Groundfish SDMs for Atlantis

sdmTMB model convergence and ensemble statistics

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Each functional group was modelled as an ensemble of four models. Each sub-model has the same predictors, but the models vary in the assumed functional form of the relationship between predictors and CPUE: models represent the relationship of CPUE with bottom temperature and oxygen as either linear or as a GAM spline. The general model formula, therefore, is:

```
cpue ~ +bottom_temperature + I(bottom_temperature^2) + bottom_oxygen +I(bottom_oxygen^2)
```

For the "linear" (non-spline) environmental relationships, and:

```
cpue~ +s(bottom_temperature, k = 3) + s(bottom_oxygen,k=3)
```

For the spline relationships. The `k=3` parameter denotes the maximum allowable "smoothness" of the fitted spline relationship. This spline k parameter is set at 3 for all models. Furthermore, the models can include spatial random fields, or not. Without spatial random fields, the models reduce to simple GLMs or GAMs. Models were fit with a Tweedie distribution.

We assessed model convergence by interrogating the model output. A convergence code of 0 represents successful convergence, and additional information on model convergence can be obtained with a call to `mod$model$message`. Desirable return codes of this call are 3, 4, 5 and 6, all of which indicate convergence of the function (Gay 1990). Finally, the Matern practical range parameter, defined as the distance at which the spatial correlation in the data drops to ρ=0.13 (Lindgren and Rue 2015), was extracted for fitted models.

With the option for linear or spline environmental relationships, and the option to include spatial random fields, each functional group therefore is modelled as an ensemble of four models. Models are then weighted using a likelihood-based posterior predictive stacking approach, described in Yao et al. 2018 (DOI: 10.1214/17-BA1091), and implemented in `sdmTMB::sdmTMB_stacking()`. These relative model weights are used to determine CPUE predictions, such that each predicted value is a weighted average of the predictions of all four models.

In the following, each of the four models for each Atlantis demersal functional groups is described, along with their relative weighting.

ARR: Arrowtooth Flounder

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |ARR   |FALSE      |FALSE      |  0.021|           0|        2.828|
## |ARR   |FALSE      |TRUE       |  0.030|           0|        2.828|
## |ARR   |TRUE       |FALSE      |  0.949|           0|      287.361|
## |ARR   |TRUE       |TRUE       |  0.000|           0|      289.561|
##
```

```
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    7.035|     0.046|
## |mean_temp_roms_30_norm        |   -1.428|     0.106|
## |I(mean_temp_roms_30_norm^2)   |   -2.058|     0.088|
## |mean_oxygen_roms_30_norm      |    2.242|     0.103|
## |I(mean_oxygen_roms_30_norm^2) |   -1.027|     0.051|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.185|     0.056|
## |s(mean_temp_roms_30_norm).1   |    8.417|     0.358|
## |s(mean_temp_roms_30_norm).2   |   -2.705|     0.095|
## |s(mean_oxygen_roms_30_norm).1 |    5.369|     0.279|
## |s(mean_oxygen_roms_30_norm).2 |    0.753|     0.058|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -3.416|     3.170|
## |mean_temp_roms_30_norm        |    1.387|     0.145|
## |I(mean_temp_roms_30_norm^2)   |   -2.347|     0.120|
## |mean_oxygen_roms_30_norm      |   -0.697|     0.146|
## |I(mean_oxygen_roms_30_norm^2) |   -0.300|     0.062|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -6.117|     3.224|
## |s(mean_temp_roms_30_norm).1   |    9.512|     0.492|
## |s(mean_temp_roms_30_norm).2   |   -0.065|     0.130|
## |s(mean_oxygen_roms_30_norm).1 |    1.480|     0.335|
## |s(mean_oxygen_roms_30_norm).2 |   -1.166|     0.099|
```

BOC: Bocaccio

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |BOC   |FALSE      |FALSE      |  0.000|           0|        2.828|
## |BOC   |FALSE      |TRUE       |  0.322|           0|        2.828|
## |BOC   |TRUE       |FALSE      |  0.156|           0|      230.209|
## |BOC   |TRUE       |TRUE       |  0.522|           0|      329.900|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    1.394|     0.221|
## |mean_temp_roms_30_norm        |    5.206|     0.492|
## |I(mean_temp_roms_30_norm^2)   |   -1.548|     0.235|
```

```
## |mean_oxygen_roms_30_norm      |   -0.235|     0.363|
## |I(mean_oxygen_roms_30_norm^2) |   -0.515|     0.224|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.251|     0.406|
## |s(mean_temp_roms_30_norm).1   |    8.724|     1.226|
## |s(mean_temp_roms_30_norm).2   |    4.619|     0.394|
## |s(mean_oxygen_roms_30_norm).1 |    2.949|     1.080|
## |s(mean_oxygen_roms_30_norm).2 |   -0.991|     0.200|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -2.625|     2.941|
## |mean_temp_roms_30_norm        |    5.130|     0.847|
## |I(mean_temp_roms_30_norm^2)   |   -1.954|     0.325|
## |mean_oxygen_roms_30_norm      |    1.121|     0.596|
## |I(mean_oxygen_roms_30_norm^2) |   -0.540|     0.327|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -6.746|     4.806|
## |s(mean_temp_roms_30_norm).1   |   12.090|     1.686|
## |s(mean_temp_roms_30_norm).2   |    4.938|     0.743|
## |s(mean_oxygen_roms_30_norm).1 |    2.362|     1.517|
## |s(mean_oxygen_roms_30_norm).2 |    0.333|     0.385|
```

BRF: Black Rockfish

```
## Warning in sqrt(diag(object$cov.fixed)): NaNs produced

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```

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## Warning in sqrt(diag(object$cov.fixed)): NaNs produced

##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |BRF   |FALSE      |FALSE      |      0|           0|        2.828|
## |BRF   |FALSE      |TRUE       |      0|           0|        2.828|
## |BRF   |TRUE       |FALSE      |      1|           0|        2.828|
## |BRF   |TRUE       |TRUE       |      0|           0|        0.857|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -14.149|     8.547|
## |mean_temp_roms_30_norm        |    0.721|     3.322|
## |I(mean_temp_roms_30_norm^2)   |   -0.404|     1.464|
## |mean_oxygen_roms_30_norm      |   25.384|    17.582|
## |I(mean_oxygen_roms_30_norm^2) |  -12.173|     8.838|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -26.845|    16.063|
## |s(mean_temp_roms_30_norm).1   |    5.441|     8.718|
## |s(mean_temp_roms_30_norm).2   |    1.687|     3.195|
## |s(mean_oxygen_roms_30_norm).1 |   56.433|    39.993|
## |s(mean_oxygen_roms_30_norm).2 |    9.401|     6.307|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -14.149|     8.548|
## |mean_temp_roms_30_norm        |    0.721|     3.322|
## |I(mean_temp_roms_30_norm^2)   |   -0.404|     1.465|
## |mean_oxygen_roms_30_norm      |   25.384|    17.588|
## |I(mean_oxygen_roms_30_norm^2) |  -12.173|     8.841|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -26.835|    16.056|
## |s(mean_temp_roms_30_norm).1   |    5.441|     8.718|
## |s(mean_temp_roms_30_norm).2   |    1.687|     3.195|
## |s(mean_oxygen_roms_30_norm).1 |   56.407|    39.976|
```

```
## |s(mean_oxygen_roms_30_norm).2 |    9.397|     6.304|
```

DAR: Darkblotched Rockfish

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |DAR   |FALSE      |FALSE      |  0.317|           0|        2.828|
## |DAR   |FALSE      |TRUE       |  0.000|           0|        2.828|
## |DAR   |TRUE       |FALSE      |  0.683|           0|      120.254|
## |DAR   |TRUE       |TRUE       |  0.000|           0|      113.097|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    6.462|     0.076|
## |mean_temp_roms_30_norm        |   -0.316|     0.201|
## |I(mean_temp_roms_30_norm^2)   |   -3.456|     0.178|
## |mean_oxygen_roms_30_norm      |    2.097|     0.171|
## |I(mean_oxygen_roms_30_norm^2) |   -1.988|     0.093|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    1.449|     0.121|
## |s(mean_temp_roms_30_norm).1   |   13.957|     0.680|
## |s(mean_temp_roms_30_norm).2   |   -2.466|     0.141|
## |s(mean_oxygen_roms_30_norm).1 |   10.056|     0.494|
## |s(mean_oxygen_roms_30_norm).2 |   -0.805|     0.104|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    0.310|     1.598|
## |mean_temp_roms_30_norm        |    2.350|     0.326|
## |I(mean_temp_roms_30_norm^2)   |   -4.184|     0.232|
## |mean_oxygen_roms_30_norm      |    1.025|     0.320|
## |I(mean_oxygen_roms_30_norm^2) |   -1.462|     0.155|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -4.870|     1.524|
## |s(mean_temp_roms_30_norm).1   |   16.565|     0.891|
## |s(mean_temp_roms_30_norm).2   |   -0.290|     0.276|
## |s(mean_oxygen_roms_30_norm).1 |    7.178|     0.782|
## |s(mean_oxygen_roms_30_norm).2 |   -1.075|     0.231|
```

FBP: Deep Vertical Migrators

Lanternfish, California smoothtongue, Argentina sialis

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FBP   |FALSE      |FALSE      |  0.598|           0|        2.828|
## |FBP   |FALSE      |TRUE       |  0.272|           0|        2.828|
## |FBP   |TRUE       |FALSE      |  0.129|           0|       30.364|
## |FBP   |TRUE       |TRUE       |  0.000|           0|       29.893|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -2.051|     0.096|
## |mean_temp_roms_30_norm        |   -0.331|     0.146|
## |I(mean_temp_roms_30_norm^2)   |   -0.309|     0.077|
## |mean_oxygen_roms_30_norm      |   -2.082|     0.175|
## |I(mean_oxygen_roms_30_norm^2) |   -0.650|     0.162|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -3.055|     0.120|
## |s(mean_temp_roms_30_norm).1   |    1.723|     0.338|
## |s(mean_temp_roms_30_norm).2   |   -0.551|     0.171|
## |s(mean_oxygen_roms_30_norm).1 |    2.919|     0.890|
## |s(mean_oxygen_roms_30_norm).2 |   -2.930|     0.313|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -2.757|     0.173|
## |mean_temp_roms_30_norm        |    0.022|     0.215|
## |I(mean_temp_roms_30_norm^2)   |   -0.388|     0.092|
## |mean_oxygen_roms_30_norm      |   -2.372|     0.240|
## |I(mean_oxygen_roms_30_norm^2) |   -0.064|     0.194|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -3.261|     0.154|
## |s(mean_temp_roms_30_norm).1   |    1.853|     0.402|
## |s(mean_temp_roms_30_norm).2   |   -0.182|     0.233|
## |s(mean_oxygen_roms_30_norm).1 |   -0.168|     1.027|
## |s(mean_oxygen_roms_30_norm).2 |   -2.416|     0.329|
```

FDB: Shallow Small Rockfish

Gopher, greenstriped, and stripetail rockfish

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
```

```
## |FDB   |FALSE      |FALSE      |  0.020|           0|        2.828|
## |FDB   |FALSE      |TRUE       |  0.353|           0|        2.828|
## |FDB   |TRUE       |FALSE      |  0.000|           0|      329.190|
## |FDB   |TRUE       |TRUE       |  0.627|           0|      348.680|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.539|     0.065|
## |mean_temp_roms_30_norm        |    3.105|     0.163|
## |I(mean_temp_roms_30_norm^2)   |   -1.650|     0.079|
## |mean_oxygen_roms_30_norm      |    1.873|     0.144|
## |I(mean_oxygen_roms_30_norm^2) |   -1.269|     0.086|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.203|     0.119|
## |s(mean_temp_roms_30_norm).1   |    9.625|     0.391|
## |s(mean_temp_roms_30_norm).2   |    2.393|     0.124|
## |s(mean_oxygen_roms_30_norm).1 |    6.036|     0.415|
## |s(mean_oxygen_roms_30_norm).2 |    0.047|     0.077|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -6.722|     8.172|
## |mean_temp_roms_30_norm        |    4.402|     0.248|
## |I(mean_temp_roms_30_norm^2)   |   -2.232|     0.111|
## |mean_oxygen_roms_30_norm      |    2.639|     0.222|
## |I(mean_oxygen_roms_30_norm^2) |   -1.358|     0.104|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -9.967|     8.211|
## |s(mean_temp_roms_30_norm).1   |   12.235|     0.525|
## |s(mean_temp_roms_30_norm).2   |    3.291|     0.197|
## |s(mean_oxygen_roms_30_norm).1 |    6.777|     0.509|
## |s(mean_oxygen_roms_30_norm).2 |    0.752|     0.137|
```

FDC: Deep Small Rockfish

Aurora, sharpchin, and splitnose rockfish, and longspine thornyhead

```
##
##
## |Group |Spatial RF |Env Spline |Weight | Convergence| Matern Range|
## |:-----|:----------|:----------|:------|-----------:|------------:|
## |FDC   |FALSE      |FALSE      |NA     |           0|        2.828|
## |FDC   |FALSE      |TRUE       |NA     |           0|        2.828|
## |FDC   |TRUE       |FALSE      |NA     |           0|      241.855|
## |FDC   |TRUE       |TRUE       |NA     |           0|      251.154|
```

```
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    8.107|     0.042|
## |mean_temp_roms_30_norm        |   -1.499|     0.074|
## |I(mean_temp_roms_30_norm^2)   |   -0.455|     0.041|
## |mean_oxygen_roms_30_norm      |   -0.253|     0.082|
## |I(mean_oxygen_roms_30_norm^2) |   -1.445|     0.056|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    6.093|     0.035|
## |s(mean_temp_roms_30_norm).1   |    2.679|     0.185|
## |s(mean_temp_roms_30_norm).2   |   -1.851|     0.074|
## |s(mean_oxygen_roms_30_norm).1 |    7.513|     0.317|
## |s(mean_oxygen_roms_30_norm).2 |   -2.423|     0.078|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.074|     2.732|
## |mean_temp_roms_30_norm        |   -1.124|     0.145|
## |I(mean_temp_roms_30_norm^2)   |   -0.668|     0.065|
## |mean_oxygen_roms_30_norm      |    0.105|     0.147|
## |I(mean_oxygen_roms_30_norm^2) |   -1.264|     0.088|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.020|     2.768|
## |s(mean_temp_roms_30_norm).1   |    3.857|     0.287|
## |s(mean_temp_roms_30_norm).2   |   -1.825|     0.152|
## |s(mean_oxygen_roms_30_norm).1 |    7.104|     0.461|
## |s(mean_oxygen_roms_30_norm).2 |   -1.801|     0.156|
```

FDD: Deep Demersal Fish

Eelpouts, slickheads, and grenadiers.

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDD   |FALSE      |FALSE      |  0.237|           0|        2.828|
## |FDD   |FALSE      |TRUE       |  0.139|           0|        2.828|
## |FDD   |TRUE       |FALSE      |  0.384|           0|       61.521|
## |FDD   |TRUE       |TRUE       |  0.240|           0|       65.626|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
```

```
## |(Intercept)                   |    4.672|     0.039|
## |mean_temp_roms_30_norm        |   -1.547|     0.059|
## |I(mean_temp_roms_30_norm^2)   |    0.542|     0.024|
## |mean_oxygen_roms_30_norm      |   -0.196|     0.075|
## |I(mean_oxygen_roms_30_norm^2) |   -0.422|     0.036|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.755|     0.024|
## |s(mean_temp_roms_30_norm).1   |   -2.333|     0.112|
## |s(mean_temp_roms_30_norm).2   |   -1.213|     0.059|
## |s(mean_oxygen_roms_30_norm).1 |    2.246|     0.207|
## |s(mean_oxygen_roms_30_norm).2 |   -0.802|     0.048|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.597|     0.233|
## |mean_temp_roms_30_norm        |   -1.913|     0.103|
## |I(mean_temp_roms_30_norm^2)   |    0.389|     0.037|
## |mean_oxygen_roms_30_norm      |   -0.151|     0.118|
## |I(mean_oxygen_roms_30_norm^2) |   -0.452|     0.044|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.556|     0.249|
## |s(mean_temp_roms_30_norm).1   |   -1.490|     0.172|
## |s(mean_temp_roms_30_norm).2   |   -1.719|     0.106|
## |s(mean_oxygen_roms_30_norm).1 |    2.470|     0.252|
## |s(mean_oxygen_roms_30_norm).2 |   -0.774|     0.100|
```

FDE: Shallow Miscellaneous Fish

White croaker, plainfin midshipman, and threadfin sculpin

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDE   |FALSE      |FALSE      |  0.184|           0|        2.828|
## |FDE   |FALSE      |TRUE       |  0.000|           0|        2.828|
## |FDE   |TRUE       |FALSE      |  0.121|           0|      315.319|
## |FDE   |TRUE       |TRUE       |  0.695|           0|      270.257|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.794|     0.182|
## |mean_temp_roms_30_norm        |    9.165|     0.359|
## |I(mean_temp_roms_30_norm^2)   |   -2.250|     0.126|
## |mean_oxygen_roms_30_norm      |   -1.215|     0.254|
```

```
## |I(mean_oxygen_roms_30_norm^2) |    0.292|     0.104|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -4.191|     0.270|
## |s(mean_temp_roms_30_norm).1   |   12.006|     0.789|
## |s(mean_temp_roms_30_norm).2   |    8.087|     0.347|
## |s(mean_oxygen_roms_30_norm).1 |   -1.079|     0.642|
## |s(mean_oxygen_roms_30_norm).2 |   -0.925|     0.142|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -5.943|     2.866|
## |mean_temp_roms_30_norm        |    5.066|     0.450|
## |I(mean_temp_roms_30_norm^2)   |   -1.379|     0.148|
## |mean_oxygen_roms_30_norm      |    0.753|     0.280|
## |I(mean_oxygen_roms_30_norm^2) |   -0.031|     0.108|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -8.446|     2.474|
## |s(mean_temp_roms_30_norm).1   |    9.106|     1.006|
## |s(mean_temp_roms_30_norm).2   |    5.217|     0.486|
## |s(mean_oxygen_roms_30_norm).1 |    0.624|     0.643|
## |s(mean_oxygen_roms_30_norm).2 |    0.670|     0.181|
```

FDF: Flatfish

Pacific sanddab, rex sole, slender sole, starry flounder, english sole, deepsea sole

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDF   |FALSE      |FALSE      |  0.034|           0|        2.828|
## |FDF   |FALSE      |TRUE       |  0.075|           0|        2.828|
## |FDF   |TRUE       |FALSE      |  0.268|           0|      207.569|
## |FDF   |TRUE       |TRUE       |  0.623|           0|      210.415|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    7.384|     0.025|
## |mean_temp_roms_30_norm        |    0.410|     0.045|
## |I(mean_temp_roms_30_norm^2)   |   -0.242|     0.019|
## |mean_oxygen_roms_30_norm      |    0.703|     0.054|
## |I(mean_oxygen_roms_30_norm^2) |   -0.177|     0.021|
##
##
## |term                          | estimate| std.error|
```

```
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.985|     0.018|
## |s(mean_temp_roms_30_norm).1  |    1.008|     0.091|
## |s(mean_temp_roms_30_norm).2  |    0.192|     0.041|
## |s(mean_oxygen_roms_30_norm).1 |    1.262|     0.124|
## |s(mean_oxygen_roms_30_norm).2 |    0.466|     0.032|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.683|     0.656|
## |mean_temp_roms_30_norm       |    0.740|     0.068|
## |I(mean_temp_roms_30_norm^2)  |   -0.170|     0.025|
## |mean_oxygen_roms_30_norm     |    0.316|     0.071|
## |I(mean_oxygen_roms_30_norm^2) |   -0.116|     0.026|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.408|     0.666|
## |s(mean_temp_roms_30_norm).1  |    0.757|     0.119|
## |s(mean_temp_roms_30_norm).2  |    0.577|     0.063|
## |s(mean_oxygen_roms_30_norm).1 |    0.813|     0.151|
## |s(mean_oxygen_roms_30_norm).2 |    0.166|     0.051|
```

FDO: Deep Large Fish

Blackgill, rougheye, and blackspotted rockfish, and shortspine thornyhead

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDO   |FALSE      |FALSE      |  0.040|           0|        2.828|
## |FDO   |FALSE      |TRUE       |  0.129|           0|        2.828|
## |FDO   |TRUE       |FALSE      |  0.000|           0|      100.936|
## |FDO   |TRUE       |TRUE       |  0.831|           0|       86.489|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.125|     0.039|
## |mean_temp_roms_30_norm       |   -2.659|     0.088|
## |I(mean_temp_roms_30_norm^2)  |   -1.652|     0.052|
## |mean_oxygen_roms_30_norm     |   -0.539|     0.068|
## |I(mean_oxygen_roms_30_norm^2) |   -0.998|     0.056|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    3.252|     0.057|
## |s(mean_temp_roms_30_norm).1  |    8.930|     0.251|
## |s(mean_temp_roms_30_norm).2  |   -4.172|     0.118|
```

```
## |s(mean_oxygen_roms_30_norm).1 |    4.746|     0.296|
## |s(mean_oxygen_roms_30_norm).2 |   -1.924|     0.089|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.815|     0.457|
## |mean_temp_roms_30_norm        |   -1.656|     0.139|
## |I(mean_temp_roms_30_norm^2)   |   -1.401|     0.068|
## |mean_oxygen_roms_30_norm      |   -1.354|     0.128|
## |I(mean_oxygen_roms_30_norm^2) |   -1.116|     0.086|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    3.014|     0.362|
## |s(mean_temp_roms_30_norm).1   |    7.829|     0.318|
## |s(mean_temp_roms_30_norm).2   |   -2.998|     0.166|
## |s(mean_oxygen_roms_30_norm).1 |    5.155|     0.447|
## |s(mean_oxygen_roms_30_norm).2 |   -2.879|     0.154|
```

FDP: Dover Sole

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDP   |FALSE      |FALSE      |  0.000|           0|        2.828|
## |FDP   |FALSE      |TRUE       |  0.132|           0|        2.828|
## |FDP   |TRUE       |FALSE      |  0.868|           0|      238.331|
## |FDP   |TRUE       |TRUE       |  0.000|           0|      200.022|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    8.408|     0.027|
## |mean_temp_roms_30_norm        |   -0.862|     0.052|
## |I(mean_temp_roms_30_norm^2)   |   -1.130|     0.024|
## |mean_oxygen_roms_30_norm      |    0.213|     0.058|
## |I(mean_oxygen_roms_30_norm^2) |   -0.061|     0.027|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    7.226|     0.020|
## |s(mean_temp_roms_30_norm).1   |    5.352|     0.116|
## |s(mean_temp_roms_30_norm).2   |   -1.621|     0.050|
## |s(mean_oxygen_roms_30_norm).1 |    0.182|     0.147|
## |s(mean_oxygen_roms_30_norm).2 |    0.084|     0.035|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
```

```
## |(Intercept)                   |    5.874|     1.406|
## |mean_temp_roms_30_norm        |    0.097|     0.079|
## |I(mean_temp_roms_30_norm^2)   |   -1.083|     0.033|
## |mean_oxygen_roms_30_norm      |   -0.856|     0.086|
## |I(mean_oxygen_roms_30_norm^2) |    0.113|     0.033|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.122|     1.104|
## |s(mean_temp_roms_30_norm).1   |    4.984|     0.151|
## |s(mean_temp_roms_30_norm).2   |   -0.596|     0.076|
## |s(mean_oxygen_roms_30_norm).1 |   -0.844|     0.182|
## |s(mean_oxygen_roms_30_norm).2 |   -0.742|     0.065|
```

FDS: Midwater Rockfish

Chilipepper, vermillion, sunset, widow, and yellowtail rockfish

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FDS   |FALSE      |FALSE      |  0.020|           0|        2.828|
## |FDS   |FALSE      |TRUE       |  0.280|           0|        2.828|
## |FDS   |TRUE       |FALSE      |  0.000|           0|       66.773|
## |FDS   |TRUE       |TRUE       |  0.699|           0|       79.300|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.367|     0.109|
## |mean_temp_roms_30_norm        |    4.691|     0.253|
## |I(mean_temp_roms_30_norm^2)   |   -2.103|     0.117|
## |mean_oxygen_roms_30_norm      |    1.712|     0.185|
## |I(mean_oxygen_roms_30_norm^2) |   -0.961|     0.099|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    1.703|     0.190|
## |s(mean_temp_roms_30_norm).1   |   11.644|     0.599|
## |s(mean_temp_roms_30_norm).2   |    3.686|     0.196|
## |s(mean_oxygen_roms_30_norm).1 |    5.717|     0.571|
## |s(mean_oxygen_roms_30_norm).2 |    0.243|     0.100|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.371|     0.760|
## |mean_temp_roms_30_norm        |    3.573|     0.346|
## |I(mean_temp_roms_30_norm^2)   |   -1.594|     0.133|
## |mean_oxygen_roms_30_norm      |    3.032|     0.303|
```

```
## |I(mean_oxygen_roms_30_norm^2) |   -1.207|     0.119|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -0.703|     0.920|
## |s(mean_temp_roms_30_norm).1   |    8.675|     0.686|
## |s(mean_temp_roms_30_norm).2   |    2.825|     0.300|
## |s(mean_oxygen_roms_30_norm).1 |    6.654|     0.686|
## |s(mean_oxygen_roms_30_norm).2 |    1.239|     0.210|
```

FMM: Hake

Pacific hake

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FMM   |FALSE      |FALSE      |  0.238|           0|        2.828|
## |FMM   |FALSE      |TRUE       |  0.000|           0|        2.828|
## |FMM   |TRUE       |FALSE      |  0.000|           0|       53.987|
## |FMM   |TRUE       |TRUE       |  0.762|           0|       58.990|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    7.574|     0.040|
## |mean_temp_roms_30_norm        |    1.539|     0.089|
## |I(mean_temp_roms_30_norm^2)   |   -1.804|     0.043|
## |mean_oxygen_roms_30_norm      |    0.535|     0.089|
## |I(mean_oxygen_roms_30_norm^2) |   -0.213|     0.041|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.620|     0.038|
## |s(mean_temp_roms_30_norm).1   |    8.228|     0.205|
## |s(mean_temp_roms_30_norm).2   |    0.423|     0.076|
## |s(mean_oxygen_roms_30_norm).1 |    0.948|     0.227|
## |s(mean_oxygen_roms_30_norm).2 |    0.157|     0.050|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    6.563|     0.209|
## |mean_temp_roms_30_norm        |    2.221|     0.146|
## |I(mean_temp_roms_30_norm^2)   |   -1.894|     0.060|
## |mean_oxygen_roms_30_norm      |   -0.454|     0.153|
## |I(mean_oxygen_roms_30_norm^2) |    0.075|     0.057|
##
##
## |term                          | estimate| std.error|
```

```
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    4.756|     0.206|
## |s(mean_temp_roms_30_norm).1  |    8.724|     0.278|
## |s(mean_temp_roms_30_norm).2  |    1.170|     0.131|
## |s(mean_oxygen_roms_30_norm).1 |   -1.023|     0.322|
## |s(mean_oxygen_roms_30_norm).2 |   -0.470|     0.104|
```

FMN: Sablefish

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FMN   |FALSE      |FALSE      |  0.178|           0|        2.828|
## |FMN   |FALSE      |TRUE       |  0.000|           0|        2.828|
## |FMN   |TRUE       |FALSE      |  0.000|           0|       76.576|
## |FMN   |TRUE       |TRUE       |  0.822|           0|       77.926|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    7.196|     0.035|
## |mean_temp_roms_30_norm       |   -1.320|     0.060|
## |I(mean_temp_roms_30_norm^2)  |   -0.248|     0.031|
## |mean_oxygen_roms_30_norm     |    0.634|     0.069|
## |I(mean_oxygen_roms_30_norm^2) |   -0.813|     0.041|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.127|     0.025|
## |s(mean_temp_roms_30_norm).1  |    1.311|     0.136|
## |s(mean_temp_roms_30_norm).2  |   -1.465|     0.057|
## |s(mean_oxygen_roms_30_norm).1 |    4.251|     0.225|
## |s(mean_oxygen_roms_30_norm).2 |   -0.573|     0.047|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    6.020|     0.251|
## |mean_temp_roms_30_norm       |   -1.083|     0.106|
## |I(mean_temp_roms_30_norm^2)  |   -0.251|     0.042|
## |mean_oxygen_roms_30_norm     |    0.137|     0.115|
## |I(mean_oxygen_roms_30_norm^2) |   -0.536|     0.055|
##
##
## |term                         | estimate| std.error|
## |:----------------------------|--------:|---------:|
## |(Intercept)                  |    5.210|     0.245|
## |s(mean_temp_roms_30_norm).1  |    1.326|     0.188|
## |s(mean_temp_roms_30_norm).2  |   -1.239|     0.102|
## |s(mean_oxygen_roms_30_norm).1 |    2.767|     0.297|
## |s(mean_oxygen_roms_30_norm).2 |   -0.664|     0.091|
```

FPO: Canary Rockfish

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FPO   |FALSE      |FALSE      |  0.449|           0|        2.828|
## |FPO   |FALSE      |TRUE       |  0.143|           0|        2.828|
## |FPO   |TRUE       |FALSE      |  0.000|           0|       19.515|
## |FPO   |TRUE       |TRUE       |  0.408|           0|       18.630|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.797|     0.247|
## |mean_temp_roms_30_norm        |    3.673|     0.531|
## |I(mean_temp_roms_30_norm^2)   |   -2.578|     0.261|
## |mean_oxygen_roms_30_norm      |    4.191|     0.412|
## |I(mean_oxygen_roms_30_norm^2) |   -1.663|     0.155|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.959|     0.567|
## |s(mean_temp_roms_30_norm).1   |   12.103|     1.326|
## |s(mean_temp_roms_30_norm).2   |    2.194|     0.422|
## |s(mean_oxygen_roms_30_norm).1 |   10.172|     0.952|
## |s(mean_oxygen_roms_30_norm).2 |    1.973|     0.238|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    0.752|     0.445|
## |mean_temp_roms_30_norm        |    2.745|     0.578|
## |I(mean_temp_roms_30_norm^2)   |   -1.870|     0.282|
## |mean_oxygen_roms_30_norm      |    4.165|     0.498|
## |I(mean_oxygen_roms_30_norm^2) |   -1.593|     0.188|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -2.875|     0.590|
## |s(mean_temp_roms_30_norm).1   |    8.722|     1.337|
## |s(mean_temp_roms_30_norm).2   |    1.516|     0.462|
## |s(mean_oxygen_roms_30_norm).1 |    9.426|     1.070|
## |s(mean_oxygen_roms_30_norm).2 |    2.033|     0.303|
```

FVD: Large Piscivorous Fish

California halibut, Pacific halibut

```
##
##
```

```
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FVD   |FALSE      |FALSE      |  0.196|           0|        2.828|
## |FVD   |FALSE      |TRUE       |  0.000|           0|        2.828|
## |FVD   |TRUE       |FALSE      |  0.000|           0|      115.766|
## |FVD   |TRUE       |TRUE       |  0.804|           0|      109.688|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.127|     0.086|
## |mean_temp_roms_30_norm        |    0.167|     0.209|
## |I(mean_temp_roms_30_norm^2)   |   -0.603|     0.095|
## |mean_oxygen_roms_30_norm      |    1.711|     0.191|
## |I(mean_oxygen_roms_30_norm^2) |   -0.472|     0.078|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.999|     0.119|
## |s(mean_temp_roms_30_norm).1   |    3.347|     0.494|
## |s(mean_temp_roms_30_norm).2   |   -0.142|     0.171|
## |s(mean_oxygen_roms_30_norm).1 |    2.519|     0.453|
## |s(mean_oxygen_roms_30_norm).2 |    0.982|     0.110|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    1.722|     0.624|
## |mean_temp_roms_30_norm        |    1.270|     0.310|
## |I(mean_temp_roms_30_norm^2)   |   -0.474|     0.140|
## |mean_oxygen_roms_30_norm      |    1.132|     0.283|
## |I(mean_oxygen_roms_30_norm^2) |   -0.320|     0.094|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    0.966|     0.586|
## |s(mean_temp_roms_30_norm).1   |    2.805|     0.694|
## |s(mean_temp_roms_30_norm).2   |    0.992|     0.274|
## |s(mean_oxygen_roms_30_norm).1 |    1.676|     0.572|
## |s(mean_oxygen_roms_30_norm).2 |    0.645|     0.196|
```

FVS: Large Demersal Fish

Lingcod, cabezon

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |FVS   |FALSE      |FALSE      |  0.112|           0|        2.828|
## |FVS   |FALSE      |TRUE       |  0.168|           0|        2.828|
```

```
## |FVS   |TRUE       |FALSE      |  0.000|           0|       54.940|
## |FVS   |TRUE       |TRUE       |  0.721|           0|       61.210|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    5.018|     0.066|
## |mean_temp_roms_30_norm        |    2.824|     0.162|
## |I(mean_temp_roms_30_norm^2)   |   -1.608|     0.064|
## |mean_oxygen_roms_30_norm      |    1.789|     0.139|
## |I(mean_oxygen_roms_30_norm^2) |   -0.822|     0.060|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.176|     0.117|
## |s(mean_temp_roms_30_norm).1   |    9.081|     0.355|
## |s(mean_temp_roms_30_norm).2   |    2.121|     0.133|
## |s(mean_oxygen_roms_30_norm).1 |    4.252|     0.333|
## |s(mean_oxygen_roms_30_norm).2 |    0.517|     0.074|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    2.584|     0.416|
## |mean_temp_roms_30_norm        |    3.499|     0.217|
## |I(mean_temp_roms_30_norm^2)   |   -1.483|     0.090|
## |mean_oxygen_roms_30_norm      |    1.751|     0.195|
## |I(mean_oxygen_roms_30_norm^2) |   -0.637|     0.072|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    0.282|     0.444|
## |s(mean_temp_roms_30_norm).1   |    8.206|     0.460|
## |s(mean_temp_roms_30_norm).2   |    2.790|     0.185|
## |s(mean_oxygen_roms_30_norm).1 |    3.275|     0.401|
## |s(mean_oxygen_roms_30_norm).2 |    0.788|     0.126|
```

FVV: Shortbelly Rockfish

```
##
##
## |Group |Spatial RF |Env Spline |Weight | Convergence| Matern Range|
## |:-----|:----------|:----------|:------|-----------:|------------:|
## |FVV   |FALSE      |FALSE      |NA     |           0|        2.828|
## |FVV   |FALSE      |TRUE       |NA     |           0|        2.828|
## |FVV   |TRUE       |FALSE      |NA     |           0|       84.464|
## |FVV   |TRUE       |TRUE       |NA     |           0|       95.039|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
```

```
## |(Intercept)                   |    0.535|     0.319|
## |mean_temp_roms_30_norm        |   13.577|     0.798|
## |I(mean_temp_roms_30_norm^2)   |   -3.971|     0.337|
## |mean_oxygen_roms_30_norm      |   -5.440|     0.592|
## |I(mean_oxygen_roms_30_norm^2) |    0.643|     0.322|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -4.739|     0.517|
## |s(mean_temp_roms_30_norm).1   |   23.433|     1.637|
## |s(mean_temp_roms_30_norm).2   |   12.380|     0.600|
## |s(mean_oxygen_roms_30_norm).1 |   -3.899|     1.400|
## |s(mean_oxygen_roms_30_norm).2 |   -4.508|     0.375|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -5.034|     1.867|
## |mean_temp_roms_30_norm        |    5.100|     0.968|
## |I(mean_temp_roms_30_norm^2)   |   -2.202|     0.392|
## |mean_oxygen_roms_30_norm      |    3.240|     0.720|
## |I(mean_oxygen_roms_30_norm^2) |   -1.877|     0.432|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -10.436|     2.117|
## |s(mean_temp_roms_30_norm).1   |   16.009|     2.088|
## |s(mean_temp_roms_30_norm).2   |    5.572|     0.849|
## |s(mean_oxygen_roms_30_norm).1 |    6.388|     1.976|
## |s(mean_oxygen_roms_30_norm).2 |    0.674|     0.492|
```

PET: Petrale sole

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |PET   |FALSE      |FALSE      |  0.120|           0|        2.828|
## |PET   |FALSE      |TRUE       |  0.194|           0|        2.828|
## |PET   |TRUE       |FALSE      |  0.000|           0|      116.786|
## |PET   |TRUE       |TRUE       |  0.686|           0|      113.432|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    4.235|     0.050|
## |mean_temp_roms_30_norm        |    3.603|     0.120|
## |I(mean_temp_roms_30_norm^2)   |   -1.707|     0.061|
## |mean_oxygen_roms_30_norm      |    1.124|     0.083|
## |I(mean_oxygen_roms_30_norm^2) |   -0.469|     0.035|
##
```

```
##
## |term                           | estimate| std.error|
## |:------------------------------|--------:|---------:|
## |(Intercept)                    |    2.020|     0.095|
## |s(mean_temp_roms_30_norm).1    |    7.775|     0.295|
## |s(mean_temp_roms_30_norm).2    |    2.562|     0.094|
## |s(mean_oxygen_roms_30_norm).1  |    2.782|     0.203|
## |s(mean_oxygen_roms_30_norm).2  |    0.428|     0.046|
##
##
## |term                           | estimate| std.error|
## |:------------------------------|--------:|---------:|
## |(Intercept)                    |    3.093|     0.483|
## |mean_temp_roms_30_norm         |    2.919|     0.145|
## |I(mean_temp_roms_30_norm^2)    |   -1.226|     0.069|
## |mean_oxygen_roms_30_norm       |    1.067|     0.115|
## |I(mean_oxygen_roms_30_norm^2)  |   -0.464|     0.043|
##
##
## |term                           | estimate| std.error|
## |:------------------------------|--------:|---------:|
## |(Intercept)                    |    1.356|     0.461|
## |s(mean_temp_roms_30_norm).1    |    5.797|     0.331|
## |s(mean_temp_roms_30_norm).2    |    2.180|     0.119|
## |s(mean_oxygen_roms_30_norm).1  |    2.748|     0.254|
## |s(mean_oxygen_roms_30_norm).2  |    0.416|     0.076|
```

POP: Pacific Ocean Perch

```
##
##
## |Group |Spatial RF |Env Spline |Weight | Convergence| Matern Range|
## |:-----|:----------|:----------|:------|-----------:|------------:|
## |POP   |FALSE      |FALSE      |NA     |           0|        2.828|
## |POP   |FALSE      |TRUE       |NA     |           0|        2.828|
## |POP   |TRUE       |FALSE      |NA     |           0|      325.316|
## |POP   |TRUE       |TRUE       |NA     |           0|      299.412|
##
##
## |term                           | estimate| std.error|
## |:------------------------------|--------:|---------:|
## |(Intercept)                    |    5.962|     0.134|
## |mean_temp_roms_30_norm         |   -6.573|     0.373|
## |I(mean_temp_roms_30_norm^2)    |   -2.433|     0.285|
## |mean_oxygen_roms_30_norm       |    6.810|     0.378|
## |I(mean_oxygen_roms_30_norm^2)  |   -5.837|     0.321|
##
##
## |term                           | estimate| std.error|
## |:------------------------------|--------:|---------:|
## |(Intercept)                    |   -1.828|     0.204|
## |s(mean_temp_roms_30_norm).1    |   11.965|     1.099|
## |s(mean_temp_roms_30_norm).2    |   -7.807|     0.308|
```

```
## |s(mean_oxygen_roms_30_norm).1 |   27.198|     1.528|
## |s(mean_oxygen_roms_30_norm).2 |   -1.393|     0.279|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -12.699|     9.370|
## |mean_temp_roms_30_norm        |    0.668|     0.588|
## |I(mean_temp_roms_30_norm^2)   |   -5.286|     0.524|
## |mean_oxygen_roms_30_norm      |    1.716|     0.534|
## |I(mean_oxygen_roms_30_norm^2) |   -3.246|     0.394|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -19.223|     8.475|
## |s(mean_temp_roms_30_norm).1   |   22.217|     1.973|
## |s(mean_temp_roms_30_norm).2   |   -2.771|     0.599|
## |s(mean_oxygen_roms_30_norm).1 |   15.014|     1.820|
## |s(mean_oxygen_roms_30_norm).2 |   -2.809|     0.438|
```

SHC: Cowcod

```
##
##
## |Group |Spatial RF |Env Spline |Weight | Convergence| Matern Range|
## |:-----|:----------|:----------|:------|-----------:|------------:|
## |SHC   |FALSE      |FALSE      |NA     |           0|        2.828|
## |SHC   |FALSE      |TRUE       |NA     |           0|        2.828|
## |SHC   |TRUE       |FALSE      |NA     |           0|      124.148|
## |SHC   |TRUE       |TRUE       |NA     |           0|      128.372|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.875|     0.395|
## |mean_temp_roms_30_norm        |    7.850|     0.883|
## |I(mean_temp_roms_30_norm^2)   |   -2.717|     0.441|
## |mean_oxygen_roms_30_norm      |   -0.379|     0.614|
## |I(mean_oxygen_roms_30_norm^2) |   -1.253|     0.471|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -6.791|     0.802|
## |s(mean_temp_roms_30_norm).1   |   14.813|     2.394|
## |s(mean_temp_roms_30_norm).2   |    6.905|     0.744|
## |s(mean_oxygen_roms_30_norm).1 |    6.444|     2.172|
## |s(mean_oxygen_roms_30_norm).2 |   -2.220|     0.458|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
```

```
## |(Intercept)                   |   -5.619|     1.572|
## |mean_temp_roms_30_norm        |    6.236|     1.565|
## |I(mean_temp_roms_30_norm^2)   |   -2.581|     0.608|
## |mean_oxygen_roms_30_norm      |    2.256|     1.041|
## |I(mean_oxygen_roms_30_norm^2) |   -1.853|     0.696|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |  -11.690|     1.973|
## |s(mean_temp_roms_30_norm).1   |   16.526|     3.410|
## |s(mean_temp_roms_30_norm).2   |    6.314|     1.439|
## |s(mean_oxygen_roms_30_norm).1 |    7.704|     3.099|
## |s(mean_oxygen_roms_30_norm).2 |   -0.315|     0.616|
```

SHR: Shallow Large Rockfish

Brown, copper, greenspotted, and blue rockfish, and kelp greenling

```
##
##
## |Group |Spatial RF |Env Spline | Weight| Convergence| Matern Range|
## |:-----|:----------|:----------|------:|-----------:|------------:|
## |SHR   |FALSE      |FALSE      |  0.000|           0|        2.828|
## |SHR   |FALSE      |TRUE       |  0.575|           0|        2.828|
## |SHR   |TRUE       |FALSE      |  0.425|           0|       35.465|
## |SHR   |TRUE       |TRUE       |  0.000|           0|       37.357|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    0.245|     0.234|
## |mean_temp_roms_30_norm        |    6.816|     0.510|
## |I(mean_temp_roms_30_norm^2)   |   -2.297|     0.192|
## |mean_oxygen_roms_30_norm      |    0.461|     0.331|
## |I(mean_oxygen_roms_30_norm^2) |   -0.292|     0.145|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -3.528|     0.440|
## |s(mean_temp_roms_30_norm).1   |   13.918|     1.161|
## |s(mean_temp_roms_30_norm).2   |    6.485|     0.477|
## |s(mean_oxygen_roms_30_norm).1 |    1.090|     0.787|
## |s(mean_oxygen_roms_30_norm).2 |   -0.125|     0.177|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.221|     0.463|
## |mean_temp_roms_30_norm        |    4.773|     0.595|
## |I(mean_temp_roms_30_norm^2)   |   -1.645|     0.209|
## |mean_oxygen_roms_30_norm      |    1.768|     0.432|
```

```
## |I(mean_oxygen_roms_30_norm^2) |   -0.464|     0.161|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -4.066|     0.615|
## |s(mean_temp_roms_30_norm).1   |    9.924|     1.253|
## |s(mean_temp_roms_30_norm).2   |    4.442|     0.573|
## |s(mean_oxygen_roms_30_norm).1 |    2.374|     0.908|
## |s(mean_oxygen_roms_30_norm).2 |    1.081|     0.278|
```

YEL: Yelloweye Rockfish

```
##
##
## |Group |Spatial RF |Env Spline |Weight | Convergence| Matern Range|
## |:-----|:----------|:----------|:------|-----------:|------------:|
## |YEL   |FALSE      |FALSE      |NA     |           0|        2.828|
## |YEL   |FALSE      |TRUE       |NA     |           0|        2.828|
## |YEL   |TRUE       |FALSE      |NA     |           0|       40.781|
## |YEL   |TRUE       |TRUE       |NA     |           0|       41.324|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |    1.582|     0.339|
## |mean_temp_roms_30_norm        |    1.351|     0.867|
## |I(mean_temp_roms_30_norm^2)   |   -2.491|     0.559|
## |mean_oxygen_roms_30_norm      |    4.908|     0.720|
## |I(mean_oxygen_roms_30_norm^2) |   -2.405|     0.415|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -3.022|     0.848|
## |s(mean_temp_roms_30_norm).1   |   10.944|     2.378|
## |s(mean_temp_roms_30_norm).2   |   -0.063|     0.585|
## |s(mean_oxygen_roms_30_norm).1 |   11.327|     1.943|
## |s(mean_oxygen_roms_30_norm).2 |    1.582|     0.292|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -1.538|     0.887|
## |mean_temp_roms_30_norm        |    2.946|     1.165|
## |I(mean_temp_roms_30_norm^2)   |   -3.847|     0.891|
## |mean_oxygen_roms_30_norm      |    5.798|     0.892|
## |I(mean_oxygen_roms_30_norm^2) |   -2.511|     0.458|
##
##
## |term                          | estimate| std.error|
## |:-----------------------------|--------:|---------:|
## |(Intercept)                   |   -7.354|     1.409|
```

```
## |s(mean_temp_roms_30_norm).1   |   15.975|     3.579|
## |s(mean_temp_roms_30_norm).2   |    0.628|     0.773|
## |s(mean_oxygen_roms_30_norm).1 |   12.032|     2.157|
## |s(mean_oxygen_roms_30_norm).2 |    2.328|     0.444|
```