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.

$j \in \{1, \ldots, J\}$ Species

$k \in \{1, \ldots, K\}$ Ports

$l \in \{1, \ldots, L\}$ Gears

$m \in \{1, \ldots, M\}$ Years

$\eta \in \{1, \ldots, H\}$ Quarters

Time Models

(M1)

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

(M2)

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

(M3)

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

(M4)

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

(M5)

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

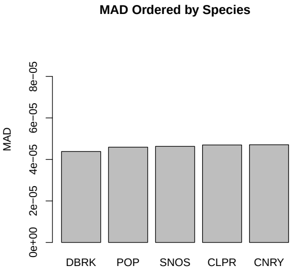
(M6)

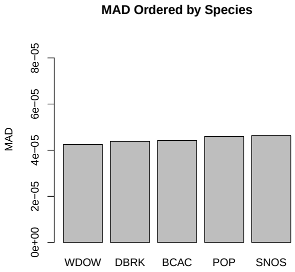
$$\beta^{(t)}_{m\eta} = \beta^{(y:q)}_{m\eta}$$
$$\beta^{(y:q)}_{m\eta} \sim N(0, v_{m})$$

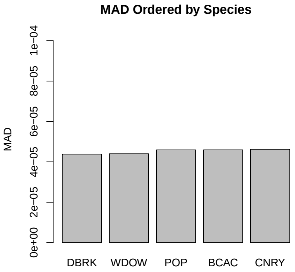
MCAT 250

	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	M3	M4


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


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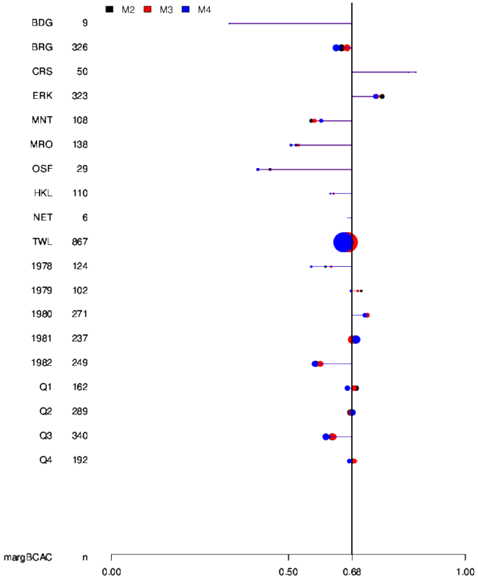
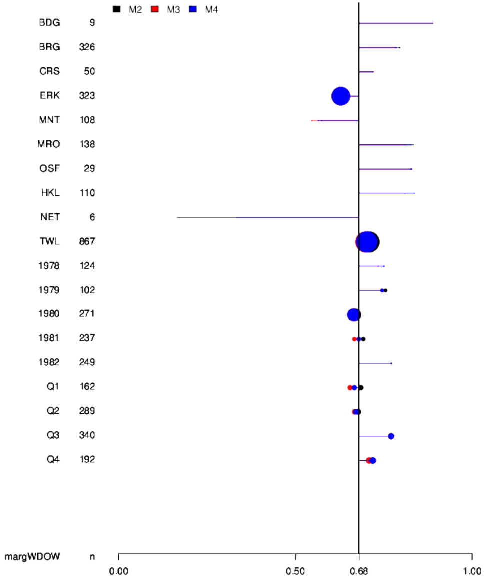
DBRK WDOW POP BCAC CNRY


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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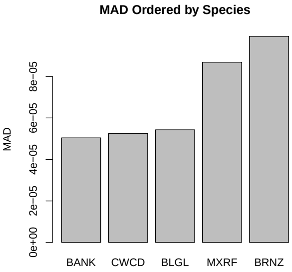
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margWDOW n
0.00
0.50
0.68
1.00

M2


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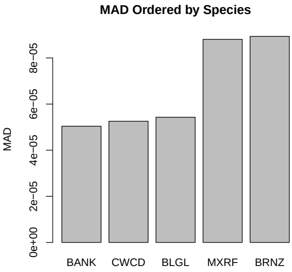
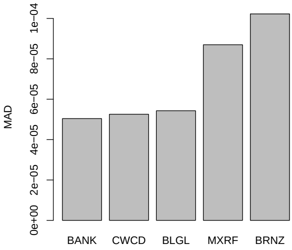
0e+00
2e−05
4e−05
6e−05
8e−05
BANK
CWCD
BLGL
MXRF
BRNZ

M3


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

M4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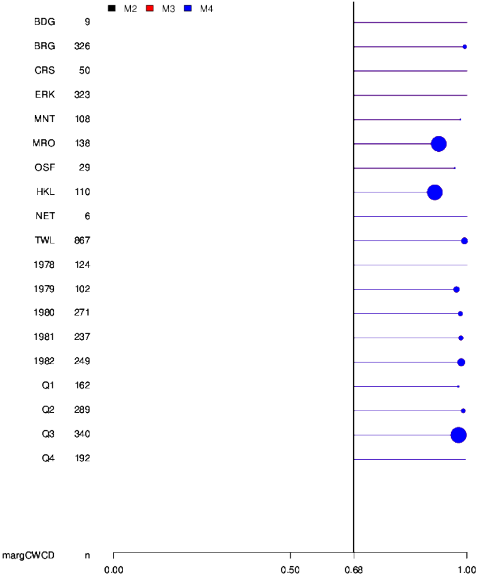
0e+00
2e−05
4e−05
6e−05
8e−05
1e−04
BANK
CWCD
BLGL
MXRF
BRNZ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M3
M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
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OSF 29
HKL 110
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Q2 289
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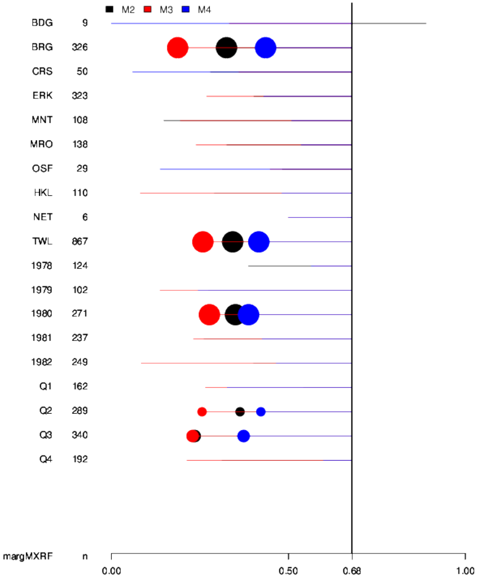
Q4 192
margCWCD n
0.00
0.50
0.68
1.00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BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
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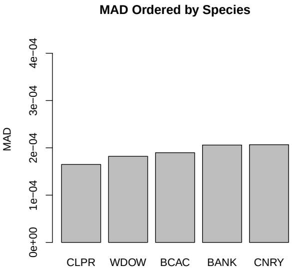
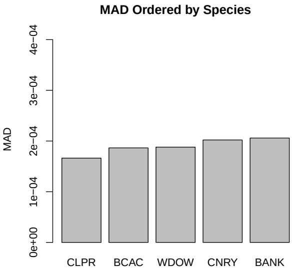
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

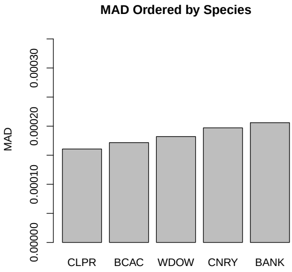
MCAT 253

	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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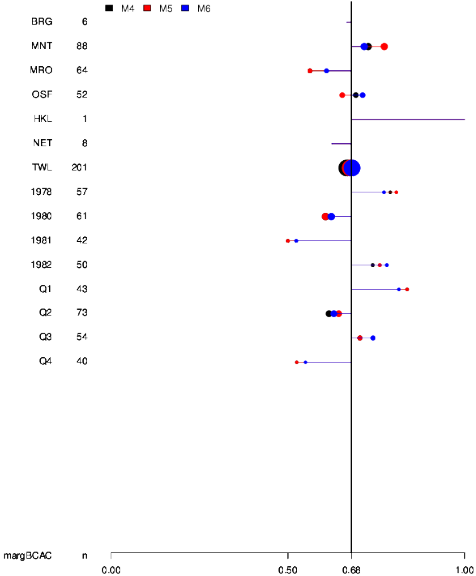
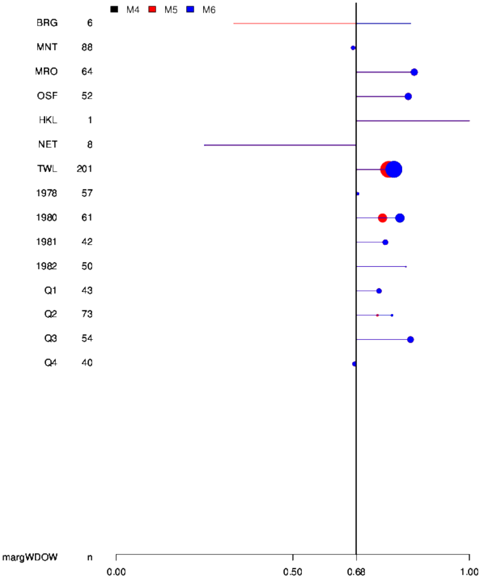
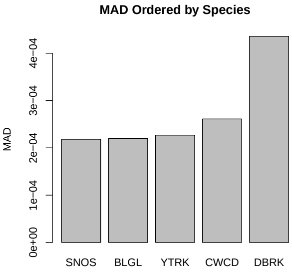
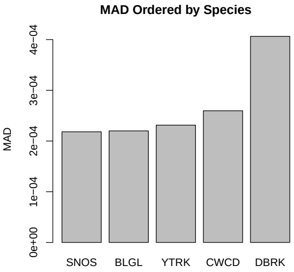
0.00010
0.00020
0.00030
CLPR
BCAC
WDOW
CNRY
BANK

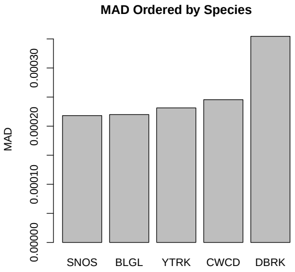

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00

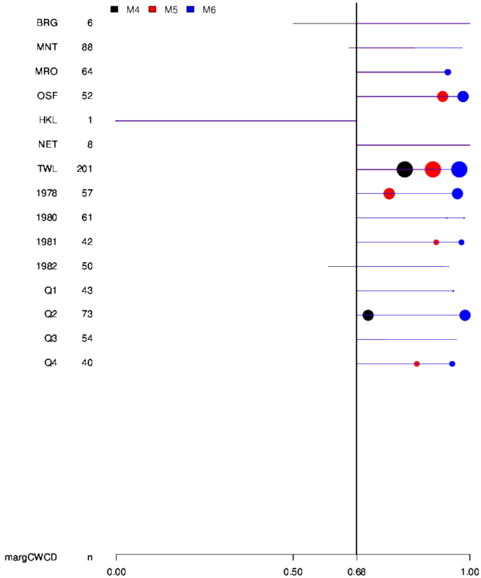

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margWDOW n
0.00
0.50
0.68
1.00

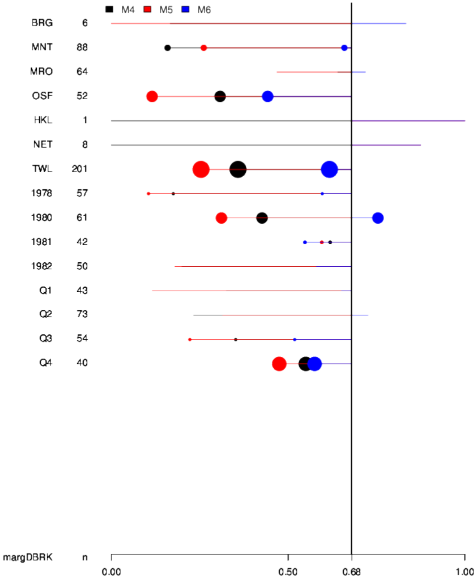
M4	M5	M6


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

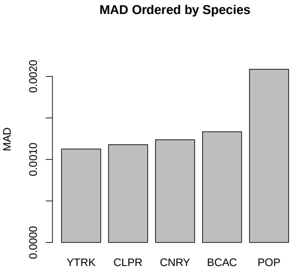

M4 M5 M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCWCD n
0.00
0.50
0.68
1.00

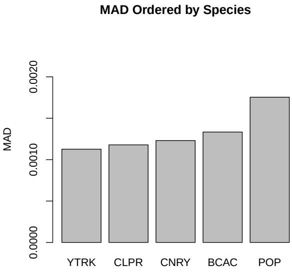

M4 M5 M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

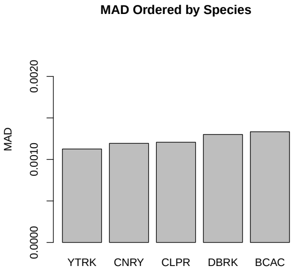
MCAT 269

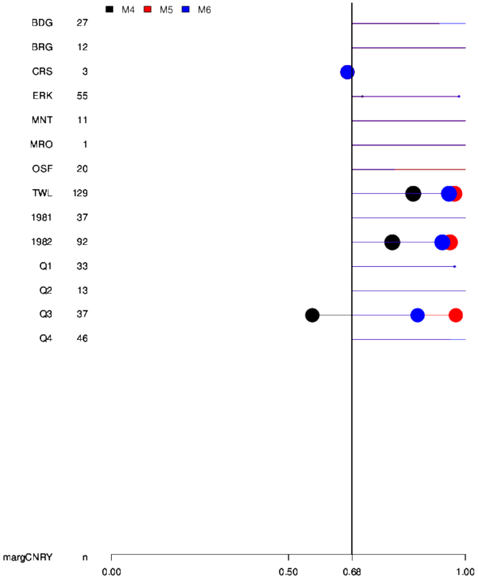
	M1	M2	M3	M4	M5	M6
Δ DIC	572.51	176.63	599.41	0.57	0	193.35
Δ WAIC	427.48	69.37	454.41	0.23	0	78.07
$pr(M\|y)$	0	0	0	0	0	1

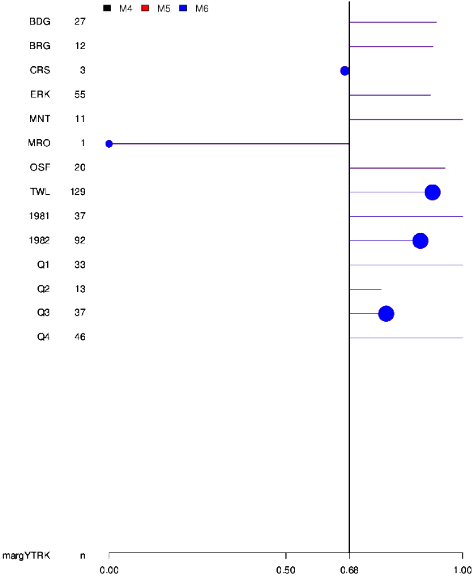
M4 M5 M6


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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BDG 27
BRG 12
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MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
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Q2 13
Q3 37
Q4 46
margYTRK n
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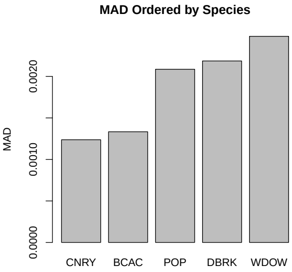
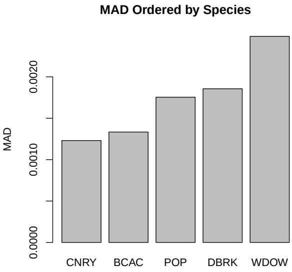
0.50
0.68
1.00

M4 M5 M6


MAD Ordered by Species
MAD
0.0000
0.0010
0.0020
CNRY
BCAC
POP
DBRK
WDOW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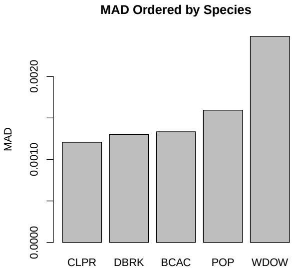
MAD Ordered by Species
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0.0000
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0.0020
CLPR
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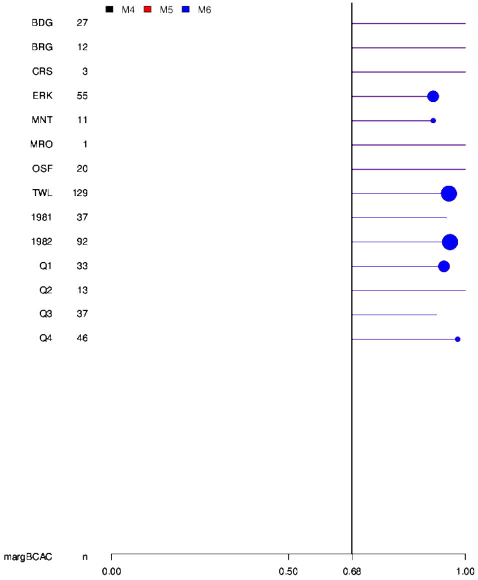
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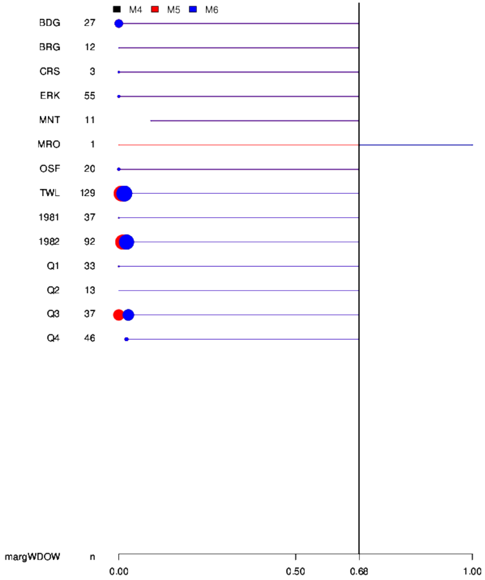
0.68
1.00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MRO 1
OSF 20
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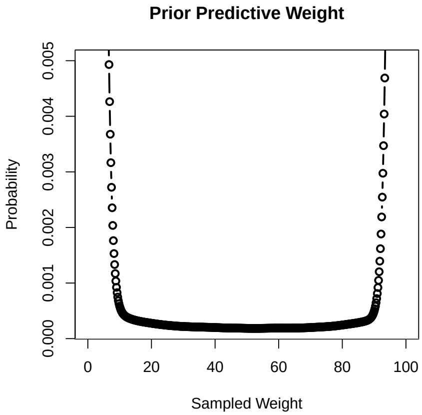
Q3 37
Q4 46
margWDOW n
0.00
0.50
0.68
1.00

Priors

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

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

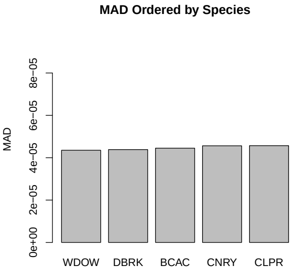
$$v \sim IG(1,\ 2x10^3) \quad \forall \quad v$$

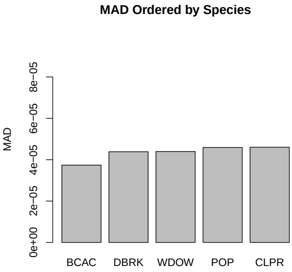


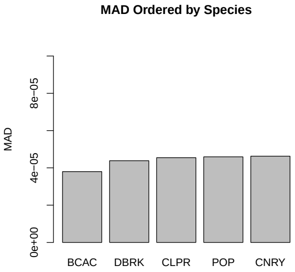
MCAT 250

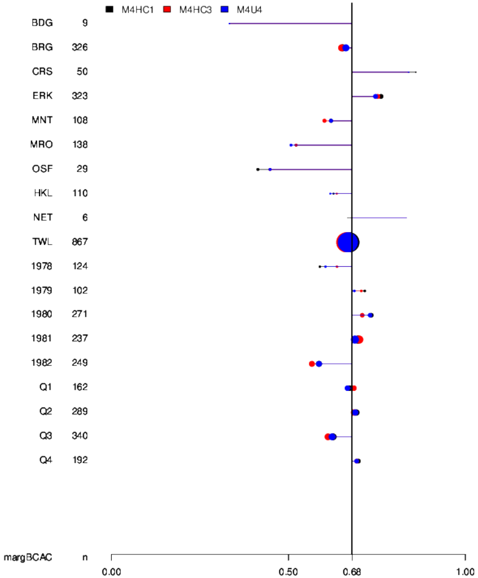
	M4	M4HC1	M4HC3	M4U4
Δ DIC	3.87	0.02	0.1	0
Δ WAIC	3.78	0.03	0.11	0
$pr(M\|y)$	0	0.21	0.37	0.42

M4HC1 M4HC3 M4U4








M4HC1
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
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MRO 138
OSF 29
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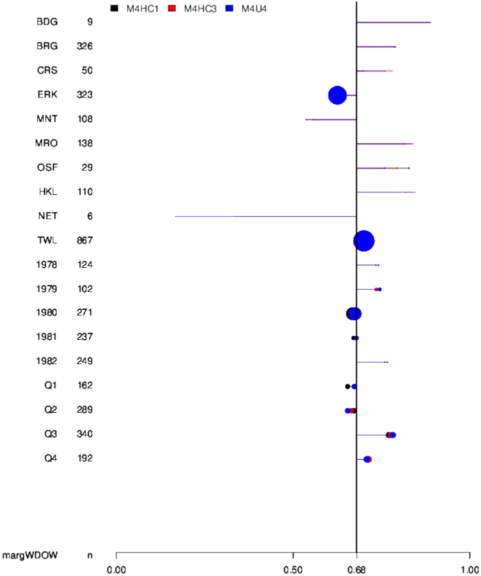
Q2 289
Q3 340
Q4 192
margBCAC n
0.00
0.50
0.68
1.00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M4HC3
M4U4
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BRG 326
CRS 50
ERK 323
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MRO 138
OSF 29
HKL 110
NET 6
TWL 867
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1982 249
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Q2 289
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Q4 192
margWDOW n
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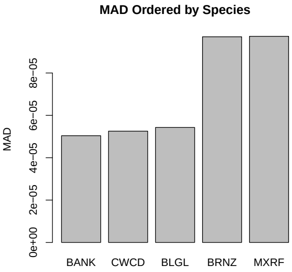
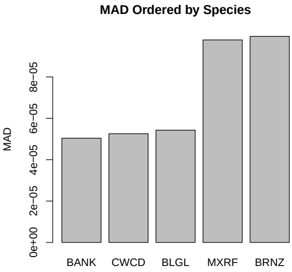
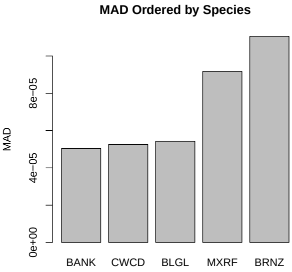
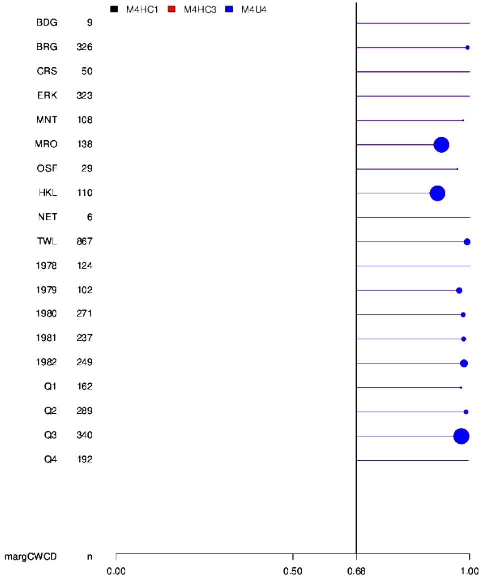
0.50
0.68
1.00

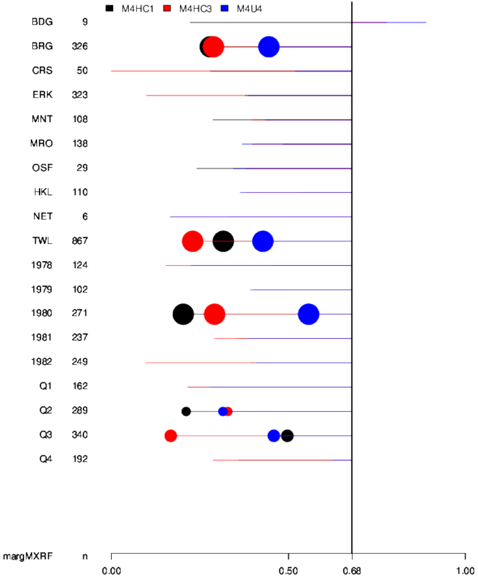
M4HC1	M4HC3	M4U4








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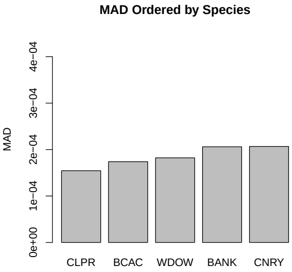
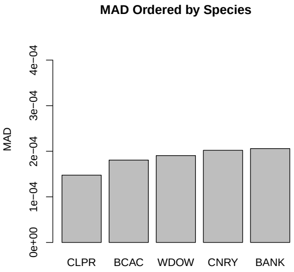
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

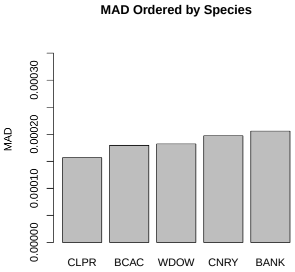
MCAT 253

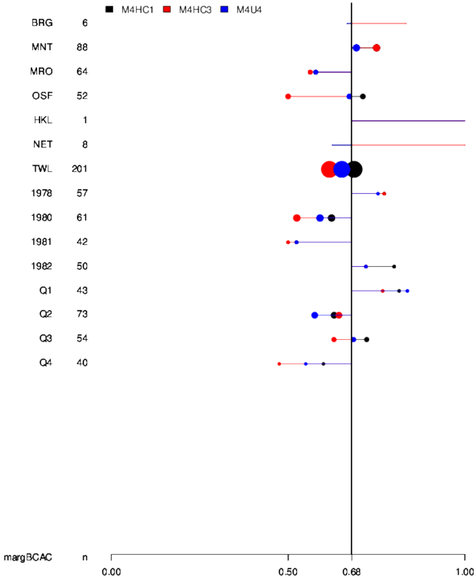
	M4	M4HC1	M4HC3	M4U4
Δ DIC	0.88	0.8	0.8	0
Δ WAIC	0.76	0.83	0.83	0
$pr(M\|y)$	0.01	0.99	0	0

M4HC1 M4HC3 M4U4





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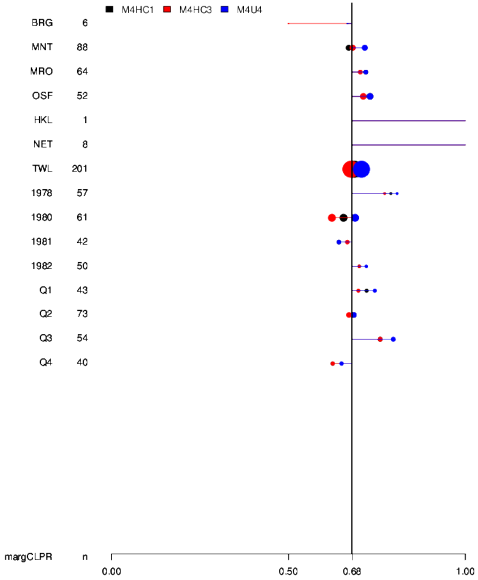
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00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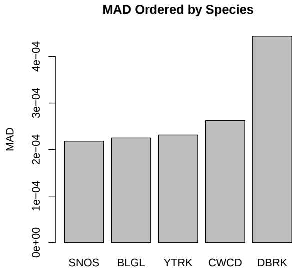
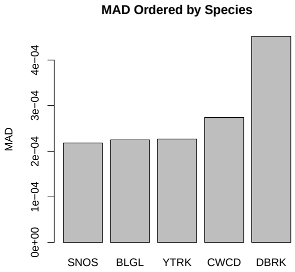
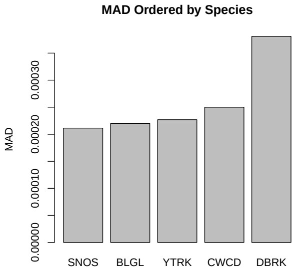
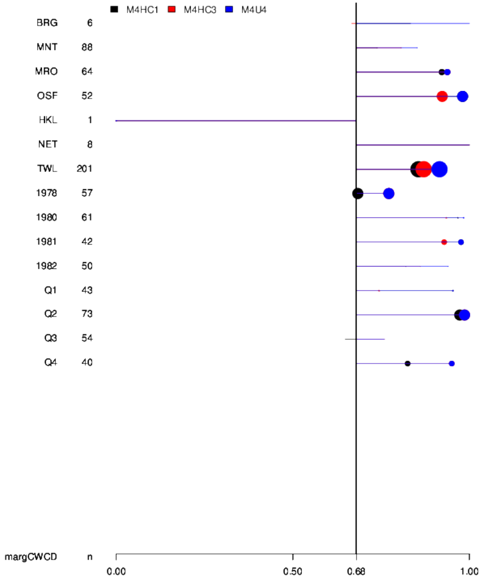
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCLPR n
0.00
0.50
0.68
1.00

M4HC1 M4HC3 M4U4





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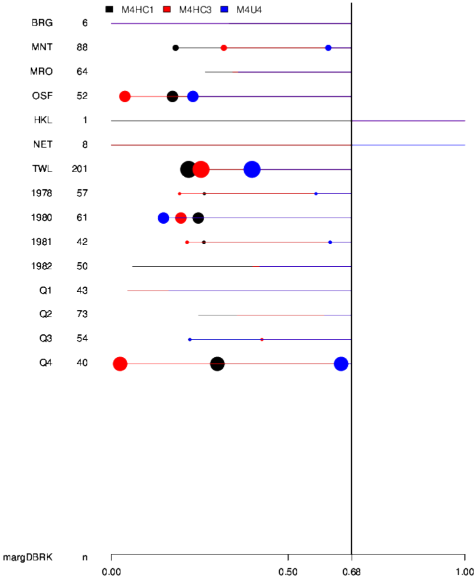
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCWCD n
0.00
0.50
0.68
1.00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M4U4
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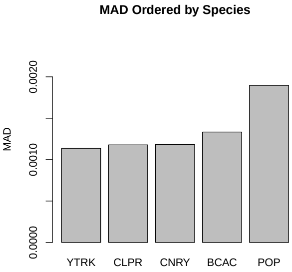
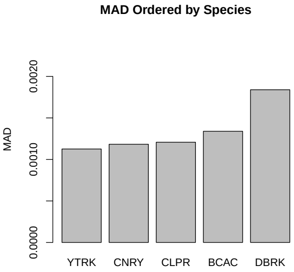
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

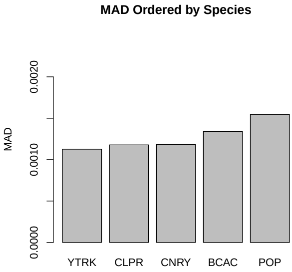
MCAT 269

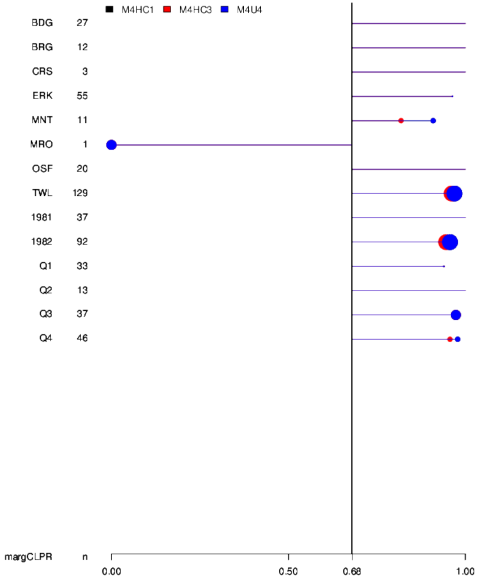
	M4	M4HC1	M4HC3	M4U4
Δ DIC	0.18	176.33	0.2	0
Δ WAIC	0.08	69.19	0.08	0
$pr(M\|y)$	0	1	0	0

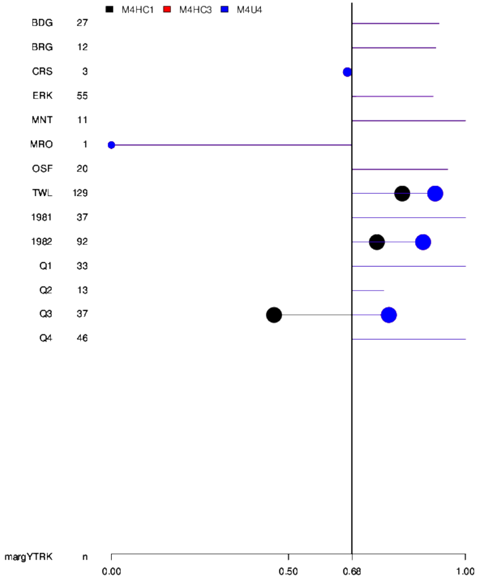
M4HC1 M4HC3 M4U4








M4HC1
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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ERK 55
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MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margYTRK n
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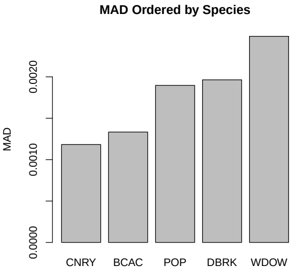
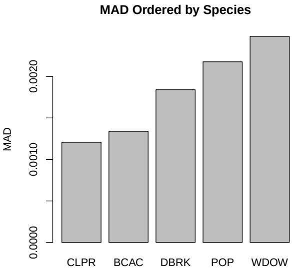
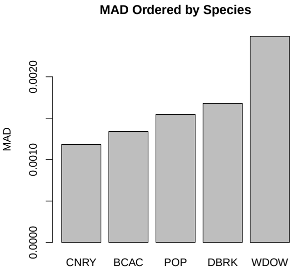
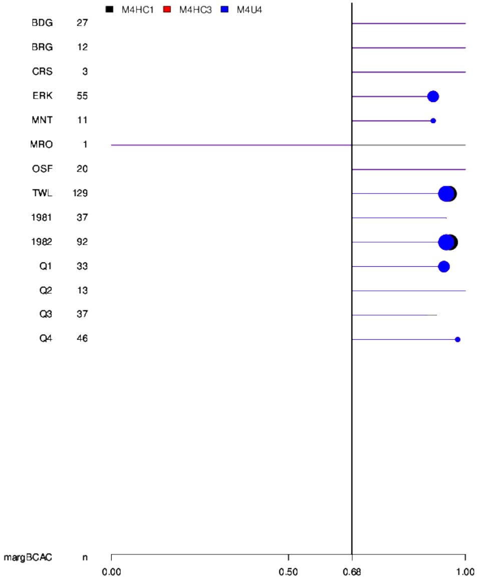
0.68
1.00

M4HC1 M4HC3 M4U4





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1981 37
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Q1 33
Q2 13
Q3 37
Q4 46
margBCAC n
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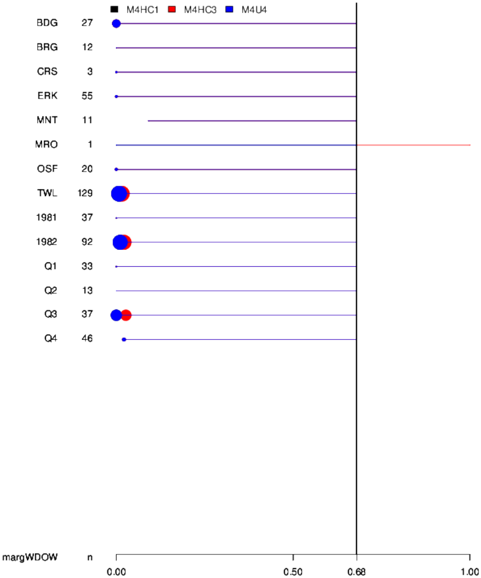
1.00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CRS 3
ERK 55
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MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margWDOW
n
0.00
0.50
0.68
1.00

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:

$$f(\boldsymbol{x}) = \prod_i x_i : \boldsymbol{x} \subset \left\{ \boldsymbol{y} \mid \sum_i y_i = 1,\ y_i \geq 0 \right\}$$

Jensen's Inequality for f is,

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

From the previous proof: $\sum_j \pi_j = 1,\ \pi_j \geq 0$ and $\sum_j \hat{\pi}_j = 1,\ \hat{\pi}_j \geq 0$.
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,

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