Bachelor Thesis

Sand temperature changes through shading on a Mediterranean *Caretta caretta* nesting beach (Calis, Turkey)

Änderungen der Sandtemperatur durch Beschattung auf einem mediterranen *Caretta caretta* Niststrand (Calis, Türkei)

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KURZFASSUNG

Die Unechte Karettschildkröte (*Caretta caretta*) sucht für ihre Eiablage Strände auf. Die geschlechtsreifen Tiere migrieren in seichte Oberflächengewässer, um sich zu paaren. Nach ca. 2 Wochen suchen die Weibchen jene Strandabschnitte auf, an denen sie selbst geschlüpft sind (natal homing) (Lohmann et al. 1996). Die Tiere graben am Strand, an geeigneten Stellen Ei-Höhlen und legen anschließend ca. 100 Eier hinein. Im Anschluss wird die Ei-Kammer wieder geschlossen und die adulten Tiere verlassen den Strand. Sie migrieren wieder zu den Paarungsgebieten. Ab diesem Zeitpunkt entscheidet die Sandtemperatur über das Geschlecht der Jungtiere. Ist sie niedrig, werden hauptsächlich Männchen geboren, ist sie hoch, entstehen vorwiegend weibliche Schildkröten.

Durch den anthropogenen Einfluss (Massentourismus, Hotelanlagen, usw.) werden die Niststrände besonders im Mittelmeerraum zunehmend verändert. Dadurch werden das Nistverhalten sowie der Nisterfolg der Meeresschildkröten negativ beeinflusst.

Diese Studie untersucht die Veränderung der Sandtemperatur durch Beschattung. Hierzu wurden verschiedene Beschattungsarten verwendet. Ein Handtuch im ersten Versuch, ein Sonnenschirm im zweiten, gefolgt von Abfall im Experiment 3. Weiters wurden der Einfluss durch natürliche Gezeitenbewässerung (4), sowie Beschattung durch eine Sonnenliege (5) erforscht.

Die Temperaturmessungen erfolgten mit Messgeräten der Firma Gemini Data Loggers. Jeder Versuch umfasste zwei gegrabene Ei-Höhlen. Eine repräsentierte die „Kontrolle“ und wurde nicht beschattet. Die zweite Ei-Höhle wurde beschattet (siehe oben) und entsprach dem „Experiment“. Die Beschattung erfolgte jeweils über einen Zeitraum von 6 Tagen. Jede Ei-Höhle beinhaltete zwei Temperaturmessgeräte, in zwei unterschiedlichen Tiefen, in 27 cm und 47 cm.

Die größte Sandtemperaturänderung (27 cm) konnte durch eine Sonnenliege festgestellt werden. Die Temperaturabnahme betrug in 27 cm Tiefe 1.3°C und in 47 cm 0.8°C. Gefolgt von dem Versuch mit natürlicher Gezeitenbewässerung und gleichzeitiger Beschattung durch einen Sonnenschirm (in beiden Tiefen 1.1°C). Einen sehr ähnlichen, aber geringeren Einfluss auf die Sandtemperatur zeigten die Beschattungsvarianten, die durch Abfall (0.9°C / 0.1°C), ein Handtuch (0.7°C / 0.1°C) und durch einen Sonnenschirm (0.6°C / 0.1°C) erzielt wurden.

Schlüsselwörter: Unechte Karettschildkröte (*Caretta caretta*) – Beschattung - Sandtemperaturänderung - Geschlechterverhältnis - Mittelmeer - Schutzmaßnahmen

ABSTRACT

The loggerhead turtle (*Caretta caretta*) uses beaches in Turkey for nesting. The sexually mature turtles migrate to shallow water areas to breed. After approximately 2 weeks the females return to beaches where they were born (natal homing). They first search for a suitable nest site; after they have dug an egg chamber, they lay about 100 eggs into the chamber; afterwards they close the nest. The adult females then return to their foraging areas. From this time on, the sex ratio of the embryos is influenced by sand temperature. At lower sand temperatures, mainly male turtles will be born, at higher temperatures mainly females.

The breeding areas, especially around the Mediterranean Sea, are affected by an increasing anthropogenic influence (mass tourism, hotels, etc.) This negatively affects breeding behaviour and breeding success.

This study quantifies the change in sand temperature through shading at various depths simulating a natural nest. The shade was made in different ways, in experiment 1 with a towel, in experiment 2 with an umbrella and in experiment 3 with litter. Experiment 4 was an attempt to determine the influence by a combination of natural flooding and shade by an umbrella. Experiment 5 examines the influence of a sun bed.

The temperature measurements were made with devices from Gemini Data Loggers. Each experiment included two egg chambers: the “control” without the influence of shading and the “experiment” with the effect of different shade variations. Each nest contained two data loggers, in two different depths (27 and 47 cm).

The highest impact on sand temperature (27 cm) was achieved through shade by a sun bed, with a temperature decline of 1.3°C in 27 cm and 0.8°C in 47 cm depth; and by natural flooding in combination with an umbrella (1.1°C / 1.1°C). A lesser sand temperature change was recorded in the experiments with litter (0.9°C / 0.1°C), towel (0.7°C / 0.1°C) and an umbrella (0.6°C / 0.1°C).

Key words: Loggerhead Sea Turtle (*Caretta caretta)* - Shading - Sand temperature change - Sex ratio - Mediterranean Sea - Conservation work

INTRODUCTION

Turkey is, beside Greece, one of the most important breeding areas of *Caretta caretta* and *Chelonia mydas* in the Mediterranean Sea (Groombridge 1990).

The loggerhead sea turtle shows, as do many other reptiles, a temperature-dependent sex determination (TSD). The sex of the hatchlings is influenced by the incubation temperature of the eggs (Yntema and Mrosovsky 1980). Even a change of 1 to 2°C can make a considerable difference to the sex ratio of the hatchlings (Mrosovsky et al. 1980). *Caretta caretta* generally show a predicted female-biased sex ratio (Kaska et al. 1998), but Fethiye has a relatively high proportion of male hatchlings (Kaska et al. 2006). The transitional range of temperature (TRT) is the range of temperature in which sex ratio shifts from 100% male to 100% female. Temperatures above the TRT produce only females and temperatures below the TRT produce only males (Wibbels 2003). The pivotal temperature is a temperature value between the TRT. This incubation temperature produces a sex ratio of 1:1. The pivotal temperature occurs over a relatively narrow temperature range from approximately 27.7°C to 31.0°C, depending on the particular species, with the majority clustering in the 29.0°C to 30.0°C range. In general, the pivotal temperatures in studies of loggerhead turtles all cluster within one degree of 29°C (Mrosovsky 1994).

The thermo-sensitive period indicates that temperature affects sex determination during the approximate middle third of incubation time (Yntema et al. 1994). Temperature therefore apparently has a cumulative and a quantitative effect on sex determination (Wibbels et al. 1991). The sex determination is also influenced by the fluctuation amplitude of sand temperature. Widely fluctuating temperatures lead to more females than under more stable temperatures (Georges et al. 1994).

Higher incubation temperatures produce hatchlings with greater body mass (Kuroyanagi and Kamezaki 1993). The sand temperature in Boca Raton, Florida, for example, is, according to Mrosovsky et al. (1995), on the average 1-2°C cooler in shaded than unshaded areas.

Finally, anthropogenic influences on nesting beaches can alter incubation environments and affect both hatchling success and hatchling characteristics. Coastal armouring, for example, influences the nesting behaviour of female sea turtles (Mosier 1998).

MATERIAL AND METHODS

The study took place in Calis, Fethiye, Turkey (Fig. 32, 33), from 4 July until 10 August 2011. Five different experiments were carried out during this time. The sand temperature measurements were made with Tinytags 2 Temperature Logger (-40 to +85 °C) from Gemini Data Loggers (Fig. 34). The loggers were housed in 35 mm film canisters. They have a reading resolution of 0.05°C (http://www.geminidataloggers.com/data-loggers/tinytag-talk-2/tk-4014, on 20 October 2011). They were programmed in Vienna with the Tinytag Explorer Software 4.6. Every 72 minutes, one temperature value was recorded. One Tinytag was used to record the temperature in a natural nest. The other four devises were used for the shading experiments. Two Tinytags were buried in each "artificial egg-chamber", in two different depths. "Artificial egg-chamber" refers here to a hole dug into the beach by hand (and refilled with sand) whose depth and diameter corresponded to an egg chamber dug by a female loggerhead turtle. One Tinytag was placed in 27 cm depth, which represented the average sand depth to the top of the egg chamber, and the second one in 47 cm, which represented the average depth to the bottom of the egg chamber (Höfle and Mangold 2009). Each experiment consisted of two "egg-chambers": one without shade represented the control and one with shade (experiment) reflected the simulated anthropogenic influence. The experiments with a towel, an umbrella and litter were located in front of the Infodesk, 6.5 m away from the promenade (distance to the sea approximately 15.7 m), which represents the average nest distance of the year 2009, at Calis (Stachowitsch and Fellhofer 2009). The distance between the nests was 4.7 m. The nest for the experiment with natural flooding was between the Infodesk and the JIM Bar, whereby the distance to the sea was approximately 5 m. The distance between the two nests was 4.7 m. The sun bed experiment was located in front of Cafe Maya. For this experiment the first sun bed from the upper sun bed row was used. Table 1 shows the details of each experiment and nest C2.

Table 1: Information's of all experiments and nest C2

Tabelle 1: Informationen über alle Experimente und Nest C2

Number	Experiment / shade	Factors	Measuring period	Figures
1	towel	Size: 1.4 x 0.7 m	6 days	35-39
2	umbrella	Projected Ø 1.61 m, 1.6 m above sand surface	6 days	40-44
3	litter	3 x 1 L plastic bottles; 4 x 0.33 L aluminium cans; 2 x brown glass bottles; 2 x plastic bags; 2x 1.5 L transparent plastic bottles	6 days	45-49
4	natural flooding	Projected Ø 1.61 m, 1.6 m above sand surface	6 days	50-51
5	sun bed	Size: Length / width / high; 1.86 x 0.71 x 0.31 m	6 days	52-54
C2	Natural nest	Distance from the promenade 4.42 m and to the see 21.3 m; depth of the data logger 0.36 m	34 days	

RESULTS

TOWEL (Experiment 1)

The measurements started on 4 July and ended on 10 July (6 days). During this time each Tinytag recorded 121 values. The two profiles show a similar course with small peak shifts (Fig. 1). The heat storage capacity of the sand is responsible for the circumstance that the maximum temperature value was reached near midnight and the minimum near midday (visible in all experiments). The mean maximum temperature difference between the control and the experiment was 0.9°C. The mean minimum difference was 0.6°C. The absolute maximum temperature difference was reached on 8 July at 19:48, with 1.4°C. The absolute maximum temperature recorded in the control was 32.5°C on 9 July at 22:12 and the absolute minimum value was 29.4°C on 7 July at 11:24. The absolute maximum temperature value in the experiment was 31.3°C reached on 9 July at 23:24, and the absolute minimum temperature was reached on 7 July at 12:36 with 28.8°C.

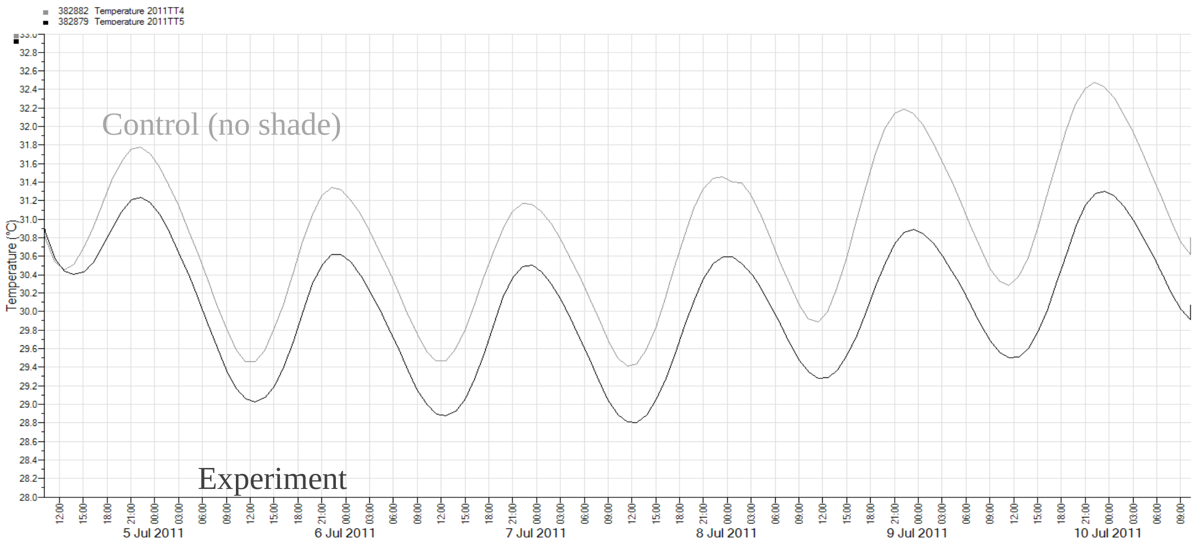

Figure 1: Temperature profile no towel and covered with a towel (27 cm depth)

Abbildung 1: Temperaturverlauf ohne Handtuch und bedeckt mit einem Handtuch in 27 cm Tiefe

At 47 cm depth, the experiment temperature profile shows a sinusoidal shape compared with the control temperature course, which shows flat and sharp peaks, and the shaded values are somewhat lower. The differences between the control and the experiment temperatures, however, are too low to represent a significant temperature decline in 47 cm depth (Fig. 2). Nonetheless, after the second day, the experimental values were consistently below the control. The temperature difference between the mean maximum and the mean minimum temperature was 0.2°C. The absolute maximum temperature difference between the control and the experiment was reached on 9 July at 22:10 with 0.6°C. The absolute maximum temperature value recorded in the control was 29.6°C on 9 July at 06:34 and the absolute minimum was 28.8°C on 07 July at 17:22. The maximum temperature value in the experiment was 29.3°C reached on 10 July at 06:34, the absolute minimum on 7 July at 17:22 (28.5°C). Table 2 summarizes the most important temperatures.

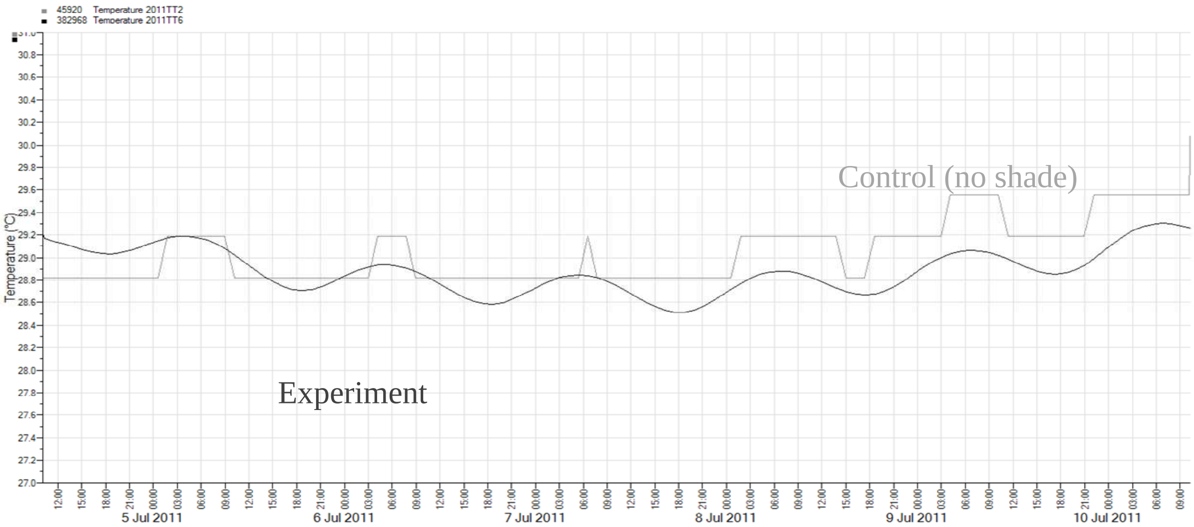

Figure 2: Temperature profile no towel and covered with a towel (47 cm depth)

Abbildung 2: Temperaturverlauf ohne Handtuch und bedeckt mit einem Handtuch in 47 cm Tiefe

Table 2: Mean maximum and minimum temperature values in 27 and 47 cm depth

Tabelle 2: Übersicht der mittleren maximalen und minimalen Temperaturen in 27 und 47 cm Tiefe

Depth / Experiment	27 cm no shade	27 cm shade by a towel	Difference
Mean maximum temperature value	31.7℃ (n=6; σ=0.51)	30.9℃ (n=6; σ=0.35)	0.9℃
Mean minimum temperature value	29.7℃ (n=5; σ=0.38)	29.1℃ (n=5; σ=0.29)	0.6℃
Mean total temperature	**30.8℃ (n=121; σ=0.79)**	**30.1℃ (n=121; σ=0.68)**	**0.9℃**
Depth / Experiment	47 cm no shade	47 cm shade by a towel	Difference
Mean maximum temperature value	29.2℃ (n=6; σ=0.28)	29.0℃ (n=6; σ=0.18)	0.2℃
Mean minimum temperature value	28.9℃ (n=6; σ=0.15)	28.7℃ (n=6; σ=0.19)	0.2℃
Mean total temperature	**29.0℃ (n=121; σ=0.27)**	**28.9℃ (n=121; σ=0.20)**	**0.1℃**

UMBRELLA (Experiment 2)

The measurements started on 11 July and ended on 17 July (6 days). 129 measurements per Tinytag were recorded. The two temperature profiles, show similar amplitudes but the umbrella profile shows earlier maximum peaks compared with the control (Fig. 3). The mean maximum difference between the control and the experiment was 0.5°C. The mean minimum difference was 0.7°C. The absolute maximum difference was reached on 14 July at 09:00, with 1.0°C. The absolute maximum recorded in the control was 32.8 °C on 12 July at 00:36 and the absolute minimum was 31.3°C on 12 July at 13:48. The maximum in the experiment was 32.4°C reached on 11 July at 23:24, and the absolute minimum was on 12 July at 11:24 (30.6°C).

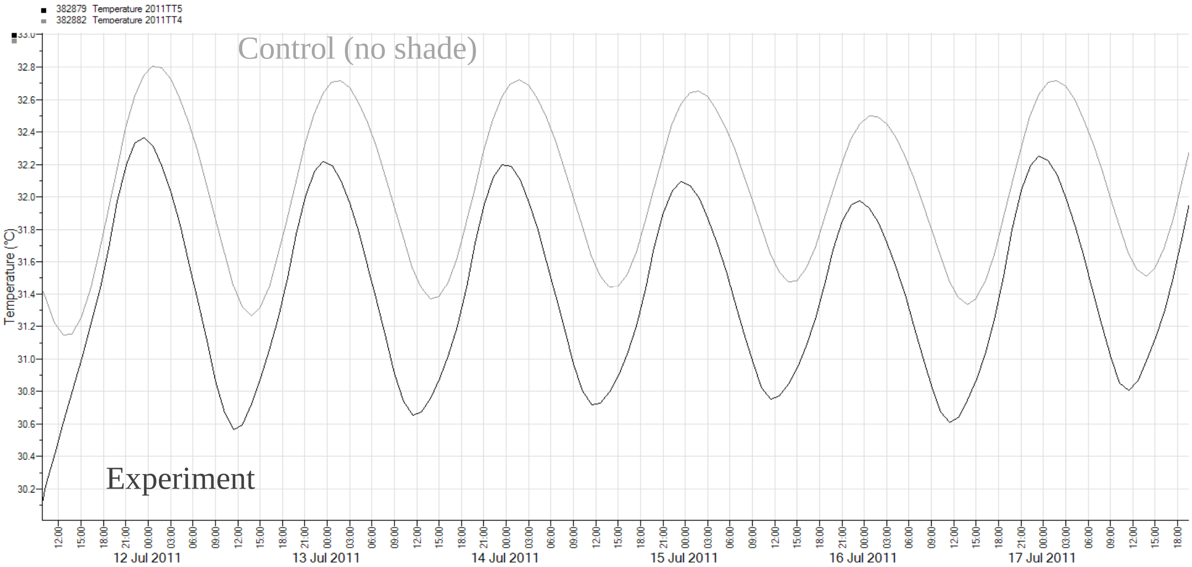

Figure 3: Temperature profile no umbrella and shade by an umbrella (27 cm depth)

Abbildung 3: Temperaturverlauf ohne Sonnenschirm und beschattet durch einen Sonnenschirm in 27 cm Tiefe

The temperature profiles – no shade versus shade by a towel in 47 cm depth – show that the effect of an umbrella lead to a sinusoidal profile compared with a more or less straight temperature course of the control (Fig. 4). Both profiles are close together; the mean maximum temperature difference between the control and the experiment was 0.2°C. Again, the experimental values were almost always below the respective control values. The mean minimum difference was 0.1°C. The absolute maximum temperature difference between control and experiment was reached on 16 July at 13:46 with 0.4°C. The maximum temperature was 30.3°C on 17 July at 06:34 and the absolute minimum was 29.6°C on 11 July at 17:22. The maximum value in the experiment was 30.1°C, reached on 17 July at 06:34, the absolute minimum on 11 July at 17:22 (29.6°C). Table 3 summarizes the most important values.

Figure 4: Temperature profile no umbrella and shade by an umbrella in 47 cm depth

Abbildung 6: Temperaturverlauf ohne Sonnenschirm und beschattet durch einen Sonnenschirm in 47 cm Tiefe

Table 4: Mean maximum and minimum temperatures in 27 and 47 cm depth

Tabelle 3: Übersicht der mittleren maximalen und minimalen Temperaturen in 27 cm und 47 cm Tiefe

Depth / Experiment	27cm no shade	27 cm shade by an umbrella	Difference
Mean maximum temperature value	32.7℃ (n=6; σ=0.10)	32.2℃ (n=6; σ=0.14)	0.5℃
Mean minimum temperature value	31.4℃ (n=6; σ=0.09)	30.7℃ (n=6; σ=0.09)	0.7℃
Mean total temperature	**32.0℃ (n=129; σ=0.48)**	**31.4℃ (n=129; σ=0.54)**	**0.6℃**
Depth / Experiment	47 cm no shade	47 cm shade by an umbrella	Difference
Mean maximum temperature value	30.2℃ (n=6; σ=0.19)	30.0℃ (n=6; σ=0.07)	0.2℃
Mean minimum temperature value	29.9℃ (n=6; σ=0.15)	29.7℃ (n=6; σ=0.09)	0.1℃
Mean total temperature	**30.0℃ (n=129; σ=0.21)**	**29.9℃ (n=129; σ=0.13)**	**0.1℃**

LITTER (Experiment 3)

The measurements started on 18 July and ended on 24 July (6 days), yielding a total of 127 measurements per Tinytag. Both profiles show a similar run but with different maximum and minimum temperatures. A small phase shift is visible between profiles (Fig. 5). The experiment temperature course shows peaks somewhat later than the control. The mean maximum temperature difference between control and experiment was 1.1°C. The mean minimum difference was 0.7 °C. The absolute maximum difference was reached on 18 July at 21:00, with 1.5°C. The absolute maximum temperature value in the control was 34.9°C on 18 July at 22:12 and the absolute minimum value was 31.6°C on 23 July at 12:36. The absolute maximum temperature in the experiment was 32.9°C reached on 18 July at 23:24, the absolute minimum value on 23 July at 13:48 (31.1°C).

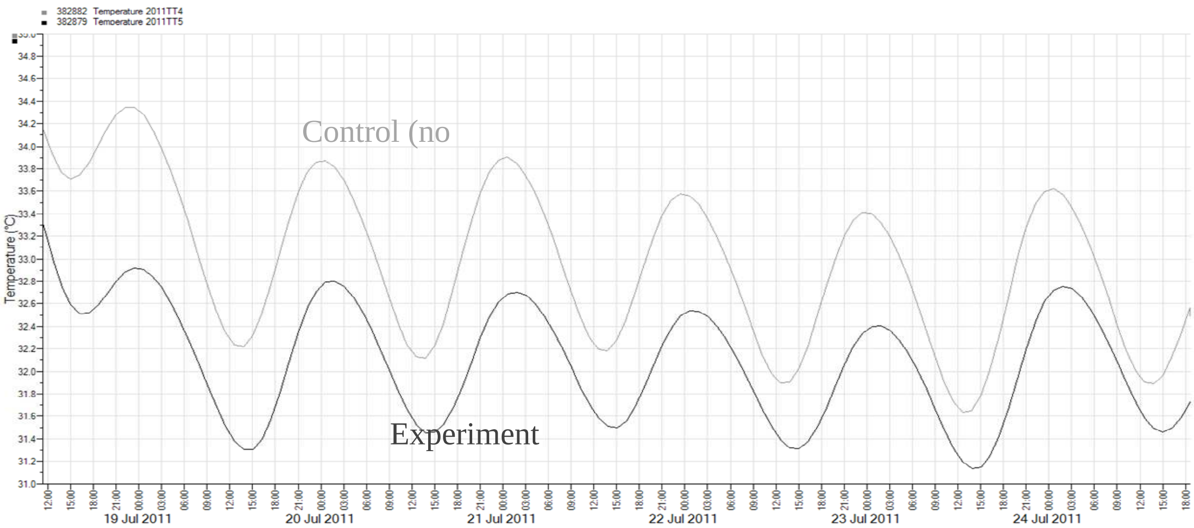

Figure 5: Temperature profile no litter and shade by litter (27 cm depth)

Abbildung 5: Temperaturverlauf ohne Abfall und beschattet durch Abfall in 27 cm Tiefe

In 47 cm depth, the control temperature profile shows jagged amplitudes compared with the sinusoidal profile of the experiment. Both profiles are in phase without a shift of the maximum and minimum peaks. Furthermore, both temperature courses are close together most of the time (Fig. 6). The mean maximum temperature difference between the control and the experiment was 0.2°C and, again, with one brief exception (22 July), the experimental values were all lower than the control. The mean minimum difference was 0.1°C. The absolute maximum difference was reached on 19 July at 13:46, with 0.4°C. The absolute maximum value recorded in the control was 30.7°C on 24 July at 08:58 and the absolute minimum value was 30.3°C on 19 July at 19:46. The maximum recorded temperature in the experiment was 30.6°C reached on 24 July at 08:58, the absolute minimum on 19 July at 19:46 (30.1°C). Table 3 summarizes the most important mean temperatures.

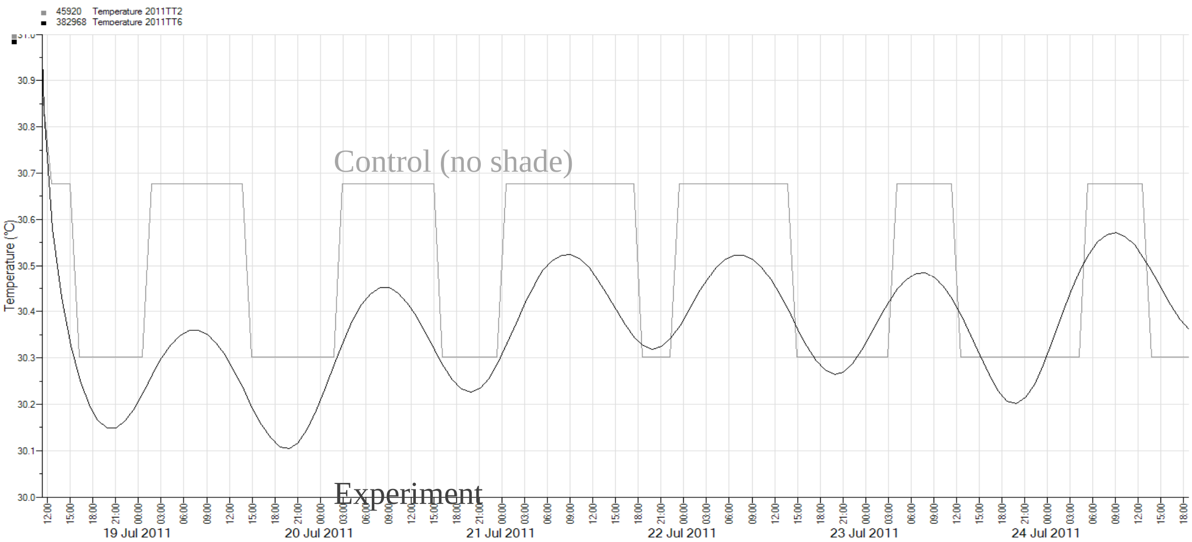

Figure 6: Temperature profile no litter and shade by litter (47 cm depth)

Abbildung 6: Temperaturverlauf ohne Abfall und beschattet durch Abfall in 47 cm Tiefe

Table 3: Mean maximum and minimum temperature values in 27 and 47 cm depth

Tabelle 3: Mittlere maximale und minimale Temperaturwerte in 27 und 47 cm Tiefe

Depth / Experiment	27cm no shade	27 cm shade by litter	Difference
Mean maximum temperature value	33.8℃ (n=6; σ=0.33)	32.7℃ (n=6; σ=0.19)	1.1℃
Mean minimum temperature value	32.3℃ (n=7; σ=0.67)	31.5℃ (n=7; σ=0.45)	0.7℃
Mean total temperature	**33.0℃ (n=127; σ=0.71)**	**32.1℃ (n=127; σ=0.52)**	**0.9℃**
Depth / Experiment	47 cm no shade	47 cm shade by litter	Difference
Mean maximum temperature value	30.7℃ (n=6; σ=0.00)	30.5℃ (n=6; σ=0.07)	0.2℃
Mean minimum temperature value	30.3℃ (n=6; σ=0.00)	30.2℃ (n=6; σ=0.08)	0.1℃
Mean total temperature	**30.5℃ (n=127; σ=0.19)**	**30.4℃ (n=127; σ=0.13)**	**0.1℃**

NATURAL FLOODING (Experiment 4)

The experiment with and without the influence of natural tide flooding in 27 cm depth started on 26 July and ended on 2 August (6 days). The control temperature shows a jagged course compared with a more sinusoidal course of the experiment. The profile in the control is flat in contrast with a smoother course in the experiment (Fig 7). The mean maximum temperature difference between control and experiment was 1.6°C. At no time were experimental values higher than the control. The mean minimum was 0.7°C. The absolute maximum difference was reached on 28 July at 21:02, with 2.1°C. The absolute maximum value recorded in the control was 33.3°C on 29 July at 22:14, and the absolute minimum was 29.9°C on 28 July at 10:14. The absolute temperature value in the experiment was 31.9°C reached on 29 July at 22:14, and the absolute minimum on 28 July at 10:14 (29.3°C).

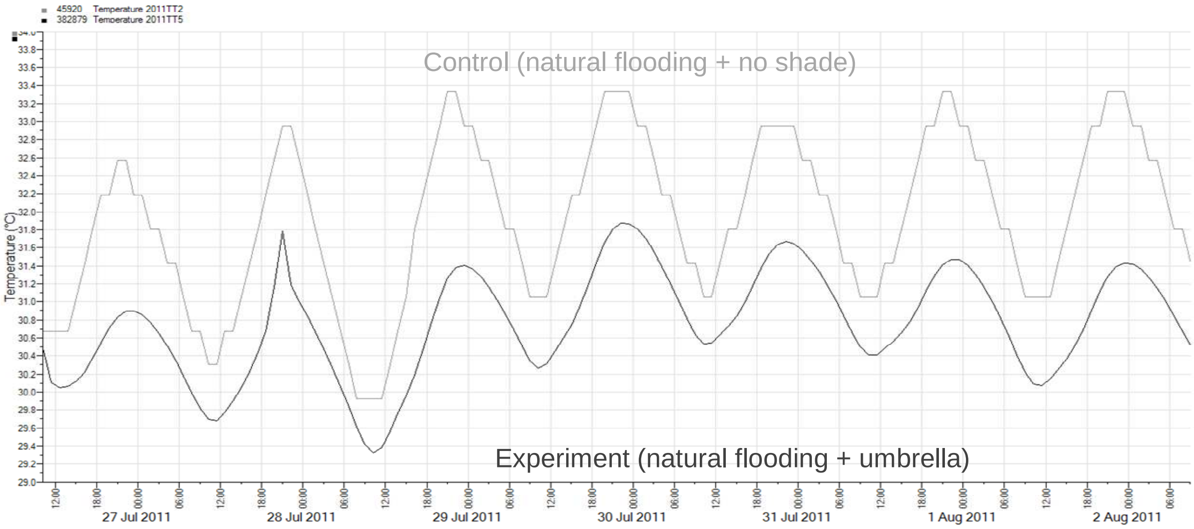

Figure 7: Temperature profile flooding no shade and flooding with shade by an umbrella (27 cm depth)

Abbildung 7: Temperaturverlauf mit Gezeitenflutung ohne Sonnenschirm und Gezeitenflutung beschattet durch einen Sonnenschirm in 27 cm Tiefe

The temperature measurements in 47 cm with the influence of natural flooding show that both curves have a similar course with a very small phase shift. The control temperatures were always higher than in the experiment. There is an outlier from the 27 to 28 July (Fig. 8). The mean maximum and the mean minimum temperature difference between the control and the experiment was 1.0°C. The absolute maximum difference was reached on 2 August at 03:02 (1.4°C). The absolute maximum of the control was 31.6 °C on 30 July at 04:14, the absolute minimum 30.4°C on 27 July at 16:14. The maximum in the experiment was 30.9°C on 27 July at 22:14, the absolute minimum on 27 July at 16:14 (29.4°C). Table 4 shows the key mean temperature values.

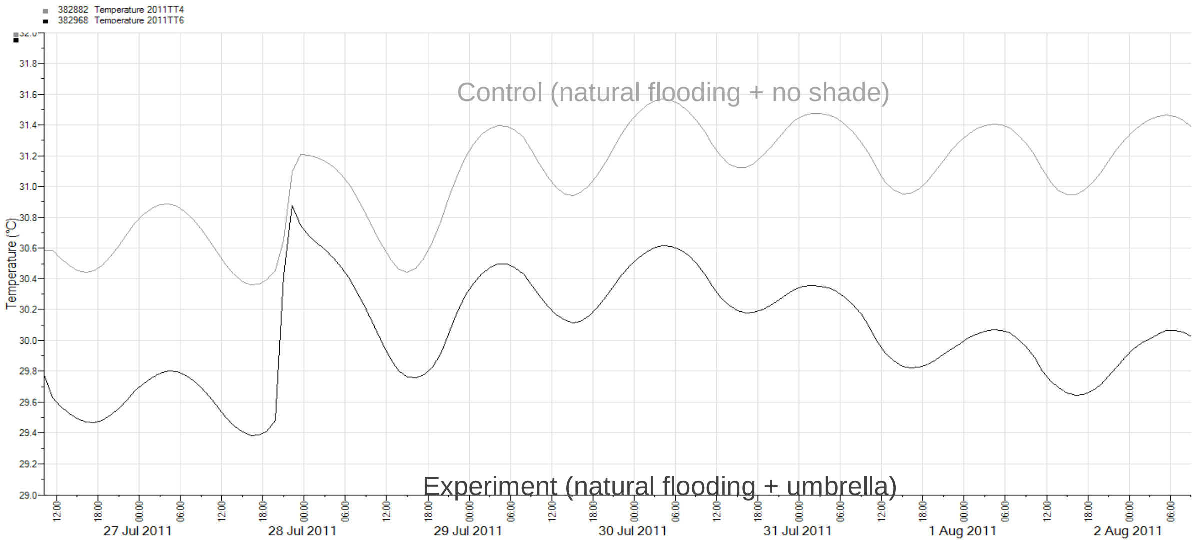

Figure 8: Temperature profile flooding no shade and flooding with shade by an umbrella in 47 cm depth

Abbildung 8: Temperaturverlauf mit Gezeitenflutung ohne Sonnenschirm und Gezeitenflutung beschattet durch einen Sonnenschirm in 47 cm Tiefe

Table 4: Mean maximum and minimum temperature values in 27 and 47 cm depth

Tabelle 4: Mittlere maximale und minimale Temperaturwerte in 27 und 47 cm Tiefe

Depth / Experiment	27cm no shade + natural flooding	27 cm shade by an umbrella + natural flooding	Difference
Mean maximum temperature value	33.1℃ (n=7; σ=0.30)	31.5℃ (n=7; σ=0.32)	1.6℃
Mean minimum temperature value	30.7℃ (n=76 σ=0.50)	30.0℃ (n=6; σ=0.46)	0.7℃
Mean total temperature	**31.9℃ (n=140; σ=0.90)**	**30.8℃ (n=140; σ=0.59)**	**1.1℃**
Depth / Experiment	47cm no shade + natural flooding	47 cm shade by an umbrella + natural flooding	Difference
Mean maximum temperature value	31.3℃ (n=7; σ=0.23)	30.3℃ (n=7; σ=0.37)	1.0℃
Mean minimum temperature value	30.7℃ (n=7; σ=0.31)	29.8℃ (n=7; σ=0.30)	1.0℃
Mean total temperature	**31.1℃ (n=140; σ=0.34)**	**30.0℃ (n=140; σ=0.35)**	**1.1℃**

SUNBED (Experiment 5)

This experiment started on 4 August and ended on 10 August (6 days). 120 measurements per Tinytag were recorded. The values from the control exhibit a jagged course with flat maximum temperature profile. The data from 27 cm with sun bed shade show a more uniform, sinusoidal course. Both profiles show a similar trend (Fig. 9). The mean maximum temperature difference between the control and the experiment was 1.7°C. The mean minimum difference was 1.0°C. The absolute maximum temperature difference was reached on 8 August at 21:12 (1.9°C). The absolute maximum value in the control was 33.3°C on 4 August at 23:36, the absolute minimum 31.4°C on 9 August at 12:48. The absolute maximum value in the experiment was 31.7°C, reached on 4 August 23:36, and the absolute minimum on 9 August at 12:48 (30.4°C).

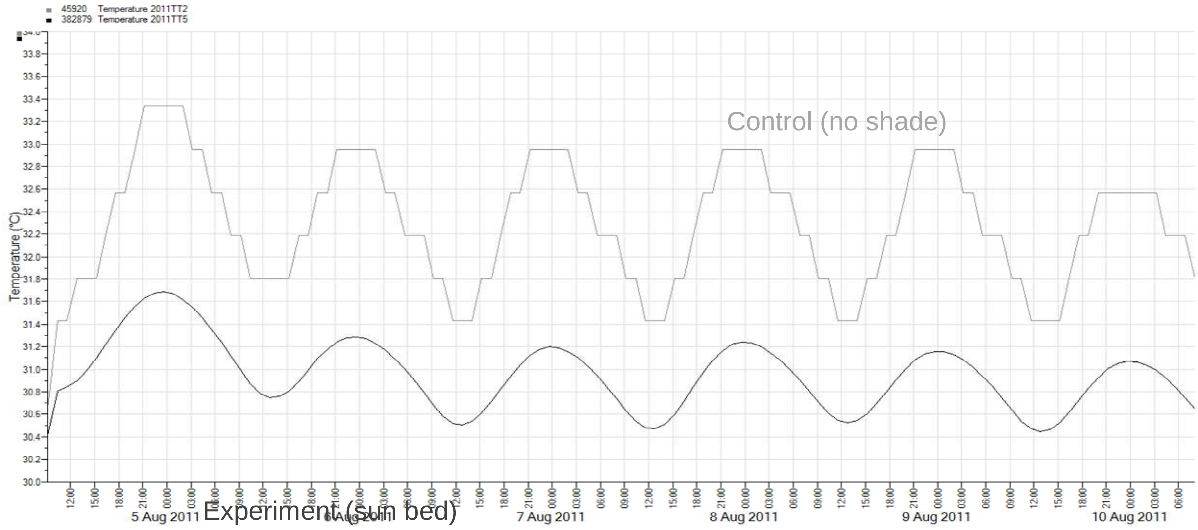

Figure 9: Temperature profile no sun bed and shade by a sun bed (27 cm depth)

Abbildung 9: Temperaturverlauf ohne Sonnenliege und beschattet durch eine Sonnenliege in 27 cm Tiefe

The temperature profile from the control without shade and the experiment with the influence of shade by a sun bed in 47 cm depth show that both temperature curves have a very similar profile. The control shows higher amplitudes than the experiment (Fig. 10). The mean maximum temperature difference between the control and the experiment was 0.8°C. The mean minimum was 0.7°C. The absolute maximum difference was reached on 5 August at 05:36 (0.9°C). The absolute maximum value in the control was 31.4°C on 5 August at 05:36, the absolute minimum 30.9°C on 9 August at 18:48. The absolute maximum value in the experiment was 30.5°C reached on 5 August at 05:36, and the absolute minimum on 9 August at 18:48 (30.2°C). Table 5 summarizes the most important mean temperatures.

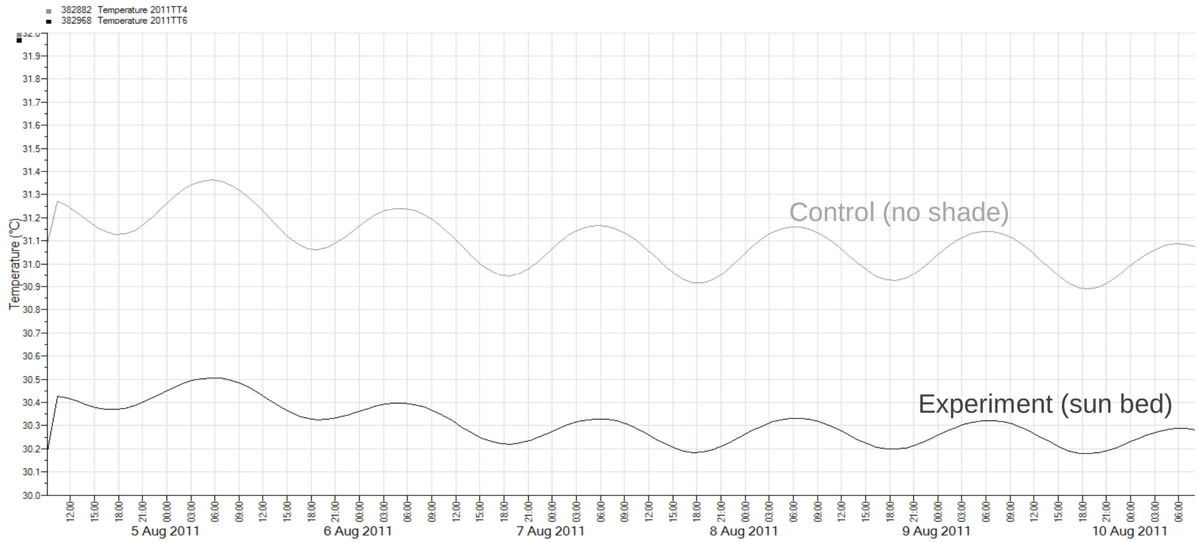

Figure 10: Temperature profile no sun bed and shade by a sun bed (47 cm depth)

Abbildung 10: Temperaturverlauf ohne Sonnenliege und beschattet durch eine Sonnenliege in 47 cm Tiefe

Table 5: Mean maximum and minimum temperature values in 27 and 47 cm depth

Tabelle 5: Mittlere maximale und minimale Temperaturwerte in 27 und 47 cm Tiefe

Depth / Experiment	27cm no shade	27 cm shade by sun bed	Difference
Mean maximum temperature value	33.0°C (n=6; σ=0.24)	31.3°C (n=6; σ=0.22)	1.7°C
Mean minimum temperature value	31.5°C (n=5; σ=0.17)	30.5°C (n=5; σ=0.12)	1.0°C
Mean total temperature	**32.3°C (n=120; σ=0.55)**	**31.0°C (n=120; σ=0.30)**	**1.3°C**
Depth / Experiment	47cm no shade	47 cm shade by sun bed	Difference
Mean maximum temperature value	31.2°C (n=6; σ=0.10)	30.4°C (n=6; σ=0.08)	0.8°C
Mean minimum temperature value	31.0°C (n=6; σ=0.09)	30.2°C (n=6; σ=0.08)	0.7°C
Mean total temperature	**31.1°C (n=120; σ=0.12)**	**30.3°C (n=120; σ=0.08)**	**0.8°C**

OVERVIEW (Egg-chambers "CONTROL" and Egg-chambers "EXPERIMENT")

TOWEL (Egg-chamber "CONTROL")

The temperatures in 47 cm are always lower than in 27 cm. Furthermore, the minimum values in 27 cm are always higher than the maxima in 47 cm depth. There is a noticeable phase shift between the two profiles. This effect could be explained by the heat storage capacity of the sand (Fig. 11). The absolute maximum temperature difference between 27 and 47 cm depth was reached on 9 July (3.2°C). The mean maximum difference between the two temperature profiles was 2.7°C. The mean minimum difference was 0.8°C.

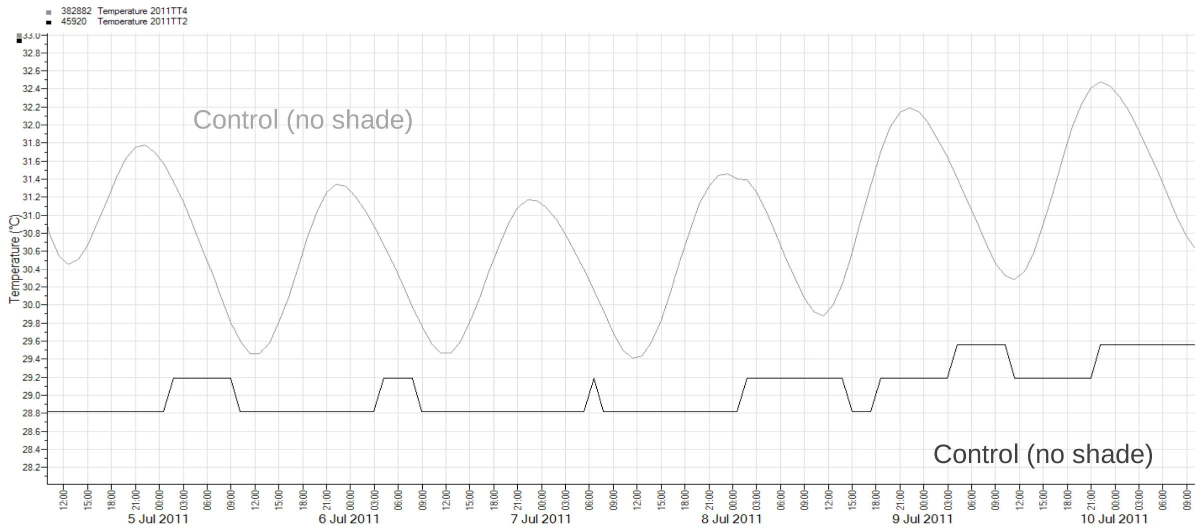

Figure 11: Temperature profile from the control (no shade) in 27 and 47 cm depth

Abbildung 11: Temperaturverlauf der Kontrolle (keine Beschattung) in 27 und 47 cm Tiefe

TOWEL (Egg-chamber "EXPERIMENT")

The 27 cm temperature profile shows higher amplitudes than the 47 cm profile. The two temperature courses are out of phase. Both curves show a similar trend but different amplitudes (Fig. 12). The absolute maximum difference between 27 and 47 cm depth was reached on 9 July at 22:12 with 2.3°C. The mean maximum difference was 1.8°C. The mean minimum difference was 0.6°C.

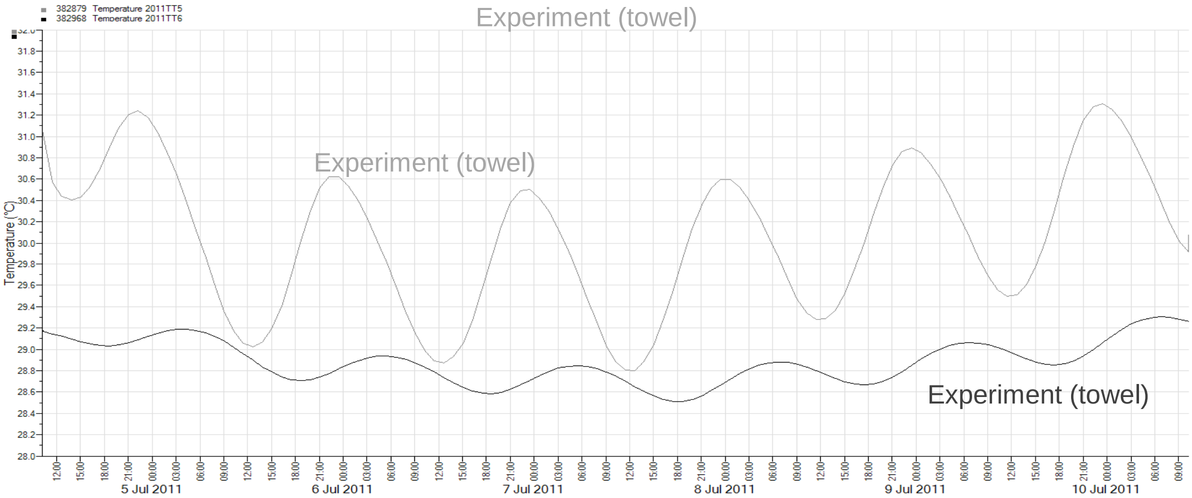

Figure 12: Temperature profile from the experiment (towel) in 27 and 47 cm depth

Abbildung 12: Temperaturverlauf des Experiments (Handtuch in 27 und 47 cm Tiefe

UMBRELLA (Egg-chamber „CONTROL“)

The profile in 27 cm shows higher amplitudes than at 47 cm. The minimum value at 27 cm was at always higher than the maximum at 47 cm (Fig. 13). The absolute maximum temperature difference between the two depths was 2.9°C on 12 July. The mean maximum difference was 2.5°C, the mean minimum difference was 1.4°C.

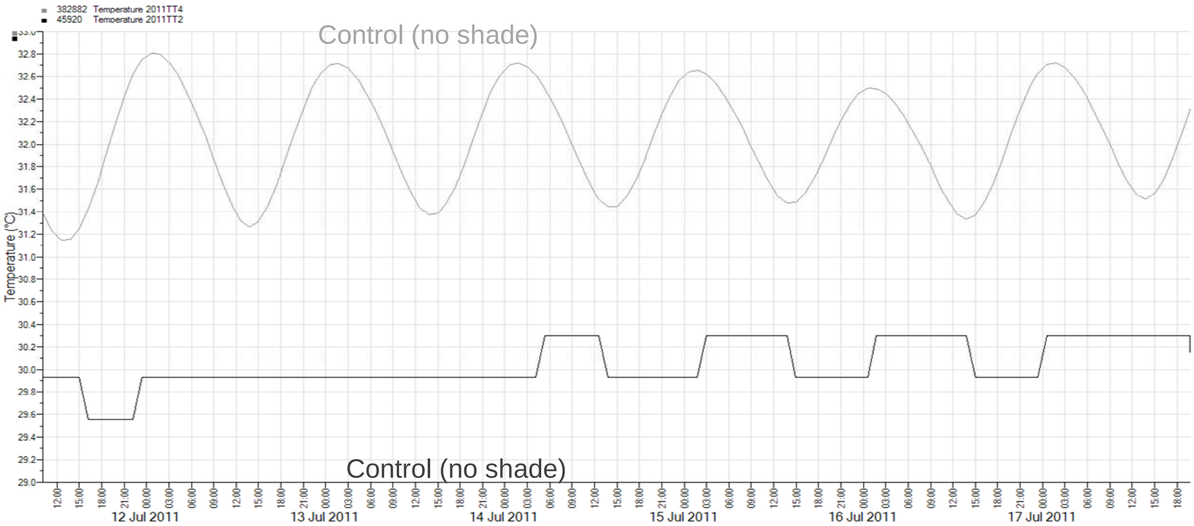

Figure 13: Temperature profile from the control (no shade) in 27 and 47 cm depth

Abbildung 13: Temperaturverlauf der Kontrolle (keine Beschattung) in 27 und 47 cm Tiefe

UMBRELLA (Egg-chamber "EXPERIMENT")

The temperature measurements from the experiment (shade by an umbrella) in 27 and 47 cm depth show an evident phase shift between both depths (Fig. 14). The absolute mean maximum temperature difference was 2.6°C recorded on 11 July. The mean maximum difference between was 2.2°C, the mean minimum difference was 0.9°C.

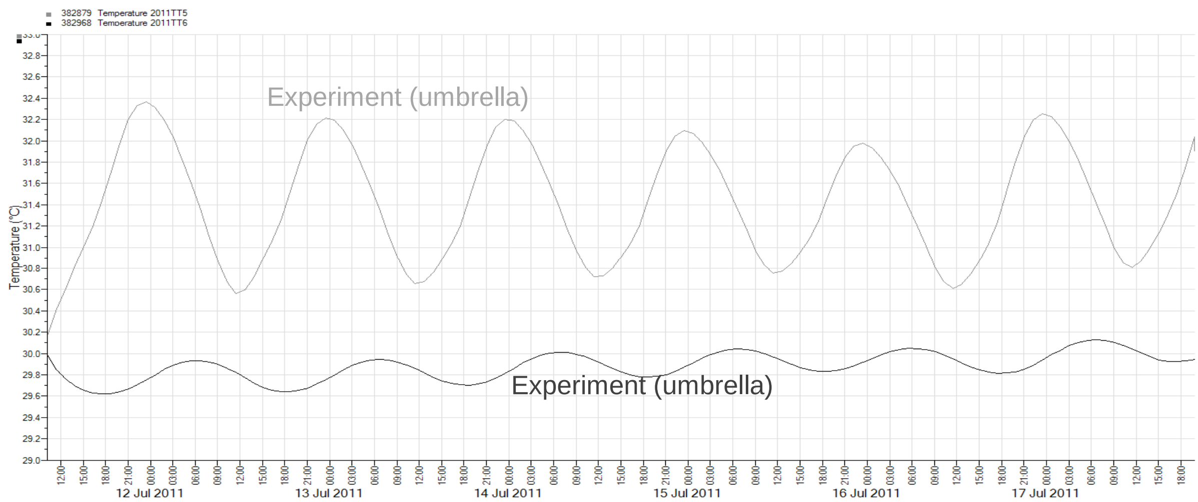

Figure 14: Temperature profile from the experiment (umbrella) in 27 and 47 cm depth

Abbildung 14: Temperaturverlauf des Experiments (Sonnenschirm) in 27 und 47 cm Tiefe

LITTER (Egg-chamber "CONTROL")

The amplitudes are higher in 27 cm than 47cm. The temperature difference in 27 cm is, compared with the towel experiment (Fig. 11), in the first third higher than in 47 cm. The smooth profile in 47 cm could be explained by the buffer effect of the sand (Fig. 15). The 47 cm profile is shifted compared to the 27 cm course. This effect is explained in the towel experiment. The absolute maximum temperature difference between both depths was recorded on 18 July at 22:12, with 4.0°C. The mean maximum difference was 3.1°C, the mean minimum was 2.0°C.

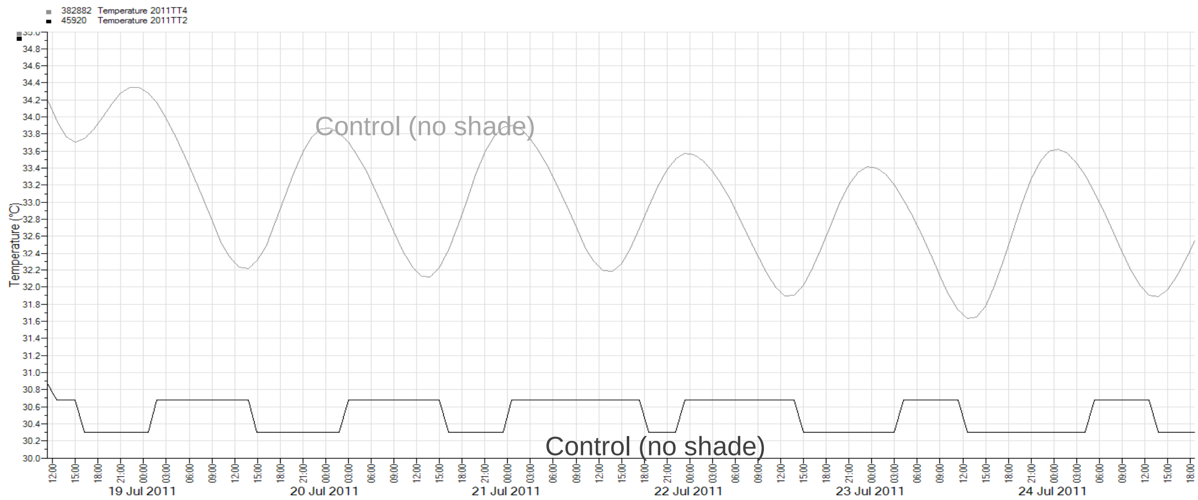

Figure 15: Temperature profile from the control (no shade) in 27 and 47 cm depth

Abbildung 15: Temperaturverlauf der Kontrolle (kein Schatten) in 27 und 47 cm Tiefe

LITTER (Egg-chamber „EXPERIMENT“)

Both temperature profiles are sinusoidal. The 47 cm profile shows a phase shift compared with 27 cm (Fig. 16). This could be explained by the heat storage capacity of the sand. The maximum value at 47 cm was always lower than the minimum at 27 cm. The absolute maximum temperature difference between both depths was recorded on 18 July at 22:12, with 2.7°C. The mean maximum difference was 2.2°C, the mean minimum difference 1.3°C.

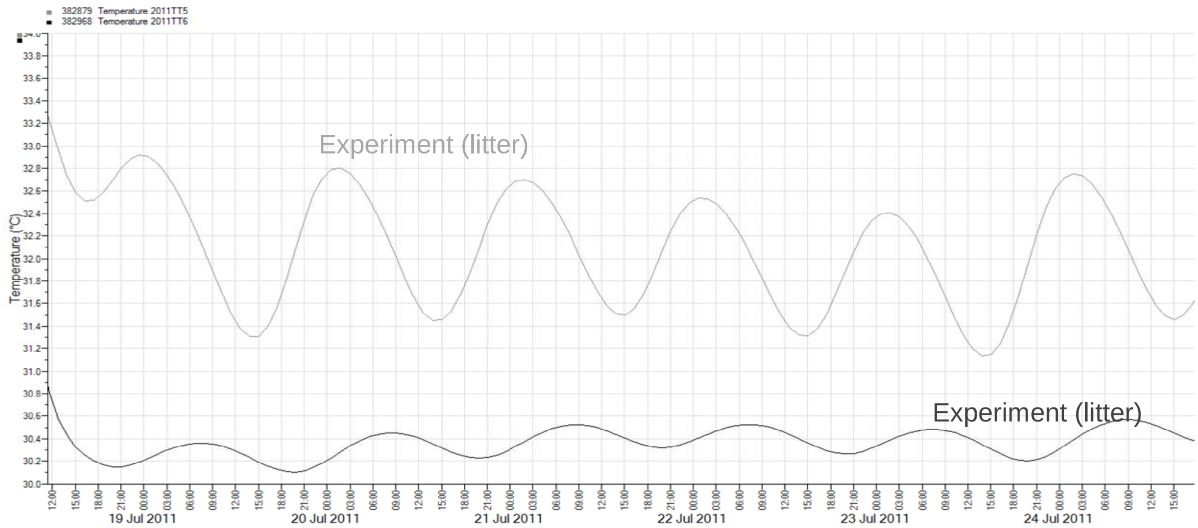

Figure 16: Temperature profile from the experiment (litter) in 27 and 47 cm depth

Abbildung 16: Temperaturverlauf des Experiments (Abfall) in 27 und 47 cm Tiefe

FLOODING (Egg-chamber „CONTROL“)

The values at 27 cm show high amplitudes with sharp peaks. A different temperature course is evident in 47 cm depth: lower amplitudes and a more sinusoidal profile. Furthermore, both profiles overlapped during the whole test period (Fig. 17). The minimum values in 27 cm are sometimes under the minimum temperatures in 47 cm. Furthermore, a phase-shift between both profiles is visible. The absolute maximum difference between both depths was recorded on 28 July at 21:02 (2.4°C). The mean maximum difference was 1.8°C. No mean minimum difference was measureable.

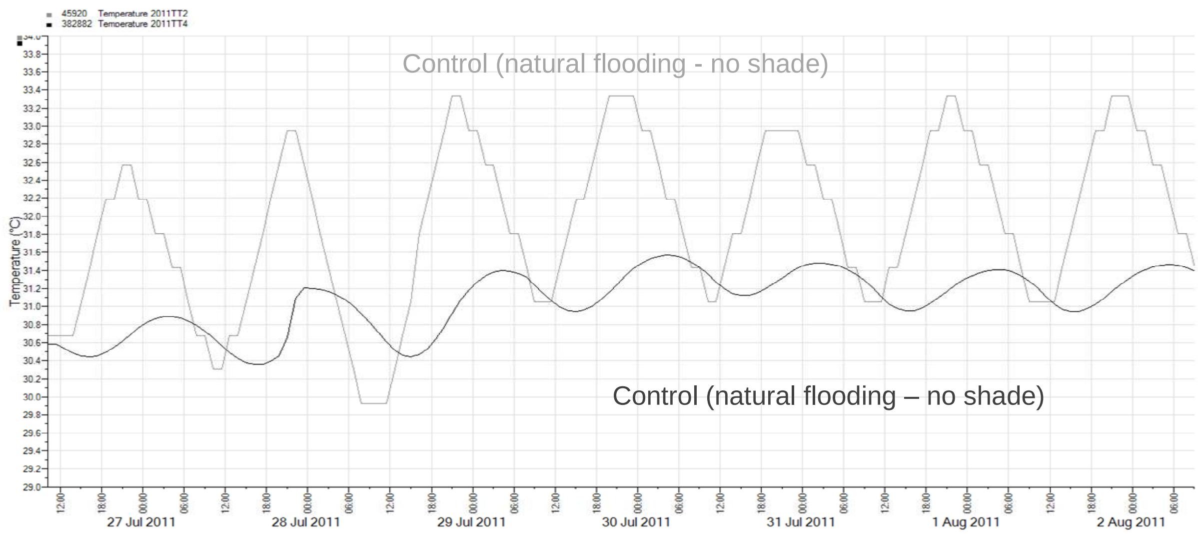

Figure 17: Temperature profile from the control (flooding - no shade) in 27 and 47 cm depth

Abbildung 17: Temperaturverlauf der Kontrolle (Gezeitenflutung - kein Schatten) in 27 und 47 cm Tiefe

FLOODING (Egg-chamber “EXPERIMENT”)

The profile in 27 cm shows higher amplitudes than in 47 cm. Both lines show a similar trend but a relative big phase shift is visible (Fig. 18). The absolute maximum temperature difference between the two depths was 1.7°C on 27 July. The mean maximum was 1.2°C, the mean minimum difference 0.3°C.

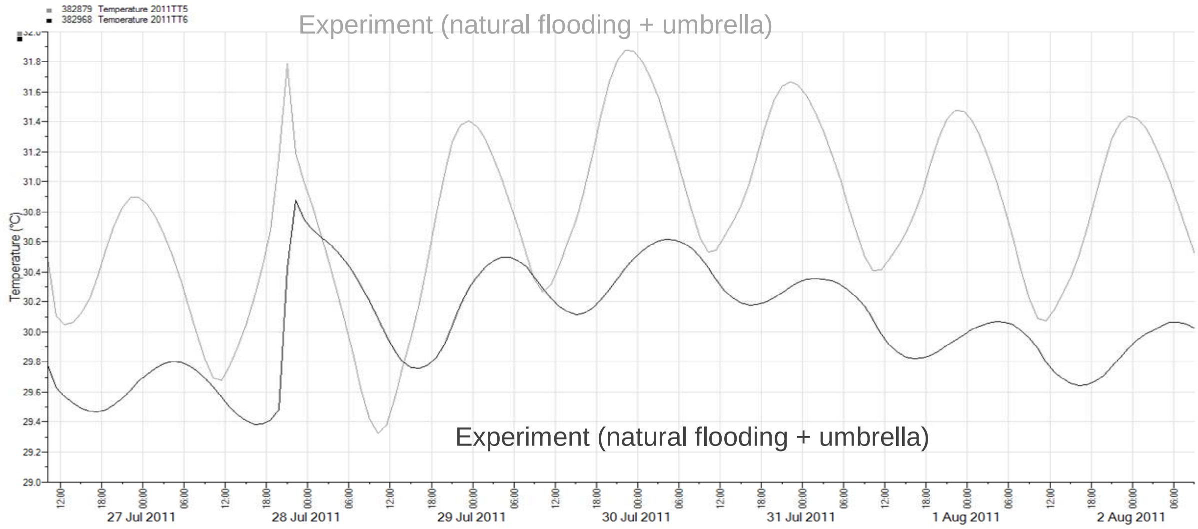

Figure 18: Temperature profile from the experiment (flooding with shade by an umbrella) in 27 and 47 cm depth

Abbildung 18: Temperaturverlauf der Kontrolle (Gezeitenflutung mit Beschattung durch einen Sonnenschirm) in 27 und 47 cm Tiefe

SUN BED (Egg-chamber„CONTROL“)

An overview between the temperature profiles in 27 and 47 cm depth (Fig. 19). The mean maximum temperature difference between the two depths was 1.8°C. The mean minimum was 0.5°C. The absolute maximum difference was recorded on 4 August at 21:12 (2.2°C).

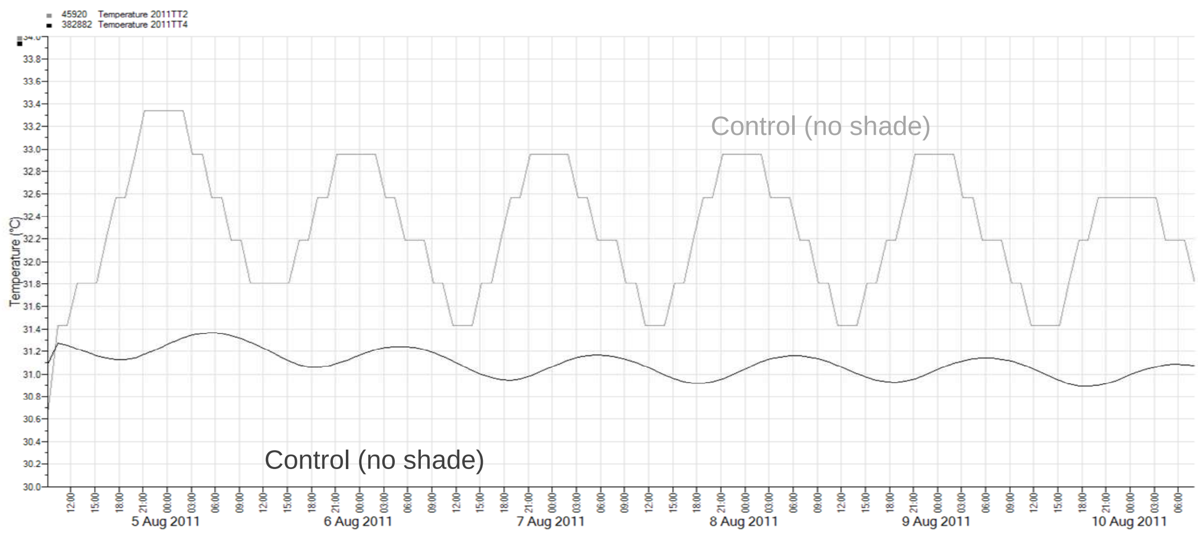

Figure 19: Temperature profile from the control (no shade) in 27 and 47 cm depth

Abbildung 19: Temperaturverlauf der Kontrolle (kein Schatten) in 27 und 47 cm Tiefe

SUN BED (Egg-chamber „EXPERIMENT“)

Figure 20 presents an overview of the experiment values with influence of shade by a sun shade. The mean maximum temperature difference between the two depths was 0.9°C. The mean minimum was 0.3°C. The absolute maximum difference was recorded on 4 August at 22:24 (1.3°C).

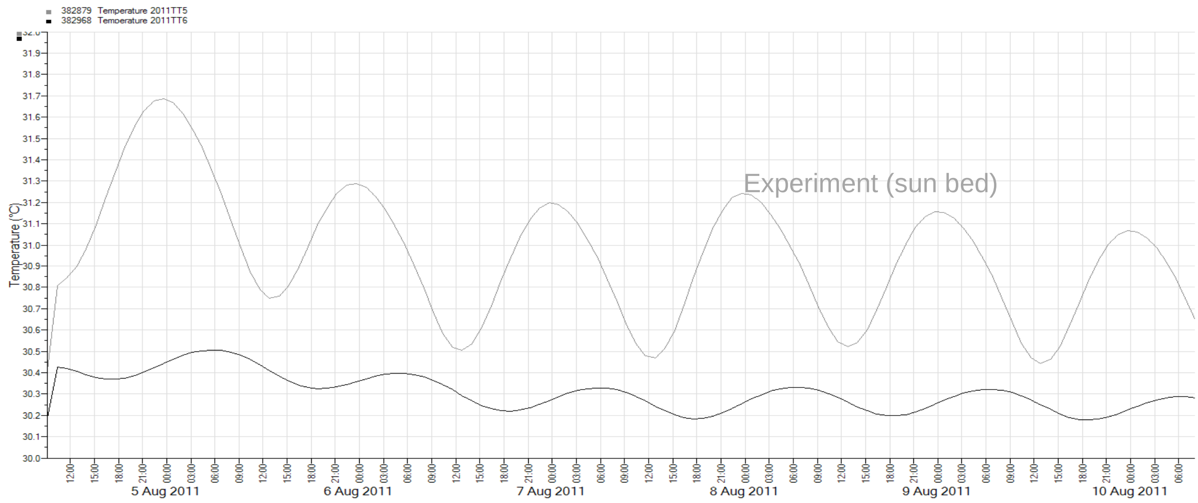

Figure 20: Temperature profile from the experiment (sun bed) in 27 and 47 cm depth

Abbildung 20: Temperaturverlauf des Experiments (Sonnenliege) in 27 und 47 cm Tiefe

MEASUREMENTS NEST C2

The nest was found on 4 July by team members. The Tinytag was placed in the nest in 36 cm depth, on 23 July at 08:50, and stayed there until the excavation, on 24 August at 06:26 (Fig. 21). The data logger was placed 19 days after the nest was found because of technical problems with the device. During this time, 640 temperature values were recorded. The mean overall temperature was 32.2°C (n=640, σ=0.52). The mean maximum 32.7°C (n=32, σ=0.43), the mean minimum 31.8°C (n=32, σ=0.44), and the mean difference = 0.9°C. The absolute maximum value (33.3°C) was reached on 28 July at 23:34, the absolute minimum (30.6°C) on 22 August at 11:34. Furthermore, a relative sharp temperature decline was visible on 14 August, lasting until the excavation. Table 6 summarizes the key values.

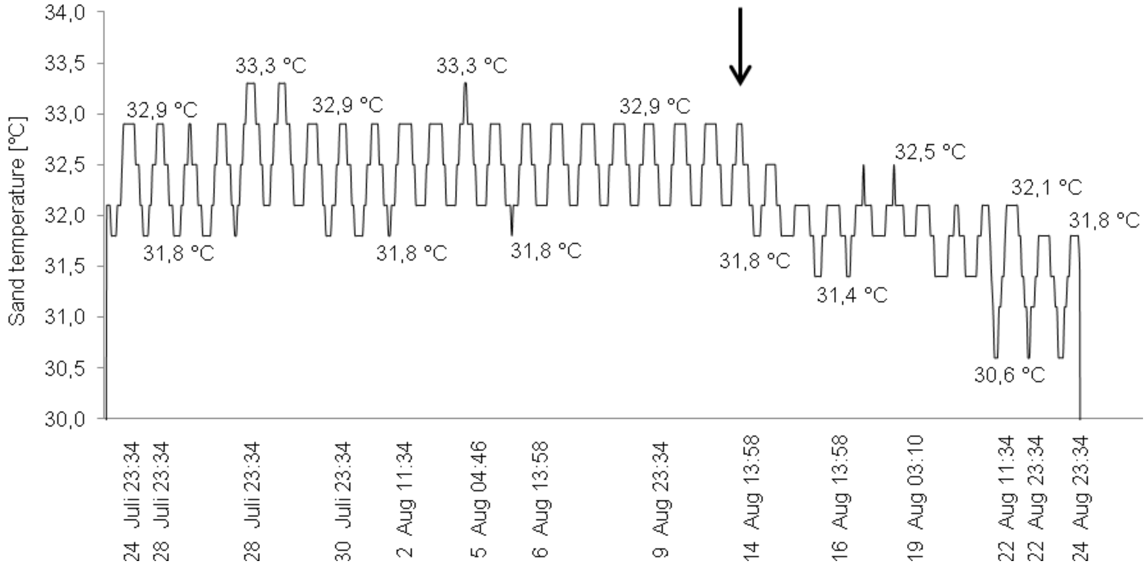

Figure 21: Temperature profile of Tinytag I from the nest C2

Abbildung 21: Temperaturverlauf von Tinytag I im Nest C2

Table 6: Overview of temperature measurements recorded in nest C2

Tabelle. 6: Übersicht der Messwerte, aufgezeichnet im Nest C2

	Mean total temperature	Mean maximum temperature	Mean minimum temperature	Difference max. / min.	Maximum temperature value	Minimum temperature value
Temperature	32.2 °C	32.7 °C	31.8 °C	0.9 °C	33.3 °C	30.6 °C
Standard deviation (σ)	0.52	0.43	0.44	x	x	x
No. of measurements (n)	640	32	32	x	1	1

AIR TEMPERATURE

The air temperature profile from 3 July until 25 August at Calis beach is shown in Figure 22. The mean minimum air temperature, which was measured at 06:00 every day, was 24.4°C (n=51, σ=1.97). The mean maximum air temperature was measured at 12:00, with 43.5°C (n=32, σ=2.59), and the air temperature at 22:00 was 28.6°C (n=50, σ=1.63). The mean overall air temperature was 30.7°C (n=134, σ=7.92). The highest recorded value at 06:00 was reached on 13 July with 29.4°C. On the 20 July at 12:00, the highest temperature (47.9°C) was measured, and on 27 July at 22:00 the highest nighttime value of 31.6°C was measured. The mean daily temperature fluctuation was 19.1°C.

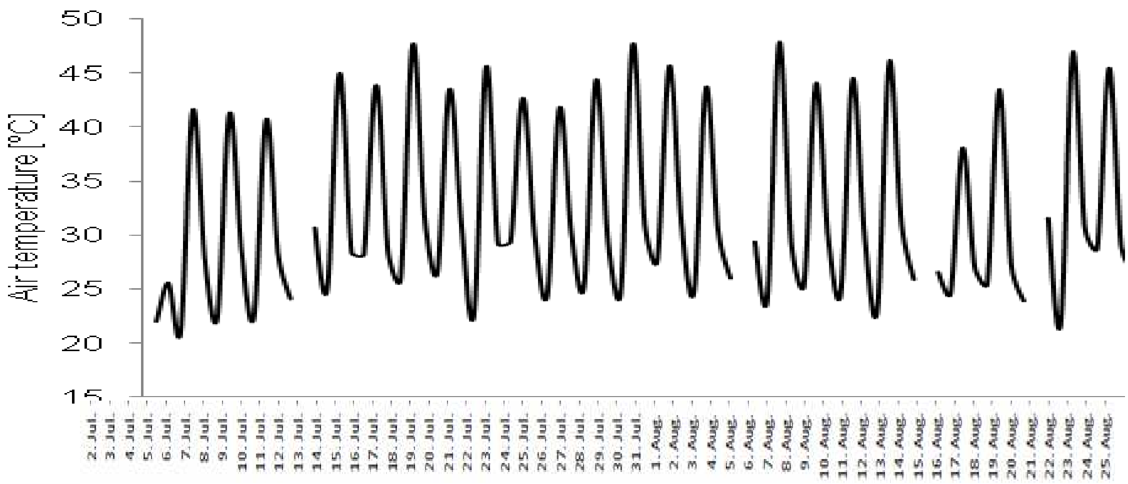

Figure 22: Overview of the air temperature at Calis beach, Turkey, summer 2011

Abbildung 22: Lufttemperaturverlauf am Strand von Calis, Türkei, Sommer 2011

The exact position of the weather station FETH is 36°63´´ North and 29°12´´ East. The weather station is about 3 m above the sea level. Figure 23 shows the maximum, minimum and the mean air temperature profiles. The maximum mean temperature from 29 June until 30 August was 35.9°C (n=63, σ=2.58). The mean minimum temperature was 22.9 °C (n=63; σ=1.57). The overall mean air temperature was 29.3 °C (n=63; σ=1.76).

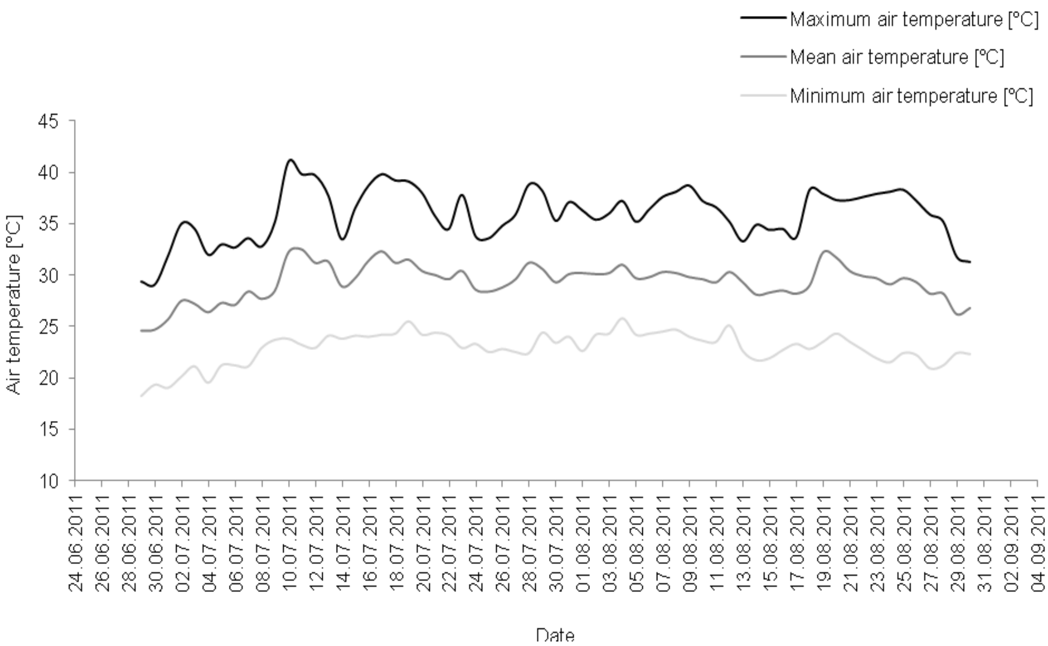

Figure 23: Air temperature profile, Fethiye weather station (FETH), Turkey, summer 2011

Abbildung 23: Lufttemperaturverlauf, Wetterstation in Fethiye (FETH), Türkei, Sommer 2011

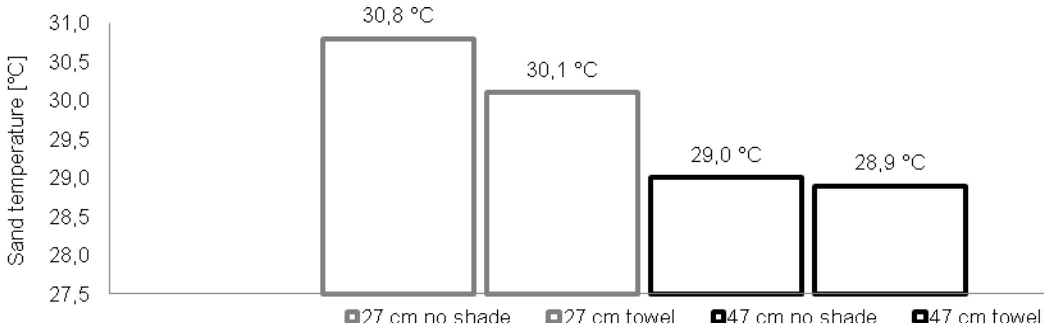

Figure 24: Mean sand temperature in towel experiment (1), 27 cm and 47 cm depth

Abbildung 24: Mittlere Sandtemperatur im Handtuch-Experiment (1), in 27 cm und 47 cm Tiefe

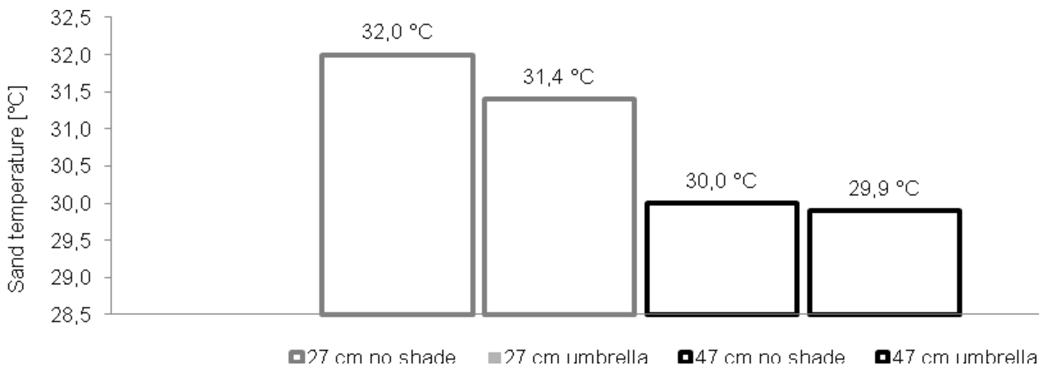

Figure 25: Mean sand temperature in umbrella experiment (2), 27 cm and 47 cm depth

Abbildung 25: Mittler Sandtemperatur im Sonnenschirm-Experiment (2), in 27cm und 47cm Tiefe

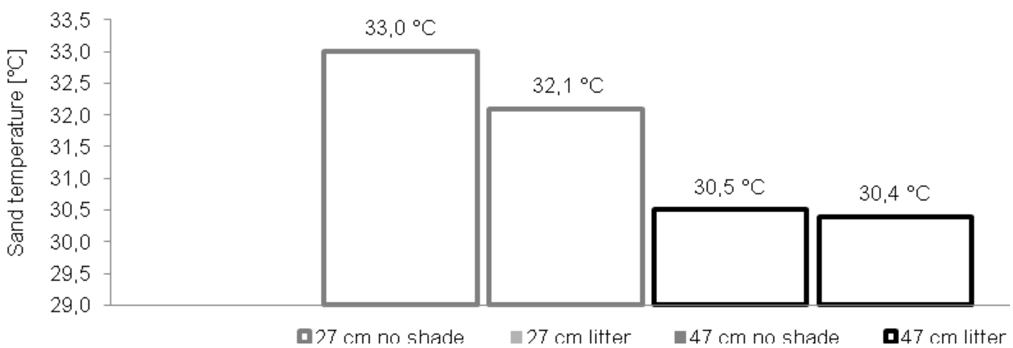

Figure 26: Mean sand temperature in litter experiment (3), 27 cm and 47 cm depth

Abbildung 26: Mittlere Sandtemperatur im Abfall-Experiment (3), in 27 cm und 47 cm Tiefe

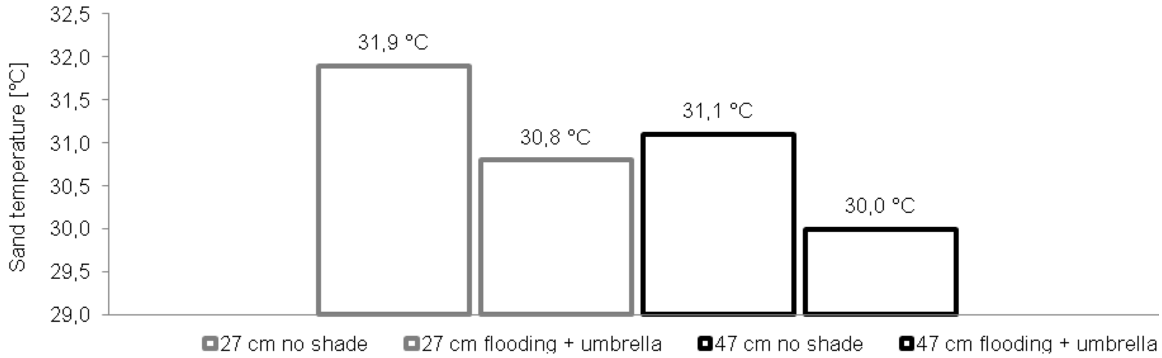

Figure 27: Mean sand temperature in flooding experiment (4), in 27 cm and 47 cm depth

Abbildung 27: Mittlere Sandtemperatur im Gezeiten-Experiment (4), in 27 cm und 47 cm Tiefe

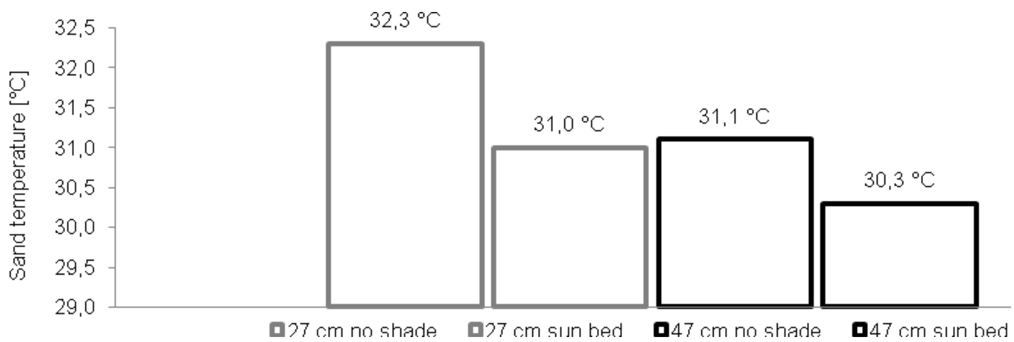

Figure 28: Mean sand temperature in sun bed experiment (5), in 27 cm and 47 cm depth

Abbildung 28: Mittlere Sandtemperatur im Sonnenliegen-Experiment (5), in 27 cm und 47 cm Tiefe

DISCUSSION

The temperature profiles in 27 cm depth are very similar in the experiments with towel, umbrella and the litter (Figs. 1, 3, 5). The towel (Exp. 1) leads to a temperature reduction of 0.7°C (Fig. 24) but does not alter the temperature course. The umbrella (Exp. 2) leads to a decline of 0.6°C (Fig. 25) and also shows a temperature course shift: the temperature peaks were reached earlier compared with the control (no shade) (Fig. 3). The litter (Exp. 3) (Fig. 5) showed the highest decline (0.9°C) and an even longer peak shift (Fig. 26). According to Mrosovsky et al. (1980), even a change of 1 to 2 °C can make a considerable difference to the sex ratio of the hatchlings. Experiments 1, 2 and 3 have a measurable effect, and although the mean temperature difference is less than the 1°C given by Mrosovsky, the highest recorded differences were within this range. Specifically, the highest values were 1.4°C in Experiment 1, 1.0°C in Exp. 2 and 1.1°C in Exp. 3. Thus, the influence of the shading is not negligible at a sand depth of 27 cm.

All three items - towel, umbrella and litter - also changed the temperature profile in 47 cm, from a more or less jagged to a more sinusoidal course (Fig. 2, 4, 6). According to Georges (1994), widely fluctuating temperatures lead to more females than do more stable temperatures. Thus, all three items affect the temperature courses in both the shallow and deeper sand layers, and could affect the sex ratio. It remains unclear whether the temperature decline of 0.1°C alone, recorded at 47 cm is high enough to shift the sex ratio significantly.

According to Mrosovsky (1994), the pivotal temperatures of loggerhead turtles cluster within one degree of 29°C. Wibbels (2003) defines the transitional range of temperature (TRT) as the range of temperature in which sex ratio shifts from 100% male to 100% female. General ranges for the lower limits are approximately 26.0 to 27.75°C and upper limits are approximately 29.75 to 32°C. Experiment 1 (towel) ranges from 28.9-30.1°C. Experiment 2 (umbrella) ranges from 29.9-31.4°C and experiment 3 (litter) from 30.4-32.1°C.

Higher incubation temperatures produce hatchlings with greater body mass Kuroyanagi and Kamezaki, (1993). Therefore, shade could lead to a small decline in hatchling body mass. Furthermore, a shift to more male hatchlings could be possible. Fethiye apparently has a high proportion of male hatchlings (Kaska et al. 2006). Usually, *Caretta caretta* show a female-biased sex ratio (Kaska et al. 1998). Most of the measurements in 27 cm depth, during the present study, were out of the range of 1-2°C, which Mrosovsky et al. (1995) established, but the flooding and the sun bed experiment were within this range (27 cm).

Note that all results were measured in egg chambers with-out eggs, so there was no influence through metabolic heating.

The effect of water (Exp. 4) in 27 cm depth shows no phase shift (Fig. 7), but a change from a jagged to a sinusoidal temperature course is visible. Furthermore, both temperature profiles show a very similar trend. Moreover, a temperature decline of 1.1°C in 27 cm and 1.1 °C in 47 cm depth is visible (Fig. 27). This could be explained by the water's heat conduction. Dry sand has a heat conductance λ, of 0.33 [W mK^{-1}]) and the heat conductance λ of wet sand is 1.1 [W mK^{-1}]; Meyer & Schiffner (1983). Thus the water leads to a heat transfer to deeper sand layers, and is responsible for the temperature change between control / experiment in 27 and 47 cm depth. A sand temperature change of 1 to 2 °C can make a considerable difference to the sex ratio (Mrosovsky et al., 1980). Accordingly, the 1.1°C drop in both depths could influence the sex ratio substantially. The thermo-sensitive period affects sex determination during the approximate middle third of incubation time (Yntema et al. 1994); and temperature has a cumulative and a quantitative effect on sex determination (Wibbels et al. 1991). Therefore, any influence that affects the sand temperature should be avoided, especially at this time of incubation.

The shade by a sun bed has a smoothening effect on the temperature profile in 27 cm (Fig. 9) and shows no phase shifts. This effect was not evident in 47 cm (Fig. 10). The temperature decline between the control and the experiment was 1.3°C in 27 cm and 0.8°C in 47 cm (Fig. 28). The temperature change between 27 cm (sun bed) and 47 cm (no shade) is very low (0.1°C) but similar to the flooding experiment (4). Apparently the sun bed also has a buffer effect, which influences the sand temperature in deeper layers. One explanation is that the airspace under the sun bed affects the heat transfer from air to sand; the influence through shade by the umbrella, during midday, could also play a role (Fig. 53).

The nest temperatures in Yaniklar in 2010 were between 30.5°C and 33.7°C Bauer (2010). The nest C2 in Calis in 2011 shows a mean temperature of 32.2°C and is in the upper third temperature range of the year 2010 at Yaniklar. Furthermore, it shows a significant temperature decline over the period of measurements ($p=0.0024$, $r^2=32.886$).

Summing up, the sun bed experiment (5) had the highest influence on the sand temperature in 27 cm depth, with a decline of 1.3°C (Fig. 29); the corresponding drop in 47 cm was 0.8°C (Fig. 30). The sun bed therefore led to a reduction especially near the surface, but had a greater influence compared with the litter, the towel, and the umbrella.

The flooding experiment (4) shows a decline of 1.1°C in both sand depths (Fig. 29, 30). Flooding in combination with an umbrella and the sun bed experiment (5) therefore triggered the strongest temperature decline.

The other three experiments influenced the sand temperature similarly. Litter (Exp. 3) induced a decline of 0.9 °C in 27 cm and 0.1°C in 47 cm depth. The towel (Exp. 1) led to a decline of 0.7°C in 27 cm and 0.1°C in 47 cm depth. The umbrella had the lowest influence: 0.6°C in 27 cm and 0.1°C in 47 cm. All three clearly had a higher effect in the shallow depth (Fig. 29) and a minimal effect at 47 cm (Fig. 30).

All temperature declines were within a range of 0.1-1.3°C.

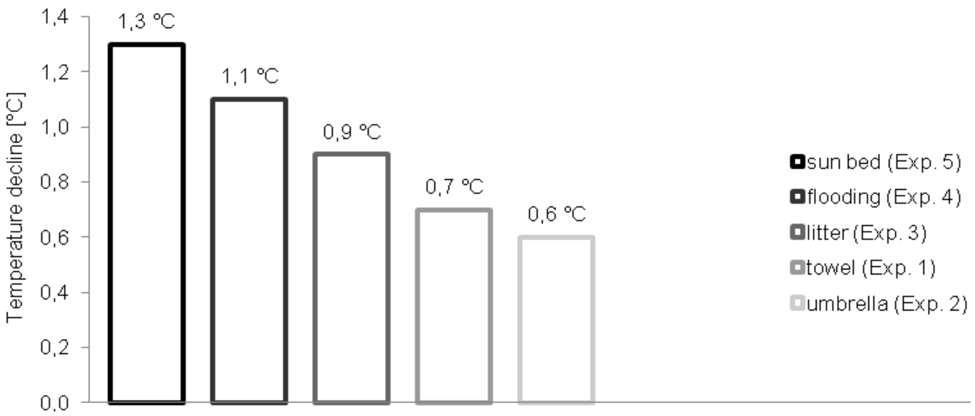

Figure 29: Temperature decline of each experiment compared with the control (27 cm)

Abbildung 29: Temperaturabnahme von jedem Experiment, verglichen mit der Kontrolle (27 cm)

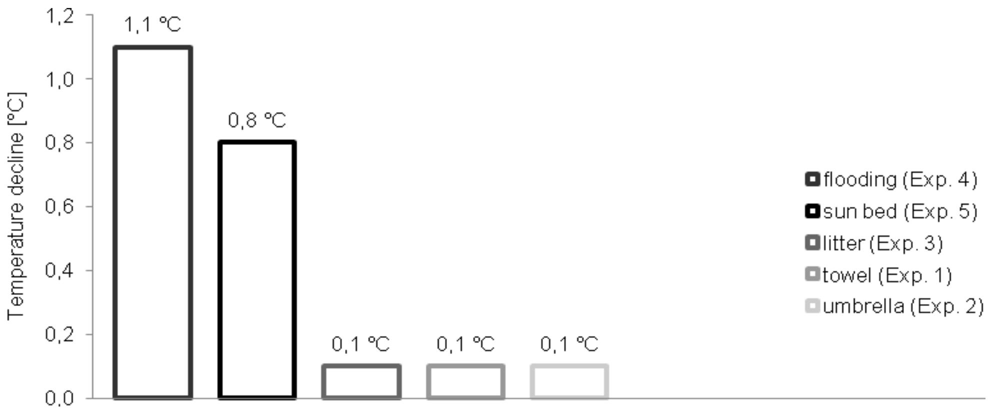

Figure 30: Temperature decline of each experiment compared with the control (47 cm)

Abbildung 30: Temperaturabnahme aller Experiment, verglichen mit der Kontrolle (47 cm)

All control experiments (without shade) in 27 and 47 cm depth along with the mean air temperature from the weather station in Fethiye are presented in Figure 31. The heat storage and buffer effect of the sand is evident, as is the correlation between each experiment and the air temperature.

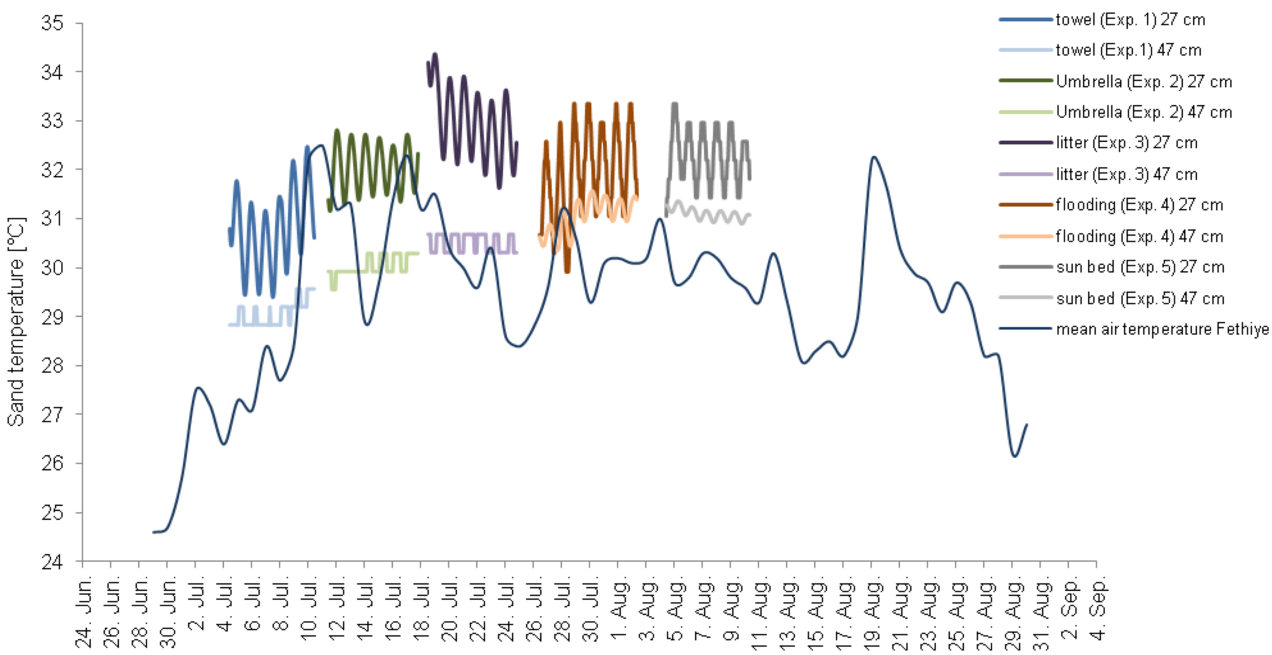

Figure 31: Overview of all experiments without shade in 27 and 47 cm depth, along with the mean air temperature from Fethiye.

Abbildung 31: Übersicht aller Experimente in 27 und 47 cm Tiefe, ohne Beschattung, zusammen mit der mittleren Lufttemperatur von Fethiye

CONCLUSION

The results show a strong temperature decline as a result of shade. This reduction differs with each type of shading item. In general the influence declines with depth, although the combination of shade by an umbrella and natural flooding (Exp. 5) (Figs. 50-51), and a sun bed (Exp. 5) (Figs. 52-54), show the highest temperature decline in deep sand layers.

In 2011 in Calis, 215 umbrellas were counted near the waterline and an additional 146 along the promenade. Two sun beds were positioned per umbrella, yielding a total of approximately 720 sun beds at Calis beach. The sun beds which were located near the waterline were pulled towards the promenade at the evening and in the morning back to the old position. This opens up the possibility that turtle could choose the nest position on a sun bed site, leading to anthropogenic nest shading.

Furthermore, 53 beach umbrellas from tourists were counted, leading to another potential problem. The official blue umbrellas have a concrete base, which extends only a few centimetres under the sand surface. The tourist umbrellas, however, were typically stuck more than 30 cm deep into the sand. Finally, the risk of nest damage was increased by the unfavourable location of such umbrellas between the two fixed umbrella rows. Beside the above threats, there is an increasing risk of shading by towels. According to the results presented here, any shading should be avoided, but clearly this is very difficult to do in a tourist region like Calis. Suitable conservation work is very important to reduce the anthropogenic influence that can alter incubation environments and affect hatchling success and characteristics Mosier (1998).

One such approach for effective protection involves efforts such as the Sea Turtle Course. Most of the so-called secret nests (nesting by adult female turtle not observed directly) are found during the work shifts. This yields the exact nest positions, a prerequisite to do conservation work. If the position is known, protection against damage by tourist umbrellas and towel shade can be achieved. An equally important measure is the educational work with tourists. Therefore, holistic conservation effort should include:

• Nature protection (to maintain and/or re-establish the natural environment)

• Field courses and projects (active protection carried out by students, volunteers, etc.)

• Research (to learn more about the species and their behaviour)

• Public relations (to provide information about proper behaviour)

• Management (to implement government action)

ACKNOWLEDGEMENTS

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APPENDIX

Fig. 32: Satellite image of Fethiye (photo: Google Maps), arrows show, from left to right, Akgöl, Yaniklar and Calis beach

Abb. 32: Satellitenbild von Fethiye, Pfeile zeigen von links nach rechts, Akgöl, Yaniklar und Calis Strand

Fig. 33: Satellite image of Calis (photo: Google Maps), circles show: 1 Camp, 2 Infodesk, 3 Location of the egg-chambers

Abb. 33: Satellitenbild von Calis, Kreise zeigen: 1 Camp, 2 Informationsstand, 3 Positionen der Ei-Kammern

Fig. 34: Tinytag with PVC-film canister

Abb. 34: Tinytag mit PVC Filmdose

Fig. 35: Preparation of the towel experiment (1); Fig. 36: Positioning the data loggers; Fig. 37: Taking notes about the nest location; Fig. 38, 39: Overview of experiment 1

Abb. 35: Vorbereitung des Handtuch-Experiments (1); Abb. 36: Positionierung der Messgeräte; Abb. 37: Notizen der Nestposition; Abb. 38, 39: Übersicht des Experiments 1

Fig. 40: Fasten the umbrella on the cage; Fig. 41: Taking notes for evaluation; Fig 42: Attaching the umbrella; Fig 43, 44: Overview of the umbrella experiment (2)

Abb. 40: Befestigen des Sonnenschirms; Abb. 41: Notizen für die Auswertung; Abb. 42: Anbringen des Sonnenschirms; Abb. 43, 44: Übersicht des Sonnenschirm-Experiments (2)

Fig. 45: Placing the data loggers into the egg-chamber; Fig. 46: Overview of the litter composition; Fig. 47: Litter placement above the egg-chamber; Fig. 48, 49: Overview of the litter experiment (3).

Abb.45: Platzierung der Messgeräte in der Ei-Kammer; Abb. 46: Übersicht der Abfallzusammensetzung; Abb. 47: Abfallplatzierung über der Ei-Kammer; Fig. 48, 49: Übersicht des Abfall-Experiments (3).

Fig. 50: Measuring the depth of the egg-chamber (4); Fig. 51: Closing the egg-chamber

Abb. 50: Tiefenmessung der Ei-Kammer (Exp. 4); Abb. 51: Schließen der Ei-Kammer

Fig. 52, 53, 54: Overview of the sun bed experiment (5)
Abb. 52, 53, 54: Übersicht des Sonnenliegen-Experiments (5) (All photos: B. Pontiller)

Bachelor Thesis

Light pollution along the beach promenade in Calis, Turkey

Lichtverschmutzung an der Lichtverschmutzung an der Strandpromenade in Calis, Türkei

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KURZFASSUNG

Lichtverschmutzung ist ein immer größer werdendes Problem auf der Promenade in Calis, weil hier viele Lokale wie Bars, Restaurants, Reiseveranstalter oder andere Geschäfte ansässig sind welche am Abend und in der Nacht teilweise sehr hell beleuchtet sind. Da dieser Strand ein Niststrand für die Unechte Karettschildkröte *Caretta caretta* ist, sollte das Problem der Lichtverschmutzung verkleinert oder gar gelöst werden. Das künstliche Licht ist eines der größten Ursache für die Desorientierung der schlüpfenden Hatchlinge während der Nacht.
Um den Grad der Lichtverschmutzung festzustellen, wurden die Lichter der Lokale entlang der Promenade in Calis gezählt. Die Promenade wurde in 85 Sektionen unterteilt, wobei eine Sektion einem Lokal entspricht. In der Nacht wurden Fotos von nahezu jeder Sektion erstellt und mit diesen Fotos ein Katalog erstellt. Die unterschiedlichen Lichttypen wurden in verschiedene Kategorien eingeteilt.

2011 wurden insgesamt 1015 Lichter gezählt. Mehr als 55 % waren Glühbirnen. Im Vergleich zu den Vorjahren stieg die Gesamtzahl der Lichter. Die Nester befanden sich nur auf dem westlichen Teil der Promenade, wo weniger Lichter gezählt wurden als auf dem östlichen Teil. Es gab insgesamt 11 Nester auf dem untersuchten Strandabschnitt. Alle Nester bis auf eines befanden sich im letzten Drittel der Promenade, welche am wenigsten Lichter (28%) aufweisen konnte im Vergleich zu den beiden anderen beiden Dritteln (34% und 38%).

Zusätzlich wurden verschiedenen Strategien zur Verringerung der Lichtverschmutzung ausgearbeitet. Die beste Lösung – auch wenn unrealistisch - wäre es, die Lichter abzudrehen. Andere Strategien zur Verringerung wären die Anzahl der Lichter, die Höhe der Laternen oder die Helligkeit der Lampen zu reduzieren. Zur Veranschaulichung dieser Strategien wurden Zeichnungen entworfen.

Um die Situation am Strand von Calis, der in einer „special protected area“ liegt, zu verändern, werden Gesetze und Kontrollen benötigt. Zusätzlich sollten die Touristen und die Landesleute darüber informiert werden, damit ein Schritt in eine Zukunft gemacht werden kann mit weniger Licht bzw. gar kein Licht an einem der Niststrände der Meeresschildkröte *Caretta caretta*.

ABSTRACT

Light pollution is a growing problem along the promenade in Calis because many bars, restaurants, travel agencies and other shops are located there which are partially very strongly illuminated in the evening and night time. Due to the fact that this beach is a nesting site of the loggerhead sea turtle *Caretta caretta* the problem of light pollution should be reduced. Artificial light is one major reason for the disorientation of the hatchings when they emerge from their nests during the night.

To detect the light pollution along the promenade of Calis the lights from all bars, restaurants and other shops were counted. The promenade was divided into 85 sections. One section corresponds to one building/restaurant. At night, photos were taken of nearly each section and a catalogue of all these photos is presented in the appendix. The light sources were classified into different types of lights.

1015 lights were counted in 2011. More than 55 % were light bulbs. Compared to the last years the total number of lights increased. The nests were restricted to the western side of the beach, where fewer lights were counted than on the eastern side. Altogether there were 11 nests on the analysed section of the beach. All nests except one were located in the last third of the beach. In this third the number of lights was the lowest (28%) in comparison to the other two thirds (34% and 38%).

Additionally, strategies to reduce the light pollution were elaborated. The best solution would be to turn off all the lights, although this is clearly unrealistic. Other strategies would be to reduce the number of lights, the height of the lanterns and the light intensity, for example. To demonstrate these strategies, illustrations were designed and are presented here.

To change the situation of the promenade in Calis, laws and controls in the special protected area of Calis are required. It is also important to inform the tourists and the local people to make a step into a future with less light on one of the nesting beaches of the sea turtle *Caretta caretta.*

INTRODUCTION

Light pollution is a major problem for sea turtles such as loggerhead turtles. Artificial lights disrupt the hatchlings when they crawl from their nest to the sea (Tuxbury & Salmon, 2005).

After the hatchlings emerge onto to the sand surface they orientate by visual cues. They perceive all lights in the "cone of acceptance". The cone of acceptance is about 180° wide horizontally and -10° up to -30° wide vertically. Normally they crawl away from the landward horizon where high silhouettes of structures such as vegetation or dunes are. They also crawl towards the brightest horizon, which should be the sea: normally the moon and the stars reflect on the sea so that the brightest horizon is seawards. Artificial night lighting disrupts this orientation of the hatchlings (Salmon, 2006). However, the wave length of the light also has an influence on the sea turtles, depending on the species. The spectral sensitivity of loggerhead turtles is lower in the yellow spectrum. Witherington & Bjorndal (1991) report that low-pressure sodium vapour lamps have less influence on the orientation of hatchlings. The low-pressure sodium vapour lights emit only yellow light. Other broad-spectrum lighting types and white mercury vapour lights probably have a negative influence on loggerhead turtle hatchlings (Witherington, 1992).

Landward silhouettes are also important for hatchling orientation. Light barriers such as natural vegetation or dunes but also artificial light barriers such as walls or buildings can make a contribution to sea-finding (Salmon et al., 1995).
Mann (1978) also analysed the behaviour of hatchlings. He found that the hatchlings were disorientated when artificial light was visible to them. But when the artificial light was not visible, for example because of light barriers, they mostly orientated correctly.

Witherington (1997) lists some strategies to handle light pollution. One solution is to reduce the power of light by using lower wattage. Another solution is to use shields so that the light doesn't shine directly toward the hatchlings. Further strategies are to use yellow, low-pressure sodium vapour lights or to plant higher dune vegetation or construct higher dune profiles. Another thought is to reduce the light duration with motion-detectors.

Salmon (2003) also elaborated some strategies to solve the photo pollution problem. First, the unnecessary lights should be turned off. Second, the wattage of the luminaires should be reduced. Third, the lights should be redirected and focused to the places where they are needed or on the ground by using shields, for example. Fourth, the upward-directed lights which are for decoration should be eliminated. Fifth, alternative light sources should be used such as lights with certain wavelengths which are less disruptive to sea turtles. Finally, new constructions should incorporate the latest light management technology.

The purpose of this bachelor thesis is to document the light pollution along the promenade in Calis. The beach of Calis, Fethiye, is a nesting area of the loggerhead turtle *Caretta caretta* and a special protected area. Despite this, there are many hotels, bars, travel agencies and restaurants along the promenade. The light pollution on this beach has determined by counting the lights of the different types of light sources and to compare this with the position of the nests on the beach. Strategies to reduce light pollution are worked out by designing pictures which depict practical solutions for restaurants and bars. Additionally, a catalogue of the restaurants and bars along the promenade is provided. This depicts every building along with its lights in the night time on the promenade.

MATERIAL AND METHODS

The promenade of Calis was analysed between Hotel Mutlu on the eastern end (Facing Fethiye) and Mimoza on the western end. The documentation started on the eastern end.
This area, which is about 1.5 km long, was subdivided into 85 sections (Appendix 1, page 1). Each section corresponds to one building, e.g. a restaurant or a bar. Data were collected between 9.00 p.m. and 10.45 p.m. on 17 August 2011 when most of the lights were on.
For every section the lights were counted in an about 15m wide area measured from the landward promenade edge towards the restaurants. Lights beyond this 15m stretch were counted separately and noted in a special category. The lanterns between the beach and the promenade were a separate category. The lights from the sales booths on the promenade, between the buildings and the beach, were also counted.

The lights were divided into different types of lights: Light bulbs, background lights, illuminated signs, neon lights, chains of lights, lanterns, others, spot lights and sales booths. Energy-saving light bulbs or bulbs that resemble like lanterns were counted as light bulbs. Neon writing falls into the category of illuminated signs. The lanterns next to the wall which separate the beach from the promenade fall in the category lanterns. The lights from the sales booths were noted separately. The lights behind the limit of 15 m were classified as “background lights”. “Others” include flat screens, video projectors (beamers) or indirect light sources. The figures were drawn using Microsoft Excel.

The number and the position of the nests in front of the promenade were taken from the data sheets which were filled out by the students during the summer of 2011.

The total number of lights was compared with earlier years going back to 2005. The figures were drawn in Microsoft Excel.

To create a catalogue of all bars and restaurants on the promenade, photos were taken between 9.00 p.m. and 10.45 p.m. on 17 August 2011. Camera angles varied slightly due to space restriction on the promenade. The light intensities on the images do not necessarily reflect actual brightness.
Strategies to reduce light pollution were elaborated. Demonstrative illustrations were designed using the computer software Autocad.

RESULTS

In 2011 along the promenade of Calis the total sum of counted lights was 1015. Tab. 1 shows the number of different types of lights. Light bulbs were the most commonly used type of light (564), equivalent to more than half of the lights. The number of background lights was 141 (i.e. 13.9 %) and the number of illuminated signs was 126 (i.e. 12.4 %). 84 neon lights and 29 chains of lights were counted. Along the promenade there were 24 lanterns, equivalent to 2.4%. Finally, there were spot lights (19) and sales booths (5 lights).

Tab. 1: Number of different types of lights along the promenade of Calis
Tab. 1: Anzahl der unterschiedlichen Lichttypen entlang der Promenade von Calis

Types of lights	Sum	Sum in %
Light bulbs	564	55.6
Background lights	141	13.9
Illuminated signs	126	12.4
Neon lights	84	8.3
Chains of lights	29	2.9
Lanterns	24	2.4
Others	23	2.3
Spot lights	19	1.9
Sales booths	5	0.5
Sum	1015	100

Fig. 1 shows the number of lights in each section. The sections in which nests were located are specially marked. There were 11 nests on the analysed section of the beach. Clearly, all of the nests are on the western side of the promenade.

On the eastern side (sections 1 – 43) there were 555 lights, on the western side (sections 43 – 85) 461 lights. Therefore the eastern side contained 55% of the lights and on the western side 45%.

In the sections with over 25 lights there were no nests, and most nests were in sections with less than 16 lights. Next to these strongly lit sections there also were no nests: the distance from such sections to a nest was always at least nine sections or more.

Dividing the promenade into three sections yields another perspective. The first third had 348 lights (34%, sections 1-28), the second third had 381 lights (38%, sections 29-56)) and the last third had 286 lights (28%, sections 57-85). One nest was in the second third, other nests (10) in the last third and very close to each other.

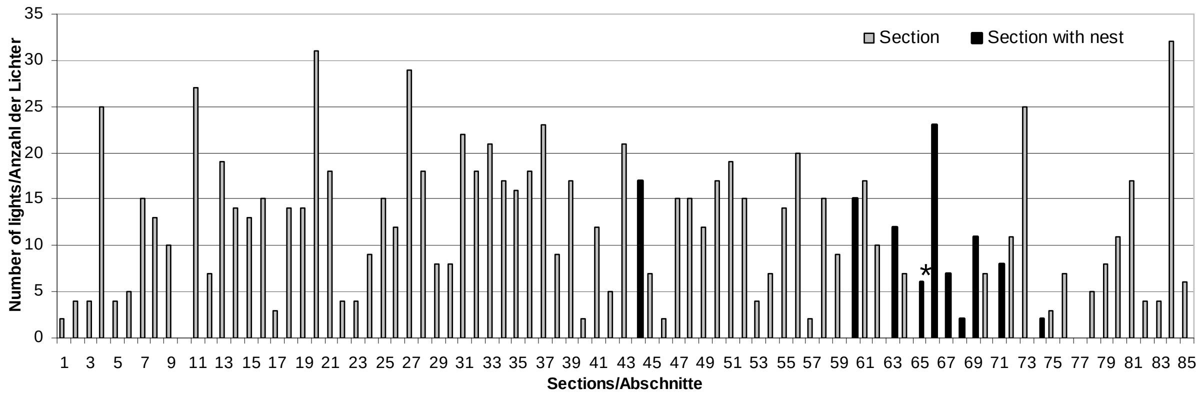

Fig. 1: Number of lights (sum) in each section: the sections with nests are marked black, the section with * has 2 nests, the others have one nest each
Abb. 1: Summe der Lichter in den jeweil. Abschnitten, Abschnitte mit Nestern sind schwarz markiert, der Abschnitt mit * hat 2 Nester, die anderen schwarz markierten haben jeweils 1 Nest

Tab. 2 shows the list with the sections and their total lights sorted in ascending order. The highest number of lights counted in one section was 32. Two sections had no lights. Half of the sections had more then 11 lights per section. Half of the nests were in front of sections with less than 9 lights. Only 2 nests were in sections with more than 16 lights.

Tab. 2: Sum of lights from the different bars and restaurants and the nests in the corresponding section of the beach

Tab. 2: Summe der Lichter der verschiedenen Lokale und die davor liegenden Nester

		sum	nests
10.	House	0	
77.	House	0	
1.	Snack bar next to fitness park	2	
40.	Taksi Stand	2	
46.	Painter	2	
57.	Mendos	2	
68.	Info Desk	2	CS2
74.	House	2	C2
17.	Gül Market	3	
75.	House	3	
2.	Mutlu park	4	
3.	Snack bar next to fitness park	4	
5.	House	4	
22.	Eylül Optik	4	
23.	Karaoke Bar	4	
53.	Hanibal Tours	4	
82.	Little House	4	
83.	Little House	4	
6.	Jewellery Shop	5	
42.	Funpark Entrance + Snack bar vis-à-vis	5	
78.	House	5	
65.	Seketur open house	6	CS11, CS13
85.	Hotel	6	
12.	Ice Cream Shop	7	
45.	Deniz + Sales booth vis-à-vis	7	
54.	Turkish Kitchen	7	
64.	Travel Agency	7	
67.	Hotel Seketur	7	CS3
70.	Jewellery and Paint Shop	7	
76.	Turkuaz Market	7	
29.	Pioneer Travel	8	
30.	La casa di Mamma / Han Otel	8	
71.	Maya Café	8	C1
79.	Café Bahane	8	
24.	Orient Express Restaurant	9	
38.	Souvenir Shop	9	
59.	Lilys Steak & Grill House 2	9	
9.	Indian Cuisine	10	
62.	Clothing Shop	10	
69.	Keyif Café	11	CS1
72.	Cinar Bar	11	
80.	Hotel Dophin	11	
26.	Moussaka Restaurant	12	
41.	Café Green	12	
49.	Travel Agency	12	
63.	Secil Market (+ Ice Cream)	12	CS6
8.	Manas Park Otel	13	
15.	Hotel Berlin (+Ice Cream)	13	
14.	Hotel Simsek (+Ice Cream)	14	
18.	Harem Restaurant	14	
19.	Bella Mammas / Delta Hotel	14	
55.	Mehraba Restaurant	14	
7.	Hamsi Bar	15	
16.	Er-öz Hotel	15	
25.	Nil Bar	15	
47.	Lighthouse Lounge & Bar	15	
48.	Okyanus Restaurant	15	
52.	Bar & Restaurant Ögretmenvi	15	
58.	Lilys Steak & Grill House 1	15	
60.	Calis beach Restaurant	15	CS5
35.	Georges Restaurant	16	
34.	Serkul 1 Restaurant	17	
39.	Focus travel agency	17	
44.	Mado + Funpark Entrance	17	CS8
50.	1905 Pub / Hotel Area	17	
61.	Günes Restaurant	17	
81.	Malhun	17	
21.	Bostons	18	
28.	Café Soul	18	
32.	Seaside Travel Agency	18	
36.	Eyna Restaurant	18	
13.	Deniz Beach Otel	19	
51.	Rosebar	19	
56.	Clothing Shop	20	
33.	Serkul 2 Restaurant	21	
43.	Calis Fast Food Restaurant	21	
31.	Red Tattoo / Souvenir Shop	22	
37.	The Palms Restaurant / Hotel Idee	23	
66.	Sim Bar	23	CS10
4.	Mutlu Restaurant	25	
73.	Hotel Ceren	25	
11.	Anna Restaurant	27	
27.	Dennis Bar	29	
20.	Chinese Breeze	31	
84.	Hotel Letoon	32	
	Sum	**1015**	

Compared to recent years the number of lights has increased. In 2011 there were more lights then previously. In 2005 there were only 273 lights. Since 2005 the number of lights rose continuously, except in 2008 (Fig. 2).

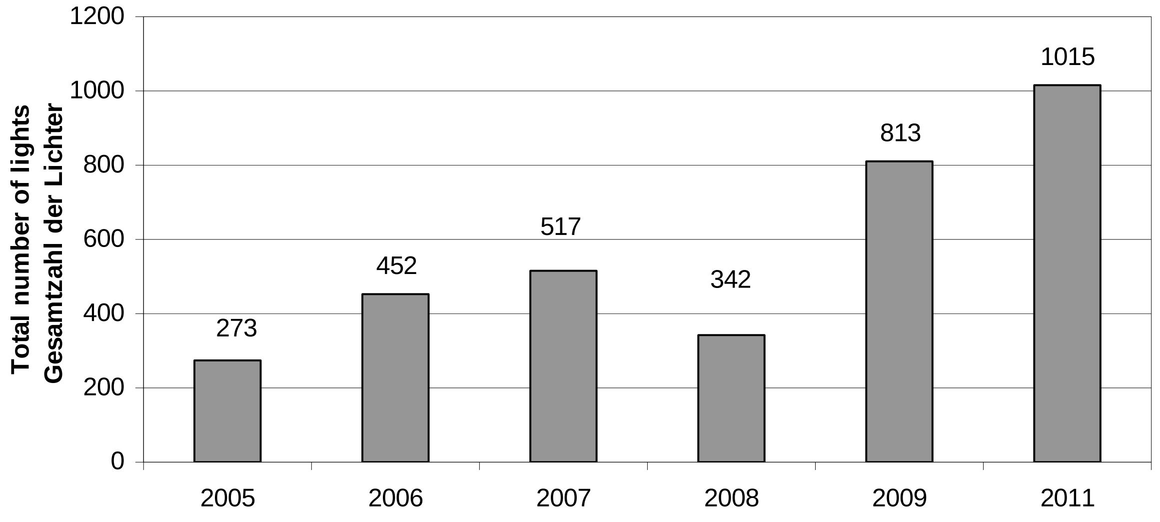

Fig. 2: Total number of lights in Calis from 2005 to 2011 except 2010
Abb. 2: Gesamtzahl der Lichter in Calis von 2005 bis 2011 außer 2010

A promenade catalogue is provided (Appendix 1). All bars and restaurants are listed and numbered from the eastern end to the western end of the promenade. This list, along with the photographs of each section, provide an overview of all the bars, restaurants, travel agencies and other shops on the promenade in Calis. The photos give an impression of the lights closest to the beach.

The following proposals are designed to reduce the light pollution along the promenade of Calis and were developed especially for this area:

-) the number of lights should be reduced
-) the height of the lights should be reduced
-) the light intensity should be reduced
-) there should be shields so that the lights do not shine directly on the beach. Examples include an awning for illuminated signs, a bush for a small lantern, or a lampshade or other type of shield directly on the light bulb to direct the beam of light in one direction.
-) the wall should be raised

-) the number of lanterns should be minimized
-) the sales booths directly on the promenade should be removed and forbidden
-) the lights in the hotel rooms should be turned off when they are not needed and curtains installed in every room.
-) the chains of lights should be eliminated or be lowered onto the ground or shifted to places further away from the beach.
-) the lights should be installed in such a way that they shine in the opposite direction of the beach

Fig. 5 shows a schematic cross-section of Calis beach with the promenade and a hotel with a restaurant. The promenade is depicted in the middle.

Fig. 6 shows an example of the current lighting situation on the promenade. The front side of the hotel in the direction of the beach is open so that the light from inside the hotel can shine out of the room. This includes hanging lamps and a lamp on the wall. There also are some lights outside among the restaurant tables and chairs. In the hotel room in the first floor the lights are on and shine out of the window. There is an illuminated sign on the front side of the hotel too. A chain of light is wrapped around the tree and a small light is located next to the tree, facing the beach. On the promenade there is an illuminated sales booth. Left of the wall there is a tall lantern with a partial shield.

Fig. 7 shows the strategies to reduce the light pollution. The hanging lamps inside the hotel are reduced. The lamps are hung up higher so that less light can shine to the outside. The light on the inside wall is installed on another place so that it can only shine in the opposite direction of the beach. The number of lights in the restaurant is also reduced. Some lights are replaced by candles on the tables. The height of the lights is reduced too. The lights in the hotel room are blocked by curtains. An awning is mounted to shield the light from the illuminated sign. The chain of light is removed and the small light next to the tree is shifted to the landward side of the tree and additionally shield by a bush. The sales booth is removed. The wall is raised and the lantern next to the wall is replaced by a lower light mounted on the inside wall. Over the light, a shield directs the light to the promenade. Additionally the intensity of all lights is reduced.

DISCUSSION

The determination of light pollution was restricted to quantifying the number of lights. More than 55% of the lights were light bulbs, probably because they are readily available and inexpensive. Only 0.5% of the lights were lights from the sales booths, reflecting that there were only a few sales booths (App. 1, Fig. 46). Nonetheless, these are positioned on the promenade, very close to the beach.

Tall lanterns made up only 2.4%. Despite their low number, they probably have a large effect because they were the nearest lights to the beach. The lanterns had a small shield (Fig. 3) that partially blocks the light from shining on the beach. On the one hand this is a strategy against light pollution. Without this shield the light would shine directly on the beach. On the one hand the light cannot be shielded completely. A better solution such as lower lights (Fig. 7) would help solve the problem.

Note that about 2/3 of the sections had one or more illuminated signs. There were 126 illuminated signs in 85 sections. As is evident in the catalogue (App. 1, Fig. 29) these signs hung rather high at many bars or restaurants. Another example is walls of highly illuminated signs used by travel agencies (App. 1, Fig. 49). Most had several such bright signs. One solution would be to reduce the amount of the illuminated signs.

The time of night when the data is collected has an effect on the data. Later in the night, more bars and restaurants close and turn off their lights. Data were collected when most of the lights were on. This is also the time when hatchlings can begin to emerge from their nests.

A few nests were in front of sections with more light. In those cases, the females may have come out from the sea at a late hour when the bars and restaurants turned off the light. This could not be determined because most nests had been laid earlier in the season before arrival of the sea turtle team. Another explanation for these nesting places can be sand condition, which plays a role in nest side selection. Optimal sand condition could help explain why all nests were on the western side of the promenade and why many were very close to each other.

However most of the nests were in sections with less than 16 lights. Near the nests also were no sections with more than 25 lights and half of the nests were in sections with less then 9 lights. The eastern side (with no nests) of the promenade had 10% more lights than the western side (with all nests). It’s also interesting that all nests except one nest were in the third with the fewest lights. This would allow the cautious conclusion that the nests were in the area with less light.

The total number of lights increased in comparison with the last years. The comparison of the total lights has to be interpreted critically. In the last years there was no exact information about the delimitation of the area in which the lights were counted, and there are no doubt inconsistencies due to the different methods. Nonetheless, an increase in lights over the years is evident.
However, due to the different types of light sources, the comparison of the types of lights with the last years is not possible. In 2011 the types of lights were also reclassified compared to the last years. Any classification, however, is suboptimal because the individual type of light gives no information about the brightness of the light source. Inside one class there can also be lights with different intensities. Measuring light intensity would instruments and expertise going beyond the means of this field course.

The catalogue (App. 1) will provide a good baseline for evaluating the lights of the different bars and restaurants in future years. These images also help develop suggestions for improving the situation on the promenade of Calis. This catalogue is also useful as a template for counting the lights in the following years. Unfortunately, they do not reflect the true light intensity preventing direct comparisons.

It is nearly impossible to quantify all sources of light pollution. An example is the hotels next to the beach. When the lights in the rooms on the sea side were turned on it was an additional source of light (App. 1, Fig. 31 or 52). On the promenade some people sold toys that light up and laser pointers. Such items can also contribute to light pollution.

One strategy to help the hatchlings is to use protective cages with nets (Fig. 4). Such cages were used by the students on the beach of Calis. The protective cage prevents the hatchlings from crawling in the false direction. The advantage is that the students can release the hatchlings at places with less light. The disadvantage is that the sources of light pollution will not be solved; making cages only a temporary solution.

The strategies elaborated to reduce light pollution are primarily designed for the promenade of Calis. The illustrations (Fig. 6 and 7) show an example of a hotel with a restaurant on the promenade of Calis. Not all the strategies will be applicable for all the different bars and restaurants on the promenade. But overall, these pictures do demonstrate how light pollution can be reduced.

As a first strategy, special light bulbs like low-pressure sodium vapour lamps (Witherington & Bjorndal, 1991) can be used. These are no doubt more expensive than other light bulbs, so the chance for voluntary usage is less.

Because landward silhouettes promote the correct orientation of the hatchlings (Salmon et al., 1995), consideration should be given to raising the wall. Because the tourists like to walk on the promenade and look out on the sea, the wall should not be too high. But compromise could be found if there is a will to reduce light pollution.

All strategies against light pollution will be unsuccessful if there are no laws to govern such matters. And there have to be controls if the owners of the bars and restaurants are abiding by the laws. For example, the sales booths should be forbidden. It would be rather easy to enforce this because the sales booths are mobile. Finally, it is also important to inform the people how to behave in such a special protected area. First of all the hotels should inform the tourists. Secondly, the local people also should be informed about the problems on the beach in Calis.

In sum, light pollution is a problem on the promenade of Calis. There are suitable strategies to combat the light pollution, but without statutory rules and controls the light pollution will be an increasing problem for the sea turtles on Calis beach.

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Fig. 3: Lantern on the beach of Calis with beach-facing part partially shielded (Photo: B. Böswart)
Abb. 3: Laterne mit Abschirmung am Strand von Calis

Fig. 4: Protective nest cage with netting (Photo: B. Böswart)
Abb. 4: Schutzkäfig mit Netz

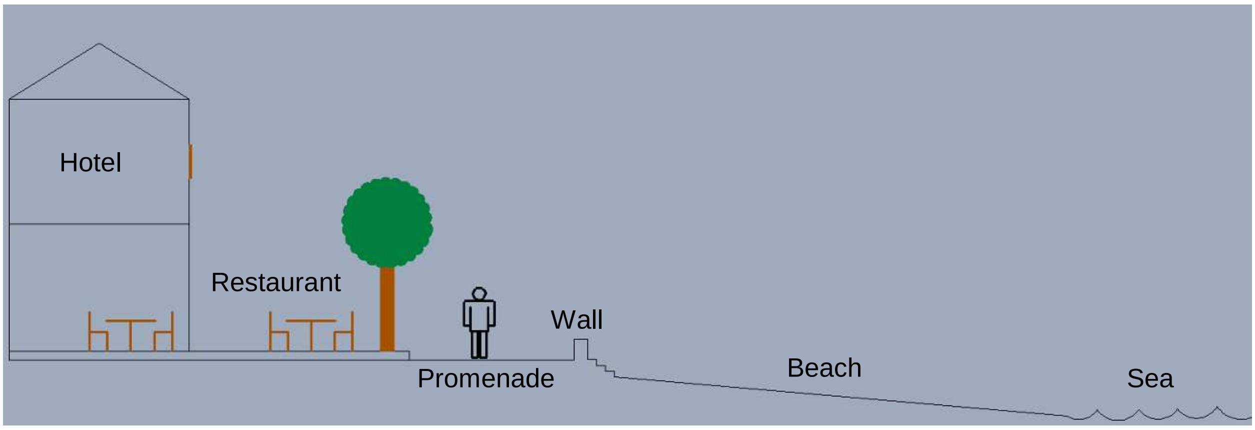

Fig. 5: Idealized sketch of the promenade in Calis with a hotel and a restaurant, the beach and the sea
Abb. 5: Zeichnung von der Promenade in Calis mit Hotel und Restaurant, Strand und Meer

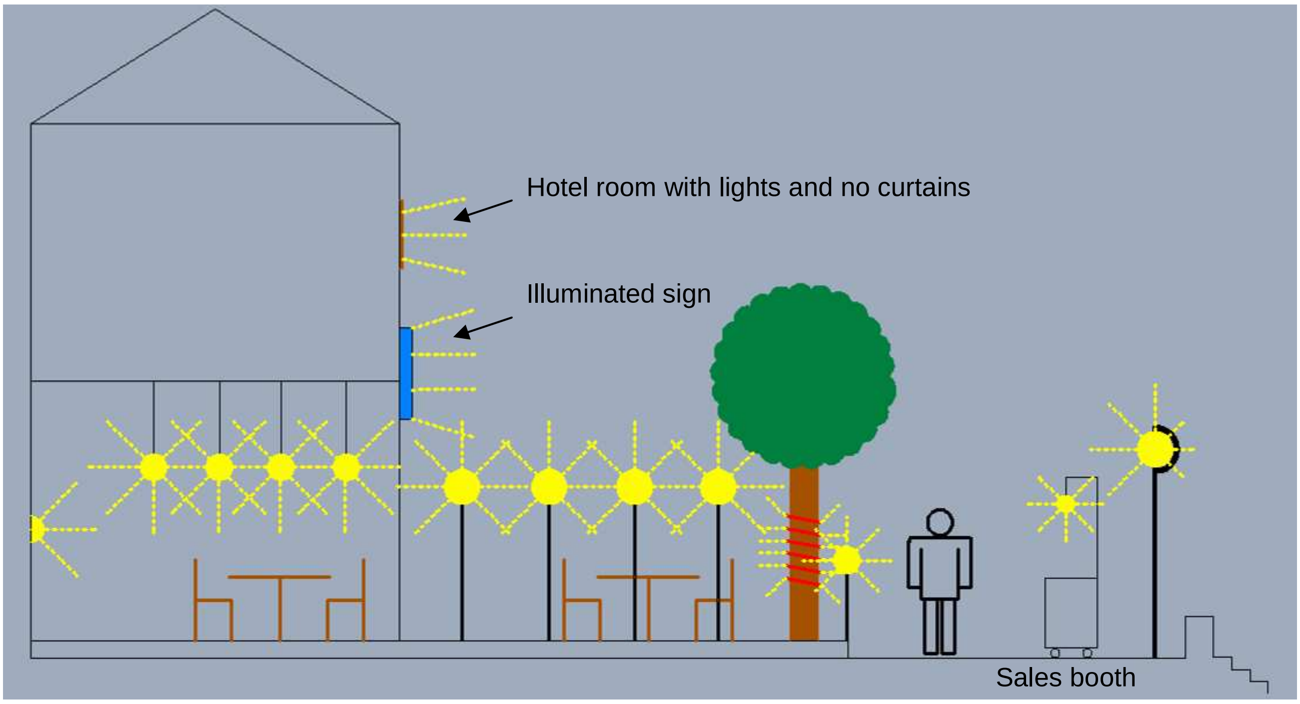

Fig. 6: Composite sketch of promenade and various light sources
Abb. 6: Zeichnung eines Hotels mit Restaurant und ihren Lichtern auf der Promenade

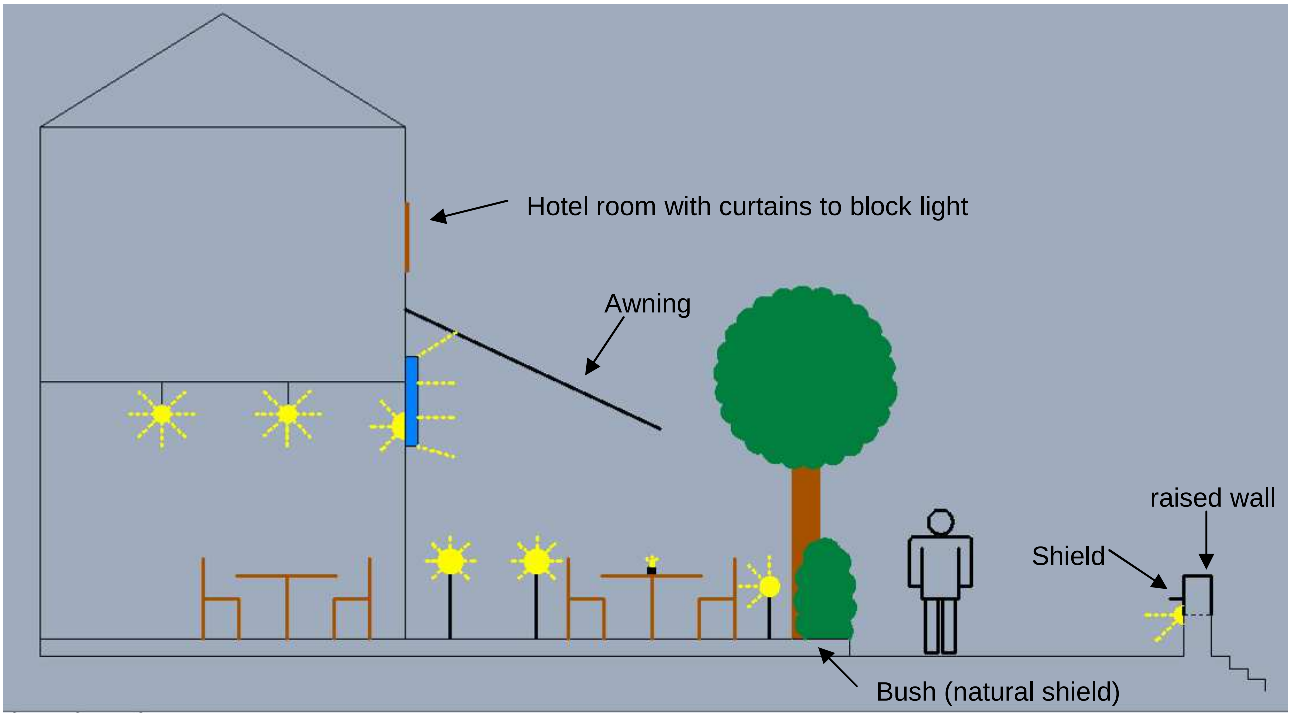

Fig. 7: Sketch of promenade with strategies to reduce light pollution
Abb. 7: Zeichnung eines Hotels mit Restaurant nach Anwendung der Strategien zur Reduzierung der Lichtverschmutzung

Bachelor Thesis

Study on tourists' knowledge about and interest in *Caretta Caretta*

in Çaliş (Turkey)

Studie über das Wissen und die Interessen der Touristen in Çaliş (Türkei)

über *Caretta caretta*

Theresa Rößler

Aspired academic title

Bachelor of Science (BSc)

Vienna, October 2011

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KURZFASSUNG

Der Strand von Çaliş wurde 1988 zur Special Environment Protected Area erklärt. Leider werden aber immer noch viele Aktivitäten inklusive Bauarbeiten durchgeführt, die nicht mit diesem Status vereinbar sind.

Die größten Gefahren sind der schnell wachsende Tourismussektor und der Verlust an Sand. Deshalb ist es umso wichtiger das Bewusstsein von Touristen gegenüber Meeresschildkröten zu erhöhen. Im Juli und August wurden Fragebogen in Çaliş verteilt um den Wissens- und Interessensstand der Touristen zu evaluieren.

Die meisten wählten Çaliş für ihren Urlaub wegen Erholung und Natur und fanden, dass nistende Meeresschildkröten eine Bereicherung für den Strand sind. Deshalb sollten Möglichkeiten aufgezeigt werden wie man Entspannung kombinieren kann mit einem Verhalten, das die Störung der Schildkröten gering hält (z.B. keine nächtlichen Strandbesuche, keine eigenen Sonnenschirme in den Sand stecken, etc.).

Nur 13% der Befragten denken, dass der Strand sauber ist. Diese Meinungen können für Argumente verwendet werden um mit lokalen Unternehmen zu verhandeln, da der Ruf des Strands auch für die lokale Wirtschaft von Interesse ist - Tourismus stellt die größte Einnahmequelle dar.

Der Informationsfluss kann durch mehr Hinweisschilder am Strand, bessere Kennzeichnung von Schutzkäfigen, Inkludierung von Informationen über Käfige an Hinweisschildern und regelmäßige, gut angekündigte Präsentationen in Hotels, verbessert werden.

62% der Befragten wissen, dass Meeresschildkröten am Strand von Çaliş nisten. Von diesen geben 30% den Infostand als Quelle ihres Wissens an. Das bestätigt seine Wichtigkeit und positiven Einfluss.

42% der befragten Touristen sind bereit Natur- und Umweltschutz finanziell zu unterstützen und würden gerne das Geld für folgendes verwendet sehen:

Artenschutzprojekte, Strandreinigungen und Hinweisschilder. Spendenboxen könnten bei den Hinweisschildern platziert werden.

Zur weiteren Auswertung der Interessen der Touristen wurden die am Infostand gestellten Fragen aufgezeichnet. Die am häufigsten gestellten Fragen sind über das Projekt, den Zweck der Schutzkäfige, die Nester, die Brutzeit und über die Anzahl der Nester.

Viele wollen auch mehr Informationen über die Hatchlinge, z.B. ob gerade welche schlüpfen oder wie lange die Inkubationszeit ist.

Diese Interessen können für eine bessere Interaktion mit Tourismus und für Schutzmaßnahmen eingesetzt werden.

ABSTRACT

Çaliş beach was declared a Special Environment Protected Area in 1988, but many activities including construction work is incompatible with this status. The main threats for the beach are tourism development and sand extraction. This is why it is even more important to raise tourists´ awareness to save Çaliş as a nesting site. In July and August, questionnaires were distributed on Çaliş beach to evaluate the tourist knowledge and interests.

Most choose Çaliş for their vacation for relaxation and nature and think that nesting sea turtles are an enrichment for the beach. Therefore, strategies should be considered on how to combine relaxing at the beach with keeping the disturbance for sea turtles to a minimum (e.g. not visiting the beach at night, not sticking own parasols into the sand, etc.).

Only 13% of those interviewed think that the beach is clean. Those opinions can be used as an argument with local businesses because the opinions on the beach pollution are also of interest for the local economy as tourists are the biggest source of income.

The information work can be improved by more information signs at the beach, better marked protective nest cages, information about cages on the signs and regular presentations at hotels planned and promoted on a regular basis. 62% know that sea turtles nest at the beach of Çaliş. 30% of those state the info desk as source of their knowledge. This shows its importance and positive influence.

42% of the questioned tourists are willing to pay to support environmental protection in Çaliş. They would like seeing it spent on sea turtle protection projects, beach cleanings and information signs. Donation boxes could be placed next to all signs.

To further evaluate the tourists' interests, the questions asked at the info desk were recorded.

The most asked questions are about the project, the purpose of the cages, nests, nesting season and about the number of nests.

Many people also want get more information about the hatchlings, e.g. whether there are any hatching now or how long the incubation time is.

This interest can be used for a better interaction with tourism and to promote protection issues.

INTRODUCTION

Tourism plays an important role in the development of the beach in Çaliş, Turkey. It is important to keep tourists informed, especially because the ongoing construction is incompatible with the Special Environment Protected Area status (www.medasset.gr). According to Casale & Margaritoulis (2010) the main threats for the beach are tourism development and sand extraction.

Therefore, a survey on tourists´ knowledge and interests is helpful to develop new strategies for sea turtles protection projects. The survey contains a questionnaire distributed at the beach and the promenade. The results are analyzed for a better understanding of the tourists' demands and the opportunities to inform them about sea turtles.

Turkish students from the Pamukkale University and Austrian students from the University of Vienna maintain an info desk at the promenade, where from 21:00 to 23:00 every night they inform and raise the awareness of passing tourists. All the questions asked at the information desk are recorded to get a better overview of their interests and prepare new students for the information work. The asked questions provide ideas for information flyers or information signs at the beach.

MATERIAL AND METHODS

The knowledge and interests of tourists were evaluated by a closed format questionnaire which was distributed on the beach and the promenade in Çaliş in Turkish, English, German and Russian.

The questionnaire contained 24 questions (see appendix I).

The questioned person was asked to answer 3 numeric open end questions (duration of stay, number of previous visits and age) and 1 open question about their nationality.

Further there were 4 multiple-choice questions with a supplementary option each.

The rest were single-answer questions of which 7 were asked with a rating scale and 9 were polar questions. The questions were designed to obtain information but also to inform the interviewees. 86 tourists participated.

To further evaluate the tourists' interests, all questions asked at the information desk during a 5-week period were recorded and later arranged in 3 main categories (project-related questions, sea turtle-related questions and other questions). For a better overview, questions asked less than twice are counted into the total number but not listed in the results (listed in the appendix II). A total of 524 questions were recorded by the students.

RESULTS

The results are split into 2 parts. The first part is about the questionnaire and the second about the asked questions at the information desk.

Questionnaire

Nationality

86 tourists were interviewed. The 4 biggest nationality groups were German (34%), Turkish (26%), British (11%) and Dutch (11%) (Fig.1).

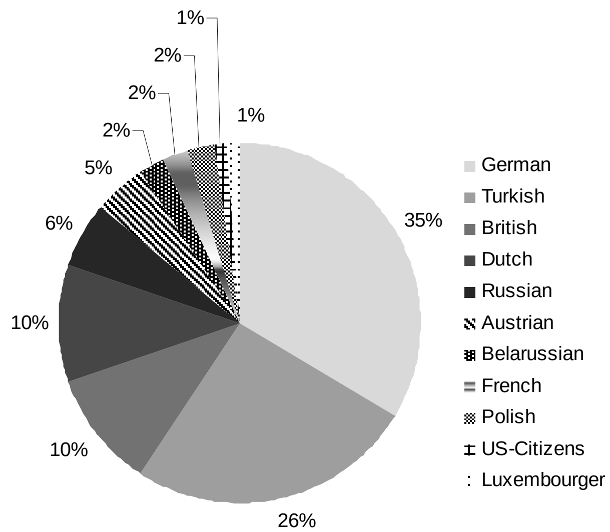

Fig. 1: Diversity of nationalities of interviewed tourists in percent
Abb. 1: Diversität der Nationalitäten der befragten Touristen in Prozent

Gender

63% of the questioned tourists were female, 34% were male. 3% did not reply to this question.

Age

79 interviewed tourist gave information about their age. The most asked age group was people from 20-35 (40%) followed by the age group 35-49 (33%) and tourists over 50 (16%). The least questioned age group was from 13-19 (11%).

Duration of stay

Questioned about the duration of their stay, most respondents answered with 14-21 days (45%) or 7-13 days (34%) (Fig.2). Some answered less than one week (16%) while a few planned their holiday for more than 3 weeks (5%) (Fig.2).

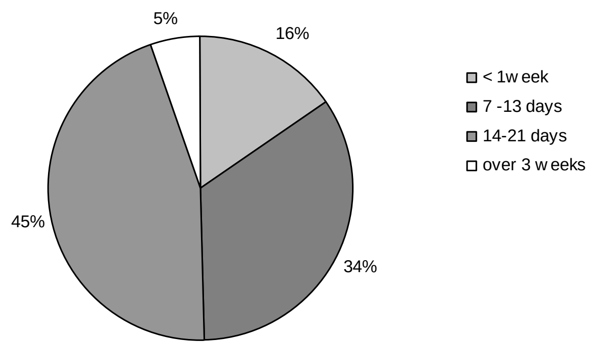

Fig. 2: Duration of the stay of the interviewed in percent (n=77)
Abb. 2: Dauer des Aufenthalts der Befragten in Prozent (n=77)

Previous visits

57% had been to Çaliş before (between 1 and 20 times), while 43% had not (n=68).

Why did you choose Çaliş for your stay?

For a better understanding of the tourists' demands they were asked why they chose Çaliş for their vacation. Through the multiple-choice setup, 85 answered the question and 110 answers were recorded. By far the biggest group stated that relaxation was the reason for choosing Çaliş (47%) (Fig.3). For many, it´s the nature (18%), other reasons (14%) or the reputation (13%) (Fig.3). Few chose because of an all-inclusive offer (3%), a sports offer (3%) or are just traveling through (2%) (Fig.3). Comments describing other reasons are: parents have a house there, friends apartment, cheap, visit somebody (4 answers), because of Fethiye's natural beauties, because of family problems, because it's the most satisfying place for me or it's my hometown.

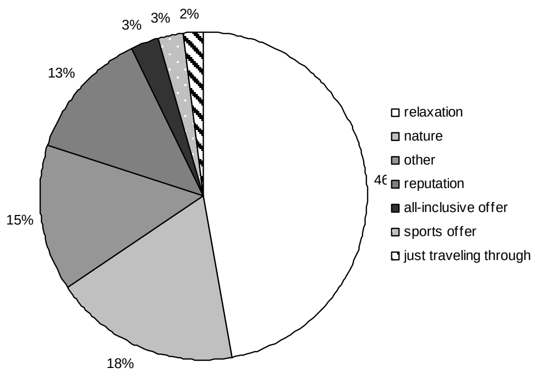

Fig. 3: Reasons for choosing Çaliş for vacation in percent
Abb. 3: Gründe um Çaliş als Urlaubsort zu wählen in Prozent

How much do you integrate environmental protection into your holiday planning?

Most of the questioned people declared to integrate environmental protection only little into their holiday planning (55%) (Fig.4). 24% answered with hardly and 14% much (Fig. 4). 7% didn't integrate environmental protection at all (Fig. 4).

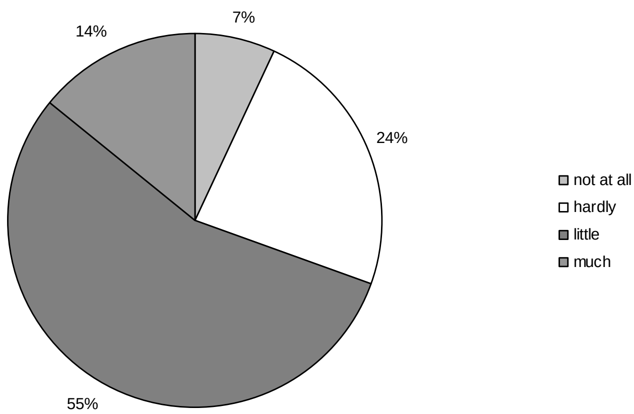

Fig. 4: Values for the integration of environmental protection in the holiday planning in percent (n=85)
Abb.4: Werte für die Integration von Natur- und Umweltschutz in der Urlaubsplanung in Prozent (n=85)

From your point of view, how clean is the beach?

Out of 85 people, most answered that the beach is slightly polluted (47%) (Fig.5). A big group also said that it is polluted (34%) (Fig.5). 13% thought the beach is clean, and 6% stated that it is severely polluted (Fig.5).

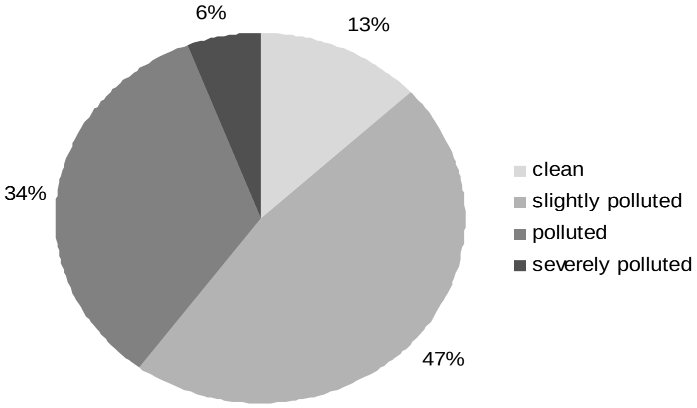

Fig. 5: Statements about beach pollution in percent.
Abb. 5: Angaben zur Strandverschmutzung in Prozent

How often are you at the beach at night?

42% of all respondents claimed that they didn’t go at the beach at nighttime at all (Fig.6). 28% did this 2-6 times a week and 22% once a week (Fig.6). 8% visited the beach every night (Fig.6).

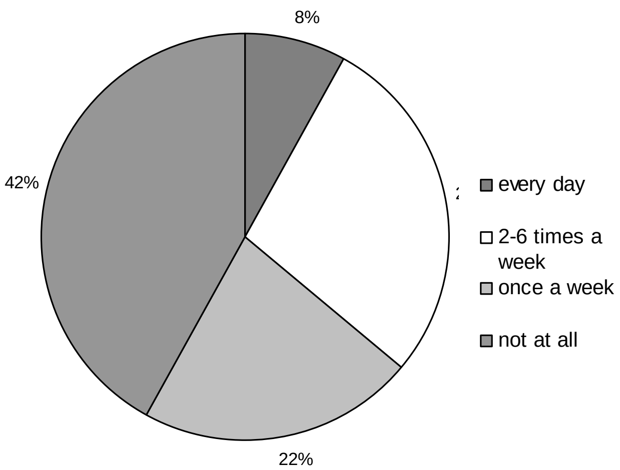

Fig. 6: Number of nightly beach visits in percent (n=86)
Abb. 6: Anzahl der nächtlichen Strandbesuche in Prozent (n=86)

Did you know that sea turtles are nesting on this beach?

Out of 86 people, 62% knew that sea turtles nest in Çaliş, while 38% didn’t.

If so, where did you get this information from?

55 tourists answered this question, and due to the multiple-choice modus there are 77 answers. 30% claimed that they got their information from the *Caretta caretta* - Infodesk (Fig.7). A lot also chose friends (23%) or "other" (16%) as their answer (Fig.7). 10% got information from the internet and 9% from travel agencies (Fig.7). TV (5%) and the hotels (7%) were the least named sources (Fig. 7).

Answers for "other" are: environmental project of our organization, neighbors, information signs (2 answers), family, travel organization “ÖGER”, locals, visit in Dalyan, travel guide, information board at hotel, and "I know because Fethiye is my hometown".

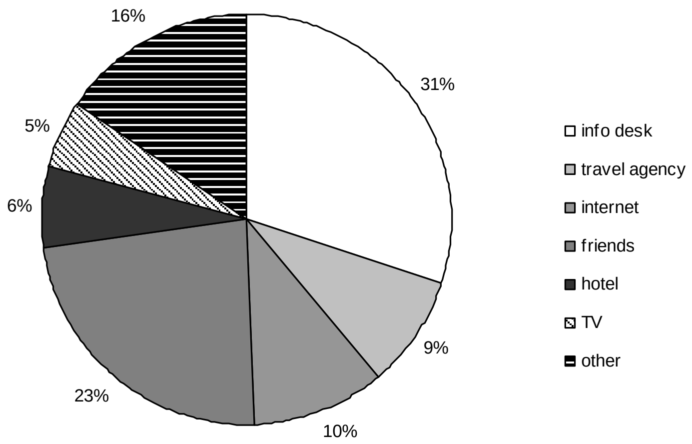

Fig. 7: Statements about the information source regarding sea turtles in percent
Abb. 7: Angaben zur Informationsquelle betreffend Meeresschildkröten in Prozent

Would you like to learn more about sea turtles?

66% of respondents wanted to learn more about sea turtles. 22% were undecided and 12% were not interested (n=85).

If so, what would you like to know about them?

Only 20 people answered this question, but due to the multiple-choice modus there are 145 answers.

There is no clear preference between habitat (32%), protection (27%), nesting behavior (22%) or population (18%). Only 1% wanted to know something else (Fig. 8).

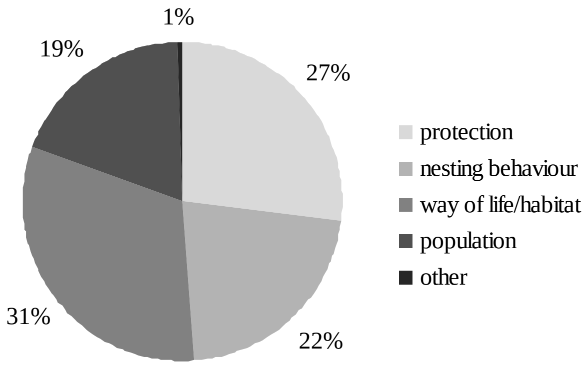

Abb. 8: Angaben zu potentiellem Interessen an Meeresschildkröten in Prozent
Fig. 8: Statements on potential interest about sea turtles in percentage

From your point of view, is the beach marked adequately as a nesting beach?

Clearly, most of the respondents thought that it is not marked adequately (72%). Only 15% said yes, whereas 13% were undecided (n=85).

From your point of view, are the nests marked adequately?

47% thought that they are not marked adequately, while 37% say they are. 16% were undecided (n=85).

Do you think that nesting sea turtles are an enrichment for Çaliş?

Out of 84 tourists asked 84% agreed that sea turtles were an enrichment. Only 9% didn't think so, whereas 7% were undecided.

Have you ever seen a sea turtle at the beach of Çaliş?

Most of the questioned people had never seen a sea turtle on this beach (63%), but 20% saw one once and 17% had seen a sea turtle several times in Çaliş (n=84).

Did you know that the sex of a sea turtle is determined by temperature and can therefore be influenced by parasols, towels or other shadow-creating objects?

Most of the 84 persons said no (70%). Only 30% claimed to know this fact.

How much are female sea turtles handicapped by the following while nesting?

Sunbeds were rated as the least handicapping (low on "very much" and "much" but high on "hardly" and "not at all" compared to the other factors) (Fig. 9). People at the beach were seen as quite a big problem as well as bonfires, cars and similar objects and litter (Fig. 9). The sample size for the flashlight block is 3 to 4 samples less than the others.

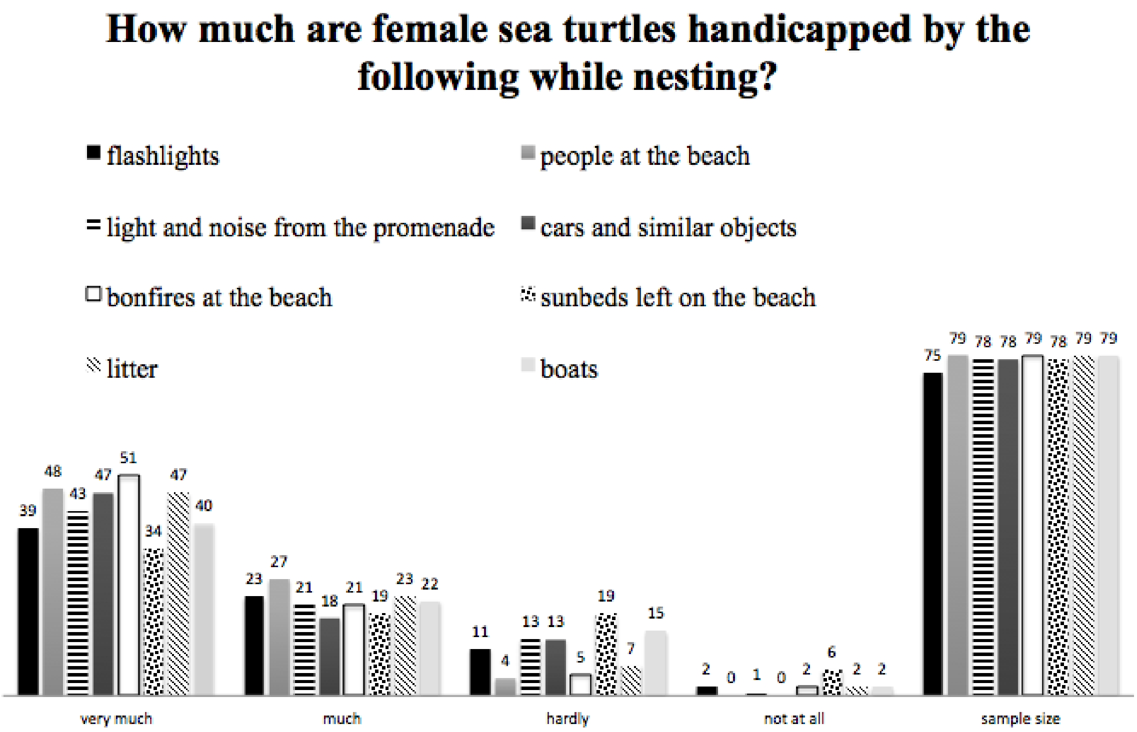

Fig. 9: Valuations of 8 handicapping factors while nesting (note smaller sample size for flashlights)
Abb. 9: Wertungen zu 8 behindernden Faktoren beim Nisten (Stichprobenumfang für Blitzlichter kleiner)

How much do the following incidents decrease the number of surviving hatchlings?

Litter and artificial light were rated high to be a problem for the hatchlings (Fig. 10). Many also answered that cars and similar objects are very harmful, but 14 also said it is hardly any trouble for the hatchlings (Fig. 10). Tourists were the least aware that shadow-creating objects can be a problem (Fig. 10).

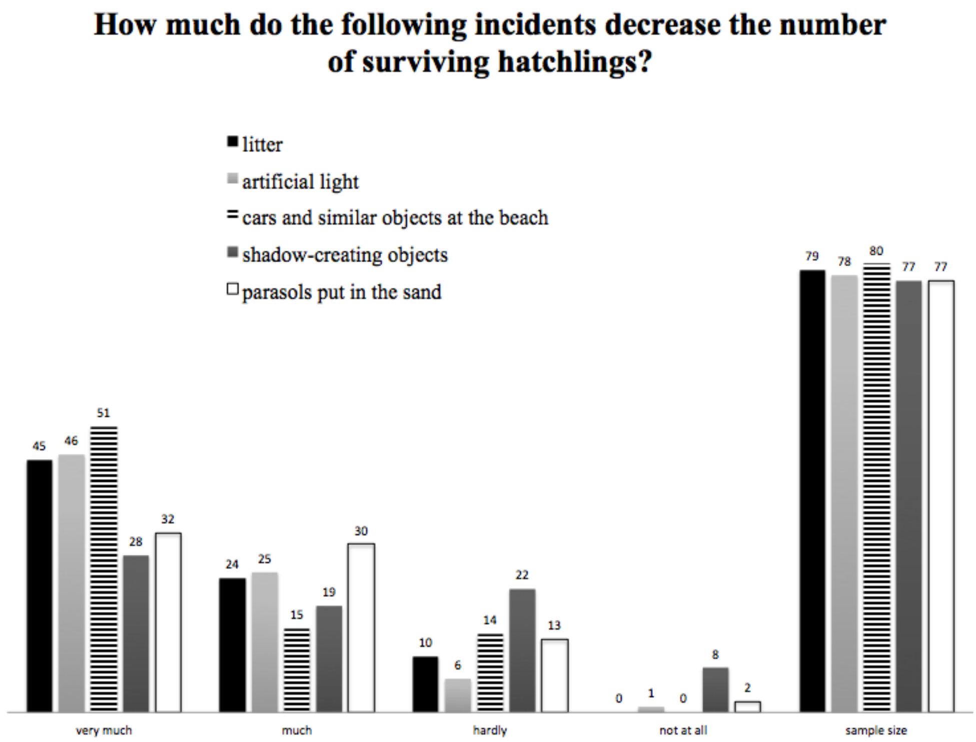

Fig. 10: Valuations of 5 potential threat factors for hatchlings.
Abb. 10: Wertungen zu 5 gefährliche Faktoren für Hatchlinge.

Would you be willing to pay to support professional environmental protection in Calis?

42% of the questioned claim to be willing to pay, while 37% were undecided and 21% said no (n=81).

If so, how much?

Most of the people would pay either <10 TL (46%) or 11-30 TL (42%) (Fig.11). 7% said that they are willing to pay 31-50 TL and 5% would pay >90 TL (Fig.11). Only 43 people answered this question (Fig. 11).

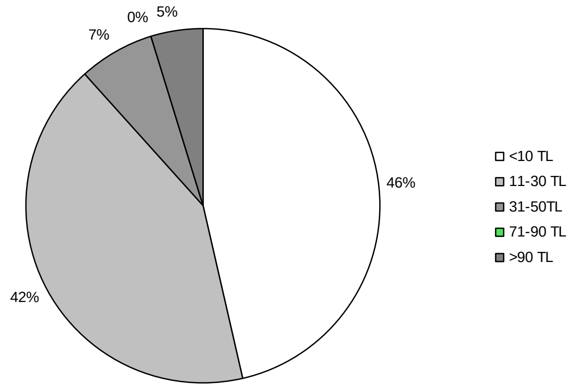

Fig. 11: Statements on the amounts of Turkish Lira people would pay to support environmental protection in Çaliş
Abb. 11: Angaben zur angemessenen Geldmenge (türkische Lira) um Umweltschutz in Çaliş zu unterstützen

If so, how should the money be spent?

61 people answered this question, and due to the multiple-choice modus there are 138 answers. Most thought that the money should be spent on sea turtle protection projects (33%) (Fig. 12). Also big groups were for beach cleanings (26%) and information signs (20%)

(Fig. 12). 10% wanted Çaliş beach to switch to ecotourism (Fig. 12). Only 7% wanted to finance lecture in hotels (Fig. 12). Adopt-a-sea turtle program and "other" were not chosen often (2%) (Fig. 12). Comments at "other" include: to reconnoiter locals better, to call attention by travel agencies.

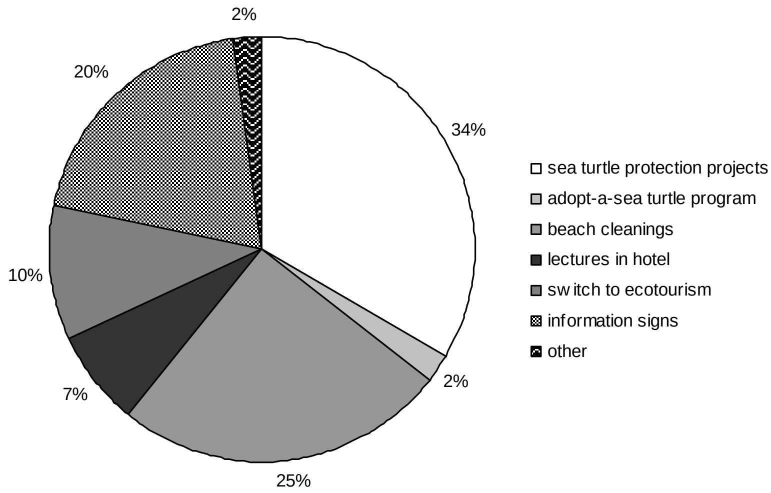

Fig. 12: Statements on the preferred use of donations in percent.
Abb. 12: Angaben zum bevorzugten Gebrauch der Spenden in Prozent.

If you've been to Çaliş more than once, how would you describe the changes?

Out of 36 respondents 50% said that there were more or much more tourists in Çaliş, and 22% rated it as unchanged (Fig. 13).

56% agreed that the litter increased or increased considerably over the years, while 21% said had decreased or decreased considerably (Fig. 14) (n=39).

Out of 37 interviewees, 60% thought that there are more or much more restaurants at the promenade and 30% thought it did not change over the years (Fig. 15).

The amount of people on the beach at night was mostly rated as being unchanged (46%), but 48% also thought that there are much more (Fig. 16) (n=35).

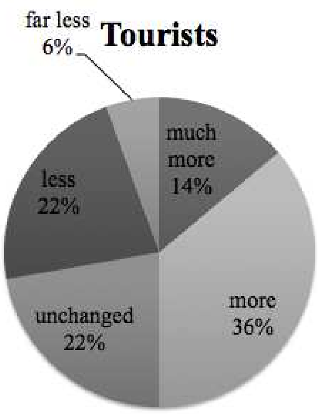

Fig. 13
Abb. 13

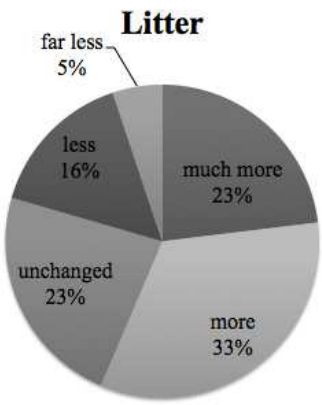

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Abb. 14

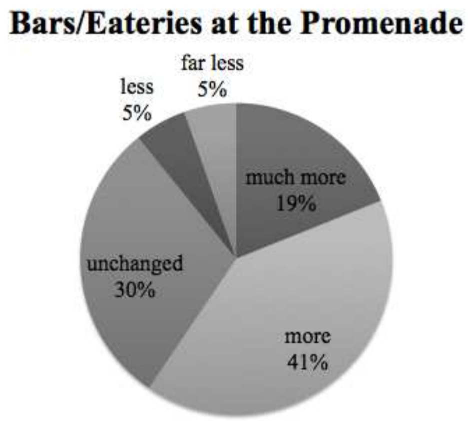

Fig. 15
Abb. 15

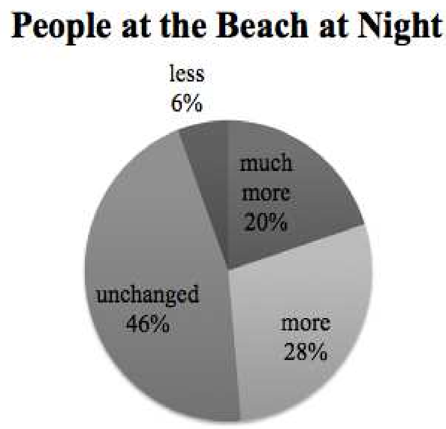

Fig. 16
Abb. 16

Fig. 13-16: Statements about the changes in terms of tourists, litter, restaurants at the promenade, and people at the beach at night in percent
Abb. 13-16: Angaben über die Veränderungen in Hinsicht auf Touristen, Müll, Restaurants an der Promenade und nächtliche Strandbesucher in Prozent

Questions asked at the information desk

The questions asked at the info desk are allocated into 3 main categories: project-related questions, sea turtle-related questions and other questions (Fig. 17). For a better overview, questions asked less than 3 times are counted into the total number but not listed in the results (listed in the appendix). Questions on price, size and color of the articles being sold are excluded.

Sea turtle- related questions were asked the most (63%), followed by project-related questions (29%) (Fig. 17). 8% of the questions are about other things (Fig.17) (n=524).

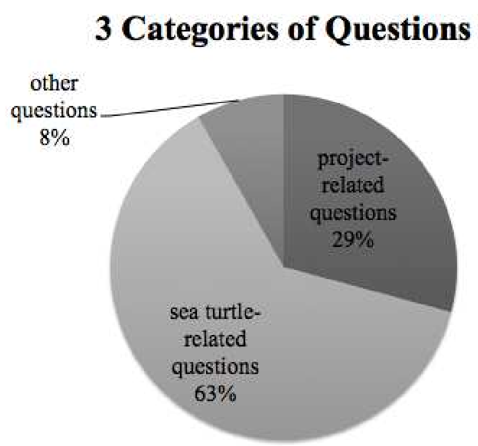

Fig. 17: Percentage of the 3 categories of questions asked at the info booth
Abb. 17: Prozentanteil der 3 Kategorien von Fragen die am Informationsstand gefragt wurden

Tab. 1: Project related questions asked by tourists and their relative frequency. R.F. a) = relative frequency of project-related questions, R.F. total = Relative Frequency of all asked questions
Tab. 1: Fragenkatalog der gestellten projektbezogenen Fragen, deren Häufigkeit und relative Frequenz. R.F. a) = relative Häufigkeit projektbezogener Fragen, R.F. total = relative Häufigkeit aller gestellten Fragen.

	Frequency	R.F. a)	R.F..total
a) Project-related questions	153	100.0%	29.2%
Basic questions on the project and the people working on it	79	52.0%	15.1%
What do you do here?	26	17.0%	5.0%
Where are you from?	12	7.8%	2.3%
How long do you stay here for this project?	8	5.2%	1.5%
Can I book a sea turtle tour?	8	5.2%	1.5%
How do you finance this project?	5	3.3%	1.0%
What are the opening ours of the information desk?	4	2.6%	0.8%
What do you study?	3	2.0%	0.6%
Questions on this topic, that were only asked twice or less	13	8.5%	2.5%
Questions on the shift (time, duration, route)	11	7.2%	2.1%
When and how often do you do your shifts?	8	5.2%	1.5%
How far do you go on your shift and how long are they?	3	2.0%	0.6%
Direct questions on the work	18	11.8%	3.4%
What do you do after you collect the hatchlings?	8	5.2%	1.5%
What do you do on your shifts?	5	3.3%	1.0%
Questions on this topic, that were only asked twice or less	5	3.3%	1.0%
Questions about the protection cages	22	14.4%	4.2%
What are the cages for?	14	9.2%	2.7%
Questions on this topic, that were only asked twice or less	8	5.2%	1.5%
Questions about the litter	6	3.9%	1.1%
Who is in charge of keeping the beach clean?	4	2.6%	0.8%
Why is there so much litter on the beach?	2	1.3%	0.4%
Other	17	11.1%	3.2%
How can people join/help (beach clean up, how to behave, help with the shifts, join an adopt-a-sea-turtle program?	11	7.2%	2.1%
Questions on this topic, that were only asked twice or less	6	3.9%	1.1%

Tab. 2: Sea turtle-related questions asked by tourists and their relative frequency. R.F. b) = relative frequency of project-related questions, R.F. total = Relative Frequency of all asked questions
Tab. 2: Fragenkatalog der Meeresschildkörten-bezogenen gestellten Fragen, deren Häufigkeit und relative Frequenz. R.F. b) = relative Häufigkeit projektbezogener Fragen, R.F. total = relative Häufigkeit aller gestellten Fragen.

	Frequency	R.F. b)	R.F. total
b) Sea turtle-related questions	328	100.0%	62.6%
Questions about the nests:	132	40.2%	25.2%
When is the nesting season?	22	6.7%	4.2%
Are sea turtles nesting on this beach?	20	6.1%	3.8%
How many nests are there in Çaliş	18	5.5%	3.4%
How many eggs per nest?	15	4.6%	2.9%
Where are the nests?	13	4.0%	2.5%
At which time of the day do the adults come for nesting?	7	2.1%	1.3%
How deep are the nests?	4	1.2%	0.8%
Why do sea turtles come to the beaches where they were born for nesting?	4	1.2%	0.8%
At which other beaches does *Caretta caretta* nest in the Mediterranean Sea?	4	1.2%	0.8%
How do they nest?	3	0.9%	0.6%
How often do they nest?	3	0.9%	0.6%
Questions on this topic, that were only asked twice or less	19	5.8%	3.6%
Questions about hatchlings:	115	35.1%	21.9%
Are any hatching now?	20	6.1%	3.8%
How long is the incubation time?	17	5.2%	3.2%
At which time of the day do they hatch?	15	4.6%	2.9%
Can I see hatchlings?	13	4.0%	2.5%
How many hatchlings survive until they reach maturity?	8	2.4%	1.5%
Where are the nests that are hatching now?	7	2.1%	1.3%
How big are the hatchlings?	6	1.8%	1.1%
How many hatchlings make it to the sea?	4	1.2%	0.8%
Who are the predators of hatchlings?	4	1.2%	0.8%
How do the hatchlings find their way to the sea?	3	0.9%	0.6%
How does the hatching process work?	3	0.9%	0.6%
Why are they hatching at night time?	3	0.9%	0.6%
Questions on this topic, that were only asked twice or less	12	3.7%	2.3%
Other questions:	81	24.7%	15.5%
Can I see adult sea turtles?	9	2.7%	1.7%
How big do sea turtles get?	9	2.7%	1.7%
Can I have some information about *Caretta caretta*?	6	1.8%	1.1%
Why is tourism in Çaliş a problem for the turtles?	5	1.5%	1.0%
Which routes do they swim?	4	1.2%	0.8%
Why are people being at the beach at night a problem for *Caretta caretta*?	3	0.9%	0.6%
Questions on this topic, that were only asked twice or less	45	13.7%	8.6%

Tab. 3: Other questions asked by tourists and their relative frequency. R.F. c) = relative frequency of project-related questions, R.F. total = Relative Frequency of all asked questions
Tab. 3: Fragenkatalog der restlichen gestellten Fragen, deren Häufigkeit und relative Frequenz. R.F. c) = relative Häufigkeit projektbezogener Fragen, R.F. total = relative Häufigkeit aller gestellten Fragen.

	Frequency	R.F. c)	R.F. total
c) Other questions	43	100.0%	8.2%
Sortiment (questions on size, colour and price excluded)	13	30.2%	2.5%
Do you still have toy turtles?	3	7.0%	0.6%
Questions on this topic, that were only asked twice or less	10	23.3%	1.9%
Questions about the movie Tortuga	7	16.3%	1.3%
What kind of movie is this?	4	9.3%	0.8%
Questions on this topic, that were only asked twice or less	3	7.0%	0.6%
Questions about the use of the phone booth	7	16.3%	1.3%
Where can I get phone cards?	3	7.0%	0.6%
Questions on this topic, that were only asked twice or less	6	14.0%	1.1%
Questions about directions/sights/places	8	18.6%	1.5%
Questions on this topic, that were only asked twice or less	8	18.6%	1.5%
Other questions	8	18.6%	1.5%
Can I ask you questions about my fresh water turtle?	3	7.0%	0.6%
Questions on this topic, that were only asked twice or less	5	11.6%	1.0%

DISCUSSION

Fethiye´s beach is 8.5 km long and is divided into the following parts: Çaliş, Yaniklar and Akgöl. It is one of over 17 major sea turtle nesting beaches in Turkey and was declared a Special Protected Area in 1988 (Casale & Margaritoulis 2010).

The Bern Convention Standing Committee asked the Turkish Government in its Recommendation No.66 in the year 1998 to "secure the remaining unbuilt beach plots against development" in Fethiye. MEDASSET submitted a complaint to the Bern Convention Secretariat in September 2009 because "the destruction of the nesting beaches, combined with the ongoing destruction of immediately adjoining wetlands for major upcoming construction projects, are incompatible with the Special Protected Area status of the region" (www.medasset.gr).

Nesting data point to a negative population trend of the loggerhead turtles at Fethiye (Ilgaz et. al. 2007). Global coastal tourism, which started in the 19th century, has increased in non-linear fashion (Davenport, Davenport 2006).

One of the major reasons why sea turtles are endangered is the continuing loss of nesting habitat often due to tourism (www.turtles.org). This is also true in Çaliş (Fellhofer & Stachowitch 2005). Therefore it is important to educate the tourists about sea turtles to protect Çaliş as a nesting beach.

The biggest nationality groups visiting Çaliş are German, Turkish, British and Dutch (Fig. 1). Therefore it is important to make information available in at least the Turkish, German and English language.

Most tourists who were interviewed try to integrate environmental protection at least a little bit into their holiday planning (Fig. 4) and are interested to learn more about sea turtles. According to this result, it can make a difference in awareness when more information material is distributed for example at the hotels.

Most chose Çaliş as a vacation site for relaxation and nature (Fig. 3) and think that nesting sea turtles are an enrichment for the beach. Therefore consideration should be given as how to combine relaxing at the beach with keeping the disturbance for sea turtles as low as possible (e.g. not visiting the beach at night, not sticking own parasols into the sand etc.).

Only 13% think that the beach is clean (Fig. 5). This points to an insufficient cleaning effort. Those opinions can be used for arguments because the condition of the beach is also of interest to the local economy, as tourists are the biggest source of income.

Surprisingly, 42% of questioned tourists state that they do not visit the beach at night (Fig. 6). More information for the people, who might disturb the turtles, especially at night, has to be provided through more signs and lectures at hotels. Due to the promenade, the beach cannot be closed easily, but official patrols could help to reduce the disturbance by people at the beach at night.

62% know that sea turtles are nesting at the beach of Çaliş. 30% of those state the info desk as source of this knowledge (Fig. 7). This shows its important and positive influence.
Only 7% state to have the information for the hotel (Fig. 7). This shows that the hotels can do a lot more information work, which is possible by hanging up posters, distributing folders at the reception desk and in the rooms or showing sea turtle-related videos.

Most tourists agree that the signs do not mark the beach adequately as a nesting beach. This year two big new signs were put up at the stairs to the beach. This is a good place where a lot of people see them, but a lot more of them would be needed.

47% think that the nests are not marked adequately. Closing the top of the protective cages is a problem because it would increase the shade, but signs out of a more solid material than plain paper, which is not that much influenced by the wind, could make a positive change. The cages and their purpose could be explained on the information signs.

Tourists seem to think that sunbeds are the least troublesome factor for sea turtles (Fig. 9). This makes it even more important to remove the sunbeds from the beach at night, because when people are not aware of them being a problem, they will use them.

Most don't know the influence of shadow-creating objects on nests (Fig. 10). The respondents also rated shade the least harmful problem for hatchlings (Fig. 10). It may help to include this on the information signs and on the cages.
The way of questioning about the influencing factors of nesting sea turtles and hatchlings (Fig. 9, Fig. 10) might have influenced answers. This is because the questions hint that everything is harmful. On a positive note, this modus is itself a way to inform the tourists.

42% of the questioned tourists are willing to pay to support environmental protection in Çaliş. Out of these people, 88% choose <30 TL as an acceptable amount (Fig. 11). They would like seeing it spent on sea turtle protection projects, beach cleanings and information signs (Fig. 12).
Mandatory payment will be hard to follow through, but donation boxes could be put next to the information signs.
With that money, more information signs could be afforded and regular beach cleanings could be paid. It also opens possibilities for a better distribution of information material in hotels. Financing local sea turtle protection projects would include this plus other local expenses, but the raised money could also be used for international sea turtle protection projects.

During the last week of July, presentations were held by Turkish and Austrian students in 5 different hotels. These presentations were held on short notice. Not many people (5-20) attended, but most of those who did were interested. A lot of people could be informed by such lectures, but they need to be planned more in advance. A list for the presentations held at a certain time in a hotel needs to be distributed at the information desk and at the hotels.

Figs. 13-16 show that most tourists detect a negative development involving more tourists, litter, restaurants at the promenade and people at the beach at night. Those factors are of course all linked to the number of tourists.

Most of the people visiting the information desk ask questions about sea turtles-related topics (Fig. 17). This shows that tourists choose to get information at the info desk and that it successfully educates people about the turtles.
Many ask what we are doing and want to know more details about the project (Tab. 1). Many are interested in the purpose of the cages (Tab. 1). The most asked questions are asked about the nests, especially about the nesting season, about nesting turtles and about the number of

nests (Tab. 2). Many people also want get more information about the hatchlings, e.g. whether there are any hatching now or how long the incubation time is (Tab. 2).
They often asked about the hatching nests and expressed a desire to go there and see hatchlings. This can have a positive effect on people's behavior, but can also be a problem when they want to take photos with flashes or touch the hatchlings.
There has to be a healthy compromise of keeping the tourists away from the cages to keep the disturbance to a minimum and letting people see why this beach is so important to save as a nesting beach.

Altogether, there is a negative ecological development related to the increase of tourism, and the apparently decreasing number of nest. At the same time because people are interested in this topic, it might change the situation by keeping them informed. This has to happen also in hotels and preferably already at the planning stage of the holiday by travel agencies or travel guides.

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APPENDIX I: Questionaire

1. Duration of our stay in Çaliş: **2. Number of previous visits:**

3. Why did you choose Çaliş for your stay?

reputation □ all-inclusive offer □ just traveling through □

nature□ relaxation □ sports offers □ other □_________

4. How much do you try to integrate environmental protection into your holiday planning?

much □ little □ hardly □ not at all □

5. From your point of view, how clean is the beach?

clean □ slightly polluted □ polluted □ severely polluted □

6. How often are you at the beach at night?

not at all□ once a week□ 2-6 times a week□ every day□

7. Did you know, that sea turtles are nesting at this beach?

yes □ no □

If so, where did you get this information from?

info desk □ travel agency □ internet □ friends □ hotel □ TV □

other □____________

8. Would you like to learn more about sea turtles?

yes □ no □ don´t know □

If so, what would you like to know about them?

protection□ nesting behaviour□ way of life/habitat□ population□

other □____________

9. From your point of view, is the beach marked adequately as a nesting beach?

yes □ no □ don´t know □

10. From your point of view, are the nests marked adequately?

yes □ no □ don´t know □

11. Do you think that nesting sea turtles are an enrichment for Çaliş?

yes □ no □ don´t know □

12. Have you ever seen a sea turtle at the beach of Çaliş?

yes, once □ yes, several times □ no □

13. Did you know, that the sex of a sea turtle is determined by temperature and can therefore be influenced by parasols, towels or other shadow-creating objects?

yes □ no □

14. How much are female sea turtles handicapped by the following while nesting?

flashlights:	very much □	much □	hardly □	not at all □
people at the beach:	very much □	much □	hardly □	not at all □
light and noise from the promenade:	very much □	much □	hardly □	not at all □
cars and similar objects at the beach:	very much □	much □	hardly □	not at all □
bonfires at the beach:	very much □	much □	hardly □	not at all □
sunbeds left on the beach at night:	very much □	much □	hardly □	not at all □
litter:	very much □	much □	hardly □	not at all □
boats:	very much □	much □	hardly □	not at all □

15. How much do the following incidents decrease the number of surviving hatchlings?

litter:	very much □	much □	hardly □	not at all □
artificial light:	very much □	much □	hardly □	not at all □
cars and similar objects at the beach:	very much □	much □	hardly □	not at all □
shadow-creating objects:	very much □	much □	hardly □	not at all □
parasols put in the sand:	very much □	much □	hardly □	not at all □

16. Would you be willing to pay to support professional environmental protection in Çaliş?

yes □ no □ don´t know □

If so, how much?

< 10 TL□ 11-30 TL□ 31-50 TL□ 51-70 TL□ 71-90 TL□ >90 TL□

If so, how should the money be spent?

sea turtle protection projects □ adopt-a-sea turtle program□

beach cleanings □ lectures in hotel □ switch to ecotourism □

information signs □ other □____________

17. If you´ve been to Çaliş more than once, how would you describe the changes?

tourists:	much more □	more □	unchanged □	less □	far less □
litter:	much more □	more □	unchanged □	less □	far less □
bars/eateries at the promenade:	much more □	more □	unchanged □	less □	far less □
people at the beach at night:	much more □	more □	unchanged □	less □	far less □

18. Nationality: **19. Age:** **20. Gender:** male □ female □

APENDIX II: Questions asked at the Infodesk less than 3 times

	Frequency
a) Project related-questions	
Basic questions on the project and the people working on it	
Do you have to learn Turkish to join this project?	2
Are you volunteers?	2
How many students are working in this project?	2
Do you work together with Dalyan?	2
Did you have anything to do with the satellite tagging?	2
Since when does this project exist?	1
Is this project happening every year?	1
Do the hotels help you with this project?	1
Direct questions on the work	
How do you find nests?	2
Why are you not putting the hatchlings directly into the water?	2
Are these reports part of your work?	1
Questions about the cages	
What do you do with the cages after the nest hatched?	2
Do people respect the cages?	2
Are the cages dangerous for the hatchlings?	1
How long do the hatchlings have to stay in the cages?	1
What are the research cages for?	1
Is there a punishment for the misuse of the cages?	1
Questions about the litter	
Why is there so much litter on the beach?	2
Other questions	
How did the tourism change over the years?	2
Is there a tension between nature conversation and locals?	1
Is this information about Patara?	1
Why do you also have light at your info desk?	1
Do tourists react to your work?	1
b) Sea turtle-related questions	
Questions about the nests	
How many nests are in Dalyan?	2
Can’t you bring the turtles to nest on darker/more silent beaches?	2
Are there fewer nests then the years before?	1
Which turtles nest in Çaliş?	1
How many nests have been in Çaliş last year?	1
Where in turkey are better nesting beaches?	1
Is Çaliş the only turtle nesting beach in this area?	1
Can’t you relocate the nests?	1
Why is the beach not closed during nesting season?	1
What happens when I put the pole of my parasol into a nest?	1
Can I dig up a nest?	1
How long does it take to nest?	1
How do you find the nests?	1

How big are the nests?	1
Do they only come offshore for nesting?	1
Are there eggs in the nest?	1
How big are the eggs?	1
Questions about hatchlings	
Can I take hatchlings home with me?	2
What are the dangerous for hatchlings?	1
Can you tell the sex of a hatchling?	1
Do they only hatch when there is full moon?	1
Are the hatchlings able to swim right after they hatch?	1
Why does the female sea turtle leave the eggs/hatchlings alone?	1
Can I touch a hatchling?	1
Where do the hatchlings rest?	1
Do they hatch fully developed?	1
Are they all hatching at the same time?	1
Can you guide the hatchlings with light into the sea?	1
Other questions	
Where is the tagged sea turtle?	2
Do the sea turtles from Çaliş swim all the way to the Atlantic Ocean?	2
Is the fishing industry a big problem for sea turtles?	2
What do sea turtles eat?	2
How long can sea turtles stay under water?	2
When do turtles reach maturity?	2
Are there really male sea turtles in Çaliş?	1
How big are the eggs?	1
At which time can we see the males in Fethiye?	1
Do sea turtles have ears?	1
Do sea turtles have a sense of sight?	1
Do cormorants eat the same as the sea turtles?	1
Why does the light of the promenade disturb the turtles?	1
Are the turtles hurt by strong waves?	1
Why is litter a problem for the turtles?	1
Which litter (plastic bottles, plastic bags, etc.) is the most dangerous for sea turtles?	1
What do sea turtles do during daytime?	1
Are there surveillance cameras to penalize cars on the beach?	1
Why are the sea turtles in Dalyan injured?	1
Do you get money for dead sea turtles?	1
Are there still no hotels in Patara?	1
Why is *Caretta caretta* endangered?	1
How do you see the future for *Caretta caretta in Çaliş?*	1
Are there more hotels planned in Çaliş?	1
Did you have dead turtles due to boots yet?	1
Do you think it's possible to have less tourism in Çaliş in the next couple of years?	1
How long are the bars open and have their lights on?	1
Do the males also come on land?	1
Can you see turtles in Dalyan?	1
What are the biggest problems for sea turtles?	1

How long do sea turtles grow?	1
Why does it work in Dalyan?	1
At which temperature range will the embryos develop to females?	1
Why do you do excavations?	1
How do the turtles sleep?	1
Which is the biggest sea turtle species worldwide and how big are they?	1
Why are the turtles not included in brochures about Çaliş?	1
Why is not more information about *Caretta caretta* distributed in Çaliş?	1
c) Other questions	
Sortiment (questions on size, colour and price excluded)	
Is the toy turtle alive?	2
Do you have drawing books?	1
Do you have turtle key chains?	1
Did you do the postcards on your own?	1
Are the postcards taken in Fethiye?	1
Are the postcard pictures from this year?	1
Are the bags made by children?	1
Do you have tissues?	1
Can the toy turtles move?	1
Questions about the movie Tortuga	
Can I buy this video?	1
Where was this movie produced?	1
Why is this movie in english?	1
Questions about the use of the phone booth	
Do you sell phone cards?	2
What is the country code for England?	1
How does this phone booth work?	1
Questions about directions/sights/places	
Where is the Orient Hotel?	1
Do you have information about Fethiye?	1
Do you have Fethiye maps?	1
What can I see in this area?	1
What can you recommend in Dalyan?	1
What can I see at the rescue and rehabilitation center in Dalyan?	1
Can I go rafting on the Dalyan River?	1
Is there a Disco somewhere?	1
Other questions	
Have you been to Dalyan yet?	1
Do you do tattoos?	1
Do you have internet connection?	1
Did you find a cell phone?	1

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……………….............2011 Observer:…………………..………………

ADULT/NEST/TRACK

<table>
<tr><td colspan="2">Date:………………. Time:………………..</td><td>Nest Nr.:…………..</td><td>Track Nr.: ……………..</td></tr>
<tr><td colspan="2">Tag Nr.: [L / R]

Straight measurements:
SCL ……. SCW ………
Curved measurements:
CCL ……. CCW ……….

Epibionts ………………….

Deformations……………….</td><td>Shape of track

dry zone(1)

moist zone(2)

wet zone(3)</td><td>Total track length:………………..
Track width:………………………
Nr. of body pits: ………………….
Nest Dist. to sea: ………………..

Beach zones
1:…………………m (dry)
2:..………………....m (moist)
3:…………………..m (wet)
Hatchery
Yes No</td></tr>
</table>

Exact position of the nest:

Notes: vegetation, substrate type (sand, pebbles > 2mm, cobbles > 64 mm)

.....................2011

HATCHING-DATA

Nest Nr:................. Nest Date:………………… Incubation Time:………………….. Observer:………………………………………

Emerging days	1	2	3	4	5	6	7	8	Total
Hatch date									
Hatch time (start)									
Number of tracks									
Hatchlings reaching the sea									
Predated hatchlings									
Predated eggs									
Dead due to sun/heat									

Other observations and remarks:

Nest excavation: Date:.......…………….. Time :…….…..……….… Observer:………………………………………………

Empty shells	
Hatchlings still living inside nest	
Dead hatchlings in nest	
Unfertilized eggs	
Total Nr. of fertilized eggs:	

Early-embryonic stage (<1 cm)	
Mid.-embryonic stage (>1 cm <2cm)	
Late-embryonic stag (> 2cm)	

Total Nr. of eggs	
Total Nr. of empty shells	
Total Nr. of hatchlings reaching the sea	

Depth: top eggs	
Bottom of chamber	
Diam. of chamber	
Nest dist. to sea	

Insects ets. in nest:

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