

***Using Satellite Telemetry to Determine Post-Nesting
Migratory Corridors and Foraging Grounds of
Green Turtles Nesting at Poilão, Guinea Bissau.***



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CONTENTS

	Page Number
Acknowledgements	1
Executive Summary and Recommendations	2
Introduction	3-4
Methodology	5-7
Results	8-20
Project Outputs	21-22
Statement of Accounts	23
References	24-25

ACKNOWLEDGEMENTS

This project was a joint venture between the following organisations:

- **Centre for Applied Research on Fisheries, Guinea Bissau (CIPA)**
- **Coastal Planning Office, Ministry of Agriculture and Rural Development, Guinea Bissau (GPC)**
- **IUCN Office, Guinea Bissau (IUCN)**
- **Marine Turtle Research Group, University of Wales, Swansea, UK (MTRG)**
- **National Institute for Research, Guinea Bissau (INEP)**
- **Unidade de Investigação em Eco-Etologia, Instituto Superior de Psicologia Aplicada, Portugal (UIE-ISP)**

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NB It is expected that this work will result in scientific publications. Please contact us if you would like to receive copies.

EXECUTIVE SUMMARY AND RECOMMENDATIONS

Recent surveys have shown that the small island of Poilão, located amongst the islands of the Bijagós archipelago, Guinea Bissau, hosts the largest green turtle (*Chelonia mydas*) rookery on the west coast of Africa, and one of the largest in the Atlantic Ocean. Traditionally, Poilão has been regarded as a sacred site by the Bijagós people, and this has contributed to turtle conservation. However, an emerging threat is the rapid development of fisheries in this region. In order to support efforts towards the recently established MoU Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa under the CMS we set out to identify important foraging areas for green turtles from this rookery. We attached 10 satellite transmitters to nesting turtles in November 2001 and were then able to follow these individuals via satellite showing that turtles demonstrated a diversity of behaviours. The key findings were as follows:

Migration

Four females migrated from Poilão to the Park National du Banc D'Arguin, Mauritania, where they remained until the transmitter units failed. Data gathered gave insights into the migration paths and habitat utilisation in one of Africa's most important national parks.

Two individuals travelled to Senegalese waters where transmissions for one individual ceased. The other individual was tracked as it returned to waters of the Bijagós Archipelago, Guinea Bissau.

The last four individuals were recorded making shorter range movements before premature cessation of transmissions. Thus, we cannot be sure as to the final destination of these individuals.

The findings illustrate the clear need for international collaboration for the protection of marine turtles, with at least four nations (Gambia, Guinea Bissau, Mauritania and Senegal) clearly sharing responsibility for the Poilão nesting population. This highlights the importance of the CMS MoU Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa and other international agreements.

Inter-nesting Behaviour

Turtles usually lay multiple clutches in any given breeding season. For six turtles we were able to record their behaviour between nestings. This showed that although most turtles stayed very close to Poilão for the duration of nesting, at least one turtle moved extensively within the Archipelago during the internesting period.

Recommendations:

Regional:

1. Support should be given for additional studies which, through telemetry or molecular techniques, allow a fuller assessment of the location of additional important foraging areas for green turtles in West Africa.
2. Given the migratory nature of this species it is important that threats, especially direct and incidental catch in both artisanal and industrialised fisheries, be assessed throughout the region.
3. Research recommendations should feed into a regional management plan such as already been drafted (Anon 2002)

Site specific:

4. It is clear from these and other findings that the João Vieira and Poilão National Marine Park (Guinea Bissau) and the Park National du Banc D'Arguin (Mauritania) constitute two key elements of the range of the single largest green turtle nesting aggregation in West Africa. Further studies should be undertaken in the Park National du Banc D'Arguin and throughout the Bijagos Archipelago to gain a fuller appreciation of the ecology of all species of marine turtle residing in their waters.
5. Ongoing monitoring of marine turtles at Poilão should be undertaken to allow a fuller assessment of the current status and trend in population size especially since green turtle populations have been demonstrated as showing profound inter-annual variation in nesting numbers (Broderick *et al.* 2001).

INTRODUCTION

The green turtle (*Chelonia mydas*) has feeding and nesting areas largely lying in the tropics and is considered “Endangered” by the World Conservation Union (Hilton-Taylor 2000). The phylogenetic structure of the species has been investigated using molecular methods (Bowen *et al.* 1992) suggesting a fundamental split into those populations from the Atlantic-Mediterranean and those from the Indo-Pacific. The major nesting colonies for the green turtle in the western Atlantic are: Tortuguero (Costa Rica; Bjorndal *et al.* 1999); Ascension Island (UK; Mortimer and Carr 1987); Suriname; (Shulz 1975); Aves Island (Venezuela; Sole and Medina 1989); and Trinidad (Brazil; Moriera *et al.* 1995). The knowledge of the breeding colonies in Africa is relatively limited.

In the Bijagós Archipelago of Guinea-Bissau, four species of marine turtle are known to nest: the green turtle, the olive ridley turtle (*Lepidochelys olivacea*), the leatherback turtle (*Dermochelys coriacea*) and the hawksbill turtle (*Eretmochelys imbricata*) (Limoges and Robillard 1991a; 1991b). Information regarding the other species is scant but data collected in recent years has shown the green turtle population nesting in the Bijagós to be of global importance. In 1995, 1650 females were tagged at Poilão Island during just part of the nesting season (Fortes *et al.* 1998). In 2000, approximately 7000 clutches were laid between July and November (Catry 2000; Catry *et al.* 2002). This places Poilão amongst the most important rookeries for green turtles in the Atlantic. The only other large colony as yet described in west Africa is that of Bioko Island (Equatorial Guinea; Tomas *et al.* 1999) but numbers of nests appear to be in the region of an order of magnitude less than Poilão.



Left: Remoteness of Poilão; arrival by boat.



Right: High density nesting on Poilão.

Poilão is a traditional sacred site in the Bijagós culture. This, allied with its remoteness has helped to conserve the turtles nesting there whereas other sites in the region have been exploited. In addition, its importance to sea turtles was one of the main supporting arguments for the creation of one of the first marine protected areas of Guinea-Bissau: the João Vieira and Poilão Marine National Park (August 2000).

The local threats to green turtles in Guinea Bissau have not yet been fully quantified but include harvest of eggs and adults and the incidental catch of turtles in artisanal and industrial fisheries (Barbosa *et al.* 1998; Fortes *et al.* 1998). Anecdotal accounts from local people of the Bijagós Archipelago reveal that, although turtles are still numerous at Poilão, in recent years they have noticed the decline and sometimes disappearance of marine turtles from some nesting grounds. Constructive steps are being taken to minimise these factors. These will all be in vain if the turtles are being critically impacted in other parts of their range.

The life cycle of marine turtles involves movements over great temporal and spatial scales (see Musick and Limpus 1997 for review), taking decades for turtles to reach adulthood. Although adults from this population are likely to forage widely in African coastal waters their life cycle will involve periods in seas of other nations and shared coastal foraging areas with individuals from other nesting populations as has been found in other regions (Lahanas *et al.* 1998).

This is likely to result in the exposure to a number of fisheries and associated directed and incidental catch. The consumptive use in west Africa has been found to be common in recent research of coastal communities in all the nations of tropical West Africa (pers. comm A Formia). All populations studied to date have shown that distances separating nesting beaches from feeding areas involve hundreds or thousands of kilometres (Carr 1975; Luschi *et al.* 1998). Only with knowledge of these movements and the subsequent regional collaboration and co-operation of different nations, can the conservation of this endangered species be assured.

For decades the main tool which was used to gain insights into the distribution and movements in sea turtles was flipper tagging (Hendrickson 1958) and a great deal has been learned from this technique. Flipper tagging of nesting adults has given insights into reproductive behaviour (Miller 1997), pre and post breeding migrations (Balazs 1980; Carr *et al.* 1978; Limpus *et al.* 1992). However, despite extensive flipper tagging at Poilão, only three tag returns have been obtained: 2 from Mauritania and 1 from Gambia (Castro Barbosa unpublished data). However, as a result of recent technical advancements, the exploitation of novel technology has allowed greater steps to be made in the understanding of the ecology of turtles. The increased performance and reduction in size of satellite tracking units has allowed them to become of great utility in turtle tracking studies. Using satellite transmitters it has been possible to detail the post-reproductive migration routes of adult females and males (Balazs and Ellis 2000; Hatase *et al.* 2002a;2000b; Morreale *et al.* 1996; Sakamoto *et al.* 1997) and to ascertain the location and usage of foraging grounds of adult turtles, in neritic (Godley *et al.* 2002; 2003) and pelagic areas (Hughes *et al.* 1998; Nichols *et al.* 2000).

Against this background we set out to use satellite tracking technology to track individual turtles following nesting at Poilão. Our fundamental aim was to ascertain foraging grounds and migratory corridors for this population as outlined as a priority by Broderick *et al.* (1998). An ancillary aim was to gain insights into habitat utilisation between nestings. This work was expected to contribute towards section 4 of the Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa < <http://www.wcmc.org.uk/cms/>>:

“Facilitate the expeditious exchange of scientific, technical and legal information needed to co-ordinate conservation measures; and co-operate with recognized scientists of international organizations and other Range States in order to facilitate their work conducted in relation to the Conservation Plan.”

METHODOLOGY

Personnel:

Project co-ordination was undertaken by: **Castro Barbosa** BSc (Coastal Planning Office, Bissau); **Annette Broderick** PhD (Marine Turtle Research Group); **Paulo Catry** PhD (IUCN Guinea-Bissau and Unidade de Investigação em Eco-Etologia, Instituto Superior de Psicologia Aplicada, Portugal); **Brendan Godley** PhD (Marine Turtle Research Group); **Graeme Hays** PhD (School of Biological Sciences, University of Wales); **Alfredo Simão da Silva** MSc (Director of the Coastal Planning Office, Bissau). Field work was carried out by **Castro Barbosa**, **Paulo Catry** and **Brendan Godley** (above) and: **Amadeu Almeida** BSc (Centre for Applied Research on Fisheries); **Bucar Indjai** BSc (National Institute for Research); **Januário da Silva** (Canhabaque); **Preto João Perrida** (Canhabaque).

Study site:

The island of Poilão is the southernmost and one of the smallest (43 ha) of the Bijagós Archipelago, Guinea Bissau ($10^{\circ} 36' - 11^{\circ} 37' \text{N}$, $15^{\circ} 36' - 16^{\circ}, 29' \text{W}$; West Africa; Figure 1). It is covered by undisturbed tropical forest and surrounded by a rocky subtidal zone. Sandy beaches comprise a total of 2.3 km of the ca. 4 km coastline. The climate is tropical, with a rainy season (May-November). The nesting biology of this population has been more fully elaborated in Catry *et al.* (2002).

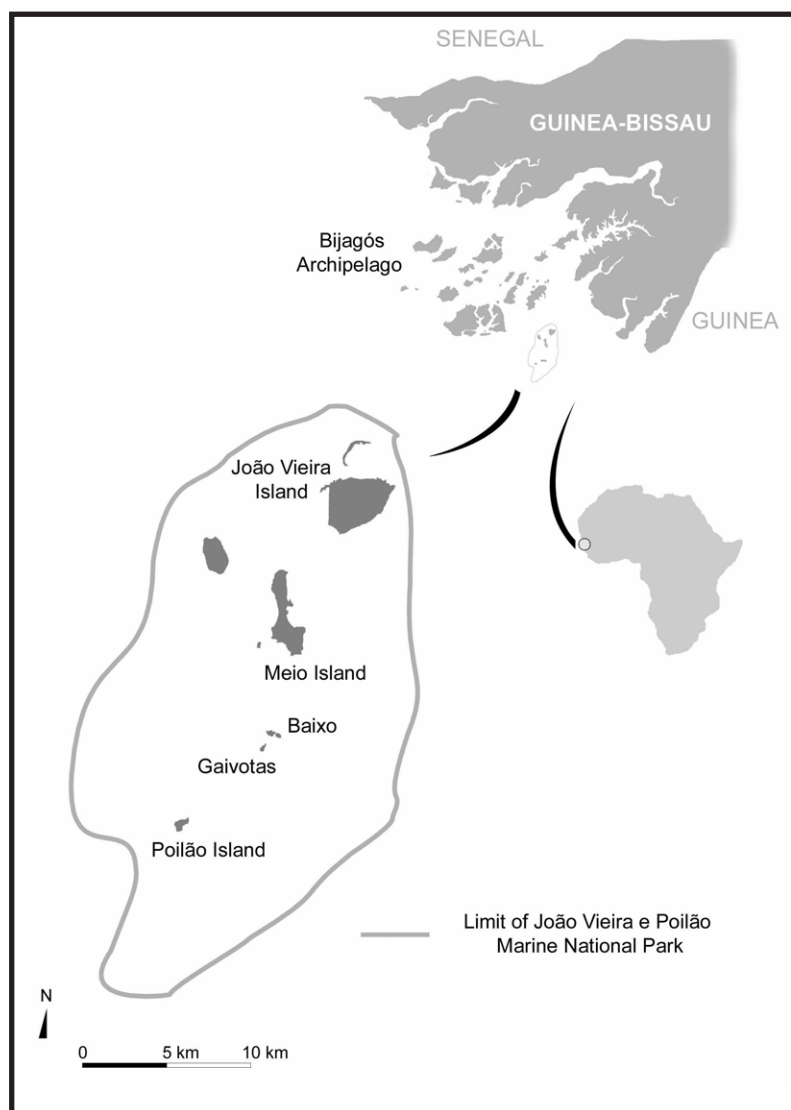


Figure 1. Location of Poilão Island within the João Vieira and Poilão National Marine Park in Guinea Bissau, West Africa (after Catry *et al.* 2002).

Fieldwork:

Between 17th November and 2nd December 2001 Drs. Godley and Catry were in Guinea Bissau carrying out field work in conjunction with IUCN and the consortium of individuals and organisations (GPC, INEP, CIPA, BBR) who undertake the ongoing turtle monitoring and conservation work at Poilão. The project team and field camp are shown below:



Left: Field team. Back Row: Paulo Catry (IUCN, ISPA), Januário da Silva (Canhabaque), Preto João Perrida (Canhabaque), Amadeu Almeida (CIPA), Front Row: Castro Barbosa (GPC), Bucar Indjai (INEP). **Right:** Field camp in forest behind main nesting beach.

Satellite transmitters were attached to the carapace of 10 female green turtles. We utilised two models: six Telonics ST-18 Platform Terminal Transmitters (PTTs) and four Telonics ST 6 PTTs (see photos below). The carapace was first cleaned using mildly abrasive sandpaper, then wiped with acetone to remove natural oils. Where possible carapace measurements were taken (standard curved carapace length (CCL) and width (CCW) in cm). The PTTs were attached using a two part epoxy resin (Foilfast, SFS Stadler, Cheltenham, UK) according to a methodology used previously (Godley *et al.* 2002). Attention was paid to make attachment package hydrodynamic to minimise drag (Watson and Granger 1998). Transmitters were tracked using the Argos system resulting in fixes of variable accuracy (Argos 1996). All field team members were trained in attachment.



Left: Castro Barbosa with ST-18 and ST-6 in his right and left hands, respectively. **Right:** Green turtle returning to sea following ST6 attachment.

Additional Studies

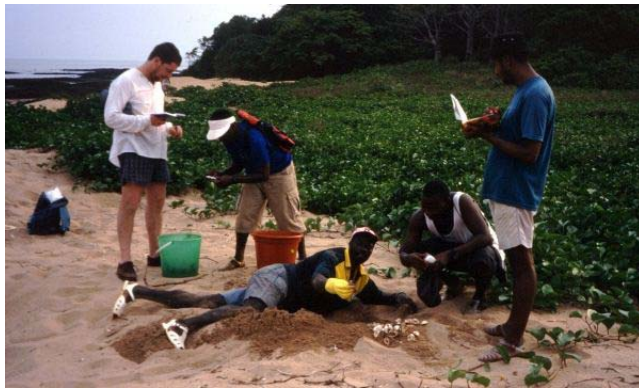
During the field visits, the following additional work was undertaken.

Deployment of Temperature Logging Devices

To give long term insights into thermal regimes being experienced in nests at Poilão, two ‘Tinytalk’ data loggers (Gemini Data Loggers (UK) Ltd., Chichester, UK) which were set to record synchronously at 4 hour intervals were buried at nest depths at two control sites. When local partners retrieve these, an annual nest temperature profile can be estimated.

Sampling for Molecular Ecological Studies

Vouchers (skin biopsy or dead hatchling) were collected representing 50 individual turtles. These were given to Angela Formia/Mike Bruford of the University of Cardiff who are currently studying the molecular ecology of marine turtles throughout West Africa. As part of this major study these samples will greatly contribute towards a regional understanding of the biology of this species.



Left: Excavating a hatched nest to obtain information on nest success and a voucher for analysis.



Right: Females may become trapped in rockpools after nesting and await rising tides.

RESULTS

Details of the performance of the transmitters and sizes of study individuals are given in table 1.

Individual	Date attached	CCL (cm)	CCW (cm)	Duration (days) of Transmissions	Number of locations	Destination
A	21/11/01	103	95	105	285 (73)	Banc D'Arguin
B	23/11/01	100	91	95	90 (5)	Banc D'Arguin
C	23/11/01	110	96	75	172 (40)	Banc D'Arguin
D	23/11/01	110	102	82	121 (20)	Banc D'Arguin
E	22/11/01	nm	nm	34	45(2)	Senegal/ Bijagós
F	21/11/01	102	94	22	87 (7)	Poilão/ Bijagós
G	22/11/01	108	100	30	26 (2)	Poilão/Senegal
H	23/11/01	99	95	20	85 (5)	Poilão/ Bijagós
I	23/11/01	99	96	30	56 (12)	Bijagós
J	21/11/01	92	83	17	57 (6)	Poilão

Table 1. Summary data of individual females and performance of PTTs. Numbers in parentheses are the number of locations of the highest accuracy classes: 1, 2 or 3. (nm: not measured as attachment carried out within deep undergrowth).

The tracks of individual females (A-J) are illustrated in figures 2-11.

The detailed biological ramifications of the data gathered will be explored in scientific papers (to request copies please e-mail MTN@swan.ac.uk or contact Dr. B. Godley, contact details on front cover). The most important aspects of our findings are summarised below:

Four Females Travelled to Mauritania Following Nesting

Following the completion of nesting, four females A-D (Figs 2-5) migrated from Poilão to the Park National du Banc D'Arguin, Mauritania, where they remained until the transmitter units failed. This involved travel of >1000km in all cases.

Two Females Made Shorter Range Movements Following Nesting

Two individuals (E Fig 6 and G Fig 8) travelled to Senegalese waters where transmissions for individual G ceased when its position was >200km from Poilão. Turtle E was tracked as it moved >400km away from Poilão before it returned to waters of the Bijagós Archipelago, some 60km away from the nesting site.

Four Individuals Remained in the Bijagos Region for the Duration of Tracking

The last four individuals (F Fig 7, H-J Fig 9-11) were recorded making short range movements within the waters of Guinea Bissau. Unfortunately, premature cessation of transmissions, before turtles were demonstrated as resident for any length of time in the same foraging location, prevent us from ascertaining the final destinations for these turtles. The short transmission duration was probably due to damage to the units, a common problem when turtles remain in coastal waters. Their movements do, however, highlight the fact that it is likely that the Bijagós Archipelago hosts foraging habitats, as well as the nesting, inter-nesting and migratory habitats for the largest green turtle population in West Africa. This augments anecdotal accounts of large adult turtles being observed and captured throughout the archipelago throughout the year, including during periods when nesting is exceptional.

Insights Were Obtained into Inter-nesting Habitats

Turtles lay multiple nests in any given season and although efforts were made to select females which had been tagged earlier in the season, only 4 individuals left immediately following the nesting of attachment. We were thus able to record the utilisation of the Bijagós Archipelago by all the 6 other individual turtles during one inter-nesting interval (Individuals B (Fig 3) F (Fig 7), G (Fig 8), H (Fig 9), I (Fig 10), J (Fig 11)). For five individuals this meant most if not all of their time between nesting was spent within the boundaries of the João Vieira and Poilão National Marine Park (Fig 1). This was in marked contrast to Individual H (Fig 9) which made a concerted movement towards the mainland before heading back to lay another clutch. Unfortunately transmissions were lost from two of these individuals (Individuals H and J) immediately following the subsequent nesting.

Insights Regarding Foraging Behaviour were Obtained.

Data gathered gave insights into the habitat utilisation patterns at one of Africa's most important national parks at Banc D'Arguin. For the duration of transmissions, individual turtles showed remarkable fidelity to discrete foraging areas (Fig. 12). These data will help managers in Banc D'Arguin focus their efforts.

These combined findings lead us to make the following research recommendations:

Regional:

1. Support should be given for additional studies which, through telemetry or molecular techniques, allow a fuller assessment of the location of additional important foraging areas for green turtles in West Africa.
2. Given the migratory nature of this species it is important that threats, especially direct and incidental catch in both artisanal and industrialised fisheries, be assessed throughout the region.
3. Research recommendations should feed into a regional management plan such has already been drafted (Anon 2002)

Site specific:

4. It is clear from these and other findings that the João Vieira and Poilão National Marine Park (Guinea Bissau) and the Park National du Banc D'Arguin (Mauritania) constitute two key elements of the range of the single largest green turtle nesting aggregation in West Africa. Further studies should be undertaken in the Park National du Banc D'Arguin and throughout the Bijagos Archipelago to gain a fuller appreciation of the ecology of all species of marine turtle residing in their waters.
5. Ongoing monitoring of marine turtles at Poilão should be undertaken to allow a fuller assessment of the current status and trend in population size especially since green turtle populations have been demonstrated as showing profound inter-annual variation in nesting numbers (Broderick *et al.* 2001).

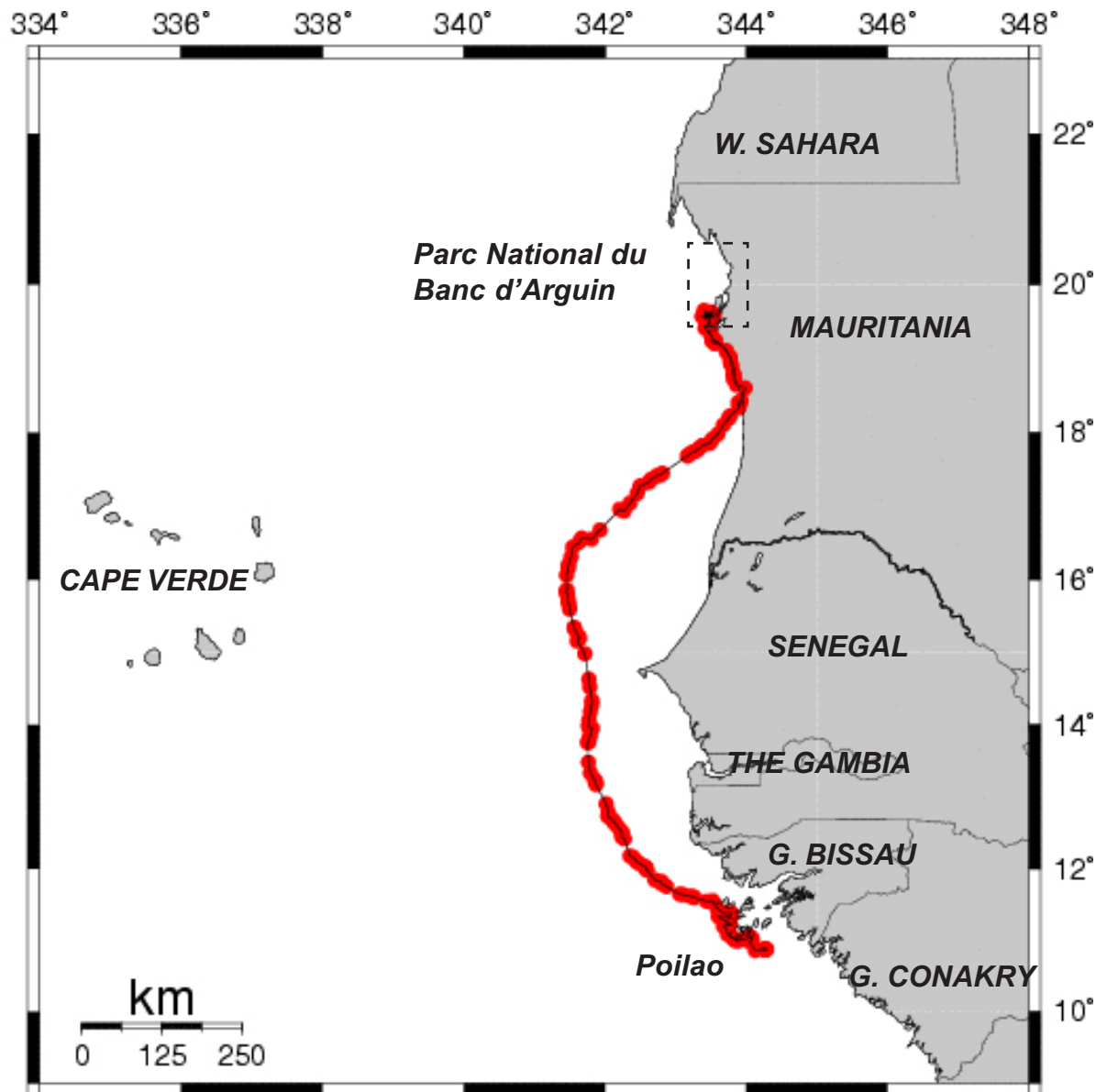


Figure 2. Track of individual A from Poilão to Mauritania. Locations shown are corrected as per Godley *et al.* (2002).

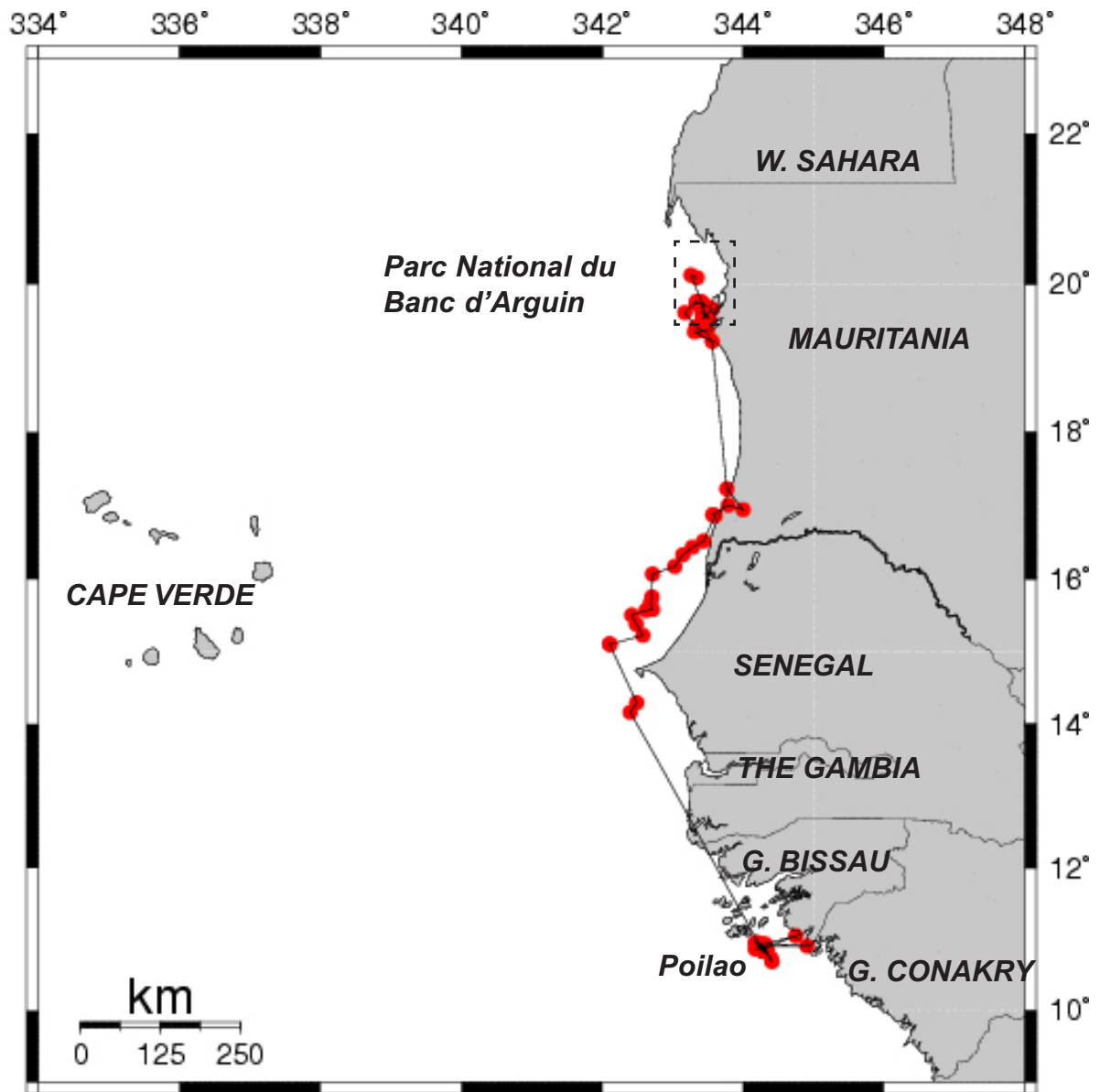


Figure 3. Track of individual B from Poilão to Mauritania. Locations shown are corrected as per Godley *et al.* (2002).

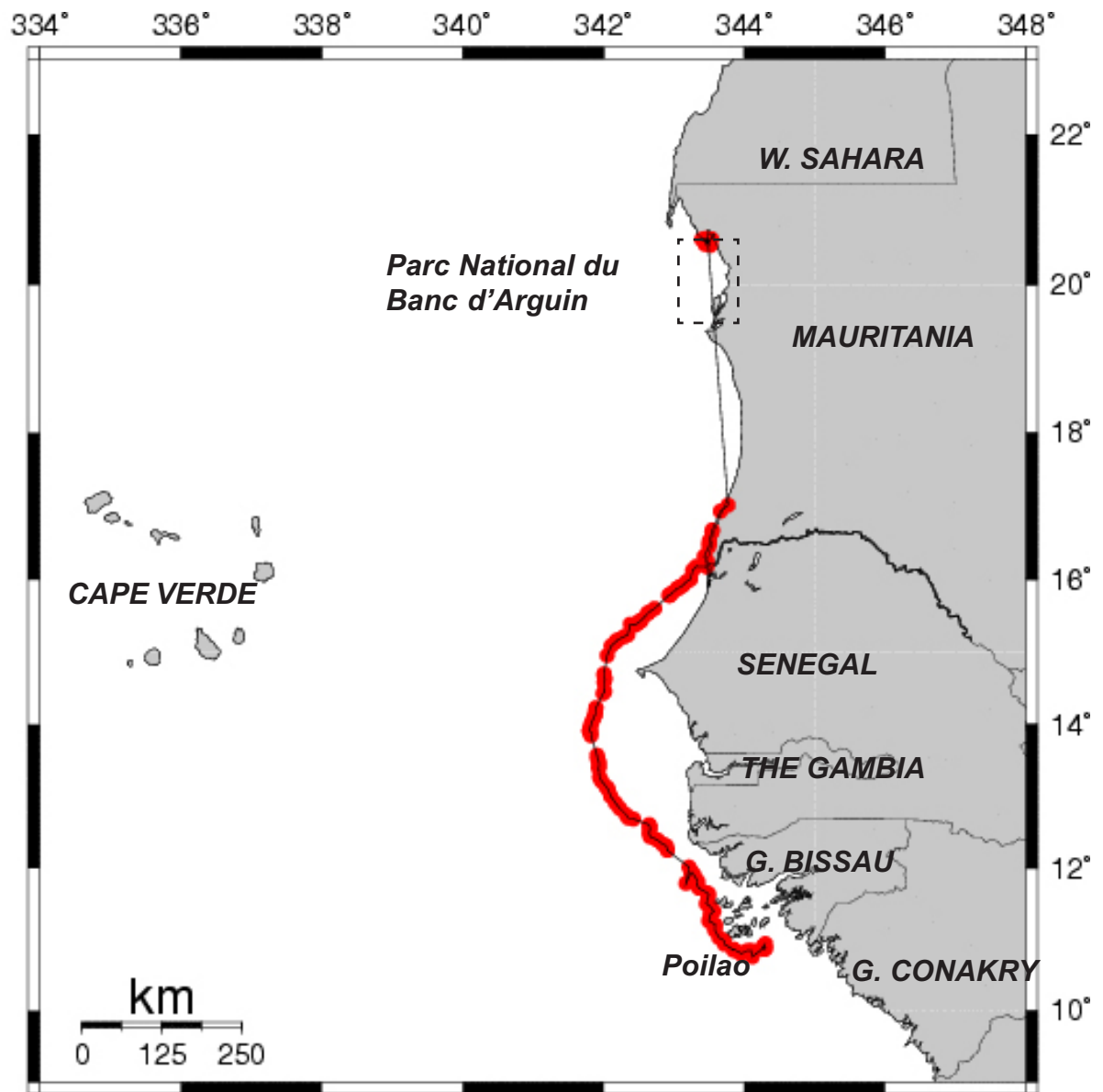


Figure 4. Track of individual C from Poilão to Mauritania. Locations shown are corrected as per Godley *et al.* (2002).

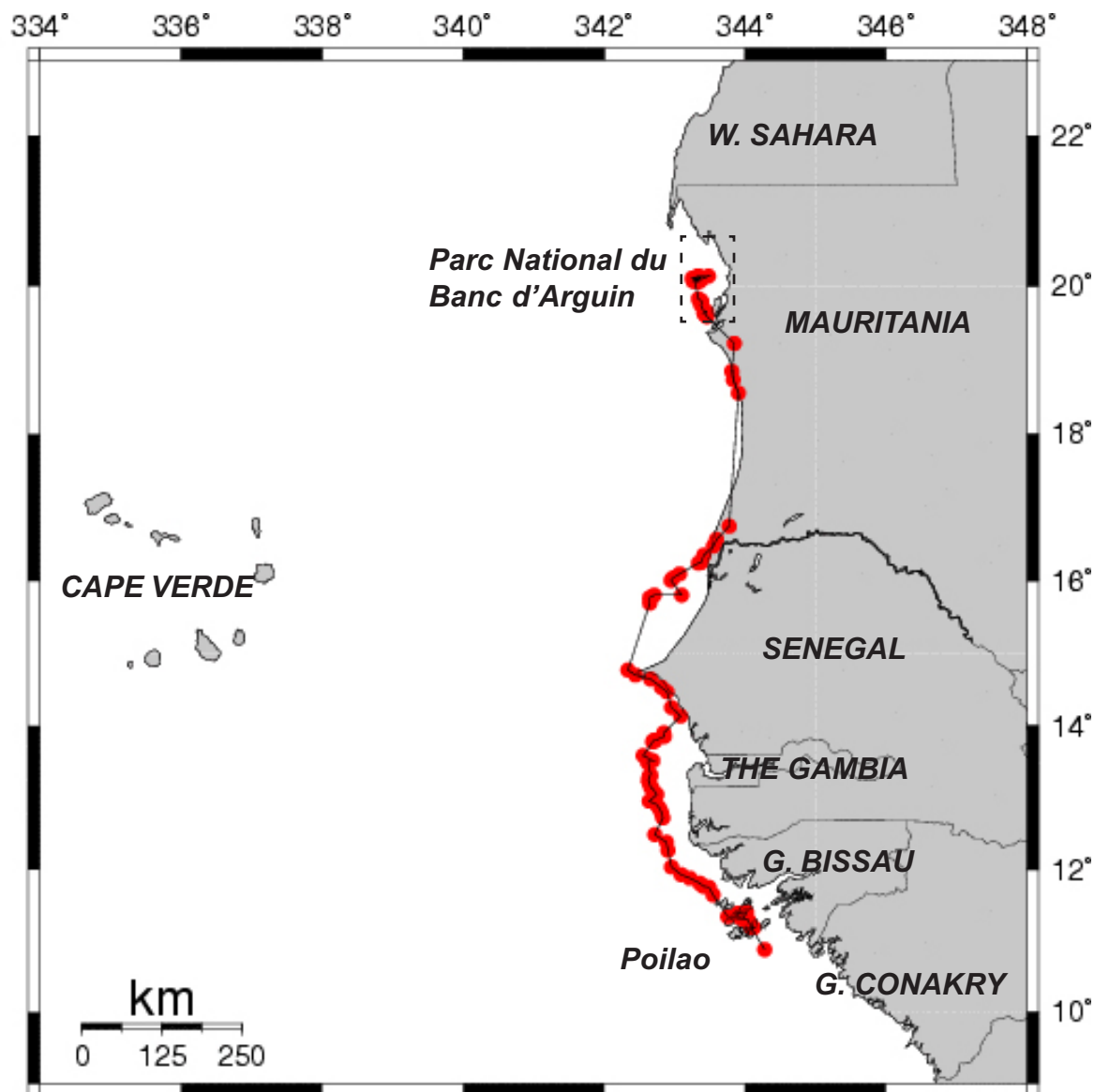


Figure 5. Track of individual D from Poilão to Mauritania. Locations shown are corrected as per Godley *et al.* (2002).

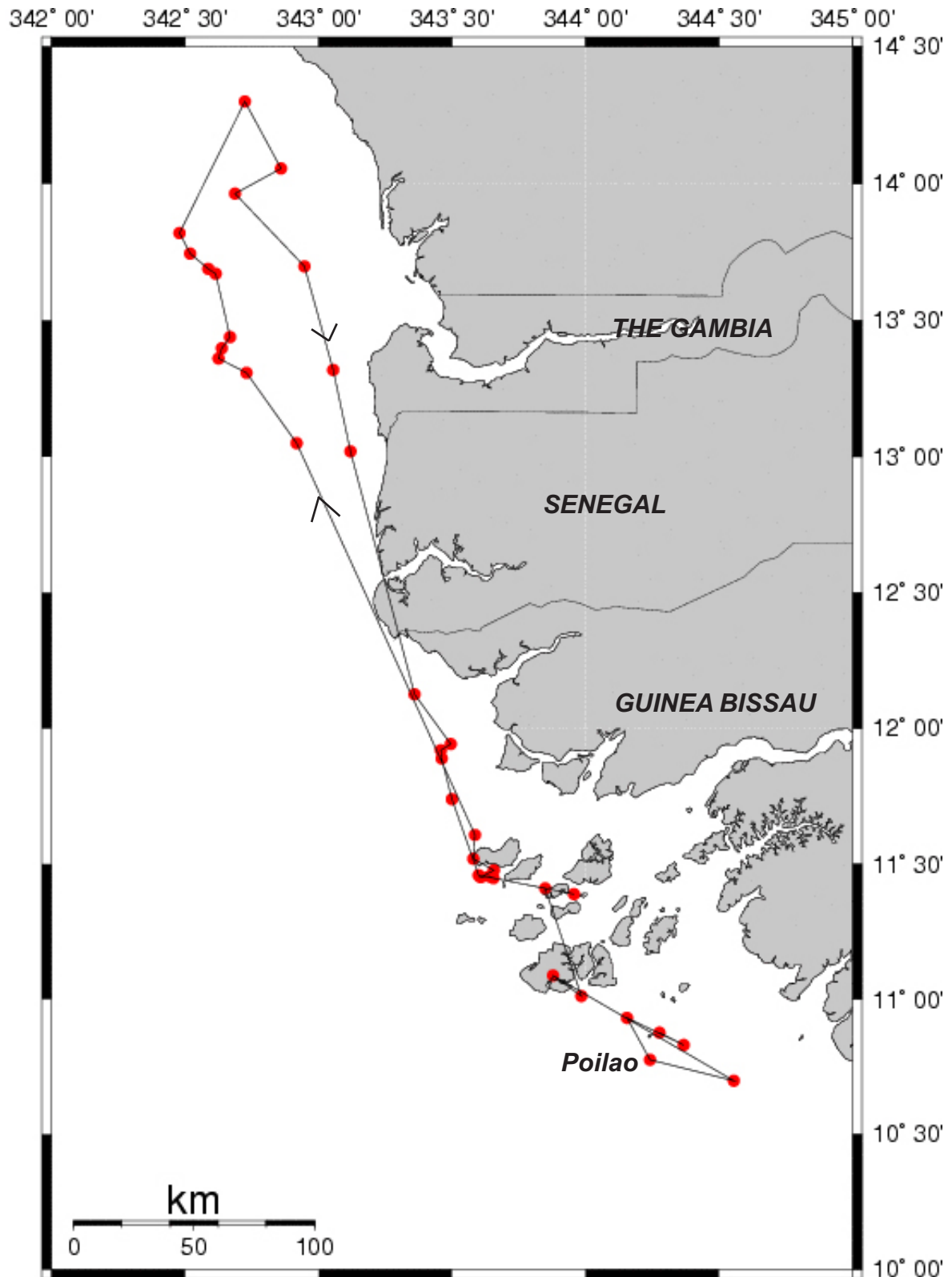


Figure 6. Track of individual E from Poilão to Senegal and returning to the Bijagos. Locations shown are corrected as per Godley *et al.* (2002).

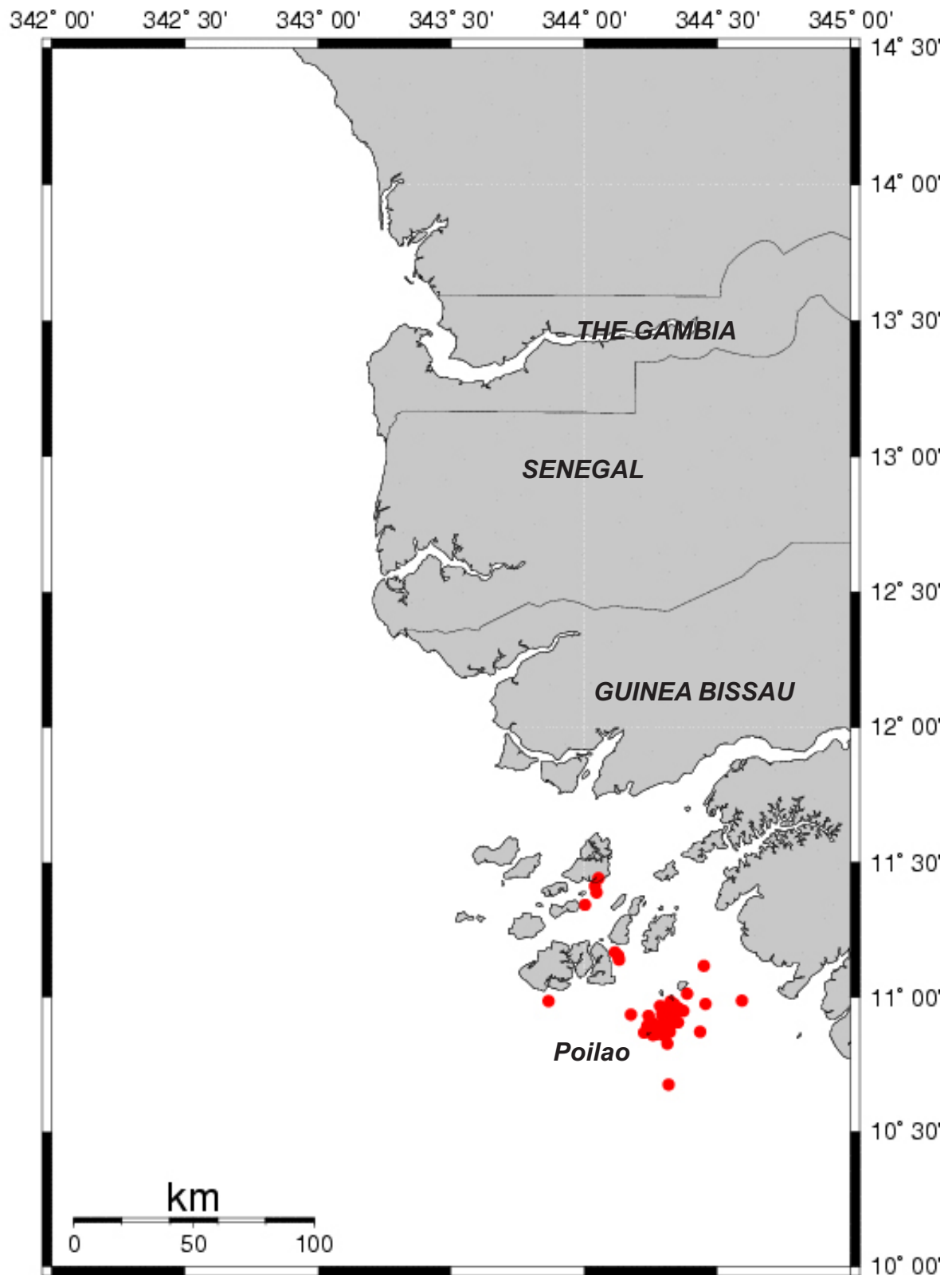


Figure 7. Track of individual F around Poilão and the Bijagos Archipelago. Locations shown are classes 1, 2, 3 and A.

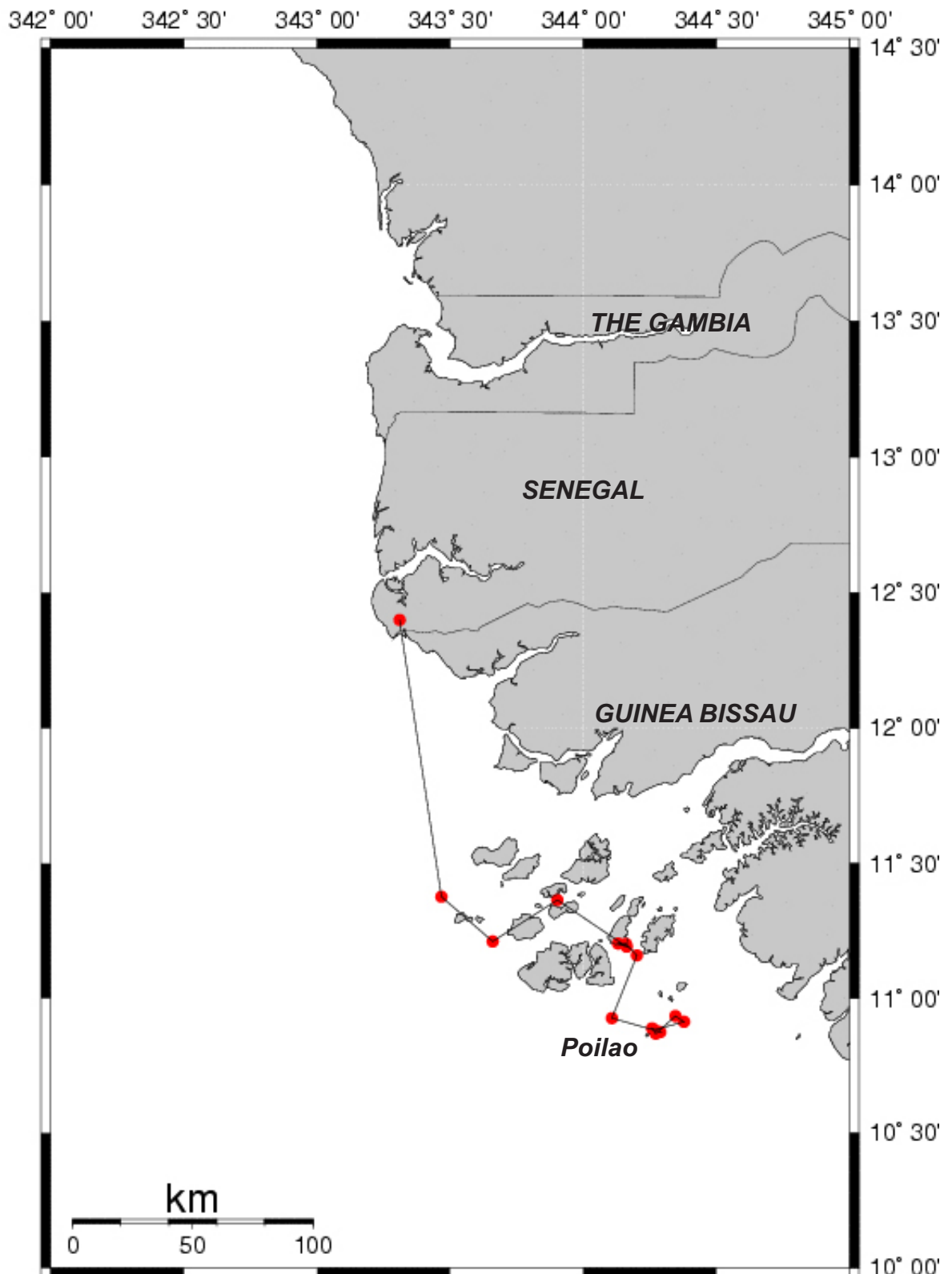


Figure 8. Track of individual G from Poilão north into Senegalese waters. Locations shown are classes 1, 2, 3 and A.

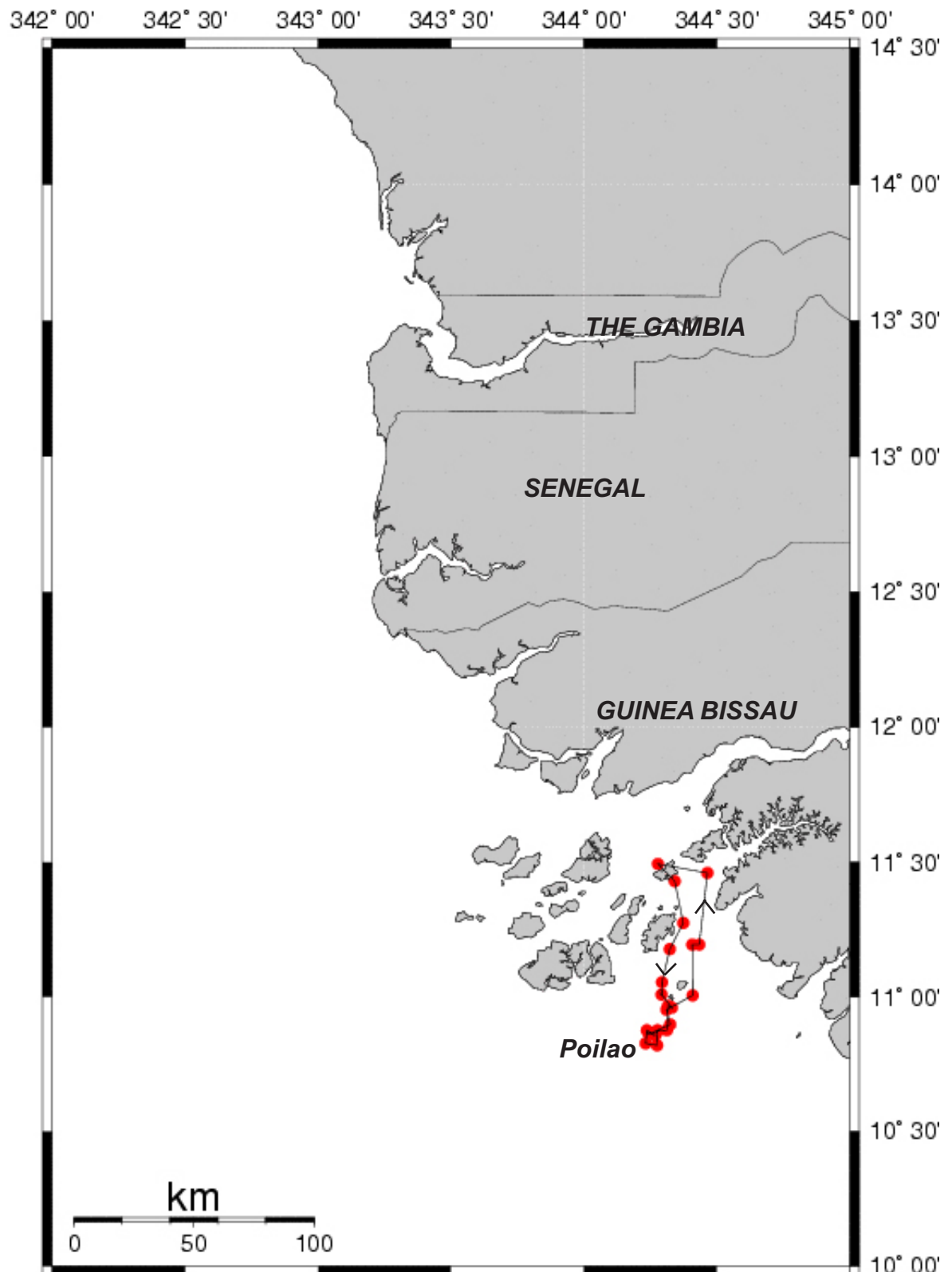


Figure 9. Track of individual H from Poilão, towards the mainland and back to Poilão. Locations shown are classes 1, 2, 3 and A.

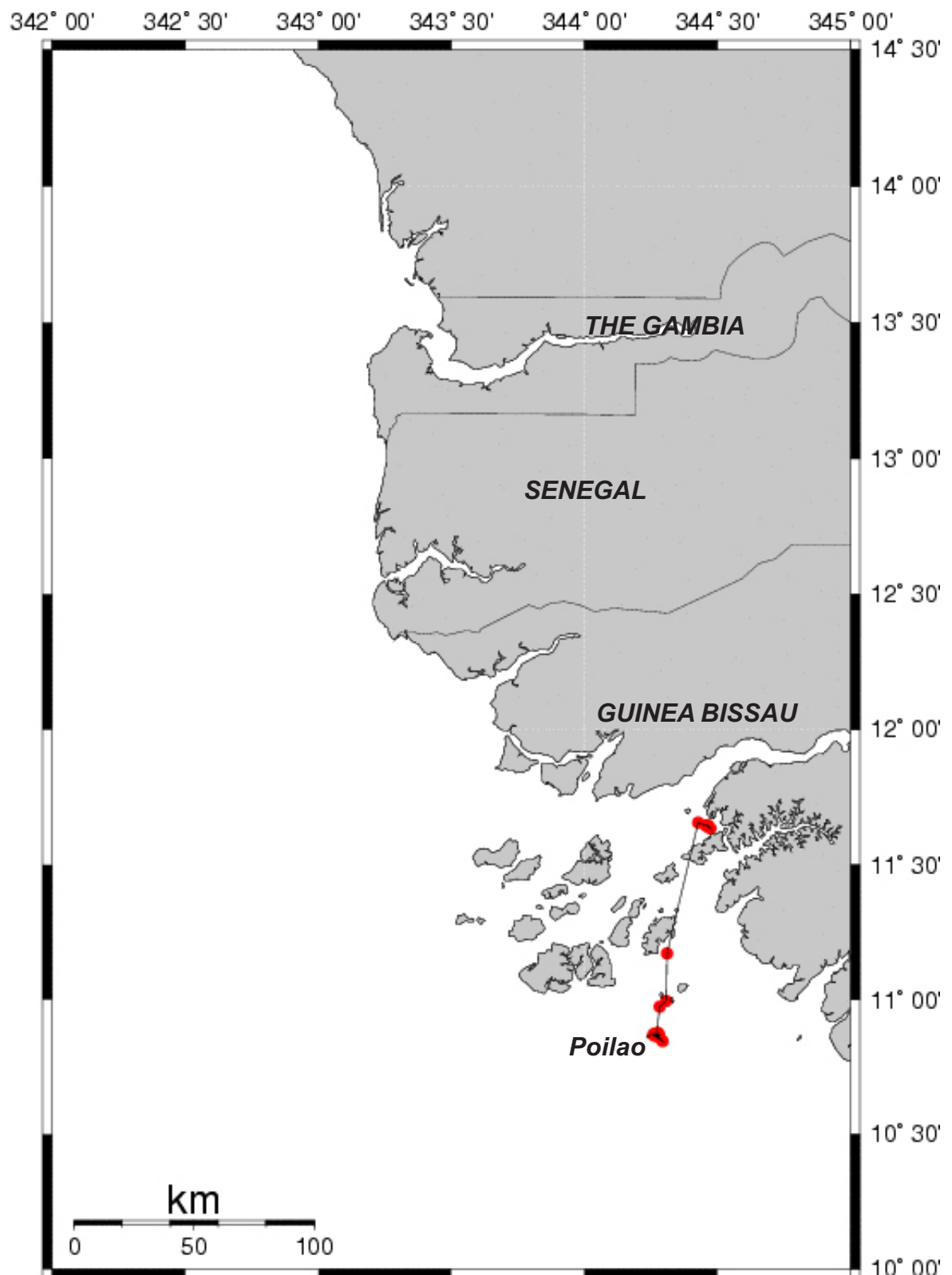


Figure 10. Track of individual I from Poilão to the mainland. Locations shown are classes 1, 2, 3 and A.

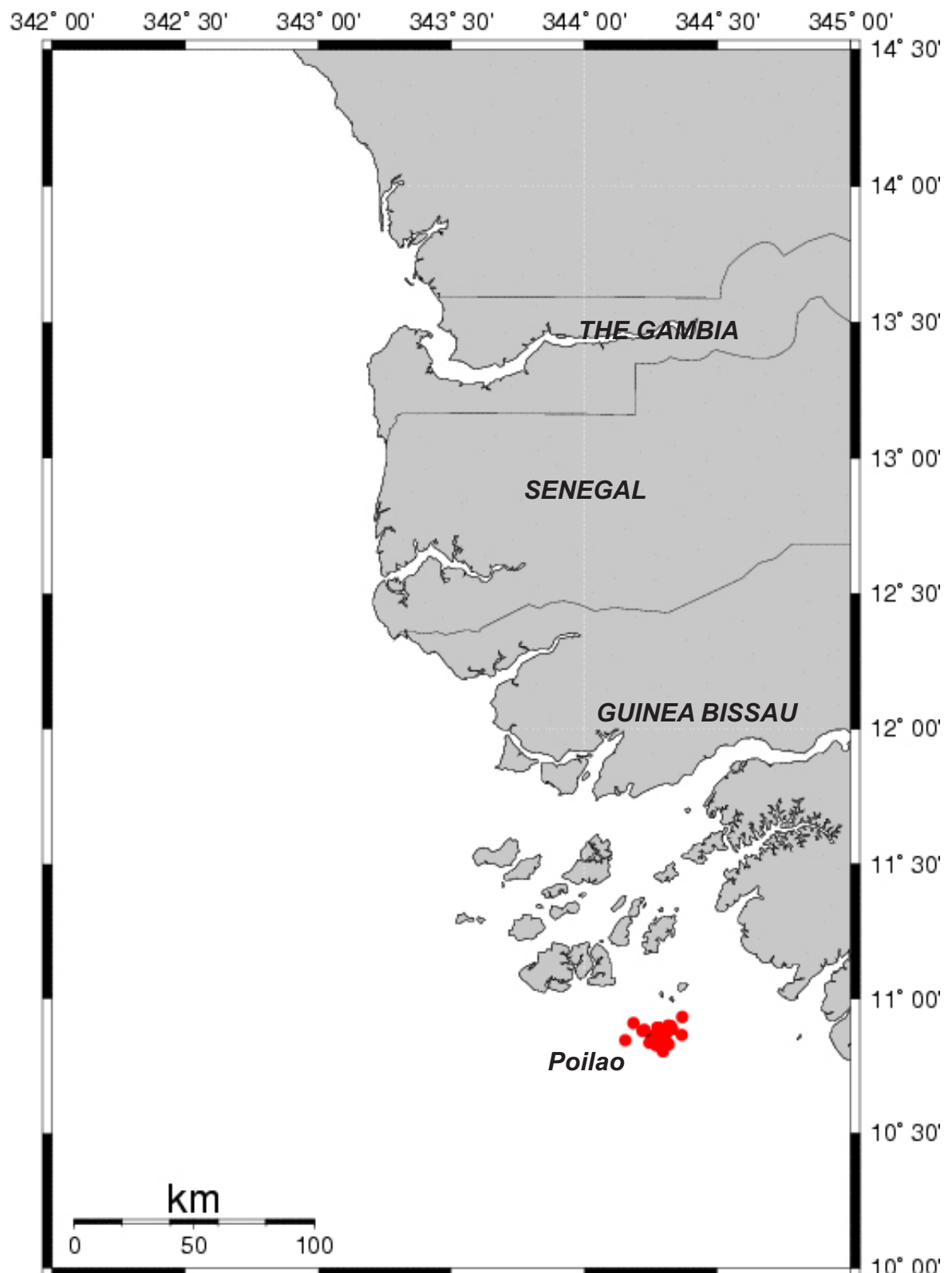


Figure 11. Track of individual J around Poilão. Location classes 1, 2, 3 and A are shown.

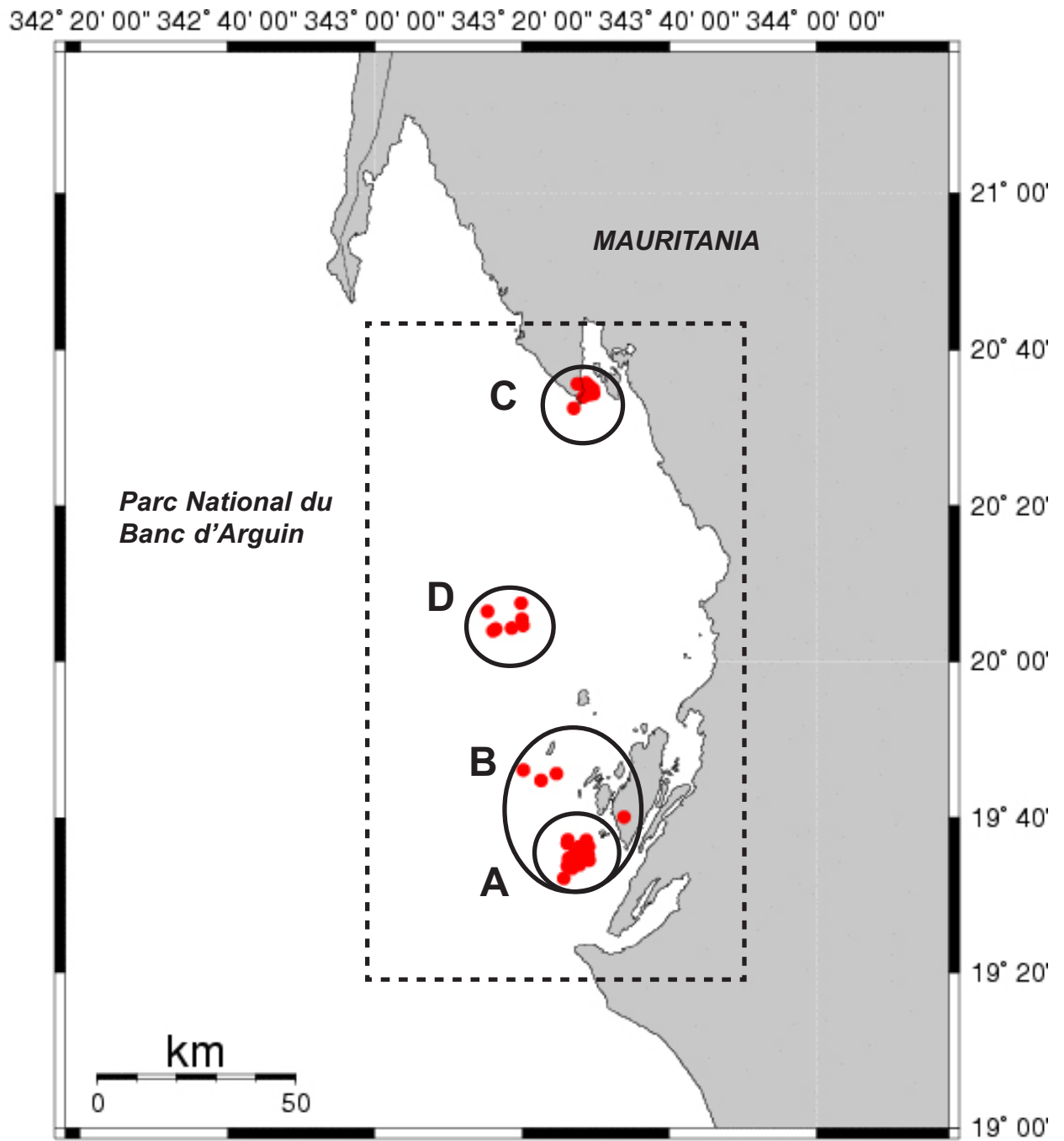


Figure 12. Foraging arease of individuals A-D in the Parc National du Banc D'Arguin. Location Classes shown are 1, 2, 3 and A.

PROJECT OUTPUTS

During the fund-raising for this project we outlined that we would generate a great deal of information which would be translated into a wide range of outputs. All sponsors were to be acknowledged in all outputs and their logo will be displayed where possible. Tangible outputs have differed slightly from those outlined in relative magnitude and timing but we are confident that value for money has been obtained.

The following include outputs already attained and details of those planned:

A. Media Items:

The uptake of an initial press release in UK and internationally was limited. It is expected that uptake following press release following publication of technical publications will be better, however, the following items have appeared to date:

Radio Broadcast on *Radio Djan-Djan* by Paulo in the Bijagós Archipeligo in November 2001 (see below)

“West African Marine Turtles, Difficult to Protect” *Afrol News* 21st May 2002

<http://www.afrol.com/news/2002/wa005_seaturtles.htm>

“Turtle Conservation in West Africa” *PTES News* Summer 2002

“Guine-Bissau – Primeiros Passos – Tartarugas da Paz” *National Geographic* (Portuguese Edition) November 2002.

“Tracking West African Turtles” to appear in future edition of *CMS Bulletin*

B. Web Site:

The project web site is located at < http://www.seaturtle.org/mtrg/projects/guinea_bissau/>. It has been visited 954 times as of April 1 2003.



Left: Paulo Catry giving radio interview in Canhebaque. **Right:** Project Website

C. Presentations:

We have disseminated the results of this project at scientific meetings, with full acknowledgement of sponsors and will do more of this when the scientific data have been published. To date four presentations have been made:

Godley BJ. (2001). “Marine Turtle Research at the University of Wales Swansea” Presented at the Institute of Biology, Aberystwyth, December 2001.

Godley BJ (2002). “Tracking Marine Turtles by Satellite.” Presented as part of Bermuda Turtle Project Annual Training Course in Marine Turtle Biology and Conservation, August 2002.

Barbosa C (2002) “Satellite Telemetry of Green Turtles from Poilão, Guinea Bissau: Preliminary Results” Presented at the First Meeting of the Signatory States to the Memorandum of Understanding Concerning Conservation Matters for Marine Turtles of the Atlantic Coast of Africa.

Godley BJ (2003) “Satellite Telemetry of Green Turtles from Poilão, Guinea Bissau.” Presented at the Annual Sea Turtle Symposium, Kuala Lumpur, March 2003

D. Final Technical Report.

This report will be produced and distributed widely regionally and internationally.

E. Scientific Publications:

It is envisioned that this work will result in two high impact scientific publications, which are expected to be completed and submitted in the next few months. Reprints will be circulated widely in hardcopy and .pdf format. MTRG maintains a policy of free reprint distribution.

STATEMENT OF ACCOUNTS**INCOME**

Income at variable exchange rates (taken at the time of transfer by the UWS) was as follows:

	US \$	£STG
Convention on Migratory Species (CMS)	\$12,000	£ 9, 038.63
People's Trust for Endangered Species (PTES)	\$17,400	£12, 133.38
Fondation Internationale du Banc d'Arguin (FIBA)	\$11,400	£ 8, 165.72
Total	\$40, 800	£29, 337.43

A final payment of \$3000 will be received from CMS upon receipt of final report

EXPENDITURE

	£STG
Equipment	£ 25, 170.21
Satellite transmitters and satellite time	
Maps and Charts	£ 344.10
Medical	£ 109.50
Misc. Field Equipment	£ 344.10
Travel and Subsistence	£ 4, 342.42
Medical	£ 109.50
Photography	£ 95.70
Post/Fax/Stationary	£ 269.50
Total	£31, 113.41

Expenditure to date means that we are in deficit of £1775.68. This will be met by the final payment from CMS. Any overspend, including that incurred in the printing and distribution of the final report and subsequent publications, will be covered by MTRG. It should be noted that, as agreed, all CMS funds have been spent on transmitters.

REFERENCES

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