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Effectiveness of Concealed Nest Protection Screens Against Domestic Predators for Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*) Sea Turtles

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ABSTRACT. – Mammalian depredation of nests has been listed amongst the most significant threats to hatchling success in sea turtles. In 2013, at least 13% of green turtle (*Chelonia mydas*) and 25% of hawksbill turtle (*Eretmochelys imbricata*) nests were lost to domestic dog predation on Playa Norte, Costa Rica. In 2014 and 2015, plastic and bamboo protective screens were deployed to protect nests. Screens were deployed at different stages of the incubation period and the success of the nests analyzed. Predation rates increased as the seasons progressed with October and November being the peak depredation months, as well as the peak for hatchling emergences. Eggs remaining in nests that had been partially depredated had a significantly lower percentage of hatching success than eggs in undisturbed nests. There was no significant difference between timing of deployment and likelihood of a screen being breached. The likelihood of a screen being breached was highly dependent on the type of material used; bamboo screens were ca. 153% more effective than plastic and successfully prevented the complete predation of ca. 48% of nests. Bamboo screening is an inexpensive, environmentally inert, yet labor-intensive method for reducing nest depredation by domestic dogs. This screening method does not impact the hatching or emerging success of the nest.

KEY WORDS. – domestic predator; bamboo; nest screening; nest depredation; hatching success

Mammalian predation of nests has been listed amongst the most significant threats to hatchling success in sea turtles (Barton and Roth 2008; Kurz et al. 2011). The proficiency of subsidized, domestic, or introduced predators, and the quantity of eggs lost severely reduces level of recruitment into the population (Riley and Litzgus 2013). In the United States, mammalian nest depredation rates of up to 100% have been widely reported for both marine and freshwater turtles (Stanyek 1980; Feinberg and Burke 2003; Browne and Hecnar 2007; National Marine Fisheries Service [NMFS] and US Fish and Wildlife Service [USFWS] 2008; Riley and Litzgus 2013; Buzuleciu et al. 2016). At Tortuguero, Costa Rica, the largest green turtle (*Chelonia mydas* Linnaeus 1758) rookery in the Western Hemisphere, 24.5% of nests were lost to mammalian predators in 1 season (Fowler 1979).

Recovery programs for marine turtles aim to reduce annual rates of mammalian depredation to below 10%–30% (NMFS and USFWS 2008; Department of Environment and Energy Commonwealth of Australia 2017). Management options exist (Stancyk et al. 1980; Lamarre-DeJesus and Griffin 2013; Engeman et al. 2016), but all carry limitations that may have adverse effects on both target and nontarget species (Riley and Litzgus 2013). Predator removal is an effective mechanism for reducing turtle nest mortality (Christiansen and Gallaway 1984; Engeman et al. 2005, 2010; Garmestani and Percival 2005; Munscher et al. 2012). In Florida, raccoon (*Procyon lotor*

Linnaeus 1758) removal significantly reduced depredation of both adult diamondback terrapins (*Malaclemys terrapin* Schoepff 1793) and their nests (Muncher et al. 2012), and loggerhead (*Caretta caretta* Linnaeus 1758) turtle nest depredation was reduced to 6.1% by removing raccoons and armadillos (*Dasypus novemcinctus* Linnaeus 1758) (Engeman et al. 2005). However, intricacies of predator–prey interactions in a community need to be considered before predator eradication (Stansyk 1982; Ratnaswamy and Warren 1998; Barton 2005; Engeman et al. 2006, 2012; Barton and Roth 2008). The mesopredator release hypothesis (Soule et al. 1988) suggests that top predators limit abundance of secondary mesopredators and removal of top predators in such a system may cause a cascade effect, increasing abundance of the mesopredator and thus increasing depredation pressure on the species designated for protection (Barton 2005). Such an effect was identified on a loggerhead turtle nesting beach in Florida, where raccoon abundance and ghost crab (*Ocypode quadrata* Fabricius 1787) density were negatively correlated. The removal of raccoons from this system resulted in an increase in depredation of nests by ghost crabs (Barton 2005). In cases where the predator is domestic, eradication programs may not be possible due to social repercussions.

Further management strategies include nest relocations to hatcheries; however, hatcheries carry risk of undesired consequences such as reduced hatchling fitness and undetected skewed sex ratios (Kornaraki et al. 2006;

Sari and Kaska 2017). Physical deterrents with visual cues (flags and protective cages) (Longo et al. 2009) have not been found to increase depredation rates (Riley and Litzgus 2013; Buzuleciu et al. 2015), but can increase nest vulnerability to poaching by highlighting its location. Taste aversion techniques (pepper powder or foul-tasting bait) have been assessed with mixed results (Lamarre-DeJesus and Griffin 2013; Burke et al. 2015) and may impact hatchlings (Lamarre-DeJesus and Griffin 2013), nontarget species (Ratnaswamy et al. 1997), and the surrounding environment, namely future nesting sites (Burke et al. 2015).

Nest barriers have the potential to reduce mammalian depredation rates to 0% (Addiston 1997; Yerli et al. 1997) by blocking predator access to the egg chamber. Screens or cages may be placed above or around the nest but careful consideration regarding design and construction materials is important. Riley and Litzgus (2013) evaluated the effectiveness of above- and belowground wire cages, and wooden-sided cages in protecting painted (*Chrysemys picta* Schneider 1783) and snapping (*Chelydra serpentina* Linnaeus 1758) turtle nests. They found no significant difference in hatchling fitness or nest temperature between caged and uncaged nests, or in the number of predator interactions with cages between treatments. Metal screens and cages, while effective (Addison 1997; Kurtz et al. 2011), have been found to affect the surrounding magnetic field, risking disruption to imprinting and therefore potentially affecting natal homing of the adult turtle (Irwin et al. 2004). In Brazil, the National Marine Turtle Conservation Program in Brazil (Projeto TAMAR) and Brazilian Institute for the Environment (IBAMA) manage 18 conservation stations and use both wire and plastic screens to successfully prevent depredation at these sites (Marcovaldi and Marcovaldi 1999); however, Kurtz et al. (2011) found plastic screens less effective than metal cages at preventing breaching by red foxes (*Vulpes vulpes* Linnaeus 1758).

Monitoring of turtle nesting events has taken place on a 5.03-km transect along Playa Norte since 2006. Green, hawksbill (*Eretmochelys imbricata* Linnaeus 1766), and leatherback (*Dermochelys coriacea* Vandelli 1761) turtles nest seasonally, and loggerhead turtle nests have also been documented. While nesting events for all species undergo annual fluctuations, a total of 4821 (annual \bar{x} = 482.1) green, 534 (annual \bar{x} = 53.4) leatherback, and 268 (annual \bar{x} = 26.8) hawksbill nests have been recorded inside the beach transect from 2006 to 2015. Complete data on depredation rates were unavailable on Playa Norte until 2013 when the minimum predation rate was estimated at 13% and 25% for green turtle and hawksbill nests, respectively (Canadian Organization for Tropical Education and Rainforest Conservation, unpubl. data, 2013), and prompted our study.

Understanding predator interactions with sea turtle nests assists in development of suitable management strategies to reduce this impact to negligible levels

(< 10%) (Engeman et al. 2005; NMFS and USFWS 2008). The objectives of this study were, first, to enhance conservation management by increasing our understanding of the behavior of sea turtle nest predators on Playa Norte, and second, to find an effective magnetically inert alternative to metal screens, on a beach suffering both depredation and poaching pressure, without having detrimental effects on the eggs or hatchlings during incubation and emergence.

METHODS

Study Site. — Playa Norte is situated on the northern Caribbean coast of Costa Rica and belongs to the Barra del Colorado Wildlife Refuge (lat 10°35'38.4216"N, long 83°31'31.2234"W) (Fig. 1). The area is managed by the Tortuguero Conservation Area and is regulated by Ministerio de Ambiente y Energía (the Costa Rican Ministry of Environment and Energy). Here, both green and hawksbill turtle nests are predated by domestic dogs (*Canis familiaris* Linnaeus 1758). The beach is dynamic, with recurrent coastal erosion making relocations to a hatchery unfeasible. The transect is bordered by both seasonally and permanently occupied houses and hotels at each end. The majority of these properties have domestic dogs that regularly depredate turtle nests.

Depredation Study. — During the 2014 and 2015 nesting seasons (March–October) we undertook efforts to prevent domestic dogs from depredating monitored green and hawksbill nests. Leatherback nests were typically deep enough that they did not experience mammalian depredation. Visual encounters and signs such as paw prints, scratch marks, and an exposed egg chamber surrounded by scattered egg shells identified nests predated by domestic dogs. Survey teams patrolled the beach every night during the nesting season. When teams encountered a turtle before or during oviposition, they triangulated the nest, counted eggs as they were laid, and placed a piece of flagging tape with a unique identification code (Nest ID) into the nest. Triangulation involved tying flagging tapes to 3 fixed points in the vegetation in front of the nest, and taking measurements from the egg chamber to these points. This enabled the location of the egg chamber to be identified without highlighting its position to others. Once the turtle returned to the sea, the team levelled the sand as much as possible to disguise the nest area and prevent poaching.

Screening. — In 2014, we deployed flat plastic grid screens buried above the egg chamber and, early in the 2015 nesting season, we switched to grid screens woven from 1-m strips of bamboo, secured with fishing nylon. Grids in both materials were large enough to allow hatchlings to escape. Teams checked all triangulated nests daily for the entire incubation period. Each nest was recorded as one of the following:

- Depredated: zero viable eggs in the egg chamber.

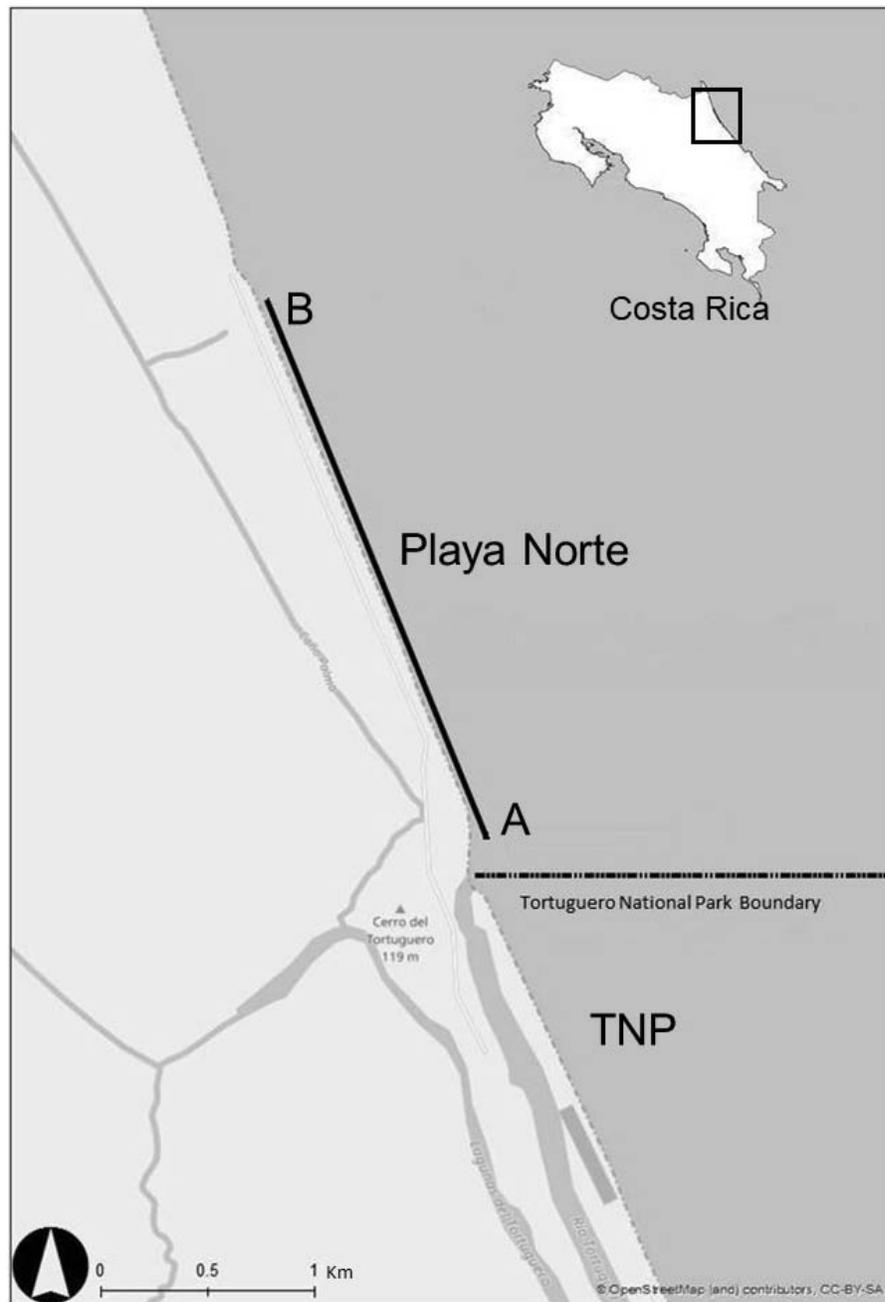


Figure 1. Playa Norte beach transect represented by the line running from A to B.

- Partially depredated: some eggshells outside the nest but one or more eggs/hatchlings still present in the egg chamber.
- Depredation attempt: evidence of dog digging, but screen not exposed.
- Failed attempt: screen exposed by dog digging, but screen and egg chamber intact.
- No attempt: no evidence of disturbance by dogs.

In the event the nest had been depredated, the survey team removed and discarded exposed punctured eggs and shells and covered remaining eggs with cool sand. They

smoothed the surface of the sand over the nest area so additional predator interactions could be recorded. Incubation period for green turtles have been recorded on Playa Norte since 2006, mean incubation period at this location is 55 d. Using this mean and a 5-d window of error we used the following definitions:

- Day 1 to Day 50: development period.
- Day 1 to day of main hatchling emergence: incubation period.
- Day 50 to day of main hatchling emergence: emergence period.

At the end of the emergence period we excavated all nests. Each egg was opened and allocated a category:

- Hatched: empty eggshell, > 50% of the shell intact.
- Unhatched: with embryo.
- No embryo.
- Depredated by crabs: identified by a slice in the egg shell and contents appearing “dusty,” sometimes with bones present.
- Depredated by microorganisms (fungi or bacteria): contents brightly colored, often purple or pink, with characteristic odor.
- Dead hatchlings.
- Live hatchlings.

Recovery of the Nest ID from triangulated nests enabled us to identify the nest, and thus calculate the exact incubation period.

Green Turtle Nests. — Plastic screens for green nests measured 102 × 128 cm with rows of 10 × 10-cm exit holes. We buried plastic screens 25 cm below the surface of the sand, and bamboo screens were roughly 1 m² and buried 30 cm deep. Bamboo screens were buried 5 cm deeper to account for additional depth of woven bamboo. We deployed all screens at dawn or dusk, when ambient air temperatures were lowest. In 2014 we split all triangulated green nests into 3 treatments that determined when we would deploy a plastic screen:

- Control nests: received no screen.
- Development period: deployment within 18 hrs of oviposition.
- Emergence period: deployment on 50th day of incubation.

Hawksbill Nests. — Because of their low abundance and the species’ critically endangered status (Mortimer and Donnelly 2008), all triangulated hawksbill nests were included in the development treatment to ensure they were protected for the duration of the incubation period. Hawksbills have a nesting preference for the beach vegetation zone and deposit eggs in shallow egg chambers (Pritchard and Mortimer 1999). For this reason, with the exception of 1 nest that was located in the open zone and therefore suitable for a bamboo screen, we were limited to burying smaller (75 × 75-cm) plastic screens at a maximum depth of 10 cm.

Statistical Analysis. — The percentages of hatchling (H) and emerging (E) success of nests were calculated using the following formulas:

$$H = \left(\frac{\lambda}{\lambda + \theta + \mu} \right) \times 100$$

$$E = \frac{(\lambda - [\sigma + \rho])}{(\lambda + \theta + \mu)} \times 100$$

where λ = empty eggshells, θ = unhatched eggs (including eggs with and without an embryo, and those predated

by crab or microorganism), ρ = dead hatchling, σ = live hatchling, and μ = the number of eggs depredated by dogs. To calculate μ we used Ψ = egg count at oviposition in the following equation:

$$\mu = (\Psi - \lambda + \theta)$$

We tested whether deploying a screen increased predation attempts using the χ^2 test. We also used this test to compare the number of predator interactions with nests between years, to compare the frequency of predation attempts and likelihood of screen failure for nests with screens deployed at the start of development period vs. the start of emergence period, and to compare effectiveness of plastic and bamboo screens. We compared the incubation period for green turtles between 2014 and 2015 using the Welches 2-sample t -test. To establish if timing of deployment or type of material used had an effect on hatching or emerging success of the nest we used a Kruskal-Wallis rank sum test. We hypothesized that a partial depredation event may reduce viability of remaining eggs in the nest. To test this we used a Wilcoxon rank sum test to compare percentages of hatching and emerging success of green turtle nests between eggs remaining in partially depredated nests and nests that were undisturbed. Assuming partially depredated nests would have a higher likelihood of introduced microorganisms, directly from dogs and from increased bacterial loads from punctured eggs, we compared percentage of egg loss to microorganisms between partially predated and undisturbed nests using a Wilcoxon rank sum test. All tests were performed using a confidence interval of 95% ($\alpha = 0.05$). We analyzed all data using R for Windows 2.15.0 with Deducer (Fellows 2012). The data for green and hawksbill nests, unless specified, were analyzed separately.

RESULTS

Over the 2-yr study, 277 green and 27 hawksbill nests were successfully triangulated. Triangulated nests that were lost to erosion or poaching ($n = 62$), were relocated, or contained fewer than 5 eggs ($n = 15$), were also necessarily excluded. Of nests that were included in the analysis, 55% of hawksbill turtle and 45.95% of green turtle nests were partially or fully depredated.

Predator Impact. — The only mammalian predator observed on Playa Norte was the domestic dog. Mortality of eggs predated by ghost crabs, microorganisms, or unknown predators was 4.086% for green and 2.611% for hawksbill turtles (Table 1). No significant difference ($w = 2787$, $p = 0.054$, $n = 179$) was found between the number of eggs lost to microorganisms between undisturbed nests and nests with predation attempts.

There was no significant difference in the amount of nest predation activity between the years ($\chi^2_1 = 0.046$, $p = 0.83$, $n = 203$). Predation rates increased as the seasons progressed with October and November being peak predation months both years, as well as peak for

Table 1. Egg fate. Losses as a percentage of all eggs laid in triangulated nests. Numbers in parentheses are total eggs laid in each treatment. Eggs identified with no embryo during excavations were counted separately.

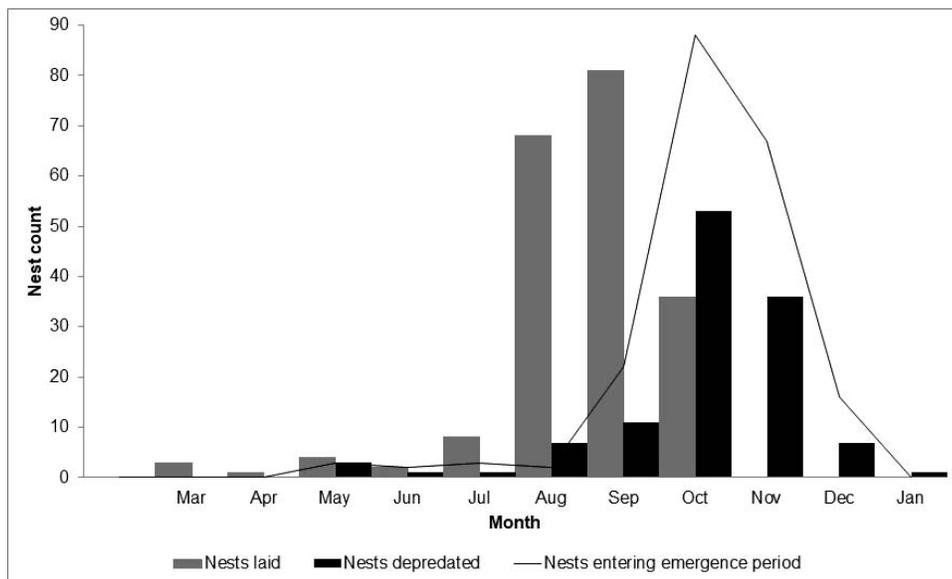
	<i>Eretmochelys imbricata</i>					<i>Chelonia mydas</i>				
	No screen (1046)	Plastic (1270)	Bamboo (151)	Excavated (1286)	Total no. of eggs lost	No screen (4683)	Plastic (7740)	Bamboo (5846)	Excavated (4614)	Total no. of eggs lost
No embryo (egg count)	20	167	0	0	187	255	620	170	39	1084
Percentage of eggs lost										
Erosion	0.00	0.00	0.00	8.31	312	0.00	0.00	0.00	4.02	921
Lost/poached	0.00	0.00	0.00	25.95	974	2.42	1.97	1.80	12.71	4320
Embryonic mortality	0.05	1.31	0.00	0.00	51	2.06	2.08	4.15	0.04	163
Dogs	20.01	12.82	4.02	0.00	1383	8.43	8.23	5.05	0.00	1924
Crabs	0.08	0.56	0.00	0.00	24	0.10	0.23	0.16	0.00	22
Microrganism	0.05	0.93	0.00	0.00	37	1.30	0.67	0.34	0.05	297
Predator unknown	0.00	0.99	0.00	0.00	37	0.52	0.39	0.33	0.00	120
Total no. lost	758	623	151	1286	2818	3394	3103	2705	3853	13,055
No. of eggs hatched	288	647	0	0	935	1289	4637	3141	761	9828
Total no. of eggs laid					3753					22,883

hatchling emergences (Fig. 2). While small sample size prevented further analysis of the hawksbill data, it was possible to calculate incubation periods for 40 green turtle nests over the 2-yr period, with no significant difference in length between the years ($t = 0.14$, $p = 0.886$).

Predation activity (full, partial, or failed attempts at predation) of green turtle nests by domestic dogs increased during the emergence period (after Day 50): 62.04% of nests were affected at this time compared with 37.96% during the development period. Partially predated nests had a lower percentage of hatching and emerging success of remaining eggs than nests that were undisturbed. After removing the number of mammalian-predated eggs from the analysis, there was a significant difference between the hatching ($w = 1962.5$, $p = 0.005$, $n = 116$) and emerging ($w = 1961.0$, $p = 0.005$, $n = 116$) success of remaining eggs in partially depredated green turtle nests ($\bar{x} = 37.36\% \pm 28.89\%$ SD and $\bar{x} = 36.06\% \pm 28.75\%$

SD, respectively, $n = 38$) and green turtle nests that were not depredated ($\bar{x} = 59.87\% \pm 40.26\%$ SD and $\bar{x} = 58.93\% \pm 39.92\%$ SD, respectively, $n = 78$).

Deployment Timing. — Deploying a plastic screen did not significantly alter predation attempts ($\chi^2_1 = 2.43$, $p = 0.119$, $n = 185$). Nests with a screen deployed at the start of emergence period had significantly more predation attempts on them (96.97%) than nests where the screen was deployed at the start of developmental period (74.19%) ($\chi^2_1 = 6.86$, $p = 0.009$, $n = 64$). However, there was no significant difference between timing of deployment and likelihood of the screen being breached ($\chi^2_1 = 3.48$, $p = 0.062$, $n = 47$). In nondisturbed nests, there was no significant difference in hatching or emerging success between deploying plastic screens at the start of development period (\bar{x} hatching success = 64.17%, \bar{x} emerging success = 63.83%) or start of emergence period (\bar{x} hatching = 78.44%, \bar{x} emerging = 73.49%), or nests

**Figure 2.** Relationship between emergence of green and hawksbill turtle nests and nest predation.

without a screen (\bar{x} hatching success = 68.07%, emerging = 67.96%) (hatching success $H = 0.36$, $p = 0.834$ and emerging success $H = 0.48$, $p = 0.787$, $n = 36$).

Materials. — The likelihood of a screen being breached was highly dependent on type of material used: 100% ($n = 31$) of nests with no screen, 80.85% ($n = 38$) of nests with plastic screens, and 51.61% ($n = 16$) of nests with bamboo screens were breached ($\chi^2_2 = 21.53$, $p < 0.001$, $n = 109$), meaning 48.39% of nests with bamboo screens successfully prevented complete predation. Bamboo therefore was 152.69% more effective than plastic.

DISCUSSION

On Playa Norte, we found domestic dogs to be the dominant predator of sea turtle nests, with no variation in their effort between years. This finding is consistent with those of Fowler (1979) who identified dogs to be the main predator with vulture and crab presence noted. Black vultures (*Coragyps atratus* Bechstein 1783) and turkey vultures (*Cathartes aura* Linnaeus 1758) were frequently seen depredating nests exposed by dogs; however, as they are not known to open nests themselves (Burger and Gochfeld 2014), we do not consider them to be a primary predator. Microorganisms were the second highest predator of eggs in our study after dogs. However, although the difference in eggs lost to microorganisms was not significantly higher in disturbed nests than in undisturbed nests, the p -value of 0.054 suggests that these events may be weakly correlated. Thus, further research should be directed toward specifically determining whether dog predation activity is a significant factor contributing to microorganism predation of nests.

Ghost crabs have the capacity to seriously threaten hatching success, and removal of their natural predators has caused cascade effects in the form of population explosions and subsequent turtle nest predation by this taxa (Stancyk 1982; Burggren and McMahon 1988; Barton 2005; Marco et al. 2015). On Playa Norte, domestic dogs have been witnessed chasing crabs and signs of digging around crab holes suggest they may opportunistically predate them, as raccoons do in other locations (Stancyk 1982; Barton 2005). Dogs on Playa Norte may be restricting ghost crab abundance to a less detrimental level to turtle hatchling production, despite not being their natural predators.

We found no significant correlation between predator activity on nests with or without screens, suggesting that deploying a screen did not per se increase or decrease its attractiveness to dogs. Through our disguising efforts it is unlikely any visual cues were left for dogs to identify nests, but it is possible that disruption of sand above the egg chamber may have released odors that alerted the dogs to the nest site. This was found by Buzuleciu et al. (2016), where raccoon identified nests by scent left in the soil from nesting diamondback terrapins. This possibility derives

support from the observed increase in frequency of predation attempts during the emergence period (62.04%) and on nests with screens deployed at this time (96.97%), which we suggest is primarily due to olfactory cues from hatching activity. This pattern was also identified in Tortuguero, where dogs would take nests throughout the incubation period but there was noticeable preference shift to end of incubation nests when the hatching season began (Fowler 1979). Congdon et al. (1983) speculated the emergence of Blanding's turtle (*Emydoidea blandingi* Holbrook 1838) hatchlings alerted predators, either directly through the movement of hatchlings or by releasing odors from the egg chamber. Further analysis would be needed to draw stronger conclusions, but we suggest that where possible, screens should be deployed at the start of incubation period to deter predators. That said, we also found no significant difference in the likelihood of a screen being breached regardless of when it was deployed. At peak nesting season it can be difficult for stewardship projects to have sufficient capacity to screen all nests at the start of incubation; from a management perspective knowing screens can be placed at any stage of incubation offers potential for more nests to be protected when the predator shows a preference for nests at the end of the incubation period.

Our finding that domestic dogs preferentially predate nests at the end of the incubation period is contrary to studies with raccoons, which, using both visual and olfactory cues, largely prey on nests within the first 48 hrs of being laid, and have been documented consuming eggs while the turtle is laying (Stancyk et al. 1980; Burke et al. 2005; Buzuleciu et al. 2016). Mongooses (*Herpestes auro-punctatus* Hodgson 1836), however, have been found to use olfactory cues both to locate freshly laid nests as well as emerging hatchlings (Nellis and Small 1983). In Tortuguero, Fowler (1979) and Tiwari et al. (2006) found a significantly higher number of nests depredated by domestic dogs and coati (*Nasua narica* Linnaeus 1766) after eggs in the nest had begun to hatch, lending further support to our suggestion that on adjacent Playa Norte, dogs are primarily using olfactory cues, namely odor released from eggs hatching, to locate nests.

Plastic mesh screens have long been used in the protection of sea turtle nests (Kurz et al. 2011) and unlike metal screens, do not risk disorienting emerging hatchlings (Irwin et al. 2004). However, their effectiveness is inconsistent: rates of 75%–100% effectiveness have been reported (Kurz et al. 2011), yet in our study, 80% of plastic screens were breached, and thus were largely ineffective at preventing nest predation. Additionally, plastic is increasingly recognized as being harmful to the marine environment (Andrady 2011). We found bamboo screens were 152.69% more effective at preventing predation and did not pose the environmental threat of plastic screens.

In our study, surviving eggs in depredated nests had a significantly lower hatching, and therefore emerging,

success than eggs in undisturbed nests. This is contrary to Barton and Roth (2008) who found the hatching success of remaining eggs from depredated nests to be similar to undisturbed nests. Developing embryos are vulnerable to changes in moisture, gas exchange, and temperature (Miller et al. 2003), all of which are likely during a partial predation event, potentially lowering the viability of the remaining eggs. We hypothesize this exposure to the elements to be a strong factor in the failure of eggs in disturbed nests. The variation in localized abiotic conditions between Barton and Roth's (2008) study site and Playa Norte may explain our different results. We further suggest there may be differences in survivorship of eggs between the 2 projects, owing to the different predation timings between raccoons (start of incubation) and dogs (end of incubation). It is possible late-incubation eggs are more vulnerable to disturbance than those at the start.

Some variability in screen design or placement (e.g., screen set too close to the egg chamber, or screen slats that were not secure enough), may have contributed to failure of the screen in some instances. Hawksbill nests had a higher percentage of predation than green turtle nests (55% and 45.95%, respectively), which we attribute to their shallower egg chamber and easier accessibility by dogs, as also reported with raccoons (Addiston 1997). Similarly shallower loggerhead turtle nests were more commonly depredated than those of green and leatherback turtles (Antworth et al. 2006).

Conclusions

Bamboo screening is an inexpensive, environmentally inert yet labor-intensive method for reducing nest depredation by domestic dogs. This method does not impact the hatching or emerging success, or incubation length of the nest, nor does it lead to cascade effects that may result from predator removal. We recommend it for in situ nest protection projects where bamboo is available with high mammalian predation rates and a strong labor force.

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