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Migration, residency, and homing of bluefin tuna in the western Mediterranean Sea

Jean-Marc Fromentin[1,*] and Daniel Lopuszanski[2]

[1] IFREMER, UMR 212 EME, Avenue Jean Monnet, BP 171, 34203 Sète, France
[2] BGFCF (Big Game Fishing Club France), Carry le Rouet 13620, France

*: Corresponding author : Jean-Marc Fromentin, tel: +33 4 99 57 32 32 ; fax: +33 4 99573295 ; email address : jean.marc.fromentin@ifremer.fr.

Abstract:

This study presents the results of an electronic tagging programme on mature Atlantic bluefin tuna (ABFT) that has been conducted since 2007 offshore of the French Mediterranean Coast. The spatial distributions of ABFT showed little year-to-year variation and the fish concentrated in a small area of the central northwestern Mediterranean, where they may stay for several months. The individual tracks display sinuous trajectories in this area, indicating the possibility of feeding behaviour. No fish went out to the North Atlantic, but several fish displayed some migration to the southern western Mediterranean Sea during winter and the central Mediterranean during the spawning season. The homing behaviour of one fish after a full year as well as the back and forth of several fish further indicates that this restricted feeding area is probably persistent from year to year. We hypothesize that this area could result from local enrichment due to permanent mesoscale oceanographic features related to the North Mediterranean Current and the North Balearic front. The option of a spatial management, through marine protected areas, for a highly migratory species, such as ABFT, thus deserves more careful consideration because those species displayed complex spatial dynamics (e.g. homing), and population structure (e.g. several subpopulations of different sizes).

Keywords: feeding area ; Front ; marine protected area ; pop-up archival tag ; spatial distribution ; *Thunnus thynnus*

1. Introduction

Atlantic bluefin tuna (ABFT) is a commercial fish of high market value that crystallises many of the problems found in fisheries in areas beyond national jurisdiction, i.e. severe overcapacity, open access in international waters, geographical expansion of the fisheries and deficient governance at both the international and national levels. While the scientific community has raised serious concern about the East Atlantic and Mediterranean stock status since the mid-1990s (ICCAT, 1997), management has not followed, until recently, the scientific advice (Fromentin and Powers, 2005). Furthermore, management regulations have largely been ineffective in limiting catches because of a lack of compliance and control (ICCAT, 2007). This has meant that catches were under-reported until 2007 (and probably afterwards, but to a lesser extent) and overexploitation occurred for years (ICCAT, 2009). Such failure in management was unfortunately not specific to ABFT and can be found in many fisheries around the world (e.g. Beddington et al., 2007; Garcia and Grainger, 2005; Hilborn et al., 2005). This situation probably has resulted in the scientific community starting to consider alternative management options for the pelagic and highly migratory species, such as Marine Protected Area (MPA, e.g. Halpern and Warner, 2002; Sumaila et al., 2007).

However, highly migratory species, such as tuna and billfish, are likely to move out of the reserves, so that MPAs may be inefficient as conservation tools (Claudet et al., 2010). Mobile marine species often display more population structure than usually assumed and have complex spatial dynamics, such as homing behavior (see e.g. Hauser and Carvalho, 2008; Kritzer and Sale, 2004; Secor, 2010; Rooker et al., 2008; Ruzzante et al., 2006). Such features could make MPAs more effective than expected if well designed in order to protect particular life-history phases, key habitats or given sub-populations. Knowledge of spatial dynamics will also be important for developing simulation models that include plausible hypotheses about stock structure and fisheries dynamics for use in management strategy evaluation (see e.g. Kell et al., 2009).

Studies of highly migratory fish, such as ABFT, based on electronic tagging have been shown to be successful for investigating the spatial dynamics and to identify preferential feeding and spawning areas (e.g. Block et al., 2005; Wilson et al., 2005; Teo et al., 2007; Sibert et al., 2006). However, the great majority of studies on ABFT has been conducted in the western Atlantic and, therefore, has focused on the spatial dynamics of ABFT in the North Atlantic.

In this study, we present the results of an electronic tagging programme for ABFT in the Northwestern Mediterranean that has been conducted since 2007. The objectives of the study are to: (i) better understand ABFT spatial dynamics in the Mediterranean Sea, especially the migration patterns within the Mediterranean and between the Mediterranean and the North Atlantic, (ii) identify the potential key feeding and spawning areas in the Mediterranean and (iii) explore the appropriateness of MPAs as a management and conservation tool for ABFT in the Mediterranean sea.

2. Methods

2.1. Pop-up archival tags

Pop-up archival tags record several times a day, water temperature, depth and light intensity that are used to calculate the average daily location of the fish. The tag is fixed, through a tether, close by the second dorsal fin of the fish. After a period set by the scientists (here 10 or 12 months), the tag detaches itself and emits a summary of the recorded data to the closest satellites (see e.g. Gunn and Block, 2001 for more details). However, premature detachment is a general problem with pop-up archival tags that usually truncate the time-at-liberty to a few months (see e.g. Sibert et al., 2006).

ABFT were caught using rod and reel on board of a recreational fishing boat. Tuna were brought on-board, through the back door, onto a wet vinyl mat. During the tagging operation, the eyes of the fish were covered by a wet tissue and the fish was irrigated with a deck hose with flowing seawater. Since 2008, the pop-up archival tag was also maintained along the body of the fish using a second tether. This avoids harm to the fish caused by the tag hitting and dragging the fish. The whole tagging operation lasts one to two minutes. All the tagging operations were performed on the same boat, with the same crew (i.e. captain, recreational fishermen and scientist).

Pop-up archival tags were primarily deployed on fish of 125cm to 255 cm (fork length) offshore of the French Mediterranean Coast, slightly West of Marseille (at 43°14'N and 04°58'E, Table 1). We released 11, 6, 9, 5 and 8 pop-up archival tags from 2007 to 2011, respectively. All the tags, except tag 92109, have successfully transmitted (Table 1). Past pop-up archival surveys on different biological platforms (fish and birds) suggested problems with the transmission in the Argos band over the Mediterranean Sea (see de Metrio et al., 2001; Fromentin, 2010). After an inquiry from Argos-France, it appeared that the Argos band is subject to interference due to various sources of noise over the Mediterranean Sea, so that a minimum transmission power of 0.3 W is needed (Argos unpublished). Therefore, we only deployed Mk-10 pop-up archival tags from Wildlife Computers, which have a transmission power of about 0.5 W.

2.2. Geolocation estimates

Observed geolocations estimated from light intensity alone are known to be incomplete and/or impaired by large observation errors (Sibert and Fournier, 2001). To circumvent this difficulty, we used a state-space model developed by Royer et al. (2005) and improved later on to integrate constraints from coastlines, bathymetric limits and sea surface temperature information from oceanic models in the optimisation function (Royer and Lutcavage, 2009). This constrained non-linear and non-Gaussian estimation method partly corrects for erroneous sunrise and sunset times, which are known to explain most of common error patterns in latitude deduced from light-based geolocations (Nielsen et al., 2006). However, in our case study, the main limitations in estimating unbiaised tracks from pop-up archival tags mostly result from the transmission. In average, we obtained 24% of the daily geolocations (from 12% in 2007 to 30% in 2009) and about 37% of temperature and depth profiles (from 25% in 2007 to 50% in 2011). However, the quality of the Argos transmission also varied considerably among tags: from 3.3% of daily geolocations for tag 68409 (over 139 days-at-sea) to 84% of information for tag 87643 (over 55 days-at-sea). The paucity of data for some tags was thus a key limitation because this leads to a monotonic and poorly informative trajectory. This was the case for 6 tracks (tags 68406, 68408, 68409, 87642, 34261 and 61958). Note that the tags 68407, 92109 and 73422 did not send any archived data because of transmission failure, so that the locations of release and pop-off are the only available information for those three tags (see Table 1).

2.3. Mapping

To identify the potential key areas of ABFT, we calculated the probability distribution from the geolocations, using a two-dimensional kernel density estimation with an axis-aligned bivariate normal kernel (Venables and Ripley, 2002). The kernel density was evaluated on a square grid of N=500 in both directions. Kernel density plots have been computed for each year (from 2007 to 2011) as well as for the whole period by pooling all the tracks together. All the calculations have been performed using the libraries „MASS", „fields", „mapdata" and „Hmisc" of R software 2.15.0 (http://www.r-project.org/).

3. Results

3.1. Tagging release and recapture

20 pop-up archival tags were deployed on medium-size fish of 124cm to 172cm (i.e. young spawners of 4 to 7 years old when referring to the Von Bertalanffy equation used by the scientific committee of ICCAT) while 19 were deployed on larger-size fish of 180 cm to 255 cm (i.e. spawners from 8 years to 16 years old, Table 1). Large fish (> 190cm) were tagged in all years, but smaller fish (124 cm< ABFT < 144 cm) were tagged during the first two years and fish of 160 cm to 190 cm were mostly tagged during the 3 subsequent years. While small size fish were available during all the period, medium-size fish (i.e. 160-190 cm) were mostly abundant in the last years. The overall average of time-at-liberty is 110 days, ranging from 68 days in 2007 to 160 days in 2011 (Table 1). This substantial increase in the duration of the tag attachment is probably due to an anchorage through the pterygiophores and the use of a double dart since 2008. Nonetheless, all the tags, except tag 61964, popped-off prematurely. As mentioned in the Methods section, premature detachment is a well-known problem for pop-up archival tags. In our study, we identified three main causes: (i) premature rupture of the tag pin (confirmed on the single premature detached tag that has been recovered), (ii) fishing, as for tag 68407 and possibly for 1 to 3 other fish and (iii) death of the fish just after release (i.e. tags 37333, 80083 and 62008).

3.2. Geolocations and Tracks

Deployment mostly occurred in August and September, so most of the tracks start in late summer and end in early spring and summer for a few tags (Table 1). The rather low temporal resolution of pop-up archival tags and the limitations of the transmission in the Mediterranean Sea probably mean that the actual tracks underestimate the distance traveled. However, both the total distance (as the sum of the distances between each daily geolocations) and the mean distance per day (as the total distance divided by the time-at-liberty) were calculated in order to get an order of magnitude and for comparison purposes (Table 1).

The mean distances per day (i.e. a minimum estimate) mostly ranged from 7 to 30 nm/day. The mean distance did not depend on the type of the trajectory (i.e. migration *versus* residency), nor the quality of the transmission. The great majority of fish remained in a rather small area, i.e. the central part of the Northwestern Mediterranean (Figure 1), where they may stay for several months (see tag 92108, Figure 2). In this area, all individual tracks display sinuous trajectories, indicating the possibility of feeding behavior (Figures 2 and 3). Even if those fish remained in a restricted area, the total covered distance can be rather long. For instance, fish 92108 covered at least 2,100 nm in this area over 300 days (Figure 2).

Without including tag 73422 (for which no track is available, see Table 1), six tag durations are long enough to include data up to and including April and could thus be informative on the reproductive migration patterns. Of these six tracks, two ABFT (tags 80082 and 87642) showed clear migration towards North Sicily and the Gulf of Sidra in 2008, i.e. two known spawning locations in the Mediterranean (Figure 1). Three other tags (i.e. 92108, 92116 and 34274) remained in the Northwestern Mediterranean and did not display any migration towards a known spawning ground during the spawning season. The last ABFT (tag 61964) clearly migrated from the Northwestern Mediterranean to Gibraltar from February to April and then went back to the southern part of the Balearic Islands in May to move back to Gibraltar in June-July (Figure 3). This individual fish did not show any clear residency in the Balearic Islands spawning ground during the spawning season in that area (usually occurring from early June to early July). Finally, none of the other tagged fish (which were all mature) showed any clear migration to this spawning location, albeit it is the closest and most important one in the Western basin.

No fish migrated to the North Atlantic, except tag 61964. This fish only stayed 7 days in mid-July 2012 at the entrance of the Gibraltar Sea and then went back to the Northwestern Mediterranean (Figure 3). More interestingly, this fish displayed a clear homing behavior (i.e. the ability of the fish to return to a given place when displaced from it over great distances) to the northwestern Mediterranean. It remained in this area from September 2011 to February 2012 and went back to it in August/September 2012. The release and pop-off locations are only separated by 40 nm while the fish had traveled 1,250 nm away from the release location a few weeks before pop-off and covered a total distance of at least 8,460 nm during the year (Table 1, Figure 3).

Several other fish also displayed clear migration patterns towards the southern western Mediterranean Sea during winter (see ABFT offshore Tunisia and Algeria in 2007, 2009 and 2011 on Figure 2). Our sample size is too small to deduce any robust relationship between fish size and migration patterns. The two longest migrations (i.e. towards Gulf of Sidra or the Gibraltar Sea) have been performed by large fish (i.e. 180 and 210 cm long), but some small fish (i.e. 127 to 144 cm long) also displayed long migrations to wintering/feeding grounds in the southern Mediterranean Sea.

3.3. Spatial Distributions

ABFT spatial distributions (using a two-dimensional kernel density estimation) showed little year-to-year variation. In all the years, the core of the distribution is concentrated in this rather small area of the Northwestern Mediterranean that was already noted from the individual tracks, i.e. between the Gulf of Lions, the Balearic Islands and Corsica (Figure 4). The spatial distribution does not seem to be affected by the number of geolocations, which differs substantially from year-to-year (Figure 1). ABFT spatial distributions appear more widely spread in 2008, 2010 and 2011 than in 2007 and 2009 (Figure 4). This is due to a few fish displaying longer migration patterns in those years. Nonetheless, the core of the ABFT spatial distribution observed over the five years (2007-2011) is very similar to those observed during an individual year and is always highly concentrated within the Northwestern Mediterranean (Figure 4).

3.4. Residency and Homing

Figures 2, 3, 4 and 5 indicate a potential ABFT hotspot in the Northwestern Mediterranean Sea. As this area is just south of the release location (about 50 nm), we investigated if the time-at-liberty could be the main factor explaining dispersion and thus the concentration in that area. There is no apparent relationship between the time-at-liberty and the distance from the release location (Figure 5). The latter does not increase (either linearly or non-linearly) with the former, as would be expected if the proximity of release location affected ABFT dispersion and spatial distribution.

As noted above, a majority of fish spent several months in the Northwestern Mediterranean, at a distance of 30 to 150 nm from the release location (such as tags 34274, 61964 and 92108 in Figure 5). Fewer fish, however, seem to disperse more (such as tag 61954 or tag 87642 after 180 days, Figure 5), but they nonetheless spent several months in the vicinity of the same area. The Northwestern Mediterranean could be a key area for ABFT; a hypothesis that is further supported by the homing behavior of tag 61964 and the back and forth to this area of tags 92108 and 34274 (Figure 5).

4. Discussion

Pop-up archival tagging has several limitations, especially premature detachment (Sibert et al., 2006), which make large-scale studies (in both time and space) difficult. Nonetheless, it is one of the rare approaches that can provide fisheries-independent information, which is crucial to understand the spatial dynamics of highly migratory species, such as tuna, swordfish, marlin and pelagic shark (Block et al., 2011). The tagging program described in this study, which is still ongoing, has produced new information about ABFT migratory patterns in the Mediterranean; this includes about 4,000 geographical locations and 1,500 observed depth and temperature profiles. Such a program would have been of limited scientific interest if it had been restricted to a few tagged fish in a given year, but the replication of the same tagging protocol over five consecutive years has allowed to the study to identify some recurrent patterns and a possible key area in the Western Mediterranean.

Our results clearly showed that ABFT can remain in the Mediterranean Sea all year long. During the spawning season, only one tagged fish was in the vicinity of the closest spawning ground, i.e. the Balearic Islands, but it did not display any clear spawning behavior in that area. Two other tagged fish clearly migrated to rather distant spawning grounds while the remaining three tagged fish were far from any known spawning locations during the spawning season. It is not possible to draw any conclusion on such a low sample size, but it is of interest to note that a more intensive electronic tagging program on ABFT in the northwestern Atlantic also showed that a substantial proportion of the tagged ABFT were far from any known spawning grounds during the spawning season, which lead the scientists to postulate to the occurrence of some unknown spawning locations/seasons and/or the possibility of ABFT to skip spawning in some years (Galuardi et al., 2010; Lutcavage et al., 1999).

No fish migrated in the North Atlantic if we ignore the 7 days when tag 61964 was at the entrance of Gibraltar Sea. Such a result was unexpected because ABFT is a highly migratory species that is known to enter and leave the Mediterranean for reproduction (see e.g. Ravier and Fromentin, 2001; Mather et al., 1995). ABFT migration patterns within the Mediterranean remain, nonetheless, poorly known, as most of the electronic tagging programs were conducted in the northwestern Atlantic and thus mostly described ABFT dynamics in the North Atlantic (e.g. Walli et al., 2009). Interestingly, another current electronic ABFT tagging program in the Western and central Mediterranean, using both pop-archival and archival tags, also showed that none of the tagged ABFT left the Mediterranean Sea (Tudela et al., 2011). Results from recent genetic studies (Carlsson et al., 2004; Riccioni et al., 2010; Viñas et al., 2011) and retrospective analysis of fisheries data (Fromentin, 2009) clearly indicate that

ABFT population structure is more complex than the current two-stocks hypothesis, with probably one or two sub-populations within the Mediterranean. This likely hypothesis is thus in agreement with the results of our study (and those from Tudela et al. 2011) and could explain the relative residence of ABFT within the Mediterranean Sea. In other words, there could be more diversity in ABFT migratory behavior and spatial range than currently assumed and ABFT from the Mediterranean sub-population(s) could be more resident (or displaying a different spatial range) than ABFT from the North-Atlantic sub-population(s).

Our results also showed similar spatial distributions from 2007 to 2011, with a high concentration in a rather small area of the Northwestern Mediterranean that has never been documented before (Mediterranean ABFT fisheries indeed operated more North, in the Gulf of Lions, or more South, in the Balearics area, see Fromentin and Powers, 2005). Most of the tagged fish spent a long time in this rather small area and displayed sinuous tracks. This area could thus be a key feeding ground for ABFT in the Western Mediterranean. The homing behavior of a fish to this area after a full year and the back and forth of several ABFT to this area indicate that this feeding area is probably persistent from year-to-year. We put forward that this feeding area could be related to the general circulation in the northwestern basin (Millot, 1999), especially the North Mediterranean Current and the North Balearic front, which displayed permanent frontal zones that are known to concentrate abundant vertebrate and invertebrate preys for ABFT and marine mammals (e.g. Royer et al., 2004; Gannier and Praca, 2007). 'Such a hypothesis, however, needs deeper investigations of the mesoscale oceanic circulation, which could be performed through a comprehensive analysis of the remote sensing information (see e.g. Belkin and O'Reilly, 2009).

The results suggest that properly design MPAs used alongside with other management measures could be a useful tool for Mediterranean ABFT because the ABFT in this study were highly resident in the northwestern Mediterranean and highly concentrated in a small area. This area that could be roughly delimited by a box of 4°E to 6°E longitude and 43°N to 41°N latitude (i.e. about 49,400 km² and 5.8% of the surface of the whole western Mediterranean basin) includes 50% of all the daily geolocations. This percentage increases up to 60% to 70% from August to November and is lower during ABFT spawning season (June-July, Figure 6). This area could thus be a key hotspot for ABFT feeding, especially during autumn and secondarily in winter and early spring. These findings are in agreement with a recent study on Mediterranean ABFT habitat derived from satellite information (Druon et al., 2011), which also showed a main potential ABFT feeding habitat during late summer and autumn in the Northwestern Mediterranean. Although our tagging study remains preliminary, it indicates that the option of a spatial management, through MPAs, for a highly migratory species, such ABFT, deserves more careful consideration. ABFT, like most of the migratory species, displayed complex spatial dynamics through homing to spawning and feeding locations, which may lead to restricted seasonal areas, such as the Northwestern Mediterranean box of this study. Furthermore, ABFT is likely to display a complex population structure that could include several sub-populations of different size, migratory behavior and spatial range.

These two key features make MPAs a potential useful tool, but those processes have to be better understood and quantified prior to any comprehensive study on MPAs efficiency. In the case of Mediterranean ABFT, this should be soon possible, as genetic and tagging large-scale studies have been ongoing in the last few years and should substantially improve our understanding of ABFT population structure and spatial dynamics.

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Figures

Figure 1. Daily geolocations of Atlantic bluefin tuna by year and over the whole period (2007-2011). Note that the individual tracks may extend over two consecutive years (the year of release and the following year, see Table 1). The total numbers of geolocations for each map is given in parentheses. The release location (red square) is about 43.2°N and 4.7°E.

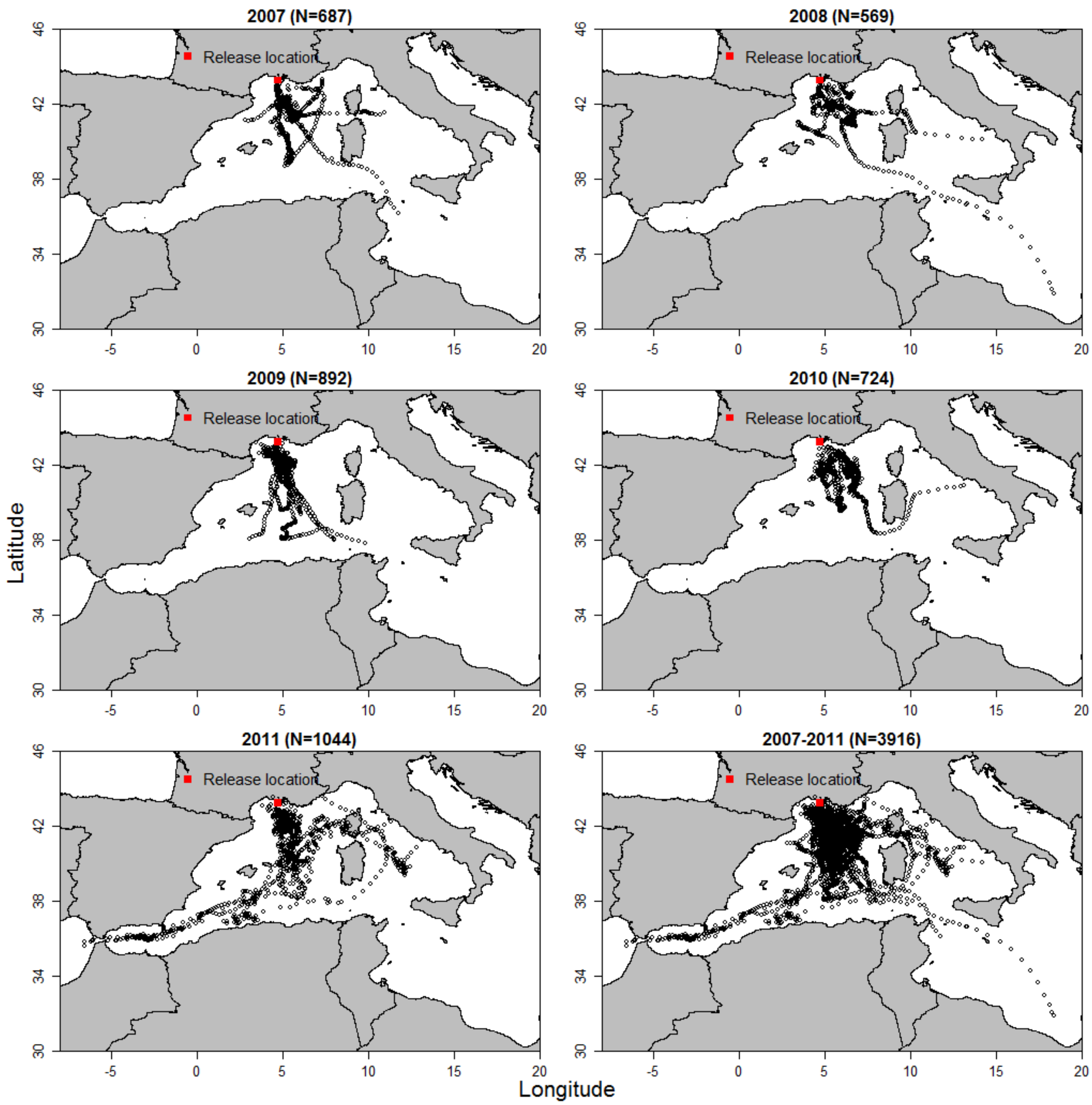


Figure 2. Track of tag 92108 with the release (black square) and pop-off (black circle) locations. Information about the month and year is provided by colour and symbol, respectively. The rectangle indicates the potential key area where details of the track are given in a subplot.

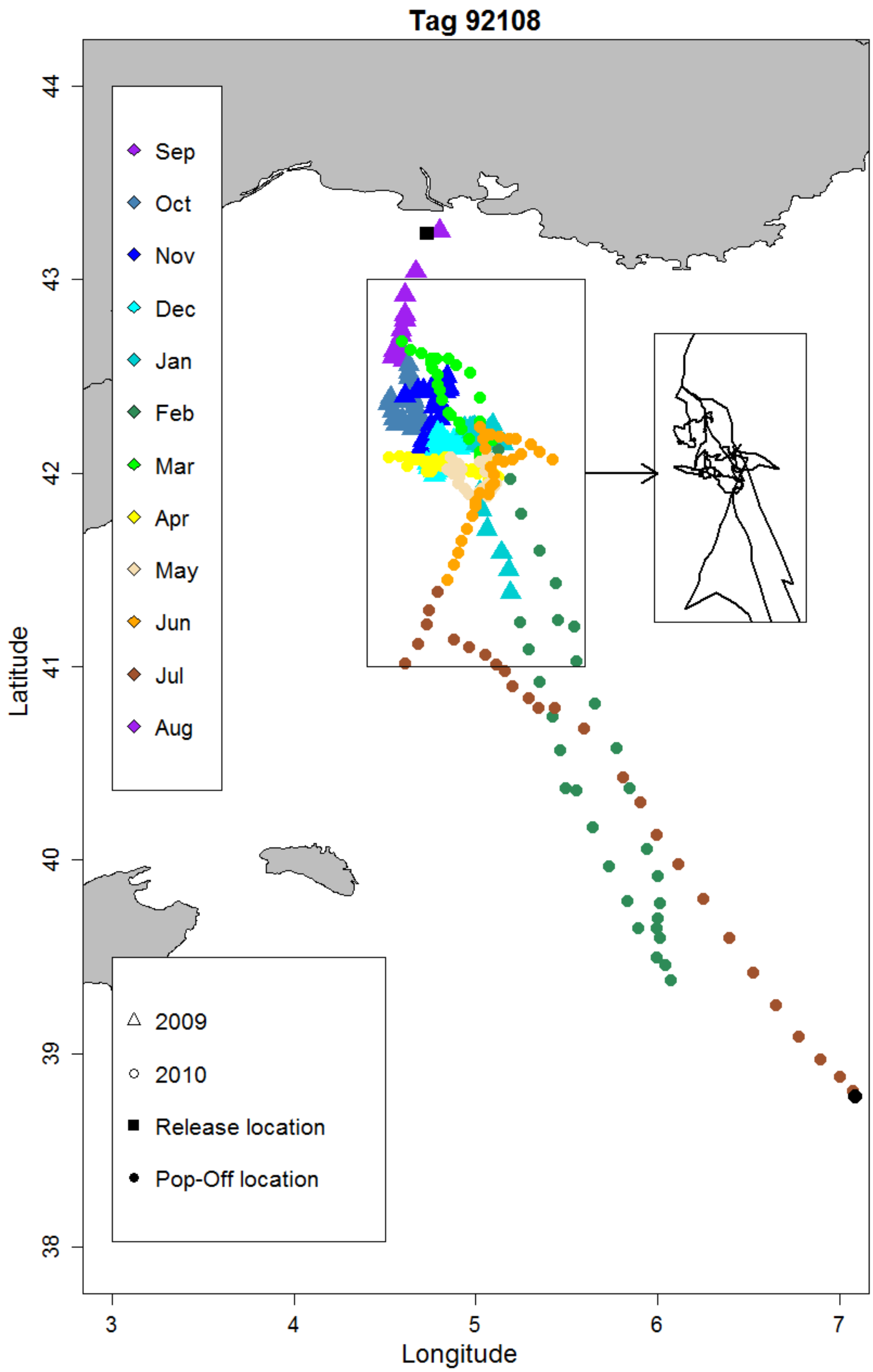


Figure 3. Track of tag 61964 with the release (black square) and pop-off (black circle) locations. Information about the month and year is provided by colour and symbol, respectively. The rectangle indicates the potential key area where details of the track are given in a subplot.

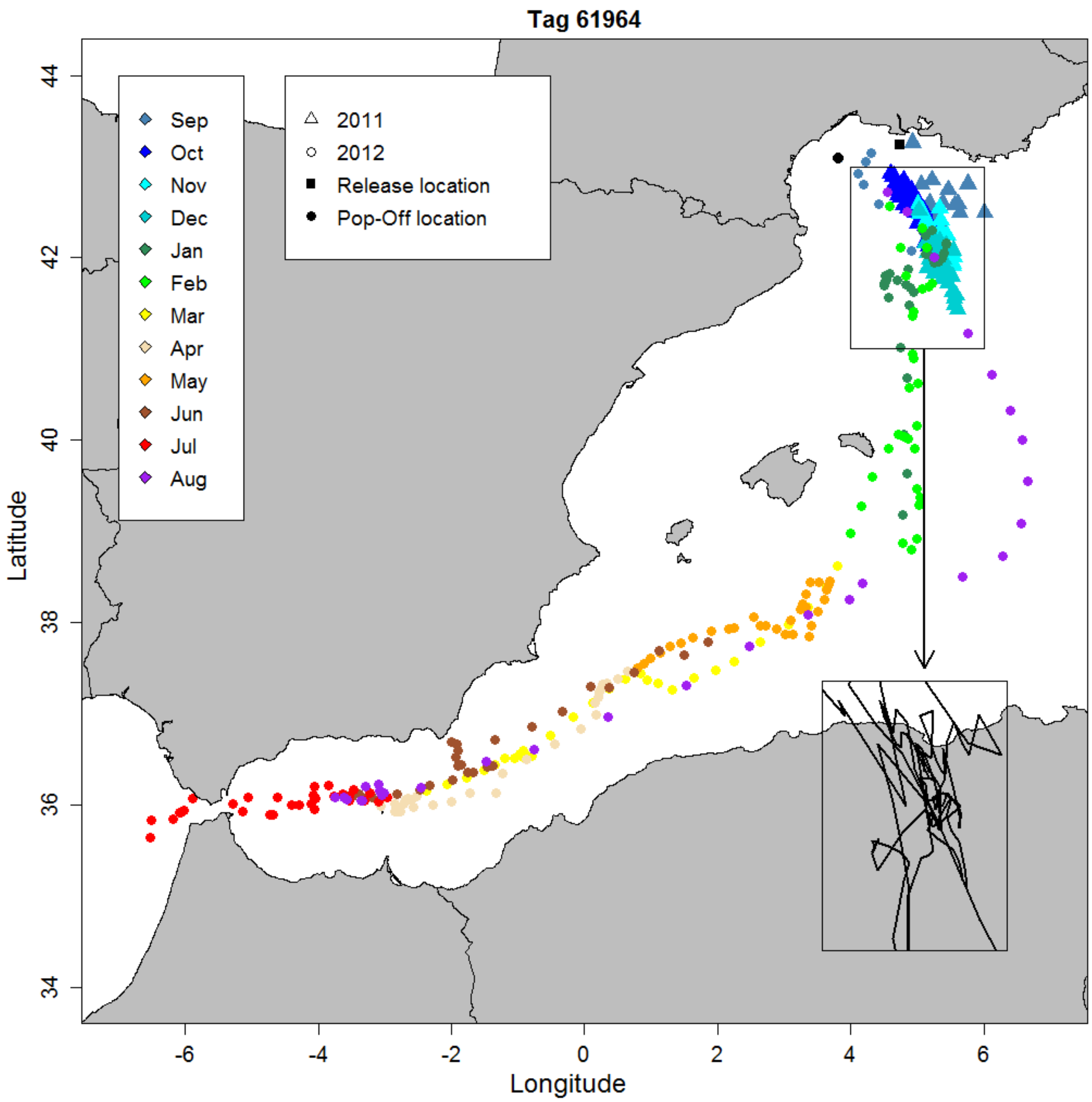


Figure 4. Annual and overall (2007-2011) spatial distributions of Atlantic bluefin tuna, using a two-dimensional kernel density function on the daily geolocations (number given in parentheses).

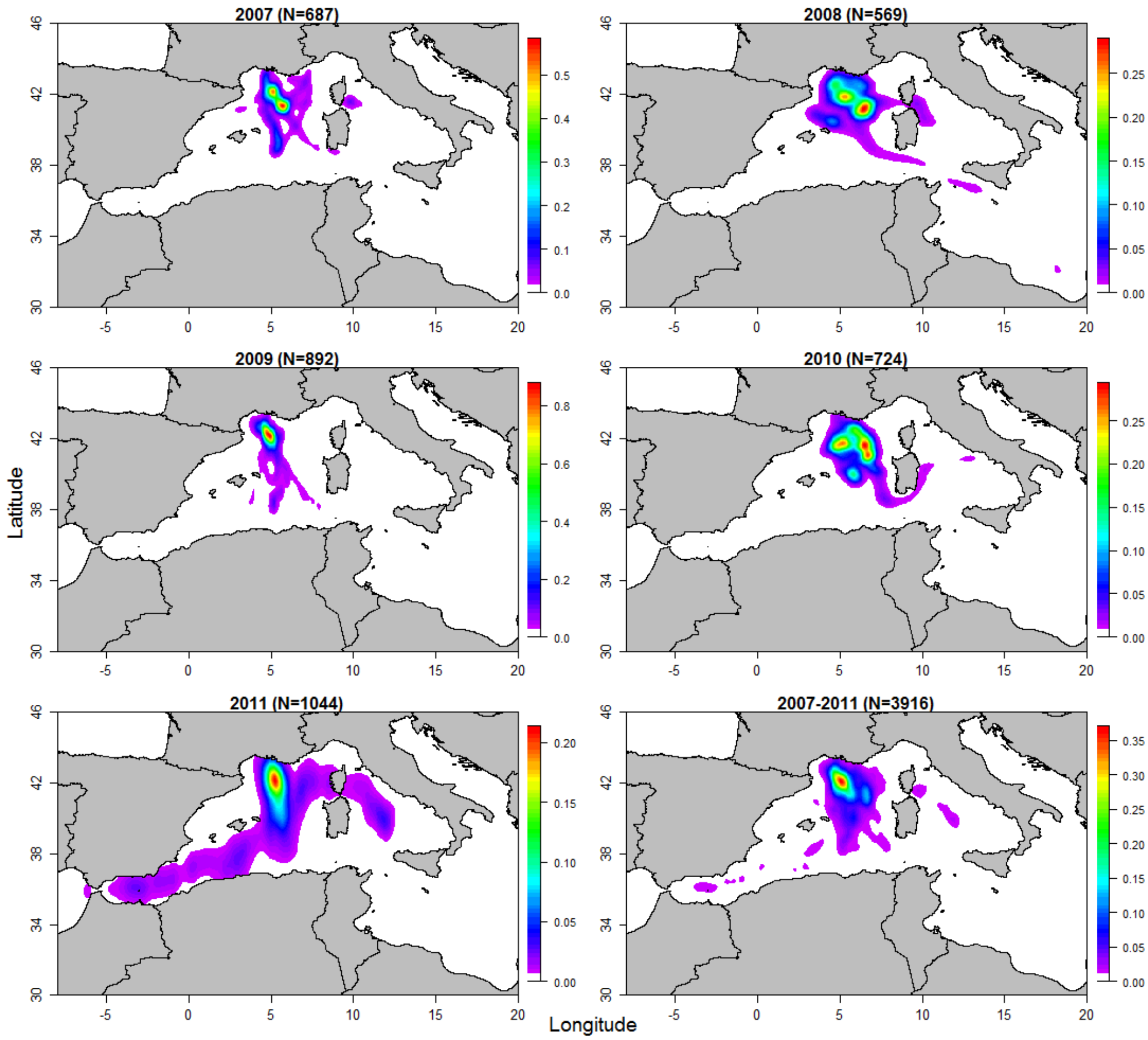


Figure 5. Distance between each daily geolocation and the release location (in nautical miles) against the number of days after release for all the tags (top-left) and for a few illustrative individual tags.

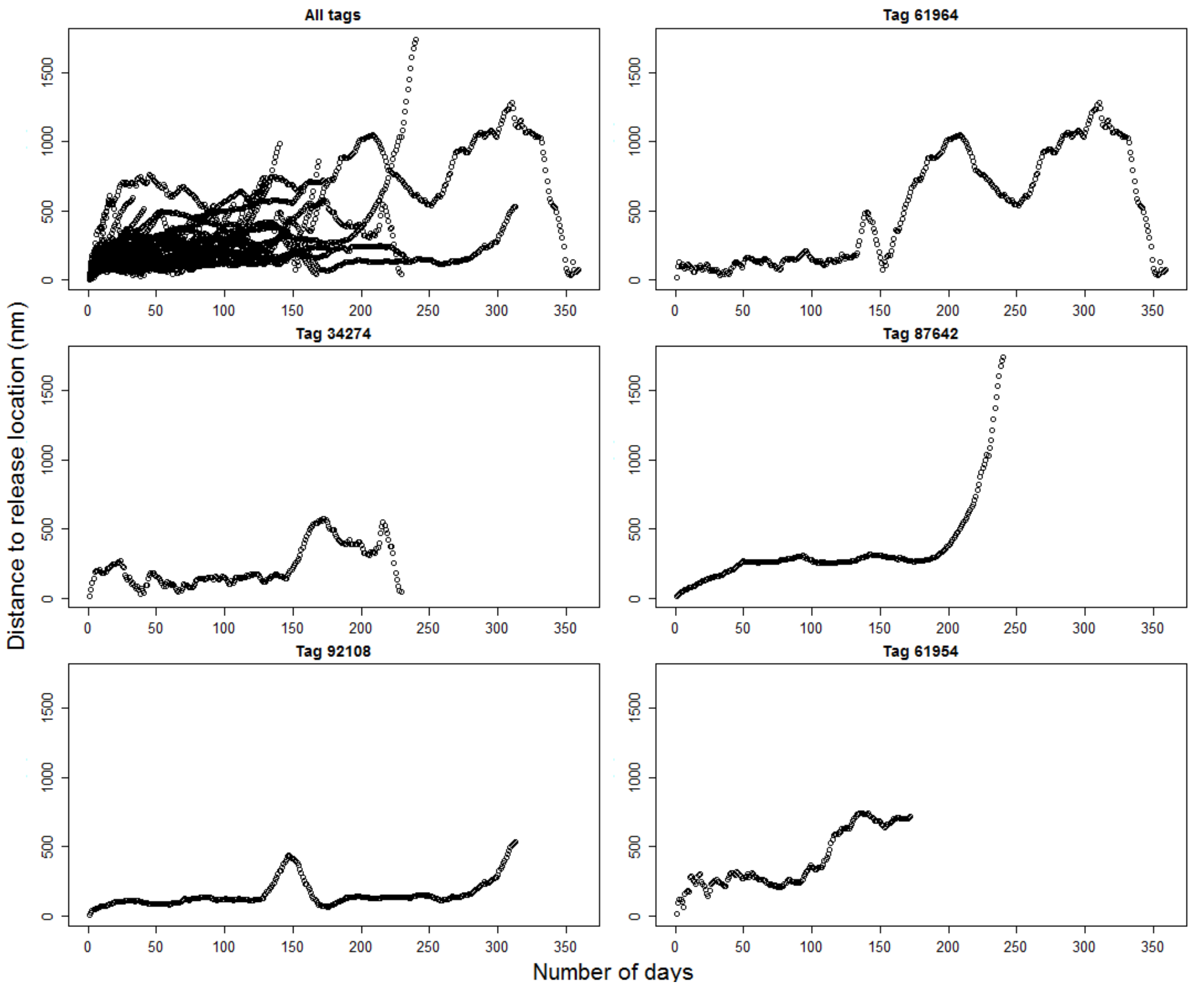
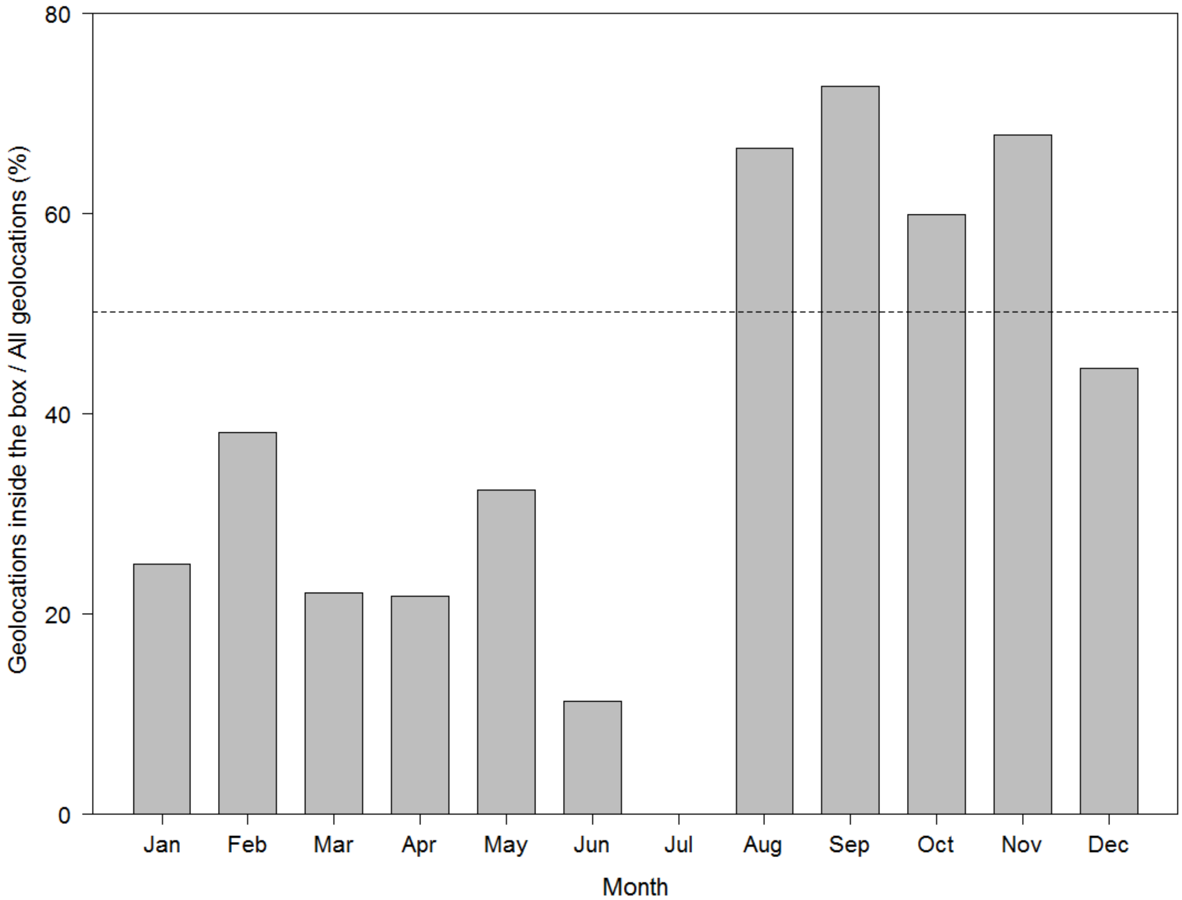


Figure 6. Monthly percentage of daily geolocations inside the key feeding area (delimited by a box of 4°E to 6°E longitude and 43°N to 41°N latitude). The calculation has been performed for each month using all the data.



Tables

Table 1. Detailed information about the 39 pop-up archival tags deployed between 2007 and 2011, i.e. the time and place of release, size of the fish at release, place of pop-off (or recapture) and time at sea (in days). Total distance is the sum of the distances between each daily geolocations while the mean distance per day is the total distance divided by the time-at-liberty.

Tag Ids	Release Date	Release Latitude (°E)	Release Longitude (°N)	Fish size (cm)	Recapture Latitude (°E)	Recapture Longitude (°N)	Time-at-Liberty (day)	Total Distance (nm)	Mean Distance/ day (nm)
68402	24/09/07	4.73	43.23	124	9.87	38.17	15	688	45.9
68403	03/10/07	4.97	43.28	235	4.86	38.44	40	756	18.9
68404	24/09/07	4.73	43.25	128	2.68	40.96	59	872	14.8
68405	21/09/07	4.73	43.23	127	4.06	41.14	88	946	10.8
68406	24/09/07	4.73	43.23	128	7.17	43.58	122	847	6.9
68407	02/11/07	4.92	43.27	130	0.25	36.2	69	*Transmission Failure*	
68408	22/09/07	4.73	43.23	132	11.68	41.95	91	829	9.1
68409	22/09/07	4.73	43.23	127	12.27	35.74	139	1280	9.2
37332	03/11/07	4.93	43.23	128	5.68	39.3	7	282	40.2
37333	03/11/07	4.93	43.23	133	6.16	41.07	4	161	40.4
37334	03/11/07	4.93	43.23	130	4.92	41.12	112	916	8.2
37331	31/07/08	5.4	43.05	225	6.27	41.23	18	209	11.6
80082	08/11/08	4.92	43.23	144	14.49	40.08	168	1717	10.2
87641	21/08/08	5.4	43.05	228	6.9	38.6	71	835	11.8
87642	26/10/08	4.91	43.26	210	18.33	31.88	239	2537	10.6
87643	26/10/08	4.91	43.26	143	3.95	42.03	55	509	9.2
87644	21/08/08	5.4	43.05	188	3.52	41.07	14	357	25.5
80083	20/08/09	4.8	43.27	197	4.79	43.28	1	*Death after Release*	
80084	16/08/09	4.82	43.27	198	4.95	41.32	149	1540	10.3
80085	07/08/09	4.82	43.27	190	8.92	44.36	1	*Death after Release*	
92107	21/08/09	4.8	43.27	192	5.98	37.99	112	854	7.6
92108	20/08/09	4.8	43.27	180	7.08	38.77	309	2098	6.8
92109	26/08/09	4.85	43.27	172		*Transmission failure*			
92110	28/08/09	4.98	43.27	180	11.03	37.42	129	1290	10
92111	26/09/09	4.82	43.28	156	2.32	37.72	33	659	20
92115	11/09/09	4.82	43.27	160	8	38	151	1466	9.7
92112	10/08/10	4.92	43.27	255	3.97	41.85	19	526	27.7
92113	28/08/10	4.82	43.27	160	5.22	43.06	166	1493	9
92114	01/09/10	4.89	43.27	160	3.97	41.85	176	1588	9
92116	24/09/10	4.87	43.27	160	4.38	42.85	234	1692	7.2
34261	24/09/10	4.87	43.27	156	13.13	40.89	125	1345	10.8
34273	06/08/11	4.78	43.27	165	7.29	43.6	101	3039	30
34274	18/08/11	4.91	43.27	160	4.13	43.04	228	3931	17.2
61954	24/08/11	4.9	43.27	165	13.04	41.15	170	3316	19.5
61958	19/08/11	4.91	43.27	169	11.28	42.23	105	1883	17.9
61964	16/09/11	4.93	43.28	185	16.25	41.31	362	8460	23.4
61966	17/09/11	4.93	43.3	207	4.79	41.91	75	2085	27.8
62008	16/09/11	4.93	43.28	237	4.96	43.3	1	*Death after Release*	
73422	21/08/11	4.91	43.28	159	8.45	40.26	238	*Transmission Failure*	