PRELIMINARY REVIEW OF ICCAT BLUEFIN TUNA CONVENTIONAL TAGGING DATABASE

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SUMMARY

A review of the ICCAT bluefin tuna conventional tagging database was performed in order to identify outliers following different criteria: geographic area of tag release and/or recapture, length-weight relationship, and growth. All incoherent data were closely checked and revised, getting in contact with the tagger institutions for verification. The final result is a qualitative improvement of the conventional tagging bluefin tuna database.

RÉSUMÉ

On a réalisé un examen de la base de données de marquage conventionnel de l'ICCAT pour le thon rouge afin d'identifier les valeurs atypiques suivant différents critères : zone géographique où la marque a été remise à l'eau et/ou récupérée, relation longueur-poids et croissance. Toutes les données incohérentes ont été minutieusement vérifiées et les institutions de marquage ont été contactées à des fins de vérification. Le résultat final est une amélioration qualitative de la base de données de marquage conventionnel pour le thon rouge.

RESUMEN

Se llevó a cabo un examen de la base de datos de marcado convencional de atún rojo de ICCAT con el fin de identificar datos atípicos siguiendo diferentes criterios: zona geográfica de colocación y/o recaptura de la marca, relación talla-peso y crecimiento. Se comprobaron y revisaron a conciencia todos los datos incoherentes, contactando con las instituciones de marcado para su verificación. El resultado final es una mejora cualitativa de la base de datos de marcado convencional de atún rojo.

KEYWORDS

Bluefin tuna, Conventional tagging, Growth

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1. Introduction

The objective of this work was to review the quality of data included in the ICCAT conventional tagging database for bluefin tuna. For this purpose, different criteria were used to identify potential errors and outliers including geographic area of event (release or recapture), length-weight relationship and growth rates.

2. Materials and methods

2.1 Data

The source of data used for this work was the ICCAT database of bluefin tuna conventional tagging in its version of 26th October 2012, which contains 70802 records from tagging campaigns between 1940 and 2012. Some fish were double tagged, in these analyses only the primary tags were considered. The data include tag release information of 70796 bluefin tuna, of which 5548 (7,84%) have recapture information, there are 6 recovery records for which there is not information of the tag release event (**Figure 1)**.

GBYP conventional tagging data was only partly included due to the fact that not all data had been received and /or processed by the time this study was carried out. Nevertheless, GBYP data of 52 additional records were included for the section of this paper in which growth rates were analysed. Of these, 30 tagged fish showed positive growth (> 0 in size or weight) between the release and recapture events, 11 did not had size or weight measurements, and 5 records correspond to fish fattened in farms (hence these records were not considered in this work). Three of these records correspond to recoveries of only electronic tags, two within those that lack measurements information and the third one is an internal archival tag that was included in the analyses despite the fact that the accompanying conventional tag was not recovered.

2.2 Methods

Data was divided in three groups based on the type of information each record presented: tag releases only, tag releases with recovery information, and tag recoveries without release information.

First analysis of "area" was performed to identify possible outliers by comparing the common fishing areas of the fleets that carried out the release and or the recovery against the reported geographic coordinates in the tag information record. Records without fleet or geographic coordinates were excluded. Records for which the geographic coordinates were outside the common fishing area for a given fleet were identified as potential errors (**Table 1)**. The results of this study can be observed in **maps 1 to 3**.

The second analysis consisted in identifying outliers to the length-weight relationship. The amount of records with or without size information for each group is summarised by area in a series of mosaic plots (**Figures 2 to 4**). Records used in this case were exclusively those with values for both length and weight (green areas of **Figures 2 to 4**). Length-weight fits for tag releases by stock unit are plotted in **Appendix 1**. All length data was transformed to fork length (FL) and all weight data to round weight (RWT) using the current SCRS bluefin tuna length-weight relationships (http://www.iccat.int/Documents/SCRS/Manual/CH2/A4_3_L-W_ENG.pdf). For those records in which only length or only weight values were registered, length and weight frequency distributions were plotted to identify possible outliers (**Figures 5 to 10)**.

With the length-weight relationship analysis, the identification of outliers was carried out by comparing the reported weight against the expected weight at size estimated using the official SCRS FL-RWT curves. However as the SCRS length-weight functions does not provide estimated variance of the fitted models, it was considered that if the reported weight of the tagging data differ more than a 50% compared to the predicted weight by the SCRS function then this record was marked as outlier.

The analyses of displacement speed and growth rates were performed only with the release and recovery tag data. Because actual fish trajectories are not available and only release and recovery locations could be used to study the animal´s speed, a simple exercise was completed to verify the reliability of the data based on speed. A preliminary evaluation of speed was carried out with tag recoveries with a time increase of 0 days (0 to 1 day) which were extracted and the distance (km) between release and recovery location was calculated using the following formulation prescribed by the FCC (47 CRF 73.208), recommended for distances not exceeding 475 km.

$$D = \sqrt{(K_1 \Delta\phi)^2 + (K_2 \Delta\lambda)^2};$$

Where D = distance in kilometers; $\Delta\phi$ and $\Delta\lambda$ are the differences of longitude and latitude (degrees), respectively, and

$$K_1 = 111.13209 - 0.56605\cos(2\phi_m) + 0.00120\cos(4\phi_m);$$
$$K_2 = 111.41513\cos(\phi_m) - 0.09455\cos(3\phi_m) + 0.00012\cos(5\phi_m).$$

With ϕ_m expressed in units compatible with the method used for determining $\cos(\phi_m)$; with the K1, and K2 parameters adjusted to the *meridional* and its perpendicular (*normal*) radii of curvature of the Earth, using the Clarke 1866 reference ellipsoid ("Geographical distance", 2013).

The criteria to identify any of these records as errors was to disregard any record that described a fish as having covered a long distance in an extremely short period of time. The longest distance registered in the subset extracted was of 222.7 km. Given that BFT can reach 80 km/h, this distance could be covered in less than 3 hours; therefore, no potential errors were identified using this method.

Growth was studied for two types of records, those which had both release and recovery information for length; and those that had release and recovery information for weight. Firstly, the distribution of growth was plotted; for those records with null growth, the time period between the release and the recovery of the tag was also looked into for further clarification and, finally, growth increments were plotted against time periods to try to find data that do not follow the general tendency. These analyses included the latest tagging data collected under the GBYP programme.

3. Results and discussion

From the analysis of "area", a total of 26 tag releases and 6 tag recoveries were identified as possible outliers by contrasting the geographical location of tags with the fleet's common fishing areas. Each single case will be thoroughly studied in order to corroborate the data and/ or to correct the possible existing errors. In any case, the percentage of data with potential incorrect coordinates is negligible (less than 0.05%).

From the analysis of length-weight relationship a total of 927 records were identified as possible outliers, marked in red in plots included in **Appendix 1**. This analysis will be refined in the future when all new data is included in the database. At the moment, it was useful for the aim of having a first overview of the data. Nonetheless, there are various observations that could be described as errors/ outliers with a 100% certainty. These were extracted and will be checked individually to correct their values when possible (**Table 2**).

Out of the 5548 bluefin recaptures extracted from the database for this study, only 2275 records presented both release and recovery length data. **Figures 11, 12, 14** and **15** show the results of the length increments study. Time periods registered for records with null length growth range from 0 to 90 days (**Figure 12**). A boundary needs to be established to differentiate those records that are in no way acceptable (i.e. e. no growth in length in 90 days). Similarly, round weight was described and thoroughly examined (**Figures 13,** and **16** to **18**). In both cases some records showed a negative growth (358 out of 2275 in length and 166 of the 799 with RWT data). A detailed examination of those records needs to be carried out to establish which ones can be fixed and which ones will have to be omitted. In this work only those records with a negative growth for a time period longer than 60 days are considered as potential outliers.

Out of the 52 recoveries reported during GBYP Phase 3, 11 do not include measurements; therefore growth could not be studied. Besides, 5 records correspond to fish fattened in farms, thus these data were not considered in this work. Out of the remaining 36 recoveries, only 30 showed growth values higher than 0 (**Figure 19)**.

Table 3 gives an overview of all possible errors identified so far in the database by type of error and subset where it was found. The three records identified as possible errors in the growth analysis of GBYP additional data are not included in this table.

In conclusion, a more detailed examination of some data registered in the database needs to be accomplished in order to establish which data is reliable for further analyses of BFT population and which need to be either corrected or omitted in case an amendment is not feasible.

References

Geographical distance. (2013, March 7). In Wikipedia, The Free Encyclopedia. Retrieved 09:41, April 9, 2013, from http://en.wikipedia.org/w/index.php?title=Geographical_distance&oldid=542697392.

ICCAT manual, http://www.iccat.int/Documents/SCRS/Manual/CH2/A4_3_L-W_ENG.pdf

Table 1. Summary of records with possible errors in geographic area information.

	Tags with release information only	*Tags with release and recapture information*	
		Release	Recapture geo-position
OK	64854	5514	5285
Possible error	23	3	6
Excluded (no coordinates/ fleet info)	371	31	257
TOTAL	**65248**	**5548**	**5548**

Table 2. Details of records identified as outliers based on the analysis of length-weight relationship. Tags with release information only.

ReFleetCode	ReAREA	ReGearCode	ReDate	ReTPC	ReFLcm	ReRWTkg
EU.MLT	MED	PS	02/01/2004	1	25	312.5
EU.ESP	MED	RR	10/05/1994	5	373.38	56
USA	ATW	RR	16/01/2004	1	462.28	156.4894
JPN	ATW	LL	30/01/1985	1	426.72	113.75
USA	ATW	RR	05/01/2005	1	210.82	37.64817
USA	ATW	RR	17/12/1987	12	205.74	17.23651
USA	ATW	RR	08/12/2004	12	226.06	10.13495
USA	ATW	RR	17/01/2004	1	2032	141.5208
USA	ATW	RR	02/07/1994	7	487.68	90.71848
USA	ATW	RR	20/07/2002	7	596.9	7.711071
USA	ATW	TRAP	17/08/1988	8	464.82	218.2913
CAN	ATW	LL	15/08/1994	8	305	90.7

Tags with both release and recapture information:

ReFleetCode	ReAREA	ReGearCode	ReDate	ReTPC	ReFLcm	ReRWTkg	RcFleetCode	RcAREA	RcGearCode	RcDate	RcTPC	RcFLcm	RcRWTkg	IncrFL	IncrRWT	IncrT(days)
USA	ATW	RR	24/09/1998	9	NA	NA	EU.MLT	MED	PS	02/01/2004	1	25	312.5	NA	NA	1926
EU.FRA	MED	UNCL	29/07/2007	7	NA	NA	EU.ESP	MED	UNCL	30/08/2011	8	108	211	NA	NA	1493
USA	ATW	LL	05/09/1992	9	NA	15.87573	EU.ESP	MED	RR	10/05/1994	5	373.38	56	NA	40.12427	612
USA	ATW	LL	16/04/1988	4	243.84	181.437	USA	ATW	LL	10/04/2000	4	144.78	311.8448	-99.06	130.4078	4377
USA	ATW	LL	01/04/1993	4	NA	17.00972	USA	ATW	RR	02/07/1994	7	487.68	90.71848	NA	73.70877	457
USA	ATW	PS	21/06/1980	6	NA	11.33981	USA	ATW	TRAP	17/08/1988	8	464.82	218.2913	NA	206.9515	2979

Table 3. Summary of records with potential errors (highlighted in red) by error type and subset where the error was identified. Growth errors include in brackets those with a negative or null growth for more than 60 days at large.

	Release area			*Release FL-RWT fit*			*Recovery area*			*Recovery FL-RWT fit*			*Growth (FL)*			*Growth (RWT)*		
	Potential error	**Ok**	**NA**	**Potential error**	**Ok**	**NA**	**Potential error**	**Ok**	**NA**	**Potential error**	**Ok**	**NA**	**Potential error**	**Ok**	**NA**	**Potential error**	**Ok**	**NA**
Release	23	64854	371	800	5716	58732	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Recovery	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	0	5	1	1	2	3	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Re and Rc	3	5514	31	47	186	5315	6	5285	257	79	1391	4078	448(27)	1827	3273	200(67)	599	4749

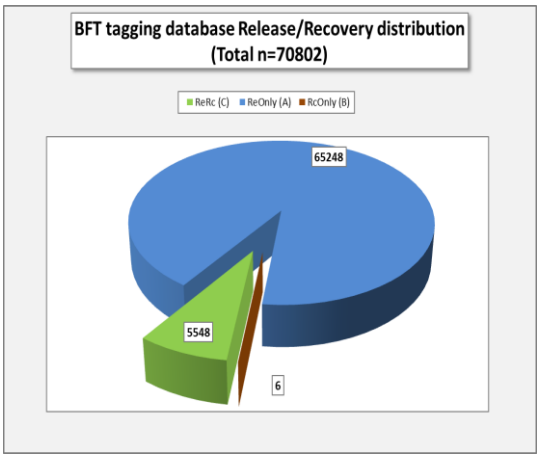
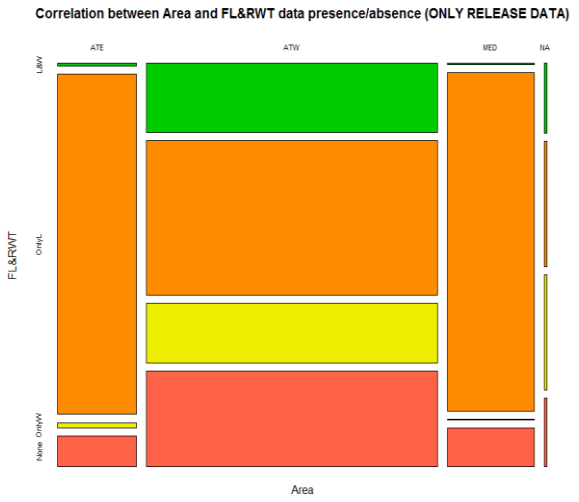
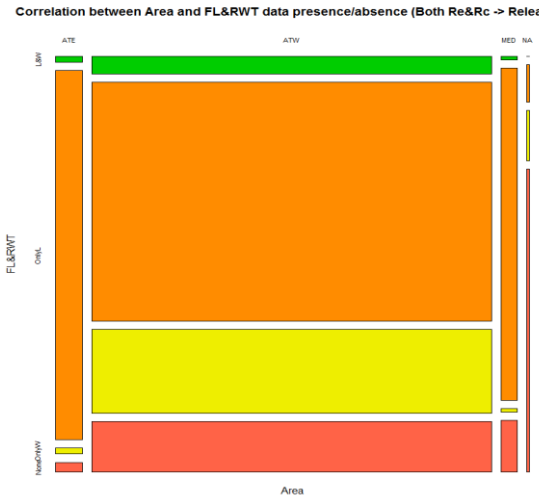


Figure 1. Content of ICCAT BFT conventional tagging DB up to 26/10/2012 (number of records)



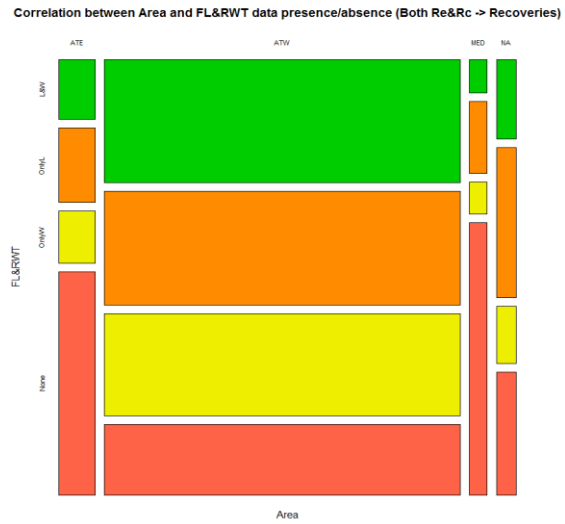
	ATE	ATW	MED	NA
L&W	73	6397	46	69
OnlyL	8482	14259	9319	122
OnlyW	132	15486	26	113
None	770	8822	1065	67

Figure 2. Number of "only release" records with values for both length and weight (L&W), only length values (OnlyL), only weight values (OnlyW) and no values for size (None) categorized by area.



	ATE	ATW	MED	NA
L&W	5	226	2	0
OnlyL	314	3045	175	3
OnlyW	5	1070	2	4
None	8	638	27	24

Figure 3. Number of "release and recovery (releases)" records with values for both length and weight (L&W), only length values (OnlyL), only weight values (OnlyW) and no values for size (None) categorized by area.



	ATE	ATW	MED	NA
L&W	68	1383	19	50
OnlyL	85	1273	41	94
OnlyW	59	1146	18	36
None	254	790	155	77

Figure 4. Number of "release and recovery (recoveries)" records with values for both length and weight (L&W), only length values (OnlyL), only weight values (OnlyW) and no values for size (None) categorized by area

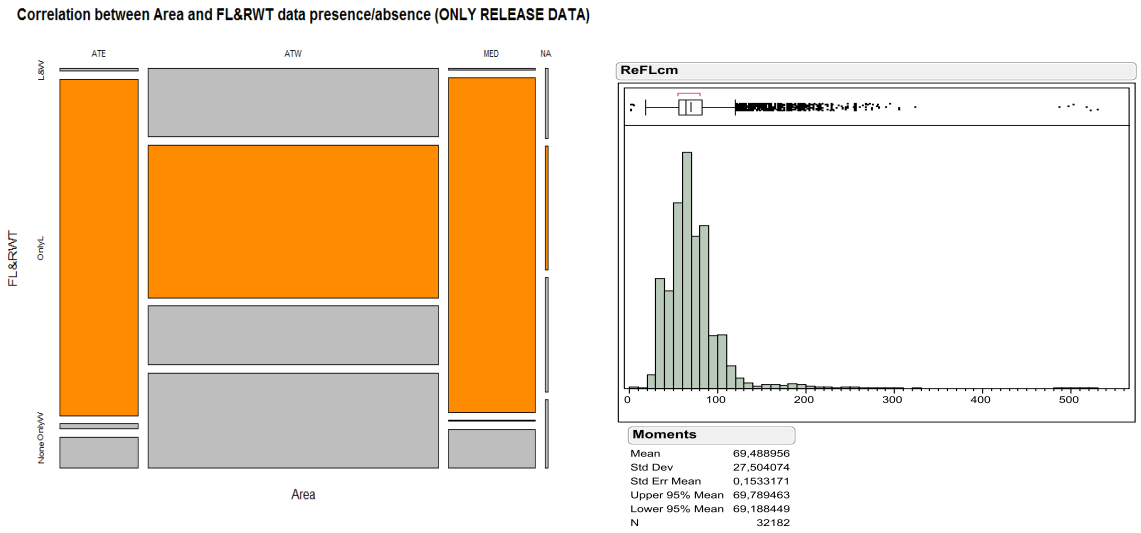


Figure 5. Size frequency distribution (FL) for records with only release information and length data only (n=32182)

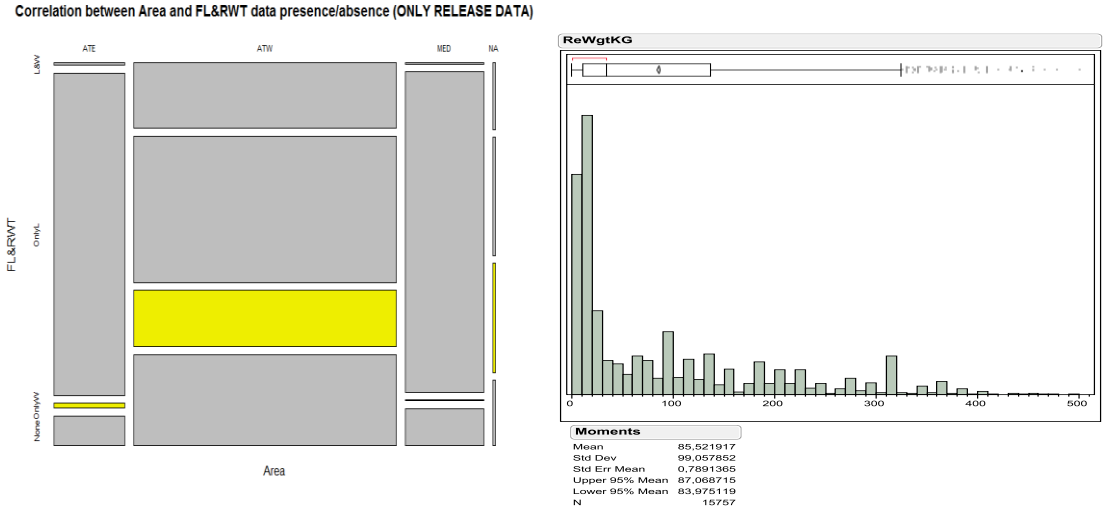


Figure 6. Size frequency distribution (RWT) for records with only release information and weight data only (n=15757)

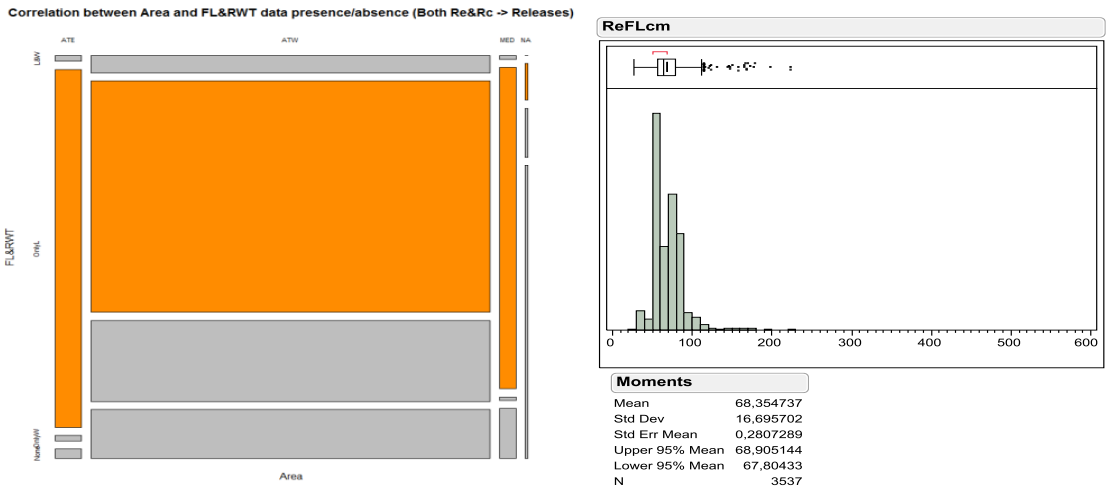


Figure 7. Size frequency distribution (FL) for records with information for both release and recovery (releases) with length data only (n=3537).

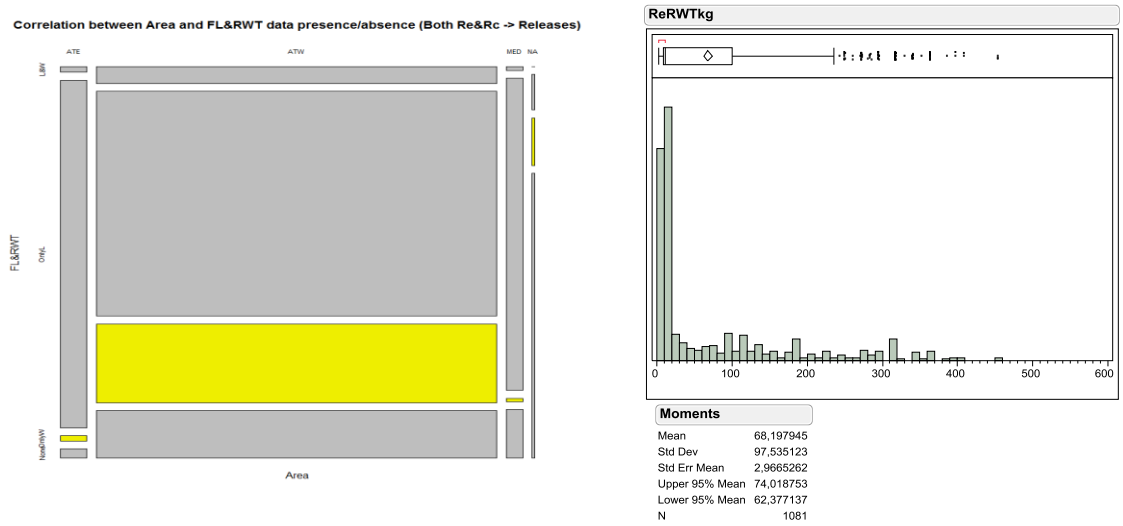


Figure 8. Size frequency distribution (RWT) for records with information for both release and recovery (releases) with weight data only (n=1081)

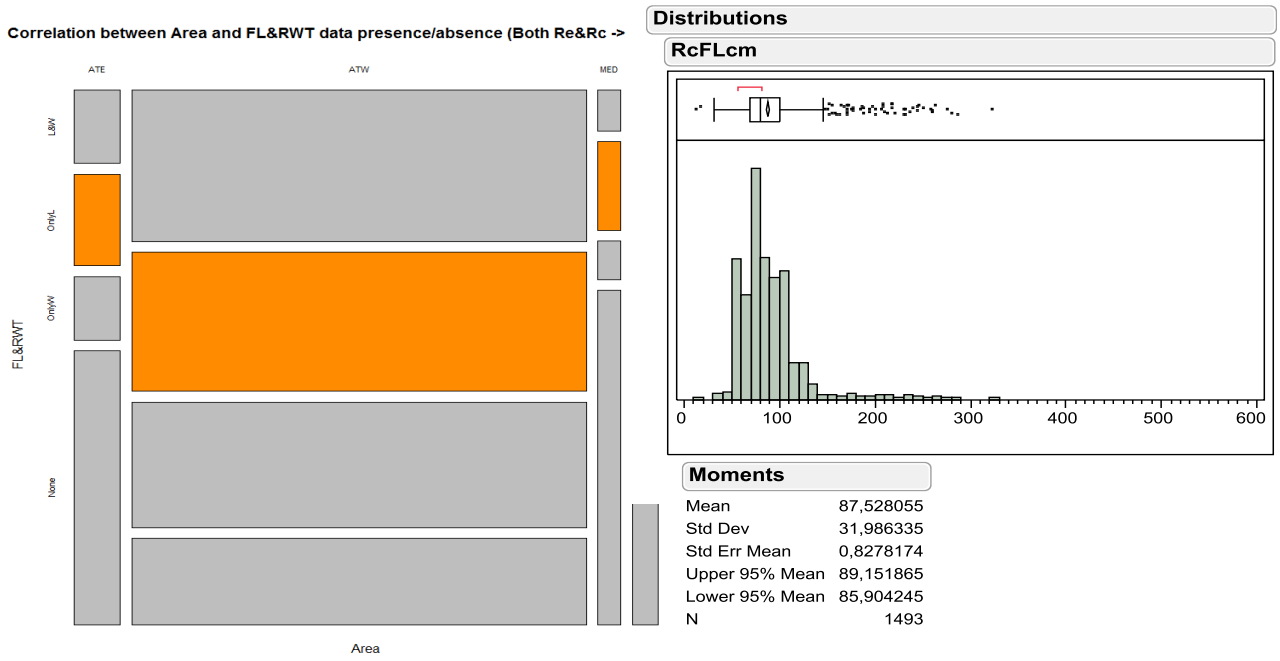


Figure 9. Size frequency distribution (FL) for records with information for both release and recovery (recoveries) with length data only (n=1493).

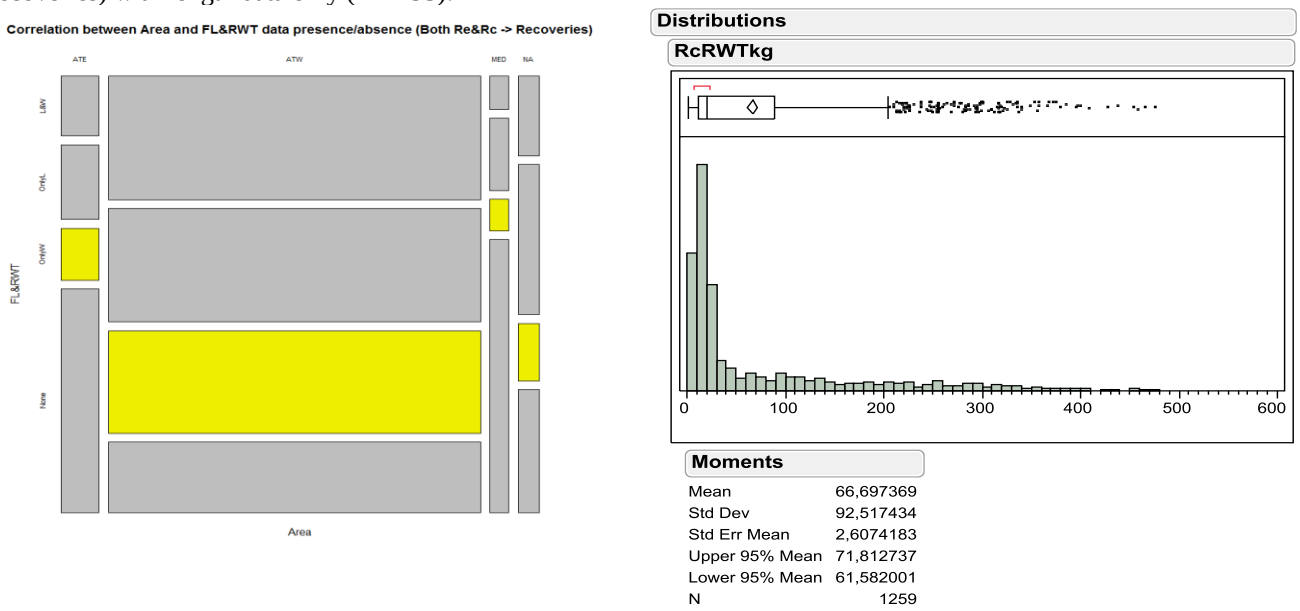


Figure 10. Size frequency distribution (RWT) for records with information for both release and recovery (recoveries) with weight data only (n=1259).

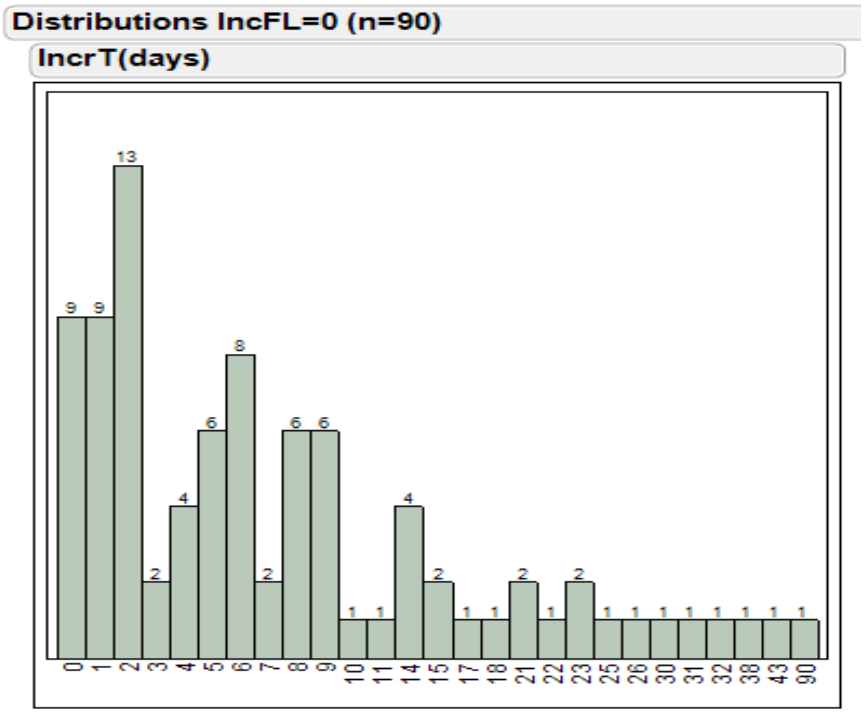
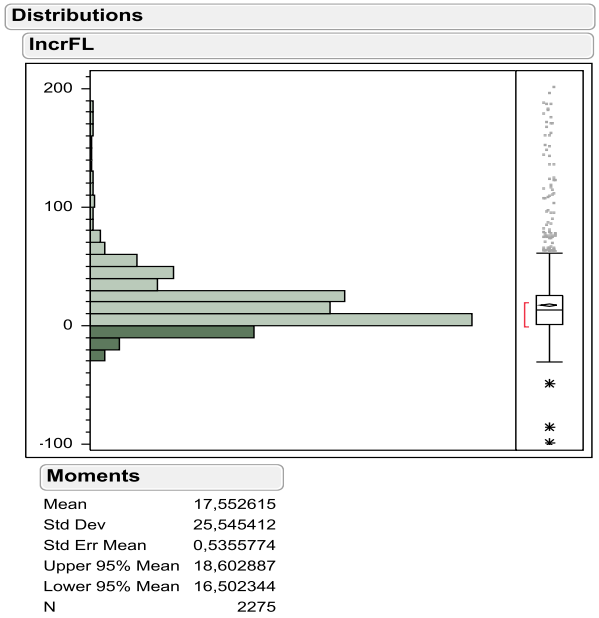
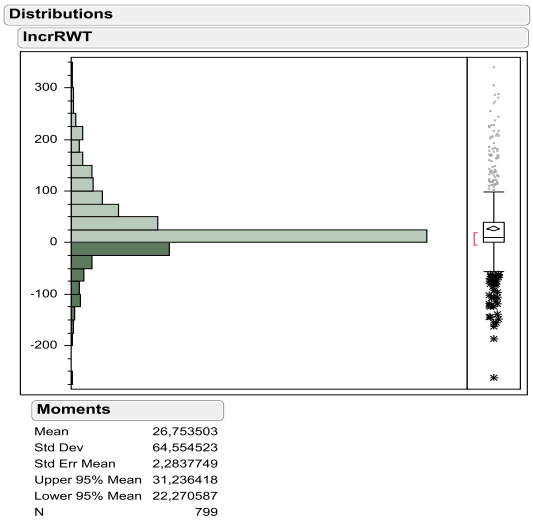


Figure 11. Bluefin tuna conventional tagging DB. Number of days at sea for records with length increase equal to zero.



Total number of records with both Re and Rc Length data	2275
Length increment > 0	1827
Length increment = 0 (of which time at sea> 60 days)	90 (1)
Length increment < 0 (of which time at sea> 60 days)	358 (26)

Figure 12. Length increase frequencies from ICCAT conventional tagging DB.



Total number of records with both Re and Rc weigth data	799
Weight increment > 0	599
Weight increment = 0 (of which time at sea> 60 days)	34 (10)
Weight increment < 0 (of which time at sea> 60 days)	166 (57)

Figure 13. Weight increase frequencies from ICCAT conventional tagging DB.

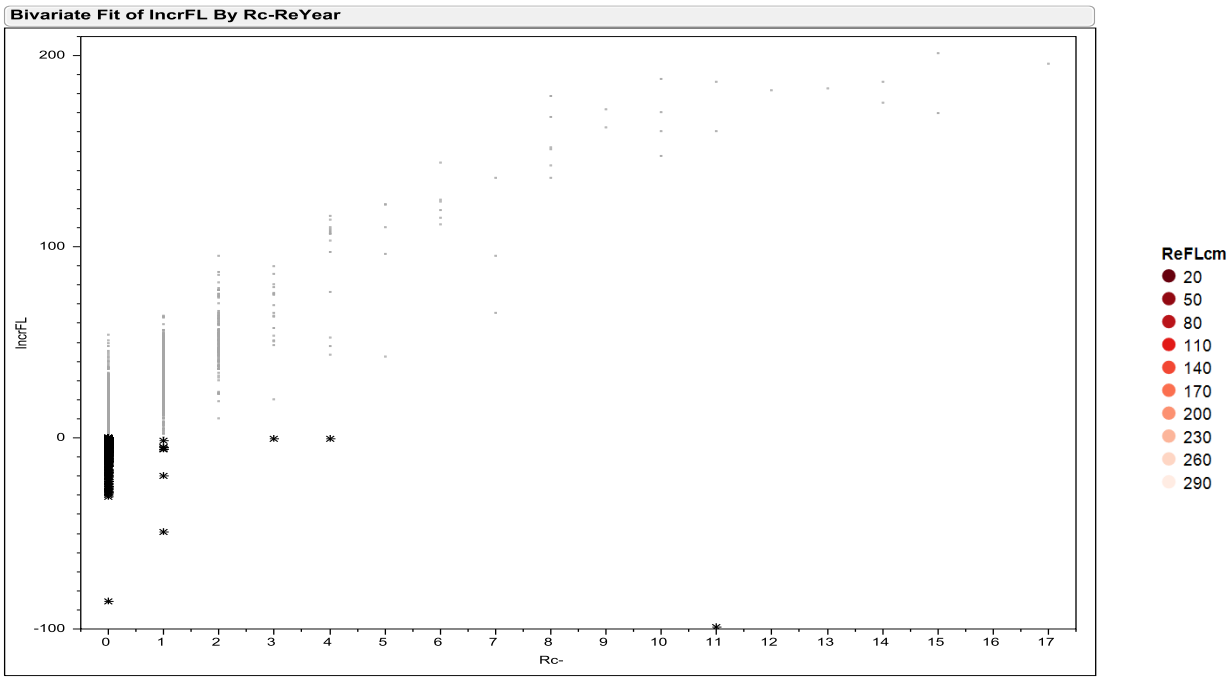


Figure 14. Bluefin tagging DB bivariate fit of length increments by number of years at sea. Records with length increments < 0 are marked with a star (*).

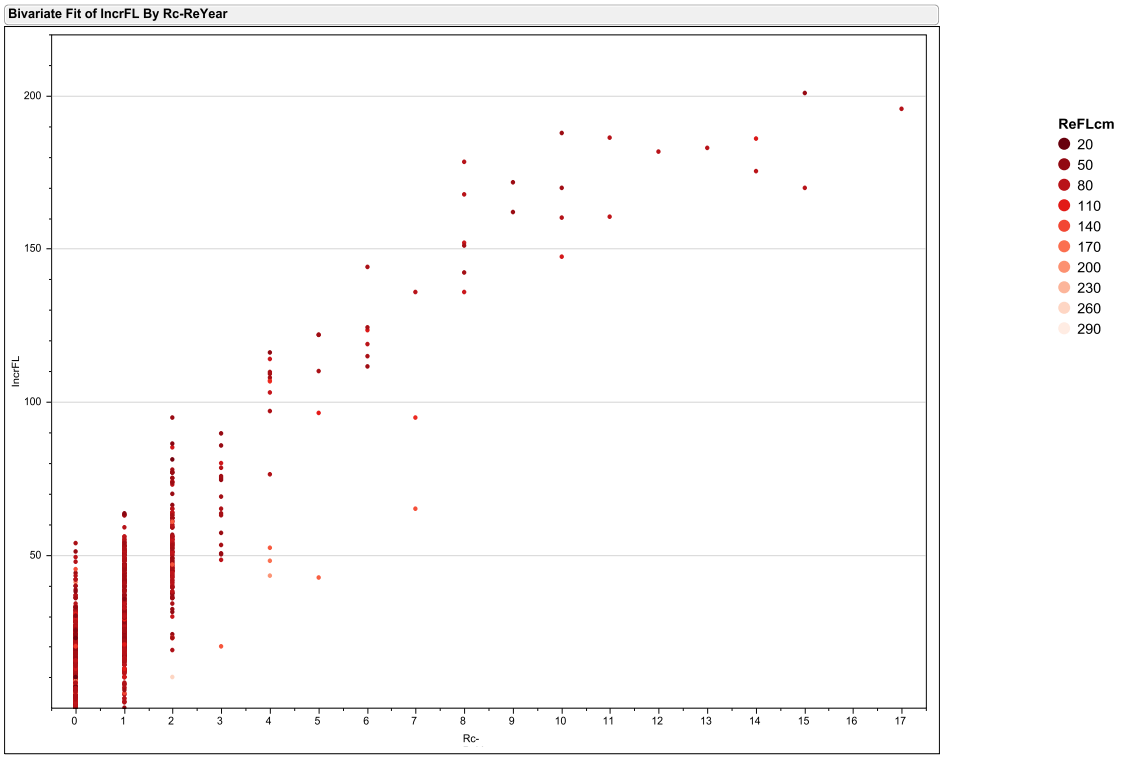


Figure 15. Bluefin tagging DB bivariate fit of length increments by number of years at sea for records with length increments > 0. Color shading corresponds to fish length at release.

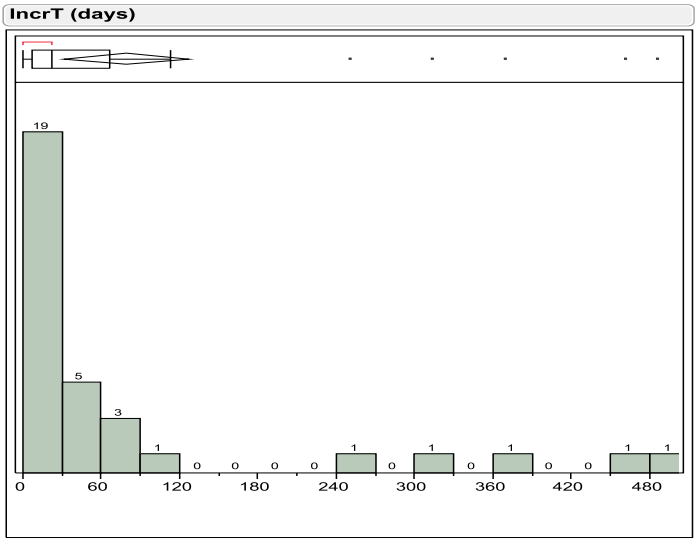


Figure 16. Number of days at sea for records with weight equal to zero.

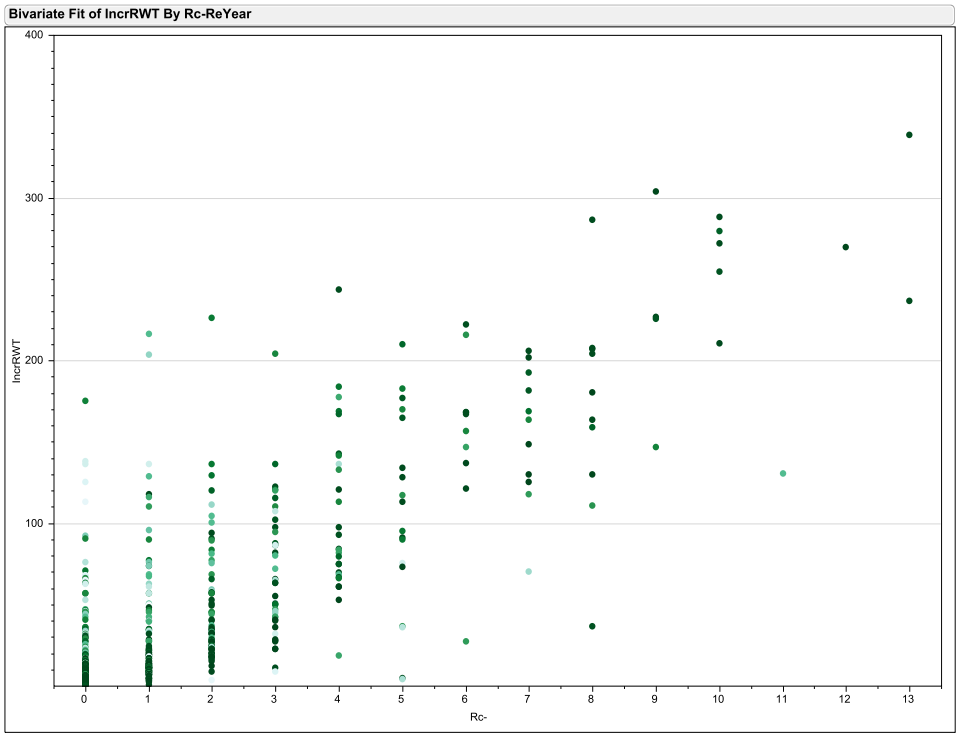


Figure 17. Bivariate fit of weight increments by number of years at sea. Records with weight increments < 0 are marked with a star (*).

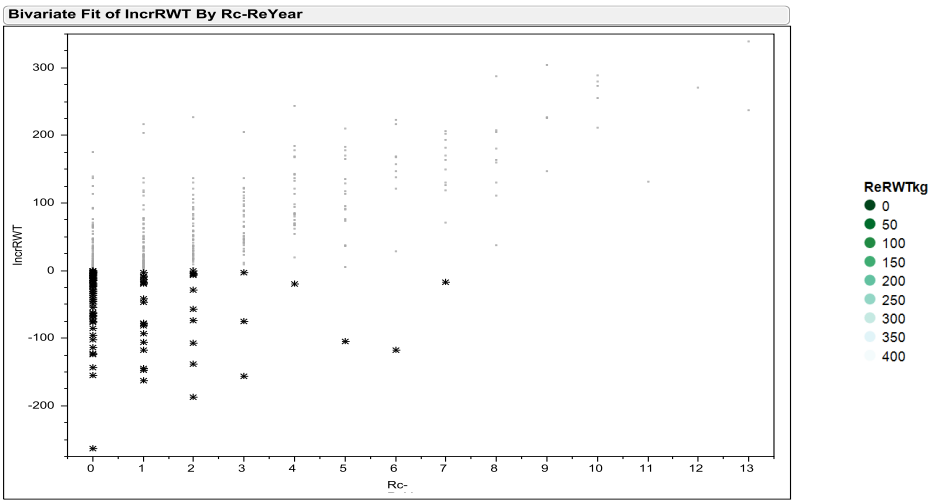


Figure 18. Bivariate fit of weight increments by number of years at sea for records with weight increments > 0. Color shading corresponds to fish length at release.

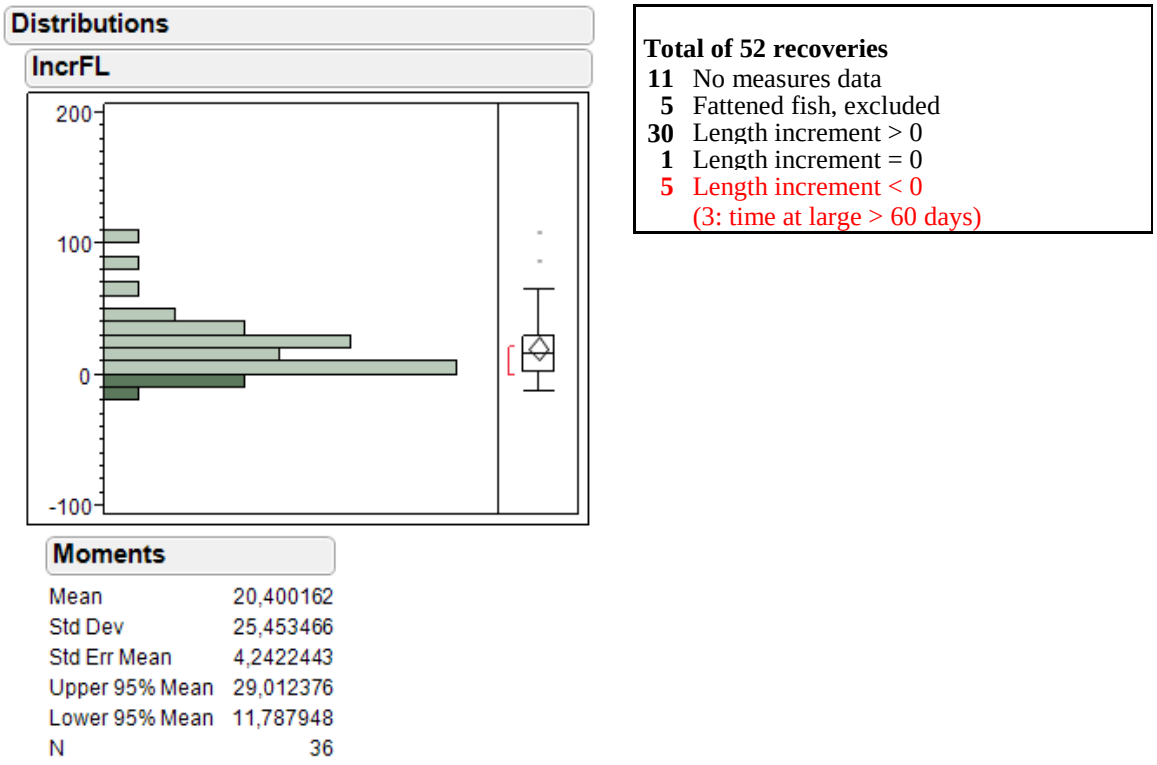
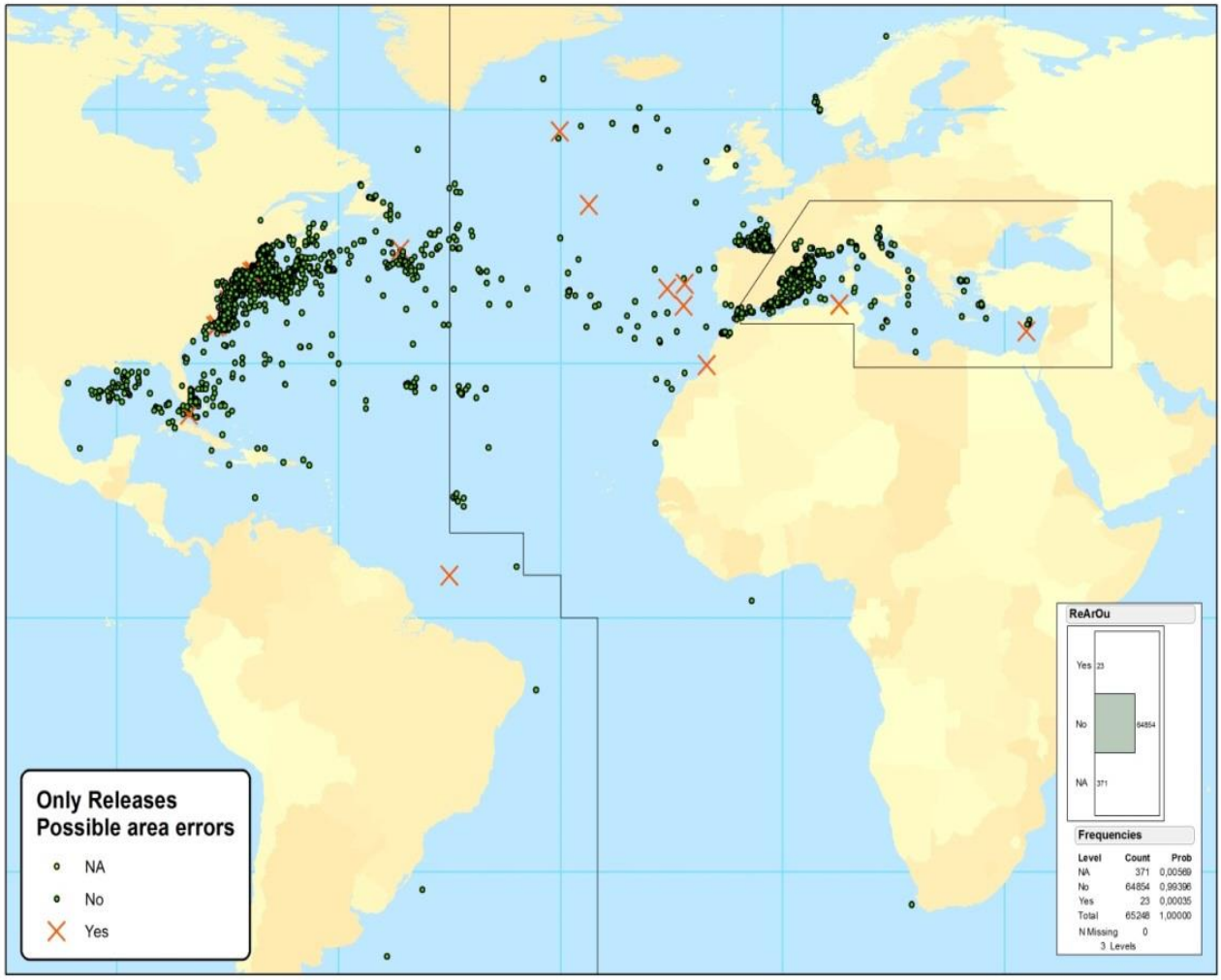
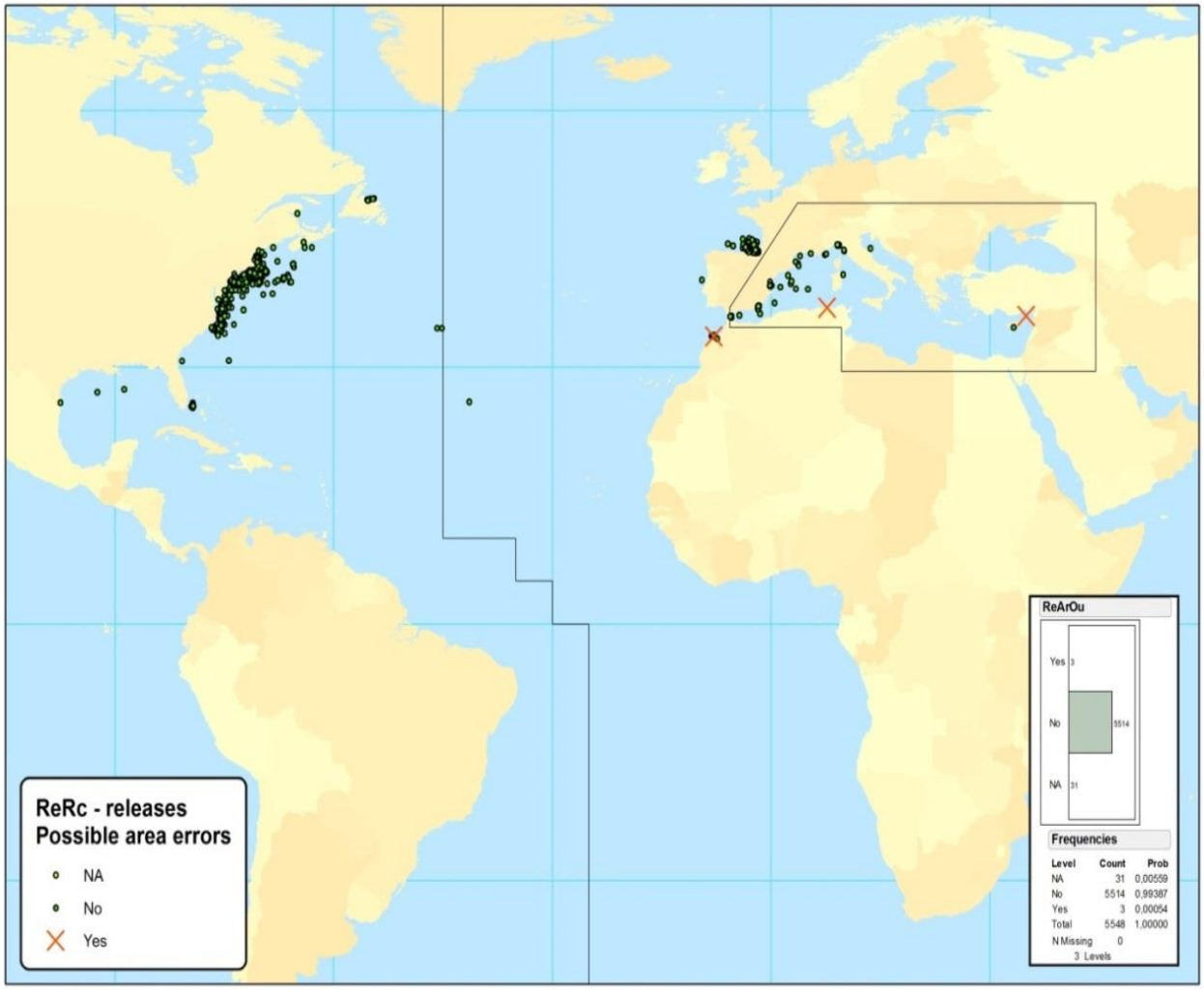


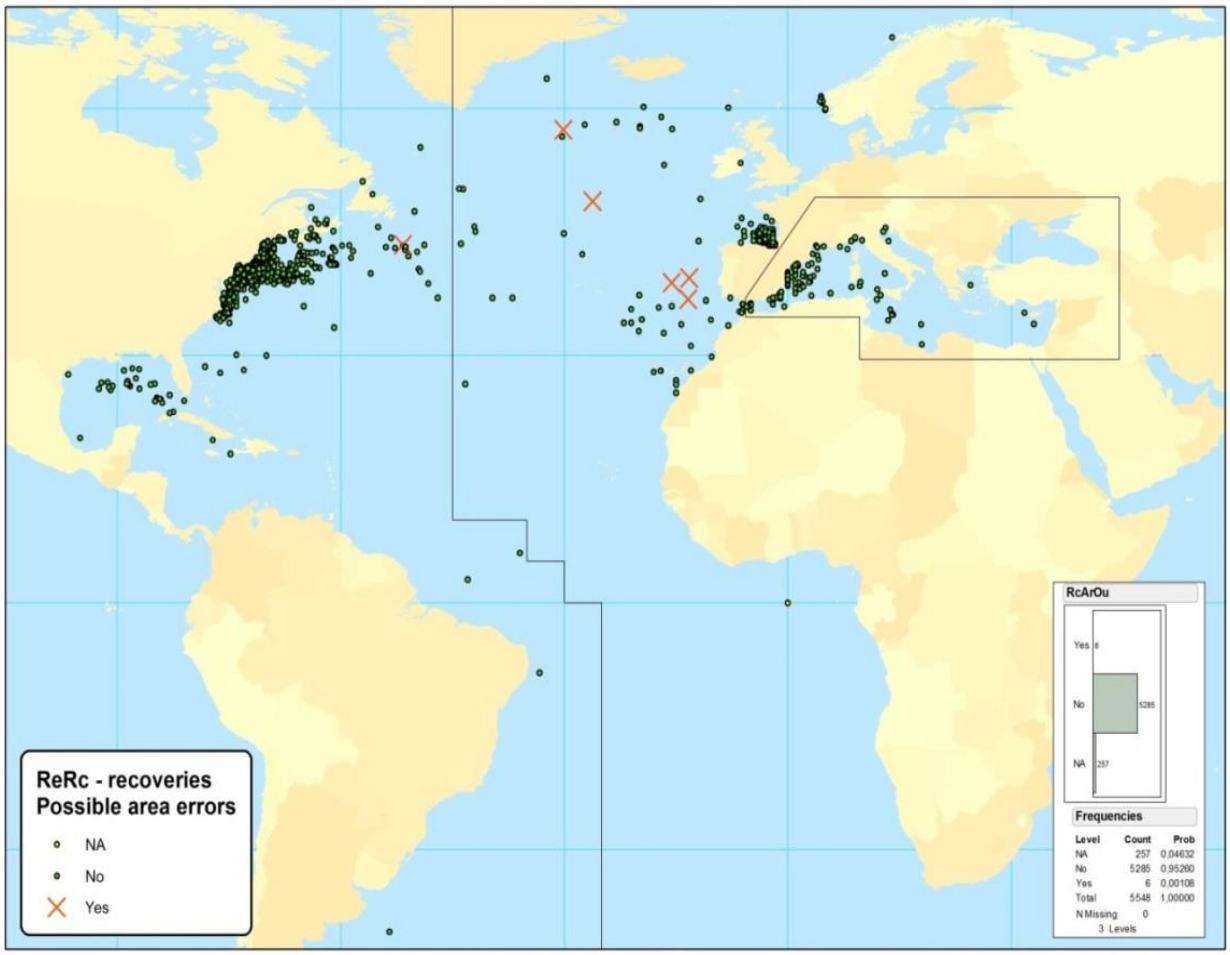
Figure 19. Length increase frequencies from GBYP Phase 3 recoveries.



Map 1. Possible errors in release coordinates for records with only release information. (Yes = possible error, No = OK, NA = Excluded (no coordinates/ fleet info))



Map 2. Possible errors in release coordinates for records with both release and recovery information. (Yes = possible error, No = OK, NA = Excluded (no coordinates/ fleet info))

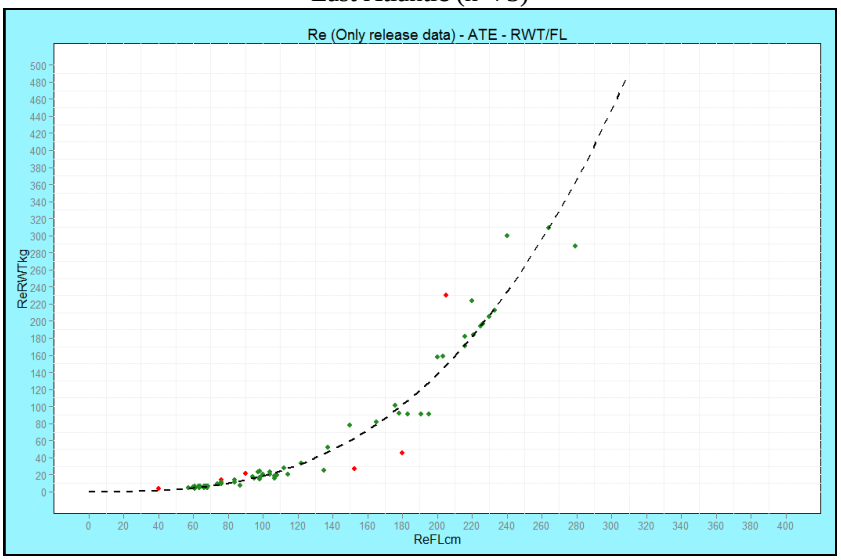


Map 3. Possible errors in recovery coordinates for records with both release and recovery information. (Yes = possible error, No = OK, NA = Excluded (no coordinates/ fleet info))

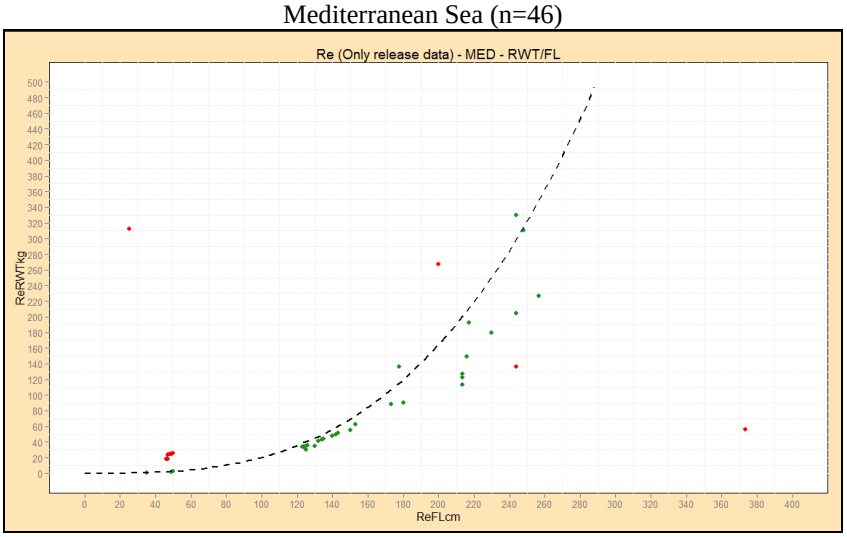
Appendix 1

Length - weight relationships
Records with information for release only with both length and weight by area (n=6585):

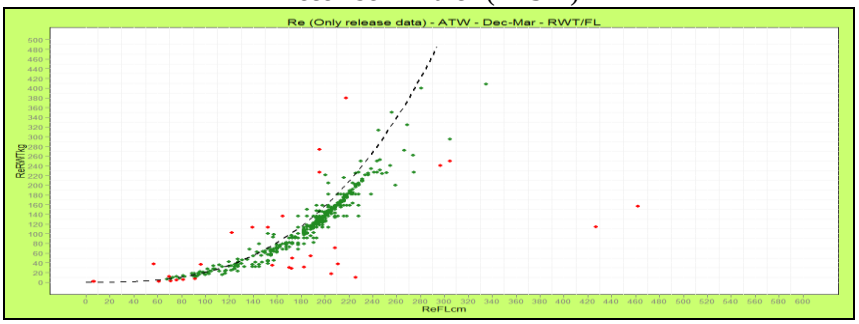
East Atlantic (n=73)



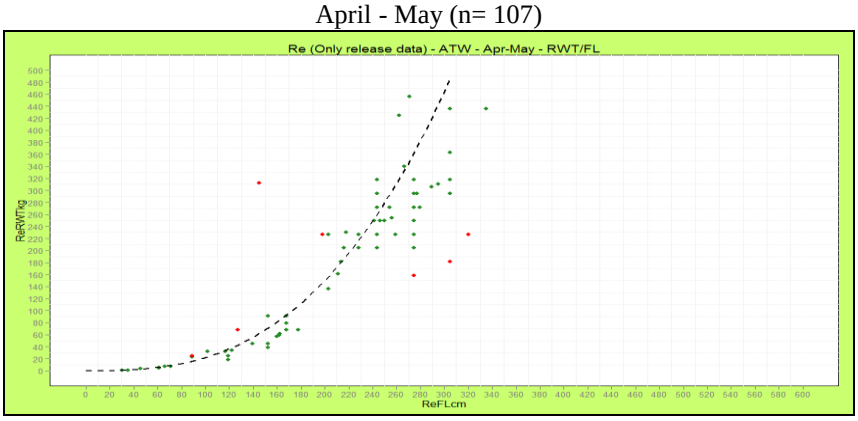
Mediterranean Sea (n=46)



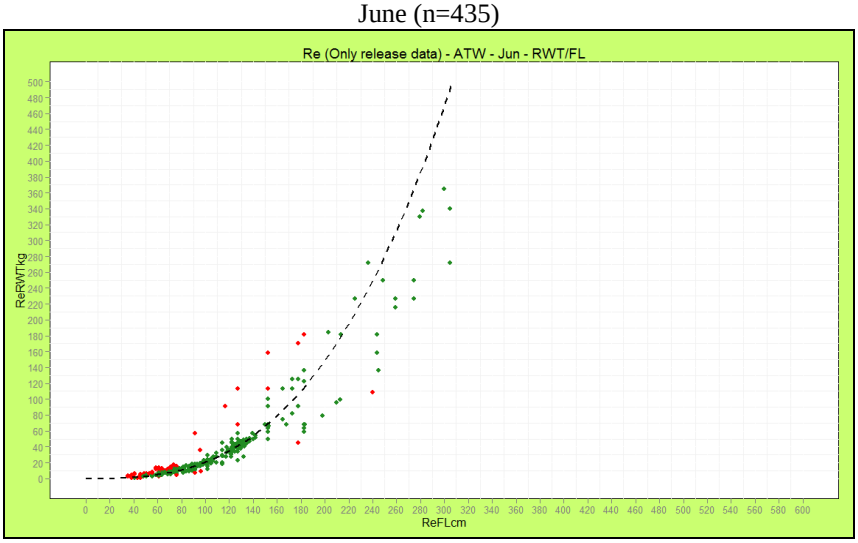
West Atlantic (n_t=6397) (different curves depending on time period)
December - March (n= 571)



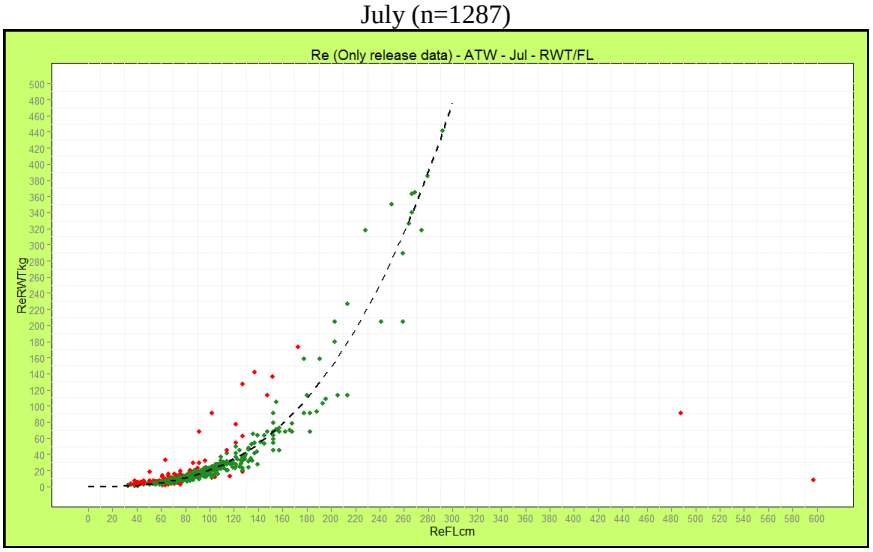
April - May (n= 107)



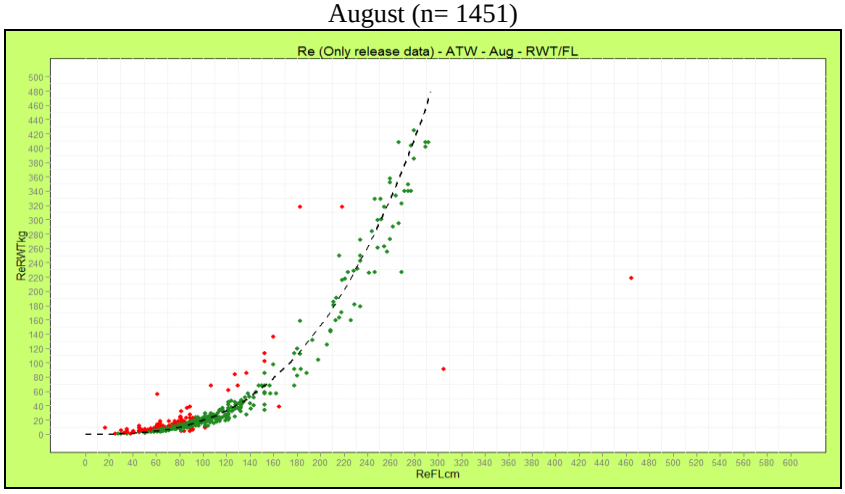
June (n=435)



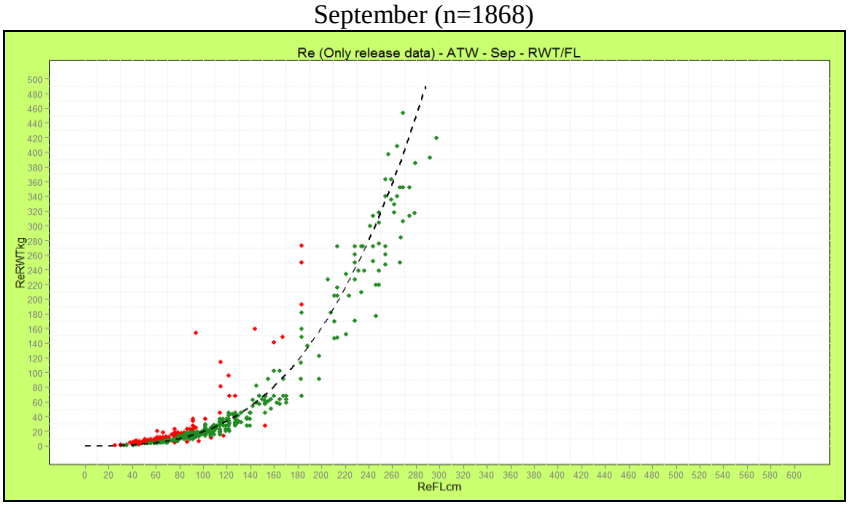
July (n=1287)



August (n= 1451)



September (n=1868)



October – November (n=678)