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To cite this version:
Mayeul Dalleau, Simon Benhamou, Stéphane Ciccone, Gilles Lajoie, Jean-Yves Georges, et al.. Modeling Spatial Population Dynamics of Green Turtle (Chelonia Mydas) in the Southwest of Indian Ocean. 30th Annual Symposium on Sea Turtle Biology and Conservation, Apr 2010, Goa, India. 2010. hal-02269586

HAL Id: hal-02269586
https://hal.univ-reunion.fr/hal-02269586
Submitted on 23 Aug 2019

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MODELLING SPATIAL POPULATION DYNAMICS OF GREEN TURTLE (CHELONIA MYDAS)
IN THE SOUTHWEST OF INDIAN OCEAN

Mayeul Dalleaua,b,c,d, Simon Benhamoua, Stéphane Ciccionec, Gilles Lajoiea, Jean-Yves Georgese, Jérôme Bourjead

“Understanding green turtle population dynamics using an Individual Based Model”

More than twenty years of active research on green turtle (Chelonia mydas) in the
South West Indian Ocean (SWIO) have contributed to improve the knowledge of the
species biology and ecology. However, lots of gaps still remain regarding the links be-
tween the main behavioral processes: alimentation, reproduction and migration, while
shifts in these processes at individual scale have major impacts at population scale.
On this basis, we have started implementing a spatially explicit individual-based model
(IBM) to assess population dynamics of the green turtle in the SWIO. Our simulation
experiment aims to unify, in a single model, alimentation, navigation and reproduction
constraints as well as potential changes in foraging or breeding sites. According to the complexity of the biological cycle of Chelonia mydas, individual-based
modeling appears to be the most suitable method to assess:

- How important is the role played by alimentation, reproduction and migration in
green turtle population dynamics?
- How these three processes interact and constrain each other?
- How sensitive they are regarding environment variability

INDIVIDUAL-BASED MODEL

FORAGING & DEVELOPMENT

Satellite Tagging

Environment

Physiology

Fisheries

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1/ An integrative approach

“Field data as the basis for parameterization and validation of the model”

Active research programs in the SWIO have generated and are still generating a large
number of data focused on green turtle that are integrated into the model:

(1) Recent nesting population status and seasonality based on long-term beach
tracks monitoring started in 1985
(2) Nest parameters and activity based on yearly nest monitoring and incubation
temperature since 2006.
(3) Regional genetic structure known for the SWIO
(4) Physiological studies conducted on captive and free-living individuals since 2007
(5) Identified adult migration routes and juveniles open sea behavior, using at least
140 satellite tracks deployed from 2004 to 2011
(6) Oceanographic data such as currents or sea surface temperature retrieved from
physical models as well as regional fisheries data from RFMOs.

This entire set of collected data acts as the basis for realistic parameterization and vali-
dation of the model.

2/ Individual Based Modeling

“A suitable tool to model green turtle population dynamics in the light of individual traits and local interactions”

Individual-based models aim to understand ecological systems from the properties
of individuals that constitute that system. They are helpful when global properties emerge
from individual singularities and local interactions. Regarding the complex biological
cycle of green turtles and the variability in individual traits, individual-based modeling
appears to be a particularly promising tool. Indeed, sea turtles population dynamics
are driven by local interactions in between individuals and between individuals and en-
vironment at breeding and foraging grounds as well as during migrations. Moreover indi-
viduals breeding at the same rookery sites are likely to feed at distinct foraging area.
Similarly, individuals from multiple rookeries may be found in the same foraging area
or developmental habitat. We believe that sea turtles population dynamics cannot be
understood without considering these local interactions.

3/ Expectations

“Viability of green turtles stock in the South West of Indian Ocean”

Main results of our simulation experiment should lead to a fine evaluation of the viability
of green turtle population in the region and also to a complete description of the under-
lying processes. A clear view of the link between these processes could help conser-
vation managers to identify key levels for conservation priorities: habitats conservation
and restoration, fishing by-catch, pollution, poaching and so forth.

References

1South-West Indian Ocean Fisheries Project (SWIOFP). http://www.swiofp.net.
3TORSOOI database : regional database and GIS for the conservation of sea turtles and their habitats in the southwest indian ocean.

Acknowledgments

The project is funded by
“Direction régionale de l’environnement - La Réunion”
“Terres Australes et Antarctiques Françaises”
“Kélonia, l’observatoire des tortues marines”
“IFREMER”
The PhD candidate is supported by “Région Réunion”
The presentation is supported by “Terres Australes et Antarctiques Françaises”
“The 30th Sea Turtle Symposium”