Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

Standardization including size composition data in VAST

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Model Structure (multiple categories (sizes))

VAST separately models encounter probability (p) and positive catch rate (λ) for each catch rate observation i:

$$\text{logit}(p_i) = \beta_1(\text{c}_i, t_i) + \sum_{f=1}^{n_{\omega_1}} L_{\omega 1}(c_i, f)\omega_1(s_i, f) + \sum_{f=1}^{n_{\varepsilon_1}} L_{\varepsilon 1}(c_i, f)\varepsilon_1(s_i, t_i, f) + \cdots$$

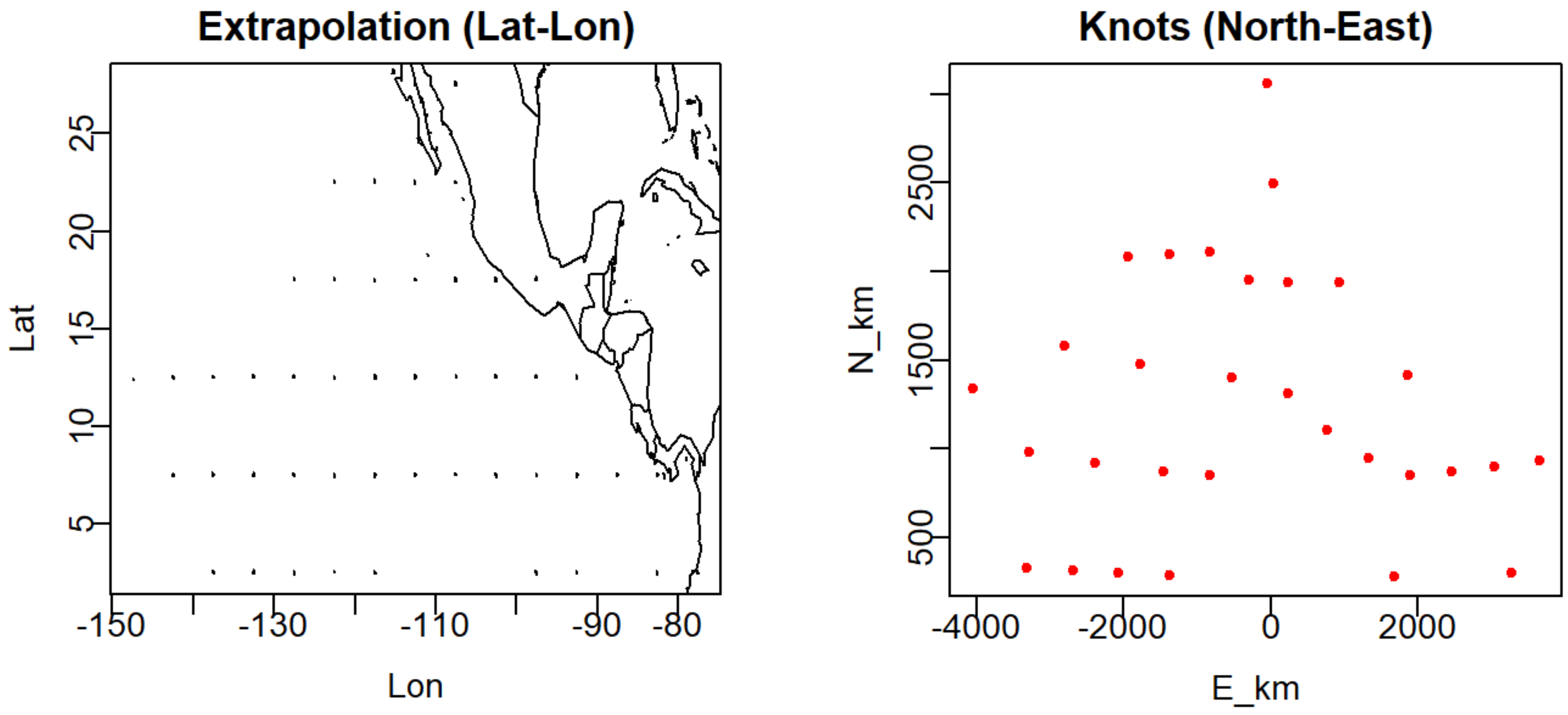
$$\log(\lambda_i) = \beta_2(\text{c}_i, t_i) + \sum_{f=1}^{n_{\omega_2}} L_{\omega 2}(c_i, f)\omega_2(s_i, f) + \sum_{f=1}^{n_{\varepsilon_2}} L_{\varepsilon 2}(c_2, f)\varepsilon_2(s_i, t_i, f) + \cdots$$

$\beta(t_i)$: intercept for category c_i in year t_i
$\omega(s_i, f)$: spatial variation for factor f at location s_i; L_ω: loading matrix
$\varepsilon(s_i, t_i, f)$: spatiotemporal variation for factor f at location s_i in year t_i; L_ε: loading matrix

Users can specify the number of factors (principle components) for the spatial (n_{ω_1} and n_{ω_2}) and spatiotemporal components (n_{ε_1} and n_{ε_2})

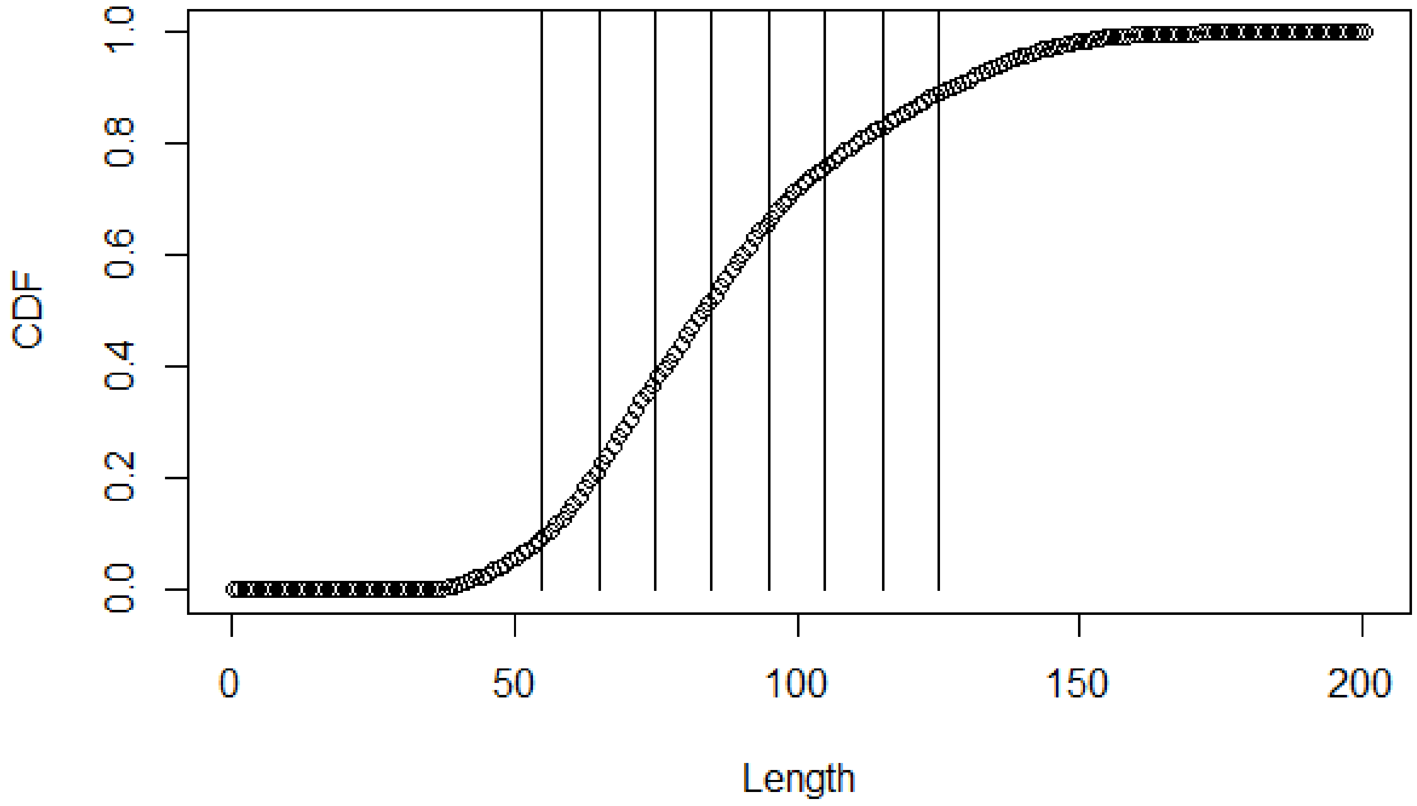
Case study: dolphin-associated EPO yellowfin fishery

- 5°*5° catch at length (1cm bin) and effort data from the dolphin-associated yellowfin fishery in the northern hemisphere in Quarter 2



Case study: dolphin-associated EPO yellowfin fishery

Yellowfin are grouped into 9 length bins



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Model Structure (multiple categories (sizes))

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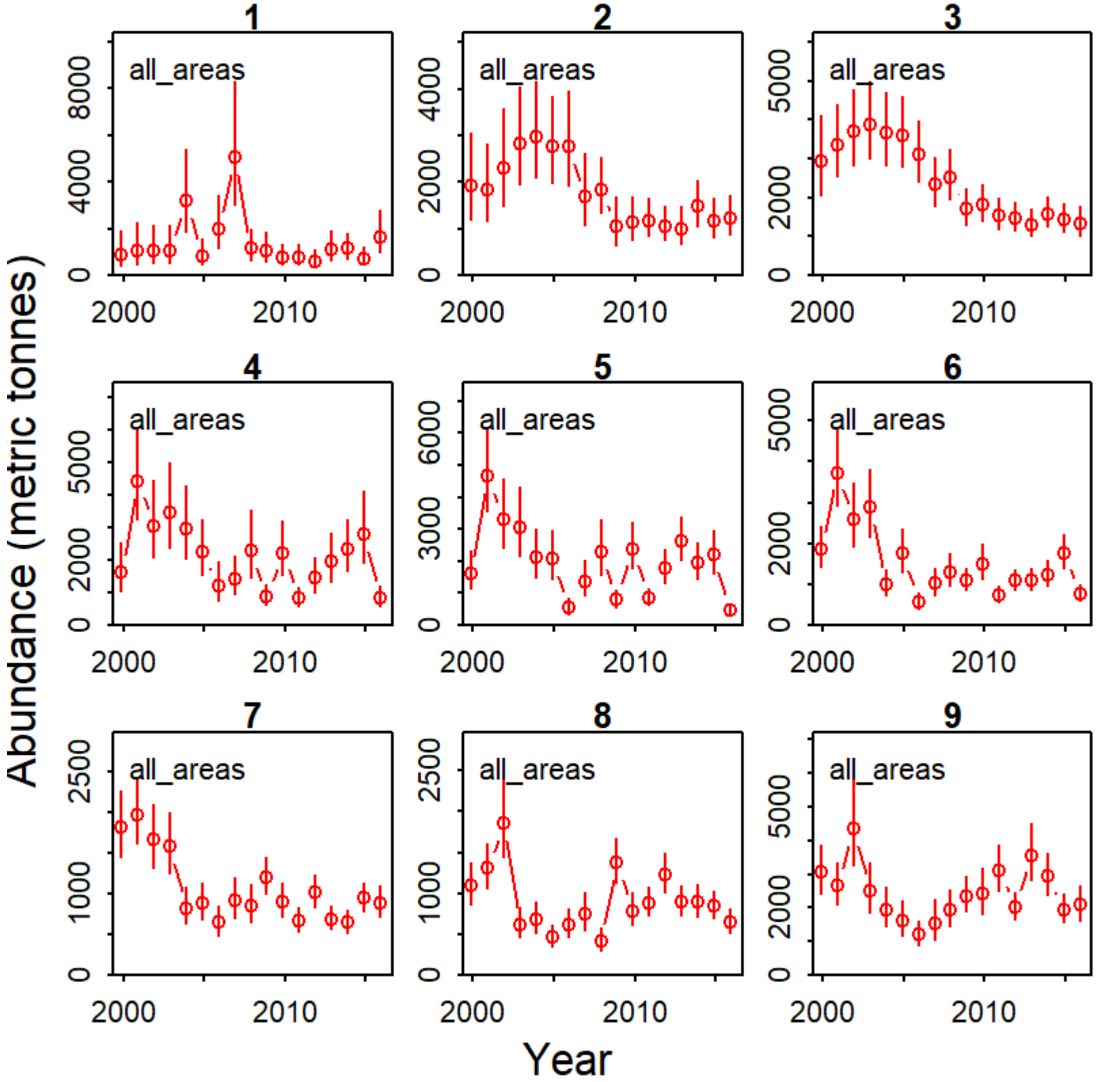
$$\text{logit}(p_i) = \beta_1(\text{c}_i, t_i) + \sum_{f=1}^{n_{\omega_1}} L_{\omega 1}(c_i, f)\omega_1(s_i, f) + \sum_{f=1}^{n_{\varepsilon_1}} L_{\varepsilon 1}(c_i, f)\varepsilon_1(s_i, t_i, f) + \cdots$$

$$\log(\lambda_i) = \beta_2(\text{c}_i, t_i) + \sum_{f=1}^{n_{\omega_2}} L_{\omega 2}(c_i, f)\omega_2(s_i, f) + \sum_{f=1}^{n_{\varepsilon_2}} L_{\varepsilon 2}(c_2, f)\varepsilon_2(s_i, t_i, f) + \cdots$$

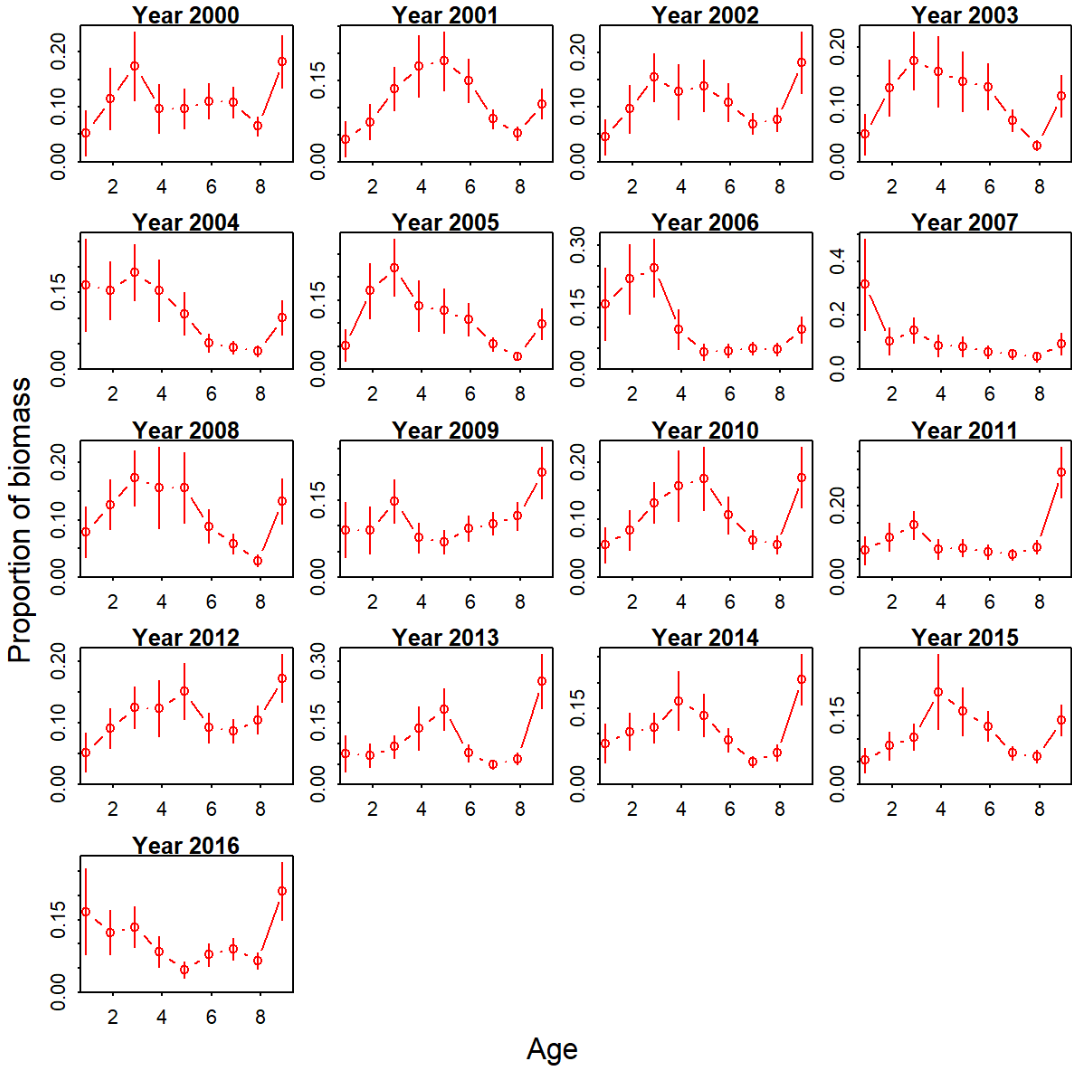
- c_i: length bin number (1-9)
- 2 factors (principle components) for the spatial (n_{ω_1} and n_{ω_2}) and spatiotemporal components (n_{ε_1} and n_{ε_2})

Results: index of abundance and length frequency

Index of abundance by length bin

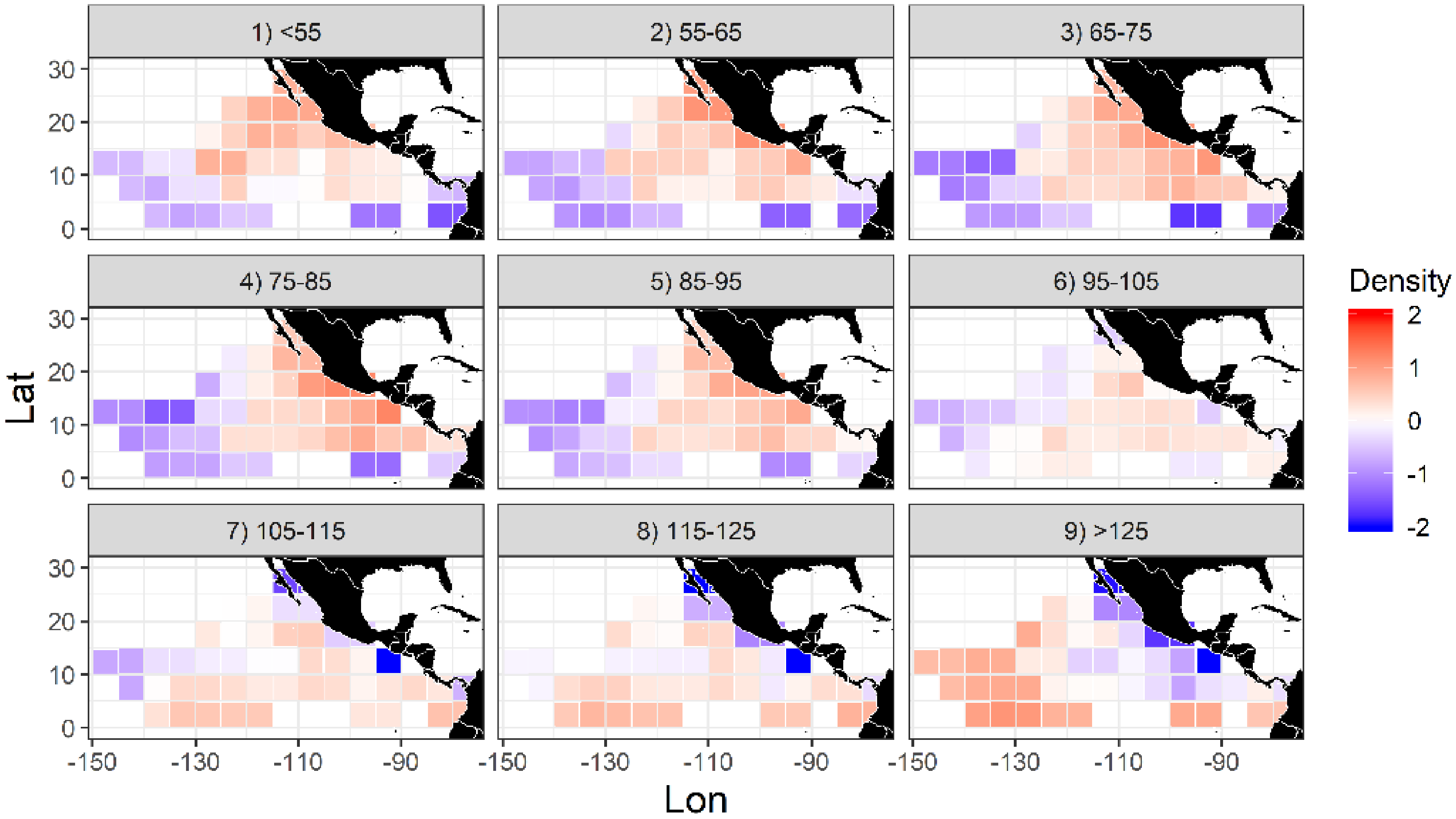


Length frequency by year

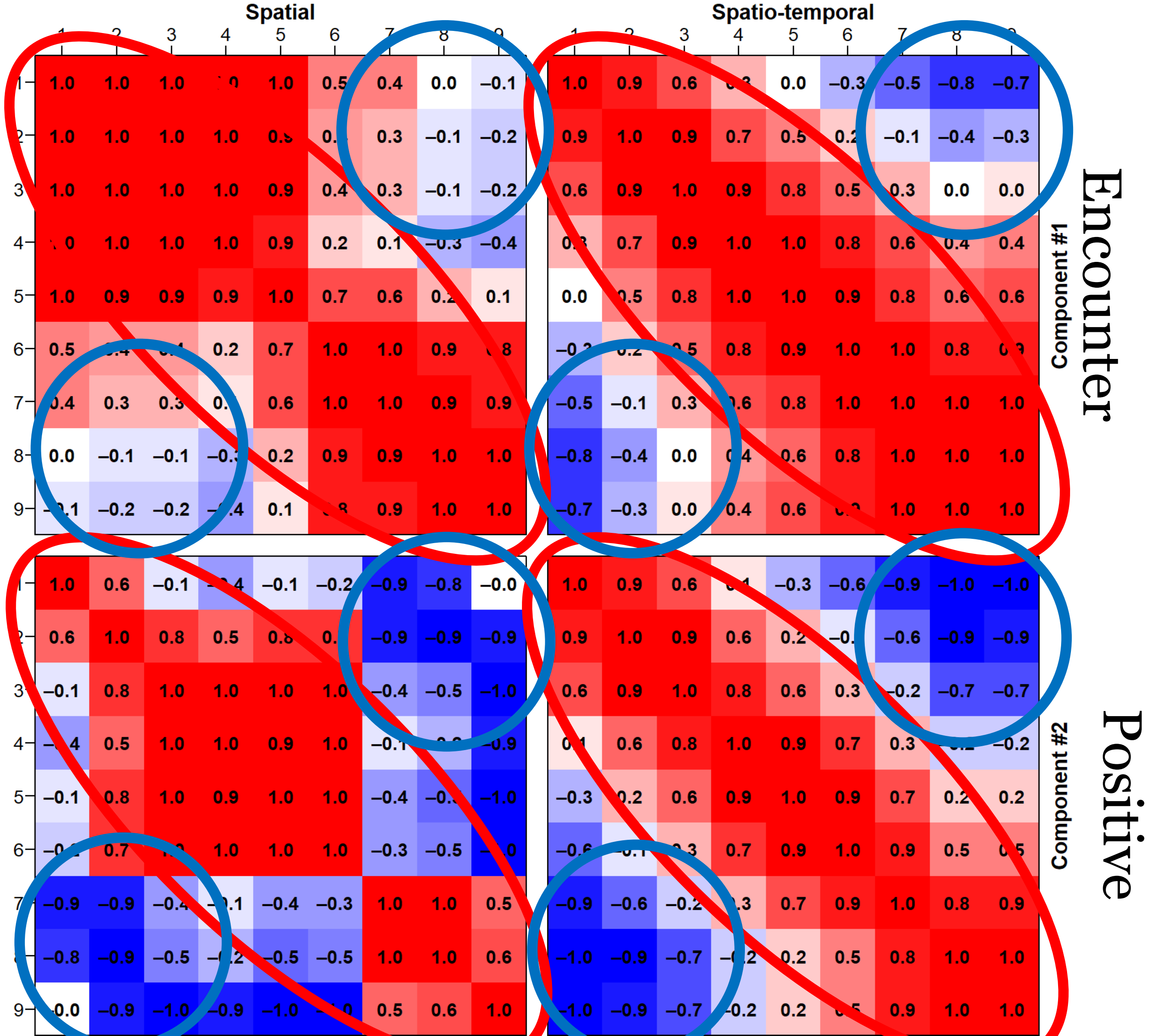


Results: mean log(density) by length bin

Spatial segregation by length



Results: correlation matrix informs segregation



Spatial segregation by size:

- positive correlations between adjacent length bins: density of adjacent length bins tends to change in the same direction
- negative correlations between distant length bins: density of distant length bins tends to change in the opposite direction

Case study: JPN LL fleet in A1

```
spp[which(Data_Geostat_raw$length<80)] <- 1
spp[which(Data_Geostat_raw$length>=80&Data_Geostat_raw$length<90)] <- 2
spp[which(Data_Geostat_raw$length>=90&Data_Geostat_raw$length<100)] <- 3
spp[which(Data_Geostat_raw$length>=100&Data_Geostat_raw$length<110)] <- 4
spp[which(Data_Geostat_raw$length>=110&Data_Geostat_raw$length<120)] <- 5
spp[which(Data_Geostat_raw$length>=120&Data_Geostat_raw$length<130)] <- 6
spp[which(Data_Geostat_raw$length>=130&Data_Geostat_raw$length<140)] <- 7
spp[which(Data_Geostat_raw$length>=140&Data_Geostat_raw$length<150)] <- 8
spp[which(Data_Geostat_raw$length>=150&Data_Geostat_raw$length<160)] <- 9
spp[which(Data_Geostat_raw$length>=160&Data_Geostat_raw$length<170)] <- 10
spp[which(Data_Geostat_raw$length>=170&Data_Geostat_raw$length<180)] <- 11
spp[which(Data_Geostat_raw$length>=180)] <- 12
```

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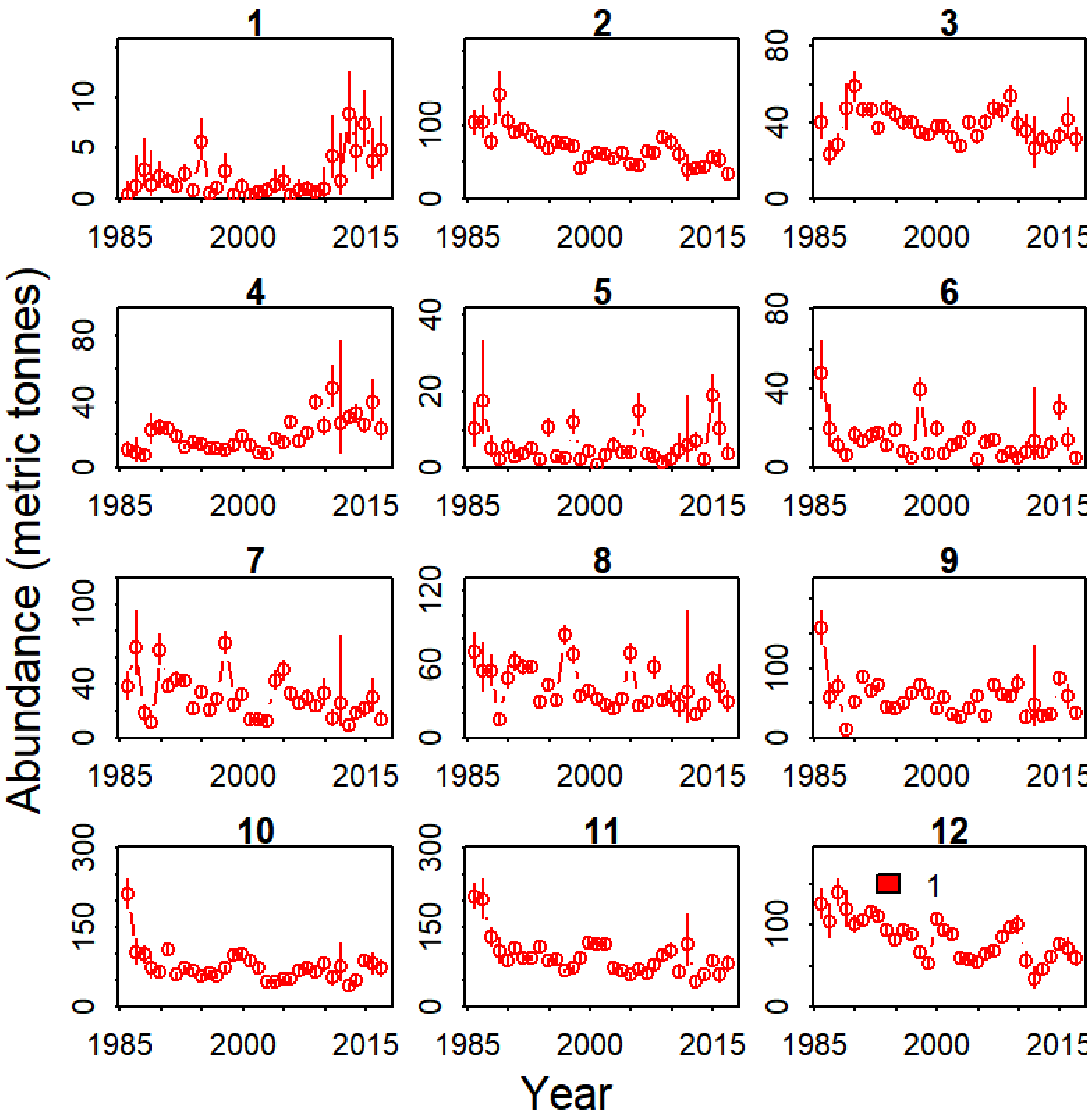
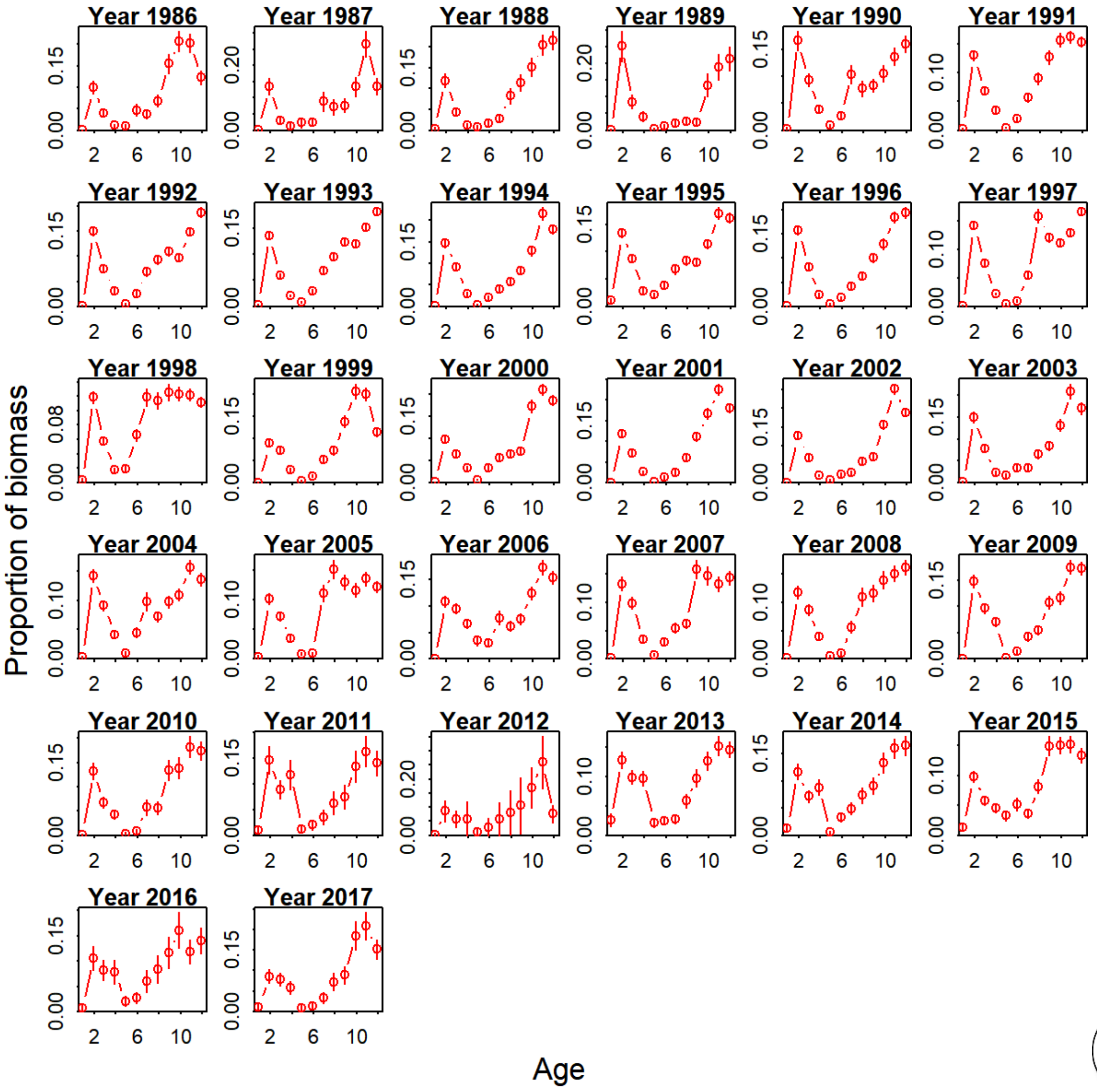
Case study: JPN LL fleet in A1

A brief look at the size catch rate data used in this analysis

Year	Month	Lat	Lon	Catch_Rate	hbf	L1	L2	…	…	L11	L12
1986	1	[redacted]	[redacted]	23.38166	13	0	0	0	0	0	9
1986	1	[redacted]	[redacted]	22.1202	12.5	0	0	0	0	0	7
1986	1	[redacted]	[redacted]	26.79236	13	0	0	0	0	5	20

Results: index of abundance and length frequency





Summary

The importance of spatiotemporal modelling using size-specific catch rate observations:

1. Provide size-specific index of abundance (CPUE + LF)
2. Estimate the spatiotemporal distribution for different life stages (e.g., juvenile vs. mature fish)
3. Evaluate the existance of spatial segregation by size

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Thank you!