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# Three decades of sea turtle rehabilitation in Greece (1995-2024) reveal high anthropogenic impact

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## Abstract

ARCHELON's Sea Turtle Rescue Centre (STRC) was established in 1994 in Glyfada, Attica, with the main objectives to rehabilitate injured turtles, assist in determining their threats at sea, and contribute to public awareness. Here, we present the main results of the STRC's 30-year (1995-2024) operation, evaluating its rehabilitation effectiveness and drawing conclusions on the main threats that turtles encounter in the Greek seas. During this period, 1,539 turtle admissions were registered, with annual numbers showing a significant positive trend. Clinical examination identified the cause of injury for 87% of admissions, with 87.3% of them assigned to fisheries interaction (n=1,170), including those bearing injuries inflicted intentionally following incidental capture (n=595). In total, more than 71% of turtles rehabilitated for more than five days were released to the wild (n=842). Released turtles generally exhibited positive post-release behaviour as indicated by subsequent observations (live sightings or nesting activity) and by satellite telemetry, although more research is needed to confirm this, especially in the case of head traumas. Notwithstanding the relatively small number of released turtles, contributing modestly to sea turtle conservation in terms of increasing population viability and abundance, the role of the STRC is paramount in covering the social need for wildlife welfare, as well as being an important vehicle of public awareness and education.

**Keywords:** wildlife rehabilitation; *Caretta caretta; Chelonia mydas*; fisheries interactions; Mediterranean.

## Introduction

Wildlife hospitals or rescue centres, established to rehabilitate injured and sick animals, contribute greatly in fulfilling a social need for rehabilitation and welfare of wild animals. They also provide insights on possible threats, both anthropogenic and natural that impact wildlife (e.g., non-human predation) (Pyke & Szabo, 2018). Further, they play important roles in raising public awareness through social media and visitation by the public (Feck & Hamann, 2013).

The aforementioned characteristics are prominent in the case of sea turtles, which use a variety of habitats and hence are exposed to a plethora of mainly anthropogenic threats on land and at sea (Wallace *et al*., 2011). While threats on land during the reproduction period are easier to assess, threats at sea remain largely unresolved (Bolten *et al*., 2011). Sea turtle rescue centres, which admit turtles injured as a result of various causes, can help in assessing threats that turtles encounter primarily at sea.

Three species of marine turtles are encountered in the Mediterranean. Of these, two −the loggerhead turtle *Caretta caretta* and the green turtle *Chelonia mydas*− have established regional populations while the third –the leatherback *Dermochelys coriacea*− is a rare visitor from the Atlantic (Casale *et al*., 2018). In Greece, only the loggerhead turtle breeds regularly, from about the end of May until the middle of August, at several nesting areas, two of which –Kyparissia Bay and Zakynthos− host the largest nesting aggregations in the Mediterranean (Casale *et al*., 2018). Sea turtle nesting in the Mediterranean is showing a long-term increase following a general global pattern (Mazaris *et al.*, 2017).

ARCHELON, the Sea Turtle Protection Society of Greece, has been working for the study and conservation of sea turtles since its foundation in 1983. A major component of its work is the rehabilitation of injured and sick turtles found stranded along the Greek coastline. Historically, levels of turtle strandings were highlighted through the Sea Turtle Rescue Network, instigated by ARCHELON in 1990 (Nantsou & Antipas, 1992), with subsequent authorized involvement of the Coast Guard (CG). In 1994, ARCHELON established a Sea Turtle Rescue Centre (STRC) in Glyfada, Attica, in cooperation with the local municipality. Besides its rehabilitation work, the STRC is visited by schools in the context of an ed-

ucational program bearing the approval of the Ministry of Education, as well as by the general public through guided visits for public awareness purposes (Rees, 2005).

Here, we analyse the main sea turtle rehabilitation results over the STRC's 30-year operation (1995-2024) assessing the annual admissions trend, species admitted, the geographical and temporal distribution of admissions, focusing on the cause of injuries in an attempt to draw possible conclusions on threats faced by sea turtles. We further examine the fate of admitted turtles, including releases and deaths, while also considering the post-release behaviours recorded for rehabilitated individuals.

## Materials and Methods

### *General description of the facilities, transport and reporting of turtles*

ARCHELON's STRC is located in Glyfada, a large seaside peripheral town about 20 km from the centre of Athens, on a 2,500 m$^2$ plot by the sea (37.8639° N, 23.7417° E), next to a yacht marina. The STRC started as a makeshift installation consisting of two train wagons donated by the Hellenic Railways. Following several expansions, as of 2024 it is comprised of seven renovated train wagons and three movable containers used for surgery, preparation of food, public exhibition and souvenir shop, presentation and meeting rooms, volunteer housing, office, and store (Fig. 1). The STRC has 42 pools, of which six are larger and set outside for the final preparation of the recovered turtles before their release, eight are assigned to intensive care, and 28 for ordinary care. The assigned intensive care pools and 20 of the ordinary care ones are located in two "greenhouse" installations which provide warmer temperatures in winter. Most pools have a continuous circulation of sea water pumped from the sea.

Injured turtles are reported to the STRC by the CG and citizens. The term "injured" here encompasses injured as well as sick, weak or exhausted turtles. A 24/7 telephone number has been made available to CG stations and to members of the general public for the prompt reporting of an injured turtle. Citizens that report an injured turtle directly to ARCHELON are advised to notify the nearest CG station. The CG arrange the transport of the injured turtle to the STRC, completing a «Stranding Sheet» containing basic information on the finding of the turtle.

Most injured turtles reach the wider Athens area through different modes of public transport (ferry, train, bus, and airplane). The STRC's designated car or volunteers' private cars collect the turtles from the terminals and bring them to the STRC. Care is taken to transport the injured turtle as soon as possible.

### *Initial assessment*

Upon admission, the usual procedure includes species and sex identification, measurements and initial assessment of possible cause of injury. After cleaning the turtle, specific medication (e.g., antibiotics, painkillers, vitamins, fluids) is administered. Subsequently, the animal is placed into a tank and left undisturbed to recover from the stress of transportation and handling. When turtles are assessed to be in critical condition due to heavy injuries or exhibiting difficulty to breathe due to lung infections, they are either placed in a tank with very low water level or remain out of water in a designated area (e.g., surgery room). Turtles admitted are given names to facilitate communication on their treatment while at the STRC.

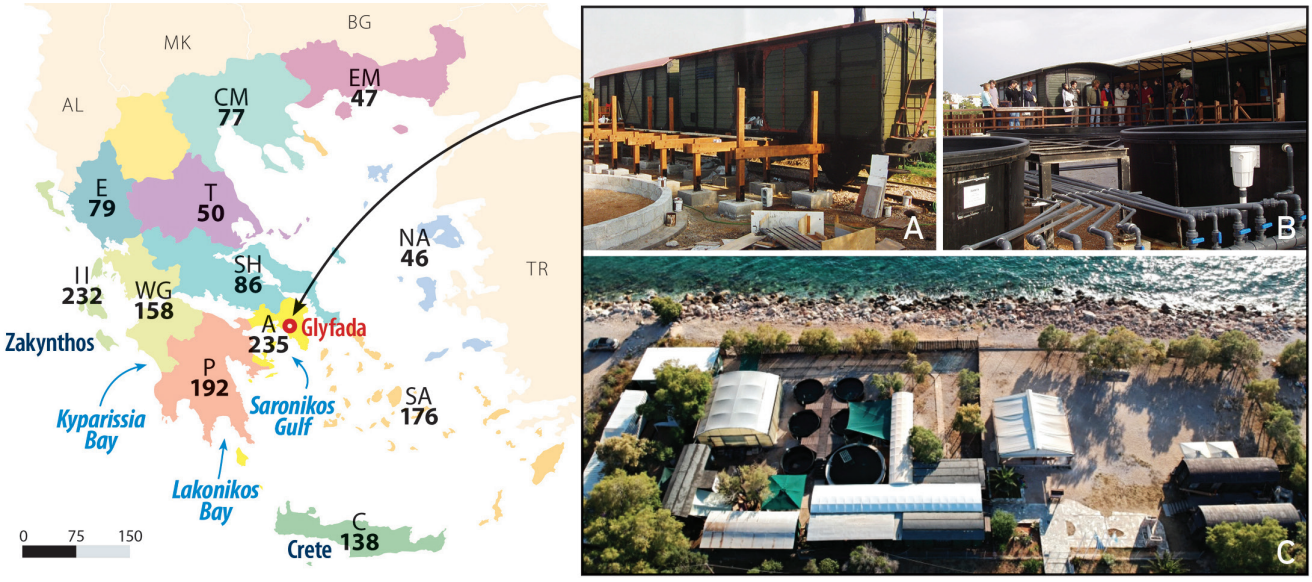


***Fig. 1:*** Map of Greece showing the location of the STRC in Glyfada and the numbers of turtle admissions per administrative region of Greece, in the 30-year period 1995-2024 (total admissions of known geographic location: 1,516). A: Attica, C: Crete, CM: Central Macedonia, E: Epirus, EM: East Macedonia & Thrace, II: Ionian Islands, NA: North Aegean Islands, SA: South Aegean Islands, SH: Sterea Hellas, P: Peloponnese, T: Thessaly, WG: West Greece. Photos show views of the STRC in different periods [A: Construction works in 1994, B: The sea water circulation system in 2004, C: Aerial photo in 2019 (by Jarne Surmont)].

### *Classification of causes of injury*

The turtles at the STRC are initially filed depending on the cause for which they were primarily admitted for treatment. However, the initial diagnosis might change if, following medical examinations, a different cause of injury is detected.

Overall, the cause of admission is assigned to one of the following categories. An experienced observer can differentiate among them following close inspection, especially if this is supported by radiographs and haematological tests.

H(d): Anthropogenic direct injuries; these are usually inflicted intentionally following incidental capture in fishing gears. They are mainly in the form of deliberate blows on the head or the eyes, and less commonly in the form of stabbings in the neck or in the plastron.

H(f): Fisheries interaction; identified through hook ingestion (detected visually or through X-rays), extraction of esophagus/stomach, fishing lines extended from cloaca or mouth, pieces of fishing gear present, constricted limbs and other flipper injuries thought to have been caused by entanglement, jaw and neck injuries (from hook extraction attempted by fishers). This category includes category H(d) as the great majority of directly inflicted injuries occur after capture in fishing gears.

H(i): Anthropogenic indirect causes; injuries by boat strikes, ingestion of or entrapment in plastics, presence of tar or oil.

N: Natural causes; cold-stunning, pneumonia and other pathogenic infections, including also weak and lethargic turtles as well as turtles with buoyancy disorders.

P: Predation; by sharks, monk seals and/or dogs (in the case of nesting turtles). Although "predation" belongs to the "natural" category it is independently assessed to discern causes of injury in greater detail.

U: Unknown; cause of injury not known.

### *Treatment protocols*

Over the years, admitted turtles are treated according to the best available rehabilitation and medication knowledge. Treatment procedures are adapted and revised with respect to the most up to date methodologies brought to the attention of STRC staff.

Depending on the admission cause and the clinical state of the turtle various rehabilitation protocols are applied and information on medical and wound care, weight change, nutrition, environmental enrichment and behaviour are recorded during rehabilitation (not analyzed here).

In cases when injured turtles have heavy injuries or other conditions with a poor prognosis that would result in significant life-long debility, preclude survival in the wild and compromise their welfare, euthanasia is considered and performed by the STRC veterinarian. Alternatively, when appropriate, they are relocated to suitable aquaria for public awareness reasons, always in compliance with the required formal administrative procedures.

Carcasses are collected from the STRC by the competent municipal authority for burial.

### Definitions used in the analysis

Some turtles, despite best efforts, are recorded dead upon arrival at the STRC; these are admitted as DoAs (Dead on Arrival), and only basic characteristics (origin, species, size, sex, cause of injury) are registered.

To accurately evaluate the degree of rehabilitation success, turtles that died within the first five days of admission are excluded from further analyses, as any procedures applied could not have influenced their fate. This time period is based on the pharmacokinetics of the administered medication in relation to the turtle's temperature, as temperature plays an important role in the effectiveness of medications. Hence, we define as "clear deaths" those deaths that occurred after the first five days following admission. Similarly, turtles with minor injuries, not requiring a regular rehabilitation plan, that were released within five days from admission are not categorized as "true releases".

### *Release: Criteria, tagging and post-release monitoring*

Turtles undergoing regular rehabilitation procedure are considered fit for release when they meet specific predefined criteria: (1) no medication for at least two weeks; (2) the ability to eat on their own and to capture live prey; (3) good body condition; (4) no diseases or lesions (wounds, tumours, skin irritation, epibionts or endoparasites); (5) normal digestive function; (6) the ability for active movement, swimming and diving; (7) the capacity to lift head and breathe normally; (8) attempts to move when on dry substrate; (9) normal blood test parameters for 2–4 weeks. Since 2016, turtles considered for release undergo an environmental enrichment process, which is reported to assist re-adaptation to the wild, especially in the case of turtles requiring long rehabilitation time (Monreal-Pawlowsky *et al*., 2007). Releases are done usually from sandy bays in southern Attica, about 30-40 km from the STRC, known to have minor boat traffic and fishing activities. At times, releases are organized as public events for environmental awareness purposes.

To evaluate the effectiveness of rehabilitation and the post-release behaviour of rehabilitated turtles, all turtles larger than 30 cm SCL (Straight Carapace Length) are tagged using external flipper tags. These bear the address of ARCHELON. In addition, since 2020, hypodermic PIT (Passive Integrated Transponder) tags are applied. Further, turtles may be fitted with satellite transmitters to follow their post-release movements.

### *Data analysis and statistics*

For each turtle admission during the 30-year period (1995-2024) the following variables are considered: ge-

ographic location, seasonality, species, admission cause, and fate (e.g., death, release or euthanasia). Since some released turtles were re-admitted, our analyses thereafter concern "admissions" rather than individual "turtles", unless stated otherwise.

For the purpose of our analyses, all data for each turtle are assigned to the year of its admission at the STRC. For all metrics mean values with SD and/or median values are used. The statistical significance of annual trends involving admissions or death rates at the STRC is assessed using the Mann-Kendall trend test. Statistical significance is established when $\alpha<0.05$.

## Results

### *Admissions*

A total of 1,539 turtle admissions were recorded at the STRC from 1 January 1995 until 31 December 2024 (Fig. 2). Of note, the total number of admissions includes 15 turtles that had been previously treated at the STRC, were released and re-admitted to the STRC. These 15 re-admissions involved 13 individual turtles, two of which were re-admitted twice each. Therefore, the number of different turtles that were admitted to the STRC, in the 30-year period, is 1,526 individuals.

Annual admissions ranged from 17 (in 1996) to 92 (in 2014) with a mean of 51.3 admissions/year (Fig. 2). The annual number of admissions shows a significant positive monotonic trend (Mann-Kendall trend test; $p = 0.031$, tau = 0.283), with two distinctive peaks, centred around the years 2001 and 2014 (Fig. 2).

All three species of sea turtles that are encountered regularly in the Mediterranean Sea have been admitted to the STRC, with the great majority being loggerhead turtles (94.7%); a percentage of 5.2% were green turtles. Only one leatherback turtle (CCL = 131 cm) which was stranded alive and very weak after entrapment in fishing nets, on 25 June 1996, about 35 km from Glyfada has been taken to the STRC. The animal died during transportation. The performed necropsy revealed many plastic sheets in the rectum, colon and mainly in the stomach. These plastic sheets added up to a total surface area of about 9.8 $m^2$.

Injured turtles arrived at the STRC from all coastal administrative regions of Greece, with the highest numbers from Attica (235; 15.5%), the Ionian Islands (232; 15.3%), Peloponnese (192; 12.7%) and the South Aegean Islands (176; 11.6%), while lower numbers arrived from the North Aegean Islands (46; 3.0%), East Macedonia & Thrace (47; 3.1%), and Thessaly (50; 3.3%) (Fig. 1).

Temporal distribution of admissions exhibited great seasonality with highest numbers (717; 46.6%) occurring during the summer months (June – August) (Fig. 3).

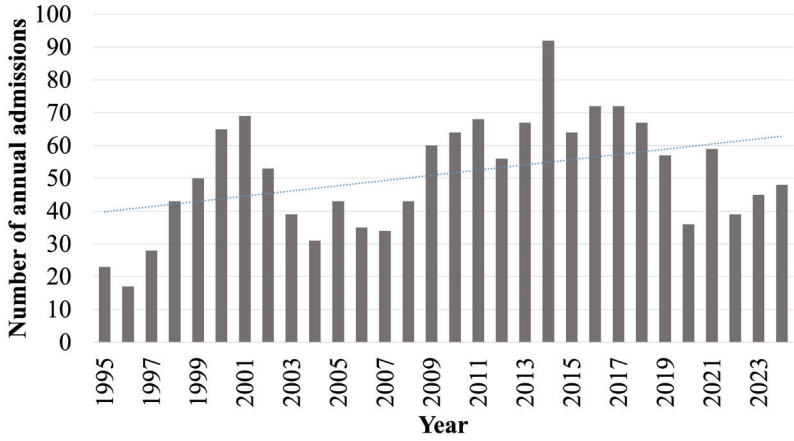


***Fig. 2:*** Numbers and linear trend of annual admissions to ARCHELON's STRC in Glyfada in the period 1995-2024 (n=1,539 admissions).

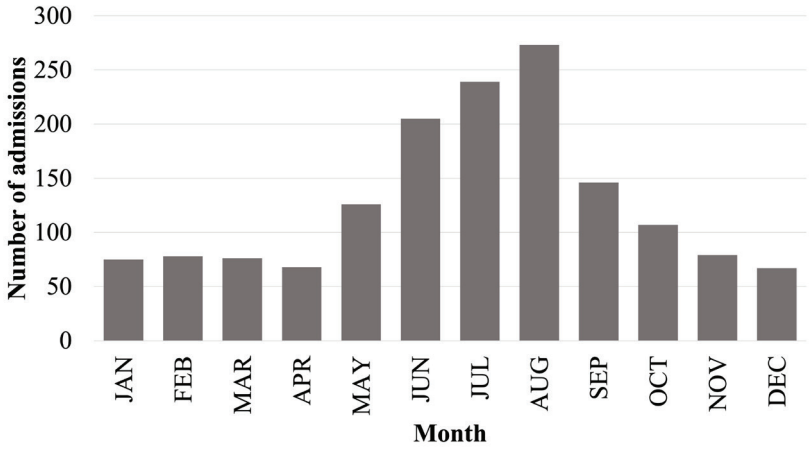


***Fig. 3:*** Turtle admissions per month at ARCHELON's STRC, for the period 1995-2024 (n = 1,539).

### *Causes of injury*

From a total of 1,339 admissions, where the cause of injury was identified (87% of total), the highest percentages were related to anthropogenic direct (intentional) injuries (H(d); 44.4%) and injuries caused as a result of fisheries interaction (H(f); 42.9%) (Table 1). Considering that intentional injuries are commonly inflicted after capture in fishing gears, we conclude that 87.3% of all admissions of known cause were the result of fisheries interaction. Of note, for several of the admissions where the cause of injury was characterized as "Unknown" (200 admissions), it could have been also attributed to fisheries interaction but no conclusive evidence was detected. For example, especially during the first years of the STRC's operation, not all turtles were X-rayed to check for hook ingestion, thus leaving possible fisheries interaction cases undetected.

Indirect anthropogenic causes (101 cases; 7.5%), largely involving injuries attributed to boat collisions, were recorded mostly in Saronikos Gulf, where boat traffic is high, and in Laganas Bay, Zakynthos Island, featuring a high concentration of sea turtles in the summer for breeding. Other indirect causes include ingestion of plastics or pollution incidents.

Natural causes (56 cases; 4.2%) involved cold-stunning of sea turtles during the winter months and usually in northern latitudes, as well as sickness (mainly pneumonia) that disrupted the turtles' diving ability. Turtles with injuries caused by predation were admitted from breeding areas (11 cases), where stray dogs attacked nesting turtles, and from Zakynthos (1 case) after a monk seal attack.

In total, anthropogenic threats (incl. deliberate traumas, interaction with fisheries, boat strikes and ingestion of plastics) constitute about 95% of all admissions of known cause.

### *Fate of admitted turtles*

Excluding DoAs (107 cases), the final outcome of the remaining live turtle admissions (1,432 cases) is shown in Table 2.

However, excluding from the above live admissions (n=1,432) all turtles that died or released within the first five days after admission (176 cases), as well as those euthanized (42 cases), those sent to aquaria (5 cases) and those still under treatment (28 cases), we have 1,181 cases that received proper care at the STRC. Of these 1,181 cases, 339 (28.7%) were recorded as "clear deaths" and 842 (71.3%) as "true releases". The annual "clear deaths", as percentage to annual admissions, showed a significant decreasing monotonic trend over time (Mann-Kendall trend test, $p = 0.011$, tau = -0.332) (Fig. 4).

Analysis of head traumas at the STRC in the period 1994-1998 showed that rehabilitation of head injuries required 134 days on average (Fig. 5).

### *Post-release observations*

#### *Deaths of released turtles*

Thirty-nine of the released turtles (4.6% of the "true" releases), identified by their tags, were subsequently found dead through the nationwide Sea Turtle Rescue Network. Deaths were reported after 2-2,210 days (mean = 340 days; SD = 481.4; median = 210 days) from the release date, at distances ranging 5-437 km (median = 62 km) from the release site. It was not possible to examine closely these deaths, and the CG reported cause of death as "Unknown" for 37 individuals. In the remaining two cases the reported cause of death was different from the original cause of injury. We therefore lack adequate information as to whether the released turtles died as a result of the original cause or of a new problem.

**Table 1.** Cause of injury for all admissions of known cause (n=1,339) at the STRC in the period 1995-2024. H(d): Anthropogenic direct injuries. H(f): Fisheries interaction. H(i): Anthropogenic indirect injuries. N: Natural. P: Predation.

| Admission cause | No | % |
|---|---|---|
| H(d) | 595 | 44.4 |
| H(f) | 575 | 42.9 |
| H(i) | 101 | 7.5 |
| N | 56 | 4.2 |
| P | 12 | 0.9 |

**Table 2.** Fate of admitted turtles (excluding DoAs, n = 1,432) at the STRC in the 30-year period 1995-2024.

| Fate category | No | % |
|---|---|---|
| Released | 853 | 59.6 |
| Died | 504 | 35.2 |
| Euthanized | 42 | 2.9 |
| Non-releasable (sent to aquaria) | 5 | 0.3 |
| In the STRC (end of 2024) | 28 | 2.0 |

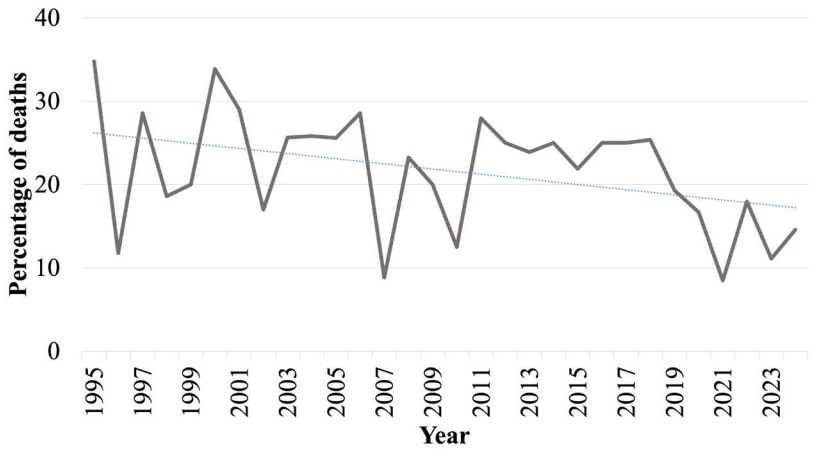


***Fig. 4:*** Trend of the annual number of "clear" deaths, shown as percentage to annual admissions, exhibiting a statistically significant decrease over the period 1995-2024.

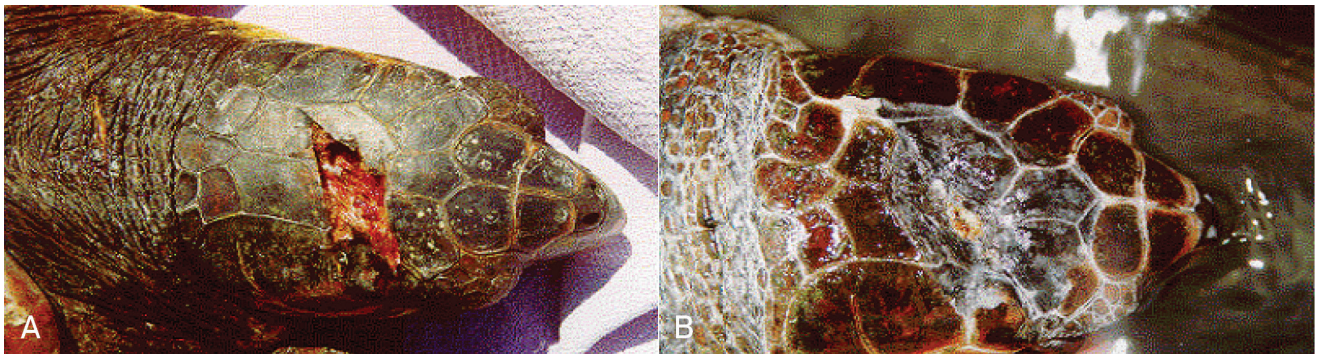


***Fig. 5:*** Intentional head trauma: (A) at admission (12 July 1998) and (B) at release (27 November 1998), after 138 days of treatment.

*Re-admissions*

Fifteen cases of re-admissions, incurred by 13 tagged individual turtles, were documented at the STRC after a mean 207.0 days since the turtles' release (SD = 263.7; range = 2-676 days; median = 77.0 days; n = 15). In about half of these cases re-admitted turtles had a different cause of injury than the one originally recorded. Eleven re-admitted turtles were eventually released after an average rehabilitation duration of 180.4 days (SD = 141.0 days; range = 21-483 days; median = 120 days, n = 11). One re-admitted turtle died during surgery to extract newly ingested hooks and another remains under treatment at the STRC.

*Satellite tracking*

Six turtles, equipped with satellite transmitters in the period 2004-2006, were treated at the STRC for 70-1,994 days (median = 390.5 days); four of them had severe head injuries and two had ingested fishing lines and hooks. Post-release movements were monitored for 16-321 days (median = 59 days) (Fig. 6). Three of these turtles −Sofia, Toby and Samson− released from a beach 35 km south of Glyfada, reached the northern African coast, indicating purposeful movements, while two −Messara (released from Chania, Crete) and Vera− reached Turkey, while one other turtle −Orestis− remained close to its release site (Rethymno, Crete) for 59 days (Fig. 6).

Within the last seven years, we tracked two more turtles after their rehabilitation. The first one, Zoë, admitted from Naxos Island (South Aegean) in September 2018 with diving disorders, was released in Naxos on 30 May 2019 and spent 684 days travelling in a wide part of the Aegean Sea (see Rees *et al*., 2022). The second one, Triton, admitted from Kythnos Island (South Aegean) in October 2023 with a severe and extensive head injury and released on 6 November 2024, headed immediately south reaching the coast of Egypt within a month.

*Released turtles observed alive and nesting*

Thirteen turtles of those released, were observed by divers or fishers after 37–3,158 days following their release (mean = 574.2 days; median = 364.0 days; n = 13). Two of them made long migrations, one was reported in Cyprus and another in Israel. However, the latter was found with buoyancy problems and was admitted to the Rescue Centre of the Nature and Parks Authority of Israel from where she was released after five months (Yaniv Levi, *pers. comm*). In addition to these, three turtles found injured while egg-laying at nesting areas, two with head traumas and one with severe flipper injuries due to dog attack, were rehabilitated at the STRC for an average

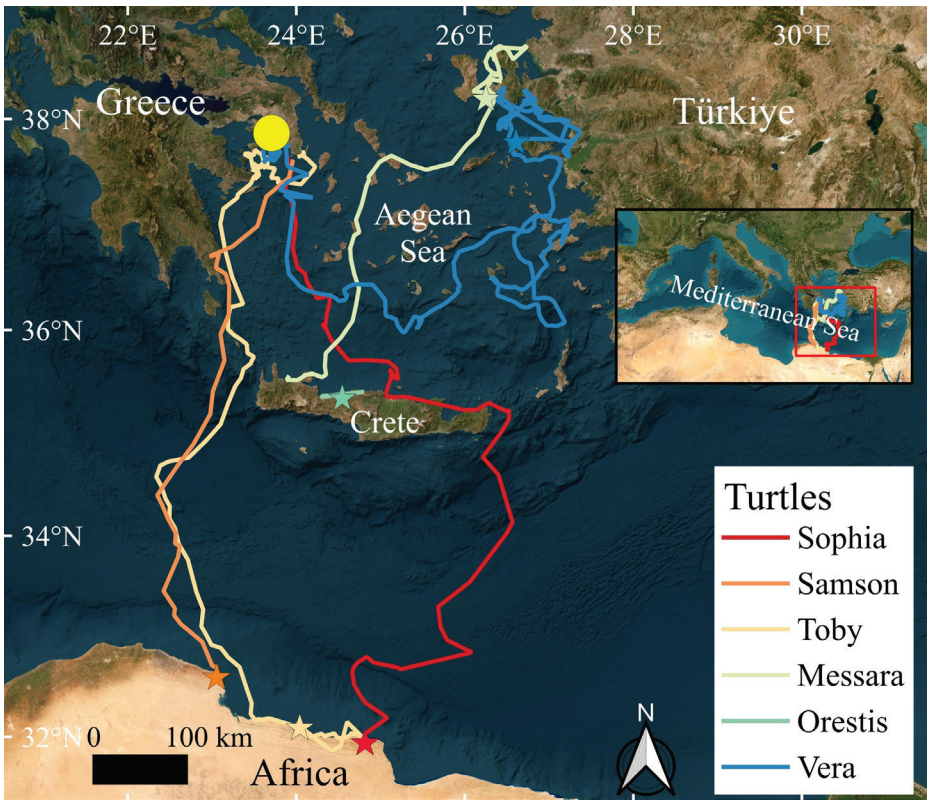


***Fig. 6:*** Satellite tracks of six turtles released after their rehabilitation at the STRC between 2004 and 2006. Yellow circle: location of the STRC and nearby turtle release point. Stars: respective end points for each turtle track.

period of 78.7 days (range = 14-159 days), and after their release were observed nesting at the same nesting areas after 953-1,794 days.

## Discussion

This is the first comprehensive presentation of data on rehabilitated turtles in Greece, including the causes of injury and the fates of the treated turtles. Below, the main data pertaining to injured turtles that have been admitted to ARCHELON's STRC in Glyfada, over the 30-year period (1995-2024) are discussed.

### *Admissions*

It is not clear whether the positive trend of admissions represents a true increase of injured turtles over time or if it is an artefact of the increased awareness of the STRC's operation that would augment reporting of injured turtles. In a previous study (Kopsida *et al*., 2002) it was estimated that in the period 1996-1999 about 20% of injured turtles were not brought to the STRC because its operation was not broadly known. Certainly, many injured turtles remained unreported and subsequently died or drifted offshore.

The noted geographic disparity of the origin of admitted turtles includes a plethora of confounding factors that may interfere with reporting and transporting an injured turtle to the STRC, e.g., distance from the STRC, willingness or ability of local stakeholders to react rapidly, difficulty in arranging turtle transport, sea turtle abundance, level and gears of fishing effort, tourist season and area.

Admission of live leatherback turtles to a rescue centre is an exceptional event, as this species is known to have low survival rates following capture in fishing gears (Levy *et al*., 2005). In the one case presented here the animal was too weak to even survive transport to the STRC.

The increased admissions in June-August is attributed to the increased turtle activity during the summer and to the increased occurrence of relevant anthropogenic threats (i.e., fisheries, tourism) (Casale *et al*., 2010; Snape *et al*., 2013), as well as to the frequent human presence along the coasts that increase the chances of encountering a stranded or nearshore injured turtle.

Of note, sea turtle strandings in Greece, reported by Despoti *et al.* (2025) for the period 2010-2021, as well as strandings in Kuşadasi Bay, Turkey, between 2007-2024 (Türkozan *et al.*, 2026), showed an upward trend over the years with an increased occurrence during the summer. Injured turtles admitted to the STRC followed similar patterns as live-stranded turtles comprise a subset of the generally larger number of dead turtle strandings (Casale *et al*., 2010; Despoti *et al*., 2025).

### *Causes of injury*

Close external inspection as well as X-rays, blood examinations and necropsies provided evidence on the cause of injury for about 87% of the admitted turtles at the STRC. Identification of cause of injury is paramount in recognizing the underlying threats. Stranding records,

collected without close inspection of the turtle by an expert, show lower rates of injury causes (e.g., 25-35% in Despoti *et al.*, (2025)).

About 87.3% of turtles with known cause of injury provided evidence of fisheries interactions. This was expected as fisheries interaction is recognized as the highest threat for sea turtles in the Mediterranean (Tomás *et al*., 2008; Casale *et al*., 2010).

Nevertheless, the percentage of intentional injuries noted in this study (44.4%) is exceptionally high, probably the highest in the Mediterranean. Recent data from Italy show that only 1.5% of 1,877 injured sea turtles, examined at the Sea Turtle Clinic (STC) of the Department of Veterinary Medicine of the University of Bari, bore head traumas (Franchini *et al*., 2023), indicative of purposeful blows. Deliberate head traumas are usually inflicted by small-scale fishers (mainly gill netters) (Kopsida *et al*., 2002; Margaritoulis *et al*., 2007) as a punitive action because of the damage caused to fishing gears (Margaritoulis *et al*., 2007; Panagopoulou *et al*., 2017). Similar attitudes on the part of fishers have been recorded in Cyprus and Turkey (Godley *et al*., 1998; Snape *et al*., 2013). Bottom trawl fishers usually do not harm captured turtles, mainly for fear of catching decomposed turtles in subsequent trawls (Margaritoulis *et al*., 2007), while longline fishers may kill captured turtles by hauling them on-board to recover expensive hooks, instead of cutting the branch line to release them (Casale & Cannavo, 2003).

In the case of natural causes, cold-stunning and pneumonia were the predominant causes of admission to the STRC. Pneumonia-related diving disorders are known in the Mediterranean (Bellido *et al.*, 2008), while cold-stunning of sea turtles has been reported in Italy during the winter months (Bentivegna *et al*., 2002). Additional natural causes (other diseases, parasitism, etc.) may have occurred (Orós *et al*., 2005) but were not possible to be detected at the STRC using the available protocols/equipment at the time. In these cases, cause of admission has been characterized as "Unknown". It is recognized that sick animals are more susceptible to the more easily detected anthropogenic threats such as fisheries interactions, hence the underlying natural causes may be underreported (George, 1997).

Predation of adult sea turtles by Mediterranean monk seals (*Monachus monachus*) was frequent in Zakynthos in 2010 (Margaritoulis & Touliatou, 2011), with only one turtle surviving the monk seal attack but having died during transport to the STRC. From the 11 turtles that were admitted to the STRC with dog bites, inflicted during nesting activity in Kyparissia Bay (Margaritoulis *et al*., 2019) and Lakonikos Bay, one died and the other 10 were released following a successful rehabilitation.

The high anthropogenic impact affecting sea turtles has been recognized in other studies in Greece (Kopsida *et al*., 2002; Despoti *et a*l., 2025), in the Mediterranean (Casale *et al*., 2010) and in the USA (Ataman *et al*., 2021). Some studies outside the Mediterranean region report that certain "natural" threats may have a heavier impact on sea turtle populations as may be the case with the disease fibropapillomatosis and shark predations (Chaloupka *et al*., 2004). However, no such cases have been reported in the Mediterranean or have a negligible impact. On the other hand, the semi-closed basin of the Mediterranean Sea exhibits a high concentration of anthropogenic activities that are known to threaten sea turtles like fishing, boat traffic, and pollution including plastics (Casale *et al*., 2010).

### *Fate of admitted turtles*

The overall outcome of turtles admitted at the STRC (35.2% deaths and 59.6% releases) appear to be better than the reported outcome from 1,700 admissions in sea turtle rehabilitation facilities in Florida (USA), which recorded 61.5% deaths and 36.8% releases (Baker *et al*., 2015).

We consider the 71.3% of "true releases" as an extraordinary rehabilitation success. Further, the decreasing rate of "clear" deaths is another sign of the steadily improving conditions and rehabilitation protocols at the STRC over the years. It should be noted, however, that several physical and biological factors contribute to defining whether a sea turtle will survive. These comprise sea turtle age, size, stress, physical condition, including state of nutritional and immune system, as well as season, sea water temperature and pollution (George, 1997). Generally, severely debilitated turtles have a lower probability of survival (Roldi & Freggi, 2020).

Nevertheless, there is a lack of studies on the effect of head traumas and the resulting neurological deficits that may impair long-term normal behaviour. More thorough analysis of the individual cases is required in order to determine how severe each head injury was and the corresponding outcome.

### *Post-release observations*

The majority of the eight tracked turtles appeared to show that rehabilitated turtles behaved normally after their release, some of them undertaking long-range migrations. Similar results are inferred from other studies in the Mediterranean Sea (Cardona *et al*., 2012; Sassoon *et al*., 2026), in the USA (Robinson *et al*., 2020) and in the Arabian Gulf (Robinson *et al*., 2021).

Turtle breeding behaviour, after their rehabilitation at the STRC, is another indication that injured turtles, including those with head traumas, can resume their ecological roles post-release. Certainly, environmental enrichment, initiated in 2016 at the STRC, will assist in the adaptation of rehabilitated turtles to their natural environment following release (Kasimati *et al*., 2024).

### *Conservation implications*

Despite the above insights, from post-release observations, we still have a poor understanding of the conservation potential of rescued turtles in terms of contribution to

population viability, especially considering the relatively small numbers that can be rehabilitated. A similar conclusion has been reported for rehabilitated marine mammals (Moore *et al*., 2007).

Loggerhead turtles in the Mediterranean experienced population increases to the effect that the IUCN down listed their regional status to Least Concern (Casale, 2015). Estimates of loggerhead abundance in the Mediterranean based on demographics (Casale & Heppell, 2016) and transect surveys (DiMatteo *et al*., 2022) indicate they now number more than a million turtles. Therefore, the benefit of rehabilitating and releasing about 850 sea turtles, over a period of 30 years, can at best only humbly contribute to the regional sea turtle population in terms of increasing population viability and abundance. Nevertheless, the great value of the STRC is the response to the social need to provide refuge and welfare conditions to an emblematic species of megafauna. Fulfilling this need, combined with the public awareness and educational work that is accomplished at the STRC, parallel to the rehabilitation work, enhance the STRC's value to wildlife conservation (see Feck & Hamann, 2013; Baker *et al*., 2015).

ARCHELON will continue its work in rescuing injured turtles in Greece, already spanning more than three decades, through the continued improvement of the Sea Turtle Rescue Network and the STRC's veterinarian procedures. In addition, ARCHELON will continue its public awareness and educational programs that are carried out at the STRC.

## Conclusions

The 30-year operation of ARCHELON's STRC in Glyfada, Attica, Greece, provided three useful conclusions: (1) Fisheries interaction is the greatest cause of injury and debilitation of sea turtles. (2) It is possible to successfully rehabilitate turtles to return to the wild and contribute to the population, but the small numbers involved assist only modestly to population-level conservation. (3) The social and education aspects of the STRC should be considered core components.

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