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LIKELIHOOD COMPONENT PROFILING AS A DATA EXPLORATORY TOOL FOR NORTH ATLANTIC ALBACORE

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SUMMARY

We use likelihood profiling by data component, i.e. for each catch per unit effort (CPUE) series as a data exploratory tool. The approach allows the information on key parameters in each time series to be evaluated.

RÉSUMÉ

Nous avons recours au profilage des vraisemblances par élément des données, c.-à-d. pour chaque série de capture par unité d'effort (CPUE) comme outil d'exploration des données. L'approche permet d'évaluer l'information sur les paramètres fondamentaux dans chaque série temporelle.

RESUMEN

Se usan los perfiles de verosimilitud por componente de datos, es decir, para cada serie de captura por unidad de esfuerzo (CPUE) como herramienta exploratoria de datos. El enfoque permite evaluar la información sobre los parámetros clave en cada serie temporal.

KEYWORDS

Biomass Dynamic, Diagnostics, Stock Assessment

1. Introduction

Biomass dynamic models are widely used in ICCAT for stock assessment and advice, parameters are estimated by fitting to time series of total catch and standardised catch per unit effort (CPUE) from fisheries. The later are assumed to track stock abundance. However it is not uncommon for such indices to contain sufficient information to estimate both parameters. Also indices may be conflicting and fitting therefore may involve weighted averages of contradictory CPUE data. This generally produces parameter estimates intermediate than would be obtained from the data sets individually (Schnute and Hilborn, 1993), who point out that the most likely parameter values are not intermediary to conflicting values; instead, they occur at one of the apparent extremes. We therefore use the ASPIC biomass model to explore uncertainty due to contradictory trends in time series of catch per unit effort (CPUE). We do this by calculating likelihood profiles for the parameter K (carrying capacity or unfished biomass B0) and MSY (maximum sustainable yield).

Parameterisation of the assessment model in terms of MSY and K is preferred to r and K since providing management advice requires management target and limit reference points and this way uncertainty in the reference points can be evaluated directly.

2. Materials and Methods

We use Piner Plots which show the likelihoods of the different data components for a profiled parameter. This allow an evaluation of what data series are affecting the parameter estimates

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2.1. Data

The data are from the North Atlantic Albacore assessment (SCRS/2013/016), and comprise 4 long line CPUE time series one from Chinese-Taipei and the Japanese longline split into 3 periods to reflect changes in targeting.

2.2. Assessment Model

The assessment model used was ASPIC, which assumes that population dynamics are determined by a surplus production function e.g. Pella and Tomlinson (1969). The biomass next year (B_{t+1}) as the sum of the biomass this year B_t less the catch (C_t) plus the surplus production (P_t).

It is also assumed that catches and catch per unit effort (CPUE) are from a single homogeneous stock and that the CPUE represent stock trends in abundance. If there are zero or negative correlations between the indices, then this means that a basic assumption of ASPIC is violated, either because factors other than stock abundance are determining catch rates or that the indices are fishing different stock components.

2.3 Software

Software used was a biomass production model implemented as a package in R, this allows it to be used with a variety of other packages for plotting, summarizing results and to be simulation tested, e.g. as part of the FLR tools for management strategy evaluation (Kell et al., 2007).

3. Results

The CPUE series are plotted in **Figure 1**. For each series the likelihood components and the combined likelihood (Total) are plotted for profiles of K and MSY in **Figures 2 and 4** on the same scale and scaled separately for each CPUE series in **Figures 3 and 5**.

For K the solution from the model using all indices equally weighted is intermediate between the series specific indices. For Chinese-Taipei and the Japanese II series no maximum is seen in the range profiled, the SS is increasing with K. While for the Japanese I and III series a lower value of K is more likely than the estimate using all series combined. In all cases the solution (using all series equally weighted) is intermediate to the individual estimates.

For MSY the picture is more complicated. For the Japanese series the estimates of MSY are similar, but the profiles are not symmetric. For I and III the profiles suggests that a lower value is more likely that a larger value, while II suggests a larger value is more likely. For the Chinese-Taipei series there is no maximum but a low value is more likely. The profile for Japanese II shows two maxima.

The residuals for selected fits (red points of **Figures 2, 4, 3 and 5**) are plotted in **Figures 6 and 7**.

4. Discussion

Actions to deal with conflicting trends are to down weight data that in the opinion of the stock assessors are not representative of stock trends or to run several scenarios then combine these in the Kobe advice plots.

The approach can also be used with stock assessment methods that use more data, e.g. Stock Synthesis that can use size composition data. However, the approach would be similar to identify what sources of data are influencing parameter estimates and derived quantities such as the stock relative to B_{MSY} benchmarks.

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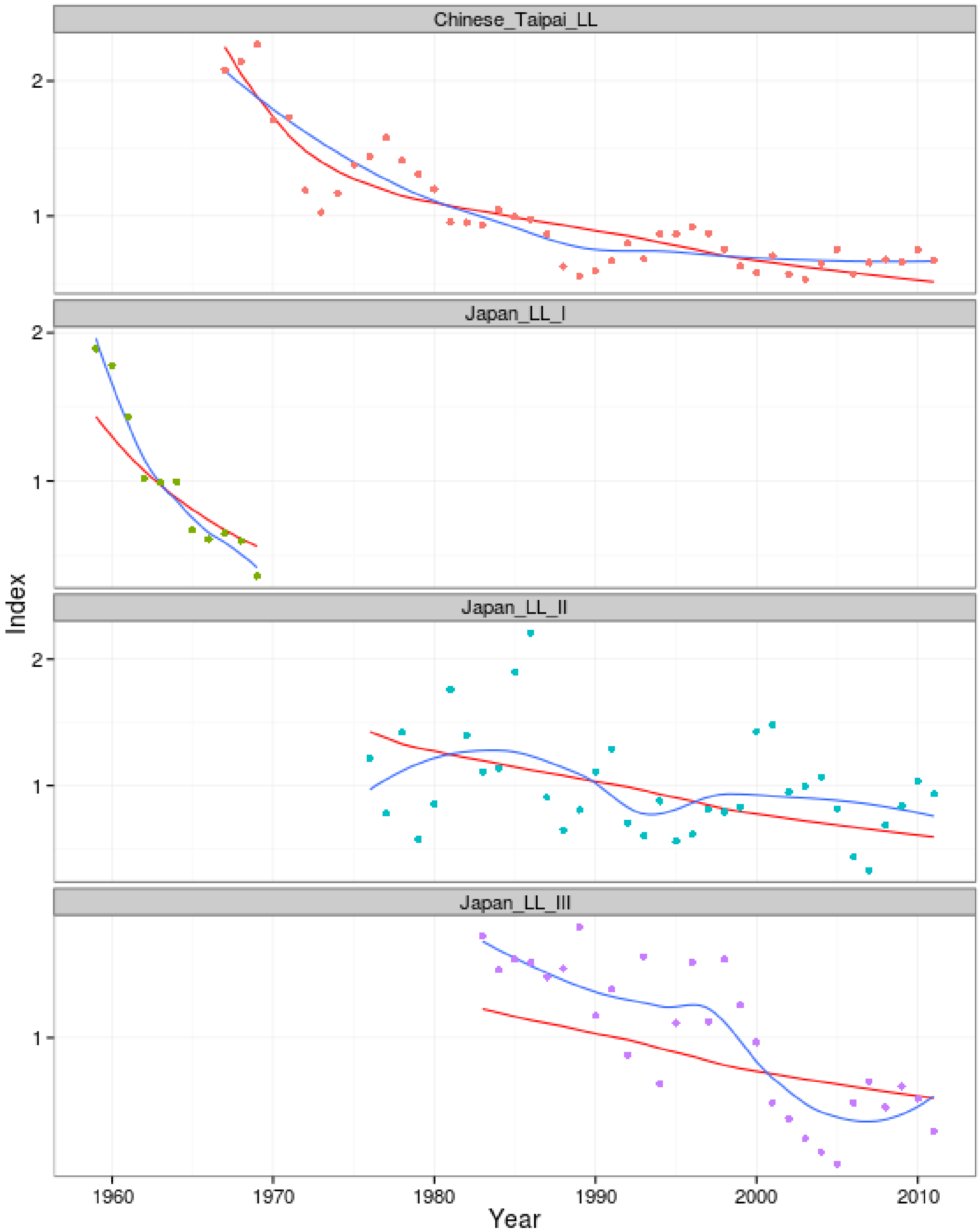

Figure 1. Plot of indices of abundance, points are the observed index values and the blue a lowes fitt to the points by index. The red line is GAM fitted to lo(year) and fleet.

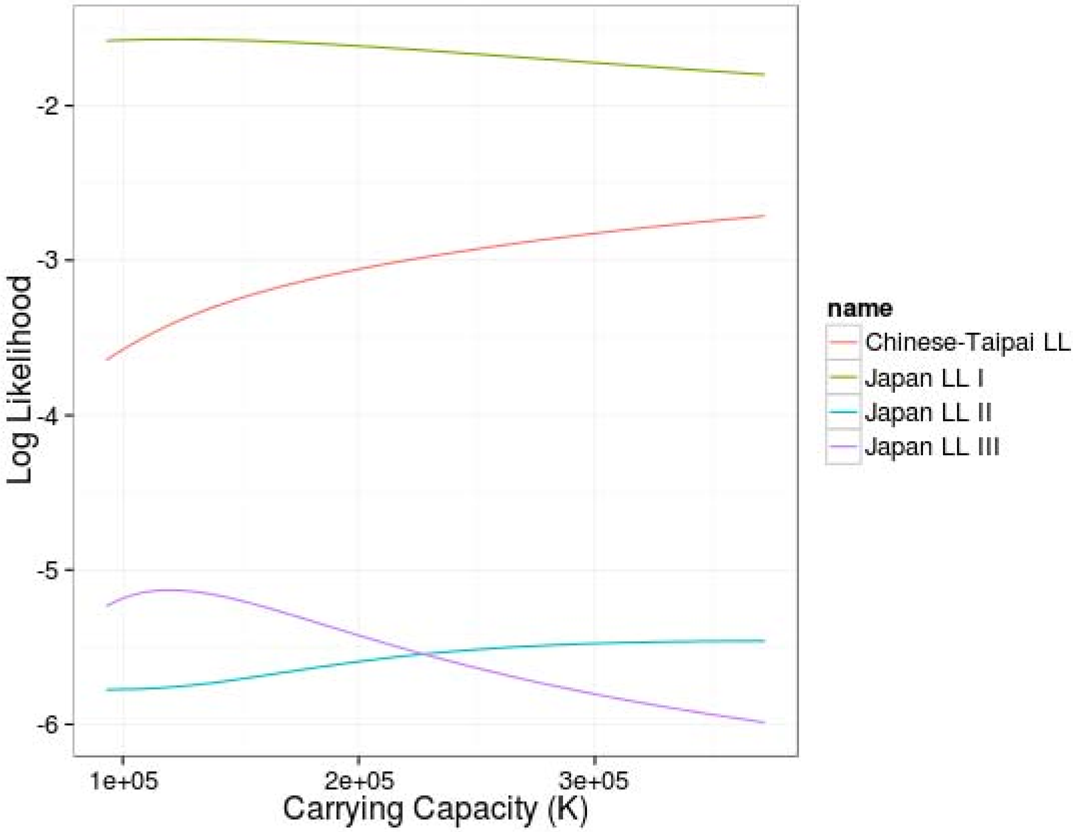

Figure 2. K likelihood profiles s by CPUE series and all components combined (Total) for K.

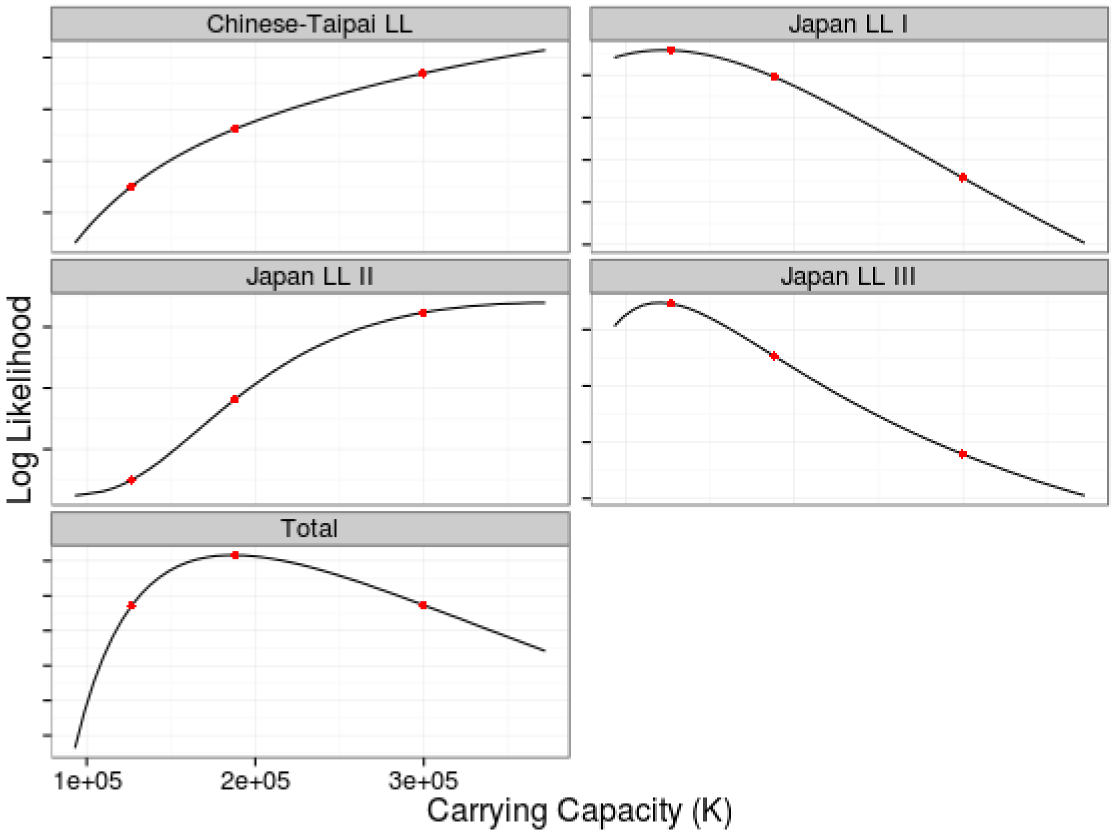

Figure 3. K likelihood profiles by CPUE series and all components combined (Total) for K.

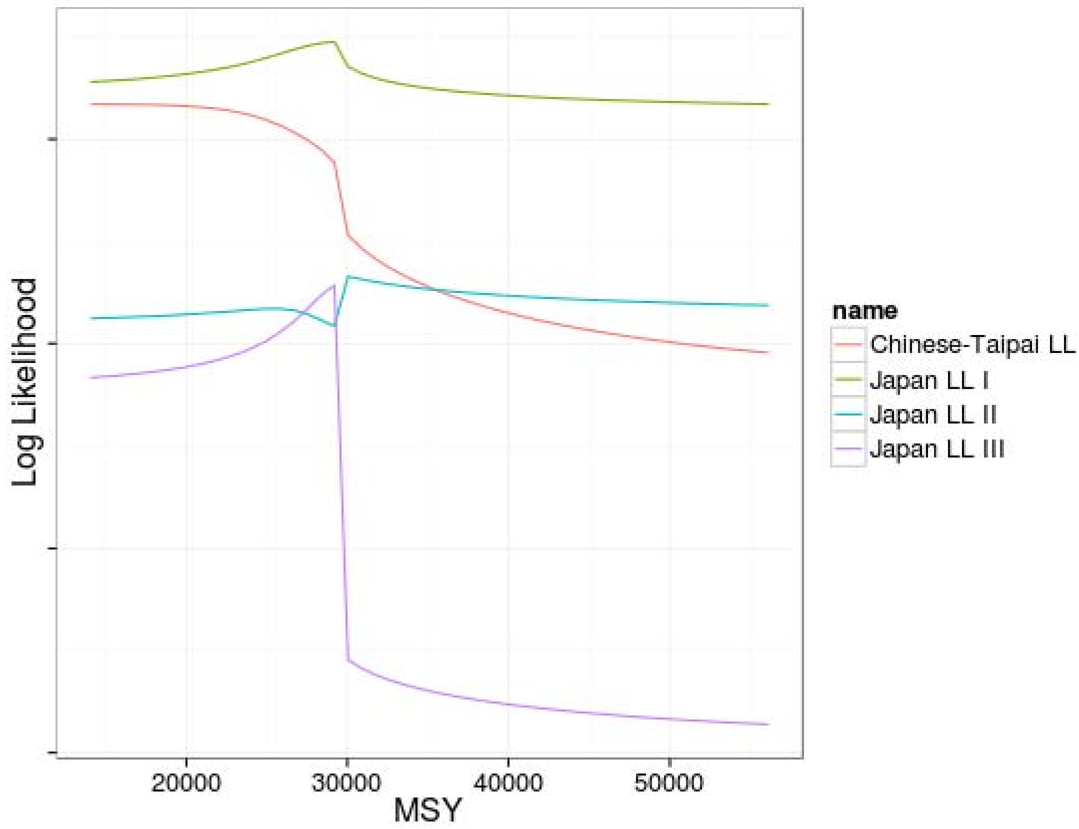

Figure 4. MSY likelihood profiles s by CPUE series and all components combined (Total) for MSY

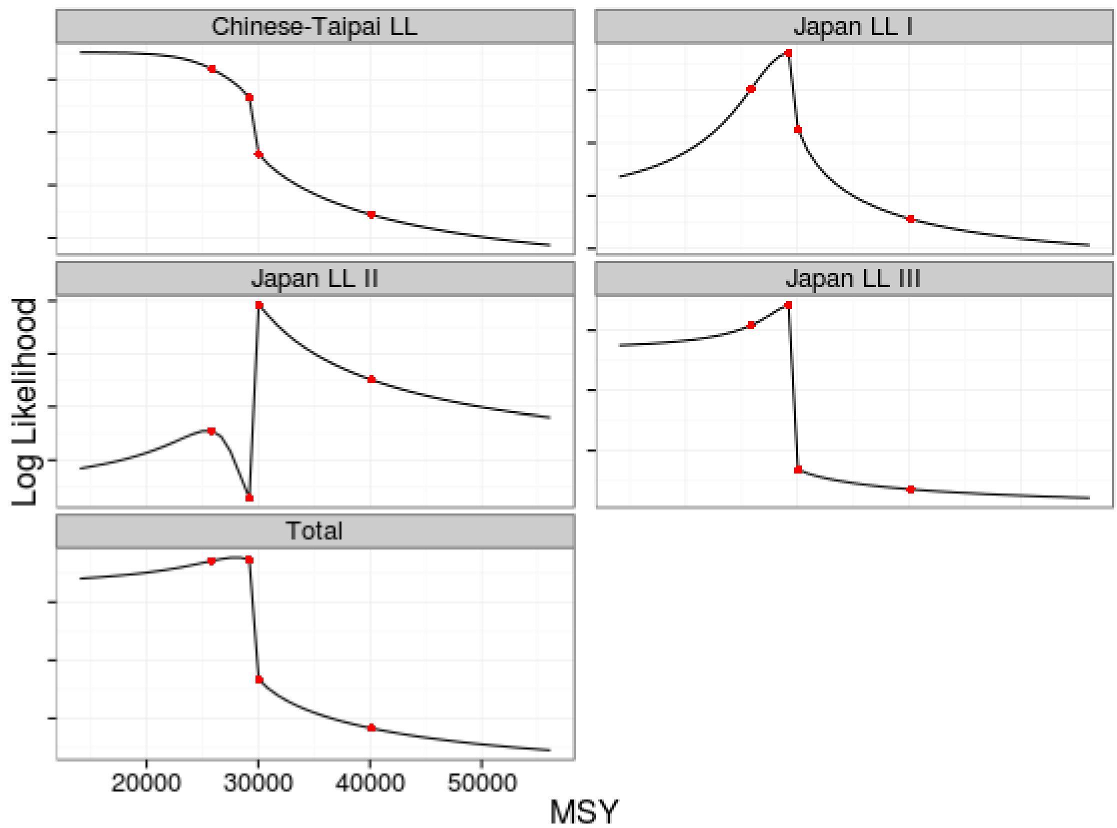

Figure 5. MSY likelihood profiles s by CPUE series and all components combined (Total) for MSY

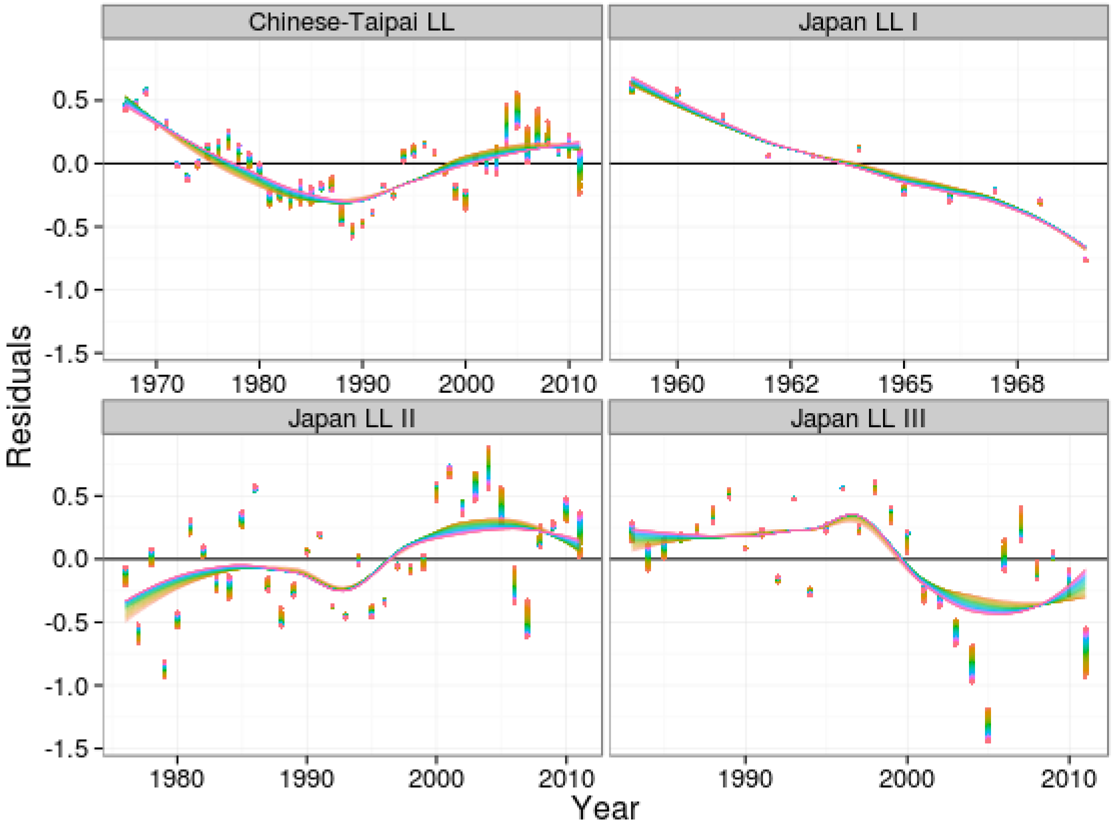

Figure 6. Residuals for K profiling by CPUE series (panel) and assumed value of K (colour), with a lowess smoother to identify systematic patterns.

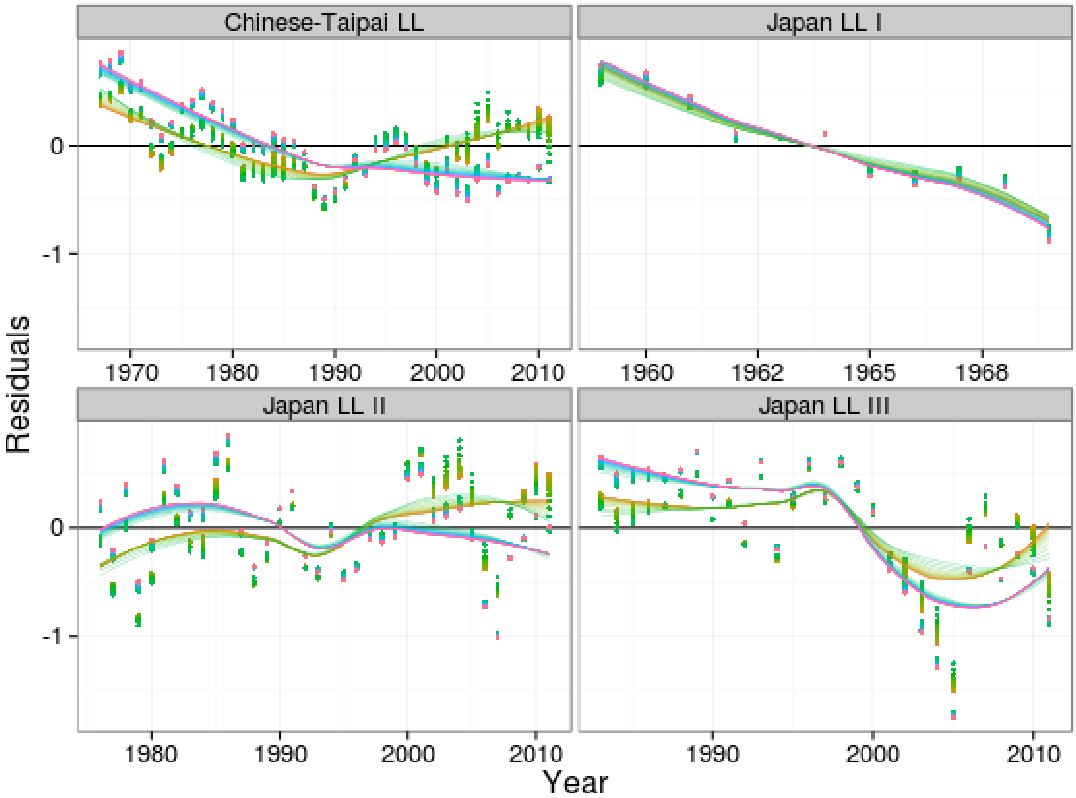

Figure 7. Residuals for MSY profiling by CPUE series (panel) and assumed value of K (colour), with a lowess smoother to identify systematic patterns