PRELIMINARY REPORT

Illegal, unreported, and unregulated (IUU) fishing in French Guiana: What impact does it have on leatherback turtle population dynamics?

Manon NIVIERE[1(†)] , Damien CHEVALLIER[2,3(*,†)] ,
Fabian BLANCHARD[4], Michel NALOVIC[1,3]

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[1] TOTM Trans Océans Tortues Marines, 78 Rue Justin Catayée, 97300 Cayenne.

[2] Laboratory of Biology of Aquatic Organisms and Ecosystems,
MNHN, CNRS 8067, SU, IRD 207, UCN, UA, Martinique Marine Research Station,
Quartier Degras, Petite Anse, 97217 Les Anses d'Arlet, Martinique.

[3] IUCN/SSC Marine Turtle Specialist Group

[4] IFREMER, French Guiana Delegation - 275 route de Montabo - P.O. Box 50477-
97331 Cayenne Cedex

* Corresponding author: D. Chevallier, damien.chevallier@cnrs.fr
† Scientific project leaders: D. Chevallier & M. Nivière, manon.niviere@totm.ong

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SUMMARY

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Abstract

The leatherback sea turtle (*Dermochelys coriacea*) is a keystone species in marine ecosystems, whose population in the Northwest Atlantic is experiencing an alarming decline. In French Guiana, a major nesting site on a regional and global scale, the number of nestings has decreased dramatically since the first monitoring efforts, with a decline of over 95%, particularly on the beaches in the western part of the territory.

Nesting females use Guiana's coastal and neritic waters during the intra-nesting period, a critical phase of their life cycle. Satellite tracking data show a **high concentration of movements in western Guiana**, particularly near the mouth of the Maroni River, while also revealing **broader use of the continental shelf**, often extending beyond national borders.

At the same time, **illegal, unreported, and unregulated (IUU) fishing,** carried out using drift gillnets by foreign fleets that do not comply with current regulations, exerts high and persistent pressure in Guyanese waters. Overlaying telemetry data from leatherback turtles with IUU fishing detection data reveals a **significant spatio-temporal overlap between areas frequented by the turtles and areas of high illegal fishing activity**, with several potential interaction hotspots identified, including **a major hotspot in the west**.

The observed spatial overlap, combined with existing knowledge on bycatch in gillnets, suggests that **IUU fishing poses a major threat to the survival of nesting females**. The results highlight the urgent need of **monitoring and enforcement at sea**, as well as **cross-border cooperation**, in order to protect critical marine habitats and halt the decline of the leatherback turtle in French Guiana. They also highlight the need **to intensify regional diplomatic efforts** and **increase the severity of criminal penalties** against offenders.

The fight against IUU fishing in French Guiana relies primarily on **at-sea surveillance and the effective enforcement of sanctions by the competent authorities.** The existing regulatory framework appears generally adequate, but its implementation faces operational challenges, particularly in identifying those responsible for violations. In this context, the effectiveness of deterrence depends heavily **on** the **frequency of inspections and the presence of at-sea surveillance resources**. **Strengthening operational capacity** is therefore a key lever for reducing the economic attractiveness of illegal fishing. Finally, **increased mobilization at the national and European levels** remains necessary to support control mechanisms and encourage compliance with international standards for the sustainable management of marine resources.

1. CONTEXT

1.1. Ecological importance of the leatherback turtle

The leatherback turtle (*Dermochelys coriacea*) occupies a unique place in marine biodiversity, particularly due to its exceptional ability to traverse vast oceanic distances during its migrations. Biologically, it is the largest of all sea turtles and the only species with a flexible carapace composed of connective tissue rather than scales.

Its diet is highly specialized and consists almost exclusively of gelatinous prey, such as jellyfish (scyphozoans and siphonophores) and certain tunicates (salps, pyrosomes) (Heaslip et al., 2012). This type of food, which is low in energy, requires the species to consume large quantities to meet its metabolic needs, with some estimates suggesting intake of up to 70% of body mass per day in adults in areas with high jellyfish abundance (Davenport, 2017). To make the most of this diet, the leatherback turtle has developed a remarkable suite of morphological and physiological adaptations: a sharp beak and jaws adapted for capturing soft-bodied prey, an esophagus lined with keratinized papillae oriented toward the stomach to retain prey, as well as large salt glands that allow it to eliminate excess ingested sodium (Davenport, 2017). Its large body size and specific metabolism also enable it to maintain an internal temperature higher than that of the surrounding water, exploit temperate zones rich in jellyfish, and perform deep dives exceeding 1,000 m to access prey concentrations in the water column (Heaslip et al., 2012).

These characteristics give the leatherback turtle an exceptional capacity to exploit a specialized diet, while playing a major ecological role. Its predation helps regulate jellyfish populations, whose proliferation is favored in productive environments such as continental shelves and oceanic frontal zones (Graham et al., 2001; Houghton et al., 2006). Jellyfish are competitive consumers of fish eggs and larvae, which are critical stages in the life cycle of many fish species (Purcell & Arai, 2001; Purcell, 2012). Thus, a decline in leatherback turtle populations could relieve this pressure, promoting jellyfish expansion and contributing to increased early fish mortality, reduced recruitment, and decreased productivity of exploited populations.

Because it depends on a wide range of marine and coastal habitats throughout its life cycle, the leatherback turtle is considered an umbrella species : protecting its feeding, migration, and nesting areas helps preserve a broad array of associated species and ecological processes, making its conservation a key driver of overall marine ecosystem health. Beyond its ecological role, the leatherback turtle also serves as a sensitive indicator of ocean health. Its transoceanic migrations expose it to a wide range of threats, from accidental bycatch in fisheries to plastic pollution, as well as the degradation of coastal habitats essential for reproduction. Thus, when populations collapse, it is a clear signal that the ecosystem as a whole is in poor condition.

1.2. Status of the Northwest Atlantic Population

Regional Management Units (RMUs) are geographic divisions that group sea turtle populations based on their nesting and foraging areas and genetic characteristics, to guide conservation at a scale relevant to threat management. The 2023 update (Wallace et al., 2023) confirmed the existence of 7 RMUs for the leatherback turtle globally : Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian Ocean, Northeast Indian Ocean, Western Pacific, and Eastern Pacific (Figure1).

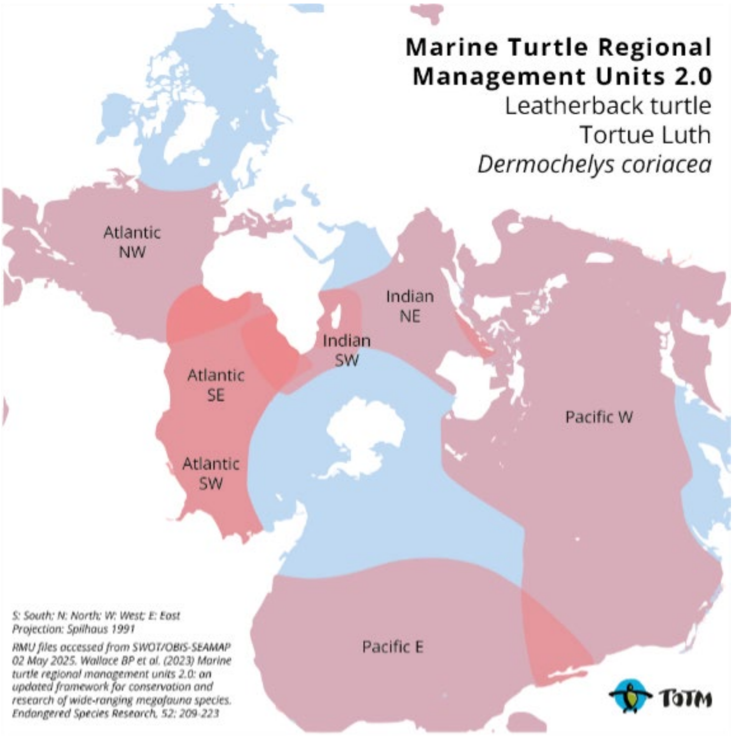


Figure1 : Regional Management Units for the leatherback sea turtle Dermochelys coriacea. Adapted from SWOT/OBIS-SEAMAP May 2, 2025. Wallace BP et al. (2023)/ Marine turtle regional management units 2.0/ an updated framework for conservation and research of wide-ranging

Classified as "Least Concern" by the IUCN in 2013 based on optimistic population projections (Wallace et al., 2011; IUCN, 2013), the subpopulation of the Northwest Atlantic has historically been considered abundant. These models predicted population stability or even growth, driven in particular by high nesting rates in key areas such as French Guiana.

Furthermore, aerial surveys by the Pelagis Observatory in the Northeast Atlantic recorded 67 leatherback turtles in 2012 between the English Channel and the southern Bay of Biscay, compared to none in 2021 within the same area (Van Canneyt et al, 2024). Although these data, derived from surveys subject to detection biases, do not allow for robust inference of demographic trends, they are consistent with the hypothesis of changes in habitat use or in the availability of individuals at the scale of the Atlantic basin.

However, more recent assessments indicate a concerning reversal of this trend. In 2019, the IUCN reclassified the Northwest Atlantic leatherback subpopulation as “Endangered,” based on data showing a marked decline in nest abundance at several major nesting sites (Northwest Atlantic Leatherback Working Group, 2019).

The latest SWOT (State of the World’s Sea Turtles) report provides a global overview of the status of various sea turtle populations worldwide. The Northwest Atlantic leatherback turtle population has thus been classified as “highly at risk” and “highly threatened” by the IUCN-SSC Marine Turtle Specialist Group in the “Conservation Priorities Portfolio 2.0 (CPP),” with bycatch identified as the greatest threat (Figure2).

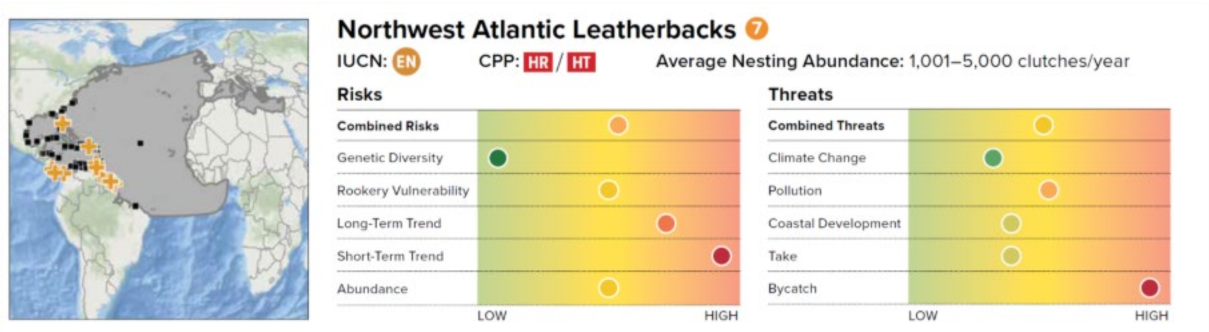


Figure2 : Status of Regional Management Units in the North Atlantic Ocean – the Northwest Atlantic Leatherback. Maps show known nesting sites. Major nesting sites are marked with a cross. (Source: SWOT)

1.3. Status of leatherback turtle populations in French Guiana

French Guiana is one of the major nesting sites for the species in the Western Atlantic, at both regional and global scales. Historically, the beaches of western French Guiana, particularly those of Mana and Awala-Yalimapo within the Amana Nature Reserve, were among the most important nesting sites for the species worldwide.

However, a recent meta-analysis by the Northwest Atlantic Leatherback Working Group (2018) highlighted a significant decline in nesting in the Northwest Atlantic since 2008, calling into question the assumption of population stability. This decline is partly attributed to the sharp decrease observed at Awala-Yalimapo (NWALWG, 2018).

The number of nests recorded in western French Guiana has declined dramatically, from over 5,000 in 2009 to just 72 in 2022 (Barthes, 2023, Figure3), representing a decline of over 95% since the first scientific surveys in 1977 (Chevalier & Kelle, 2023). This figure continues to decline, with only 39 nests recorded during the 2024 nesting season at the Yalimapo site and 71 nests in 2025.

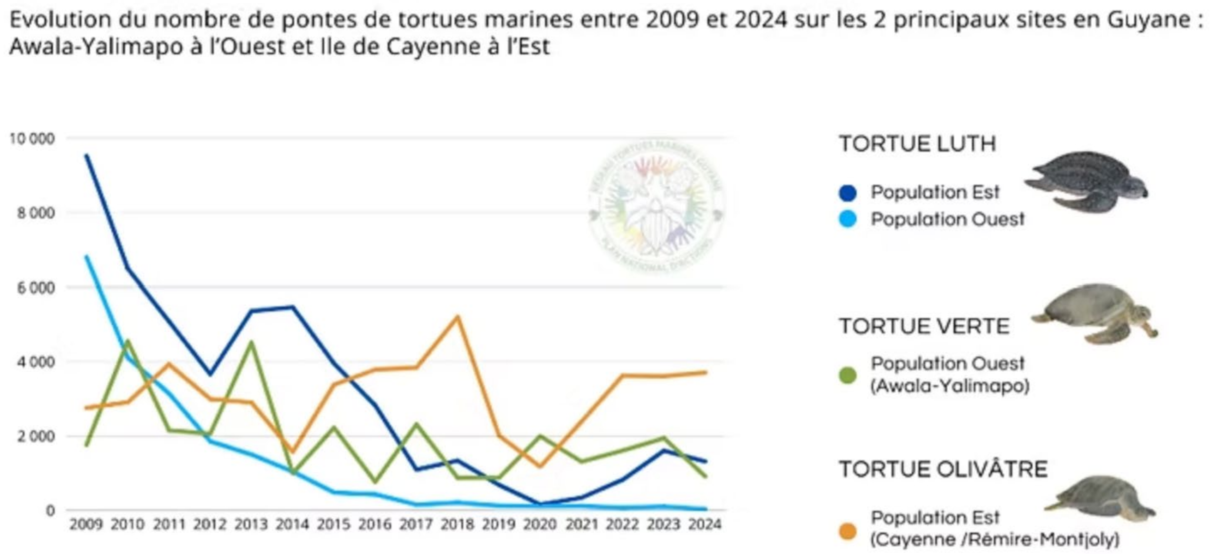


Figure3 : Trend in the number of sea turtle nests between 2009 and 2024 at the two main sites in French Guiana (source: Press release dated 12/3/2024 from the French Guiana Sea Turtle Network)

1.4. Pressure factors influencing the population dynamics of leatherback turtles in French Guiana

This decline could be explained by demographic factors : the survival of adult females, their remigration probability, the recruitment of immature females into the nesting population, as well as the average number of nests per female during a season. According to the final report submitted to WIDECAST, data from French Guiana show a marked decline in the probability of remigration, particularly among first-time nesting females. This trend is accompanied by a decrease in nesting frequency, observed on both eastern and western beaches. The apparent survival of females is lower than that observed in other regions (Chevallier et al., 2020; Wallace, 2023), which could indicate increased mortality or a loss of fidelity to Guyanese nesting sites.

The coastline of French Guiana is characterized by highly dynamic sedimentary processes. It is constantly reshaped by mudbanks, formed under the influence of massive sediment inputs from the Amazon, whose annual volumes vary between 750 million and 1 billion tons. Added to this are the hydro-sedimentary processes linked to coastal currents, which also contribute to the constant reorganization of coastal sediments. This context leads to a continuous migration of mudbanks, separated by interbank zones, from the mouth of the **Amazon** (Brazil) to that of the Orinoco (Venezuela), profoundly altering the morphology of the beaches (Lefebvre et al., 2004).

These alternating banks and inter-bank zones influence wave energy dissipation, causing marked changes in coastal morphology, sometimes accentuated by the interaction between mud and sand (Jolivet et al., 2022). In this context, coastal erosion, particularly pronounced on the beaches of western French Guiana, poses a significant threat to nesting habitats (Chevallier et al., 2023).

In fact, leatherback turtles prefer to nest in open sandy areas at the upper end of the beach (Péron et al., 2013), but these beaches are becoming increasingly unstable and fragmented. Erosion directly reduces the area available for nesting, potentially contributing to a decrease in the number of nests observed locally. Furthermore, erosion and tidal flooding compromise nest viability, leading to a decline in hatching rates (Caut et al., 2009).

These coastal morphodynamic disturbances offer a possible explanation for the decline in reproductive success among leatherback turtles in French Guiana, affecting both nesting frequency and hatching success. Added to this are anthropogenic and climate-related threats. Along the coast, human factors primarily include predation by stray and roaming dogs, coastal pollution, egg poaching, and the degradation of nesting habitats linked to certain human activities (light pollution, rock placement, fence installation, etc.). At the same time, climate change, with extreme temperatures reached beneath the sand and inside the incubation chambers, can increase embryonic mortality, sometimes leading to the total loss of the nest. However, even when combined, these factors cannot fully explain the observed decline in the adult population, suggesting that threats at sea must be considered to understand the observed decline, particularly those related to fishing activities (Chevallier et al., 2020).

1.5. Current state of knowledge on the intra-nesting movements of leatherback turtles in French Guiana

Initial work by Ferraroli et al. (2004) showed that some females exhibit relatively restricted movements, with activity centered within a radius of approximately 20 km off the mouth of the Maroni River. However, Fossette et al. (2007) demonstrated greater variability : the turtles utilize three main zones of the continental shelf of the Guianas, the coastal zone (less than 50 km from the coast), the neritic zone (less than 100 km), and the edge of the continental shelf. During a single intra-nesting interval, they can make significant journeys, regularly crossing the border to enter Surinamese waters.

Fossette et al. (2009) demonstrated that, during intra-nesting intervals, leatherback turtles frequent the warm surface waters of the continental shelf, with SSTs ranging from ~25.5 °C to 29.5 °C. This area is strongly influenced by significant inflows of brackish freshwater from coastal rivers (Baklouti et al., 2007). It is therefore plausible that the turtles use this freshwater to meet their increased water requirements, particularly those necessary for egg formation (Ackerman, 1997). Furthermore, this region benefits from high biological productivity linked to Amazonian water inflows, potentially favoring increased gelatinous plankton abundance due to high primary production, a key food resource for leatherback turtles (James & Herman, 2001, Froidefond et al., 2002, Otsuka et al., 2018). The dives observed in this area (particularly so-called bottom dives) can be interpreted as feeding behaviors (Fossette et al., 2007, 2008).

The turtles make shallow dives (approximately 5 m) immediately after leaving the beach and upon returning at the end of the intra-nesting interval. These dives are predominantly nocturnal, with activity peaks between 7:00 PM and 9:00 PM and around 2:00 AM, suggesting a preference for movement during these periods. As they move further from the coast, the turtles make deeper dives (around 10 m) up to the edge of the continental shelf. At this stage, the dives are replaced by dives characterized by a "W" shape, with a prolonged bottom phase and vertical oscillations (>2 m), indicative of foraging behavior (Fossette et al., 2007). Although the bathymetry of the Guiana continental shelf is complex due to the influence of mud banks originating from the Amazon (Anthony & Dolique, 2004), these observations are consistent with the topography of the continental shelf, which the turtles appear to follow during their vertical movements (Fossette et al., 2007).

Leatherback turtles thus exhibit a wide spatial distribution during their intra-nesting periods, utilizing different areas of the continental shelf and sometimes crossing administrative borders into Suriname. However, a marked concentration is observed near the mouth of the Maroni River, suggesting a possible spatial overlap with fishing activities, particularly illegal, unreported, and unregulated (IUU) fishing.

According to Entraygues (2014b), 46% of the leatherback turtles observed on Yalimapo Beach in French Guiana showed signs of injury. Of these, 48% were attributed to gillnets, 44% to shark attacks, and 7% to boat propellers. According to the database of the French Guiana Stranding Network (REG), coordinated by the EDEN-I association, 26 of the 42 stranded leatherback turtles (62%) recorded in Mana and Awala between March 2014 and May 2025 showed signs of capture, including 8 individuals found directly in a net, of which 3 were identified as Surinamese, while the cause of death remained undetermined for the majority of the other individuals, due to a lack of diagnostic evidence or an advanced state of decomposition. Physical evidence corroborates these observations : in 2019, a leatherback turtle tracked by satellite washed ashore on the beaches of Suriname, with fragments of nets attached to its carcass. Furthermore, during at-sea monitoring of green sea turtles and leatherback sea turtles, fragments of nets have been found attached to biologgers. All of these findings attest to the recurring occurrence of physical interactions between sea turtles and fishing gear (Chevallier D., pers. obs.).

This co-occurrence raises the hypothesis that these interactions could have an impact on their survival during the intra-nesting period. In French Guiana, several studies confirm the extent of bycatch. For instance, a WWF report notes that in 2001, 8 leatherback turtles were found entangled in a single drift net (Chevalier & Kelle, 2023). Furthermore, surveys conducted among coastal net fishermen in 2004 and 2005 provided overall estimates : 428 sea turtles observed in nets in 2004 and 473 in 2005, of which 74% and 81%, respectively, were leatherback turtles. By-catches were primarily associated with the use of long, high-sided, wide-mesh drift gillnets deployed at night (Chevalier & Kelle, 2023; Delamare, 2005).

1.6. Description of fishing activities in French Guiana

1.6.1. Types of legal fishing in French Guiana

Fishing is the third-largest economic sector in French Guiana and is divided into three main legal fisheries :

- The shrimp fishery, limited to five trawlers, operates on the continental shelf at depths between 30 and 80 m;
- The snapper fishery, operated by 45 licensed Venezuelan longliners, is located on the continental slope, at depths between 40 and 120 m;
- Artisanal coastal fishing, the most widespread, involves 122 vessels that primarily use drift gillnets in areas less than 30 meters deep.

Although regulated, these activities pose a risk of bycatch due to the lack of selectivity in the fishing gear.

In French Guiana, leatherback turtles are particularly vulnerable to gillnets used along the coast (Figure4).

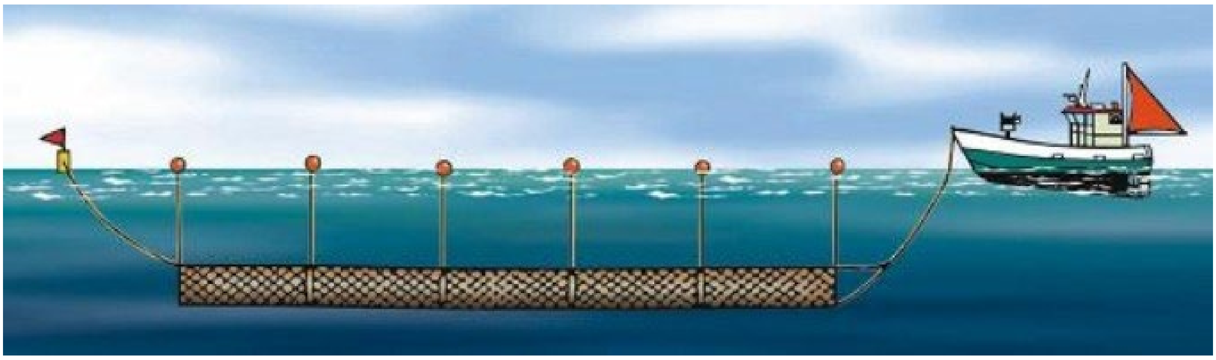


Figure4 : Illustration of a drifting gillnet. © Ifremer/Deschamps

The species' foraging behavior, which leads it to interact with floating objects, constitutes a risk factor : observations have shown that turtles may approach buoys or even attempt to bite them. Bite marks have also been found on floats recovered wrapped around the necks of entangled turtles (Senko & Nalovic, 2021).

Observations at sea conducted by the Regional Committee for Marine Fisheries and Aquaculture (CRPMEM) indicate that 20% of leatherback turtle entanglement cases involved the float lines, not the mesh of the nets themselves. Furthermore, 82% of the individuals captured were found in the upper part of the nets, which corresponds to the water column zone they frequent during their shallow dives, particularly during nocturnal activity. These interactions primarily involve polystyrene or white plastic buoys, commonly used in French Guiana (Senko & Nalovic, 2021). Several initiatives have been implemented to strengthen collaboration with fishermen and co-develop solutions, notably the PALICA program, led since 2017 by the WWF and the CRPMEM, which has enabled the testing of various technical innovations (coloring of floats, removal of float lines, reducing the vertical profile of the net, and acoustic deterrent devices) to limit the by-catch of turtles and dolphins. These initiatives, based on close cooperation between scientists, NGOs, and professional fishers, demonstrate a local commitment to reconciling the conservation of marine species with the sustainability of fishing activities.

1.6.2. Characterization of IUU fishing in the Guyanese coastal zone

Beyond its ecological impact, Illegal, Unreported, and Unregulated (IUU) fishing in French Guiana also poses a socio-economic challenge by targeting stocks of red weakfish (*Cynoscion acoupa*), a key species in local artisanal fisheries. According to the FAO, the status of red weakfish stocks in French Guiana can be considered sustainable if only legal fishing is taken into account. However, exploitation becomes unsustainable once illegal fishing is factored into the assessment (Guyader et al., 2026; Guyader et al., 2025; Tagliarolo , & Rousseau, 2023). Indeed, these stocks face increasing pressure due to international demand for swim bladders. The high commercial value of swim bladders (up to $6,000 per kilogram), combined with governance and control mechanisms that are often inadequate, encourages IUU fishing (Lam, 2024). This dynamic places increased pressure on targeted fish stocks, compromising their biological sustainability, and further undermines the socioeconomic livelihoods of coastal fishing communities that depend on these resources. Under this pressure, red weakfish populations have declined by an estimated 30% since the early 2000s, jeopardizing the sustainability of Guiana's artisanal fishery, for which this species is the primary resource for local consumption (Chao et al., 2021).

Most of this illegal fishing is carried out by foreign vessels from neighboring countries (Suriname, Guiana, and Brazil) known as "tapouilles" and "SK Boats," which use bottom-set drift gillnets in violation of current regulations. This illegal fishing activity is concentrated mainly in the east, along the border with Brazil, and in the west, along the border with Suriname (Leforestier, 2024, Figure5).

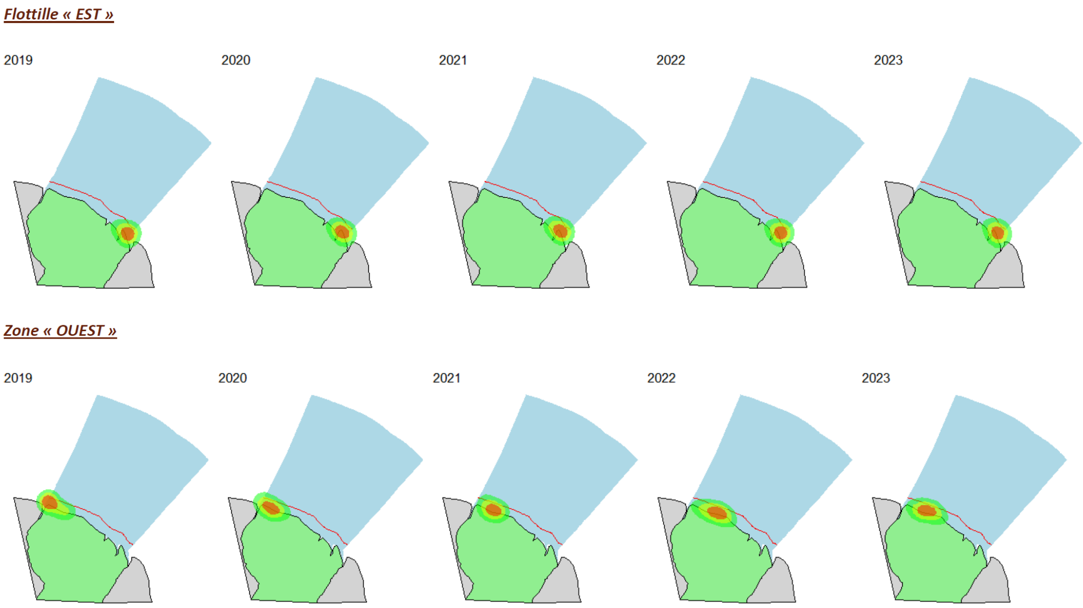


Figure5 : Annual trend in the spatial distribution of IUU vessels by fleet (green: 75% of observations for the year, yellow: 50%, red: 25%). Illustration excerpted from the report by Leforestier S., 2024.

A recent study shows a significant increase in fishing effort in Suriname and Guiana due to a rise in the number of days at sea and net length (Fishing Cleaner, First Report of the Project "WWF Regional Roadmap to Combat IUU along the Guiana Shield"). This intensification could have repercussions on IUU fishing effort in French Guiana.

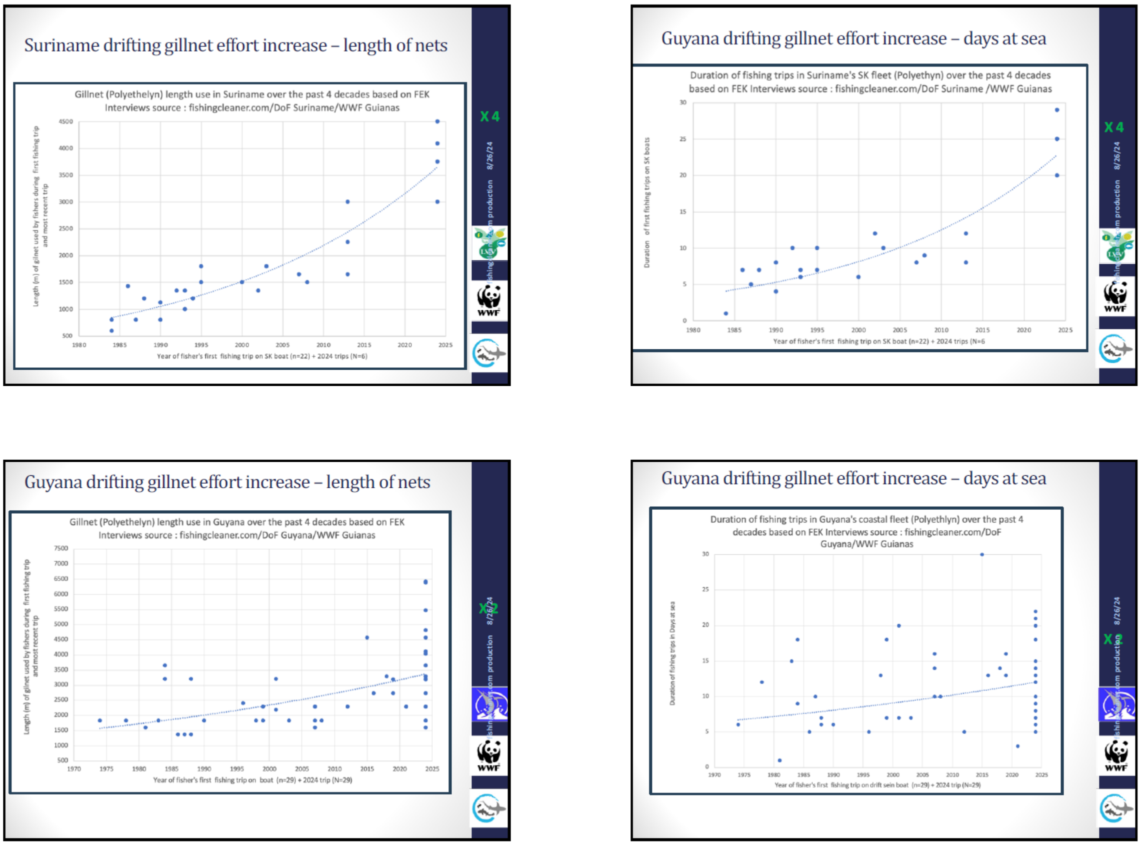


Figure6 : Evolution of fishing effort in Guiana and Suriname in terms of days at sea (b, d) and net length (a, c). (Source: Fishing Cleaner. First report of the Project "WWF Regional Roadmap to Combat IUU along the Guiana Shield")

According to Leforestier (2024), illegal fishing effort in French Guiana exceeds that of legal fishing, with an estimated net deployment between 0.7 and 3 times higher over the 2019–2023 period, while production can reach up to four times that of legal fishing. However, this estimate is likely an underestimate, as data were collected only during the day, whereas illegal activity appears to be more intense at night, and on weekdays, whereas illegal activity appears to be more intense on weekends. The actual length of the nets used by IUU fishing vessels could not be measured but was estimated to be twice the length of legal nets. It is estimated that in the eastern zone, on the Brazilian side, fishing effort, measured in kilometers of deployed nets, averages 3.9 km (ranging from 2.2 km to 5 km) and averages 5.1 km (ranging from 3 km to 7 km) on the side bordering Suriname.

Despite the existence of a legal and operational framework, the implementation of measures to combat illegal, unreported, and unregulated (IUU) fishing in the Outermost Regions (ORs) remains limited by a lack of human, financial, and technological resources, as well as by the EU's inaction regarding sanctions procedures against third countries. Regulation (EU) No. 2021/1139, establishing the European Maritime, Fisheries, and Aquaculture Fund (EMFAF), nevertheless provides for financial support dedicated to the surveillance and control of IUU fishing. Starting in 2027, the rollout of the CATCH system, a single electronic register for catch certification, will also require the modernization of traceability procedures and tools within the ORs.

With this in mind, the Advisory Committee for the Outermost Regions (CCRUP) emphasizes the importance of an integrated approach based on prevention, detection, and rapid response. It recommends, as a priority, the implementation of regional and species-specific risk map for IUU fishing. This tool would help identify sensitive areas, critical periods, and high-risk activities, thereby enabling the prioritization of enforcement actions and the optimization of resource allocation. In addition, the CCRUP recommends strengthening the capacities of the competent authorities and consolidating cooperation among Member States, regional authorities, and third countries to ensure a coordinated response at the ocean basin level.

2.STUDY OBJECTIVE

Nesting female leatherback turtles use the coastal and neritic waters of French Guiana during the intra-nesting period, a critical phase of their life cycle during which their survival directly determines the population's demographic dynamics.

Against the backdrop of a rapid and well-documented decline in the nesting population in French Guiana, understanding the pressures exerted at sea during this period is essential to understanding the causes of the observed decline.

Among these pressures, illegal, unreported, and unregulated (IUU) fishing, practiced using drift gillnets by foreign fleets, has historically been considered a major source of unnatural mortality among adult females, particularly through entanglement and bycatch (Chevalier, 2001). The National Action Plan for Marine Turtles published in 2014 already highlighted bycatch associated with illegally used drift gillnets as one of the priorities for action (Entraygues, 2014a). Certain areas, particularly the Maroni estuary, present a higher risk of interaction (Debas et al., 2000; Chevallier & Le Maho, 2012). To effectively guide monitoring and conservation efforts, it is therefore essential to have a precise spatial understanding of the interactions between turtles and IUU fishing.

With this in mind, the main objective of this study is to assess the risk of interaction between IUU fishing and leatherback turtles in French Guiana by analyzing the spatio-temporal overlap between the marine space used by nesting females during the intra-nesting period and the distribution of illegal fishing effort, in order to identify areas constituting critical hotspots of interaction and priorities for control, surveillance, and conservation actions.

More specifically, this study aims to:

- Characterize the use of marine habitat by female leatherback turtles during the intra-nesting period based on satellite tracking data;

- Describe the spatial and seasonal distribution of IUU fishing effort in Guyanese waters using available data;

- Quantify the spatial and temporal overlap between these two components to identify marine areas with a high risk of potential interactions;

- Prioritize these areas based on their relative importance for nesting turtles and the intensity of IUU fishing pressure.

This approach falls within the conceptual framework of ecological risk assessments related to fisheries, focusing on the attributes that define a species' susceptibility to fishing, which can be classified into four categories (Hobday et al., 2011):

1. Spatio-temporal overlap : corresponds to the overlap in geographic space and time between the species' distribution and fishing activity.
2. Encounter probability : the probability that the species occupies the same depth as that at which the fishing gear operates, taking overlap into account.
3. Fishing gear selectivity : the probability that the species will be captured and retained by the fishing gear, based on the overlap and the encounter probability.
4. Post-interaction mortality : the probability of mortality following interaction with the fishing gear, taking into account overlap, encounter probability, and selectivity.

3. METHODOLOGY

3.1. Data source

3.1.1. Satellite tracking data for leatherback turtles

As part of the ANTIDOT project (*Association of News Tools to Improve the Understanding of the Dynamics of Threatened Marine Turtles*, CNRS), one female leatherback turtle was tagged in 2014 with an Argos SPLASH10-F-296A tag (Wildlife Computers, Redmond, WA, USA), and in 2015, nine additional females were tagged with SRDL tags (Sea Mammal Research Unit, University of St. Andrews, Scotland) on the beaches of Rémire-Montjoly (Chambault et al., 2017). In addition to these data sets, 10 other females are being tracked using Argos tags (SPOT-375B, Wildlife Computers, Redmond, WA, USA; Table1), fitted during the 2019 nesting season at the Awala-Yalimapo site (Amana Nature Reserve).

Project	Species	Year	No. of individuals	Tag type	Deployment site
ANTIDOT (CNRS)	*Dermochelys coriacea*	2014	1	Argos SPLASH10-G-296A (WC)	Rémire-Montjoly
		2015	9	Argos SRDL (SMRU)	Rémire-Montjoly
		2019	10	Argos SPOT-375B (WC)	Awala-Yalimapo

Table1 : Summary table of tags used to collect movement data from nesting female leatherback sea turtles (Dermochelys coriacea) (n=20) between 2014 and 2019.

Among these individuals, 17 provided usable data for the analysis of the intra-nesting period. Three individuals (#149686, #149687, #149689) were excluded from the analyses due to immediate post-nesting migration or the absence of usable locations (Figure7).

These Argos tags provide geographic locations characterized by irregular time intervals and variable uncertainties, which are inherent to the Argos system.

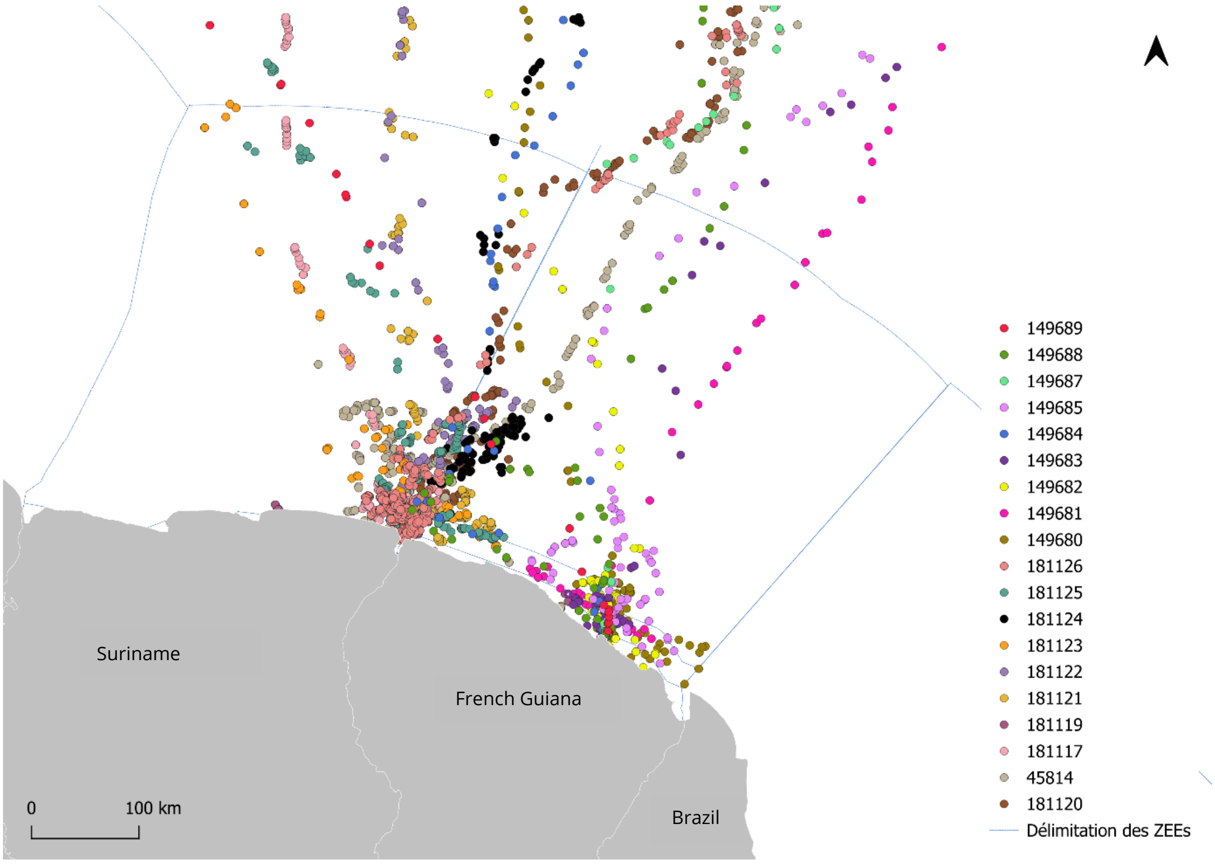


Figure7 : Raw location data recorded for the 19 leatherback turtles tagged at Awala-Yalimapo and Rémire-Montjoly in 2019 and 2014–2015, respectively.

3.1.2. Distribution of IUU fishing effort in French Guiana

The spatial distribution of IUU fishing effort was determined based on the latest quantitative assessment conducted in French Guiana (Leforestier, 2024).

Two main data sources were used:

- **The State Action at Sea (AEM) observations conducted between 2008–2011 and 2019–2023** include data from aerial, maritime, and satellite surveillance operations. They provide information on the position of detected vessels, the means of detection, and, when available, the vessel's identity and activity. Information collected in the coastal zone and that from the offshore zone, from the territorial waters boundary to the continental slope, was processed separately to distinguish the different types of fishing associated with each of these fisheries. So-called "coastal" IUU fishing targets coastal species and primarily uses drift gillnets, which can cause sea turtles to become entangled. So-called "offshore" IUU fishing targets species beyond territorial waters, particularly snapper, and primarily uses bottom longlines, which can cause turtles to become hooked on the hooks or entangled in the leaders during line retrieval.

- **Data from aerial surveys conducted by WWF Guiana** in September 2023 and May 2025 (GREAT Ocean regional project). The missions were conducted using a twin-engine aircraft equipped with bubble windows, allowing for vertical observation. Each flight, lasting an average of about four hours, covered the entire Guyanese coastal strip, from the Brazilian border to the Surinamese border, following standardized transects. The positions and characteristics of the observed vessels were systematically recorded.

3.2. Data preprocessing

3.2.1. Filtering and interpolation of satellite tracking data for leatherback turtles

Processing of satellite tracking data

Argos positions, characterized by uncertainties and irregular time intervals, were filtered using the *R package Animotum* (formerly *foieGras*, Jonsen et al., 2023) to eliminate outliers and correct positioning errors. We first eliminated class Z locations, then removed all those associated with a speed greater than 5 km/h. Points forming "outlier spikes" were then excluded, i.e., sequences of three consecutive locations with an angle less than 15°, with at least one distance greater than 2,500 m, or an angle less than 25° with at least one distance greater than 5,000 m. In the presence of duplicate locations, only the one of the highest quality was retained, provided that a minimum interval of 60 s separated it from the previous one.

Trajectory Modeling

When data quality and duration permitted, a continuous state-space model was fitted to interpolate trajectories at regular time intervals using the fit_ssm() function. This model combines a motion process (correlated random walk) and an error model using Argos ellipse parameters (smaj, smin, eor) or, failing that, location classes. This approach allows for the generation of corrected trajectories, associated with confidence intervals, while limiting biases related to temporal irregularities in the data.

Movement persistence index

For the tags deployed in 2019, we calculated a movement persistence index (γ), ranging from 0 to 1, to characterize spatial behavior. A high γ, close to 1, indicates a straight-line trajectory generally associated with a transit phase, while a low γ , close to 0, indicates a more meandering movement typical of a foraging or feeding phase.

Selection of the analysis period

For older tags (2014–2015), for which this index was not systematically available, we defined the intra-nesting period using a visual method based on corrected trajectories and speeds.

3.2.2. Filtering of IUU fishing effort data in French Guiana

The data were processed by Sophie Leforestier as part of a study on IUU fishing published in 2024 (Leforestier, 2024). For this analysis, only information regarding vessels identified as engaged in fishing activities was retained, in order to specifically model the risks of interactions with turtles.

This historical data was supplemented by the latest aerial survey conducted by the WWF in May 2025. For this campaign, only observations concerning vessels identified as originating from neighboring countries were included in the analyses, ensuring the consistency of the data used for the assessment of interactions.

3.3. Spatial analyses

3.3.1. Estimation of use distribution (UD)

To characterize the spatial use by leatherback turtles and the distribution of IUU fishing effort, we applied the Kernel Density Estimation method to the corrected positions of the individuals and the positions of fishing vessels, using the R package adehabitatHR (Calenge, 2024). This approach calculates a use distribution (UD), i.e., a probability surface representing the frequency of use of each point in space. The coordinates were projected into a metric system to obtain a reliable estimate of the areas. The smoothing parameter (h) was set to the reference value "href." For each dataset, UDs were calculated, and polygons representing the home range or areas of intense activity were extracted using getverticeshr() at the 95% (overall use area) and 50% (activity core) levels, and their areas were calculated in square kilometers.

3.3.2. Spatial overlap analyses

Spatial overlap between leatherback turtle use areas and IUU fishing concentration zones was assessed by overlaying the corresponding density polygons. The analysis was conducted at the continental shelf scale, specifically within the coastal zone, defined as the area most likely to experience direct interactions with fishing gear. The areas of overlap were quantified to identify and prioritize zones with a high risk of potential interaction.

4. RESULTS

The objective of this study is to overlay data from telemetric tracking of 17 leatherback turtles during their intra-nesting period in French Guiana in 2015 and 2019 with the estimate of illegal fishing conducted jointly by WWF, IFREMER, and CRPMEM Guyane and published in 2024. It enables us to characterize habitat use by females, quantify the overlap with IUU fishing activity, and identify priority risk areas for conservation.

4.1. Spatial and temporal distribution of IUU fishing

According to the strategic document on the French Guiana maritime basin (Prefecture of French Guiana, 2024), the distribution of illegal fishing vessels along the coastline is relatively uniform, with two areas of concentration located in the west and east of French Guiana.

However, intra-annual temporal variability is noticeable : the months of April and September show a slightly more pronounced concentration in the west, while the months of May and June reveal a shift in pressure toward the east (Figure8).

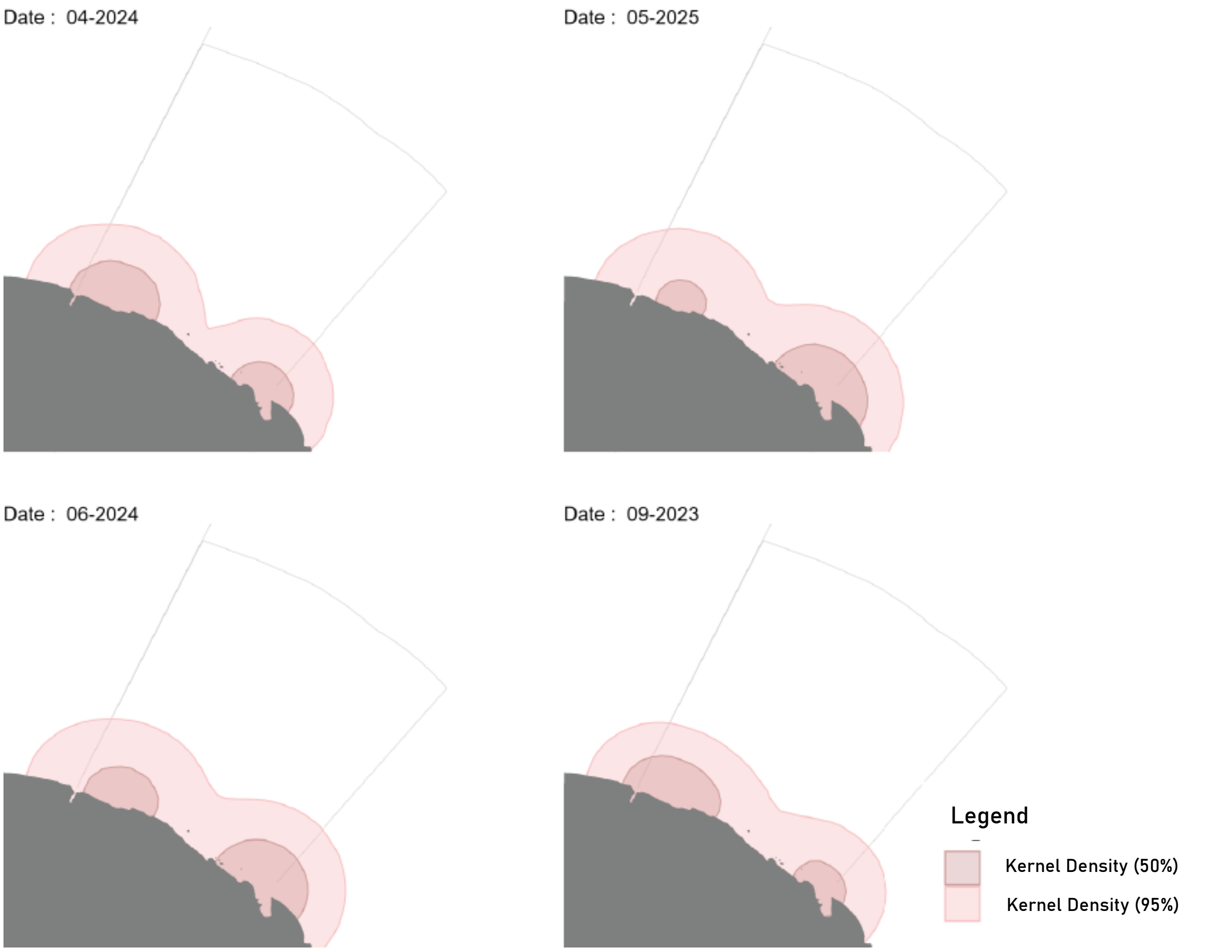


Figure8 : Spatio-temporal evolution of IUU fishing activity in the coastal strip of French Guiana (2023–2025) based on data collected during aerial surveys conducted by the WWF's French Guiana office

The missions of the Action de l'État en Mer (AEM), carried out between 2008–2011 and 2019–2023, confirm these trends and highlight the permanent presence of foreign IUU fishing along the coast (Figure9).

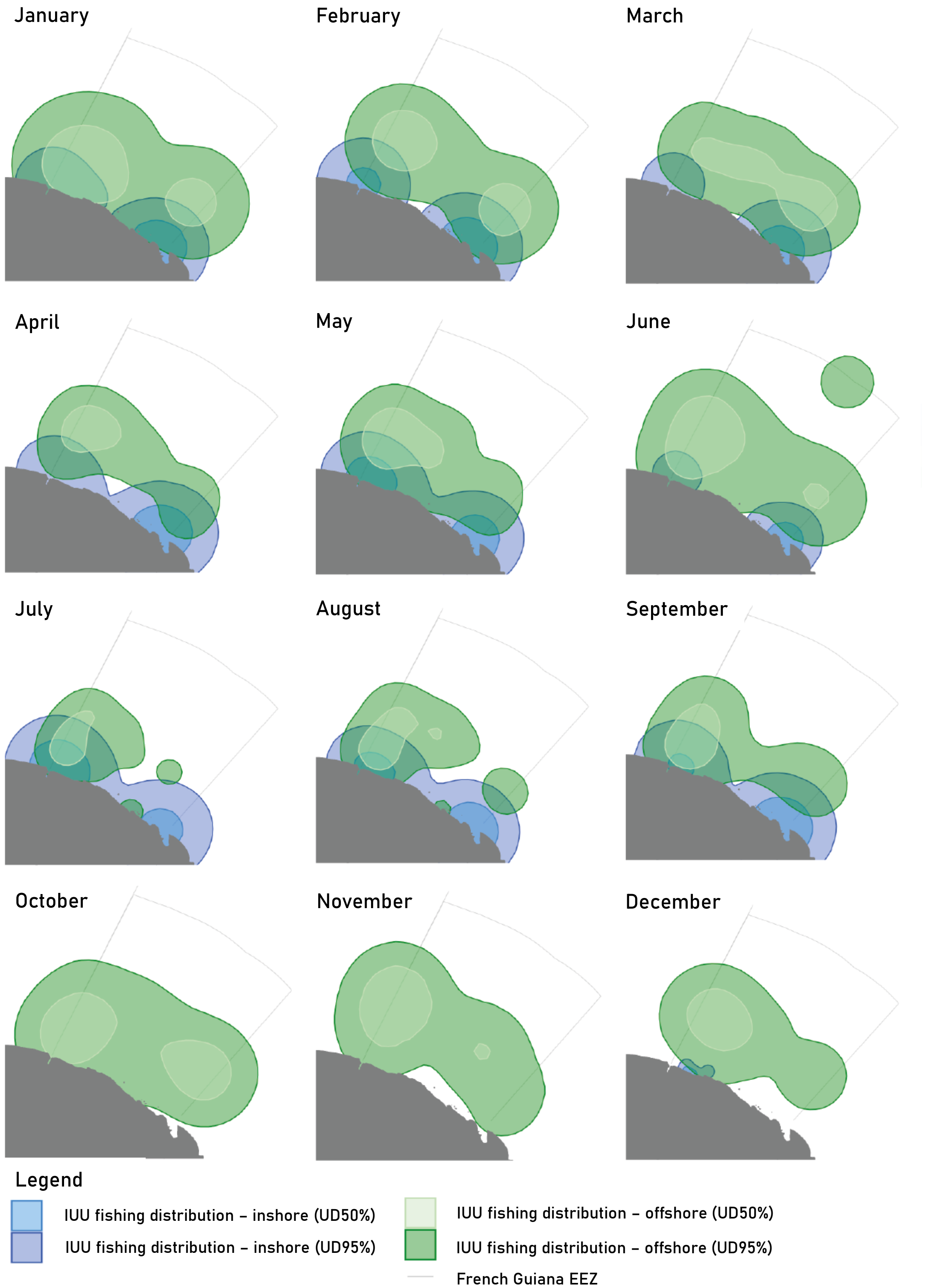


Figure9 : Spatio-temporal evolution of IUU fishing activity in French Guiana (2008–2023) based on data from aerial surveys conducted by the AEM between 2008 and 2011 and then between 2019 and 2023.

4.2. Spatial use by leatherback turtles during the intra-nesting period in French Guiana

The areas of marine habitat use during the intra-nesting period of leatherback turtles were delineated based on the corrected trajectories of 17 satellite-tracked nesting females, distributed between Awala-Yalimapo in the west and Rémire-Montjoly in the east. The western individuals were tagged in 2019 on Yalimapo Beach (n=10), and the eastern individuals were tagged at Rémire-Montjoly in 2015 (n=7) as part of the ANTIDOT project (CNRS).

Awala-Yalimapo (West)

For the 10 individuals tagged at Awala-Yalimapo, the areas of their core ranges (50%) ranged from **279 to 4,403 km^2 (mean: 2,299 ± 1,578 km^2).** The areas of use (95%) range from **1,023 to 17,963 km^2 (mean: 9,560 ± 6,349 km^2).** This variability is partly due to the monitoring duration ranging from **6 to 60 days**, with longer monitoring periods allowing for better spatial coverage and a broader estimation of activity zones (Table2). Despite this variability, a common home range clearly emerges at the mouth of the Maroni River, indicating a concentration of movements in these coastal habitats (Figure10).

ID	Intra-spawning period	Duration of monitoring (days)	Number of locations	50% area (km^2)	95% area (km^2)
181117	2019/06/05–2019/06/27	22	777	643.4	2,926.9
181119	2019/06/03–2019/06/09	6	261	278.5	1,022.8
181120	2019/06/07–2019/07/02	25	612	2,975.2	12,410.3
181121	2019/06/03–2019/06/12	9	237	1,188.8	4,184.8
181122	2019/06/05–2019/06/19	14	307	3,881.0	14,417.0
181123	2019/06/06–2019/06/30	24	244	4,403.2	17,008.3
181124	2019/06/03–2019/06/24	21	445	2,117.9	9,075.7
181125	2019/04/06–2019/06/25	21	585	4,130.9	13,572.5
181126	2019/06/05–2019/08/04	60	2,226	494.4	3,014.5
45814	2020/06/11–2020/07/11	30	1,376	2,874.5	17,963.4

Table2 : Summary table of estimated home ranges (50% and 95% kernel density) for individuals (n=10, Dermochelys coriacea) tagged at Awala-Yalimapo in 2019

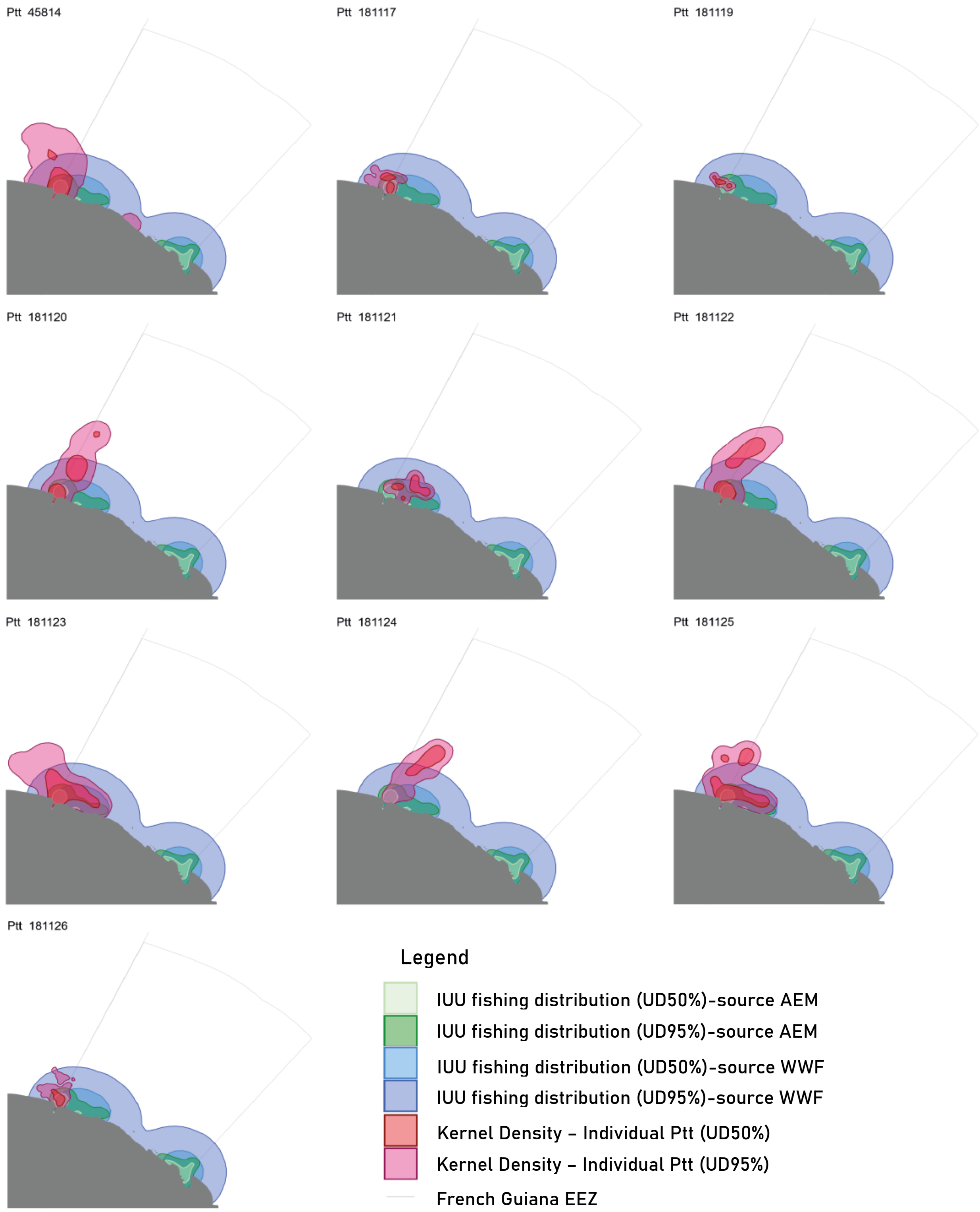


Figure10 : Maps of estimated home ranges (50% and 95% kernel density) of females (n=10, Dermochelys coriacea) tagged at Awala-Yalimapo in 2019 overlaid with areas of concentration of IUU fishing vessels

Rémire-Montjoly (East)

In Rémire-Montjoly, tracking of seven females in **2015** revealed generally larger activity ranges. Core areas (50%) covered an average of **7,439 ± 8,431 km² (min-max: 773–22,521 km²),** while home ranges (95%) reached **28,207 ± 30,587 km² (min-max: 3,972–83,945 km²)** (Table3). Compared to individuals tracked in the west, the Rémire-Montjoly females utilize home ranges that are on average 3.2 times larger, suggesting contrasting spatial strategies during the intra-nesting period, likely related to food availability, individual experience, or energy requirements.

Two individuals (#149684 and #149688, Figure11) exhibit dichotomous behavior, simultaneously utilizing areas located in the east and west, which underscores the functional importance of the entire Guyanese continental shelf for the species.

ID	Intra-nesting period	Duration of monitoring (days)	Number of locations	50% area (km²)	95% area (km²)
149680	June 24, 2015–July 26, 2015	32	72	2,053.5	11,036.2
149681	June 23, 2015–July 2, 2015	9	25	3,219.9	11,637.5
149682	June 24, 2015–July 15, 2015	21	51	1,463.0	6,272.9
149683	June 24, 2015–July 15, 2015	21	55	772.5	3,971.8
149684	June 23, 2015–July 4, 2015	11	16	22,520.5	83,945.3
149685	June 23, 2015–July 12, 2015	19	57	6,202.6	23,313.9
149688	June 23, 2015–July 7, 2015	14	36	15,837.9	57,272.1

Table3 : Summary table of estimated home ranges (kernel density 50% and 95%) of females (n=7, Dermochelys coriacea) tagged at Rémire-Montjoly in 2014 and 2015

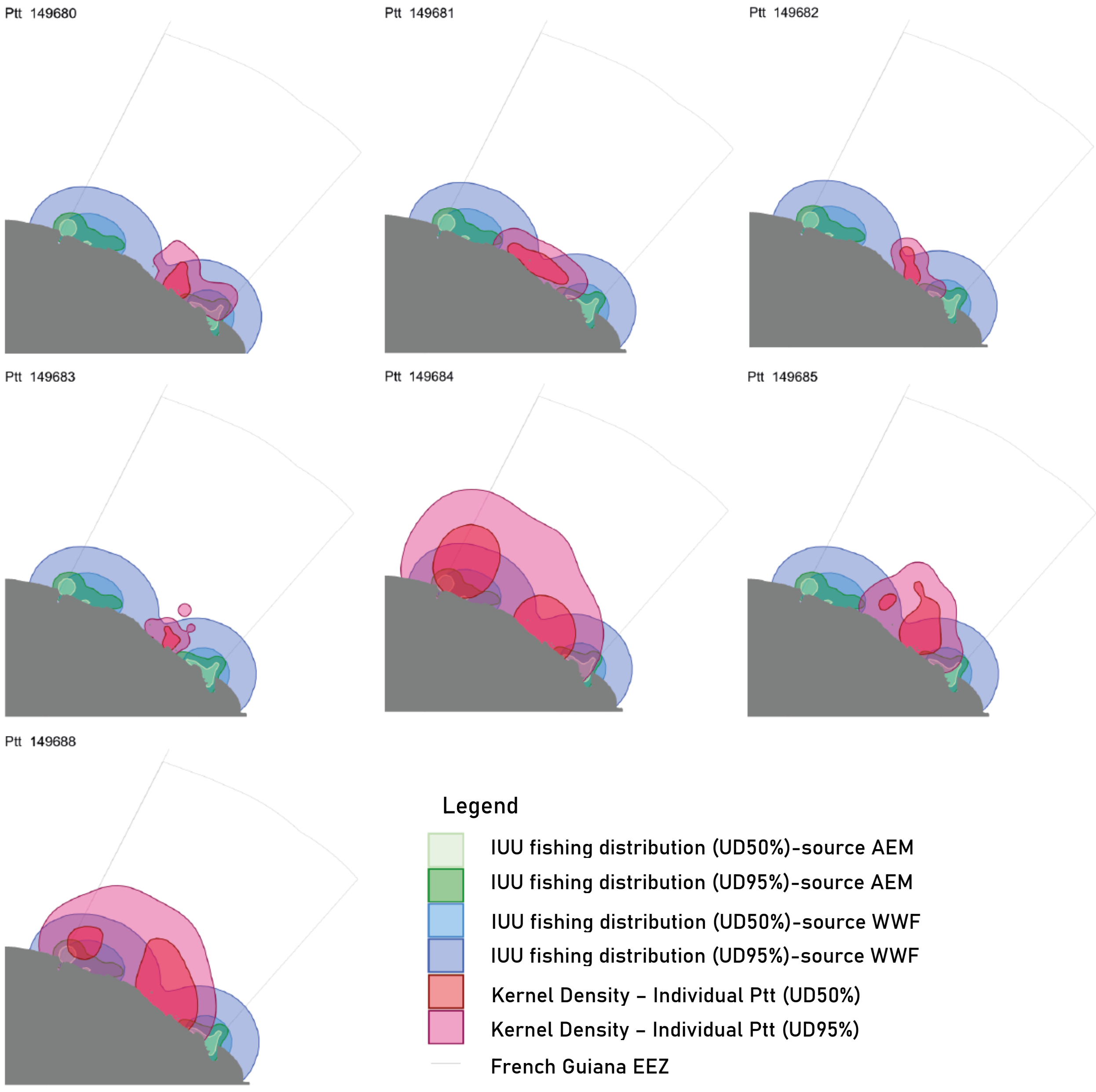


Figure11 : Map of estimated home ranges (50% and 95% kernel density) of females (n=7, Dermochelys coriacea) tagged at Rémire-Montjoly in 2014 and 2015 overlaid with areas of concentration of IUU fishing vessels.

4.3 Analysis of the risk of interaction between IUU fishing and leatherback turtles in French Guiana

4.3.1 Spatial and temporal overlap at the continental shelf scale

The overlap of leatherback turtle use areas with IUU fishing concentration zones highlights a significant spatial and temporal overlap at the scale of the Guianan continental shelf (Figure12). Spatially, the overlap area covers **11,690 km^2**, primarily located in the west, along the border with Suriname (Figure 8).

Aerial surveillance missions conducted by the State Action at Sea (AEM) between 2008–2011 and 2019–2023, and flyovers carried out by the WWF since 2023, show that IUU fishing is active throughout the year, with a concentration in the west during the leatherback turtle nesting season (April to July), where the main leatherback turtle nesting beaches are located. This finding supports the results presented in the final report of the PALICA II project, which reported a peak in bycatch during the month of June (Chevallier, 2023).

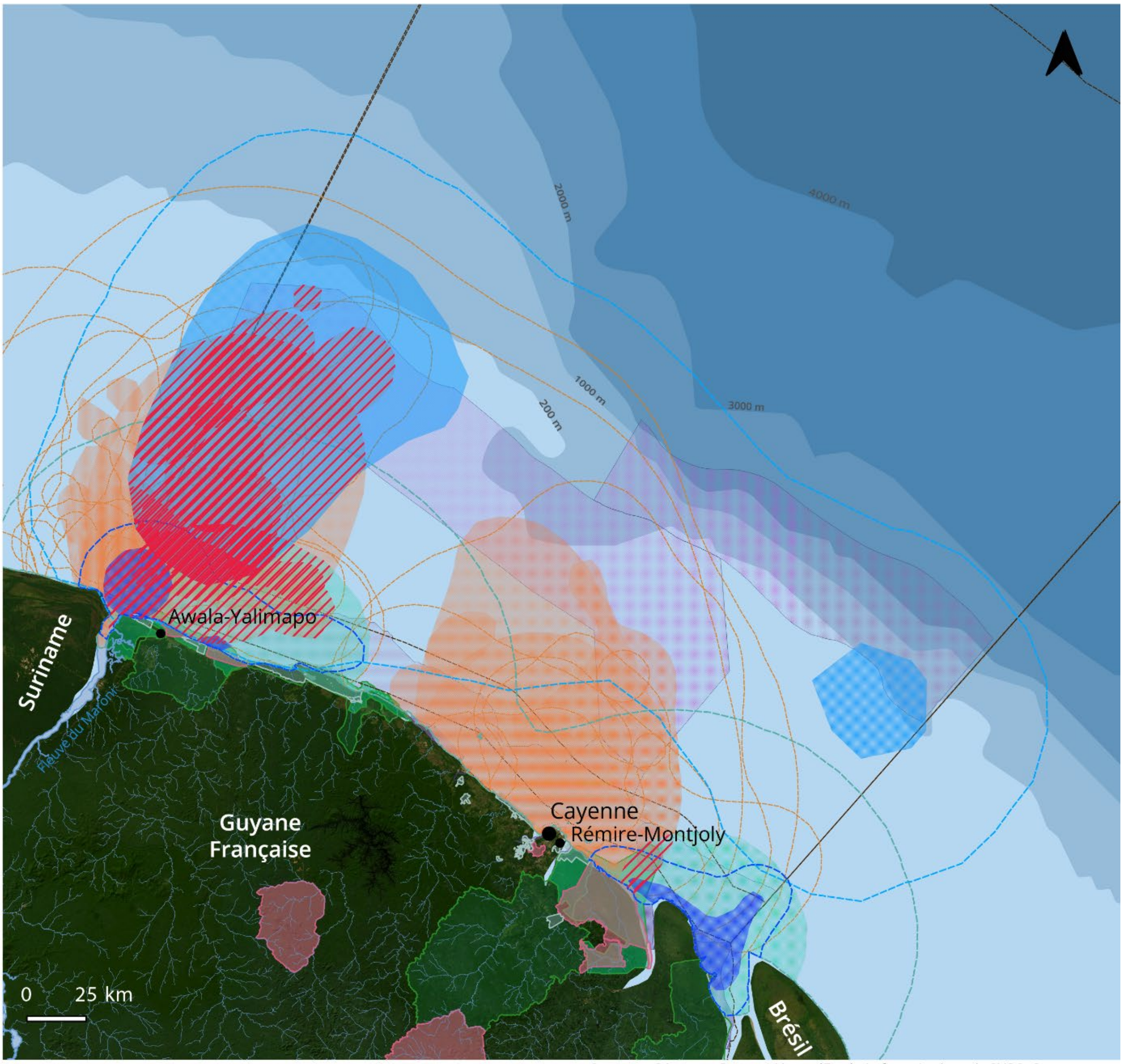


Figure12 : Map of areas of overlap between zones of high concentration of IUU fishing vessels estimated from EMA and WWF aerial surveys and zones of high use by leatherback turtles (n=17) during the intra-nesting period in French Guiana

4.3.2 Spatial and temporal overlap at the coastal zone scale

By focusing on the coastal strip (up to 200 m from the shoreline), considered most susceptible to direct interactions with fishing gear, three major overlapping zones emerge (Figure13), covering a total area of **623 km^2.**

- **Western Zone – mouth of the Maroni River (565 km^2)**

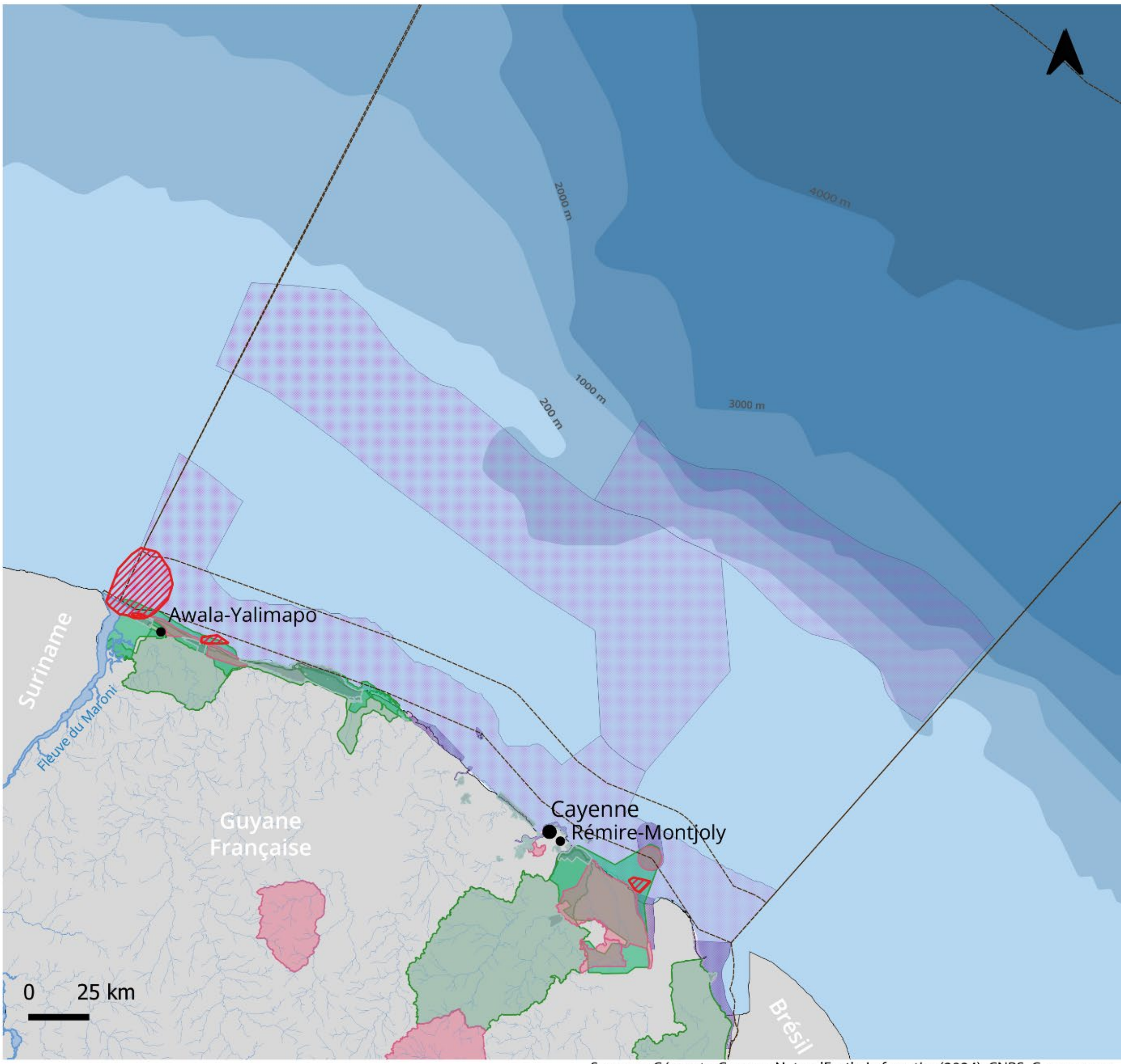
This is the largest and most critical zone. It includes 9 of the 10 individuals tracked from Awala-Yalimapo as well as one individual from Rémire-Montjoly. This zone corresponds to a high concentration of nesting females and high IUU fishing pressure, making it a hotspot for potential interactions.

- **Médeyre Zone (28 km^2)**

Located further east, this zone involves a single individual but highlights that, given the heterogeneity of leatherback turtle movements during the intra-nesting period, interactions may occur sporadically across a wider area of the plateau.

- **Approuague–Kaw Marsh Zone (30 km^2)**

Located to the east, at the mouth of the Approuague River, opposite the Kaw Marsh, this zone involves two tracked individuals. Its intermediate size and geographic location confirm that overlaps between leatherback turtles and IUU fishing are not limited to the west but also affect other portions of the Guyanese coastline.



Sources : Géocarto Guyane, NaturalEarth, Leforestier (2024), CNRS, Greenpeace

- High-risk interaction area between IUU fishing and leatherback turtles
- French Guiana EEZ
- Conservatoire du littoral
- National Nature Reserve
- RAMSAR site
- Regional Natural Park
- ZNIEFF 1
- ZNIEFF 2

Figure13 : Overlap zones between areas of high concentration of IUU fishing vessels estimated from EMA and WWF aerial surveys and areas of high use by leatherback turtles (n=17) during the intra-nesting period in the coastal strip

5.DISCUSSION

This study highlights a marked spatial and temporal overlap between the use of marine space by nesting female leatherback turtles during the intra-nesting period and the distribution of IUU fishing effort in Guyanese waters. This overlap is particularly concentrated near the mouth of the Maroni River, identified as a major hotspot for potential interactions. The intra-nesting period constitutes a critical phase in the species' life cycle, during which the survival of adult females directly determines the population's demographic dynamics. The results suggest that nesting females preferentially use coastal and neritic habitats that spatially coincide with areas of very high IUU fishing pressure, mechanically increasing the probability of interactions with fishing gear, particularly drift gillnets. Although this study does not directly estimate the mortality associated with these interactions, the observed spatial overlap, combined with existing knowledge on entanglement and bycatch rates of leatherback turtles in this type of gear, suggests that IUU fishing constitutes a significant risk factor for nesting females frequenting Guyanese waters.

Methodological Limitations and Uncertainties

Several limitations must be considered when interpreting the results. The identification of these interaction zones is based on an estimate of IUU fishing effort conducted in 2024 (Leforestier, 2024), and it is important to take into account the limitations of this estimate when interpreting these results.

First, this estimate does not account for the actual length of the nets used by illegal fishermen, which is on average twice the authorized length, thereby mechanically increasing the potential catch area and thus the probability of interactions with protected species.

Second, leatherback turtle catches documented in this type of net are primarily associated with nets deployed at night, yet the estimate was based solely on vessel positions collected during the day. These factors likely lead to an underestimation of the actual IUU fishing effort and, consequently, of the risk of interaction. The vulnerability of leatherback turtles to IUU fishing is therefore likely underestimated.

This methodological uncertainty should not lead to downplaying the threat; on the contrary, it should lead us to view current estimates as representing a minimum level of risk, thereby underscoring the urgency of taking more effective action against illegal foreign fishing and implementing strengthened, cross-border management measures.

Similarly, the areas used by leatherback turtles during the intra-nesting period were estimated based on a limited sample of 17 individuals. Although this sample size is comparable to those used in other telemetry studies, it does not allow for capturing the full range of interannual and interindividual variability in movements. The observed heterogeneity in spatial strategies suggests that certain high-risk areas may not have been detected. It therefore seems appropriate to deepen our understanding of their movements in Guyanese waters by increasing the number of turtles tracked and improving the accuracy of locations, in order to obtain a more detailed picture of the fine-scale movements of nesting females.

Third, the chosen approach focuses on spatio-temporal overlap, the primary component of susceptibility to fishing. It does not account for other dimensions of risk, such as the probability of vertical encounter, gear selectivity, or post-interaction mortality, which determine the actual demographic impact.

These limitations imply that the results should be interpreted as a conservative estimate of risk, providing a robust but non-exhaustive indication of areas of potential interaction.

6. IMPLICATIONS AND OUTLOOK

6.1. Implications for leatherback turtle conservation

The results of this study highlight several marine areas where the risk of interaction between IUU fishing and nesting female leatherback turtles is high, particularly during the intra-nesting period. These areas correspond to critical habitats regularly used by adult females. In this context, IUU fishing constitutes a major pressure driving the rapid decline of this population and is likely to hinder any potential recovery of this population in French Guiana by affecting a key demographic segment. The concentration of risk in a few areas, notably near the mouth of the Maroni River, underscores the positive impact that targeted interventions would have. Prioritizing the protection of females during the nesting period thus appears to be a key lever for enhancing the effectiveness of conservation efforts.

6.2. Implications for management and monitoring efforts

While IUU fishing in Guyanese waters appears to be a major factor limiting the recovery of leatherback turtle populations, it also undermines legal fishing communities by diminishing available fishery resources and generating social tensions. The persistence of these illegal catches threatens the integrity of Guiana's waters and France's sovereignty over its maritime domain, and has direct implications for conservation and the economic sustainability of coastal activities, particularly legal fishing and ecotourism, exacerbating conflicts over land use along the Guyanese coastline. It is also important to consider French Guiana's food sovereignty, where a large portion of the population relies on locally caught, economically accessible fish as their primary source of protein, making the sustainability of fisheries and the protection of fish stocks essential for food security.

In light of this situation, several stakeholders on the ground in French Guiana have highlighted the need to act at multiple levels and through various channels : strengthening regional and international cooperation, ensuring transparency and continuity in monitoring fishing pressure, adapting surveillance and enforcement measures to border areas, and prioritizing the protection of nesting leatherback turtles frequenting the Maroni estuary.

The fight against illegal fishing relies above all on the presence at sea of competent authorities responsible for ensuring surveillance and the enforcement of sanctions provided for by European regulations. This mission falls under the sovereign prerogatives of the country. In the context of cross-border fishing, where catches originate from neighboring countries, these measures appear essential : they establish a clear framework, reinforce legal obligations, and send a deterrent signal to actors likely to violate regulations, while contributing to the maintenance of European sovereignty over its waters and resources. The deterrence model, theorized by Gary Becker (1968), is based on a simple principle : an individual is all the more inclined to obey the law when the probability of being caught and punished makes the offense economically disadvantageous.

The limitations observed stem primarily from the difficulties encountered in effectively enforcing the legislation. In many cases, identifying those responsible for violations remains difficult, as the captains who are apprehended do not always have identification documents and identifying the vessels is impossible, making it impractical to prosecute shipowners, who are nevertheless the actual beneficiaries of the economic gains from illegal fishing in Guyanese waters. In this context, the deterrent effect of the system depends largely on the level of operational presence at sea and the frequency of inspections.

Strengthening the resources deployed on the ground therefore appears to be a central challenge. Current maritime surveillance capabilities, which must fulfill multiple missions, do not always allow for a sufficiently regular presence in areas where the pressure from illegal fishing is greatest. However, in accordance with the principles of the deterrence model, increasing the probability of inspection is one of the most effective levers for reducing the economic attractiveness of illegal fishing activities.

From this perspective, increased mobilization at the European and national levels appears essential to support control and surveillance mechanisms in the outermost regions. The European Union, which has exclusive competence to deal with third countries under the Common Fisheries Policy, also has tools at its disposal to demand compliance with international rules regarding the fight against IUU fishing. In the most serious cases, these mechanisms can go as far as banning the export of fishery products to the European market, thereby constituting a significant economic and diplomatic lever to encourage compliance with international standards for the sustainable management of marine resources.

6.3. Methodological Perspectives

6.3.1. Bycatch Risk Analysis (ByRa)

The spatial overlap between the distribution of leatherback turtle activity during the intra-nesting period and the distribution of IUU fishing activity in Guyanese waters shows a clear overlap, particularly in the area of the Maroni River estuary. This study highlighted a risk of interaction between leatherback turtles and illegal fishing vessels.

It is now necessary to include additional parameters such as:

- the characteristics of fishing gear (length, height, immersion depth, soak time, etc.),
- the vertical distribution and diving behaviors of the turtles,
- environmental conditions (bathymetry, turbidity, ocean fronts, etc.),
- the probability of post-interaction mortality.

These analyses will enable the production of more detailed risk maps, combining multiple dimensions of risk and facilitating the prioritization of management actions.

These **ByRA (Bycatch Risk Assessment) analyses** will enable the production of more detailed spatiotemporal risk maps of bycatch by combining different data sources and multiple dimensions of risk. These maps will provide an objective scientific tool for targeting measures to reduce interactions, as well as a visual aid for dialogue among scientists, managers, and fishing stakeholders.

6.3.2. Strengthening monitoring data

Improving analyses requires strengthening data collection systems for both leatherback turtles and IUU fishing. Increasing the number of individuals tracked, diversifying the years of telemetric monitoring, and improving temporal resolution would refine estimates of the variability in sea turtle movements. Similarly, standardized protocols for monitoring IUU fishing, including night observations and a more reliable estimate of fishing effort, would reduce current uncertainties.

Furthermore, strengthening and harmonizing monitoring programs at the scale of the Atlantic basin represents an important lever to improve the understanding of population dynamics. In particular, linking the time series from nesting surveys in French Guiana with observations at sea in the Northeast Atlantic could provide initial insights to better characterize the potential relationships between these dynamics. Such an approach would help assess the extent to which the decline observed on nesting beaches translates into a reduction of individuals' presence in foraging or transit areas, and guide conservation actions at an ecologically relevant scale.

6.3.3. *Development of a monitoring protocol for SK Boats with the Amana Reserve*

The identified interaction zones overlap with areas of high biodiversity importance, particularly near the **Amana National Nature Reserve** (Figure14). Located between the Organabo River and the Maroni River, this reserve plays a strategic role in the conservation of sea turtles in French Guiana, hosting nesting sites for four species of sea turtles: the leatherback turtle, the green turtle, the olive ridley turtle, and, more rarely, the hawksbill turtle.

Figure14 : Map of the Amana Reserve in French Guiana (source: Nicolle, 2015)

The development of harmonized monitoring protocols, building on the existing capabilities of the Amana Nature Reserve, would enable the production of complementary, comparable, and usable data over the long term. Reserve staff already collect information on IUU fishing from several sources:

- Opportunistic observations from the beach during sea turtle nesting monitoring,
- Inspections of SK Boats at sea or in mangrove areas with the issuance of official reports, enabling the collection of detailed information on the vessels,
- Aerial monitoring by Ultralight Aircraft, in partnership with GEPOG,
- Drone monitoring, recently implemented following training of staff in drone piloting by WWF Guiana.

The current priority is to develop a standardized protocol for beach-based monitoring and to process the data already collected. This protocol must be sufficiently clear and replicable to be extended to the eastern region. The ultimate goal is to establish a comprehensive protocol integrating all data sources, with harmonized collection and processing methods, in order to produce robust, replicable, and comparable analyses.

6.3.4. Extending these analyses to green sea turtles in French Guiana

While this study focuses on the leatherback turtle, the identified overlapping areas are likely to affect other sea turtle species present in French Guiana, notably the **green turtle** (*Chelonia mydas*). This species, also found on Guianan nesting beaches, is directly exposed to IUU fishing during the intra-nesting period and during migrations.

Extending this approach to green sea turtles would allow for a more comprehensive understanding of the pressures on sea turtles and coastal marine ecosystems in French Guiana. Integrating IUU fishing into a broader assessment of threats (including coastal erosion, climate change, and anthropogenic pressures) is a key approach for prioritizing conservation actions and guiding public policies in a coherent and sustainable manner. Such an approach would also strengthen the case for regional cooperation in the management of marine and coastal resources.

6.3.5. Assessment of the extent of the impact of illegal fishing relative to all threats

The National Action Plan for Sea Turtles, published in 2014, established the relative importance of the various pressures affecting the population dynamics of this species, identifying in particular bycatch associated with illegal driftnet fishing as one of the priorities for action (Entraygues, 2014a). Indeed, understanding the population dynamics of leatherback turtles relies on integrating multiple pressure factors acting at different scales : demographic parameters (survival rates, reproductive success, recruitment), human pressures (illegal and legal fishing, coastal activities, anthropogenic disturbances), as well as natural and environmental pressures (coastal erosion, climate change).

The launch of the INVOCTO** research project, led by the CNRS in close collaboration with stakeholders in French Guiana, will enable these factors to be analyzed jointly in order to better understand their cumulative effects on populations. Such an approach would help consolidate conservation priorities and guide future management measures toward the most effective levers for preventing the decline of local sea turtle populations.

***Influence of Oceanographic Variables and Human Activities on the Behavior, Distribution, and Demography of Sea Turtles in the Atlantic Ocean: An Essential Contribution to the Identification of Sensitive Marine Areas in French Guiana.*

6.4. The Need for Immediate Action

This preliminary work provides empirical evidence highlighting an overlap between areas used by leatherback turtles and IUU fishing activities in the waters of French Guiana, suggesting a potentially major impact on the population. Although these results must be interpreted with caution and supplemented by the inclusion of other variables in future studies, they represent a significant step forward in understanding this issue.

The observed indicators, particularly the collapse in the number of nests on beaches in western French Guiana, are particularly concerning and point to a high risk to the population's viability. In this context, the application of the precautionary principle appears fully justified : it entails the immediate implementation of measures aimed at eliminating IUU fishing in these critical areas, which are essential for any prospect of population recovery.

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