# REVIEW AND ANALYSES OF TAG RELEASES AND RECAPTURES OF YELLOWFIN TUNA ICCAT DB

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*SUMMARY*

*Conventional tagging data of yellowfin tuna was reviewed and preliminary analysis performed for its use within the stock evaluation. There are over 18 thousand fish tagged and released from 1956 to 2014, with over 1,500 recaptures giving an 8.6% average percent of recaptures. At least 408 of these recaptured yellowfin were again released with 3 fish recovered subsequently. Tagging operations covered both scientific and opportunistic tagging programs, concentrating in the Gulf of Guinea, and off Senegal coast in the east Atlantic, and in the Gulf of Mexico and off the north Atlantic coast of USA and Canada. Tagged yellowfin tuna have a median of 52 days at large with 83% of them recovered in the 1st year. The longest time at large is just above 10 years. There is substantial migration between the western Atlantic from the US/Canada coast and the Gulf of Mexico towards the Gulf of Guinea, but these movements are likely related to size/age of fish.*

*RÉSUMÉ*

*Les données de marquage conventionnel de l'albacore ont été examinées et une analyse préliminaire a été réalisée afin d'être utilisée dans l'évaluation de stocks. On compte plus de 18.000 poissons marqués et remis à l'eau entre 1956 et 2014 avec plus de 1.500 récupérations, ce qui donne une moyenne de récupérations de 8,6%. Sur les albacores récupérés, au moins 408 d'entre eux ont été une nouvelle fois remis à l'eau et trois poissons ont été récupérés par la suite. Les opérations de marquage incluaient des programmes de marquage à la fois scientifiques et opportunistes, se concentrant dans le golfe de Guinée, au large des côtes du Sénégal dans l'Atlantique Est, dans le golfe du Mexique et au large du littoral de l'Atlantique Nord des États-Unis et au Canada. Les albacores marqués ont passé en moyenne 52 jours en mer, 83 % d'entre eux ayant été récupérés au cours de la première année. Le séjour le plus long en mer dépasse juste les 10 ans. Il y a des déplacements considérables de poissons entre l'Ouest de l'Atlantique (des États-Unis / côte du Canada et le golfe du Mexique) vers le golfe de Guinée, et ces déplacements sont probablement associés à la taille/l'âge des poissons.*

*RESUMEN*

*Se revisaron los datos de marcado convencional del rabil y se llevaron a cabo análisis preliminares para su uso en la evaluación de stock. Se marcaron y liberaron 18.000 ejemplares desde 1956 hasta 2014, y hubo más de 1.500 recuperaciones, lo que supone un promedio de porcentaje de recuperación del 8,6%. Al menos 407 de estos rabiles recuperados fueron liberados de nuevo y tres se recuperaron posteriormente. Las operaciones de marcado incluían programas de marcado tanto científicos como oportunistas, concentrándose en el golfo de Guinea, en aguas de la costa de Senegal en el Atlántico este, en el golfo de México y en aguas de la costa noratlántica de Estados Unidos y Canadá. Los rabiles recapturados habían pasado una media de 52 días en libertad y el 83% de ellos había sido recuperado en el primer año. El tiempo más largo en libertad se sitúa justo por encima de 10 años. Hay una migración importante entre el Atlántico occidental desde la costa de Estados Unidos/Canadá y el golfo de México hacia el golfo de Guinea, pero estos movimientos están probablemente relacionados con la talla/edad de los peces.*

*KEYWORDS*

*Tagging, yellowfin tuna, tropical tunas*

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## 1. Introduction

The ICCAT conventional tagging database includes data from several nations and research agencies representing data from scientific and voluntary participating programs that tag and recapture ICCAT species in the Atlantic and Mediterranean Sea. Tagging information is part of the annual fisheries statistical data submissions requested to CPCs. The SCRS has commonly used the tagging data as source and support for providing best scientific advice on management of ICCAT species. In the case of tropical tunas, important biological and populations structure parameters have been inferred from conventional tagging programs and presently a large Atlantic wide tagging program has started to enhance the basic knowledge on these species. The goal of this document is to review and summarize the current information on conventional tagging for yellowfin in particular and present preliminary analysis on factors that have potential effects on recovery of tagged fish. It is important, however to note that the ICCAT tagging information is the collection of multiple tagging programs, some of them with a scientific research plan, but other are more opportunistic in nature. As such, results and conclusions from the analysis need to be carefully considered.

## 2. Data

For yellowfin tuna there are over 18,000 tag release records from 1956 to 2014, however most of the tag releases were from the 1990's to 2002 (**Fig 1**). In 2001/02 close to 2,000 tagged yellowfin were released, however in the latest decade the number of conventional tag releases has declined substantially to less than one hundred per year. **Table 1** summarized the number of tag records at the ICCAT DB by the status of the tag for yellowfin tuna. Overall 18,191 fish (R1) has been tagged and released off which 1,575 recaptures were reported. Of the recaptured yellowfin 408 were subsequently released again with the same or new tag (R2), of these 3 fish has been recapture for the second time and re-release (R3). The overall percent of recapture is 8.66% for yellowfin tuna. Most of the reports indicate at least tag number, species, date of tag / recapture, location (latitude - longitude), fishing gear, size, and weight (type of measure, units and whether it was actually measure or estimated). Unfortunately there are many incomplete records albeit the Secretariat has in collaboration with national scientist made substantial efforts to update and revise tagging information in recent years. An initial quality control was done on the data to eliminate clear outliers, both in size and dates information. Locations of release and recapture were revised and reports of latitude 0 and longitude 0 were considered unknown. Weight in particular was not considered as with tagging operations is very often poorly estimated.

**Figures 2** and **3** show the spatial distribution of YFT tag releases and recaptures by decade, respectively. Most tagging activity is centered in off the North America coast including the Gulf of Mexico and the Gulf of Guinea off West Africa. At the peak of the tagging activity in the 1990, releases where done through the north-west Atlantic including the Caribbean, Gulf of Mexico, Grand Banks, while in the east Atlantic, releases were mainly from the Gulf of Guinea, off Senegal coast and the Madeira and Canarias islands. In contrast very limited tagging has been carried out in the south Atlantic with sporadic releases of Uruguay and the South Africa coast. After close examination, 245 tags were also excluded as the geographic position of release indicated that these were fish tagged in the Pacific Ocean off the Central America coast. **Figure 4** shows the distribution of tag releases and recaptures by flag, USA has tagged over 9,000 (54%) yellowfin mostly from their cooperative tagging programs carry out mostly by recreational fisherman (Ortiz 2001). It is follow by Ghana, Sao Tome and Principe were scientific tagging programs for tagging tropical tunas were done in the 1999 to 2002. Recaptures has been reported mainly from the tropical fisheries (France, Spain, Côte d'Ivoire) and the recreational fisheries of USA.

There are several different types of gear reporting tag releases or recaptures of yellowfin, after aggregating in the main type of gear (**Table 2**), rod and reel and Baitboat are by far (86%) of the main fishing gears for releasing tagged fish (14,098). While, most recaptures are coming from baitboat (70%, 1070) reports, follow by rod and reel, and very few from other fishing gears. **Table 3** and **Figure 5** show the pattern of recaptures by gear in function of the gear of release. Most recaptures are from purse seine fishing operations (47%), particularly from fish tagged by Baitboat operations (63%) but also from fish tagged in PS. In contrast, tagged fish from rod and reel (RR) are primarily recapture also by RR (75%), with fewer caught by longliners (14%). Other (OT) gear category includes mostly unknown gear information.

Size was standardized to fork length (FL) in round centimeter units when available. Size at release was review and fish less than 10 FL cm and larger than 300 FL cm were excluded as considered outliers, no size conversion was applied for total length (TL), or lower-jaw fork length (LJFL) as considered within the margin of measurement error. **Figure 6** shows the overall size frequency distribution of tagged YFT. The mean size of tagged YFT is 62.6 cm FL with a range of tagged fish between 11 and 254 FL cm. The size frequency

distribution is skewed to the smaller sizes with a mode at 45-50 cm, and geometric mean of 58 cm, 80% of the tagged fish range between 40 and 102 FL cm. Fish larger than 100 cm FL represent about 10% of the tagged YFT. But there are at least 165 YFT tag and released of size greater than 150 cm FL. However, size distributions vary substantially in function of the type of gear of release (**Fig 7**). Smaller fish were tagged by Baitboat operations with sizes ranging from 28 to 98 cm FL with a median of 45 cm FL. In contrast, purse seine YFT tagged fish tend to be larger size fish (41- 155 cm FL) with a median of 110 cm FL although the number of fish tagged is comparatively small (45 fish only). Other gears, such longline, rod and reel, and others tagged a wider size range (18 -254 cm FL) with a median of about 61 to 71 cm FL. Similarly, the size distribution of recapture YFT varies according to the gear of recapture. **Figure 8** shows the size distribution of recaptures of YFT by main gear type, smaller fish are typically caught by baitboat, purse seine and others gear with a mean size of 54 - 59 cm FL and 80% quartile between 42 to 90 cm FL. Instead, rod and reel and longlines tend to recapture fish of mean size about 105 -113 cm FL, with 80% quantile between 68 to 130 cm FL.

For a tagged YFT the longest time at liberty was 3684 days (10 yrs.) for a fish tagged off Long Island New York coast on Sep 1991and recapture off Nova Scotia Canada on Oct 2001 weighting over 280 kg. However, the time a large of recaptured fish distribution is very skewed (**Fig 9**) with a median of 52 days at large. 40% of tag recoveries are from fish being at large less than a month, 72% less than 6 month, 84% less than a year and 99% before 4 years. There is also variation of days at large as function of the gear of release. **Fig 10** shows distributions of days at large by mean gear and the cumulative density functions. Fish tagged and released from longline and rod and reel gears showed on average longer times at large with medians of 263 and 189 days at large, respectively. On the other hand fish tagged and released from Baitboat were at large shorter times with a median of 36 days. Fish released from purse seine u other gears have intermediate times at large. Nonetheless, most tagged fish were recovered within the first 150 days. If the gear of recapture is considered (**Fig 11**), it appears that recoveries from longlines recapture fish that has been the longest time at large from any gear tagged YFT.

## 3. Methods

For observations were both location of release and recapture were available it was estimated the "displacement distance" in km as the geodesic shortest distance between two points on an ellipsoid using as reference the WGS84 and earth radius of 6378137 m (Karney 2013). **Figure 12** shows the displacement distance for groups of times at large from 1 month to 2 years plus. In order to investigate movement patterns, age of individual tagged fish was also estimated by inversion of the YFT growth curve (Shuford et al 2007) including stochastic variance of size at age (Shuford et al 2007). Ageing protocol assumed a birth at month 11 and probabilities of age at size were estimated taking into account decrease in numbers of fish with age due to natural mortality. The age vector of natural mortality (M) and variance of size at age used was the same as the ones in the last stock assessment (Anon. 2012). The ageing method gave as a result a vector of probabilities of ages in function of size and month at release; finally individual age was assigned to the highest age probability class, in case of ties, age was randomly assigned within the tied-age groups. **Figures 13** and **14** show the estimated age distribution of both YFT at release and YFT at recapture, respectively.

Preliminary evaluation of tag recaptures indicated difference in the percent of recaptures as function of several factors such gear, age and geographic location. Thus, to evaluate the success of recapturing a tagged YFT, a generalized linear model (GLM) was applied to the data where the number of recaptures of total releases by strata assumed a binomial error distribution. The factors considered in the analysis included main fishing gear at release, estimated age of fish at release, main geographic area of release and quarter of the year. Because of the scarcity of the data for some effects, the levels were aggregated as follow: i) Ages of release were considered 0, 1 and 2 plus groups, ii) main geographical areas were defined as Gulf of Mexico, Gulf of Guinea, Northeast Atlantic coast (USA and Canada), and other region, iii) quarter representing the trimester of date of release (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec), and iv) main gear of release: Baitboat (BB), longline (LL), rod & reel (RR), purse seine (PS) and other gears (OT). **Table 4** shows the results of the GLM indicating the significance of the model and main factors in the successful recovery of a tagged YFT. There is however a high variance in the data. To evaluate the effect of each level, least square means were estimated and plotted (**Table 5**). All four effects; area, quarter, gear and age were statistically significant.

Increment of size was estimated for those tagged and recaptured YFT that provided both measurements. As expected there is substantial variance in change of size particularly for fish with shorter times at large (**Fig 15**), however the overall trend is positive indicating that fish continue growth in size after the initial tag event.

## 4. Results and Discussion

The YFT ICCAT tagging db includes over 18 thousand fish tagged and released from 1956 to 2014, with about 1,500 recaptures giving an 8.6% average percent of recaptures. At least 408 of these recaptured yellowfin were again released but only 3 fish has been recovery for the second time. Tagging operations covered both scientific and opportunistic tagging programs, mostly in the mid-1980s in USA and 1990's off the Tropical fisheries in the West African coast, at the peak of tag-releasing in 2001/02 over 1700 fish were released. However, conventional tagging has substantially declined since 2004. Geographically tagging has concentrated in the Gulf of Guinea, and off Senegal coast in the east Atlantic, and in the Gulf of Mexico and off the north Atlantic coast of USA and Canada, very sporadic and few tagging has been done in the south Atlantic.

Four main fishing gears tag release or recovery yellowfin tuna, baitboats, longlines, purse seiners and rod and reel. As expected size at release is related to the fishing gear, baitboats release and recapture overall the smallest YFT (mean size 61 cm FL and 56 cm FL, respectively), while rod and reel and longlines release tagged wider sizes including small and medium large fish. Surprisingly purse seine tagged only large size yellowfin (mean size 110 cm FL), although only few fish has been tagged and released with PS. Recaptures by longline gear were of fish between 50 and 140 cm FL, in a bimodal distribution with peaks at 70 and 110 cm FL. Rod and reel recaptured the largest size yellowfin with range typically between 70 to 130 cm FL, and a median of 104 cm FL. The flow diagram between gear of release and recapture shows that releases from baitboats are recovered mainly by purse seines and other gears (mostly unreported gear), while releases from rod and reel is mostly caught again by rod & reel and longlines. There is however a significant number of records with incomplete information regarding gear of release or recapture.

Tagged yellowfin tuna that have been recovered so far have a median of 52 days at large, although the time at large is highly skewed towards few days, 25% of recoveries were in the first 15 days after release, 72 % in the first six months and 83% in the 1st year. The longest times at large so far is just above 10 years, however there is some uncertainty in the species identification of this fish that couldn't be confirmed. Nevertheless, there are 227 records of tagged fish that were recovered after a year at large. Preliminary analyses also indicated differences in time at large as function of the gear of release; fish tagged from longline and rod and reel gears, were at large longer times than other releasing gears. The median time at large from LL and RR were 263 and 189 days at large, substantially longer than baitboat (36 days at large) or purse seine (131 days at large) releases.

Although conventional tagging only provide the point of release and point of recapture, the estimated distance of displacement (straight line) show interesting patterns. Overall there is substantial migration between the western Atlantic from the US/Canada coast and the Gulf of Mexico towards the Gulf of Guinea, but these movements are likely related to size/age of fish. Mainly fish of age 1 and 2+ show displacements over 5000 km, and they travelled those distances if they were at large for at least 1 year (**Fig 12**). There are also fish that went to the Gulf of Biscay and others moving off the New England coast towards South America and the Caribbean regions. This is consistent with the current hypothesis of a single Atlantic stock unit for yellowfin tuna.

Estimated age at release indicated that most tagged YFT were age 0 and 1 at release with few age 2+. However the probabilities of recoveries vary also by age/size, the GLM model indicated that ages 1 and 2+ are about 3 times more likely to be recaptured than age 0 fish. The model also indicated that fish tagged by baitboats have higher probabilities of being recaptured (41%) compared to other fish tagged by other fishing gears although in relative very short time after release. In addition, it appears that fish tagged in the 1st quarter of the year (Jan-Mar) have also higher proportion of recaptures compared to the rest of the year. By geographical areas, yellowfin tagged and released from the Gulf of Guinea shows the lowest proportion of recaptures. As indicated in prior analysis, yellowfin travels between the western North Atlantic to the Gulf of Guinea were are recaptured, however not recoveries have been reported of the opposite direction (tagged on the Gulf of Guinea and recover in the Northwestern Atlantic), likely reflecting the interaction of tagged fish from Baitboat operations with small size/age and expected short times at large.

It is important to note that the preliminary analyses and results here exposed have several assumptions that could substantially affect the results. Difference in gear recovery or survival to tagging can be due to differences in reporting rates by fleets. It is know that some fleets may have low or not report conventional tags, because of the nature of the fishing operations (e.g. handling of catch of purse seiners) or other reasons. However, whether or not those differences are from reporting or gear actual selectivity, for factual recovery rates the results are effectively similar. Also, tagging shading / retention is assumed to be constant thought the results, which likely has varied as changes in tag materials, design and operation of tagging has evolved through the years. Finally, differences of tagging program(s) and objectives may mask some of the results. Scientific tagging programs

tend to have more limited spatio-temporal releases; while opportunistic/ recreational tagging is wider in terms of spatial and temporal distribution of releases, but accuracy of reported data tend to be lower.

Nevertheless, this review indicated some important conclusions regarding conventional tagging of Atlantic yellowfin tuna. Tagging results indicate that YFT move across the Atlantic ocean between off the North America coast and the Gulf of Mexico to the Gulf of Guinea and possible the Bay of Biscay. However, these displacements are likely size/age related and only fish of ages 1 and 2+ shows this pattern of migration (**Fig 17**). Likely this movement is an annual base, as the minimum time at large is 1 year. There are also more localized movements between for example the West African coast, from the Gulf of Guinea towards and from the Senegal coast or the Madeira/ Canarias archipelagos. Also movements along the Eastern coast of US/Canada towards the Gulf of Mexico or the Caribbean islands. There is very limited information of movement patterns in the South Atlantic due to few tag releases. The GLM model indicates substantial differences in the success of recapture tagged YFT, associated with gear of release geographical area of release, size/age of release and possible time of year (quarter). Depending upon the objective of a research, these factors can provide guidance on when, where to prioritize tagging releases to achieve higher recaptures.

**Literature Cited**

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**Table 1.** Number of yellowfin tag releases/recaptures by tag status from the ICCAT DB.

| *Tag stage code* | *Releases* | *Recaptures* | *Percent recapture* |
|---|---|---|---|
| Initial Release (R1) | 18191 | 1575 | 8.66% |
| Second release (R2) | 408 | 3 | 0.74% |
| Third release (R3) | 3 | 0 | |
| Grand Total | 18602 | 1578 | |

**Table 2**. Distribution of Atlantic YFT tag releases (R1, R2, R3) and recaptures (RC1, RC2, RCF) by main gear type ICCAT DB. Gear types: rod and reel (RR), Baitboat (BB), longline (LL), others (OT) and purse seine (PS).

| | YFT conventional tags | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Releases | | | | | | Recaptures | | | | | |
| | Tag release code | | | | | | Tag recapture code | | | | | |
| | R-1 | | R-2 | | R-3 | | RC1 | | RCF | | RC2 | |
| ReGear | N | Column % | N | Column % | N | Column % | N | Column % | N | Column % | N | Column % |
| RR | 8050 | 49.15% | 287 | 71.22% | 3 | 100.00% | 316 | 20.78% | 5 | 29.41% | 3 | 100.00% |
| BB | 6048 | 36.93% | 0 | 0.00% | 0 | 0.00% | 116 | 7.63% | 9 | 52.94% | 0 | 0.00% |
| LL | 1842 | 11.25% | 54 | 13.40% | 0 | 0.00% | 64 | 4.21% | 1 | 5.88% | 0 | 0.00% |
| OT | 394 | 2.41% | 24 | 5.96% | 0 | 0.00% | 298 | 19.59% | 1 | 5.88% | 0 | 0.00% |
| PS | 45 | 0.27% | 38 | 9.43% | 0 | 0.00% | 727 | 47.80% | 1 | 5.88% | 0 | 0.00% |

**Table 3**. Percent of tag recaptures (cols) by main gear in function of the gear of release (rows) for Atlantic YFT ICCAT db.

| | RcGear | | | | |
|---|---|---|---|---|---|
| | BB | LL | OT | PS | RR |
| ReGear | Row % | Row % | Row % | Row % | Row % |
| BB | 11% | 0% | 25% | 63% | 0% |
| LL | 0% | 23% | 10% | 13% | 54% |
| OT | 0% | 0% | 50% | 38% | 13% |
| PS | 25% | 0% | 0% | 50% | 25% |
| RR | 0% | 14% | 3% | 9% | 75% |
| All | 8% | 4% | 19% | 47% | 21% |

**Table 4**. Result GLM on the success of recovery of tagged YFT as function of area at release, fishing gear of release, calendar quarter and estimated age of release.

**Generalized Linear Model Fit**

Overdispersion parameter estimated by Pearson Chisq/DF
Response: Sucess
Distribution: Binomial
Link: Logit
Estimation Method: Firth Adjusted Maximum Likelihood
Observations (or Sum Wgts) = 14314

**Whole Model Test**

| Model | -LogLikelihood | L-R ChiSquare | DF | Prob>ChiSq |
|---|---|---|---|---|
| Difference | 789.315715 | 1578.631 | 12 | <.0001* |
| Full | 3625.64285 | | | |
| Reduced | 4414.95857 | | | |

| Goodness Of Fit Statistic | ChiSquare | DF | Prob>ChiSq | Overdispersion |
|---|---|---|---|---|
| Pearson | 16721.97 | 14301 | <.0001* | 1.0000 |
| Deviance | 7251.286 | 14301 | 1.0000 | |

| AICc |
|---|
| 7279.3151 |

**Effect Tests**

| Source | DF | L-R ChiSquare | Prob>ChiSq |
|---|---|---|---|
| Area | 3 | 357.24192 | <.0001* |
| ReGear | 4 | 510.77455 | <.0001* |
| Quarter | 3 | 280.79009 | <.0001* |
| AgeRel2 | 2 | 105.64892 | <.0001* |

**Table 5**. GLM results on the success of recovery YFT as function of area, gear, quarter and age of release.

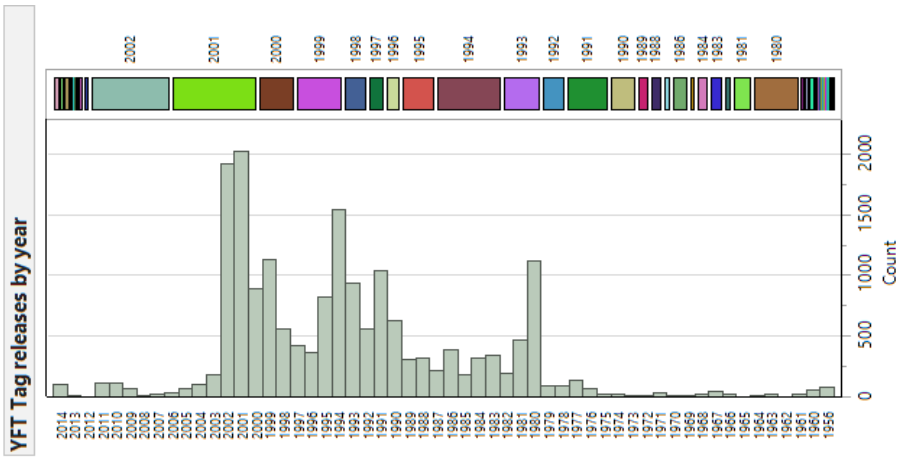



**Figure 1**. Number of YFT tag releases by year ICCAT DB.

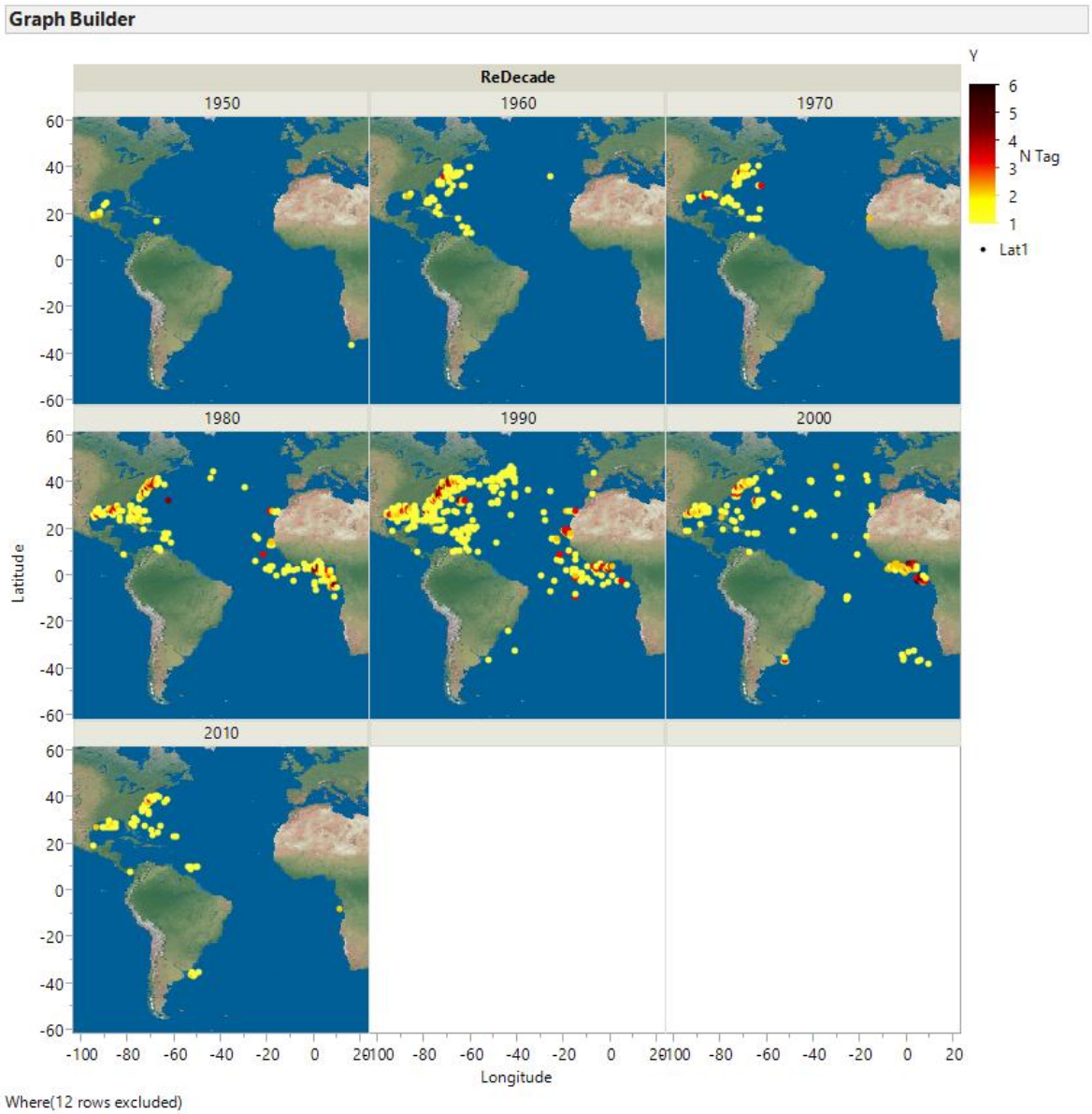



**Figure 2.** Spatial distribution of tagged YFT releases by decade. Color of symbols is proportional to the number ($log_{10}$) of tags per square 1 x 1 lat-lon grid.

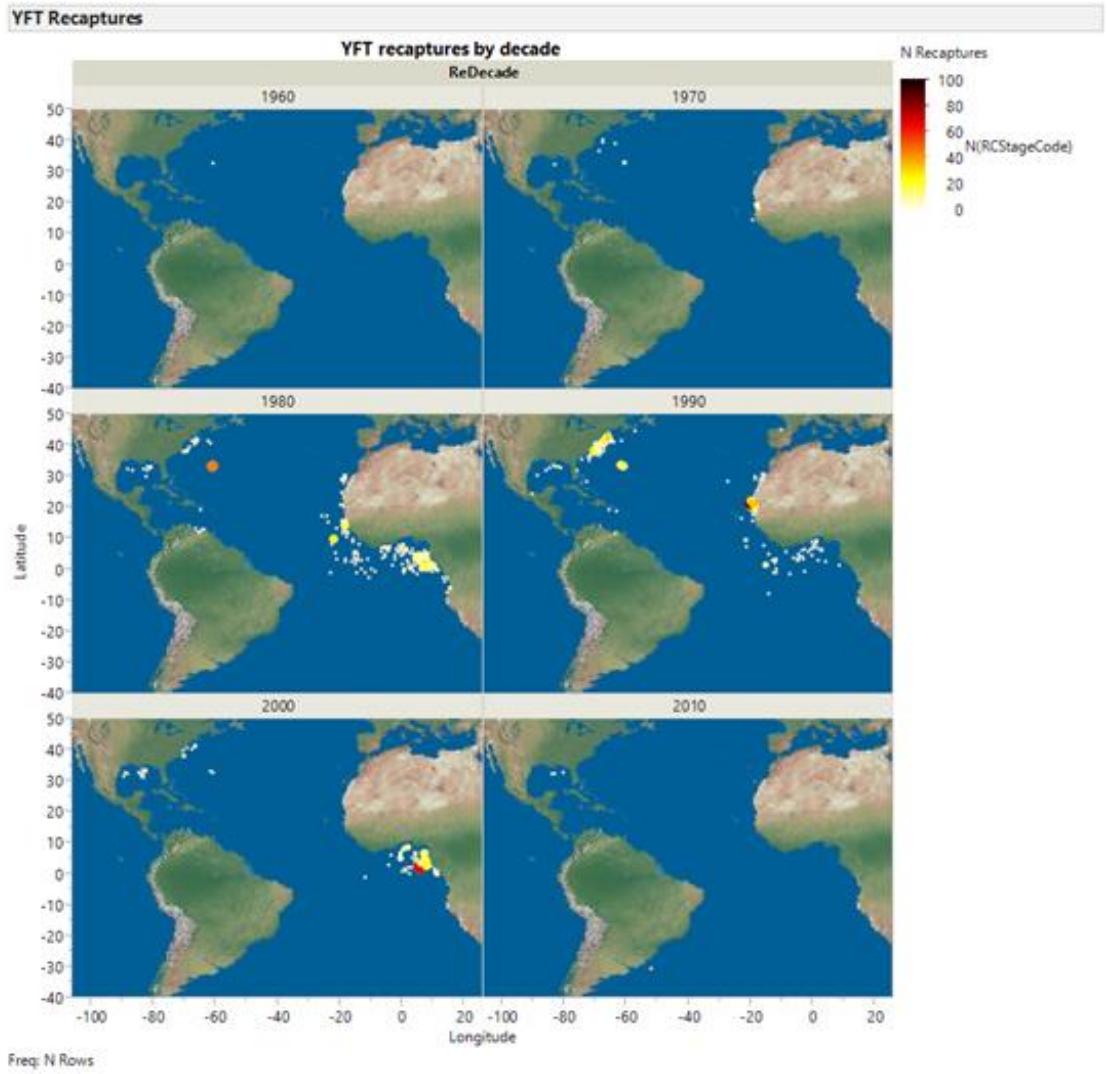



**Figure 3**. Spatial distribution of tagged YFT recaptures by decade. Color of symbols is proportional to the number of tags per square 1 x 1 lat-lon grid.

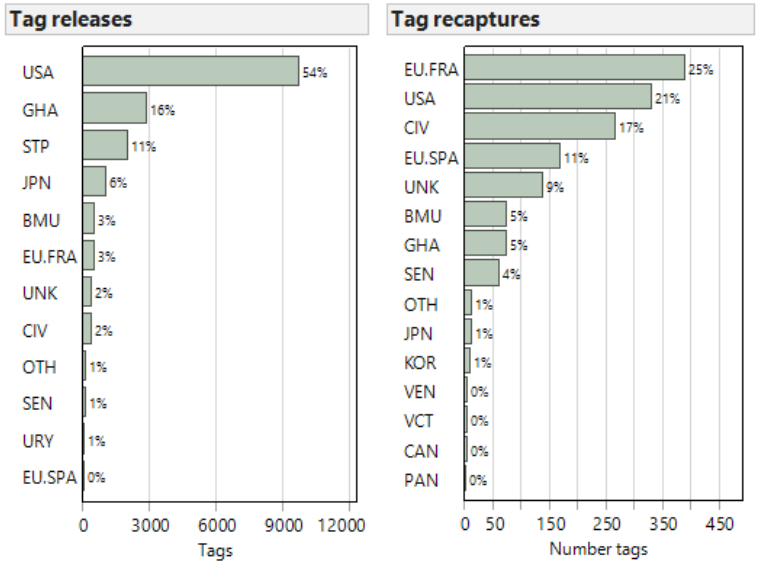



**Figure 4.** Number of YFT tag releases and recaptures by flag ICCAT DB.

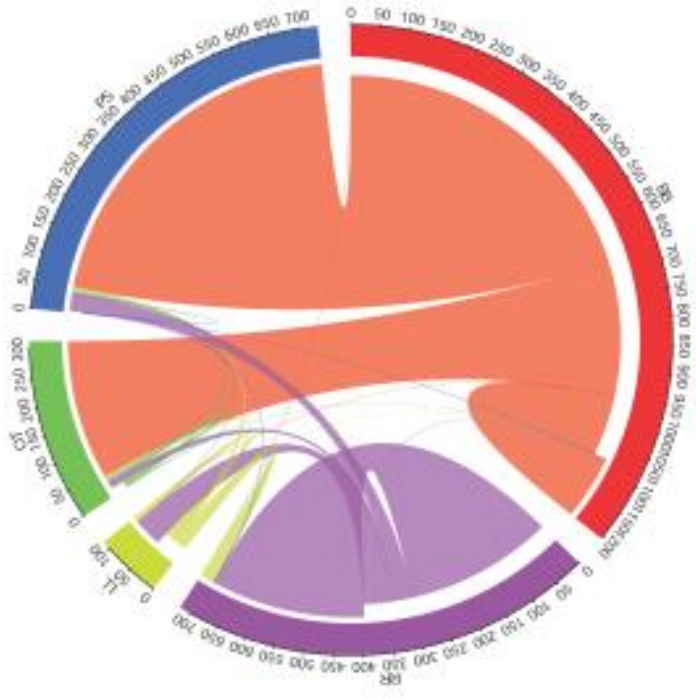


**Figure 5**. Circular flow plot of the YFT tag releases by main gear (outer ring) and the recapture gear proportion (flow patterns).

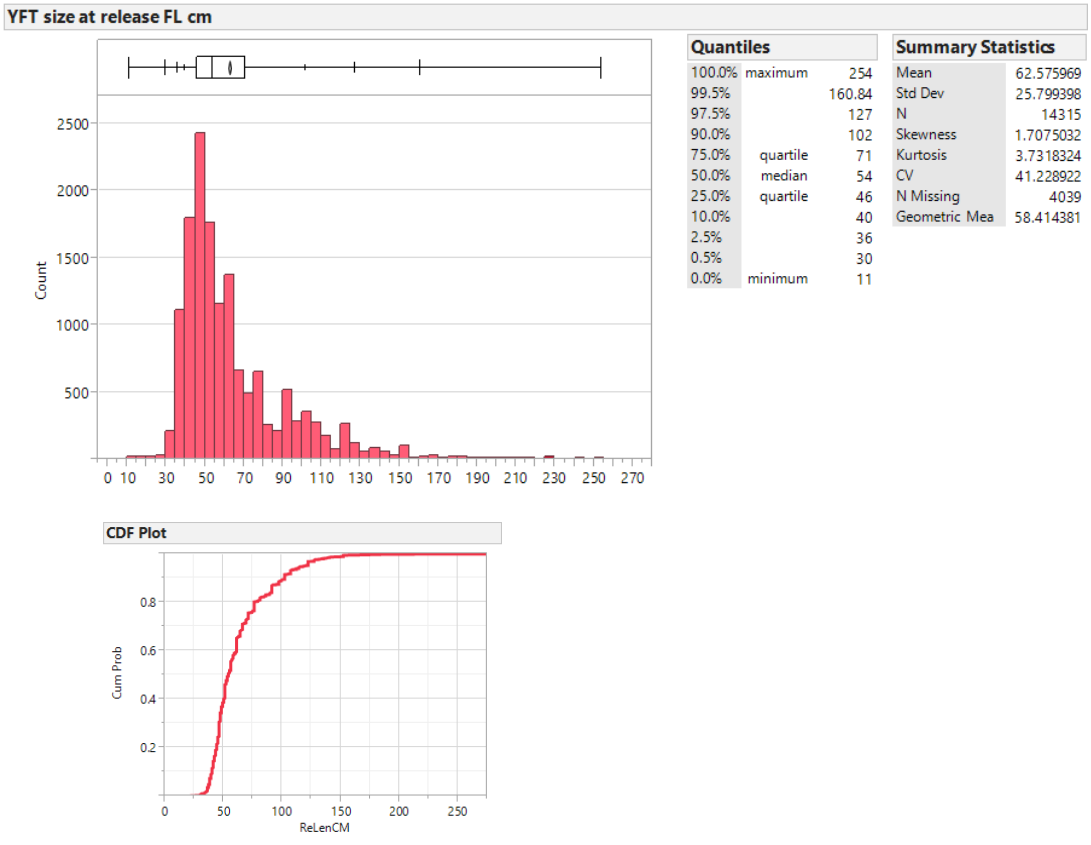



**Figure 6**. Summary of the size frequency distribution of tagged YFT fish ICCAT db.

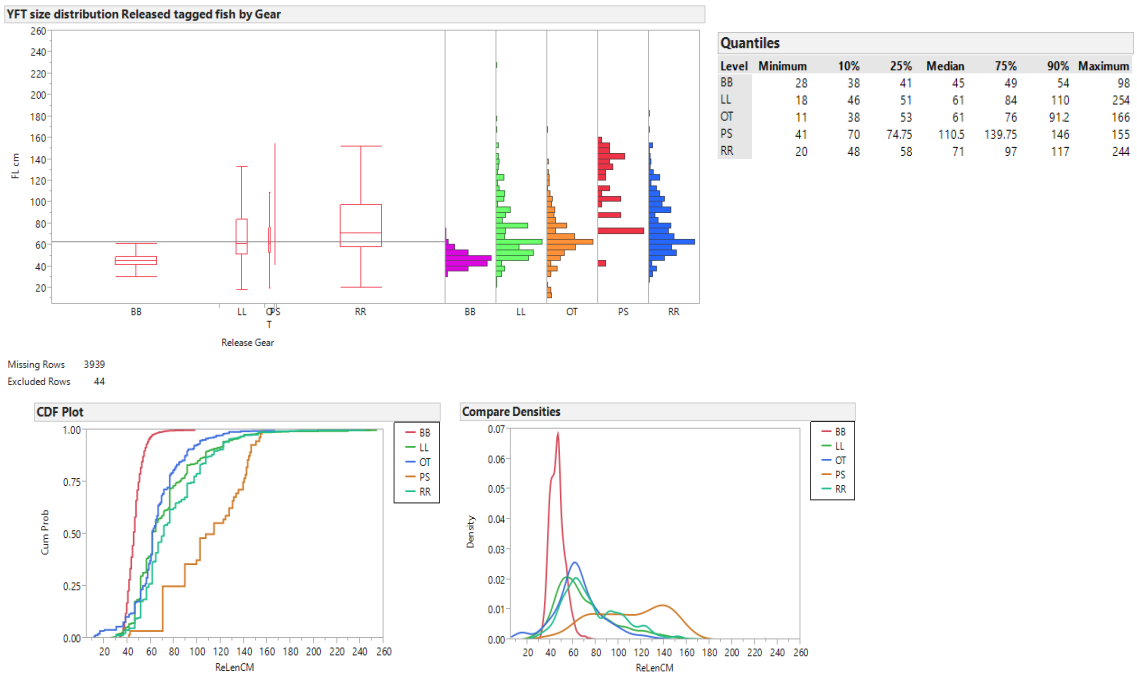



**Figure 7.** Size distributions of YFT tag and released by main gear ICCAT db.

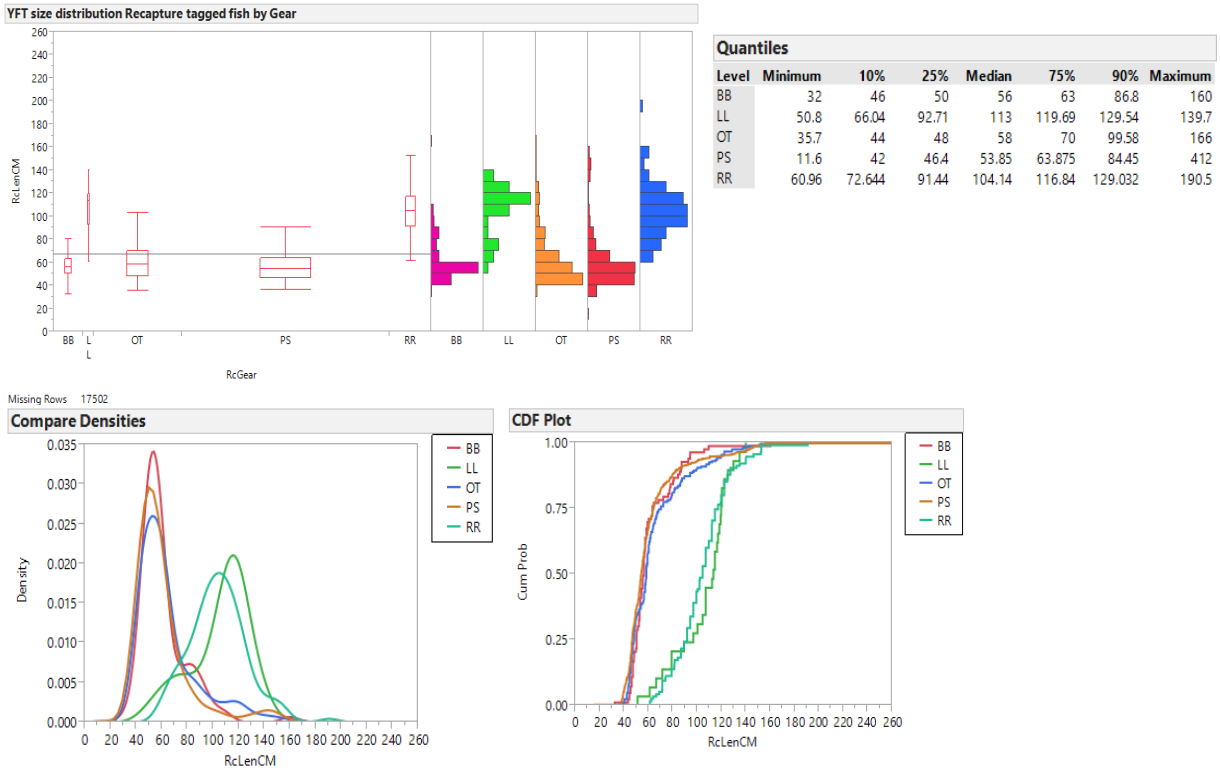



**Figure 8.** Size distributions of tagged YFT by main gear of recapture, ICCAT db.

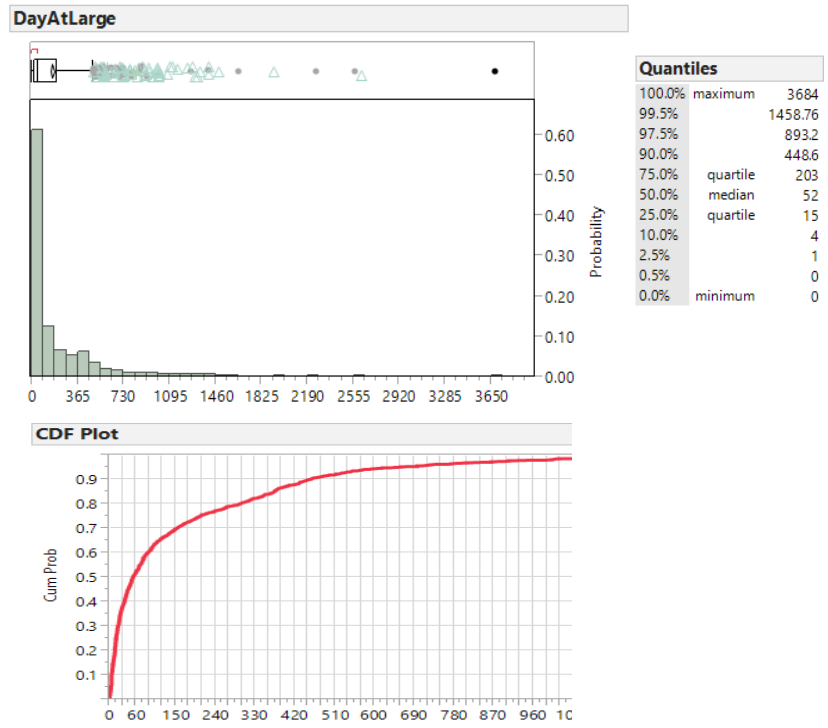



**Figure 9.** YFT days at large distribution and cdf for tag and recovered fish ICCAT db.

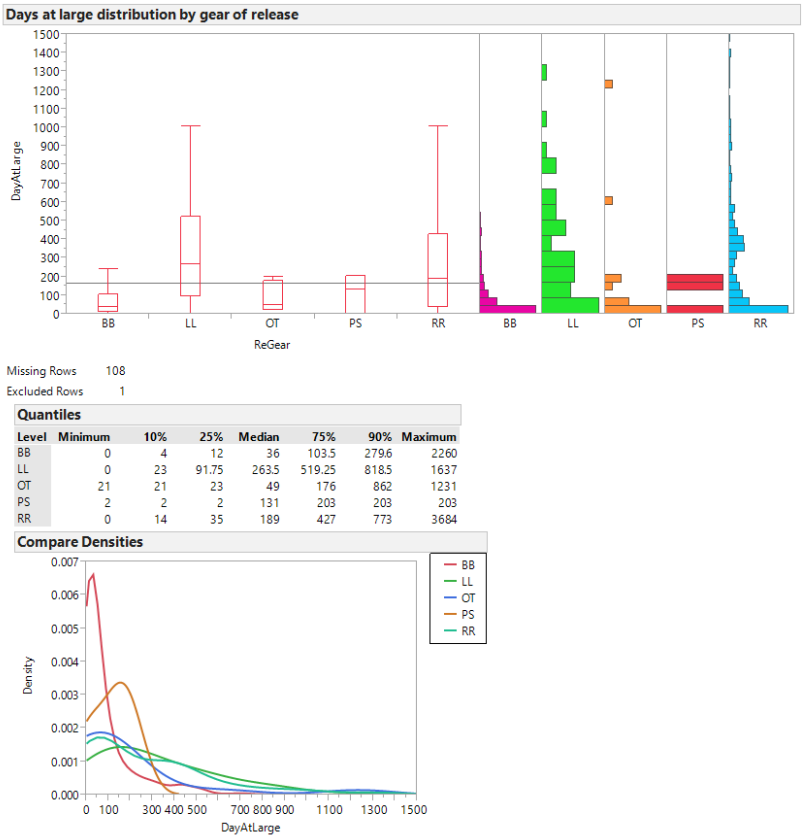



**Figure 10.** Days at large for tagged YFT as function of the main gear of release.

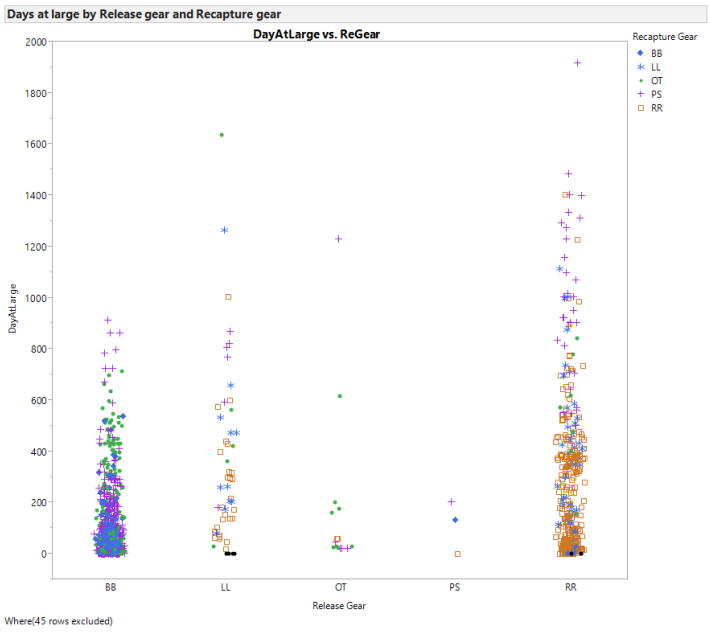



**Figure 11.** Days at large of tagged YFT by release gear (cols) and type of recover gear (symbol markers).

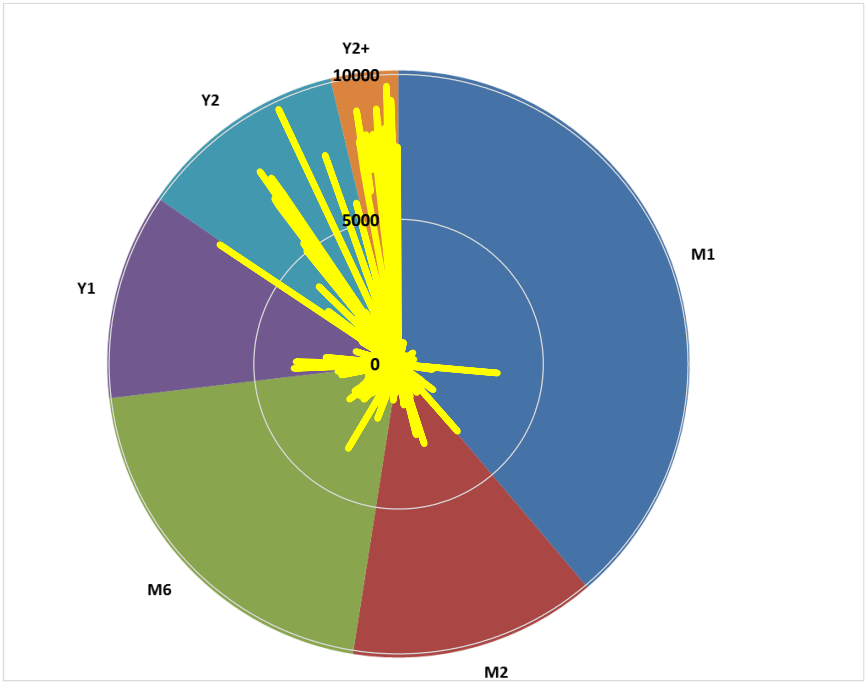
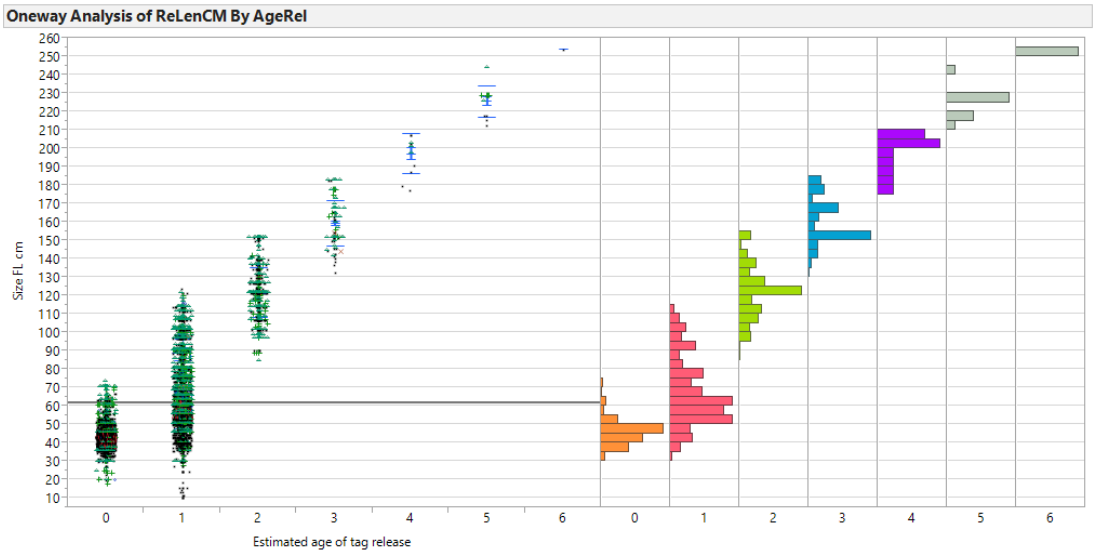



**Figure 12.** Radial plot of the displacement distance (km) of recovered YFT by time at large groups (color zones). M1 0 to 30 days at large, M2 30 to 60 days at large, M6 60 to 183 days at large, Y1 182 to 366 days at large, Y2 366 to 732 days at large, Y2+ plus 732 days at large.



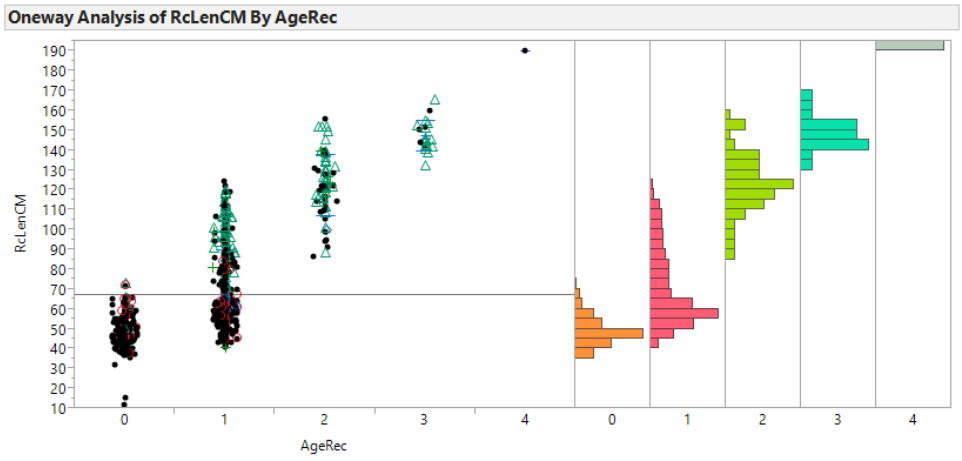

Missing Rows 4041

Excluded Rows 245

**Means and Std Deviations**

| Level | Number | Mean | Std Dev | Std Err Mean | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|
| 0 | 5341 | 44.975 | 6.8374 | 0.0936 | 44.79 | 45.16 |
| 1 | 7969 | 66.140 | 18.5063 | 0.2073 | 65.73 | 66.55 |
| 2 | 872 | 121.689 | 13.4827 | 0.4566 | 120.79 | 122.59 |
| 3 | 106 | 159.396 | 12.3879 | 1.2032 | 157.01 | 161.78 |
| 4 | 12 | 197.417 | 10.6725 | 3.0809 | 190.64 | 204.20 |
| 5 | 12 | 225.750 | 8.3897 | 2.4219 | 220.42 | 231.08 |
| 6 | 1 | 254.000 | . | . | . | . |

**Figure 13.** Estimated age of YFT tag at release vs. size (FL).




Missing Rows 17366

Excluded Rows 245

**Means and Std Deviations**

| Level | Number | Mean | Std Dev | Std Err Mean | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|
| 0 | 373 | 48.095 | 7.4245 | 0.3844 | 47.34 | 48.85 |
| 1 | 520 | 70.185 | 19.6421 | 0.8614 | 68.49 | 71.88 |
| 2 | 73 | 122.659 | 15.1870 | 1.7775 | 119.12 | 126.20 |
| 3 | 21 | 147.607 | 7.4883 | 1.6341 | 144.20 | 151.02 |
| 4 | 1 | 190.500 | . | . | . | . |

**Figure 14.** Estimated age of YFT tag at recapture vs. size (FL).

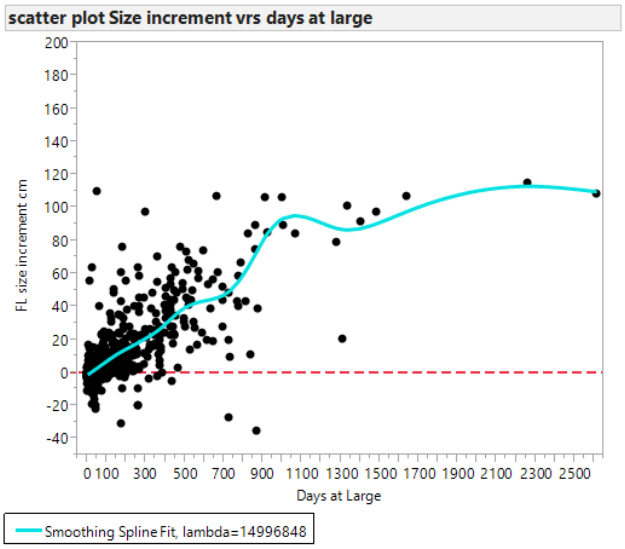



**Figure 15.** Scatter plot of size increment versus the time at large (days at large) for YFT conventional tag recoveries. Solid line show the smother trend of the data (899 observations).

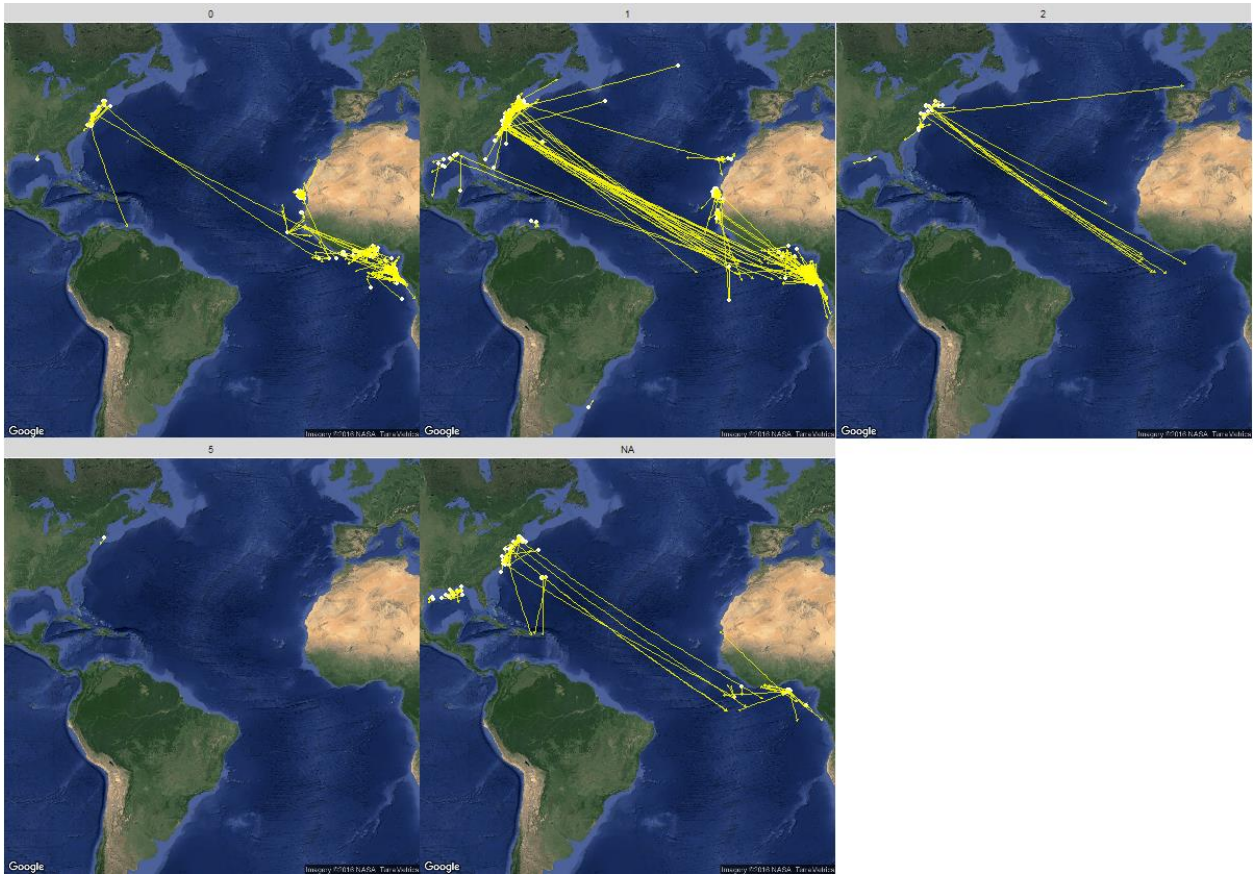



**Figure 16.** YFT tag recoveries with distance of displacement > 100 km by estimated age at release. NA indicates no size/age at release. Arrow head indicate location of recapture.