Nature conservation field course: Protection of sea turtles (*Caretta caretta*) in Turkey 2015

Projektpraktikum: Schutz von Meeresschildkröten (*Caretta caretta*) in der Türkei 2015

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EXECUTIVE SUMMARY

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Die Strände von Fethiye zu denen Çalış, Yanıklar und Akgöl gehören sind seit 1988 als "Special Environmental Protected Area" (SEPA) ausgewiesen. Seit 1994 findet ein österreichisch/türkisches Monitoring statt, bei dem Nester, Nesttemperatur, geschlüpfte Jungtiere, adulte Weibchen, tote Schildkröten sowie anthropogene Einflüsse wie die Anzahl der Sonnenliegen und Sonnenschirme, Müll sowie Lichtverschmutzung am Strand erhoben werden. Ein neues Phänomen in diesem Jahr ist die starke Prädation durch Säugetiere in Yanıklar.

In Yanıklar und Akgöl wurden auf einer Strandlänge von 5 km insgesamt 128 Nester zwischen dem 27.6.2015 und 12.9.2015 gefunden. Somit gab es 2015 die zweithöchste Anzahl an Nestern seit dem Beginn der Aufzeichnungen 1994. Die Nester waren durchschnittlich 20 m von der Wasserlinie entfernt. Die Daten von Yanıklar zeigen, dass die durchschnittliche Gelegegröße mit 73 Eiern/Nest geringer war als in den Jahren zuvor. Die mittlere Inkubationszeit betrug 51,1 ± 5,8 Tage. Die hohe Prädationsrate die zum ersten Mal 2015 auftrat führte zu einem geringeren prozentuellen Schlüpferfolg (52 %) als in den Jahren zuvor. Durch die hohe Gesamtanzahl an Nestern in Yanıklar mit 9.385 gelegten Eiern erreichten dennoch 4.880 Tiere das Meer.

In Çalış sieht die Situation etwas anders aus. Auf dem 3,5 km langen Strandabschnitt, der auf einer Länge von 1 km durch eine Promenade begrenzt wird, wurden insgesamt 30 Nester gefunden. Die 10 Nester im Bereich der Promenade waren durchschnittlich 12,4 m vom Meer entfernt. Im unbegrenzten Strandabschnitt befanden sich 20 Nester, die durchschnittlich 17 m vom Meer entfernt waren. Die Erfolgsrate der Nester lag mit 63 % (1.545 Jungtiere) deutlich höher als in Yanıklar (52 %). Die Abbildung verdeutlicht den leichten Abwärtstrend in den letzten 20 Jahren. Auffallend große Schwankungen in der Anzahl der Nester treten in Yaniklar auf. 2015 gab es auf allen drei untersuchten Stränden einen deutlichen Aufwärtstrend.

Messungen adulter Meeresschildkrötenspuren in Çalış zeigten, dass die durchschnittliche Spurenlänge zum Nest und wieder zurück ins Wasser am Strand im Bereich der Promenade 31 m betrug, während sie außerhalb der Promenade mit durchschnittlich 50 m signifikant länger war.

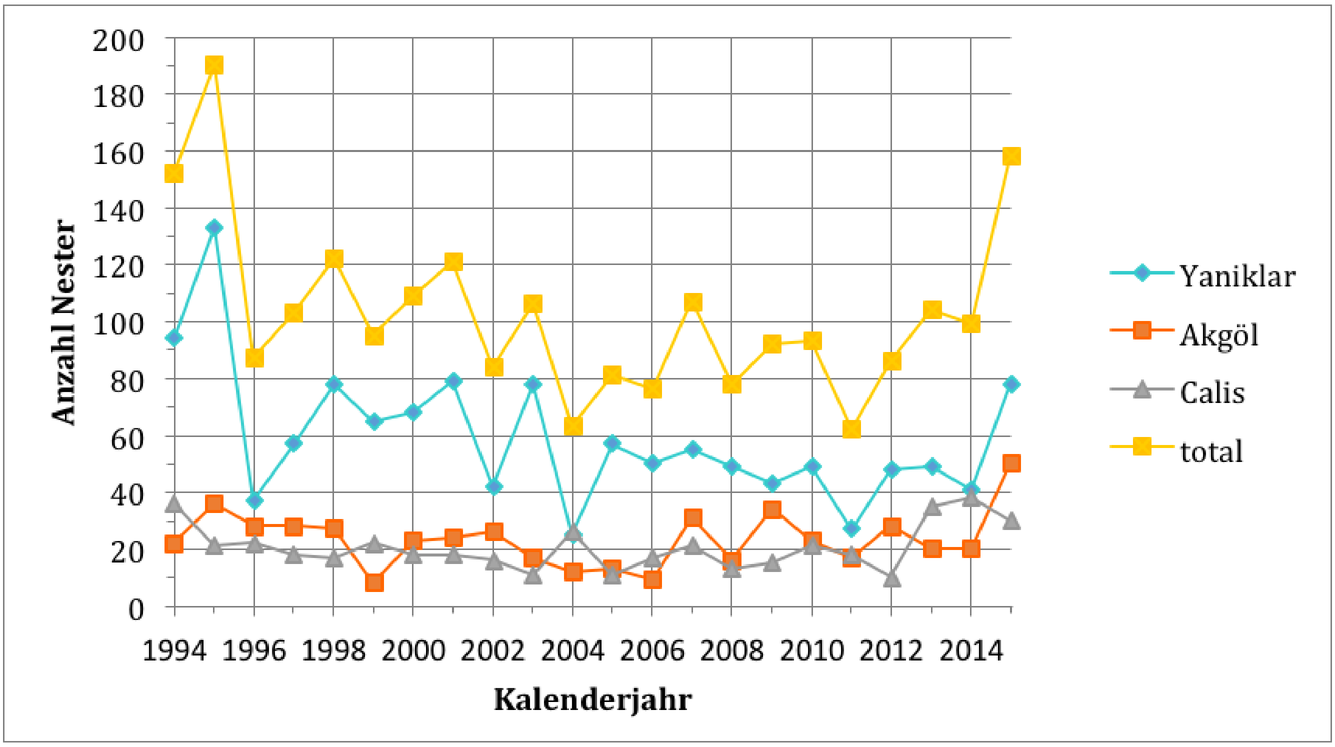


Abb. 1 Anzahl der Nester von 1994 bis 2015

Da der Schlüpferfolg von vielen Faktoren beeinflusst wird, war es naheliegend auch die Nesttemperatur zu messen. Im Rahmen einer Bachelor Arbeit wurden drei Nester mit elektronischen Messeinheiten (Tinytags) ausgestattet. Als Kontrolle dienten zwei künstliche Eikammern mit unterschiedlichem Abstand zum Meer. Auffallend war, dass ein größerer Abstand zum Meer eine Veränderung der Temperatur von bis zu plus 2 Grad C verursachen kann. Ein bedeutenderer Aspekt scheint jedoch die Tiefe der Eikammer zu sein. Ist die Eikammer nicht tief genug, kommt es im Nest zu größeren Temperaturschwankungen die zu einem Absterben der Eier führen können. Im Fall eines Nestes in Çalış wurde ein Schlupferfolg von nur 2,4 % gemessen.

Prädationsdruck: 2015 kam es in Yanıklar, an einem touristisch wenig genutzten, naturbelassenen Strandabschnitt zu einem massiven Anstieg der Prädation durch Wirbeltiere, wahrscheinlich den Goldschakal, *Canis aureus*. Die Plünderung der Nester fand meist in zwei aufeinanderfolgenden Nächten statt. Zum Schutz wurden Metallgitter über dem Nest vergraben, die allerdings eine wiederholte Plünderung nicht immer verhindern konnten. Von den 78 Nestern in Yanıklar wurden 29 von Wirbeltieren geplündert, das entspricht 37 %. Von 9.385 gelegten Eiern in Yanıklar fielen 1.384 Eier (15 %) einem Räuber zum Opfer. 17 Nester wurden durch 1-3 Plünderungsvorgänge komplett ausgeraubt, und 12 Nester wurden teilweise geplündert. Am Strandabschnitt von Akgöl wurde nur ein Nest ausgeraubt.

Mortalität: Da *Caretta caretta* erst mit 20-25 Jahren geschlechtsreif werden, stellt jede, durch äußere Einflüsse umgekommene Meeresschildkröte einen großen Verlust für die Population dar. Aus diesem Grund wurden tote und verletzte Tiere entlang der Strände von Fethiye dokumentiert. Im Sommer 2015 wurden 7 tote *Caretta caretta* sowie zwei tote *Chelonia mydas* aufgefunden. Bei drei *Caretta caretta* wurden Verletzungen nachgewiesen, die auf beabsichtigte Gewalteinwirkung zurückzuführen waren, eine andere starb an den Folgen der Kollision mit einem Boot. Seit dem Beginn der Aufzeichnungen im Jahr 2000 gibt es einen jährlichen Anstieg an tot aufgefundenen Tieren.

Eine weitere Bachelor-Arbeit beschäftigte sich mit der Mortalitätsrate von Embryos zwischen 2004 und 2014. Die embryonale Sterblichkeit war in den frühen Stadien mit 11,3 % (n = 6.272) höher als im späten Entwicklungsstadium (5,9 %, n = 3.314)) und dem mittleren (1,2 %, n = 634). Die durchschnittliche Anzahl der toten Embryos im späten Entwicklungsstadium pro Nest/Jahr betrug 3,4 (2005) - 7,6 (2008). Darüberhinaus zeigt die Datenanalyse, dass die Gesamtzahl der toten frühen Embryonenstadien und die relative Anzahl der toten frühen Embryonenstadien in Schritten von jeweils zwei Jahren schwankte.

Trotz der Ernennung der Strände zur SEPA ergeben sich jedes Jahr viele Probleme, die auf den Tourismus zurückzuführen sind. In Yanıklar gibt es zwei große Hotels „Majesty Club Tuana“ und Majesty Club Lykia Botanika“ und in Akgöl das Karaot Buffet. Zusätzlich wurde am östlichsten Strandabschnitt noch ein riesiger Hotelkomplex, das „Barut Sensatori Fethiye“ fertiggestellt und erstmals touristisch genutzt. Dadurch verschwand wieder ein naturnaher, von Schildkröten stark genutzter Strandbereich. Allein im Bereich des Hotels „Botanika“ kam es im Vergleich zum Vorjahr zu einem Anstieg der Sonnenliegen um 41 %. Insgesamt wurden am westlichen Strandabschnitt Yanıklar/Akgöl 787 Sonnenliegen und 126 Sonnenschirme gezählt. Massentourismus und Umweltverschmutzung sind leider nicht zu trennen. Die Strände sind mit Ausnahme eines kleinen Bereiches direkt vor den Hotels fast durchgängig verschmutzt. Im Zuge einer Bachelorarbeit wurde Müll gesammelt, kategorisiert, gezählt und gewogen um ein aktuelles Bild über das Wegwerfverhalten der Besucher zu erhalten. Auf 2x2m großen Flächen unter ausgewählten Sonnenschirmen wurde an 4 Tagen 40 Stück Wegwerfmüll/m^2 gesammelt, davon waren Zigarettenstummel mit 90 % der am häufigsten vorkommende Restmüll. Der gesamte gesammelte Müll hatte ein Gewicht von 1.031 g.

Nach wie vor stellt Lichtverschmutzung ein großes Problem für Meeresschildkröten, besonders für geschlüpfte Jungtiere dar. Was die Lichtverschmutzung betrifft liegen nur Daten von Çalış Beach vor. Es wurde die Lichtintensität der Gebäude gemessen und gleichzeitig die Anzahl der Lichtquellen erhoben. Dabei zeigte sich, dass sich die Lichtintensität, gemessen vor Mitternacht seit 2014 auf 13,53 Lux wieder etwas erhöht hatte. Nach Mitternacht waren immer noch 5,22 Lux zu messen, was ebenfalls eine Erhöhung gegenüber dem Vorjahr darstellt. Eine Korrelation zwischen der Lichtverschmutzung und der Position der Nester konnte nicht nachgewiesen werden. Das könnte aber auch darauf zurückzuführen sein, dass Eiablagen meist erst nach Mitternacht erfolgen, wenn viele Lichter bereits abgedreht sind.

The beaches of Fethiye include Çalış, Yanıklar und Akgöl and were designated as a "Special Environmental Protected Area" (SEPA) in 1988. A Turkish/Austrian monitoring program has taken place since 1994 and documents nests, nest temperature, hatchlings, adult females, track length, mortality in adults as well as anthropogenic influences such as the number of parasols and sunbeds, litter as well as light pollution on the beach. A new phenomenon this year was the heavy predation by mammals in Yanıklar.

In 2015, between June 27 and September 12, a total number of 128 nests were found in Yanıklar and in Akgöl. 2015 showed the second highest number of nests since the beginning of the program in 1994. The average distance of a nest to the sea was 20 m.

The data of Yanıklar showed that the average clutch size was 73 eggs per clutch and hence smaller than in the previous years. The mean incubation time was 51.1 ± 5.8 days. The high amount of predation, which had occurred for the 1st time in 2015, led to a percentage decrease of hatching success (52 %). Due to the high number of nests with 9385 eggs in Yanıklar, 4880 hatchlings reached the sea.

The situation in Çalış is different. The length of the beach is 3.5 km and approx. 1 km is bound by a promenade. A total of 30 nests were found on this beach. Ten of them were in front of the promenade and 20 on the remaining beach stretch. The average distance of the nests to the sea went from 12.4 m in front of the promenade to 17 m elsewhere in Çalış. In 2015 the overall success rate of the nests here was 63 % and corresponds to 1.545 hatchlings reaching the sea. This is in contrast to Yanıklar with only 52 %. Data from 2004 to 2014 showed a hatching success of 69 % for all three beaches. The table shows a slight decrease of nests during the last 20 years. Notable big fluctuations of the number of nests occurred in Yanıklar. In 2015 there was on all three investigated beaches a remarkable increase of nests.

The analysis of the length of adult sea turtle tracks in Çalış showed that the average track to the nest and back to the sea was 31 m while it was 50 m elsewhere in Çalış, which is significantly longer than along the promenade.

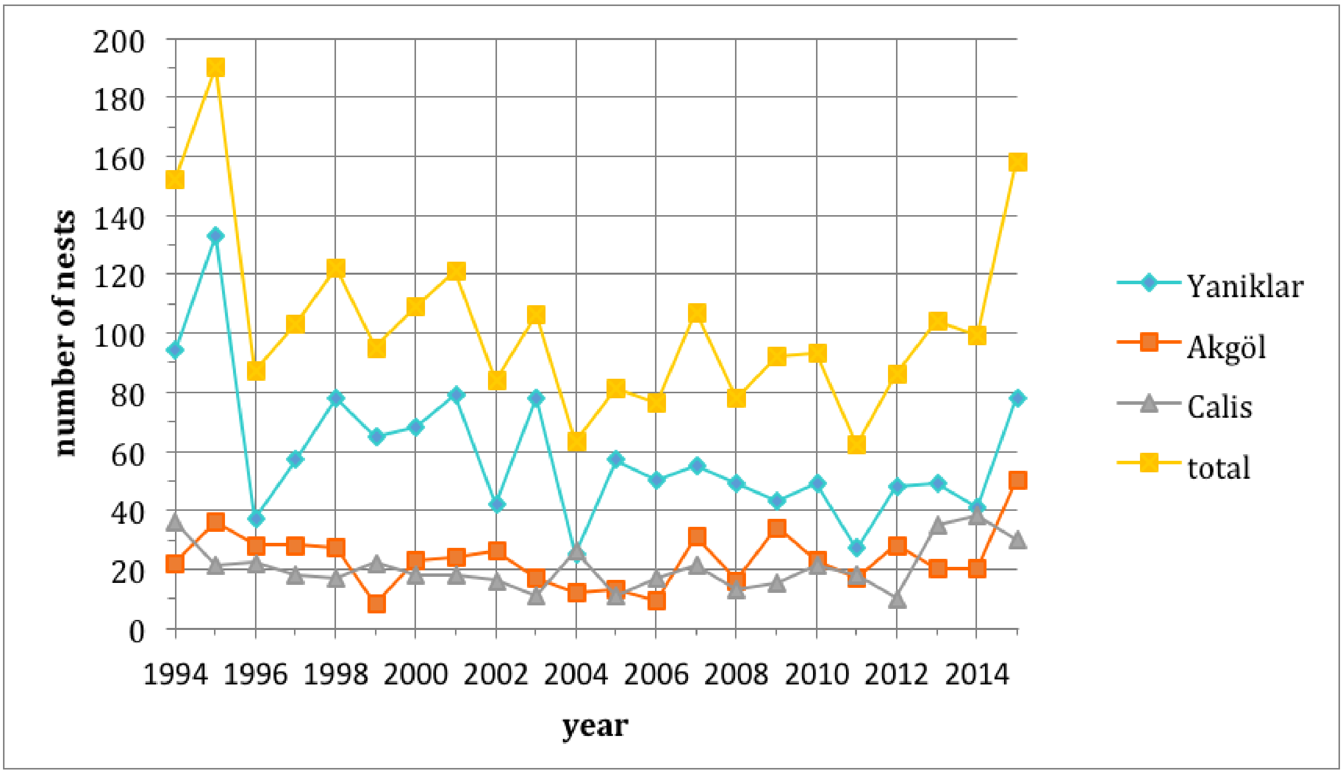


Fig. 1: Number of nests from 2004 to 2015.

Predation: In 2015 on the touristically less used, wild parts of Yanıklar beach, heavy predation by jackals (*Canis aureus*) occurred for the 1st time. In most cases the predator did not fully empty the nest but came back in the following nights to dig out the remaining eggs. To protect the eggs, metal predation grids were placed on top of such nests. This helped but did not stop further predation in all cases. In Yanıklar, 27 (37 %) nests out of 78 were predated by vertebrates. 1384 (15 %) out of 9385 eggs in Yanıklar were predated. 17 nests were completely destroyed by 1-3 predation events. 12 nests were only partially predated, thanks to the predation cages. Only one nest was predated on Akgöl beach.

Mortality: In 2015, seven dead *Caretta caretta* and two dead *Chelonia mydas* were found on the beaches of Fethiye. Three turtles had injuries caused by intentional violence and one died from the consequences of a boat collision. Two dead sea turtles were discarded before our team had arrived. Since the beginning of the recordings in 2000, there has been a constant increase of adult turtles found dead on the beach.

Another bachelor thesis analyzed the mortality rate of the embryos between 2004 to 2014. The mean number of dead late embryos ranged from 3,4 individuals per nest in 2005 to 7,6 in 2008. Embryonic mortality was higher at early (11,3 %, n = 6.272) than at late (5,9 %, n = 3.314) and middle stages (1,2 %, n = 634). Furthermore, the data analysis shows that the total number of dead early embryos and the dead early ratio had a fluctuation cycle of 2-years.

In spite of the fact that the beaches of Çalış belong so the SEPA, every year they face many problems that are caused by the increasing tourism. In Yanıklar there are two major hotels, the “Majesty Club Tuana” and “Majesty Club Lykia Botanika” and in Akgöl the “Karaot Buffet”. Moreover, a new hotel – the “Barut Sensatori Fethiye” on the most eastern turtle nesting zone started business this summer. A comparison between 2014 and 2015 showed for the “Botanika” a 41 % increase of sunbeds. On the western part of Yanıklar/Akgöl beaches there were a total of 787 sunbeds and 126 parasols counted.

Pollution: Mass tourism and environmental pollution often occur together. Beach litter was an important issue on all the beaches of Fethiye. For a Bachelor thesis waste was collected, categorized, counted and weighed in order to get a snapshot view of the littering behavior of the visitors. In Çalış, on a 2x2m area litter was collected under sunbeds and parasols during four days. In total, 2568 waste items were collected with a weight of 1031 g. This corresponds to 40 items/m2. Cigarette butts (90 %) were the most frequent items of the residual waste.

Light pollution is a major problem for sea turtles, especially for hatchlings. Measurements of light emitted from the buildings on Çalış Beach showed that since 2014 the light intensity has again increased up to 13.53 lux before midnight and after midnight it was still at 5.22 lux. There was no correlation between the intensity of light at the nest site and the position of the nest. This might be due to the fact that eggs are mostly laid after midnight, when many of the lights are turned off.

Nesting Behaviour of *Caretta caretta* at Çaliş Beach in 2015

Sophia Hämmerle, Denny Morcher, Kaja Danowska

KURZFASSUNG

Vom 27. Juni 2015 bis 12. September 2015 fand das jährlich seit 1993 stattfindende Projekt zum Schutz der Unechten Karettschildkröten (*Caretta caretta*) der Universität Wien in Kooperation mit diversen türkischen Universitäten statt. 22 Studenten der Universität Wien arbeiteten in Kooperation mit Studenten der türkischen Hacettepe Universität (Ankara) mit dem Ziele des Arten- und Naturschutzes zusammen. Bei dem betreuten Gebiet handelt es sich um die türkischen Mittelmeerstrände Çaliş und Yaniklar in Fethiye, welche zu einem SEPA (Special Environmental Protected Area) im Kontext der Barcelona Konvention gehören. In Früh- und Abendschichtpatrouillen am 3,5 km langen Strand in Çaliş, wovon ein drittel durch eine Promenade begrenzt wird, wurden adulte Weibchen vermessen und die Kriechspuren dokumentiert. Neue Nester wurden lokalisiert, genau dokumentiert und regelmäßig kontrolliert. Zum Schutz der Nester wurden Metallkäfige verwendet. Ebenfalls wurden Veränderungen am Strand regelmäßig dokumentiert. Da der Strand sehr stark touristisch genutzt und hochfrequentiert ist, wurde während der Patrouillen besonders darauf geachtet, adulten Weibchen durch das fernhalten von Menschen und Hunden eine möglichst störungsarme Nestablage zu ermöglichen. Mit Beginn der Schlupfsaison wurde besonderes Augenmerk auf das finden von unbekannten Nestern und den frisch geschlüpften Schildkröten am Strand gelegt. Insgesamt konnten in der Nistsaison 2015 30 Nester in Çaliş gefunden werden. Davon befanden sich 10 Nester entlang der Promenade und 20 abseits der Promenade. Von 66 dokumentierten Kriechspuren führten 19 zu einem Nest (28,8%). 14 Schildkröten konnten vermessen und 4 konnten getaggt werden. Die Nester befanden sich im Strandabschnitt der durch die Promenade begrenzt wurde durchschnittlich 12,4m vom Meer entfernt. Im unbegrenzten Strandabschnitt befanden sich die Nester im Durchschnitt 17m, also 16% weiter vom Meer entfernt. Im Vergleich zu den letzten zwei Jahren wurde ein geringer Rückgang der Nestzahlen beobachtet. Verglichen mit den letzten 21 Jahren ist aber trotzdem ein positiver Trend der Nestzahlen zu verzeichnen.

ABSTRACT

From 27 June to 12 September 2015 the annually held (since 1993) Seaturtle Project for the protection and conservation of loggerhead turtles (*Caretta caretta*) from the University of Vienna in cooperation with several Turkish universities took place. Twenty-two students from Vienna worked together with students from the Turkish Hacettepe University with the goal of nature and species conservation. The investigated areas are the beaches Çaliş and Yaniklar in Fethiye. Both beaches belong the Special Environmental Protected Area (SEPA) Fethiye in the context of the Barcelona Convention. The 3.5 km long beach in Çaliş, of which one third is restricted by a beach promenade, was patrolled in night and morning shifts. Body measurement data of adult females were taken. Nests were localized and protected with metal cages. Tracks were measured and beach conditions were documented. Because Çaliş Beach is highly frequented by tourists, we sought to keep people and dogs away from the turtles to permit an undisturbed oviposition. When hatching started, the beach was scanned for hatchlings and unknown nests. A total of 66 tracks was recorded with 19 (28.8%) resulting in nests. In the 2015 nesting season there was a total of 30 nests on Çaliş Beach. Ten nests were located in front of the promenade and twenty offside the promenade. Fourteen adult females could be measured and 4 could be tagged. The average distance of nests to the sea was 12.4 m at the beach section restricted by the promenade and 17.0m (16% difference) at the unrestricted area. In comparison with the last two years a small decrease in nesting number could be noticed but compared to the last twenty-one years there is still a positive trend observed.

INTRODUCTION

According to the ICUN (International Union for Conservation of Nature and Natural Resources), all sea turtle species are classified as “endangered” and listed on the Red list of Threatened Species. Because most of the studies onmarine turtles show declining populations, they are protected by the Convention for the International Trade in Endangered Species called CITES, by the Bern Convention and the United Nations Environment Program (UNEP-WCMC) (Nagorzanski & Pifeas 2013). The populations of the two species nesting in the Mediterranean, the loggerhead *Caretta caretta* and the green turtle *Chelonia mydas*, are far below historical levels and face a range of anthropogenic threats at sea and on land (Ullmann & Stachowitsch 2015). Fisheries bycatch, boat strikes, intentional killing, and entanglement in marine debris including ghost gear have been identified as the main threats at sea (Tomás et al. 2008, Casale and Margaritoulis 2010, Casale et al. 2010, Casale 2011). On land, degradation and reduction of nesting habitat caused by touristic and recreational activities, light pollution, noise, construction, sand extraction, and traffic pose the most serious threats (Camiñas 2004).

The loggerhead sea turtle nesting beaches in Fethiye (Mugla Province, Turkey) are among the 12 most important nesting beaches in Turkey (Türkozan 2000; Margaritoulis et al. 2003; Canbolat 2004). Although Fethiye has the status of a SEPA (Special Environmental Protected Area) as in the Barcelona Convention, all the above-mentioned problems are ubiquitous. Real estate and tourism development is progressing with little regard for the sea turtle nesting habitat or for the protected coastal ecosystem which includes small wetlands and forests (Strasburg 2015).

Especially the beach in Çaliş, next to Fethiye, contains various hotels, major resorts, bars, and restaurants along the promenade. This is associated with light pollution, human activities and noise. That has a major impact of the behaviour of the female *Caretta caretta*. Females are often interrupted while trying to find an adequate spot to nest or cannot find any spot at all and crawl back to the sea without laying eggs (Nagorzanski & Pifeas 2013).

Since 1993, the University of Vienna and several Turkish Universities (this year, Hacettepe University of Ankara) worked together to protect the *Caretta caretta* population in Çaliş and Yaniklar. The work combines monitoring, informing tourists and local residents, as well as protecting adults and hatchlings.

MATERIAL AND METHODS

From 27 June to 12 September 2015, the field course for the conservation and protection of the loggerhead *Caretta caretta* took place. The monitoring work was divided into a night shift and morning shift, which means that 2-3 students walked the beach and collect data. The course took place in Fethyie, which is naturally divided into three subsections Çaliş, Yaniklar and Akgöl. Çaliş Beach is 3.5 km long and a promenade wall borders about half of the beach. The substrate of the whole section varies from fine sand to big stones. This is a hot spot for tourism and raises all of the above major issues of sea turtles conservation on the beach.

Nightshift

The night shift started at 10pm. A group of 3 students was optimal for covering the beach. The starting point was at the end of the promenade at the bar “Türkü Cadiri”. The group patrolled in a line; one person walked along the waterline, the second in the middle of the beach and the third next to the promenade wall. In this formation the beach was fully covered. At the Surf Café the group had a 15-minute break. After that the team returned to the starting point. All together the beach was patrolled four times per night.

The working tools for the night shift were a wooden calliper, a short and a long measuring tape, red-light flashlights, a thermometer, walkie-talkies and a field data book.

If an adult female loggerhead emerged from the water during the night shift, the group sat down at a distance to the sea turtle. In the meanwhile, the group quietly observed the animal during the nesting. In addition, the group checked the surroundings in order to intervene rapidly in case of disturbance (for example, if persons tried to photograph the animal). After the sea turtle finished the nesting process, or she could not because of disturbance, two persons started to perform the measurements. One held the animal and the other one measured the straight carapace length (SCL) and straight carapace width (SCW) with the calliper. The curved carapace length (CCL) and width (CCW) was measured with the tape. In the meantime, the third member wrote the data down in the field data book. Furthermore, the team checked the flippers for tags. If no tags were found the animal was marked with a special tagging device on the right front flipper. Also, epibionts or deformations on the carapace were noted. After the measurements, the animal was released immediately. The next step was to find the exact location of the nest, which requires some experience because, after nesting, the sea turtles hide the nests using their flippers to shuffle the sand onto the nest. For localisation, the group used a metal rod, termed shish, that was carefully stuck into the sand.

The sand above the nest was loose, which is an indication for an egg camber. The found nest was equipped with a cage. Because the cage could be displaced and the located nest therefore undetectabl, we triangulated each nest as a backup system.

When sea turtles crawled on land, they leaved tracks behind. Important parameters to measure included the track width and length as well the number of body pits. In addition, the nest distance to the sea was added to the data. If no nest was made, the team measured the highest point of the track.

Morning shift

The difference between morning shift and night shift is that the turtles mostly nested at nights. That means the students did not need the wooden calliper in the morning. The morning shift started at about 6 pm: two students walked only once to the very end of the Çaliş coast, called Çaliş Tepe. The monitoring work involved looking for all nests and tracks that were made after the last night shift. The methodology was the same as on night shift. Furthermore, the position of all the known nests was checked with the help of triangulation.

RESULTS

Nests

In the 2015 nesting season 30 nests were recorded in Çaliş Beach. This number is lower than in 2014 (38 nests) and 2013 (35 nests) (Fig. 1), but still over the mean number of nests over the 22-year period (20 to 21 nests). There is still a positive trend in the last three years, it remains to be seen if the number of nests will remain at this high level or even steadily increase over the next years. Overall, the number of nests clearly fluctuates very strongly over the past 20 years. For example in 2003 there were 11 nests, and in 2004 26 (Fig. 2), so the number more than doubled during that period. Accordingly, the number of nests laid per year is a very unstable variable. The value of a particular year is rarely similar to that of the previous or following. This year’s value is 8 nests less in 2014 and about 5 nests less than 2013.

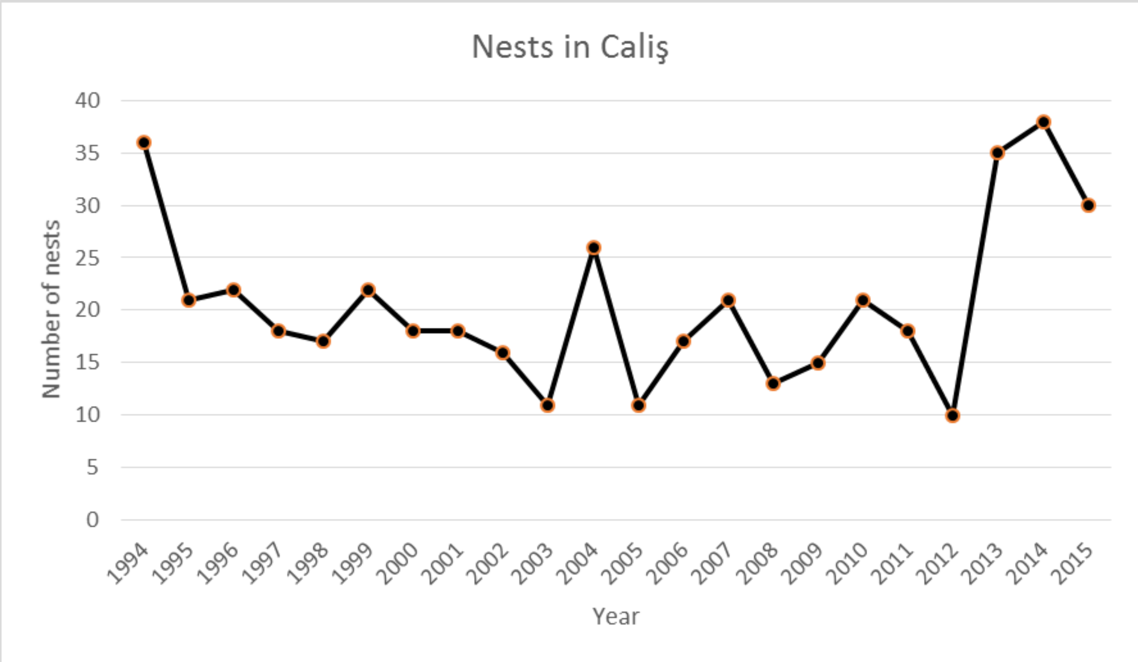


Fig. 1: Number of nests on Çaliş Beach from 1994-2015.
Abb. 1: Anzahl der Nester am Strand von Çaliş in den Jahren von 1994-2015

The nests CY-01 to CY-09 were found by Turkish colleagues and were laid before the Austrian students arrived in Turkey. Nests CY-10 to CY-17 were found by the Austrian students and in total, 17 nests were found by students. Furthermore there are so-called "secret nests" which were discovered only when hatchlings emerged (designated with CS in tab.1). At least 6 nests (CS-01 to CS-06) were laid before the Austrian students arrived and were found by the Turkish colleagues. Overall, 13 nests (CS) were not observed during oviposition in the night shift or on patrol in the morning shift, and 17 nest were recorded while being dug in the night shift or on patrol in the morning shift by Turkish and Austrian students.

No hatchery had to be made this year because the location of the nests did not demand a relocation.

Tab.1: Overview of the nests and their data in Çaliş Beach (CS: "Secret nest", <: nest laid before the date, -: no data available)
Tab.1: Überblick der Nester und ihrer Daten vom Strand von Çaliş (CS: „Secret nests", <: Nest wurde vor dem Datum gelegt, -: keine Daten vorhanden)

Nest	Date	Location	Distance to sea (m)	Wet zone (m)	Moist zone (m)	Dry zone (m)
CY-01	05.06.2015	Beskaza	16.8	2.1	6.3	8.4
CY-02	10.06.2015	Lee`s Cafe Bar	10.5	2.8	3.5	4.2
CY-03	11.06.2015	Hotel Ceren	8.8	2.1	4.6	2.1
CY-04	17.06.2015	Between Apartments and Daphne Resident	11.2	2.8	2.1	6.3
CY-05	19.06.2015	Okyanus Hotel	11.2	2.1	2.1	7.0
CY-06	23.06.2015	Aroma Beach Club	21.7	7.7	0.0	14.0
CY-07	23.06.2015	Adrian Hotel	10.5	2.8	0.0	7.7
CY-08	24.06.2015	Lighthouse	14.7	2.1	1.4	11.2
CY-09	25.06.2015	Yücel Hotel	22.1	2.1	0.0	20.0
CY-10	28.06.2015	Daphne Residence	8.2	2.3	3.9	2.0
CY-11	29.06.2015	Beskaza and Dolmus Station	30.0	4.0	1.0	25.0
CY-12	02.07.2015	Hotel Letoon	16.1	3.9	0.0	12.2
CY-13	06.07.2015	Beach House	8.3	0.0	1.9	6.4
CY-14	08.07.2015	Hotel Ceren	18.3	1.2	1.4	15.7
CY-15	11.07.2015	Daphne Residence	20.67	0.64	1.36	18.67
CY-16	14.07.2015	Daphne Residence	31.0	1.5	1.4	28.1
CY-17	19.07.2015	Ibrahim Bey Hotel	7.56	1.5	0.6	5.46
CY-18	27.07.2015	Sunset Beach	23.2	0.0	1.9	21.3
CS-01	<17.06.2015	Close to Daphne Residence	9.1	2.1	2.1	4.9
CS-02	<17.06.2015	Sunset Hotel	15.4	2.8	0.0	12.6
CS-03	<17.06.2015	Sunset Hotel	17.5	2.1	0.0	15.4
CS-04	<17.06.2015	Dolmus Station	10.5	2.8	2.1	5.6
CS-05	<04.06.2015	Next to Surf Cafe	17.4	2.6	2.1	12.7
CS-06	<15.06.2015	Sunset Beach Club	19.1	1.7	2.0	15.4
CS-07	<20.07.2015	Caretta Caretta Info Desk	14.5	1.5	1.0	12.0
CS-08	<31.07.2015	Beskaza and Dolmus Station	19.8	1.0	2.0	16.8
CS-09	<04.08.2015	Sunset Hotel	15.3	2.0	1.5	11.8
CS-10	-	SeaSide Travel	-	-	-	-
CS-11	<17.08.2015	Beskaza	-	-	-	-
CS-13	<27.08.2015	after Bakraç	-	-	-	-

Thirteen nests were laid in front of the "promenade" from Café Mutlu to Aroma Beach Club; one is a secret nest. Twenty nests were laid offside the promenade between Aroma Beach Club and Çaliş Tepe; 11 of them were secret nests. In Nest CS-12, no hatchlings ever emerged: it was incorrectly recorded as being a secret nest.

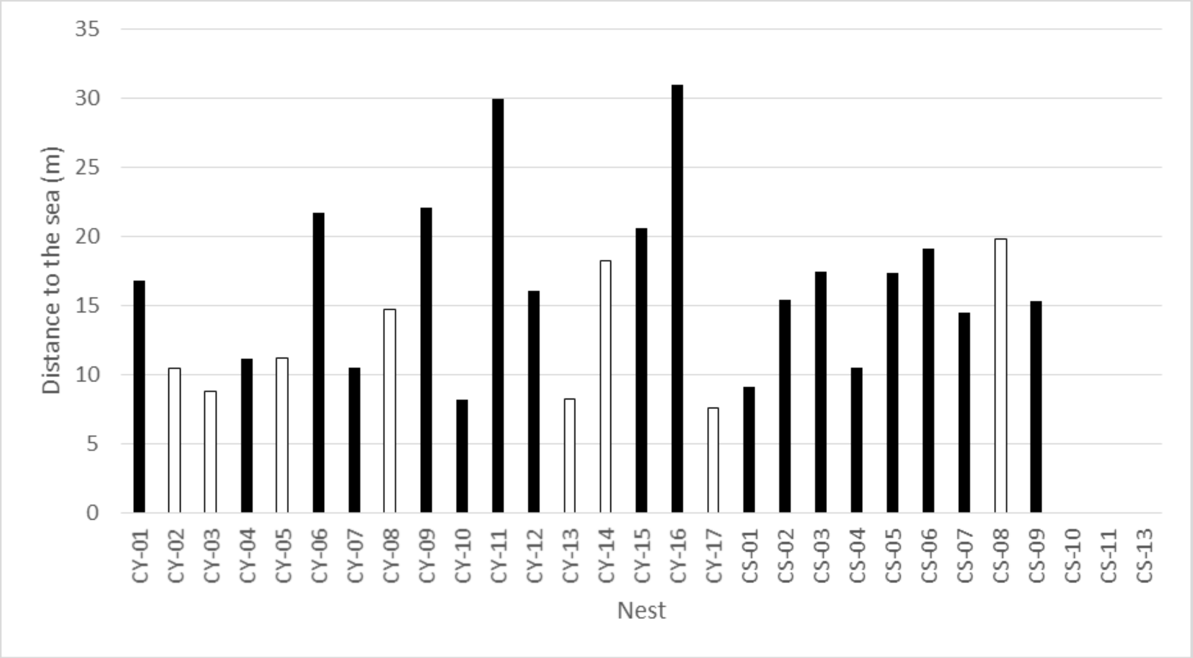


Fig.2: Overview nest distance to the sea in Çaliş. White bars: nests in front of promenade; black bars: nests offside promenade; CS: secret nest
Abb.2: Überblick der Distanzen der einzelnen Nester zum Meer. Weiße Balken: Nester vor der Promenade; schwarze Balken: Nester abseits der Promenade

Fig.2 shows that there is a difference in the distance to the sea of nests along the promenade and the nests offside the promenade. The mean distance of the nests in front of the promenade is 12.40 m and the mean distance of those offside the promenade is 17.06 m, so the latter is about 16% more distant to the sea.

Fig.3: Satellite photo of Çaliş Beach from Café Mutlu to the sea turtle campsite with reference locations and the nests.
Abb.3: Satellitenfoto vom Strand in Çaliş vom Cafe Mutlu bis zum Meeresschildkröten Camp, mit wichtigen Orientierungspunkten.

Abb.4: Satellitenfoto vom Strand in Çaliş von Aroma Beach Club bis zur Daphne Residence am Nest CY-10.
Fig.4: Satellite photo of Çaliş Beach from Aroma Beach Club to nest CY-10 at Daphne Residence.

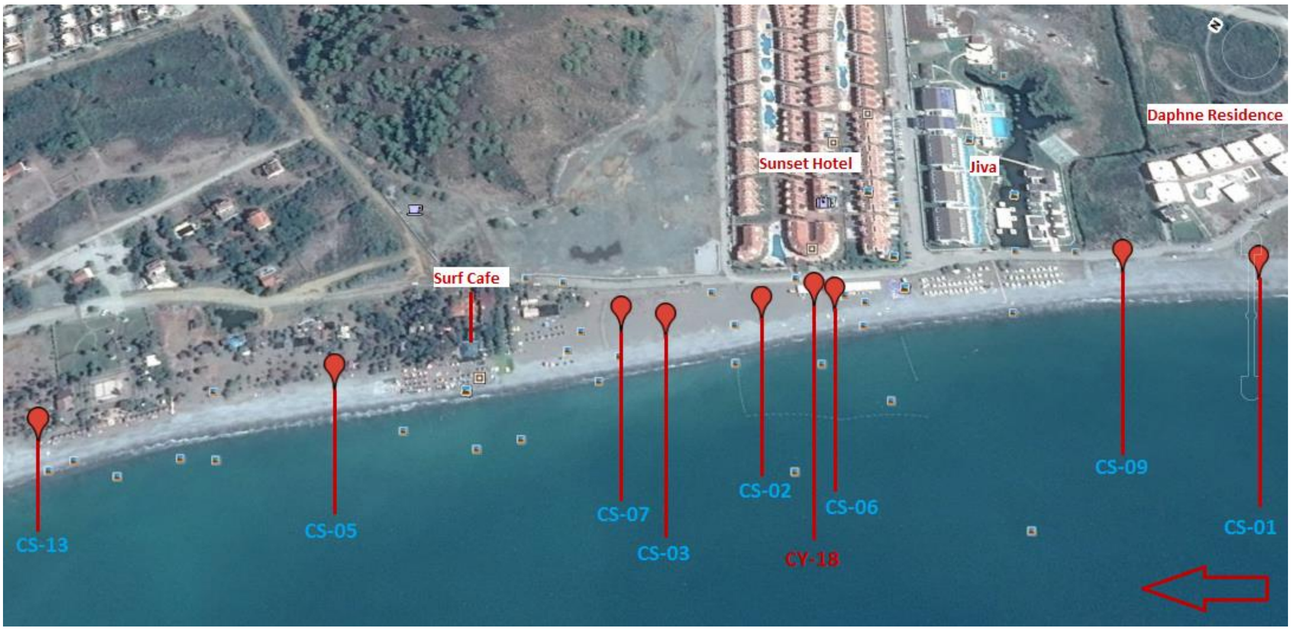
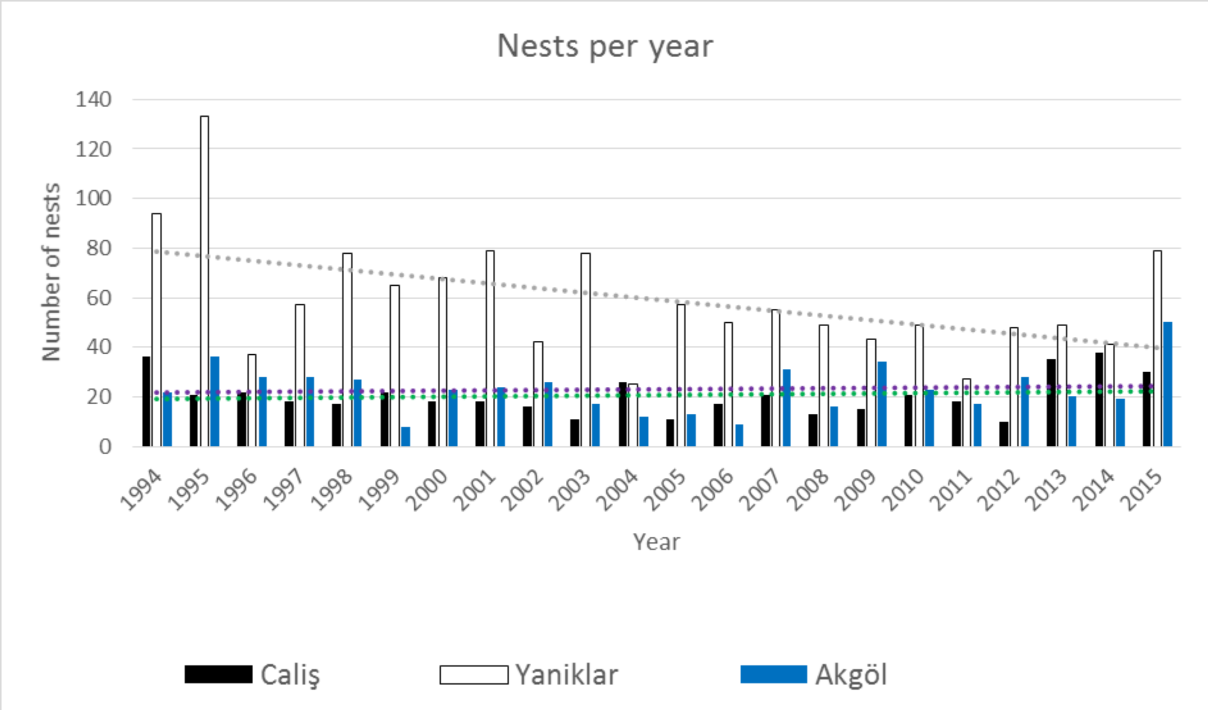


Fig.5: Satellite photo of Çaliş Beach from Daphne Residence to nest CS-13 at Bakraç.
Abb.5: Satellitenfoto vom Strand in Çaliş von Daphne Residence bis Bakraç am Nest CS-13.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
■ NN Calis	36	21	22	18	17	22	18	18	16	11	26	11	17	21	13	15	21	18	10	35	38	32
□ NN Yaniklar	94	133	37	57	78	65	68	79	42	78	25	57	50	55	49	43	49	27	48	49	41	79
■ NN Akgöl	22	36	28	28	27	8	23	24	26	17	12	13	9	31	16	34	23	17	28	20	19	50

Fig. 6: 21-year comparison of the number of nests laid in Çaliş, Yaniklar, Akgöl with linear trendlines (top-trendline: Yaniklar; middle-trendline: Akgöl; lowest-trendline: Çaliş). (Trendlines were calculated with the trendline-function of Excel)
Abb.6: Vergleich der Anzahl der Nester in Çaliş, Yaniklar, Akgöl über die letzten 21 Jahre mit linearen Trendlinien (oberste Trendlinie: Yaniklar; mittlere Trendlinie: Akgöl; unterste Trendlinie: Çaliş).

Fig.6 shows that in Yaniklar the number of nests decreased over the past 21 years. In Akgöl and Çaliş the trend shows a very slight increase. If this trend extends far into the future, this three trendlines could approach or even cross each other.

Tracks

Figure 6 presents the successfulness of turtles laying a nest after emerging onto the beach. Over two-thirds of the attempts to make a nest were unsuccessful.

The nests CY-07,10,11,12,13,14,15,16,17 were laid in presence of the sea turtle monitoring teams; all the other nests were laid in absence of students and were found based on the adults tracks.

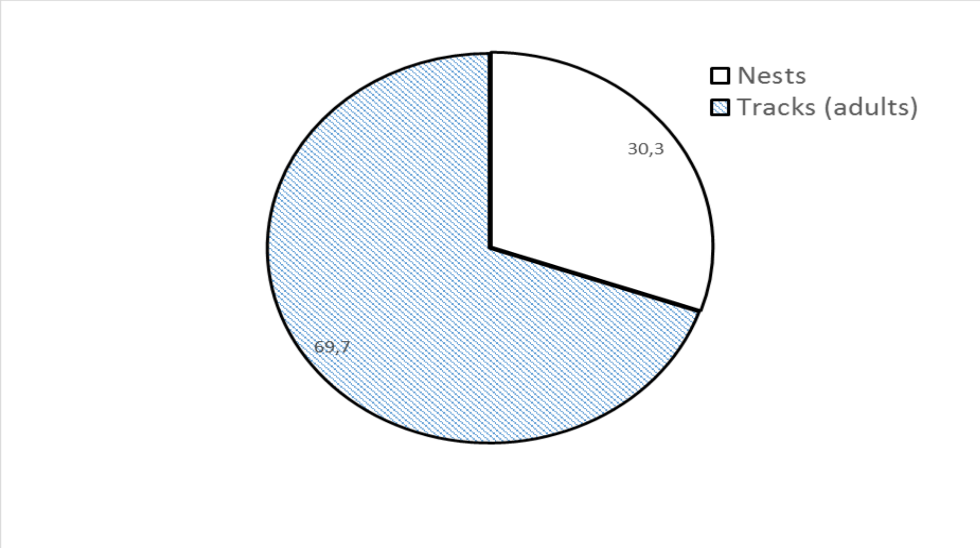


Fig. 7: Comparison of the total number of nests and the total number of adults tracks (in %). (shaded: tracks without laying a nest; white: counted nest)
Abb.7: Vergleich der Gesamtsumme der Nester die gezählt wurden und der Summe aller Tracks die gezählt wurden in Prozent. (schattiert: Tracks ohne Nest; weiß: gezählte Nester)

Adults

Female sea turtles made nests from 01.06. to 27.07. this year, that were recorded by Austrian students, which is also valid for adult tracks ("Secret nests" not incorporated).

In most cases the students had to take the measures very quickly to minimally disturb the sea turtles or to not attract people. Interestingly, differences in measurements of turtles that were measured two or more times did happen. Sometimes the sea turtle was not measured because it was exhausted after egg laying or due to stress through people standing too close or using flashlights.

Almost every sea turtle that was measured had epibionts, except for the three seaturtles. Tagging was not done by any Austrian students; only Turkish colleagues tagged the turtles. In a total 4 seaturtles were tagged. Normally the tagging was done on the left front flipper of the sea turtle, but the tutor of the Turkish colleagues changed the tagging to the right front flipper.

Tab.2: Overview of all measured sea turtles in the 2015 nesting season. (*Caretta caretta*; SCL: straight carapace length; SCW: straight carapace width; CCL: curved carapace length; CCW: curved carapace width)

Tab.2: Überblick über alle gemessenes Meeresschildkröten in dieser Legesaison (*Caretta caretta*; SCL: straight carapace length; SCW: straight carapace width; CCL: curved carapace length; CCW: curved carapace width; L: left fin; R: right fin)

Date	Tag Nr.	SCL (cm)	SCW (cm)	CCL (cm)	CCW (cm)	Epibionts	Nest
01.06.2015	-	52	52	93	68.5	yes	-
23.06.2015	TR676 (L)	76	58	78	65		CY-07
28.06.2015	TR-C2498 (L)	74	53	78	69	yes	CY-10
29.06.2015	TR-C2492 (L)	64	52	70.5	66.5	yes	CY-11
02.07.2015	-	64	48	69	62	yes	CY-12
05.07.2015	-	72	52	75	65	yes	-
06.07.2015	-	67	52	72	66	no	CY-13
08.07.2015	-	75	51	69	78	yes	CY-14
08.07.2015	-	71	53	76	72	yes	-
11.07.2015	-	75	55	78	70	yes	CY-15
13.07.2015	TR679 (L)	82	49	72	67	no	-
14.07.2015	TR685 /R	69	51	75	66	yes	CY-16
19.07.2015	-	78	45	69	62	yes	CY-17
26.07.2015	TR685 /R	72	52	77	64	yes	-
27.07.2015	-	72	48	74	68	no	-
27.07.2015	TR685 /R	72	51	76	68	yes	CY-18

DISCUSSION

The total number of nests (30) in 2015 is lower than the values in the last two years. In 2014, 38 nests and in 2013, 35 were recorded. Nonetheless, in 2015 there are still 10 more nests (33%) than the average number of nests the last 21 years, which is 20-21nests per season (Fig. 1). The data show that there are significant fluctuations in nesting numbers, but that the population trend appears to be increasing in Çaliş. A fluctuation is to be expected because female turtles lay their eggs in a 2-3 year rhythm (Spotila, 2004).

Remarkable is also the numerous adult turtles observed in the sea along the coastline (personal communication with local residents and fieldwork coordinators). The reason for this unusual high number of adult turtles close to the beach is not easily explainable. One interpretation is that the efforts over the last 2 decades are now paying off and the hatchlings that entered the sea back then are now returning as sexually mature adults to their place of birth in greater numbers. Another reason could be a shift of some turtles from other nesting areas to the Fethiye beaches. This, however, is difficult to determine without nesting data from adjoining sites, information which is currently not available to us. Finally, the many turtles seen could reflect an increasing number of green turtles (*Chelonia mydas*), which have feeding grounds in this area. Global warming, for example, and better seagrass and algae growth (green turtles are herbivores), could conceivably promote an eastward shift in the Mediterranean green turtle population. Note also the recently recorded westernmost Mediterranean record of a nesting green turtle at adjoining Yaniklar Beach (Fellhofer-Mihcioglu et al. 2015).

Nests are not evenly distributed over the beach; the highest nesting activity occurred in the so-called picnic-area located between the Beskaza beach bar and Jiva Resort Hotel, with 11 nests (36.7%) (Fig. 4, Fig. 5). This section is the broadest beach area with no parasols and sunbeds. Although this area is used by a large number of tourists and local residents, the noise level lower than on the beach section along the promenade with its uninterrupted series of hotels, restaurants and bars. Especially because this beach section is so favored by the turtles, it is necessary to secure it from anthropogenic disturbance. People leave much rubbish on the beach, make bonfires and play music at night. A sufficient number of properly dimensioned and strategically placed rubbish bins and control by authorized authorities are urgently needed. The lowest nesting activity occurred in the about 1-km-long beach section between the Surf Cafe and the north-west end of Çaliş Beach (Fig.5). Only two nests (6.7%) were found in this section. The quality of the beach might be unfavorable for turtles because of steep slopes and a substrate of mainly stones and pebbles. The few remaining sandy areas on the beaches are favored by turtles and by visitors. The extensive urbanization of the coastline, especially in areas with sandy beaches, largely aimed at tourism and recreation, is probably the most serious threat (Margaritoulis et al., 2003). This is especially observable in the beach section along the promenade. In spite of profoundly anthropogenic disturbance such as light pollution, restricted beach width and high noise level, 10 nests were recorded along the promenade (Fig.3). Conspicuous is the fact that these nests are 1,4m (16%) closer to the sea than nests offside the promenade (Fig. 3). This demonstrates that turtles instinctively aim to place their nests farther away from the sea. Nests in this seaward zone have the greatest risk of egg mortality from erosion and inundation (Witherington et al. 2011). Barriers such as exposed seawalls and other types of coastal armoring can prevent use of the upper beach by nesting sea turtles (Witherington et al. 2011). In 2001 in the *Caretta caretta* nesting population in Patara (turkey), for example, the average distance of the nests from the sea was 43.5 m (Taşkın & Baran, 2001). This shows how restricted beach conditions in Çaliş Beach are. Apparently some females accept the circumstances along the promenade because of the good sand quality. Successful oviposition along the promenade mostly occurred after midnight (S. Hämmerle, personal observation) when the intensity of anthropogenic disturbance decreases. For example, many lights begin to be turned off at midnight or shortly thereafter (see A. Diem, this annual report). The fact that many nests are first discovered in the morning shifts (i.e. are not detected during the night shifts ending at about 2 am) supports this interpretation.

A total of 66 tracks was observed, with 19 tracks resulting in nests – a nesting success (number of nests/total number of emergences) of 28,8% (Fig.7). In comparison, the mean nesting success in Dalaman-Sarigerme beach in southwest Turkey during 7 years (2002-2008) was 24.6% (Kaska et al. 2010). In the Mediterranean, a general anthropogenic degradation has been noted at almost all significant nesting sites, and some areas known in the past to host nesting activity have been lost to turtles or severely degraded (Margaritoulis et al. 2003). The main anthropogenic threats affecting loggerhead nesting include vehicular and pedestrian traffic, human presence at night, beachfront lighting and noise, uncontrolled development and construction, beach furniture, sand extraction, beach erosion, beach pollution and marine pollution (Margaritoulis et al. 2003).

Çaliş Beach is already a Special Environmental Protected Area (SEPA), but implementation of the regulations has been inadequate. It is urgently necessary to make sure that these regulations are complied with. Another important factor is to sensitize people, especially children, to the threats facing sea turtles.

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Nesting activity of the Loggerhead Sea Turtle, *Caretta caretta*, on the beaches Yaniklar and Akgöl on the Turkish Mediterranean coast, 2015

Ines Svalina, Victoria Werner

KURZFASSUNG

Die Strände von Fethiye zählen zu den wichtigsten Nistplätzen von *Caretta caretta* in der Türkei und wurden 1988 zur „Special Protected Area“ (SPA) ernannt. In Fethiye findet jedes Jahr seit 1994 in Zusammenarbeit der Universität Wien und einer türkischen Universität ein Monitoring Programm statt. Im Zuge des Monitorings wurden dieses Jahr im Zeitraum von 27.6. bis 12.9. das Nistverhalten von *Caretta caretta* untersucht und Daten über Nester, Hatchlinge und adulte Weibchen sowie anthropogene Einflüsse am Strand erhoben.

2015 konnten 20 adulte Weibchen am Strand gesichtet und vermessen werden. Es wurden insgesamt 128 Nester gefunden, 78 Nester in Yaniklar und 50 in Akgöl. Das ist die zweithöchste gezählte Anzahl an Nestern seit Beginn der Aufzeichnungen 1994. Weiters wurden 217 Tracks gezählt, wobei 36 in Yaniklar und 36 in Akgöl zu einem erfolgreichen Nistversuch führten. Die durchschnittliche Entfernung eines Nests zum Meer betrug 20,99m in Yaniklar (n= 78) und 19,36m in Akgöl (n= 50).

Trotzdem zeigen die Ergebnisse der vergangenen 21 Jahre einen Abwärts-Trend der Nestanzahlen in Yaniklar und Akgöl. Die Verteilung der Nester und der Verlauf einiger Spuren deuten allerdings darauf hin, dass sich der Zustand der Strände, trotz Ausweisung als SPA, in einigen Abschnitten negativ entwickelt und die Weibchen zunehmend Schwierigkeiten haben, einen geeigneten Nistplatz zu finden.

ABSTRACT

Fethiye Beach represents one of the most important nesting sites of *Caretta caretta* in Turkey and was declared as a Special Protected Area in 1988. Austrian students from the University of Vienna and Turkish students have been working together on a monitoring project every year since 1994. In the time between 27 June and 12 September 2015, nesting behaviour of *Caretta caretta* was monitored. In this process, key data of nests, hatchlings, adult females and also anthropogenic disturbances were collected. In 2015, twenty-two adult females were encountered. A total of 128 nests, 78 in Yaniklar and 50 in Akgöl, were found. Furthermore,

217 tracks were recorded at both beaches, 36 of them with successful nesting attempts in Yaniklar and 36 in Akgöl. That is the second highest number of nests counted since 1994. The average distance of a nest to the sea was 20.99 m in Yanıklar (n = 78) and 19.36 m in Akgöl (n = 50).

Nevertheless the overall numbers seem to support a decline in the nesting population on these two beach sections over the 21 years of observation. Although the area was designated as a SPA, the distribution of the nests and the course of some tracks indicate that the condition of the beaches has degraded in many sections and that the turtles seem to have problems finding suitable nesting spots.

INTRODUCTION

In the Mediterranean Sea, three sea turtle species can be found: the loggerhead turtle (*Caretta caretta*), the green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*).

Caretta caretta and *Chelonia mydas* nest on Mediterranean beaches. As all three species are listed as globally endangered and vulnerable by the IUCN (International Union for Conservation of Nature and Natural Resources), they are protected under the "Convention on International Trade in Endangered Species of wild Fauna and Flora“ (CITES) (Broderick & Godley 1996).

In the Mediterranean, female loggerheads emerge preferably on beaches fronted by mostly sandy areas, such as those that still exist along some parts of Yaniklar and Akgöl (Miller et al., 2003), in order to lay their eggs. Almost all nests laid by *Caretta caretta* are in the eastern basin. Fethiye is one of 17 key nesting beaches of *Caretta caretta* in Turkey (Ilgaz et al. 2007). Over the past years, sea turtles in the Mediterranean are facing increasing threats to their survival. Waste, noise- and light pollution, fisheries and increasing tourism are threatening the nesting population there. Especially this year there was a significant problem in regards to nest depredation, most likely caused by jackals. Although Fethiye is designated as a 'Special Protected Area' (SPA) since 1988, an overall decline in the number of nests has been observed (e.g. Türkozan 2006; Ilgaz et al. 2007, Lambropoulos et al. 2015).

The "Sea Turtle Field Course" was first conducted in 1994 in Fethiye and aims to collect data on nests, tracks, temperature, adult female loggerhead turtles and hatchlings as well as on anthropogenic disturbances and thereby provides an opportunity to monitor the development of the *Caretta caretta* population of nesting there. Every year students from the University of Vienna cooperate with a Turkish university to assist in data aquisition. In 2015, from 27 June to 12 September, we worked together with the organisation Akdeniz Koruma Derneği, scientifically supervised by Prof. Yerli from the University of Hacettepe.

This year's observations have shown that anthropogenic disturbances continue to increase. Especially litter on the beach, light pollution from hotels and bars, and beach furniture are major threats.

MATERIAL AND METHODS

Two groups, each consisting of two to four people, were formed at our camp, Onur Camp between 27 June and 12 September 2015. One team would walk the Akgöl beach section, which is ~1.5 km long and ends at Karaot Beach. The other group would walk the Yaniklar beach section, which is ~4.5 km long and ends at Çaliş Tepe ("Small Beach", Fig. 2i). Our surveys started every day in the morning between 5 and 6 a.m. and continued as long as there was work to do and at night from ten p.m. until 2 a.m. Since there were many nests in front of this year's newly opened Barut Hotel (near "the desert", Fig. 2g, see Kaufmann, Kluge and Laza in this report), we sometimes had to add Barut-shifts, where we slept in front of the hotel and started our morning shift from there. We carried a field book with us, in which we took notes, and back at the camp we transcribed the data into pre-printed data sheets.

Night Shifts

The night shifts started at 10:00 pm and ended earliest at 2:00 am. We stopped going on night shifts as soon as the first nest hatched. In Akgöl that was on 11 July (AS 8) and in Yaniklar on 16 July (YS20).

The groups consisted of three people, who patrolled the beach in different heights parallel to the waterline. One person walked next to the vegetation line, one person in the middle of the beach and one person along the water line. This formation provided the highest and fastest chance of discovering a turtle without using any source of light. We surveyed the beach four times per shift; we walked to Karaot Beach in Akgöl (Fig. 2a) or to the so-called "Lonely Tree" (Fig. 2e) in Yaniklar, made a 20-minute pause, walked back and waited again 20 minutes at camp (Fig. 2c) before we repeated this process.

When a turtle was encountered, the team would stop and knee or lay down. It was important to keep out of the turtle's sight in order not to disturb it. The team would wait until the turtle headed back to the water to ensure minimal disturbance and then start the measurements.

To speed up the process the specific work steps were split up beforehand; one person would measure, one would take notes and one would hold the turtle. The straight carapace length and width (SCL/SCW) were measured with a wooden sliding caliper and the curved carapace length and width (CCL/CCW) were measured with a tape measure. The person who took notes would have to carefully use a flash light if necessary. The person who held the turtle would kneel on the left side of the turtle between the front and back flipper, and quickly grab the front of the carapace with one hand and gently lean on the end of the carapace with the other hand. With this tactic we tried to hinder the turtle from pushing itself away with its front flippers. Throughout, quick work was attempted because this interference was stressful for both the turtle and the observer.

When the first nest started hatching, we stopped night shifts and started hatchling controls, in which we controlled nests in threatened positions (i.e. in front of the Tuana Hotel or Karaot Restaurant, Fig. 2b) that were due to hatch or already hatching. Those shifts started at 10:00 pm until 2:00 am, with patrols every two hours or, when a nest was hatching, every hour.

Since there were many nests (13) in front of the Barut Hotel, which opened this year between the Picnic Area and Karataş Beach (Fig 2g), we had to insert Barut night shifts. This was in part possible only because our Turkish colleague had an automobile. We slept in a pavilion in front of the hotel and proceeded with our controls as mentioned above. The Barut turtle team then started the Yaniklar morning shift from there. This was only necessary when a nest had freshly hatched to catch the first surge of hatchlings.

Morning Shifts

The morning shifts started at dawn, which was between 5:00 am and 6:00 am, and lasted as long as there was work to do. The average time we came back was 11:00 am, but it became later as the numbers of hatching nests increased.

Usually the team would consist of two to three people. As in the night shifts, one person would walk along the upper half of the beach and the other person along the lower half of the beach in order to have the best overview. In the beginning of the field course, morning shifts mainly consisted of searching for adult tracks and new nests. Later it also involved finding and counting hatchling tracks and checking the status of the nests, sometimes by digging in and checking for stones, odors, etc.

When an adult track was discovered, total track length and width and nest distance to the sea were measured with a 50-m-long measuring tape. If there was no nest, we would take the highest point of the track to measure the distance to the sea. Furthermore, the stretch was divided into wet, moist and dry zone, which roughly described the moisture content of the sand. The shape of the track was sketched regarding the direction in which the turtle had crawled, as well as body pits, and swimming movements. Body pits and nests could be distinguished by the presence or absence of a so-called camouflage. A body pit occurs when a turtle solely tests the underground, whereas a camouflage indicates that she had laid a nest and had tried to hide it. When we found a camouflage we used a metal rod ("Şiş") to gently test the sand. The resistance of the sand above a nest would differ from that of the surrounding sand. When we had taken all our data, we erased the track to avoid counting it twice. Back at camp we transferred our collected data to the data sheets.

Marking Nests

When a new nest was found, we gave it a nest ID and noted its position so we could recognize it. The designations consisted of an abbreviation of the beach section it was found on and a number, for example A1 for Akgöl or Y1 for Yaniklar. If it was a nest that was found based on hatchling tracks, hence we didn't know the exact date on which it was laid, we designated it with an "S" as a 'secret nest' (i.e. AS1 or YS1). Then we gathered stones and put them in a semicircle around it. On some of the stones we wrote the nest number and the date. We also stuck a few sticks on which we noted the nest number behind the semicircle in the sand (Fig. 15). To ensure we could locate the nest even if those marks were removed, we tied two small wooden sticks together with some rope and signed it with the nest number. This was dug into the sand slightly above the egg chamber such that it wouldn't disturb the hatchlings. Thus, when the obvious marks were gone, we could use the Şiş to go through the sand and search for those tied sticks. Whenever possible we also triangulated the nests. For that we used at least two prominent spots, i.e. a tree or a pavilion, and measured the distance to the nest with measuring tape. This helped us find the nest even if all the other markings were lost.

Near hotels and restaurants, we put cages over the nests with signs on them. Additionally, in areas with strong light pollution, we put nets over the egg chambers to catch the hatchlings. This way they couldn't get lost and we could bring them to the sea safely (Fig. 19). In frequently visited areas, for example the Picnic Area or Small Beach (Fig. 2f, 2i, 15), where our marks were removed often, we built tripods by tying three sticks together; these were provided with a sign and placed directly over the nests. (Fig. 15)

This year predation played a big role, mainly on the Yaniklar beach section, so we used metal grids to protect the nests that were likely to be predated (Fig. 14). Those grids were put directly over the egg chambers and buried with a thin layer of sand (see Fuxjäger and Wanzenböck in this report, Fig. 18). To increase protective measures we also strewed chili and laid prickly plants around the nest.

Hatchery

A hatchery is constructed when a nest is laid in a very unfortunate position, e.g. too close to the waterline, where it can become flooded or too far away from the water in vegetation or places mainly used by humans (i.e. roads, hotel grounds). Such nests are transferred. The egg chamber is measured and rebuilt in a position that is more suitable. Then the eggs are placed in the artificial nest in the exact same order as in the original nest to ensure similar brooding conditions.

This year, 2015, two hatcheries were conducted by our Turkish colleagues from Hacettepe University. They were made before our field work had started. Nest Y9, laid on 13 June, was moved 15 m towards the sea, away from the Tuana Hotel. A7 was transfered to a spot at a distance of 17.5 m from the sea. (Fig. 2A, 2b)

RESULTS

The raw data of all nesting and emerging activities of adult female loggerhead sea turtles on the beaches of Akgöl und Yaniklar in 2015 are included in the table section of the Appendix.

Nests

In 2015, a total of 128 nests laid by female loggerhead sea turtles were recorded at Akgöl and Yaniklar. That is the second highest number of nests counted since 1994 (Fig. 1).

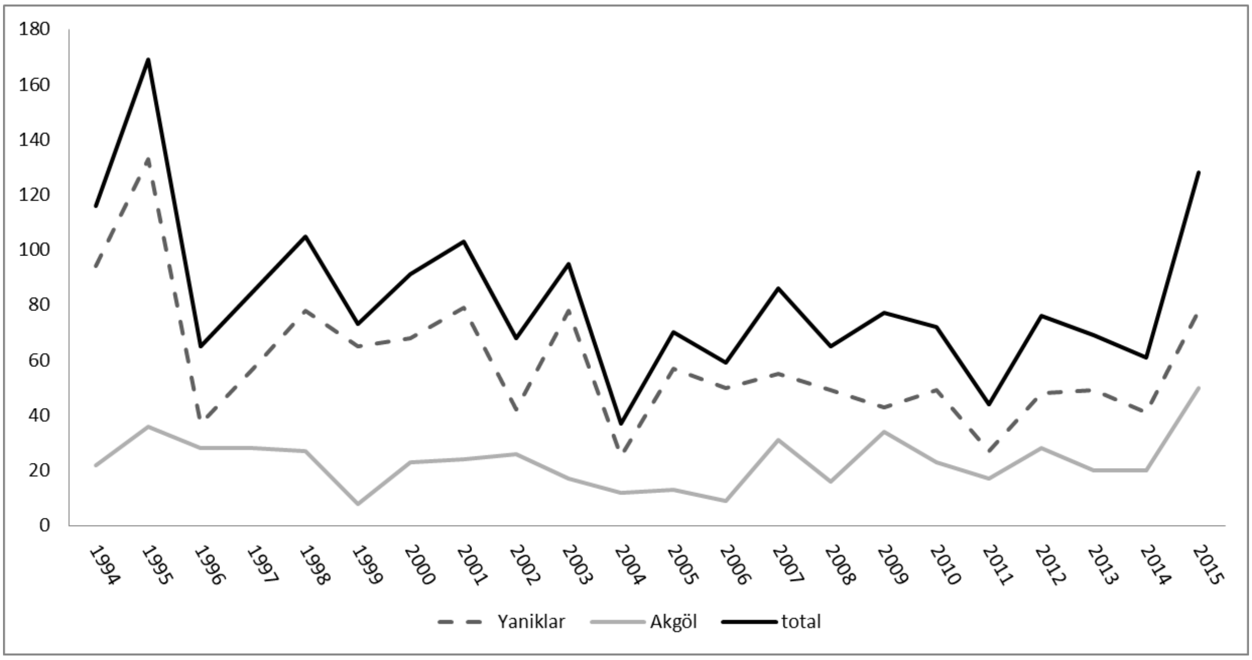

Fig. 1: Annual number of nests in Yaniklar and Akgöl from 1994 to 2015
Abb. 1: Jährliche Anzahl der Nester in Yaniklar und Akgöl von 1994 bis 2015

61% of the nests (n=78) were found in Yaniklar, whereas the remaining 40% of the nests (n=50) were located in Akgöl. 56% of all nests were "dated nests", having a known nesting date. The other nests, designated as "secret nests", were either found by our Turkish colleagues prior to our arrival or could later be located due to the hatching process.

The nests were not evenly distributed, depending on the different areas of the beaches. We identified nesting hotspots, which mainly appeared to reflect the quality of the substrate. (Fig. 2, 2a-2i)

Fig.2: Overview of Yaniklar and Akgöl beach sections with landmarks and distribution of nests.
Abb. 2: Überblick über Yaniklar und Akgöl mit Landmarken und Verteilung der Nester.

Fig.2a: Nests located around the riverbed of Akgöl.
Abb. 2a: Nester rund um das Akgöl-Flussbett.

Fig.2b: Nests located between Karoat Restaurant and Hotel Majesty Tuana.
Abb. 2b: Nestpositionen zwischen Karoat Restaurant und Hotel Majesty Tuana.

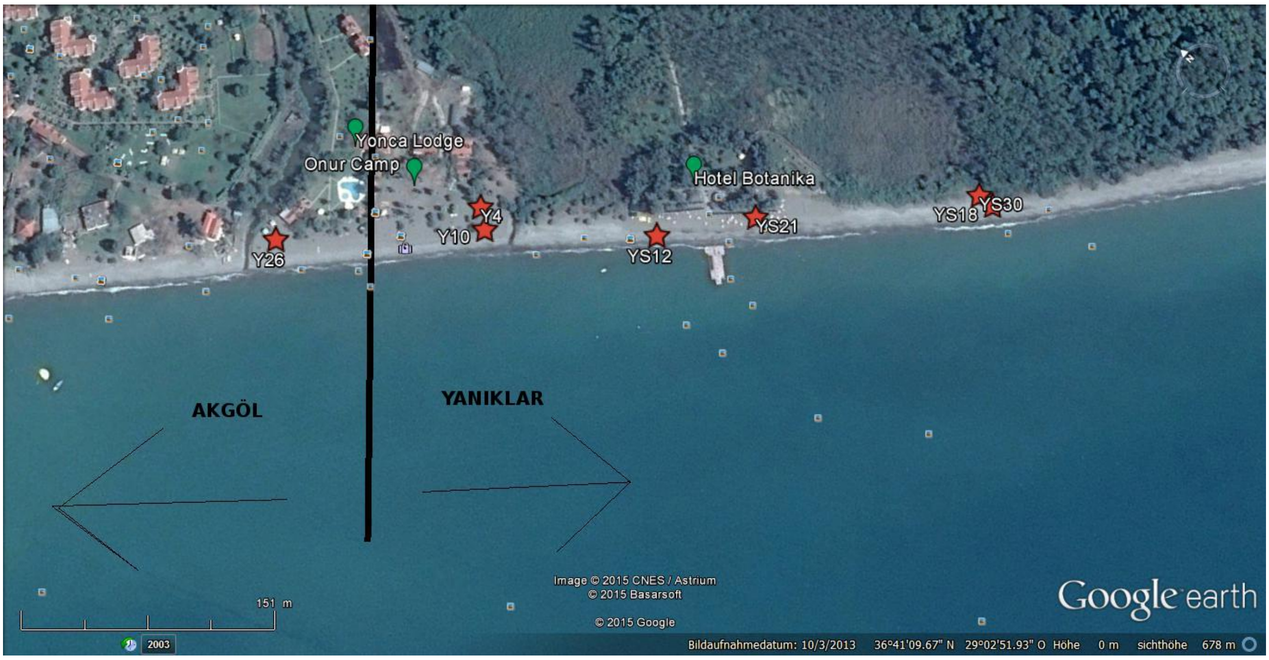

Fig. 2c: Nests located around Onur Camp and the line between the two beach sections.
Abb. 2c: Nestpositionen in der Umgebung von Onur Camp und Grenze zwischen den beiden Strandabschnitten.

Fig. 2d: Nests located between Hotel Majesty Botanica and half way to Lonely Tree.
Abb. 2d: Nestpositionen zwischen Hotel Majesty Botanica und der halben Strecke Richtung Lonely Tree.

Fig. 2e: Nests located between Fig. 2d and Lonely Tree.
Abb. 2e: Nestpositionen zwischen Abb. 2d und Lonely Tree.

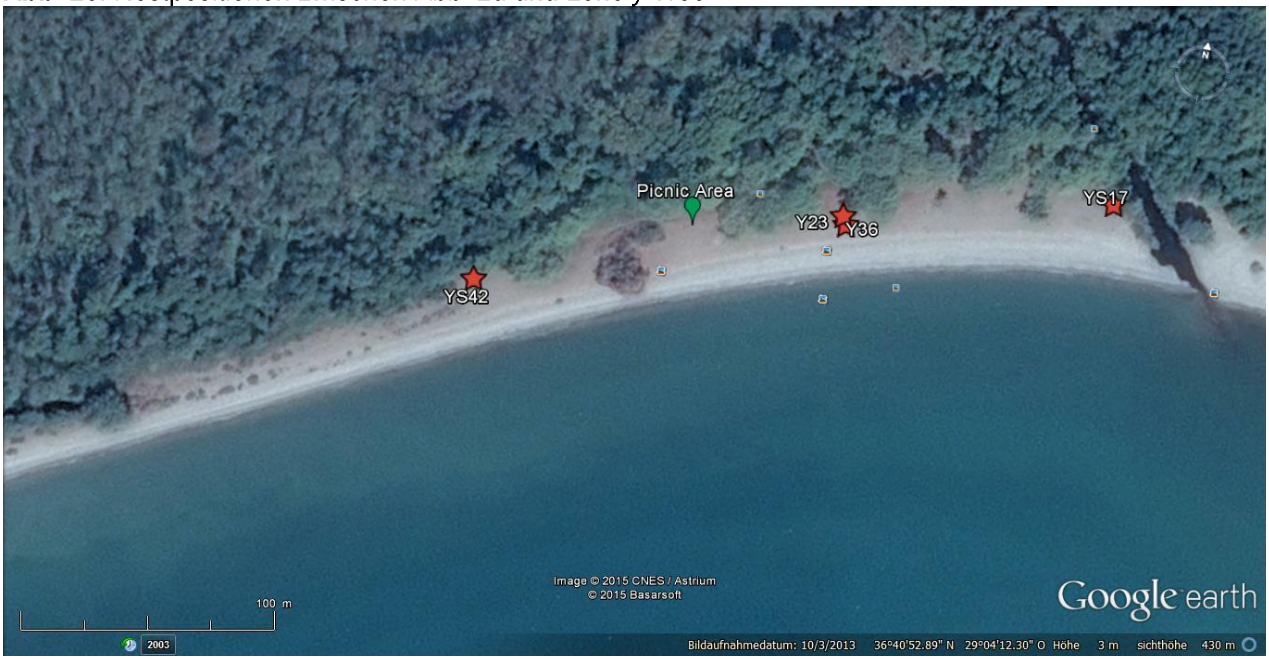

Fig. 2f: Nests located around the Picnic Area (New footbridge crossing creek on right is not yet depicted).
Abb. 2f: Nestpositionen in der Umgebung der Picnic Area (Neue Fußgängerbrücke über dem Bach rechts ist noch nicht dargestellt).

Fig. 2g: Nests located around Barut Hotel (New hotel complex is not yet depicted).
Abb. 2g: Nestpositionen in der Umgebung des Barut Hotels (Neuer Hotelkomplex ist noch nicht dargestellt)

Fig. 2h: Nests located between Barut Hotel and Karatas Restaurant.
Abb. 2h: Nestpostionen zwischen Barut Hotel und Karatas Restaurant.

Fig. 2i: Nests located around Karatas Restaurant and on Small Beach.
Fig. 2i: Nestpositionen in der Umgebung von Karatas Restaurant und am Small Beach.

The average distance of a nest to the sea was about 21 m in Yaniklar (n=78) and 19.4 m in Akgöl (n=50) (Fig. 3). The longest measured distance to the sea in Yaniklar was 112 m, whereas in Akgöl it was 39.7 m. The distance to the sea was divided in three different zones (wet, moist and dry). The nests in Yaniklar (n = 78) had average distances of 1.75 m (±0.68 m) in the wet; 2.72 m (±1.78 m) in the moist and 16.15 m (±12.98 m) in the dry zone. The nests in Akgöl (n = 50) had average distances of 2.10 m (±0.89 m) in the wet; 3.70 m (±2.27 m) in the moist and 13.56 m (±8.81 m) in the dry zone (Fig. 4, Fig. 5, Fig. 6).

Two of the nests, A07 and Y09, were dug in a very short distance to the sea. Those nests were relocated in the form of a hatchery to 17.5 m (A07) and 15.4 m (Y09) distance to the sea by our Turkish colleagues.

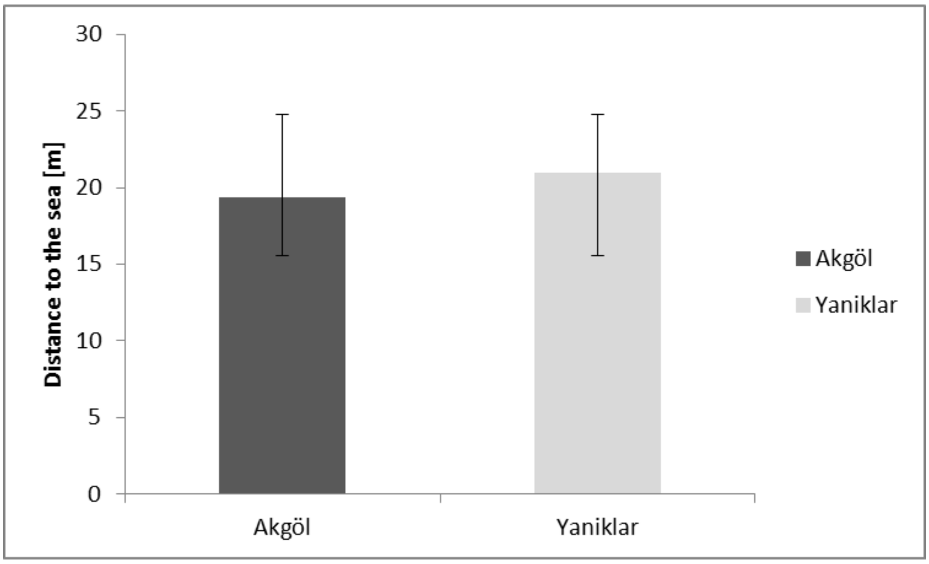

Fig. 3: Average distance to the sea of the nests in Yaniklar and Akgöl including standard deviation
Abb. 3: Mittlere Entfernung der Nester zum Meer in Yaniklar und Akgöl inklusive Standardabweichung

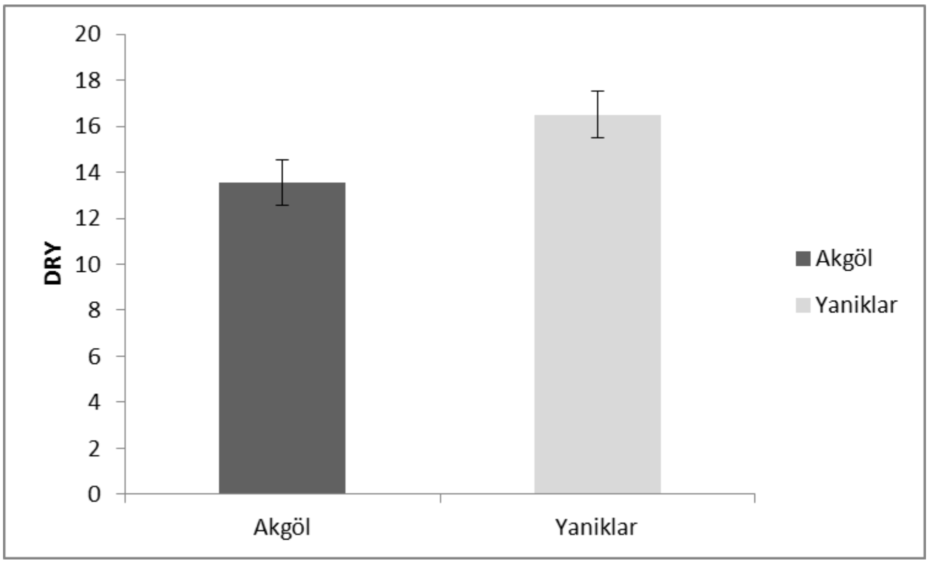

Fig. 4: Average dry zone of the distance to the sea of the nests in Yaniklar and Akgöl including standard deviation
Abb. 4: Mittlerer trockener Abschnitt der Entfernung der Nester zum Meer in Yaniklar und Akgöl inklusive Standardabweichung

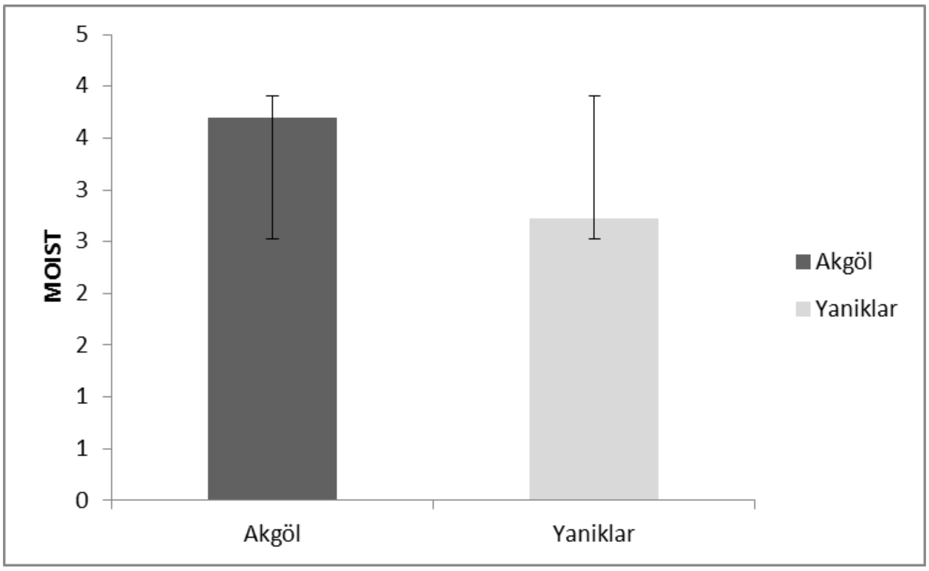

Fig. 5: Average moist zone of the distance to the sea of the nests in Yaniklar and Akgöl including standard deviation
Abb. 5: Mittlerer feuchter Abschnitt der Entfernung der Nester zum Meer in Yaniklar und Akgöl inklusive Standardabweichung

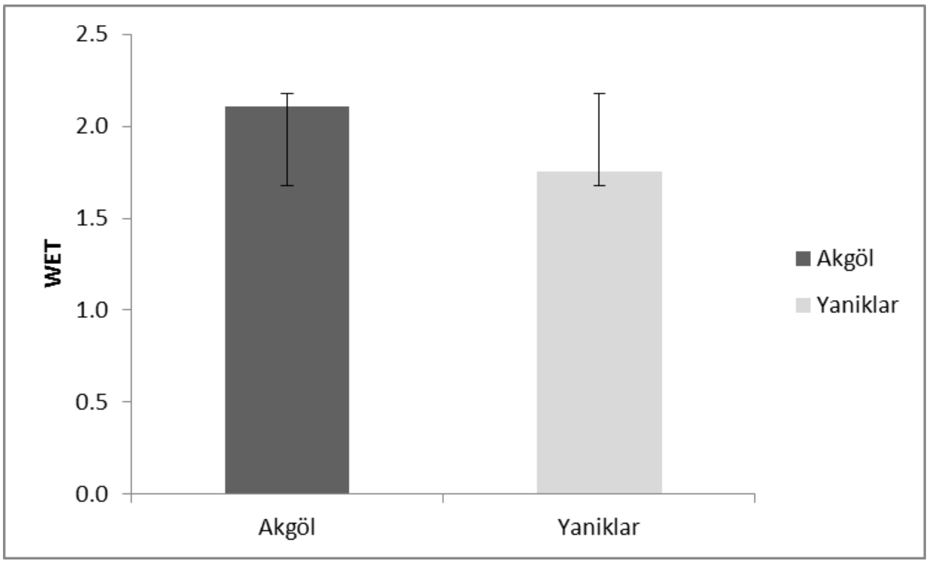

Fig. 6: Average wet zone of the distance to the sea of the nests in Yaniklar and Akgöl including standard deviation
Abb. 6: Mittlerer nasser Abschnitt der Entfernung der Nester zum Meer in Yaniklar und Akgöl inklusive Standardabweichung

Tracks

In the morning shifts from 26 June until 12 September a total of 217 tracks – 122 in Yaniklar and 95 in Akgöl – was counted. Only 33% (36 in Yaniklar and 36 in Akgöl) of those tracks included a successful nesting attempt (Fig. 7).

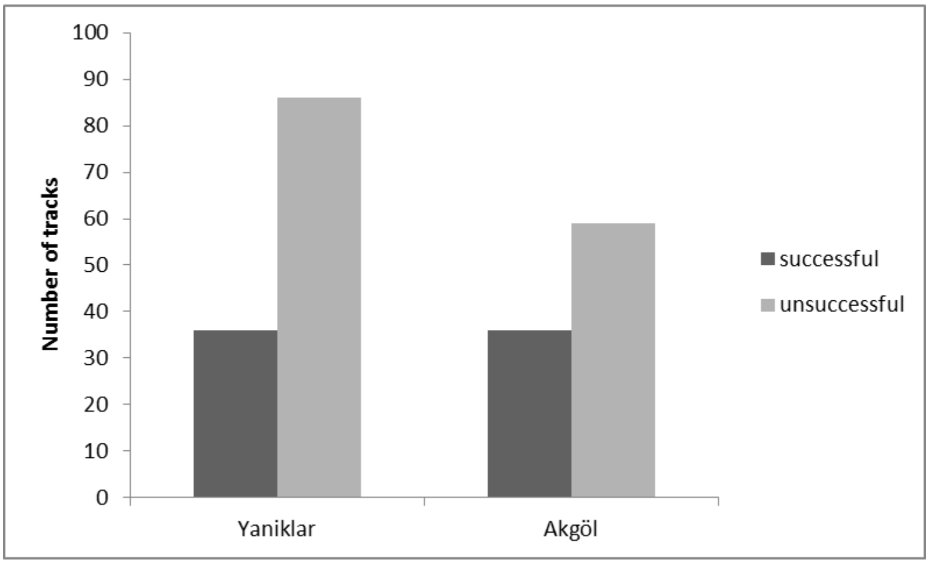

Fig. 7: Number of tracks distinguished into successful and unsuccessful nesting attempts on Yaniklar and Akgöl Beach
Abb. 7: Anzahl der Spuren getrennt in erfolgreiche und nicht-erfolgreiche Nistversuche auf den Stränden Yaniklar und Akgöl

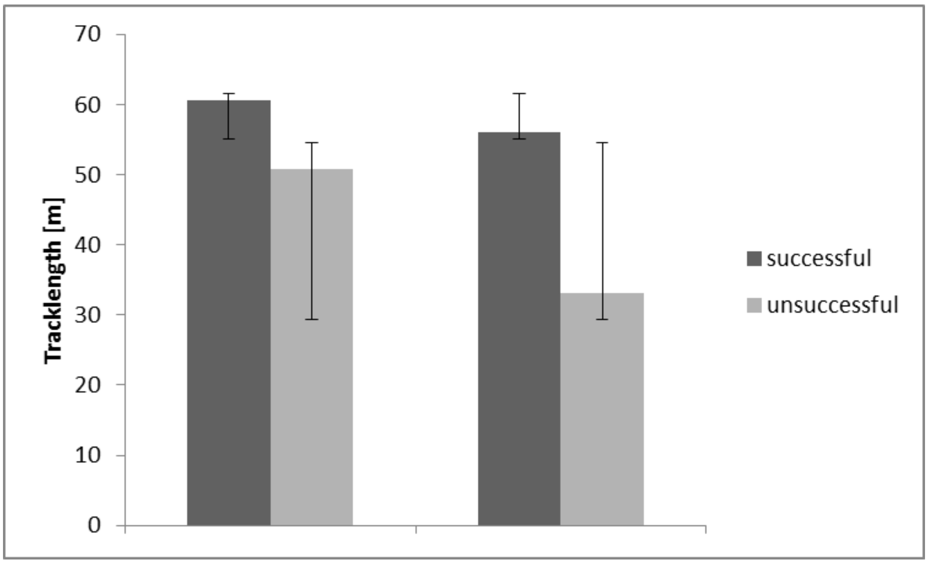

Fig. 8: Average track length including standard deviation, distinguished into successful and unsuccessful nesting attempts on Yaniklar and Akgöl Beach
Abb. 8: Mittlere Spurenlänge inklusive Standardabweichung, getrennt in erfolgreiche Nistversuche und nicht-erfolgreiche Nistversuche auf den Stränden Yaniklar und Akgöl

Adults

We observed and measured 20 female *Caretta caretta* adults during our night shifts. Eight of them had a tag. Two of the 8 tagged adult females were sighted twice. We recorded their carapace dimensions as well as possible epibionts and further remarks. Eight females were tagged by our Turkish colleagues.

The average values for straight measurements were 66 cm length (SCL) and 49 cm width (SCW). The average curved carapace measures were 75 cm in length (CCL) and 69 cm in width (CCW) (Fig. 13). In comparison to the data of 2014, the turtles had similar measurements (2014: SCL = 67 cm; SCW = 52 cm; CCL = 77 cm; CCW = 68 cm; n=4).

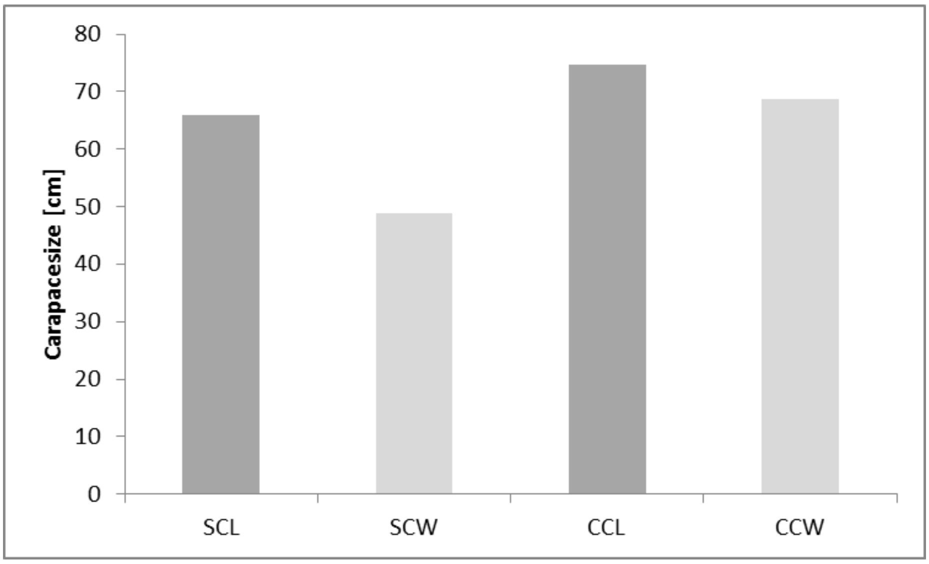

Fig. 9: Average carapace size (in cm) of adult females in 2015, SCL: straight carapace length, SCW: straight carapace width, CCL: curved carapace width, CCW: curved carapace width.
Abb. 9: Mittlere Panzergröße (in cm) der adulten Weibchen von 2015, SCL: gerade Panzerlänge. SCW: gerade Panzerbreite, CCL: gekrümmte Panzerlänge, CCW: gekrümmte Panzerbreite

Tab. 1: Tagged female adults; sighting numbers: AY = adult on Yaniklar beach; AA = adult on Akgöl beach. L = left, R = right flipper
Tab. 1: Markierte weibliche Adulte; Sichtungs-Nummern: AY = Adult am Strand von Yaniklar; AA = Adult am Strand von Akgöl. L = linker, R = rechter Flipper

sighting #	date	nest #	emerging time	tag #	SCL	SCW	CCL	CCW
AY01	28.06.2015		n.a.	TR679 (L)	54	48	76	61
AY03	05.07.2015	Y21	02:00	TR682 (R)	62	47	84	91
AY04	06.07.2015		n.a.	TR683 (R)	64	52	72	77
AY06	07.07.2015	Y23	00:00	TR680 (L)	61	41	72	66
AY14	19.07.2015	Y38	n.a.	TR682 (R)	n.a.	n.a.	75	67
AY15	21.07.2015	Y39	00:30	TR686 (R)	65	45	73	63
AA01	25.06.2015			TR 678 (L)	78	48	75	67
AA02	25.06.2015	A12	n.a.	TR 677 (L)	77	53	83	72
AA03	04.07.2015		22:30	TR 681 (R)	64	48	77	66
AA04	05.07.2015	A19	n.a.	TR 681 (R)	68	50	74	66

DISCUSSION

Since the start of the turtle conservation and research course in 1994, the nest numbers have generally been declining, as the data of the last 20 years show (Fig. 1). Previous annual reports claimed that a downward trend has been observable (Bürger & Kriegl 2014). The higher value this year represents an interruption of that trend here. With 128 nests (50 in Akgöl, 78 in Yaniklar) we have the second highest peak since the first surveys were done.

There are several possible explanations for the sudden rise in nest numbers. The years it takes a sea turtle to reach maturity vary very strongly depending on geographical position and population (Dodd 1988). The estimated range for C. caretta in the Mediterranean is 14.9-28.5 years (Casale 2011). These estimations would permit the rather optimistic interpretation that the population is starting to rise due to the work the project has carried out, i.e. those hatchlings helped to the sea decades ago are now returning in larger numbers. Nonetheless, since such fluctuations regarding nest numbers happen frequently around the globe (Margaritoulis 2005), it is equally likely that this year's peak merely represents an outlier. Another potential explanation is a short-term shift in nesting beaches, i.e. some females that normally nest at other closeby Turkish beaches came to Fethiye this year. This would require knowing the nest numbers at other beaches, data which is currently not yet available.

Finally, turtles have a migratory lifestyle. After a female has laid her eggs, which can occur one to six times during a season, she leaves the nesting area. The general assumption has been that she returns to the same beach in a 2-4 year cycle. But studies show that a female turtle comes back to her natal beach in rather irregular intervals, for example sometimes switching between a 2-year and a 3-year-cycle (Dodd 1988). One paper on the decline of the Loggerhead sea turtle population in Fethiye stated that the peaks since 1995 occurred in a 3-year-cycle until 2003, after which the peaks apparently occurred in 2-year-cycles. Furthermore, the authors stated that each subsequent peak was lower than the one before (Ilgaz 2005). This is also visible in Fig. 1. The peaks after 2003 happened in a 2-year-cycle until 2009 and then continued in a 3-year-cycle, with the latest peak in 2015 at a higher level than the preceding one. This development leaves room for hope that the future peaks won't continue to drop, as suggested in the paper.

Another interesting fact is that in the last five years no turtles with tags have been recorded, whereas this year we had 8 newly tagged females of which 2 were sighted twice (Tab 1). All together, these turtles laid 7 nests (A12, A13, A19, Y21, Y23, Y38, Y39). One turtle laid two nests in the same beach section, Y21 and Y38. The other female that was sighted twice made one nest, which we recorded (A19), but the second emergence was unsuccessful. All the turtles were tagged this year by our Turkish colleagues.

The above-mentioned fluctuations in nest numbers might also be correlated with the survival of female adults (Dodd 1988). Anthropogenic influences no doubt play an important role here. Besides the death of adult sea turtles by bycatch, climate change, marine debris (Derraik 2002), collision with boats, etc., the nesting sites are also threatened by human uses of beaches involving hotels, restaurants, and bathing sites. This involves not only light pollution and litter on the beaches, but also densely arranged beach furniture (pavillions, sun loungers, parasols) and construction work on the beaches. The latter includes sand removals and mechanical 'clean up' efforts.

These human influences immensely impact the nesting behaviour and success of sea turtles. Before a turtle lays a nest she tests the sand, and often it happens that she returns to the sea without having made a nest. This year we counted 95 tracks in Akgöl, of which ~38% were successful (with nest) and ~62% were unsuccessful (without nest). In Yaniklar we counted 122 tracks in total, 29.5% were successful and 70.5% were unsuccessful (Fig. 7). In comparison to the results of last years survey, where they had a success rate of approximately 20% on both beach sections (Bürger & Kriegl 2014), this year's nesting success turned out better. Notable is this year's big difference between Akgöl and Yaniklar regarding nesting success. Furthermore the successful tracks were longer than the unsuccessful tracks in Yaniklar and in Akgöl, suggesting that disturbed turtles immediately left the beach without having made a nest. Despite the numerous construction works in Akgöl, the success was higher and the successful and the unsuccessful track lengths were shorter than in Yaniklar (Fig. 8). This might be due to predation, of which there was more in Yaniklar (Fig. 14) – for example a jackal sighted during the egg-laying process at Y38 (Fig. 2g). While this turtle (TR682) was not disturbed by this appearance, other turtles might have been. Other reasons could be the high concentration of litter and vegetation on the Yaniklar beach section and the new Barut Hotel.

In 2015, as in previous years, the nests clearly were not distributed uniformly; many clusters formed. Most likely, females lay nests in positions where hatchling survival can be expected to be highest, thereby creating aggregations of nests or even clear hotspots. Hays and Speakman (1993) stated that the distance to the sea and vegetation on the beach do not play a role in terms of hatchling survival, but that attempts of adult females to lay nests in the vegetation line would be impeded by the texture of the sand. This might apply to our study site: in Yaniklar there was much more vegetation and litter on the beach than in Akgöl. The Karaot Beach was a very prominent hotspot, with a very high nest density, whereas in the adjoining lengthy gravel section, no nests were recorded (Fig. 2). Also in Yaniklar there was a very prominent cluster, namely in front of Barut Hotel, even though the light pollution was very strong and people were on the beach at all times of the day and night. Here, the quality of the sand might be a reason for the dense nests.

Especially clusters such as the one in front of Barut underline the necessity of turtle protection and monitoring. The anthropogenic influences are immense (Fig. 12, 13, 16, 17, 19, 21, 22), but what made our work so important is the often poor state of knowledge of tourists and even local residents. More information signs should be put up, and also the signs the sea turtle monitoring team uses to mark the nests should be designed in a more noticeable way (i.e. bigger cardboard with coloured prints), to prevent them from being overseen (Fig. 10, 11, 15). The fact that one nest (Y36) was used as a fireplace shows how difficult it is to raise awareness for the importance of these beaches (Fig. 10). More signs directly in hotels such as Tuana, Botanika or Barut could help (Fig. 23).

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APPENDIX

Fig. 10: Anthropogenically destroyed nest-marking of Y36.
Abb. 10: Durch Menschen zerstörte Nest-Markierung von Y36.

Fig. 11: Rebuilt nest-marking of Y36.
Abb. 11: Wieder aufgebaute Markierung von Y36

Fig. 12: A freshly hatched nest in front of a car in Yaniklar at „the desert".
Abb. 12: Ein frisch geschlüpftes Nest vor einem Auto in Yaniklar in „der Wüste".

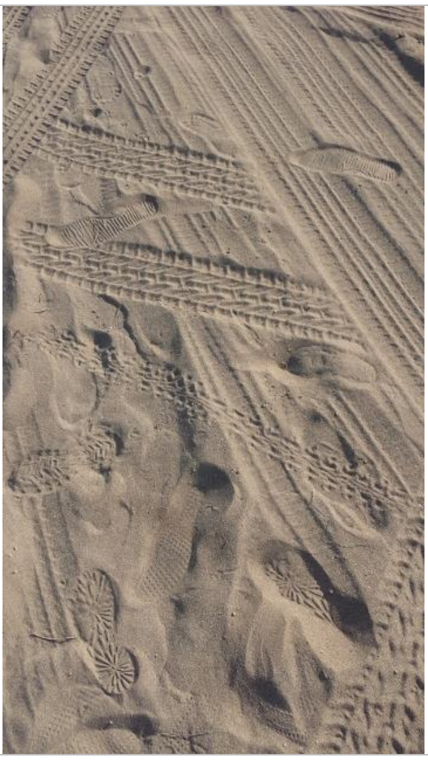

Fig. 13: Hatchling tracks destroyed by car and shoe tracks near Barut Hotel.
Abb. 13: Hatchlingspuren zerstört durch Reifen- und Schuhabdrücke in der Nähe vom Barut Hotel.

Fig. 14: A predated nest in Yaniklar with a predation cage.
Abb. 14: Ein prädiertes Nest in Yaniklar mit einem Prädationskäfig.

Fig. 15: A marked nest with a tripod and a semicircle of stones on Small Beach.
Abb. 15: Ein markiertes Nest mit einem Stativ und einem Halbkreis von Steinen auf Small Beach.

Fig. 16: An illegally parked caravan on the beach in Yaniklar ("the desert“).
Abb. 16: Ein illegal geparkter Wohnwagen auf dem Strand in Yaniklar („die Wüste“).

Fig. 17: A tent between the pavillons in front of Karaot Restaurant.
Abb. 17: Ein Zelt zwischen den Pavillons vor Karaot Restaurant.

Fig. 18: Hatchlings caught in a predation cage.
Abb. 18: Hatchlinge gefangen in einem Schutzkäfig

Fig. 19: A marked nest with a cage and a net over the egg chamber in front of Barut Hotel, beside a partially buried parasol base.
Abb. 19: Ein markiertes Nest mit einem Käfig und einem Netz über der Eikammer vor dem Barut Hotel; Sonnenschirmverankerung im Vordergrund.

Fig. 20: The turtle team at work on Karaot Beach.
Abb. 20: Das Schildkröten-Team bei der Arbeit auf Karaot Beach.

Fig. 21: YS21 in front of Botanika with bread on the nest.
Abb. 21: YS21 vor Botanika mit Brot auf dem Nest.

Fig. 22: Hatchling tracks beside what appears to be chemicals next to Barut Hotel.
Abb. 22: Hatchlingspuren durch Chemikalien? neben Barut Hotel.

Fig. 23: A sign on a cage in front of Barut.
Abb. 23: Ein Schild auf einem Käfig vor Barut.

Tab. 2: Annual number of nests in Akgöl and Yaniklar from 1994-2015.
Tab. 2: Jährliche Anzahl der Nester in Akgöl und Yaniklar von 1994 bis 2015.

Year	Yaniklar	Akgöl	total
1994	94	22	116
1995	133	36	169
1996	37	28	65
1997	57	28	85
1998	78	27	105
1999	65	8	73
2000	68	23	91
2001	79	24	103
2002	42	26	68
2003	78	17	95
2004	25	12	37
2005	57	13	70
2006	50	9	59
2007	55	31	86
2008	49	16	65
2009	43	34	77
2010	49	23	72
2011	27	17	44
2012	48	28	76
2013	49	20	69
2014	41	20	61
2015	78	50	128

Tab 3: Nesting data Akgöl including emergence data; A = nest Akgöl; Y = nest Yaniklar; n.a. = no data available; As and Ys mixed because the division of the beacheswas changed during the data acquisition process.
Tab. 3: Nestdaten von Akgöl inklusive Landgangsdaten; A = Nest Akgöl; Y = Nest Yaniklar; n.a.= keine Daten vorhanden; As und Ys gemischt da die Teilung der Strände nach der Datenaufnahme geändert wurde.

date	nest #	total length [m]	track width [m]	body pits (started chambers)	dist. to sea	dry	moist	wet	hatchery
27.05.2015	Y01	n.a	0.63	n.a.	7.70	4.20	0.00	3.50	0
30.05.2015	A01	n.a.	0.50	1	15.40	7.00	5.60	2.80	0
30.05.2015	A02	n.a.	n.a.	n.a.	16.10	9.80	4.20	2.10	0
31.05.2015	A03	n.a.	0.87	2	10.50	2.80	4.90	2.80	0
05.06.2015	A25	n.a.	0.51	1	10.50	2.10	5.60	2.80	0
08.06.2015	A17	n.a.	0.52	1	29.40	21.00	6.30	2.10	0
09.06.2015	Y07	n.a.	0.51	0	18.90	14.00	2.80	2.10	0
11.06.2015	A04	n.a.	0.79	0	5.10	2.30	1.40	1.40	0
13.06.2015	A05	n.a.	0.52	0	23.60	17.30	4.20	2.10	0
13.06.2015	Y09	n.a.	0.69	0	15.40	12.60	2.10	0.70	1
14.06.2015	A06	n.a.	n.a.	n.a.	5.60	2.80	0.70	2.10	0
15.06.2015	A07	n.a.	0.57	n.a.	17.50	13.30	2.80	1.40	1
16.06.2015	A31	n.a.	0.64	3	18.90	10.50	5.60	2.80	0
17.06.2015	A08	n.a.	0.54	1	33.60	30.10	2.10	1.40	0

Tab 3 (cont.): Nesting data Akgöl including emergence data; A = nest Akgöl; Y = nest Yaniklar; n.a. = no data available; As and Ys mixed because the division of the beacheswas changed during the data acquisition process.
Tab. 3 : Nestdaten von Akgöl inklusive Landgangsdaten; A = Nest Akgöl; Y = Nest Yaniklar; n.a.= keine Daten vorhanden; As und Ys gemischt da die Teilung der Strände nach der Datenaufnahme geändert wurde.

date	nest #	total length [m]	track width [m]	body pits (started chambers)	dist. to sea	dry	moist	wet	hatchery
17.06.2015	A09	n.a.	0.57	1	20.50	11.90	6.50	2.10	0
23.06.2015	A10	n.a.	0.68	0	17.50	10.50	3.50	3.50	0
23.06.2015	A11	n.a.	0.70	0	30.00	21.00	5.50	3.50	0
25.06.2015	A12	n.a.	0.84	0	18.90	11.90	2.10	4.90	0
25.06.2015	A13	n.a.	n.a.	n.a.	22.90	19.00	2.70	1.20	0
28.06.2015	A14	169.00	0.86	5	28.50	23.60	3.40	1.50	0
28.06.2015	A15	n.a.	n.a.	n.a.	9.90	2.00	6.10	1.80	0
28.06.2015	A16	76.20	0.82	0	27.90	21.20	4.80	1.90	0
04.07.2015	A18	41.00	0.75	0	17.20	10.80	5.00	1.40	0
05.07.2015	A19	74.50	0.70	1	29.00	23.30	3.60	2.10	0
06.07.2015	A20	50.70	0.60	0	23.00	19.40	1.90	1.70	0
07.07.2015	A21	29.40	0.57	0	12.20	9.70	1.20	1.30	0
08.07.2015	A22	59.10	0.50	1	24.70	20.60	2.70	1.40	0
08.07.2015	Y26	52.00	0.51	0	24.50	20.30	2.50	1.70	0
09.07.2015	A23	78.10	0.64	4(1)	27.80	23.40	2.60	1.80	0
11.07.2015	A24	17.30	0.49	0	8.50	4.60	2.30	1.60	0
11.07.2015	Y32	99.80	0.52	3	29.40	25.40	2.20	1.80	0
14.07.2015	A26	24.70	0.52	0	9.20	0.00	7.20	2.00	0
18.07.2015	A27	36.80	0.50	2	13.50	8.10	4.00	1.40	0
20.07.2015	A28	33.20	0.55	4	39.70	34.60	3.10	2.00	0
22.07.2015	A29	102.00	0.60	6	20.40	16.40	2.60	1.40	0
28.07.2015	A30	26.10	0.49	0	8.85	2.85	1.50	4.50	0

Tab 4: Nesting data Akgöl – secret nests; As = secret nest Akgöl; Ys = secret nest Yaniklar; n.a. = no data available; As and Ys mixed because the division of the beacheswas changed during the data acquisition process.
Tab. 4: Nestdaten Akgöl – Secret Nester; As = Secret Nest Akgöl;Ys= Secret Nest Yaniklar n.a. = keine Daten vorhanden; As und Ys gemischt da die Teilung der Strände nach der Datenaufnahme geändert wurde.

date	nest #	total length (m)	width (m)	body pits	dist. to sea (m)	dry	moist	wet	hatchery
26.05.2015	As01	n.a.	n.a.	n.a.	13.30	4.20	4.90	4.20	0
26.05.2015	As02	n.a.	n.a.	n.a.	5.60	0.00	2.80	2.80	0
26.05.2015	As03	n.a.	n.a.	n.a.	18.20	1.40	14.00	2.80	0
08.06.2015	As04	n.a.	n.a.	n.a.	24.50	20.30	2.80	1.40	0
13.06.2015	As05	n.a.	n.a.	n.a.	11.20	7.70	2.10	1.40	0
03.07.2015	As06	n.a.	n.a.	n.a.	29.00	25.30	2.30	1.40	0
08.07.2015	As07	n.a.	n.a.	n.a.	12.20	4.70	5.50	2.00	0
11.07.2015	As08	n.a.	n.a.	n.a.	31.80	24.70	5.50	1.60	0
15.07.2015	As09	n.a.	n.a.	n.a.	30.30	22.90	6.20	1.20	0
17.07.2015	As10	n.a.	n.a.	n.a.	27.10	20.70	4.60	1.80	0
21.07.2015	As11	n.a.	n.a.	n.a.	23.30	19.10	2.00	2.20	0
18.08.2015	As12	n.a.	n.a.	n.a.	21.70	18.10	1.10	2.50	0
12.08.2015	Ys34	n.a.	n.a.	n.a.	11.00	7.10	1.90	2.00	0
15.08.2015	Ys37	n.a.	n.a.	n.a.	16.60	11.30	4.00	1.30	0

Tab 5: Nesting data Yaniklar including emergence data; Y = nest Yaniklar; n.a. = no data available
Tab. 5: Nestdaten Yaniklar inklusive Landgangsdaten; Y= Nest Yaniklar; n.a. = keine Daten vorhanden

date	nest #	total length (m)	width (m)	body pits (started chamber)	dist. to sea	dry	moist	wet	hatchery
28.05.2015	Y02	n.a.	0.73	1	10.60	7.80	1.40	1.40	0
04.06.2015	Y03	n.a.	0.85	2	32.90	28.00	3.50	1.40	0
04.06.2015	Y04	n.a.	0.62	2	27.30	21.00	4.90	1.40	0
05.06.2015	Y05	n.a.	0.62	1	21.00	11.90	4.90	4.20	0
09.06.2015	Y06	n.a.	0.52	3	31.10	16.40	11.20	3.50	0
11.06.2015	Y08	n.a.	0.69	1	41.30	36.40	2.80	2.10	0
13.06.2015	Y10	n.a.	0.69	0	10.50	7.70	1.40	1.40	0
13.06.2015	Y11	n.a.	0.52	0	15.40	10.50	2.80	2.10	0
19.06.2015	Y12	n.a	0.55	0	13.30	9.80	1.40	2.10	0
19.06.2015	Y13	n.a.	0.61	1	18.90	16.10	0.00	2.80	0
27.06.2015	Y14	41.10	0.61	1	20.00	12.30	5.40	2.30	0
27.06.2015	Y15	230.00	0.89	6(1)	112.00	109.00	2.00	1.00	0
28.06.2015	Y16	37.40	0.61	0	17.10	10.10	5.20	1.80	0
13.06.2015	Y17	n.a.	0.53	0	8.40	4.90	2.10	1.40	0
02.07.2015	Y18	67.00	0.76	1	24.40	19.90	3.70	0.80	0
05.07.2015	Y19	40.50	0.75	3	17.90	12.20	5.00	0.70	0
05.07.2015	Y20	33.80	0.58	0	14.70	8.40	5.30	1.00	0
05.07.2015	Y21	59.80	0.51	2	25.50	19.90	4.40	1.20	0
06.07.2015	Y22	48.00	0.59	4(1)	20.20	13.50	4.20	2.50	0
07.07.2015	Y23	65.20	0.63	3(1)	22.60	19.50	2.00	1.10	0

Tab 5: Nesting data Yaniklar including emergence data; Y = nest Yaniklar; n.a. = no data available
Tab. 5: Nestdaten Yaniklar inklusive Landgangsdaten; Y= Nest Yaniklar; n.a. = keine Daten vorhanden

date	nest #	total length (m)	width (m)	body pits (started chamber)	dist. to sea	dry	moist	wet	hatchery
07.07.2015	Y24	12.20	0.46	0	5.90	3.00	1.90	1.00	0
08.07.2015	Y25	24.30	0.68	0	11.20	8.20	1.80	1.20	0
10.07.2015	Y27	38.20	0.61	0	17.52	11.12	4.50	1.90	0
04.06.2015	Y29	n.a.	0.49	2	18.20	14.00	2.80	1.40	0
08.06.2015	Y30	n.a.	0.61	1	14.30	9.80	2.40	2.10	0
11.07.2015	Y31	67.10	0.56	1	20.80	16.60	2.90	1.30	0
12.07.2015	Y33	53.50	0.22	2	17.30	11.80	4.40	1.10	0
13.07.2015	Y34	59.40	0.55	3	25.20	20.50	3.30	1.40	0
14.07.2015	Y35	35.00	0.55	0	15.20	10.20	3.00	2.00	0
14.07.2015	Y36	44.00	0.48	1	20.00	16.60	1.60	1.80	0
17.07.2015	Y37	52.10	0.55	1	15.70	12.50	2.00	1.20	0
19.07.2015	Y38	64.30	0.45	3	22.20	17.70	2.20	2.30	0
21.07.2015	Y39	44.40	0.52	1	19.50	13.20	2.00	4.30	0
21.07.2015	Y40	62.60	0.62	4(3)	22.60	19.30	2.70	0.60	0
28.07.2015	Y41	n.a	n.a.	n.a.	12.10	7.80	2.70	1.60	0
01.08.2015	Y42	52.50	0.60	1	24.60	21.20	3.00	0.40	0

Tab 6: Nesting data Yaniklar – secret nests; Ys = secret nest Yaniklar; n.a. = no data available
Tab. 6: Nestdaten Yaniklar – Secret Nester; Ys= Secret Nest Yaniklar; n.a. = keine Daten vorhanden

date	nest #	total length (m)	width (m)	body pits	dist. to sea	dry	moist	wet	hatchery
04.06.2015	YS01	n.a	n.a.	n.a.	18.90	11.90	4.20	2.80	0
09.06.2015	YS02	n.a	n.a.	n.a.	23.80	22.40	0.00	1.40	0
09.06.2015	YS03	n.a	n.a.	n.a.	23.10	21.70	0.00	1.40	0
09.06.2015	YS04	n.a	n.a.	n.a.	22.40	21.00	0.00	1.40	0
10.06.2015	YS05	n.a	0.69	0	39.90	32.20	2.80	4.90	0
10.06.2015	YS06	n.a	n.a.	n.a.	18.50	15.40	1.00	2.10	0
10.06.2015	YS07	n.a	0.65	n.a.	17.80	14.00	1.00	2.80	0
23.06.2015	YS08	n.a	n.a.	n.a.	15.70	10.80	2.80	2.10	0
23.06.2015	YS09	n.a	0.49	0	15.60	9.60	3.00	3.00	0
27.06.2015	YS10	n.a	0.69	n.a.	29.10	26.60	1.60	0.90	0
27.06.2015	YS11	75.40	0.69	0	37.70	34.10	2.50	1.10	0
28.06.2015	YS12	n.a	n.a.	n.a.	15.60	8.60	5.00	2.00	0
29.06.2015	YS13	n.a	n.a.	n.a.	42.00	35.00	5.60	1.40	0
23.06.2015	YS14	n.a	n.a.	n.a.	10.80	5.60	2.90	2.30	0
24.06.2015	YS15	n.a	n.a.	n.a.	19.10	16.10	2.30	0.70	0
06.07.2015	YS16	n.a	n.a.	n.a.	12.70	8.20	2.00	2.50	0
09.06.2015	YS17	n.a	n.a.	n.a.	18.20	16.80	0.00	1.40	0
13.06.2015	YS18	n.a	n.a.	n.a.	10.10	7.30	1.40	1.40	0
15.07.2015	YS19	n.a	n.a.	n.a.	12.25	11.25	0.00	1.00	0
16.07.2015	YS20	n.a	n.a.	n.a.	26.60	21.10	3.60	1.90	0
21.07.2015	YS21	n.a	n.a.	n.a.	14.20	9.00	4.00	1.20	0
22.07.2015	YS22	n.a	n.a.	n.a.	36.50	33.50	2.00	1.00	0

Tab 6: Nesting data Yaniklar – secret nests; Ys = secret nest Yaniklar; n.a. = no data available
Tab. 6: Nestdaten Yaniklar – Secret Nester; Ys= Secret Nest Yaniklar; n.a. = keine Daten vorhanden

date	nest #	total length (m)	width (m)	body pits	dist. to sea	dry	moist	wet	hatchery
25.07.2015	YS23	n.a	n.a.	n.a.	19.40	16.40	1.30	1.70	0
26.07.2015	YS24	n.a	n.a.	n.a.	18.45	15.65	1.60	1.20	0
09.07.2015	YS25	n.a	n.a.	n.a.	16.10	9.00	5.70	1.40	0
02.08.2015	YS26	n.a	n.a.	n.a.	14.40	11.70	2.00	0.70	0
03.08.2015	YS27	n.a	n.a.	n.a.	18.60	13.60	1.50	3.50	0
04.08.2015	YS28	n.a	n.a.	n.a.	25.20	21.20	2.00	2.00	0
05.08.2015	YS29	n.a	n.a.	n.a.	22.60	18.20	2.10	2.30	0
06.08.2015	YS30	n.a	n.a.	n.a.	18.50	13.80	3.50	1.20	0
08.08.2015	YS31	n.a	n.a.	n.a.	15.20	10.00	3.90	1.30	0
08.08.2015	YS32	n.a	n.a.	n.a.	17.30	14.70	1.20	1.40	0
09.08.2015	YS33	n.a	n.a.	n.a.	19.30	12.80	4.80	1.70	0
13.08.2015	YS36	n.a	n.a.	n.a.	5.45	0.00	2.95	2.50	0
16.08.2015	YS38	n.a	n.a.	n.a.	22.20	18.20	1.00	3.00	0
17.08.2015	YS39	n.a.	n.a.	n.a.	14.20	10.60	2.20	1.40	0
18.08.2015	YS40	n.a	n.a.	n.a.	14.00	12.00	1.00	1.00	0
20.08.2015	YS41	n.a	n.a.	n.a.	23.00	19.00	1.70	2.30	0
22.08.2015	YS42	n.a	n.a.	n.a.	22.80	20.90	1.00	0.90	0
19.08.2015	YS43	n.a	n.a.	n.a.	13.90	11.00	1.20	1.70	0
24.08.2015	YS44	n.a	n.a.	n.a.	36.00	30.20	4.50	1.30	0
06.09.2015	YS45	n.a	n.a.	n.a.	12.30	7.90	2.80	1.60	0

Tab. 7: Emergences in Akgöl without successful nestig attempt; n.a.= no data available
Tab. 7: Landgänge in Akgöl ohne erfolgreichen Nistversuch; n.a. = keine Daten vorhanden

Track #	date	total length	width	bodypits (started chambers)	dist. to sea	dry	moist	wet
1	27.06.2015	23.90	0.59	0	10.80	3.40	5.60	1.80
2	28.06.2015	27.00	0.57	0	12.00	4.20	4.60	3.20
3	29.06.2015	37.10	0.47	0	8.30	4.30	3.10	0.90
4	29.06.2015	28.50	0.57	2	12.10	6.40	2.50	3.20
5	29.06.2015	31.90	0.55	1	10.10	0.00	7.30	2.80
6	29.06.2015	40.10	0.73	1	19.80	15.40	3.30	1.10
7	02.07.2015	13.70	0.63	0	8.20	2.40	3.20	2.60
8	03.07.2015	160.60	n.a.	0	36.70	31.80	2.40	2.50
9	03.07.2015	68.60	0.49	1	36.00	31.30	3.30	1.40
10	04.07.2015	140.00	0.50	4	35.00	25.70	6.10	3.20
11	05.07.2015	107.00	0.60	1	48.50	42.80	2.50	3.20
12	05.07.2015	175.50	0.59	1	80.00	74.60	2.10	3.30
13	06.07.2015	26.50	0.43	1	13.30	3.40	7.70	2.20
14	07.07.2015	176.00	0.61	2	48.00	42.70	3.50	1.80
15	07.07.2015	81.20	0.56	0	37.10	34.00	1.80	1.30
16	07.07.2015	17.80	0.55	1	8.80	3.90	3.40	1.50
17	08.07.2015	96.00	0.54	0	44.40	36.40	5.00	3.00
18	09.07.2015	19.70	0.62	0	9.50	7.50	0.30	1.70

19	09.07.2015	79.20	0.53	2	36.90	31.30	5.30	0.30

Tab. 7: Emergences in Akgöl without successful nestig attempt; n.a.= no data available

Tab. 7: Landgänge in Akgöl ohne erfolgreichen Nistversuch; n.a. = keine Daten vorhanden

Track #	date	total length	width	bodypits (started chambers)	dist. to sea	dry	moist	wet
20	09.07.2015	28.40	0.52	0	8.70	6.50	0.80	1.40
21	09.07.2015	23.20	0.64	0	10.00	6.80	1.10	2.10
22	10.07.2015	63.50	0.55	0	23.90	18.50	3.60	1.80
23	11.07.2015	32.90	0.50	1(1)	13.90	7.80	4.20	1.90
24	11.07.2015	55.70	0.55	1	20.40	17.30	1.60	1.50
25	11.07.2015	24.00	0.65	0	10.60	6.90	1.70	2.00
26	12.07.2015	33.20	0.56	1	13.80	7.10	4.60	2.10
27	13.07.2015	62.00	0.49	2	15.50	9.70	3.30	2.50
28	13.07.2015	59.80	0.55	3(1)	19.30	11.30	5.80	2.20
29	13.07.2015	29.60	0.51	3	14.00	8.85	3.55	1.60
30	14.07.2015	32.00	0.63	0	11.20	3.80	5.65	1.75
31	18.07.2015	23.60	0.54	0	11.60	8.00	1.30	2.30
32	18.07.2015	29.30	0.54	1	13.90	9.20	3.10	1.60
33	19.07.2015	21.50	0.64	1	9.20	5.00	1.80	2.40
34	19.07.2015	15.40	0.52	1	7.90	2.60	3.40	1.90
35	19.07.2015	33.80	0.48	0	13.40	6.60	1.20	5.60
36	20.07.2015	15.90	0.52	1	7.50	3.50	2.60	1.40
37	21.07.2015	32.30	0.55	1	14.80	13.10	1.00	0.70
38	21.07.2015	36.00	0.57	0	12.40	9.70	0.80	1.90
39	22.07.2015	72.20	0.62	0	20.90	17.30	2.00	1.60
40	22.07.2015	52.00	0.70	0	6.20	2.60	1.70	1.90
41	22.07.2015	28.10	0.71	1	12.83	8.83	3.30	0.70
42	23.07.2015	49.30	0.56	0	18.70	12.00	5.40	1.30
43	24.07.2015	105.10	0.58	0	32.50	27.20	3.80	1.50
44	24.07.2015	75.90	0.57	2	36.00	32.10	2.30	1.60
45	25.07.2015	36.00	0.49	0	9.00	6.80	1.20	1.00
46	25.07.2015	19.20	0.64	0	7.40	4.00	2.50	0.90
47	26.07.2015	46.00	0.46	4	16.00	8.30	4.60	3.10
48	26.07.2015	26.30	0.48	1	10.70	7.60	1.00	2.10
49	27.07.2015	14.40	0.60	0	6.40	2.70	1.10	2.60
50	28.07.2015	18.70	0.52	2	8.15	3.95	2.70	1.50
51	29.07.2015	18.30	0.61	0	8.00	5.70	1.60	0.70
52	30.07.2015	19.80	0.57	0	9.20	5.50	0.50	3.20
53	30.07.2015	27.10	0.65	0	12.30	9.10	1.10	2.10
54	01.08.2015	60.00	0.59	2	29.00	26.60	0.40	2.00
55	01.08.2015	26.00	0.47	1	11.60	8.20	0.90	2.50
56	01.08.2015	131.00	0.54	6(1)	43.50	40.90	0.80	1.80
57	04.08.2015	79.35	0.66	1	34.50	28.30	2.70	3.50
58	04.08.2015	56.50	0.68	1	27.60	22.30	1.90	3.40
59	08.08.2015	36.50	0.70	0	9.80	6.30	1.20	2.30

Tab 8: Emergences in Yaniklar without successful nestig attempt; n.a.= no data available
Tab. 8: Landgänge in Yaniklar ohne erfolgreichen Nistversuch; n.a. = keine Daten vorhanden

Track #	date	total length (m)	width (m)	body pits (started chamber)	dist. to sea	dry	moist	wet
1	27.06.2015	65.70	0.72	1	29.00	23.20	4.00	1.80
2	27.06.2015	34.60	0.66	1	17.00	10.40	4.80	1.80
3	27.06.2015	42.00	0.66	0	21.00	17.90	1.70	1.40
4	27.06.2015	44.60	0.66	4	18.40	11.80	5.40	1.20
5	27.06.2015	29.20	n.a.	4(2)	37.80	36.40	0.40	1.00
6	28.06.2015	39.30	0.65	1	19.00	12.10	5.30	1.60
7	28.06.2015	76.80	0.78	3	39.20	34.70	3.40	1.10
8	28.06.2015	21.10	0.54	2	7.30	0.00	5.30	2.00
9	28.06.2015	12.70	0.50	1	7.10	1.40	3.80	1.90
10	28.06.2015	11.60	0.56	1 (1)	5.80	0.50	4.40	0.90
11	28.06.2015	44.30	0.68	2	12.40	8.20	3.10	1.10
12	29.06.2015	13.00	0.62	1	6.50	2.70	3.00	0.80
13	29.06.2015	11.30	0.70	0	5.50	0.00	4.50	1.00
14	01.07.2015	60.10	0.60	4	78.00	74.40	2.90	0.70
15	03.07.2015	50.80	0.76	5	25.40	21.70	2.70	1.00
16	04.07.2015	66.60	0.63	4	32.00	26.30	4.70	1.00
17	04.07.2015	53.80	0.69	2	24.70	18.00	4.50	2.20
18	05.07.2015	34.70	0.59	1	16.80	10.50	5.00	1.30
19	05.07.2015	43.40	0.62	1	21.10	12.50	6.70	1.90
20	05.07.2015	10.50	0.64	0	5.60	0.00	4.20	1.40
21	05.07.2015	18.40	0.58	0	9.20	4.70	3.70	0.80
22	06.07.2015	12.00	0.63	0	6.10	0.80	3.30	2.00
23	06.07.2015	37.50	0.63	5	15.30	9.80	2.80	2.70
24	06.07.2015	18.30	0.63	1	9.00	3.70	4.00	1.30
25	06.07.2015	20.00	0.60	1	9.60	4.00	3.90	1.70
26	06.07.2015	22.50	0.64	0	10.80	5.20	3.50	2.10
27	06.07.2015	21.30	0.66	2	10.80	7.70	1.60	1.50
28	06.07.2015	46.50	0.59	1	21.30	17.50	1.50	2.30
29	06.07.2015	12.60	0.55	0	6.50	0.00	5.50	1.00
30	06.07.2015	48.60	0.61	0	22.90	18.00	3.30	1.60
31	06.07.2015	31.50	0.67	1	14.20	7.60	4.90	1.70
32	06.07.2015	32.10	0.61	0	14.20	8.50	3.70	2.00
33	06.07.2015	44.00	0.60	1	20.00	16.70	1.60	1.70
34	07.07.2015	27.70	0.59	0	13.30	6.30	5.70	1.30
35	07.07.2015	34.50	0.48	3	20.30	15.30	3.80	1.20
36	07.07.2015	14.00	0.49	1(1)	7.40	0.00	6.40	1.00
37	07.07.2015	44.60	0.65	2	21.60	17.10	2.10	2.40
38	08.07.2015	31.70	0.66	1	13.70	10.60	2.10	1.00
39	09.07.2015	47.80	0.60	0	23.80	18.80	3.60	1.40
40	09.07.2015	43.00	0.57	0	19.90	17.60	1.10	1.20
41	10.07.2015	51.00	0.59	4(2)	23.60	19.00	2.30	2.30
42	10.07.2015	46.40	0.58	2(1)	21.40	15.90	4.40	1.10
43	10.07.2015	16.30	0.62	0	6.85	2.05	3.60	1.20

Tab 8: Emergences in Yaniklar without successful nestig attempt; n.a.= no data available
Tab. 8: Landgänge in Yaniklar ohne erfolgreichen Nistversuch; n.a. = keine Daten vorhanden

Track #	date	total length (m)	width (m)	body pits (started chamber)	dist. to sea	dry	moist	wet
44	11.07.2015	59.50	0.66	2	21.00	18.00	1.00	2.00
45	11.07.2015	35.30	0.63	1(1)	12.20	8.50	2.30	1.40
46	11.07.2015	29.60	0.55	0	12.90	7.90	3.20	1.80
47	11.07.2015	33.40	0.49	2	12.70	8.60	2.60	1.50
48	12.07.2015	14.60	0.67	0	6.10	2.00	3.20	0.90
49	12.07.2015	21.50	0.58	0	10.20	8.00	1.00	1.20
50	12.07.2015	27.20	0.73	0	13.10	9.40	2.50	2.10
51	12.07.2015	30.10	0.59	0	12.60	10.60	0.60	1.40
52	12.07.2015	35.70	0.28	1	15.60	12.50	1.20	1.90
53	13.07.2015	6.60	0.63	0	3.30	0.50	0.80	2.00
54	13.07.2015	23.90	0.58	0	8.20	5.50	1.70	1.00
55	14.07.2015	56.70	0.54	0	15.60	11.30	2.70	1.60
56	15.07.2015	50.30	0.54	1(1)	21.70	16.10	3.70	1.90
57	15.07.2015	51.70	0.60	2	22.80	17.10	4.10	1.60
58	16.07.2015	42.70	0.58	1	20.60	14.10	4.20	2.30
59	16.07.2015	57.60	0.62	0	27.10	23.20	3.00	0.90
60	16.07.2015	44.60	0.57	0	15.00	13.00	1.00	1.00
61	17.07.2015	64.80	0.60	4	32.60	26.80	4.10	1.70
62	17.07.2015	50.20	0.51	0	22.95	17.45	4.10	1.40
63	17.07.2015	32.40	0.51	0	15.30	10.60	1.90	2.80
64	18.07.2015	45.50	0.58	2(2)	22.00	17.40	1.50	3.10
65	18.07.2015	24.80	0.47	0	11.50	8.50	0.20	2.80
66	18.07.2015	10.00	0.68	0	4.35	0.75	0.60	3.00
67	18.07.2015	53.50	0.45	2	44.40	37.60	2.30	4.50
68	18.07.2015	20.80	0.52	2	10.40	3.30	2.90	4.20
69	18.07.2015	24.60	0.52	1	12.45	5.35	2.90	4.20
70	18.07.2015	14.00	0.47	0	7.30	1.10	2.60	3.60
71	19.07.2015	19.20	0.54	0	8.40	3.40	3.10	1.90
72	19.07.2015	35.10	0.52	3	16.80	12.80	3.20	0.80
73	19.07.2015	32.50	0.59	0	12.10	6.30	4.50	1.30
74	19.07.2015	32.60	0.55	0	15.20	10.00	3.00	2.20
75	19.07.2015	17.50	0.67	0	8.20	4.20	3.00	1.00
76	19.07.2015	18.50	0.44	1	9.60	5.10	3.50	1.00
77	20.07.2015	12.80	0.47	1(1)	6.35	1.45	3.20	1.70
78	20.07.2015	25.30	0.47	2(1)	10.20	4.60	1.60	4.00
79	20.07.2015	13.70	0.62	1	6.80	2.20	2.80	1.80
80	20.07.2015	16.00	0.52	1	7.90	0.00	5.30	2.60
81	21.07.2015	10.40	n.a.	1	5.30	1.90	1.90	1.50
82	21.07.2015	49.70	0.59	5(3)	22.30	21.00	0.90	0.40
83	22.07.2015	16.50	0.65	1(1)	6.30	2.30	2.30	1.70
84	27.07.2015	45.00	0.66	6	19.80	17.10	1.00	1.70
85	28.07.2015	34.10	0.65	1(1)	9.70	5.60	2.80	1.30
86	09.08.2015	12.90	0.81	0	5.60	3.60	0.60	1.40

Tab 9: Total adult data Akgöl and Yaniklar
Tab. 9: Gesamte Adult-Daten von Akgöl und Yaniklar

nest #	Date (2015)	total length	width	body pits (started chamber)	dist. to sea (m)	dry	moist	wet	nest #	emerging time	tag #	SCL	SCW	CCL	CCW
AY01	28.06.	76.8	0.78	3	39.2	34.7	3.4	1.1		n.a.	TR679 (L)	54	48	76	61
AY02	28.06.	44.3	0.68	2	12.4	8.2	3.1	1.1		n.a.	n.t.	65	43	77	67
AY03	05.07.	59.8	0.51	2	25.5	19.9	4.4	1.2	Y21	02:00	TR682 (R)	62	47	84	91
AY04	06.07.	44	0.6	1	20	16.7	1.6	1.7		n.a.	TR683 (R)	64	52	72	77
AY05	07.07.	44.6	0.65	2	21.6	17.1	2.1	2.4		n.a.	n.t.	59	59	73	69
AY06	07.07.	65.2	0.63	3 (1)	22.6	19.5	2	1.1	Y23	00:00	TR680 (L)	61	41	72	66
AY07	11.07.	29.6	0.55	0	12.9	7.9	3.2	1.8		n.a.	n.t.	76	47	84	76
AY08	11.07.	33.4	0.49	2	12.7	8.6	2.6	1.5		06:30	n.t.	62	50	69	60
AY09	11.07.	99.8	0.52	3	29.4	25.4	2.2	1.8	Y32	n.a.	n.t.	63	50	69	61
AY10	12.07.	35.7	0.28	1	15.6	12.5	1.2	1.9		n.a.	n.t.	70	54	72	77
AY11	14.07.	35	0.55	0	15.2	10.2	3	2	Y35	n.a.	n.t.	66	46	77	69
AY12	15.07.	51.7	0.6	2	22.8	17.1	4.1	1.6		n.a.	n.t.	69	48	80	71
AY13	19.07.	18.5	0.44	1	9.6	5.1	3.5	1		n.a.	n.t.	n.a	n.a.	70	66
AY14	19.07.	64.3	0.45	3	22.2	17.7	2.2	2.3	Y38	n.a.	TR682 (R)	n.a.	n.a.	75	67
AY15	21.07.	44.4	0.52	1	19.5	13.2	2	4.3	Y39	00:30	TR686 (R)	65	45	73	63
AA01	25.06.	n.a.	n.a.	n.a.	22.9	19	2.7	1.2			TR 678 (L)	78	48	75	67
AA02	25.06.	n.a.	0.84	0	18.9	11.9	2.1	4.9	A12	n.a.	TR 677 (L)	77	53	83	72
AA03	04.07.	140	0.5	4	35	25.7	6.1	3.2		22:30	TR 681(R)	64	48	77	66
AA04	05.07.	74.5	0.7	1	29	23.3	3.6	2.1	A19	n.a.	TR 681(R)	68	50	74	66
AA05	08.07.	96	0.54	0	44.4	36.4	5	3		01:00	n.t.	63	52	68	64
AA06	13.07.	29.6	0.51	3	14	10.85	3.55	1.6		n.a.	n.t.	66	46	74	73
AA07	01.08.	131	0.54	6(1)	43.5	40.9	0.8	1.8		02:00	n.t.	n.a.	n.a.	69	62

LOGGERHEAD TURTLE HATCHLINGS IN ÇALIŞ 2015

Sina Siedler, Katja Schmölz

KURZFASSUNG

Dieser Bericht ist Teil des Projektpraktikums zum Schutz und der Erforschung der Unechten Karettschildkröte (*Caretta caretta*) und zeigt die gesammelten Daten über die frischgeschlüpften Meeresschildkröten in Çalış Beach. 2015 wurde das Projekt in Zusammenarbeit mit der Hacettepe Universität ausgeführt. Der Untersuchungszeitraum dauerte von Ende Juni bis Mitte September.

Der Hauptgrund für die Schutzarbeit in Çalış Beach ist die Lichtverschmutzung, sowie die hohen Besucherzahlen des Strandes. Es wurde mit Schutzkäfigen gearbeitet, um zu verhindern, dass die Hatchlinge nach dem Schlupf von künstlichen Lichtquellen desorientiert werden. Außerdem wurden die Nester markiert, um zu vermeiden, dass Liegestühle oder Sonnenschirme von Strandbesuchern auf die Nester gestellt werden.

Es wurden insgesamt 30 Nester von *Caretta caretta* gefunden. Darin wurden insgesamt 2.354 Eier gezählt, wovon 1.729 (73,4 %) geschlüpft sind und 1.545 Hatchlinge (65,6 %) schließlich das Meer erreicht haben. Dies ist die vierthöchste Zahl von Hatchlingen seit Beginn des Projektes 1994. Die Erfolgsrate der Nester lag 2015 im Durchschnitt bei 63,0 %.

Die Schutzarbeit in der Special Protected Area Çalış Beach ist dringend notwendig und zeigt möglicherweise bereits erste Erfolge. Eindeutige Korrelationen zwischen der Erfolgsrate und dem Schlupfbeginn, bzw. der Erfolgsrate und der Distanz zum Meer der einzelnen Nester wurden nicht gefunden.

ABSTRACT

This report is part of the conservation and research field course of the University of Vienna on the loggerhead sea turtle (*Caretta caretta*) and processes data on hatchlings from Çalış Beach. In 2015, the project was carried out in cooperation with Hacettepe University. The evaluation period lasted from the end of June until mid-September.

The main reason for the conservation work is light pollution and the high visitor frequency at Çalış Beach. Protective cages were used to prevent hatchlings from becoming disorientated

by artificial light. Furthermore, all nests were marked to hinder people from putting sunbeds or sunshades on the nests.

We found 30 nests of *Caretta caretta* with a total of 2,354 eggs, whereof 1,729 (73.5 %) hatched and 1,545 (65.6 %) hatchlings reached the sea. This is the fourth highest number of hatchlings reaching the sea since the beginning of the project in 1994. In 2015, the overall success rate of the nests averaged 63.0 %.

Conservation work is an urgent need on the Special Protected Area Çalış Beach and is potentially showing first positive results. No clear correlations between hatching success and hatch date, nor between hatching success and distance to the sea of nests were found.

INTRODUCTION

There are only a few sights more majestic than a big graceful sea turtle gliding through the water. For more than a hundred million years, sea turtles have been swimming through the world´s oceans. These living ‘dinosaurs’ survived mass extinctions and other cataclysms in the past but today face new dangers that threaten their life, including pollution, destruction of their nesting grounds, and nets of fishing boats (Spotila 2004).

Today, seven species of sea turtles remain: Leatherback Turtle (*Dermochelys coriacea*, Vandelli 1761), Kemp´s Ridley Turtle (*Lepidochelys kempii*, Garman 1880), Olive Ridley Turtle (*Lepidochelys olivacea*, Eschscholtz 1829), Hawksbill Turtle (*Eretmochelys imbricata*, Linaeus 1766), Flatback Turtle (*Natator depressus*, Garman 1880), Green Turtle (*Chelonia mydas*, Linaeus 1758) and Loggerhead Turtle (*Caretta caretta*, Linaeus 1758). The latter two have nesting sites along the Mediterranean coasts, mostly in Greece, Turkey, Cyprus and Libya. All species are listed as ‘endangered’ or ‘vulnerable’ on the IUCN (International Union for the Conservation of Nature and Natural Resources) Red List and are also under protection of conventions such as the Barcelona Convention, Bern Convention or Convention for the International Trade of Endangered Species CITES (Magaritoulis 2005).

For *Caretta caretta* the Turkish coastline is the third most important nesting area after Greece and Libya in the entire Mediterranean; for *Chelonia mydas* it is the most important one. Since the early 1990s the three nesting beaches Akgöl, Yaniklar and Çalış have been monitored by students of the University of Vienna in cooperation with Turkish universities. Fethiye Beach is one of three listed special protected areas (SPAs) - besides Dalyan and Patara - and belongs to the 14 nesting beaches of *Caretta caretta* in Turkey (Stachowitsch & Fellhofer 2015). The 2.5 km long nesting beach of Çalış is one of 17 key sea turtle nesting sites in Turkey (Baran & Türkozan 1989). Nonetheless, Calis Beach is highly light-polluted by restaurants and hotels and frequented by tourists and local residents, so that conservation work is an urgent need here.

The nesting season in Turkey starts in late May and in mid-July the hatch time begins. After reaching sexual maturity, female sea turtles return to the same beach they were born at every two to four years for oviposition. Up to an average number of 3.9 clutches can be laid within two weeks and the number of eggs can reach up to 112 per nest (Spotila 2004). Depending on external factors such as sand temperature, humidity, sand composition, nest location, and depth of the egg chamber (Stachowitsch & Fellhofer 2015), the incubation time of eggs spans from 45 to 80 days. Whether the hatchlings are males or females depends on the temperature: nest temperatures between 26 and 34°C allow a successful hatching, whereby temperatures under 30°C lead to male turtles and temperatures over 30°C lead to female juveniles (Spotila 2004).

After the incubation time, the young *Caretta caretta* open their leathery shell with their 'egg tooth' and they begin with the so-called 'hatchling frenzy': they crawl about and climb over each other in hectic movements. The small sea turtles start to flap their flippers and tunnel up towards the surface. After 24 to 48 hours they reach the sand surface – usually after sunset. The hatchlings have to climb over, under and around many barriers on their way to the sea. In the ocean they keep moving and swimming for up to six or seven days without long breaks. They only rest and sleep at night, when they fold their flippers against their body (Spotilla 2004).

After emerging from the sand, the juveniles crawl seawards, orientated by visual cues, responding above the horizon with a 30° vertical and 180° horizontal range. Due to light reflections of the moon and the stars, the seawater is brighter than the vegetation and has lower elevation on the horizon, thus, drawing the hatchlings seawards (Spotila 2004) – under natural conditions. Light bulbs of restaurants and hotels, as well as car headlights and street lights on touristic beaches, such as Çalış Beach, outshine the reflection of the ocean. Therefore, the hatchlings become disorientated and crawl inland, where they often die from the heat or from exhaustion or are eaten by predators (Witherington & Martin 2000).

Research and conservations go hand in hand, and all the data collected and evaluated over the years helps to discover potential negative influences on nesting activity and success. The goal is to stop and reverse overall declining nesting activity caused by human activities.

MATERIAL AND METHODS

In the summer 2015, eleven Austrian and five Turkish students monitored the nesting beach of *Caretta caretta* in Çalış. Every team member from the University of Vienna stayed five weeks in Turkey; one Turkish colleague Uğur Sü of Hacettepe University stayed from May to late September on both beaches, Çalış as well as Yaniklar.

Our work was divided in morning and night shifts, as well as the information desk service. The two shifts include the tasks to find adult turtles or at least their tracks, measure them, observe the nests, count hatchlings, and excavate the finished nests. The info desk tasks consist of providing tourist information and doing educational and public relation work on sea turtle biology, conservation and behaviour. During the night shifts, students patrolled the beach from 'Turkis Cadiri Restaurant' to the 'Surf Café' two times there and back from 10 p.m. until 2 a.m.; nests beyond 'Surf Café' were checked as needed. During the first third of the project, until early July, students patrolled the beach to look out for female adult loggerheads laying their eggs or to find their tracks. From early July to late August the team members were on the lookout for adults, tracks of adults and hatchlings, as well as hatchlings inside or outside the protection cages. It was also possible to find hatchlings crawling over the beach, because some nests were already laid before our work group arrived on 27.06.15. Such nests could not be marked at the time of egg deposition and were called 'secret nests'. They had to be located during hatching or afterwards by re-tracing the tracks of the hatchlings. Accordingly, the students controlled the beach until late August four times per night and one time in the morning.

At the end of August, the likelihood of newly discovered secret nests was very low, so only the marked nests were checked in the nights at 10 p.m., 12 p.m. and 2 a.m. in the so-called 'hatchling-control'. The morning shift controlled the whole beach, including Çalışteppe until the end of the season.

In June, July and early August, students put protection cages on newly discovered nests. Those were located by actually observing egg deposition or based on the tracks of adults or hatchlings. If hatchling-tracks were found, they were counted and followed to locate the hatchlings and allow them to reach the sea safely as well as to locate the nest. Thereafter, the tracks were covered so that other students could distinguish new tracks without confusion. Sometimes it was not possible to re-trace the tracks and find the nest immediately. In such cases, free members of the team waited for the next hatching during the following nights.

There were three types of cages in the 2015 season. The first type were pyramid-shaped, metal ones which were used to mark and protect the nests. After an incubation time of about 40 days, they were replaced with either three-cornered or quadrangular cages that were surrounded by a net with a mesh of approximately 1 centimetre aperture size (compare Figure 8 and 13 in the Appendix). This net could be raised and lowered. The net was lifted up during the morning shift and closed before sunset. This was necessary because hatchlings sometimes emerge during the day, when the sun is out and the sand is hot. Trapped in a cage, hatchlings would definitely die due to heat before our team could be there; with an open cage they had at least a chance of survival. Before sunset, the cages had to be closed to ensure that the night-hatchlings stayed in the cage and could be collected by the *Caretta*-team and be released on a dark stretch of the beach.

On the top of all cages, we put signs out of paper in a plastic wrap to inform tourists and local residents in three languages (German, English, Turkish) about the presence of a sea turtle nest. All installed cages on nests that reached or passed their incubation time were checked in each shift in order to see if the nests hatched already. Moreover, local visitors and tourists often either displaced the cages or misused them as dustbins or barbecue etc. The morning shift additionally included measuring the correct position of the cages. The triangulation marks used for this purpose were applied by the students who originally found the nest. The students of the early shift went to the beach predawn and at sunrise they started with the observation. The beach was controlled once from ‘Turkis Cadiri Restaurant’ up to end of Çalışteppe to ensure that no secret nest was overlooked.

In 2016, new wooden cages with nets will replace the old ones. Figure 12 in the Appendix shows the prototype.

Cages are very important to help reduce many hazards such as dogs as predators or light pollution. Çalış is a tourist resort and there are many hotels and restaurants, including a promenade with thousands of lights, not to mention. Hatchlings emerge during the night and orientate to the brightest direction (Spotila 2004). Therefore, *Caretta caretta* hatchlings do not find the right way to the ocean on their own in Calis. They must therefore be retained by the cages, until the patrolling students pass by. Then, the hatchlings were put into plastic buckets with moist sand and covered with a wet towel and were brought to a darker section of the beach, where they were set free a few meters away from the waterline. If necessary, a groove was dug in the sand to facilitate reaching the sea. If hatchlings were found during the morning shift before out 7:30 a.m. they were released into the sea immediately. After that point in time they were put in a plastic bucket with moist sand and covered with a wet towel during the day at the camp. These collected hatchlings were released in the following night shift at a dark part of the beach.

Sometimes poor sand-conditions made it necessary to open nests at positions with big stones or similar objects to ensure that the hatchlings were not blocked. Apart from that, the nests were opened only for the excavation, which occurred about three days after the last hatchling emerged.

The excavation took place in the morning shift and all eggs and shells were removed and divided into groups including closed eggs, egg shells, dead turtles or still living hatchlings. The closed eggs were opened and the embryonic stage was determined, either ‘early’ with no pigmentation and smaller than 1 centimetre, ‘middle’ with pigmented eyes and a size more than 1 centimetre, and ‘late’ with more than 2 centimetres and complete pigmentation and development (compare Figure 2, 3, and 4 in the Appendix). Moreover, the nests were measured, including the depth from the sand surface to the top of the eggs, the diameter and depth of the egg chamber and the distance to the sea. Dead embryos, hatchlings and eggshells were then returned to the empty nest and covered with sand, to mimic natural conditions.

Back in the camp, all data on turtles and information on the weather conditions (temperature and wind strength) were transferred from the shift booklet to the data sheets. The material required for the shift was in a backpack and consisted of the booklet, gloves, measuring tape, pens, Stanley knife, pieces of rope, water, thermometer, and a flashlight – but the flashlight was only used in rare cases at night.

RESULTS

We found 30 nests of *Caretta caretta* during the 2015 nesting season on Çalış Beach, which is a decrease by 8 nests compared to the previous nesting season. Twelve of the 30 nests were secret nests, which mean that they were only detected directly during hatching events or afterwards by discovering hatchling tracks.

Figure 1 shows the trend of the number of nests since 1994. The rising tendency since 2013 did not continue this year. Nevertheless, 30 nests in 2015 is the fourth highest value since the beginning of the conservation programme. The numbers of maximal hatchlings reaching the sea since 1994 (Figure 2) show a very similar pattern.

Table 1 provides an overview on all the nest and hatchling data for the nesting period 2015. Missing nest numbers are a result of misidentified nests or missing data.

Nest date is stated where known. The first oviposition was observed on 08.06.15, the last one on 27.07.15. Due to the number of secret nests, the nest date is missing for 12 nests but can be roughly estimated to at least 42 days before the first hatching (Spotila 2004).

Similarly, the incubation time is also not known for these 12 nests, whereby the information about the incubation time of CY-12 and CY-17 is not available because no hatching occurred in these nests. The incubation time based on the available data of all other nests ranged from 44 to 59 days and averaged out at 50.6 days (SD ± 4.2).

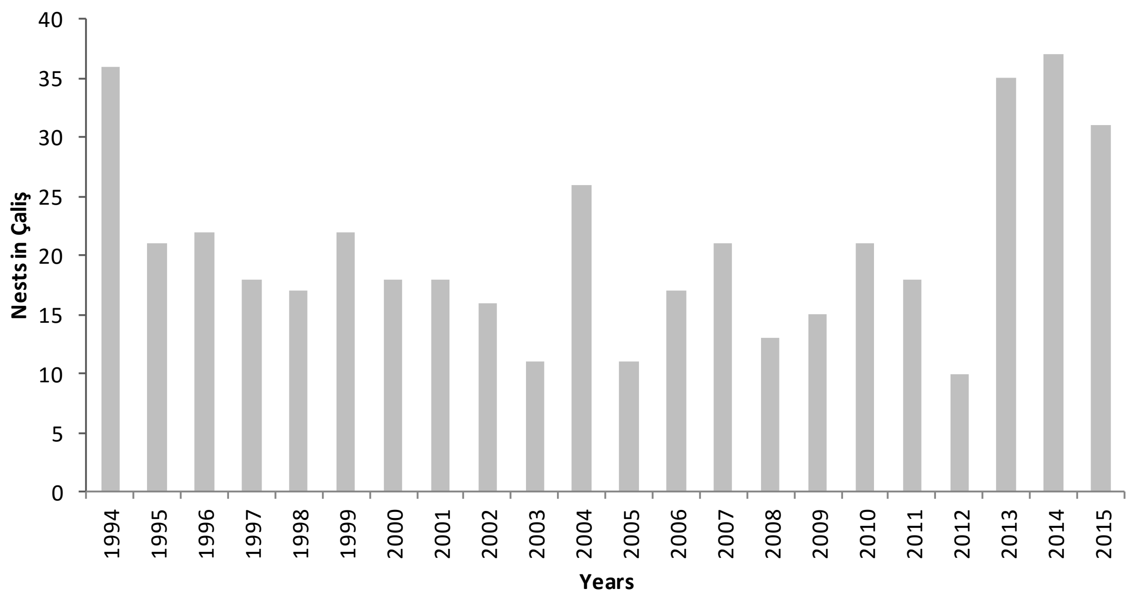

Fig. 1: Total number of nests on Çaliş Beach from 1994 to 2015.
Abb. 1: Vergleich der Nestzahlen in Çaliş von 1994 bis 2015.

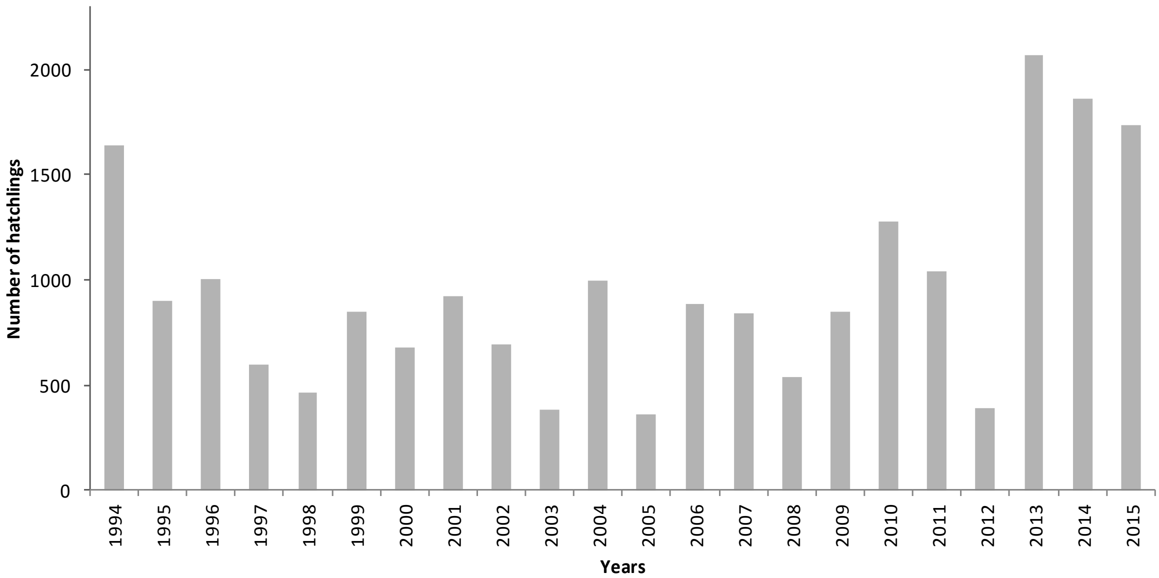

Fig 2: Total number of maximal hatchlings reaching the sea on Çaliş Beach from 1994 to 2015.
Abb 2: Vergleich der Anzahl von Hatchlingen, die das Meer in Çaliş von 1994 bis 2015 maximal erreicht haben.

Tab 1: Overview of all nest data for the nesting period 2015 in Çaliş: nest date (unknown: 'secret nest'), incubation time (unknown: 'secret nest'), hatch start (first hatchling emerged), distance to the sea (distance between nest and sea), number of eggs, number of fertilized eggs, number of empty shells, number of predated/dead hatchlings, number of dead hatchlings stuck in egg, number of fertilized, not hatched eggs, early-embryonic stage, mid-embryonic stage, late-embryonic stage, maximal hatchlings reaching the sea, success rate (ratio between number of eggs and maximal hatchlings reaching the sea).
Tab 1: Überblick über alle Nestdaten der Nistsaison 2015 in Çaliş.
Letters in Notes: a = albino hatchling; b = big stones; c = some hatchlings were outside the cage; f = fungi, parasites, maggots, larvae or rotten; l = some hatchlings were released by locals; m = cage was moved; o = observation of the nest; p = predators; r = hatchlings died on the road; s= sand was moist.

Nest	Nest Date	Incubation Time	Hatch start	Distance to the sea [m]	Notes	Number of eggs	Number of fertilized eggs	Number of empty egg shells	Number of predated / dead hatchlings	Number of dead hatchlings stuck in egg	Number of fertilized, not hatched eggs	Early-embryonic stage	Mid.-embryonic stage	Late-embryonic stage	Maximal hatchlings reaching the sea	Success rate [%]
CS-01	unknown	unknown	3.8.15	10,25		101	93	78	5	9	6	0	1	5	73	72,28
CS-02	unknown	unknown	1.8.15	18,12	f	57	20	6	1	1	13	4	0	9	5	8,77
CS-03	unknown	unknown	26.7.15	20,4	m f b	114	103	70	14	19	14	1	3	10	56	49,12
CS-04	unknown	unknown	11.8.15	12,02		85	73	69	4	0	4	0	0	4	65	76,47
CS-05	unknown	unknown	12.8.15	15,8	l o c	90	82	76	3	0	6	0	1	5	73	81,11
CS-06	unknown	unknown	15.8.15	18,3	r	104	104	104	5	0	0	0	0	0	99	95,19
CS-07	unknown	unknown	20.7.15	15,2		75	53	49	0	0	4	1	2	1	49	65,33
CS-08	unknown	unknown	28.7.15	21,43	f b	55	55	53	3	0	2	1	0	1	50	90,91
CS-09	unknown	unknown	3.8.15	15,3	r a b	98	93	85	7	0	8	0	0	8	78	79,59
CS-10	unknown	unknown	6.8.15	17,17	r	89	85	84	1	0	1	1	0	0	83	93,26
CS-11	unknown	unknown	17.8.15	28,4		86	86	86	0	0	0	0	0	0	86	100,00
CS-13	unknown	unknown	27.8.15	22,75	l f	63	60	57	1	0	3	1	1	1	56	88,89
CY-01	08.06.2015	54	1.8.15	16,5	c	96	78	75	14	0	3	1	0	2	61	63,54
CY-02	10.06.2015	59	8.8.15	9,18		34	10	8	0	0	2	0	1	1	8	23,53
CY-03	11.06.2015	54	4.8.15	n.d.		107	105	104	1	0	1	0	0	1	103	96,26
CY-04	17.06.2015	56	12.8.15	15,77	f	83	80	63	41	12	5	0	0	5	22	26,51
CY-05	19.06.2015	50	8.8.15	13,7	c	72	70	69	0	0	1	0	0	1	69	95,83
CY-06	23.06.2015	49	11.8.15	16,9	c	82	82	81	1	1	0	0	0	0	80	97,56
CY-07	23.06.2015	47	9.8.15	13,82	s	68	53	51	2	0	2	0	1	1	49	72,06
CY-08	24.06.2015	52	15.8.15	15,39	c f	85	64	56	0	0	8	8	0	0	56	65,88
CY-09	25.06.2015	48	12.8.15	15		94	86	82	1	0	4	0	0	4	81	86,17
CY-10	28.06.2015	52	n.d.	5,5	b	70	69	49	21	15	5	0	0	5	28	40,00
CY-11	29.06.2015	48	16.8.15	29,1	p o	71	70	50	7	16	4	0	0	4	43	60,56
CY-12	02.07.2015	n.d.	n.d.	14,41	p f	53	26	21	9	0	5	1	2	2	12	22,64
CY-13	06.09.2015	47	23.8.15	9,4	c	60	60	52	1	0	8	0	0	8	51	85,00
CY-14	08.09.2015	44	22.8.15	16,3		81	78	71	28	7	0	0	0	0	43	53,09
CY-15	11.07.2015	45	25.8.15	21,7		61	59	48	5	8	3	1	0	2	43	70,49
CY-16	14.07.2015	49	1.9.15	15,6	p f	75	69	30	9	2	37	10	3	24	21	28,00
CY-17	19.07.2015	n.d.	n.d.	6,2	s	63	0	0	0	0	0	0	0	0	0	0,00
CY-18	27.7.15	55	20.9.15	29,1	f	82	82	2	0	0	80	28	32	20	2	2,44
						2354	**2048**	**1729**	**184**	**90**	**229**	**58**	**47**	**124**	**1545**	**63,02**
						Total										Mean average

On average, the total number of eggs per nest was 76.4 (SD ±23.09). The range was from 34 to 114. Altogether, 2,354 eggs were recorded, whereof 2,048 were fertilized and a maximum of 1,455 reached the sea. This number is calculated by subtracting the number of dead and predated hatchlings from the empty egg shells counted during the excavation, which is the 'best case scenario'. In the 'worst-case scenario' at least 1,147 hatchlings reached the sea. This is the amount of hatchlings directly observed reaching the sea by our team. A number of 229 of the 2,048 fertilized eggs contained dead embryos that were categorized in 58 early-stage embryos, 47 middle-stage embryos and 124 late-stage embryos.

If no signs of embryonic development could be observed, the eggs were considered infertile. Figure 3 visualizes the proportion of fertilized and unfertilized eggs in a pie chart: 88.2 % of the eggs were fertilized and 11.7 % were unfertilized. An average of 9.9 eggs per nest were unfertilized, with a standard deviation of 13.74, which indicates big differences between the single nests. For example, there were 20 nests with fewer than 10 unfertilized eggs, in contrast to CS-02 with 37 and CY-17 with 63 unfertilized eggs. CY-17 will be examined in detail in the discussion.

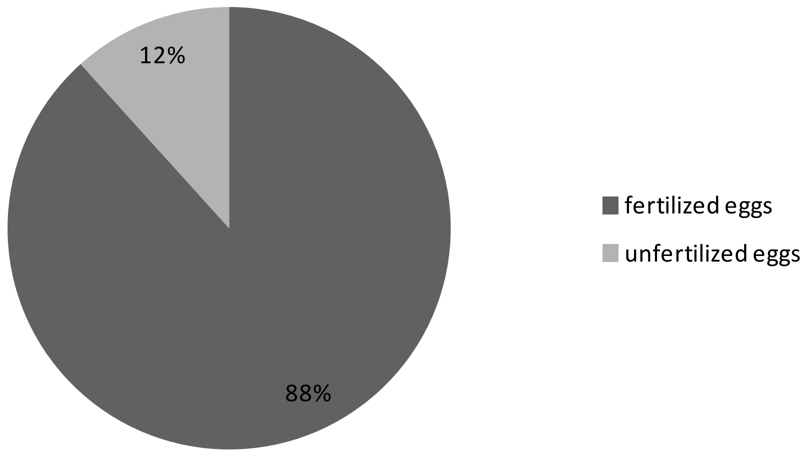

Fig 3: Percentage of fertilized and unfertilized eggs laid in Çaliş in 2015.
Abb 3: Prozentsatz von befruchteten und unbefruchteten Eiern, die 2015 in Çaliş gelegt wurden.

Altogether, 274 fully developed yet dead hatchlings were recorded. Thereof, 150 were found dead in the nest during the excavations, 90 were found as dead hatchlings stuck in egg during the excavations, 12 were run over by cars when they had escaped from the cage, 7 were found dead in the afternoon and are thought to have hatched during the day and died due to the heat, and 15 were killed by dogs that dug into CY-11, CY-12 and CY-16.

The success rate of the nests was calculated as the percentage of maximum hatchlings reaching the sea compared to the total number of eggs in the nest. It averaged 63.0 % (SD ±30.70) with a range from 0 % to 100 %.

Figure 4 shows the hatching activity during the summer months. The highest activity was in early- and mid-August.

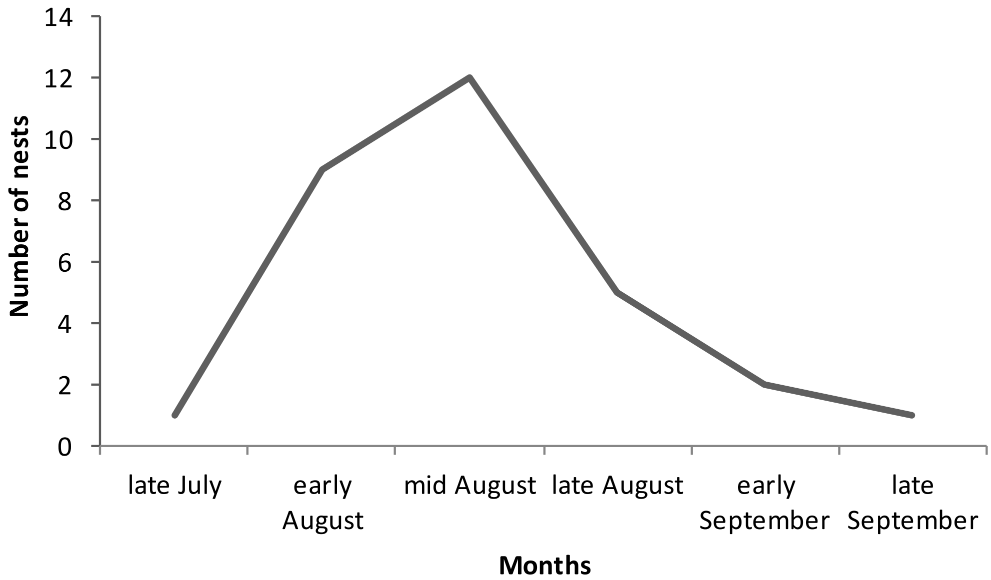

Fig 4: Amount of hatching activity during the nesting season 2015 in Çaliş.
Abb 4: Anzahl der Schlupfereignisse während der Nistsaison 2015 in Çaliş.

Figure 5 plots the total number of eggs with the respective maximal number of hatchlings reaching the sea.

The correlation between the total number of eggs and the success rate of nests is r = 0.38 (tested by Pearson's linear correlation) and indicates a slight tendency of nests with bigger clutches to be more successful.

Figure 6 shows the success rate in dependence of the date of first hatching. One hypothesis could be a positive correlation between early oviposition and more successful nests. The statistical analysis does not confirm that: no clear correlation between the first hatch date and success rate was found (r = -0.43), when tested by Pearson's linear correlation. The test based on a polynomial regression led to a value of $R^2 = 0.31$, what also shows no clear relation.

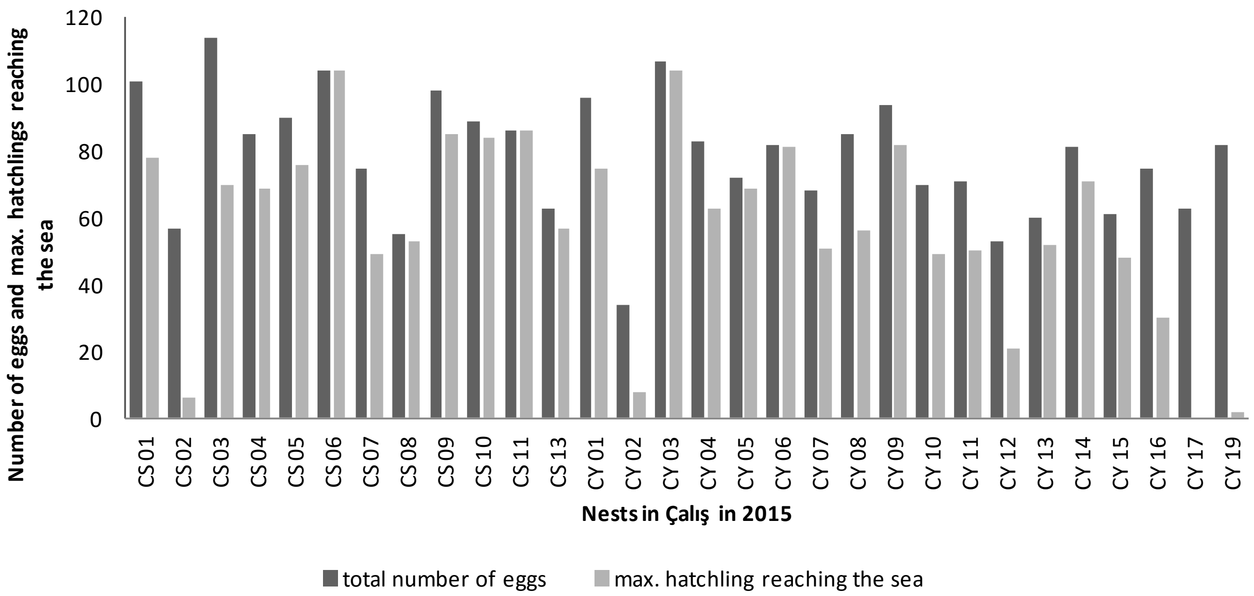

Fig 5: Total number of eggs (black) compared with the number of hatchlings reaching the sea (grey) for each nest.
Abb 5: Gesamtanzahl der Eier pro Nest (schwarz) im Vergleich zu den Hatchlingen, die das Meer erreicht haben (grau).

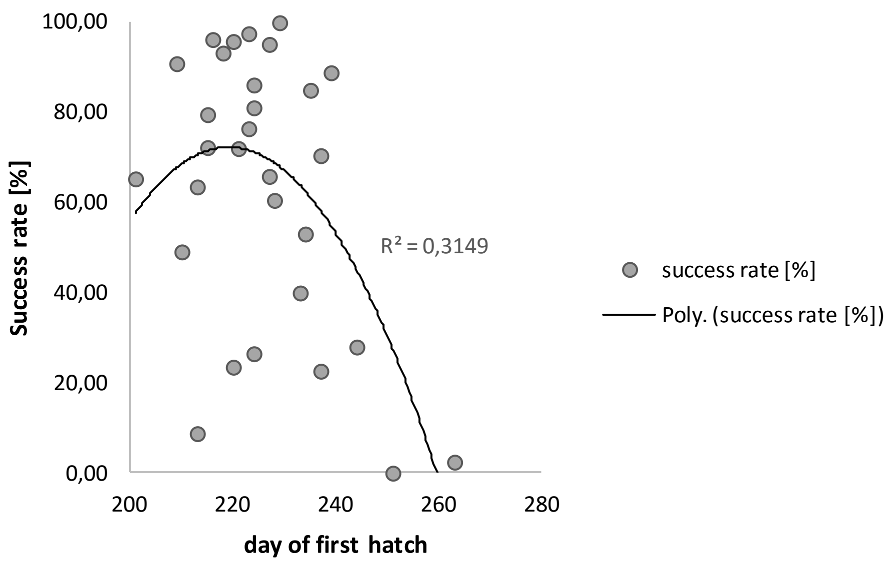

Fig 6: Success rate of the nests in dependence of the first appearance of hatchlings – polynomial line.
Abb 6: Erfolgsrate der Nester in Abhängigkeit vom ersten Schluptag – Polynomiale Linie.

Figure 7 shows the number of fertilized but unhatched eggs in each nest, separated in early-, middle- and late-embryonic stage. CY-18 is not included because it contained 28 early-, 32 mid- and 20 late-embryonic staged eggs, which would be oversized in the figure.

The fertilization rate did not correlate with the progression of the season (r = -0.07), which was tested by Pearson's linear correlation.

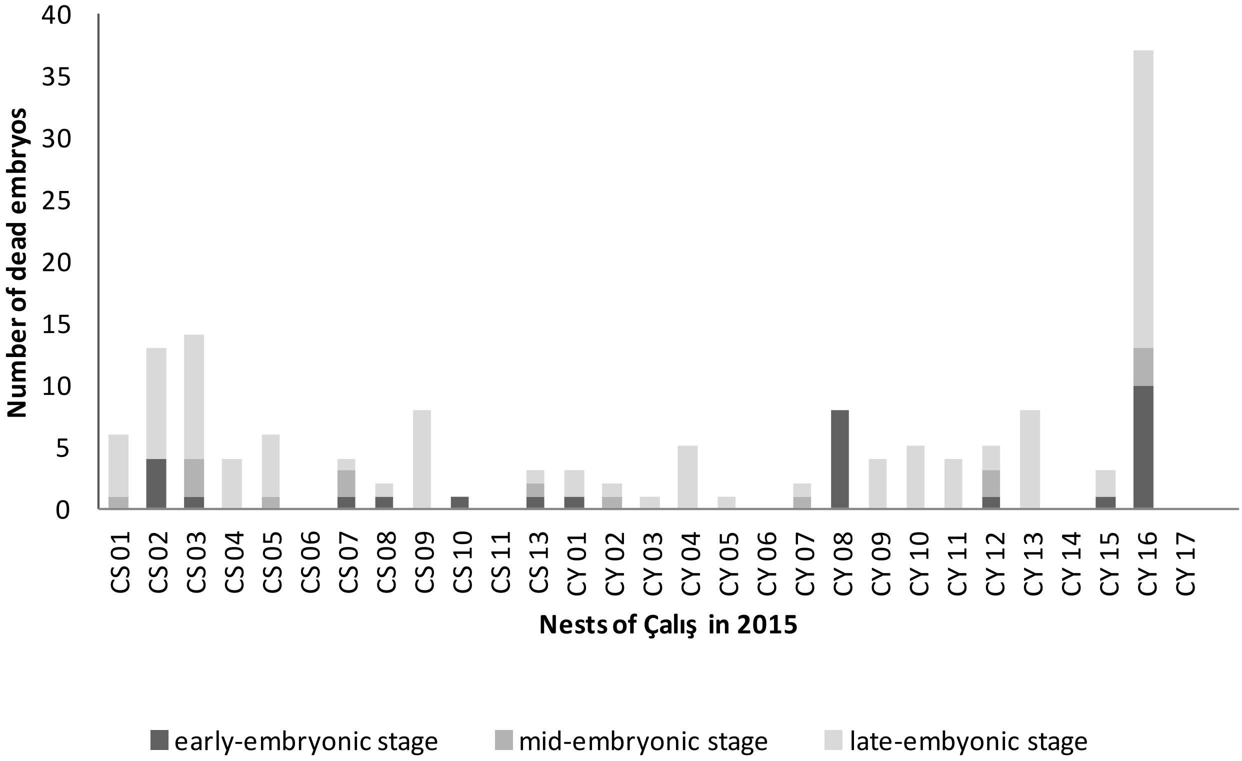

Fig 7: Number of dead embryos in each nest - separated in early, middle and late embryo stage.
Abb 7: Anzahl der toten Embryos in jedem Nest - unterteilt in frühe, mittel und späte Embryonalstadien.

Furthermore the regression between the success rate and the distance to the sea of nests was calculated as two different two-order-regressions. Reasons are explained in the discussion. The polynomial regression reached $R^2 = 0.35$ and the logarithmic regression amounted to $R^2 = 0.05$.

DISCUSSION

It is striking that there was a major increase in the number of nests on Çalış Beach in the last three years. This contradicts the predicted negative trend for nesting activity on Fethiye Beach from Ilgaz et al. (2007). They forecasted 40-50 nests on Fethiye Beach (with the subsections of Akgöl, Yaniklar and Çalış) for the year 2015, but indeed there were 158 nests in these areas this year. Given that the efforts of the sea turtle conservation programme have been running for 23 years now, and that female loggerheads start reaching sexual maturity at an age of about 20 years (Parham & Zug 1997), a relation is possible, i.e.

the increased number of hatchlings successfully reaching the sea two decades ago are now returning in greater numbers as adults. However, no data exist on the exact age of loggerhead maturation (Mazaris et al. 2005), and various publications place sexual maturity of loggerheads at between 13 (Frazer & Ehrhart 1985) and 26.5 years (Bjorndal et al. 2000). In addition, Margaritoulis (2005) warns of over-hastily supposing trends of nesting efforts of sea turtles because possible trends can be obscured by high interannual fluctuations.

Annual comparison

Comparing annual data such as the number of nests as well as the number of maximal hatchlings reaching the sea shows differences from year to year (compare Figure 1 and Figure 2). Since 1994, the lowest number of maximal hatchlings reaching the sea was 359 in 2005, when only 11 nests were laid. In 2012, only 10 nests were laid but 390 hatchlings reached the sea. Thirty nests in 2015 is the fourth highest value since the beginning of the conservation programme. The highest nest number was reached in 2014 with 37 nests, followed by 1994 with 36 nests and 2013 with 35 nests. Considering maximal hatchlings reaching the sea, 2015 is the fourth highest value again: 1545 hatchlings reached the sea in 2015, topped by 1638 in 1994, 1861 in 2014 and 2066 in 2013.

Interannual fluctuations of nesting effort are common in loggerhead populations around the globe: from South Africa (Hughes 1974) to Florida (Davis & Whiting 1977), South Carolina (Talbert et al. 1980), Brazil (Marcovaldi & Laurent 1996) and to Japan (Sato et al. 1997). Also in the Mediterranean there are examples of interannual fluctuations in nest numbers: in Turkey (Fethiye) and in Cyprus, annual fluctuations over 3 seasons reached 117 % (Turkozan 2000) respectively 112 % (Broderick & Godley 1996). In the Bay of Kyparissia, the annual number of nests exhibited a maximum fluctuation of 224 % in a 17-year period from 1984 to 2000 (Margaritoulis & Rees 2001, Margaritoulis 2005). Such high interannual fluctuations in nest numbers are often referred to specific reproductive characteristics of sea turtles: most individuals do not nest every season but exhibit irregular remigration patterns, and a portion of nesting females nest several times within the same season (Dodd 1988, Margaritoulis 2005).

Due to such variability, more years of monitoring the nesting activity may be necessary to reliably evaluate trends in Çalış.

Not only do nest numbers and hatchlings reaching the sea differ between years, but also the mean success rates of nests. For example the mean success rate was 63.0 % in 2015, while the values averaged 70.6 % in 2014, 76.0 % in 2009, and 74.3 % in 2014. Such seasonal (and spatial) variations are mainly attributed to changes within the nest environment influencing the egg development, such as gas exchange, humidity, and temperature (Miller 1997, Margaritoulis 2005).

Number of empty egg shells and observed hatchlings reaching the sea

There was almost never a clear-cut relationship between empty egg shells counted at excavations and hatchlings found in the cages, hatchlings still alive inside the nests during excavations, and counted tracks of escaped hatchlings. On average, 14.4 more empty egg shells were counted than hatchlings observed reaching the sea. We attribute this to the highly frequented beach in Çalış: it is likely that tourists or local residents, when seeing hatchlings in the cage, take them out and bring them to the sea on their own. At the same time, tracks of hatchlings are rapidly blurred by people walking through the sand. Therefore, secret nests could remain undetected for a longer time or escaped hatchlings remain unnoticed. The nests with the biggest discrepancies were CS-01 and CS-06, which were located in the middle of the so-called 'picnic-area', that was crowded with locals during the hatching events. The same holds true for CS-10, which was in front of 'Seaside Travel' in a very touristic part of the beach between sunbeds and close to the promenade, where lots of tourists spent the evenings and nights.

Hatching success in general

In comparison to the hatching success of *C. caretta* in other Mediterranean nesting beaches, the value of 63 % recorded in Çalış this year is relatively low. For example, there were success rates in northern Cyprus of 77 % in 2000 (Godley et al. 2001a), and 75-83 % there from 1992 to 1995 (Broderick & Godley 1996), or 77 % in the Göksu Delta, Turkey (Peters & Verhoeven 1992). One potential reason is that the recreational uses of some of these beaches (Broderick & Godley 1996) did not reach the proportions they have in Çalış. Moreover, some authors exclude undeveloped nests from their success rate calculation (Peters & Verhoeven 1992).

In contrast, the fertilization rate of 88.2 % for loggerheads in Çalış is higher in comparison to the 83 % Peters et al. (1994) found for loggerheads in Göksu delta in Turkey as well as Wyneken et al. (1988) for loggerheads in Georgia, USA.

In comparison to older data from Çalış, where in the last two years similar nest and hatchling numbers were recorded, 2015 performed worse: in 2014 there was a mean success rate of 70.6 % and a fertilization rate of 89.1 %, whereas in 2013 the mean success rate was 74.3 % and the fertilization rate 96.1 %.

Comparing the hatching success of Loggerhead and Green Turtles (*Chelonia mydas*), the latter often scores better. This is in part due to the more stable conditions of temperature and moisture in the deeper nests of *C. mydas* (Broderick & Godley 1996).

Distance to the sea

No correlation between the distance to the sea and the success rate of nests was found. According to Wood et al. (2000), nests deposited close to the ocean have a greater likelihood of inundation and egg loss to erosion, whereas nest placement farther inland results in greater likelihood of desiccation, hatchling disorientation, and predation on nesting females, eggs, and hatchlings.

So, nests with a very short distance to the sea as well as nests with a very long distance to the sea show factors that can influence the success rate of nests increasingly negatively. This led to the expectation that the success rate of nests could be highest at a moderate distance to the sea, becoming less successful the farther the nests are placed inland or seaward, which was represented by a polynomial regression. Yet, this was not confirmed by the statistical analysis ($R^2 = 0.09$). Importantly, however, some factors, such as hatchling misorientation and predation of hatchlings crawling to the sea, were altered by the conservation efforts, so that negative factors from nest positions farther inland were masked. Taking this into consideration, factors negative to the success rate of nests could be highest very close to the sea, so that a (negative) logarithmic regression of the distance to the sea and the success rate of nests could have been surmised, but this also did not prove to be the case ($R^2 = 0.03$).

In general, a scattered pattern of nests in relation to the distance to the sea was found. As reported by Wood et al. (2000), sea turtles scatter their nests if environmental characteristics such as slope, temperature, moisture, and salinity provide only little information about nest success on beaches. Other authors determined that nest site selection was even random and varying between individuals, species, and populations, or they proposed no significant relationship between nest site selection and hatching success (Johannes & Rimmer 1984, Eckert 1987, Bjorndal & Bolten 1992, Woody et al. 2000, Kamel & Mrosovsky 2005, Santos et al. 2015).

Seasonal variation

Figure 4 showed that the hatching activity was the highest in early and mid-August, while it was lower before and after these periods. One might presume that evolutionary processes filtered this time for the best hatching success, but no such definite seasonal dependency of success rate was observed based on a two-ordered polynomial regression ($R^2 = 0.31$). Furthermore, it is conceivable that there is a decreasing hatching success during the season due to a declining number of fertilized eggs if females used stored sperm from a single mating event to fertilize eggs for the entire nesting season and the sperm supply was depleted as the season progressed (Bell et al. 2004). Therefore a linear correlation was tested ($r = -0.43$). It showed a trend of decreasing hatching success with progression of the season, which, though, cannot be explained by fertilization rates, because there was no linear correlation between first hatch dates and the fertilization rates of the nests ($r = -0.07$). Other studies also found no significant seasonal patterns for hatching success (Godley et al. 2001b, Matsuzawa et al. 2002).

Clutch sizes also did not show clear seasonal relations when tested for linear correlation ($r = -0.25$). Clutch size of loggerheads is probably determined by several factors. Because a group effort is required for hatchlings to emerge successfully from a nest (Carr & Hirth 1961), there must be some minimum limit on the size of successful clutches. Given that female sea turtles encounter some risk upon leaving the sea to nest (Stancyk 1982), as well as energy expenditure (Hays & Speakman 1991), selection should favour large clutches so that the number of trips ashore is minimized. However, since each nest has some finite probability of being destroyed by predators or abiotic factors (Hopkins et al. 1978), selection should favour individuals that do not lay all of their eggs in one very large nest, so that the probability of an entire season's reproductive output being destroyed by one event is minimized.

A number of investigators have reported trends in clutch size for sea turtles over the course of the nesting season. Most authors maintain that clutch sizes decrease at the season progresses (Caldwell 1959, LeBuff & Beatty 1971, Davis & Whiting 1977, Marquez et al. 1982), while others report that it is increased (Kaufmann 1975), or exhibits no trend in either direction (Ehrhart 1978). Frazer and Richardson (1985) observed clutch sizes in consideration of the size of sequentially laid nests by single loggerheads in detail: there was a decrease in mean clutch size for each subsequent nest in turtles that laid only three to four nests per season.

Mean clutch sizes did not differ in successive clutches of turtles that laid five nests, and the mean size of the last clutch was significantly smaller than for earlier clutches for turtles that laid six nests, but mean clutch size first increased and then decreased. Overall, no monotonic seasonal increase or decrease could be determined, as was also the case in our analysis. Such inconsistent trends for individual nesting female suggest that monotonic seasonal trends are not to be expected at all - but nevertheless a decreasing tendency in mean clutch sizes was shown by Frazer and Richardson (1985), our results, as well as the publications listed above.

In general, also the different reproductive capacity of sea turtles of various ages cannot be excluded. Newly mature turtles (Fowler 1979) as well as very old sea turtles (Balasingam 1967, Hirth & Carr 1970) showed a decrease of reproductive capacity in earlier investigations. Undeveloped and infertile clutches in Fowler's (1979) study were all laid by first-time nesters. The slight trend of bigger clutches having a higher success rate (r = 0.38) could be attributed to the fact that body size is related to the number of eggs laid (Elgar & Heaphy 1989, Hays & Speakman 1991, Van Buskirk & Crowder 1994), so that bigger clutches are laid by more experienced nesters. Clutch size, however, varies with the number of sequentially laid nests, as explained above, which must be taken into account.

The best nests

The nest with the most hatchlings reaching the sea was CY-03. A number of 103 of 107 laid eggs fully developed and reached the sea, yielding a success rate of 96.3 %. Only one dead hatchling was found during the excavation, two eggs were unfertilized and there was one late-staged dead embryo.

CY-03 was laid on 11.06.2015 and hatched first on 04.08.15 after an incubation time of 54 days. It was placed 10.10 metres from the sea and was located in front of ‘Ceren Hotel’ where relatively fine sand with no big stones was available. Sand properties become particularly important regarding CY-04 and CY-10, which were located on the 'picnic-area', with stony conditions, and had low success rates (26.5 % and 40.0 %). The low success rates relate to 41 respectively 21 dead hatchlings and 12 respectively 15 dead hatchlings stuck in egg that were found in these nests. These hatchlings seem to have not been able to pass by the big stones and crawl to the surface. The relevance of different types of sand for the emergence success was also stated by Peters et al. (1994).

There was one nest with a success rate of 100 %: CS-11. A number of 86 hatchlings reached the sea from this nest, 28.4 metres away from the sea. It was located near ‘Beşkaza’, where the sand was also quite fine. The nest date is unknown, but first hatching occurred on 17.08.15.

The worst nest

The nest with the lowest success rate was CY-17. No single hatchling from this nest reached the sea. The nest date was 19 July, which was the last nest that was laid in 2015 on Çalış Beach. It was very close to the sea (6.80 metres) and was noted as being in the wet zone of the sea several times. When it was seen in the wet zone for the first time, it was already too late for a hatchery (Miller 1999, Mortimer 1999, Shanker et al. 2003). All 63 eggs of the nest were categorized as unfertilized because there was no sign for fertilization. Such an unfertilized clutch could be a hint for a first-time nester (Fowler 1979). Nonetheless, it is possible that an early inundation led to the death of all eggs (Small 1982, Whitmore & Dutton 1985) before they could develop to a fertilization stage that was detectable under field conditions (Peters et al. 1994). Inundation by sea water on turtle nests leads to suffocation of the developing embryos and disrupts egg metabolism as a result of exposure to higher salinities (Small 1982, Whitmore & Dutton 1985).

The new cages

As mentioned in ’Material and Methods’, there has been an effort to provide new cages for our project next year, initiated by Mr. Mehmet Ünalan. The prototype is pictured in Figure 12 in the Appendix. They will be constructed of wood to eliminate possible effects of metals on the electric field orientation of the hatchlings. Metal cages could act as a Faraday cage (Schatz & McCaffery 1969) and influence the imprinting of the natal beach by the newly born sea turtles. The development of the imprinting process and the magnetic field orientation itself is not completely understood (Lohmann et al. 1997, Lohmann & Lohmann 2000, Åkesson et al. 2003), so that it is sensible to avoid potential negative impacts.

The prototype has thick wooden struts that will be reduced in the new batch to avoid increased shading of the nests, which would influence temperature and moisture. Temperature and moisture are important factors for nest site selection (Wood et al. 2000) and altering the conditions after nesting could undermine the intention of the nesting sea turtles. A principle in conservation is to ensure that all processes take place as naturally as possible (Margules et al. 2007). Some wooden struts, however, are necessary for stabilisation and to prevent cats and dogs from getting into the cages.

Nets will be inserted in the lower section of the cage to keep the hatchlings inside when the cage is closed. One side of the cage is provided with a flap that can be used easily to open the cage during the day.

Survivorship of hatchlings

According to the generally accepted opinion, only 1 in 1000 hatchlings reaches sexual maturity and reproduces (Frazer 1983). Here, it has to be considered that the crawl from the nest to the sea is one of the most dangerous stages for hatchlings (Stewart & Wyneken 2004). Precisely this threat was reduced by the conservation work, so that there is hope for a better survivorship for 'our' hatchlings.

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APPENDIX

Fig. 8: Cage closet to vehicle tracks.
Abb. 8: Reifenspuren neben Käfig.
(Photo: S.Siedler)

Fig.9: Early embryonic stage.
Abb.9: Frühes Embryonalstadium.
(Photo: S.Siedler)

Fig.10: Mid embryonic stage.
Abb.10: Mittleres Embryonalstadium.
(Photo: S. Siedler)

Fig.11: Late embryonic stage.
Abb. 11: Spätes Embryonalstadium.
(Photo: S. Siedler)

Fig. 12: Egg chamber and empty egg shells after Excavation.
Abb. 12: Die Nestgrube und die leeren Eischalen nach einer Excavation.
(Photo: K. Schmölz)

Fig.13: Dead hatchling, two placeholdereggs and one unfertilized egg.
Abb.13: Toter Hatchling, zwei Platzhaltereier und ein unbefruchtetes Ei.
(Photo: K. Schmölz)

Fig. 14: Cage next to fielfwork utensils.
Abb.14: Käfig mit Arbeitsutensilien.
(Photo: K. Schmölz)

Fig.15: Quadrangular cage among sunbeds.
Abb.15: Quadratischer Käfig inmitten von Sonnenliegen.
(Photo: K. Schmölz)

Fig.16: Pollution on the beach of Çalış.
Abb.16: Verschmutzung des Strandes von Çalış.
(Photo: K. Schmölz)

Fig.17: Emerging hatchling.
Abb.17: Hatchling während des Schlüpfens.
(Photo: K. Schmölz)

Fig.18: Hatchlings trapped in the cage.
Abb.18: Hatchlinge im Käfig.
(Photo: S. Siedler)

Fig.19: New cage (prototype) for 2016.
Abb.19: Neuer Käfig für 2016.
(Photo: S. Siedler)

Fig.20: Three-cornered protection cage.
Abb.20: Dreieckiger Schutzkäfig.

(Photo: N. Steurer)

Caretta caretta hatchlings in Yanıklar and Akgöl 2015

Astrid Neumann, Katharina Huchler

KURZFASSUNG

Yanıklar und Akgöl sind Teil einer Special Environmental Protection Area (SEPA) der Türkei und Niststrände der gefährdeten *Caretta caretta* (Unechte Karettschildkröte). Von Juni bis September sammelten Studenten Daten zu Nisterfolgen und Populationsentwicklungen und beschützten die Tiere. Damit führten sie ein Langzeitprojekt welches seit 1993 läuft fort.

Diese Saison wurden 128 Nester gelegt (Y: 78, A: 50), was im Vergleich zu den letzten zehn Jahren eine Steigerung von 154-291% darstellt. Von 9385 gelegten Eiern waren 13% nicht befruchtet, 19% prädiert oder von Insekten befallen, 6% waren befruchtet aber nicht geschlüpft, 10% sind geschlüpft, aber gestorben bevor sie das Meer erreicht haben und 52% haben das Meer erreicht. Im Vergleich zu vergangenen Jahren bedeutet das einen niedrigeren prozentuellen Schlüpferfolg, der vor allem durch die hohe Prädationsrate verursacht wurde. Die mittlere Inkubationszeit betrug 51.1 ± 5.8 Tage (43-70 Tage), was länger ist, als vergangene Inkubationszeiten an diesen Stränden. Die durchschnittliche Gelegegröße war mit 73 Eiern pro Nest (71-119 Eier) kleiner als frühere. Betrachtet man alle Daten, so scheint 2015 trotzdem ein erfolgreiches Nistjahr gewesen zu sein, was auf eine gute Entwicklung der Schutzbemühungen für die Unechte Karettschildkröte in Fethiye hindeuten könnte.

ABSTRACT

Yanıklar and Akgöl are part of a Special Environmental Protection Area (SEPA) of Turkey and nesting beaches of the endangered *Caretta caretta* (Loggerhead seaturtle). From June to September students collected data on adult females, clutches and hatchlings as well as protected the animals. This is the continuation of a long-term cooperative effort since 1993.

This season, 128 nests were laid (Y: 78, A: 50), which is an increase of 154-291% compared to the last ten years. Out of 9385 laid eggs, 13% were unfertilized, 19% predated or infested by insects, 6% fertilized but did not hatch, 10% hatched but died before reaching the sea and 52% reached the sea. Compared to former years this means a decrease in hatching success, mainly caused by the high amount of predation. The mean incubation time was 51.1 ± 5.8 days (range: 43-70 days), which is longer than former incubation times in this area, while the

average clutch size with 73 eggs per clutch (range: 71-119 eggs) is below former clutch sizes. All data considered 2015 was a successful nesting year, which might be sign for loggerhead turtle conservation success in Fethiye.

INTRODUCTION

The loggerhead turtle, *Caretta caretta*, is classified as an endangered species in the IUCN Red List of Threatened Species (Marine Turtle Specialist Group 1996). Greece, Turkey and Cyprus have the main nesting beaches of *Caretta caretta* in the Mediterranean (Margaritoulis & Demetropoulos 2003). In Turkey, there are 13 key nesting sites for the loggerhead turtle (Margaritoulis et al. 2003). One of them is Fethiye beach, which is part of the Special Environmental Protection Area (SEPA) Fethiye-Göcek (Bann & Başak 2013). The SEPA was established in 1988 and concedes marine and coastal conservation status for this area. Local loggerhead turtle population studies have been carried out since 1993 (Ilgaz et al. 2007) and are continued by this study.

Worldwide, adult loggerhead females nest at intervals of 2 to 4 years. In one season they are able to lay up to 6 nests, each containing about 100 to 126 eggs. (Sea Turtle Conservancy, N.D.) Moreover, they show so-called nest site fidelity, which means that female turtles return to their former nesting beaches to lay their eggs. These site preferences can encompass 2.4 - 109 km in one season, which are values equal to the linear distance between the two most distant nests of one female (Tucker 2010).

Increasing tourism in nesting areas overlaps with the nesting season: adult female turtles are disturbed while nesting and incubating clutches and hatchlings are also severely threatened (Margaritoulis & Demetropoulos 2003). Intensive and poorly planned development such as the construction of hotels at protected beaches, deployment of beach furniture or vehicular traffic minimize vital space for sea turtles in general and especially increase the mortality of eggs and hatchlings. Another important threat is light pollution, whereby emerging hatchlings are distracted while heading toward sea (Margaritoulis 2005; Margaritoulis & Demetropoulos 2003). Since clutch sizes and nest numbers fell from 1993 to 2004, a decline of the *Caretta caretta* population at Fethiye beach was assumed (Ilgaz et al. 2007). This chapter shows the values for clutches and hatching success of *Caretta caretta* compared to the trend in former years.

MATERIAL AND METHODS

The beaches of Yanıklar are main nesting areas for *Caretta caretta* around Fethiye and are part of the long-term studies of the sea turtle field course run by the University of Vienna in cooperation with Turkish universities. In 2015, students were worked from 27 June to 12 September at the subsections Yanıklar beach and Akgöl beach to investigate and protect females coming to the beach as well as the nests and the hatchlings themselves.

Yanıklar beach is about 3.8 km long and includes two major hotels, two camping sites and a restaurant as well as rather natural pebbly and sandy areas and the small beach section Karataş beach. Akgöl, which is only 1.5 km long, contains two hotels and two further regions of higher human usage including umbrellas, pavilions and restaurants. Both interfere with the section of the beach which has shown the highest nesting activity within the last years in Akgöl (Fig. 8a, In: Bürger & Kriegl 2014). Both beaches are used by tourists and local residents alike for swimming and fishing.

The students working at the beaches patrolled them every morning, starting at sunrise between 05:30 and 06:00 a.m. New nests, which were indicated by the tracks of the females on the beach, were found by using a Şiş (a metal rod) to carefully sense the differences in sand structure that are created by nesting activities. Once a nest was found, it was given a code consisting of either Y (for Yanıklar beach) or A (for Akgöl beach) and an identification number. All nests were registered in a beach plan and data sheets, and the time span of potential hatching (between 40 and 60 days later) was calculated.

In areas with little human influence, the nests were marked by a stone half-circle, a buried string with two sticks at the ends pointing to the nest itself, and two vertically fixed sticks containing the nest code (Fig. 1a). In areas with high visitor usage the markings were complemented by two buried sticks on both sides of the nest entrance, protection cages (mainly “pyramid” cages) and warning labels (Fig. 1b). Furthermore, the nests were triangulated by using two different landmarks nearby, which were marked, too. For further protection, some nests were equipped with natural or artificial grids or spiny plant remains (Fig. 1c and d). At other nests which were severely influenced by light pollution, fences were installed to capture the hatchlings. These were pulled down in the evening and pushed back up in the morning to keep hatchlings from crawling towards the light sources. The fences were controlled during the time span of potential hatching between every one to two hours from 10:00 p.m. to 02:00 a.m. Hatchlings emerging from those nests were released at a place as close as possible to their nest but with less severe light pollution. Between both spots, the hatchlings were transported in buckets with moist sand.

As the offspring began to hatch, the morning shifts also checked for hatchling tracks, which were counted and noted. Tracks not leading towards the sea, over difficult terrain or ending abruptly were traced to identify and rescue hatchlings which had not made their way to the sea. The entrances of the nest chambers were checked regularly for stones blocking the way or for hatchlings that were stuck or trapped. If dead hatchlings were found in, on or near the nest, they were buried about 3-5 m from the nest to prevent attracting predators to the nest itself. If living hatchlings were found, they were either immediately released close to the sea, or, if they seemed to be exhausted or if it was too late (too hot) for releasing them, they were taken back to the camp. Since the predation pressure is reduced at night, they were kept in a cool and moist bucket with sand and released in the evening.

Three to five days after the last hatching of a nest, it was excavated during a morning shift. The sand above the nest was carefully removed and the depth to the top of the eggs was measured. Then, the complete content was removed and sorted into empty eggshells, dead hatchlings, hatchlings stuck in egg and unopened eggs. All unopened eggs were opened and classified into unfertilized eggs or embryos in early (embryo < 1 cm, unpigmented), mid (> 1 cm < 2 cm, partly pigmented) or late (> 2 cm, fully pigmented) embryonic stage. Finally, the complete content and all natural markings were returned into the nest, which was closed and deleted from the beach map. If any living hatchlings were found during this process, then the excavation was immediately cancelled.

In some cases, it was necessary to open up and partly excavate a nest, for example when a bad odour indicated problems within the nest. In most such cases, dead hatchlings blocked the entrance of the nest for living hatchlings underneath them. After carefully removing the dead and the living hatchlings, the nests were closed again to prevent a premature excavation.


a


b


c


d

Fig. 1, a-d: **a)** Nest in an area with little human influence, marked only by a stone half-circle, a buried string (not visible), and at least two vertically fixed sticks containing the nest code. (Photo: A. Neumann) **b)** Nest in an area with high human influence, protected by a cage with a warning sign and a fence to prevent hatchlings from crawling towards lights at night. (Photo: S. Wanzenböck) **c)** Improvised nest protection against predators (Photo: M. Lambropoulos) **d)** Predated nest with predation grid exposed. Note egg fragments from predation event. (Photo: K. Huchler)

Abb. 1, a-d: **a)** Nest in Umgebung mit geringem menschlichen Einfluss, nur von einem halben Steinkreis, einer vergrabenen Schnur (nicht sichtbar) und min. zwei vertikal fixierten Stöcken mit dem Nestcode markiert. (Foto: A. Neumann) **b)** Nest in Umgebung mit hohem menschlichen Einfluss, beschützt von einem Käfig mit einem Warnschild und einem Zaun um die Hatchlinge davon abzuhalten, sich nachts in Richtung des Lichts zu bewegen. (Foto: S. Wanzenböck)
c) Improvisierter Nestschutz gegen Prädatoren (Foto: M. Lambropoulos) **d)** Prädiertes Nest mit freiliegenden Eifragmenten und Prädationsgitter (Foto: K. Huchler)

RESULTS

Altogether, 78 nests were recorded at Yanıklar beach and 50 nests at Akgöl beach, yielding a total number of 128 laid nests. This is an increase compared to every year since 1995 and marks an increase of 154-291 % compared to the former 10 years (Fig. 2). Also if the beaches are considered separately, the nest number is higher within the last ten years: the only exception is 2010, in which Akgöl showed an outstanding number of 68 nests.

In 53 cases, nests were predated and eggs were destroyed by other animals, whereby 16 nests were completely predated, meaning that because of predation no hatch occurred. Thirty of these nests were infested by insects (Y: 25, A: 5) and 30 (Y: 29, A: 1) were predated by larger carnivores. Another 2 nests did not hatch for reasons other than predation (As7: flooded; Y6: hatchlings could not emerge on their own because of stones, which were blocking their way out). Ultimately, 106 nests hatched (Y: 59, A: 47). 8 nests could not be excavated (because of inundation, etc.).

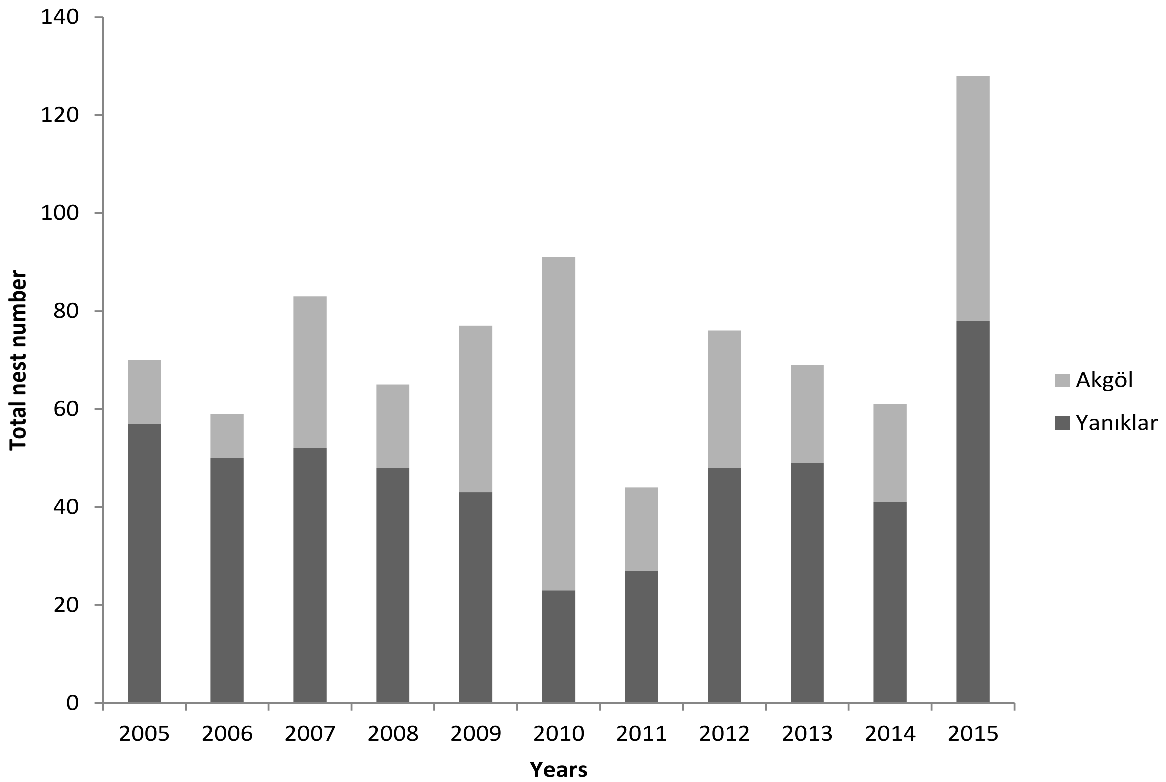

Fig. 2: Total nest numbers in Yanıklar beach and Akgöl beach from 2005 to 2015.
Abb. 2: Gesamte Nestanzahl von Yanıklar beach und Akgöl beach von 2005 bis 2015.

The mean incubation time of all hatching nests (i.e. neglecting so-called secret nests) was 51.1 ± 5.8 days. The shortest incubation time was 43 days, the longest 70 days. The first nest hatched on 11 July, the last on 9 September. The average incubation time of the previous five years was 47.5 days.

In total, 9385 eggs were laid (Y: 5810, A: 3575), of which a minimum of 5820 eggs were fertilized (Y: 3025, A: 2795) (Fig. 3). 5600 empty eggshells were recorded (Y: 3161, A: 2439), a number equal to all hatchlings which emerged from their egg (Fig. 4). When compared to the previous ten years, the total number of empty shells is constantly higher than in the past 10 years, both as a total and for each beach section separately. Nonetheless, when considered in association with the nest number, the hatching success is one of the worst of the past 10 years (Fig. 5), scoring a ratio of 0.6 empty shells per laid egg. The mean number of eggs per nest was 73, which varied from 71-119 eggs throughout the previous 10 years with a median of 79.

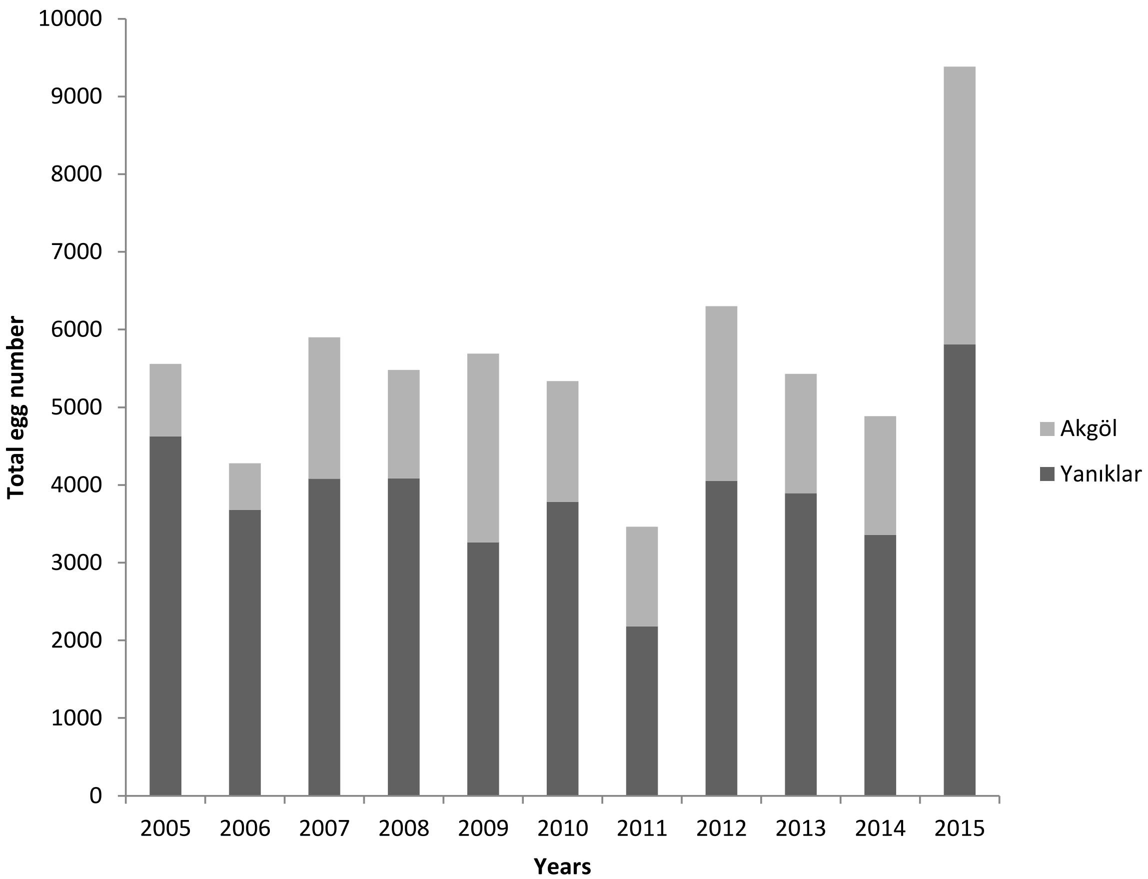

Fig. 3: Total egg number from 2005 to 2015.
Abb. 3: Gesamte Eieranzahl von 2005 bis 2015.

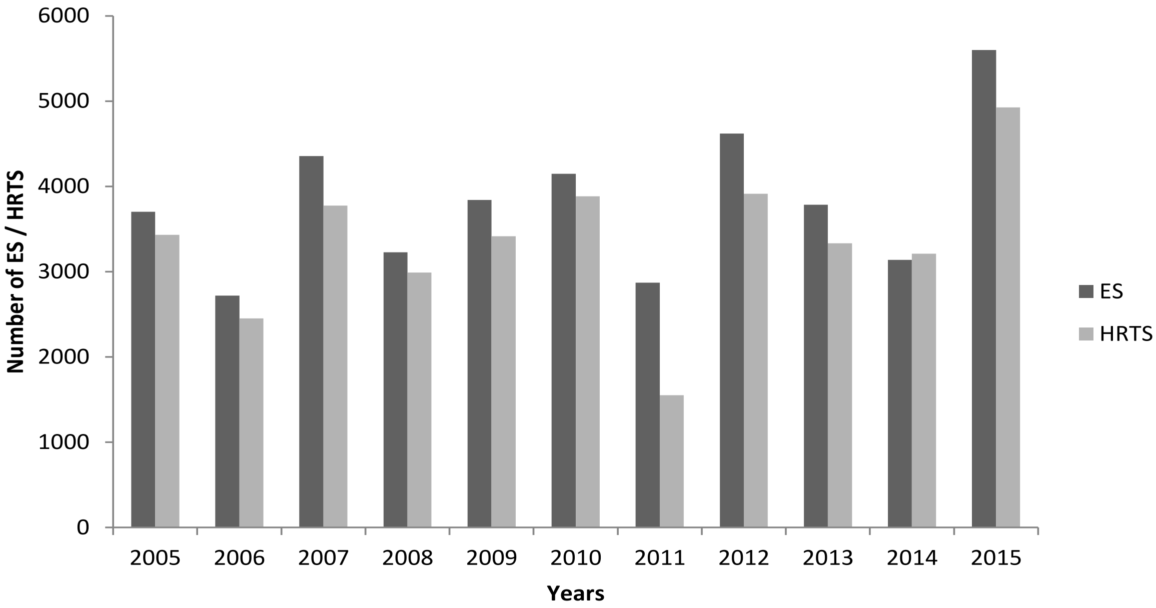

Fig. 4: The years 2005 to 2015 regarding number of empty eggshells (=ES) and calculated number of hatchlings reaching the sea (=HRTS).
Abb. 4: Die Jahre 2005 bis 2015 in Bezug auf Gesamtanzahl aller leeren Eischalen (=ES) und ermittelter Anzahl aller Hatchlinge, die ins Meer fanden (=HRTS).

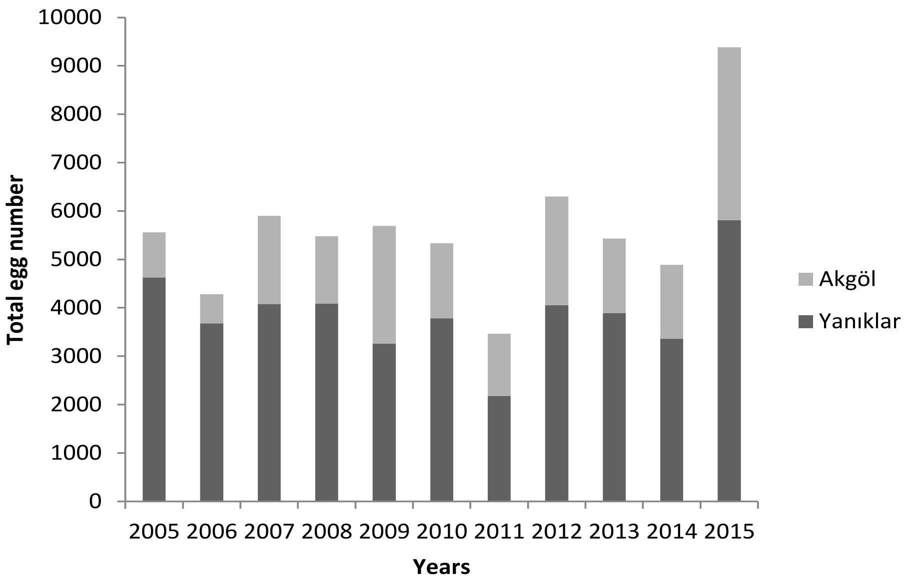

Fig. 5: Hatching success from 2005 to 2015 based on ratio of number of empty eggshells to total number of eggs.

Abb. 5: Schlüpferfolg von 2005 bis 2015 basierend auf Verhältnis von leeren Eischalen zu Gesamtanzahl aller Eier.

In relation to the hatch date (and therefore broadly to the date of egg deposition), the clutch size decreased during the season, especially after 21 August (Fig. 6).

Importantly, not all of the hatchlings trying to leave their egg reached the sea: 154 hatchlings got stuck in their egg (Y: 89, A: 65), an additional 451 hatchlings died in their nest without reaching the surface (Y: 278, A: 173). 295 hatchlings definitely died on their way from the nest to the sea (Y: 179, A: 116). 291 living individuals were found in the nests during excavations or nest controls (Y: 181, A: 110). Nonetheless, a total of 4927 hatchlings reached the sea (Y: 2727, A: 2200) (Fig. 4).

Compared to the previous 10 years the total number of eggs increased by 151-271 % whilst the number of empty eggshells increased by 121-205 % and the number of hatchlings reaching the sea by 126-318 %.

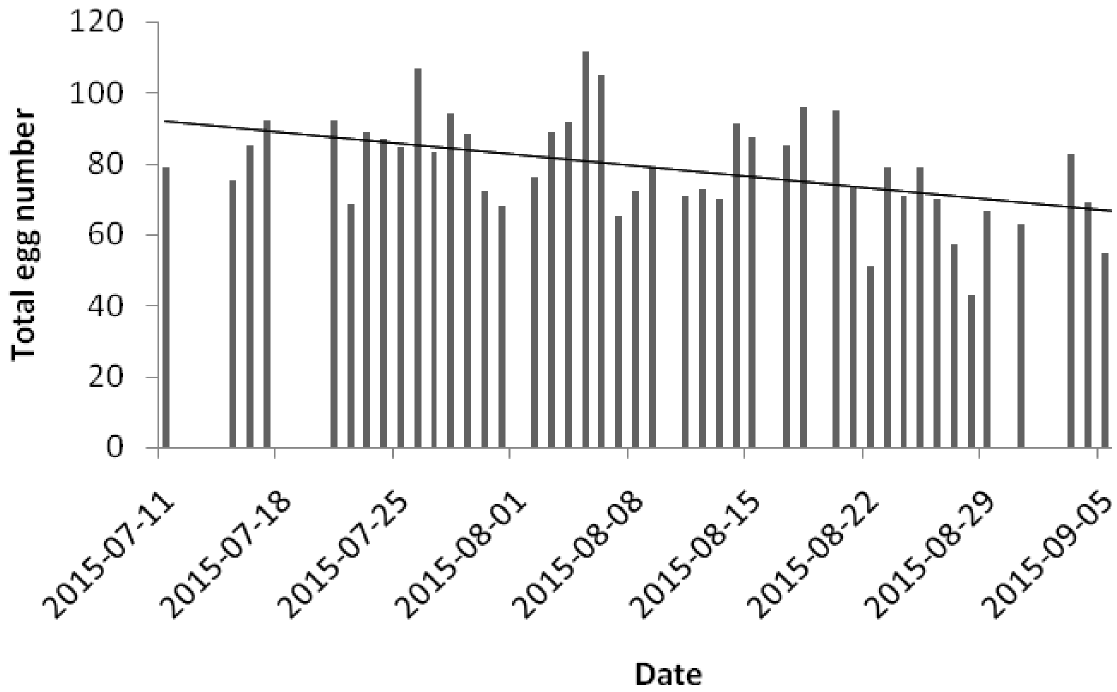

Fig. 6: Clutch sizes regarding hatch dates. Total egg number per nest declined during season, shown by the decreasing regression line (R^2=0.240).

Abb. 6: Gelegegröße im Bezug auf Hatchdaten. Gesamtanzahl der Eier nahm über Saison hinweg ab, ersichtlich durch abfallende Regressionslinie (R^2=0,240).

Of the 606 eggs (Y: 303, A: 303) that were fertilized but did not hatch, 101 were in an early-, 87 in a mid- and 423 in a late-embryonic state. 112 of all not hatching eggs were completely mouldy (all coming from a single rotting nest) and further 264 were infested by insects. Accordingly, in a total of 376 cases it was unclear if the egg was fertilized or unfertilized. Further 1572 eggs were predated by a larger carnivore (Y: 1568, A: 4). Therefore, of all laid eggs, 13 % were unfertilized, 19 % predated or infested by insects, 6% fertilized but did not hatch, 10 % hatched but died before reaching the sea and 52 % reached the sea (Fig. 7) (remark: for the percent data, the 112 mouldy eggs mentioned above were excluded from the data set).

As nest distance to sea at the date of excavating, an average value of 20.7 m and a standard deviation of 9.8 m were measured. The nest closest to the sea was in Akgöl with a distance of 4.4 m; the highest value was scored by a nest in Yanıklar 68.3 m from the sea. The distance between the surface of the sand and the top of the eggs was 26.0 ± 7.6 cm, while the mean distance from the surface to the bottom of the egg chamber was 40.3 ± 6.2 cm. The diameter of the egg chamber averaged 23.0 ± 4.3 cm. All of these values varied very little between Akgöl and Yanıklar.

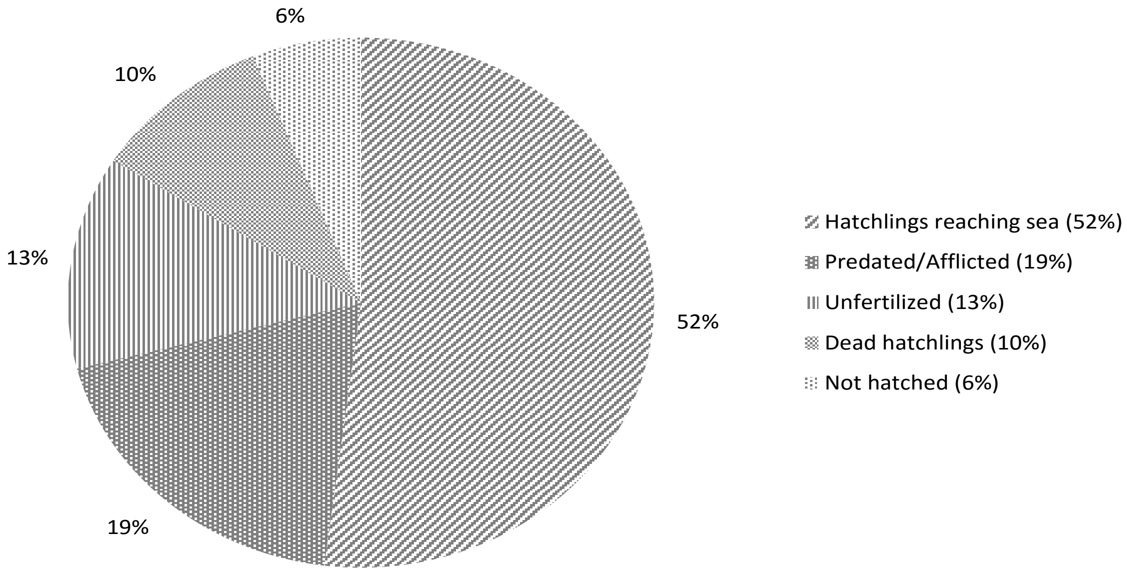

Fig. 7: Percentage distribution of all laid eggs. In somewhat more than half of all cases, the hatchlings reached the sea. Nearly one fifth of all eggs was predated or infested by insects. 13% were unfertilized and in 10% the hatchlings died before reaching the sand surface. Only 6% of all eggs were fertilized but did not hatch.

Abb. 7: Prozentuelle Verteilung aller gelegten Eier. In etwas mehr als der Hälfte aller Fälle haben die Hatchlinge das Meer erreicht. Nahezu ein Fünftel aller Eier wurde prädiert oder von Insekten befallen. 13% waren unbefruchtet und 10% der Hatchlinge starben bevor sie die Sandoberfläche erreichten. Nur 6% aller Eier waren befruchtet aber brachten keine Hatchlinge hervor.

The average distance to sea of the previous five years is 20.6 m, so this year's results were close to those of recent years. In the same time period, mean nest diameter was 24.6 cm, the mean top of the eggs depth was 28.6 cm and the mean bottom of the eggs depth was 44.6 cm. Accordingly, the average nest diameter was slightly lower than the mean values of the last years. The nests in 2015 were a little closer to the surface and also the bottom of the nest chamber was less deep.

DISCUSSION

In 2015, record high numbers were scored in all aspects. Especially the nest quantity is prominent compared to previous years (Fig. 2). In former investigations, the nest number was seen as directly correlated to the number of females coming to the beach (Ilgaz et al. 2007). Therefore, a higher nest number indicates a higher number of adult, nesting females. Although positive developments in conservation projects should always be interpreted with caution, it is possible that we are achieving a first success from the past decades of protecting loggerhead turtles.

In contrast to the success in nest numbers (128), the number of eggs per nest (73) was not very high, but in a very expectable range compared with other Mediterranean clutch sizes (Broderick et al. 2003: 73 eggs per nest ± 16, range: 28-144). In comparison to the clutch sizes of the previous years, this year's results are still within a normal range but on the lower limit. The study of Broderick et al. (2003) showed that clutch sizes increase with the female's body sizes and thus are smaller if a female is small-sized. So maybe this year's females nesting at the beach were smaller than in former seasons. If this is proven to be true (compare Fig. 9, chapter "Nesting activity of the Loggerhead Sea Turtle, *Caretta caretta*, on the beaches Yaniklar and Akgöl on the Turkish Mediterranean coast, 2015", Svalina & Werner, this volume), it would support the theory of young individuals coming to the beach for the first time, therefore being born during the early years of our conservation efforts at the beaches of Yanıklar.

According to Broderick et al. (2001), sea turtles are likely to lay fewer instead of smaller clutches if their body conditions restrict them. This mostly occurs due to environmental circumstances especially regarding food availability. Still, clutch sizes tend to decrease during the season, and Broderick et al. (2002) found that the first four nests laid in one season by a single female do not vary too much in size but that the fifth clutch is on average 38% smaller than the first clutch of the same season. As shown in figure 6, the clutch size did decline during the season. So if the females had very good body conditions this seasons, it is possible that more nests per individual were laid, explaining the high nest number as well as the small clutch sizes at the end of the season, reducing the average clutch size of the whole season.

The incubation time was longer than in the previous years. One potential reason is the apparently low spring and summer temperature in Turkey of 2015. Another possible reason could be higher sand moisture levels caused by rain or nest closeness to the sea. On the other hand, the average incubation time of the previous five years was lower than in the years before (personal communication, M Lambropoulos). Based on experience gathered throughout the long-term project, normal nest incubation time ranges from 42 to 60 days. In a study of Matsuzawa et al. (2002) carried out in Japan, incubation times of loggerhead nests ranged from 46 to 81 days, correlated to the time of the season when the nests were laid. The later a nest was laid, the shorter the mean incubation period. According to that study, the decrease in incubation time might be caused by temperature increasing during a particular season, because a negative correlation between incubation time and ambient sand temperature exists.

The hatching success, estimated by the ratio of empty shells per all laid eggs, is the second lowest in the last 10 years: only the results of 2008 were lower. Many natural reasons for hatching failure exist. Peters et al. (1994) showed that hatching success can be affected by sand consistence and inundation. Other known reasons for egg failure include infertility, embryonic mortality caused by microbial infection, developmental arrest and developmental abnormalities (Peters et al. 1994). Those authors also observed that clutches of *Caretta caretta* tend to emerge over a several day period instead of one hatching event (see also Adam et al. 2007). The moisture content of the sand can also highly affect egg development. According to McGhee (1990) incubation times increase significantly in the presence of very high moisture levels. These high values seem to be even more harmful to developing eggs than extremely dry ground.

Indeed, the most frequent reason for low hatching success at Yanıklar was predation by mammals was extraordinarily high. Based on the tracks around the predated nests, jackals were considered to be the main predators. Another effect besides the high loss of eggs was the possible effect on the egg categories distinguished in the collected data: it is unclear if the predators consumed unfertilized and fertilized eggs to the same extent. Accordingly, the calculated ratio of unfertilized to fertilized eggs may be biased. Furthermore, it is possible that the number of predated eggs and therefore the total egg number was underestimated because the predator tended to carry away its prey. As conventional predation cages, deterrent food spices and spiny plants did not help keep the predators away (Fig. 1d), better methods are needed to reduce the high predation rate in future years.

In any case, the results of the next few years will be of great interest to help determine whether we are in fact observing the first positive long-term trends since the early beginnings of this project. If this is the case, then better methods to keep away predators would be an important step to further improve the hatching success and ultimately, nest numbers.

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