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Alfonsino age and growth - rev1

Relates to agenda item: 3.3 Working paper ☒ Info paper ☐

Delegation of Cook Island

Abstract

The growth estimations provide information on, growth rate and length-at-age that inform age-based stock assessment models and are used to estimate mortality, age-at-maturity, longevity and production. This report provides an assessment of the length-at-age data for alfonsino collected in alfonsino East of the SIOFA area.

Alfonsino saggital otoliths were collected by fishery observers from fish caught in the Southern Indian Ocean from 2001 to 2017 during the months of November to June. Each fish was measured (fork length mm) and otoliths were stored dry and sent to the Fish Ageing Services (Australia) for processing. Otoliths were read whole and assigned an age, edge type and readability score independently by two readers. Five hundred and thirty one fish were aged; of these 267 were male and 259 female. When only fish with good readability scores (R1-R3) were used the number of samples dropped to 397 for all fish 206 for males and 188 for females. Fish length ranged from 189-540mm for all fish; 189-540mm for male fish and 207-530mm for females. Age estimates in this study ranged from 0 to 25 years old.

The von Bertalanffy growth parameters are provided for both sexes combined and for males and females separately and all the data and only otoliths with good readability.

Recommendations

It is recommended that these estimates be used in the 2020 SIOFA alfonsino assessment.

Ministry *of* Marine Resources

GOVERNMENT OF THE COOK ISLANDS

Alfonsino age and growth - rev1

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Contents

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The von Bertalanffy growth parameters are provided for both sexes combined and for males and females separately and all the data and only otoliths with good readability. It is recommended that theses estimates be used in the 2020 SIOFA alfonsino assessment.

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1 Introduction

Alfonsino (*Beryx splendens*) has been a major fishery in the Southern Indian Ocean Fisheries Agreement (SIOFA) area targeted with trawl gear. The Cook Islands, Australia and Japan have provided alfonsino otoliths from key fishing grounds in the East and West of the Agreement area to the Fish Ageing Services (FAS) to carry out age estimations. Saggitus Limited was contracted on behalf of the Ministry of Marine Resources (MMR) to estimate the growth parameters using these aged fish. Sub-areas four and five were identified to be high density fishing areas for alfonsino to the East of the Agreement area and were selected as areas to collect the otoliths.

The growth estimations provide information on, growth rate and length-at-age that inform age-based stock assessment models and are used to estimate mortality, age-at-maturity, longevity and production. This report provides an assessment of the length-at-age data for alfonsino collected in alfonsino East of the SIOFA area, and are intended for use by the SIOFA alfonsino assessment team.

2 Methods

Alfonsino saggital otoliths (Figure 1) were collected by fishery observers from fish caught in the Southern Indian Ocean (Figure 2) from 2001 to 2017 (Figure 3) during the months of November to June (Figure 4). Each fish was measured (fork length mm) and otoliths were stored dry and sent to the Fish Ageing Services (Australia) for processing. Otoliths were read whole and assigned an age, edge type and readability score independently by two readers.

Edge types were assigned as follows:

- WT - Wide translucent.
- NT - Narrow Translucent.
- O - Opaque.

Readability scores were defined as:

1. - Unambiguous and clear to interpret.
2. - More difficult than 1, however little doubt in the count.
3. - Slight uncertainty, possibly zone count might differ by 1.
4. - Some doubt, zone count could differ by 2 - 3.
5. - Unreadable/no sample.

Massey and Horn (1990) adjusted age for edge type during the months between April - August for their samples. All the samples aged here (except one fish sampled in June) were collected outside of these months therefore zone count was equivalent to the adjusted zone count. The adjusted counts were used for further analyses. Growth rings were assumed to be annuli as other studies on alfonsino have shown that one opaque and one translucent zone are laid down annually (Anachi, 2001; Lehody and Gandperrin, 1996; Rico *et al.* 2001).

The von Bertalanffy growth function was used to describe fish growth. The growth parameters were estimated in R (R Core Team 2017) using nonlinear least-squares estimates function (nls) which uses the methods described by Bates and Watts (1988) and Bates and Chambers (1992). Growth was estimated using all the data and only otoliths with good readability (readability scores 1-3 [R1-R3]).

3 Results and Discussion

Five hundred and thirty one fish were aged; of these 267 were male and 259 female. When only fish with good readability scores (R1-R3) were used the number of samples dropped to 397 for all fish 206 for males and 188 for females. Fish length ranged from 189-540mm for all fish; 189-540mm for male fish and 207-530mm for females (Figure 5). Age estimates in this study ranged from 0 to 25 years old.

The otoliths were read by two readers and Figure 6 and Figure 7 show the difference between reader counts. There was a high degree of agreement between readers with most otoliths (54%) being assigned the same age, and 90% being within 1 year difference. The APE score for alfonsino from this age sample was good at 3.43 showing a high degree of readability for these otoliths.

Overall for all fish the von Bertalanffy growth function fitted the data reasonably well (Figure 8), with only a marginal improvement when using the otoliths with good readability (Figure 9). However, due to the loss of some older fish from the good readability sample the L_∞ estimates increased slightly.

Separating the sexes resulted in a good fit for males but not females (Figure 10 and Figure 11) due to the lack of females over 10 years old with an associated length measurement (87 fish). As a result the growth parameters for females is unreliable. Given the similarity in fits of the male fish to the combined sample it is recommended that the parameters derived from the combined growth curve be used in the stock assessment. In addition, as the outcomes are broadly similar between the total sample to the sample only with good readability it is recommended that the good readability sample be used due to the ambiguity that arises when otoliths of poor readability are included in growth estimates. While this does not appear to be highly influential here it is simply good practice.

However, looking at the distribution of the estimates (Figure 12) and the fits to the data for fish of 1-9 years old, it appears that the fits at the lower end of the spectrum was not good. While these estimated parameters can be used in the interim it is recommended the additional sampling be undertaken using a stratified sampling approach for males and females to ensure consistent sampling across the size range in order to resolve this and get better age estimates for female fish. The distribution around the mean length for fish 1-9 years old is fairly consistent, while the older fish the length distributions are wide (Figure 12). This could also be a result of ageing whole otoliths which is usually not accurate for long-lived species. Other studies have shown that comparing ages estimated from whole and sectioned otoliths revealed a large discrepancy in agreement between the two methods for fish over 7 years old (Dwyer *et al.* 2003). Chilton and Beamish (1982) noted that the under ageing of older fish using the whole otoliths occurs as growth increments do not form equally on all parts of the otolith. This has been demonstrated in a number of species of fish (Dwyer *et al.* 2003). However, in the case of alfonsino

early attempts to age them tried whole and sectioned otoliths (Peter Horn NIWA, *pers. comm.*), this investigation found that sectioned alfonsino otoliths are difficult to read. This suggests that the change in growth variability after age 9 could be a result of some other factor such as the onset of maturity. This should be investigated further for alfonsino.

In comparison to other alfonsino populations, fish from alfonsino East were of a similar maximum size but older than samples from the North Atlantic (Rico *et al.* 2001). Overall alfonsino growth is similar between studies (Figure 13) with this study showing slower increase in size with age for the first ten years, but higher length at age thereafter. Variability in age estimates may be a result of differing ageing techniques, where some studies (Taniuchi *et al.* 2004) used microincrements to age the fish, or the size range used in the ageing sample was limited.

4 Recommendations

- Use these age estimates for the eastern portion of the stock.
- Use the combined length-at-age estimates.
- Undertake additional sampling to get better estimates of female age and for small fish.
- Assess whether change in growth at around age 9 coincides with the onset of maturity or can be attributed to other factors.

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Tables

Table 1: Age and growth paremeters from alfonsino East based on all otoliths irrespective of readability.

Parameters	Combined sexes	Male	Female
Linf	653.82	615.21	4902.10
k	0.06	0.07	0.00
t0	−5.73	−5.13	−9.97

Table 2: Age and growth paremeters from alfonsino East based on all otoliths with readability scores of 1-3.

Parameters	Combined sexes	Male	Female
Linf	692.05	646.52	4882.77
k	0.05	0.06	0.00
t0	−6.12	−5.51	−9.94

Figures

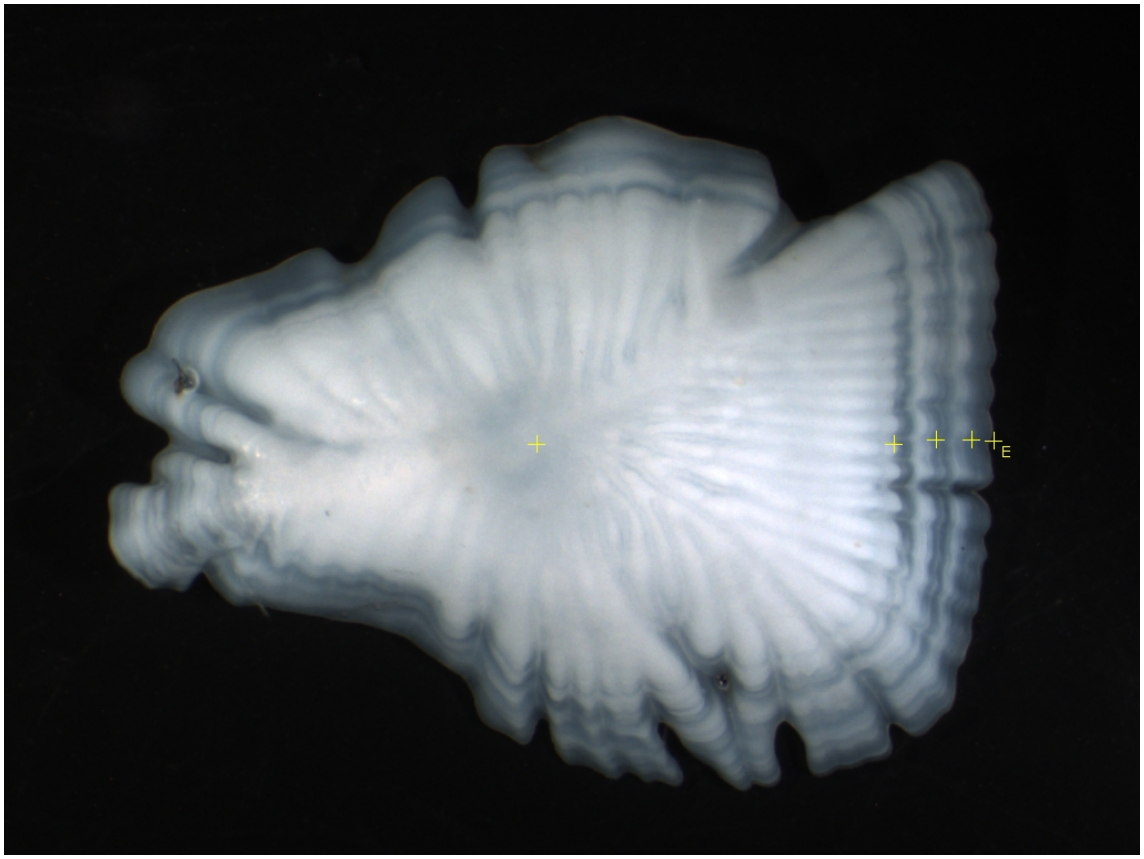

Figure 1: An alfonsino otolith collected from Alfonsino East for ageing showing the annuli.

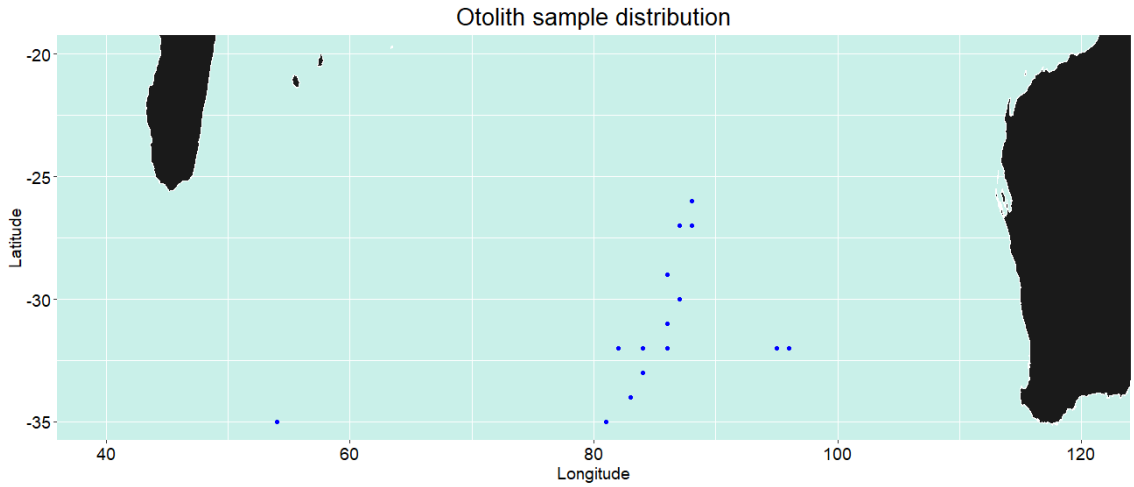

Figure 2: Location (blue dots) of age samples collected from Alfonsino East.

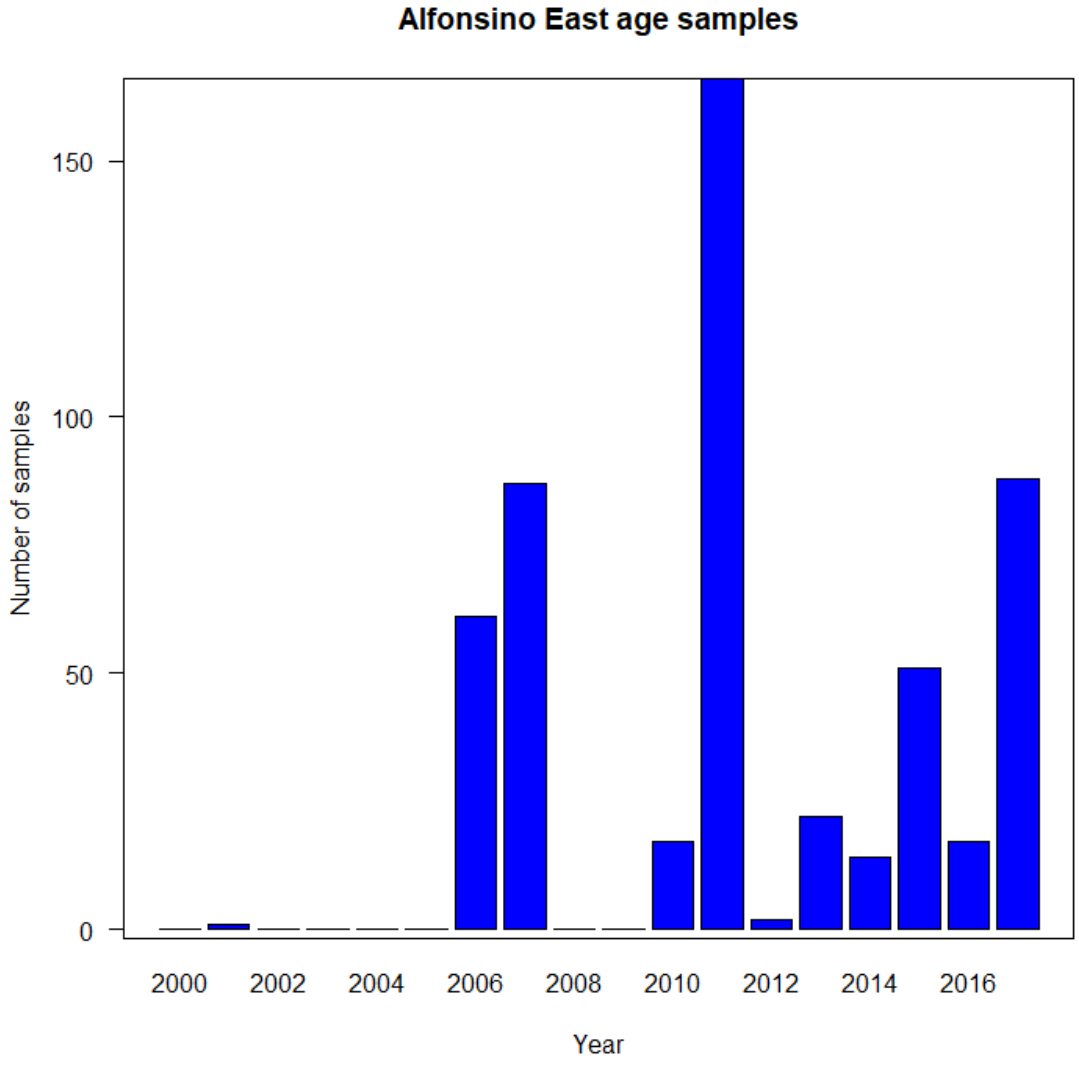

Figure 3: Number of otolith samples collected by year and aged from Alfonsino East.

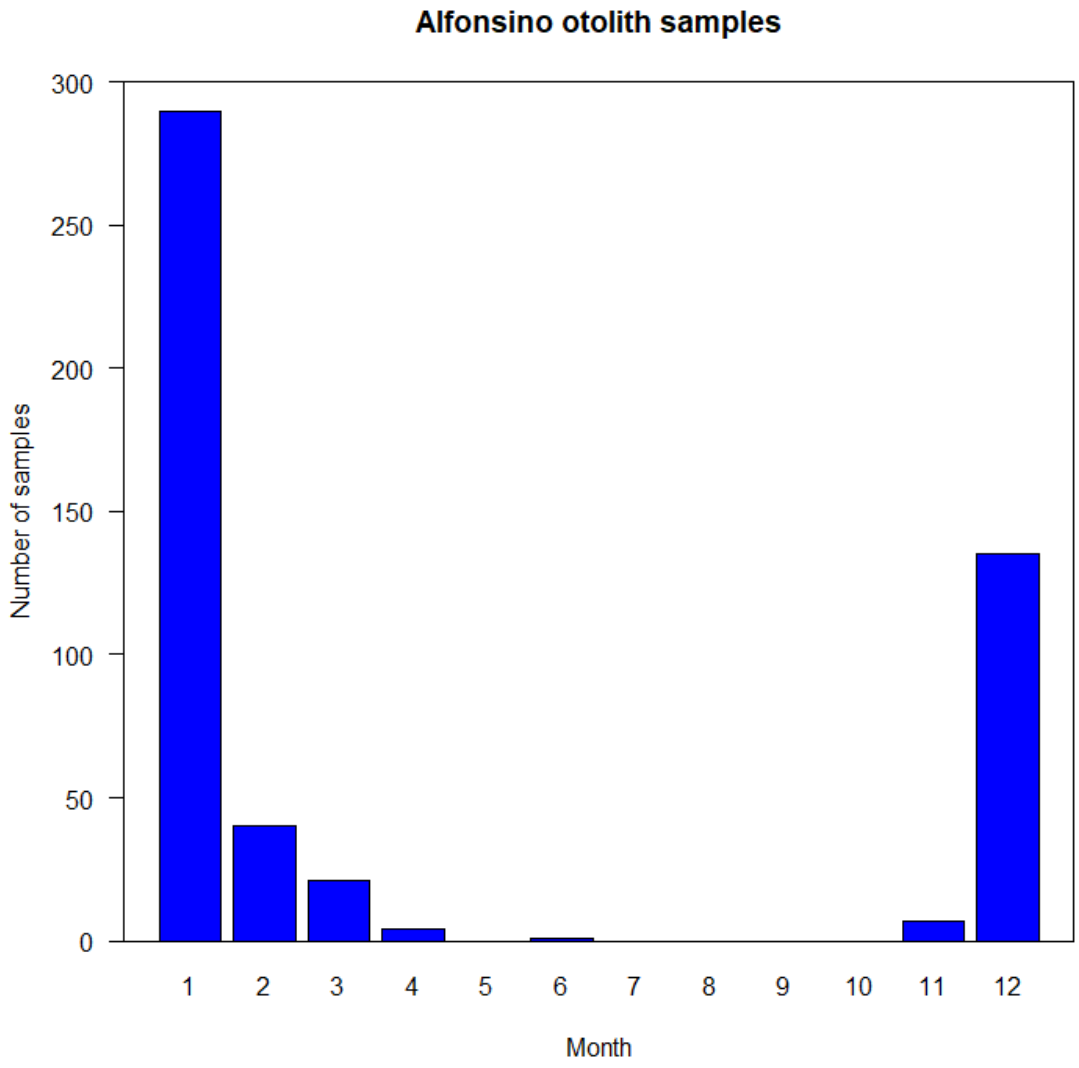

Figure 4: Number of otolith collected by month and aged from Alfonsino East.

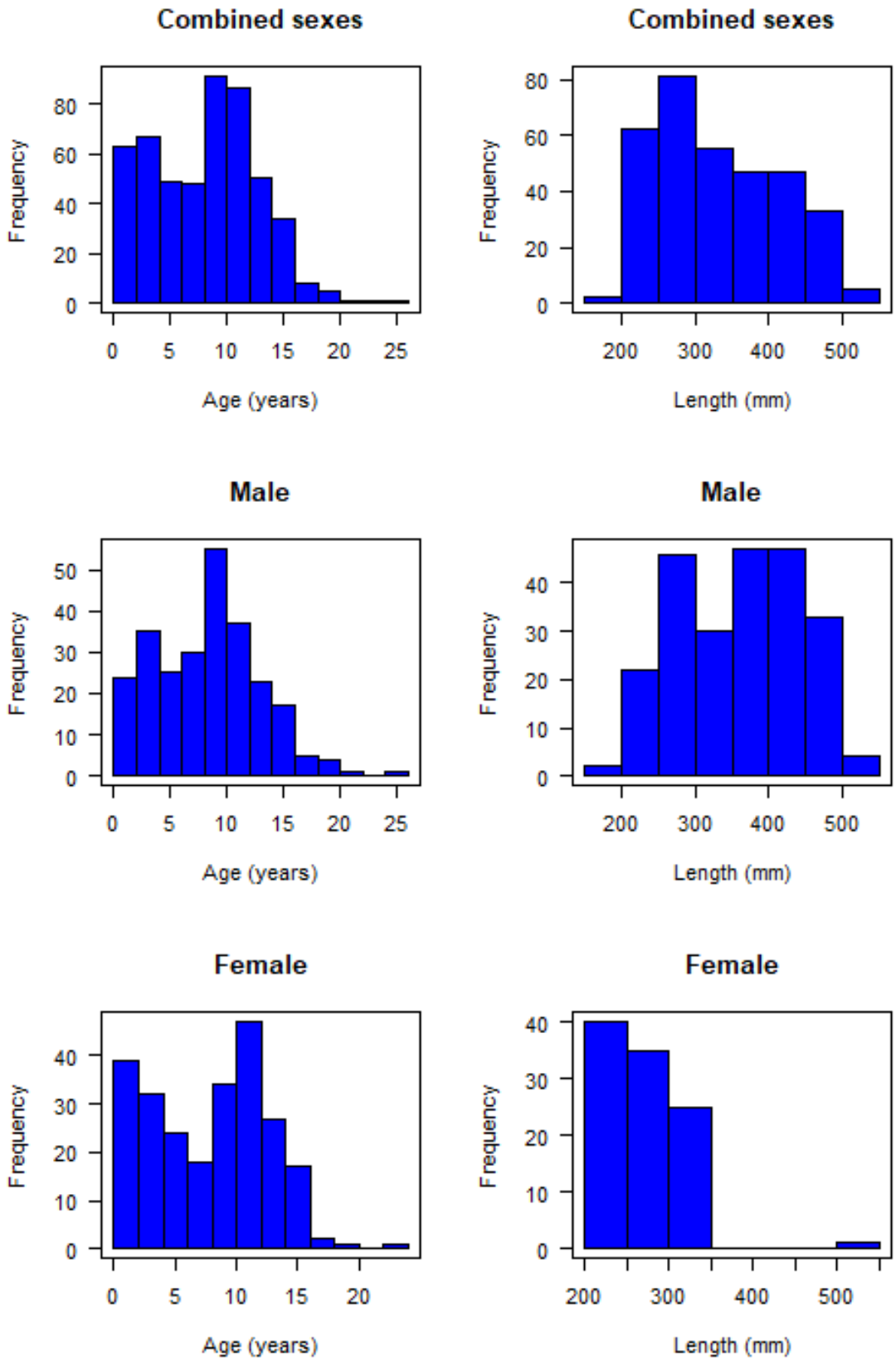

Figure 5: Age and length sample distribution of alfonsino collected in Alfonsino East.

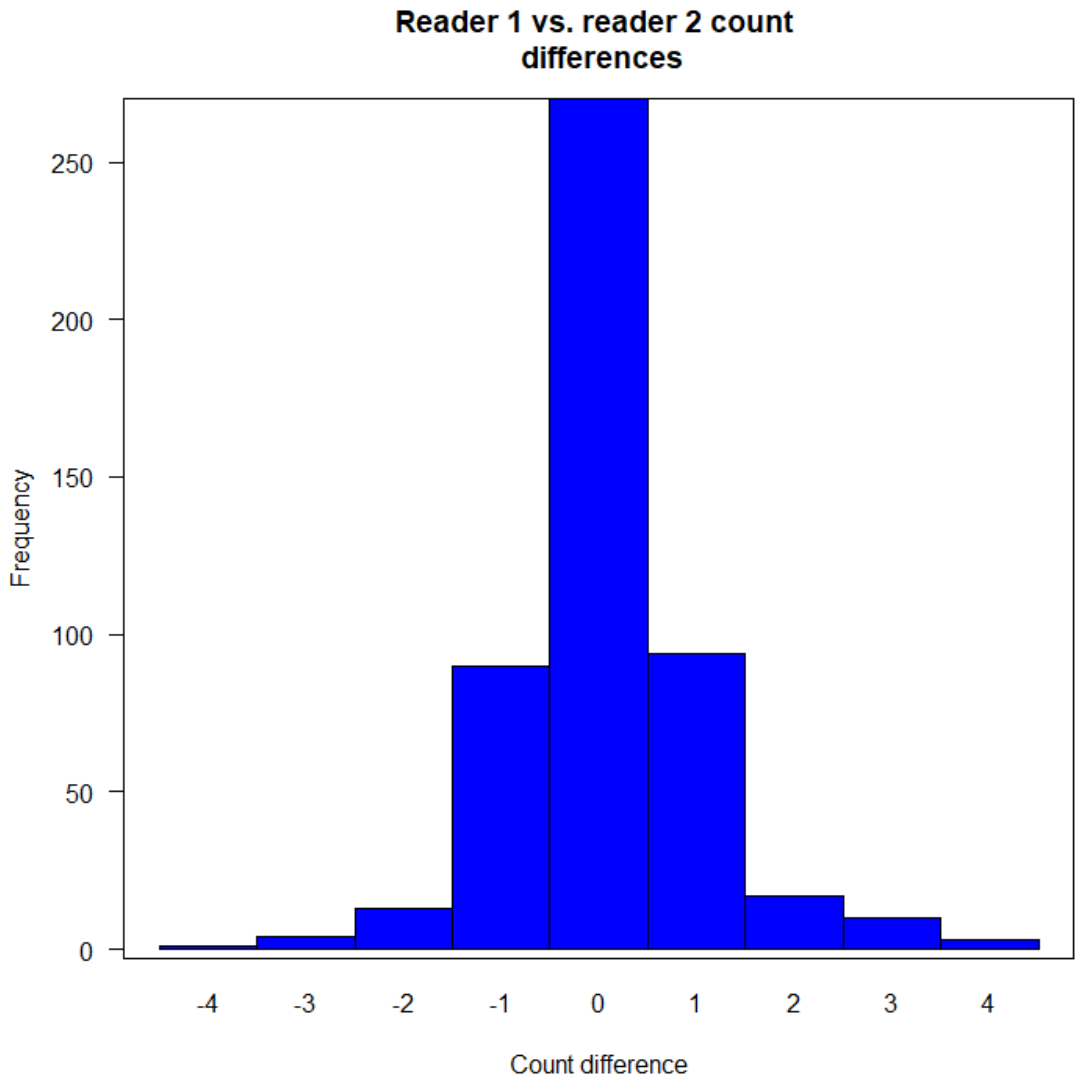

Figure 6: Age and length sample distribution of alfonsino collected in Alfonsino East.

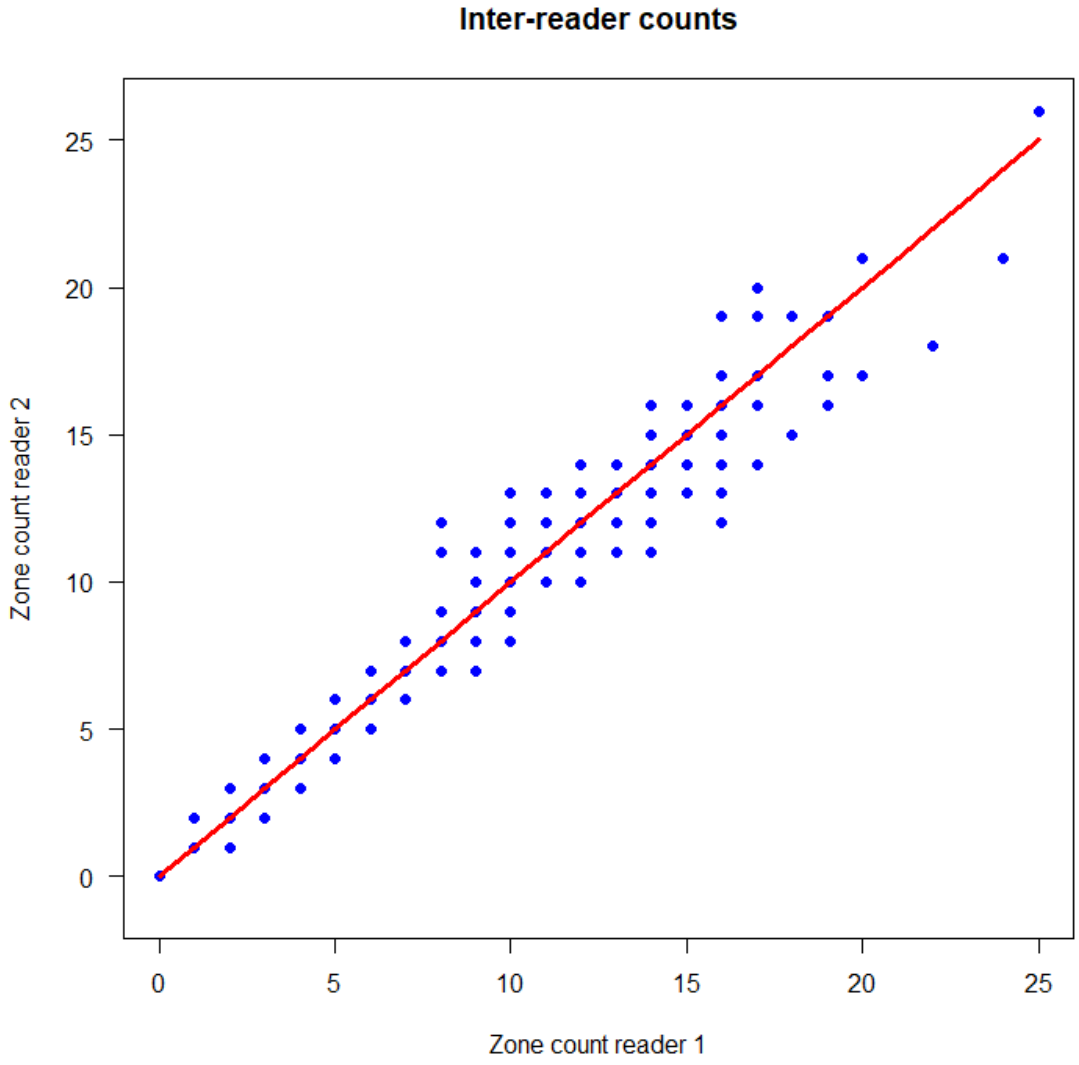

Figure 7: Age and length sample distribution of alfonsino collected in Alfonsino East.

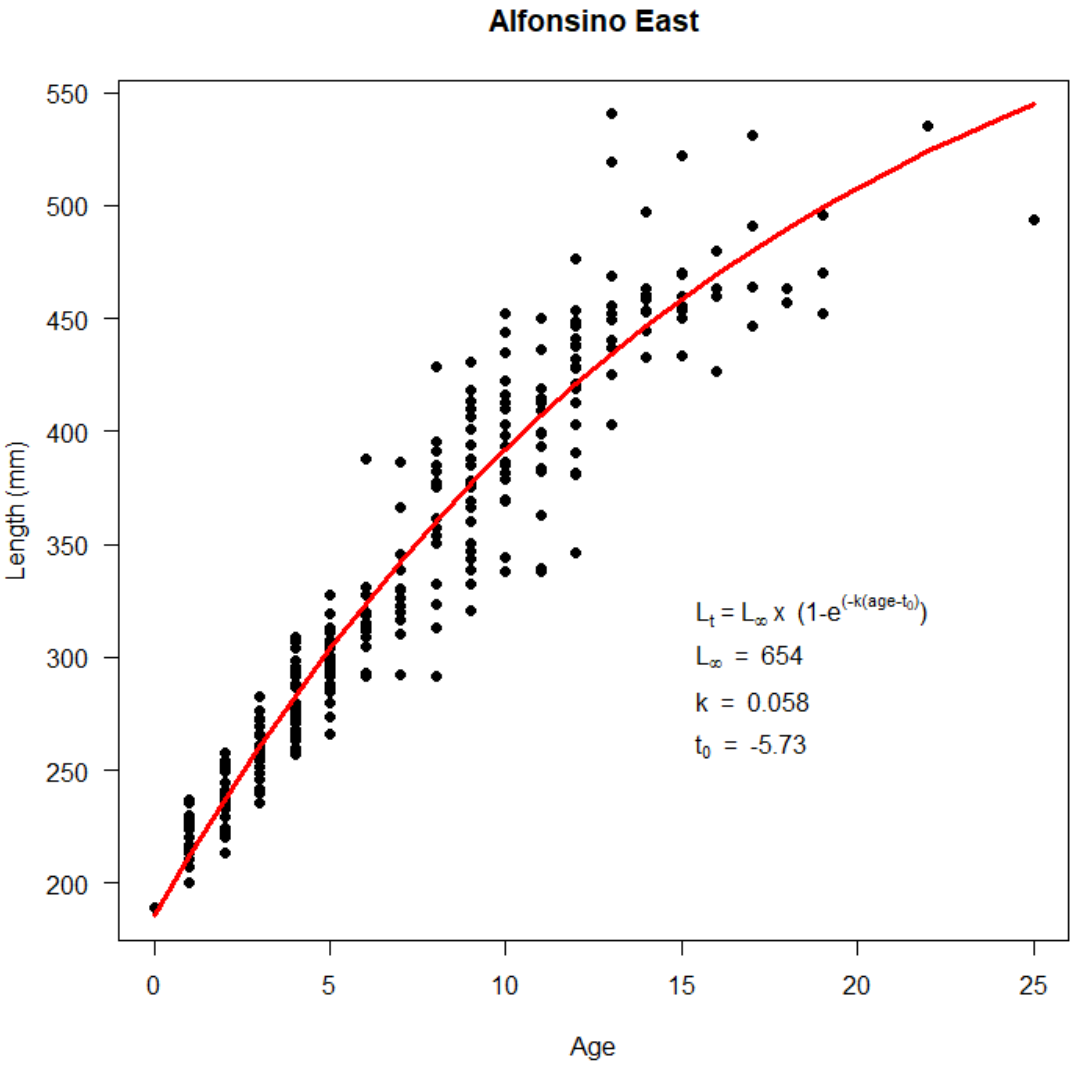

Figure 8: Length-at-age of alfonsino samples in the Indian Ocean showing all samples irrespective of readability and the fitted von Bertalanffy growth curve along with the derived growth parameters.

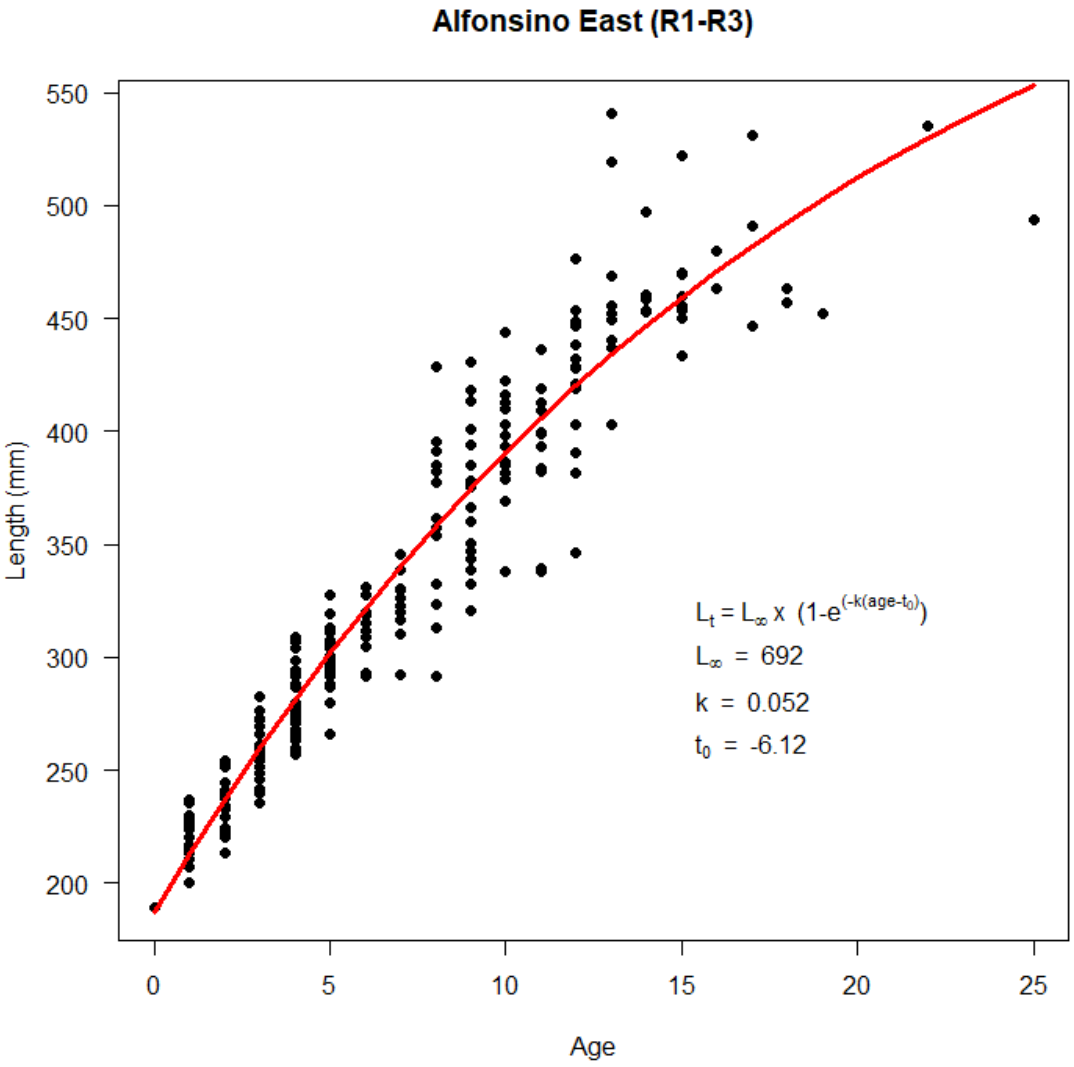

Figure 9: Length-at-age of alfonsino samples in the Indian Ocean showing samples with readability scores of 3 or less and the fitted von Bertalanffy growth curve along with the derived growth parameters.

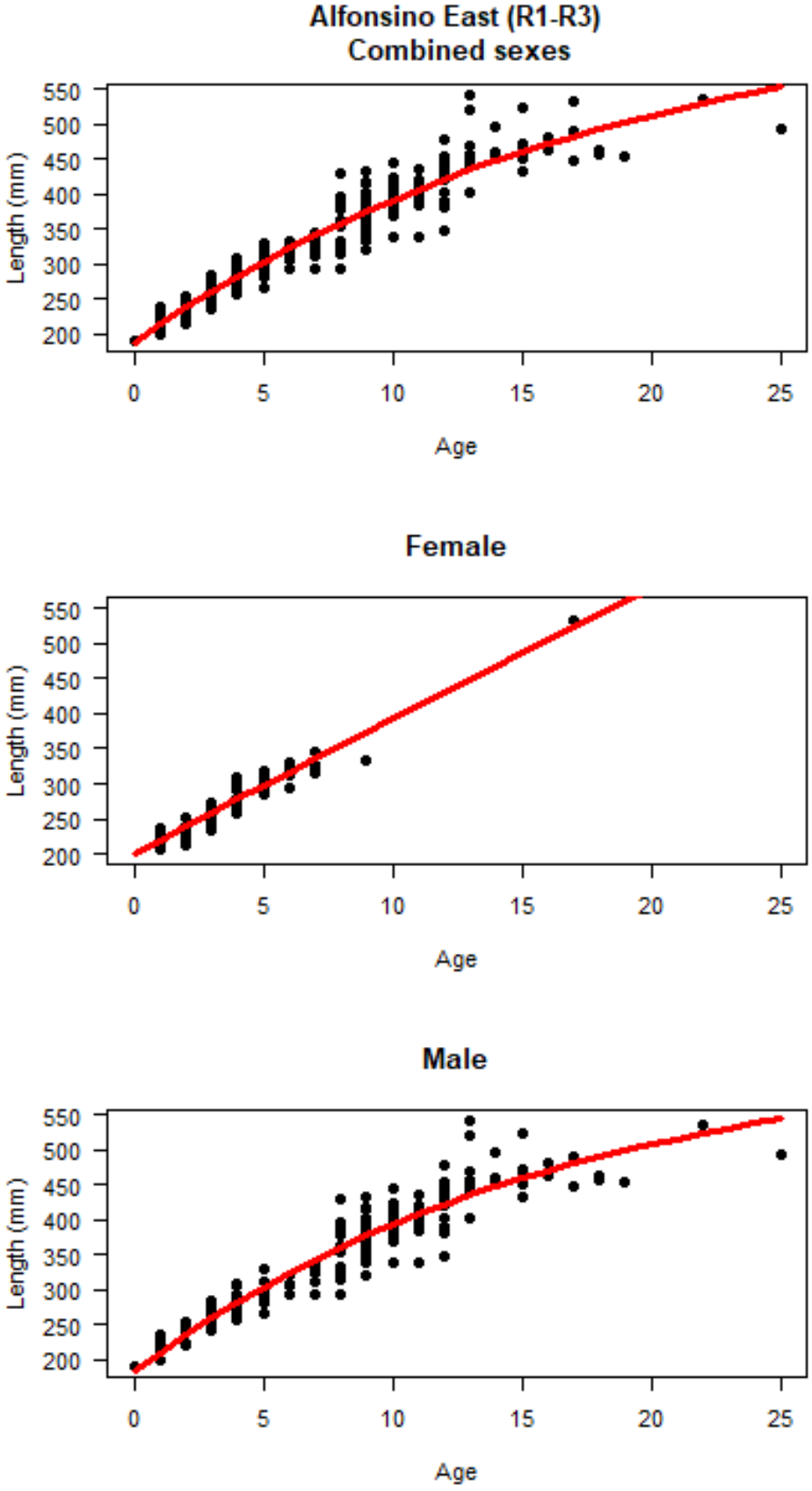

Figure 10: Length-at-age of alfonsino samples in the Indian Ocean showing samples with readability scores of 3 or less and the fitted von Bertalanffy growth curve for both sexes combined (top), females (middle) and males (bottom).

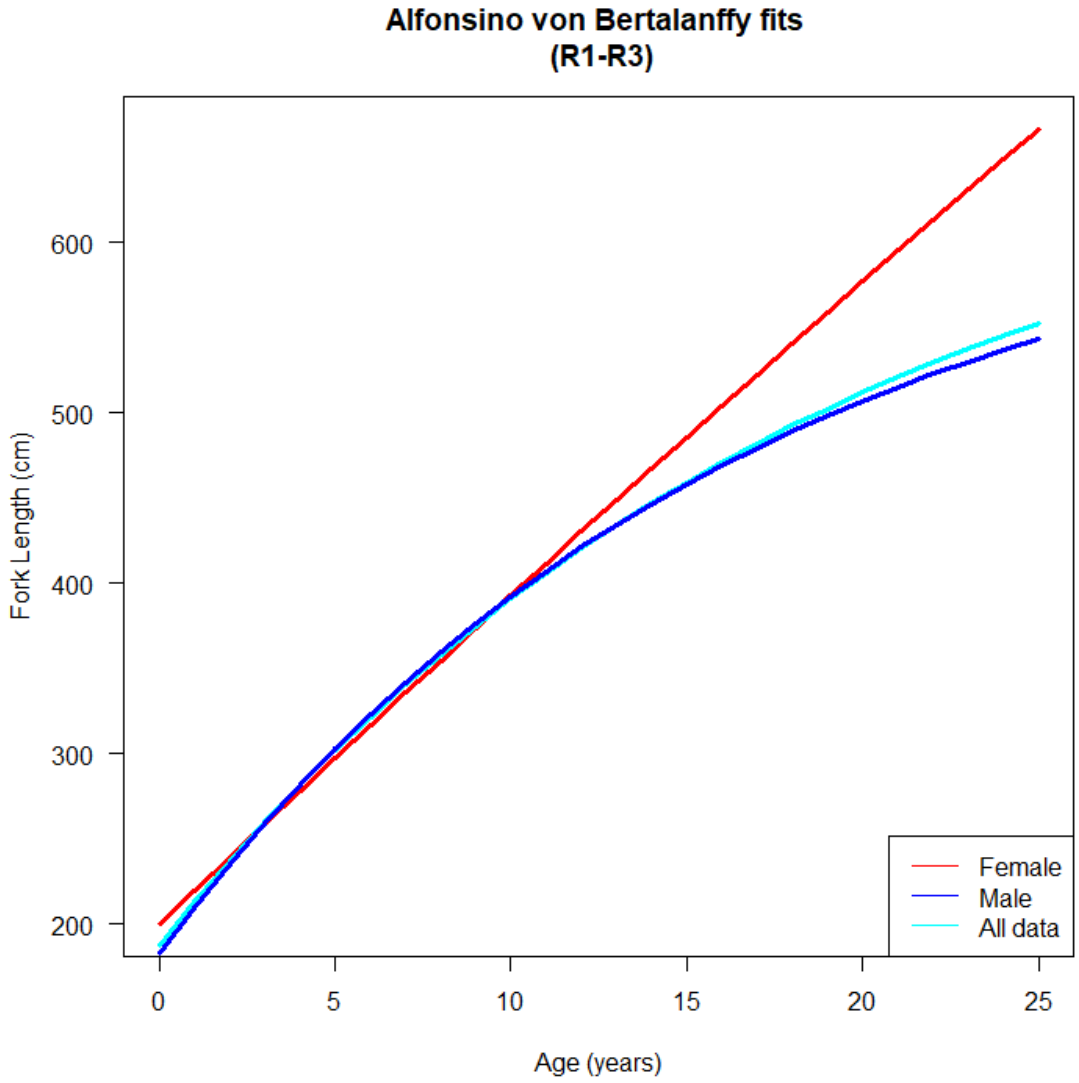

Figure 11: The fitted von Bertalanffy growth curve for both sexes combined, female and male alfonsino sampled in the Indian Ocean with readability scores of 3 or less.

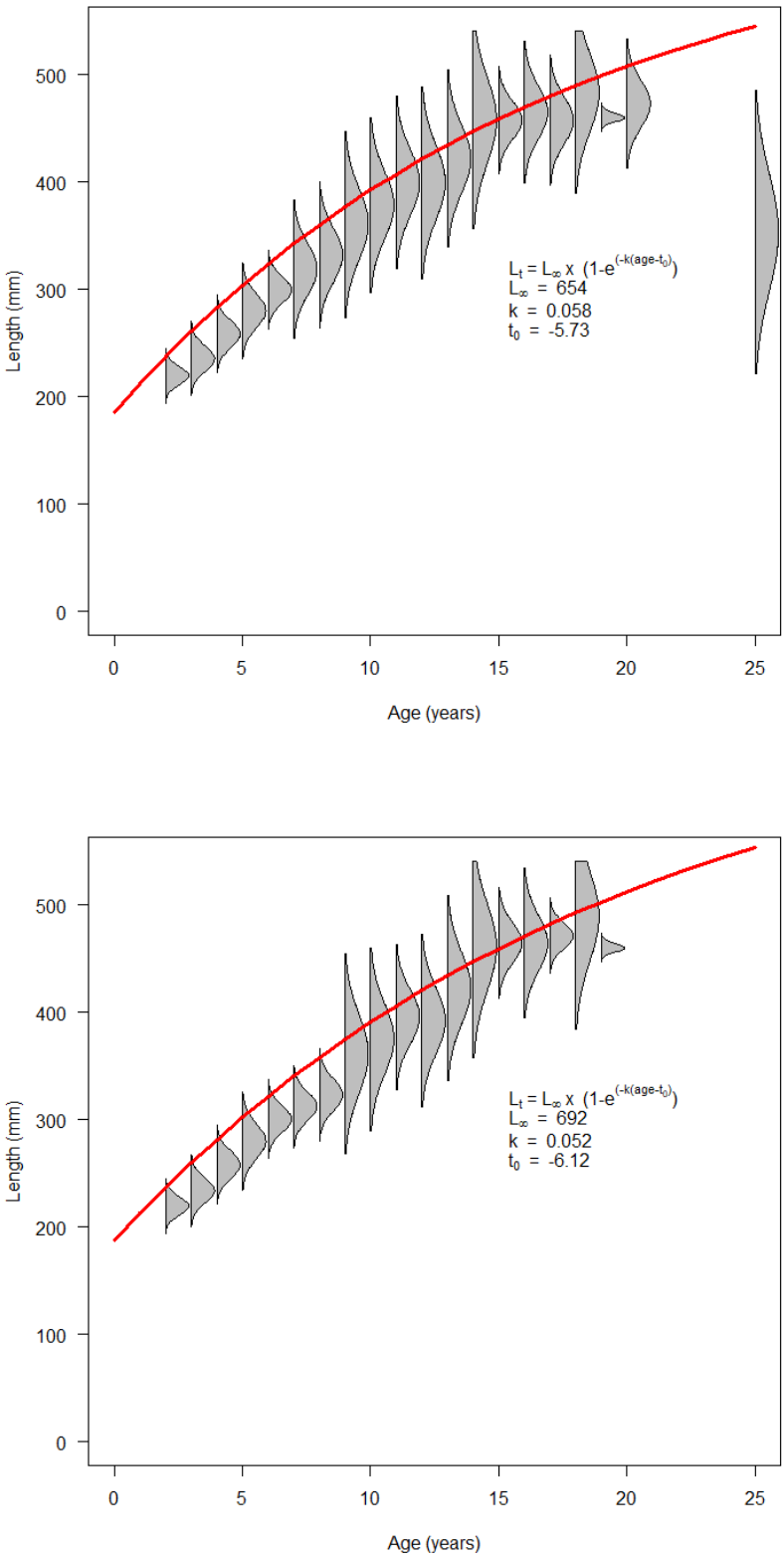

Figure 12: Length-at-age data distributions of alfonsino sampled in the Indian Ocean and the fitted von Bertalanffy growth curve for both sexes combined and with all readability scored included (top) and readability scores of 3 or less (bottom).

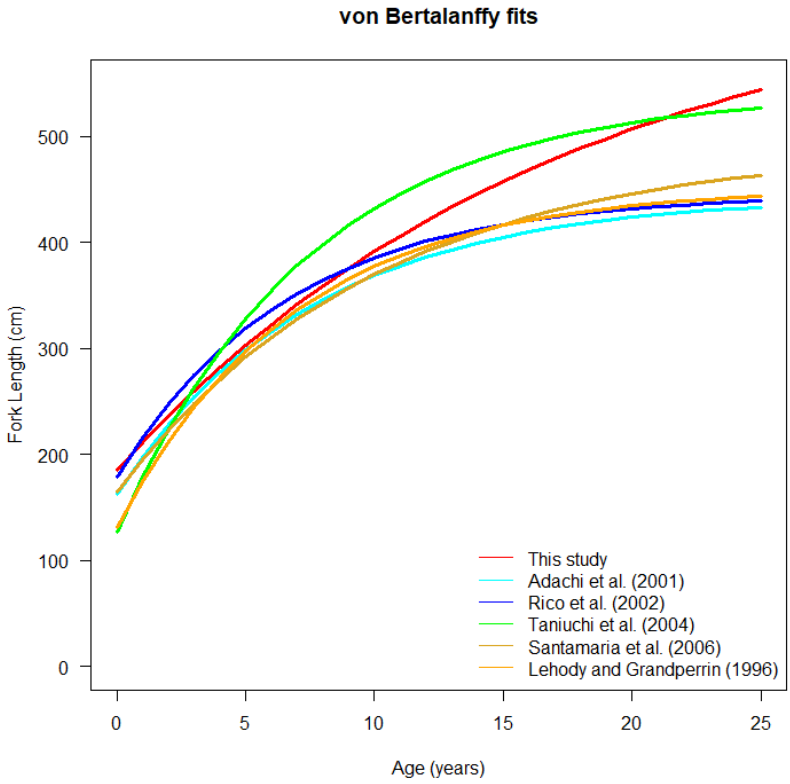

Figure 13: Comparisons of various alfonsino growth trajectories form the Indian, Atlantic and Pacific Oceans.