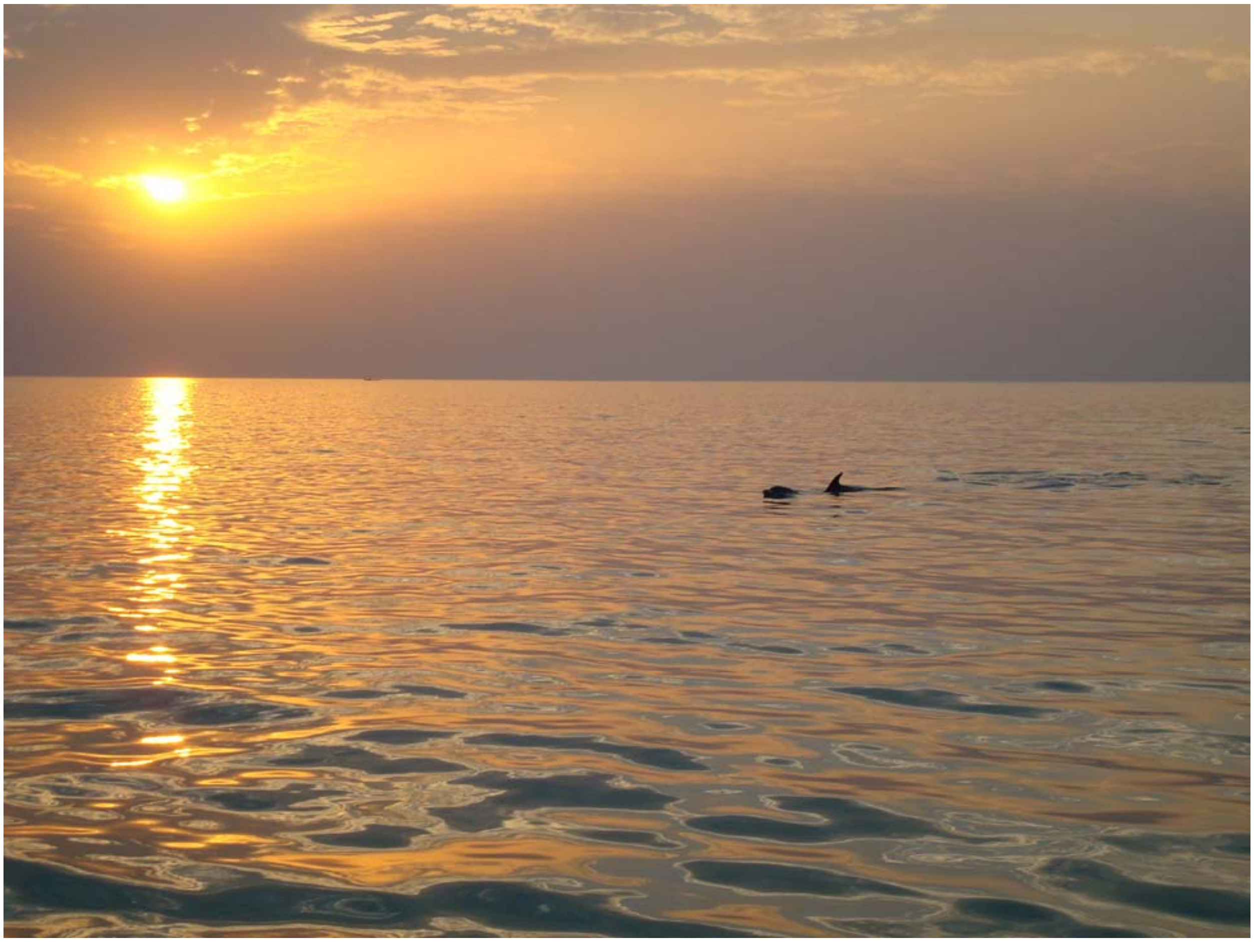
Pilot Survey of Coastal Small Cetaceans in the Waters of Guinea-Bissau



G.L. Fulling, Ph.D., Marine Ecosystem Research Solutions, 15520 Mill Creek Boulevard #H204, Mill Creek, Washington 98012 USA

J. Foster, Marine Research Consultants, LLC. 4226 South 137 Place, Auburn, Washington 98001

D. C. Fertl, Ziphius EcoServices, 8112 Springmoss Drive, Plano, Texas 75025 USA

T. Fagin, Oklahoma Biological Survey, 111 East Chesapeake Street, Norman, Oklahoma 73109 USA

Prepared for Truk Bissau

Collaborators: Antonio Jose Ferrage De Brito, Fai Djedjo, Quirino Spencer, Antao Da Costa, Rita Fumy and Fernando Moriais Parente

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INTRODUCTION

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the treaty organization that governs international trade in wildlife species, requires an exporting country to provide a "non-detriment finding" (NDF) to support wildlife captures and trade involving certain species (including many cetaceans). An NDF is supposed to be based on scientific studies of the abundance and status of the wild stock from which exported animals were taken, as well as a scientific assessment that shows that removing the animals will not cause the stock's depletion. The IUCN Cetacean Specialist Group also notes that appropriate population assessments should precede any considerations for live-captures of dolphins for captive purposes (e.g., Reeves et al. 2003).

The live-capture trade of bottlenose dolphins (*Tursiops truncatus*) is shifting to developing nations, including those in West Africa (e.g., Fisher and Reeves 2005). Currently, there is sparse published information on cetaceans found in the waters off Guinea-Bissau (e.g., Spaans 1990; Jefferson et al. 1997; Perrin and Van Waerebeek et al. 2007; Van Waerebeek et al. 2000, 2003, 2008). The bottlenose dolphin and the Atlantic humpback dolphin (*Sousa teuszii*) are resident to the coastal waters of this country. As noted by Van Waerebeek et al. (2008), no population assessment of bottlenose dolphins has ever been made for Guinea-Bissau. The purpose of the current survey was to collect distributional information to address concerns that insufficient data exist on the size and status of bottlenose dolphins occurring in the coastal waters of Guinea-Bissau.

METHODS

Study Area

The West African state of Guinea-Bissau is sandwiched between Senegal and Guinea (**Figure 1**). Guinea-Bissau includes the Arquipélago dos Bijagós (which is protected as a UNESCO biosphere reserve since 1996). This archipelago is just off the mouth of Rio Geba and is comprised of 48 islands and islets that help shelter the country's coastline from the Atlantic Ocean.

We defined the Guinea-Bissau ecosystem as the waters to the 12 nautical mile (22 km) international limit (17,465 km^2). The area is located at the southern limit of the Canary Current System and the western limit of the Gulf of Guinea System. This region is characterized by strong seasonal variations of oceanographic conditions (see Amorim et al. 2004). From January to February, the continental shelf is marked by upwelling events. Characteristically warm and salty tropical waters dominate from May to June. With the progression of the rainy season, the intrusion of warm, low salinity inner waters tends to dominate. As a result of upwelling events and the input of organic matter from river run-off, primary productivity is relatively high in the area (see Amorim et al. 2004).

The coast of Guinea-Bissau includes seven major river systems. In this country, waters to the north are turbid due to the muddy waters of the Rio Geba, while to the south, the waters are clear. The low coasts and estuarine shores are covered by mangroves. This is a biologically rich delta region, providing 1,570 km^2 of intertidal flats within a radius of only ca. 220 km (Zwarts 1988). Between the islands and along the coastline, extensive mudflats are drained by a network of canals and creeks as the tide recedes. The tidal amplitude in this area varies from about 3 m on neap tides to about 4.5 m on spring tides (Zwarts 1988).

The survey area (**Figure 1**) consisted of three distinct habitat types. The first (SaA) consisted of coastal area along the Quinhamel (Point Biombo) coast closer to the western border. The second (SaB) focused on rivers and estuaries and encompassed Canal do Géba, Canal de Boloma, and Canal de Bolola. The third area (SaC) was an offshore islands environment, centralized around the islands of Rubane and Bubaque in the Arquipélago dos Bijagós.

Survey Procedures

Visual surveys were conducted between 18 February and 29 April 2008, using one of three small boats: 5 m zodiac, 5.5 m center console boat, or a 7.3 m center console boat. Vessel selection was based on sea conditions, distance from Quinhamel (where team was based) to survey location, and draft of the vessel's keel. Pre-determined transect lines were followed at a speed of 16-32 km/hr depending on water conditions. Sighting data were collected by a team consisting of two observers and one data recorder working in "closing mode"; if a sighting was made, effort was stopped and the sighting was investigated. The boat drove along a transect line and the team recorded animals within 300 m of either side of the transect line sighted with naked-eye or 25x binoculars. On-effort was defined as both observers actively scanning the study area. Only on-effort sightings were used in any analysis. When animals were spotted, the observers would go off-effort, the boat would divert from the transect line and move closer to the group of animals to verify/confirm species identification, estimate group size (GS), observe behavior, and take photographs (for identification of individuals) when possible. Once a sighting was made, any additional animals seen were determined to be part of the first group sighted (included in the GS estimate). New groups of animals seen which were not part of the original groups were noted, but not included or counted for our analyses.

Extra time was spent to confirm dolphin species identification as bottlenose dolphins can be difficult to distinguish from Atlantic humpback dolphins (as noted by Van Waerebeek et al. 2008). The two species can be distinguished by differences in beak length, dorsal fin shape (including the presence of the hump in Sousa), and coloration (e.g., Jefferson et al. 2008). If there was not a confirmation of identification, the sighting identification was recorded as unknown species. Additionally, attempts were made to ensure animals seen previously were not recounted in nearby transect lines; this may have reduced the number of animals recorded.

Data collected for each sighting included: species identification, number of individuals (including calves), behavior, location (GPS), time, wave height, and water clarity. Surveys were conducted when weather conditions permitted and were only considered valid if the entire survey was completed. A calf was defined as an individual two-thirds the length of an adult, swimming beside and slightly behind an adult. Observed behavior was classified into four major categories according to the definitions provided by Shane (1990):

- Traveling: moving steadily in one direction
- Feeding: repeated dives in varying directions in one location
- Socializing: some or all group members in almost constant physical contact with one another, and often displaying surface behaviors; no forward movement
- Milling: moving in various directions in one location but showing no surface behaviors and no apparent physical contact between individuals; usually staying close to the surface.

Analytical Procedures

Daily survey effort was calculated as a summation of the distance surveyed for that day, after the coordinates were converted to radians. To accomplish this, the latitude and longitude coordinates were converted from degrees to radians. Once in radians, the coordinates were then used to calculate the great circle distance in kilometers between successive latitude and longitude positions. All of the distances for each day were summed to produce an estimate of daily effort for each survey area. These, in turn, were summed to provide a total estimate of effort for the entire survey.

Several metrics were used to address dolphin presence in the region including encounter rate, animal density and animal abundance. Encounter rate is a useful statistic as a gross assessment of the number of animals in a specific region. Sightings per unit of effort (SPUE) for a given species in a given location were used as an estimator of encounter rate and were calculated as:

$$SPUE = (n/L);$$

Where n = total number of sightings for a given area and L is the total effort (km) for that area.

One requirement for unbiased line-transect estimates of abundance is that the cetacean group should not move in response to the survey vessel before it is sighted (Buckland et al. 2001). If cetaceans are not sighted before they respond to the vessel, that is attracted to the vessel to bow ride etc., the abundance estimates will be overestimated. This survey design called for each observer to search a predefined area (300 m) on either side of the boat at water level. It is likely therefore that this restricted sighting of dolphins before they responded to the boat. Former surveys in other areas (e.g., U.S. Gulf of Mexico and Hong Kong) using these same techniques for bottlenose and humpback dolphins have shown that effective detection of small animals drops off at 250-300 m (personal observations and T. Jefferson, personal communication). Therefore, the abundance and variance of groups sighted (naked-eye and binoculars) were estimated by:

$$N = \frac{A * n * S}{2 * L * w}$$

and

$$var(N) = N^2 \left\{ \frac{var(n)}{n^2} + \frac{var(S)}{S^2} \right\}$$

Where A = area;

S = mean group size of each species in the region; and

w = line transect strip-width with $var(w) = 0$

Animal density (D) was estimated by removing the area from the above equation.

The coefficient of variation (CV) for the abundance estimation was estimated as

$$CV(N) = \frac{(CV^2(N) * N^2)^{1/2}}{N}$$

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RESULTS

<u>Effort</u>

There were 1344 km of transect effort completed from 18 February - 29 April 2009, with majority of the surveys occurring during April (9/10). Daily effort varied by number of survey days per location (2 days at SaC to 5 days at SaA) and transect km for each location (109 km in SaA to 193 km in SaB; **Table 1**; **Figure 1**).

<u>Sightings</u>

There were 50 dolphin groups recorded: 43 bottlenose dolphin, 6 Atlantic humpback dolphin, and one group of unidentified dolphins. Only sightings of dolphins where the species identification was confirmed are depicted in **Figure 2**. No mixed-species groups were sighted.

<u>Bottlenose dolphin</u>

Eighty-six percent of the sightings were of bottlenose dolphins. Sixty-percent (*n* = 26) of the groups included calves. This species was seen in all three survey areas, but most often in SaA (**Table 1; Figure 2**)

GS estimates ranged from 7 to 82 individuals, with a mean group size of 11.04 (sd=14.05; 95% CI = 3.47-18.69; *n* = 40). The largest GS occurred at SaC (**Table 1**).

Bottlenose dolphins were most often observed feeding (70%), then traveling (17%) and socializing (14%). There was no noticeable difference in habitat usage relative to behavioral state for this species.

<u>Atlantic humpback dolphin</u>

Only six groups of Atlantic humpback dolphins were sighted, all at SaB (**Figure 3; Table 1**). GS was 6 to 12 individuals ($\bar{x}$ = 9.33; sd = 2.80; 95% CI = 7.53-11.13; *n* = 6). Thirty-three percent of the groups included calves, and all groups were observed feeding.

<u>SPUE and Abundance</u>

<u>Bottlenose dolphins</u>

Overall, SPUE was 0.03 animals per km of effort, ranging from 0.009 at SaC to 0.057 at SaA (**Table 1**). The point estimate was 5757 bottlenose dolphins (*D* = 0.33; CV = 1.27; 95% CI = 1559-13,073) in all waters of Guinea-Bissau.

<u>Atlantic humpback dolphins</u>

Overall, SPUE was 0.004 animals per km of effort and was 0.010 at SaB (the only study area with sightings during this survey. Number of dolphins per km of effort was 0.041 overall and 0.096 at SaB (**Table 1**).

The point estimate was 727 Atlantic humpback dolphins (*D* = 0.54 CV = 0.30; 95% CI = 700-754) in all waters of Guinea-Bissau.

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DISCUSSION

This report provides data that is an incremental contribution to the still sparse available data for bottlenose and Atlantic humpback dolphins occurring in Guinea-Bissau. Data reported here are from a single time-frame (e.g., snap-shot). While this report provides information on abundance of these two species in the area, it is important to note that these estimates are preliminary and provide baseline information only. As noted earlier, for the most part (exception being Van Waerebeek et al. 2000), only opportunistically collected data are available for Guinea-Bissau. These data are invaluable since this survey is the first attempt to assess the population dynamics for dolphins in the waters of Guinea-Bissau. It must be stressed that our abundance estimates represent only a 'snapshot' of the dolphin population during the time of the survey and do not account for possible population movement patterns, etc. We must emphatically point out that since this was not a year-round survey, it cannot be confirmed that information collected during this survey truly is reflective of the occurrence, and more importantly, the abundance, of the two species. Furthermore, the design of this survey was not conducive to traditional line-transect methods (Buckland et al. 2001; transects perpendicular to bathymetry) and did not estimate parameters (bearing and distance to sightings needed to estimate animal detection) needed to produce a robust analysis; based on data collected there was no way to truly estimate the detection function (how effectively the observers could see animals out to 300 m) and this probably resulted in an overestimate of abundance. Abundance estimates were calculated using strip-transect methods which are not as mathematically rigorous as line-transect methods, and therefore, less reliable.

Caution should be used when reporting the bottlenose dolphin abundance estimate provided here. Recently, Van Wareebeek et al. (2000) predicted there were several of hundred animals in all of Guinea-Bissou based on estimates from Sarasota, Florida USA. Our estimate here is much larger and as can be seen by the high CV (1.27) and large confidence interval, not reliable for management of bottlenose dolphins in the region. Future surveys need to be designed specifically to address the shortcomings of this survey so that effective and correct management of the dolphins in this region can be ensured.

Humpback dolphin estimates are also not reliable due to the low number of sightings (n=6). Rarely would any estimate be utilized for management purposes unless the number of sightings exceeded 40. Therefore, as with bottlenose dolphins, care should be taken when reporting the abundance estimates for humpback dolphins.

<u>Other species</u>

Other studies have shown other species to be sighted in the region. For example, Van Wareebeek et al. (2000) reported sightings of Risso's dolphins (*Grampus griseus*) and pilot whales (*Globicephala* spp.) at Galhinas Island in January 1998. West African manatee (*Trichechus senegalensis*) occurrence in the area is also known (e.g., Silva and Araújo 2001). No additional species were sighted, however, during this study.

<u>Dolphin sightings</u>

As reported earlier, 50 dolphin groups were reported, with the vast majority of those being bottlenose dolphins. Sighting data for both species that was readily available from previous surveys in the area are depicted in **Figures 3 and 4**; sightings of unidentified dolphins are not presented here. This survey recorded no mixed-species dolphin groups. The only survey in this area to note mixed groups of the two dolphin species was Krömer et al. (1994) as reported by Van Waerebeek et al. (2000) who also noted that juvenile humpback dolphins are easily mistaken for bottlenose dolphins.

Bottlenose dolphins from this study were observed in all three survey areas (that covered a diversity of habitat types). A similar distribution in sightings was previously reported for the area (**Figure 3**; Spaans 1990; Wolff 1998 (as reported in Van Waerebeek et al. 2003)). While bottlenose dolphin sighting information is also presented in Van Waerebeek et al. (2000), the location coordinates plotted in GIS and compared to textual description are not exact (in some instances, off as much as 11 km). As a result, bottlenose dolphin sightings found in that report are not depicted in **Figure 3**, but the locale information places the animals in previously reported areas of occurrence for the species.

GS parameters are generally similar to those previously reported for the area (**Tables 2 and 3**). The difference between our reported overall mean and the other studies is due to the two large bottlenose dolphin group sightings in SaC (the offshore islands environment). In fact, when those two sightings are eliminated the mean drops to 7.9 animals. It should be noted that previous accounts did not include a focus on the offshore islands, and while Van Waerebeek et al. (2000)'s assessment included waters of the archipelago, they did not report group sizes as large as the ones reported here. Habitat characteristics are known to influence bottlenose dolphin social organization, with offshore environments typically hosting larger group sizes (e.g., Shane et al, 1986).

Atlantic humpback dolphin

The Atlantic humpback dolphin in this survey was only reported in the area that encompassed Canal do Géba, Canal de Boloma, and Canal de Bolola. These sightings are within the area of previously reported observations for the species (**Figure 4**; Spaans 1990; Wolff 1998 in Van Waerebeek et al. 2004). Van Waerebeek et al. (2004) noted that the still relatively undisturbed coastal waters of Guinea-Bissau may support one of the largest known populations of the Atlantic humpback dolphin. This species occurs around the islands composing the Arquipélago dos Bijagos, particularly off the islands of Formosa, Canhabaque, and Bubaque (e.g., Van Waerebeek et al. 2004). They are associated with the sea-arms and estuaries of (from north to south) Canal do Gêba and Canal de Bolola as far "inland" as the confluence with the Río Sahol, Río Fulacunda, and Río Empada (e.g., Spaans, 1990; Van Waerebeek et al., 2000; Van Waerebeek et al. 2004).

Range in GS from our study was also similar to GS presented for the species in this area as presented by Van Warebeek et al. (2004) (**Table 3**).

All sightings of the Atlantic humpback dolphin were of feeding groups. Stomach contents of an individual incidentally entangled in fishing gear revealed that this species here in Guinea-Bissau feeds on fishes from at least three different mid-water species: Gorean snapper *(Lutjanus goreensis)*, Atlantic emperor *(Lethrinus atlanticus),* and West African spadefish *(Chaetodipterus lippe*) (Sequeira and Reiner 1992).

RECOMMENDATIONS FOR FUTURE WORK

Information collected during this survey contribute to the understanding of the occurrence of both the bottlenose dolphin and the Atlantic humpback dolphin in this area, which will contribute vital information for population assessments needed by resource managers for environmental planning purposes. As noted in the 2007 *Draft Action Plan for the Conservation of Small Cetaceans of the African Eastern Atlantic Basin*, anthropogenic threats to West African cetaceans include fishery interactions, directed takes (which include live-captures), pollution, ecotourism, habitat degradation, vessel strikes, and oil/gas exploration/development activities.

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Future research efforts should include (with no ranking assigned for level of importance):

Systematic line-transect surveys. Systematic line-transect surveys are needed to enable sound management decisions regarding animals within the GB study area. As noted by Van Waerebeek et al. (2008), small-boat surveys would be best, since it would be difficult to discern the two dolphin species from one another from the air, as well as difficult to cover areas with mangrove habitat. The addition of well-planned surveys will allow solid estimates of animal density and abundance. These surveys need to be conducted year-round to better understand possible seasonal fluctuations in occurrence.

Support bottlenose and humpback dolphin projects. Photo-identification (photo-ID) is a widely-used technique for monitoring populations of marine mammals wherever individuals vary enough in distinctive characteristics to be individually recognizable. Photo-ID data can be used to derive more precise estimates of abundance and/or population demographic parameters than is possible from survey data for some populations through mark-recapture methods. Photo-ID studies that collaborate with similar studies in nearby areas can address questions of population stock structuring, or movements within the region.

Support a biopsy sampling program to compliment the photo-ID work. Modern genetic methods are capable of levels of discrimination approaching the same sort of precision provided by photo-ID. The combination of photo-ID and genetic methods would address how dolphins in this region fit into overall African stock structure.

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Table 1. Summary of survey effort, sighting data and sightings per unit of effort calculations for each species and location. Coastal (SaA), Estuarine/Riverine (SaB), Island (SaC) study areas, *Tursiops truncatus* (Tt), *Sousa teuszii* (St), sightings (n), kilometers of survey effort (km), sampling days (d), mean ($\bar{x}$), standard deviation (sd), group size (GS), sightings per unit of effort (SPUE; sightings per kilometer of effort (SPUE = N/km).

Location	Species (n)	Effort (km)/Day (d)	Total Effort (km)	Sightings ($\bar{x}$ (sd))	$\bar{x}$ GS (sd)	SPUE
Point Biombo (SaA; Coastal)	Tt (31)	108.9 (5)	544.51	6.4 (4.1)	8.56 (5.64)	0.057
Rolo Bolama (SaB; Estuarine/Riverine)	Tt (7)	192.6 (3)	577.82	2.33 (0.58)	7.14 (5.50)	0.012
	St (6)			2 (1.0)	9.33 (2.80)	0.010
Ihla Bubaque (SaC; Island)	Tt (2)	111.1 (2)	222.24	1 (0.0)	63.75 (26.52)	0.009
Overall	Tt (40)	(10)	1344.57	4.1 (3.70)	11.08 (14.05)	0.030
	St (6)			2 (1.0)	9.33 (2.80)	0.004

Table 2. Reported group sizes for the bottlenose dolphin (*Tursiops truncatus*) in Guinea-Bissau. n=number of group sightings.

Year	Range	Median	Mean	sd	n	Source
1968 - 1987	1-25	4.07	4.07	6.47	13	Spaans (1990)
1992	1-10	-	3.19	-	32	Wolff (1998)
1995 - 2000	1-10	-	4.60	-	5	Van Waerebeek et al. (2000)
2008	1-82	7.5	11.08	14.05	43	Current Study

Source: Van Waerebeek et al. (2008), except for 2008 data

Table 3. Reported group sizes for the Atlantic humpback dolphin (*Sousa teuszii*) in Guinea-Bissau.

Year	Range	Median	Mean	sd	n	Source
1986 - 1987	1-15	2.5	4.39	4.19	54	Spaans (1990)
1992	1-20	-	6.50	6.09	15	Wolff (1998)
2008	6-12	9	9.33	2.56	6	Current Study

Source: Van Waerebeek et al. (2008), except for 2008 data

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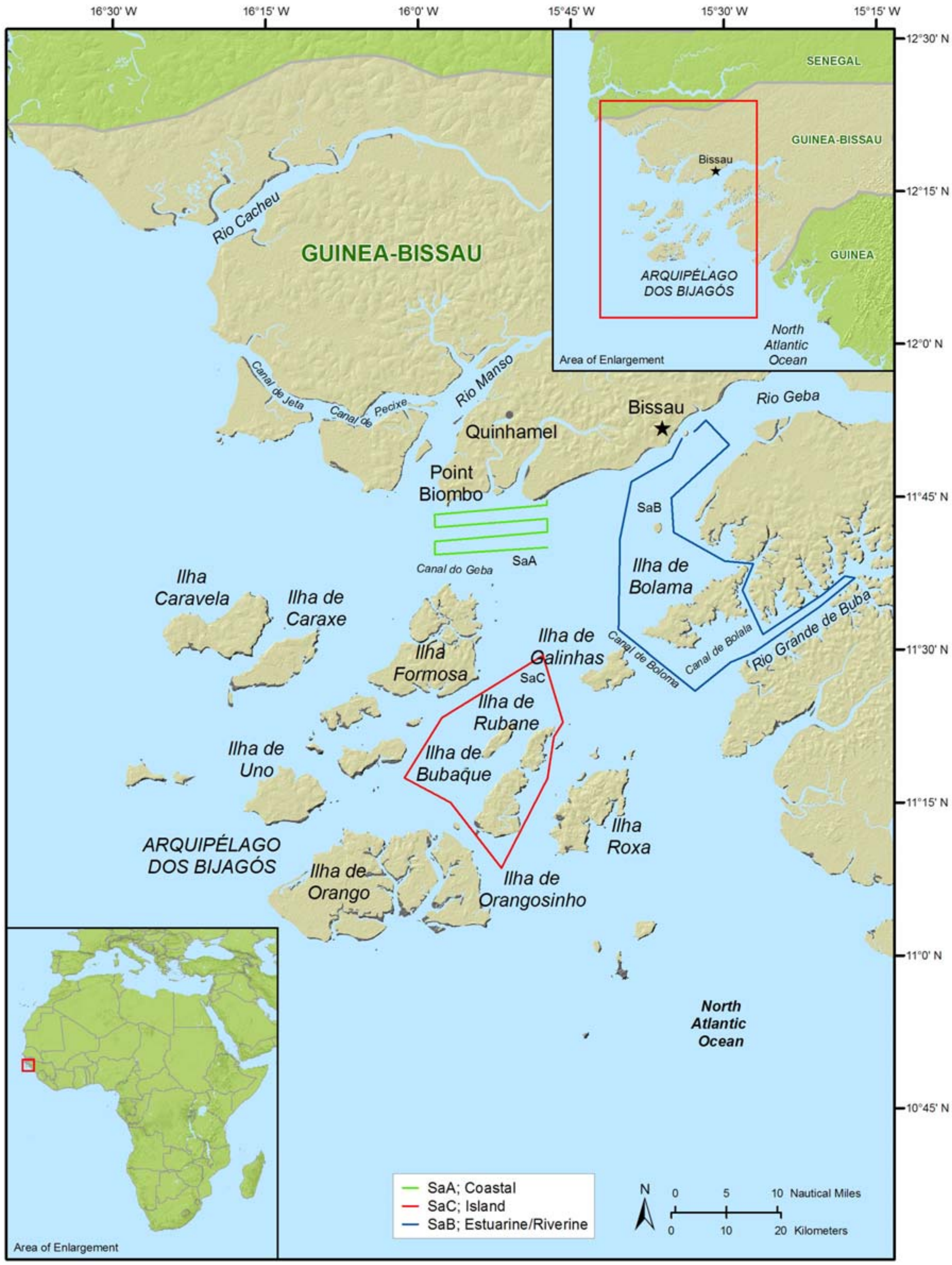

Figure 1. Study area in Guinea Bissau, West Africa. Three study areas are depicted where dolphin surveys took place during 18 February - 29 April 2008.

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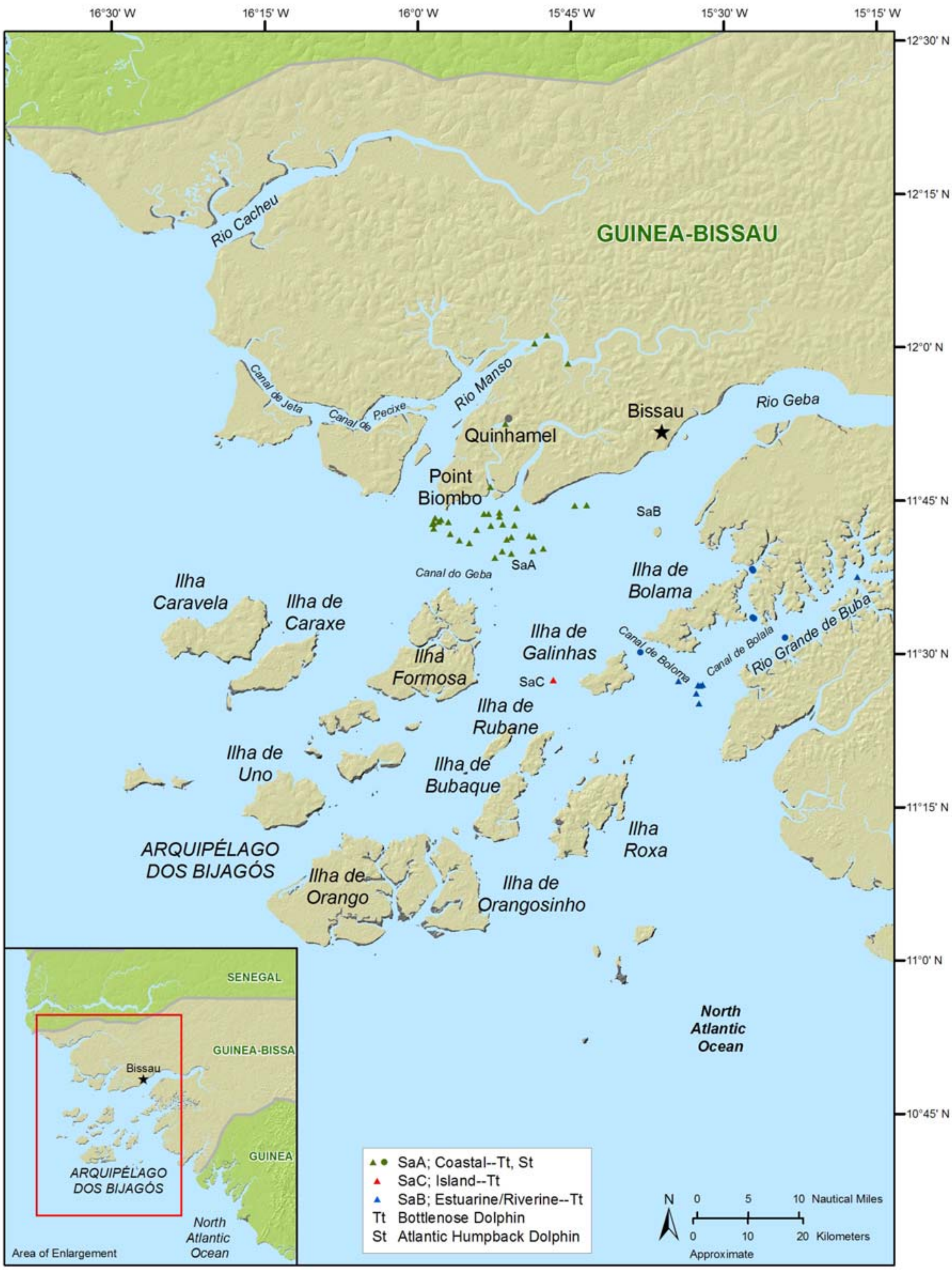

Figure 2. Bottlenose (*Tursiops truncatus*) and Atlantic humpback (*Sousa teuszii)* dolphin sightings made during 18 February - 29 April 2008 survey at Guinea Bissau.

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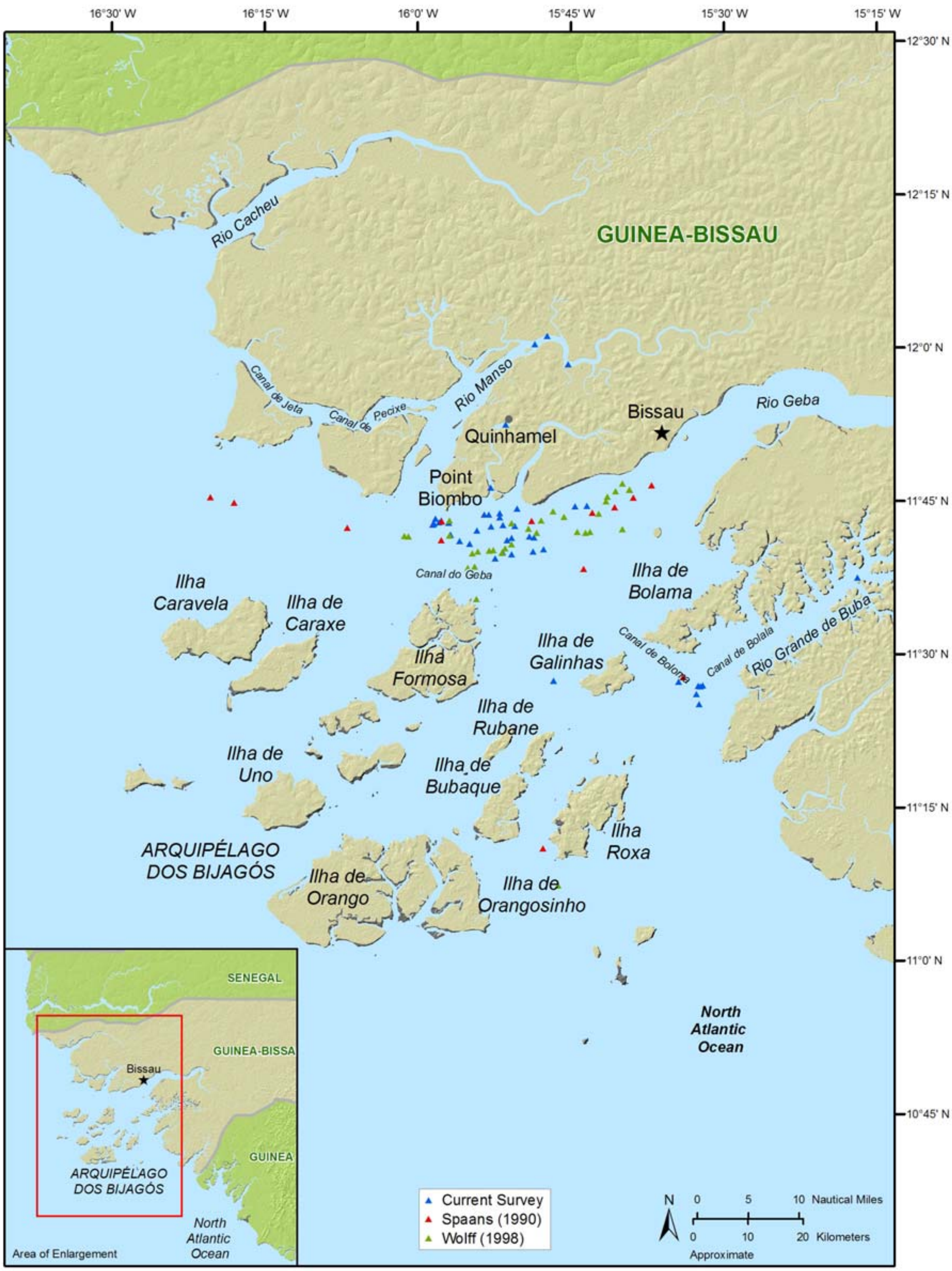

Figure 3. Published bottlenose dolphin (*Tursiops truncatus*) sightings from Guinea Bissau. Source data: Spaans (1990), Wolff (1998) in Van Waerebeek et al. (2003), and this report. Van Waerebeek et al. (2000) data not included (see text for more information).

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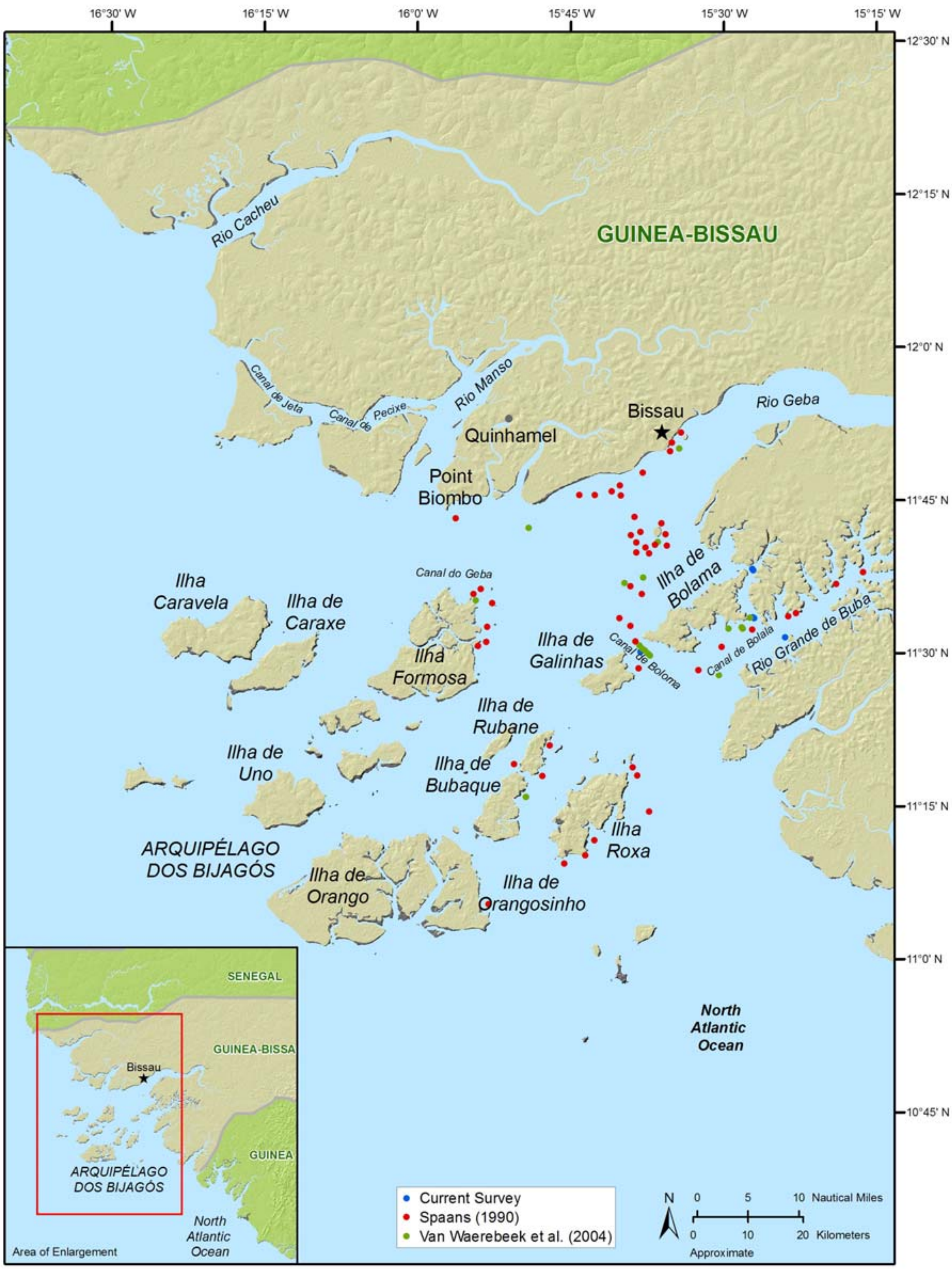

Figure 4. Published Atlantic humpback dolphin (*Sousa teuszii)* sightings from Guinea Bissau. Source data: Spaans (1990), Van Waerebeek et al. (2004; includes Woff 1998), and this report.Van Waerebeek et al. (2000) data not included (see text for more information).

Data provided in this report should not be cited without consulting the senior author.

Lone bottlenose dolphin near Rubane.

Data provided in this report should not be cited without consulting the senior author.

Pair of bottlenose dolphins near islands.

Data provided in this report should not be cited without consulting the senior author.

Jumping dolphins off Pt. Boloma.

Data provided in this report should not be cited without consulting the senior author.

Unique dorsal fin.

Unique dorsal.