

# A rebuttal to the claim natural beaches confer fitness benefits to nesting marine turtles

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## Comment

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Survival rates of early life stages (eggs/hatchlings) in marine turtle populations critically influence adult recruitment rate and thus population persistence (Mazaris *et al.* 2005, 2006). Therefore, for conservation and management purposes, it is particularly important to understand how marine turtle hatching success (percentage of eggs that produce hatchlings) may be affected by human disturbance. Coastal development at nesting habitats is a key issue. Recently, in *Biology Letters*, Pike (2008) has drawn attention to a critical issue; he investigated whether coastal development (permanent development, e.g. houses) negatively influences hatchling production, and concluded that hatching success is significantly lower at developed beaches. In this article, we discuss some of the concerns we have with Pike's study, focusing on misconceptions about factors that underlie hatching success and the dataset used. We also explore whether Pike's conclusions have the conservation merits claimed.

Our first disagreement with Pike's study is that it oversimplifies variability in factors that influence hatching success. As mentioned by Pike '...variation in hatching success can be caused by many different factors, including nest site location,...temporal effects...[and] geographic variation...' However, Pike did not account for the influence of any of these important factors on his study sites and only included data on presence or absence of development. According to Pike '...not accounting for such factors...should create sufficient variation in the data to lead to acceptance of a null hypothesis (that natural and developed beaches have similar rates of hatching success)', and no significant pattern should arise. Then, on finding a significant difference between natural beaches and those that had been developed, Pike attributed low hatching success to the presence of development, thereby assuming that hatching success at a developed beach would have been higher prior to the development. However, by doing this, Pike fails to adequately recognize the risk that the effect found may be a consequence of which beaches have become developed, rather than of the development itself. It could well be that the developed beaches used for Pike's study were peripheral beaches that experienced poor nesting success prior to being developed or had lower hatching success for other

reasons, such as sub-optimal temperature rather than the influence of development itself. It is not possible for us to determine the likelihood of a significant (natural) difference between the 'developed beaches' and the rest of the sample population of beaches because Pike does not provide identities of beaches included in his analysis.

Our second disagreement with Pike's study is that the sample size and the manner in which the data were analysed are inadequate to support the conclusions drawn. The sample sizes for some locations are low. For example, for green turtles (*Chelonia mydas*) Pike has a sample size of 3 for developed beaches. Given that there are dozens of genetically distinct green turtle populations throughout the world, the three beaches in Pike's study are unlikely to be a robust representation of hatchling production. There are considerable data on hatching success contained within non peer-reviewed literature (grey literature) and the analysis could have been improved by incorporating this wealth of data. In addition to sample size issues, there are deficiencies in the way the data were analysed. Hatching success data within the different regions were combined under either developed or natural beaches and then the 'developed' and 'natural' datasets were compared. This method assumes that hatching successes at the sites used are equally representative in their importance for the population. This assumption may be legitimate but was not explicitly identified and no supporting evidence of the sites used was provided. Furthermore, Pike's study also lacks datasets for developed beaches within several regions (e.g. for greens—Atlantic Ocean, Caribbean Sea), yet data for natural beaches for these regions were still incorporated into the analysis. Because the different regions present diverse incubating environments (each of which can, independently and in association, affect hatching success), a nested analysis may have been more appropriate to account for potential difference among regions. However, there is no indication that this was done.

Our final note about Pike's study is in relation to conclusions about the value of the study's findings for on-ground conservation. Pike claims that 'immediate and readily apparent' implication for conservation arises from his study and that 'populations nesting at natural beaches may be able to recover faster'. However, for many genetically distinct populations of marine turtles, nesting occurs on multiple beaches, and individual beaches differ in their importance to the population—at least in terms of numbers of turtles. Thus beaches that have become developed may not be a random subsample of the beaches a population uses in terms of both the natural factors affecting hatching success and the relative importance of individual beaches to a particular population. In addition to this, beaches for many populations would include a mix of developed and natural sites. There is a scale mismatch between Pike's assessment that was done at a global level and implications for conservation or coastal planning, which more often than not occurs at a population or beach level. We feel that it will be difficult for information on whether hatching success is lowered on developed beaches to be used to its full potential

The accompanying reply can be viewed on page 268 or at <http://dx.doi.org/doi:10.1098/rsbl.2008.0693>.

(e.g. influencing development decisions) until data are analysed at smaller scales, such as for populations, and when practical information on causal mechanisms also becomes available.

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