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Estimation of length distribution for landing data of Pacific Blue-Fin tuna in Sakai-minato port.

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Introduction

Pacific bluefin tuna (*Thunnus orientalis*: PBF) is one of the most high-priced fish and is important commercially in the world. PBF has a long life span, (i.e. at least 26 years) and for that reason, multi cohort model is used for stock dynamics. Because PBF is a highly migratory pelagic species, it is difficult to make research fishery cover all over the habitat so commercial fishery data are essential for its stock assessments. Sakai-minato port is one of the most important landing ports for PBF. At the Sakai-minato port, the length data of landed PBF are measured as fundamental data to estimate fish length distribution for purse seine catches in the Sea of Japan. In the previous stock assessments, the length distribution of sampled individuals is considered to represent that of the entire landings. Purse seine fishery makes a set on one school of fish. In particular for the adult PBF purse seine fishery in the Sea of Japan, each landing is usually consisted of the catch by one set. Therefore, the length distribution of each landing has narrower size range than that for the entire catches on an annual or seasonal basis. To account this characteristic, sum of all length distributions weighted by numbers of fish in each landing is now proposed to be used. The purpose of this document is to show the differences between sum of length distribution weighted by each landing and simple sum of entire length samples.

Materials and Methods

1) Data set

Length data which have associated information on the sampled vessels were used for this study. These samples were from 1987 to 2009, except for 1990, in which there was no PBF catch. (see Table 1). They were collected at Sakai-minato port by the Tottori Prefectural Fisheries Experimental Station. Although Sakai-minato-based tuna fishing season is usually from June to July, one exceptional operation with some amount of catch was observed in October in 1997. We removed this operation from the data in this analysis. In addition, as sample size of individual of length below around 80 cm, called "Yokowa", was small, we also excluded these data in this analysis.

At Sakai-minato port, in most cases, carrier vessels transport the catches to the port immediately after each operation. This suggests that one landing by a vessel comes from single operation i.e. one school. In this analysis fish in a single landing was considered as catch by a single operation. Additionally, when catch in one haul of seine exceeds the capacity of the port, the landing is usually taken place in two consecutive days. Thus in this analysis the multiple landings by the same vessel in consecutive days were combined and considered as one single landing.

In the stock assessment, quarterly season is used as time unit. However, in Sakai-minato-port the main fishing season starts in June and ends July. Because the length data should not be divided in the middle of fishing season, the length data were combined in an annual basis in this analysis.

2) Estimation of catch at size

I Weighted length distribution (proposed procedures shown as “new” in the Figures)

The length distribution is calculated by summing the length distributions of each landing raised to the number of fish in each landing.

The length bin which was used for the input data of SS2 (Anonymous 2007) was adopted for this analysis.

II Procedures used in past studies (referred as “former” in the Figure)

The catch at size is calculated by just combining all measured individuals and then raised to the total number of fish landed at the Sakai-Minato Port

4) The structure of bootstrap

The confidence intervals were estimated by percentile methods of bootstrapping (Davison & Hinkley 1997). The bootstrap replicates were drawn from the actual sampling structure; i.e. two-stage re-sampling method:

1. Landings are re-sampled without replacement while keeping the original number of landings for each year.
2. Length data in every landing are re-sampled with replacements.

The trials of bootstrapping were repeated 1000 times. The confidence intervals of length frequency of landings were obtained by percentile method through 1000 bootstrap runs.

Result & Discussion

The confidence interval of 95 % and median in each year is shown in Fig. 1a, for proposed and past methods, respectively. The positions of modes of length distribution are almost same between proposed and past methods but the relative heights of modes are different. The differences between two series increase since 2004, probably because the number of landing increased. As a general trend, the values of the frequencies for smaller individuals estimated by the proposed method are relatively larger than those estimated by the previous method (Fig 1b).

To clarify the variation of length frequency in each bin, the standard deviations estimated by bootstrap and by assumption of multinomial distribution are compared (Fig. 2). The standard deviation by bootstrap is larger than that by multinomial distribution, for the most years. Therefore the standard deviation ratios between multinomial divided by bootstrap are less than 1. The variations in this ratio, which depend on length bin, are larger in the proposed method than in the past method, because more individuals are involved in each landing in the proposed method. This suggests that estimated length frequency by proposed method has more variation than that by previous method. .

However, the method which produces more variation does not mean incorrect method. This is the consequence of the characteristic of purse seine fishery, as the catch of one set, which comes from the same school of fish consists of fish of similar sizes. The consideration to include such the difference in variation depend on length bin to stock assessment model is required e.g. including bin specific weighted value to input stock assessment model.

References

Anonymous. 2007 The Third Working Group Meeting in 2007, on the Pacific Bluefin Tuna of ISC December 11 -18, 2007, Shimizu, Japan

Davison, A. C. and D. V. Hinkley. 1997. Bootstrap method and their application. Cambridge University Press. Cambridge, UK, 202 p.

Table 1 The total numbers of main vessels, main vessels with length measurements data, landings, landings with length measurements data, catch amount in terms of individuals, sample size and sample coverage rate to catch (i.e. sample size divided by catch) for each year. Values regarding sample were calculated from data used in this study.

Year	Vessel	Vessel with lenghs data	Landing	Landing with lengths data	Catch	Sample size	Coverage (%)
1987	1	1	2	2	1419	791	55.7
1988	5	5	10	10	3539	2006	56.6
1989	3	3	4	4	2395	1166	48.6
1990	-	-	-	-	-	-	-
1991	4	4	7	7	2024	1300	64.2
1992	4	4	6	6	2913	2220	76.2
1993	2	2	3	3	1801	1284	71.2
1994	2	2	4	4	9608	1935	20.1
1995	3	3	3	3	3508	1035	29.5
1996	6	6	6	6	4238	2772	65.4
1997	5	5	9	8	3955	1902	48.0
1998	4	4	8	7	4265	2240	52.5
1999	4	4	8	8	6129	3333	54.3
2000	5	5	10	10	7548	3775	50.0
2001	5	5	5	5	2193	1365	62.2
2002	5	5	13	13	5976	3190	53.3
2003	4	4	14	14	6649	2895	43.5
2004	8	8	36	36	27102	9122	33.6
2005	11	11	55	55	47120	15626	33.1
2006	10	10	50	50	19418	10814	55.6
2007	9	9	49	48	41911	17073	40.7
2008	9	9	60	58	44500	19961	44.8
2009	9	9	31	28	16513	2328	14.0

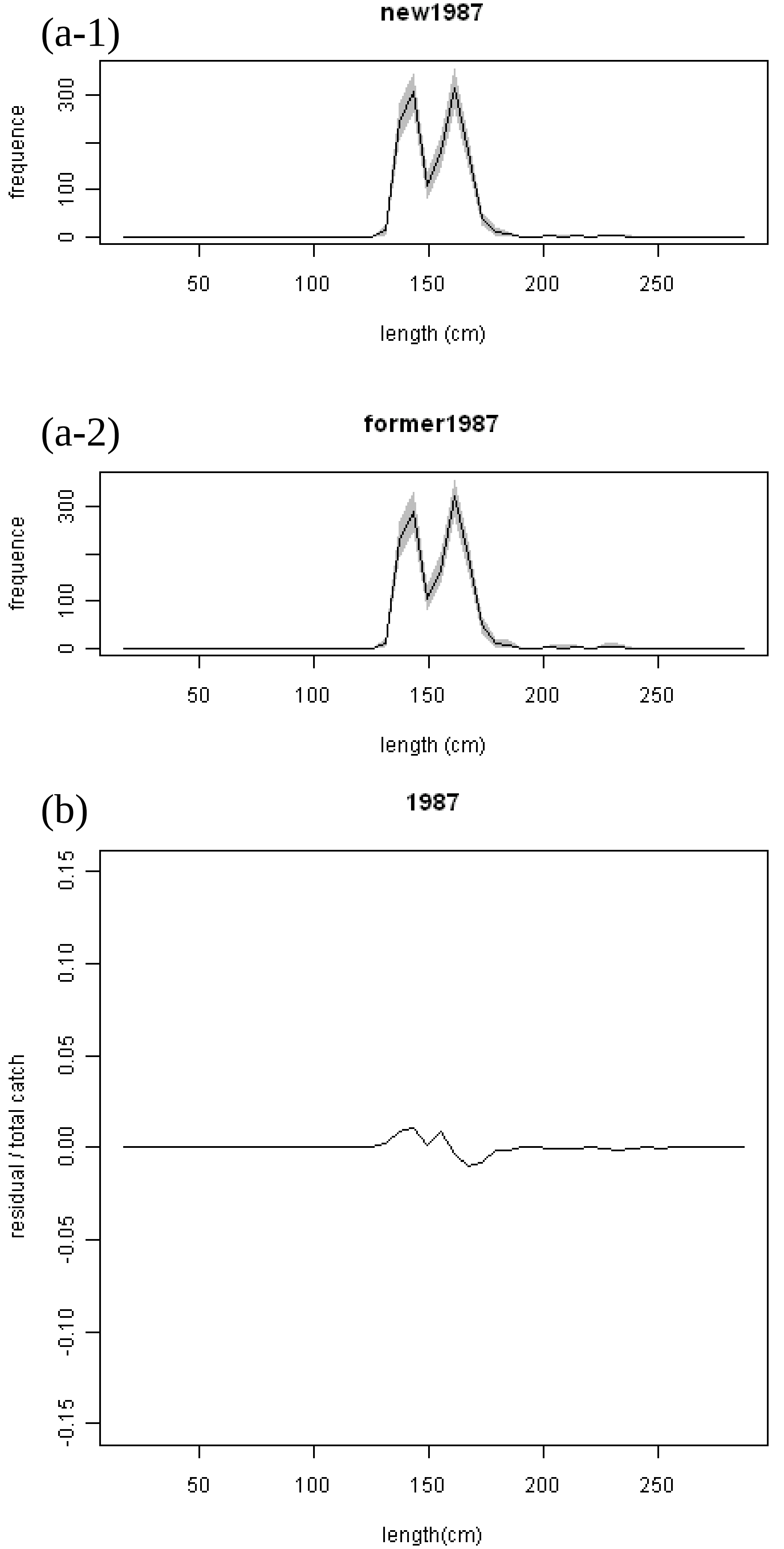
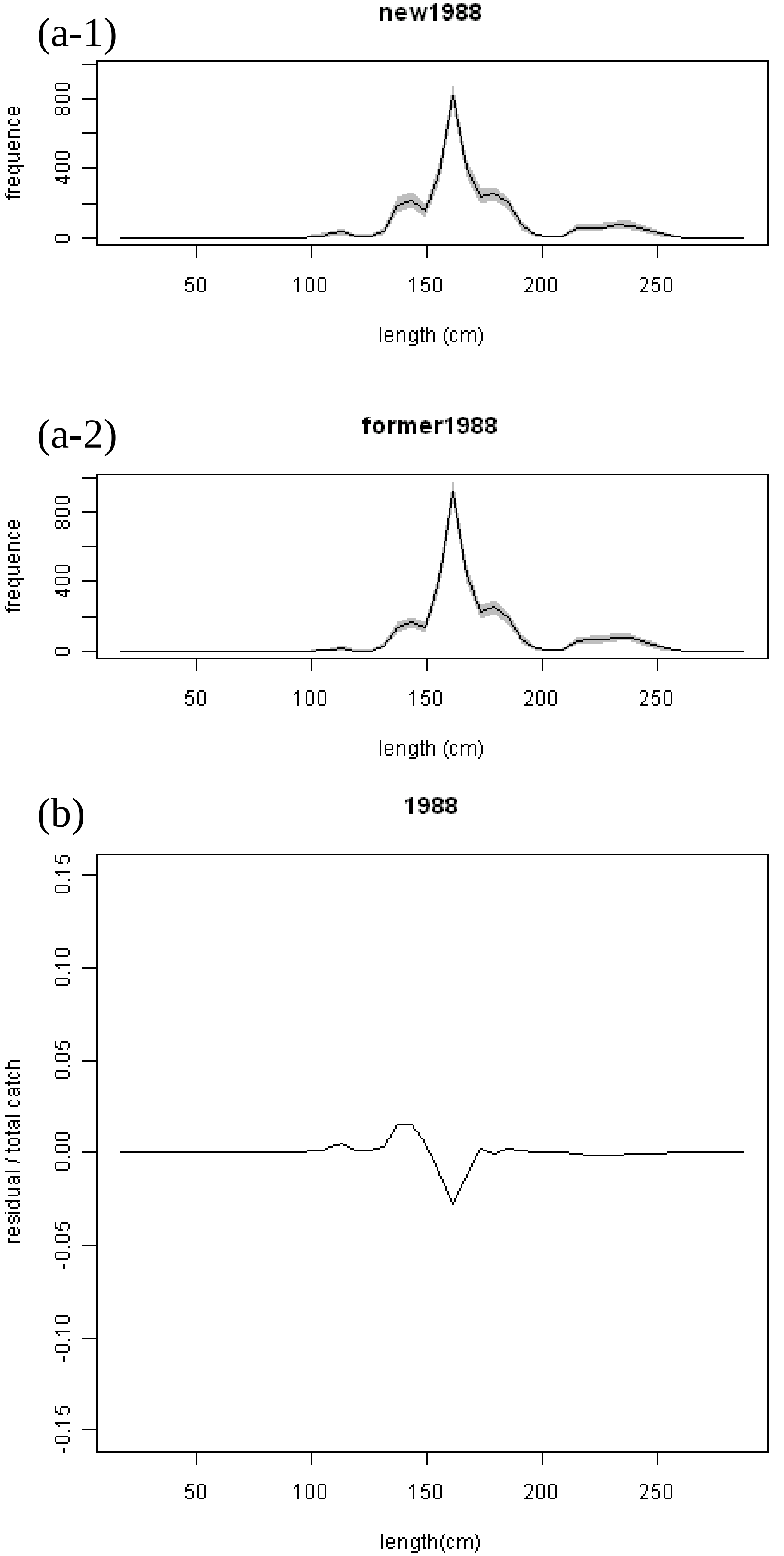


Fig. 1 (a) black line shows median of length frequency of catch and gray polygon shows 95% interval for new and former aggregation method. (b) line shows residual between two aggregation methods divided by total catch.



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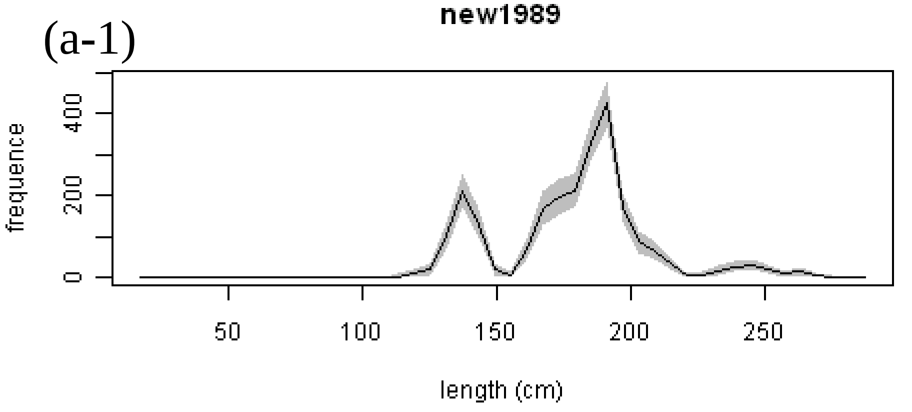

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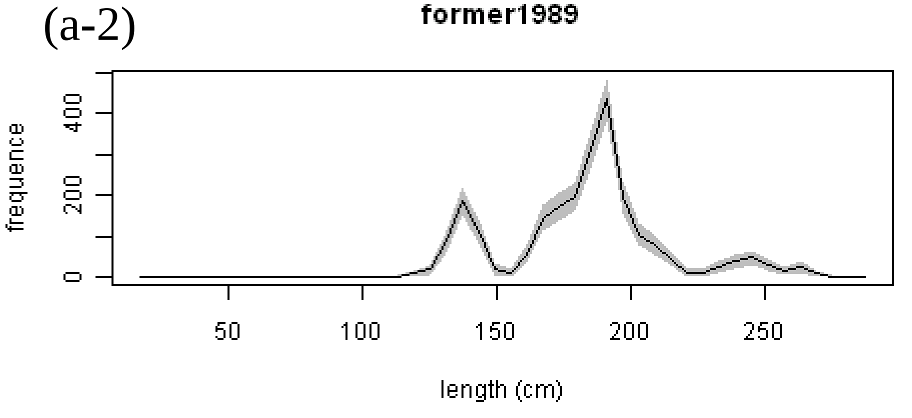

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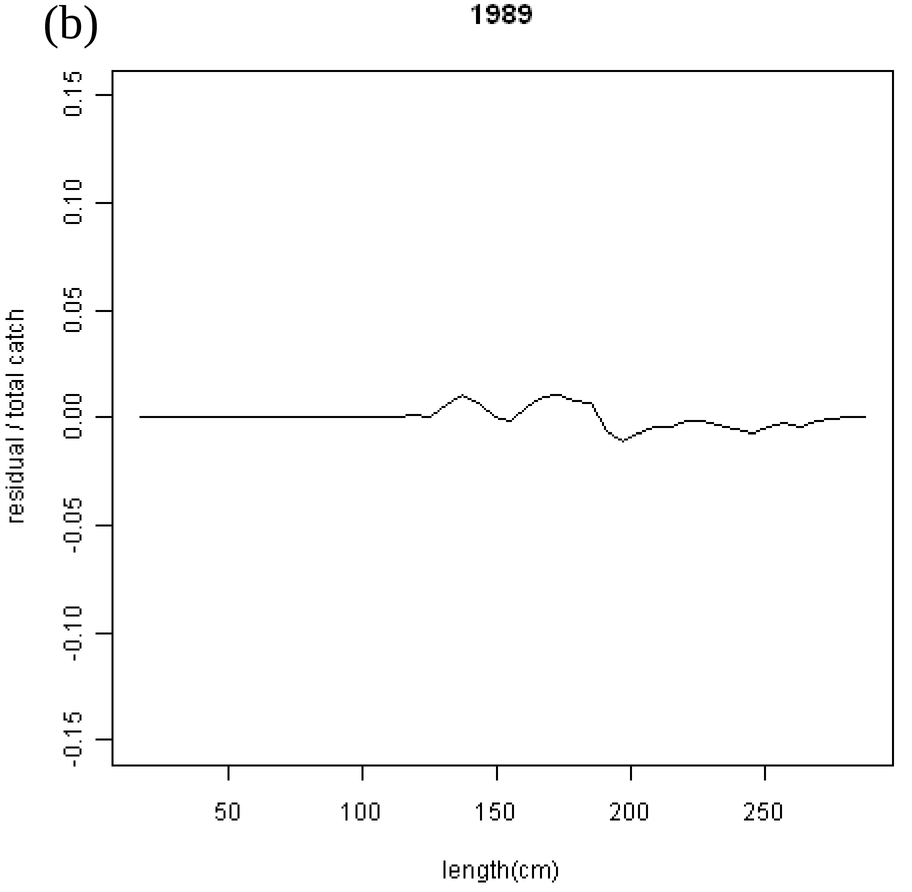

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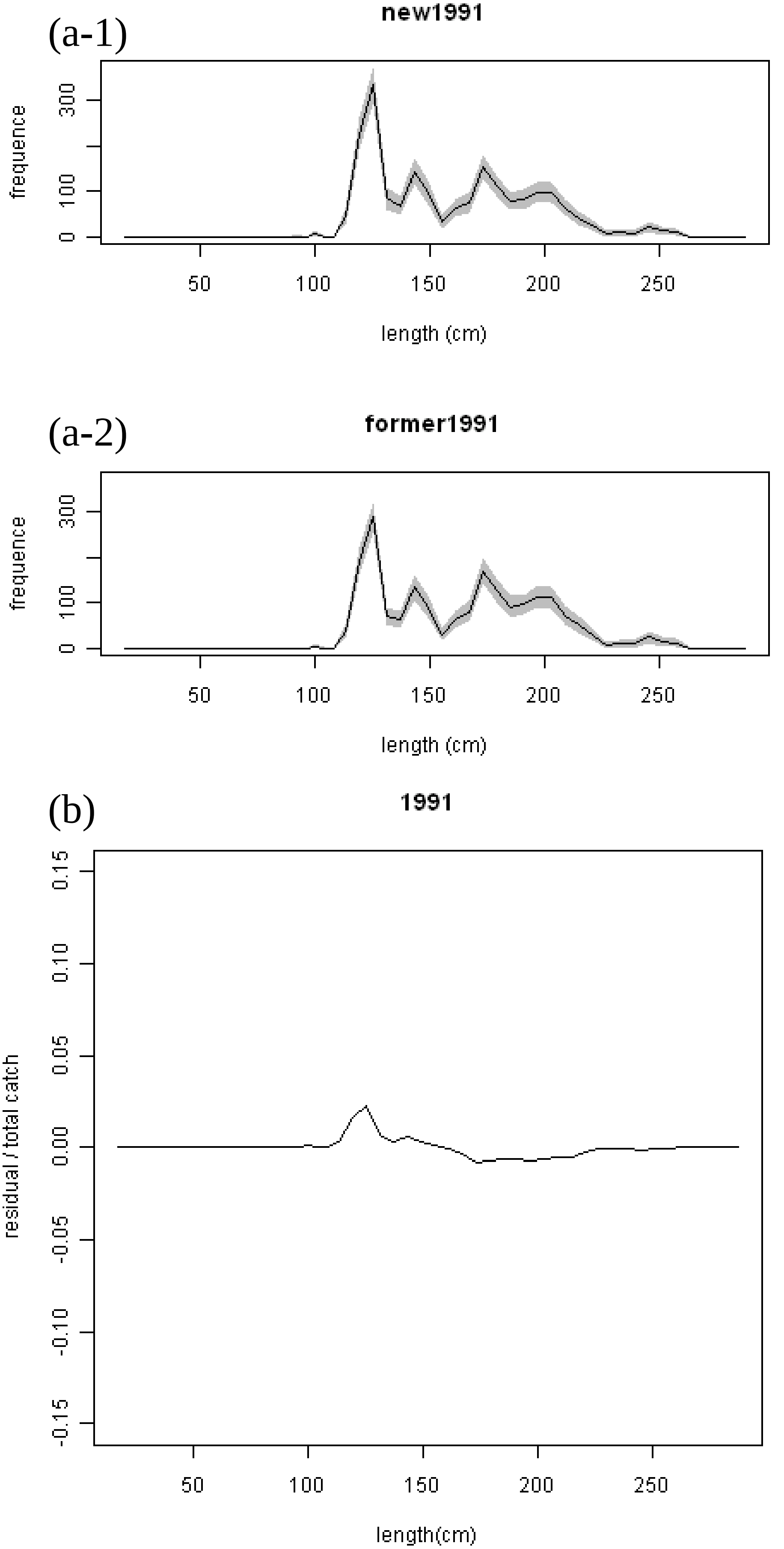

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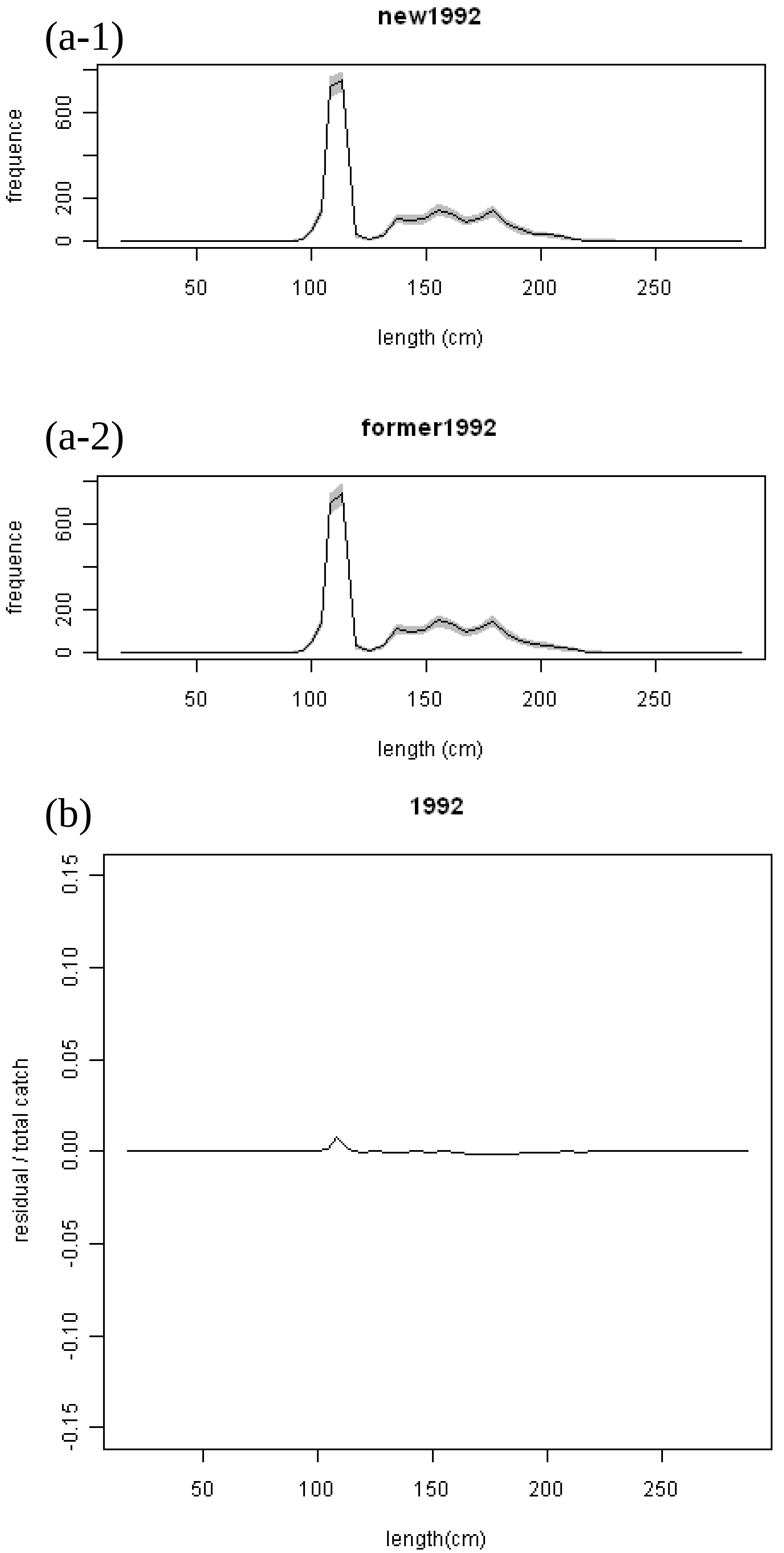

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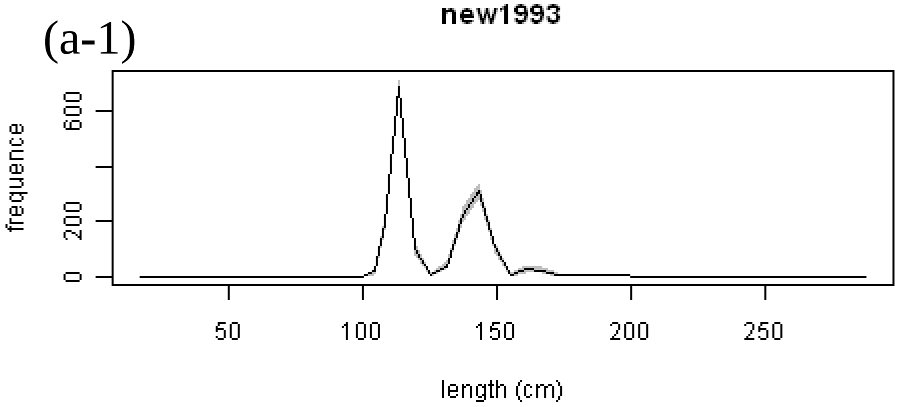

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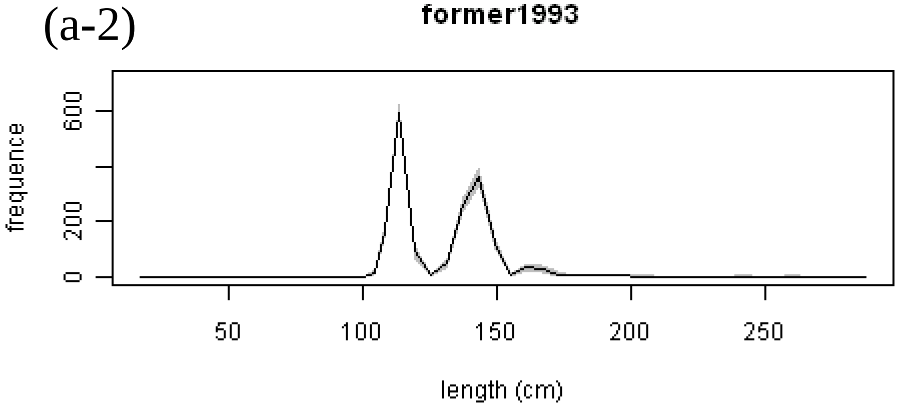

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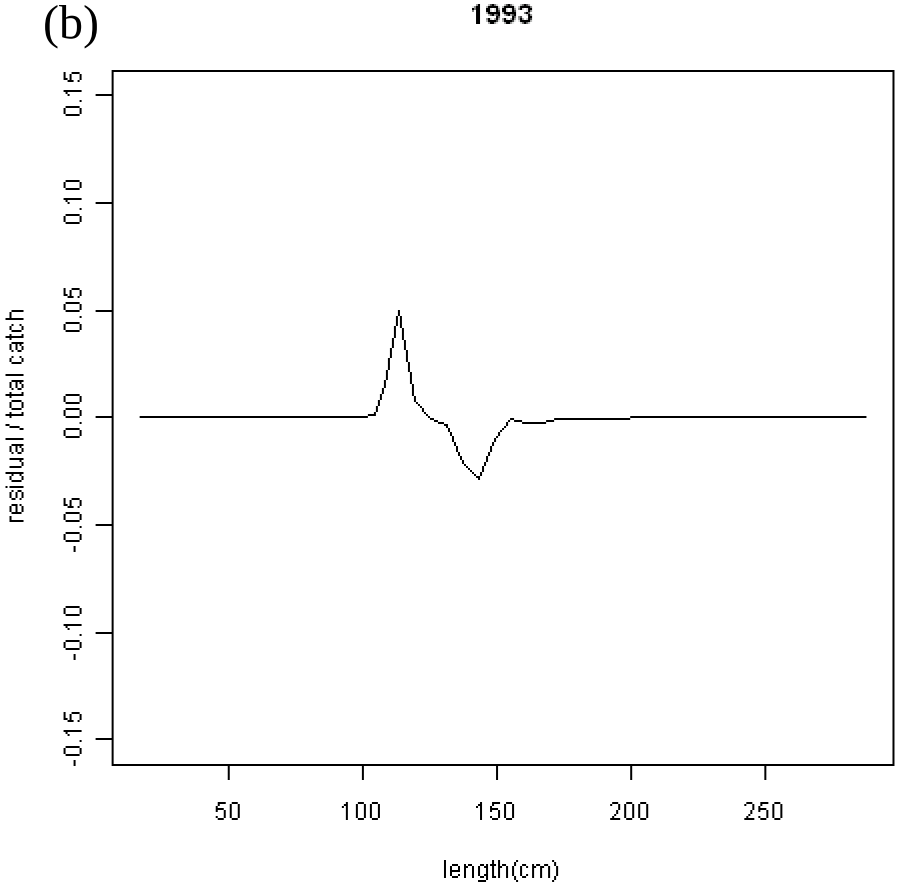

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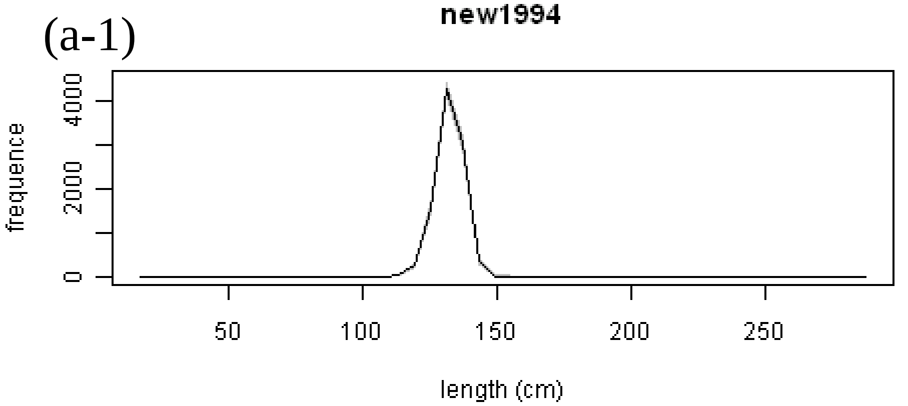

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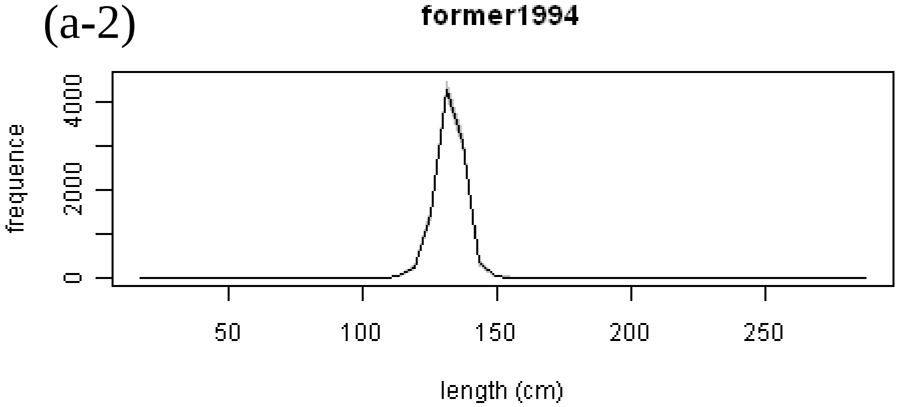

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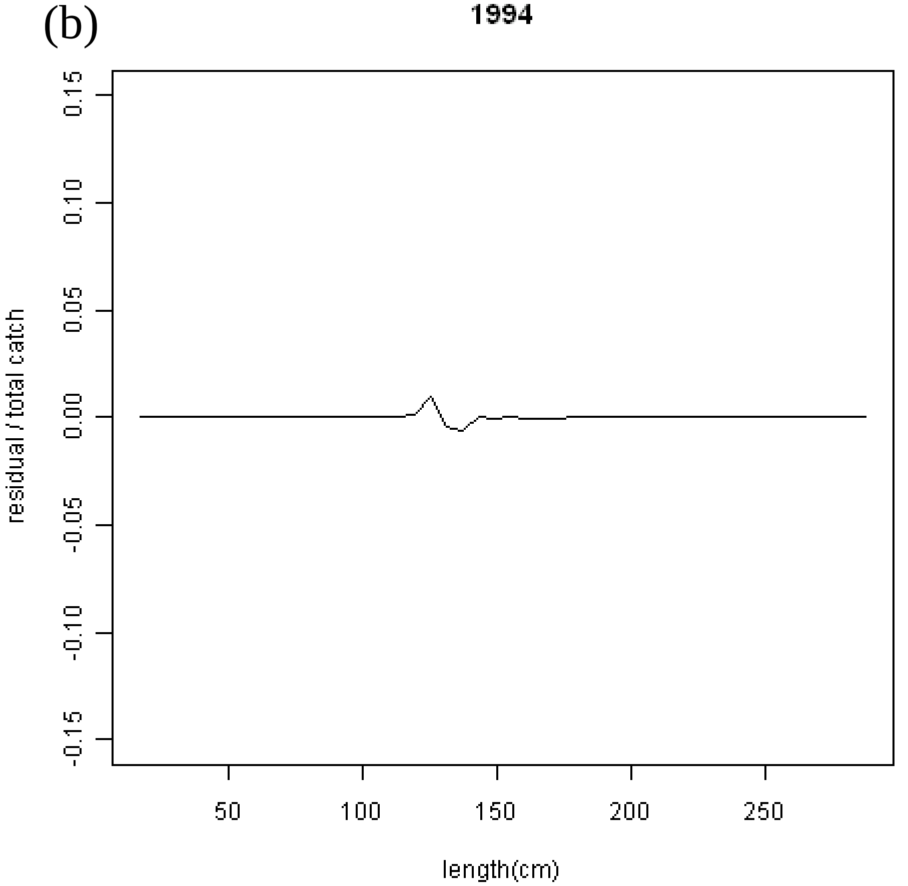

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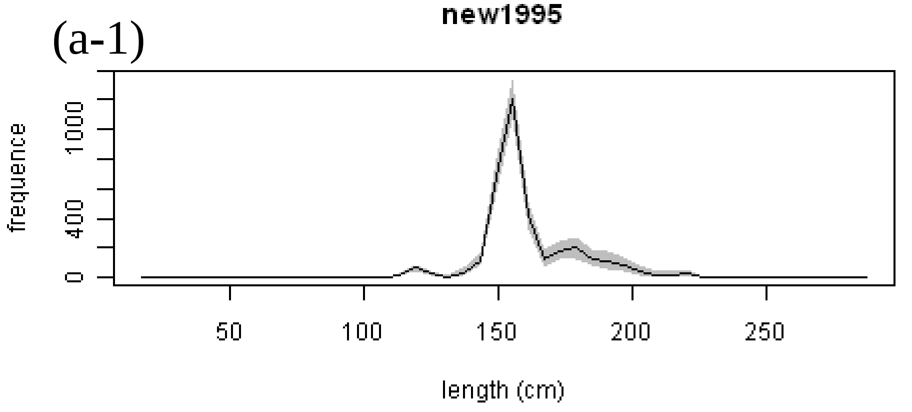

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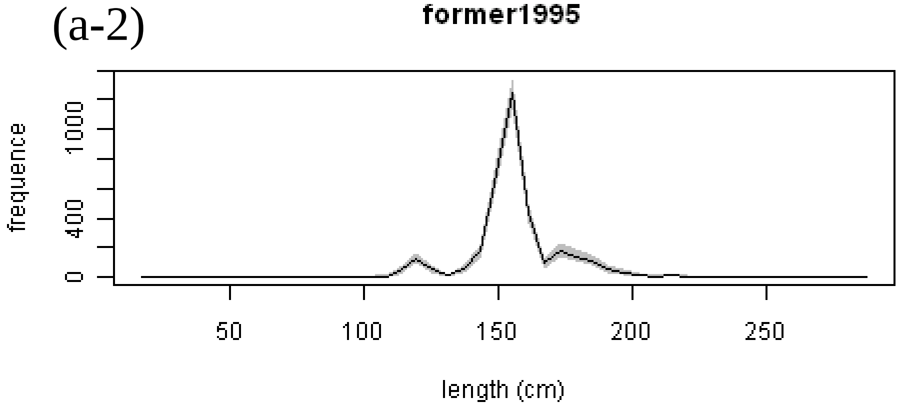

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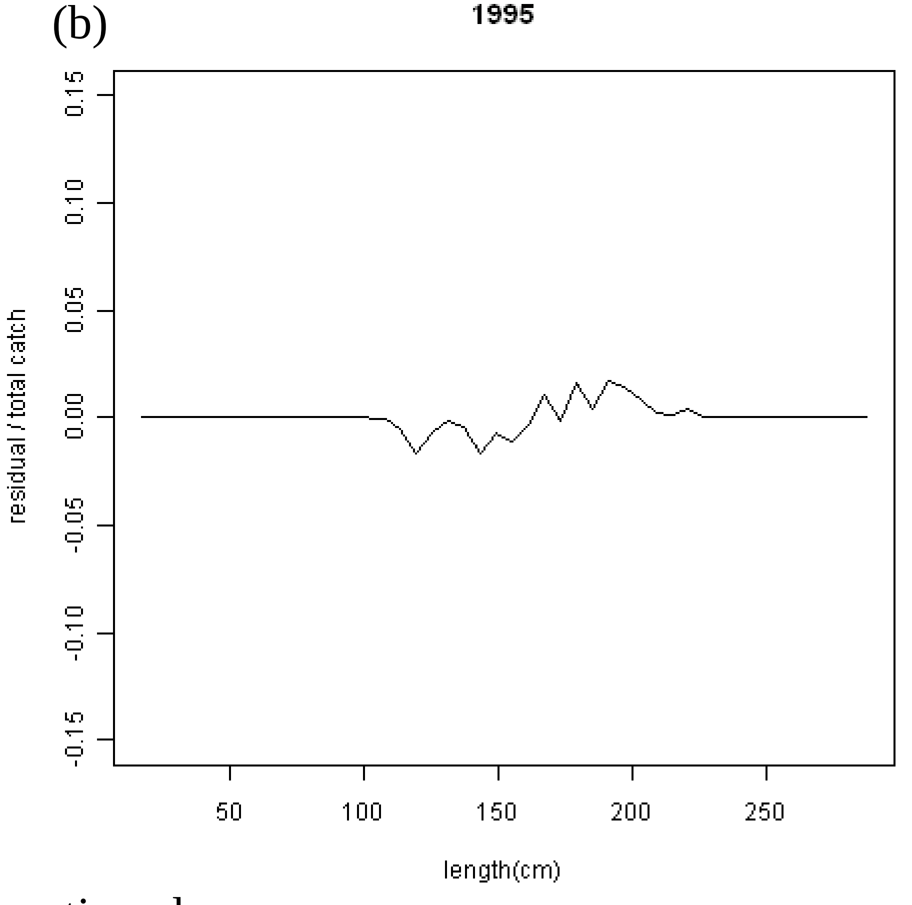

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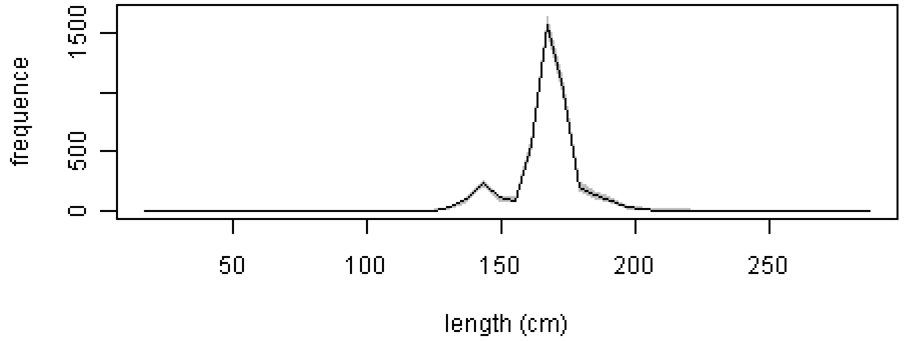

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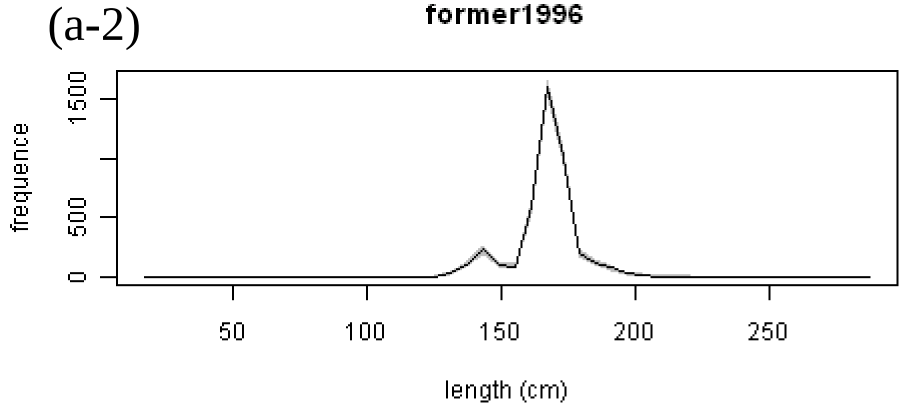

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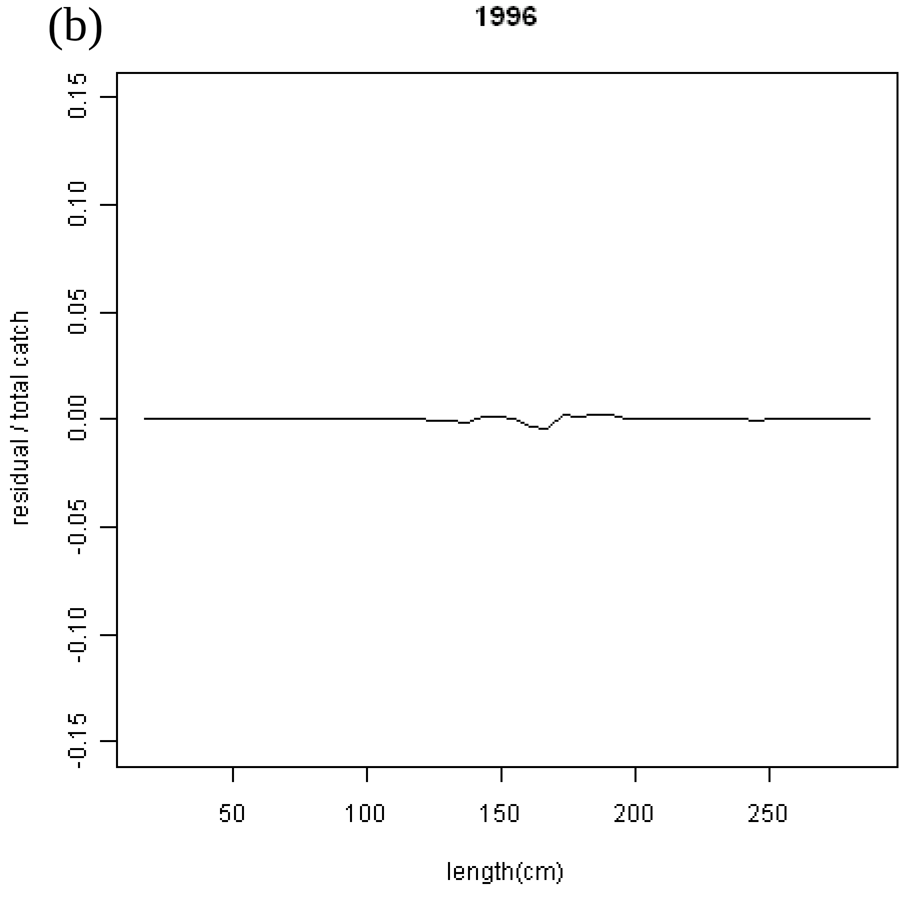

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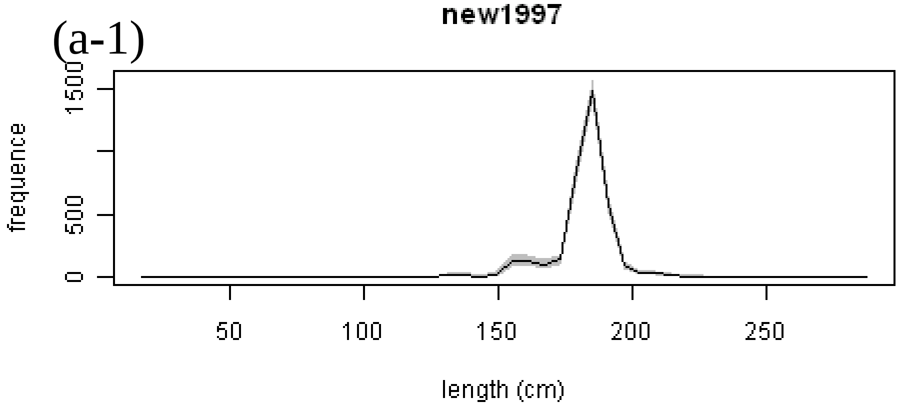

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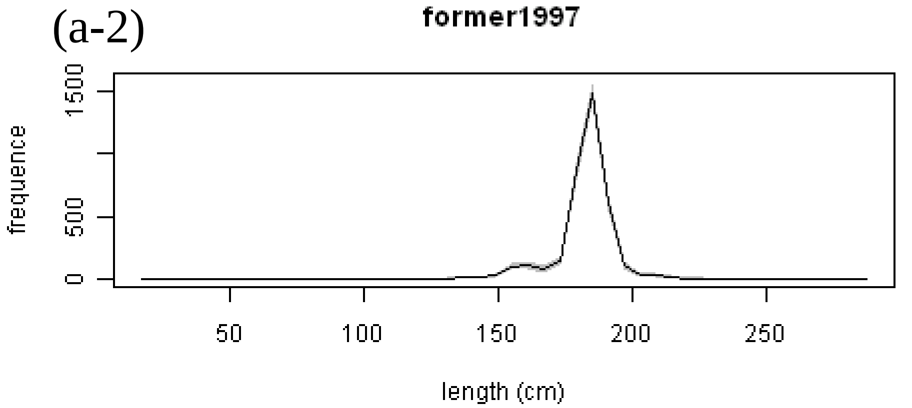

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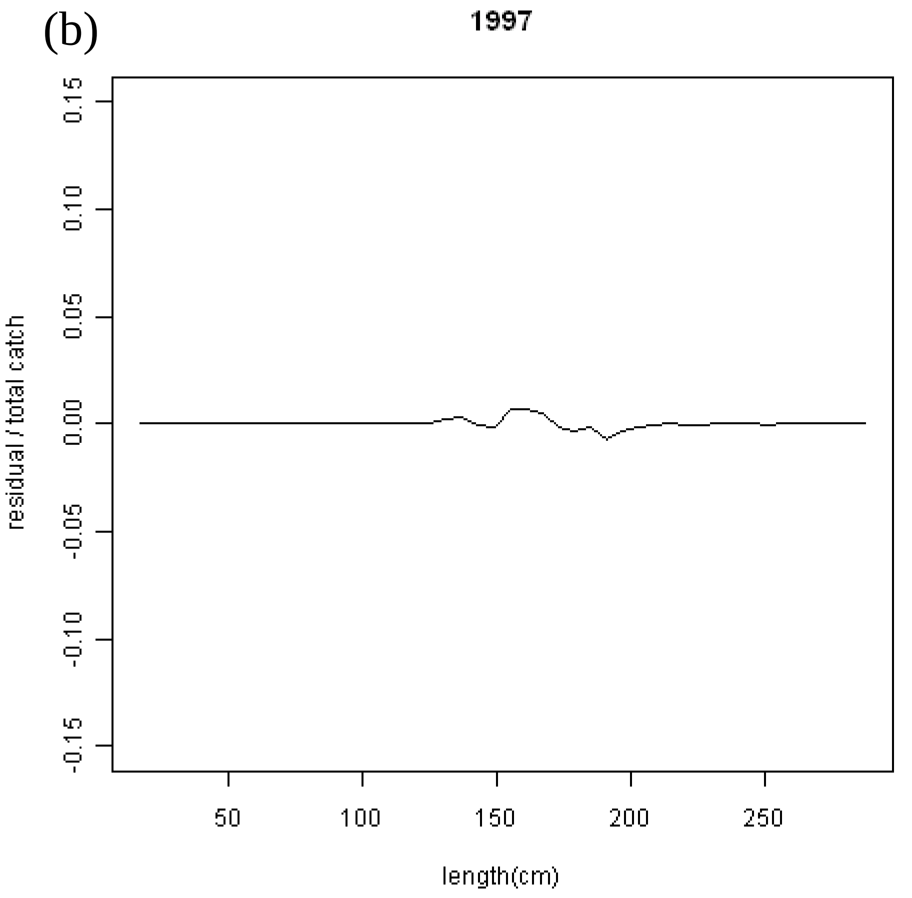

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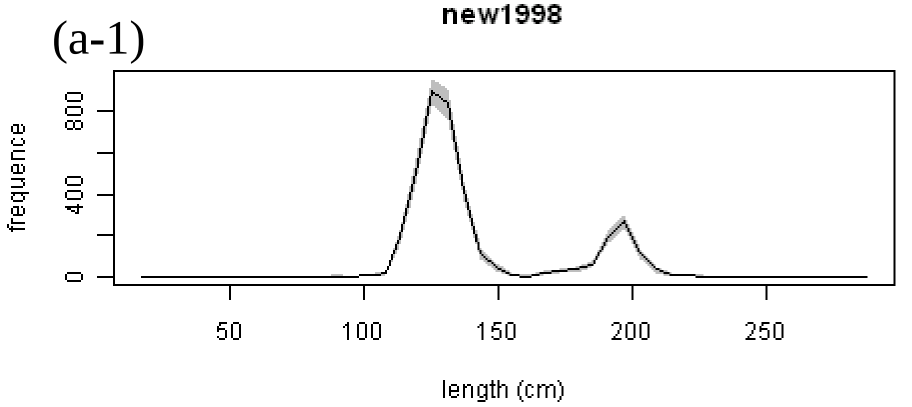

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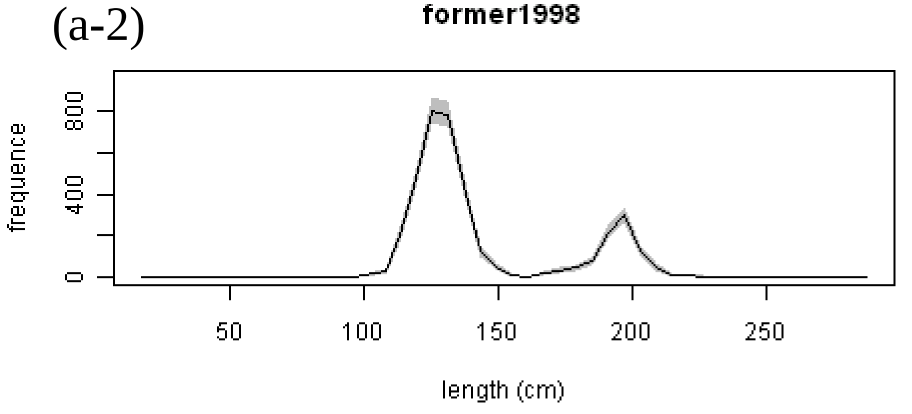

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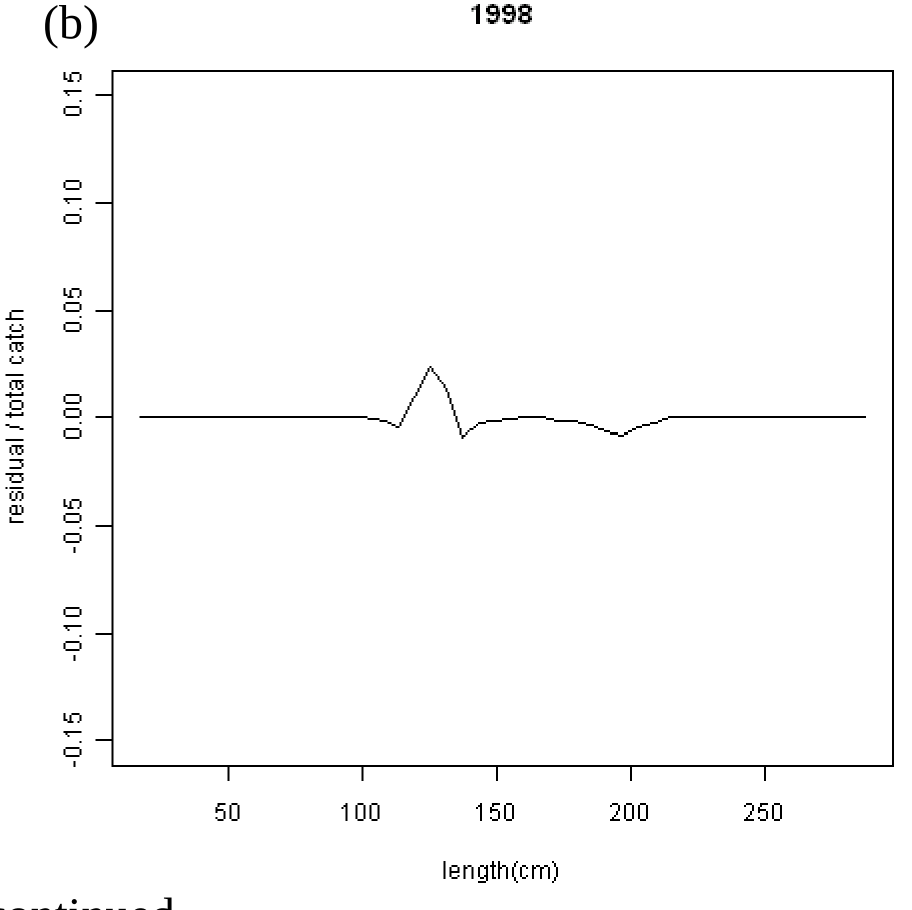

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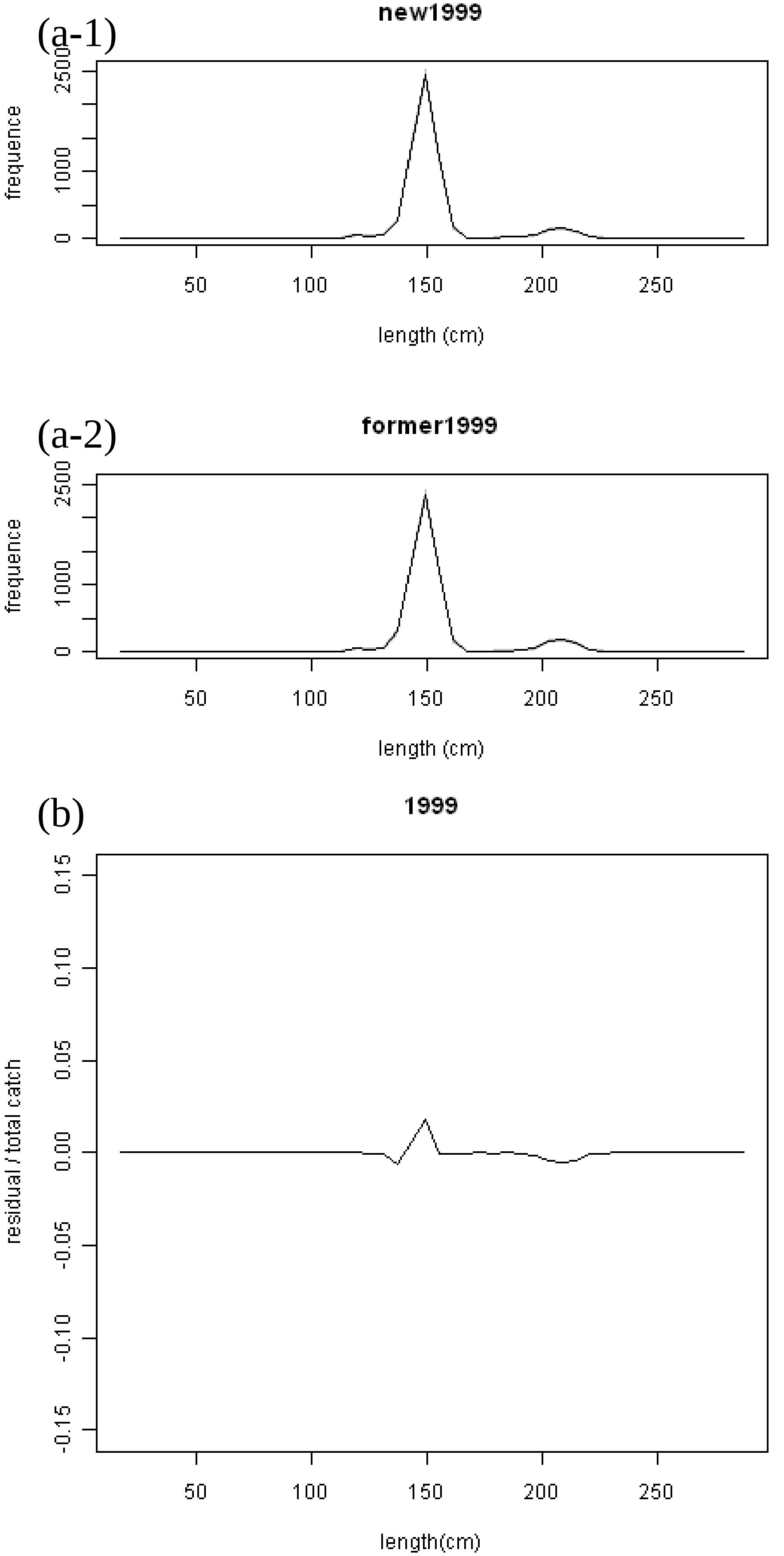

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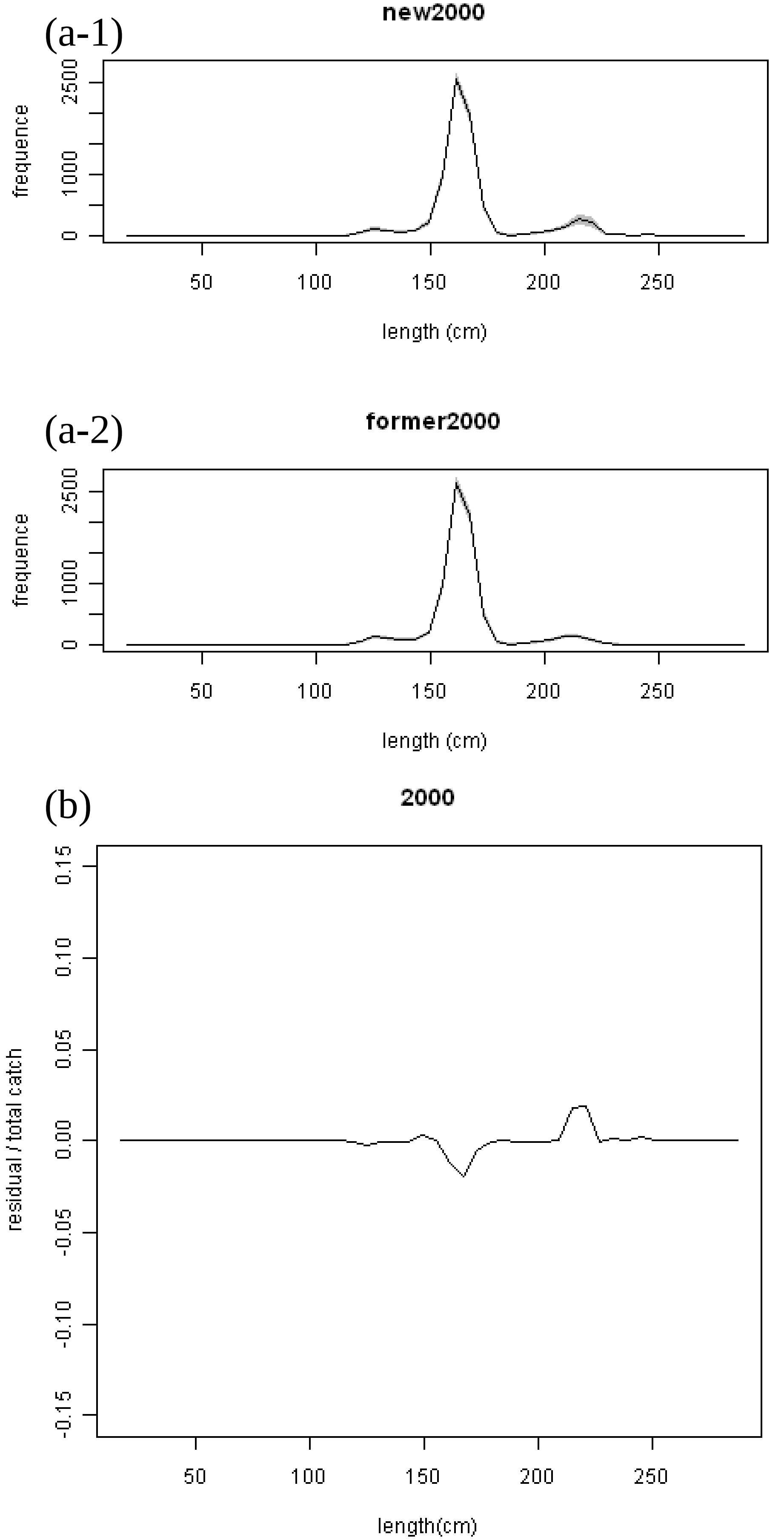

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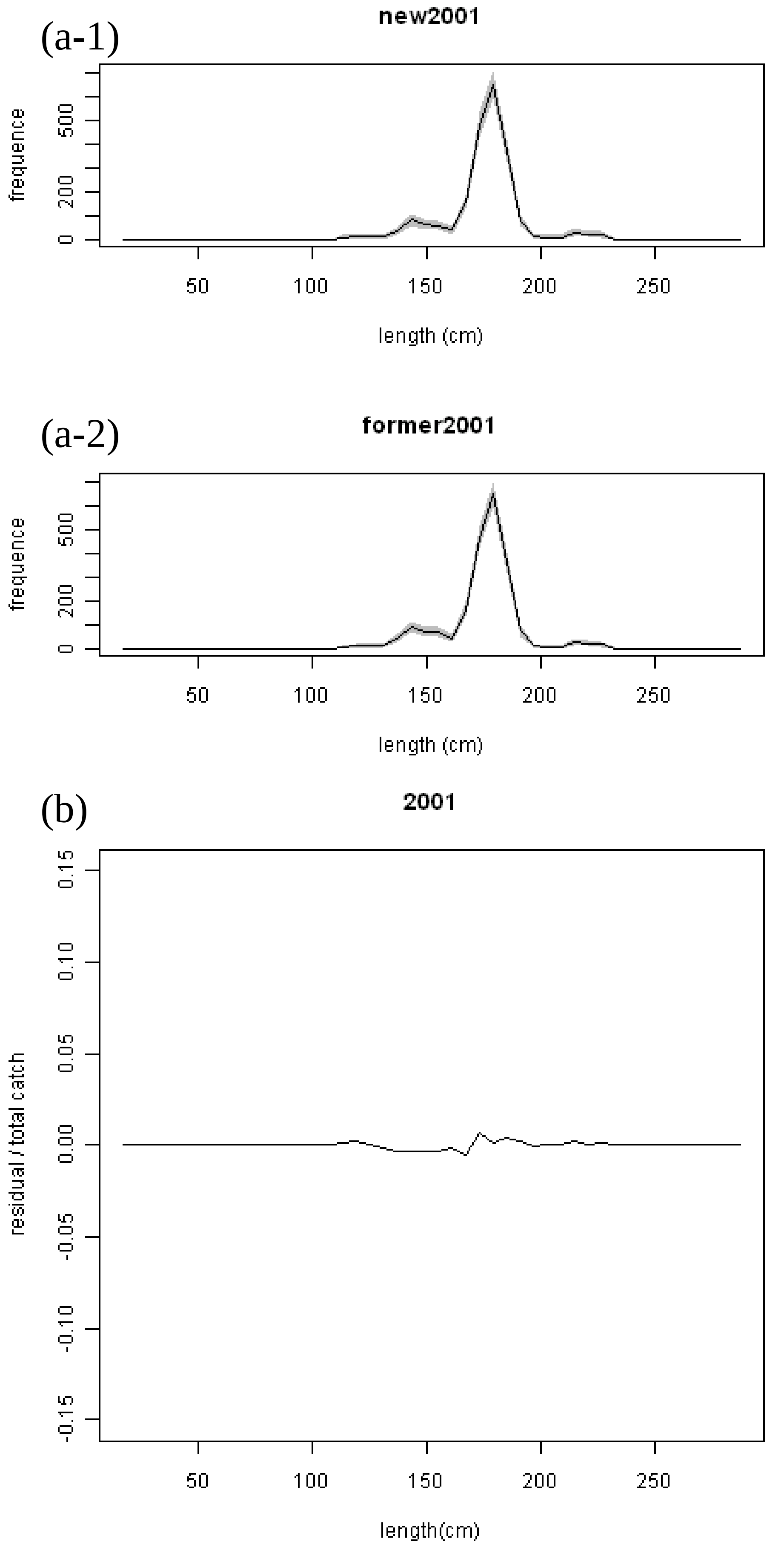

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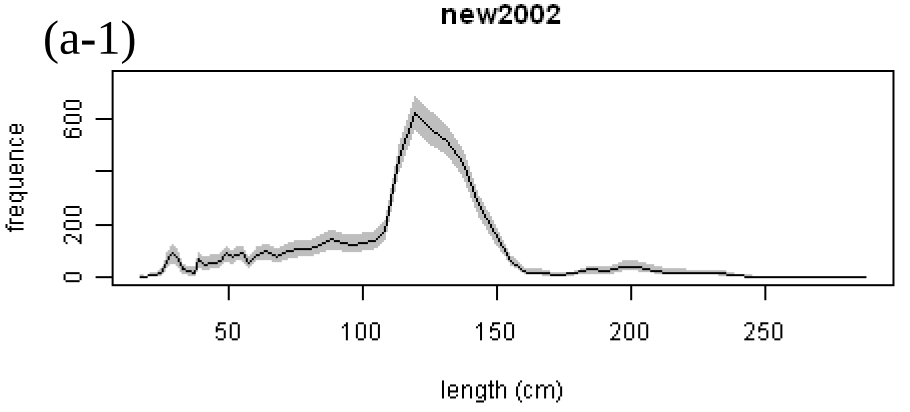

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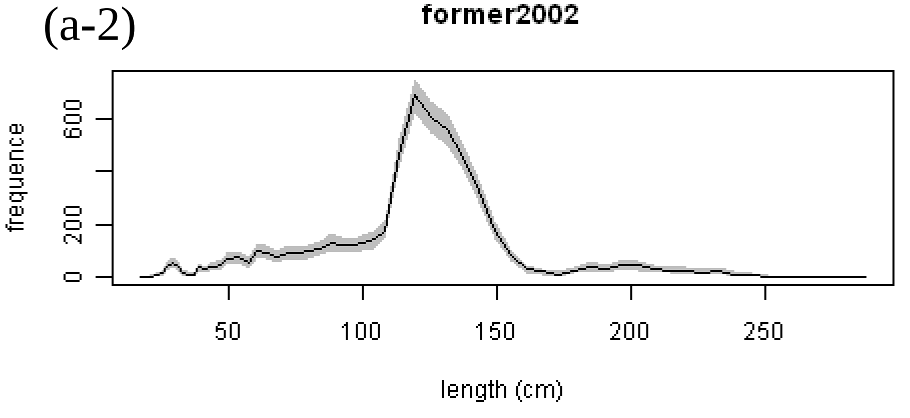

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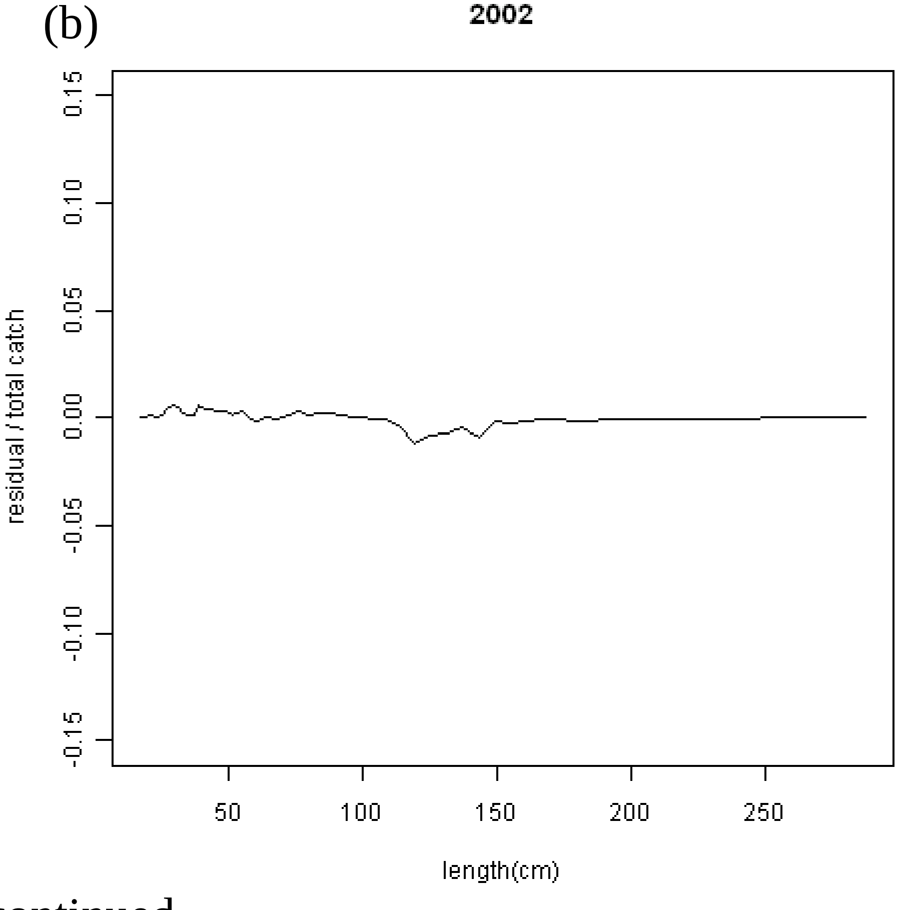

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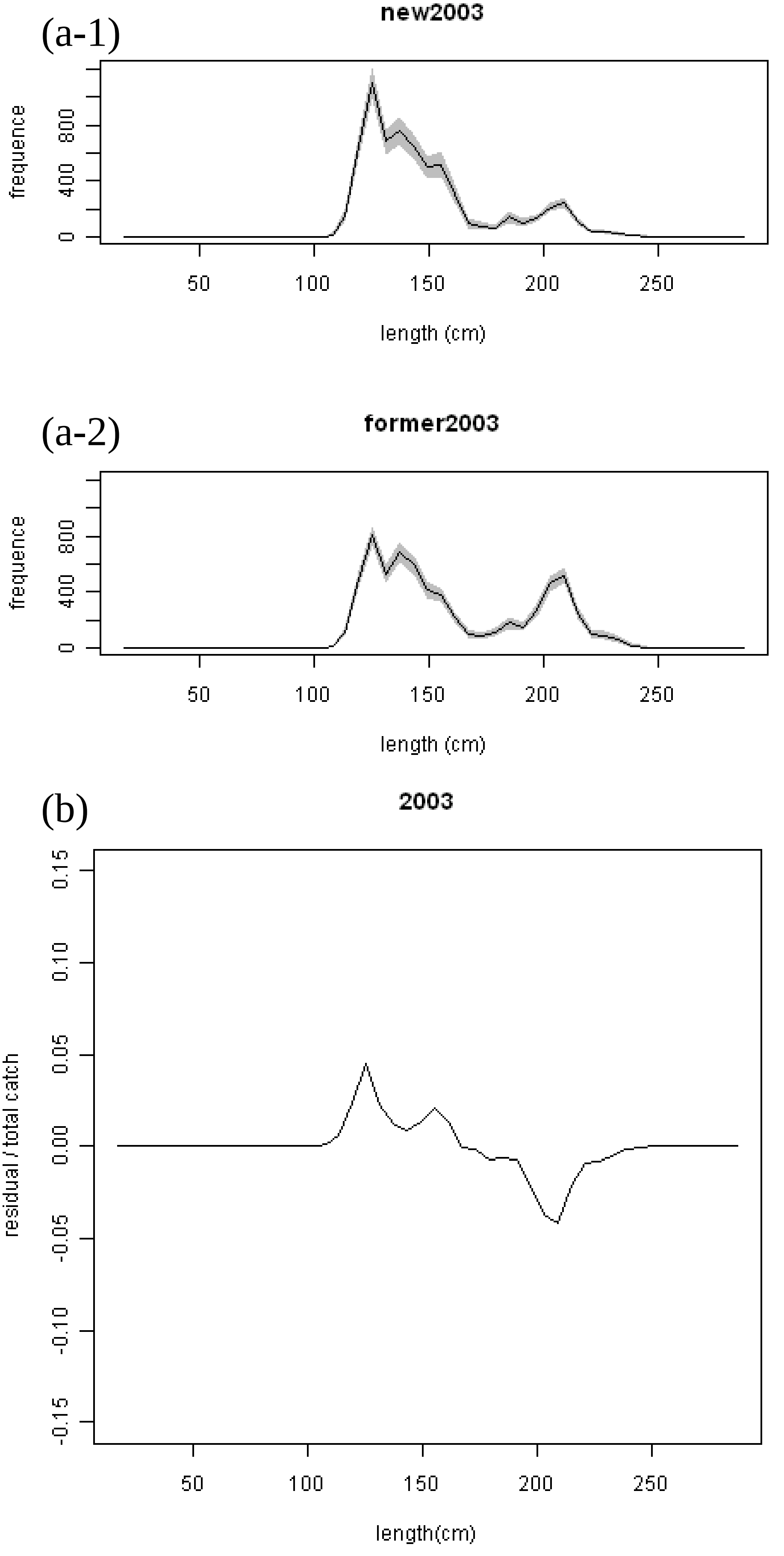

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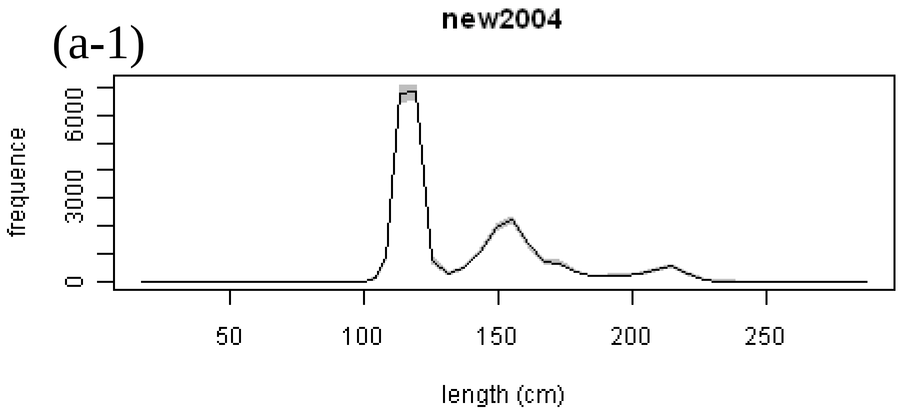

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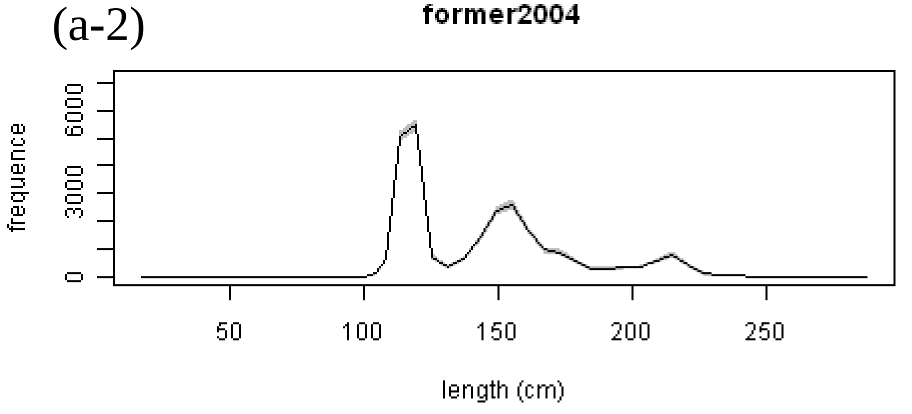

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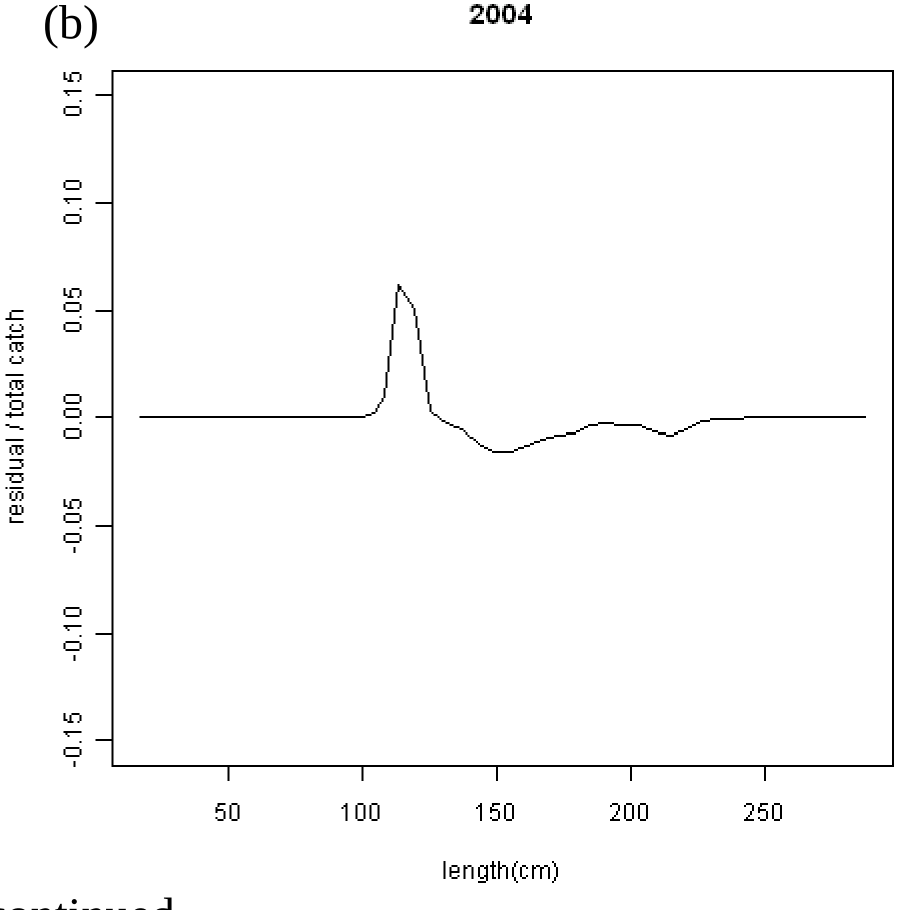

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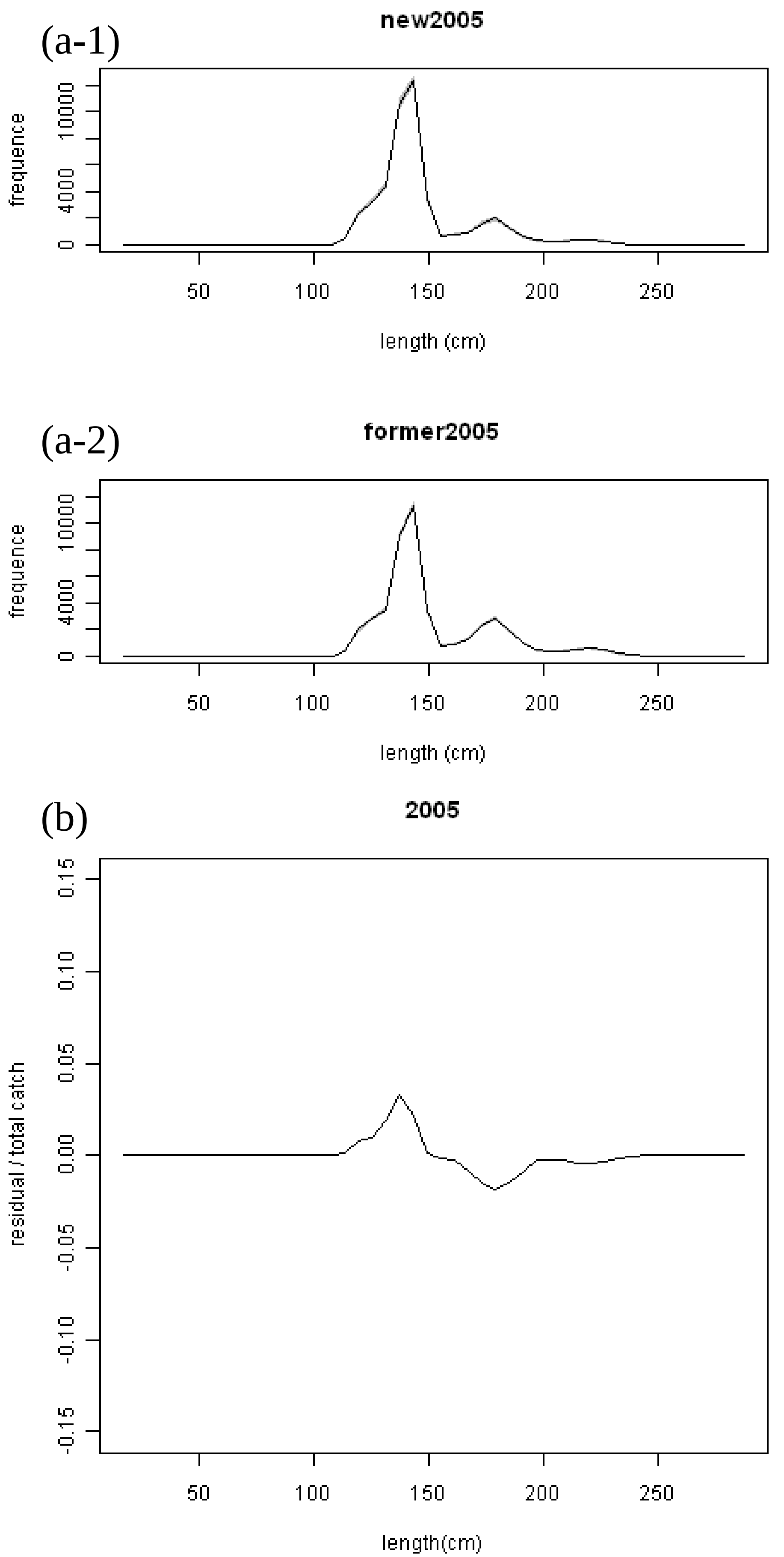

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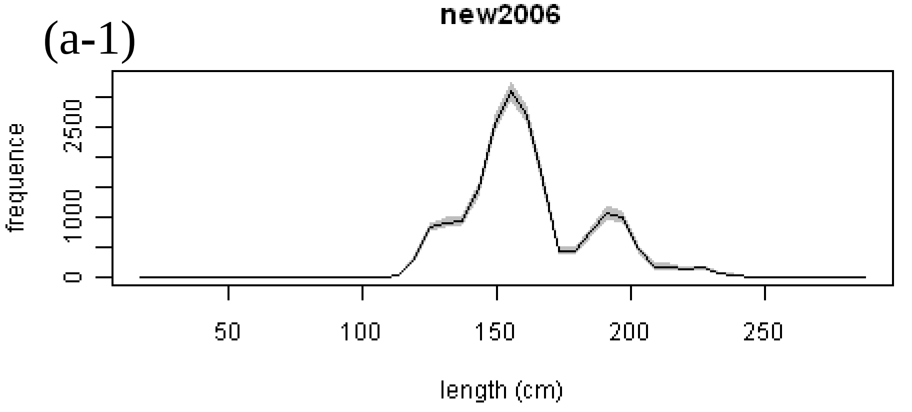

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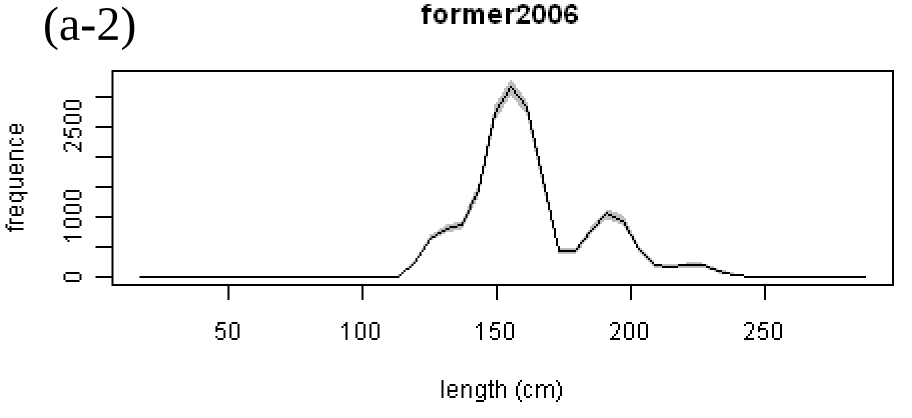

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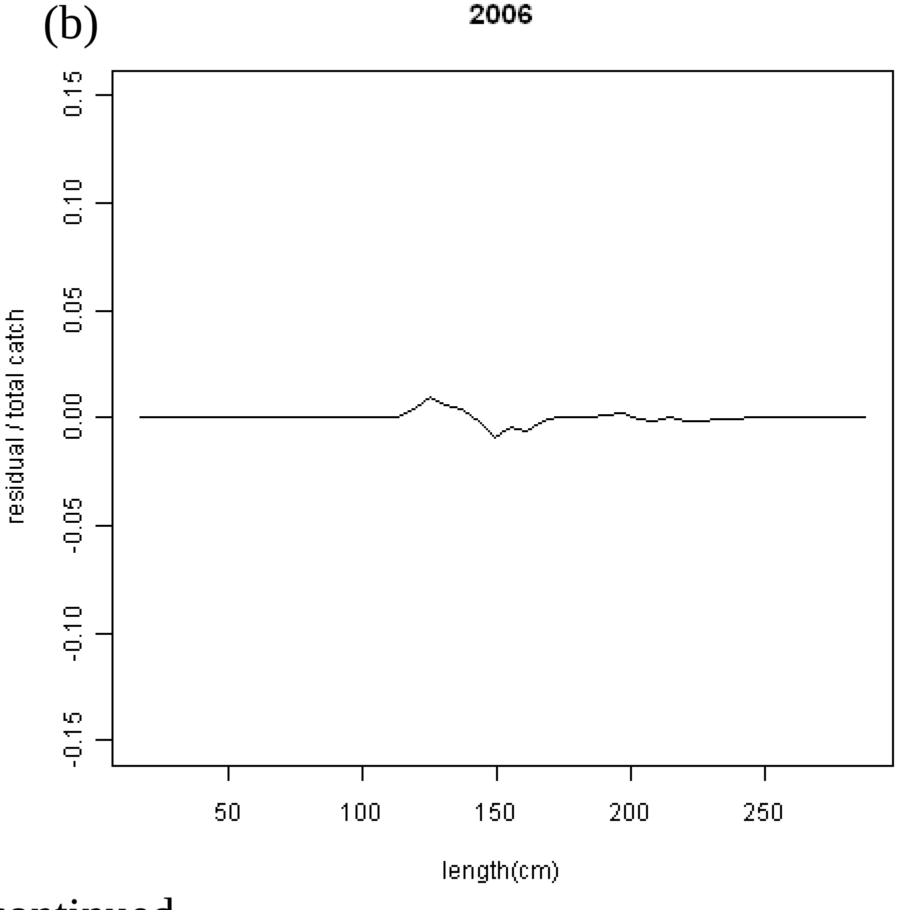

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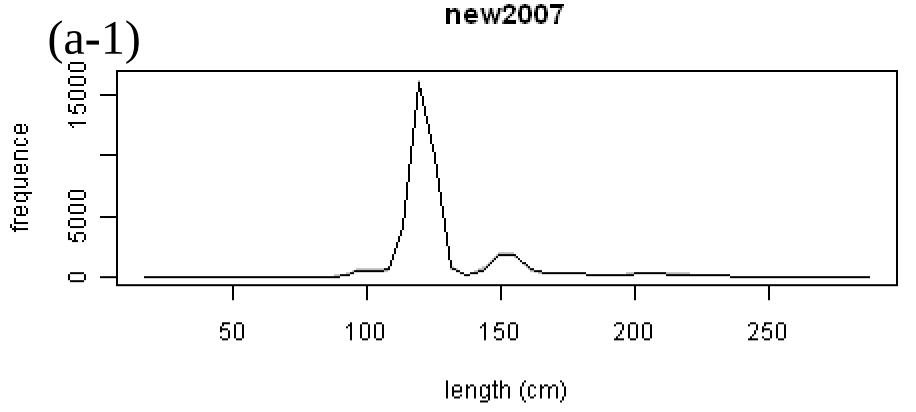

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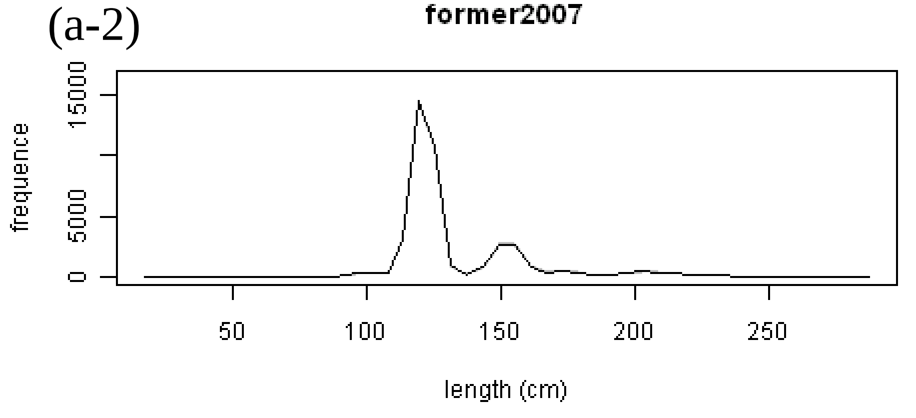

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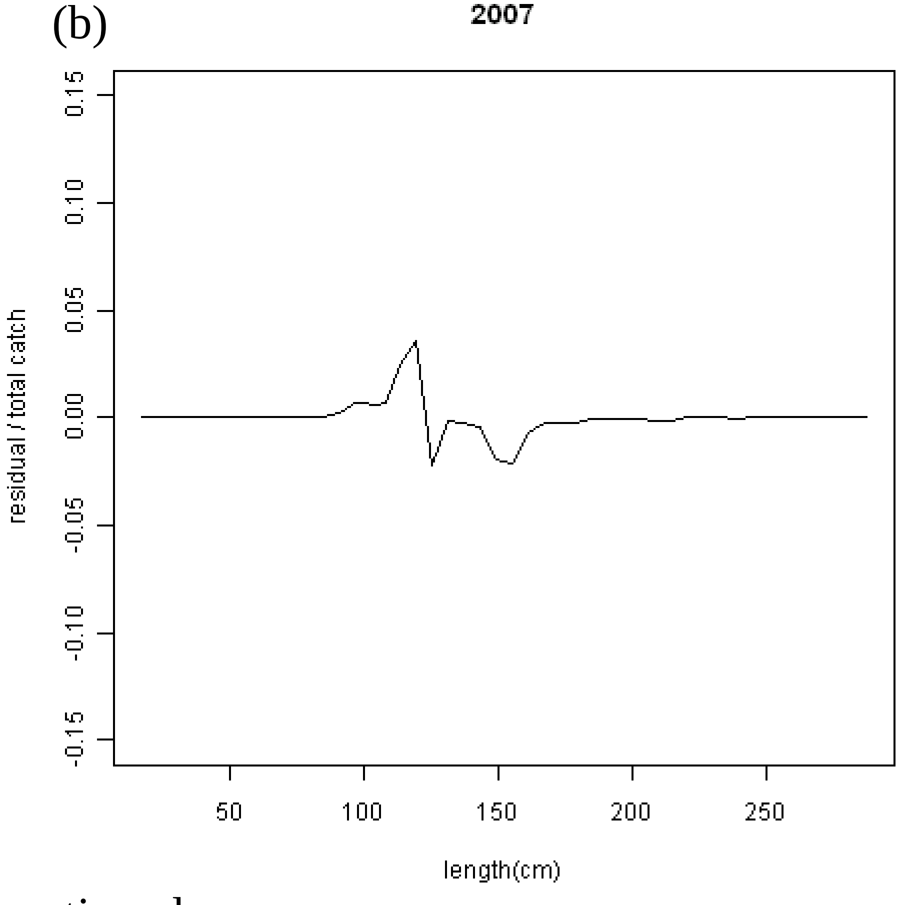

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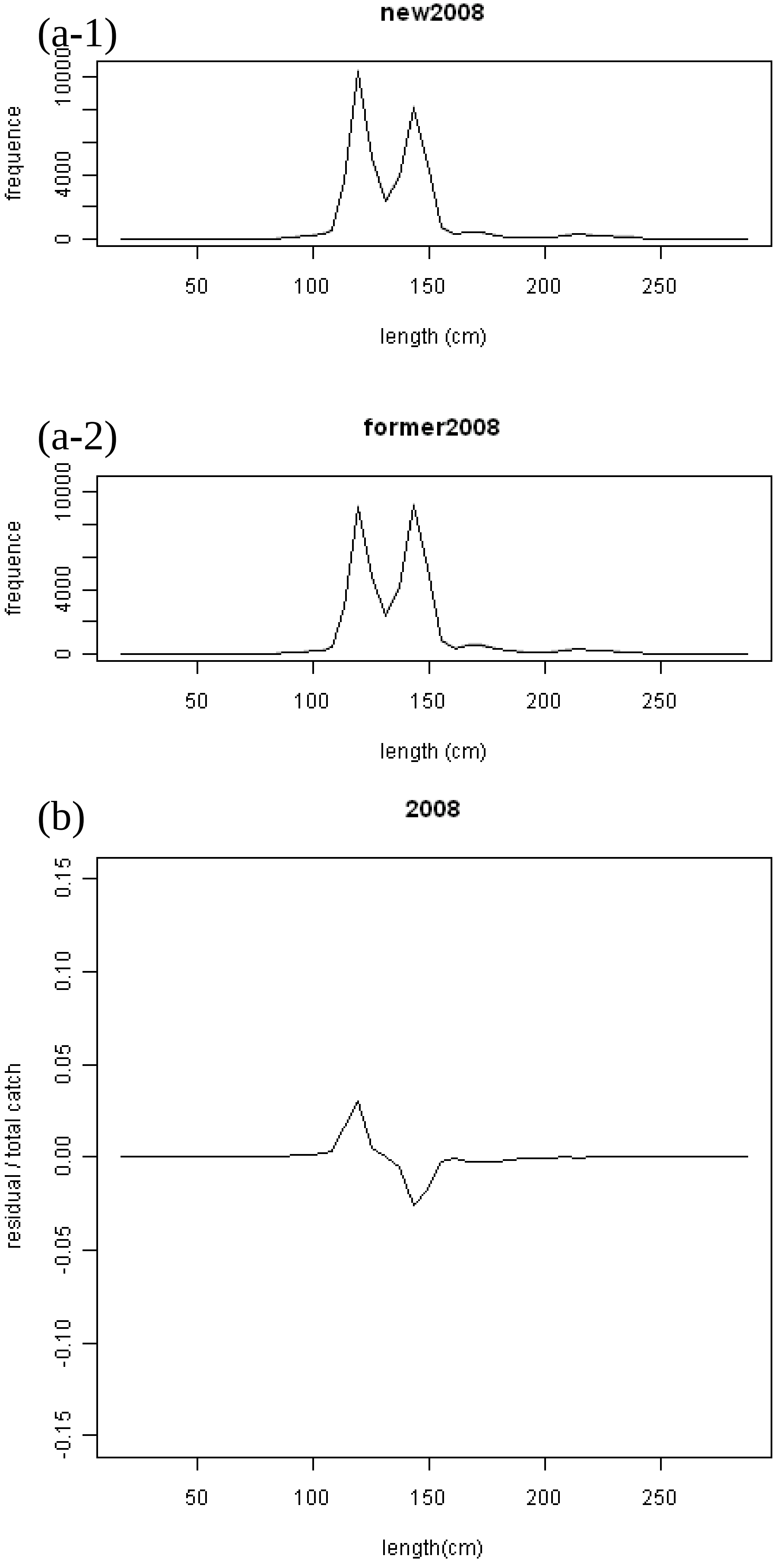

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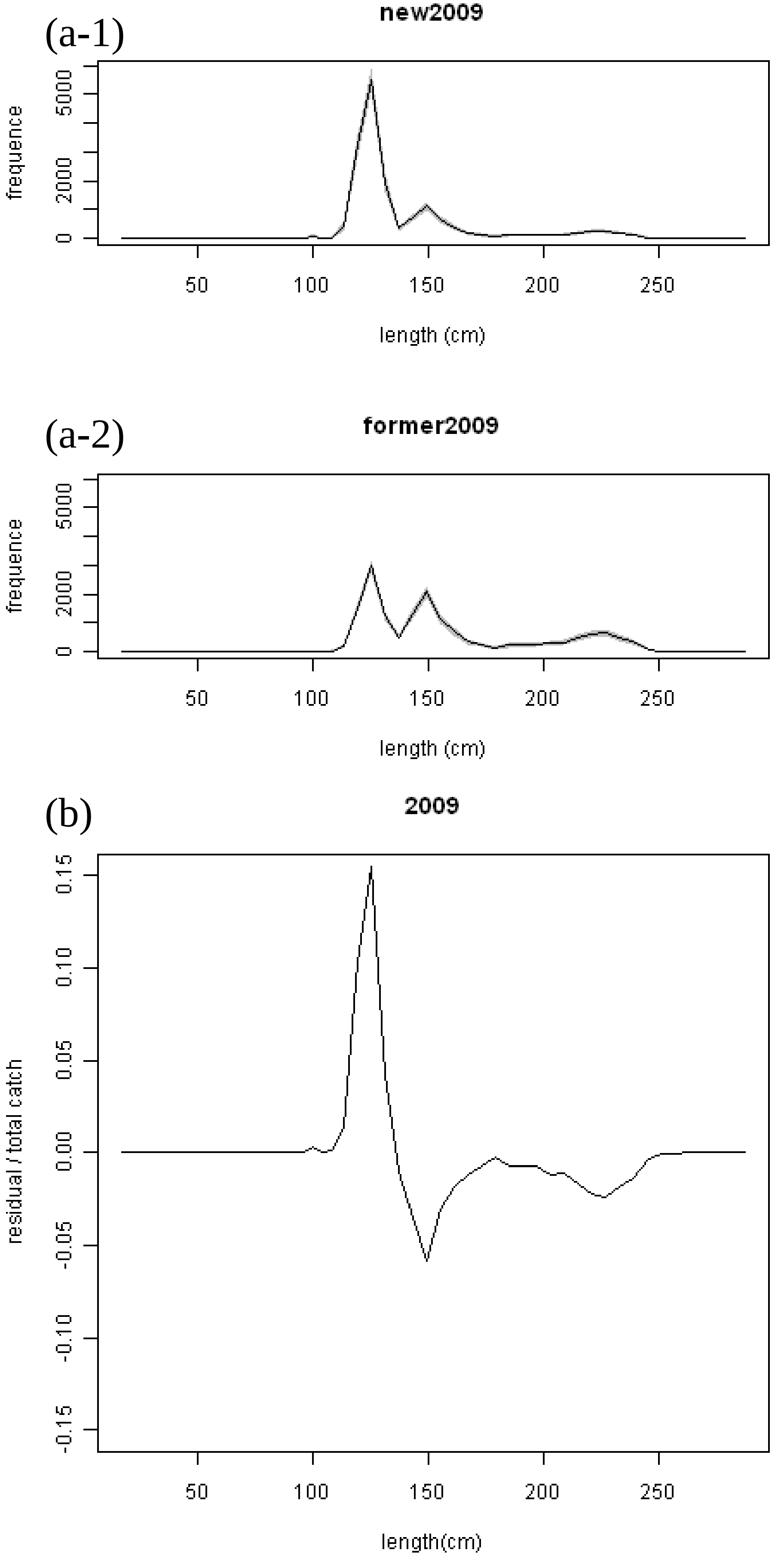

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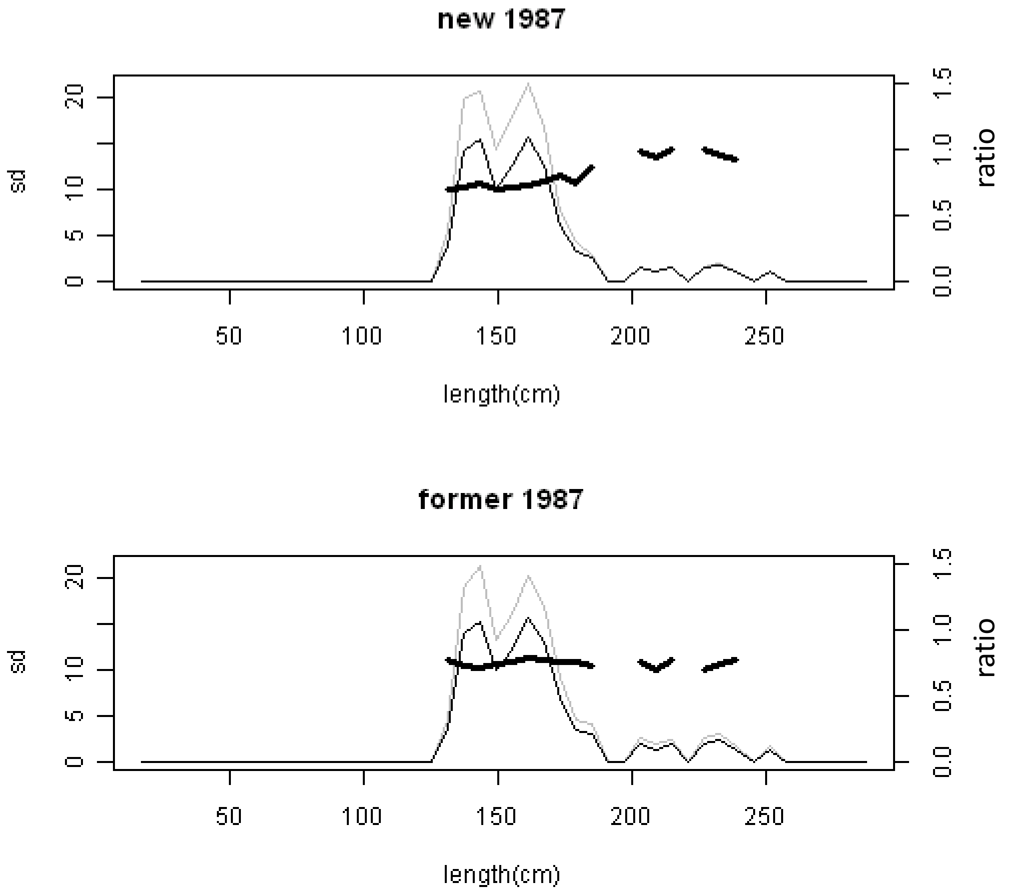
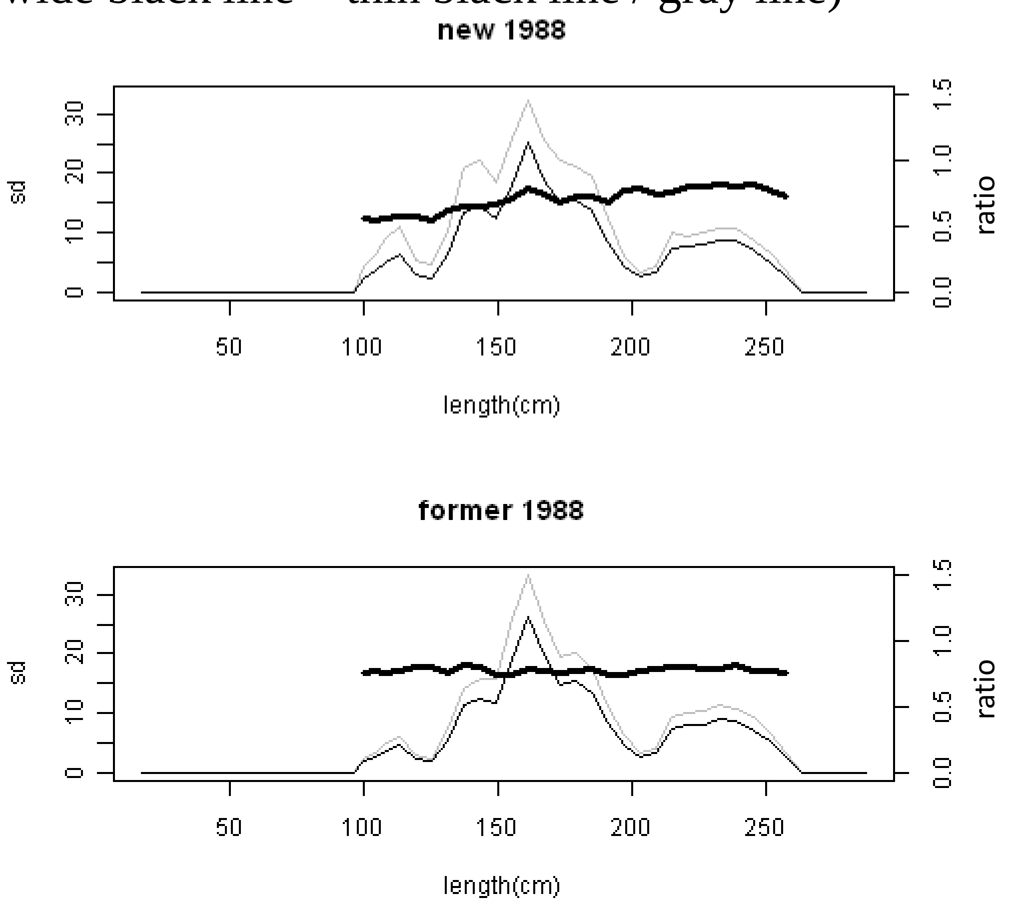


Fig. 2 estimated standard deviations by bootstrap (gray line) and by assumption of multinomial distribution (thin black line) and there ratio (wide black line = thin black line / gray line)



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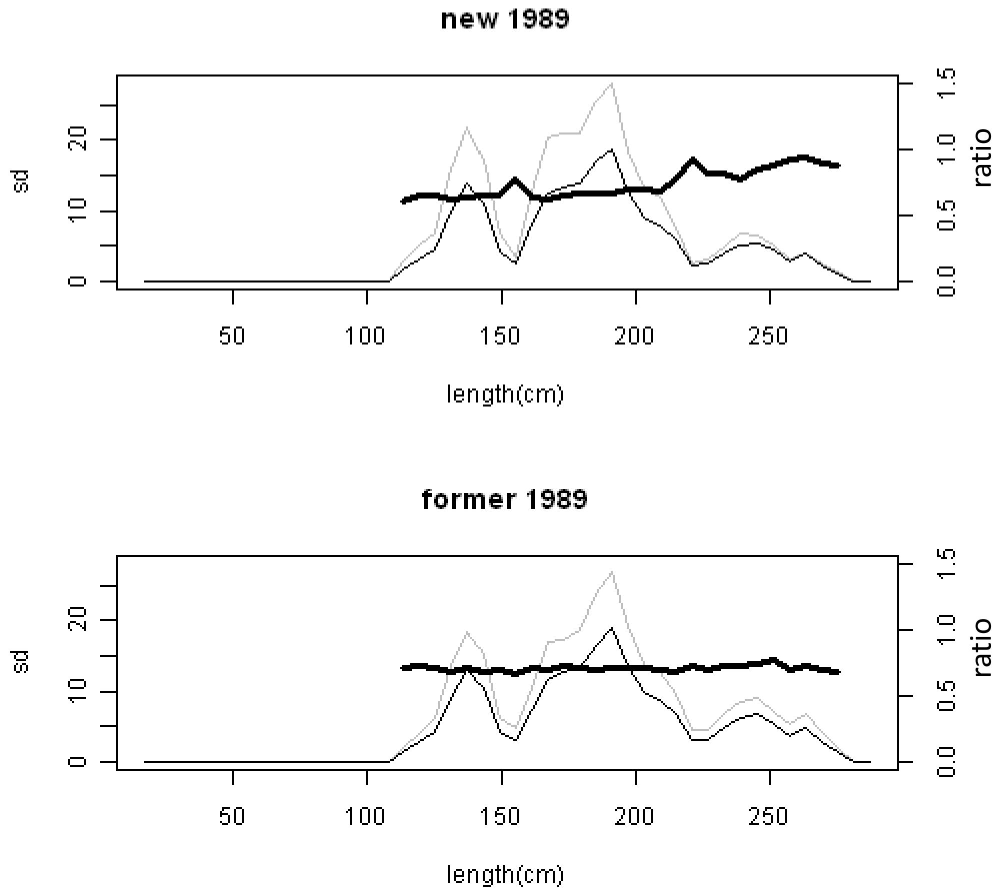

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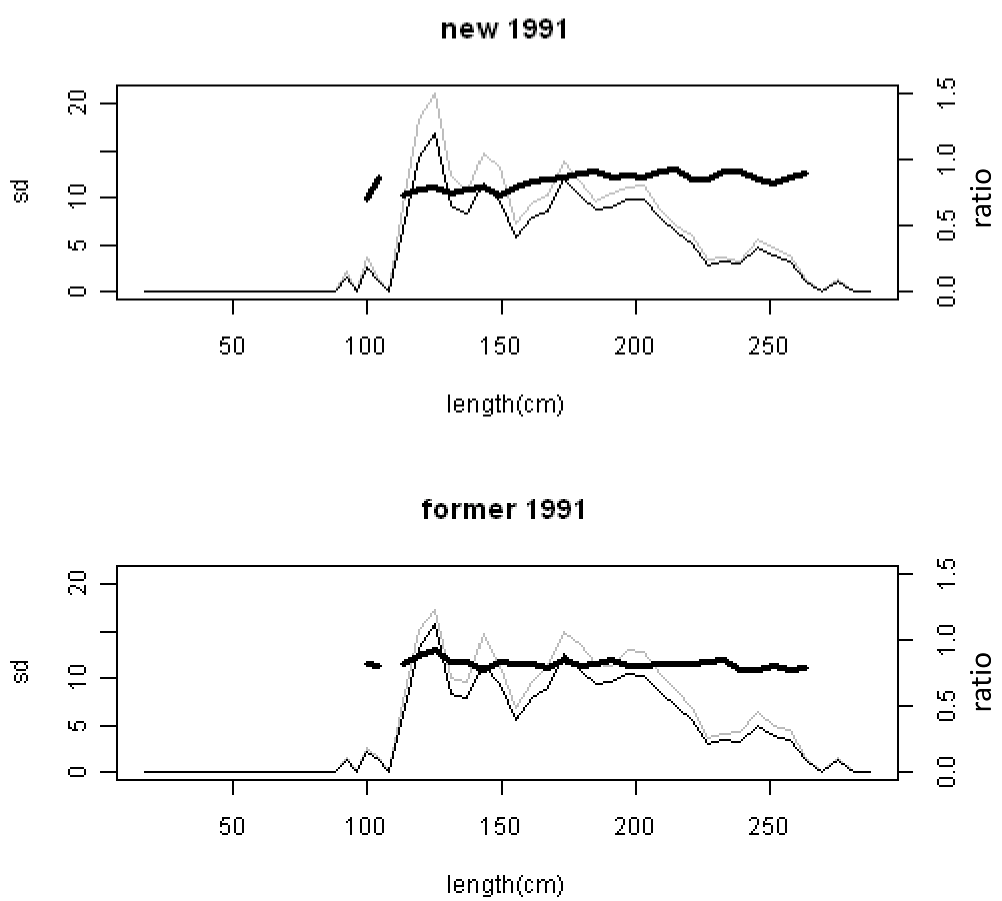

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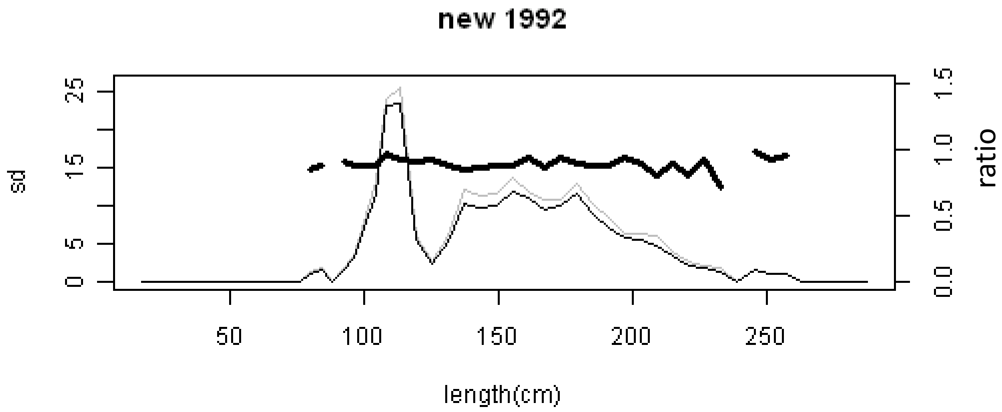

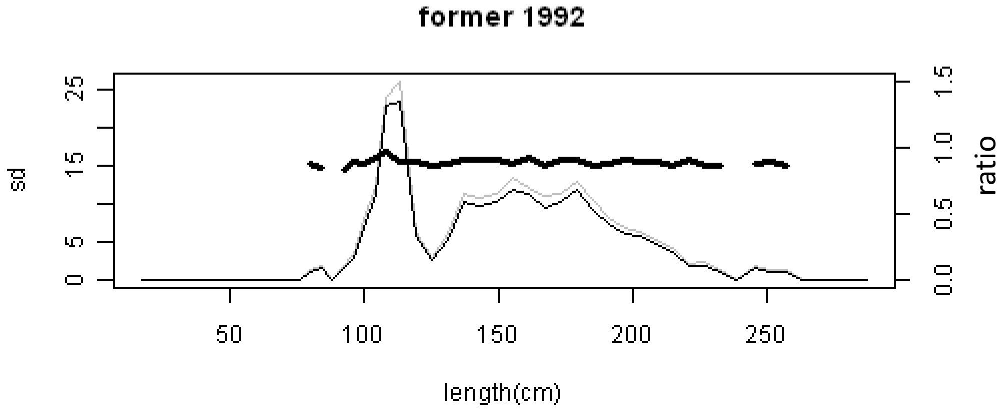

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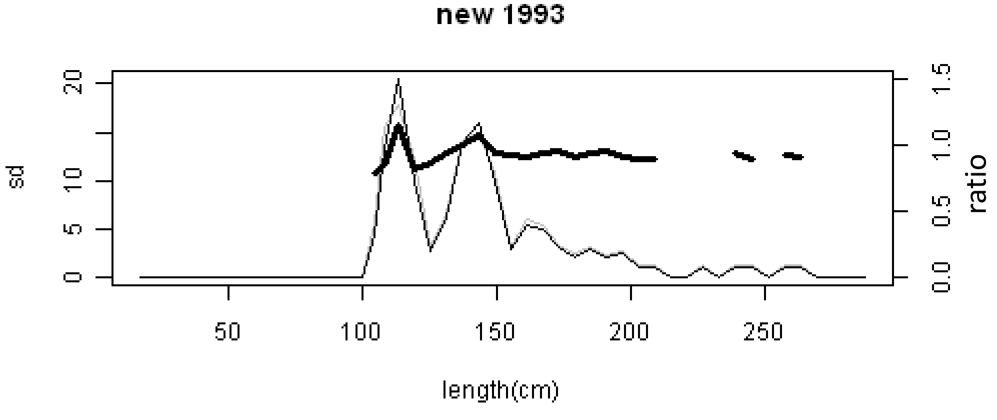

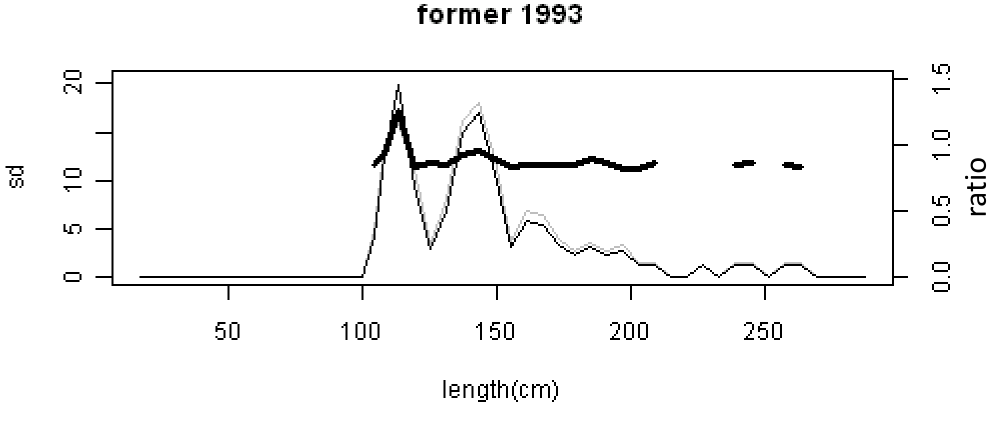

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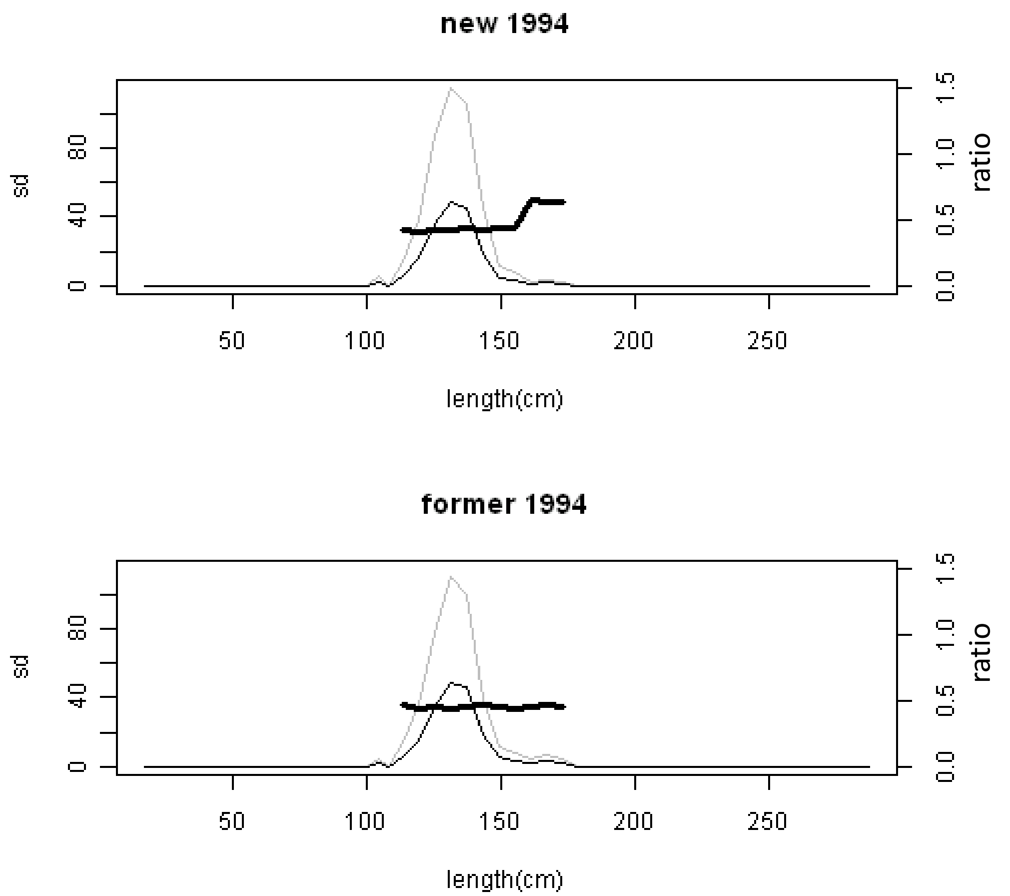

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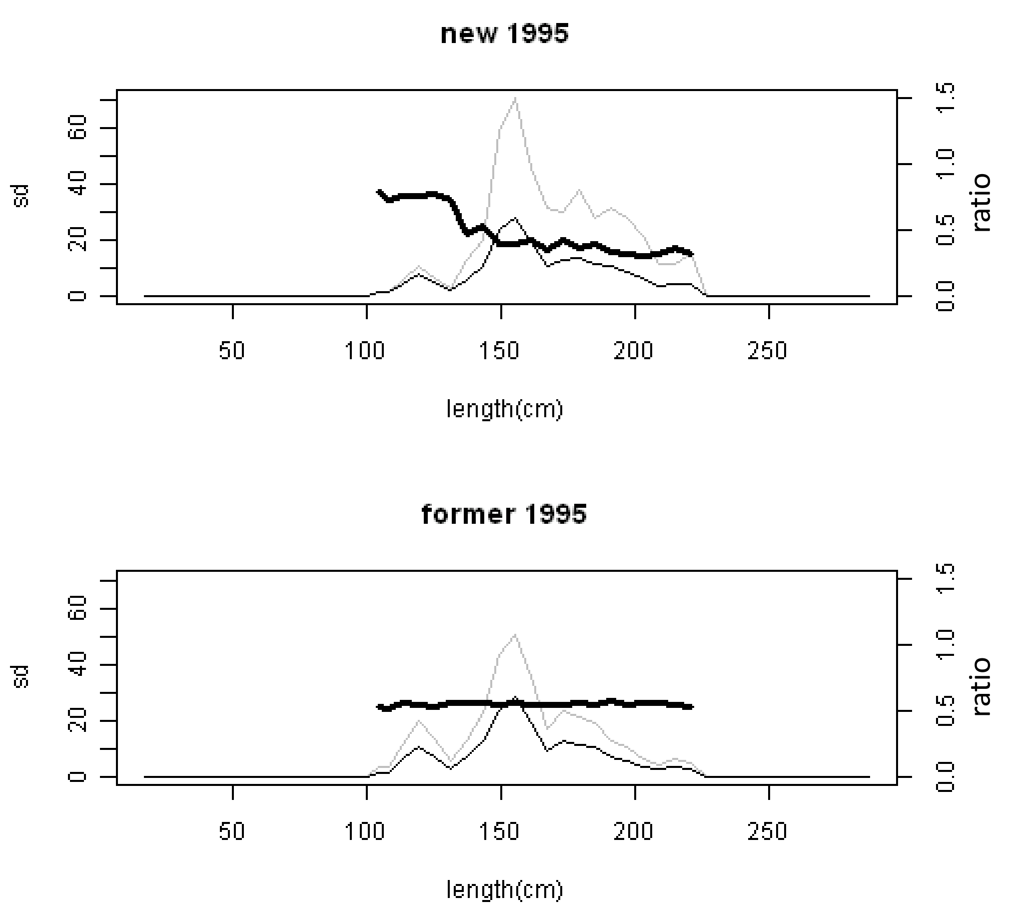

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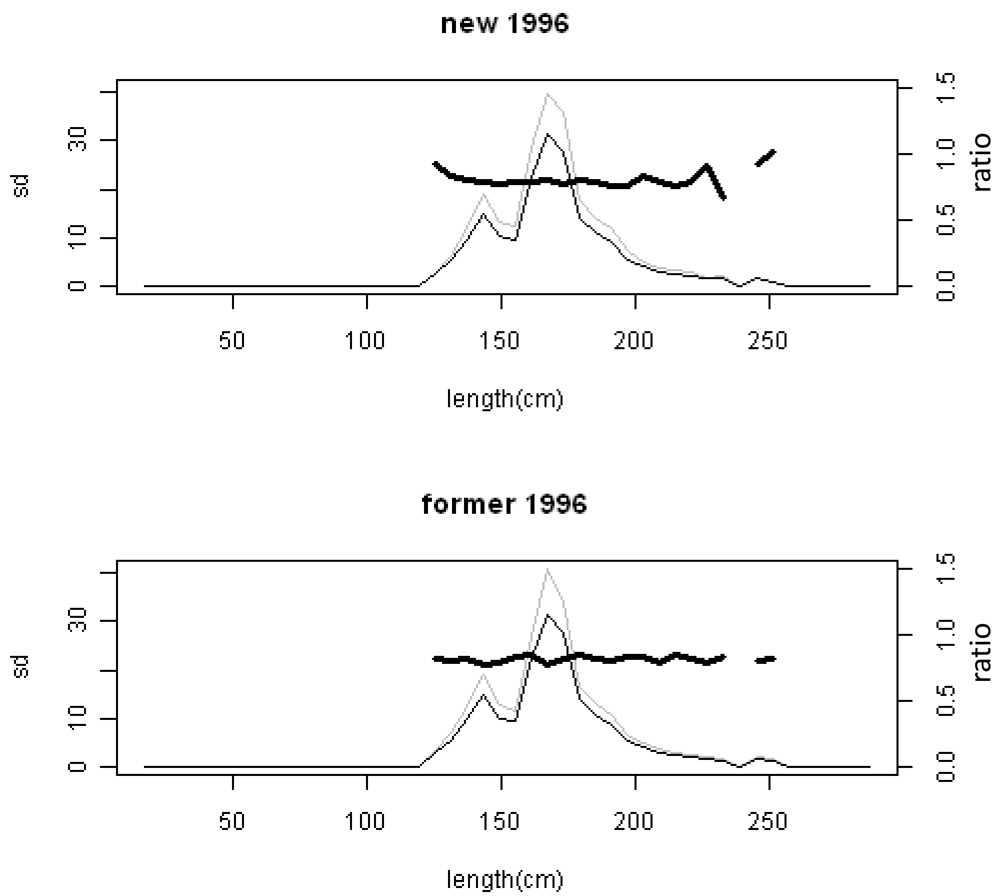

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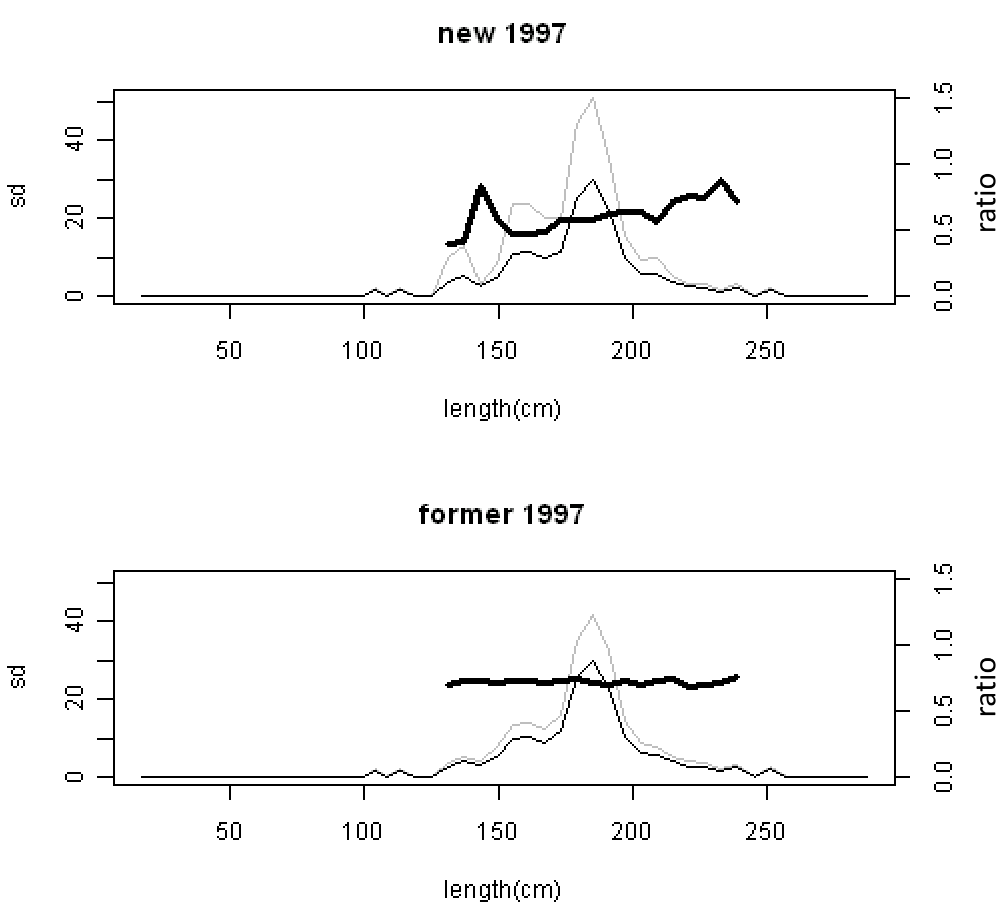

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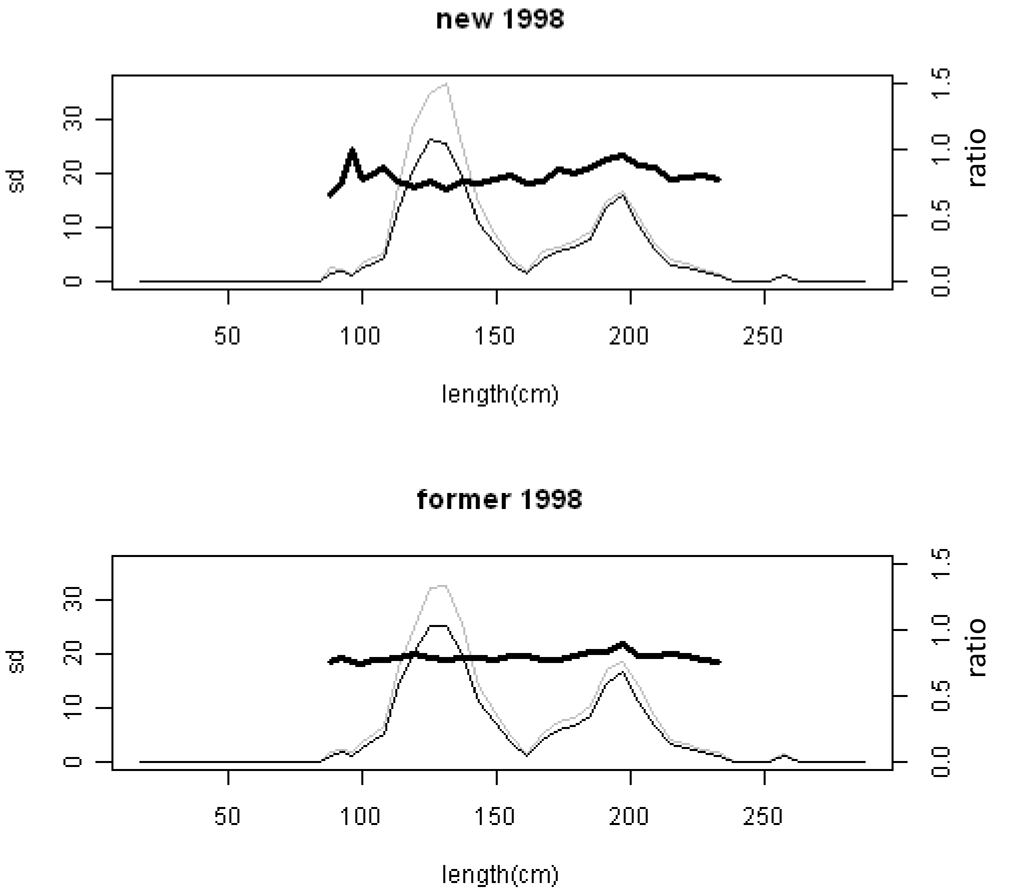

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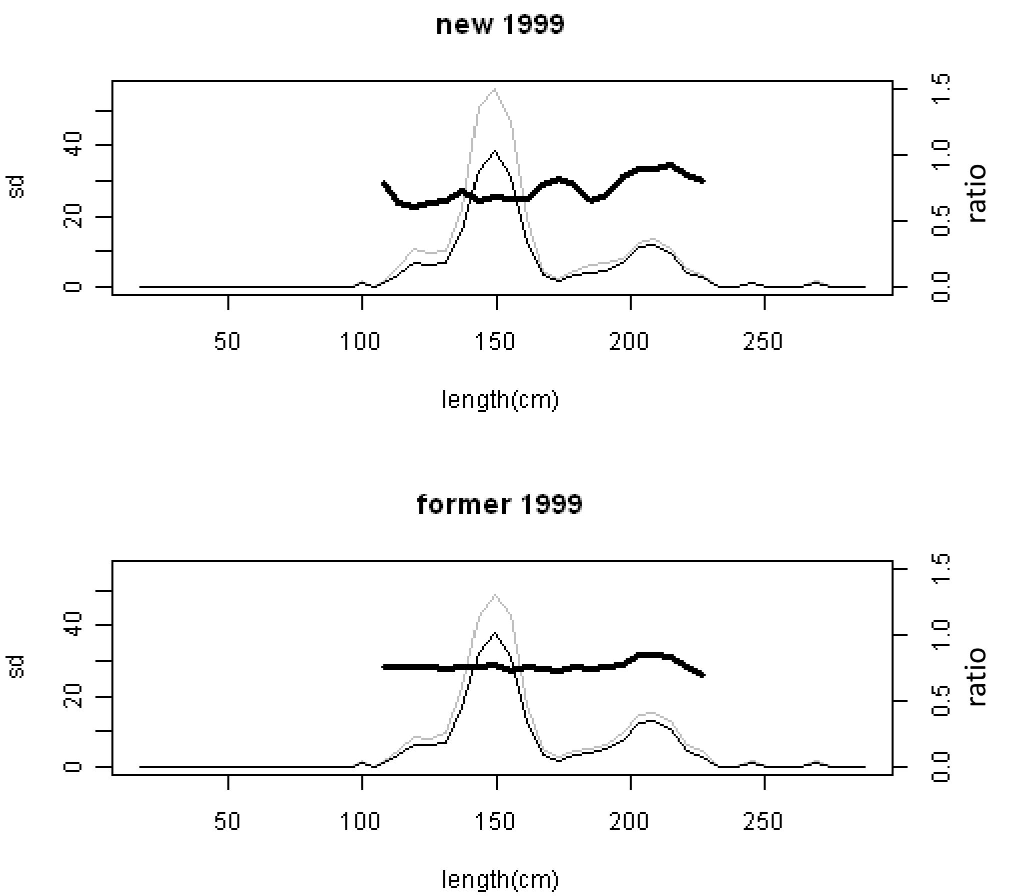

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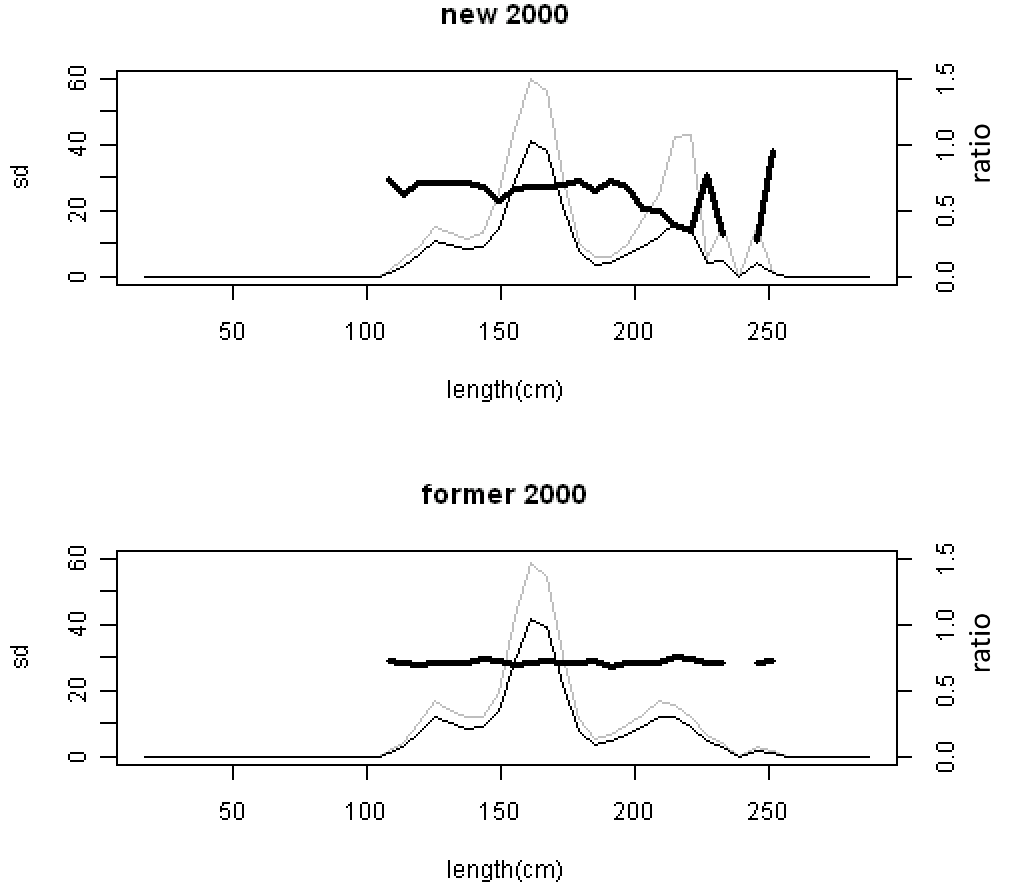

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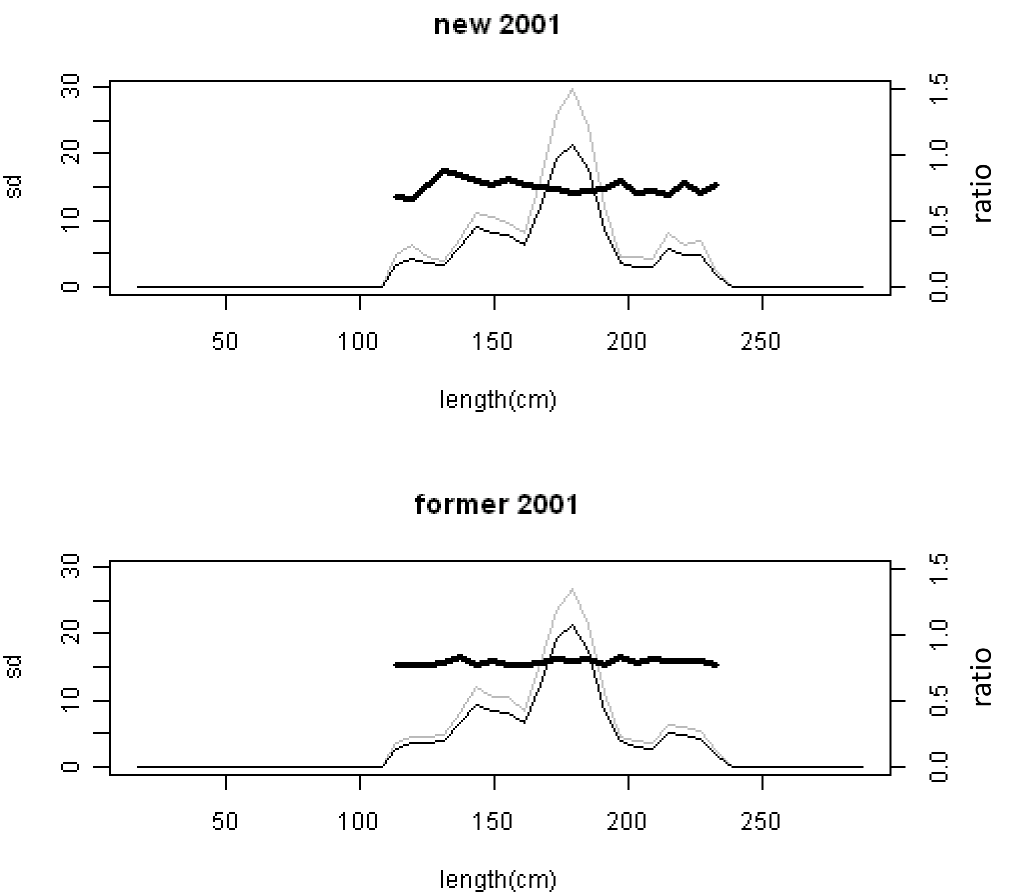

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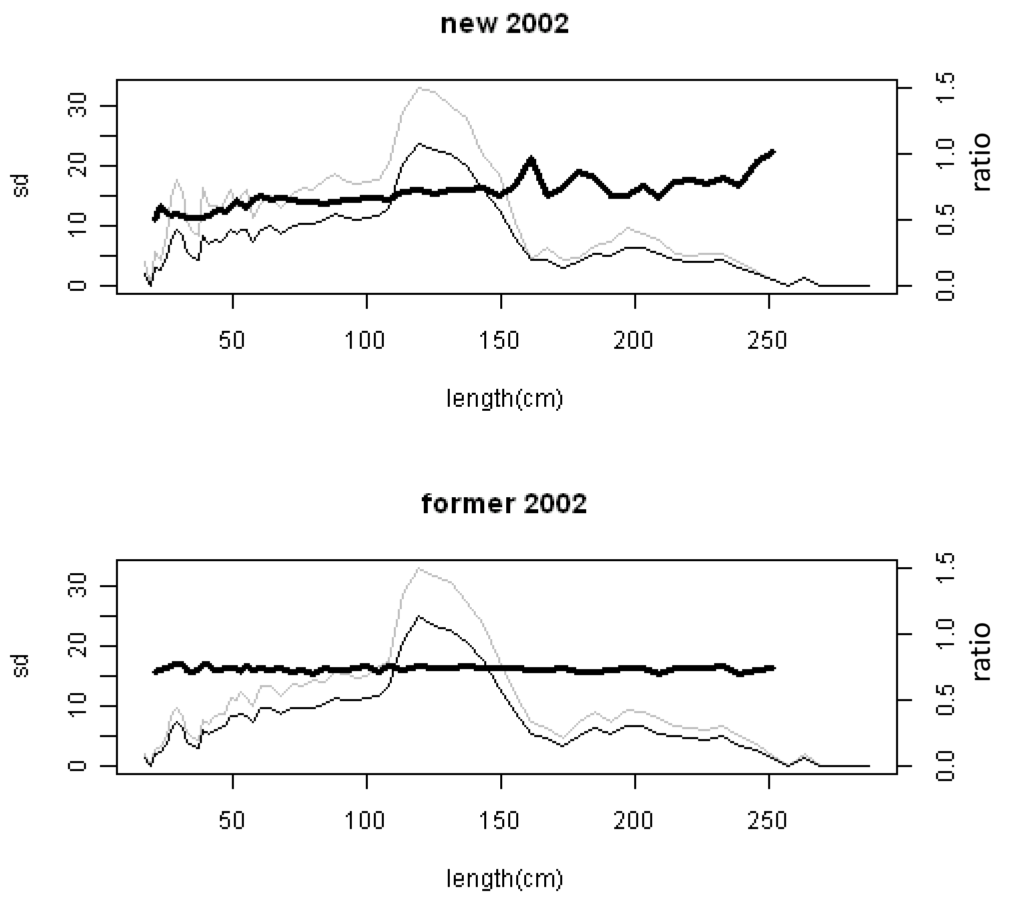

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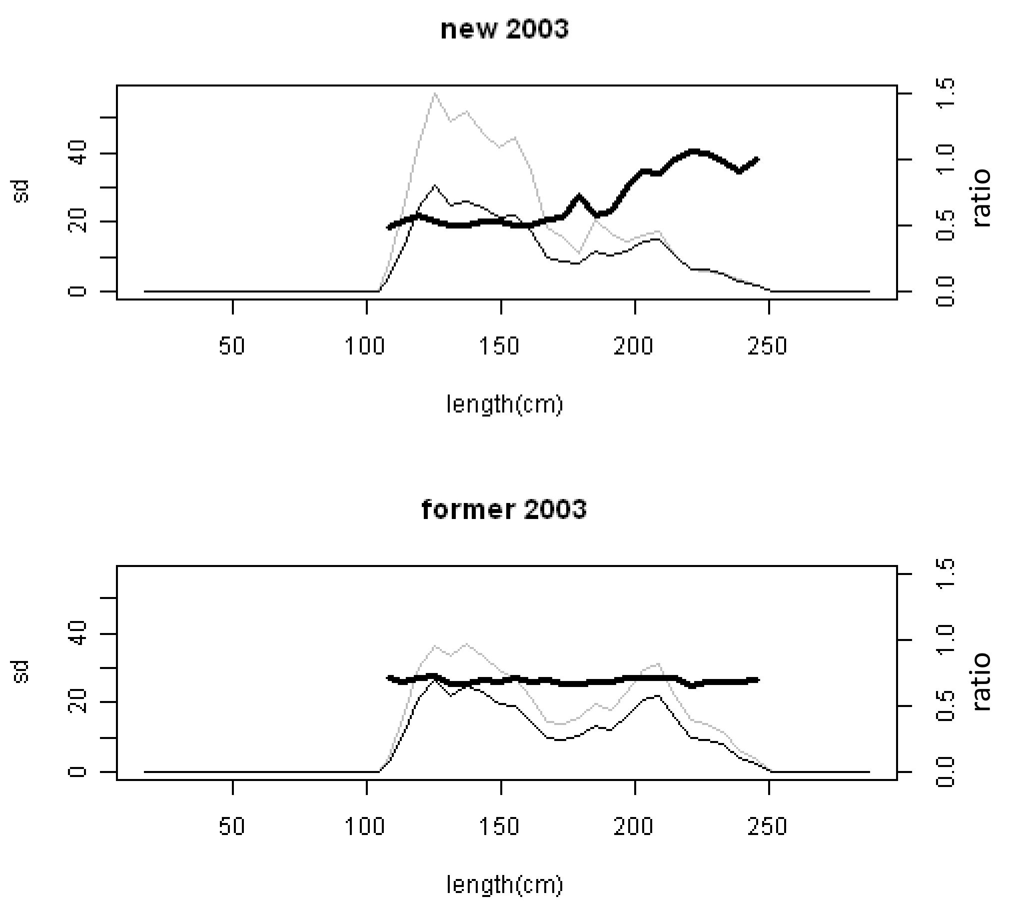

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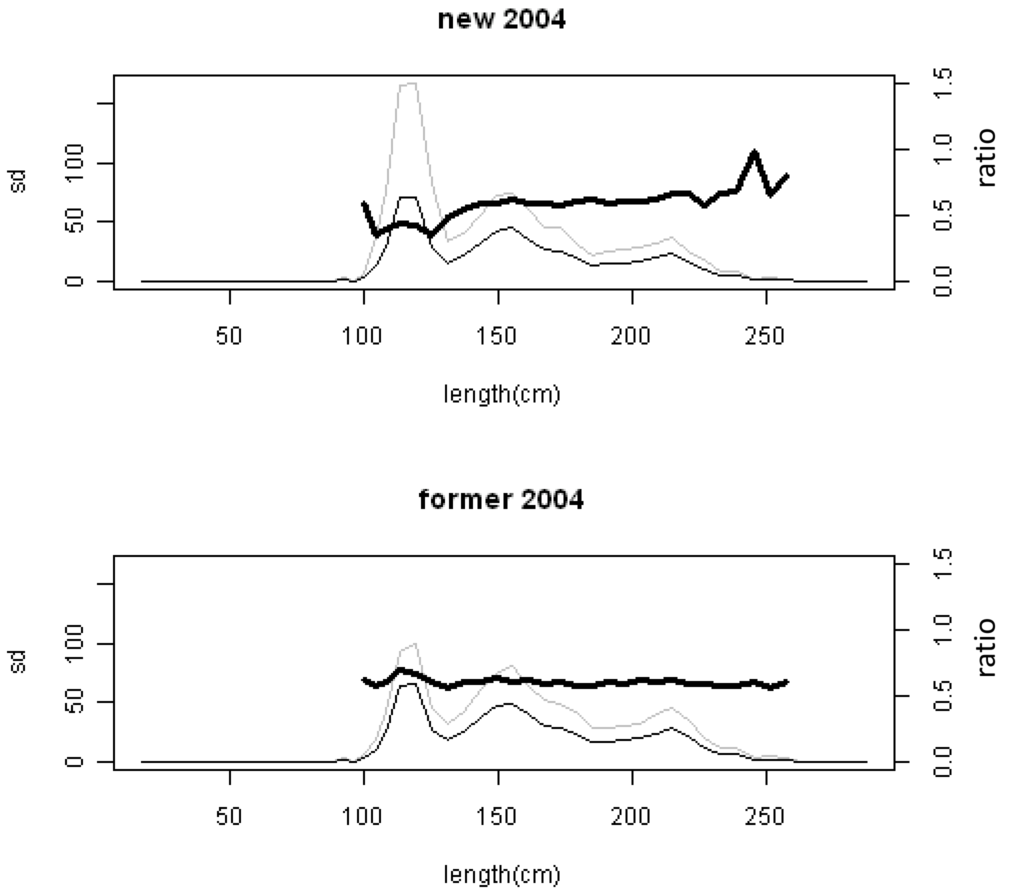

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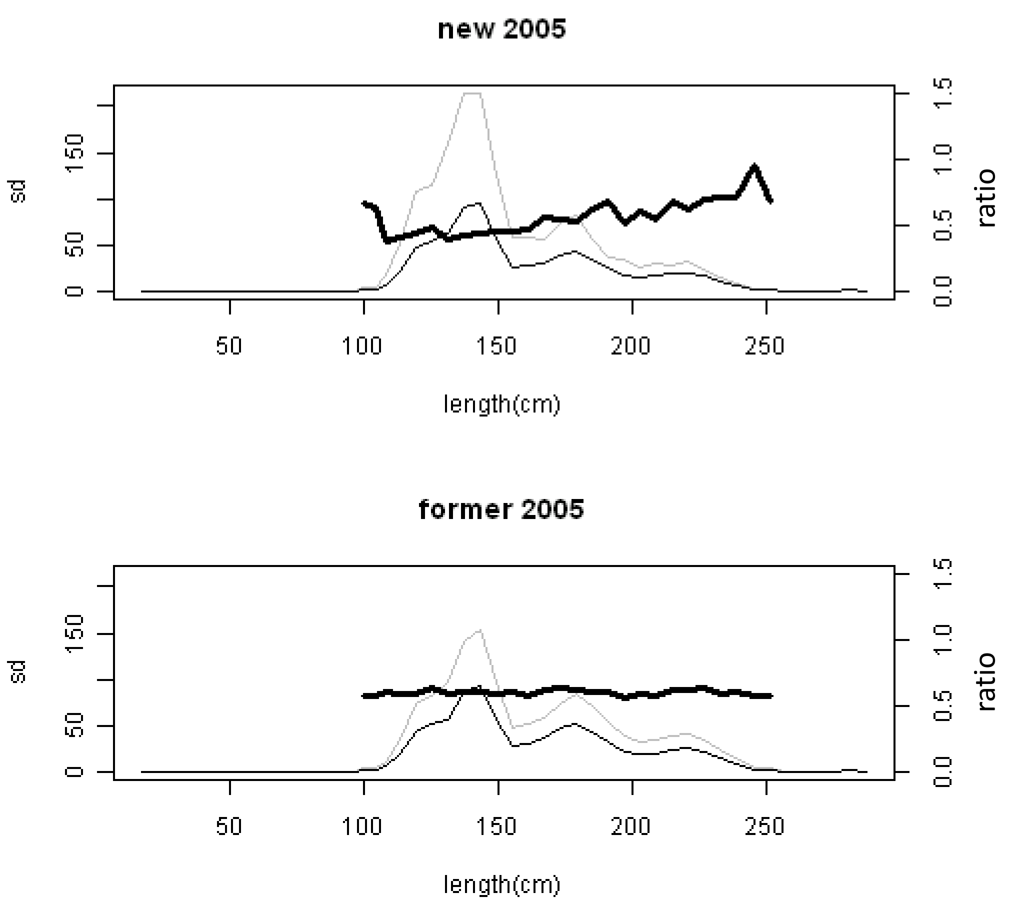

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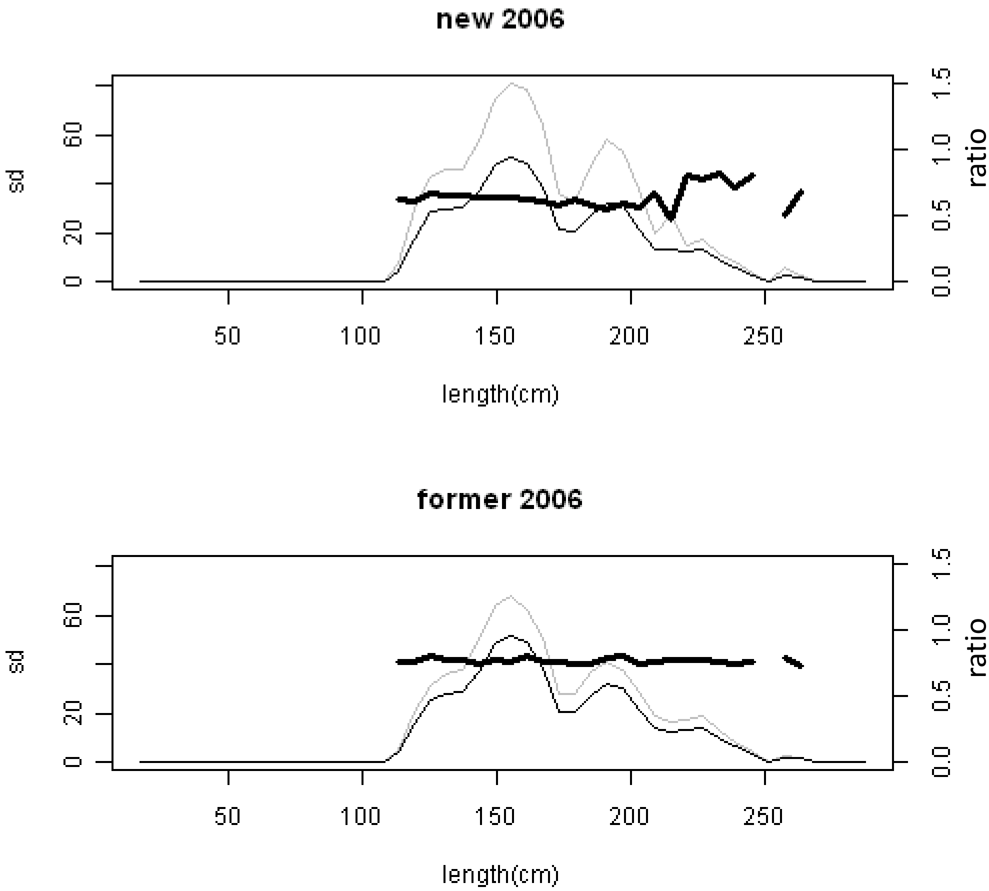

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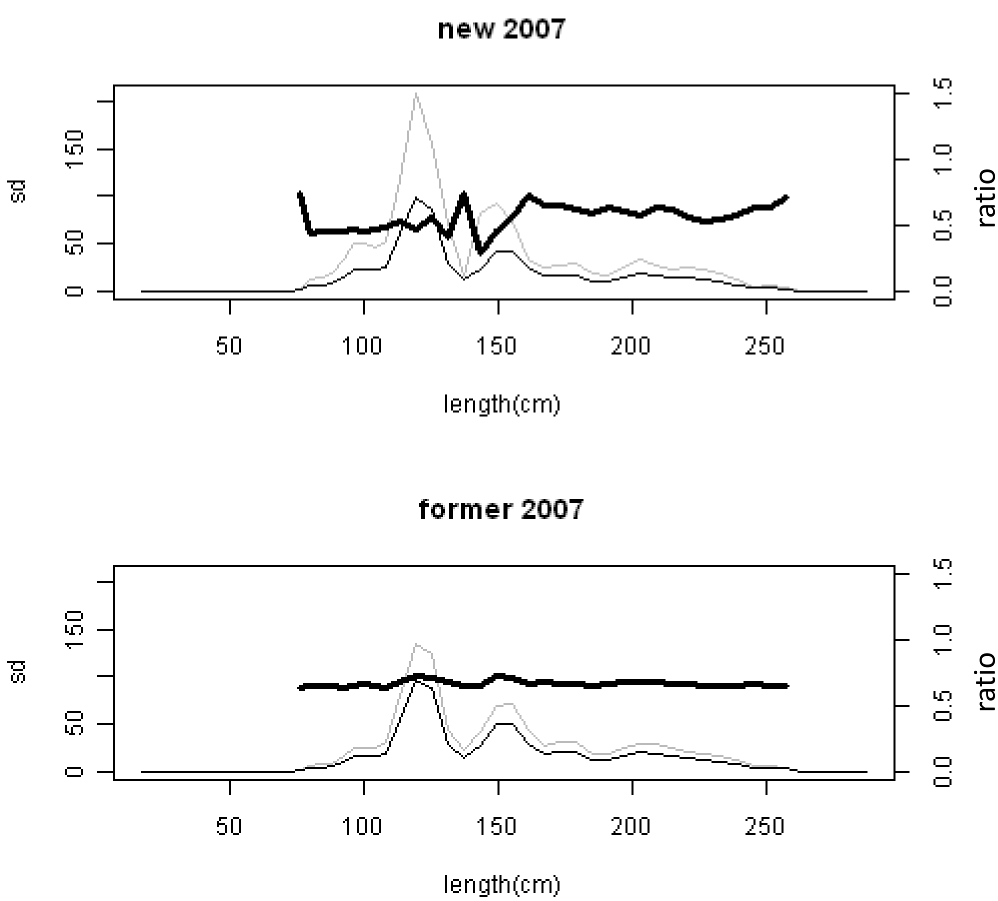

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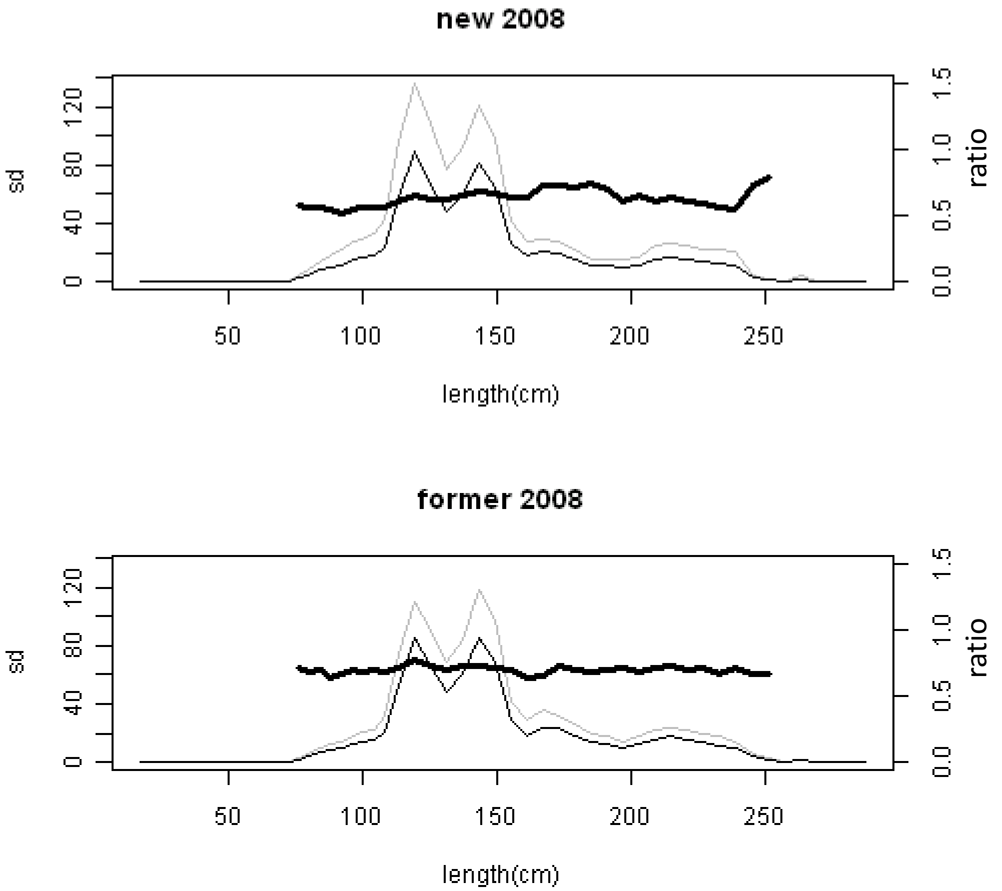

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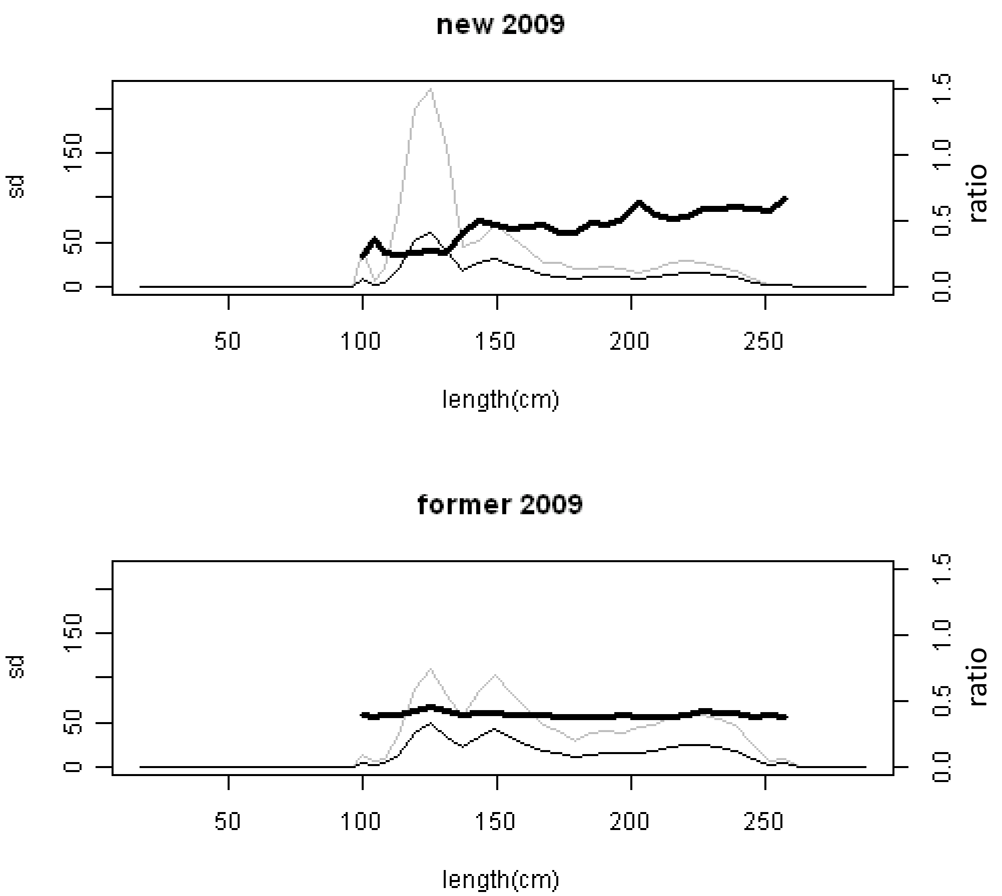

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