Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries.

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UCSC :: CSTAR :: SWFSC :: NMFS

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Diagnostic

Show Example

Beta-Binomial Model

$$y_{ijklm\eta} \sim \text{Beta-Binomial}\Big(\mu_{jklm\eta},\ \sigma^2_{jklm\eta}\Big)$$

$$\mu_{jklm\eta} = n\ \text{logit}^{-1}(\theta_{jklm\eta})$$

$$\sigma^2_{jklm\eta} = \mu_{jklm\eta}\Big(1 - \frac{\mu_{jklm\eta}}{n}\Big)\Big(1 + (n-1)\ \rho\Big)$$

$$\theta_{jklm\eta} = \beta_0 + \beta^{(s)}_j + \beta^{(p)}_k + \beta^{(g)}_l + \beta^{(t)}_{m\eta}\beta^{(y:q)}_{m\eta}$$

$y_{ijklm\eta}$: i^{th} sample of the j^{th} species' integer weight, in the k^{th} port, caught with the l^{th} gear, in the η^{th} quarter, of year m, for a particular market category.

$j \in \{1, ..., J\}$ Species
$k \in \{1, ..., K\}$ Ports
$l \in \{1, ..., L\}$ Gears
$m \in \{1, ..., M\}$ Years
$\eta \in \{1, ..., H\}$ Quarters

Time Models

(M1)

$$\beta_{m\eta}^{(t)} = \beta_m^{(y)} + \beta_\eta^{(q)}$$
$$\beta_m^{(y)} \sim N(0, 32^2)$$
$$\beta_\eta^{(q)} \sim N(0, 32^2)$$

(M2)

$$\beta_{m\eta}^{(t)} = \beta_m^{(y)} + \beta_\eta^{(q)}$$
$$\beta_m^{(y)} \sim N(0, v^{(y)})$$
$$\beta_\eta^{(q)} \sim N(0, v^{(q)})$$

(M3)

$$\beta_{m\eta}^{(t)} = \beta_m^{(y)} + \beta_\eta^{(q)} + \beta_{m\eta}^{(y:q)}$$
$$\beta_m^{(y)} \sim N(0, v^{(y)})$$
$$\beta_\eta^{(q)} \sim N(0, v^{(q)})$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v)$$

(M4)

$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v)$$

(M5)

$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v_\eta)$$

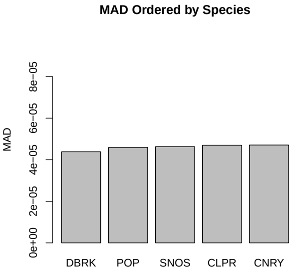
(M6)

$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v_m)$$

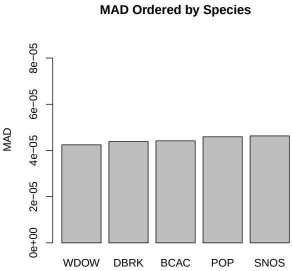
MCAT 250

	M1	M2	M3	M4	M5	M6
Δ DIC	6448.98	0.33	0	4.45	9.3	7.42
Δ WAIC	6421.5	0.37	0	4.52	8.25	6.55
$pr(M\|y)$	0	0	0	0.03	0	0.97

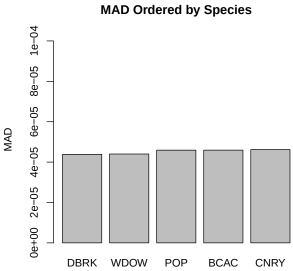
M2

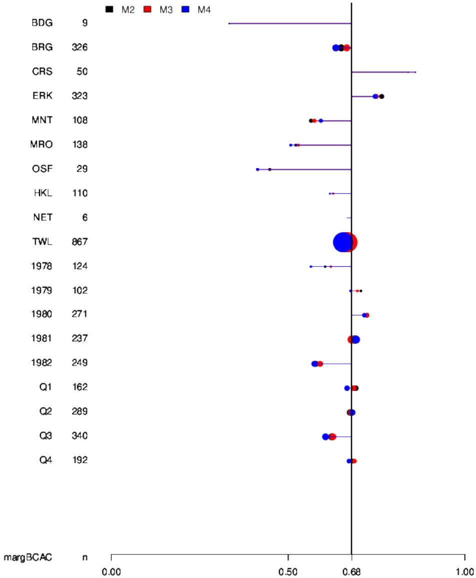

MAD Ordered by Species
MAD
0e+00
2e−05
4e−05
6e−05
8e−05
DBRK
POP
SNOS
CLPR
CNRY

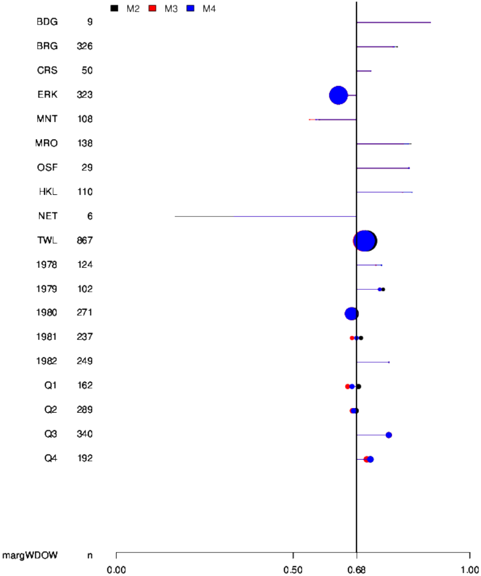
M3


MAD Ordered by Species
MAD
0e+00
2e−05
4e−05
6e−05
8e−05
WDOW
DBRK
BCAC
POP
SNOS

M4


MAD Ordered by Species
MAD
0e+00
2e−05
4e−05
6e−05
8e−05
1e−04
DBRK
WDOW
POP
BCAC
CNRY


M2 M3 M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margBCAC n
0.00
0.50
0.68
1.00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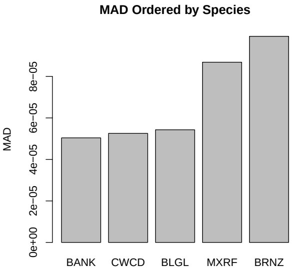
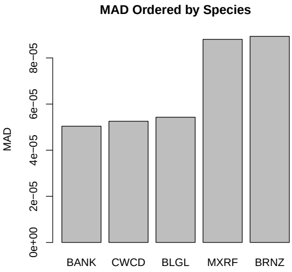
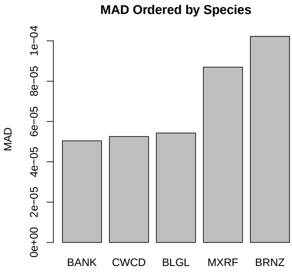
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margWDOW n
0.00
0.50
0.68
1.00

M2 M3 M4


MAD Ordered by Species
MAD
0e+00 2e−05 4e−05 6e−05 8e−05
BANK CWCD BLGL MXRF BRNZ


MAD Ordered by Species
MAD
0e+00 2e−05 4e−05 6e−05 8e−05
BANK CWCD BLGL MXRF BRNZ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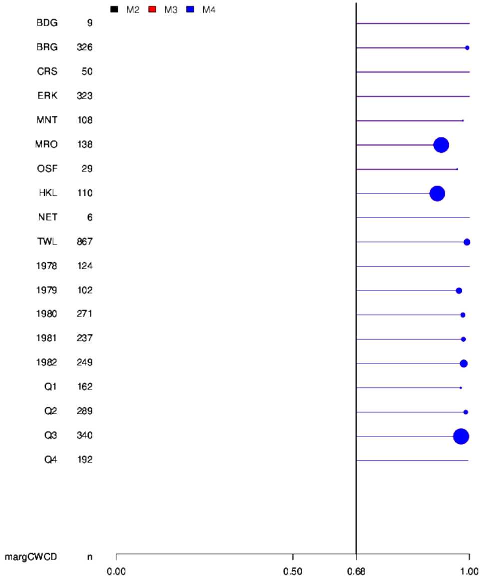
BANK CWCD BLGL MXRF BRNZ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M3
M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
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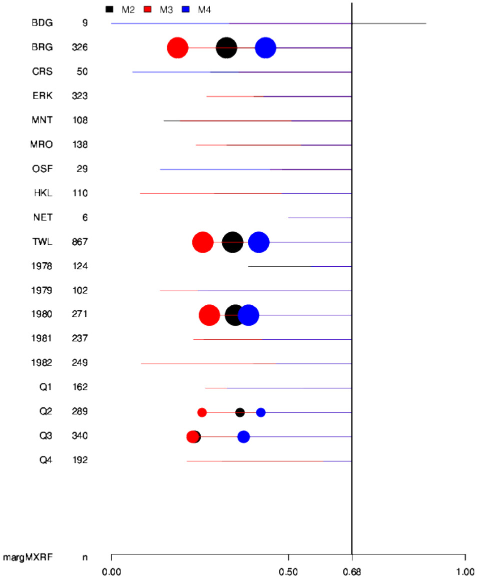
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margCWCD n
0.00
0.50
0.68
1.00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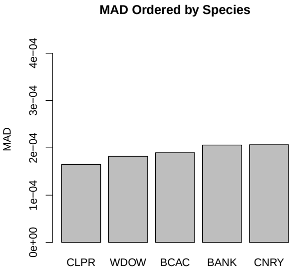
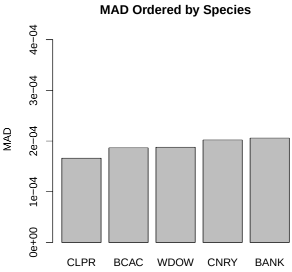
M3
M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF
n
0.00
0.50
0.68
1.00

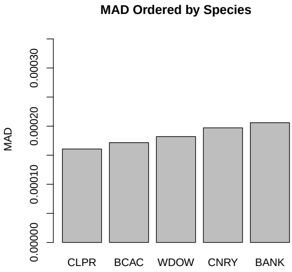
MCAT 253

	M1	M2	M3	M4	M5	M6
Δ DIC	1409.81	0.09	0.1	0.07	0.05	0
Δ WAIC	1391.66	0.16	0.18	0	0.13	0.08
$pr(M\|y)$	0	0	0	1	0	0

M4	M5	M6


MAD Ordered by Species
MAD
0e+00
1e−04
2e−04
3e−04
4e−04
CLPR
WDOW
BCAC
BANK
CNRY


MAD Ordered by Species
MAD
0e+00
1e−04
2e−04
3e−04
4e−04
CLPR
BCAC
WDOW
CNRY
BANK


MAD Ordered by Species
MAD
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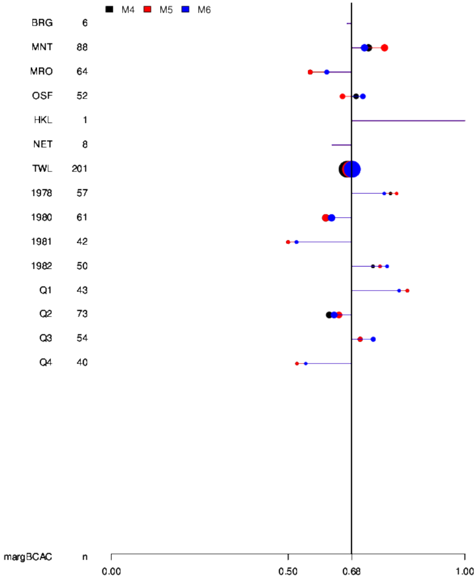
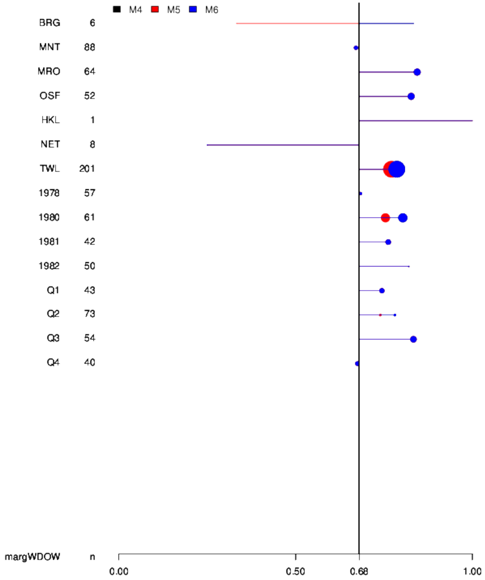
0.00010
0.00020
0.00030
CLPR
BCAC
WDOW
CNRY
BANK


M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00


M4
M5
M6
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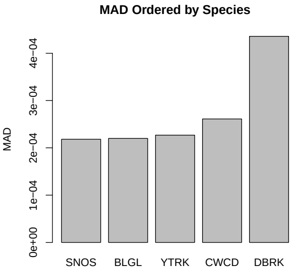
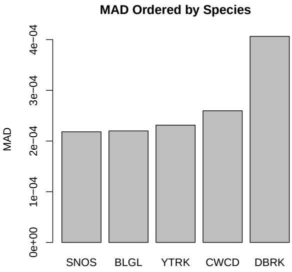
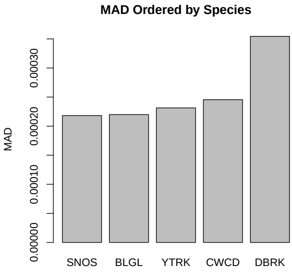
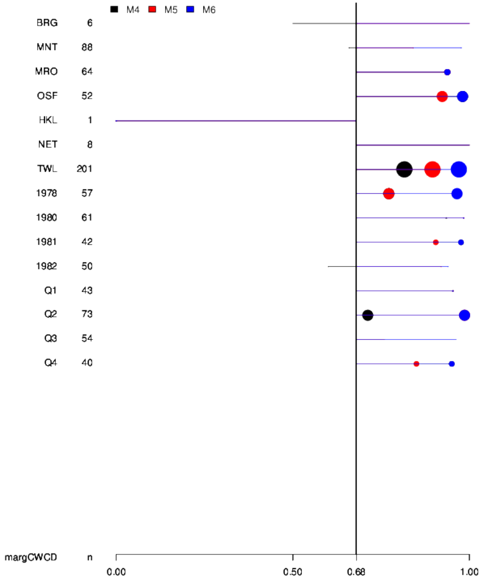
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margWDOW n
0.00
0.50
0.68
1.00

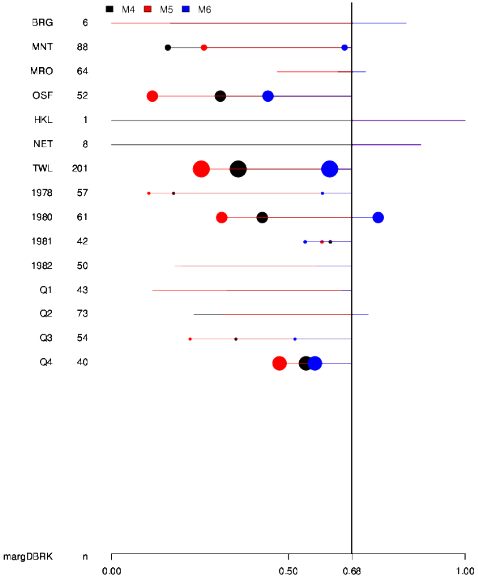
M4 M5 M6


MAD Ordered by Species
MAD
0e+00
1e−04
2e−04
3e−04
4e−04
SNOS
BLGL
YTRK
CWCD
DBRK


MAD Ordered by Species
MAD
0e+00
1e−04
2e−04
3e−04
4e−04
SNOS
BLGL
YTRK
CWCD
DBRK


MAD Ordered by Species
MAD
0.00000
0.00010
0.00020
0.00030
SNOS
BLGL
YTRK
CWCD
DBRK

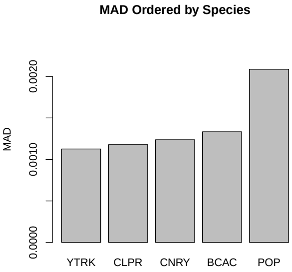

M4 M5 M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCWCD n
0.00
0.50
0.68
1.00

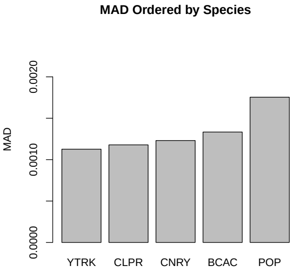

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

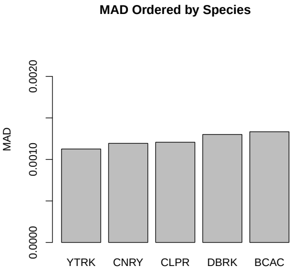
MCAT 269

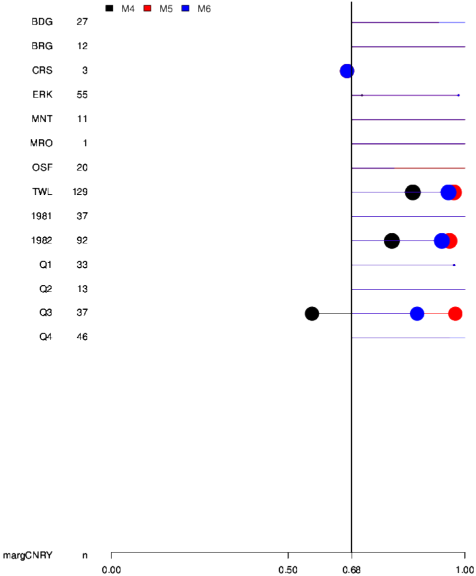
	M1	M2	M3	M4	M5	M6
Δ DIC	572.51	176.63	599.41	0.57	0	193.35
Δ WAIC	427.48	69.37	454.41	0.23	0	78.07
$pr(M\|y)$	0	0	0	0	0	1

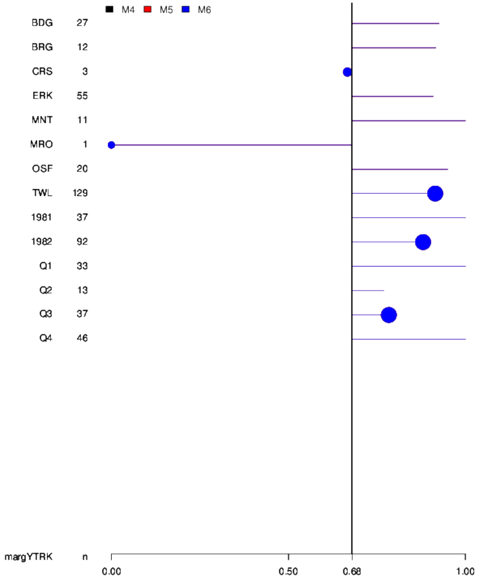
M4 M5 M6


MAD Ordered by Species
MAD
0.0000
0.0010
0.0020
YTRK
CLPR
CNRY
BCAC
POP


MAD Ordered by Species
MAD
0.0000
0.0010
0.0020
YTRK
CLPR
CNRY
BCAC
POP


MAD Ordered by Species
MAD
0.0000
0.0010
0.0020
YTRK
CNRY
CLPR
DBRK
BCAC


M4 M5 M6
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margCNRY n
0.00 0.50 0.68 1.00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BRG 12
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ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
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1982 92
Q1 33
Q2 13
Q3 37
Q4 46
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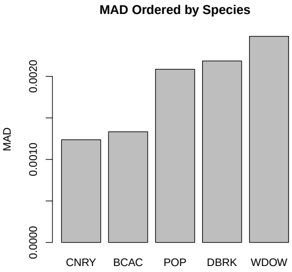
0.68
1.00

M4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MAD
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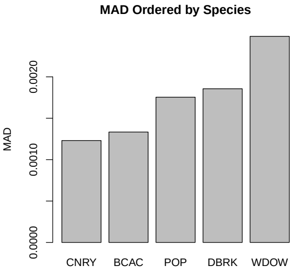
0.0010
0.0020
CNRY
BCAC
POP
DBRK
WDOW

M5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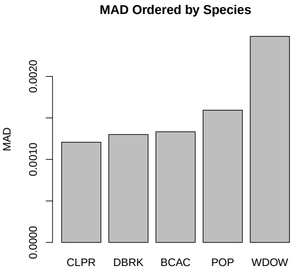
BCAC
POP
DBRK
WDOW

M6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CLPR
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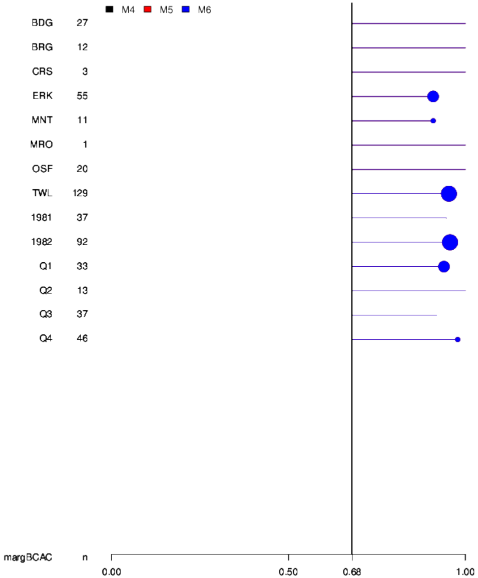
BCAC
POP
WDOW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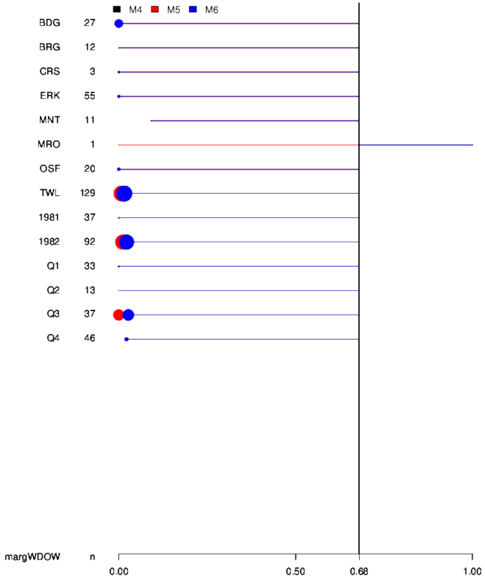
0.50
0.68
1.00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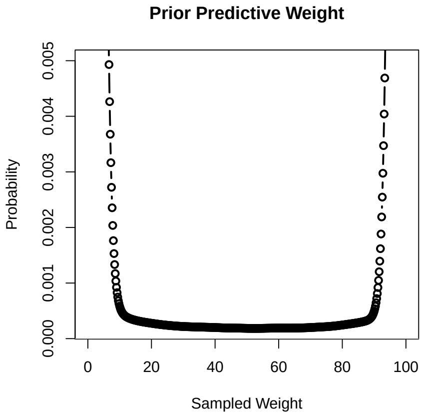
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margWDOW n
0.00
0.50
0.68
1.00

Priors

$$\beta_0 \propto 1$$
$$\beta_j^{(s)} \sim N(0, 32^2)$$
$$\beta_k^{(p)} \sim N(0, 32^2)$$
$$\beta_l^{(g)} \sim N(0, 32^2)$$

$$\text{logit}(\rho) \sim N(0, 2^2)$$

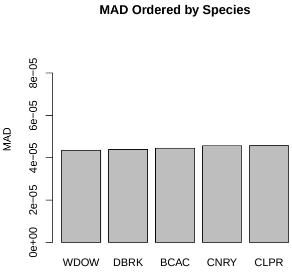
$$v \sim IG(1,\ 2x10^3) \quad \forall \quad v$$

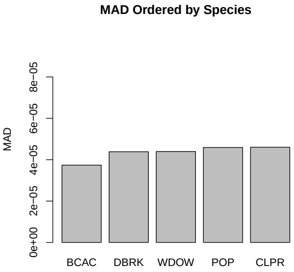


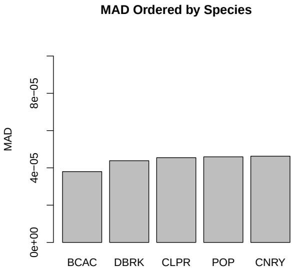
MCAT 250

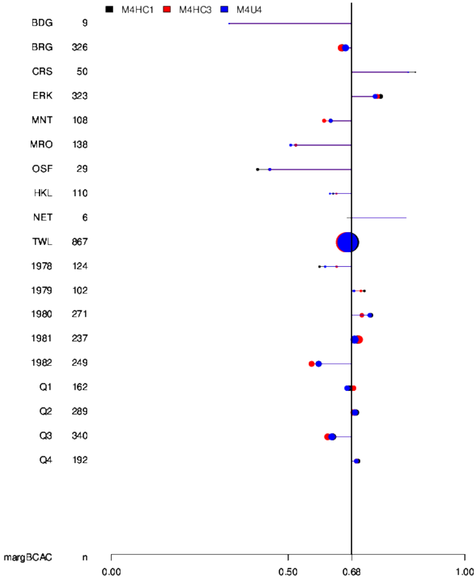
	M4	M4HC1	M4HC3	M4U4
Δ DIC	3.87	0.02	0.1	0
Δ WAIC	3.78	0.03	0.11	0
$pr(M\|y)$	0	0.21	0.37	0.42

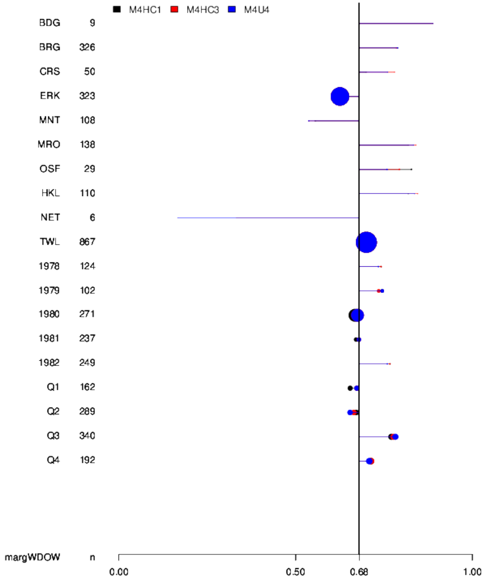
M4HC1 M4HC3 M4U4








M4HC1
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margBCAC n
0.00
0.50
0.68
1.00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M4HC3
M4U4
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BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
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1979 102
1980 271
1981 237
1982 249
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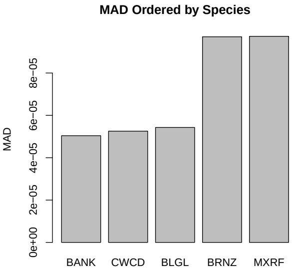
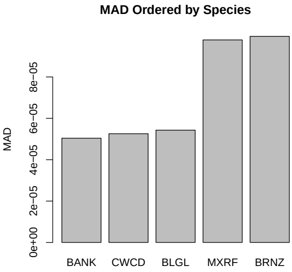
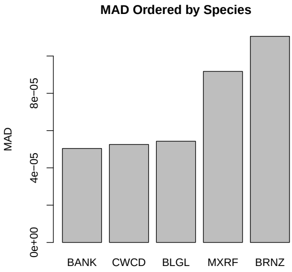
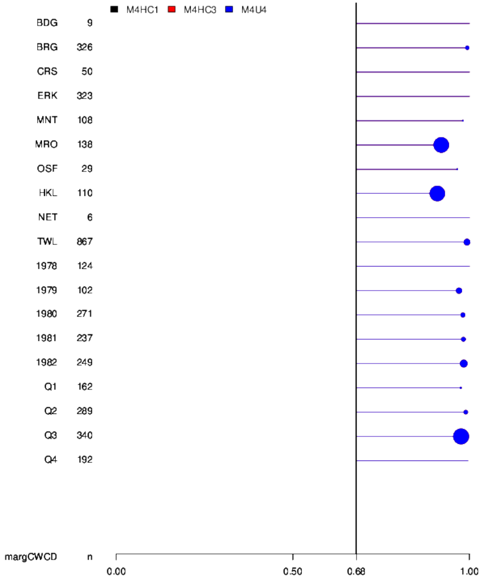
Q2 289
Q3 340
Q4 192
margWDOW n
0.00
0.50
0.68
1.00

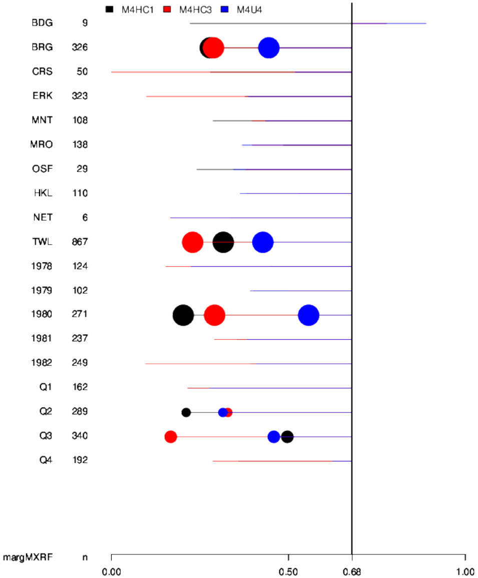
M4HC1 M4HC3 M4U4








M4HC1
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margCWCD n
0.00
0.50
0.68
1.00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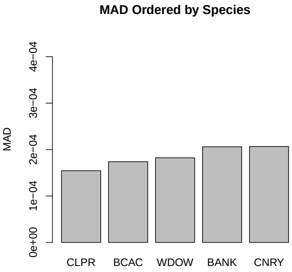
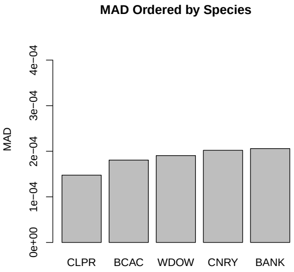
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

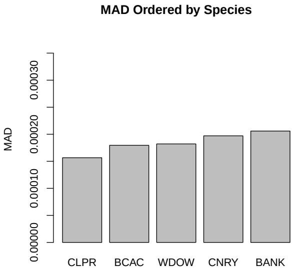
MCAT 253

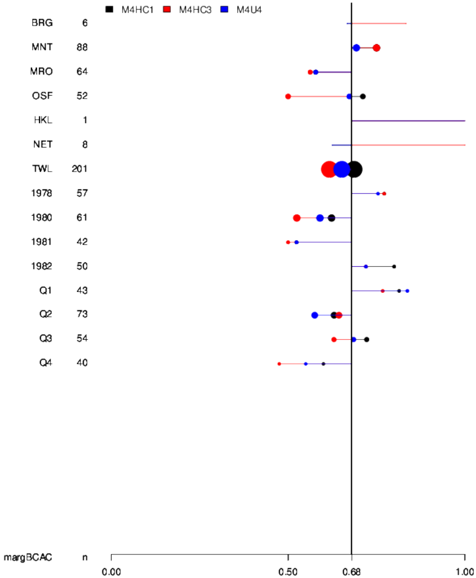
	M4	M4HC1	M4HC3	M4U4
Δ DIC	0.88	0.8	0.8	0
Δ WAIC	0.76	0.83	0.83	0
$pr(M\|y)$	0.01	0.99	0	0

M4HC1 M4HC3 M4U4





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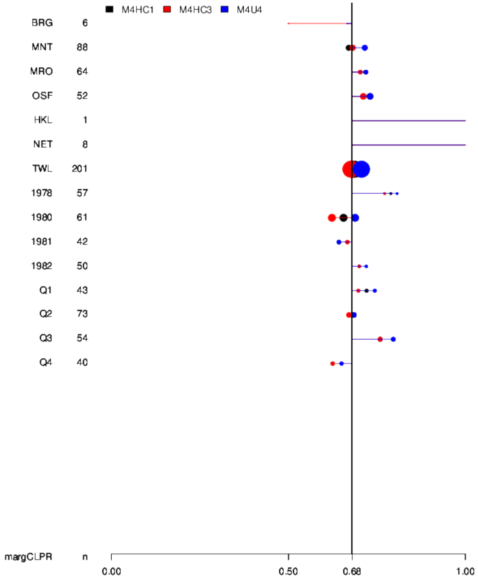
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00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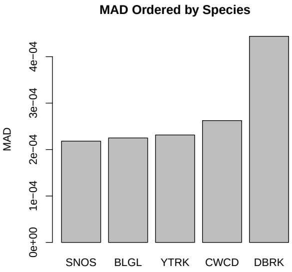
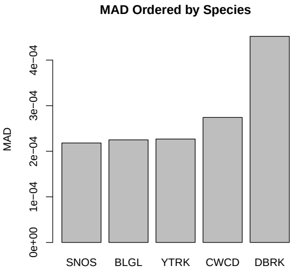
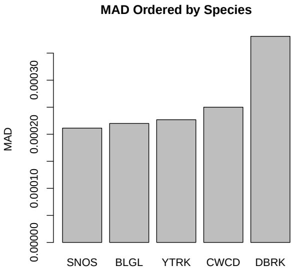
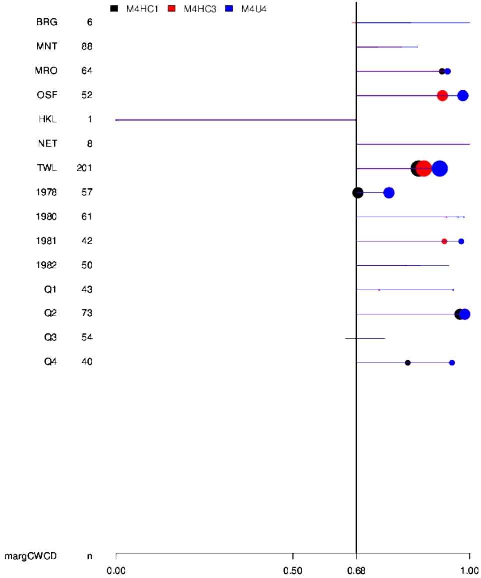
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCLPR n
0.00
0.50
0.68
1.00

M4HC1	M4HC3	M4U4





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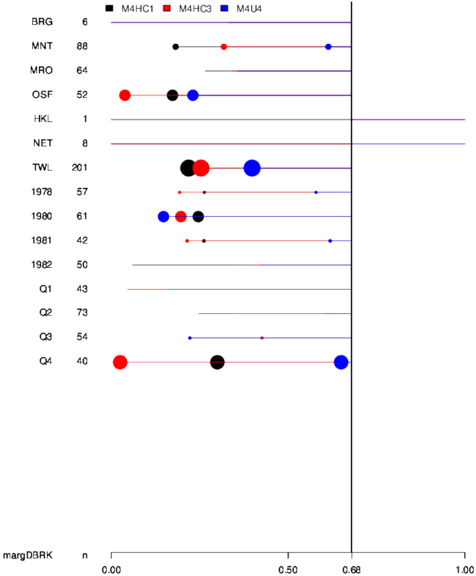
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCWCD n
0.00
0.50
0.68
1.00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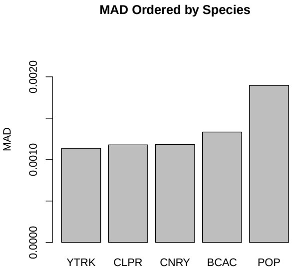
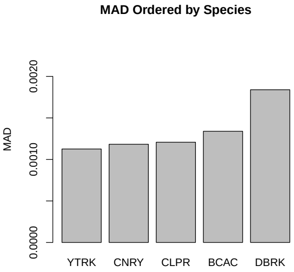
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

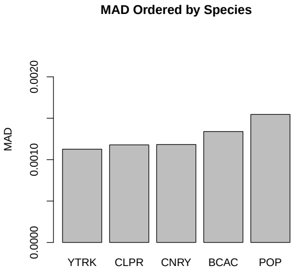
MCAT 269

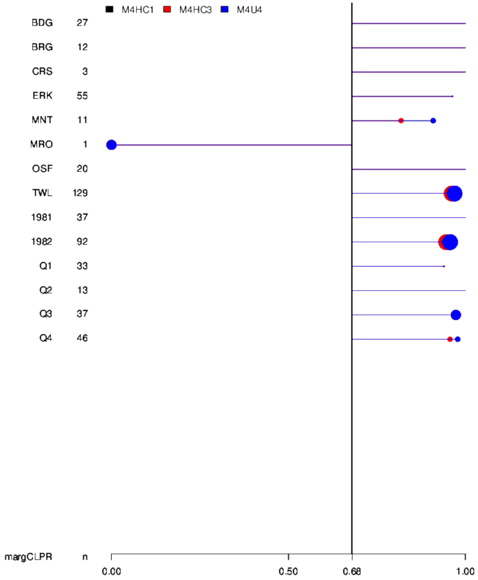
	M4	M4HC1	M4HC3	M4U4
Δ DIC	0.18	176.33	0.2	0
Δ WAIC	0.08	69.19	0.08	0
$pr(M\|y)$	0	1	0	0

M4HC1 M4HC3 M4U4





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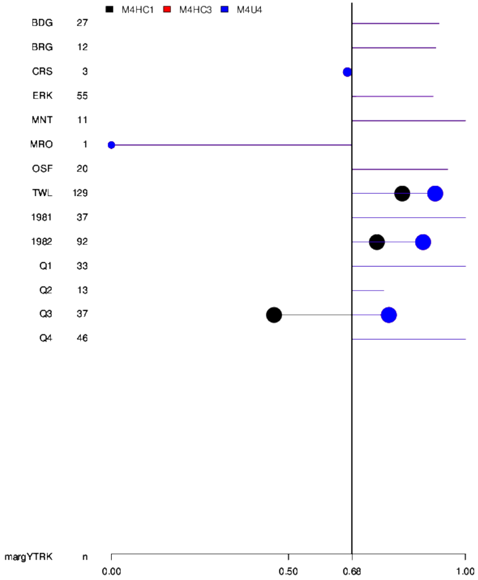
M4HC3
M4U4
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margCLPR n
0.00
0.50
0.68
1.00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M4HC3
M4U4
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BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margYTRK n
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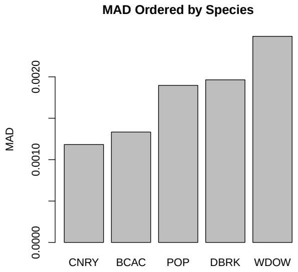
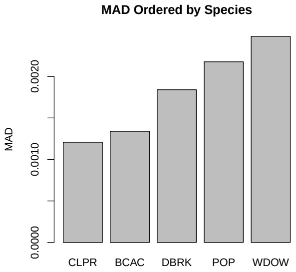
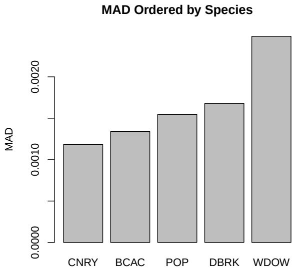
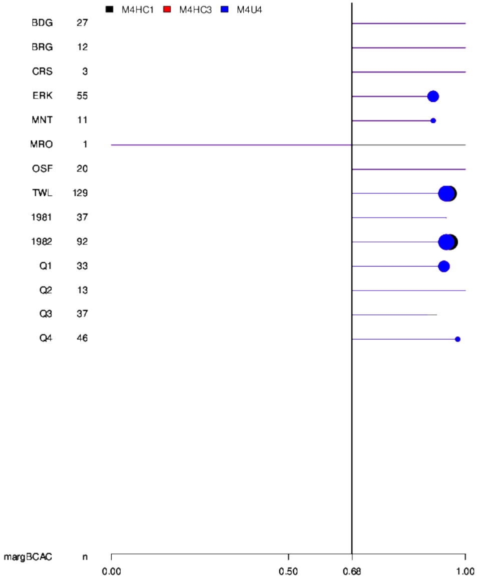
0.50
0.68
1.00

M4HC1 M4HC3 M4U4





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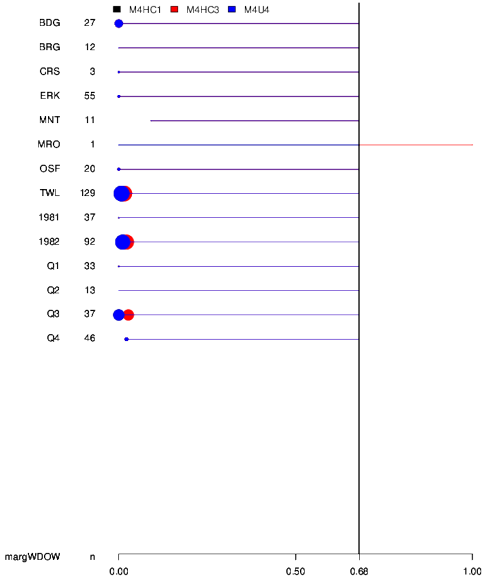
M4HC3
M4U4
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margBCAC n
0.00
0.50
0.68
1.00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BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margWDOW n
0.00
0.50
0.68
1.00

Port and Gear Interactions

Time Blocks

Proof: Species Comps Sum to One... as do Their Means.

If y_{jk} is the k^{th} draw, $k \in \{1, ..., K\}$, of the posterior predictive weight of species j in a particular stratum. Then,

$$\pi_{jk} = \frac{y_{jk}}{\sum_j y_{jk}} \quad \boldsymbol{y}_k \neq \boldsymbol{0}. \tag{1}$$

The predictive mean for species j is,

$$\hat{\pi}_j = \frac{\sum_k^K \pi_{jk}}{K}. \tag{2}$$

Summing $\hat{\pi}_j$ across species, it follows from (1) and (2) that,

$$\sum_j \hat{\pi}_j \overset{(2)}{=} \sum_j \frac{\sum_k^K \pi_{jk}}{K} = \frac{\sum_k^K \sum_j \pi_{jk}}{K} \overset{(1)}{=} \frac{\sum_k^K \sum_j \frac{y_{jk}}{\sum_j y_{jk}}}{K} = \frac{\sum_k^K 1}{K} = \frac{K}{K} = 1. \quad \blacksquare$$

Proof: Species Comps are Negatively Correlated.

Here we seek to show for any two species $l \neq m$, $Corr(\pi_l, \pi_m) < 0$.
Recall:

$$Corr(\pi_l, \pi_m) = \frac{Cov(\pi_l, \pi_m)}{\sigma_{\pi_l}\sigma_{\pi_m}} \quad \sigma_{\pi_l} \geq 0,\ \sigma_{\pi_m} \geq 0$$

$$Corr(\pi_l, \pi_m) \leq 0 \iff Cov(\pi_l, \pi_m) \leq 0$$

$$\begin{aligned} Cov(\pi_l, \pi_m) &= \mathbb{E}[(\pi_l - \mathbb{E}[\pi_l])(\pi_m - \mathbb{E}[\pi_m])] \\ &= \mathbb{E}[\pi_l\pi_m])] - \mathbb{E}[\pi_l]\mathbb{E}[\pi_m] \end{aligned}$$

$$Cov(\pi_l, \pi_m) \leq 0 \iff \mathbb{E}[\pi_l]\mathbb{E}[\pi_m] \geq \mathbb{E}[\pi_l\pi_m]$$

Proof: Species Comps are Negatively Correlated Cont.

Consider the strictly concave function: $f(\boldsymbol{x}) = \prod_i x_i : \sum_i x_i \leq 1,\ x_i \geq 0$.
Jensen's Inequality for f is,

$$f(\mathbb{E}[\boldsymbol{x}]) \geq \mathbb{E}[f(\boldsymbol{x})]. \tag{3}$$

From the previous proof: $\sum_j \pi_j \leq 1,\ \pi_j \geq 0$ and $\sum_j \hat{\pi}_j \leq 1,\ \hat{\pi}_j \geq 0$.
Thus applying (3) to $\boldsymbol{\pi}$ gives

$$\mathbb{E}[\pi_l]\mathbb{E}[\pi_m] \geq \mathbb{E}[\pi_l \pi_m] \tag{4}$$

with equality only if π is a constant. Since π is never a constant,

$$\mathbb{E}[\pi_l]\mathbb{E}[\pi_m] > \mathbb{E}[\pi_l \pi_m]$$
$$Cov(\pi_l, \pi_m) < 0$$
$$Corr(\pi_l, \pi_m) < 0. \quad \blacksquare$$