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A Sea Turtle Nesting Beach Indicator Tool

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Introduction

Bluedot Associates are committed to creating tools for supporting developer decision-making as part of our overall approach to delivering consultancy advice. This approach is described in the 'Developer Toolbox' section of our company website: www.bluedotassociates.com. In line with this, we have developed a Sea Turtle Nesting Beach Indicator Tool that we are providing as a free download. In the spirit of collaboration that is central to our approach to consultancy and research, we have developed this tool in partnership with the Centre for Ecology & Conservation, University of Exeter.

As part of our services, we provide niche support for assessing the impacts of development on sea turtle species internationally. During our work, it has become clear that, in many countries where nesting occurs or is expected, there is a paucity of data for understanding the sea turtle nesting spatial coverage and habitat value. As sea turtle nesting areas are commonly encountered issue for development in some regions, and given the conservation importance of the species affected, we feel it requires a better understanding to both manage the impacts and also project risks. The low level of baseline understanding can be due to lack of funding to deliver research, lack of easy accessibility to nesting beaches, a research focus on more easily accessible areas that can skew spatial data, the lack of in-country expertise to undertake detailed research or the vast extent of beaches that need to be surveyed in areas where turtle nesting may occur during relatively short seasonal periods. In addition, single-season surveys are not normally sufficient to truly understand nesting potential given the potential for annual differences associated with nesting cycles. There can also be a tendency for long term research to focus effort in areas that are known to support nesting, have historically been thought to be of greater importance and/or form part of protected areas. For project related studies, seasonality may not align with project schedules for completing baseline studies; and it is not always possible to collect multi-seasonal data. All of the above factors in isolation or combination could mean that project decisions are made based on low levels of useful information or decisions are biased.

These issues pose a problem for undertaking assessments for developer decision-making, and it is especially a limitation for screening studies. Where gaps in information exist, the potential for sea turtle nesting can be overlooked with focus given to areas where nesting is known. In addition, early project decision-making is often made using high level data sets that have inherent limitations associated with the data they use and gaps that exist. At an early project or screening stage

developers often make decisions without site specific information as the costs for completing surveys on projects that may not continue can be unattractive. Issues are then often missed, addressed at a later project stage when impacts are more difficult to address or not considered properly - with implications for the development and nesting turtles. The combination of these factors means that the nesting potential of beaches across less researched areas can be poorly understood, which is a significant limitation to project assessments and good decision-making, especially at the screening stage when avoidance and minimisation measures are potentially easiest to implement.

It is therefore obvious to us that there is a need to try to improve baseline knowledge by facilitating the rapid assessment of potential nesting beaches. This should supplement the use of information that can be gathered from existing data sources and provide a mechanism for gathering site-specific information in a pragmatic way. This is the fundamental aim of the tool we have developed. The tool provides an easily accessible guide to understanding the potential value of a beach for nesting sea turtles based on physical features and various issues that influence nesting potential and habitat quality - in lieu of and in addition to signs of turtle nesting activity; and is not reliant on seasonal periods. Understanding the nesting value of a beach based on these aspects is essential to avoid limitations set out above; and should be the central part of any sea turtle nesting beach assessment irrespective of whether records of sea turtle emergence activity are noted or not.

The intention is to provide developer teams with an easy to use tool to assess the nesting potential in their project area as early as possible and at minimal cost – to inform decision-making at screening or later stages. The tool can be used without the reliance on experts at any project stage. There is, however, an expectation that if the tool indicates that nesting is possible then this would be followed by a more detailed study by specialists. The tool is therefore meant to be indicative rather than conclusive.

In addition to presenting a development resource, the tool provides an accessible guide for local researchers, and possibly, local communities to collect data on nesting potential. As noted above, in many places there is a paucity of information; and the tool should enable rapid collection of data for potential nesting beaches. The simple approach of the tool and the limitations it seeks to address re seasonality of emergence surveys means that data could be collected all year round. The information gathered may then act as a steer for the prioritisation of funds to promote research into understanding areas that are identified as being of greatest interest; and help to create a rapid assessment of nesting beach value across regions in a way that has not yet been achieved. This could then feedback into the creation of new data sets, which if made accessible, should help to promote better developer decision-making.

Background

Sea turtle nesting occurs on suitable coastlines (nesting beaches) throughout the tropics and into temperate regions. Successful nesting and hatching requires certain prerequisite conditions to be met at the nesting area, namely the substrate needs to be able to maintain structure (i.e. the excavated egg

chamber) and eggs need to incubate in low-salinity, high-humidity, well ventilated substrate of correct temperature that is not inundated during development. Indeed, sea turtle nesting successfully occurs on artificially re-nourished beaches, showing that these species are resilient and can adapt to altered environments.

Extensive research has led to the opinion that factors other than the physical conditions of the nesting beach may be as important for nest site selection and stable nesting populations. Even the most suitable nesting beaches may be susceptible to episodic perturbations, such as flooding and erosion caused by storms. Beach conditions may therefore change drastically over both long and short timeframes. That said, it is possible to identify factors that indicate a beach may be suitable for sea turtle nesting and, to some degree, which species of sea turtle might nest there.

A broad outline of beach types preferred by the different sea turtle species is given by Pritchard & Mortimer (1999) and Mortimer (1982):

Loggerhead sea turtles (*Caretta caretta*): Preferred beach type: generally extensive mainland beaches and barrier islands; moderately steep beach profile preferred. Often nest on beaches near subtidal reefs.

Green sea turtles (*Chelonia mydas*): Preferred beach type: ranges from large, open beaches to small cove beaches; preferably with an open offshore approach. Moderate beach slope preferred and deep sand required for nesting.

Leatherback sea turtles (*Dermochelys coriacea*): Preferred beach type: wide, long, tropical beaches with steep slope, deep rock-free sand, and an unobstructed deep water or soft mud bottom approach. Avoids areas with mud and sand flats exposed at low tide.

Hawksbill sea turtles (*Eretmochelys imbricata*): Preferred beach type: almost exclusively tropical; often use narrow beaches on islands or mainland shores with reefs obstructing offshore approach. Hawksbill nesting habitat is often separated (spatially or temporally) from that used by other sea turtle species. May nest in beaches with high component of coral rubble in the sand.

Kemp's ridley sea turtles (*Lepidochelys kempii*): Preferred beach type: wide, extensive, and continuous beaches with scrubby dune vegetation on mainland shores and barrier islands.

Olive ridley sea turtles (*Lepidochelys olivacea*): Preferred beach type: tropical mainland shores and barrier islands, often near river mouths. May select nesting beaches behind mud banks. However, the authors have noted, at least in Africa, the common presence of olive ridley and leatherback turtle nesting on the same steep, high energy beaches.

Flatback sea turtles (*Natator depressus*): Preferred beach type: fairly large open beaches, on mainland or large islands; reef habitat avoided.

It should be noted that the Kemp's ridley turtle nesting range is restricted to continental beaches in the Gulf of Mexico and the flatback turtle only nests on Australia's beaches.

Approach

The tool inputs and outputs are divided into two sections: the first section assesses the potential for supporting a viable nesting population, based on beach geomorphology; and the second assesses if human disturbance is already likely to be impacting nesting activity. In the interest of transparency, we detail the methods by which the outputs of the two sections are determined below.

The *Beach Suitability* section is a percentage score that is the sum of a single choice from each of the five categories shown in the table below. *Beach sediment composition* is important as it needs to be able to maintain the egg-chamber structure during a nest's incubation. *Beach elevation and width* are important to ensure sufficient suitable space is available in which nests are constructed; and nests need to be made in sand that is neither flooded by the sea or ground water. *Beach slope* reflects wave energy as steeper beaches are likely to shed waves washing on to the beach more quickly than flat beaches and hence maintain better conditions for egg incubation; and also steeper slopes reduce the turtle crawl distance above high water to a suitable nesting zone. *Beach length* is important as short distances make it harder for turtles to repeat-nest at the location and encourages dispersed nesting. A score over 70 results in the statement "This location is a typical beach to have regular nesting", a score between 50 and 70 gives "This location has potential to be a beach with regular nesting" and a score less than 50 gives "This location is unlikely to be a beach with regular nesting". If a beach is considered as likely or unlikely to be a beach with nesting activity then this is stated in the 'Tool Predictions' section of the tool. Also, the adjacent box is coloured green for a likely nesting beach, orange for a beach with potential to be regular nesting areas and red for a beach that is unlikely to have regular nesting.

The *Human Impacts* section is a star-rating based on the presence or absence of the six anthropogenic factors listed below:

- Fixed or semi-fixed development behind the beach (houses, huts, bars, cantinas, sheds, fences, pipe lines etc.)
- Obstructions on beach (boats, furniture, logs etc.)
- Disturbance on the beach (e.g. access, recreation, livestock rearing, beach excavation, fires, litter etc.)
- Evidence of Light pollution on the beach (Direct lighting [up to 1.5km away for large developments] and skyglow)

Most of these impacts may be reversible except for where development is permanent and approaching urban-scale. The star rating is based on the highest impact score, indicated from the four impact categories. The input development and physical disturbance values are halved to create an impact score whereas the obstructions and light pollution categories are scored as given. A score of 0 gives a 5* rating, 1 gives 4* etc., and score of 4 or 5 gives a 1* rating. The star rating is presented in the 'Tool Prediction' section of the tool.

Category	Options	Max Contribution	Option Value
Beach sediment (to 50cm)[1]	Beach composed of only sand (fine to coarse)	30%	30
	Predominantly sandy beach with gravel (i.e. granule, pebble, cobble, boulder)		20
	Predominantly gravel beach with areas of sand		15
	Gravel beach		-30
Beach elevation (above high tide)[2]	Less than 0.5m	15%	5
	Between 0.5m and 1.5m		10
	Greater than 2m		15
Beach width (above high tide)	0m	25%	-15
	Less than 5m		15
	Between 5m and 15m		20
	Greater than 15m		25
Beach slope	Low	15%	5
	Moderate to steep		15
Beach length	Less than 200m	15%	5
	Between 200m and 1km		10
	Greater than 1km		15

[1] Sediment types are based on the Wentworth Scale (Wentworth 1922), where grain size larger than 2mm is classed as "gravel".

[2] To simply determined elevations above high tide, the observer stands at the high tide line and, generally, if the beach rises higher than the observer's eye level the beach height is > 1.5m.

Nesting Beach Preferences

Whilst the tool sets out an understanding of nesting beach potential and value; it is also acknowledged that certain species are affected by offshore and onshore conditions that limit or preclude nesting. *Dry sand depth* can restrict which turtles can successfully nest on a beach as a deep later of surface dry sand mean that only turtles that dig a deep body pit during nesting (i.e. green and leatherback turtles) are physically able to reach the moist sand in which an egg chamber can be constructed. *Offshore approaches* may deter certain species from nesting due to the physical nature of the turtles themselves. For instance, the leatherback turtle is a large heavy turtle that lacks the hard shell of other species and instead is covered in skin; and for this reason it avoids nesting in rocky areas or areas with subtidal reef where it could cause itself harm. We have considered placing this understanding as an additional element within the tool, but concluded that this is best kept as a separate component that can be used to complement the tool. We have produced some guidance in the figure below for some key limiting factors. This can be used as addendum to consider if there is potential for species preference if nesting has been indicated as possible when using the tool. In the table below (+) denotes an attractive feature for the species; a (–) symbol would normal preclude or limit nesting for this species; and (?) means there is a possible feature of influence.

		Offshore Approach			
		Unobstructed sand or muddy bottom	**Subtidal reef**	**Mud / sand flats**	**None given**
Dry Sand Depth	**Less than 25 cm**	Any species	+Hawksbill	+Olive Ridley -Green -Leatherback	All possible
	25-40 cm	+Green, +Leatherback, Others ?	Hawksbill ?	Olive Ridley ?	All species, but Green and Leatherback more likely
	Greater than 40cm	+Green, +Leatherback -Others	None likely	None likely	Green or Leatherback only
	None given	Any species	+Hawksbill -Green -Leatherback -Flatback	+Olive Ridley -Green -Leatherback -Flatback	N/A

Bibliography

Dellert LJ, O'Neil D, Cassill DL. 2014. Effects of Beach Renourishment and Clutch Relocation on the Success of the Loggerhead Sea Turtle (*Caretta caretta*) Eggs and Hatchlings. Journal of Herpetology 48(2): 186-187.

Márquez MR. 1990. FAO species catalogue. Sea Turtles of the World. An Annotated and Illustrated Catalogue of Sea Turtle Species Known to Date. FAO Fisheries Synopsis No. 125, Vol. 11. Rome, FAO. 81 pp.

Mortimer JA. 1982. Factors influencing beach selection by nesting sea turtles. In K.A. Bjorndal (ed), Biology and Conservation of Sea Turtles, Smithsonian Institution Press, Washington, DC. pp 45-51.

Miller JD. 1997. Reproduction in sea turtles. In Lutz PL, Musick JA (eds). The Biology of Sea Turtles. CRC Press, Boca Raton, FL. pp 51–81.

Pritchard PC, Mortimer JA. 1999. Taxonomy, external morphology, sand species identification. In Eckert K, Bjorndal K, Abreu-Grobois, Donnelly M (eds). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. pp 21-38.

Rumbold DG, Davis PW, Perretta C. 2001. Estimating the effect of beach nourishment on *Caretta caretta* (loggerhead sea turtle) nesting. Restoration Ecology 9: 304–310.

UNESCO, 2005. Introduction to Sandwatch: An educational tool for sustainable development. Coastal region and small island papers 19, UNESCO, Paris. 91 pp.

Varela-Acevedo E, Eckert KL, Eckert SA, Cambers G, Horrocks JA. 2009. Sea Turtle Nesting Beach Characterization Manual, p.46-97. In: Examining the Effects of Changing Coastline Processes on Hawksbill Sea Turtle (Eretmochelys imbricata) Nesting Habitat, Master's Project, Nicholas School of the Environment and Earth Sciences, Duke University. Beaufort, N. Carolina. 97 pp.

Wentworth CK. 1922. A scale of grade and class terms for clastic sediments. The Journal of Geology 30(5): 377-392.