GENETIC VERSUS ENVIRONMENTAL CAUSES OF EXTREME MALFORMATIONS OF FLATBACK EMBRYOS

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Abstract:

Extremely malformed embryos were found amongst the clutches laid by three individual Flatback Sea Turtles, *Natator depressus*, at West Alligator Head, Northern Territory, Australia.

Methods:

The three beaches at West Alligator Head (Figure 1) support a population of fewer than 80 nesting Flatback sea turtles. Over the nesting seasons of 1993 and 1994, nine nests were transferred to a hatchery set up on the beach to protect them from predation by monitor lizards (*Varanus panoptes*). Other nests were left undisturbed to assess natural hatching success. All nests were moved during laying to minimise movement induced mortality. Nests protected in the hatchery were examined 24 hours after hatching as were those that survived in situ. All of the nesting turtles were tagged. Moved and in situ nests were identified to their respective female.

Results:

Female CA108/109 had a high percentage of deformed embryos and hatchlings in 1993 and 1994 and from preliminary studies in 1992. Deformities occurred in clutches left in situ and in those that were relocated to the hatchery. Two other females had high rates of deformities in hatchery protected nests. Unfortunately their in situ nests did not survive predation by monitors.

Deformities in embryos from hatched nests included: dicephalic, amelanistic and hypomelanistic and cycloptic embryos, macrocephalic, incomplete jaw formation, and incomplete closure of the plastron with unbounded organs with and without malformation of the carapace (Figure 2).

Discussion:

This small population of nesting Flatback sea turtles displayed a high frequency (2.5%) of gross malformations of unhatched embryos. The evidence suggests these abnormalities are genetic, or possibly teratogenic, rather than being caused by relocation to a hatchery. This may be a relictual population faced with eventual extinction given the high proportion of malformed embryos, the high levels of nest predation during the survey, the high philopatry of Flatbacks (Limpus *et al.* 1984), and the nesting season coinciding with the cooler months of the year. Additionally the beaches flank the northern shores of Australia with no means for the population to gradually shift southwards in response to a predicted global warming scenario (Chaloupka *et al.* 2008).

Conclusion:

The small sample size contributed in part to the elevated percentage of malformations contributed mainly by two turtles one of which, CA 108/109, produced malformed embryos and hatchlings in the year prior to this study.

The question of a genetic or environmental cause for the observed malformations remains unresolved.

- Malformations when detected are notable and usually reported. Miller (1982, 1985) reported cycloptic and dicephalic malformations, albinism and incomplete twins in turtle embryos.
- The Flatback population nesting at West Alligator Head is small (<80 individual Flatbacks per year) (Vanderleley 1995).
- For some decades the nests have been subjected to near 100% depredation by monitor lizards, feral pigs, and indigenous harvest.
- Nesting occurs during June and July; the coolest time of the year.
- Faced with increasing coastal water and sand temperatures (Fuentes et al. 2009) the beach produces mostly female hatchlings.
- Under a continuing warming scenario, the small population at West Alligator Head shows signs of local extinction (Figure 3: “Guinea effect” in Limpus 2007: Guinea 1994) in part because of its latitudinal constraint by the Australian continent (Figure 4).

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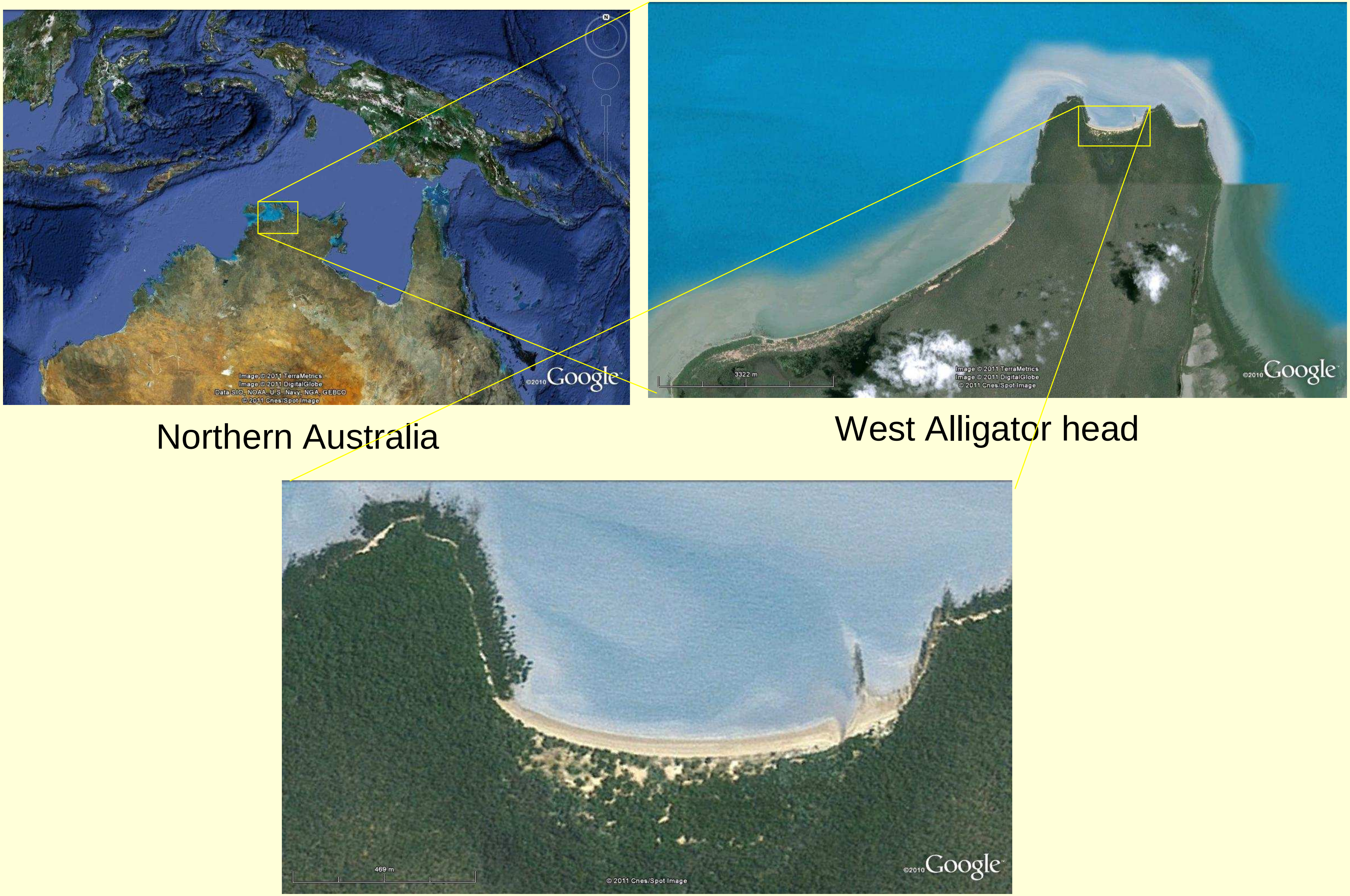
Figure 1 Locality of West Alligator Head



Northern Australia

West Alligator head

Hatchery site Middle Beach

Figure 2 Malformed Flatback Embryos

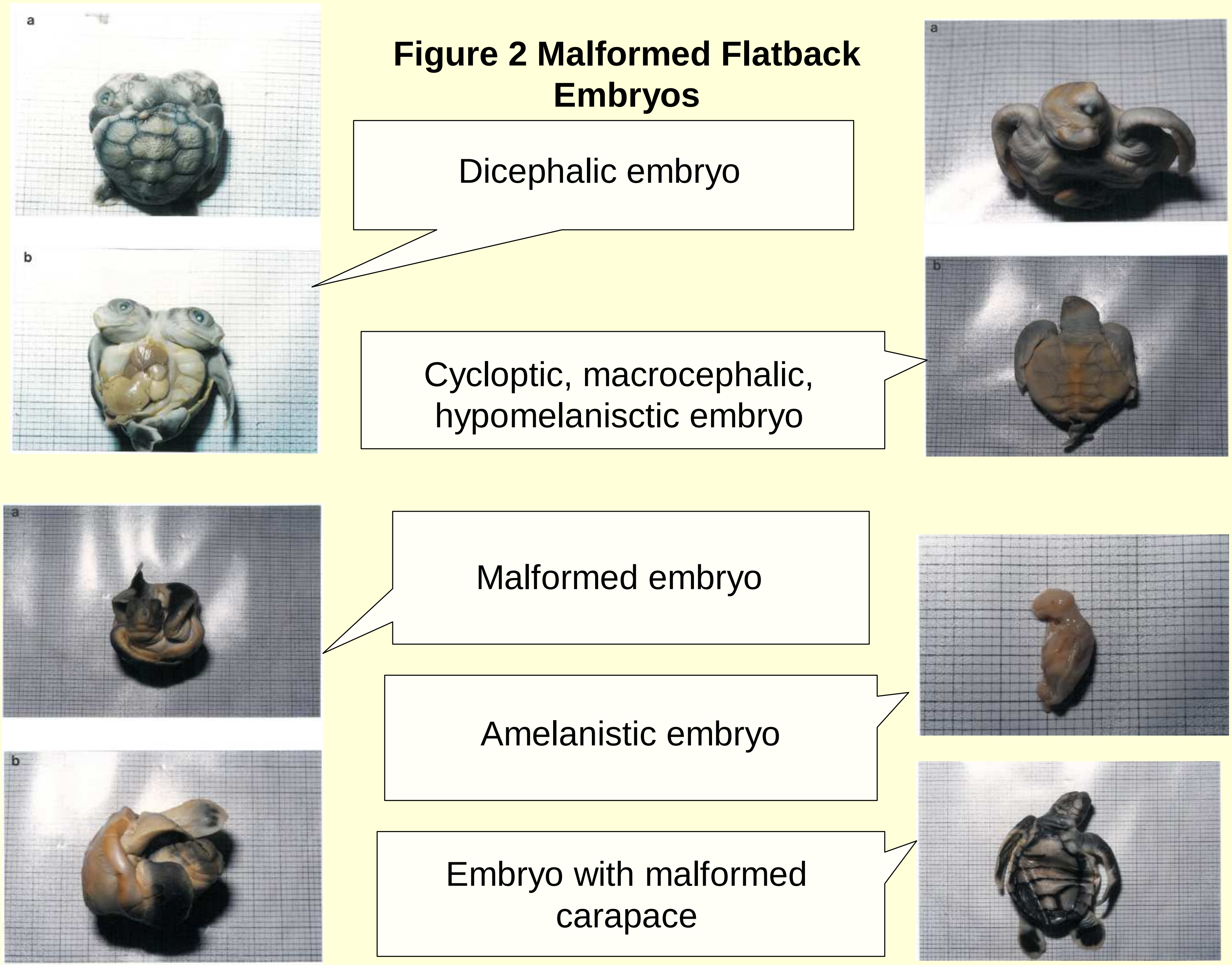


Figure 3 “The Guinea Effect”

A Possible Model to Explain Winter Nesting by the Flatback Turtle *Natator depressus* at Fog Bay, Northern Territory

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Of the three strategies for sea turtles faced with rising global temperatures and sea levels (Mrosovsky et al., 1984), only changes to nesting site fixity have been demonstrated (Limpus, 1987). The flatback turtle, *Natator depressus*, in addition to relaxing nesting site fixity, may have altered the fixity of nesting season from unimodal summer-nesting at Mon Repos (Limpus, 1971) to unimodal winter-nesting in Fog Bay (Guinea, this workshop) with a possible bimodal year-round-nesting at Crab I (Limpus et al., 1983). Should temperatures increase to above the thermal maximum for embryogenesis at Mon Repos and should nesting season fixity be a phenotype displayed by individual females, then disruptive selection (Krebs, 1985 p17) could account for a proposed bimodal nesting distribution. Similarly, by stabilising selection, the Crab I population may develop unimodal winter-nesting and that at Fog Bay may become accentuated or extinct. Alternatively should temperatures decrease, the *Natator* population at Mon Repos could face extinction, while that at Crab I may adopt a unimodal summer-nesting strategy and that at Fog Bay may attain a bimodal nesting strategy brought about by unfavourably low temperatures in July. Each population would respond to the physical requirements of the species for an optimum sand temperature regime for successful incubation of eggs (Limpus, 1971). Research into the chemical and physical (including thermal) properties of sands from nesting beaches holds promise for understanding variations in *Natator* nesting seasonality.

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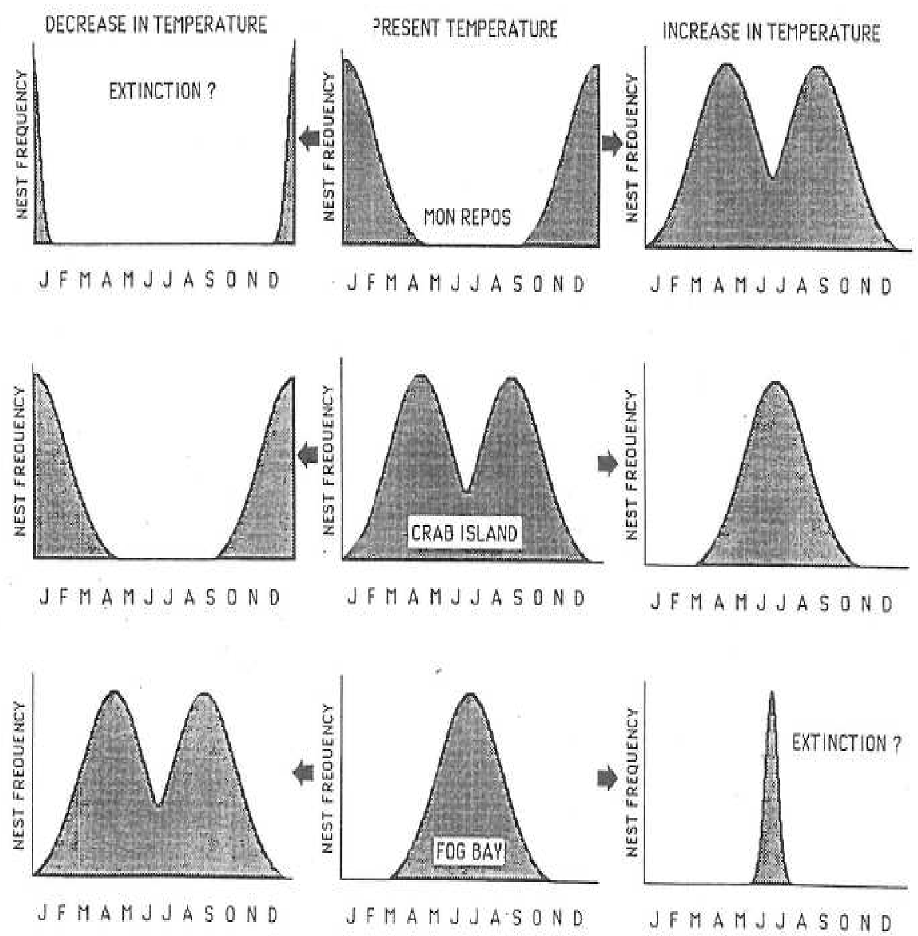

Figure 4 Are you checking for hatching success and embryonic malformations in turtle nesting areas constrained by latitude?

(Chaloupka *et al.* 2008).