Update on Standardization of Catch per Unit Effort

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Scallop Plan Team Meeting

Feb. 19, 2020

Kodiak, AK

Using Raw CPUE

- Guideline Harvest Levels (GHLs) are set by management district, based on interannual trends in fishery performance (CPUE)

- Key assumption: CPUE ∝ Abundance[1]

$$\frac{Catch_t}{Effort_t} = qN$$

- q represents catchability, or the proportion of the population caught with one unit of effort – **if q varies, we violate our key assumption**

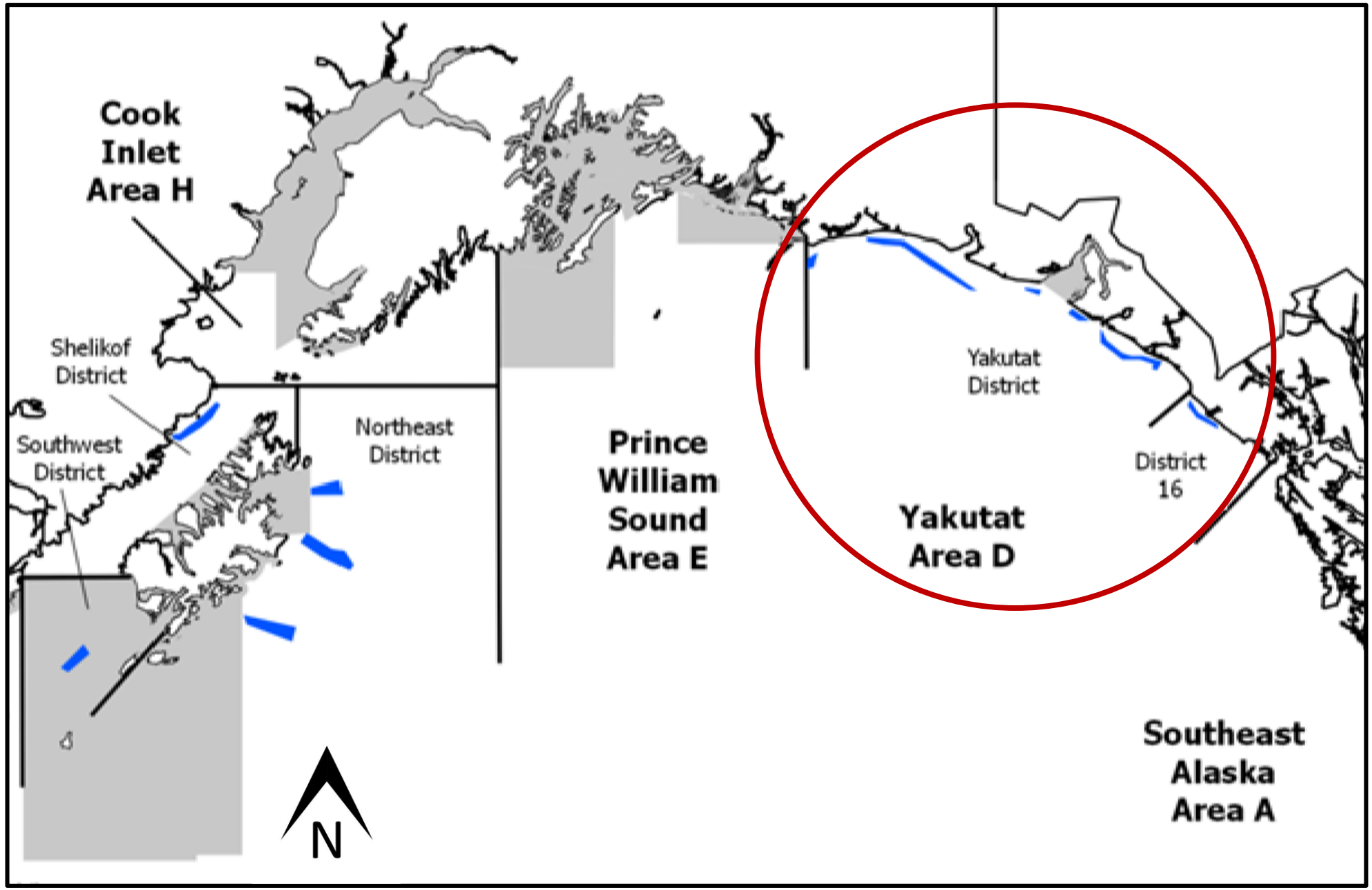
…and it most certainly does

[1]Maunder et al. (2006) *ICES Journal of Marine Science 63*

Standardizing CPUE

- Catchability varies by vessel crew efficiency, environmental variables, weather, gear performance, etc., *anything that changes the quality of effort and affects catch*

- Objective: Estimate trends in CPUE while controlling for factors that influence catch rate other than abundance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Area H
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Southwest
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Northeast
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William
Sound
Area E
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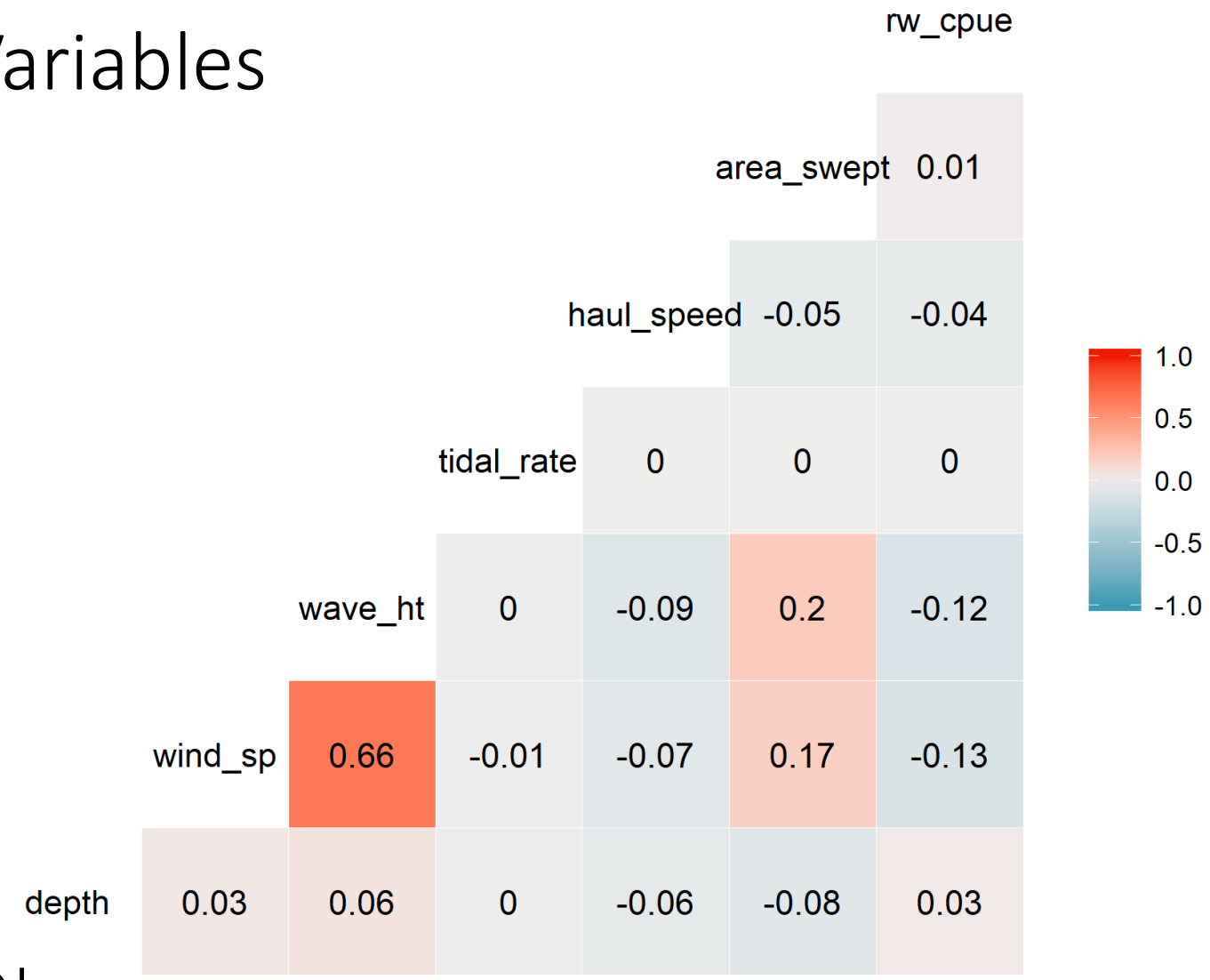
District
16
Yakutat
Area D
Southeast
Alaska
Area A
N

Available Explanatory Variables

- Logbook Data:
  - ***Year***
  - ***Month***
  - ***Vessel***
  - Haul speed (kts)
  - Area swept (nm^2)
  - Depth (fa)
  - Location (lat, lon) → ***Bed***
- Buoy Data:
  - Wave height (ft)
  - Wind speed (kt)
  - Tidal rate = $|s'(water\ level)|$



Discrete variable

Continuous variable

Model Parameterization

Full Model (m_0):

$$(cpue + \gamma) = f_1(depth \cdot Bed) + f_2(wave\ height) + f_3(wind\ speed) + f_4(haul\ speed) + f_5(tidal\ rate) + f_6(location \cdot Bed)\ \varepsilon + \text{Year:Bed} + \text{Year} + \text{Bed} + \text{Month} + \text{Vessel} + \varepsilon$$

Adjustment so CPUE > 0

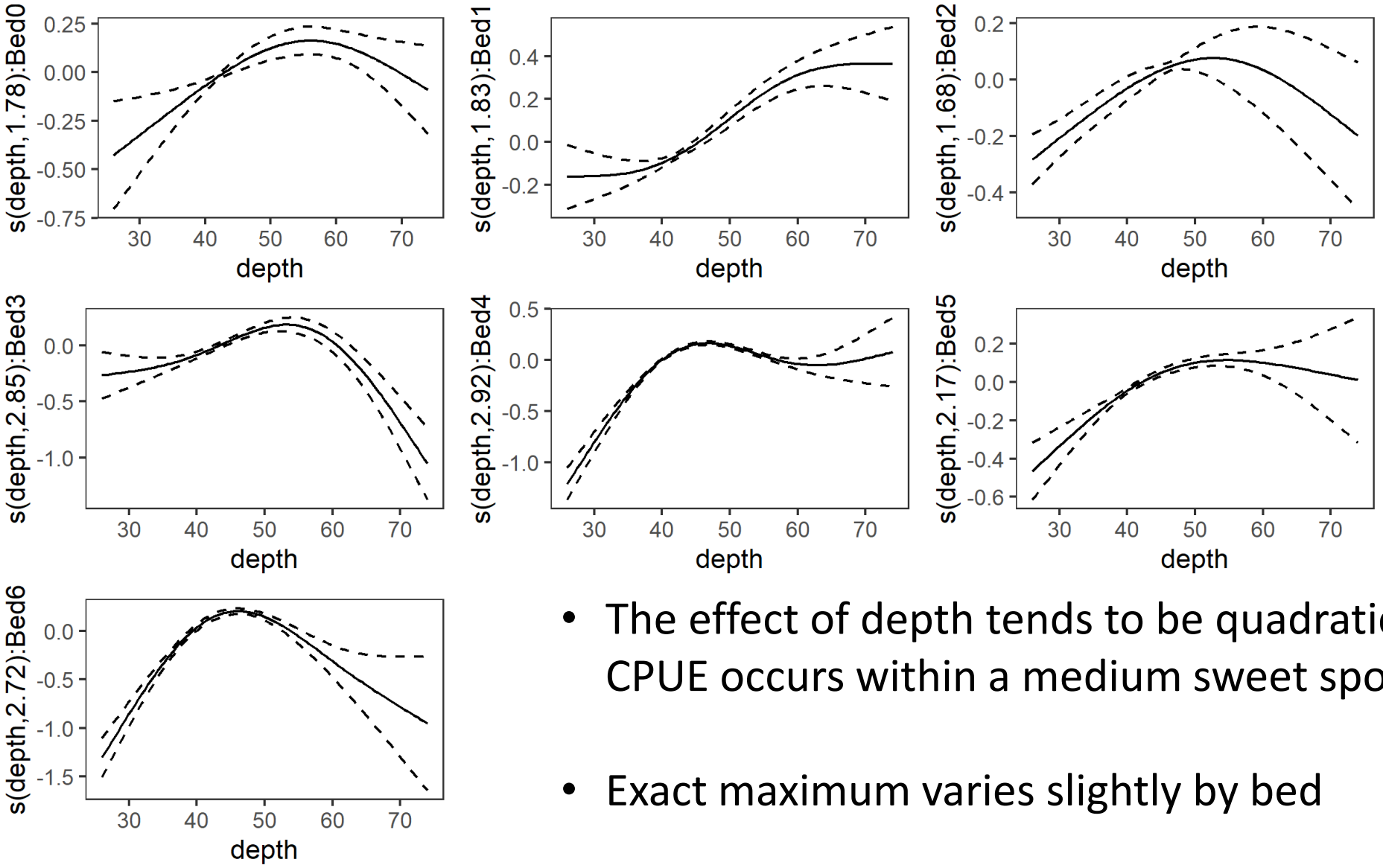
tensor product of lat, lon

Evaluated as a fixed effect and random effect

Response distribution:

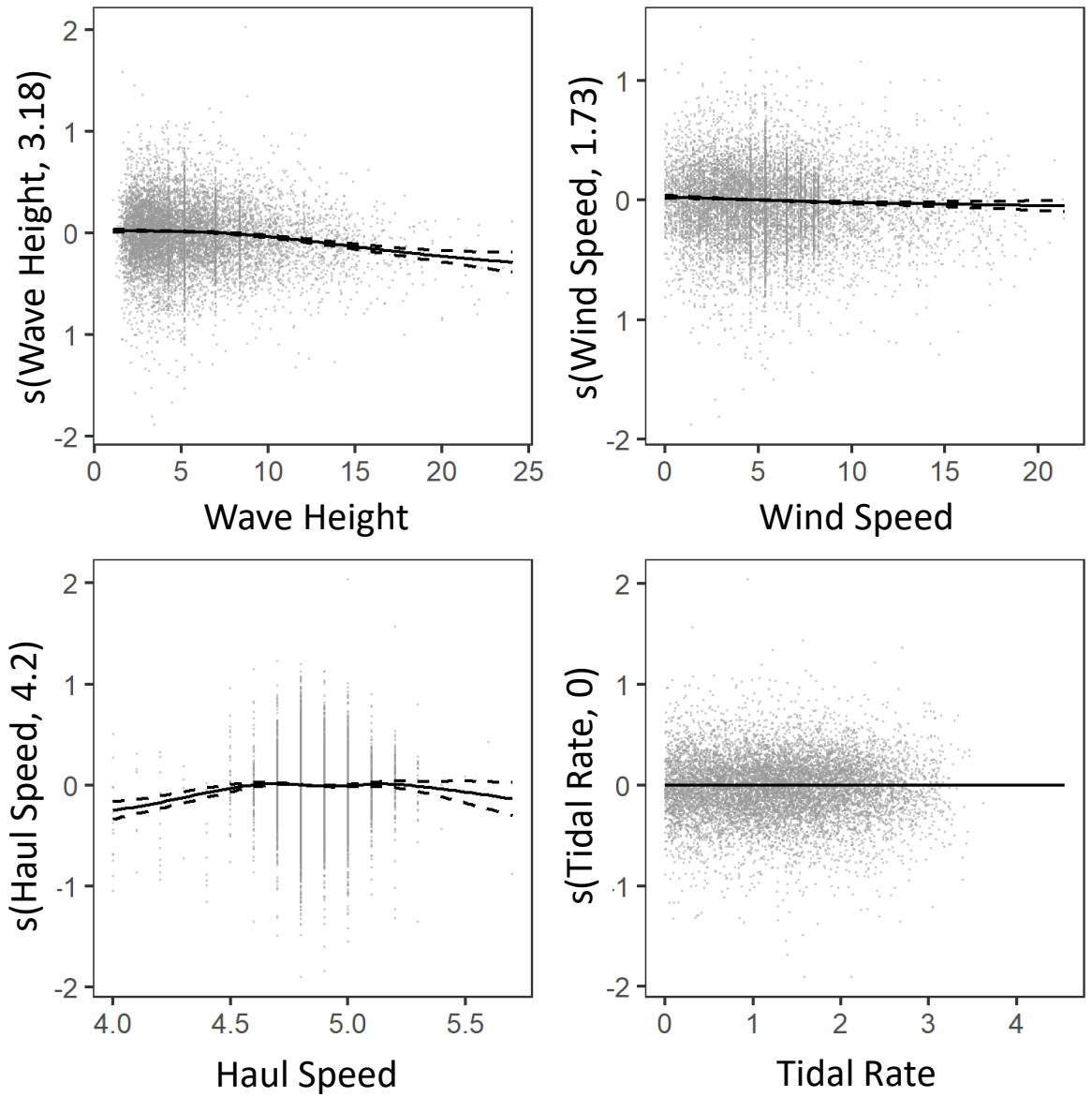
- Gamma, $\varepsilon \sim \Gamma(\alpha, \beta)$, log-link
- Lognormal, $\ln(\varepsilon) \sim N(0, \sigma^2)$

Covariate Selection



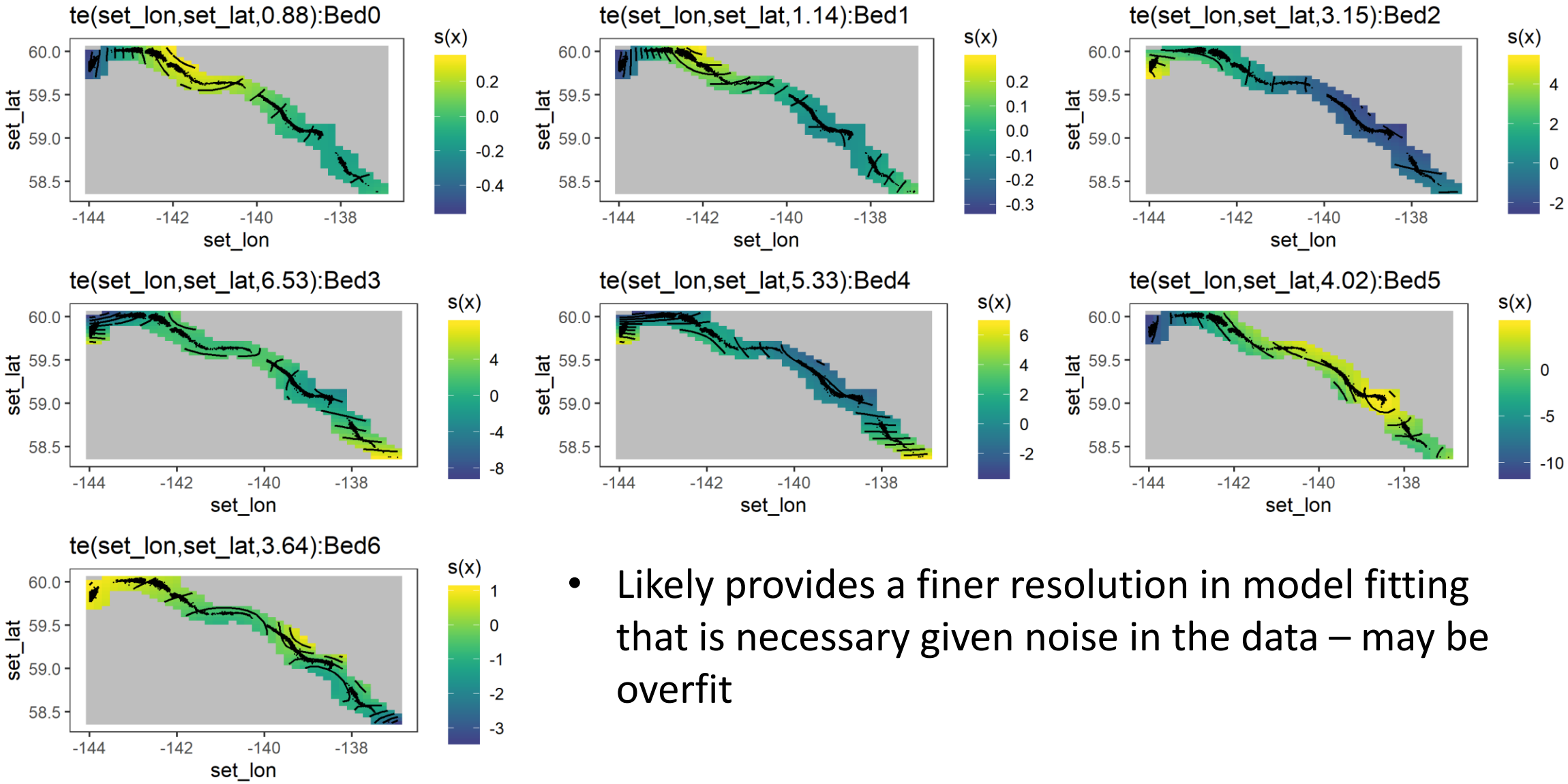
- The effect of depth tends to be quadratic – best CPUE occurs within a medium sweet spot
- Exact maximum varies slightly by bed

Covariate Selection



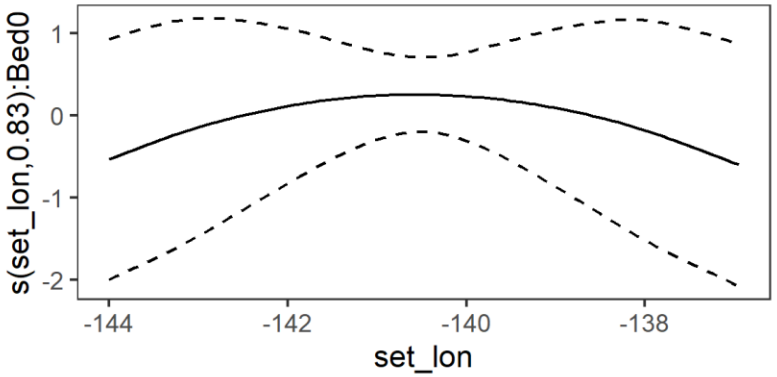
- No need to include tidal rate
- Wind speed and haul speed, can likely also be dropped, model fitting to noise and outliers
- Wave height may be informative, though data in close proximity may not be available for all districts

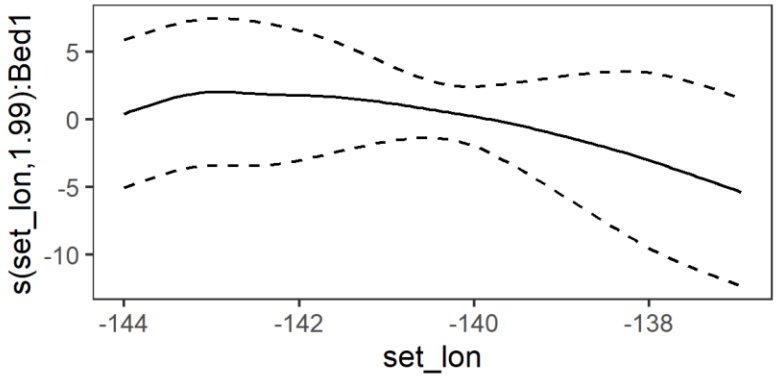
Covariate Selection

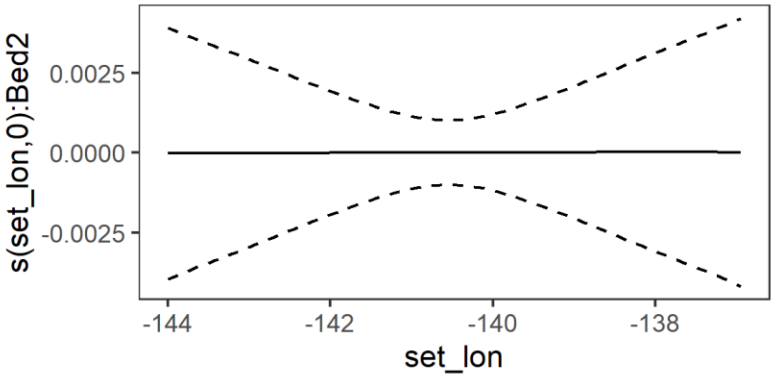


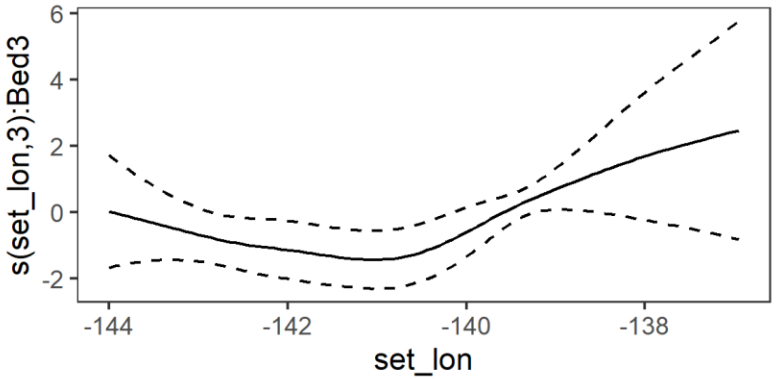
- Likely provides a finer resolution in model fitting that is necessary given noise in the data – may be overfit

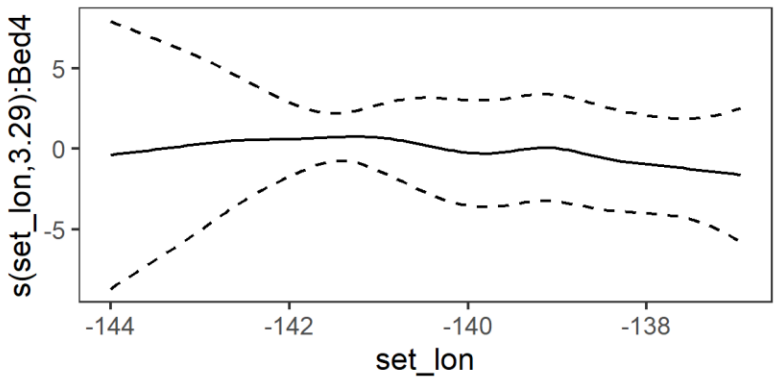
Covariate Selection

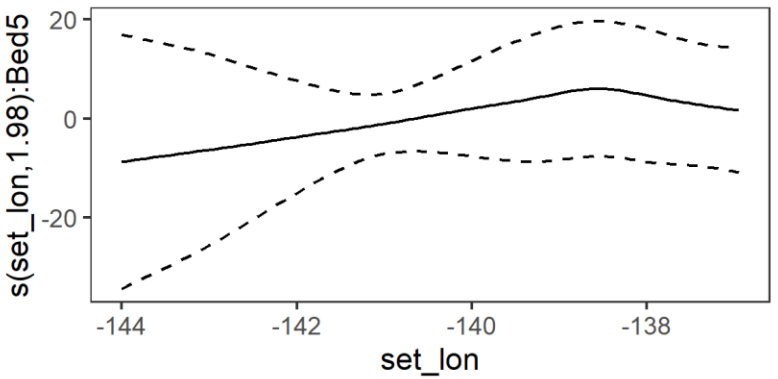


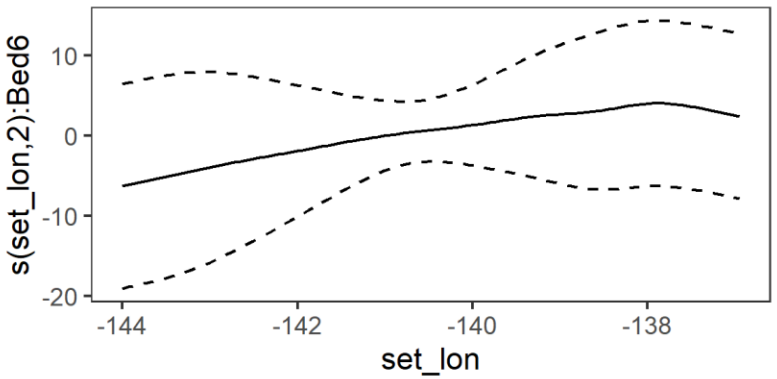












- Location within bed, can be described in most districts by longitude and depth, exceptions:
  - Bering Sea
  - Kodiak Northeast

Covariate Selection

Reduced model (1):

$$(cpue + \gamma) = f_1(depth \cdot Bed) + f_2(wave\ height) + f_6(longitude \cdot Bed\ ) +$$

$$\text{Month + Vessel + Bed + Year + Year:Bed} + \varepsilon$$

Reduced model (2): ~ Reduced model (1) - $f(wave\ height)$

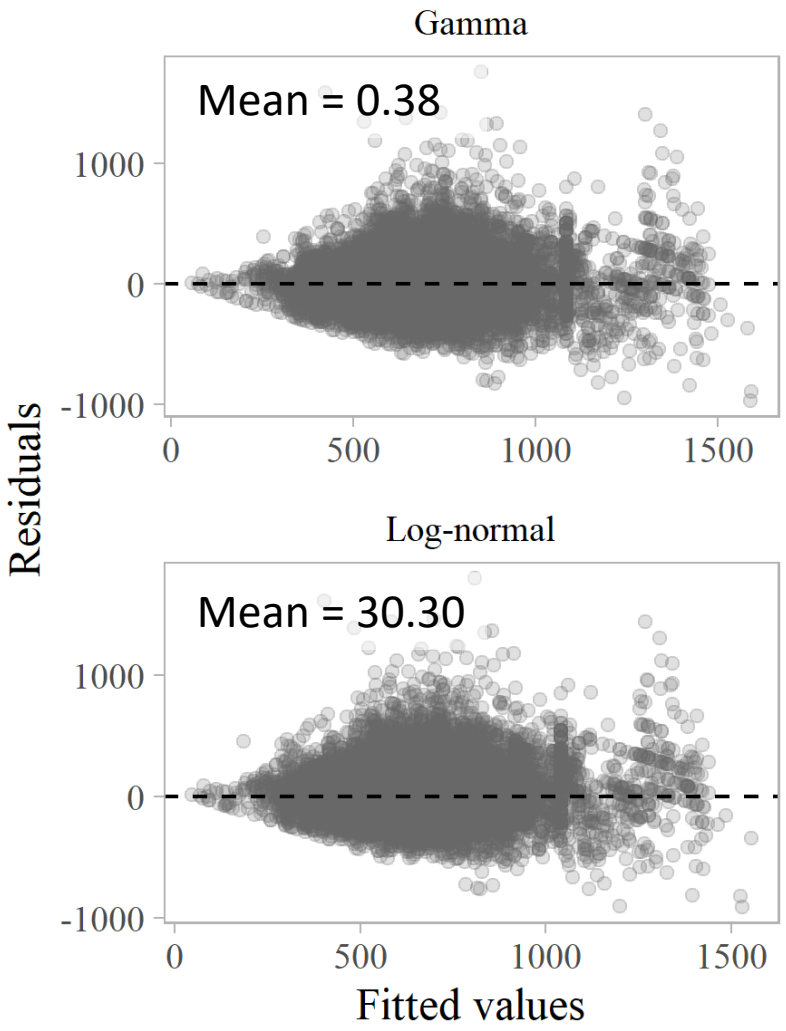
Gamma Distribution

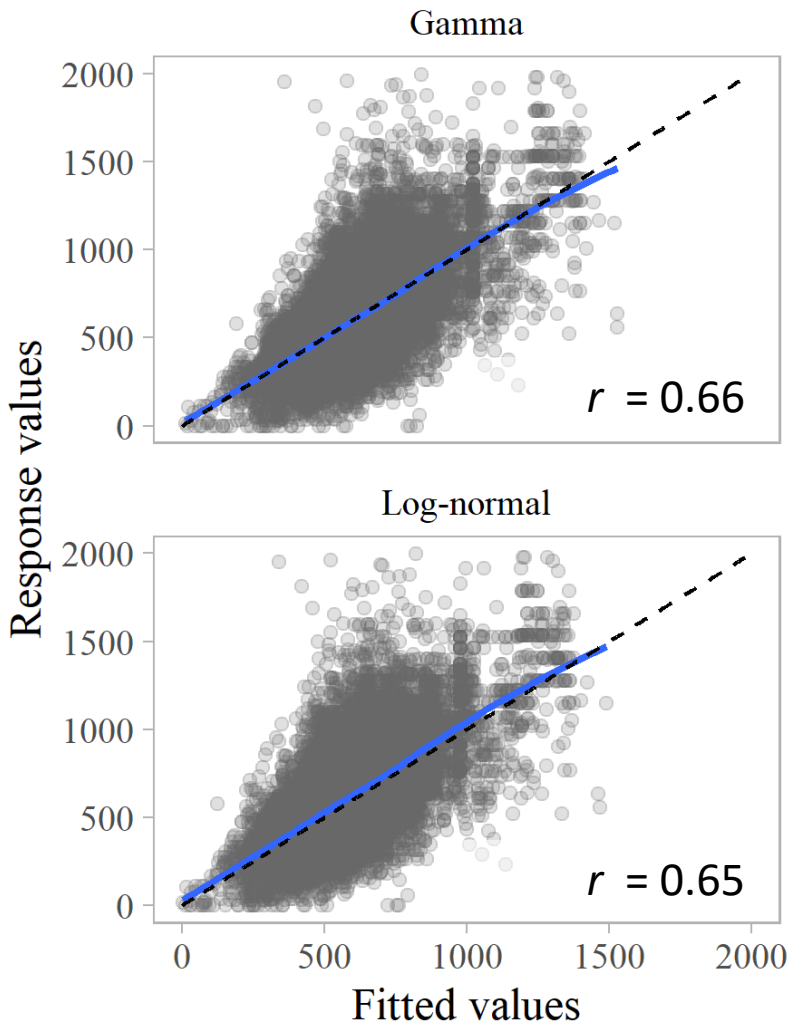
Model	edf	GCV	Δ AIC	Deviance Explained
Full	133	2912	0	42.7
Red. (1)	111	2987	430	41.5
Red. (2)	109	3022	540	41.1

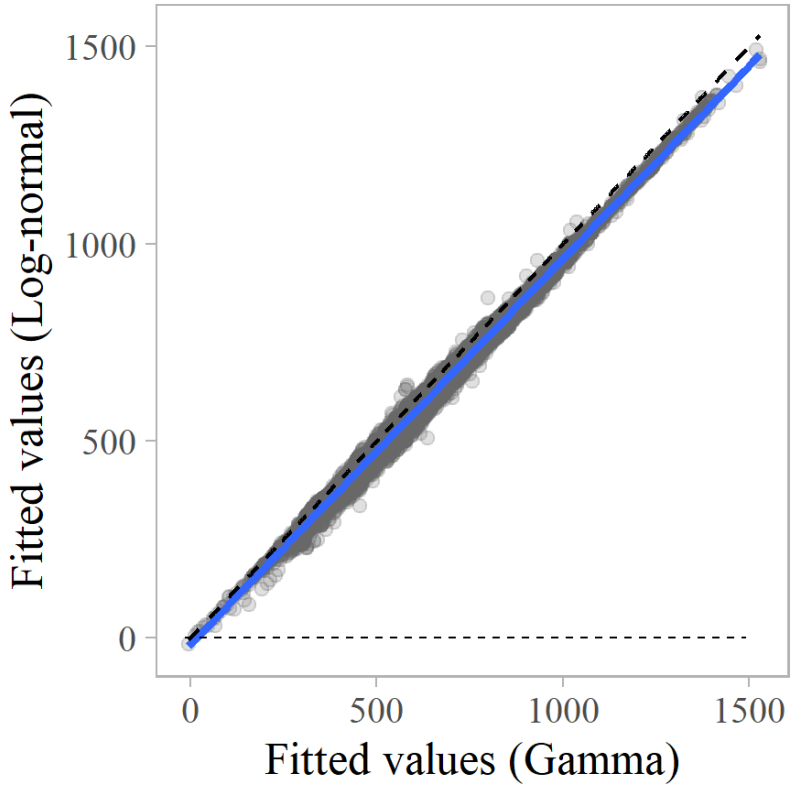
Log-Normal Distribution

Model	edf	GCV	Δ AIC	Deviance Explained
Full	134	3577	0	43.4
Red. (1)	112	3711	554	41.7
Red. (2)	109	3749	671	41.3

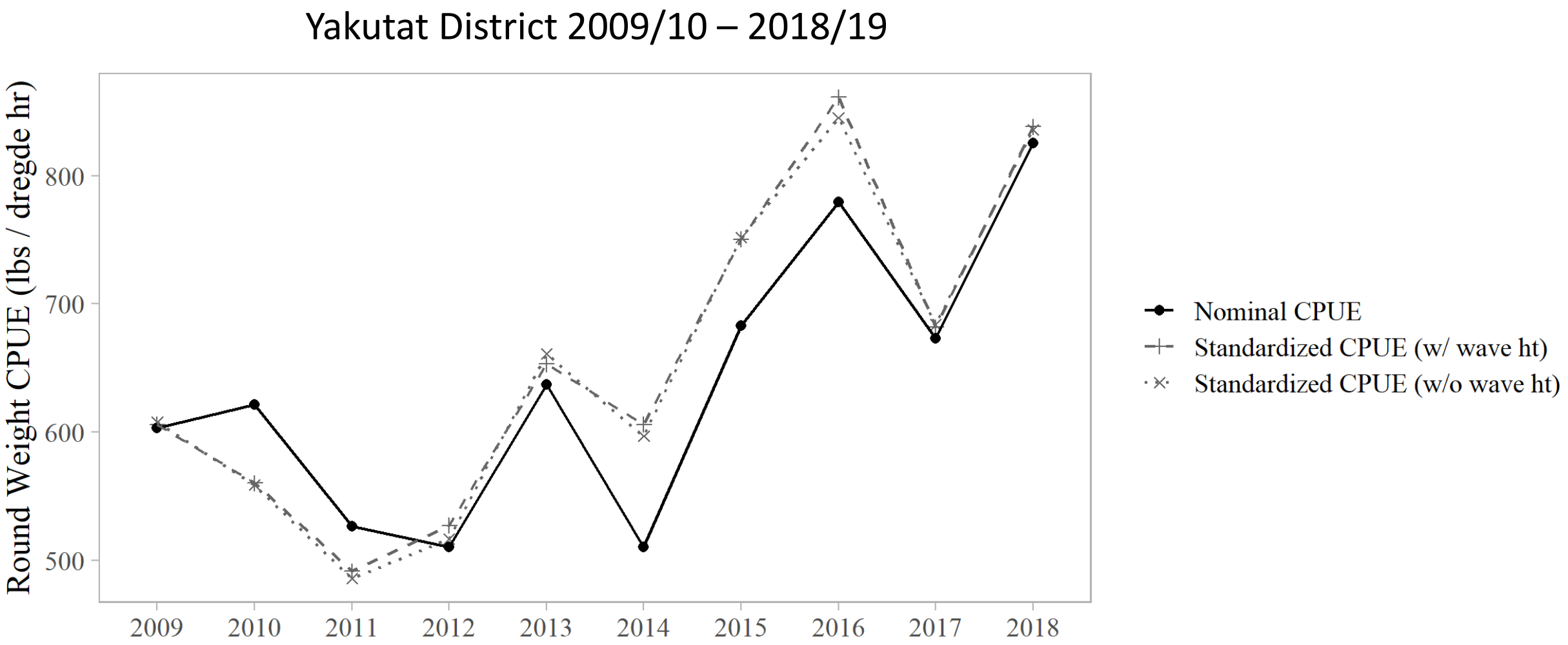
Error Distribution Selection







Comparison w/ Nominal CPUE



Summary and Next Steps

- *CPUE should be standardized to control for variables that influence the interannual trend, other than abundance*

- In Yakutat district, standardized CPUE tends to track nominal CPUE

- Additional covariates:
  - Use of a dredge master?
  - Tidal rate may be relevant in Kodiak districts

- Evaluate standardization model(s) in other districts, define a single suitable model for all districts

Questions?