



PRCM



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Alliance Régionale
pour la **Survie**
des **Tortues**
Marines



Conservation of **sea turtles** in West Africa

Capitalization of research efforts
Lessons learned and future directions

© Conservation of sea turtles in West Africa
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Lessons learned and future directions
May, 2022

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West Africa is a region of global importance for sea turtles

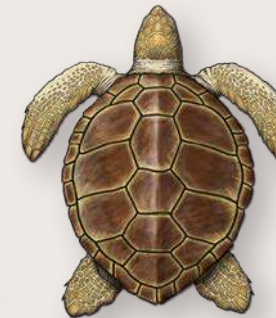
Five of the seven existing sea turtle species occur along the coastline of West Africa, nesting at near-pristine sandy beaches or feeding in productive marine habitats, and constitute some of the most important biodiversity in the region.



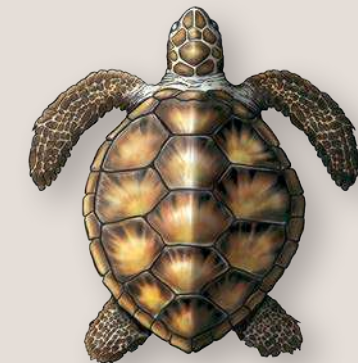
Olive Ridley
Lepidochelys olivacea



Hawksbill Turtle
Eretmochelys imbricata



Loggerhead Turtle
Caretta caretta



Green Turtle
Chelonia mydas

some of the
world largest
sea turtle
populations are found
in the region!



Leatherback turtle
Dermochelys coriacea

1 Sea turtles in West Africa and the value of research

Research and education support the conservation process

Deepening the knowledge on the nesting and feeding ecology of sea turtles in West Africa is critical to **identify threats**, quantify impacts, evaluate the status of populations and inform effective **conservation strategies**.

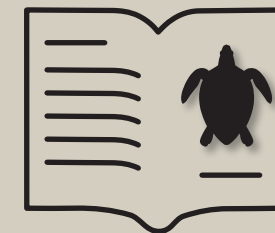


In the marine habitat, great concentrations of turtles are found in the **Banc d'Arguin National Park of Mauritania** and in the **Saloum Delta National Park of Senegal**. Other sites may remain undiscovered.

Olive ridley, hawksbill and leatherback turtles exist in **smaller numbers**, but every year they can be seen nesting, foraging or traveling across the region.

The **Cabo Verde** archipelago hosts the main breeding population of **loggerhead turtles** worldwide, while the Bijagós archipelago in **Guinea-Bissau** is one of the core breeding areas for **green turtles**, globally.

Research findings are also key to generating content for **communication tools** to raise awareness among different stakeholders and to support legal documents for sea turtle and habitat protection. Further, research on sea turtles as indicators contributes to the **general monitoring** of the marine environment.



The technical and advanced training of national partners on the ecology, biology and conservation of sea turtles **build stronger conservation teams**, with enhanced reputation, authority and national and international visibility.



This document summarizes some of the advanced training activities and scientific research towards sea turtle conservation in West Africa, conducted within the framework of ongoing projects funded by the PRCM ('Survie des Tortues Marines') and the MAVA Foundation.



2 Building stronger conservation teams

Conferences and advanced courses

During 2021, **advanced training** on sea turtle biology, ecology and conservation was offered to university students and conservation technicians, in the form of conferences, lectures and workshops.



Universities

Dakar
Praia
Nouakchott
Bissau

Lectures on sea turtle ecology, biology and conservation at the University of Nouakchott, Mauritania April and May 2021.

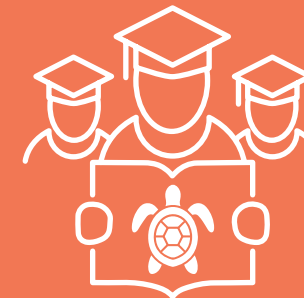
Conference at the Université Cheikh Anta Diop, of Dakar, Senegal 27th to the 30th of July 2021.

Training course at the Universidade de Cabo Verde, Praia, Cabo Verde 2-5 November 2021.

Lectures on sea turtle ecology, biology and conservation at the Universidade Lusófona de Bissau, Guinea-Bissau – July and December 2021.

Attendance: university students, sea turtle specialists, managers of protected areas.

Advanced training and education



Benefitting from grants and partnerships established within the sea turtle conservation projects **two Bissau-Guinean biologists** completed a master program in Marine Biology and Conservation at ISPA – Instituto Universitário of Portugal, and a third is currently enrolled in the same program, and a **Cabo Verdean biologist** conducted a PhD degree on the Biology of Sea Turtles, at the University of Algarve in Portugal.

Additional technical and financial support was given to a **PhD student** from the Atmosphere and Ocean Research Institute (AORI) of the University of Tokyo, and a **master student** enrolled in the Professional Master in Biodiversity, Fisheries and Marine Conservation from the University of Algarve in Portugal, both **from Cabo Verde**, to conduct their research on sea turtle conservation.

Five undergraduate students from Cabo Verde have completed their degree dissertations on sea turtle biology and ecology, also with support from the sea turtle conservation projects.

Regional Workshop

From 6 to 11 of December of 2021 a **West Africa sea turtle workshop** was held **at Bissau**, Guinea-Bissau, with the aim of sharing experiences to broaden and strengthen the regional network along the PRCM countries.

The workshop counted with 50 participants, among researchers, managers, technicians and students from the **seven PRCM countries** (Mauritania, Cabo Verde, Senegal, Gambia, Guinea-Bissau, Guinea and Sierra Leone) and participants from four European countries that collaborate in research and training activities in the region.

This initiative was pioneer in terms of its sea turtle technical and scientific focus, and also in terms of the degree of inclusion of relevant sea turtle actors of all the PRCM space, and promoted a **rich exchange of experience and new collaborations** between participants.

Regional meeting on sea turtle conservation at Maio Island, Cabo Verde, from 17 to 20 of May 2021- 35 participants from 4 PRCM countries (Cabo Verde, Guinea-Bissau, Senegal and Mauritania).

50 participants

from the
7 PRCM countries



3

Sites of global importance for nesting green turtles and threats at the nesting beach

Major green turtle rookery in the Bijagós archipelago

Poilão Island, located within the João Vieira Poilão National Marine Park, in the Bijagós archipelago, Guinea-Bissau, hosts the largest green turtle rookery in Africa, and the second largest in the Atlantic, where **up to 10,000 green turtles** come ashore to nest every year!

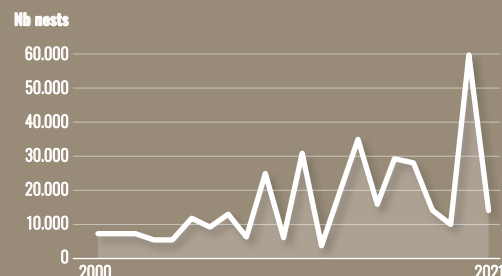
Turtles at Poilão nest year-round, with most nesting activities concentrated between **June** and **December**.



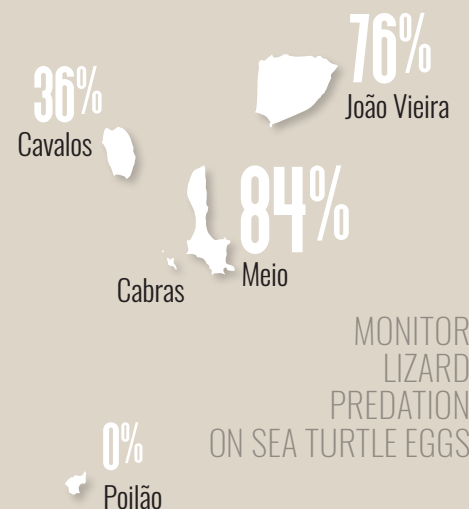
Poilão is considered a **sacred island** among the **Bijagós people**, which has contributed to the conservation of the green turtle population nesting there.



Since the year 2000, this population has been **monitored** allowing to estimate the nesting abundance trends. Research and monitoring confirm that the **population is growing!**



Significant nesting also occurs on the other islands of the João Vieira Poilão National Marine Park, where recent research has found that predation by **monitor lizards** (*Varanus niloticus*) has a moderate to high impact, affecting 36% of the clutches in Cavalos Island, 76% in João Vieira and 84% in Meio.



Research has also shown that this predation occurs within the first **2 days** after egg laying.



Preliminary experiments at the island of Cavalos suggest that the application of concentrated **clove oil** on the surface of the nest can **reduce nest predation** by monitor lizards.



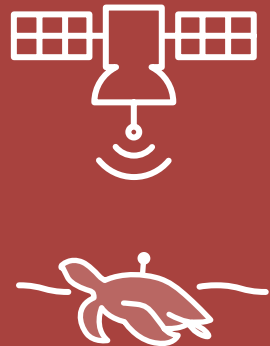
Future research will further assess the effectiveness of measures to mitigate predation by monitor lizards, such as translocating eggs to safe hatcheries or *in situ* deterrents.

Nest predation by monitor lizards

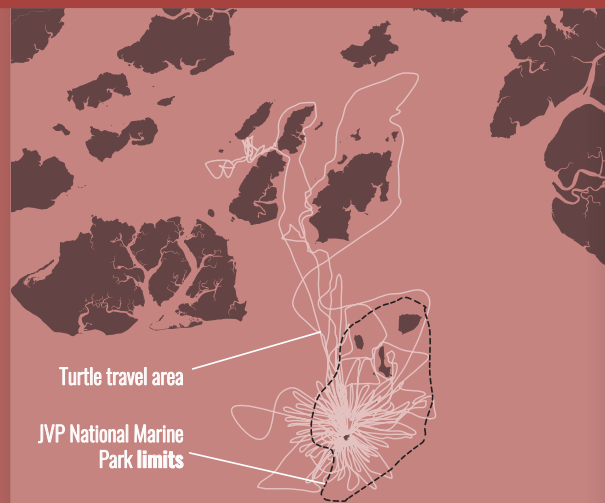


4 Geographic distribution & connectivity of green turtles in the PRCM region

MPA effectively protects major green turtle breeding area



Satellite tracking of nesting female green turtles revealed that, during the breeding season, most turtles remain close to the nesting beach of **Poilão**, within the limits of the João Vieira Poilão National Marine Park.



The core use areas, where turtles spend most of their time between laying eggs, were **inside the no-take zone** of the Park.

These findings are encouraging, supporting the **current limits** of this MPA to protect this large breeding aggregation.



Connectivity across the RAMPAO

Satellite tracking has shown that the nesting **green turtles** from the large Bijagós population **connect many marine protected areas** of the RAMPAO – the Regional Network of Marine Protected Areas in West Africa - through their migrations.

This demonstrates the **important role of the RAMPAO** for the conservation of one of the major green turtle populations globally. Recent satellite tracking of adult male green turtles from Poilão indicates that they also intensively use the RAMPAO.

Atlantic-wide connectivity

Genetic studies have further shown that juvenile green turtles from the Bijagós can also grow in places not used by adults, such as South America and the islands of Cabo Verde. On the other hand, some juvenile green turtles born in the American continent are present in the Banc d'Arguin and in the Bijagós.



MAURITANIA
Banc d'Arguin
National Park

SENEGAL
Joal-Fadiouth
Saloum Delta

GUINEA BISSAU
Bijagós Archipelago

Research using satellite tracking and genetic tools highlights that **West Africa green turtles** are a resource shared across the Atlantic Ocean!





5 Largest West Africa MPA is a major feeding site for green turtles

The Banc d'Arguin National Park provides food for tens of thousands of green turtles



The Banc d'Arguin has long been recognised as a feeding ground for green turtles, but until recently nothing was known on their abundance, age-structure and origins, other than that some females nesting in the **Bijagós archipelago** migrated to the Banc d'Arguin.



Scientific fishing of turtles in the Park, conducted in collaboration with **Imraguen fishers**, indicated that less than 10% of the green turtles feeding there are adult females, which implies that the number of **green turtles residing** in the Banc d'Arguin is likely of the order of **100,000**.

Recent satellite tracking surveys revealed that approximately

50% of green turtles that nest at **Poilão Island** are residents at the **Banc d'Arguin!**

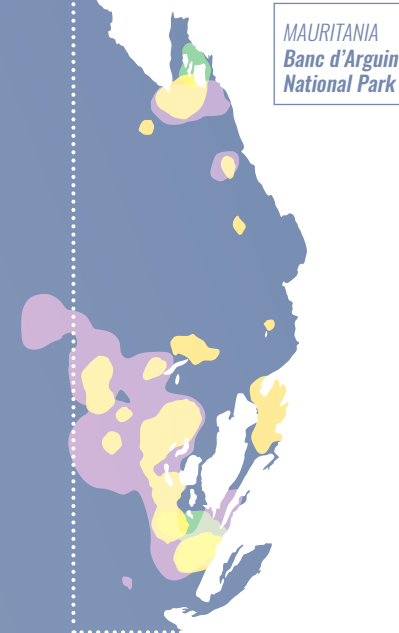
Since there are around **15,000 to 20,000 turtles nesting** at Poilão Island, this means that **7,500 to 10,000 adult females** are residents at the **Banc d'Arguin!**

Sea turtle distribution in the Banc d'Arguin

Satellite tracking of **juvenile, adult female** and **adult male** green turtles at the Banc d'Arguin National Park has shown that turtles are not dispersed randomly across this MPA, instead, they seem to **concentrate in specific areas** of the Bay.



- Adult male green turtles
- Adult female green turtles
- Juveniles green turtles



The Banc d'Arguin has vast **seagrass meadows**, which are an important source of nourishment for the resident green turtles.



Recent seagrass maps of the Banc d'Arguin show considerable agreement with the spatial distribution of foraging green turtles, so the distribution of **turtles** is likely **associated** with the **seagrass** coverage.



The core areas identified have the potential to be used, together with information on the distribution and abundance of other marine biodiversity, to further **refine the zoning** and the **fishing regulations** of the PNBA.



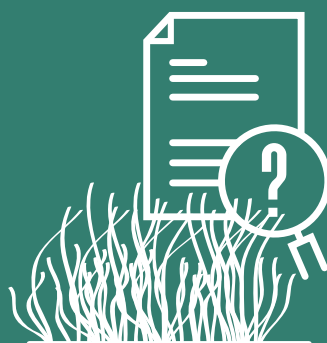
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Major green turtle foraging areas that remain understudied

The Saloum Delta National Park



In the heart of the delta, in the Saloum Delta National Park of Senegal, there is an **exceptional feeding area** for green turtles, with thousands of individuals coming from the population of the Bijagós archipelago, as revealed by satellite tracking.



The Park has significant areas of seagrass meadows which may be key to support a large foraging aggregation of green turtles. However, nothing is known about **the role of the area** as a **developmental site** for sea turtles, or about the numbers present and their ecology and conservation status.

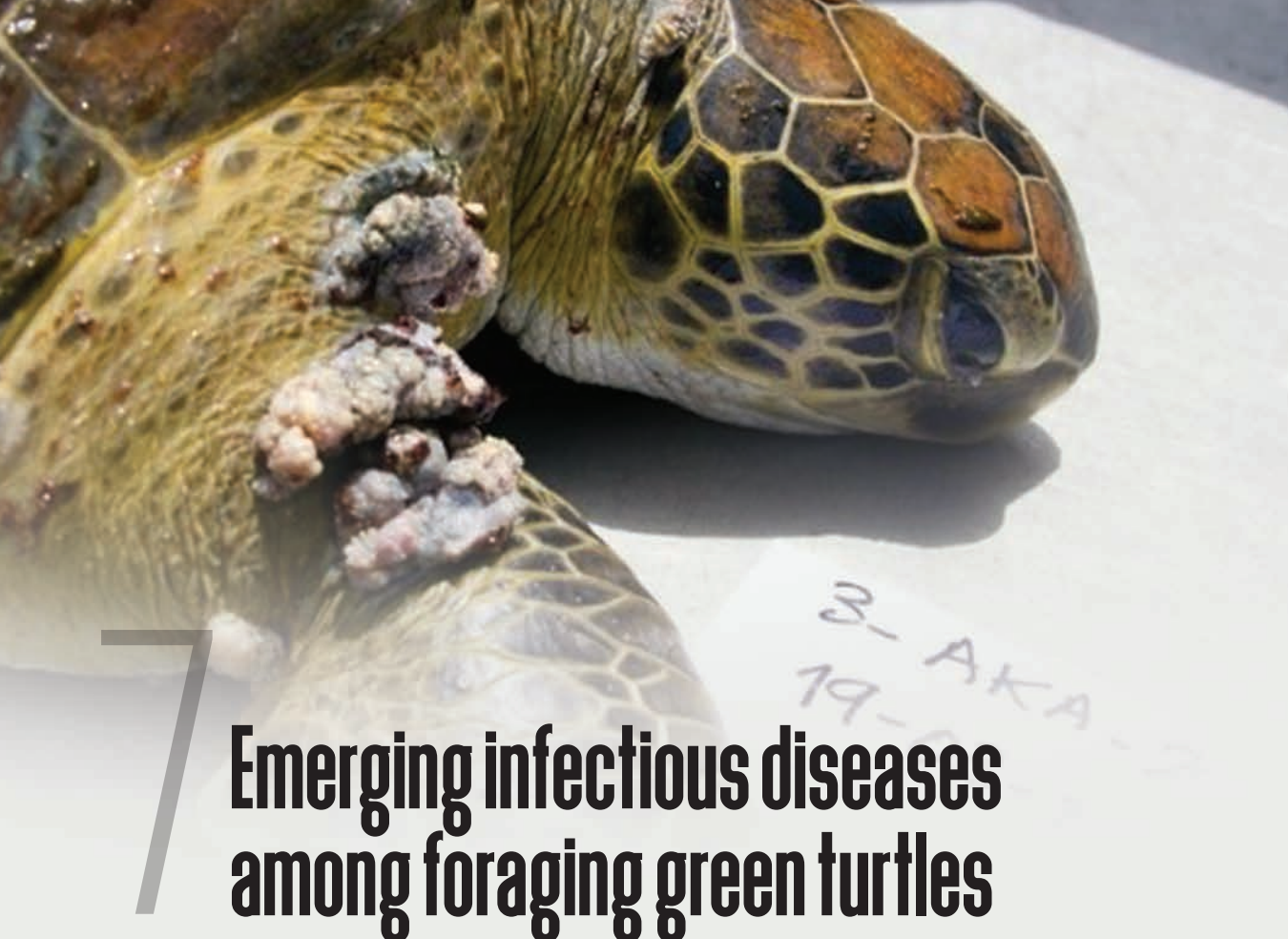
Preliminary surveys suggest that this could be one of the **highest-density feeding grounds** in the world!

Joal-Fadiouth and the Bolama-Bijagós

Additionally, satellite tracking also revealed that the Joal-Fadiouth MPA of Senegal and the Bolama-Bijagós region of Guinea-Bissau also provide **important feeding sites** for male and female green turtles from the population of Poilão Island, in the Bijagós.

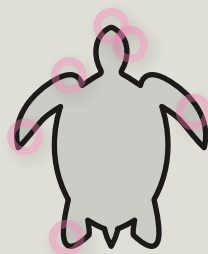
Future research at these feeding grounds is essential to allow assessing the abundance and age-structure of foraging green turtles, **to identify potential threats** and **to guide conservation actions**.



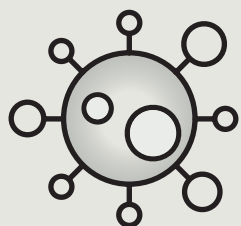


7 Emerging infectious diseases among foraging green turtles

Fibropapillomatosis



Fibropapillomatosis (FP) is an infectious disease that **causes tumors** on the flippers, skin, eyes, mouth and internal organs of sea turtles. Large tumors can cause difficulties in sight, feeding, swimming and lead to organ failure.

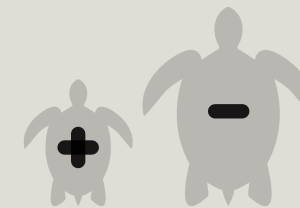


This disease affects all sea turtle species but it is **more frequent among immature green turtles**. It is caused by a virus, the **Chelonid Alpha Herpesvirus 5** (ChAHV5) and potentially linked to habitat degradation.

First baselines of Fibropapillomatosis prevalence among West Africa green turtles

During dedicated surveys, FP **tumors were detected** on 33% of green turtles analyzed in the coastal waters of the islands of **Unhocomo** and **Unhocomozinho**, in the Bijagós archipelago of Guinea-Bissau, and on 28% of green turtles analyzed in the **Banc d'Arguin**, Mauritania.

Juvenile turtles had higher tumor prevalence (35%, n=82) compared to **subadults** (5%, n=21), probably because older turtles have acquired resistance to disease over time. Prevalence amongst reproducing females is almost zero.



The DNA of the ChAHV5 was detected in 83% (n=24) of the tumor samples analyzed, which is consistent with the role of this virus as causative agent of FP. However, viral DNA was also detected in some turtles that exhibited no tumors (21% in the Bijagós and 68% in the Banc d'Arguin), suggesting latent or early infection.



Fibropapillomatosis was also documented among green turtles foraging in the coastal waters of **Boa Vista Island**, in Cabo Verde.



To better understand the dynamics of FP among West Africa green turtles, **long-term monitoring is needed**, as the prevalence and virulence of this disease may fluctuate over time, and can be exacerbated by global warming.




28%
Banc d'Arguin


33%
Unhocomo
Unhocomozinho

MAURITANIA
Banc d'Arguin
National Park

GUINEA BISSAU
Bijagós
archipelago

8

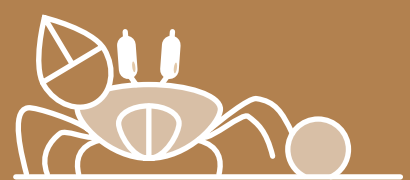
The reproductive success of loggerhead turtles

Ecological drivers of high predation of sea turtle hatchlings during emergence



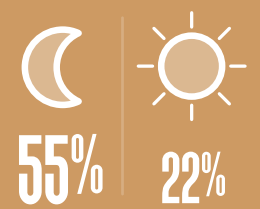
Ghost crabs (*Ocypode cursor*) are the main predators of loggerhead eggs and hatchlings in Cabo Verde.

An experiment evaluated the effect of hatchling group size on ghost crab predation rates during the crawl to the sea on Boa Vista Island.



Synchronous hatchling emergence reduced rates of predation, as **predation decreased** from 75% in **smaller groups** to 25% in larger groups, **due to the lower probability of an individual being attacked by a ghost crab.**

Ghost crab predation was **higher during the night** (55%), compared to the day (22%).



The distance between the nest and the surf zone did not influence predation rates, likely because ghost crabs wait close to the tide line for hatchlings.

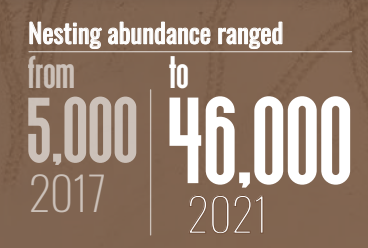


These findings are useful **to guide hatcheries' release protocols:** to reduce predation rates, hatchlings should be released in large groups at twilight hours and in areas of low ghost crab densities.



As the coastlines across the world are becoming **increasingly urbanized, illuminated, and disturbed**, undisturbed nesting areas are vital sites for sea turtle persistence.

Recent research shows that Maio Island in Cabo Verde has virtually **pristine beaches** that host a high abundance and high density of **loggerhead sea turtle nests**.



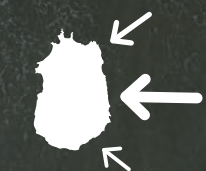
These findings confirm that the island of **Maio** supports a great proportion of the **loggerhead population** from Cabo Verde, being among the **largest nesting rookeries in the world.**

A nesting refuge in the pristine island of Maio, Cabo Verde



Nest site selection by loggerhead turtles in Maio Island, Cabo Verde

Loggerhead turtles in Maio Island, Cabo Verde, **prefer to nest** on beaches **facing east**, and show high fidelity to beach orientation, as **>70% of turtles return to lay consecutive clutches in east-facing beaches.**



Turtles nesting at north and southeast facing beaches tend to select a different area of the coastline for their subsequent nests, **often selecting east-facing beaches.**

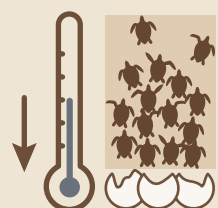
Female loggerhead turtles also seem to avoid nesting in low elevation **areas more prone to flooding**, at least after a first nest, as turtles usually do not return to lay subsequent clutches in areas with high-risk of flooding.

These findings indicate that the **east coast of Maio** is of **high priority for loggerhead conservation** and that **nesting female behavior can enhance clutch survival!**

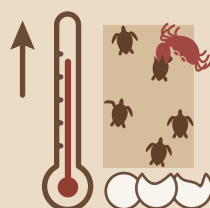
9 Threats to loggerhead nests at the nesting beach and conservation tools

Warmer temperatures impact hatchling survival and phenotype

A 3-year study assessed **the effect of incubation temperature**, associated with sand color, on sea turtle embryo mortality, hatchling size, and hatchling predation during their crawl to the sea, at Boa Vista Island, Cabo Verde.



The mean hatching and emergence successes were higher under **colder incubation** conditions.



Hatchlings incubated at **warmer temperatures** were smaller with poorer locomotion abilities, and suffered higher ghost crab predation during seaward transit.

Chemical contents of sand also determine hatching success and phenotype

A 5-year (2017-2021) field and laboratory study evaluated the relationship between **substrate type** and both embryonic development and the quality of hatchlings in loggerhead turtle nests, at Maio Island, Cabo Verde.



Dark volcanic sands



Light biogenic sands

When loggerhead nests are incubated in dark volcanic sands with a lower amount of calcium carbonate, embryos die in greater numbers and at earlier stages. **Light sands of biogenic origin produce larger and faster hatchlings**, and more hatchlings per nest, which implies a reproductive advantage. This is relevant information to **manage nest protection** programmes of threatened populations.

Potential impacts of sea level rise and flooding on reproductive success

A 3-year study assessed the potential impacts of tidal inundation on loggerhead hatching success and hatchling phenotype across three elevation zones with variable inundation risk, at Boa Vista Island, Cabo Verde.

Embryonic development was **faster on the upper zone** of the beach, where the number of hatchlings emerging simultaneously from the nest was also higher (mean=35.1), compared to middle (16.7 hatchlings) and low elevation sites (10.1 hatchlings).

Emergence and hatching success **decreased** with increasing water content, being lower in the **low-elevation/wet zone**.



Hatchery efficiency as a conservation tool in threatened sea turtle rookeries with high embryonic mortality

During 6-years, several thousand of high-risk clutches from loggerhead turtles were **relocated to a hatchery** within the Sea Turtle Natural Reserve, at Boa Vista Island, Cabo Verde.

In situ nest
< 35%
mean survival

Relocated clutches
70-85%
mean survival

The incubation period and the morphology of hatchlings incubated at the hatchery was **similar to those incubated in situ**, suggesting that **sex-ratios** and fitness of the hatchlings are probably **similar** between the **hatchery** and the **natural sites** at the beach.

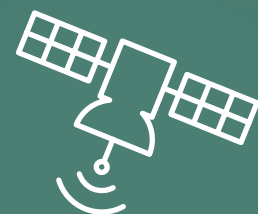
These findings, support that beach hatcheries can be a **valuable conservation tool** for threatened sea turtle clutches of populations of conservation concern.



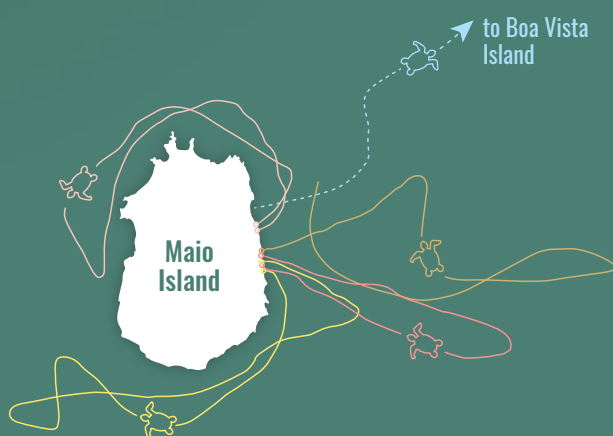
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Movements of loggerhead turtles in coastal waters of Cabo Verde and threats at sea

Loggerhead inter-nesting habitat use around Maio Island, Cabo Verde



The movements of sea turtles during the inter-nesting period, which is the period between consecutive nesting events, **varies** between **species** and **populations**.



14 days
200 km

Turtles spent an average of 14 days (range 12 - 15 days) at sea, and travelled a mean distance of 200 km, ranging from <100 km to more than 400 km.

Knowing their **spatial distribution** and **movements** during this critical period allows optimisation of at-sea conservation actions.

Tracking of 10 loggerhead turtles that nested in the island of Maio, revealed **high individual variability** in inter-nesting movements.



Most turtles laid consecutive clutches **on the same beach area** (90%), but 1 turtle moved from Maio to the island of Boa Vista.

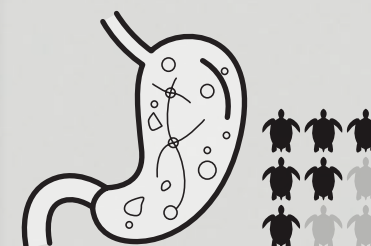
Continuing this monitoring in the coming years will improve estimates of the use of marine protected areas by loggerhead turtles during reproduction, and their exposure to various threats.

Plastics are one of **the most conspicuous negative environmental impacts** of humans. Global production has grown

from 1.5 million to **299 million tonnes** in the last **6 decades!**

Plastic waste has **increased** at the same rate both **on land** and **in the sea**, affecting marine life, including sea turtles.

Among **9 reproductive** loggerhead females found stranded at Maio island, **6 presented macroplastics** (> 5 mm) in their stomachs!



Macroplastic Ingestion by loggerhead turtles

Some items identified were **pieces of plastic cups, transparent bags, and fishing rope**, with 5 of the 6 affected turtles presenting macroplastics of both domestic and fishery origins.





Sea turtle bycatch in the PRCM region

Sea turtle bycatch by Artisanal fisheries

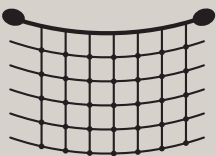


Interviews to fishermen from Senegal, The Gambia, Guinea and Sierra Leone, conducted between 2020 and 2021, indicate that **sea turtle bycatch by artisanal fisheries** is an **important threat** in the region.

Among
651
fishermen
interviewed

55% report catching sea turtles, either as targeted or bycatch, with differences between countries: 100% of fishers in The Gambia, 89% in Guinea, 78% in Sierra Leone and 48% in Senegal.

Fishing gears that catch more turtles



50%



27%

Purse seines (11%) and beach seines (6%) have lower impact.

The great majority of captures are **incidental**, 71% fishermen report to release bycatch turtles, and 21% report to land them. Landed turtles are mostly consumed (88%), sometimes sold (10%).



88%



10%

Over
55%

of the identified captures were of **green turtles** but all five species were victim of bycatch.

Industrial fisheries

Globally, the **loggerhead turtle** is the species of sea turtle **most often captured** by the industrial fishing boats operating off North-Western Africa and the **drifting longline** is the gear with the highest impact.

Turtles hooked in the longlines may drown or die **a few weeks after** release because of the injuries caused by the hook and the line.



This mortality is **often goes unnoticed** but is a serious threat for the loggerhead population nesting in Cabo Verde.

Little is known about the mortality caused by purse seines on loggerhead and leatherback turtles, although turtles are usually released unharmed and post-release mortality has not been reported.

Loggerhead and **leatherback turtles** inhabit mostly oceanic waters and hence they are the species **most often bycaught** in drifting longlines and purse seines. Green turtles inhabit mainly the continental shelf and so this is the species most often bycaught by trawlers.



Overlap of fishing effort and turtle habitat

- Overlap between longlining and loggerhead habitat
- Overlap between trawling and green turtle habitat

What should be the next steps?

Research and training priorities
for the coming years in the PRCM region

Discussions held at the **West Africa sea turtle workshop**, in December 2021 in Bissau, sought to identify main priorities for sea turtle conservation in the PRCM region.

There was a general feeling that there is
**a need for the reinforcement of
the study and conservation in
the feeding areas**

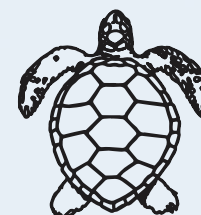
(representing some redirection of the efforts very focused on the nesting beaches), and for the integration of **other threatened species** of sea turtles, beyond loggerhead and green turtles, which have been the main target of efforts to date.



A non-exhaustive list of **research, monitoring** and **training** priorities resulting from these discussions are presented here, to support future planning:

1.

Investigate the **ecology** and **abundance of green turtles** in identified coastal feeding areas, particularly in the Delta du Saloum and the Bijagós regions.



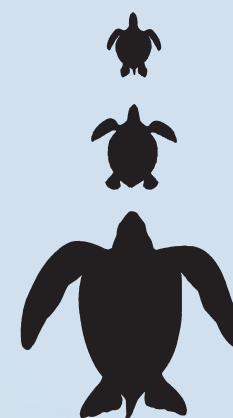
2.

Fill-in important knowledge gaps on the spatial distribution and ecology of **male green and loggerhead turtles** in the region.



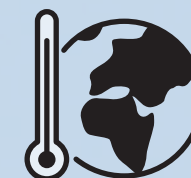
3.

Increase the knowledge on the poorly known species present in the PRCM region, namely the **hawksbill turtles** (*Eretmochelys imbricata*) - Critically Endangered, the **olive ridley turtles** (*Lepidochelys olivacea*) - Vulnerable, and the **leatherback turtles** (*Dermochelys coriacea*) - Vulnerable.



4.

Investigate and propose measures to adapt to **climate and other global changes**.



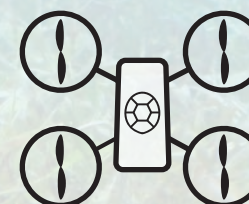
5.

Reinforce advanced training (master programmes) for technicians and researchers from PRCM countries.



6.

Continue monitoring beaches using **new tools and methodologies**.



7.

Continue **technical and scientific exchanges** through regional meetings and training courses.



Institutions involved



Recent research articles on West African sea turtles

Chefaoui RM, Duarte CM, Tavares AI, Frade DG, Sidi Cheikh MA, Ba MA, Serrão EA (2021) Predicted regime shift in the seagrass ecosystem of the Gulf of Arguin driven by climate change. *Global Ecology and Conservation* 32: e01890

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Fernandes M, Grilo ML, Carneiro C, Cunha E, Tavares L, Patino-Martinez J, Oliveira M (2021) Antibiotic Resistance and Virulence Profiles of Gram-Negative Bacteria Isolated from Loggerhead Sea Turtles (*Caretta caretta*) of the Island of Maio, Cape Verde *Antibiotics* 10:771

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Marco A, Martins S, Martín-Rábano A, Lopes S, Clarke LJ, Abella E (2021) Risk assessment of wildlife-watching tourism in an important endangered loggerhead turtle rookery. *Endangered Species Research* 45: pp195-207

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Martins ST, Peteiro L, Marco A (2020) First documented record of fibropapillomas on green turtles *Chelonia mydas* in the Cabo Verde Archipelago, West Africa. *Zoologia Caboverdiana* 8: pp14-16

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Martins S, Ferreira-Veiga N, Rodrigues Z, Querido A, de Santos Loureiro N, Freire K, Abella E, Oujo C, Marco A (2021) Hatchery efficiency as a conservation tool in threatened sea turtle rookeries with high embryonic mortality. *Ocean & Coastal Management* 212: p105807

Martins S, Patino-Martinez J, Abella Perez E, de Santos Loureiro N, Clarke LJ, Marco A (2022) Potential impacts of sea level rise and beach flooding on reproduction of sea turtles. *Climate Change Ecology* 3 p 100053

Monteiro J, Duarte M, Amadou K, Barbosa C, El Bar N, Madeira FM, Regalla A, Duarte A, Tavares L, Patrício AR (2021) Fibropapillomatosis and the Chelonid Alphaherpesvirus 5 in Green Turtles from West Africa *EcoHealth* p1-12

Patino-Martinez J, Dos Passos L, Afonso IO, Teixidor A, Tiwari M, Székely T, Moreno R (2021) Globally important refuge for the loggerhead sea turtle: Maio Island, Cabo Verde. *Oryx* 1-9

Patino-Martinez J, Dos Passos L, Dos Reis E, Moreno R (2020) Integrating local leaders in efforts to improve biodiversity conservation. *African Sea Turtle Newsletter* 12:4-7

Patino-Martinez J, Veiga J, Afonso IO, Yeoman K, Mangas-Viñuela J, Charles G (2022) Light Sandy Beaches Favour Hatching Success and Best Hatching Phenotype of Loggerhead Turtles. *Frontiers in Ecology and Evolution* p235

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