REPORT OF THE 10th MEETING OF THE WESTERN INDIAN OCEAN MARINE TURTLE TASK FORCE

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IOSEA
Marine Turtle MOU

Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia

10th Meeting of the Western Indian Ocean Marine Turtle Task Force

Report

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Report of the 10th Meeting of the Western Indian Ocean Marine Turtle Task Force

1. Welcoming Remarks and Adoption of the Agenda

The Chair, Jeanne Mortimer (Seychelles), welcomed all present to the 10th Meeting of the Western Indian Ocean Marine Turtle Task Force on behalf also of the Co-Chair, Cristina Louro (Mozambique) and the Coordinator, Heidrun Frisch-Nwakanma (Secretariat). It was the first time the Task Force met in a hybrid format, and she thanked all for joining either in person or online.

Task Force Members from Madagascar, Mozambique, the Seychelles, South Africa, the United Republic of Tanzania and the United Kingdom, as well as two observers attended the meeting. The list of participants is contained in Annex 1.

The Chair invited comments on the Provisional Agenda which was adopted without revision (Annex 2).

Most participants had already attended the Open Session in the morning and had had opportunity to hear and present updates from around the region. Summaries of the presentations are contained in Annex 3.

2. Recap of WIO-MTTF-9 Meeting Outcomes

Ms Frisch-Nwakanma, referring to the Report of the 9th Meeting of the WIO-MTTF (23 March 2021), recalled that this meeting had been held in a virtual format and had mostly focused on organizational matters.

It had also been an opportunity to discuss the plans for the celebration of the 20th anniversary of the MOU and encourage the region to participate. More information on the outcomes would be presented under agenda item 3.

2.1 Terms of Reference of the WIO-MTTF

Ms Frisch-Nwakanma explained that a key item of the WIO-MTTF-9 Meeting had been a discussion of a proposal for revised terms of reference for the Task Force. This revision had intended to update the document and adjust provisions that had proved to be impractical. The agreed text was then sent to the National Focal Points of the countries in the WIO region for approval.

In response, the Government of Mauritius had submitted objections related to the territorial dispute regarding the Chagos Archipelago. The Secretariat accordingly drafted the proposed revision contained in Doc.2.1: Revised Draft Terms of Reference for the WIO-MTTF, which sought to respond to Mauritius' concerns without prejudice to the matter at hand. Specifically, substantial changes had been made to sections 1 and 3 of the document.

She requested participants to consider and discuss the draft contained in this document, and agree the text to be circulated to National Focal Points for their approval.

A lively discussion ensued, with many Task Force Members expressing their concern about removing the direct link between nominating country and Task Force Member, as had been

suggested by the Secretariat. It was also considered essential that ongoing research in the Chagos archipelago would be able to continue, and would continue to be reported into this group.

After carefully considering different options and their pros and cons, Members agreed that the best way to ensure that the work of the Task Force would not be disrupted by this political dispute was to abolish the attempt to update the terms of reference and continue to use the original Terms of Reference of the Task Force agreed in 2008 (available on this page).

3. Implementation of the IOSEA Work Programme 2020-2024

Ms Frisch-Nwakanma drew participants' attention to Doc.3: Progress Report on Implementation of the Work Programme 2020-2024, which provided an overview of the activities of the Advisory Committee (AC) and Secretariat in relation to the Work Programme (WP) adopted by the 8th Meeting of the Signatory States (MOS8). Each sub-region, including the WIO, had prioritized the items in the WP, and it addressed a variety of actors besides the AC and Secretariat, and of course first and foremost the Signatory States themselves. Task Force Members had an important role in supporting their country's National Focal Point in facilitating the implementation of the activities foreseen.

In her presentation, Ms Frisch-Nwakanma drew particular attention to the following completed items:

- #12 – Assessment of the Conservation Status of Hawksbill Turtles in the IOSEA Region launched on 25 March 2022 at ISTS Workshop
- #42 – List of IOSEA AC-endorsed research and other priorities to help to leverage funding for scientific research finalized after consultations and published
- #50 – "Anniversary" Celebration of World Sea Turtle Day in June 2021, in which many countries in the sub-region had an active share
- #60 – Illegal Trade Working Group re-established with updated task list; chair: Iran
- #78 – Revised National Reporting Format developed and adopted to be used in preparation of MOS9 in 2024
- #82 – Updated Flipper Tag Series database online
- #69+95 – AC held its first intersessional meeting (AC9, online, March 2021), NWIO Sub-Regional Meeting in November 2021
- #102 – Funding Opportunities and Fundraising Resources for Marine Turtle Conservation

She encouraged all to consult the webpage about Capacity-building Resources, where more guidance would be made available as and when it became available. She also thanked the Advisory Committee, Task Force Members and all others who had provided input during the various consultations and had participated in activities.

Ms Frisch-Nwakanma stressed that this report could only capture a snapshot of selected activities, as many more were ongoing. Also, outside of the National Reporting cycles there was no mechanism for tracking progress of Signatory States in implementing the many activities foreseen for them, so their side was completely missing from this report. As had been shown in the presentations during the morning session, many relevant activities were ongoing. Further, implementation of many activities required funding beyond the levels usually collected by the MOU, or the submission of information by Signatory States.

She encouraged all to consider submitting articles on their projects or any other topics of interest to the MOU constituency for publication in the news section of the MOU website and in the Newsletter.

Finally, she noted that the 9th Meeting of the Signatory States (MOS9) was due to take place in the first half of 2024, but to date no country had offered to host. She encouraged all to support the search for a host country, especially given that the WIO region had so far not hosted a MOS.

4. Regional Priorities and Opportunities for Collaboration

The Chair recalled the regional priorities identified during the 8th Meeting of the WIO-MTTF:

Assessing and Addressing Threats	• *Domestic consumption and trade* • *Nesting habitat (coastal development, erosion, temperature change)* • *Fishing practices/bycatch* • *Plastic pollution/entanglements* • *DDT*
Research and Monitoring	• *Linkage of developmental and adult foraging and nesting habitats through genetics and satellite telemetry* • *Genetic studies: developing regional capacity* • *Systematic sharing of flipper tag series and returns*
Regional Strategies	• *Twinning of IOSEA Network Sites* • *Engaging government* • *Long term funding* • *Developing best practices to feed into EIAs involving coastal development.*

Regarding nesting habitat changes, Nicole Esteban (United Kingdom) mentioned a paper that describes set up, deployment, explains how to decide on depth of loggers and analyse data.[1] Since the paper was not open access, she invited people interested in seeing it to contact her directly for a copy.

Regarding marine debris and plastic pollution, there was a discussion about the importance of systematic monitoring of marine debris that should include periodic waste audits across different monsoon seasons. The suggested method was to use 100 metre transects with a waste audit conducted two metres either side.

There was also a suggestion to conduct a regional assessment of marine debris with sampling on specific beaches in each range state that would be repeated over time. The NOAA marine debris tracker app[2] was highlighted as a useful tool.

[1] Laloë, J. and Esteban, N., Berkel, J. & Hays, G.C. (2016). Sand temperatures for nesting sea turtles in the Caribbean: Implications for hatchling sex ratios in the face of climate change. Journal of Experimental Marine Biology and Ecology 474, 92-99. doi:10.1016/j.jembe.2015.09.015

[2] https://marinedebris.noaa.gov/collecting-marine-debris-data

5. Next Meeting

The Secretariat raised the issue of arrangements for the next WIO-MTTF meeting. If new terms of reference had been agreed, these would have foreseen annual online meetings, as well as in-person meetings to be held at least every two years. Since there had been general agreement that this would be a practical way forward, Ms Frisch-Nwakanma suggested to aim for an online meeting in 2023. Further communication on this would follow.

6. Closing of the Meeting

Jeanne Mortimer (Chair) thanked everyone for their participation, including the observers, and hoped that with organizational matters concluded for now, future meetings would again be able to focus mostly on substance. Heidrun Frisch-Nwakanma (Secretariat) concurred and thanked everyone, including the Chair and Vice-Chair, for their active participation, understanding and patience in view of the challenges this meeting and the Task Force had been facing.

List of Participants

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Agenda

1. Welcoming Remarks and Adoption of Agenda
2. Recap of WIO-MTTF-9 Meeting Outcomes

   2.1. Terms of Reference of the WIO-MTTF
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6. Closing of the Meeting

OPEN SESSION REPORT

1. Welcome note, session objectives and expected outputs

Jeanne Mortimer welcomed participants and explained that the key objectives of this open morning open session were to:

- Share updates about current marine turtle research and monitoring programmes, conservation and management initiatives and key emerging threats identified in the region.
- Identify opportunities for future collaboration incorporating multi-disciplinary approaches.
- Identify effective tools to communicate information about marine turtles and emerging issues and threats they face in the WIO region.

2. Sharing monitoring and research initiatives and results

Below are summaries of the presentations given as submitted by the presenters.

2.1. Islands

2.1.1. Chagos Archipelago

Sea turtle conservation research in the Chagos Archipelago
(Graeme C. Hays, Nicole Esteban, Jeanne A. Mortimer)

The numbers of green and hawksbill turtle nests in the Chagos Archipelago are being assessed by regular beach patrols to counts tracks. Green and hawksbill turtle tracks are distinguished by their different shapes and widths. These data are showing encouraging upward trends in the annual number of nests for both species. Current estimates are of around 6,300 hawksbill and 20,500 green turtle egg clutches laid annually, placing the archipelago as a major nesting area for both species in in the Western Indian Ocean (WIO) (Mortimer et al. 2020).

Satellite tracking has been used to assess the foraging grounds for turtles that nest in Chagos. After nesting, green turtles travel to foraging grounds across the WIO, with individuals being tracked to countries including the Seychelles, Somalia, Kenya, Madagascar, Mozambique and the Maldives (Hays et al. 2020). In a minority (20%) of cases, post-nesting green turtles remain within the Chagos Archipelago, feeding on the Great Chagos Bank. In contrast, 100% of post-nesting hawksbill turtles that have been tracked (22 of 22 individuals) remained in the Chagos Archipelago, foraging on submerged banks including the Great Chagos Bank, Pitt Bank and Centurion Bank (Hays et al. 2022).

Monitoring sand temperatures at nests depths across seasons and years has revealed relatively cool temperatures, which will likely lead to fairly-balanced hatchling sex ratios (Hays et al. 2021a). In this respect, the nesting beaches so far examined in the Chagos Archipelago are likely to be fairly resistant to the feminisation of hatching sex ratios caused by climate warming that threatens many nesting areas in other parts of the world.

The Chagos Archipelago is also an important foraging area for immature green and hawksbill turtles. Drone surveys have revealed exceptionally high densities of foraging turtles (Stokes et al in press) and long-term satellite tracking, as well as mark-recapture studies, are showing

that immature turtles can remain resident in the archipelago for many years or even decades (Hays et al. 2021b).

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2.1.2. Seychelles

Sea Turtle Populations and Habitats in the Republic of Seychelles
(Jeanne Mortimer, Turtle Action Group of Seychelles (TAGS) & Ashley Diaz, Ministry of Agriculture, Climate Change & Environment)

Seychelles comprises more than 115 islands spread over a 1.4 million km^2 Exclusive Economic Zone (EEZ). Most of the human population (~99%) lives in the granitic Inner Islands the most northeasterly part of the archipelago, while the other islands are spread across a much larger area and comprise sand cays (Amirantes and Southern Corallines) and upraised limestone reef (Farquhar and Aldabra Groups). Two species of sea turtle nest in Seychelles: the hawksbill (~5,500 clutches annually) and the green turtle (~44,000 clutches annually) (Mortimer et al. 2020). Hawksbill nesting occurs mostly on the northern islands (i.e., Granitics, Amirantes and Northern & Southern Corallines), while green turtles nest primarily on the remote southern islands of the Farquhar and Aldabra Groups.

The Turtle Action Group of Seychelles (TAGS) is a nationally registered association of 20 member organizations that conduct turtle monitoring and public awareness. TAGS provides a forum to facilitate harmonization of protocols, data sharing, and procurement and distribution of flipper tagging equipment. There are 11 long-term turtle monitoring projects operating in the granitic islands, 7 long-term projects in the outer islands (with 3 more planned during 2023). Some of these projects, including at Aldabra, Aride and Cousin islands have been operating for more than four decades.

In recent years, seagrass ecosystems have become a topic of study in Seychelles. With funding from Pew Charitable Trusts and in collaboration with Oxford University, the German Aerospace agency, University of Seychelles, and local researchers, Seychelles has created a map of its seagrass habitats, estimated at ~142,000 hectares. These habitats are important to both green turtles and hawksbills. Satellite tracking of post-nesting green turtles both from nesting beaches in Seychelles (Bourjea et al. 2015) and at Diego Garcia, Chagos (Hays et al. 2014) have corroborated the locations of seagrass habitat identified by the mapping studies.

Long-term study of adult green turtles at Aldabra Atoll demonstrated declines in the mean size of nesting females over a period of 21 years, and also documented growth rates nesting females to be 0.14 cm per year (Mortimer et al. 2022). The same study also documented sexual dimorphism in adult green turtles and the relationship between clutch size and carapace length.

In February 2016 the Government of Seychelles completed a first-of-kind $21.6 million debt swap that paved the way for protecting and managing more than 400,000 km2 ocean in Seychelles through the Seychelles Marine Spatial Plan (SMSP) initiative with technical and financial support of the Nature Conservancy (TNC). By March 2020, 32.6% of Seychelles waters had been designated as protected (15% in high biodiversity protection and 17.6% in medium protection.)

The Government of Seychelles has completed a number of policies and legislations including: Coral Policy and Strategic Action Plan 2022, Protected Area Policy, Trade of Wild Flora and Fauna Act 2021, and Nature Reserves and Conservancy Act 2022. Other initiatives expected to be completed by 2023 include: the Biodiversity Policy, and Wild Animals and Birds Protection Act 1961 currently under review.

The Ministry of Agriculture, Climate Change and Environment (MACCE) launched a sea turtle volunteer programme in 2019 which is running annually. MACCE has also installed information boards on Mahé, Praslin and La Digue to sensitize the public about sea turtles.
An international study, conducted by graduate student Alessia Lavigne and Dr Nicola Hemmings of University of Sheffield in UK, is currently underway in Seychelles involving both hawksbill and green turtles as well as Aldabra giant tortoises to study egg fertility. Methods are being developed to identify sperm penetration, fertilization success, and early embryo development in unhatched chelonian eggs – including undeveloped eggs.

Literature cited:

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2.1.3. Reunion Island

Satellite tracking highlights populations connectivity of hawksbill turtle in the Western Indian Ocean (TIMOI)

(Katia Ballorain, Claire Jean & Manon Nivière, Centre d'Etude et de Découverte des Tortues Marines)

The Southwest Indian Ocean (SWIO) is one of the most important breeding areas for the critically endangered hawksbill turtle. However, knowledge remains scarce on the movement ecology of the species in this region. The TIMOI project aims to strengthen our understanding

of the distribution of populations by studying their origin (genetic structure) and their migratory behaviour (satellite tracking).

From sites dispersed across the SWIO, >800 new genetic samples have been collected between 2005-2022 (in process) and 26 hawksbill turtles (20 nesting females, 3 potentially breeding males and 3 juveniles bycaught in offshore fisheries) were equipped with Argos tags between 2007-2022. None of the males migrated. Analysis of the migratory dynamics of females and juveniles shows a range of movements across the Indian Ocean. In particular, juveniles performed unexpected migratory behaviours, up to more than 8,000 km.

The analysis of interpolated location data during migration, based on the estimation of a continuous index of movement persistence, allowed to i) reveal a strong inter-individual variability in the migratory movement of post-nesting females, ii) highlight a relationship between movement persistence and bathymetry and iii) identify 15 foraging areas.

This study is a new step towards understanding the migratory movement of hawksbill turtles and the connectivity of their populations in the Indian Ocean (soon to be completed by the genetic analysis). Results will contribute to the ongoing reflections on the putative Regional Management Units of Southwest Indian Ocean.

GECOS Project: Genetic structure and Assessing the level of individual Stress Based on Bio-markers
(Claire Jean, Kelonia, La Réunion, France)

The GECOS Project developed and conducted by IFREMER Marbec (located at Montpellier, France) is part of the Monaco Exploration expedition on the ship SA Agulhas II in Aldabra which took place in October 2022 in the Western Indian Ocean. This project has two main objectives:

- To study the influence of highly contrasted environments on the exposure of green and hawksbill turtles to inorganic contaminants and their consequence on the stress levels of individuals
- To contribute to a better understanding of the population genetic structure of green and hawksbill turtles in the southwest Indian Ocean (SOOI) (based on long-term used mitochondrial as well as Single Nucleotide Polymorphism genetic libraries)

For that purpose, it is articulated in three actions: Genetics, Habitat use, and the Development of biomarkers of turtle's conditions.

The population structure of nesting females in the region is well known, as well as the origin of juveniles exploiting the islands as a developmental habitat, thanks to the recent work of Jensen et al. (2016, 2020) in particular, and others (Bourjea et al. 2007, 2015). This is true for the green turtle, whereas there is still much to do with the hawksbill turtles. The genetic action aims at assessing the temporal stability of the green turtle recruitment on development habitats, and more specifically in the frame of the ongoing field mission : i) to look at the stability of recruitment on Aldabra over time by comparing the known results for the structure of juveniles in the lagoon in 2015 Jensen et al 2020), to those sampled in 2022, ii) to contribute to a better understanding of the contribution of SOOI breeding sites to recruitment in Aldabra through a comprehensive genetic screening of the genome (Marie Curie M. Jensen Projects).

The Habitat use study is based on tracking methods, as telemetry is a powerful tool to track juvenile turtles in space and time. The costal space utilization from juvenile green turtle in the IO French islands has been studied by Chambault et al. (2020, 2021). In this project, two fastlock GPS tags were deployed on juvenile green turtles in Aldabra on two different sites in order to confirm the small home ranges of this species at this stage in Aldabra, and to validate

that the turtles sampled in the two areas do not mix in time in the lagoon - and confirm the "group" aspect in the analyses – as observed in other islands in the region (Chambault et al. 2020, 2021).

The last action, focusing on the development of biomarkers of turtles' conditions, will assess levels of contamination and stress according to their environment. In that purpose, sea turtles' exposure to inorganic contaminants will be measured as well as its consequences on individual health by evaluation of oxidative stress, stress hormone levels, and liver degradation markers. Two contrasted islands of the SOOI will be studied: Reunion Island and Aldabra. If the results are conclusive on the scale of these two islands, this approach would easily be extended to other sites in the Indian Ocean with different environmental features (habitats, anthropogenic and natural pressures). This will also provide a better understanding of the environmental pressures on sea turtles and their ability to cope and adapt.

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Sea Turtle for Ocean Research and Monitoring in the Indian Ocean (STORM)

(Anne Barat, University of La Réunion)

Biologging technology is a proven methodology to study marine animals as well as an innovative tool to investigate ocean properties. To further assess the ability of sea turtles to behave as autonomous sampling platforms in tropical oceans, several campaigns of observation were conducted as part of the STORM (Sea Turtle for Ocean Research and Monitoring in the Indian Ocean) research program (Bousquet et al. 2020), launched in Reunion Island in January 2019.

STORM-IO is a transdisciplinary and international research program, focused on two main scientific objectives: on the one hand, it aims to improve the observation and forecasting of the ocean and weather (esp. tropical cyclone) in tropical areas. On the other hand, it seeks to improve our knowledge of the spatial and thermal ecology of the five species of sea turtles living in the South West Indian Ocean (SWIO) basin with an emphasis on the behavior of the animals in relation to the characteristics of their environment.

To this end, 93 sea turtles of 5 species (loggerhead, leatherback, hawksbill, green and olive ridley) and at different stages of their life cycle, were equipped with Argos/GPS tags including environmental sensors (a.k.a. biologgers) to sample the structure of the ocean (temperature, salinity and fluorescence). The turtles were released between January 2019 and April 2022, from various nesting beaches or care centers located in Reunion Island, Comoros (Moheli), Seychelles (Aldabra), South Africa (iSimangaliso) and Scattered (Eparse) Islands of Tromelin and Europa.

The preliminary analysis of the dataset confirmed the interest of sea turtles to collect and transmit, in near-real time, oceanographic observations at high spatial and temporal frequency. In the field of physical oceanography, biologging data are used to improve tropical cyclone forecasts (through assimilation of biologging data into the NEMO numerical ocean model), sample mesoscale ocean structures (such as eddies), verify satellite-derived ocean surface products, and assess the variability of the tropical Indian Ocean at intra-seasonal and seasonal scales. In marine ecology, the monitoring has demonstrated the ability of sea turtles to travel thousands of kilometers to reach their nesting beaches or feeding habitats (for example, as far as the Gulf of Oman for loggerheads equipped in Reunion Island or as far as the Seychelles for those equipped from South Africa).

2.1.4. Madagascar

Sea Turtle Conservation Network Madagascar : Mahajanga pilot site
(Benjamin Tsirilaza)

A sea turtle conservation network has been set up in Majunga (north-western Madagascar) with the aim of enhancing law enforcement action for the protection of sea turtles against the catch of traditional fishing and sale at regional level. By improving communication between local fishing communities with the relevant authority, and increasing the capacity to make interventions in remote areas, 15 sea turtles were released between January and August 2022.

2.2. Mainland

2.2.1. South Africa

Dispersal corridors of neonate turtles in the SWIO
(Diane le Gouvello)

Identifying migratory corridors and connectivity is critical for efficient conservation of threatened migratory species. There is a general paucity of information on the early life-history of sea turtles during the “lost years”, which hinders effective management measures. The aim of this study was to investigate the spatial distribution and connectivity of post-hatchlings dispersal corridors of the four sea turtle’s species nesting in the South-Western Indian Ocean (SWIO).

To fill this knowledge gap, a Sea Turtle Active Movement Model (STAMM), was used to simulate post-hatchling oceanic dispersal from the main nesting beaches in SWIO. This novel Individual Based Model, simulates the active dispersal of neonate turtles under the combined effects of oceanic currents and habitat-driven movements. Lastly, we used movement-based kernel density estimation to identify dispersal corridors for each species.

Simulation results revealed that neonate turtles do not drift purely passively, instead dispersal patterns are driven by both regional surface currents and active swimming, directed towards favourable habitats, and that there is high connectivity between natal hatching sites and developmental areas in the SWIO. The results also highlighted a long-distance dispersal migratory connectivity linking oceanic turtles from the SWIO into the South Atlantic Ocean.

Simulation outputs from this study provide a better understanding of the spatial distribution of neonate turtles by identifying developmental areas and dispersal corridors and could thus inform management to generate effective conservation measures for threatened migratory species in the region.

In-water relative abundance, demographics and distribution of sea turtles along the east coast of South Africa

(Natalie dos Santos, Department of Zoology, Nelson Mandela University, Gqeberha, South Africa)

South Africa has the southernmost rookeries for loggerhead and leatherback sea turtles in the world which have been protected and studied since 1963. However, sea turtles spend most of their lives in the ocean where information on males and juvenile size classes of nesting species is scarce. Additionally, little is known about non-nesting green and hawksbill turtles that occur in these waters. This study's objectives were to investigate the in-water relative abundance, demographics and distribution (reef fidelity) of sea turtle species along the east coast of South Africa.

Two marine protected areas (MPAs) were selected as study sites: the iSimangaliso MPA in northern KwaZulu-Natal (KZN) and Aliwal Shoal MPA in southern KZN. Weekly underwater observations of sea turtles were made at both sites over a two-year period where turtle sighting and behaviour data, photo-identification and environmental data were collected. A citizen science approach was also used to gather more data from these sites as well as other areas along the south and western seaboards that were sampled opportunistically. Computer-automated software (I^3S Pattern) was used to analyse the unique facial scutes of individual turtles and sightings per unit effort (SPUE) were used as an index of sea turtle abundance.

The relative abundance of sea turtle species in the northern study site (iSimangaliso MPA, tropical climate) followed patterns of nesting female turtle abundance in the southwestern Indian Ocean (SWIO) as expected. However, the relative abundance of species in the southern study site (Aliwal Shoal MPA, subtropical climate) did not follow these patterns as hawksbill turtles were the most abundant species. Hawksbill size classes were also dominated by juveniles and sub-adults – the life stages most important to protect for population recovery. All species showed high reef fidelity with many individuals being resighted numerous times throughout the two-year study period. One individual, however, an adult female hawksbill, was found to have migrated from Aliwal Shoal MPA to iSimangaliso MPA (over 350 km) having been sighted exactly one month apart in each MPA. This individual was perhaps on a breeding migration to other parts of the southwestern Indian Ocean since we generally do not have resident adult hawksbills on our reefs.

In conclusion, this research represents the first study to investigate the in-water ecology and distribution of nesting and non-nesting sea turtles in South Africa. The results suggest that Aliwal Shoal MPA may be an important habitat for Critically Endangered hawksbill sea turtles that are highly abundant in this area. There is also a much broader distribution of sea turtles across the entire coastline than currently recognised. South African waters seem to be an unrecognised foraging ground for green turtles of all size classes as well as sub-adult hawksbill turtles. This study, therefore, has significant research potential in utilizing citizen science-

based data to describe the spatial distribution of sea turtles in South African waters. It is recommended to establish a long-term in-water monitoring programme using citizen science.

Portfolio effect in sea turtle populations: evidence from loggerheads (Caretta caretta) and leatherbacks (Dermochelys coriacea)
(Shaun Hoekstra)

Sea turtles are ancient animals that have existed for over 100 million years, despite being exposed to a wide diversity of terrestrial and marine threats. In recent decades, many component populations and entire species have vanished rapidly as a result of unsustainable anthropogenic activities. Increasing rates of habitat loss and deterioration, the unsustainable use of bioresources and the amplification of climate change are mainly responsible for exacerbating ecosystem degradation and accelerating biodiversity loss. Consequently, direct and indirect human-related impacts on the environment have forced earth's "sixth mass" or "Holocene" extinction event, whereby species are going extinct at rates that are hundreds or thousands of times faster compared to natural background rates. In contrast to historical mass extinction events, the undergoing "sixth mass extinction" is thought to be driven solely by unsustainable human actions. A total of seven species of sea turtles have, however, continued to persist for millennia and survive through some of earth's most catastrophic events by responding effectively to change. How has one of the most threatened group of animals globally survived for as long as they have?

The portfolio effect concept may potentially serve as a possible explanation for the persistence of sea turtles into the modern world. According to the portfolio theory related to financial investments an investor can minimise the risk of financial devastation and (probabilistically) guarantee stable returns by investing capital into a range of financial schemes resulting in a diversified financial portfolio. The portfolio concept in ecology predicts that biological entities may achieve long-term stability by individual components that show weak or negative correlations with each other through space and time. Individual components comprising a larger system will show different trends and/or patterns in some biological parameter due to the non-uniformity of the prevailing environmental conditions and threats in space and time. The portfolio concept therefore suggests that individual biological components (species, populations or individuals) are more susceptible to change than the combined system (communities, species or populations) due to weak/negative correlations among the finer-scale components over time. A change in a particular property (e.g. population abundance) within an individual component (a population) will not result in a change in the entire system (e.g. species decline/growth). In other words, abundance trends may have remained stable at the species or population level across space and time as a result of their individual components (i.e. population-level abundances) responding independently to their own prevailing environmental conditions and/or threats.

It is possible that the portfolio effect applies to sea turtles. Sea turtles are divided into different population segments, termed Regional Management Units (or RMUs for short). The environmental conditions and threats experienced within and surrounding each RMU, however, differs. As a result, different sea turtle RMUs may potentially show independent trends and patterns in abundance over time, which could produce portfolio effects that are evident when abundance trends are viewed at the species or global level.

The aim of my investigation is to investigate whether the portfolio effect applies to sea turtles, using loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles as examples. The key question for this investigation is: "Are global loggerhead and leatherback abundance trends stable over time as a result of variability in abundances at the RMU-level". It is hypothesised that different loggerhead and leatherback RMUs will display independent trends in abundance over time but with an overall stabilising effect.

If the hypothesis is supported by the results obtained, it would suggest that different RMUs display different trends in abundance over space and time, and that these differential responses in abundance at the RMU-level has a stabilising effect on the abundance trend at the species-level. If this is the case, and the portfolio effect holds, then it becomes evident that all sea turtle populations are important enough to be conserved, regardless of whether their population sizes are large or small. Smaller sea turtle rookeries may potentially have a buffering effect on a large sea turtle rookery that may be experiencing declines in abundances over time. Protecting a diversity of individual sea turtle populations may be more important than conserving only those sea turtle rookeries that have large annual number of sea turtles.

Loggerhead and Leatherbacks Nesting Habitat Selection and Associated Seashore Features in South Africa

(Michaela King, Ronel Nel, Linda Harris, Diane le Gouvello, Nelson Mandela University, Zoology Department)

Mature sea turtles exhibit broad-scale natal philopatry between foraging areas and their natal rookeries. However, upon arrival at the rookery, turtles undertake selection at finer scales regarding where to place successive clutches along the rookery within a process of nest site selection. This nest site selection constitutes the only parental investment provided by sea turtles. Various cues such artificial lighting, seashore vegetation, rocks and reef in the intertidal zone and substrate characteristics e.g. temperature, sand grain size and salinity on nesting beaches are used to guide nest site selection.

The site chosen is vital because nests placed in inappropriate locations may result in reduced or failed egg development, hatching and/or emergence. Consequently, nest site selection is an important determinant in reproductive success. Frequent failed nesting reduces individual female reproductive output over reproductive lifetime.

The study area is the turtle rookery in iSimangaliso Wetland Park, South Africa. The focus species were loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles, which are the only two turtle species that nest in this area. Long-term spatial and temporal patterns in nest placement were determined using contour plots of the number of tracks (emergences) recorded for each species in one-mile units over 55 years (1965-2020).

The nest distribution of each species was then mapped onto a digital coastal ecosystem map: Using ArcGIS, shoreline was split into one-mile units and the emergences of each species determined for each unit. The seashore features for each unit was also mapped such that the total area of beach morphodynamic types, coral communities, seashore vegetation water bodies and absence or presence of dune hummocks, rocky headland, estuarine lake (Kosi Bay lakes) or freshwater lake (Lake Sibaya) was quantified for each shore unit. The seashore features which could potentially guide nest site selection for each population was investigated by entering the distribution map and seashore features map along the one-mile units using a General Niche-Environment System Factor Analysis (GNESFA) within the adehabitat package in R.

Loggerhead tracks increased over time from 1965 and peaked in 2015, with a decline between 2015 and 2019. Conversely, leatherback tracks increased initially but then remained constant from 1970 onward. Emergences of both species was consistent temporally and spatially, with contour plots depicting some interannual variation for both species. Loggerheads had an area of high nest density in the northern part of the rookery, whereas the distribution of leatherback tracks was more uniform along the rookery with a few “hotspots” (areas with relatively concentrated emergences). The GNESFA showed that loggerheads selected for coral reef

habitat and dissipative-intermediate beaches, whereas leatherbacks selected for dune vegetation and areas where lakes were present.

Although both species have received the same protection at their shared rookery, the loggerhead population has increased, whereas the leatherback population plateaued after an initial increase. Site of emergences for loggerheads and leatherbacks was consistent temporally and spatially, but the areas alongshore chosen by species differed, with loggerheads having concentrated distribution of emergences northerly while leatherbacks had a uniform distribution. The associations between seashore features investigated and species emergences differ, with site selection being more specific for loggerheads than for leatherbacks. This indicates that loggerheads may be more specialist in their approach to selecting nesting sites while leatherbacks are more generalist. While this study suggests that both terrestrial and subtidal features are avoided or preferred during nest site selection, it does not identify specific mechanisms driving loggerhead and leatherback nest site selection. Thus, the difference in association may be because of differences in nesting strategy but this remains to be tested experimentally.

Bang for the buck in sea turtle conservation
(Amanda Robbins)

My PhD will be investigating the ecological, economic and social aspects of five different *in situ* and *ex situ* sea turtle conservation approaches (both land and sea). These include Aquaria, Hatcheries, Nesting Beaches, MPAs and Community Work (like Watamu).

The ecological portion will focus on the absolute and relative densities and population contributions of each approach, while the economics section will assess the costs to develop, maintain and (if applicable) improve each approach. The social section will use direct observation, surveys and interviews with local communities and tour operators to examine i) current understandings and inclusions of the local cultural relationships with and knowledge of sea turtles within these conservation approaches; as well as ii) educational efforts (if any) these conservation approaches are putting forth (for the local community and tourists) and their effectiveness.

The goal of the project is to identify the lowest costing conservation approach with positive social impacts that most conserves and contributes to the sea turtle population. The hope is that the project outcome can be used to better inform policy makers with a sustainability framework that can be applicable on a global scale.

It should be noted that this project began as a concept idea in early October 2022 (the week before WIOMSA) and is currently in the design phase, as such it is subject to change. However, we aim to present a formal PhD proposal to Nelson Mandela University in April 2023.

Feminization of leatherback turtles
(Lauren Wienand)

The beach temperature in which leatherback sea turtle eggs develop determines offspring sex; a process known as temperature-dependent sex determination, with warmer temperatures directing the development of gonads into ovaries. Leatherback dependence on temperature therefore makes them specifically vulnerable to climate change, as rising temperatures increase the risk of population feminisation and potentially exacerbates extinction risk. Monitoring sex ratio is therefore a fundamental step to understanding leatherback vulnerability to climate change. This study therefore aimed to determine the current sex ratio stability of the SWIO leatherback sea turtles nesting in iSimangaliso Wetland Park during the 2021/22

season. By studying the thermal profiles of nests and of the beach along which they were laid, I 1) estimated hatchling sex ratio for a number of monitored nests; 2) investigated spatial and temporal variation in nest and sand temperature along the rookery and over the season; 3) estimated the population sex ratio production for this season; and lastly; 4) evaluated if the climate of the 2021/22 season was typical or anomalous.

Daily foot patrols allowed for the detection of nesting females. During the egg-laying process, iButtons were deployed into the nests amongst the eggs where they were left to record nest and sand temperatures every 30 minutes for the entire incubation period.

While location alongshore had a weak effect on temperature, it was found that the greatest variation in sand temperature was explained by time, where temperature increased from start to end of the season. A higher proportion of males were therefore produced earlier in the season where temperatures were cooler, and a higher proportion of females produced later in the season as temperatures increased. The sex ratio of the SWIO leatherback population was therefore estimated to be relatively close to a stable 1:1 ratio. It was therefore concluded that the SWIO population of leatherbacks are currently not affected by climate change in terms high sand temperatures and feminization is currently not a major concern. While these results provide a reliable sex ratio estimate for the SWIO leatherback population, season 2021/22 was significantly colder than previous seasons and the hatchling sex ratio is likely to change in the future.

Future studies should therefore continue to monitor this population so that early mitigation towards the negative impacts of climate change can be implemented. Additionally, since sex ratio biases raise the concern of limited male production and subsequent reduction in genetic variation, future studies should prioritise quantifying genetic variability through the use of genomics to determine the number of breeding males that contribute to the gene pool of the SWIO population of leatherbacks. Such research would greatly contribute to understanding the degree of vulnerability of this population to climate change.

Inspiring care for turtles – tips and techniques: Communicating about turtles for action
(Talitha Noble & Judy Mann, Two Oceans Aquarium Foundation)

Turtles are powerful ambassadors and can inspire care/ action. One of the key roles of the Turtle Conservation Center at the Two Oceans Aquarium Foundation is to be the voice of our remarkable turtles and share their stories of hope, resilience and strength.

Key story/ Case study: YOSHI

- Female Loggerhead adult who had spent 20 years at the Two Oceans Aquarium and was released in December 2017.
- Yoshi was tracked with a satellite tag for almost 1000 days and travelled up to Angola, back down to Cape Town and across the Indian Ocean to Northern Australia.
- There was substantial media exposure that came from Yoshi's journey and story.
- Yoshi became an internationally recognized figure who symbolized what turtles are capable of.

2.2.2. Mozambique

Update 2019 - 2022 Monitoring, tagging and Mozambique conservation programme
(Isabel M. da Silva, Gélica Inteca, Cristina M. M. Louro, Lorena Matos, Herminio Antonio, Eduardo Videira)

Monitoring of turtle nesting beaches is happening in Mozambique in Vamizi island in Palma and Qurimbas National Park (PNQ) in Cabo Delgado; Primeiras e Segundas Archipelago (APAIPS); Bazaruto Archipelago National Park (BANP); and Maputo National Park (MNAP).

Vamizi island has daily patrols of the nesting beaches and 4 monitors working, with 156 nests recorded. In PNQ from August to October 2022- daily monitoring, 11 nests were recorded and monitored, and the first recorded nest was 89% successfully hatched. Both areas have hawksbills and green turtles.

Primeiras &Segundas Islands Environmental Protection Area (APAIPS) did or is going to satellite tag green turtles; re-start nesting monitoring; study of the Local Ecological Knowledge on ETP species; also a pilot study on interaction with ETP and artisanal boats.

Bazaruto National Park (BANP), with 5 species, has daily patrols during seasonal monitoring, one research (Ecology and conservation status of marine turtles – Gelica Inteca); trained rangers and monitors, environmental education classes (primary schools) and awareness (fishermen); with 76 nests recorded.

Maputo National Park (MNAP) does monitoring: Tracks and nesting females from Ponta do Ouro to Santa Maria and nests from Ponta Mucombo to Santa Maria. Since 1994 sites have registered an increase in nests with time. It has approximately 50 community monitors.

People's perceptions on sea turtle conservation in the Ponta do Ouro-Kosi Bay Transfrontier Conservation Area
(Cristina MM Louro, Ronel Nel, Linda Harris)

Background: The Ponta do Ouro – Kosi Bay Transfrontier Conservation Area (TFCA), includes the contiguous protected areas (PAs), the Maputo National Park (MNAP), in Mozambique, and the iSimangaliso Wetland Park World Heritage Site (iSimangaliso), in South Africa. The coastal and marine component of the TFCA is an important courtship and nesting ground of the southernmost loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtle populations in the Western Indian Ocean (WIO). Although a priority area for regional conservation, the great majority of the people that live and work adjacent to the TFCA face great social and economic everyday challenges, where access to natural resources is limited and livelihood sources includes subsistence agriculture, cattle farming, artisanal fisheries and tourism. Nonetheless, the PAs' authorities make continuous efforts to improve the people's well-being by creating employment opportunities as sea turtle monitors and tour guides, as well as in hospitality. In the Mozambican and South African counterparts, conservation, monitoring and research of sea turtles has been running for more than 30 and 60 years, respectively. Interestingly, within the TFCA, and potentially within the South WIO (SWIO) region, there is still no comprehensive research on the socio-economic value of sea turtles, the impacts of their conservation on people, but also on the entire social-ecological system in which these species are embedded. Therefore, the aim is to provide insight by documenting the perceptions on the values and conservation of sea turtles and their associated habitats held by the people living and working within and adjacent to the TFCA.

Methods: The methodology was a combination of two complementary approaches, the Community Voice Method (CVM) and Participatory Mapping (PM). The CVM is based on filmed

interviews to facilitate data recording and promote dialogue through the production of a documentary. The interviews were face-to-face, using a Canon EOS800D camera with a lapel microphone, and online, using the Zoom video conferencing tool. PM uses maps for people to translate their knowledge and, in this case, through highlighting sea turtle occurrence areas, natural or anthropogenic potential threat areas, and people's cultural, social and economic value areas. The maps, based on Google Earth Pro, with 2.5 x 2.5 km grids, were available in printed A_4 paper or electronic format, showing the names of communities, locations and points of interest. To identify potential interviewees, a preliminary mapping exercise was made and included national, district and local authorities, community members (e.g. traditional leaders, elders, priests, fishers, collectors, housewives, teachers, monitors), local businesses (e.g. turtle guides, diving, fishing, ocean safaris and lodge owners and employees) and research institutions. The non-probability 'snowball' sampling method was used, where interviewees were recommended by their peers and so forth, but considering that these had knowledge or experience on the research subject. The number of interviewees was determined through the theoretical saturation principle, where sampled ceased when no new data was considered as bringing additional value to the research. Interviews and mapping took place in four languages: English, Portuguese, Zulu and Rhonga, with the support of a local facilitator and translator. The interviews were translated and transcribed into English and analysed using the Nvivo 12 software, and the maps compiled using the QGIS 3.12.0 Bucaresti software.

Results: A total of 136 participants took part in the filmed and mapping interviews. Of these, 65.4% (n=89) where from Mozambique and 34.6% (n=47) from South Africa. Overall, the main groups of participants consisted of community members (58.8%), Government (19.1%), Non-Governmental Organizations (7.4%), tourism operators (5.9%) and University researchers (7.4%). The participants that benefit the most from sea turtle and their associated habitats are those that live close to their nesting and courtship grounds, and are dependent either by employment (e.g. monitors, tourism guides and researchers), by promoting their business (e.g. ocean safaris, diving operators and hospitality), by complying with their work responsibilities (e.g. PAs' authorities and rangers) or by the experience gained when observing a sea turtle (e.g. people in general). Interestingly, on both sides of the TFCA, members of local communities valued sea turtles as a source of meat but this value has shifted by acknowledging their value as protected species, this shift in perspective was identified, especially, within the Maputo Bay artisanal fishers. In terms of threats and impact knowledge, perceptions varied. Researchers, government authorities and tourism operators had a more comprehensive knowledge, listing threats and impacts across all the associated habitats (feeding, nesting and migratory habitats). On the Mozambican counterpart, the MNAP, the rangers and monitors, that work closely with nesting sea turtles, only have knowledge on threats regarding beach erosion, poaching and pollution. Interestingly, for the majority of them, including members of the local communities, coastal development and lighting, which are outside the limits of the MNAP, were not considered as threats. Another important aspect that was found was that some members of Government, local communities and rangers, in general, did not address, or did not have the knowledge of the potential threats regarding offshore developments, such as the Ponta Dobela port construction and potential oil and gas development. Results of the mapping interviews were based on the area that the participant works, lives or had a sea turtle experience. Nonetheless, participants consistently highlighted the main areas of importance as the nesting grounds where sea turtle nesting abundance is high, the potential feeding grounds on the seagrass beds where sea turtles are commonly observed by the fishers on the north-western shores of MNAP, and the courtship and feeding grounds on coral reefs observed mainly by experienced divers and researchers. Maputo Bay and Ponta do Ouro were highlighted as the main threat areas due to the fishing pressure and coastal development, respectively.

Conclusion**:** People have mixed perceptions on the value of sea turtles and their associated habitats because of their varied draw on direct benefits that arise from these.

2.2.3. Kenya

The Olive Ridley Project (ORP)
(Leah Mainye and Joana Hancock, ORP)

The Olive Ridley Project was founded in 2013 as a UK charity based in the Maldives. Today they have the largest sea turtle identification and ghost net databases in the Indian Ocean. The overall aim of this project is to understand sea turtle population dynamics and estimate sea turtle abundance, density, and distribution ranges throughout the area.

Our vision is a world where sea turtles can roam free from human induced threats.

Our mission is to protect sea turtles and their habitats through rescue and rehabilitation, scientific research, and education and outreach.

We take a multifaceted and holistic approach to protecting sea turtles and their habitats. This includes:

- Rescue and rehabilitation of injured and sick sea turtles at our rescue and rehabilitation facilities.
- Scientific research to fill data gaps in sea turtle knowledge with the aim to inform sea turtle conservation policy
- Education and community outreach to increase awareness about the importance sea turtles play in a healthy ocean ecosystem and the threats they face.

Kenya

a) Use photo-ID data in Kenya's MPAs to:
   - Create real-time view of sea turtle abundance, recruitment and survival
   - Inform and feed into management plans
   - Recognize areas that need intervention
   - Identify threats ad propose mitigation plans
b) Promote research in sea turtle foraging ecology and population connectivity in Kenya.
c) Promote capacity building for in-water sea turtle research and monitoring
   - Incorporate university students and modular integration for schools and universities' educational programs.

2.3. Regional

2.3.1. Review paper: Marine turtles of the African east coast: current knowledge and priorities for conservation and research

(Casper van de Geer, University of Exeter)

Open access: https://doi.org/10.3354/esr01180

Although published literature regarding the five species of marine turtle found along the continental African east coast has grown substantially over the last decades, a comprehensive synthesis of their status and ecology is lacking. Using a mixed methods approach, which combined an exhaustive literature review and expert elicitation, we assessed the distribution and magnitude of nesting, foraging areas, connectivity, and anthropogenic threats for these species in Somalia, Kenya, Tanzania, Mozambique, and South Africa.

A complex pattern of nesting sites, foraging areas, and migration pathways emerged that identified areas of high importance in all five countries, although significant data gaps remain, especially for Somalia. Most green turtle nesting sites were reported from northern Kenya to northern Mozambique, and approximately 1000 clutches are laid at these sites per season. Hawksbill nesting along the continental coast has reduced to a handful of sites and less than 50 clutches are estimated to be laid per year. Loggerhead and leatherback nesting is well-documented in southern Mozambique and South Africa, which constitute the most significant rookeries for these species in the WIO region. There have been reports of nests further north along the Mozambican coast (up to the Bazaruto Archipelago) as monitoring efforts have increased. Olive ridley nesting is rare (less than 20 clutches per year) and is mainly reported in Kenya.

The most pressing knowledge gaps identified were spatial ecology, impacts from anthropogenic threats, and nesting ecology.

Illegal take, bycatch, and loss of foraging and nesting habitat were identified as the most serious anthropogenic threats. Although these threats are broadly similar along most of the coast, robust data that enable quantification of the impacts are scarce.

Experts identified regional strengths and opportunities, as well as impediments to turtle conservation. Topics such as legislation and enforcement, collaboration, local stakeholders, and funding are discussed, and future directions suggested. Regional structures such as the IOSEA and the MTSG play important roles in enhancing knowledge exchange and collaboration. Such (sub-) regional approaches can facilitate funding opportunities that are beyond the scope of local conservation efforts and produce results that are of regional significance.

Given the projected growth in human population along the continental African east coast and expected accompanying development, anthropogenic pressures on turtle populations are set to increase. Stronger regional collaboration and coordination within conservation and research efforts are needed if current and future challenges are to be tackled effectively.

2.3.2. Southwest Indian Ocean Green Turtle Genomics (Dr. Michael Jensen) *(Jeanne Mortimer)*

This regional study is building on our understanding of genetic stock structure and connectivity in green turtle nesting populations and foraging aggregations across the Southwest Indian Ocean. Samples available for this study include most of the samples used in previous genetic studies of green turtles in the region, including Bourjea et al. 2007, 2015 and Jensen et al. 2020. Additional nesting and foraging samples from Chagos and Seychelles (including from Aldabra and D'Arros/St Joseph) will also be included to refine our understanding of stock structure and connectivity and to improve the accuracy of stock assignmennts in foraging areas.

DNA from 250 green turtle tissue samples were extracted. Complete mitochondrial genomes were sequenced from 24 turtles using MinIon nanopore including 12 nesting samples from Chagos Archipelago and 12 nesting samples from Aldabra. RadSeq of 200+ samples from key rookeries across SWIO to be complete by February 2023. Select foraging samples from Chagos, Aldabra and D'Arros to be analysed.

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IOSEA
Marine Turtle MOU

Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia

UN environment programme
CMS