

MOVEMENTS OF BIGEYE TUNA (*Thunnus obesus*) IN THE TUNA ASSOCIATED BAITBOAT FISHERY OF DAKAR

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ABSTRACT

A total of 3102 bigeye tuna were tagged in the Dakar baitboat fishing area (9°N-22°N/15°W-30°W) from 1994 to 2000. Movements obtained from the recaptures are analysed and compared to movements from historical tagging programs conducted from 1971 to 1986 in the Eastern Atlantic Ocean. Two long-distance recaptures are remarkable: one in Azores and one in the Caribbean. Bigeye movements demonstrated by historical recaptures are confirmed. But movements between Mauritania and Canary Islands and between the African coast and Cape Verde Islands are completely new. This last movement is directly related to the associated school fishing technique developed by Dakar baitboats. This is a demonstration that association of tuna with floating objects can alter their normal movements.

RÉSUMÉ

Un total de 3.102 patudos a été marqué dans la pêcherie des canneurs de Dakar (9°N-22°N/15°W-30°W) de 1994 à 2000. Les déplacements obtenus d'après les recaptures sont analysés et comparés aux déplacements issus des programmes de marquage réalisés de 1971 à 1986 dans l'océan Atlantique est. Deux recaptures longue-distance sont remarquables : l'une aux Açores, l'autre dans les Caraïbes. Les déplacements des patudos issus des recaptures historiques sont confirmés. Mais des déplacements totalement nouveaux entre La Mauritanie et les Canaries et entre la côte africaine et les îles du Cap Vert apparaissent. Ces derniers sont directement en relation avec la technique de la matte associée développée par les canneurs de Dakar. C'est une démonstration de l'altération possible des déplacements des thons lorsqu'ils sont associés à des objets flottants.

RESUMEN

Se marcaron un total de 3.102 patudos en la zona de pesca con cebo vivo de Dakar (9° N -22° N/15° W-30°W) desde 1994 hasta 2000. Se analizan y comparan los movimientos deducidos de las recuperaciones con los movimientos de los programas históricos de marcado realizados desde 1971 a 1989 en el océano Atlántico oriental. Se realizaron dos recuperaciones a larga distancia que resultaron notables: una en Azores y otra en el mar Caribe. Se confirmaron los movimientos del patudo deducidos de las recuperaciones históricas. Pero los movimientos entre Mauritania y las islas Canarias y entre la costa africana y las islas de Cabo Verde son completamente nuevos. Este último movimiento está directamente relacionado con la técnica de pesca de bancos asociados desarrollada por los barcos de cebo vivo de Dakar. Es una demostración de que la asociación de los tñidos con objetos flotantes puede alterar sus movimientos normales.

MOTS-CLES

Tagging, migration, schooling behaviour, Bigeye, Eastern Atlantic

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1 INTRODUCTION

In the 1980s, baitboats operating from Dakar (Senegal) have developed an efficient fishing technique, which consists of keeping a permanent association between the fishing boat and the tuna school they fish on (Fonteneau and Diouf, 1994; Hallier and Delgado, 2000).

From 1996 to 2000 a research program, called MAC for “Mattes de thons Associées aux Canneurs”, was implemented on this fishing technique and its consequences (Hallier *et al.*, 2001). One of the main working tools used by this program was ordinary tuna tagging (Kearney, 1982). The catch of this baitboat fishery is made of the three tropical tuna species : skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye (*T. obesus*). In 1999 and 2000, a special emphasis was put on bigeye with the help of funds from the Bigeye Year Program of ICCAT. Altogether, 3102 bigeye were tagged within MAC program including 2398 with the help of Betyf funds. In this document, all bigeye data from MAC program are analysed and discussed for movements in and outside the baitboat fishing area. For comparison, references are made to historical bigeye tagging results.

2 MATERIALS AND METHODS

First ordinary tagging on this fishery was conducted on a trial basis from 1994 to 1996 by different types of taggers (fishermen, technicians and scientists). From 1997 to 2000, only experienced scientists have tagged tunas. Bigeye tagged from 1994 to 1996 have registered a recapture rate of 30.4 % and 52.7 % for the 1997-2000 period. Regarding bigeye movements, we estimate this difference in recapture rates between the two periods did not affect movements of bigeye. Therefore all bigeye tagged between 1994 and 2000 and recaptured until June 2002 are used in this study. However, one should keep in mind that from the 1593 bigeye recaptured only 56 were tagged before 1997.

All tags used during this program were provided by ICCAT and 2145 bigeye were tagged with yellow traditional “spaghetti” tags, 376 with red traditional tags, this colour indicating that fish were injected with oxy-tetracycline (antibiotic that makes the otolith ring deposited that day visible with ultraviolet light; this is used for growth study). Finally 581 bigeye were tagged with Betyf tags. These tags adopted by ICCAT for the Betyf program are derived from tags used by sport fishermen. Hallier and Gaertner (2001) discussed their efficiency.

Historical bigeye recaptures were provided by ICCAT from a file check and corrected by Bard and Hallier. This file contains bigeye recaptures from tagging that occurred from 1971 to 1986 mainly in the gulf of Guinea and in the North of Mauritania and secondly on a seamount located by 9°15'N-21°20'W and around Azores Islands.

Catch data for baitboats and purse seiners are for all fleet.

3 RESULTS

3.1 Tagging and recapture

During MAC tagging program, 3 102 bigeye were tagged and 1593 were recaptured (51.4%). Tagging and recaptures by month are given in **Table 1** and by year in **Table 2**.

As tagging was conducted on an opportunist basis and taking into account the seasonality of the fishery (Hallier et Marec, 1998), tagging is not evenly distributed but is mainly concentrated from July to December and in March with few fish tagged in January, February and April and no fish tagged in May and June.

However, the distribution of recaptures by month is mainly related to the seasonality of the fishery with more than 100 recaptures per month from August to January, less than 100 but more than 10

recaptures per month from February to April and from June to July and less than 10 for May (**Table 1**).

Recovery rates of bigeye per year are greater than 50 % only in 1997 and 1999 and they fluctuate from 15.4 % in 1995 to 59 % in 1999. Even with experienced taggers, recovery rates are low in 1998 and 2000. In 1998, only 29 bigeye were tagged all in October; in 2000 they were tagged in March and April at the end of the fishing season.

3.2 Time at liberty and duration at sea

Time at liberty according to size at tagging is given in **Figure 1**. The three groups of points piled up correspond to the seasonality of the recapture with fish returning to the main baitboat fishing ground one or two years later. This return tends to decrease for larger bigeye; this could be due either to a non-return of these fish or to the selectivity of the gear (larger fish being difficult to catch by pole-and-line).

Duration according to size at tagging is given in figure 2. Small fish tend to travel longer distances than bigger fish. However bigeye that returned one or two years later on the area where they were tagged (seasonality of this fishery) tend to decrease that effect as their distances travelled are low. When only bigeye with time at liberty less than 90 days are retained (Figure 3), it is even more obvious that small fish tend to travel further away from the baitboat fishing ground than larger bigeye.

3.3 Overall movements from recaptures

Figure 4 gives the overall movements from tagging-recapture data. The main features are:

- Almost all recaptures (1287 from a total of 1593 recaptures or 80.8 %) are reported into the main baitboat fishing area 17°N-21°N/16°W-21°W
- Five bigeye are recaptured in Canaria Islands (north of 21°N)
- 95 recaptures (or 6 % of the total) located south of 17° N and along the coast of Africa (east of 22°W) are recorded including 8 fish caught near a seamount by 9°N/21°W
- 192 bigeye (or 12.1 %) are recaptured near Cape Verde Islands (west of 22°W)
- two long-distance recaptures are noted, one near Azores and one between Haiti and Cuba (these two long-distance recoveries are not included in **Figures 1, 2 & 3**)
- Twelve bigeye were recorded without recapture positions.

3.4 Movements according to tagging periods

Recaptures were distributed in 5 different periods of tagging :

- Bigeye tagged from January to April (end of the fishing season)
- Bigeye tagged in July (beginning of the fishing season in the North of Mauritania),
- Bigeye tagged in August (full fishing season in the North of Mauritania),
- Bigeye tagged in September and October (fishing is still occurring in the North of Mauritania but some fish start to move to the South),
- Bigeye tagged in November and December (The displacement of the fishery towards the South is well underway).
- May and June are not considered as no bigeye were tagged during these months (**Table 1**)

The movements of bigeye according to their tagging periods are given in **Figure 5**.

- Bigeye tagged during the first quarter of the year and recaptured were all tagged in Cape Verde Islands in March and April except for two fish tagged in March 1996 on the 9°N seamount and recaptured the same month at the same place. Some of them moved to the east-

south-east the same year in April, one moved to the South and was recaptured by a purse seiner by 9°N/26°W and the others were either caught locally in March/April except one fish caught by a Cape Verde baitboat in December 2000 or towards the African coast from April 2000 to January 2001.

- Bigeye tagged from July to October have the same movement pattern with most fish being recaptured locally, some to the South and few fish moved to Cape Verde Islands, to the seamount or to Canary Islands. Movements to the South correspond to the displacement of the fishery at the end of the fishing season. The bigeye recaptured on the 9°N seamount was tagged in September 1996 and caught by a baitboat in June 1997. Two bigeye tagged in August 1999 were recaptured in June and July 2000 near Canary Islands. Bigeye tagged in July 1999 (1), August 1999 (5) and October 1997 (1) and recaptured west of 22°W were caught during the first quarter of the year (5 in January, 1 in February and 1 in March). One bigeye tagged in August 1999 was caught in June 2001 near Azores Islands.
- Bigeye tagged in November and December were either caught locally (most of them the same year, some one year later), or to the South, or to the North (Canary Islands), or near Cape Verde Islands. Those recaptured to the South of the tagging area were either recaptured in December the same year and from January to March the following year (they were moving South) or in May or June the following year (they were moving North to go back to the North of Mauritania). Those recaptured locally were caught in November and December the same year, in January and from July to November the following year, from July to December two years later or in January and February three years later. Three bigeye tagged in November 1999 were recaptured near Canary Islands : two in August 2001 and one in April 2002. Four bigeye tagged on the 9°N seamount in December 1994 were recaptured on this seamount the following month. 153 bigeye tagged in the North of Mauritania were caught near Cape Verde Islands. They were all recaptured between January and April 2000 (107 in January, 26 in February, 19 in March and 1 in April). One bigeye tagged in November 1999 was caught between Cuba and Haiti in January 2002.

3.5 Movements according to month of recapture

Bigeye were recaptured every month of the year (**Table 1**). Bigeye movements for each month of recapture are given in **Figure 6**.

- January, February and March show movements to the South along the coast of Mauritania and Senegal and movements towards Cape Verde Islands.
- In April, movements are from Cape Verde Islands towards the coast of Senegal in an east-south-east direction. There is also two bigeye tagged in the North of Mauritania and recaptured in Canary Islands (1) and in Cape Verde Islands (1).
- In March, bigeye tagged in the North of Mauritania moved to the South along the coasts of Mauritania and Senegal and one bigeye tagged in Cape Verde Islands moved to the South-south-west.
- In June bigeye tagged in the North of Mauritania are recaptured to the South (they are certainly coming from the South returning to their tagging area). One moved to the 9°N seamount and one to Canary Islands. One bigeye tagged in Cape Verde Islands is caught off the Mauritanian coast.
- In July, most bigeye tagged in Mauritania are caught locally but one fish is caught in Canary Islands and one off Dakar. Two bigeye tagged in Cape Verde are recaptured : one on the 9°N seamount and one in the North of Mauritania but very far offshore.

- In August, bigeye tagged in Mauritania are recaptured mostly locally but one fish moved to Canary Islands and one bigeye tagged in Cape Verde Islands is recaptured in Mauritania.
- September is peculiar as all recaptures are made locally.
- In October, all recaptures are registered locally but three: one is caught near Cape Verde Islands by a baitboat from Cape Verde, and two tagged in March and April 2000 in Cape Verde are recaptured in the North of Mauritania.
- In December, numerous tagged bigeye are recaptured locally but many show either a movement to the South (4 of them are recaptured south of 16°N) or a movement to the south-west towards Cape Verde Islands (6 bigeye are recaptured to the west of 20°W). One bigeye tagged near Cape Verde Islands in March 2000 is recaptured in the same area just 2°N of its tagging position.

3.6 Historical bigeye recaptures

In **Figure 7** are given bigeye movements from historical tagging operations from 1971 to 1986.

Tagging occurred mainly in the gulf of Guinea but some were performed in the Dakar baitboat fishing area (9°N seamount, Mauritania waters) and few even more north around Azores Islands. Some bigeye from the Gulf of Guinea show movements towards west and a bigeye was getting closer to Brazilian coast. For bigeye tagged more north there is no movements of fish between the African coast and Cape Verde area despite the presence of a baitboat fishery in Cape Verde at this time. Bigeye tagged on the 9°N seamount were caught mostly at the same location but some moved towards the African coast from the North of Mauritania to the South of Sierra Leone. One bigeye tagged by 2°28N/10°15W was caught near Azores Islands. Bigeye tagged around Azores were recaptured either locally or around Madeira and Canary Islands.

4 DISCUSSION

The overall area fished by Dakar baitboats goes from 6°N to 21°N and from the African coast to 30°W. Purse seiners catching the same species also fish this area seasonally. Catch by species for these two fisheries are given from 1994 to 2000 in **Table 3**.

Catch by purse seiners in this area is generally two to four times the baitboat catch. Even if skipjack is the main species caught by purse seiner, their yellowfin catch is much higher than yellowfin baitboat catch and their bigeye catch is often of the same order of magnitude as bigeye baitboat catch at least until 1998. Then, purse seine bigeye catch is much lower than baitboat bigeye catch. However among the 1593 bigeye recaptured only 5 were caught by purse seiners.

Recaptures according to their location are discussed and compared to historical bigeye recaptures (**Figure 7**).

4.1 Recaptures in the main fishing ground

The very high percentage of local recoveries is directly related to the school associated fishing technique used by these boats (Fonteneau and Diouf, 1994. Hallier and Delgado de Molina, 2000; Hallier *et al.*, 2001). Tunas including bigeye are kept around the fishing boat on a permanent basis during the all fishing season and transferred from boat to boat.

However historical data show already numerous recaptures in this area (**Figure 7**), which probably means that bigeye tend to stay for some time in this area. The development of the school associated

fishing technique might even more than before trapped bigeye in this area under baitboats. And it also certainly increases their vulnerability to pole-and-line fishing.

Of the 5 bigeye recaptured by purse seiners 3 are coming from the main baitboat area, 1 from the 9°N seamount and one was caught 5° west of this seamount. This very low recovery rate of bigeye by purse seiners cannot be related to purse seine bigeye catch (**Table 3**) but to the fact that bigeye associated to baitboats do not tend to join free schools vulnerable to purse seiners (Hallier and Delgado de Molina, 2000).

4.2 Recaptures to the South of the baitboat main fishing ground

These recaptures concern smaller fish than those which remained north (**Figure 8**). This is in accordance with data from **Figure 2 and 3**: small fish move more away from their tagging spot than larger fish.

The 9°N seamount look like a meeting point from which bigeye moved to many different direction except west. Eight bigeye were recaptured on the 9°N seamount or nearby but six of them were tagged on this seamount and recaptured within one month after tagging. One bigeye was tagged off Mauritania in September 1996 and recaptured in June 1997 on the seamount. One was tagged in Cape Verde Islands by 14°N/24°W in March 2000 and recaptured in July the same year by a purse seiner. All these bigeye measured less than 57 cm at tagging (3 less than 40 cm) except for one 65 cm fish. In this case as well as for bigeye recaptured north of 22°N (cf. § 4.3) these long distance recaptured concern small size fish at tagging and very few individuals.

These movements to the south are registered from January to July and in December (**Table 4**).

The monthly recaptures are in relation with the baitboat catch and the rapid recapture decrease after tagging. These movement to the south are directly related to the movement of baitboats.

Starting from the north of Mauritania, baitboats moved south from December to March until they reach 10°N or even further south. At the same time the catch is decreasing rapidly and boats tend to leave the fishery and to stay in port. Generally active boats are rare in April and May while purse seiners start to fish in this area. Then in June baitboat fishing start again off the Senegal coast and soon boats move north to settle again in the north of Mauritania during July. They will remain there until November-December. These movements to the south were already well illustrated by the historical tagging data (**Figure 7**).

Despite the fact that purse seine catch is quite high in this area from April to July, only one bigeye was caught by purse seiner (in July).

4.3 Canary Islands recaptures

Only 5 bigeye were recaptured north of 22°N (0.3 % of the recaptures) all tagged in 1999. Despite the fact that 22.7 % of the bigeye were tagged from 1994 to 1998, none of them were recaptured north of 22° N. Total number of bigeye tagged, recaptured south and north of 22 °N and the Canary Islands baitboat catch (Delgado de Molina *et al.*, 2001) are given in **Table 5** from 1994 to 2000.

The 5 bigeye recaptured north of 22°N represent 0.24 % of the 2084 bigeye tagged in 1999. If the same percentage is applied to the number of bigeye tagged each year, the expected number of recaptures north of 22° N is lower than one except for 1997 (1.2). Therefore it is not surprising that only bigeye tagged in 1999 were recaptured north of 22° N as movements of bigeye from the North of Mauritania to Canary Islands are quite rare. It might be for the same reason that historical tagging data (**Figure 7**) do not show such movements.

Except for one fish of 81 cm, all recaptured fish measure less than 54 cm at tagging (41 – 43 – 46 – 53 cm). Bigeye less than 54 cm account for 52.2 % of the total tagged. Therefore, it seems that mainly small bigeye move north of 22°N. All recaptures were recorded off the Canary Islands and after long durations at sea (between 295 to 883 days) but none were recorded off the Sahara coast. Despite the fact that 67.2 % of the bigeye were tagged in 1999 (54 in July, 947 in August, 942 in November and 141 in December) none of them was recaptured north of 22°N in 1999. They were recaptured in 2000 (2), in 2001 (2) and in 2002 (1). This non-reporting of 1999 bigeye around Canary Islands in 1999 despite very good bigeye catch by the Canary Islands baitboats this year could mean that bigeye which are in the Dakar baitboat fishing area do not move to Canary Islands during the ongoing fishing season but only during the following fishing seasons. This is at least true for bigeye tagged from August to December (97.4 % of the bigeye tagged in 1999). Bigeye tagged in August were recaptured in June and July the following year and those tagged in November were recaptured in August two years later (2) and in April two and half years later (1). This could mean that bigeye coming from the south to Canary Islands arrive in June or July but most of them remained in the main baitboat fishing area (105 recaptures).

The general pattern would be :

- Bigeye arrive in the North of Mauritania in July (fish between 35 and 100 cm FL or even greater but these large bigeye are not caught by baitboats),
- At this time some of the big fish continue to the North towards Canary Islands and maybe further north to Madeira and Azores.
- During the main Dakar baitboat fishing season (August to December), bigeye do not moved to the north towards Canary Islands.
- From November-December, bigeye moved to the south until March-April.
- Then they reverse their movement to go back north, small bigeye tagged the previous season or even two seasons before are bigger and some of them do not stop on their way to the north into the main baitboat fishing ground but they continue to swim north up to Canary Islands.

4.4 Recapture around Cape Verde Islands

A total of 192 bigeye were recaptured west of 22°W but all were caught between January and April 2000 by Dakar baitboats except for one fish caught by a Cape Verde baitboat in December 2000. 28 of these recaptures are from the 314 bigeye tagged in Cape Verde by Dakar baitboats in March and April 2000, one was tagged in October 1997 in the North of Mauritania and recaptured in February 2000 by a Dakar baitboat. The 163 others were tagged in 1999 in the north of Mauritania.

These movements from Mauritania to Cape Verde Islands are totally unexpected from the historical recapture data (**Figure 7**). It will be quite unlikely that these movements would be the consequence of a modification of the migratory movements of bigeye in this area. In fact, they are a perfect illustration of the fact that bigeye can be trapped in the schools associated to baitboats. Movements illustrated by these bigeye recaptures correspond to the movement of baitboats at the same time from the North of Mauritania to Cape Verde Islands. This is illustrated by the route followed by a baitboat (President Matar Ndiaye) and the bigeye it has recaptured on its way from the North of Mauritania to the South of Cape Verde Islands (**Figure 9**).

At the end of the fishing season in Cape Verde Islands some bigeye have followed baitboats in the opposite direction from Cape Verde Islands to waters off the South coast of Senegal (**Figure 10**).

To better illustrate and understand the fact that bigeye can be trapped under baitboat we will follow the recapture destination of bigeye tagged in 1999 and 2000. In 1999, all bigeye tagging occur

in Mauritania area (between 17°N and 22°N) in July, August, November and December. While in 2000, all tagging was done in Cape Verde area (south of 17°N and west of 22°W) in March and April. Data are listed in **Table 6** for 1999 and in **Table 7** for 2000.

From **Table 6**, bigeye tagged in the north of Mauritania remain in this area until December. If more bigeye are recaptured in December it is because 942 bigeye were tagged in the second half of November and 141 in the first week of December. At the end of December, some boats start to move towards Cape Verde area and 2 bigeye are recaptured there. In January the fleet leave Mauritania (only 9 recaptures) and split in two, one part of the fleet move along the coast of Africa (east of 22°W) as usual (44 recaptures in Senegal area) and the rest move to Cape Verde area and draw along with them the associated schools that contain tagged bigeye (104 recaptures in Cape Verde). In February, the number of boats actively fishing and the catch decreased in Senegal as well as in Cape Verde with respectively 5 and 26 recaptures. In March and April recaptures are recorded only in Cape Verde, respectively 20 and 1. In May, all baitboats have left Cape Verde area for Senegal area but no bigeye are recaptured. All tagged bigeye have left the baitboat associated schools. Bigeye listed as “others” are either bigeye with no recapture position or recaptured elsewhere. For 1999 tagged bigeye, bigeye listed as “others” are bigeye recaptured in Canary Islands (in June and July 2000, in August 2001 and in April 2002). One “other” is recaptured in Azores in June 2001 and another one near Cuba in January 2002. The rest (6) are with unknown positions.

From **Table 7** (bigeye tagged in 2000), in March all bigeye are recaptured in Cape Verde. In April 20 bigeye are recaptured in Cape Verde but 15 in Senegal. Then very few of the bigeye tagged in Cape Verde show up: only 10 fish between May 2000 and October 2001. While the recapture rate for the 1999 bigeye reaches 59 %, it is only 16.6 % for bigeye tagged in 2000 in Cape Verde. Therefore, if some baitboats draw along with them bigeye into the Senegal area in April, most of these fish do not remain with the associated schools. Two bigeye are listed as “others”: one is recaptured by a purse seiner by 9°N and 26°W in May 2000 and one has an unknown position.

Therefore, if bigeye movements can be modified when they are associated to baitboat it is only for a limited period of time. Bigeye from the north of Mauritania will follow baitboats to Cape Verde but the next fishing season they will be recaptured in the north of Mauritania. Once baitboats from Dakar left Cape Verde fishing grounds it seems that none of the bigeye, which have followed baitboats to Cape Verde, will remain there. None were recaptured by Cape Verde baitboats in 2000. However this fishery is catching less than 200 tonnes of bigeye annually. Unfortunately, Dakar baitboats do not gained access to the EEZ of Cape Verde in 2001, therefore they were not able to eventually catch some bigeye which might have remained there. If the traditional movements of bigeye of Mauritania was altered when they followed baitboats that moved to Cape Verde it seems they left this area with or without the baitboats and do not returned.

The same conclusion can be made for bigeye tagged in Cape Verde. Several associated schools from Mauritania were brought to Cape Verde and some bigeye tagged in Cape Verde might have come from Mauritania (these fish might be those recaptured in Mauritania in 2000 and 2001). However, this possibility is very low as the transportation of Mauritania schools to Cape Verde took place in January while tagging starts mid-March. In between, a lot of bigeye have been caught. Therefore during tagging most bigeye associated to baitboats have joined the associated schools in Cape Verde, they were “local” bigeye. Bigeye tagged in Cape Verde were recaptured there by Dakar baitboats. Some followed baitboats when they returned to Senegal area. But later as Dakar baitboats do not returned to Cape Verde we do not know if some of these bigeye remained in Cape Verde waters. However, apart from the April recaptures in Senegal, only 5 other bigeye were recaptured outside Cape Verde waters including 4 in the main baitboat fishing area in Mauritania. Therefore, part of the bigeye from Cape Verde Islands trapped within the associated schools were temporary brought to Senegal area but they do not remain there in the associated schools or in free schools, they probably returned to their traditional grounds.

4.5 Long-distance recaptures

Two bigeye have travelled long distances (**Figure 4**): one to the North-West and one to the West. The first fish is a 53 cm FL bigeye tagged in the north of Mauritania by 20°41'N-17°56'W on 19/8/1999 and recaptured at 94 cm FL on 13/6/2001 80 miles north of Faial (Azores). It has travelled 1350 miles in 666 days (2 miles/day) and grew 41 cm (1.8 cm/month). The second fish is a 44 cm FL bigeye tagged in the north of Mauritania by 19°06'N-19°27'W on 20/11/1999 and recaptured at 87 cm FL on 14/1/2002 between Haiti and Cuba by a US longliner. It has travelled 3100 miles in 786 days (3.9 miles/day) and grew 34 cm (1.3 cm/month). This is the first bigeye that realises a full transatlantic migration. These long distance trips were made by juvenile bigeye.

Historical data has already proved that juvenile bigeye can travel long distances. A 49 cm FL fish tagged off Gabon coast was recaptured at 69 cm FL after 441 days and 2626 miles 5° from the coast of Brazil (6 miles/day and 1.4 cm/month). A 46 cm FL fish tagged off the Liberia coast was recaptured at 58 cm FL after 226 days and 2344 miles near Azores Islands (10.4 miles/day and 1.6 cm/month).

5 CONCLUSIONS

Recaptures registered by MAC tagging program confirm bigeye movements displayed from historical tagging operations conducted in the Eastern Atlantic Ocean from 1971 to 1986. For example the South-North movements along the coast of African and movements from fish tagged on the 9°N seamount are found in both sets of data (MAC and historical). But new movements are illustrated by MAC data such as from Mauritania to Canary Islands and to Cape Verde Islands and from this last area to Senegal. The lack of recapture in Canary Islands in the historical data set can be due to a limited number of bigeye tagged as very few fish move from Mauritania to Canary Islands. The movements of bigeye from Mauritania to Cape Verde Islands and back to the East are a direct consequence of the trapping of bigeye in schools associated to baitboats. However, this altered behaviour is temporary because after some months trapped bigeye tend to go back to their original grounds.

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Table 1 : Number of bigeye tagged and recaptured by month from MAC Program and average bigeye catch by month by Dakar baitboat (BB) fishery (1994-2000).

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Tag	1	9	306	15			81	997	155	52	1106	380	3102
Recovery*	194	47	35	37	4	17	51	333	179	158	150	381	1586
BB Bigeye catch (MT)	110	187	142	47	31	221	693	776	558	535	325	394	4019

* 7 bigeye recorded with unknown month at recovery are not included in this table

Table 2: Number of bigeye tagged, recovered and recovery rate by MAC program (1994-2000)

	Tagged	recovered	recovery rate
1994	113	32	28.3
1995	26	4	15.4
1996	45	20	44.4
1997	491	248	50.5
1998	29	8	27.6
1999	2084	1229	59.0
2000	314	52	16.6
Total	3102	1593	51.4

Table 3 : Baitboat and purse seine catch by species from 1994 to 2000 in the area 6°N-22°N/15°W-30°W.

	Year	1994	1995	1996	1997	1998	1999	2000
Baitboat	YFT	3427	2236	2387	1848	760	3140	1439
	SKJ	3540	3758	2750	6026	8499	7295	7973
	BET	3209	3187	3795	2991	3340	7201	5995
	Total	10176	9181	8932	10865	12599	17636	15407
Purse seiner	YFT	11055	11371	9587	4027	8884	4524	8734
	SKJ	23742	25029	11532	21394	22614	21929	17938
	BET	3157	2744	2518	3430	2003	1148	1989
	Total	37954	39144	23637	28851	33501	27601	28661

Table 4 : Distribution of bigeye (bet) recapture by month in the area 8°N-17°N/15°W-21°59'W and average bigeye baitboat (BB) and purse seine (PS) catch (1994-2000)

	January	February	March	April	May	June	July	December	Total
Number	45	13	3	15	3	10	2	4	95
% Total	47.4	13.7	3.2	15.8	3.2	10.5	2.1	4.2	100
Average BB bet catch	179.7	211.3	111.9	59.4	35.6	88.4	22.3	97.1	
Average PS bet catch	1.4	0.7	9.9	490.1	662.0	279.9	208.9	7.1	

Table 5 : Bigeye tagged by MAC program, recaptured south and north of 22° N and bigeye catch by the Canary Islands baitboat fishery (1994-2000)

Year	Number tagged	Number recaptured south of 22° N	Number recaptured north of 22° N	Catch by Canary Islands Baitboats (in T)
1994	113	32	0	9325
1995	26	4	0	7271
1996	45	20	0	5253
1997	491	248	0	5559
1998	29	8	0	1034
1999	2084	1223	5	6191
2000	314	52	0	2167

Table 6 : Distribution of the recaptures by area for bigeye tagged in 1999

	Area	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
1999	Mauritania							17	264	101	104	119	262
	Senegal												
	Cape Verde												2
	Others												
	Total							17	264	101	104	119	264
2000	Mauritania	9					1	24	39	12	17	6	1
	Senegal	44	5				7	1					
	Cape Verde	104	26	20	1								
	Others						1	1					1
	Total	160	31	20	1		9	26	39	12	17	6	2
2001	Mauritania	1					1	3	3	3	2	3	
	Senegal					2	1						
	Cape Verde												
	Others	1					3	1	2	1			
	Total	2				2	5	4	5	4	2	3	
2002	Mauritania	1	1										
	Senegal												
	Cape Verde												
	Others	1			1								
	Total	2	1		1								

Table 7 : Distribution of the recaptures by area for bigeye tagged in 2000 (no recapture in 2002)

	Area	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
2000	Mauritania							1				1	
	Senegal				15			1					
	Cape Verde			7	20								1
	Others					1							
	Total			7	35	1		2				1	1
2001	Mauritania						1		1		2		
	Senegal												
	Cape Verde												
	Others	1											
	Total	1					1		1		2		

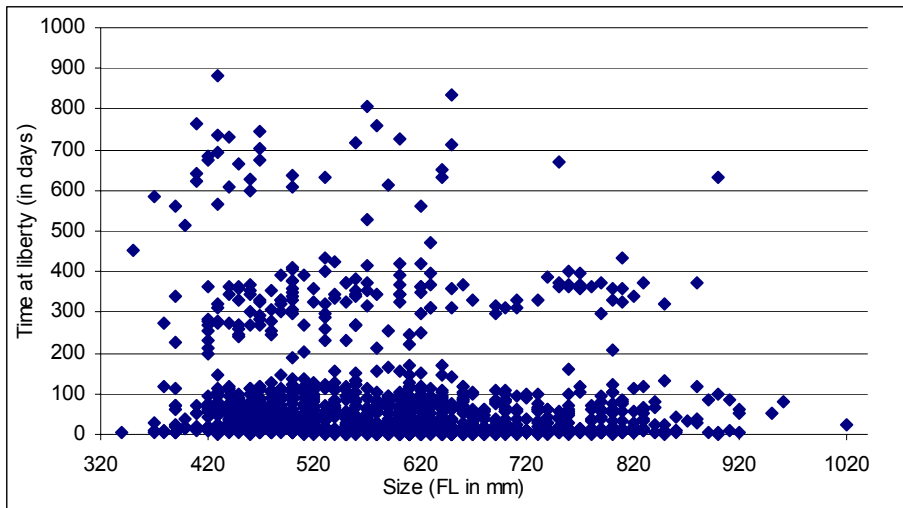


Figure 1: Time at liberty versus size at tagging for MAC bigeye recaptures (1994-2000)

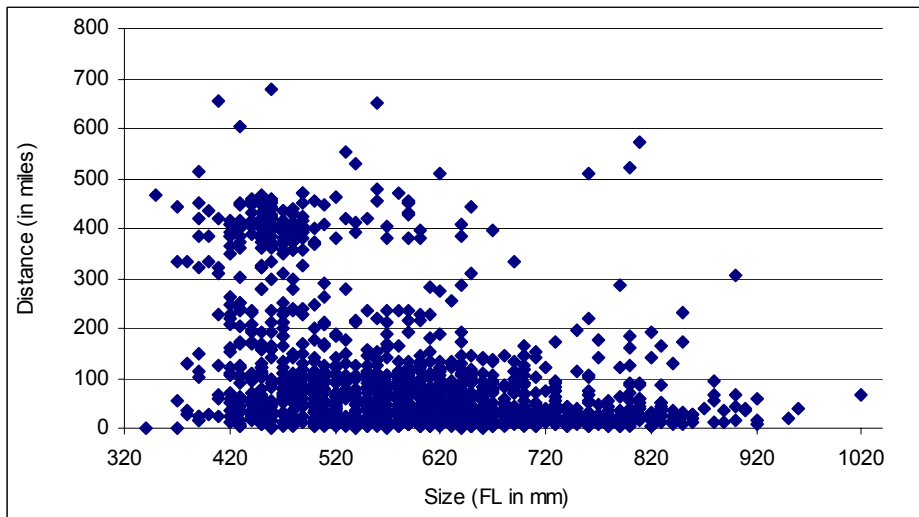


Figure 2: Distance travelled (miles) versus size at tagging for MAC bigeye recaptures (1994-2000)

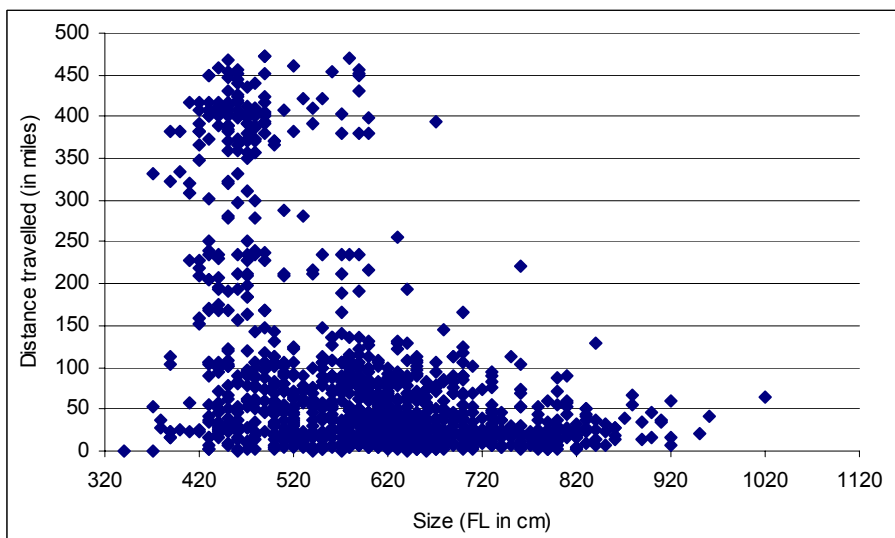


Figure 3: Distance travelled (miles) versus size at tagging for MAC bigeye with time at liberty less than 90 days (1994-2000).

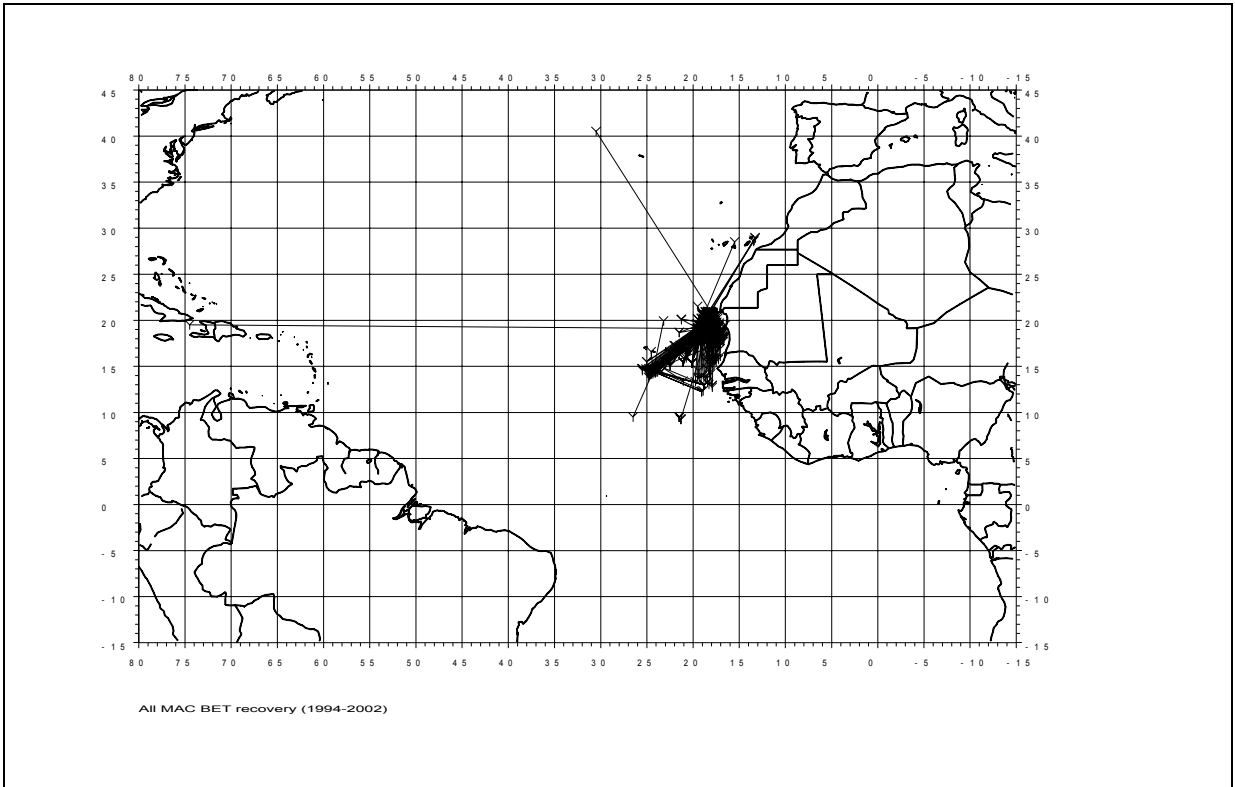


Figure 4 : All bigeye movements from MAC program (recaptures from 1994 to 2002)

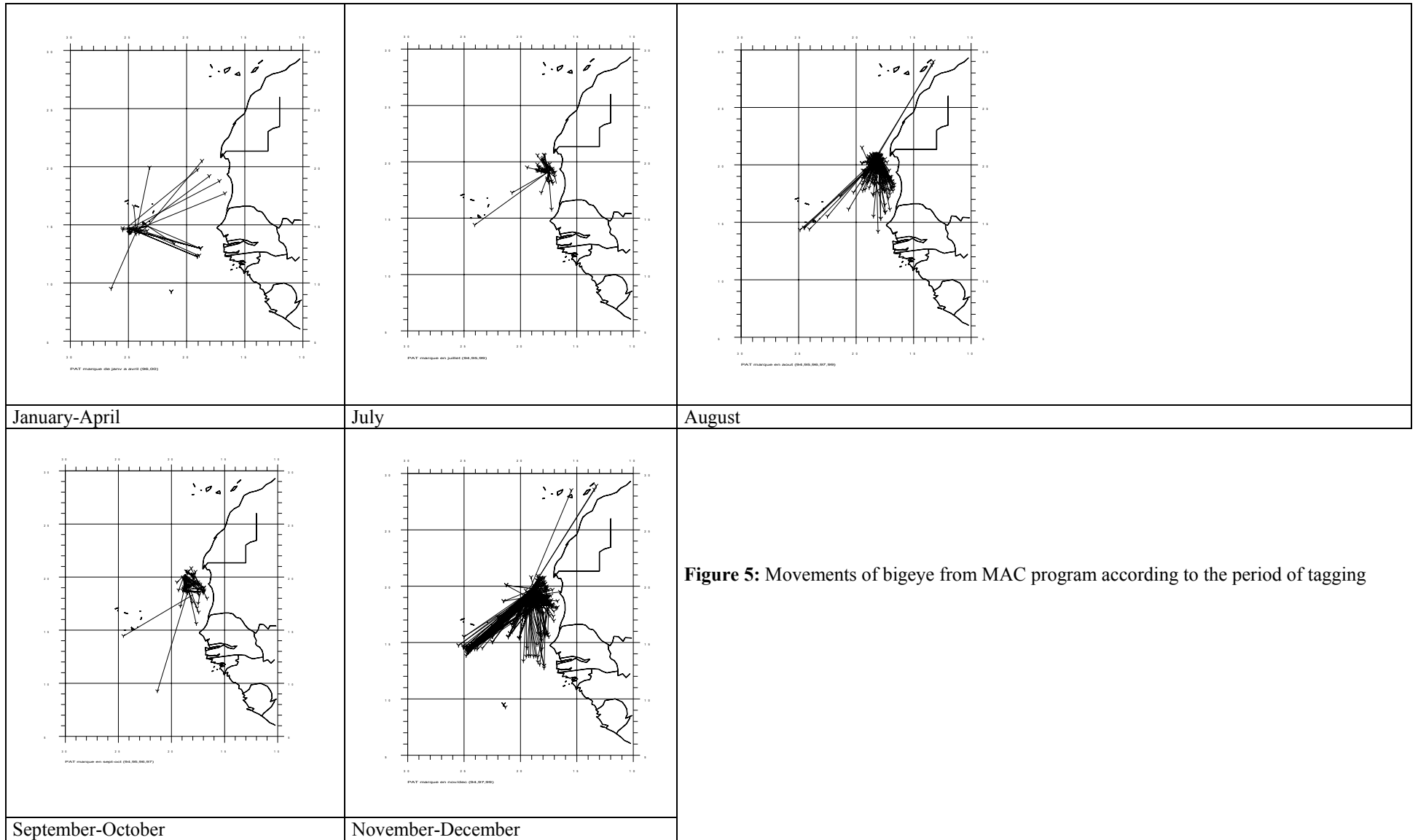
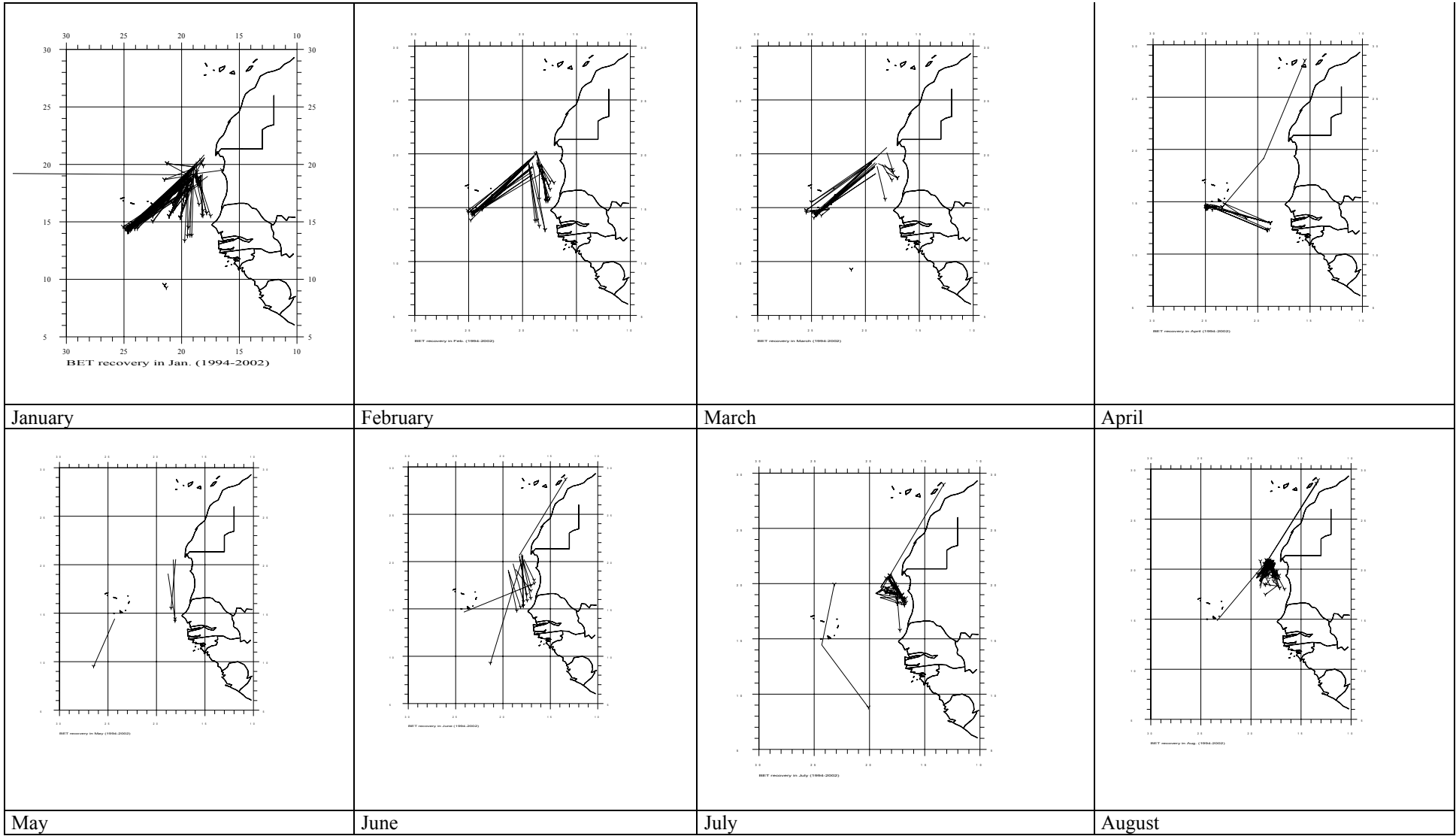


Figure 5: Movements of bigeye from MAC program according to the period of tagging



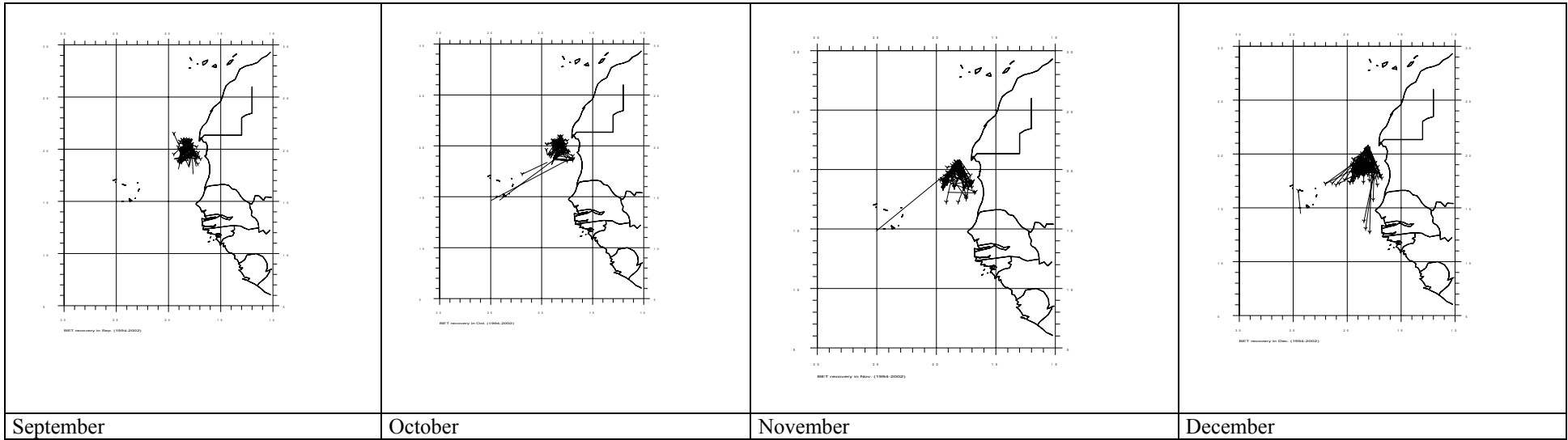


Figure 6: Bigeye movements from MAC program according to the month of recapture (1994-2002)

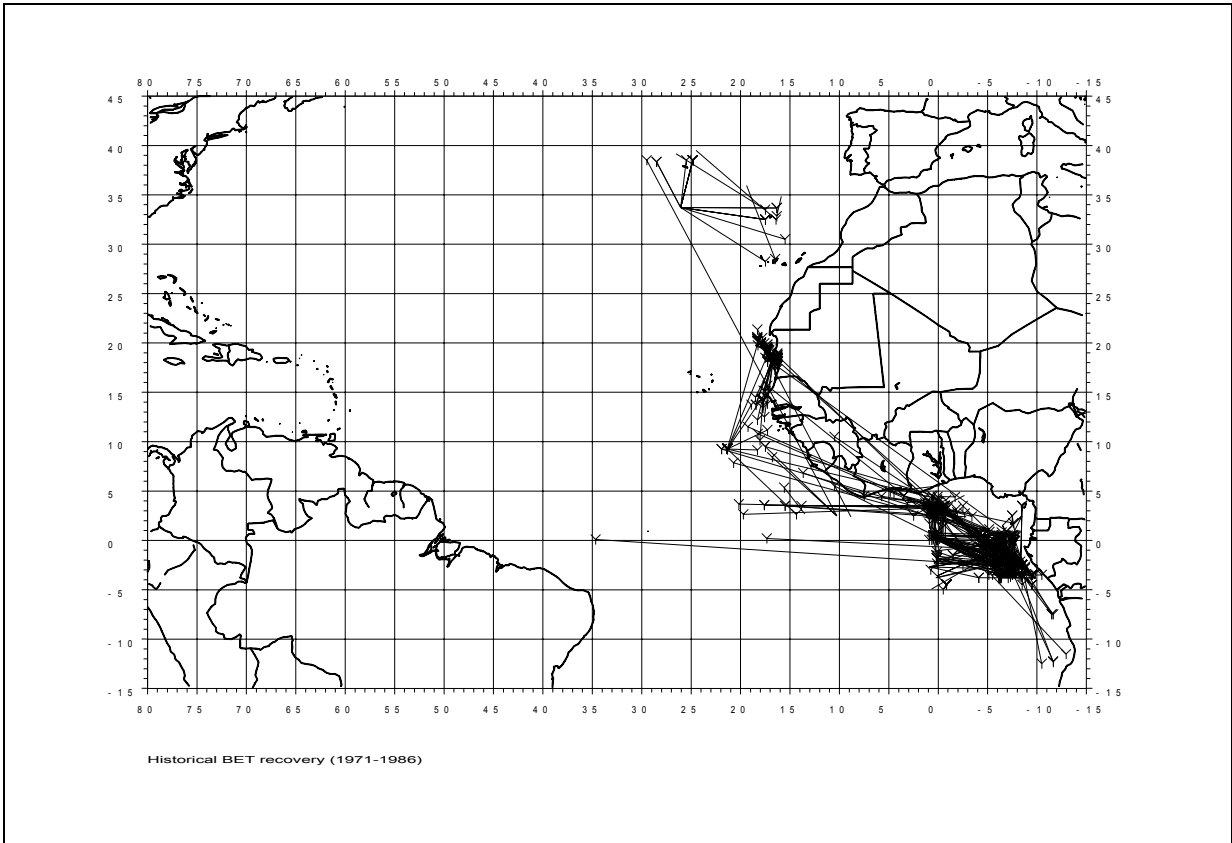


Figure 7: Bigeye movements from historical tagging operations in the Eastern Atlantic Ocean (1971-1986)

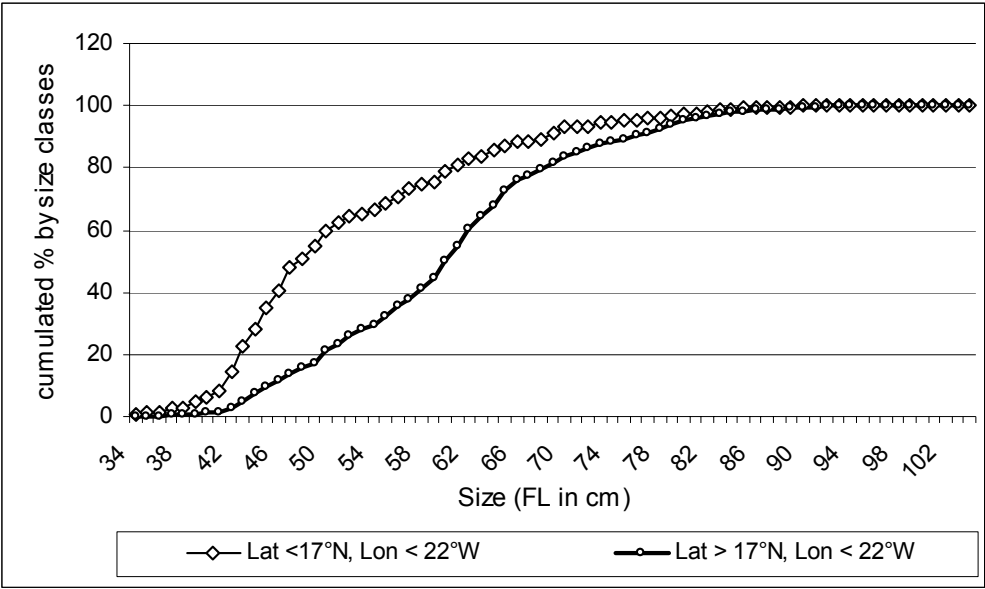


Figure 8: Cumulated size classes for bigeye recaptured North and South of 17°N

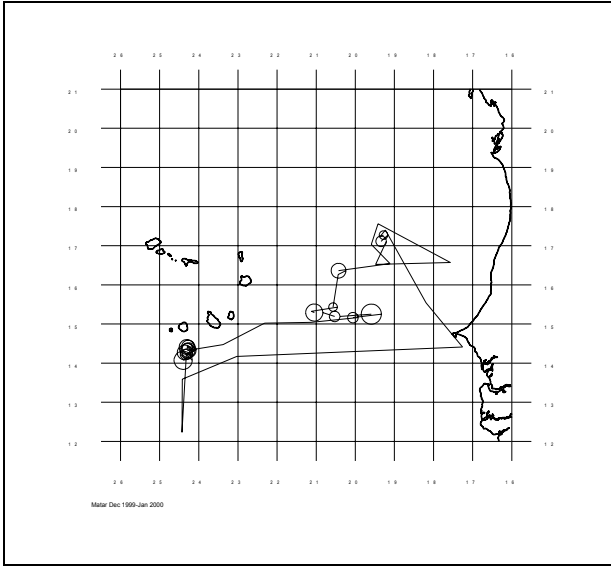


Figure 9: Route followed by the baitboat, President Matar Ndiaye, in January 2000 and bigeye recaptures (circles) on its way from Mauritania to Cape Verde Islands

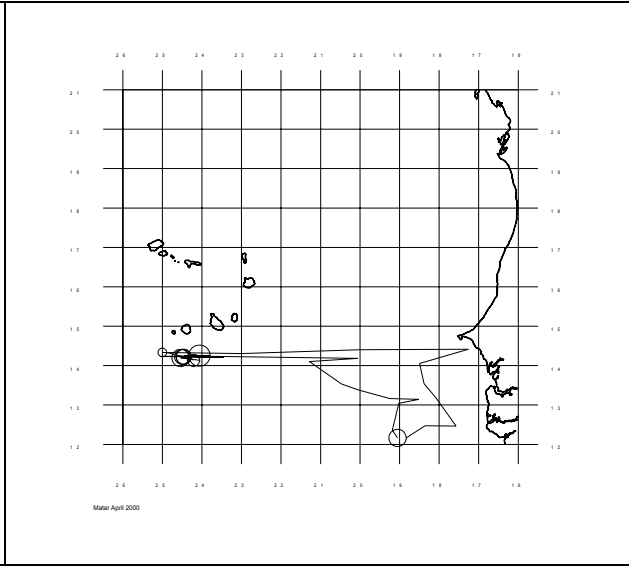


Figure 10: Route followed by the baitboat, President Matar Ndiaye, in April 2000 and bigeye recaptures (circles) on its way from Cape Verde Islands to the South of Senegal