Wildlife Sense Sea Turtle Monitoring Report 2013

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Acknowledgements

The 2013 Wildlife Sense project was conducted under research license no. 178061/3212 by the Ministry of Environment, Energy & Climate Change. Data collection in the 2013 season was made possible thanks to the dedication of the Wildlife Sense field research team; all the data presented in this report were collected by several local and international volunteers that worked tirelessly in the field. We would especially like to thank Mike and Shirley Ogden, Paul and Ena West, Phil and Linda Davison and Jane Lent for their upbeat attitudes and enabling us to expand the beaches monitored by Wildlife Sense. We would also like to thank Peter Lee and Martyn Green with their help in spreading awareness and assisting in stranded and rescued turtles.

1. Introduction

The objectives of this project were to assess and protect loggerhead (*Caretta caretta*) sea turtle nests on the beaches of Kefalonia, study characteristics of those nest sites throughout the season, observe and record sea turtle foraging behavior in the Argostoli harbor area and promote public awareness to locals and visitors about the local sea turtle population.

A special goal for 2013 was to ensure proper monitoring methodologies were followed and that Level 1, the highest level of data collection, was achieved for the majority of the beaches that were monitored. The beaches on the southwestern part of the Island had not previously been patrolled using standardized sea turtle monitoring methodology and past data failed to meet the minimum data requirements, as published in State of the World's Sea Turtles (SWOT).

2. Methods

All research sites were located on the island of Kefalonia, Greece. Kefalonia is situated off the west coast of Greece and is the largest island of the Ionian Sea. The nesting beaches monitored by Wildlife Sense were all located along the southern coast of Kefalonia.

A presentation was given on 23 May 2013 to members of the public interested in contributing towards the protection of the local sea turtles. After this meeting, seven local volunteers assisted in the collection of data during the summer of 2013. The addition of these local volunteers allowed for an expansion in the beaches patrolled, extra patrols to be conducted and aided in sea turtle rescues and handling of strandings.

The bulk of the work that was required for data collection and the application of conservation practices on the nesting beaches and the harbor of Argostoli was carried out by approximately 100 volunteers. The volunteers, mostly coming from European, North American, and Asian countries, travelled to Kefalonia to participate to the project. Most volunteers were students or recent graduates in Biology, Ecology, or associated fields of study, so the project especially designed to offer on-hands experience on scientific and practical aspects of wildlife conservation.

All non-local volunteers stayed for two to seven weeks at the basecamp, which was organized and operated by Wildlife Sense. The basecamp was setup in Camping Argostoli on 29 May to prepare for our 2013 program. Training and orientation sessions were conducted when new volunteers arrived, every two weeks, by Chanel Comis with support from Nikos Vallianos.

During the first two weeks of June, the beaches were prepared by adding bamboo beach markers and conducting beach cleanups. The beach markers allowed the surveyors to measure each nest's precise location on the beach, as GPS coordinates are only ±3m accurate. Each beach marker was placed 25m apart at the back of the following beaches: Minies, Megali Ammos, Eglina, Ammes, Megali Petra and Avithos.

2.1 Monitoring Areas

The main nesting beaches monitored were located in the south central portion of the Island: Kalamia, Palliostafida, Makris Gialos, Platis Gialos, Minies, Megali Ammos, Eglina, Ammes, Ai Chelis, Megali Petra, and Avithos. These beaches were separated into three sections; The **Lassi section** (Kalamia, Palliostafida, Makris Gialos and Platis Gialos), the **airport section** (Minies, Megali Ammos, Eglina and Ammes) and **Avithos Bay section** (Ai Chelis, Megali Petra, and Avithos).

Four additional beaches were monitored during the season. Megas Lakkos located along the southern coast of **Paliki** peninsula in west Kefalonia and three beaches in the **Lourdata** area: Lourdas, Kanali and Trapezaki.

The following beaches had daily beach surveys conducted around 06:00 between 1 June and 7 October 2013: Minies, Megali Ammos, Eglina, Ammes, Ai Chelis, Megali Petra and Avithos. The following beaches had daily beach surveys conducted around 06:00 between 15 June and 7 October 2013: Kalamia, Palliostafida, Makris Gialos and Platis Gialos.

The marine area of **Argostoli bay**, including the **Koutavos lagoon**, have been found to host daily sea turtle activity. In these areas sea turtles have been observed mating, foraging, and interacting with the public (White 2002). Much of the turtle activity has been observed during the day between 07:00 and 14:00.

2.2 Nesting beach monitoring

Beach surveys were conducted in accordance to methodology described by Schroeder and Murphy (1999). The purpose of these surveys was to assess and protect the nesting activity of sea turtles on the beaches of Kefalonia.

Morning surveys were performed by teams of two to three volunteers. Each team surveyed a group of beaches, starting early in the morning to ensure all surveys were completed before noon time. Volunteers arrived at the beginning of each beach and walked its entire length along the coastline. During the morning survey, volunteers identified sea turtle emergence tracks that occurred during the previous night and monitored known nest locations for signs of hatchling activity.

When turtle emergence tracks were encountered, they were **analyzed to identify and categorize the actions of the turtle** (e.g. nest, false crawl, swim in sand, abandoned egg chamber). In case the site was categorized as a potential nest site, the volunteers identified the exact nest location and carefully dug the area to find the top egg, which confirmed the presence of a nest. Before reburying the nest, the depth from beach surface to the top of the first egg in the chamber (h) was recorded. Nest relocations were performed in cases where the original nest location was considered to be unsuitable for successful incubation of the eggs.

All nests were protected by roping them off with red and white caution tape and placing a nest sign behind it. This reduced the risk of accidental damage by human beach visitors and aided in their monitoring during the incubation and hatching period. **Nests were monitored daily** after they were first recorded to assess their progress or identify any potential threats, with a focus on predation, beach use for tourism, vibrations, and light pollution.

The locations of **all turtle emergences and nests were measured and recorded** using tape measures as well as hand-held GPS receivers (Garmin eTrex 10, accurate to ± 3m). **All monitoring data were recorded in the team's logbook** and regularly copied on a computer file, and Wildlife Sense's nesting database. **All nesting data were shared publicly through seaturtle.org and the State of the World's Sea Turtles** (SWOT or seaturtlestatus.org).

2.2.1 Light surveys

Light pollution surveys were carried out weekly when hatching season had begun. Light surveys were conducted at 21:00 weekly from July to October where lights were determined as polluting the beach. If any nests were found illuminated, **an action plan was formulated on how to best mitigate the light pollution**.

One internship project focused on the light pollution of Megali Ammos as it yielded the largest number of nests near the Argostoli area. The main aim of the investigation was "to determine whether nesting success rates relate to areas of light pollution using GPS data of sea turtle emergence events". To do this, the boundaries of the illumination on the beach were recorded using a GPS and later mapped. Light-polygons were then created to mark the perimeters of ecological light pollution. A map was created to mark all nesting attempts, non-attempts and nests. The light-polygons illustrated the number of nests within an area of light pollution (Bancroft 2013a).

2.2.2 Nest monitoring and hatching

All identified nests were monitored for the remainder of the season as a part of the daily duties of the beach survey team. The team closely monitored each nest for hatchling emergence after 45 days of incubation. Once a nest had its first hatching event, the team identified and recorded all hatchling tracks to **make sure that all hatchlings reached the sea**.

2.3 Nest survivorship and hatching success

Once a nest hatched for 7 nights and there were less than 5 hatchling tracks coming from the nest the next morning or 70 days after oviposition, an excavation was performed to compile an egg fate inventory (USFWS 2008).

For each nest excavated the following information was recorded to determine hatching and emergence success:

1. Number of empty shells that are more than 50% complete
2. Number of live hatchlings above the egg chamber
3. Number of dead hatchlings above the egg chamber
4. Number of live hatchlings within the egg chamber
5. Number of dead hatchlings within the egg chamber
6. Number of pipped live hatchlings
7. Number of pipped dead hatchlings
8. Unhatched eggs – these were then further categorized as:
    a) No visible embryo in unhatched egg
    b) Embryo with eye spot in unhatched egg
    c) Early developmental stage embryo in unhatched egg
    d) Middle developmental stage embryo in unhatched egg
    e) Late developmental stage embryo in unhatched egg
    f) Live embryo in unhatched egg

Hatching success, referred to the **number of hatchlings that hatched out of their egg shell** (number of empty egg shells that were more than 50% complete). **Emergence success** referred to the **number of hatchlings that reached the beach surface** which was equal to the number of empty egg shells minus the number of live and dead hatchlings remaining in the nest chamber (Miller 1999).

2.4 Harbor sea turtles

The Bay of Argostoli hosts a **loggerhead sea turtle population that has demonstrated high site fidelity** (White, 2002). To further study this population and its behavior, daily observation patrols were carried out between 07:30 and 11:30. The harbor side of the bay was divided into four sections, with each section patrolled by a volunteer for the duration of the survey. S**ocial antagonistic behaviors were recorded** including both passive threat displays (e.g. head-tail circling) and aggressive combat (e.g. biting and sparring) as defined by Schofield et al. (2006). **Foraging events were also recorded** along with source of the food (natural, fisherman or tourist). Additional data like the number of male and female turtles and the total number of fishing boats was recorded each day. Many sea turtles were photographed after the observation of their social interaction was recorded. The team also sought to inform visitors that usually gathered to observe the sea turtles in the Harbor.

Using the photographs taken at the harbor, the **volunteers identified individual turtles** by using carapacial epibiotic distribution (recording which scutes are parasitized by barnacles), physical damage and scarring, the number and shape of facial scales, and other characteristics (Reisser et al. 2008). It was the focus of intern Suzy Lemoine to collect these photos, identify and catalog them with the aim to compare her findings with White (2004) who reported four turtles having site fidelity in the bay in 2001.

2.5 Stranded or injured sea turtles

The Wildlife Sense team encountered stranded turtles on the beaches and surrounding coastline of Kefalonia. In the event that a stranded or injured turtle was found, a local veterinarian was contacted immediately. When required, **stranded or injured turtles were sent to the Sea Turtle Rescue Centre** in Athens. Stranding data sheet were completed and submitted to the port police. For stranded dead turtles where the cause of death was unknown, a necropsy was performed to identify the cause of death when possible.

3. Results and Discussion

3.1 Monitoring areas

3.1.1 Daily track surveys

During the 2013 monitoring season, **36 loggerhead (*Caretta caretta*) nests and 54** non-nesting emergences were recorded by the beach surveyors in the **Lassi, Airport and Avithos Bay areas** (Table 1). While beach surveyors were normally Wildlife Sense volunteers, there was weekly help from local volunteers Mike and Shirley Ogden walking the Airport beaches bimonthly on Mondays and Fridays and Paul and Ena West walking the Airport Beaches bimonthly on Wednesdays.

Table 1. All nesting and non-nesting emergences on beaches monitored by Wildlife Sense in 2013.

	Nests	Non-nesting Emergences
Ai Chelis	2	10
Ammes	4	7
Avithos	3	7
Paliostrafida	1	0
Eglina	1	1
Kanali	1	2

Megali Ammos	15	9
Makris Gialos	4	6
Minies	2	1
Megas Lakkos	10	46
Megali Petra	3	13
Platis Gialos	1	0
Trapezaki	0	2

3.1.2 Triweekly track surveys

Megas Lakkos had triweekly beach patrols that were conducted around 06:00 between 1 June and 1 August 2013 and non-regular beach patrols conducted thereafter, including daily patrols from 9 September to 18 September. During this time, **10 loggerhead (*Caretta caretta*) nests and 46** non-nesting emergences were recorded by the beach surveyors (Table 1). The beach surveyor was typically Phill Davison with some assistance throughout the season from Wildlife Sense volunteers.

Lourdas, Kanali and Trapezaki beaches had triweekly beach patrols that were conducted around 06:00 between 1 June and 18 June and 4 September to 6 October 2013. During this time, **1 nest and 4** non-nesting emergences were recorded (Table 1). The beach surveyor was normally local volunteer Jane Lent with some assistance from Wildlife Sense volunteers.

3.2 Nesting beach monitoring

3.2.1 Light Surveys

Several beaches were found to have light pollution present, with Ai Chelis (Figure 1), Ammes (Figure 2), Megali Ammos (Figure 3) Avithos (Figure 4) and Makris Gialos having a significant light pollution problem. If a beach was found to have light pollution, there were several methods that were employed to ensure hatchlings oriented correctly once emerged out of their nest. If the light source could be turned off, it was. For example, a large spot light on Ai Chelis, as pictured in the top right photo of Figure 1, was switched off by a Wildlife Sense team each night when the nest was hatching. **If a light could not be turned off, it was either partially covered** (left photo in Figure 5) **or the nest was boxed** (top right photo in Figure 5) **or shaded** (bottom right photo in Figure 5).

On Megali Ammos there was a bright street light that could be partially covered so the light did not illuminate the beach, as shown in the photo on the left side of Figure 5. However if the light source was not directly above the nest, it could be shaded using beach mats (photo on bottom right side of Figure 5). When shading was not effective, the nest was boxed, as shown in the top right photo in Figure 5.

Boxing a nest required a team of at least two individuals, who placed a wooden box on top of the nest around 21:30 and checked the box every 30-60min until just after sunrise. If hatchlings were found in the box during the night, they were collected, taken to a dark part of the beach and released at the top of a pre-made 12m long trench leading to the sea. All hatchlings were observed until they reached the sea.

On one occasion on 16 August 2013, hatchlings on Makris Gialos were released in a dark area on the beach and observed until they swam in the sea. These hatchlings were later observed 50m farther down the beach crawling on the sand towards the bright lights of a beach bar. While the area the hatchlings were released at was dark enough to prevent disorientation, once they were in the sea, the light from the land was so bright that it interfered in their marine orientation cues and they swam back to the shore towards the beach bar.

Hannah Bancroft's internship project yielded some interesting results. While most emergences (58.33%) and most nests (53.33%) on Megali Ammos were found outside of the light polygons, there were many emergences and nests that were found to be within the light polygons. This could have been because some of the lights on the beach were tinted orange and it has been supported that white lights have a greater effect on hatchling orientation than on nesting females (Bancroft 2013b).

Figure 1. Ai Chelis Beach, the beach with the highest amount of light pollution. Top left: The beach bar of Ai Chelis, where several hatchlings were found crawling underneath the platform. These lights remained on until around 24:00 depending on beach traffic. Top right: A nest on the east end of the beach where a spot light was installed directly above it. This light was switched off once the nest boxing crew arrived. Bottom left: Spot light that remained on all night which lit the stairs that lead down to the beach. Bottom right: The area illuminated by the staircase spotlight and further down the beach is the well-lit beach bar and a bright beach house on the hill side.

Figure 2. Light pollution on Ammes beach during a dark night (left) and moon-lit night (right). Some of these lights were turned off by the nest boxing team while nests were hatching, however, when a Wildlife Sense team was not present the lights were found back on in the morning.

Figure 3. Light pollution on Megali Ammos. Top left: The light pollution survey team measuring light polygons to determine the light-polluted parts of the beach. Top right: A group of three well-lit houses near the end of the beach that were consistently lit. Communication was established with one resident who was willing to switch their porch light off, however they often forgot. Bottom left: Spot lights and outdoor lamps on Ammos Residence were found lit on many occasions, but with some reminding the cooperative owner Stelios turned them. Bottom right: The beach bar of Megali Ammos beach was lit until around 24:00 when the main lights were turned off. Light emitted from the soft drink refrigerator became a problem towards the end of the hatching season when nests near the beach bar were hatchling, but it was covered after several requests.

Figure 4. The light pollution on Avithos Beach consisted of a street light that illuminated a portion of the beach, a popular and well-lit beach bar and two busy restaurants 50m behind the beach. The beach bar was cooperative and the restaurants lights did not yield any problems as they were only visible from a small section of the beach.

Figure 5. Methods for dealing with light pollution on nesting beaches. Left: Nikos Vallianos partially covering a street light that emitted light onto Megali Ammos Beach. Top right: Nest boxing; placing a wooden box above the nest to collect hatchlings as they emerged out of the sand. The box was checked every 30-60min and hatchlings were released on a darker part of the beach. Bottom right: Nest shading was used when the light source was only on one side of the nest and at a safe distance.

3.2.2 Nest monitoring and hatching

In total, **151 loggerhead sea turtle emergences** were recorded with 47 of them resulting in nests (Figure 6) giving an **nesting success of 31.1%**. Out of the **47 total nests** found and protected, **9 (19.1%) were relocated** due to proximity to the sea or anthropogenic activity.

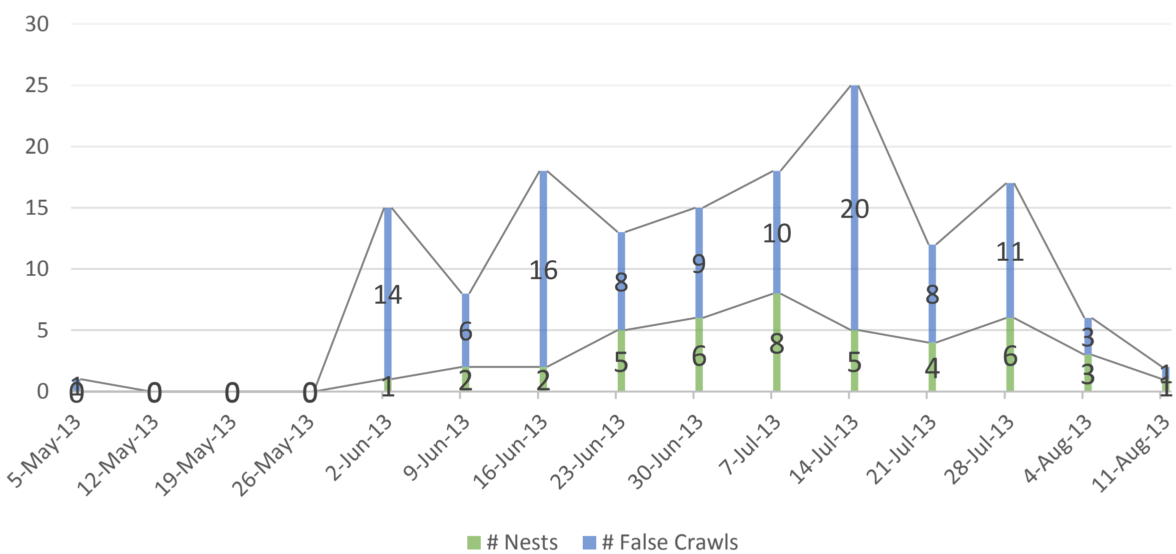

Figure 6. Temporal Distribution of Sea Turtle Emergence Activity in 2013. Please note that nests KA1, PG1, ML9 & ML10R were not included because their lay date was unknown.

The first recorded emergence was on 11 May on Megali Ammos and the last recorded emergence was on 11 August. On all but four beaches (Ammes, Avithos, Megali Ammos and Megali Petra) the turtles nested with no other nesting attempt (i.e. swim, body pit, and abandoned egg chamber). The **first nest recorded was on Avithos on 5 June** and the last recorded nest was on Megali Ammos on 11 August. As expected, the temporal nesting distribution had a typical bell-shaped curve with a defined beginning, peak and end (Figure 7). This temporal distribution of loggerhead nesting shows July to be the most popular month.

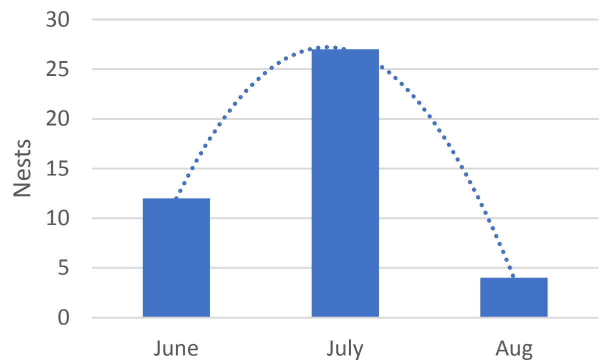

Figure 7. Temporal Distribution of Sea Turtle Nesting Activity in 2013 having typical bell-shaped curve and shows that July was the most popular month. Please note that nests KA1, PG1, ML9 & ML10R were not included because their lay date is unknown.

Nests were laid an average distance of 15±6.2m (mean ± st. dev.) from the sea with the top of the nest (h) being 26.7±6.5cm deep (i.e. the average depth from beach surface to the top of the first egg in the chamber was 26.7cm). A total of **3574 eggs** were counted from those nests that were not lost to inclement weather (n=40). The **average clutch (i.e. nest) contained 89.4±20.0 eggs**, which is relatively low compared to the published average clutch size of 112.4 eggs (Miller et al. 2003). Although the Greek loggerhead sea turtles are smaller in size than those of the Atlantic population (Broderick and Godley 1996, Margaritoulis et al. 2003), it was expected that the clutch size would be similar to other nesting areas in the region. However they were smaller than the average clutch size in Zakynthos of 106.7 eggs (Margaritoulis et al. 2011). The **smaller clutch sizes recorded on the nest beaches of Kefalonia is an important finding** that merits further research and monitoring in the upcoming years.

The **average nest incubation period was 53.1±4.5 days** with little deviation between nesting beaches.

3.3 Nest survivorship and hatching success

A post-hatching inventory excavation was performed for 32 nests, accounting for a total of 3418 eggs. 2110 eggs hatched successfully, making the **hatching success rate 61.7%**. However, 151 hatchlings did not leave the egg chamber, making the hatchling **emergence success 57.3%**.

An additional 156 eggs were accounted during nest relocations on two nests that were later lost due to inclement weather and inundations. Those eggs were excluded from nest survivorship calculations. Eggs that did not hatch were opened during the excavation to determine at what developmental stage the embryo had ceased developing. The majority (45%) of all unhatched eggs, or 15.5% of all eggs, were found not to have a visible embryo, meaning they were not fertilized eggs (Figure 8).

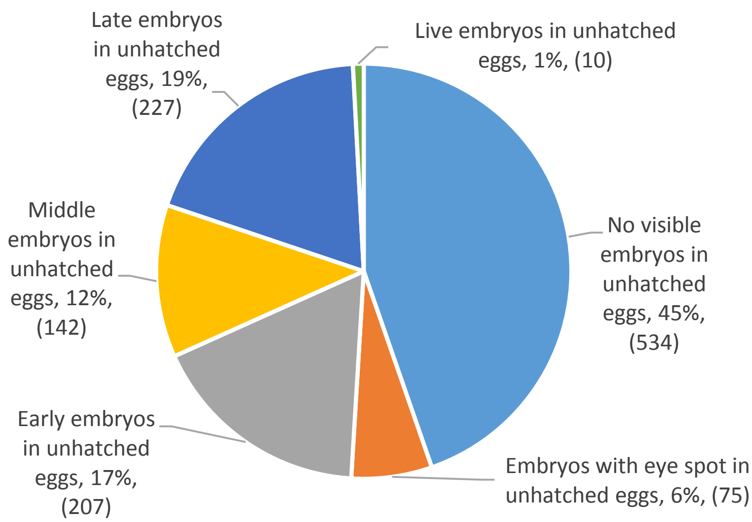

Figure 8. Unhatched egg categorization

According to Miller (1999) the hatching success is typically 1% higher than the hatchling emergence success, which was not the case this year on the beaches monitored by Wildlife Sense. In fact, the hatching success was 6% higher making it a concern that **hatchlings are having, on average, more difficulty emerging out of their nest than normal**. This could be due to sand quality, compaction or several other unaccounted for factors. Without accurate data collected in the previous years, there is no way to judge whether this statistic is standard for these beaches.

As expected relocated nests had more live hatchlings and a hatching success rate of 83.8%, which was 22.1 percentage points higher than the overall average (Figure 9). However it was not expected that the emergence success for relocated nests would be 26.6% higher than the overall average. This suggests that **hatchlings in relocated nests are more successful at emerging from their nest than the overall average**.

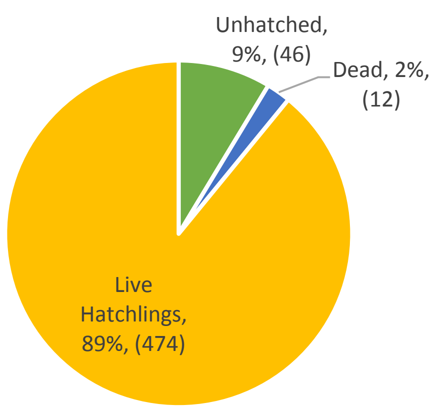

Figure 9. Fate of relocated nest.

When only relocated nests are considered, 71.7% (26.7 percentage points than the overall average) of unhatched eggs had no visible embryo, suggesting that the embryo mortality due to other reasons was greatly reduced for nests that were relocated. This was the main reason for increased hatching success in relocated nests.

In addition, eggs with no visible embryo in relocated nests accounted for 6.2% of all eggs from relocated nests, which was lower than the ratio of eggs with no visible embryo in relation to all eggs in all nests excavated, which was 15.6%. This finding can be attributed to one of two explanations: (1) In some eggs the embryo was not seen because it was present but did not develop, and this occurred more often in nests that were not relocated, or (2) turtles that nested in locations that required relocation had a lower ratio of fertilized eggs. Either explanations or a combination of these are plausible, and this is an area of interest for further research.

3.4 Harbor sea turtles

Twenty seven individual sea turtles were cataloged; **15 males and 12 females** that appeared in the harbor during the 2013 season (Lemoine 2013). However, of these 27 sea turtles on average only **4 male and 3 female individuals, on average, were sighted per day.** This implies that there was some rotation and diversity in the harbor population during the summer. Additionally, some of the turtles that were seen in June were re-sighted again at the end of August after a long absence.

During the summer only social antagonistic and feeding behaviors were recorded making for a total of 1630 records. Out of those two categories, **social antagonistic behaviors were observed more often (62.4% of all observations) than feeding behaviors** meaning the antagonistic behaviors were more common than feeding in the harbor. 49.2% of observations involved male turtles, 36.3% involved females, and in 14.5% of observations the sex could not be determined.

The most common social antagonistic behavior recorded was head to tail circling (42.3% of social antagonistic observations) followed by biting (35.6%) and sparring (20.3%).

When the sea turtles were observed foraging (37.6% of all observations), they were **often feeding on fish (56.0% of feeding observations)**. The harbor sea turtles were never observed catching live fish on their own and were **always fed fish by either a fisherman (63.9%) or a pedestrian**. Other food sources were bivalves along the harbor wall (31.7%), sea grass (7.3%) and **plastics (3.3%)**.

Most behaviors were recorded between 09:30 and 10:00 and in Sector 2 (1118, 70.5%) with Sector 3 having the most of the remainder of the sightings (286, 18.0%).

A young monk seal was also seen in the harbor a few times throughout the season. MOm, the Hellenic Society for the Study and the Protection of the Mediterranean Monk Seal, was notified and was kept informed of the seal's whereabouts as observations were recorded.

3.5 Stranded or injured sea turtles

Throughout the season **four stranded loggerhead sea turtles were found or reported in the project area**, all of which were dead when the team arrived (Table 2). Two of them were males and two were females, **three with boat strike wounds and one that was suspected to have been caught in a fishing net**. The stranded turtle caught in the fishing net had its flipper severed and it is hypothesized that it was severed so it could be removed from the net it was entangled in. None of the stranded turtles had tags or tag scars.

Additionally, one of the turtles that frequented the harbor (Artemis) was observed, by a volunteer, having fishing line coming out of her cloaca. Once she was captured (27 September) and taken out of the harbor, it was clear the line was a serious issue. She was immediately loaded into the Wildlife Sense car and driven to the Rescue Centre in Athens operated by ARCHELON. At the Rescue Centre she had two hooks surgically removed; one from her esophagus and the other from her intestines. With oils added to her diet, she slowly passed the rest of the fishing line. She was released from the Rescue Centre the second week of December 2013.

Table 2. Stranded and injured turtles in the Argostoli area

Found Date	Stranded or Injured	State	Cause of Death or Injury	Location	Male or Female	Carapace Measurements	Comments
17 May	Stranded	Dead on Arrival	Boat Strike	Koutavos Lagoon	Male	Could not be taken (not enough carapace)	Cut completely in half with only the upper portion found washed up. See Figure 10
17 June	Stranded	Dead on Arrival	Boat Strike	Paliostrafida	Female	CPL: 62 cm CPW: 55cm	Covered in barnacles. See Figure 11
18 Aug	Stranded	Dead on Arrival	Boat Strike	Fanari (opposite camping)	Male	CCL: 79cm CCW: 74cm	Carapace sliced 7 cm long 3 cm wide. See Figure 12
22 Aug	Stranded	Dead on Arrival	Fishing Net	Avithos	Female	CCL:74cm CCW: 67cm CPL: 54.1cm CPW: 55.3cm Tail: 16.1cm	RR Flipper missing. Appears to have been severed when caught in fishing gear. See Figure 13
27 Sep	Injured	Alive	Hooks and fishing line	Argostoli Harbor	Female (Artem is)	Measurement given to rescue center	Fishing line coming from cloaca. Taken to Rescue Centre in Athens. See Figure 14

Figure 10. May 17 stranding in Koutavos Lagoon. Only half the turtle was found washed up on shore. It was identified as a male due to the curved claws on the front flippers. It appeared to have been sliced in half by a propeller strike from a large boat.

Figure 11. June 17 turtle stranding on Paliostrafida. A female turtle washed up in front of Hotel Mediterranee. Half of the carapace was missing from the turtle and judging from the nature of the injury it appeared to be the result of a boat strike.

Figure 12. Sea turtle stranding on Fanari beach (across from the camping) on 18 August. This male loggerhead had a strike (7cm long, 3 cm wide) across the top of its carapace indicating that it was struck by a propeller.

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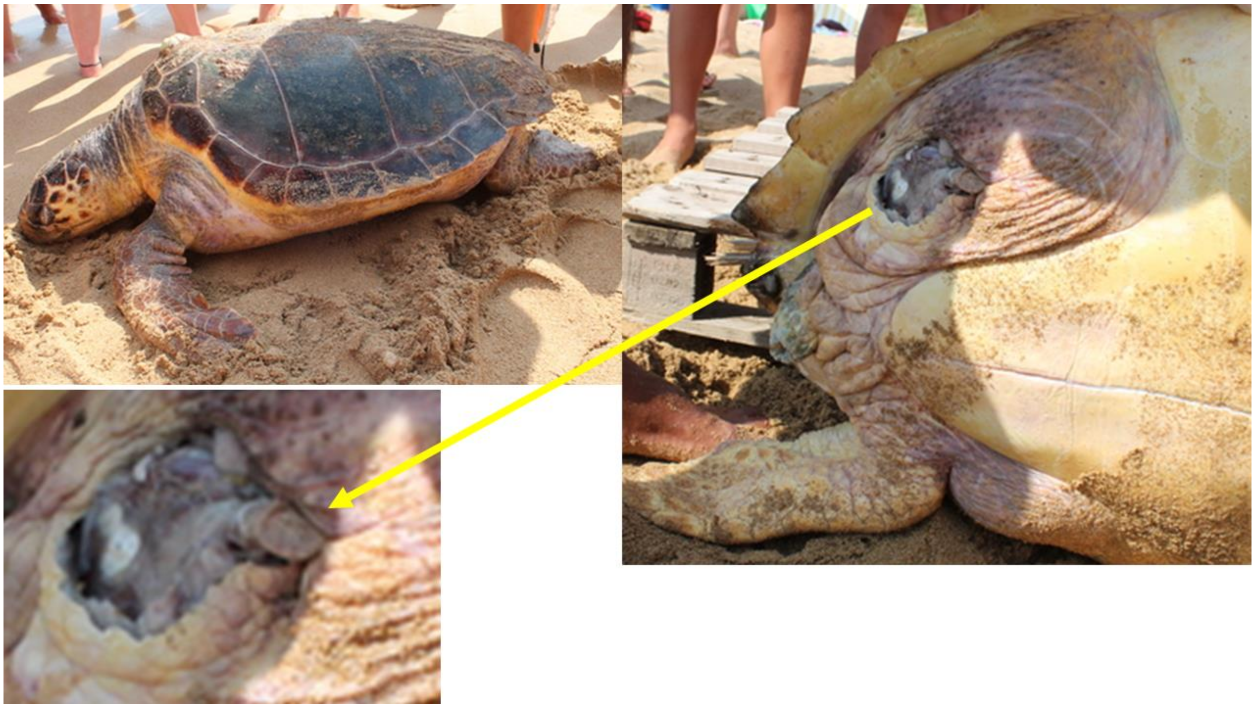

Figure 13. Sea turtle stranding on Avithos on 22 August. This turtle washed up missing its rear right flipper. When the area where the flipper was missing from was closely examined (bottom left photo), it was suspected that the bone could not have broken this cleanly on its own and it must have been cut with a knife. Sea turtles are known to become entangled in fishing nets and it is believed that this turtle became entangled in a fishing line, died and then its flipper was cut off allowing the turtle to wash ashore.

Figure 14. Artemis (bottom right photo), an injured turtle that frequented the harbor, was found to have a fishing line in her cloaca (left photo and top right photo) on September 27. A rescue mission was planned, she was captured and taken to the rescue center in Athens.

4. Recommendations

1. Increasing communication with local authorities, sunbed owners, and local businesses that provide services on or near the beach. Provide information as to how they can appropriately comply with Greek and European guidelines and legislation related to the reduction of impact on the local sea turtle population.
2. Increasing educational outreach to the public by creating leaflets to give to local businesses and to hand out at the harbor and during morning beach surveys, placing an info board at the harbor and giving talks to local schools and youth groups.
3. Use of previous data to understand the average incubation period per nest based on environmental factors, such as sediment size, beach location, etc.
4. Due to high variability in incubation success a more "aggressive" relocation policy should be used.
5. Launch a campaign to inform local authorities and businesses about the dangers of light pollution and what should be done
6. Expand survey coverage to nesting beaches which are not currently monitored.
7. Create informational signs for all nesting beaches monitored by Wildlife Sense.
8. Collaborate with fishermen and arrange that they contact Wildlife Sense when they spot an injured or stranded sea turtle.

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Appendix

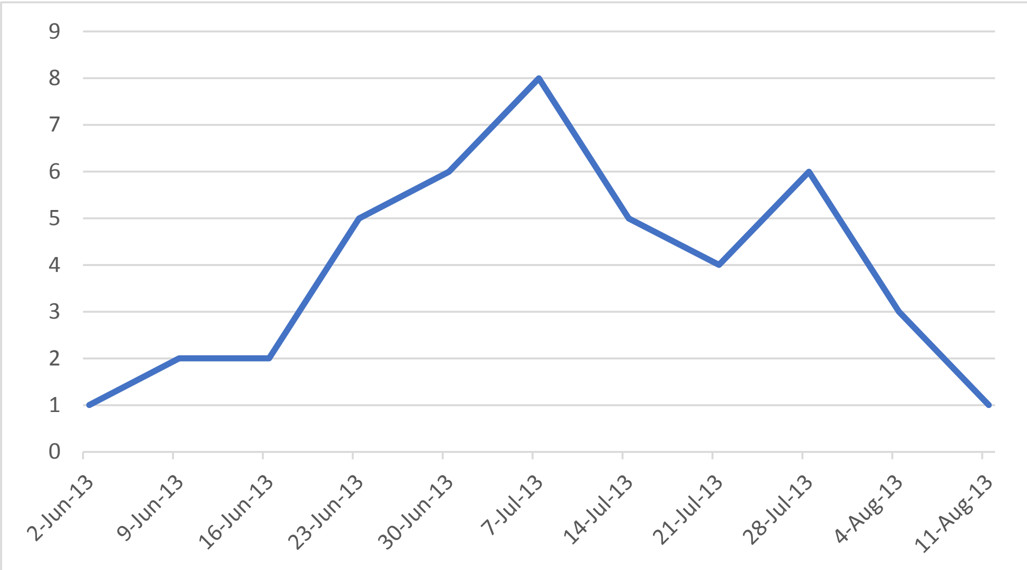

Figure 15. Nest laid weekly - All loggerhead sea turtle nests laid on beaches monitored by Wildlife Sense throughout the 2013 nesting season. Please note that nests KA1, PG1, ML9 & ML10R were not because their lay date is unknown.

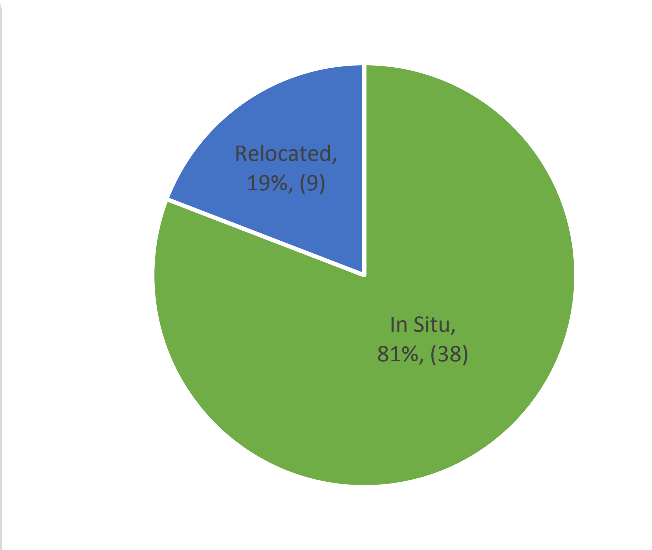

Figure 16. Number of relocated nests compared to those left *in situ*.

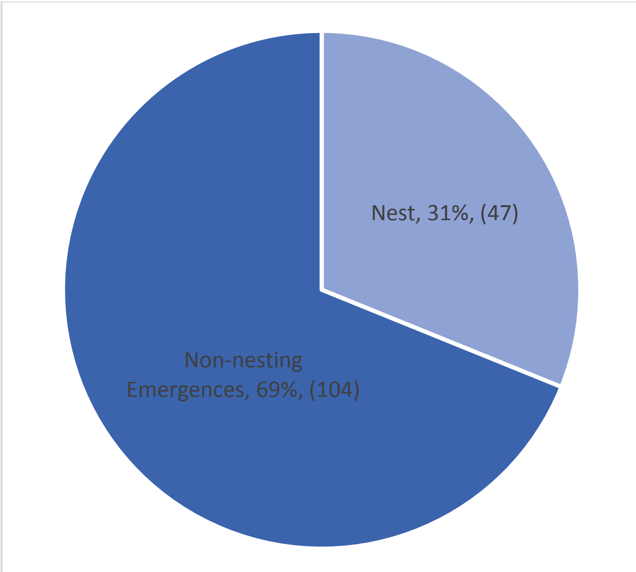

Figure 17. All recorded adult sea turtle emergences.

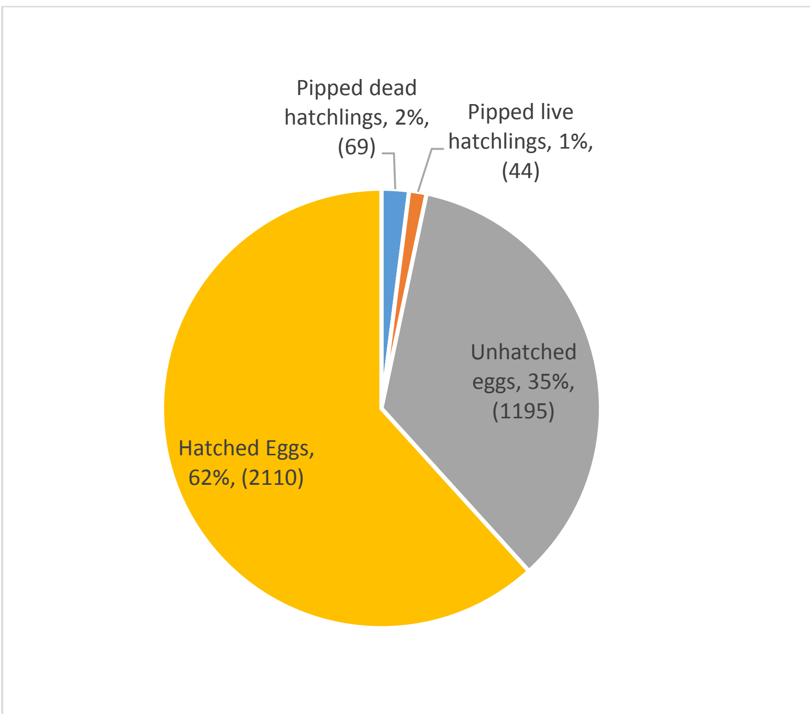

Figure 18. The fate of eggs from all nests.

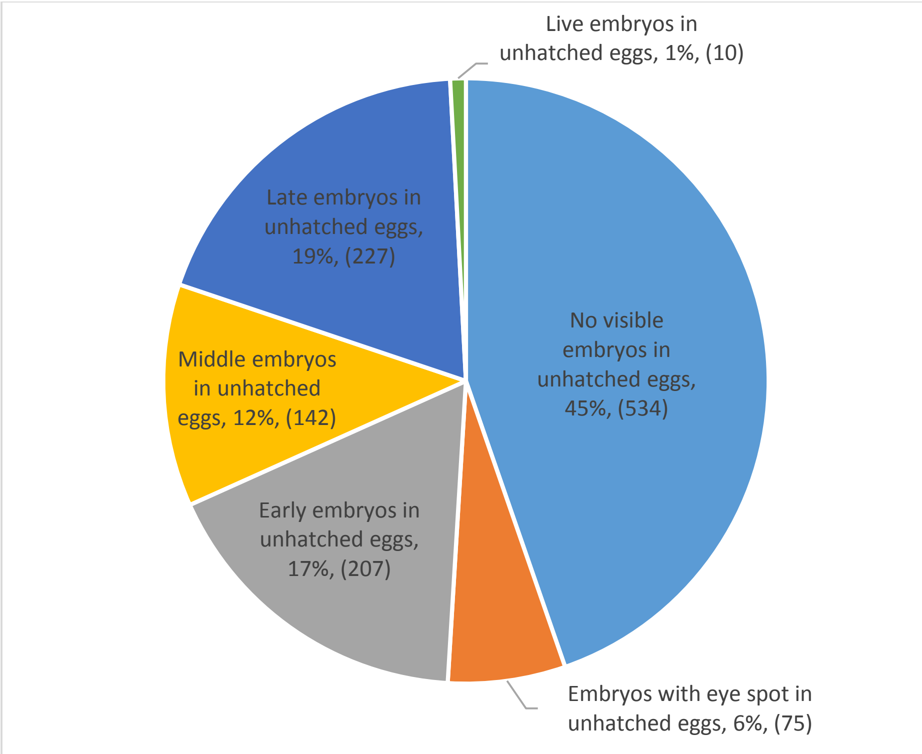

Figure 19. The egg fate of unhatched eggs from all nests.

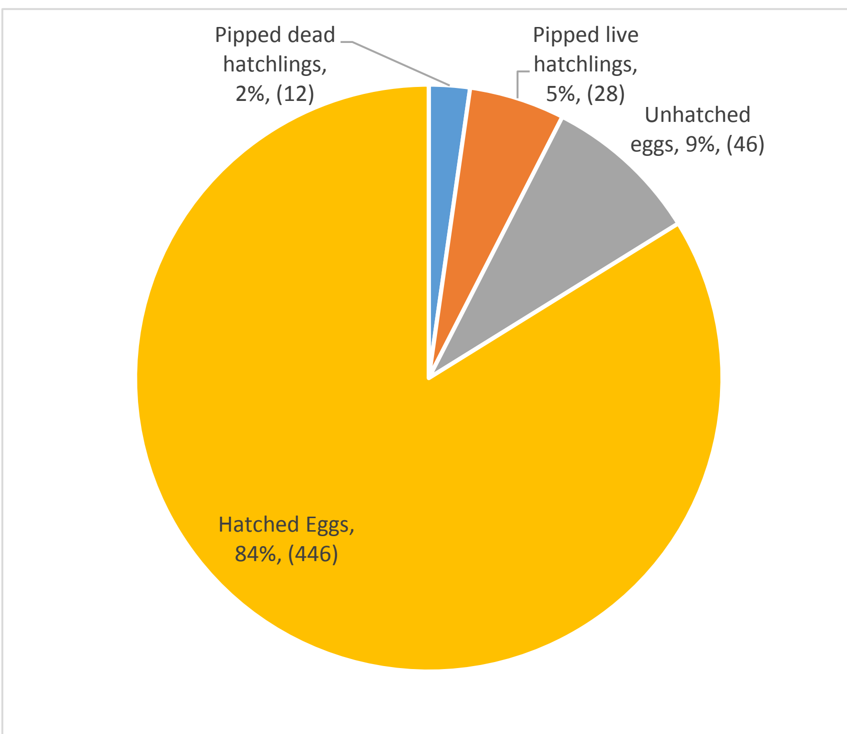

Figure 20. The egg fate from nests that were relocated.

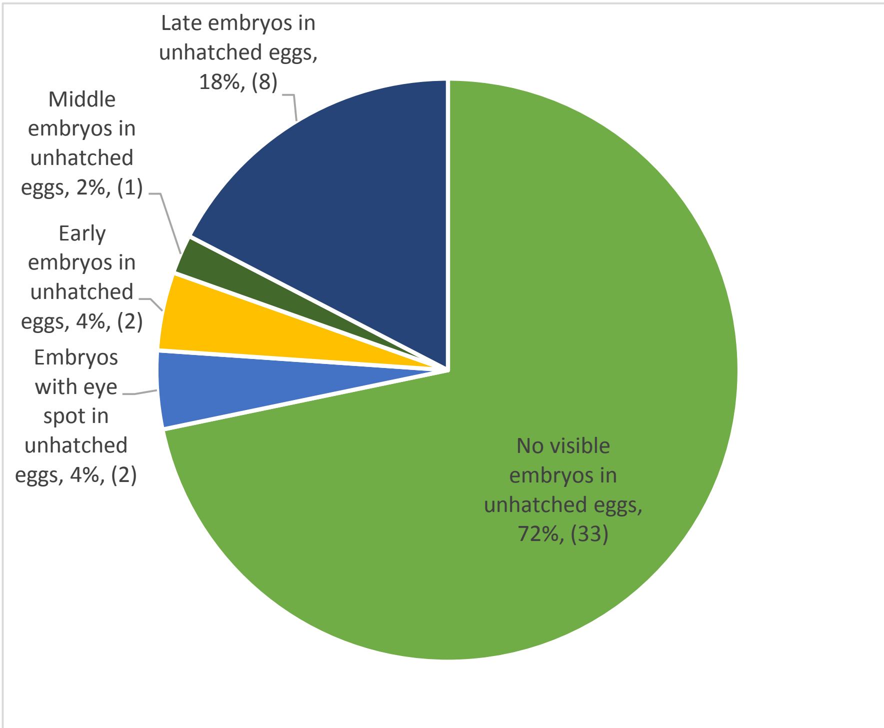

Figure 21. The egg fate of unhatched eggs from nests that were relocated.

Table 3. Nesting and hatching data from all beaches monitored by Wildlife Sense in 2013.

	Nesting Beach															
	Ai Chelis	Ammes	Avithos	Eglina	Kalamia	Kanali	Lourdas	Makris Gialos	Megali Petra	Megli Ammos	Megas Lakkos	Minies	Palliostafida	Platis Gialos	Trapezaki	Overall
Nests (# relocated)	2	4 (3)	3	1	0	1	0	4 (3)	3 (1)	15 (1)	10 (1)	2	1	1	0	47
Non-nesting Emergences	10	7	7	1	0	2	0	6	13	9	46	1	0	0	2	104
Hatching Success	52.59%	80.71%	50.91%	-	0	-	0	66.55%	3.80%	57.97%	76.21%	53.26%	-	61.16%	0	61.73%
Hatchling Emergence Success	47.16%	73.15%	46.08%	-	0	-	0	62.32%	0%	47.70%	65.50%	47.25%	-	53.45%	0	53.07%
Avg. # Nesting Attempts per emergence	0	0.25 (±0.50)	0.33 (±0.58)	-	0	-	0	0	1.33 (±2.31)	0.5 (±0.73)	0	0	-	0	-	0.35 (±0.80)
Nest Avg. Distance to Sea	31 (±1.41)	13.0 (±7.87)	10.33 (±1.53)	15	0	-	0	17.75 (±15.04)	9.67 (±5.69)	17.13 (±6.65)	10.1 (±5.65)	17.50 (±2.12)	-	9	0	15.02 (±6.26)
Depth to top egg (cm)	30	30.25 (±4.50)	27.33 (±5.69)	21	0	-	0	29.50 (±1.73)	23.67 (±3.21)	26.13 (±8.37)	25.57 (±5.47)	22.50 (±10.61)	-	-	0	26.48 (±6.46)
Avg. Clutch Size	116 (±11.31)	84.25 (±16.5)	73.339 (±31.02)	-	0	-	0	69.5	72.0 (±9.90)	94.1 (±14.64)	92.4 (±13.6)	92.0 (±43.84)	-	121	0	89.4 (±20.0)
Total Eggs (All clutches	232	337	220	-	0	-	0	278	144	1411	647	184	-	121	0	3574

counted, including those lost to inundations)																
Hatched Eggs	122	272	112	-	0	-	0	185	3	818	426	98	-	74	0	2110
Pipped dead hatchlings	2 (0.86%)	13 (3.86 %)	2 (0.91 %)	-	0	-	0	1 (0.36%)	0	33 (2.34%)	11 (1.72%)	2	-	5 (4.13%)	0	69 (2.80%)
Pipped live hatchlings	1 (1.29%)	27 (8.01 %)	1 (0.45 %)	-	0	-	0	1 (0.36%)	0	8 (0.57%)	6 (2.17%)	0	-	0	0	44 (3.30%)
No visible embryos in unhatched eggs	87 (37.5%)	17 (5.04 %)	86 (39.09 %)	-	0	-	0	50 (17.99 %	10 (6.94%)	144 (10.21%)	45 (25.98 %)	70 (38.04%)	-	25 (20.66 %)	0	534 (16.90 %)
Embryos with eye spot in unhatched eggs	2 (0.86%	1 (0.30 %)	0	-	0	-	0	3 (1.08%)	51 (35.42%)	11 (0.78%)	3 (0.84%)	2 (1.09%)	-	2 (1.65%)	0	75 (8.24%)
Early embryos in unhatched eggs	3 (1.29%)	2 (0.59 %)	1 (0.45 %)	-	0	-	0	21 (7.55%)	2 (1.39%)	166 (11.76%)	10 (2.34%)	2 (1.09%)	-	0	0	207 (15.14 %)
Middle embryos in unhatched eggs	3 (1.29%)	1 (0.300 %0)	2 (0.91 %)	-	0	-	0	5 (1.8%)	6 (4.17%)	87 (6.17%)	34 (7.50%)	3 (1.63%)	-	1 (0.83%)	0	142 (9.46%)
Late embryos in unhatched eggs	11 (4.74%)	50 (1.48 %	16 (7.27 %)	-	0	-	0	12 (4.32%)	4 (2.78%)	143 (10.13%)	24 (5.29%)	7 (3.80%)	-	5 (4.13%)	0	227 (14.29 %)
Live embryos in unhatched eggs	1 (0.43%)	0	0	-	0	-	0	0	0	0 (0%)	0	0	-	9 (7.44%)	0	10 (1.48%)

Dead hatchlings within egg chamber	3 (1.29%)	1 (0.30%)	8 (3.64%)	?	0	?	0	0	0	46 (3.26%)	15 (2.89%)	9 (4.89%)	-	0	0	82 (5.79%)
Dead hatchlings above egg chamber	0	1 (0.30%)	1 (0.45%)	?	0	?	0	5 (1.8%)	3 (2.08%)	43 (3.05%)	25 (9.26%)	1 (0.54%)	-	1 (0.83%)	0	80 (7.80%)
Live hatchlings within egg chamber	5 (2.16%)	9 (2.67%)	0	?	0	?	0	4 (1.44%)	0	29 (2.06%)	6 (1.55%)	0	-	6 (4.96%)	0	59 (2.47%)
Live hatchlings above egg chamber	3 (1.29%)	3 (0.89%)	0	?	0	?	0	2 (0.72%)	0	6 (0.43%)	8 (2.16%)	0	-	0	0	22 (1.33%)