behaviors can be affected by human activities, including artificial feeding. Thus, this study aimed to evaluate the consumption of fish waste from restaurant boats and non-target seafood by green sea turtles in Mersin Çamlıbel Fishing Shelter.

Material and Methods

A total of eight surveys were conducted to identify the species of turtles and their visiting frequency at the Çamlıbel Fishing Shelter between October 2023 and January 2024 (Figure 1). To avoid recording the same individual twice, one observer worked on restaurant boats, and the other on fishing boats returning from fishing, with the evaluations carried out simultaneously. For the first time, *Chelonia mydas*, classified as an herbivorous sea turtle species, was observed consuming discarded species from fishing nets and fish waste from restaurant boats throughout the study period. On the other hand, interviews were conducted with restaurant staff and fishermen to gain more detailed information about the frequency with which turtles visit the area, how often and what types of food people provide to the turtles, and changes in feeding behavior associated with human interaction.

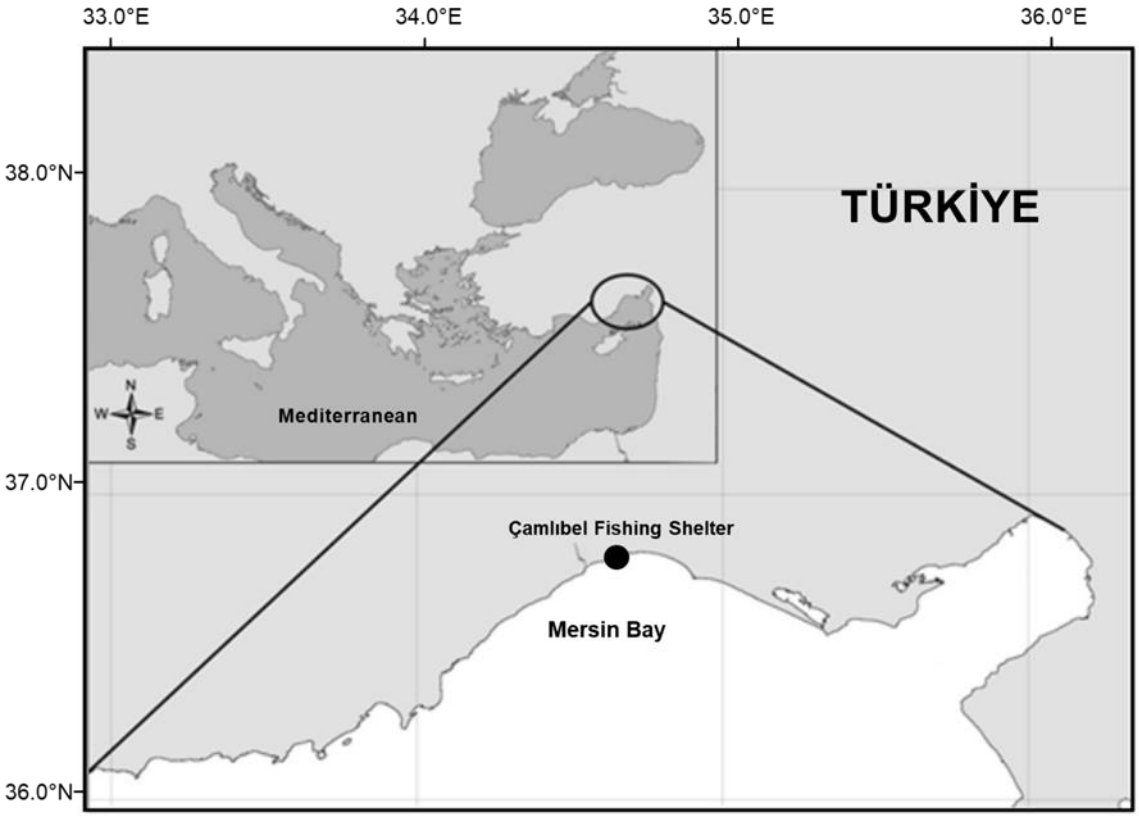

Figure 1. Study area map showing Çamlıbel Fishing Shelter located in Mersin Bay (northeastern Mediterranean).

Additionally, bottom sediment samples were collected to determine the potential impact of fish waste and non-target seafood on the chemical environment of the coastal waters of Çamlıbel Fishing Shelter. The suitability of the samples for macrozoobenthic organisms was assessed by

measuring the oxidation-reduction potential (ORP), which reflects redox reactions within the sediment. Measurements were made by immersing the ORP probe directly into the sediment, with three replicates taken at each station and temperature-corrected according to ISO 12878:2012. According to the ASC standard, an ORP threshold of >0 mV was considered a confidence level indicating aerobic conditions.

Result and Discussion

At Çamlıbel Fishing Shelter (Mersin Bay), a total of 102 turtle visitings were observed between October 2023 and January 2024. Of these turtles, green sea turtle *Chelonia mydas* and loggerhead sea turtle *Caretta caretta* are marine species, while Nile softshell turtle *Trionyx triunguis* primarily dwells freshwater and brackish water but can also be found in coastal marine habitats. Based on species-specific visiting frequencies in the area, *C. mydas* appeared most often (65 times), then *C. caretta* (33 times) and *T. triunguis* (4 times).

Observations have shown that *C. mydas*, *C. caretta*, and *T. triunguis* feed on non-target species discarded from fishermen's nets and fish waste from restaurants. Interviews with boat staff and fishermen revealed that this feeding activity by turtles at the Çamlıbel Fishing Shelter has been happening for years, with an increasing number of *C. mydas* and *C. caretta* individuals visiting the area year-round and often staying throughout the year. The continuous release of waste provides a consistent food source for the turtles, indicating a major change in their migration and feeding habits. Some individuals of *C. mydas* and *C. caretta*, which usually arrive on the coast for breeding in April and May and migrate to open waters in August and September, are now staying in the region year-round, skipping their usual winter migration.

The sediment from Çamlıbel Fishing Shelter was dark, foul-smelling, sticky mud. Macrozoobenthic sampling found no organisms in the bottom sediments, indicating the substrate is unsuitable for benthic fauna. On the seafloor, pollutants are transformed by chemical reactions and microbial activity, and negative redox potential values signal anoxic conditions. Anaerobic bacteria break down organic matter using sulfate as an electron acceptor and release hydrogen sulfide, which drives the redox potential down. Redox potential, measured as oxidation–reduction potential (ORP), distinguishes aerobic (positive mV) from anaerobic (negative mV) settings. The ORP analysis gave an average of –180 mV in the bottom sediment, confirming anoxia and the absence of macrozoobenthos. These findings reinforce that sea turtles frequent Çamlıbel Fishing Shelter solely for discarded fish waste from restaurant boats and by-catch from small-scale fishing. The shelter lies within Mersin International Port—one of Türkiye's largest ports—where no natural turtle feeding habitat exists inside or nearby. The area is increasingly polluted by heavy industrial traffic and urbanization. The closest natural feeding grounds for sea turtles are along the coast between Karaduvar and the Berdan stream inlet, to the east of the port.

Known as the gardener of the seas, *C. mydas* consumes plankton and small marine organisms from hatching until adulthood (Heithaus et al., 2014). As they approach adulthood, their diet shifts to an herbivorous feeding pattern (Bjorndal, 1997). Observations showed that green sea turtles regularly feed on waste at the Çamlıbel Fishing Shelter significantly deviated from their natural feeding habits, adopting more opportunistic behavior (Figure 2). This behavior could prevent them from migrating

to traditional feeding grounds, leading to isolation from the main population and reduced genetic diversity, with serious ecological impacts (Luke et al., 2004; Alvarez-Varas et al., 2022).

Figure 2. *Chelonia mydas* individuals fed by humans at Çamlıbel Fishing Shelter (Mersin Bay).

On the other hand, green sea turtles play a vital role in maintaining the health and recovery of seagrass meadows, which are crucial for marine ecosystems. By continuously grazing on seagrass, they prevent overgrowth and uncontrolled proliferation (Taquet et al., 2006; Gifari et al., 2018). This helps create favorable conditions for marine biodiversity and sustains the balance of coastal ecosystems (Lazar et al., 2010). However, factors like climate change, pollution, and intensive fishing can degrade macroalgae and seagrass habitats, influencing the feeding behavior of *C. mydas*. In response, they might turn to alternative food sources, such as protein-rich seafood like fish (Hatase et al., 2006). Studies by Heath (2008), Halpern et al. (2008), and Godoy and Stockin (2018) indicate

that human activities have disrupted marine habitats, pushing green turtles to alter their feeding strategies and abandon traditional grounds. For example, in Mersin Bay's Çamlıbel Fishing Shelter, habitat destruction from fishing and tourism has led turtles to opportunistic feeding in areas with easy food access. While this offers short-term benefits, it could undermine their ecological roles in the long term.

In conclusion, this study suggests that green sea turtles' feeding habits may change depending on environmental conditions, sometimes even shifting to fish consumption. These changes can disrupt the species' population dynamics and marine ecosystem balance, negatively impacting their health and reproductive performance. While human-generated fish waste may provide easy food in the short term, it poses a long-term risk to natural dietary balance and behavior. Therefore, proper disposal of fish waste, raising public awareness, and continuing studies to reveal the effects of changes in feeding habits are crucial. Further studies are also needed to explore the comprehensive ecological consequences of these behavioral adaptations and to develop targeted conservation strategies that address the root causes of these changes.

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Conflict of Interest

The authors declare that for this article they have no actual, potential or perceived conflict of interest.

Author Contributions

D.A., C.K., and A.U. contributed to the original draft preparation, review, and editing, provided critical feedback, participated in experimentation and organizational tasks, discussed the results, and helped shape the overall direction of the research. D.E. designed of the article, corrections and, supervision. S.M. discussed the results and commented on the manuscript, critical feedback, experimentation, organization and helped shape the research. H.E.Ç., M.C.A., B.U., and A.U. provided critical feedback, experimentation, organization and helped shape the research. N.N.M. and M.S. discussed the results and commented on the manuscript, critical feedback, experimentation, organization and helped shape the research. E.E.E commented on the manuscript, critical feedback. A.U. provided critical feedback, experimentation, correction, organization and revise the version to be published.

Ethical Approval Statements

No ethics committee permissions are required for this study.

Data Availability

The visual data used in the present study are available upon request from the corresponding author.

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