CPUE standardization of yellowfin tuna caught by Korean tuna longline fishery in the Indian Ocean, 1977-2017

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Abstract

In this study we standardized CPUE of yellfowfin tuna caught by Korean tuna longline fisheries in the Indian Ocean using Generalized Linear Models (GLM) with operational data. The data used for the GLMs were catch (number), effort (number of hooks), number of hooks between floats (HBF), fishing location (5° cell), and vessel identifier by year, quarter, and region. We applied cluster analysis to address concerns about target change through time which can affect CPUE indices. The CPUE was standardized using lognormal constant and delta lognormal approaches, considering with vessel effects and without vessel effects, and the main indices was estimates from delta lognormal approach.

Introduction

In the Indian Ocean, yellowfin tuna has been one of the highest catch in Korean tuna longline fisheries along with bigeye tuna. Yellowfin catch considerably increased from the mid-1960s and peaked at about 34 thousands mt in 1978, but had decreased with a fluctuation to a few hundred tons in the early 2010s. In this study, CPUE (catch per unit effort) standardization of yellowfin caught by Korean tuna longline fisheries in the Indian Ocean (1977-2017) was conducted using the approaches developed by the collaborative study on tropical tuna CPUE from multiple Indian Ocean longline fleets

Data and Method

In this study, set by set data were used for yellowfin CPUE standardization, which complied from captain onboard and contained catch (number of fishes), effort (number of hooks) and HBF (number of hooks between floats) by year, month and area from 1977 to 2017. Data preparation and analysis were carried out using the approaches described by Hoyle et al. (2015, 2016).

The region definition for yellowfin CPUE is based on the current YFT regional structure (regY) and alternative structure (regY2) that the western equatorial region (regY_R2) is subdivided into two regions (the south area and north area of the equator; regY2_R2 and R7) (Fig. 1).

We clustered all data for each area using the approach applied by Hoyle et al. (2015, 2016). For these analyses we aggregated the data by vessel-month, and calculated proportional species composition by dividing the catch in numbers of each species by catch in numbers of all species in the vessel-month. The data were transformed by centring and scaling, to reduce the dominance of species with higher average catches. And we clustered the data using the hierarchical Ward hclust method and using the kmeans method.

For CPUE standardization, two approaches, lognormal constant and delta lognormal were used, considering with vessel effects and without vessel effects. We selected the estimates from the delta lognormal as the main indices.

Results and Discussion

The indices in the tropical areas had very steep decline in standardized CPUE prior to 1980, and continued decline at a slower rate. The CPUE in the western tropical region 2 showed an increasing from 2010 (Figs. 2-4 and 6).

In the regY2 structure the western tropical region was split into two subregions, the south-western part (regY2_R2) and the north-western part (regY2_R7). The indices in regY2_R2 and regY2_R7 showed similar trend and had the differences in fluctuation by year (Figs. 3-4).

In western temperate region 3 the pattern showed a stable trend from 1978 to the middle of 2000s. But the indices decreased around 2010 and has shown an increasing (Fig. 5).

References

Hoyle, S. D., H. Okamoto, Y.-m. Yeh, Z. G. Kim, S. I. Lee, and R. Sharma. 2015. IOTC–CPUEWS02 2015: Report of the 2nd CPUE Workshop on Longline Fisheries, 30 April – 2 May 2015. Indian Ocean Tuna Commission.

Hoyle, S., D. Kim, S. Lee, T. Matsumoto, K. Satoh, and Y. Yeh. 2016. Collaborative study of tropical tuna CPUE from multiple Indian Ocean longline fleets in 2016. IOTC–2016–WPTT18–14.

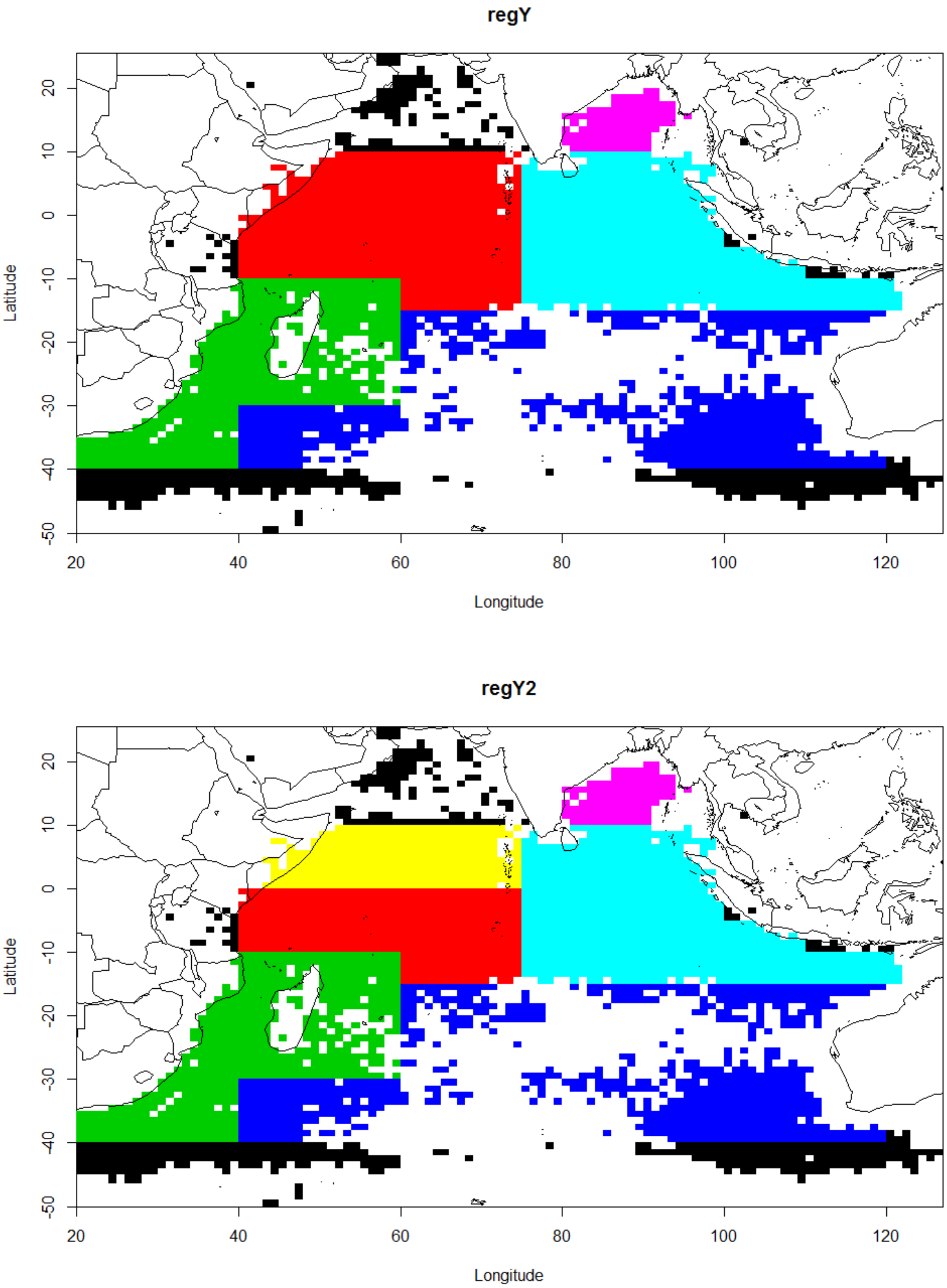

Fig. 1. Maps of the regional structures used to estimate yellowfin CPUE indices for the versions in which the western tropical region is contiguous (above) and split (below).

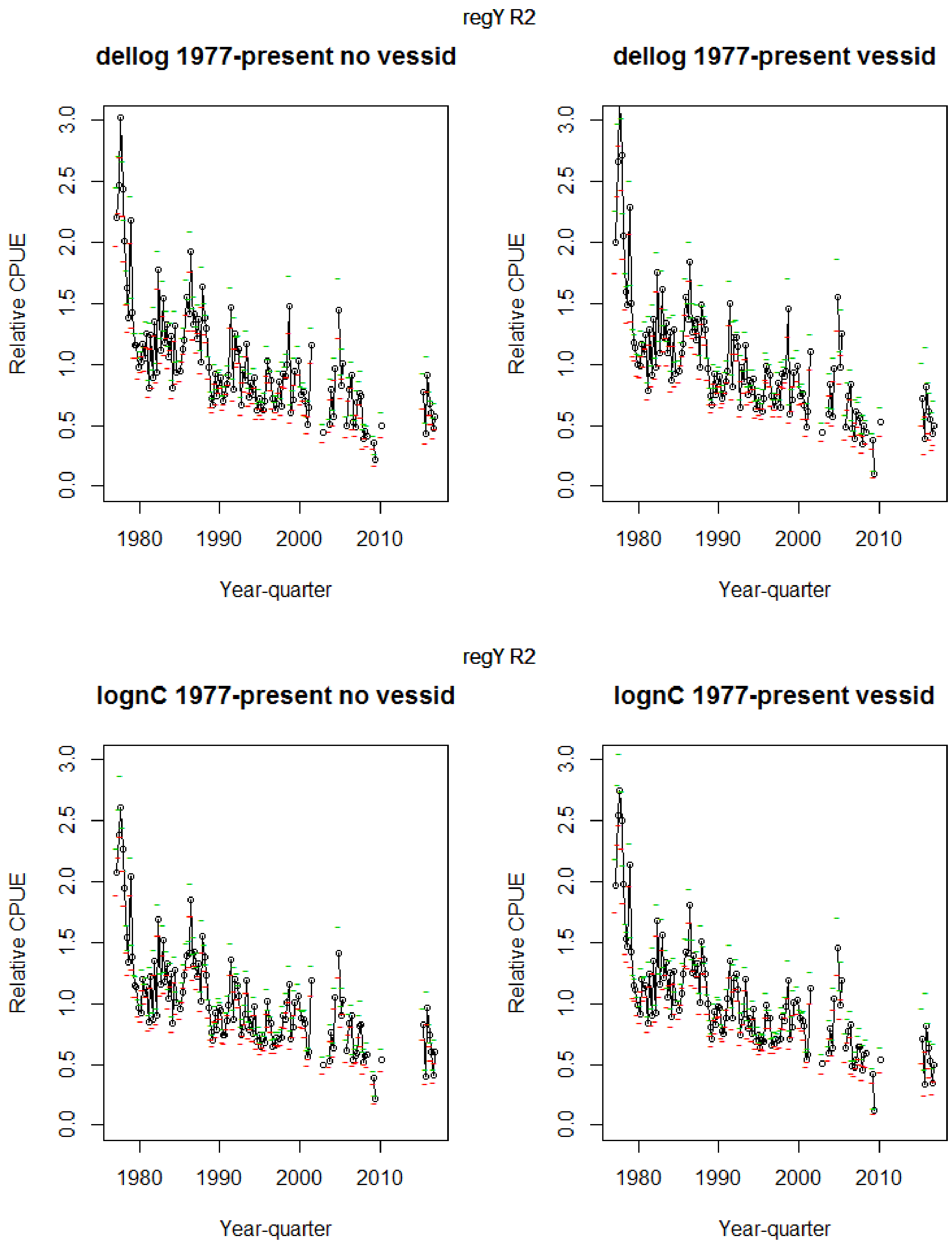

Fig. 2. Quarterly CPUE series for yellowfin region 2 (western tropical, regY_R2). The plots show indices from delta lognormal with (upper right) and without (upper left) vessel effects, and indices for lognormal constant with (lower right) and without (lower left) vessel effects.

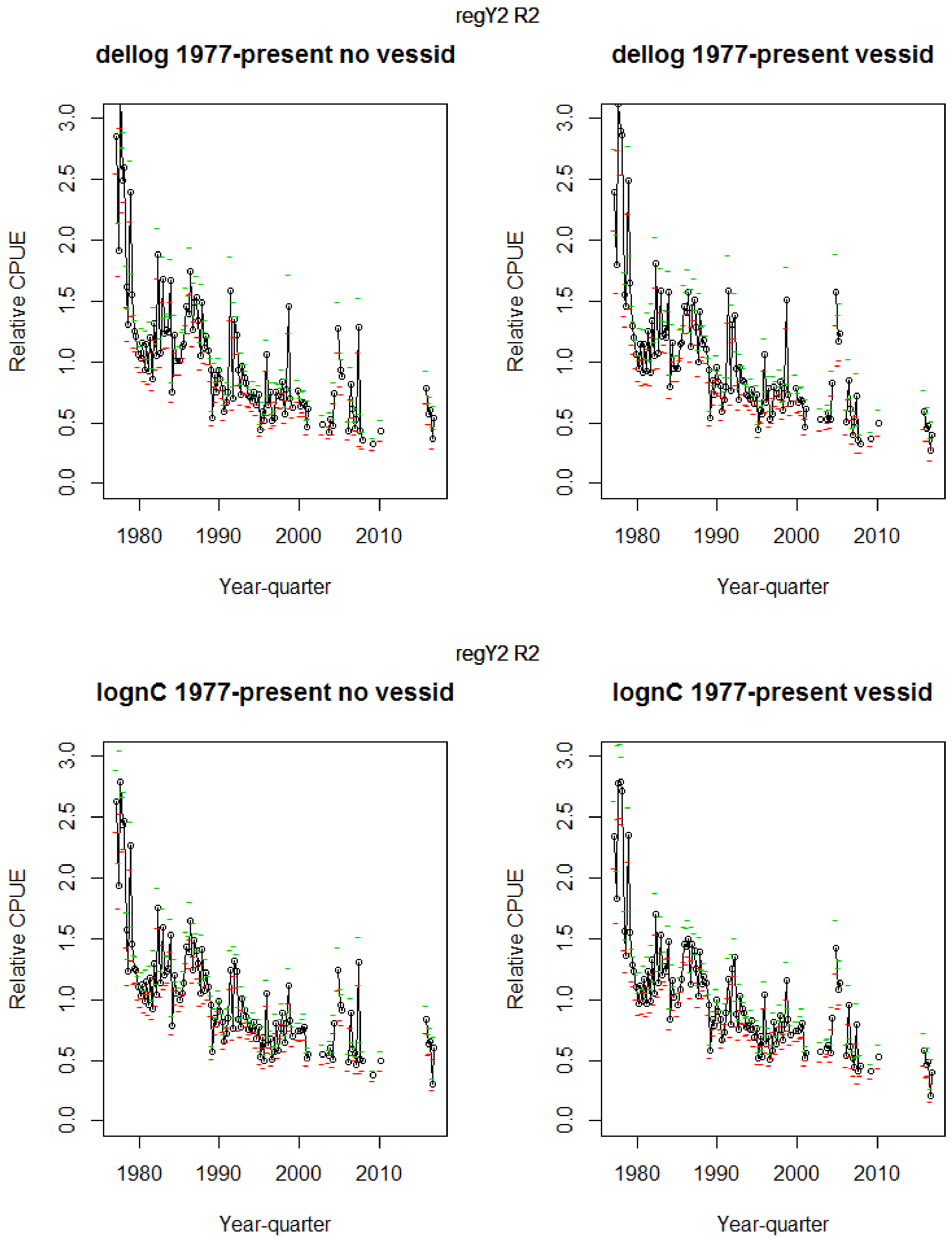

Fig. 3. Quarterly CPUE series for yellowfin region 2s (south-western tropical, regY2_R2). The plots show indices from delta lognormal with (upper right) and without (upper left) vessel effects, and indices for lognormal constant with (lower right) and without (lower left) vessel effects.

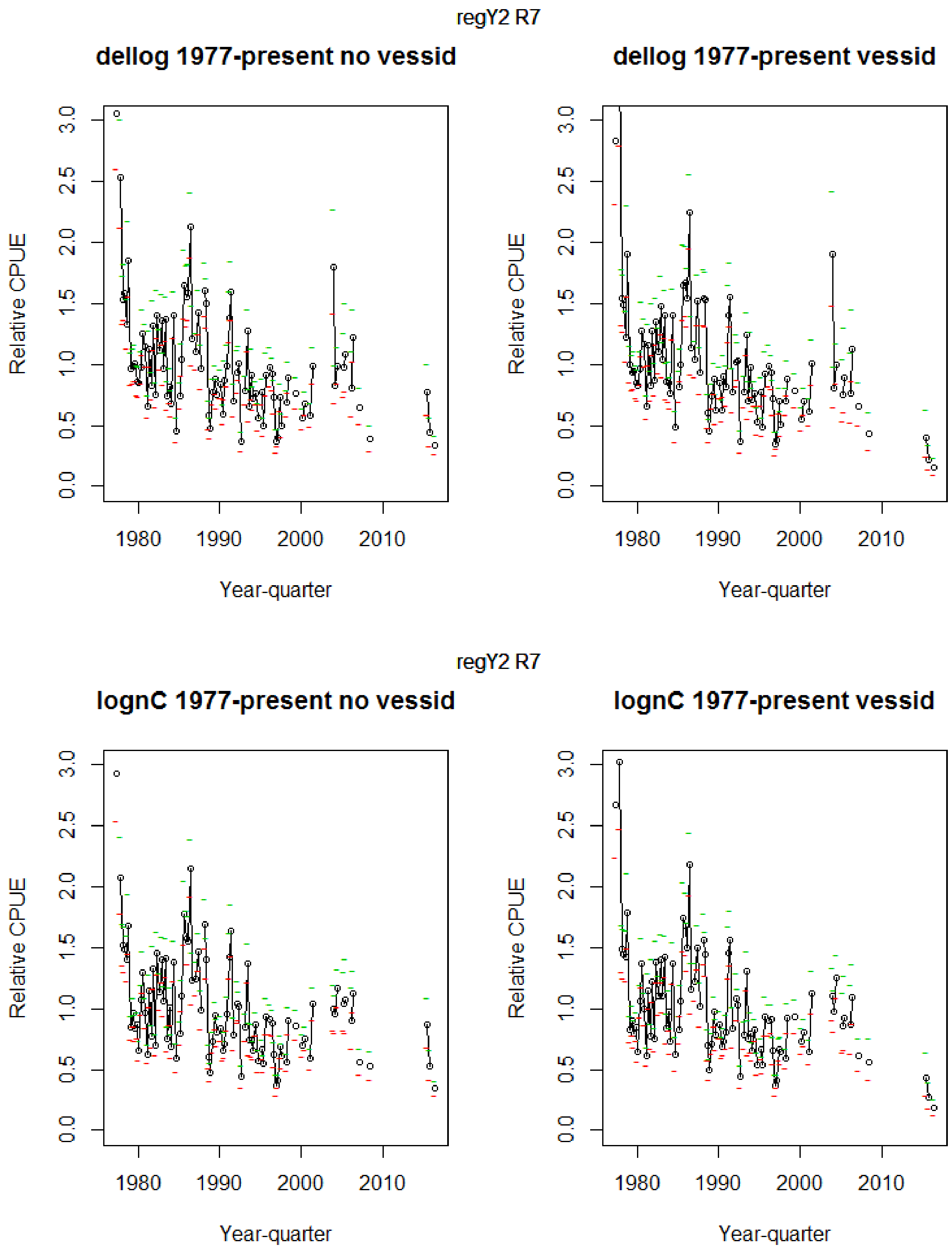

Fig. 4. Quarterly CPUE series for yellowfin region 2n (north-western tropical, regY2_R7). The plots show indices from delta lognormal with (upper right) and without (upper left) vessel effects, and indices for lognormal constant with (lower right) and without (lower left) vessel effects.

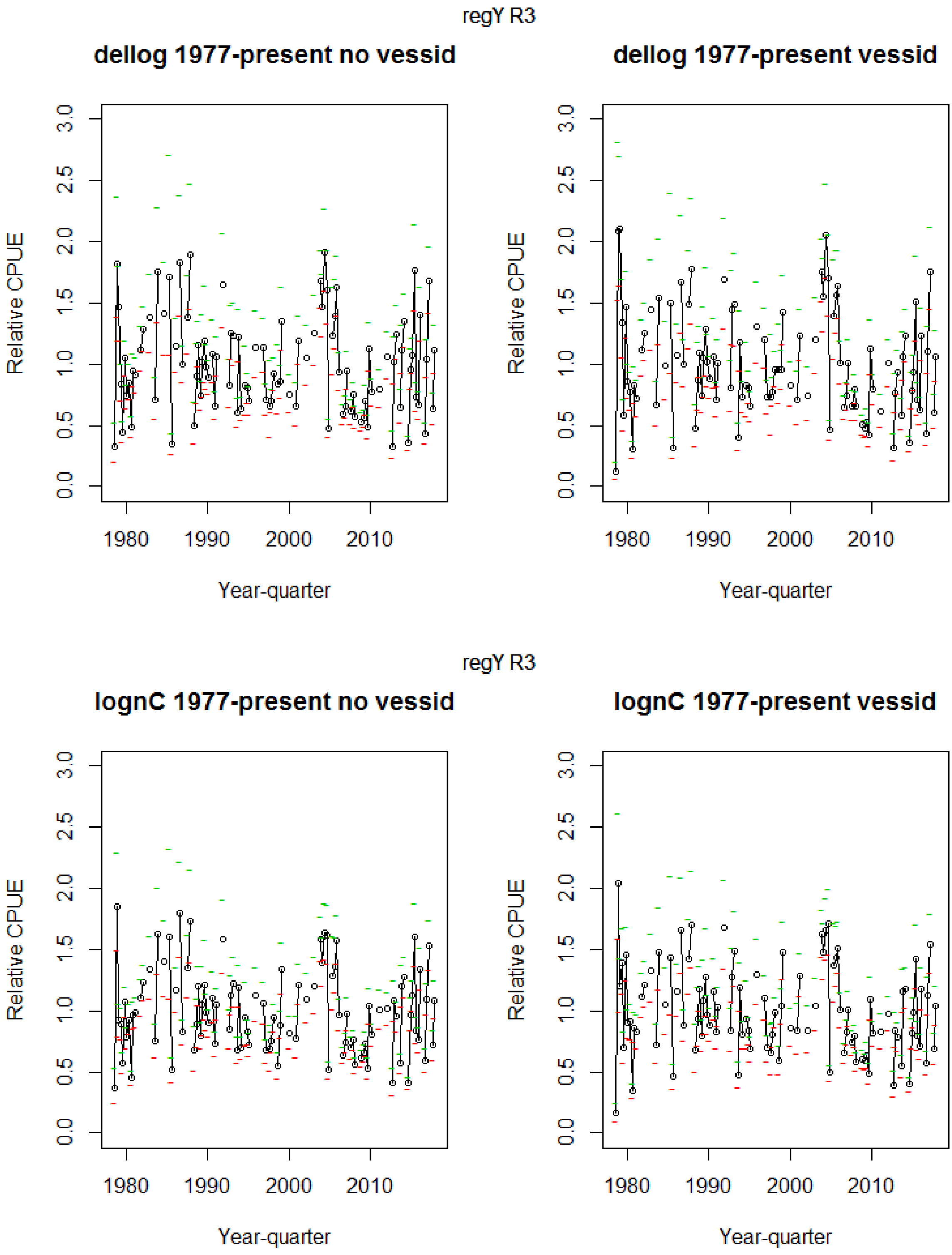

Fig. 5. Quarterly CPUE series for yellowfin region 3 (western temperate, regY_R3). The plots show indices from delta lognormal with (upper right) and without (upper left) vessel effects, and indices for lognormal constant with (lower right) and without (lower left) vessel effects.

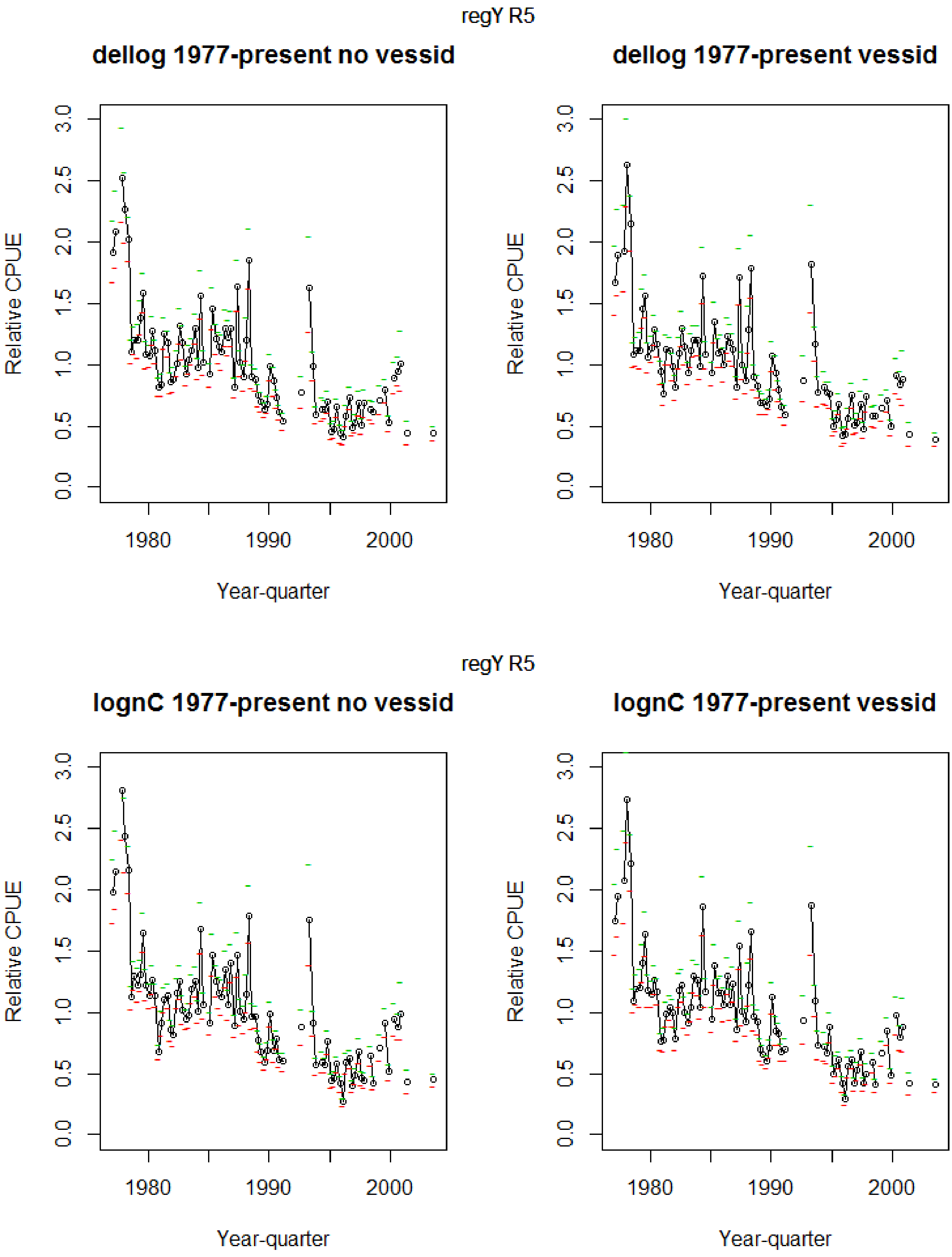

Fig. 6. Quarterly CPUE series for yellowfin region 5 (eastern tropical, regY_R5). The plots show indices from delta lognormal with (upper right) and without (upper left) vessel effects, and indices for lognormal constant with (lower right) and without (lower left) vessel effects.

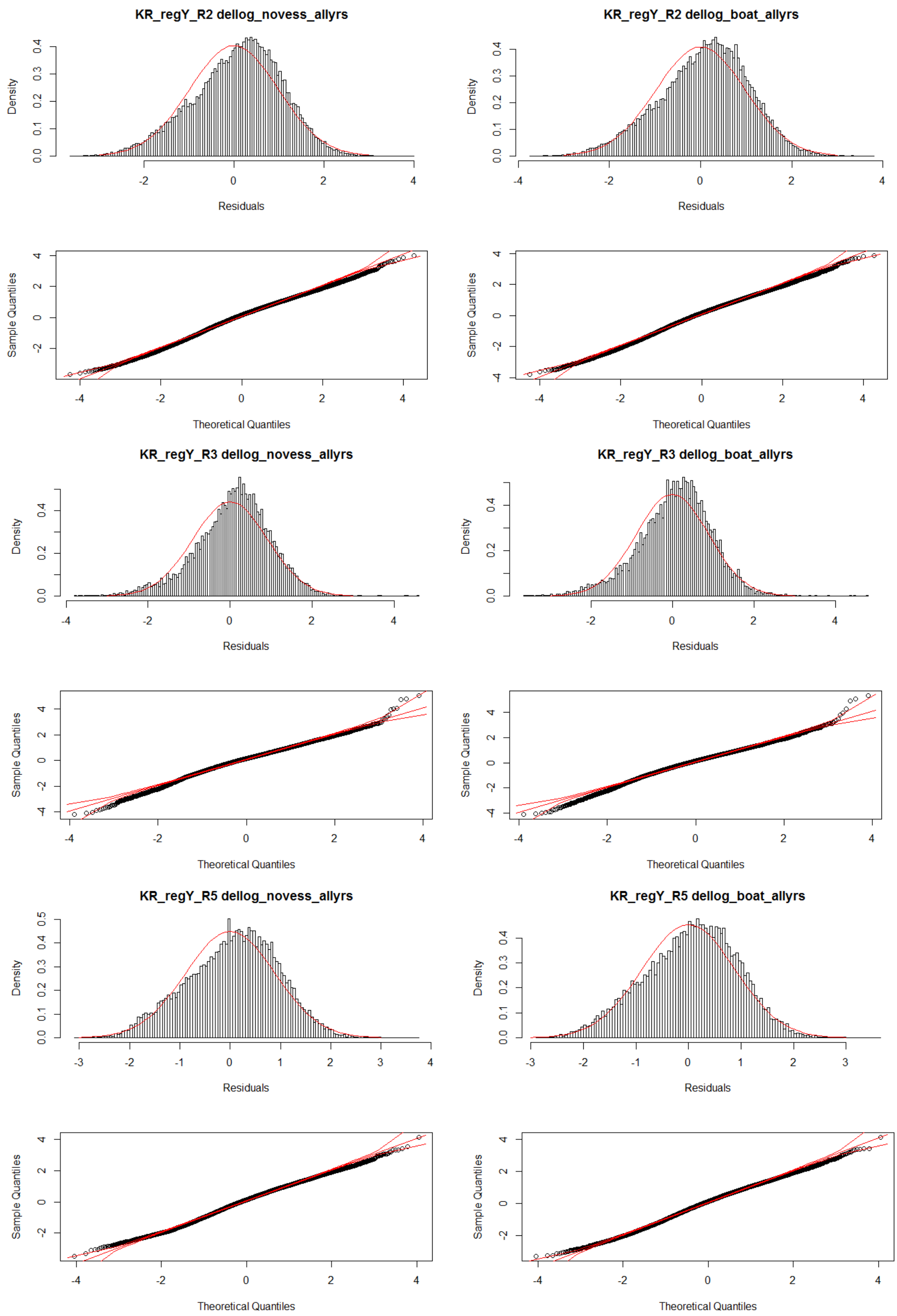

Fig. 7. Diagnostic plots for yellowfin models in regions 2, 3 and 5 (regY_R2, regY_R3 and regY_R5) without vessel effects (left) and with vessel effects (right).

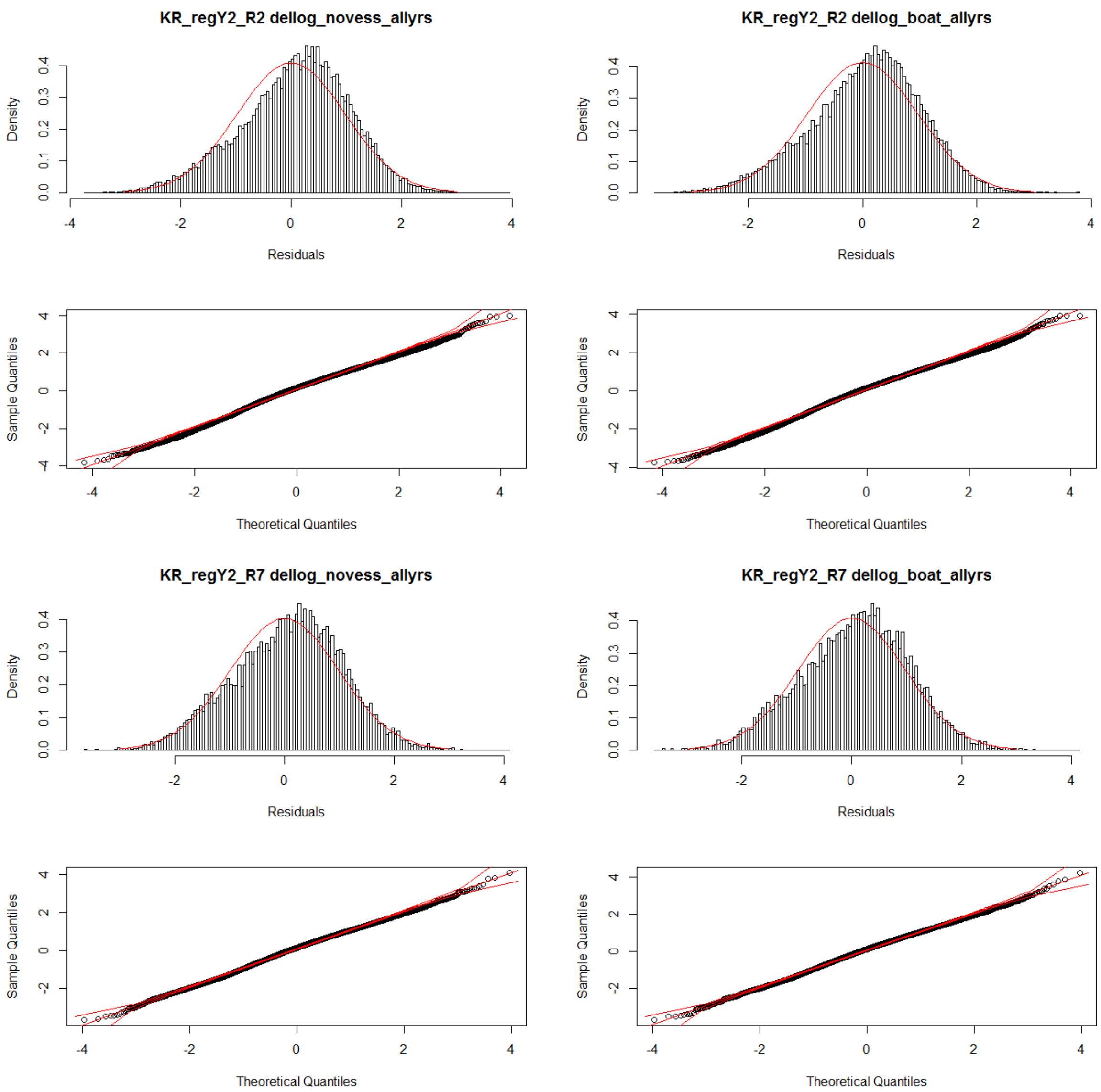

Fig. 8. Diagnostic plots for yellowfin models in regions 2s and 2n (regY2_R2 and regY2_R7) without vessel effects (left) and with vessel effects (right).

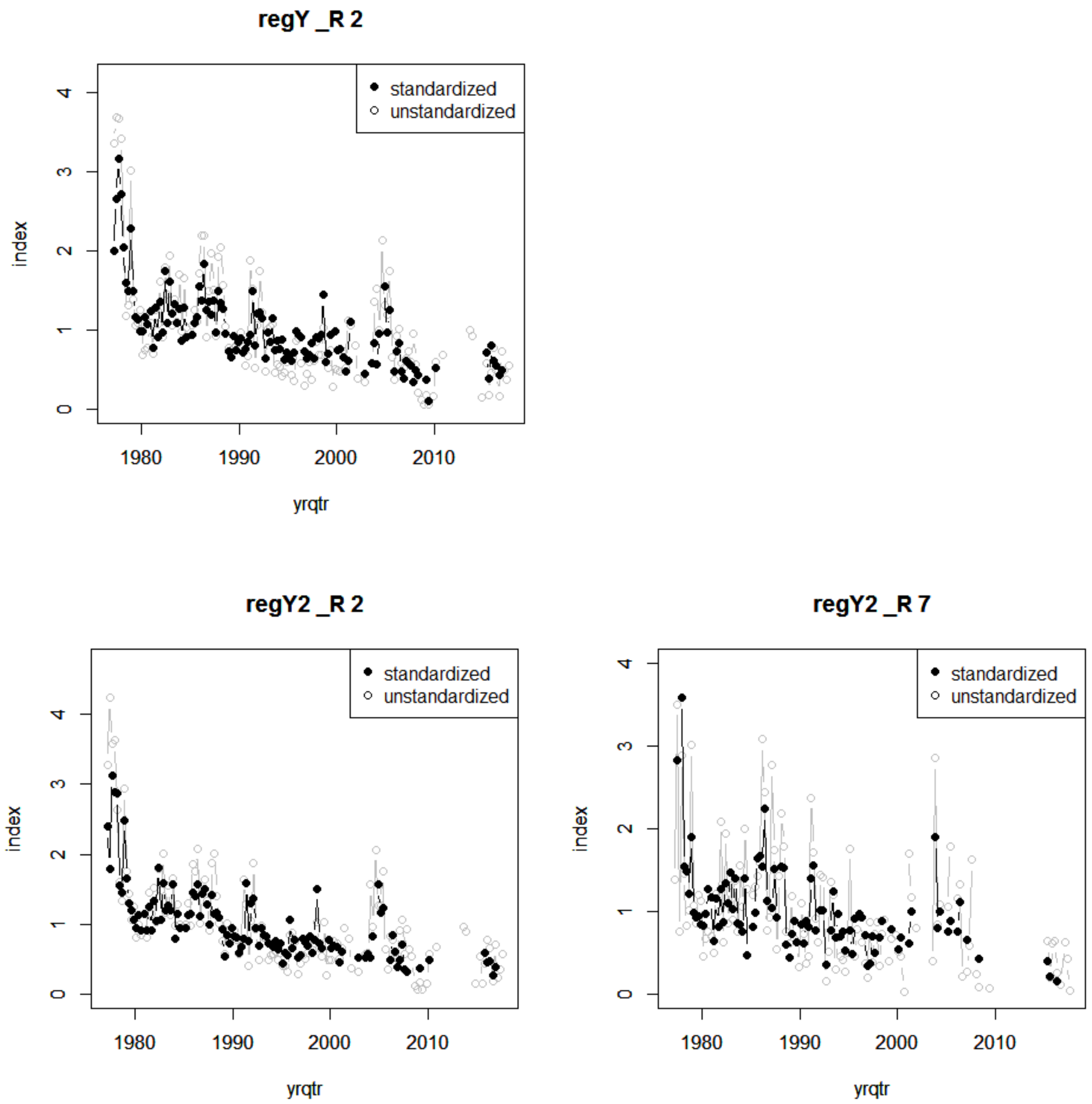

Fig. 9. Comparison plot of unstandardised and standardised indices for yellowfin in region 2 (western tropical, regY_R2), region 2S (south-western tropical, regY2_R2) and region 2N (north-western tropical, regY2_R7).

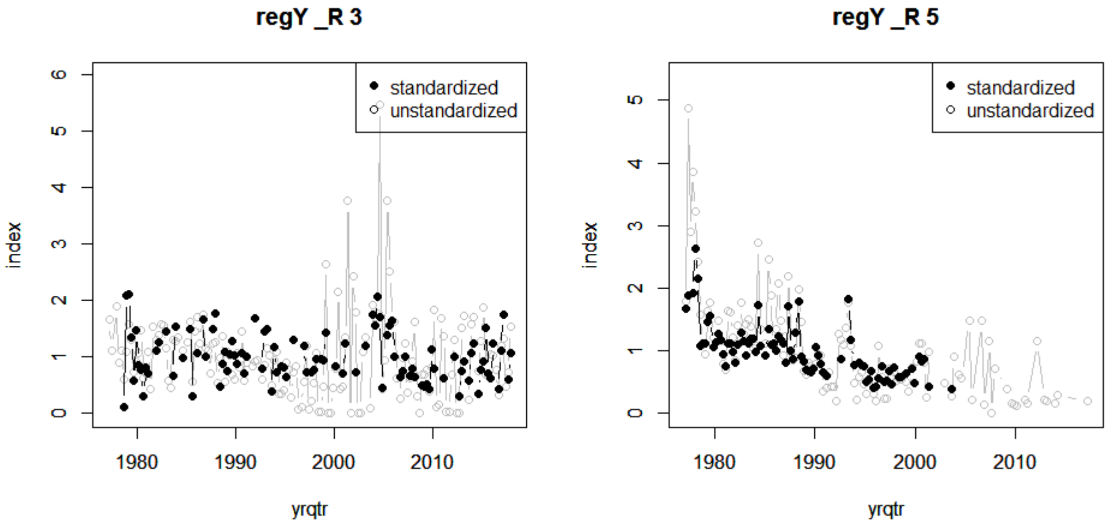

Fig. 10. Comparison plot of unstandardised and standardised indices for yellowfin in region 3 (western temperate, regY_R3) and region 5 (eastern tropical, regY_R5).