Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

Longline index of abundance and length frequency for yellowfin tuna in the EPO

2nd External review of the stock assessment of yellowfin tuna in the EPO, La Jolla, California USA, 2-8 December 2019

Data

- **Index of abundance**
  Japanese catch and effort data:
  - $1°Lat * 1°Lon * year\_month * vessel$ (mean number of set = 2.5)
  - Commercial vessel only

- **Length frequency for the index of abundance**
  Japanese length frequency data:
  - $1°Lat * 1°Lon * year\_month$
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  - Length unit: 1 or 2 cm

Data

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Model Structure (Index of abundance)

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

$$\text{logit}(p_i) = \beta_1(t_i) + l_{\omega 1}\omega_1(s_i) + l_{\varepsilon 1}\varepsilon_1(s_i, t_i) + l_{\delta 1}\delta_1(v_i) + \sum_{k=1}^{n_k} q_1(k)Q(i,k)$$

$$\log(\lambda_i) = \beta_2(t_i) + l_{\omega 2}\omega_2(s_i) + l_{\varepsilon 2}\varepsilon_2(s_i, t_i) + l_{\delta 2}\delta_2(v_i) + \sum_{k=1}^{n_k} q_2(k)Q(i,k)$$

$\beta(t_i)$: intercept in year t_i
$\omega(s_i)$: spatial variation at location s_i; l_ω: scaling factor
$\varepsilon(s_i, t_i)$: spatiotemporal variation at location s_i in year t_i; l_ε: scaling factor
$\delta(v_i)$: vessel effects on catchability; l_δ: scaling factor
$Q(i,k)$: catchability covariate (HBF); $q(k)$: associated catchability parameter

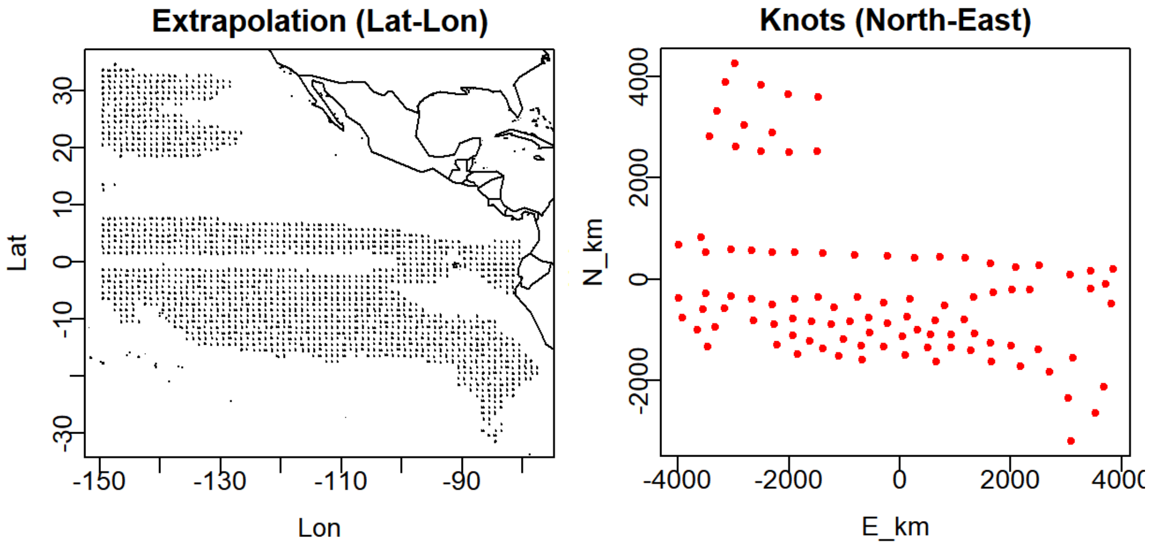
Model Structure (Index of abundance)

The probability of catch data c for sample i:

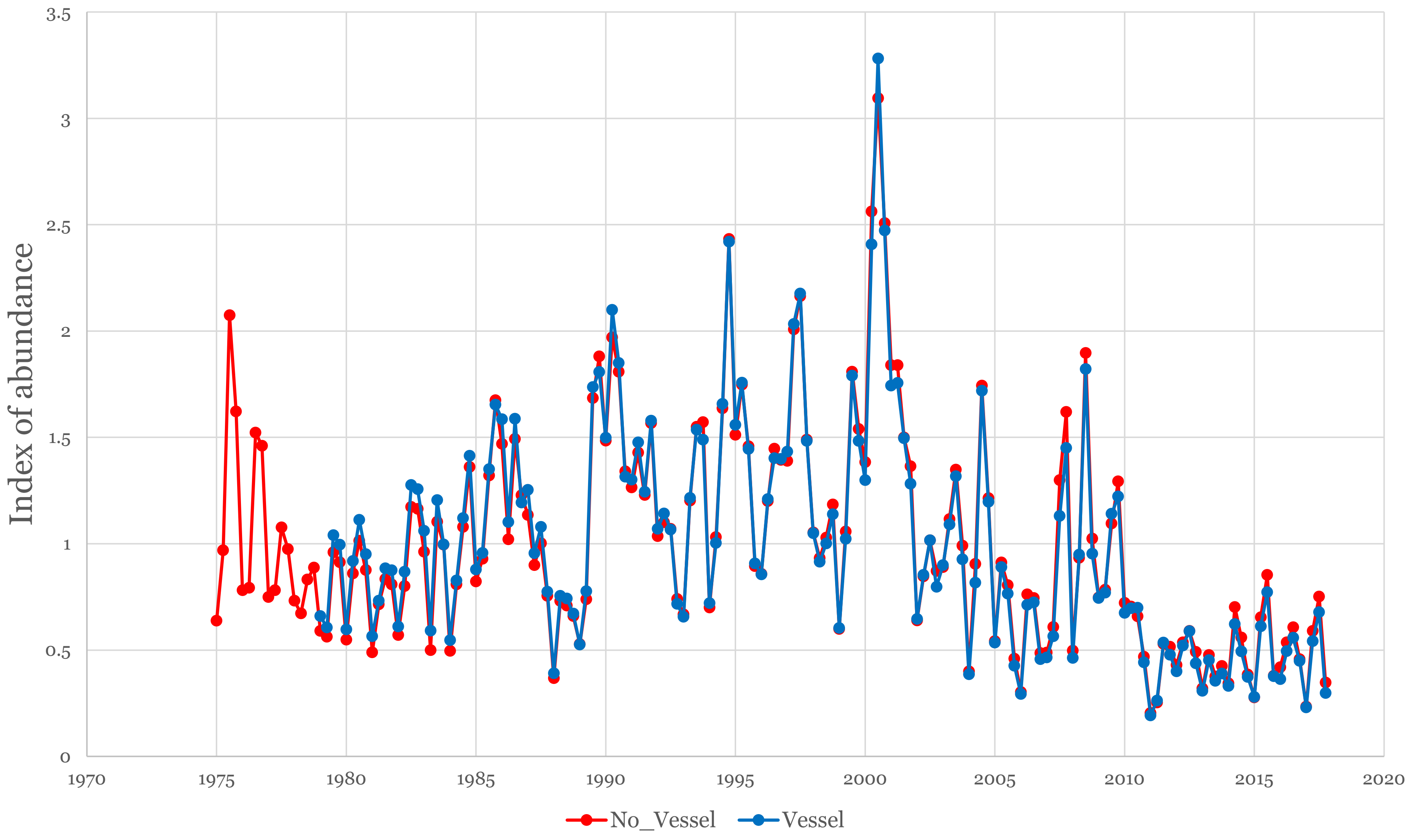
$$\Pr(c_i = c) = \begin{cases} 1 - p_i & \text{if c} = 0 \\ p_i \times \text{Lognormal}(c_i | \log(\lambda_i), \sigma_m^2) & \text{if c} > 0 \end{cases}$$

where $c_i = \frac{catch_i(in\ number)}{hook_i(in\ number)} * 1000$ (*separately model quarter 1&4 and 2&3*)

The standardized index is area-weighted: $I(t) = \sum_{k=1}^{100}(area(k) \times density(k,t))$



Vessel effects are ignored in the standardization process



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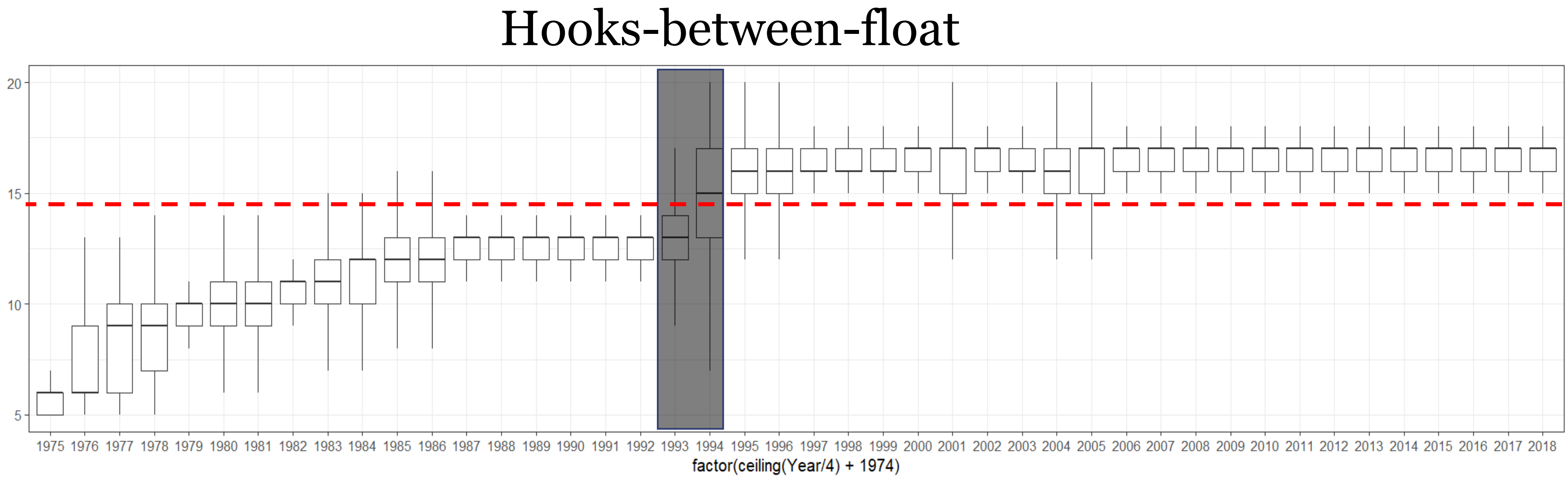
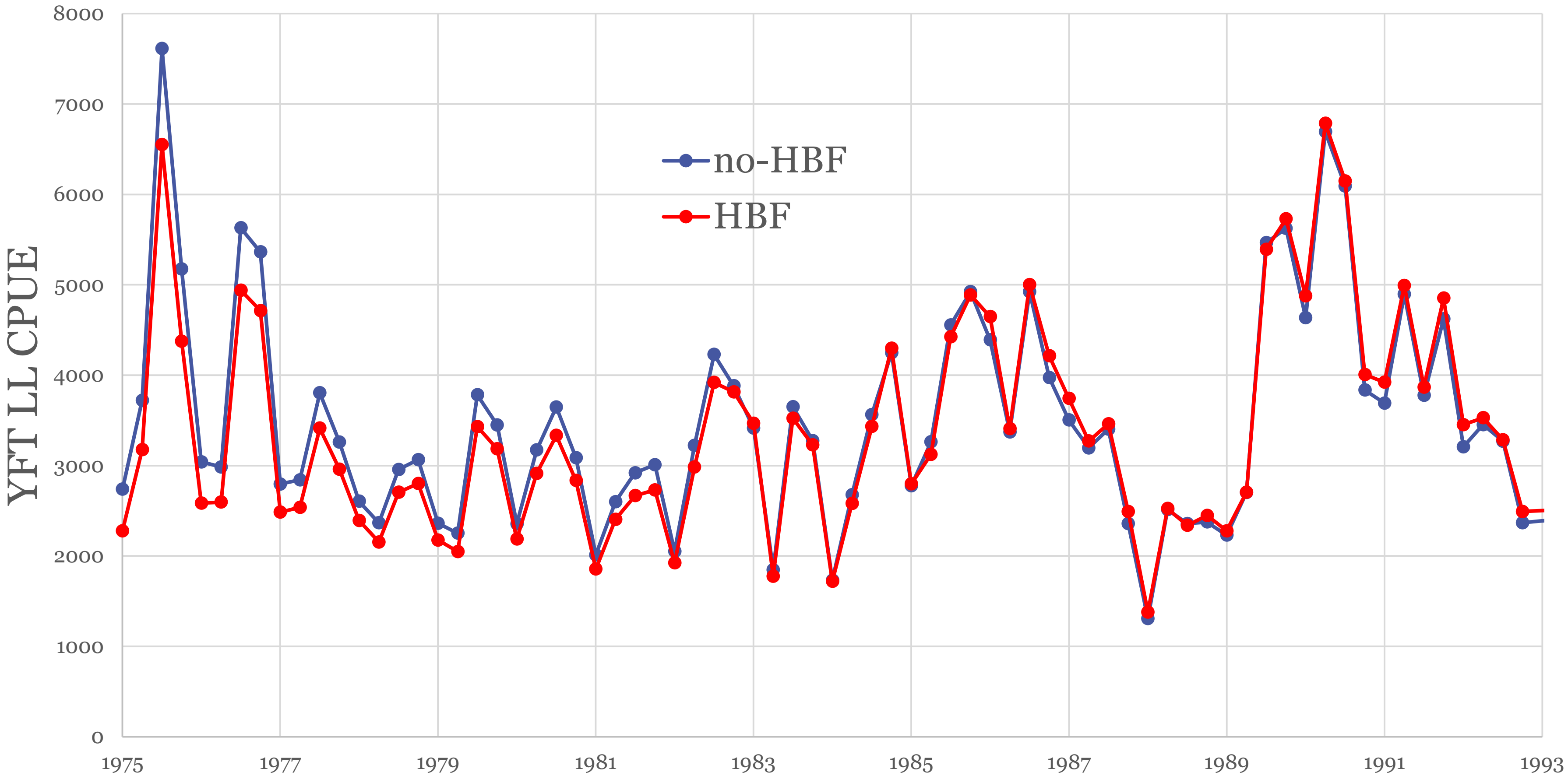
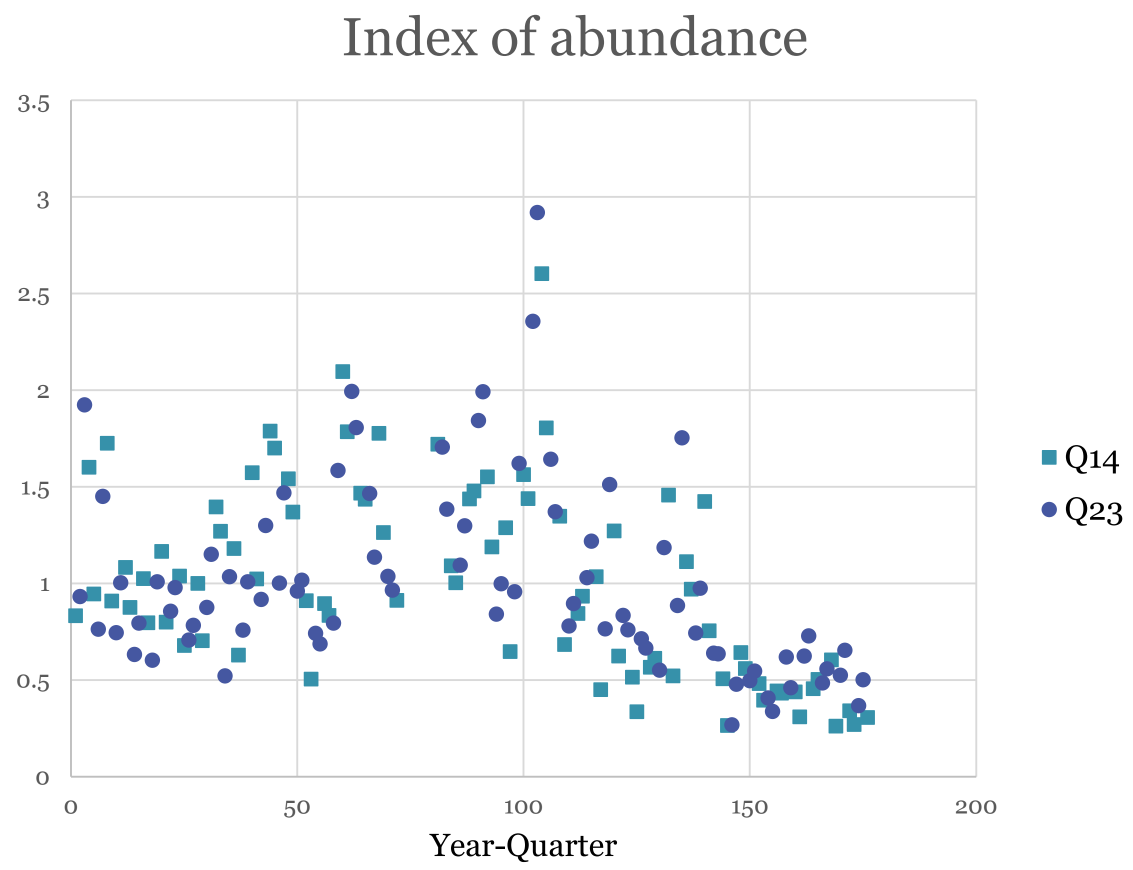
Temporal pattern of hooks between float

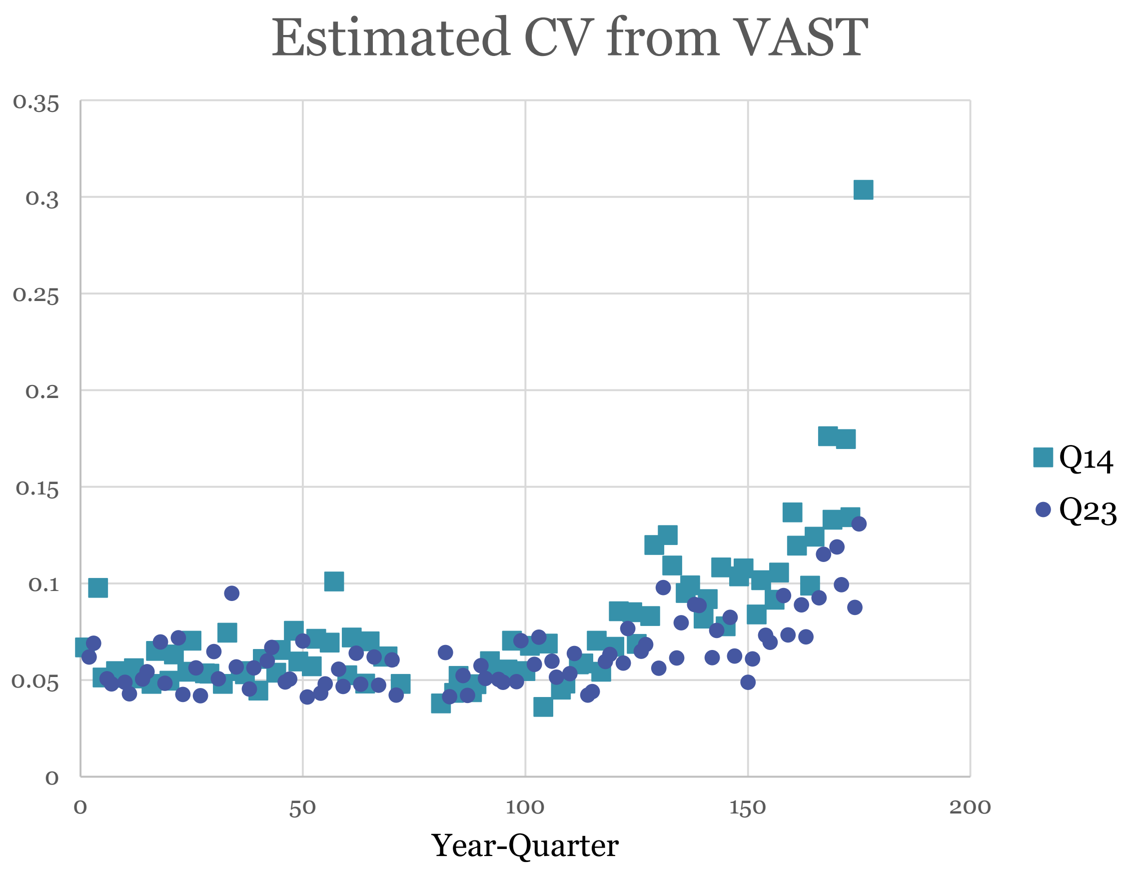


HBF effects is still important for the early period



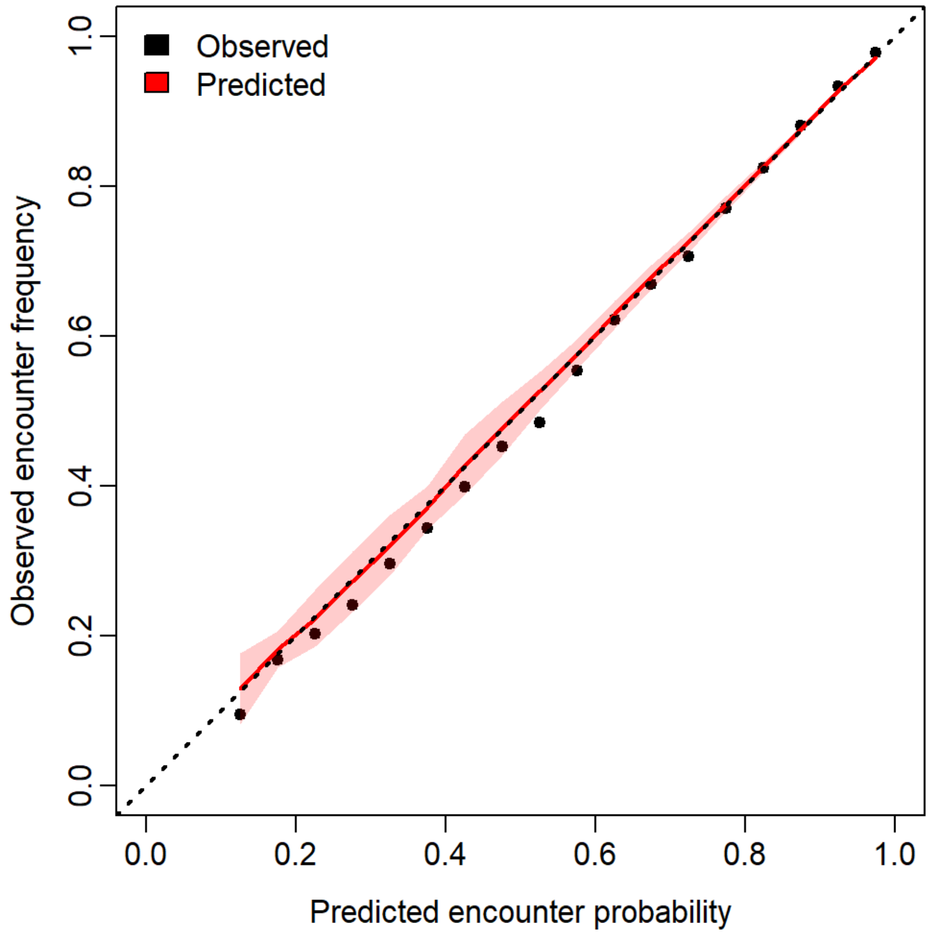
Should use time-varying CV



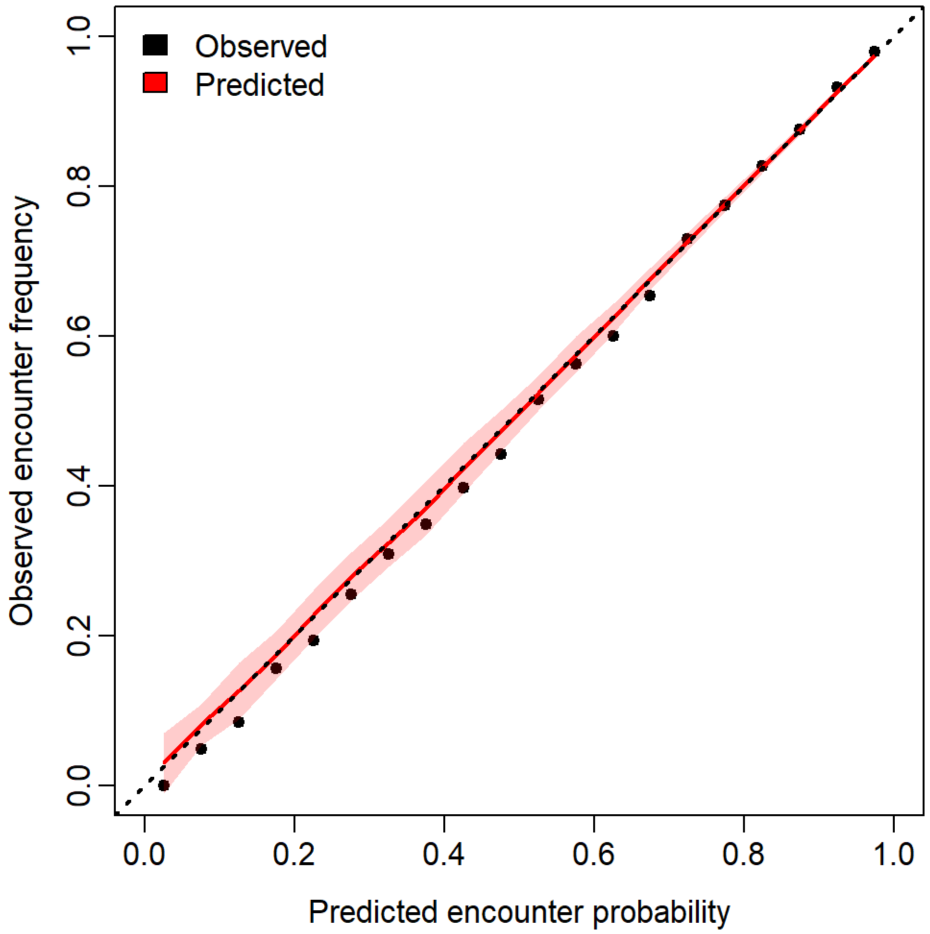


Diagnostics

Quarter 1&4

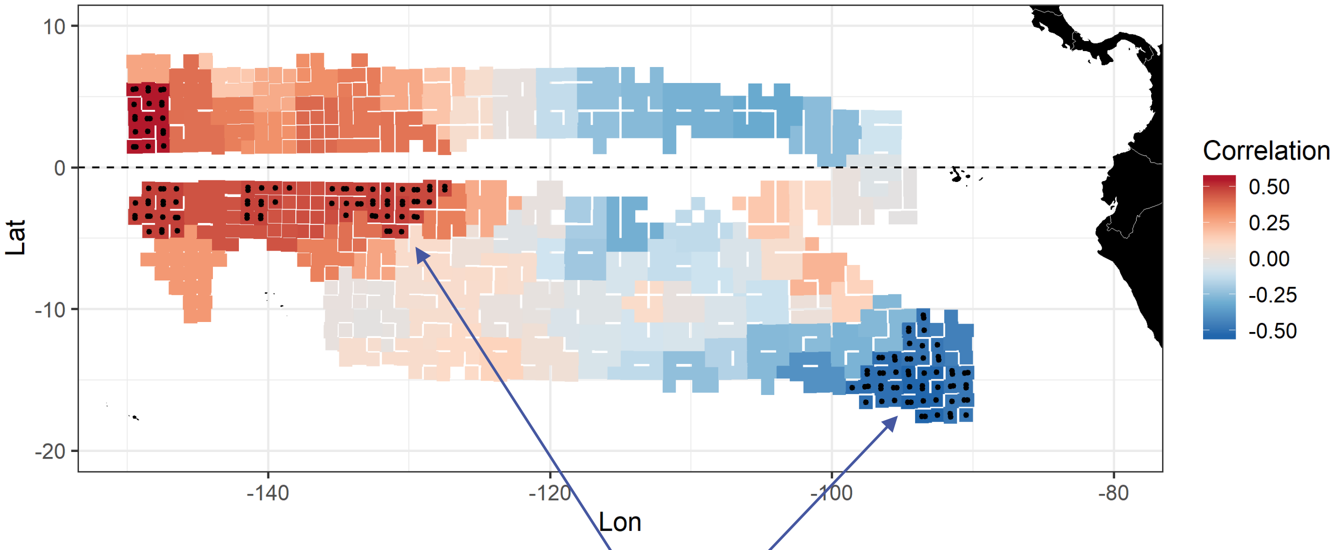


Quarter 2&3



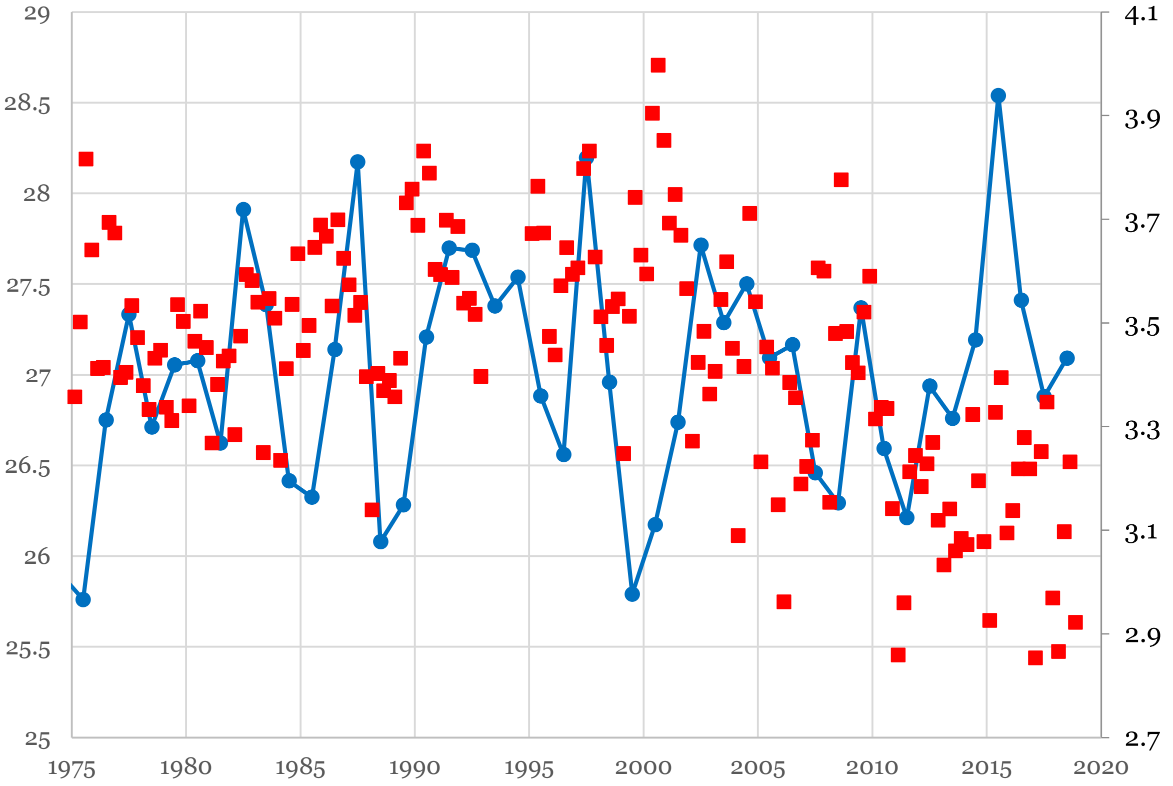
Correlation between the El Nino and LL catch rate

Movement or catchability or both?

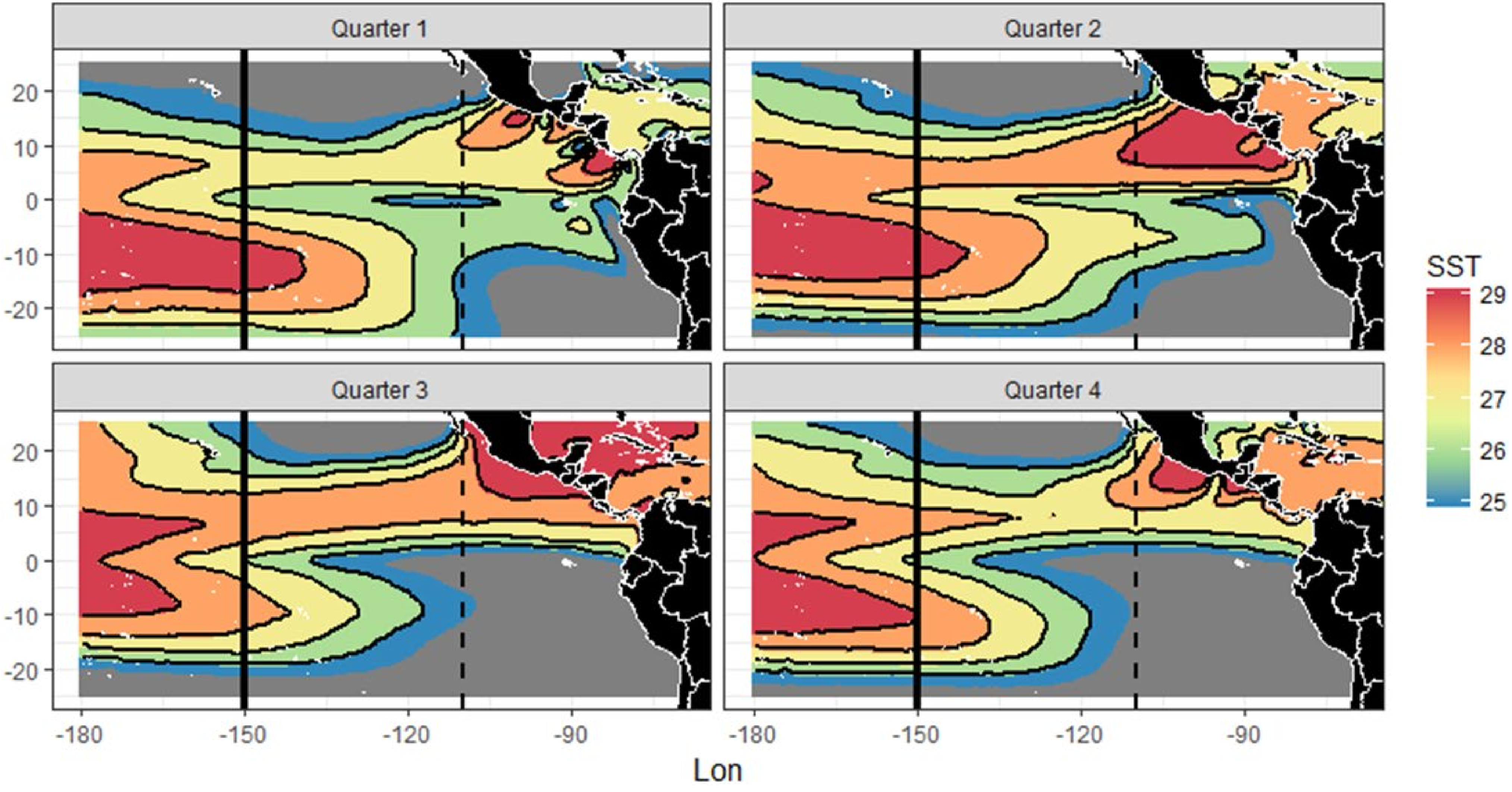


$p < 0.01$

El Nino vs. EPO LL index



SST by quarter



Data

- **Index of abundance**

  Japanese catch and effort data:
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  - Commercial vessel only

- **Length frequency for the index of abundance**

  Japanese length frequency data:
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  - Length unit: 1 or 2 cm

Model Structure (Length composition)

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

$$\text{logit}(p_i) = \beta_1(l_i, t_i) + \sigma_{\omega 1}(l_i)\omega_1(l_i, s_i) + \sigma_{\varepsilon 1}(l_i)\varepsilon_1(l_i, s_i, t_i)$$

$$\log(\lambda_i) = \beta_2(l_i, t_i) + \sigma_{\omega 2}(l_i)\omega_2(l_i, s_i) + \sigma_{\varepsilon 2}(l_i)\varepsilon_2(l_i, s_i, t_i)$$

$\beta(l_i, t_i)$: intercept for length l_i in year t_i
$\omega(l_i, s_i)$: spatial variation for length l_i at location s_i; $\sigma_\omega(l_i)$: scaling factor for length l_i
$\varepsilon(l_i, s_i, t_i)$: spatiotemporal variation for length l_i at location s_i in year t_i; $\sigma_\varepsilon(l_i)$: scaling factor for length l_i

*** No interaction among length bins (computationally too expensive)

Model Structure (Length composition)

The probability of catch data c for sample i:

$$\Pr(c_i = c) = \begin{cases} 1 - p_i & \text{if c} = 0 \\ p_i \times \text{Lognormal}(c_i \mid \log(\lambda_i), \sigma_m^2) & \text{if c} > 0 \end{cases}$$

where $c_i = \frac{catch_i(in\ number)}{hook_i(in\ number)} * 1000 * lf(l_i)$ --- CPUE by length (20, 24, 28, ... , 196)

The length-specific standardized index is area-weighted:

$$I(l,t) = \sum_{k=1}^{50} (area(k) \times density(l,k,t))$$

Standardized length composition:

$$P(l,t) = \frac{I(l,t)}{\sum_{l=1}^{n_l} I(l,t)}$$

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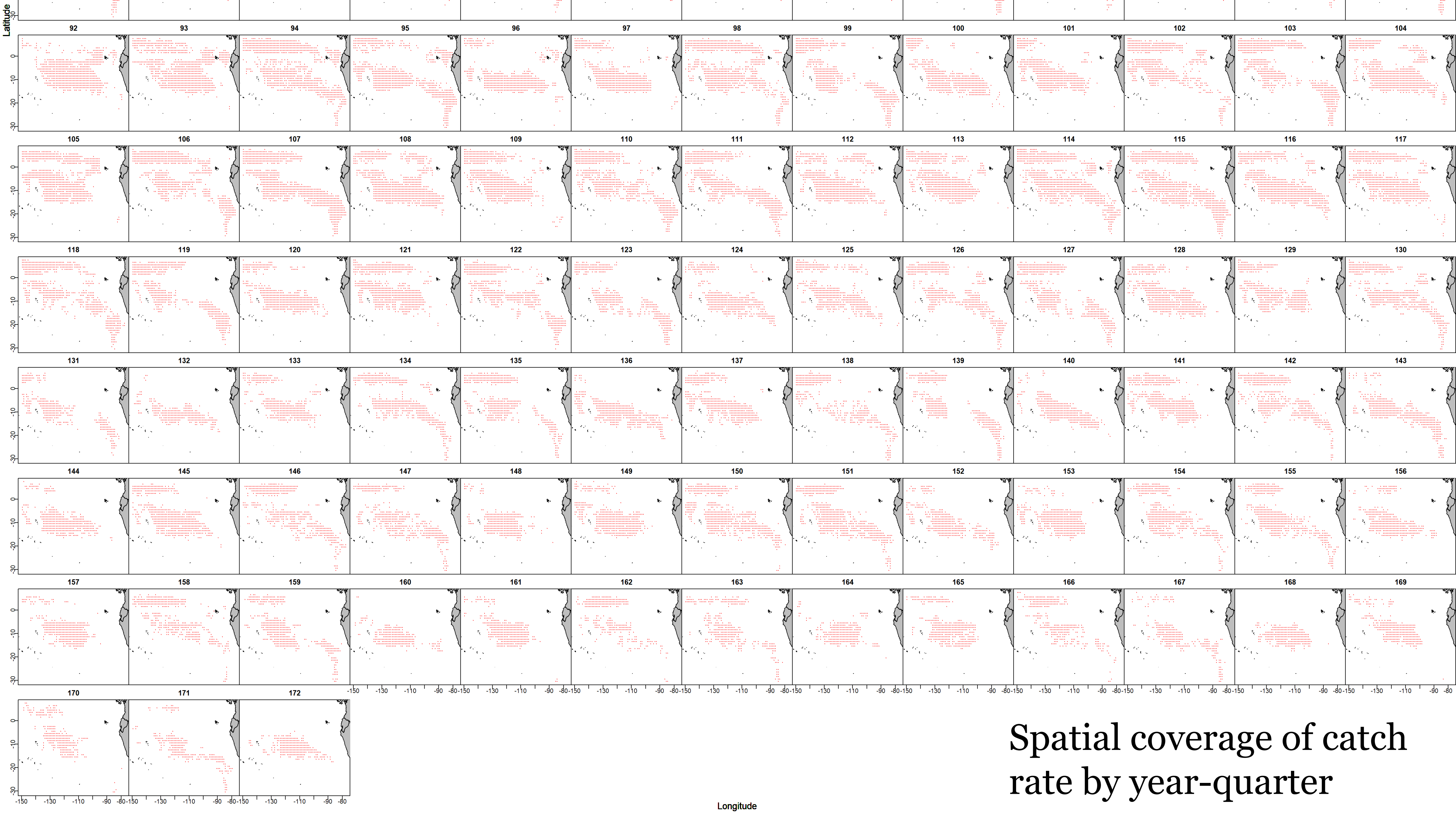
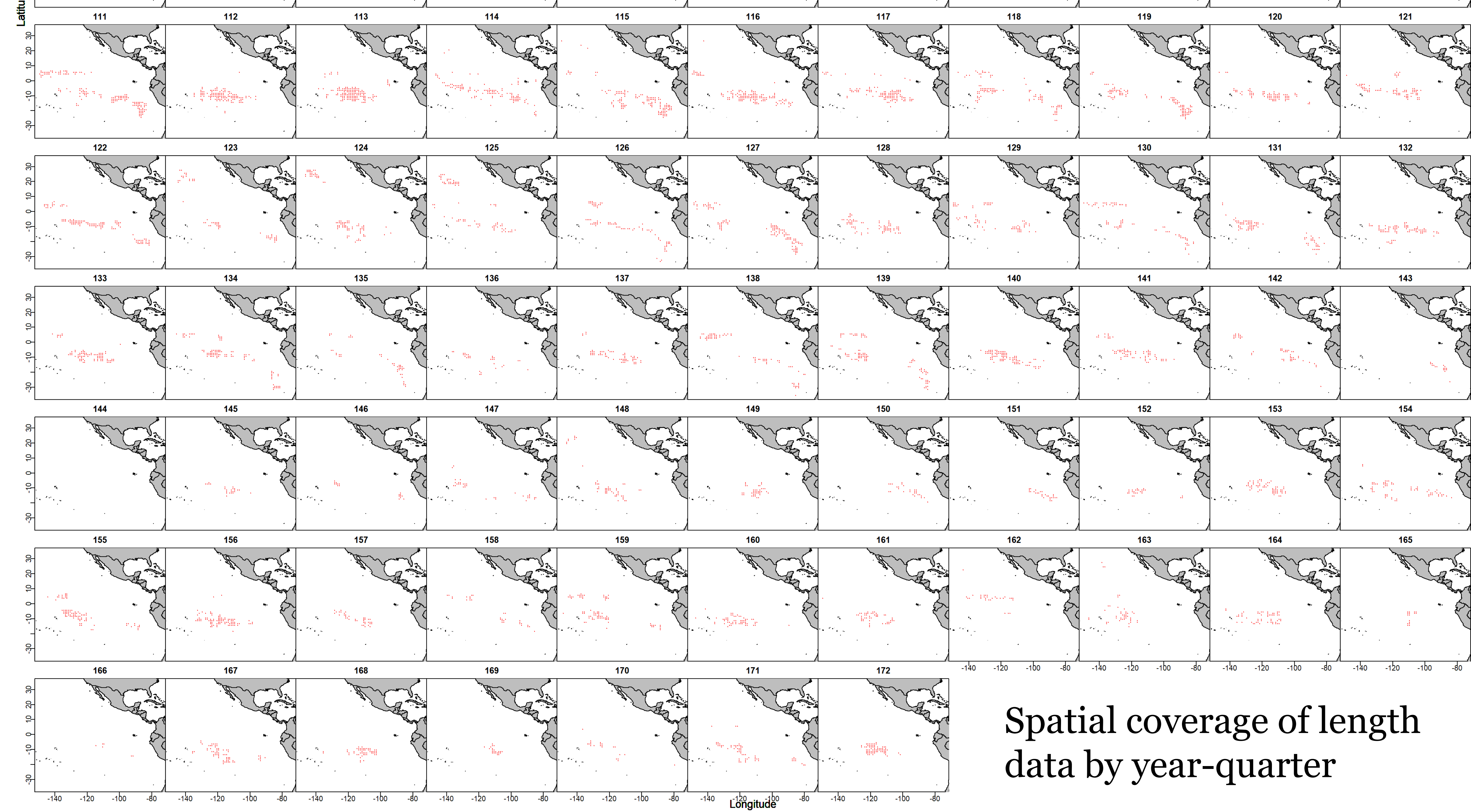


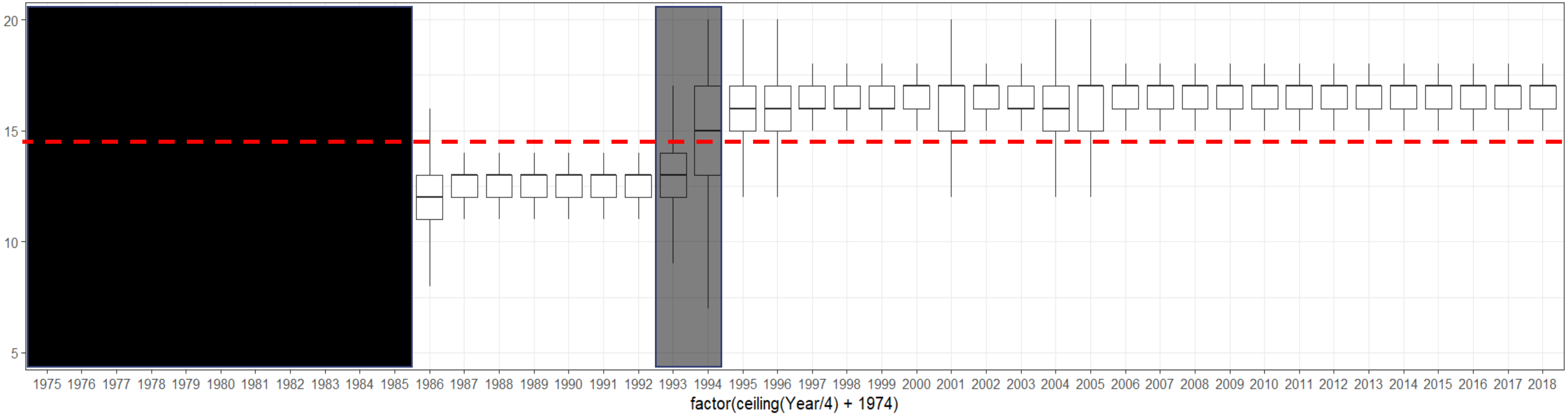
Spatial coverage of catch rate by year-quarter



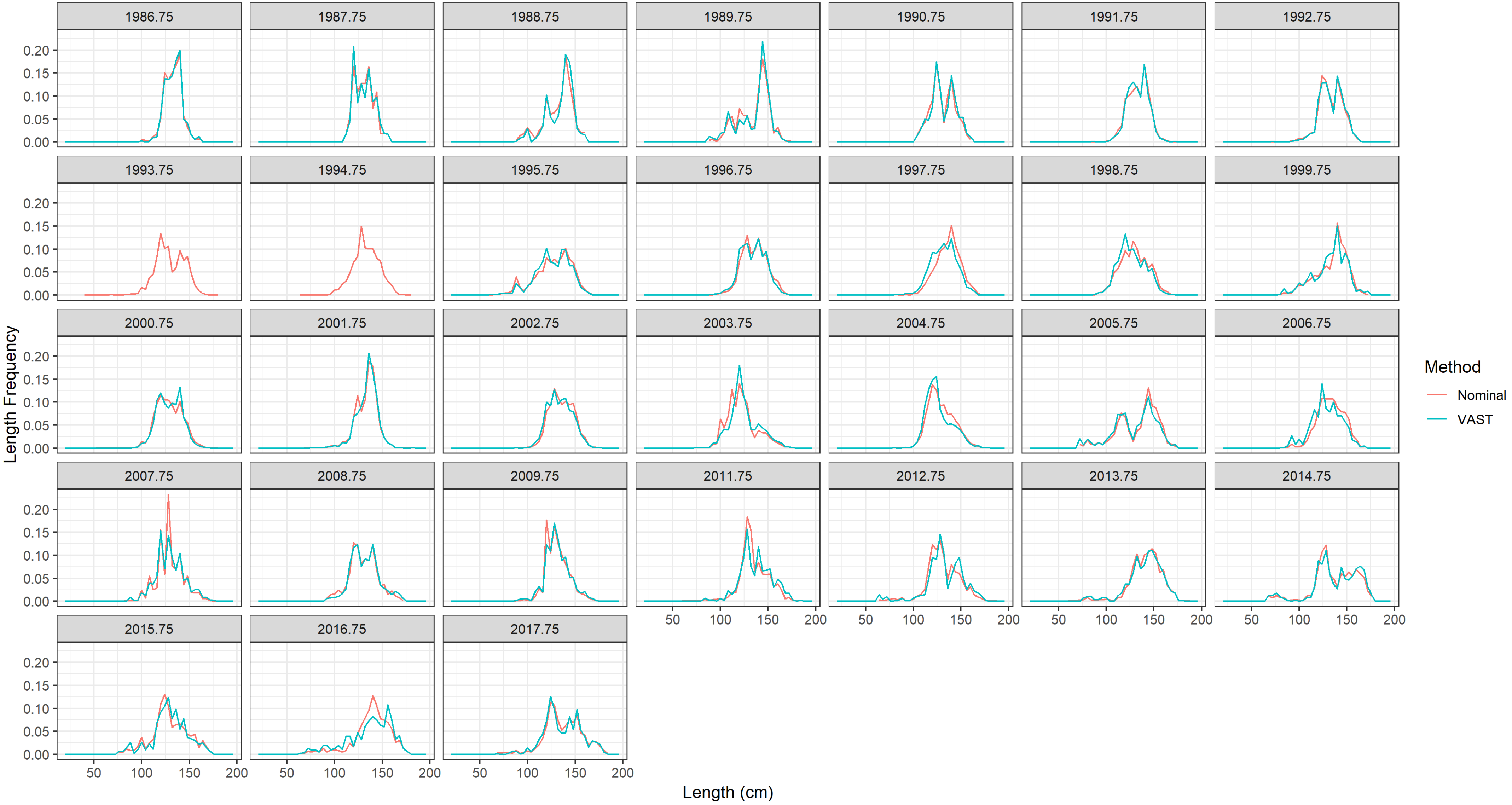
Spatial coverage of length data by year-quarter

HBF is not used in the length model

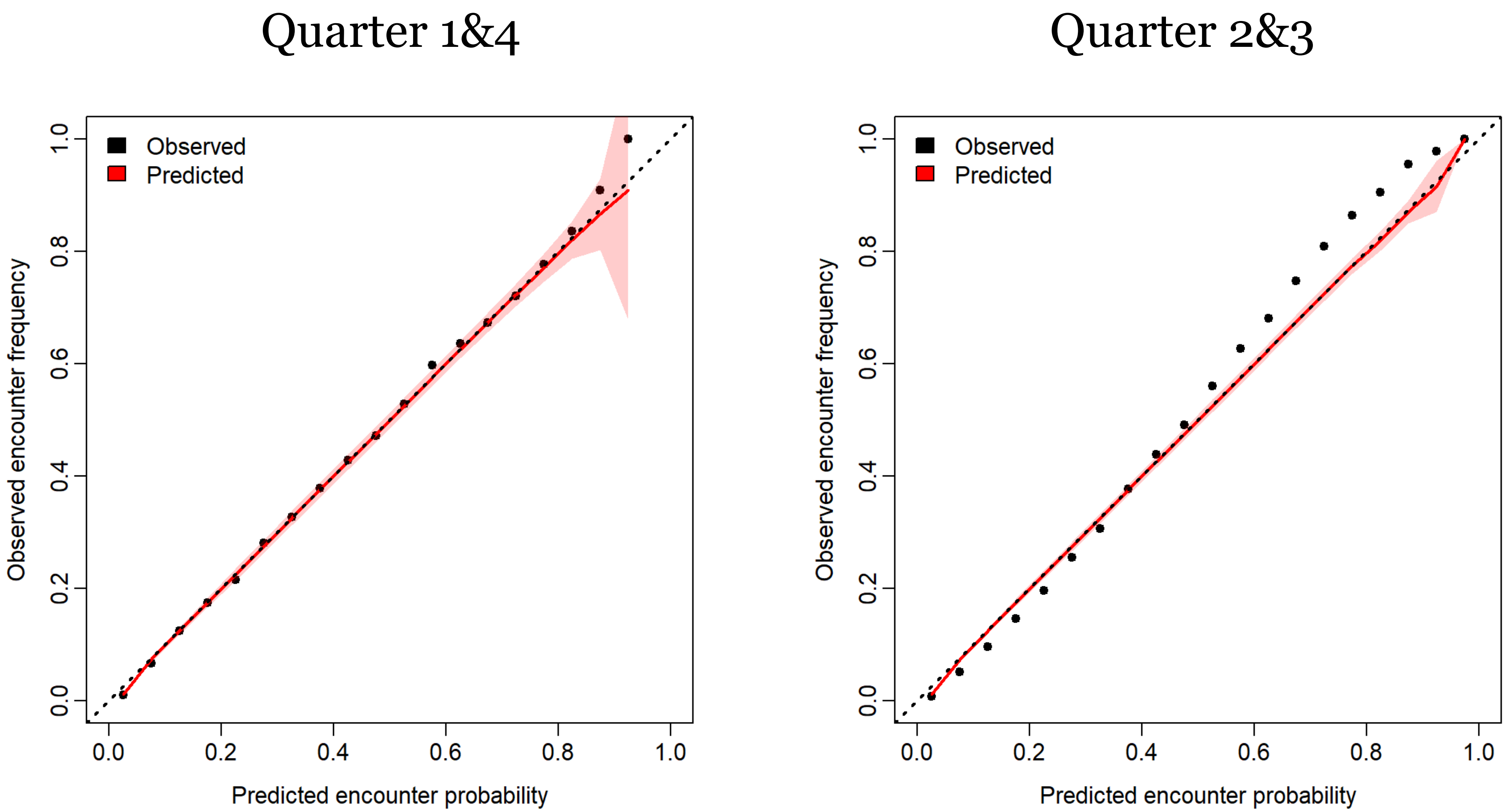
Hooks-between-float



Nominal vs. Standardized Length Composition



Diagnostics



Summary

Index of abundance

- Vessel effects are not included (vessel ID is available in 1975-1979)
- HBF is included as a catchability covariate
- 1993-4 are removed (fast transition in gear configurations)
- High CV in recent years due to the contraction of the JPN LL fishery

Length composition

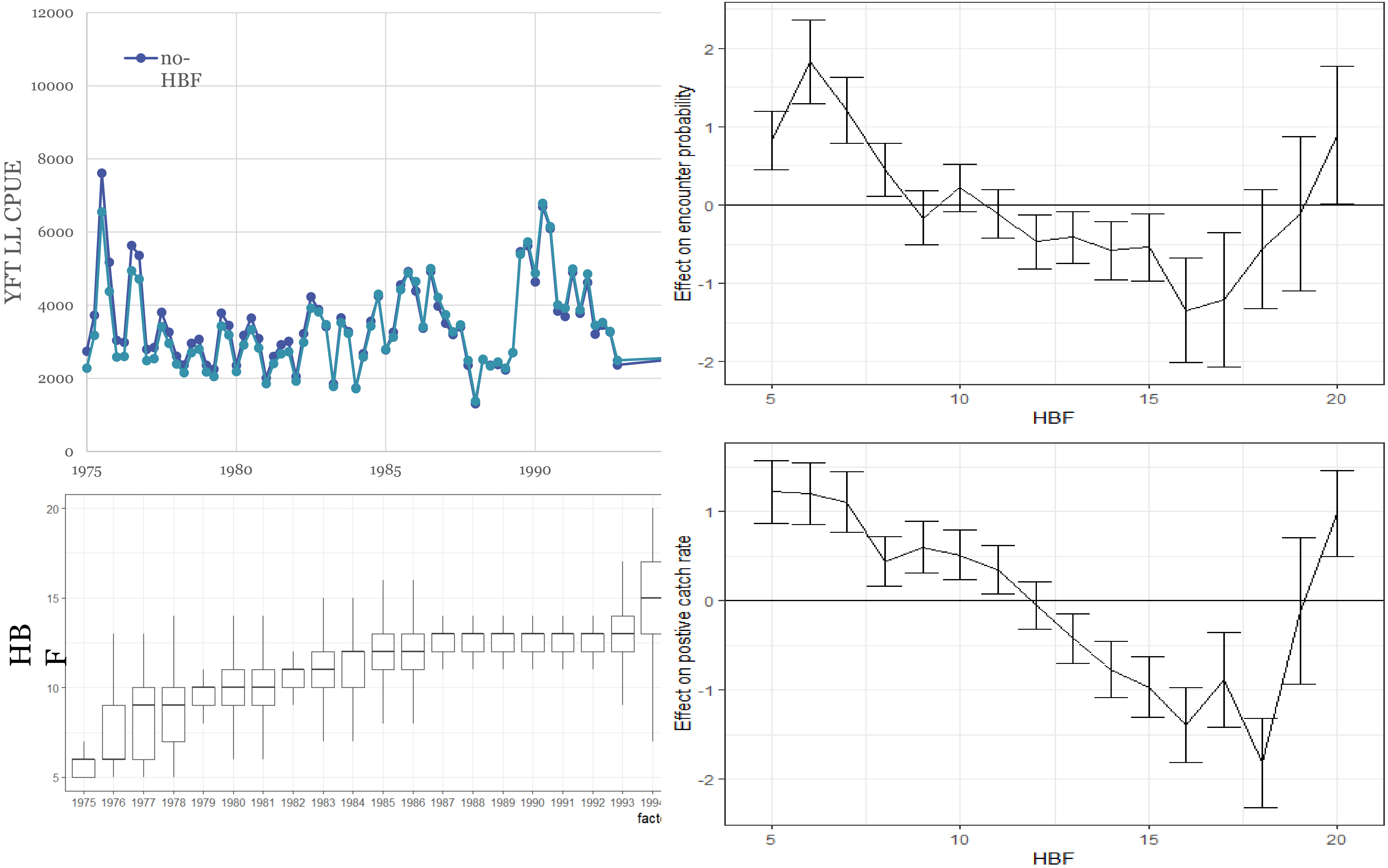
- HBF is not included as a catchability covariate
- 1993-4 are removed (fast transition in gear configurations)
- Time-consuming (~ 1.5 days for two quarters between 1995-2018)
- Reaching the population bin size (2cm) is not possible yet

Summary

Why using spatiotemporal model to standardize the index of abundance and the associated length composition?

- Spatial interpolation (filling the empty data holes)
- Area-weighting vs. sample weighting (EPO-wide index and lf)

Questions



YFT LL CPUE
no-HBF
12000
10000
8000
6000
4000
2000
0
1975
1980
1985
1990
HBF
20
15
10
5
1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994
fact
Effect on encounter probability
2
1
0
-1
-2
5
10
15
20
HBF
Effect on postive catch rate
1
0
-1
-2
5
10
15
20
HBF