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

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In Cooperation With:
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UCSC :: CSTAR :: SWFSC :: NMFS

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Request: As a diagnostic template, for each sampled stratum compare the posterior predictive distributions at the 68th, 95th, and 99th percentiles with the current observed species proportions (create fully stratified versions of tables 2 and 3 in the Grunloh et al. methods documentation). With each row, include sample sizes and associated landing weights with a graphical display to highlight problems and outliers (circle size proportional to landing weights).

Rationale: The Team provided broad-scale summary metrics (e.g., MSE and DIC) for evaluating the goodness-of-fit of the different model forms and structures. Fine-scale diagnostics are needed to help identify aspects of the data that are not adequately addressed by the different models. The diagnostic template will provide a mechanism for fine-scale exploration of goodness-of-fit.

Response: The following slides show the requested diagnostic plot and demonstrate how to maneuver as well as interpret them.

Beta-Binomial Model

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

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

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

$$\theta_{jklm\eta} = \beta_0 + \beta_j^{(s)} + \beta_k^{(p)} + \beta_l^{(g)} + \beta_{m\eta}^{(t)}$$

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

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

	M4
DIC	38721
WAIC	38725

← click

Text underlined in green links to the appropriate diagnostics for all species and stratum.

- species-port-gear-year-qtr, species-gear-year, species-year
- disaggregated*.csv, gearYearSpp*.csv, yearSpp*.csv
- marginal plots by species

(M4)

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

MAD Diagnostic

Let ℓ_i be the landings in stratum i, $\mathcal{O}_{ij}$ be the observed predictive accuracy of species j in stratum i, and $\aleph$ be the nominal level of prediction for a particular model run. The Mean Absolute Deviation (MAD) for species j in stratum i is

$$\text{MAD}_{ij} = \frac{\ell_i}{\sum_i \ell_i} \left| \mathcal{O}_{ij} - \aleph \right| .$$

- Low MAD scores occur when ℓ_i is low -or- $|\mathcal{O}_{ij} - \aleph|$ is small.
- High MAD scores occur when ℓ_i is large and $|\mathcal{O}_{ij} - \aleph|$ is large.
- Thus high MAD scores represent important mistakes, and low MAD scores represent either unimportant mistakes, or important correctness :)

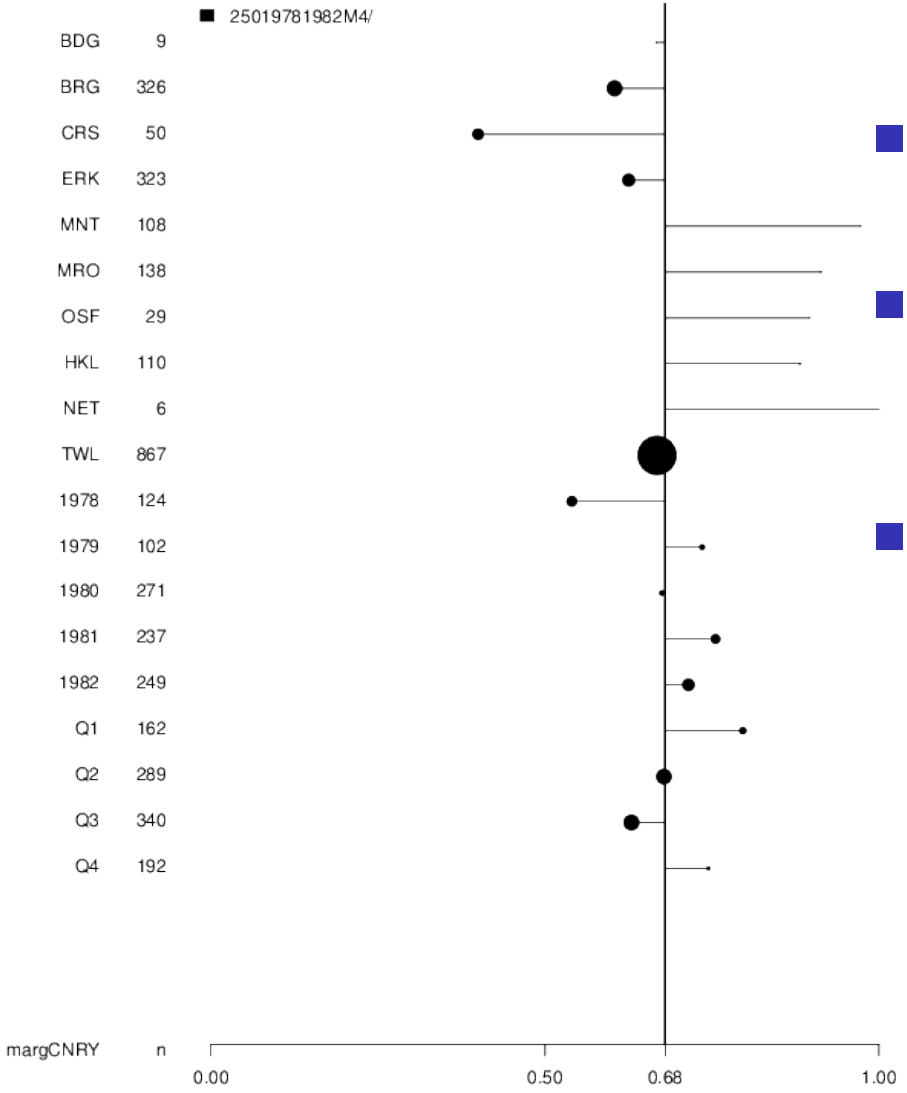
Stratum Plots

We show predictive accuracy at three levels of stratification:

- species-port-gear-year-qtr is fully disaggregated predictions.
- species-gear-year marginalizes over port and quarter; showing marginalized predictions by species, gear, and year.
- species-year marginalizes over port, quarter, and gear; showing marginalized predictions by species and year.

In each run's directory (here is M4's) disaggregated*.csv, gearYearSpp*.csv, yearSpp*.csv are csv versions of these images.

Diagnostic Tutorial



- Marginal Plots condition on a single species (CNRY here).
- For a particular species, each row conditions on a single stratum and marginalizes over all other strata.
- Use:
  - Sort species by MAD score.
  - Given a particular species, explore margins via marginal plots.
  - Explore within the margins via the previously described stratum plots.

Request: Provide a summary table of species sample sizes in each market category by time block.

Rationale: The requested information will assist in understanding where there are gaps in the available data that the model is filling in by means of its pooling structure.

Response: The following slides show tables of total sample sizes and the frequency of occurrence by species within each sample (across all years, gears, ports and quarters within a time period) for the three rockfish market categories that we focus on in the presentation, as well as elasmobranchs and flatfish. Supplementary excel files include data summaries and pivot tables that can be used to review the same information for all other market categories, as well as these and other market categories at higher levels of stratification (year, port complex, gear, quarter) to address specific questions or concerns.

This table shows the total number of samples for Market Category 250 (Unspecified rockfish) in five major time periods. The sparseness of some species in the sample data (e.g., bronzespotted rockfish in the 1978-1982 period, when just one was encountered) directly relates to the challenges and poor diagnostics in the fits for such rare species.

Market Category 250: Unspecified Rockfish

	1978-82	1983-90	1991-99	2000-09	2010-17
Total Samples	1021	2933	2020	24	15
ARRA	25	194	105		
BANK	90	1179	517	3	
BCAC	719	1980	408	2	
BLCK	67	60	240		1
BLGL	31	697	355	2	
BLUR	11	24	345	6	
BRNZ	1	36	5		
BRWN	8	9	80		3
BYEL		2	21		1
CBZN	1		42	2	
CHNA		1	46		
CLCO			2		
CLPR	550	1760	855	3	
CMEL		76	8		
CNRY	358	482	143		
COPP	7	23	97		6
CWCD	16	132	127	1	1
DBRK	153	719	334	3	
DOVR			1		
EGLS	1				
FLAG	8	60	59	1	1
GBLC	6	44	27		
GPHR		1	74		2
GRAS	1	1	25		
GSPT	162	365	224	3	2
GSRK	87	269	170		
HBRK		1		1	
HNYC		2	1		
KLPG			47	1	
KLPR			33	2	
LCOD	32	31	31		
LSPN	2	9	2		
MISC	9	8			
MXRF	2	34	10		
OLVE	8	23	186	5	
OWFS			2		

	1978-82	1983-90	1991-99	2000-09	2010-17
Total Samples	1021	2933	2020	24	15
PGMY			1		
PNKR		18	14		
POP	1	1			
POP	50	232	67		
PRRK		1			
PWHT		1			
QLBK	1	2	31		
RDBD	83	230	104	1	
REDS	5	19	22		
REX	1				
REYE	1	4	20	1	
ROSY	4	10	38		1
RSTN	4	27	41		
SABL	1	4	3		
SBLY	4	28	25		
SCLP			1		
SHPD			1		
SHRP	2	95	121		
SLGR	1	13	5		
SNOS	96	705	334	2	
SPKL	35	111	143		
SQRS		5	9		1
SRKR		1	3		
SSPN	7	85	16	1	
STAR	10	45	77		2
STRK	90	188	98		
SWSP	1				
TIGR	1	1	4		
TREE		2	10		1
URCK	1	44	2		
VRML	61	110	99	3	10
WDOW	313	844	249		
YEYE	49	80	57		
YMTH	1	21	9		
YTRK	200	427	449	1	1

These tables show the total number of samples for Market Category 253 (Bocaccio) and 269 (Widow rockfish), with the frequency of occurrence of all other rockfish species in each sample, in five major time periods.

Market Category 253: Bocaccio

	1978-82	1983-90	1991-99	2000-09	2010-17
Total Samples	224	44	718	171	310
ARRA	4	5	2		
BANK	39	19	53	2	1
BCAC	207	37	709	170	310
BLGL	9	9	10		
BLUR	6		2		
BRNZ			2		
BRWN	1		2		
CLPR	187	34	113	8	14
CNRY	21	4	1		1
CWCD	6	1	15		
DBRK	4	6	8		
EGLS	2				2
FLAG	1	1			
GBLC	3				
GSPT	16	1	9	1	
GSRK	17	3	7		1
KLPG	1				
LCOD	17	1	2		
LSPN					1
MISC	2				
MXRF			1		
OLVE	5		4		
OWFS			1		
PDAB	1				1
PNKR	1	2			
POP			1		
PTRL			1		
RDBD	2	5	2		
REX					1
REX	1				
RSTN			3		
SABL	3				
SBLY	9		2	1	
SHRP		1	2		
SLGR			7	1	
SNOS	27	12	18		
SPKL	5	1	6		
SSPN	6	2	1		
STAR			1		
STRK	12	2	3		3
TIGR	1				
URCK			1		
VRML	4		2		
WDOW	51	5	23		1
YTRK	19	1	19		

Market Category 269: Widow rockfish

	1978-82	1983-90	1991-99	2000-09	2010-17
Total Samples	132	497	514	150	198
ARRA			1		
BANK		5	29	3	
BCAC	6	13	5	2	1
BLCK	1	1			
BLGL		2	7	2	
BLUR			2		
BRNZ			1		
CLPR	4	19	18	1	
CMEL		1			
CNRY	2	3			
CWCD			1		
DBRK	1	3	6		
EGLS					1
GSPT		1	2		
GSRK	1	2			
LCOD			2		
MISC			1		
OLVE			1		
POP					1
POP	1	1			
RDBD				1	
REX					1
SBLY		1	2		
SHRP		3	1		
SLGR		1			
SNOS		1		1	
SPKL	2	3	30	1	3
SQRS			2		
STRK		3	4		
VRML		1			
WDOW	130	494	489	148	195
YTRK	11	14	54	8	8

Moving beyond rockfish into flatfish and elasmobranch (primarily skates) market categories, these tables shows the total number of samples and frequency of occurrence by species for the largest flatfish (table on left) and elasmobranch (table on right) market categories. Flatfish species composition data have only been collected since 2002, and elasmobranchs since 2009, so all years are combined here (and information at higher stratification levels, including more sparsely sampled market categories, are available in the excel file).

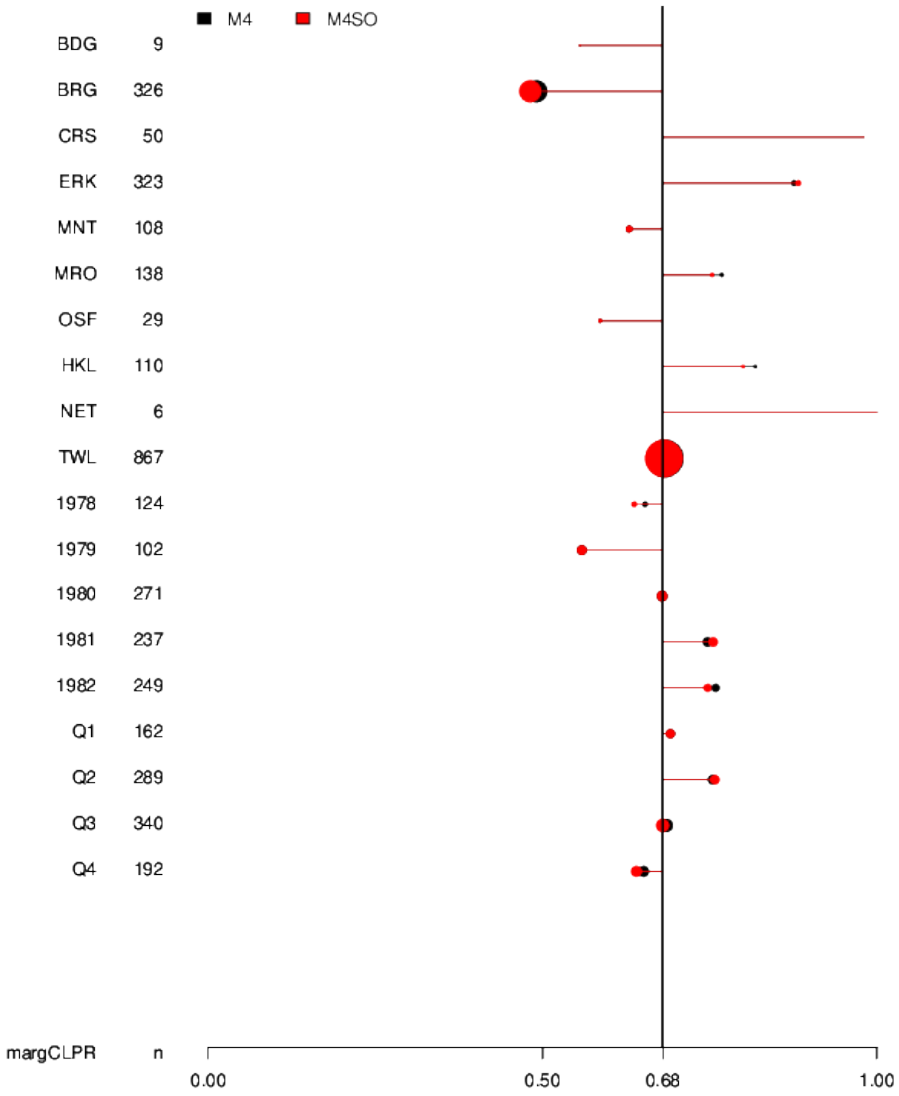
	200 Unspecified sole	201 arrowtooth flounder	205 sand sole	206 Englilsh sole	207 rex sole	209 petrale sole	211 Dover sole	225 Sanddabs	231 starry flounder
Total samples	85	253	154	444	511	1170	1159	346	199
ARTH		252		2	4		2	3	
BMOL	4						1	1	
BSKT						1			1
BSOL			3						
CHLB			2						2
CSOL	3		2	16	1	2		4	1
CTRB					1				
DOVR	7	7		16	77	22	1158	3	
DSOL	22						26		
DTRB	4								
EGLS	40	1		443	14	65	4	30	2
FNTS	27								
FSOL					1				
GRDR							1		
GSRK						1			
HTRB	13		1	1				1	
LSKT				1					
LSPN		1			1	1	11		
MISC						2	2		
PDAB	23			16	4	25	2	344	
PTRL	19	7	8	60	8	1169	11	27	2
PWHT						1			
RATF						1			
REX		2		22	397	20	57	9	
REX		2		7	114	4	93	10	
RSOL	2		3	8		3		3	
SABL						1	1		
SBLY						1		1	
SHRK							1		
SLNS	5			2	6	2	2	8	
SNOS						1	1		
SPSK		1							
SQRS						1			
SSOL			151			3		1	2
SSPN							2		
STRB	2								
STRY			13						199
UDAB								2	
UFLT	1				2		2	1	
USKT						1	1		
UTRB			1						1

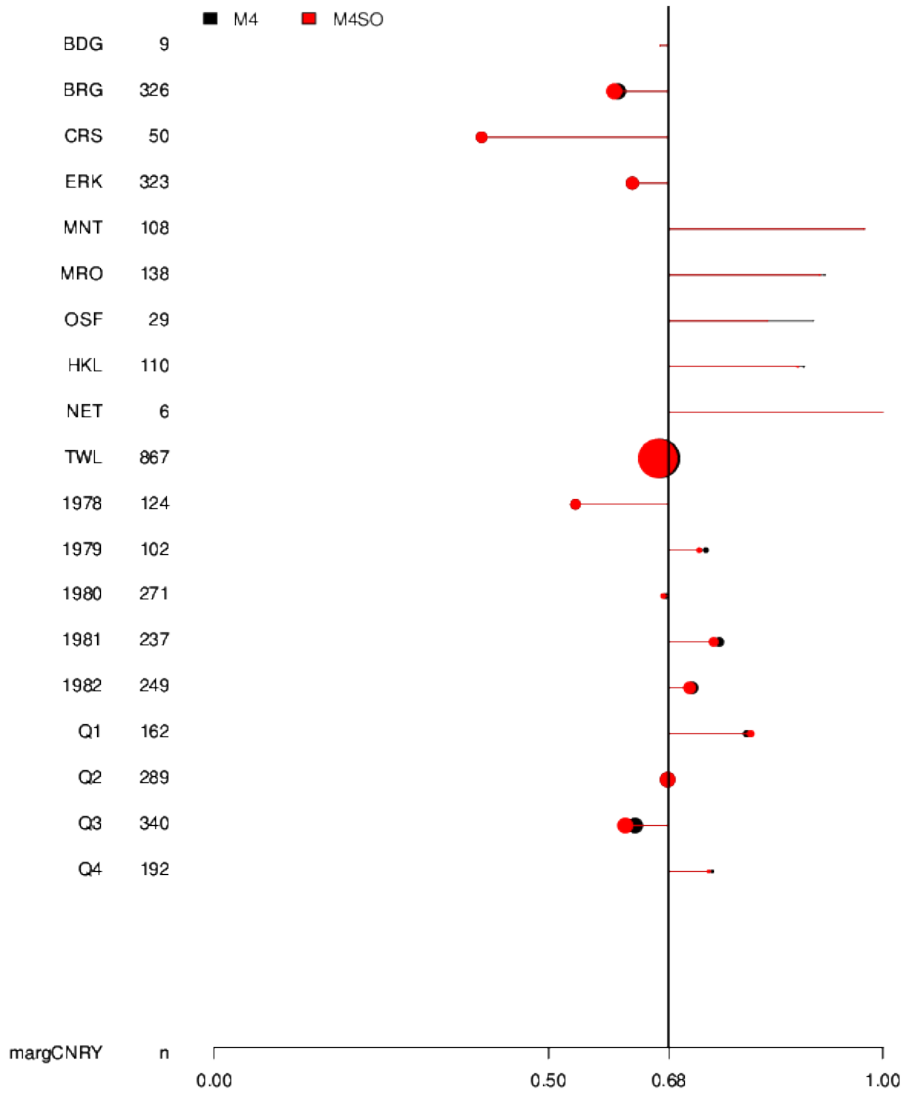
	147 Longnose skate	152 spiny dogfish	175 unspecified skate	176 big skate	177 California skate
Total samples	374	12	32	70	3
BSKT	19		5	70	
CSKT	3		4		2
CSRK					
DSRK		12			
LSKT	372		21	5	
PTRL	1				
RATF					
RTSK	5		5		1
SPSK	9		3		
SSKT			1		
SSPN	1				
URAY					
USKT	3		4		

Request: Redo the modeling of the early time block without southern CA ports. Explore spatially and temporally (i.e., alternative time blocks).

Rationale: The available dataset does not have any sample data in the early time block from the southern CA ports. It was unclear how this lack of data influenced the model results. The requested analysis will clarify the situation.

Response: All of the model runs and plots from this point forward only model ports north of point conception.


M4
M4SO
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
margCLPR n
0.00
0.50
0.68
1.00


M4
M4SO
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
margCNRY n
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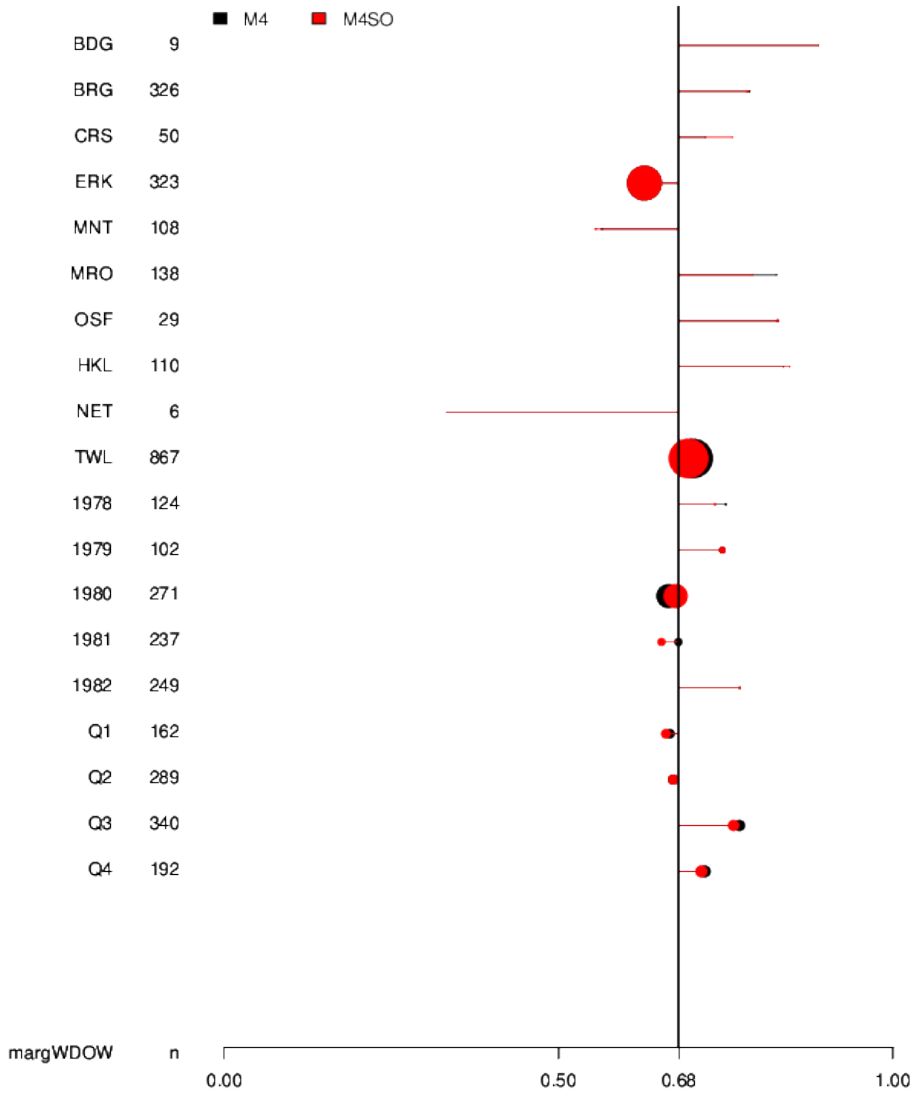
0.50
0.68
1.00


M4
M4SO
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
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0.50
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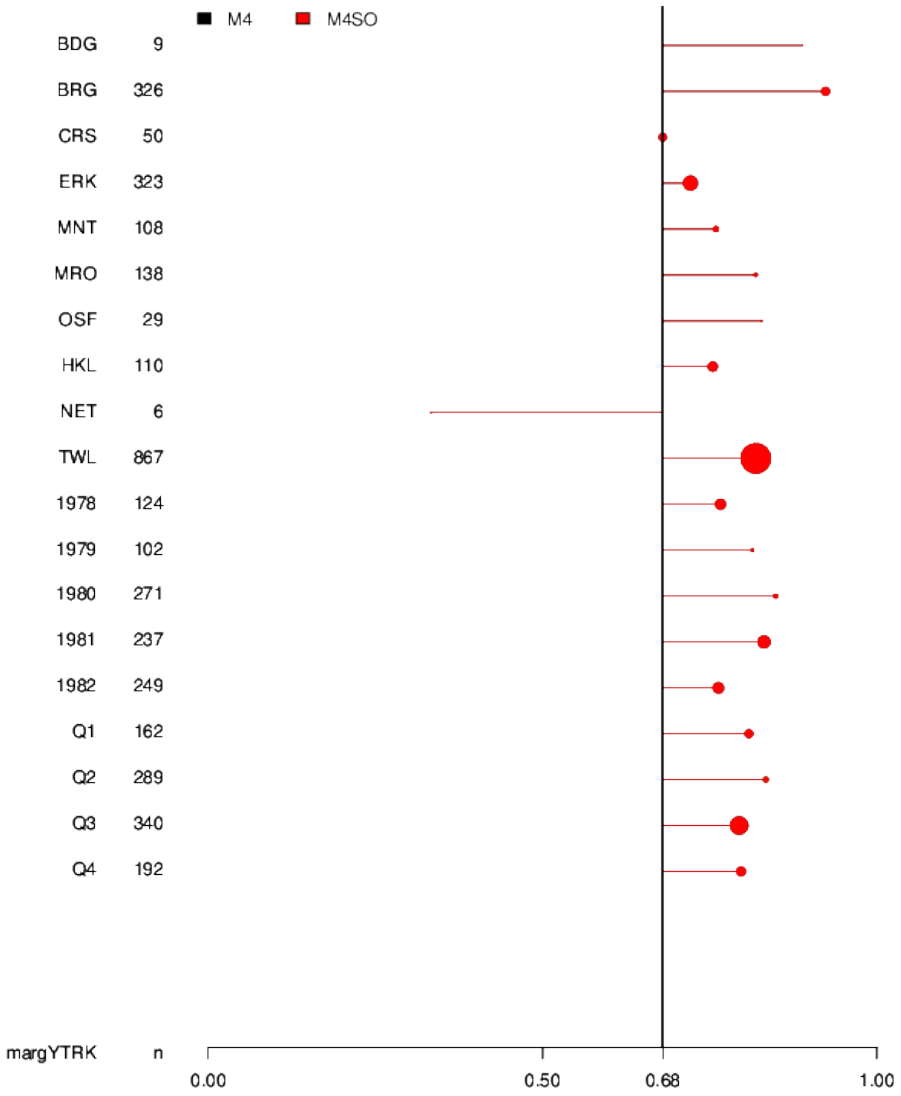
1.00


M4
M4SO
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
margYTRK n
0.00
0.50
0.68
1.00

Summary

- Making predictions in unobserved strata, do not effect observed strata.
- Small differences come from variations in run-by-run fits.
- Very data-poor settings can cause slight model instability.

All Combined Plots

Request: The diagnostic template should be developed for each of the sensitivity runs (vary across a range of plausible time models and priors and limit to the top 2-3 market categories).

Rationale: Application of the diagnostics across a wide range of models will form a test of how well the diagnostics illustrate whether the models capture important structural features that are thought to be embedded in the data.

Response: The following slides show the requested diagnostic plots as applied to models across a range of time models and prior choices.

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)

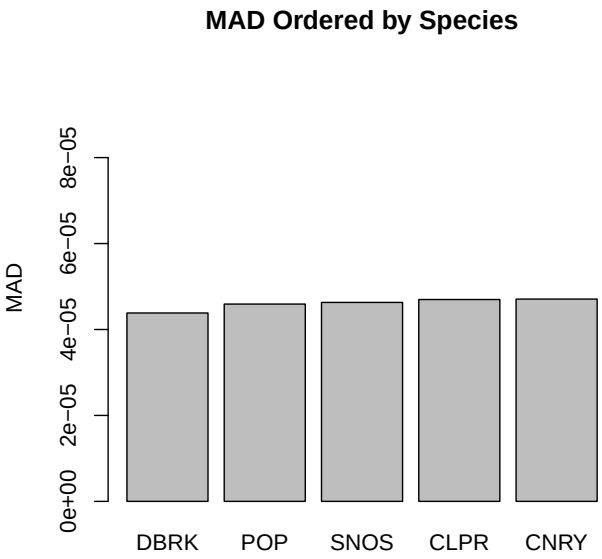
$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v_\eta)$$

(M6)

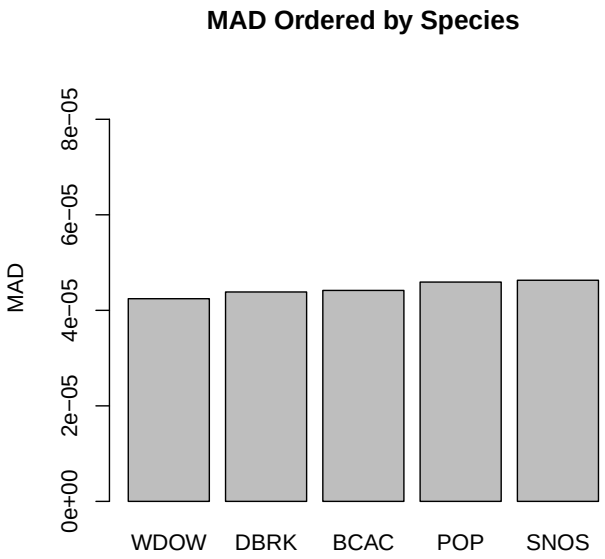
$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$
$$\beta_{m\eta}^{(y:q)} \sim N(0, v_m)$$

	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

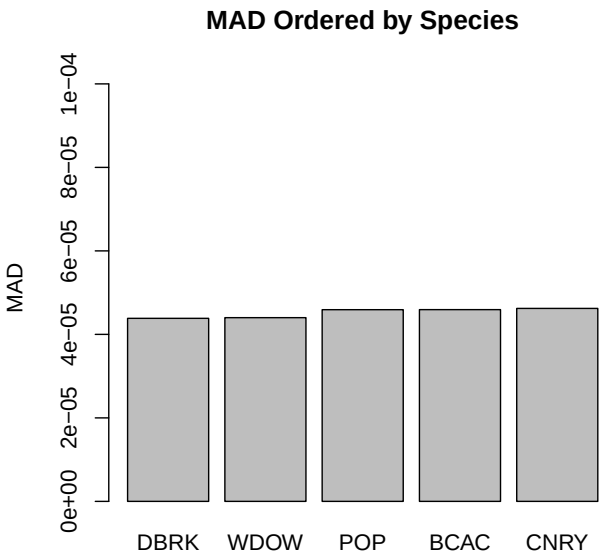
M2



M3

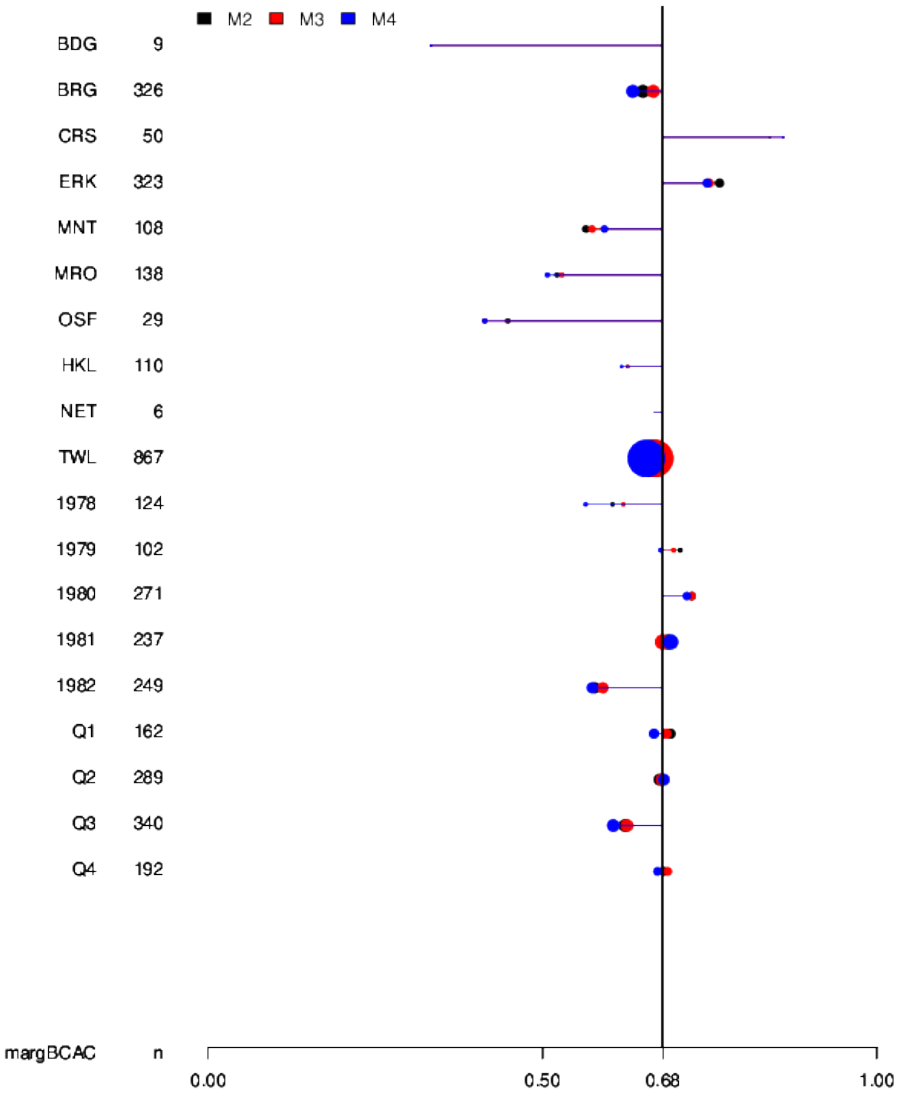


M4



Combined

MCAT 250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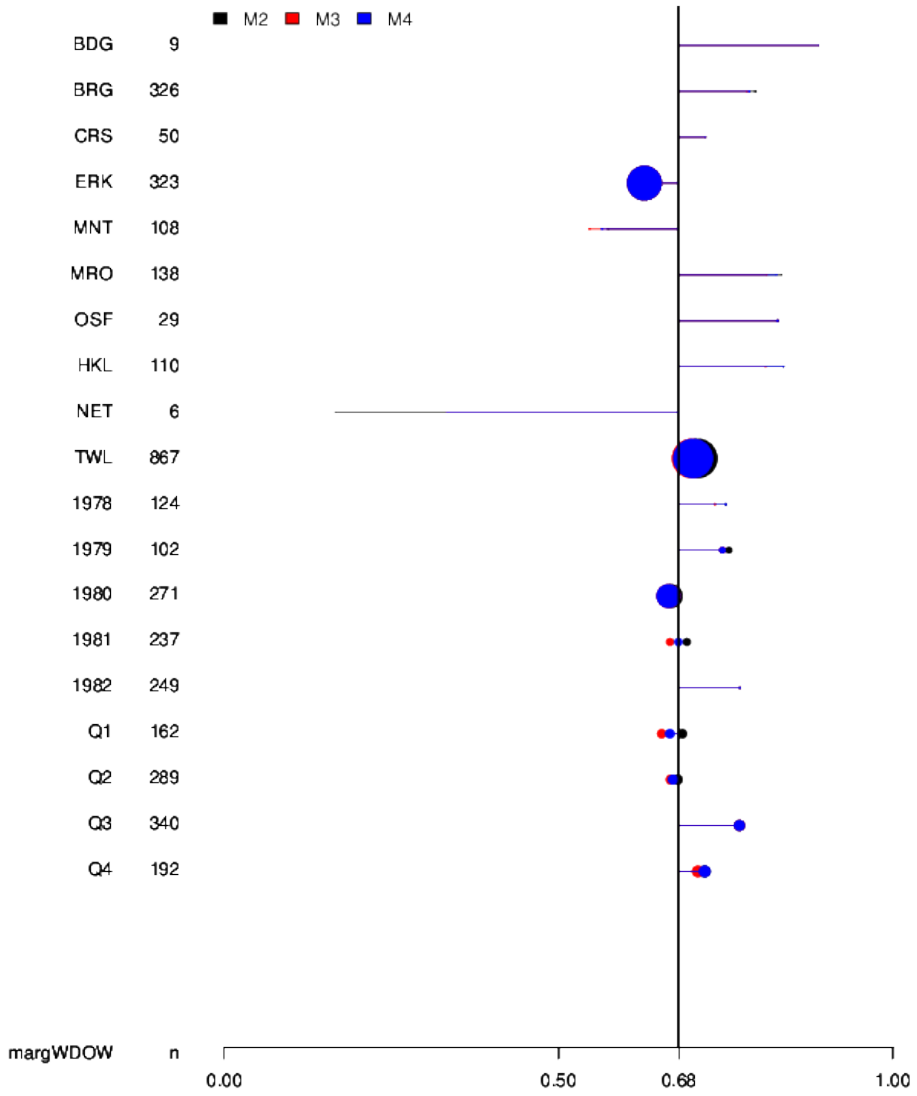
M3
M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margBCAC n
0.00
0.50
0.68
1.00

MCAT 250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M3
M4
BDG 9
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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
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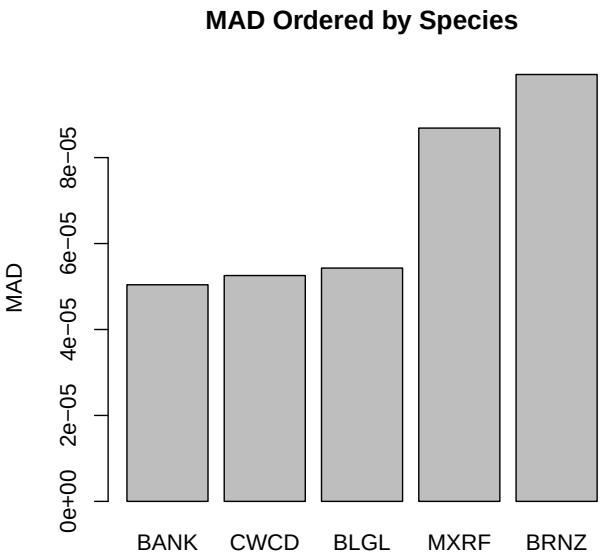
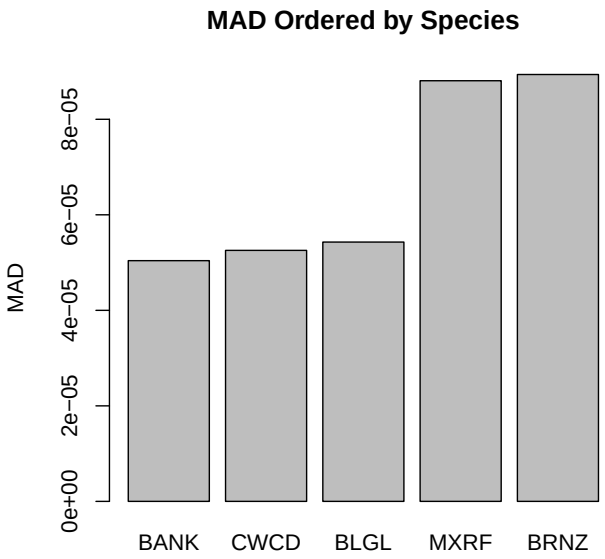
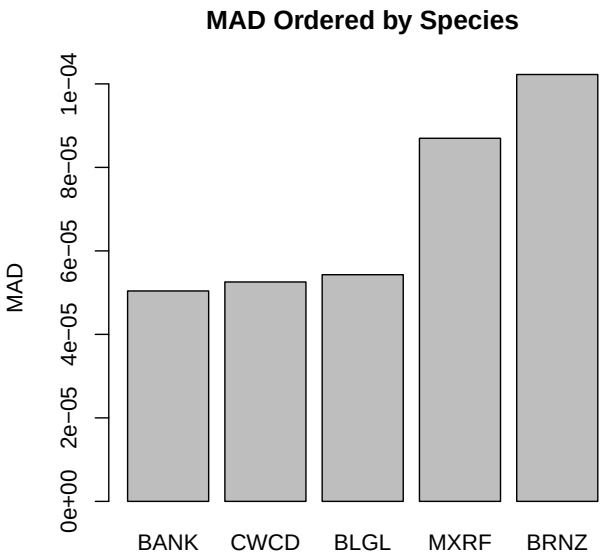
1.00

M2 M3 M4

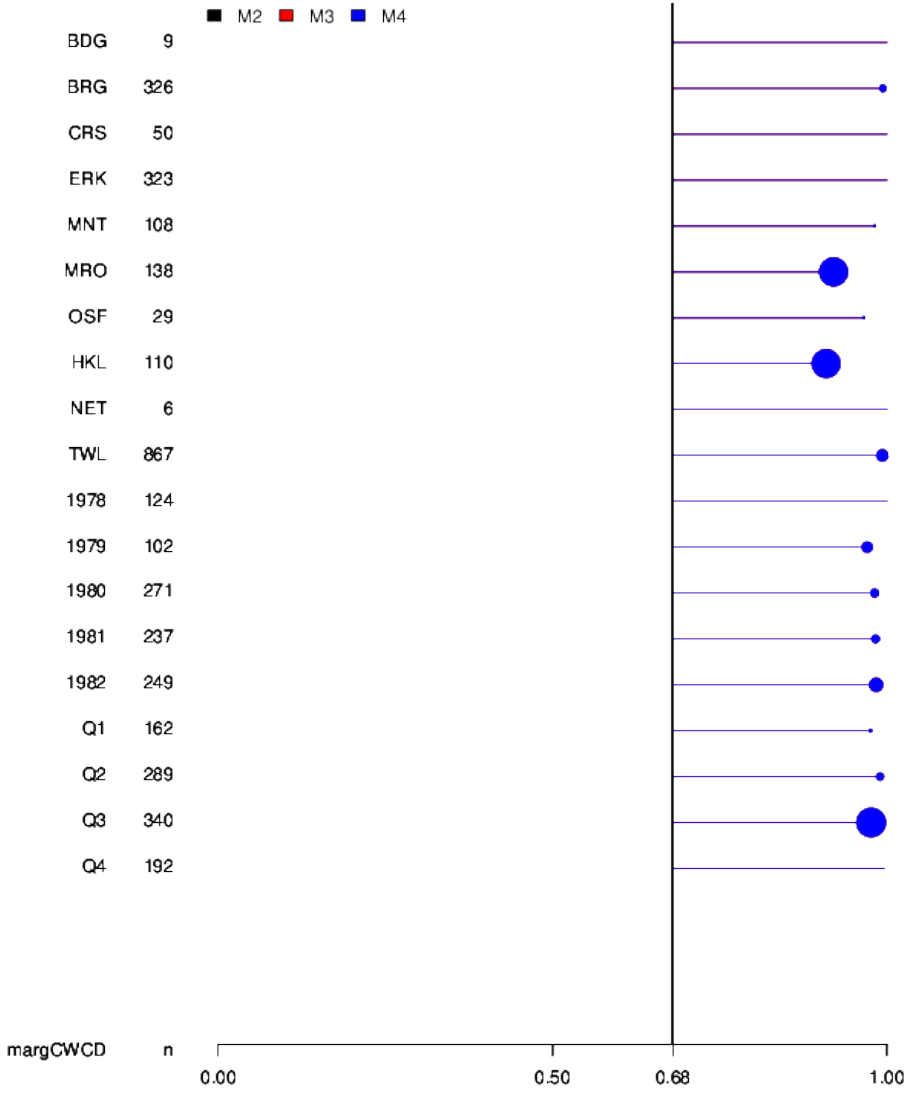






Combined

MCAT 250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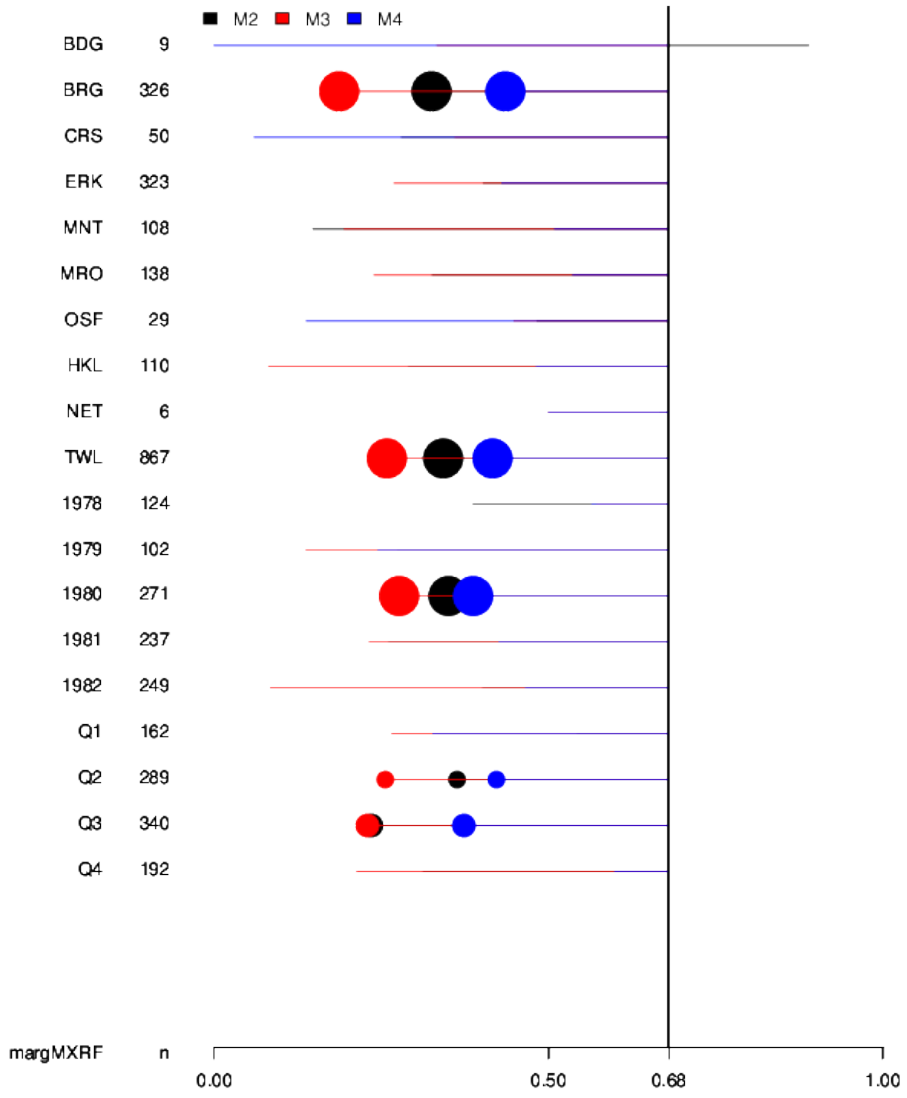
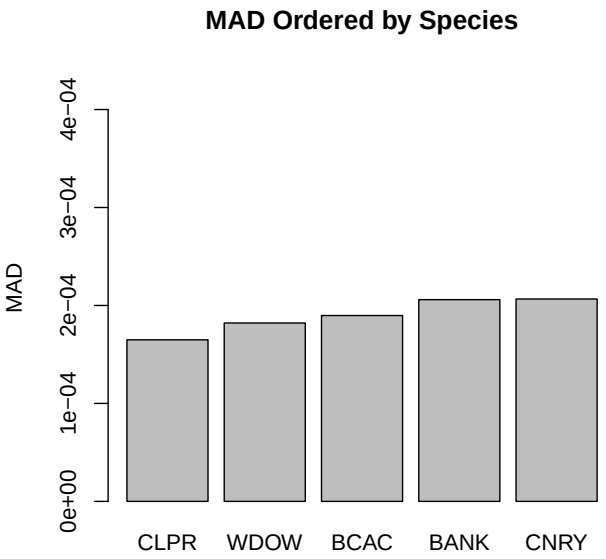
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margCWCD n
0.00
0.50
0.68
1.00

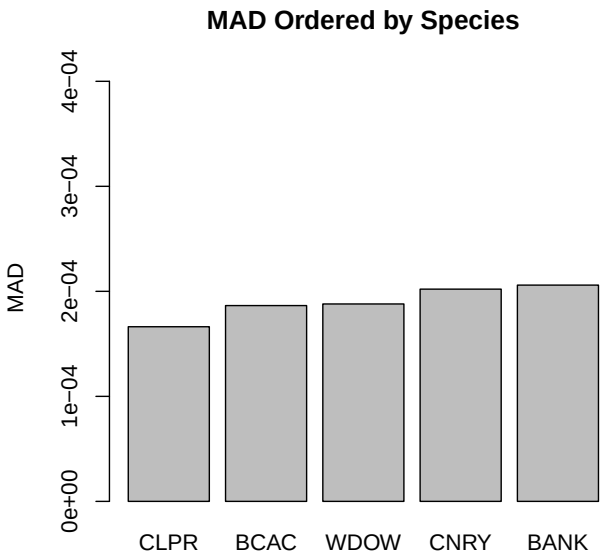
MCAT 250

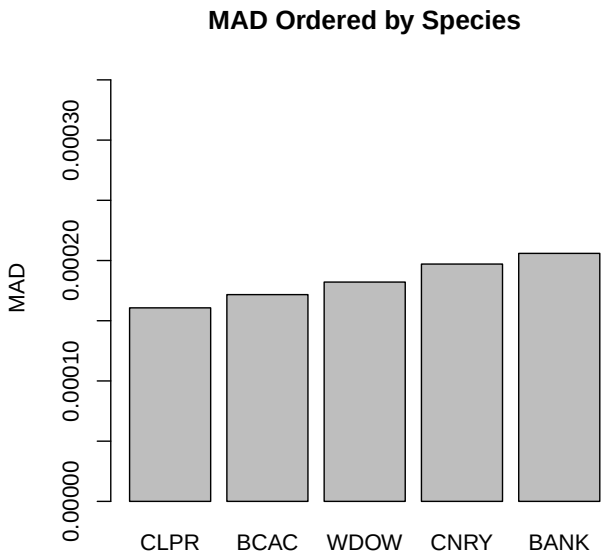

M2
M3
M4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

	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

M4 M5 M6

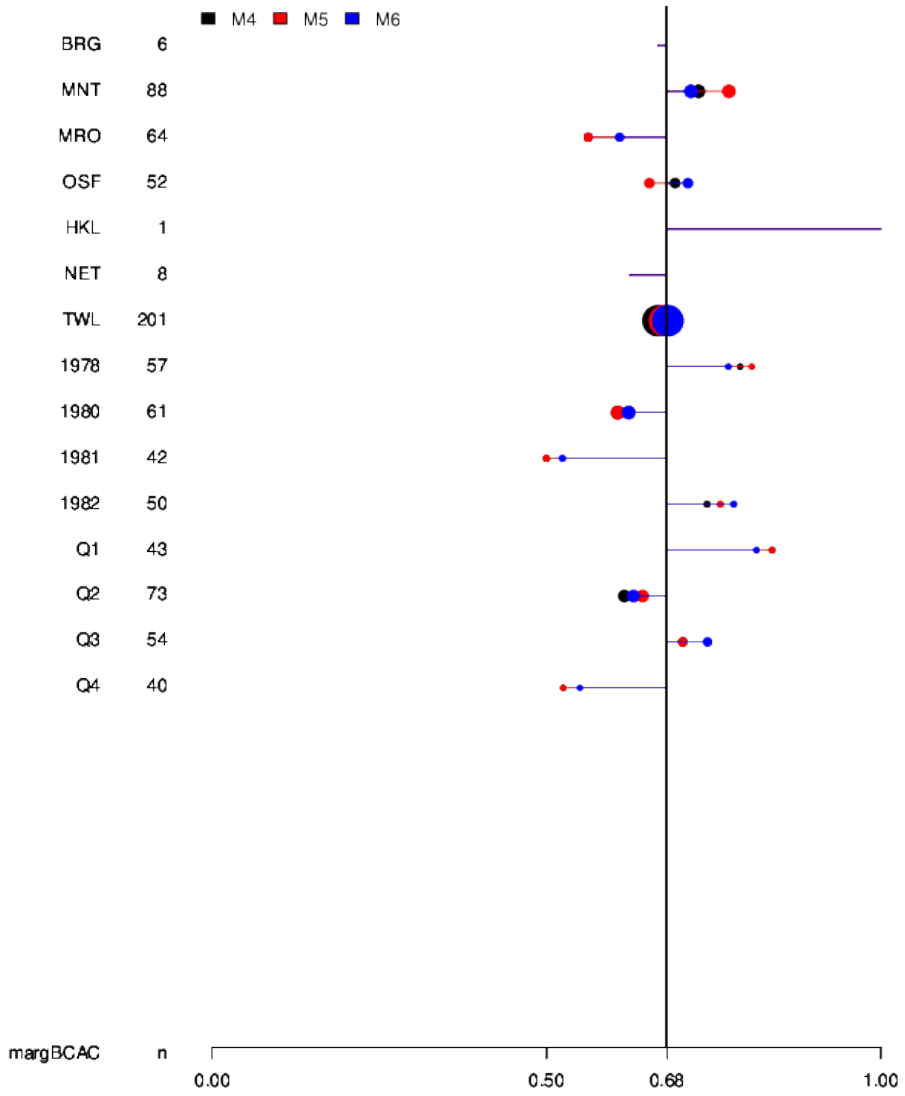




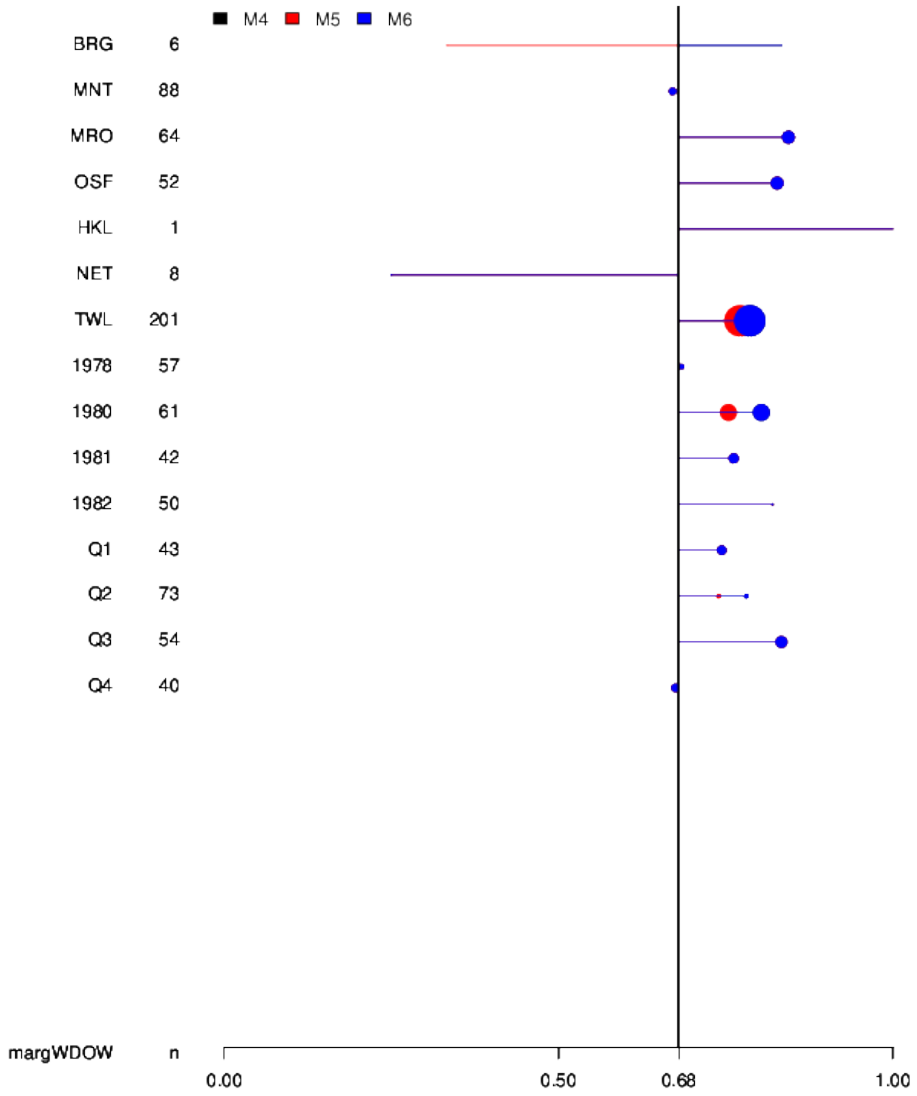


Combined

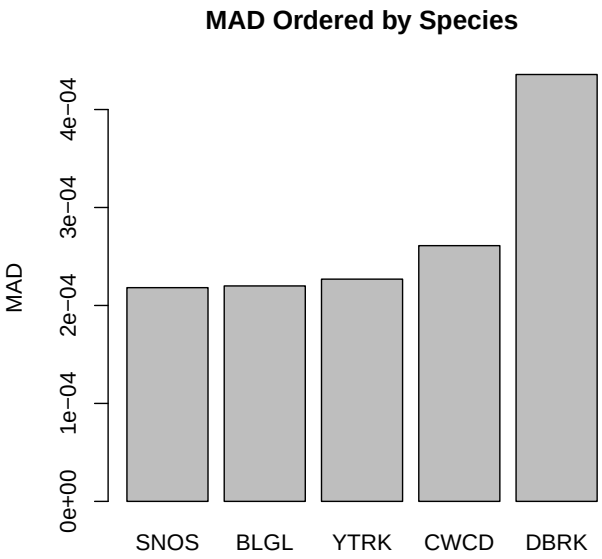
MCAT 253

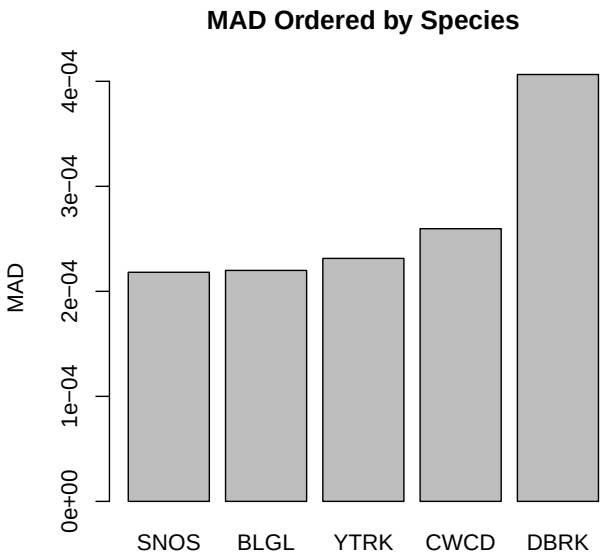

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00

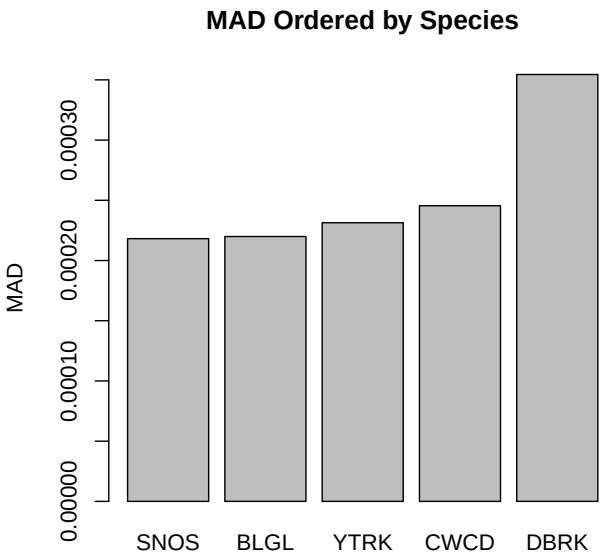
MCAT 253


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

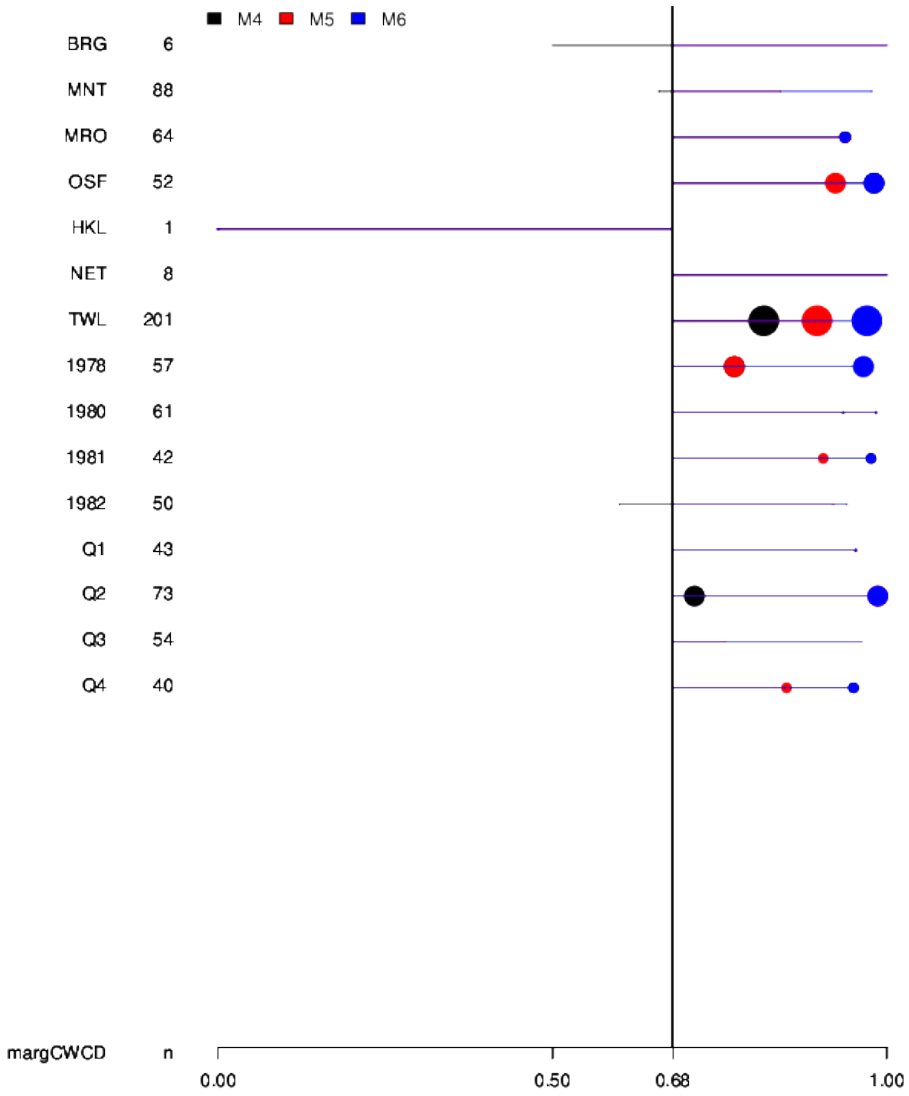




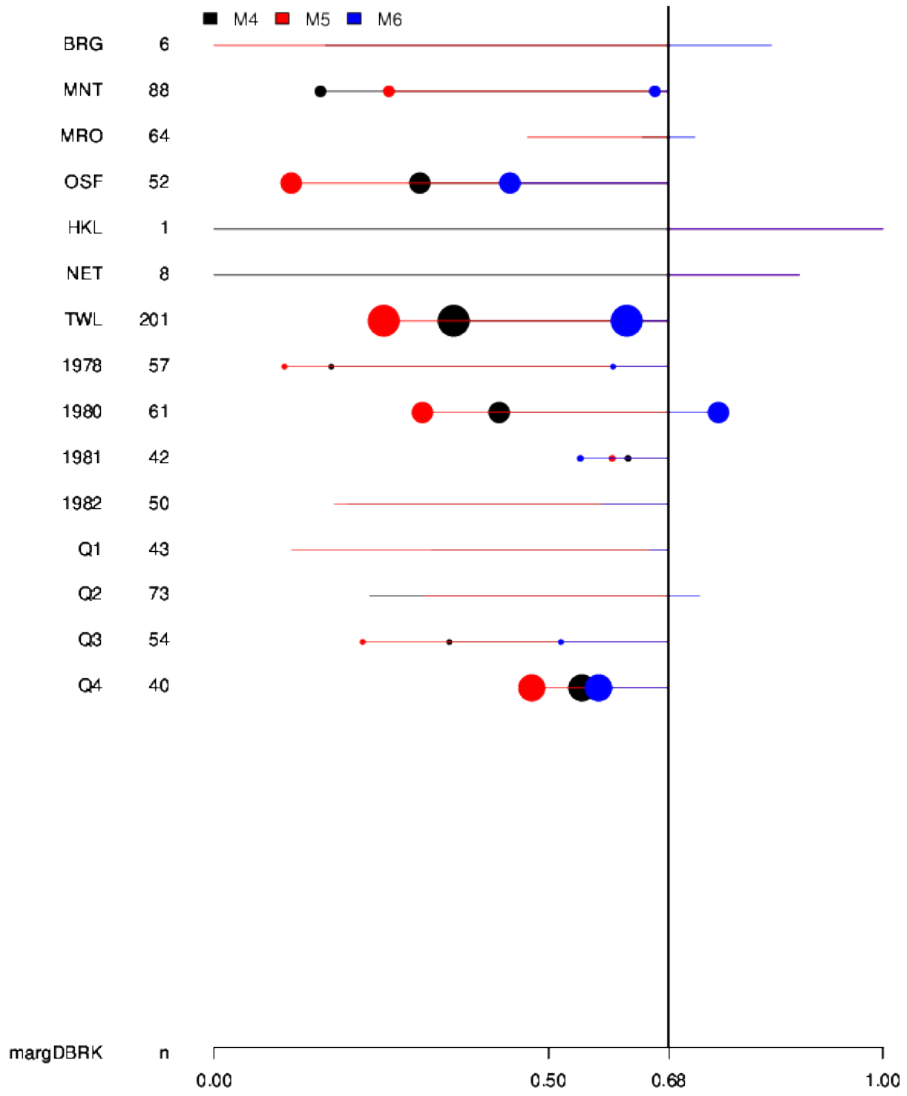


Combined

MCAT 253

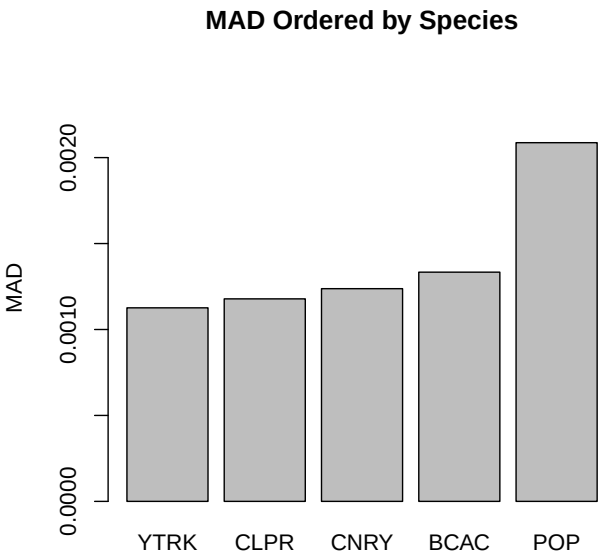

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margCWCD n
0.00
0.50
0.68
1.00

MCAT 253

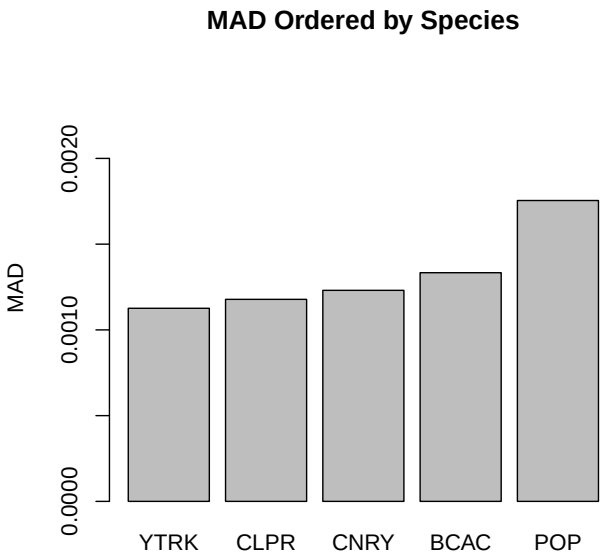

M4
M5
M6
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

	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

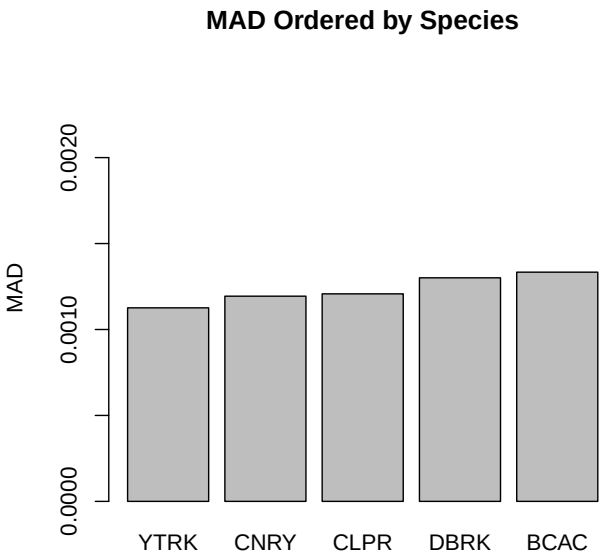
M4



M5

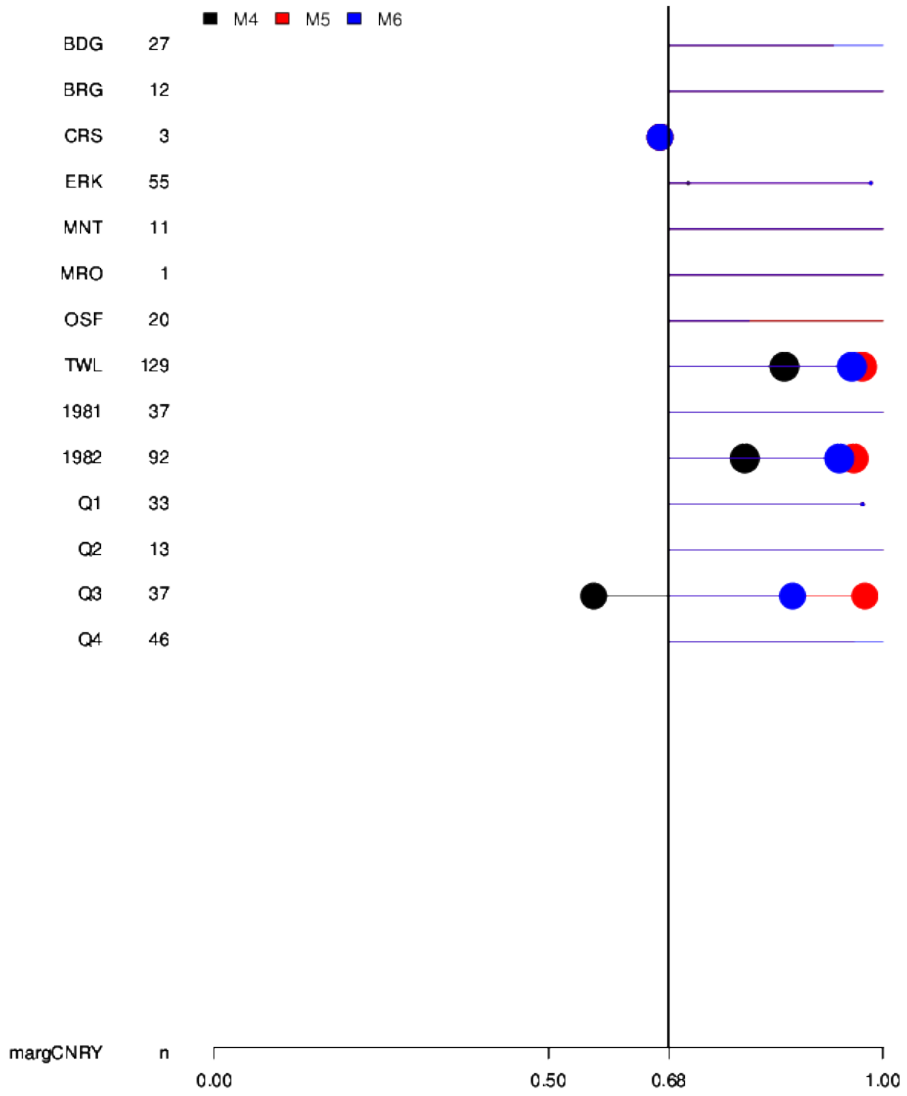


M6

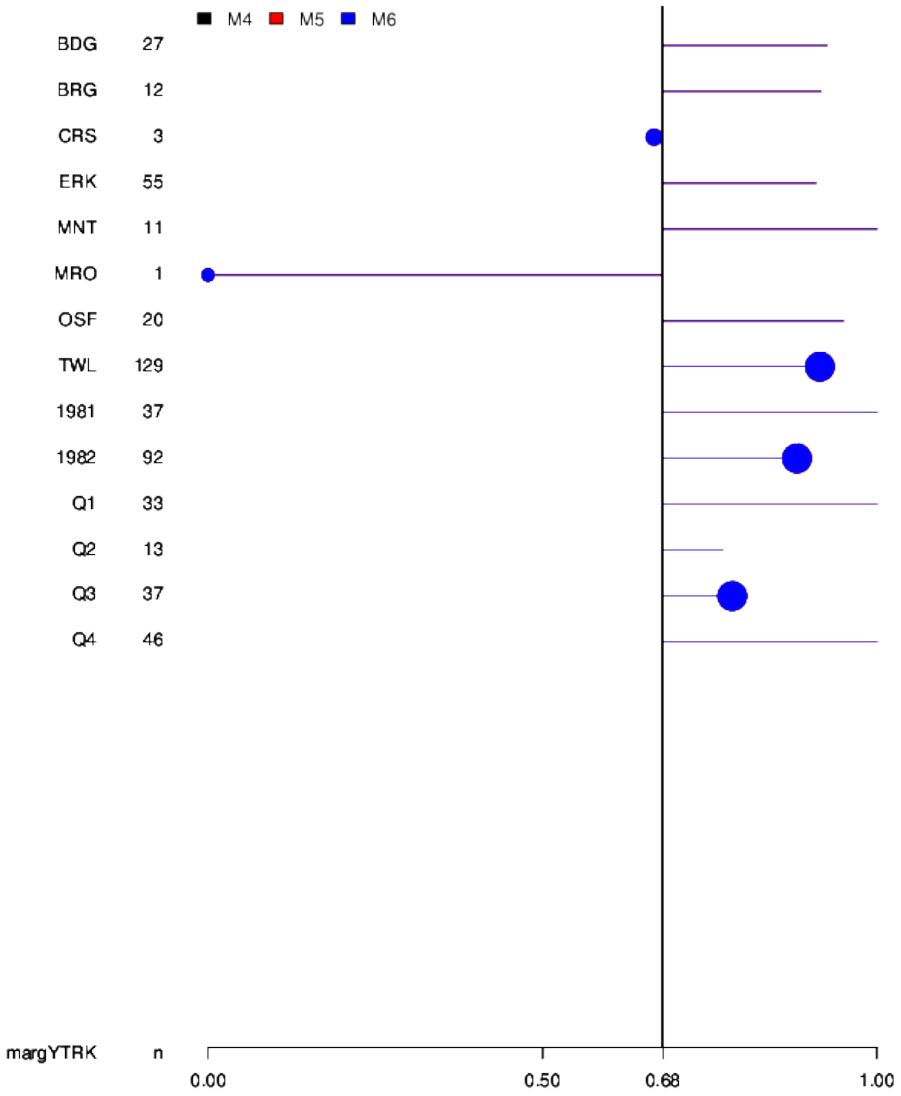


Combined

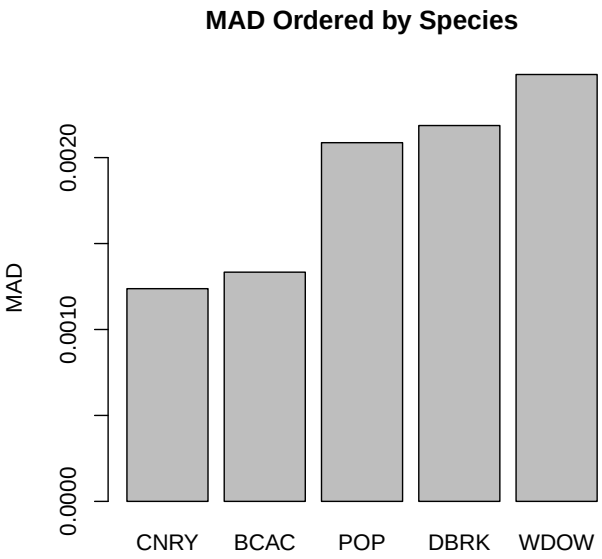
MCAT 269

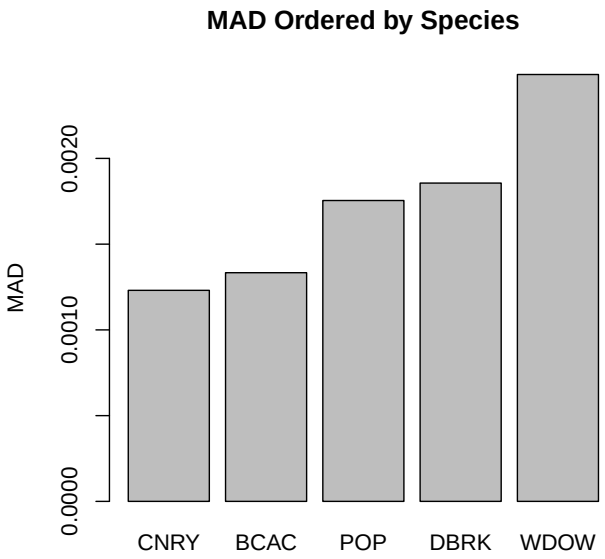

M4 M5 M6
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margCNRY n
0.00
0.50
0.68
1.00

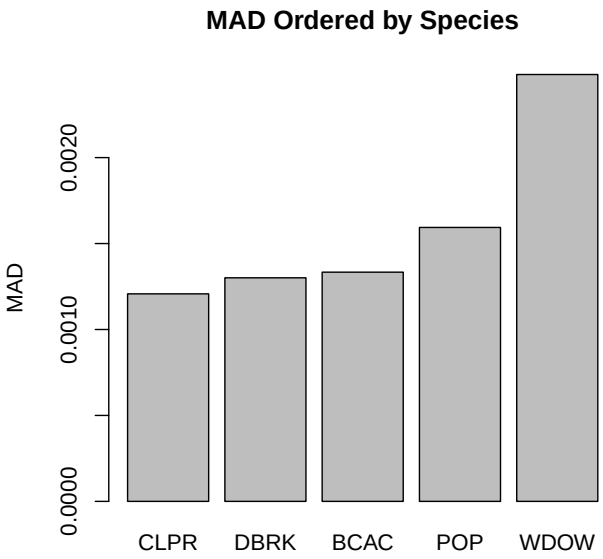
MCAT 269


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
margYTRK n
0.00
0.50
0.68
1.00

M4 M5 M6

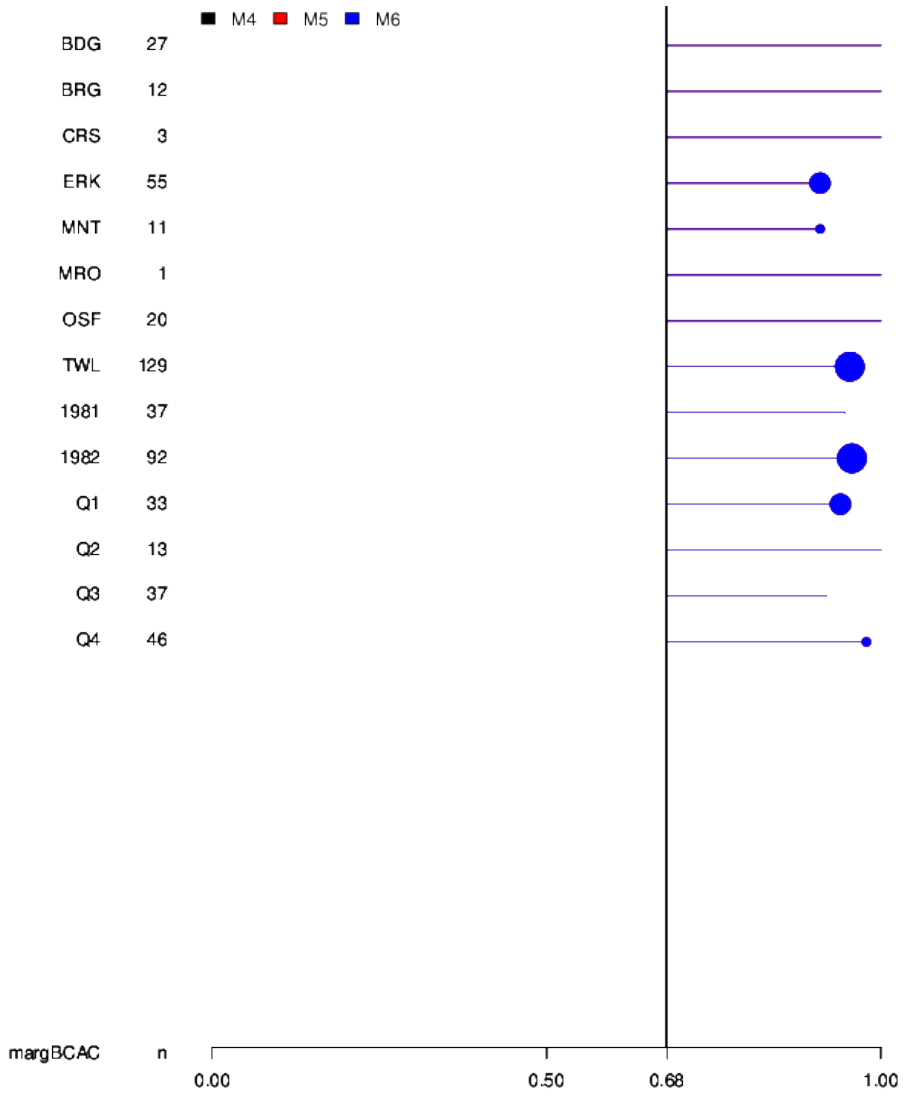




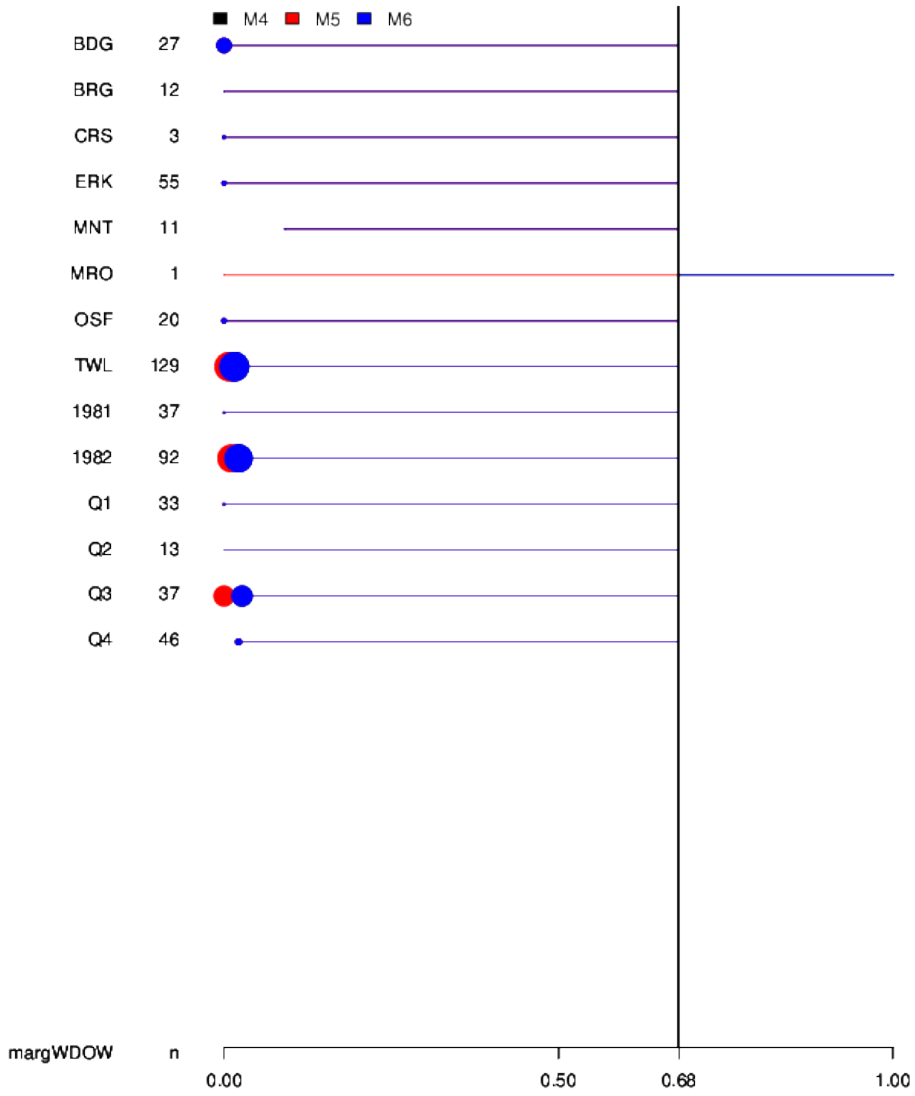


Combined

MCAT 269


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
margBCAC n
0.00
0.50
0.68
1.00

MCAT 269

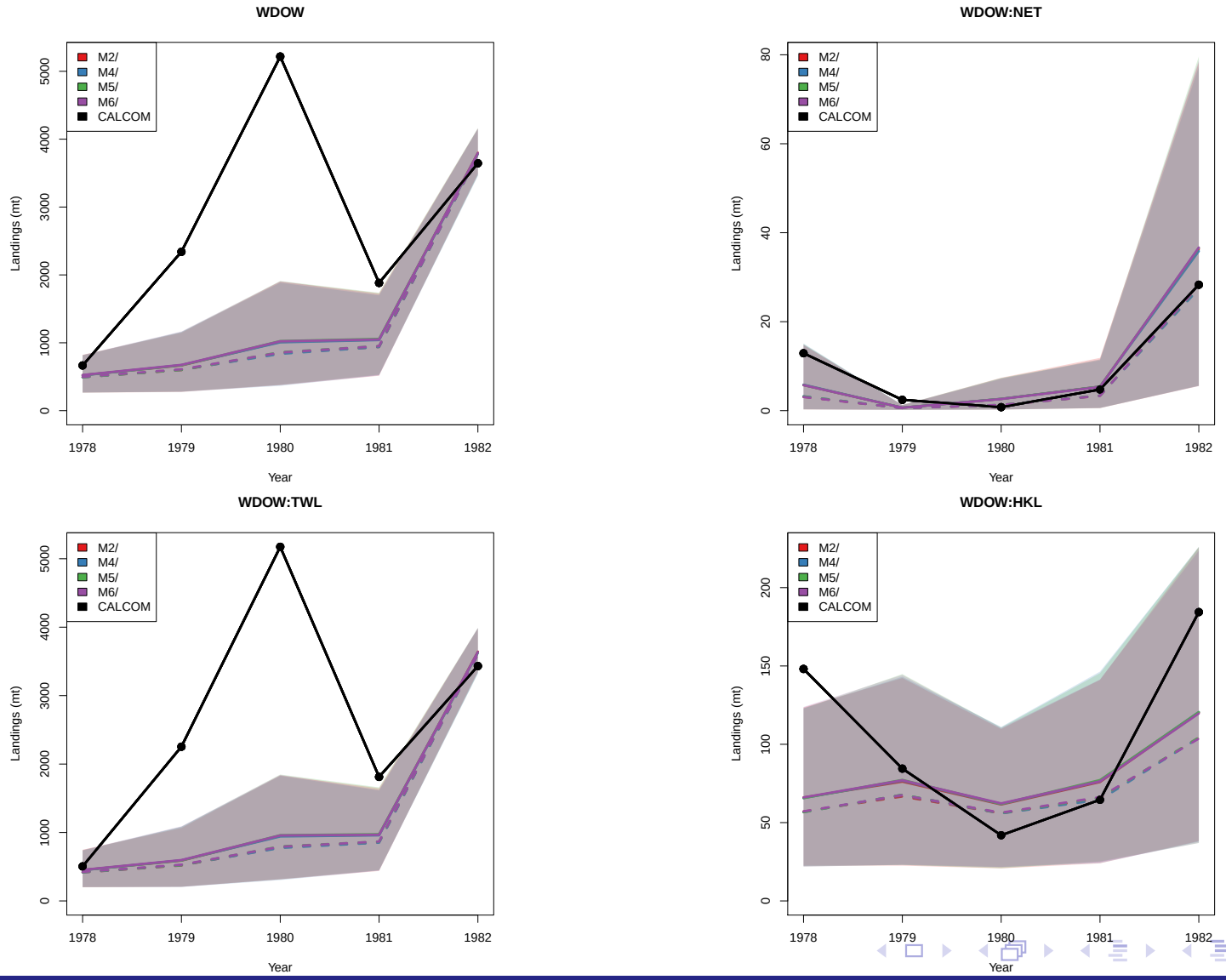

M4
M5
M6
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margWDOW n
0.00
0.50
0.68
1.00

Request: Compare alternative ComX outputs and the current time series of estimated catches.

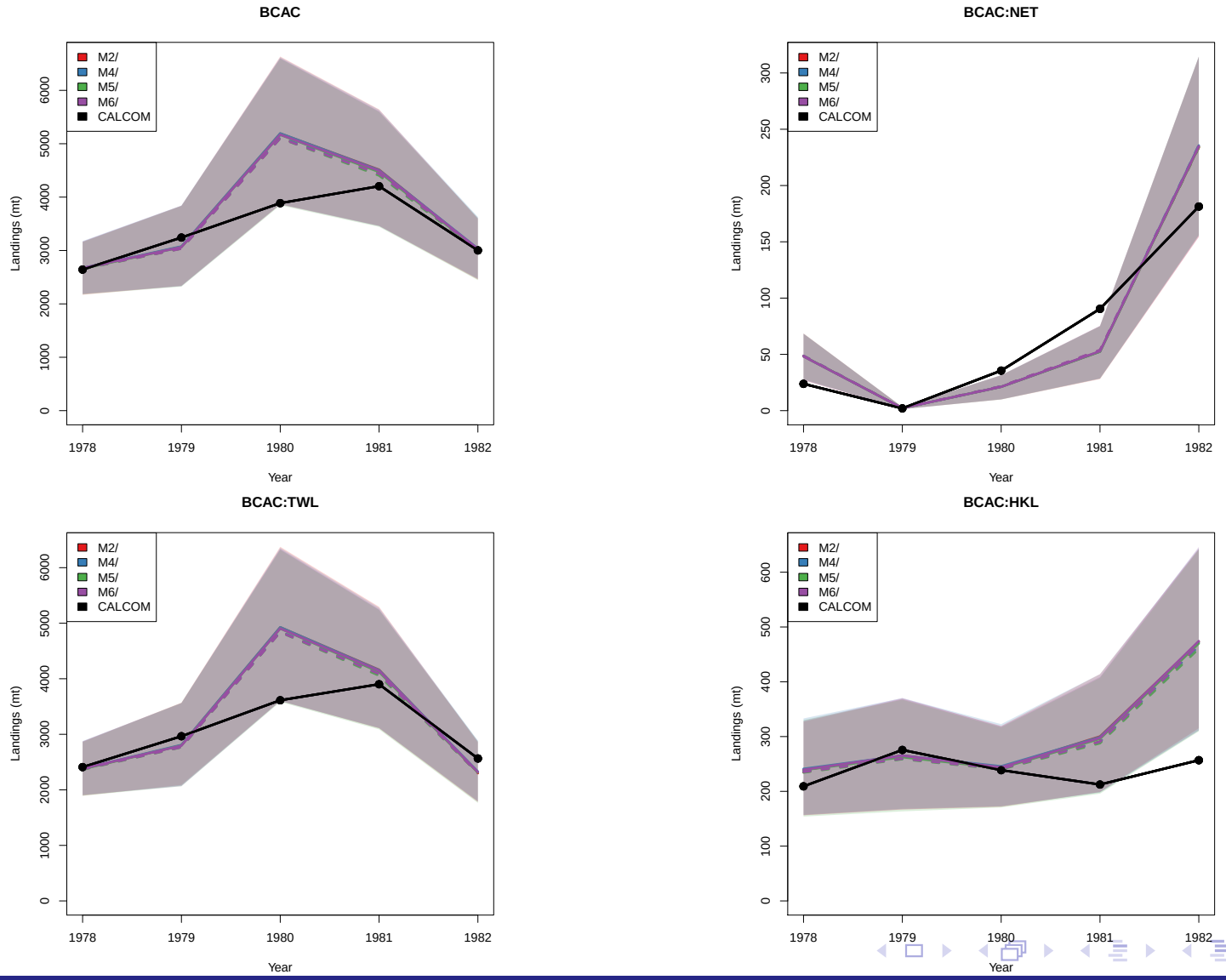
Rationale: It would be informative to see the landings estimates corresponding to the additional models developed in response to the above requests. The landings estimates can be generated for a small set of illustrative species and do not need to be comprehensive.

Response: The following slides show expanded landings (by year and by year:gear) from the early time period, summing across market categories 250, 253, and 269 associated with time model, prior, interaction model, and time block sensitivity runs.

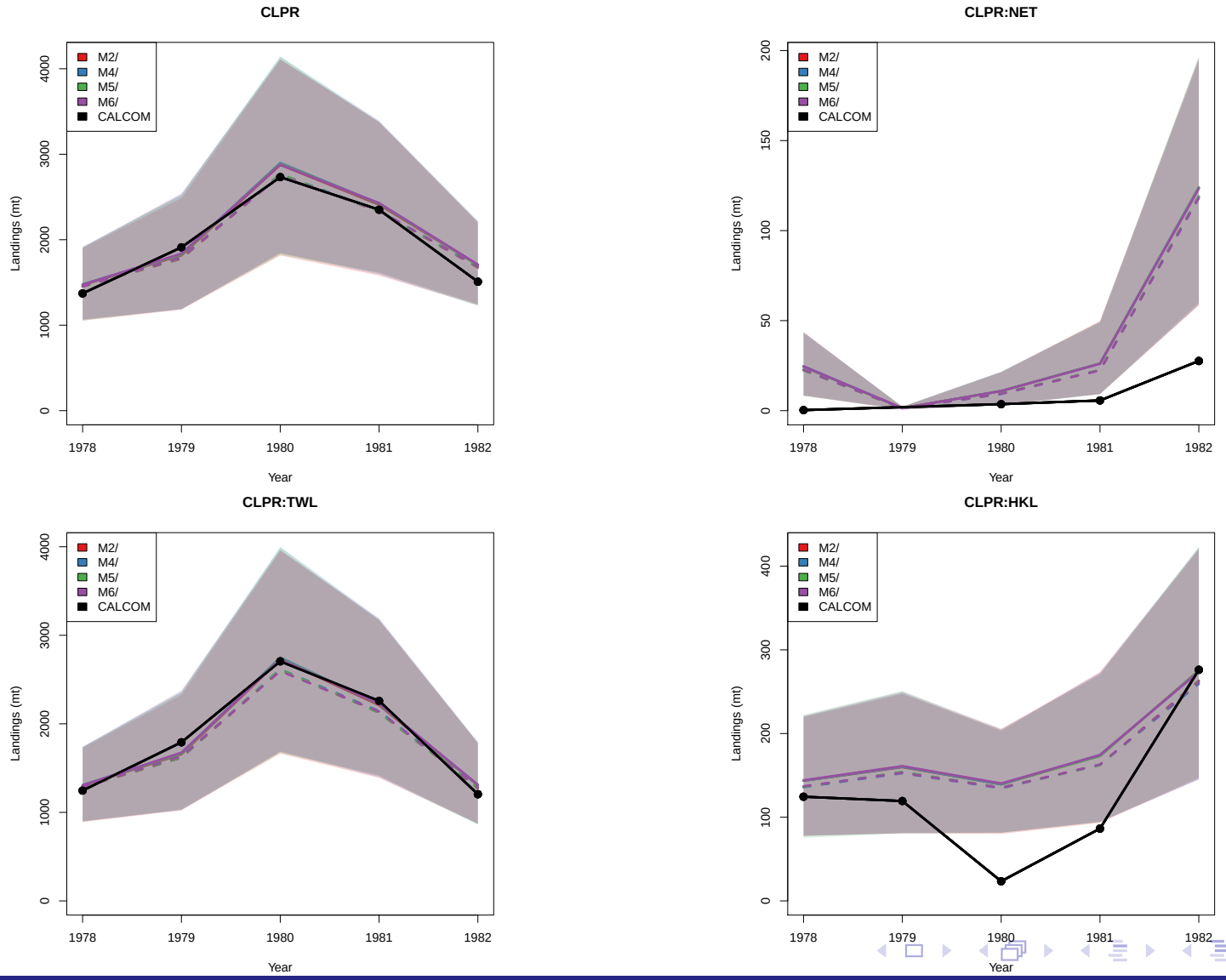
Landings Sensitivity



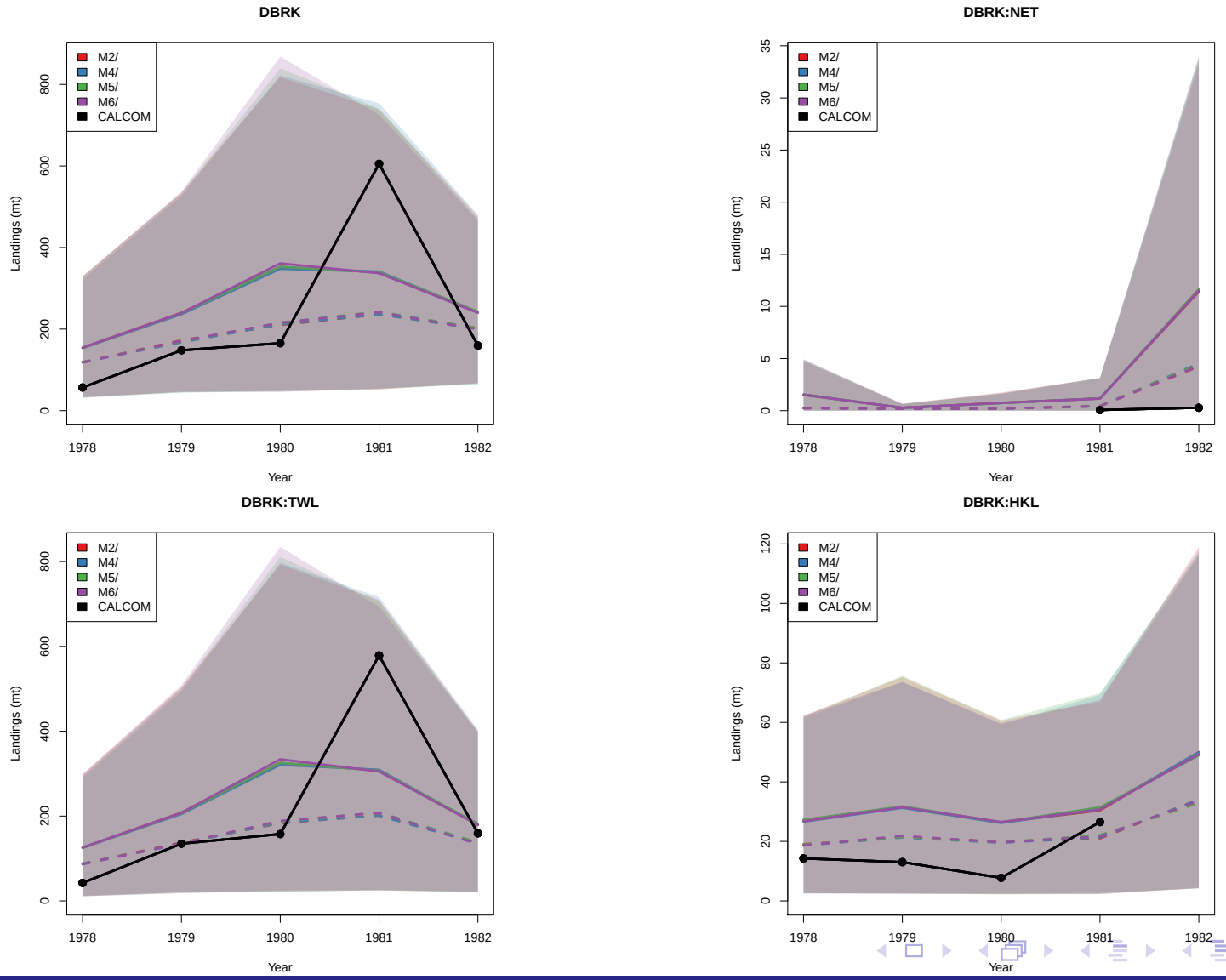
Landings Sensitivity



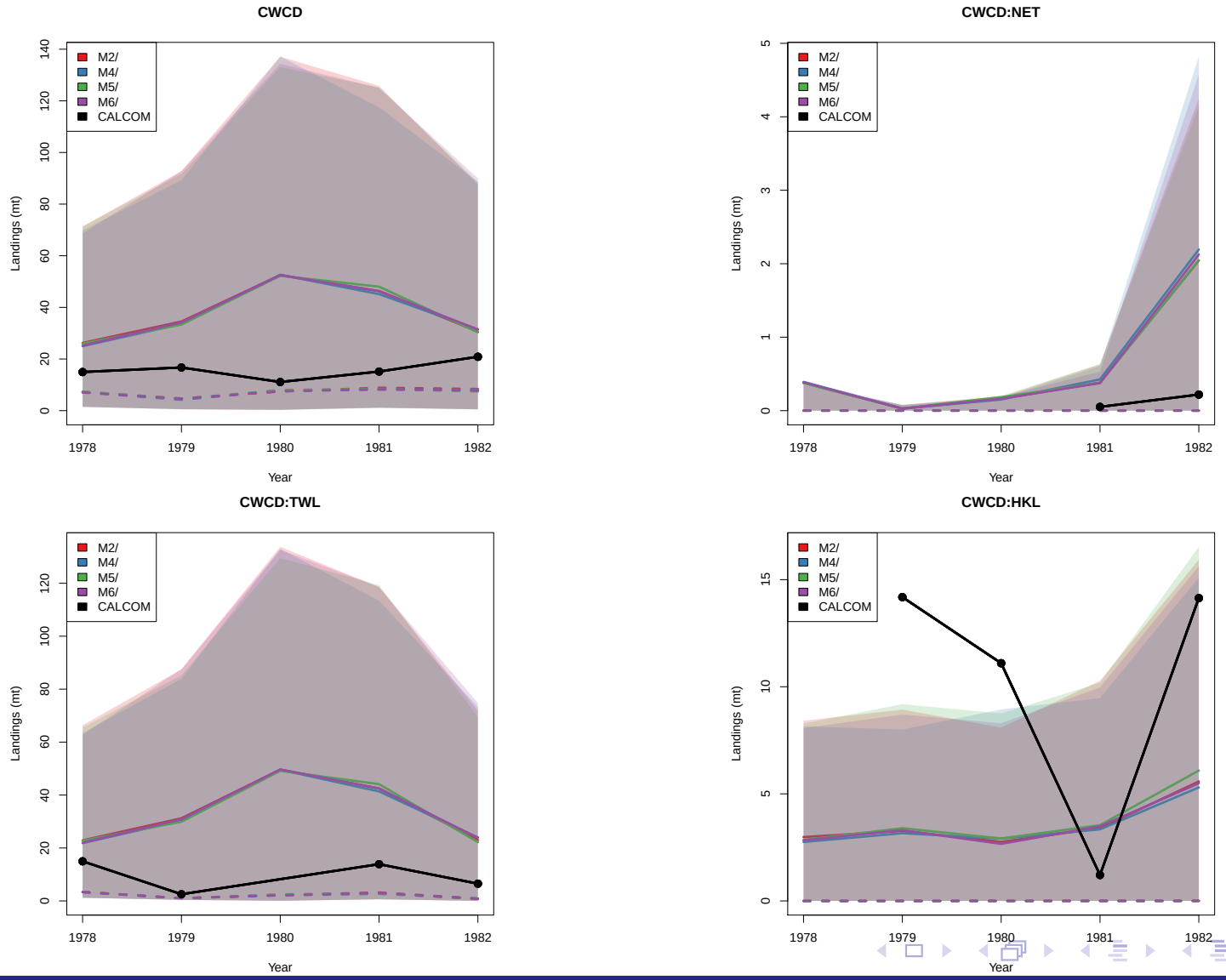
Landings Sensitivity



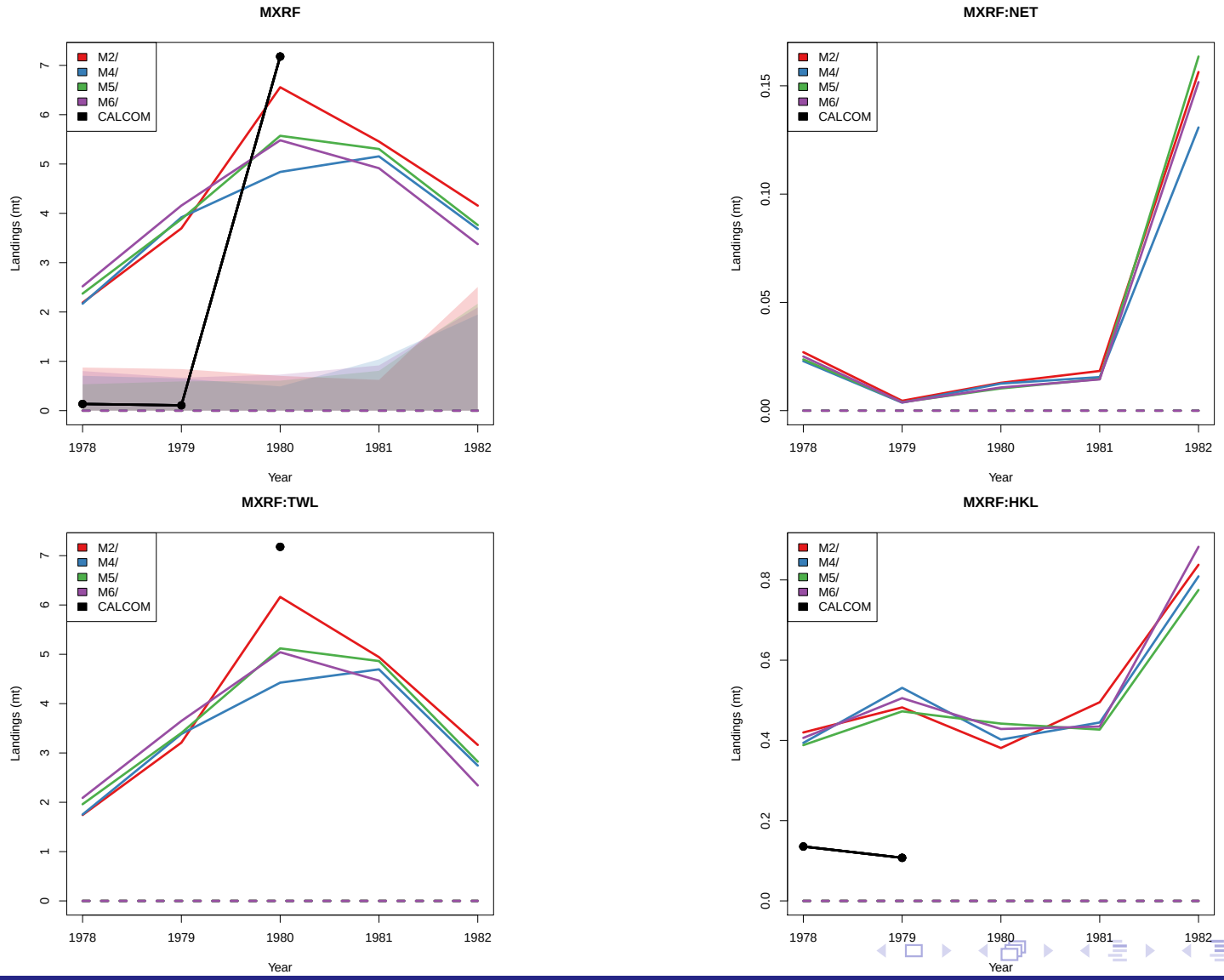
Landings Sensitivity



Landings Sensitivity



Landings Sensitivity



Time Model Summary

- The time model appears to be slightly dependent on market category, although several models perform similarly.
- M4 generally performs well in a data-poor environment.
- Differences are small in a data-rich environment.

MCAT 250 Combined Plots

MCAT 253 Combined Plots

MCAT 269 Combined Plots

All Species Landings

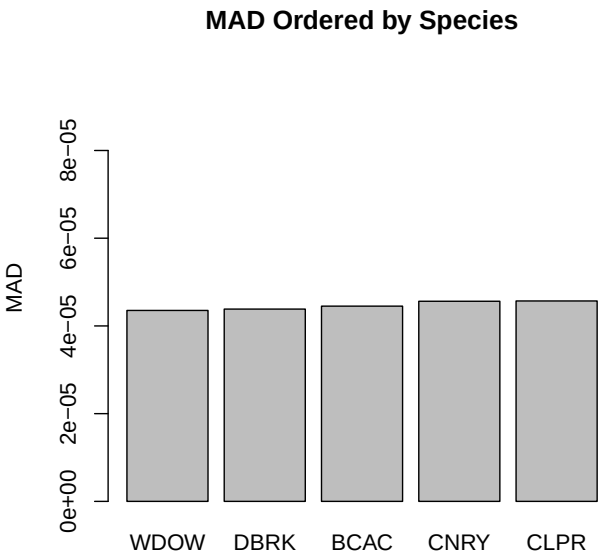
Priors

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

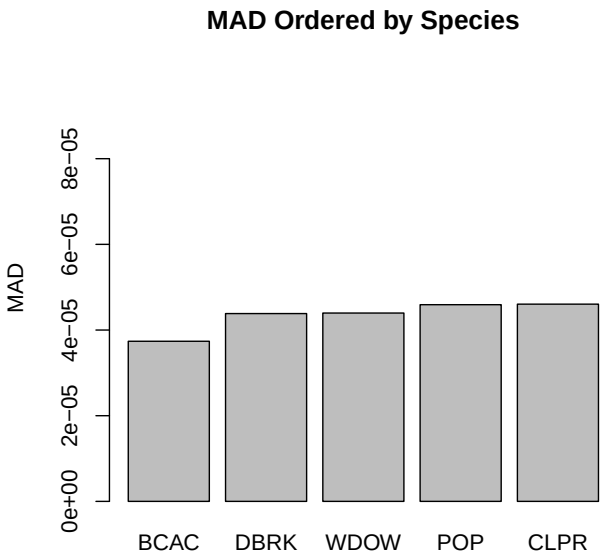
$$\begin{aligned}
\text{IG}: \quad & v \sim \text{Inv-Gamma}(1,\ 2x10^3) && \forall \quad v \\
\text{HC1}: \quad & \sqrt{v} \sim \text{Half-Cauchy}(10^1) && \forall \quad v \\
\text{HC3}: \quad & \sqrt{v} \sim \text{Half-Cauchy}(10^3) && \forall \quad v \\
\text{U4}: \quad & \sqrt{v} \sim \text{Uniform}(0, 10^4) && \forall \quad v
\end{aligned}$$

	M4IG	M4HC1	M4HC3	M4U4
Δ DIC	3.87	0.02	0.1	0
Δ WAIC	3.78	0.03	0.11	0

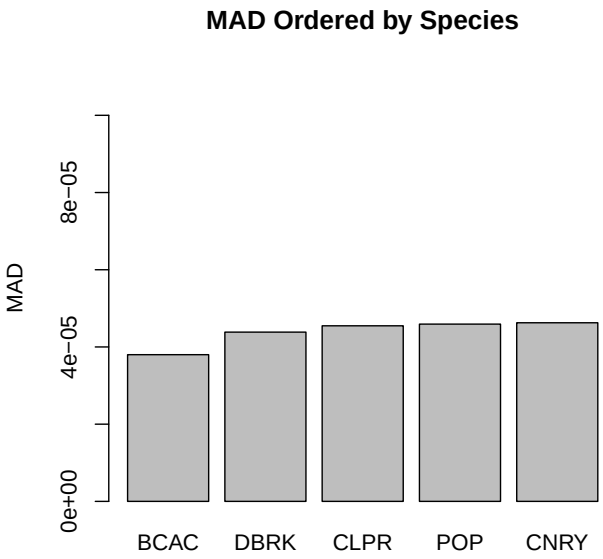
M4HC1



M4HC3

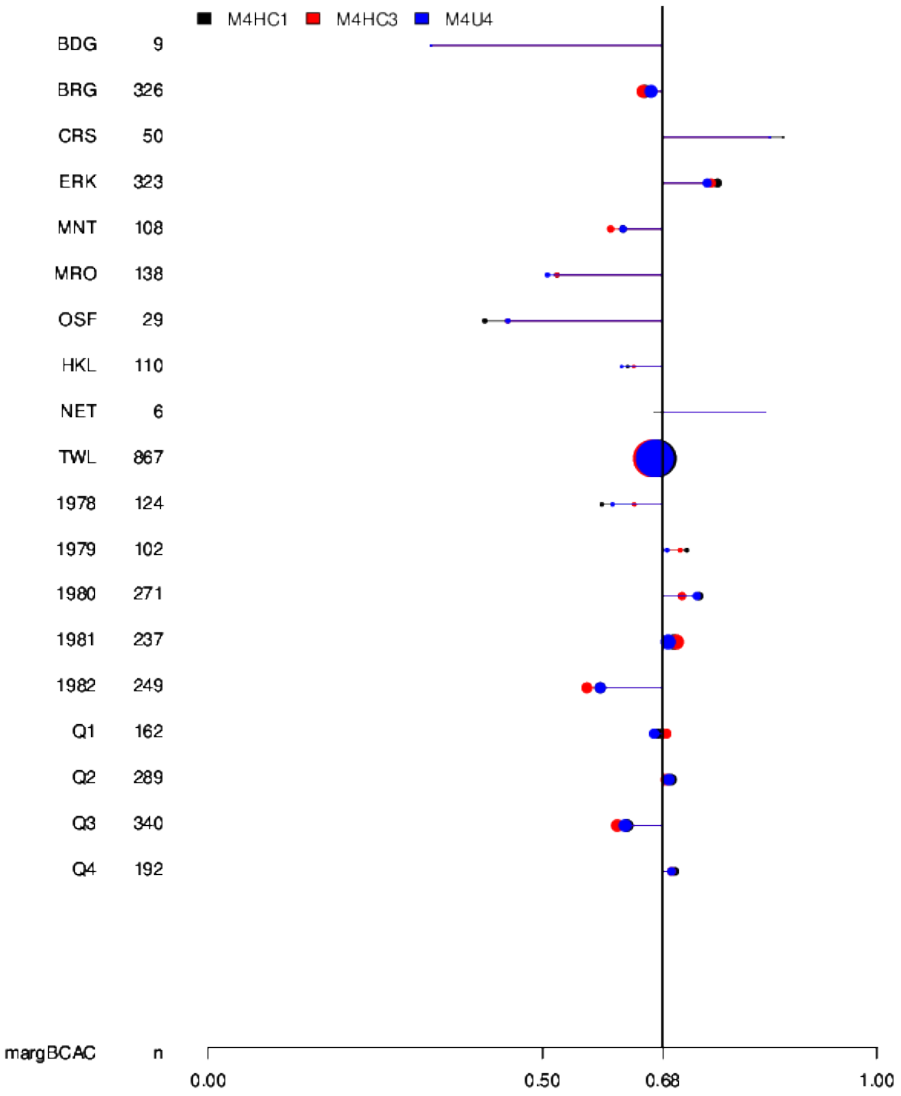


M4U4

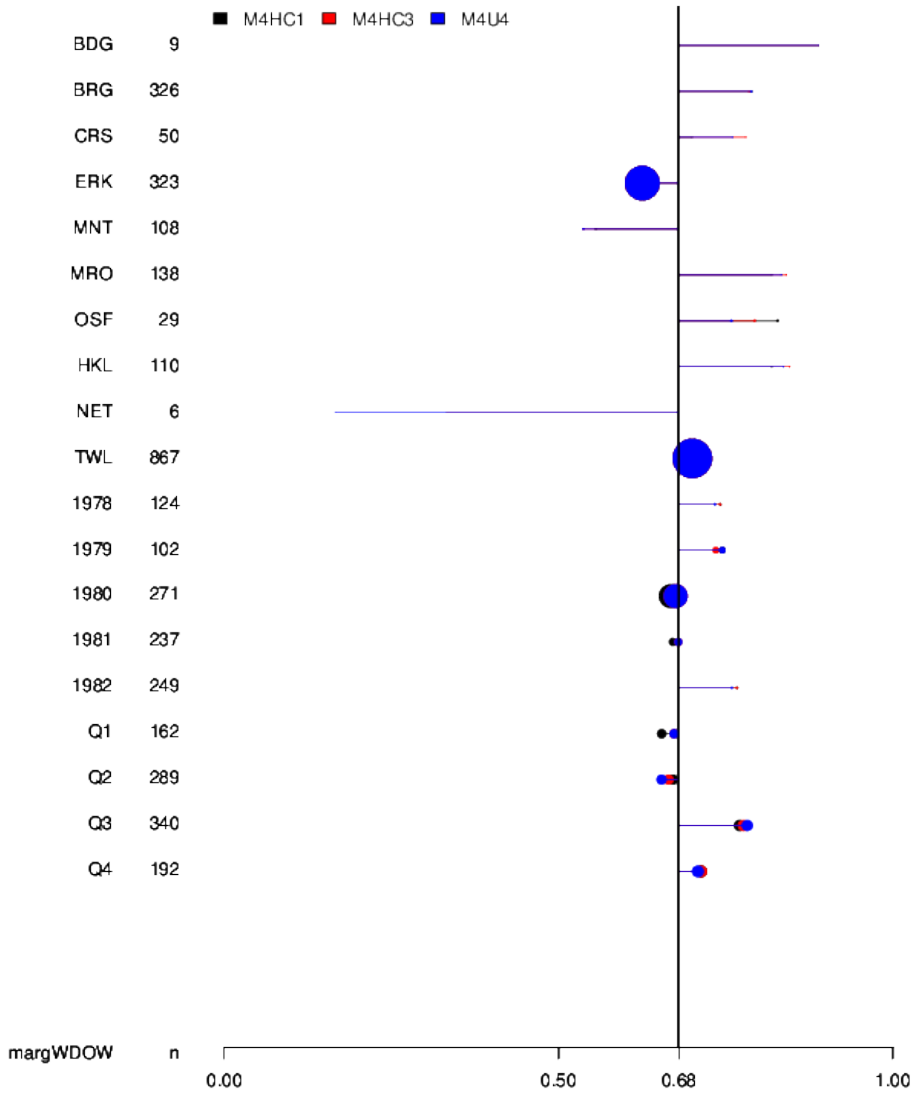


Combined

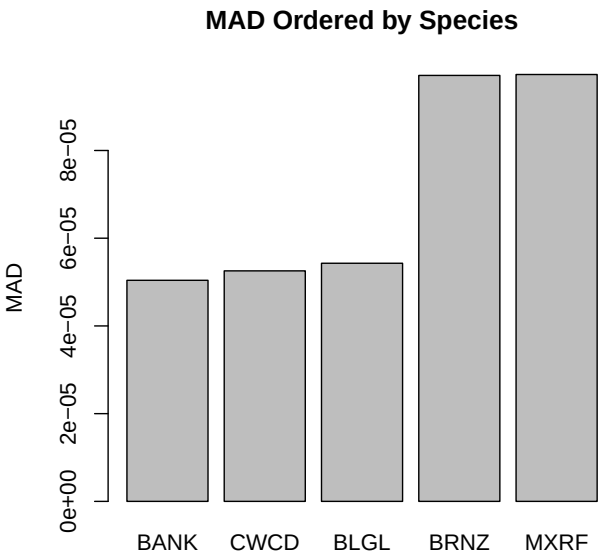
MCAT 250


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

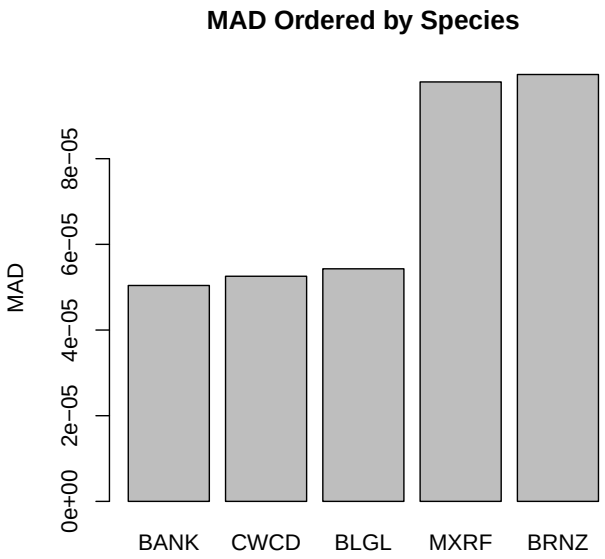
MCAT 250


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
margWDOW n
0.00
0.50
0.68
1.00

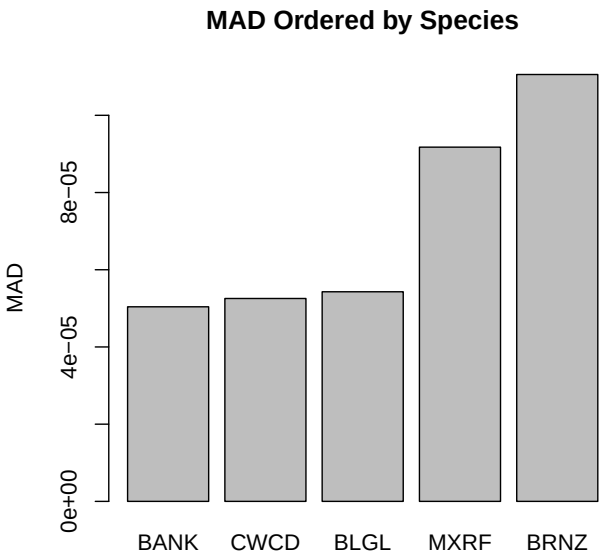
M4HC1



M4HC3

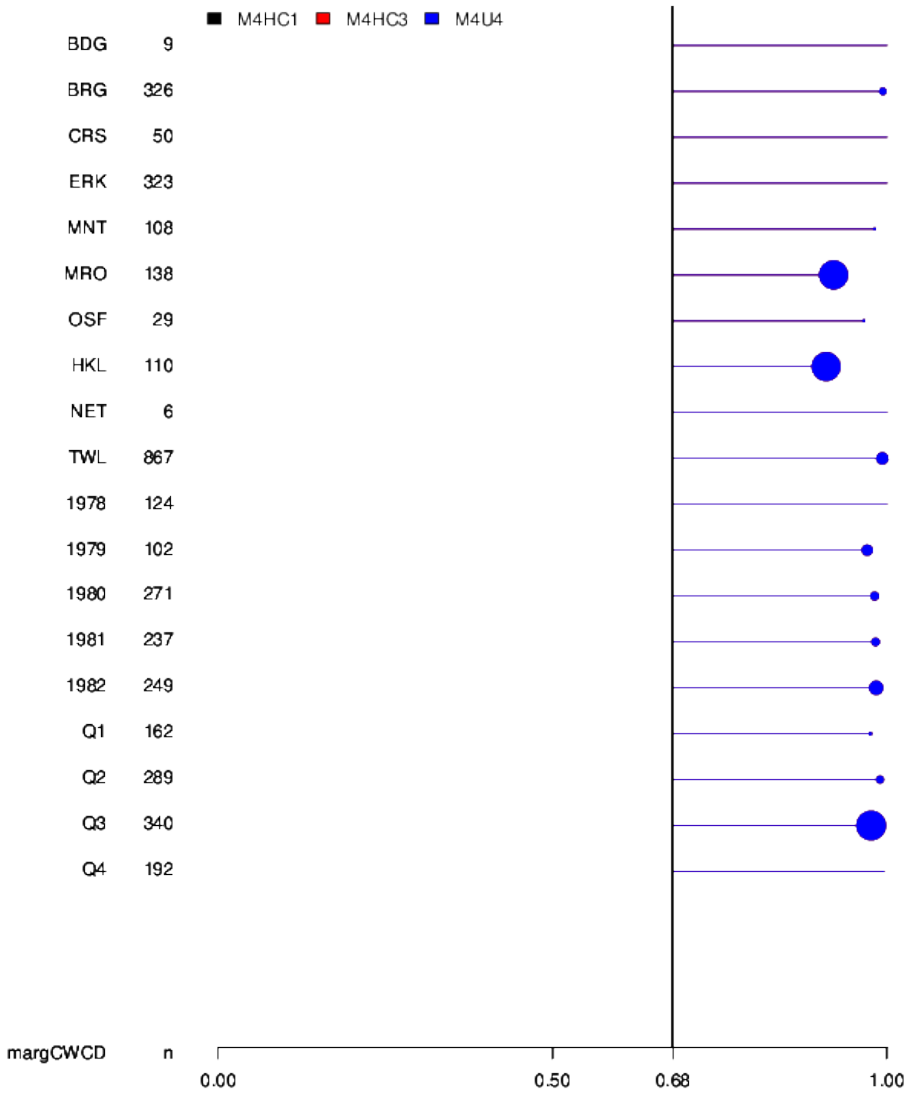


M4U4

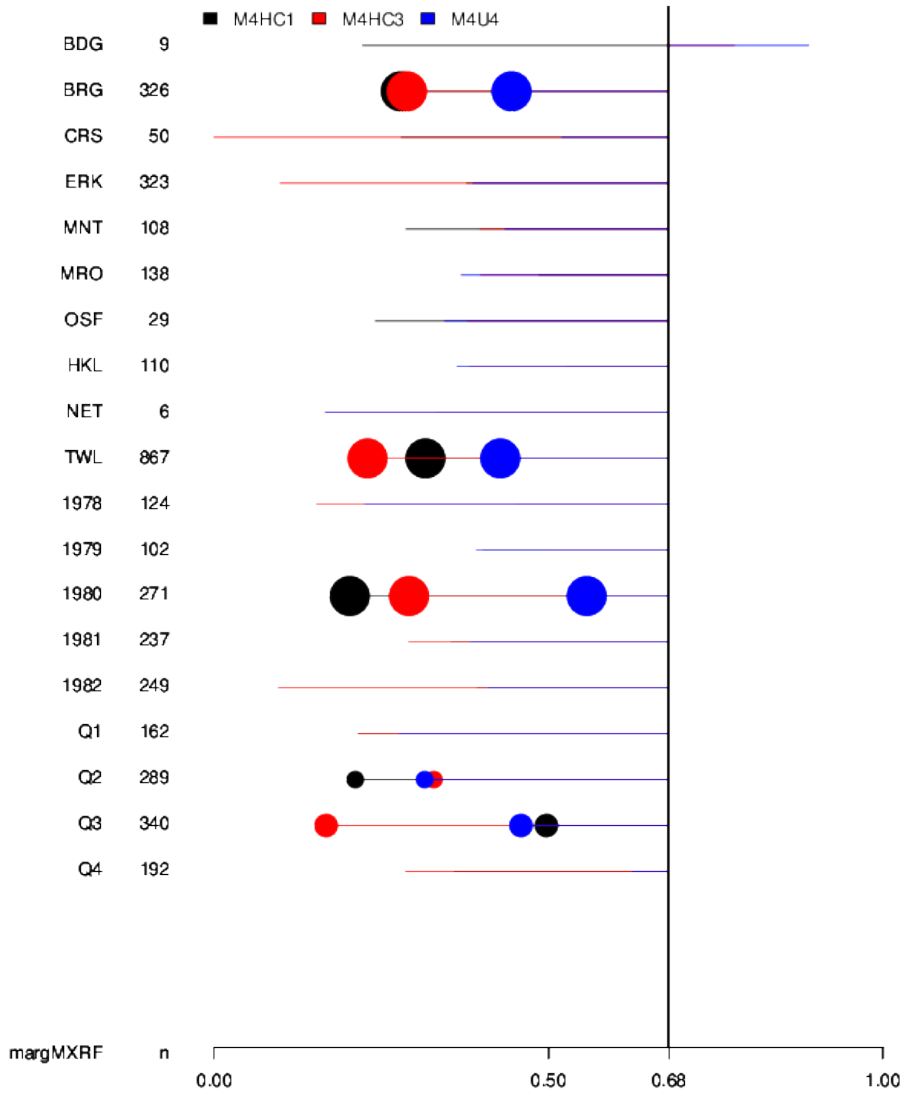


Combined

MCAT 250

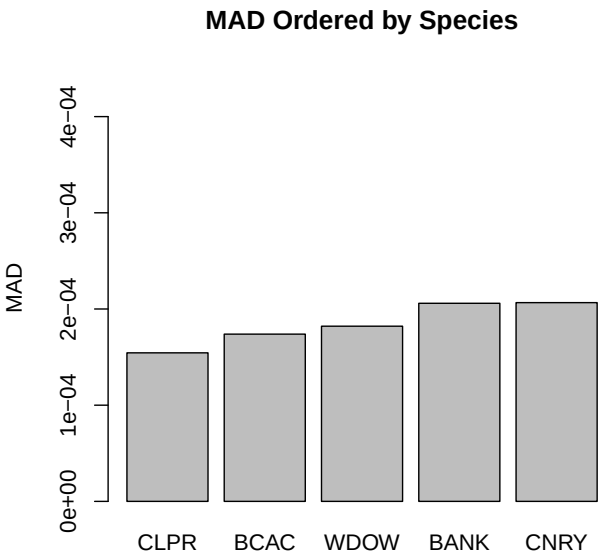

M4HC1
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margCWCD n
0.00
0.50
0.68
1.00

MCAT 250

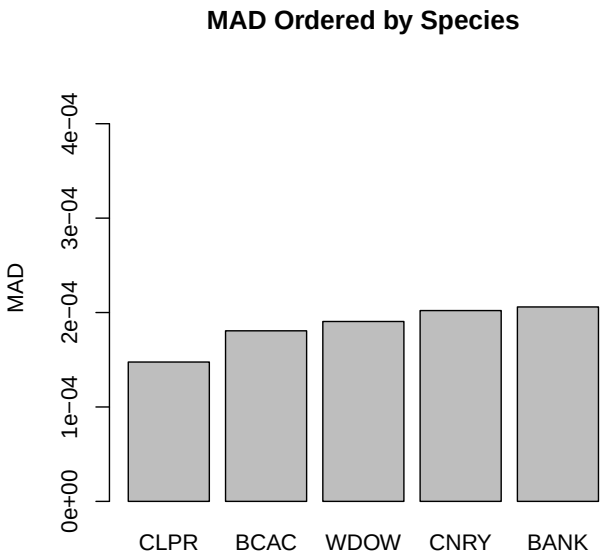

M4HC1
M4HC3
M4U4
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

	M4IG	M4HC1	M4HC3	M4U4
Δ DIC	0.88	0.8	0.8	0
Δ WAIC	0.76	0.83	0.83	0

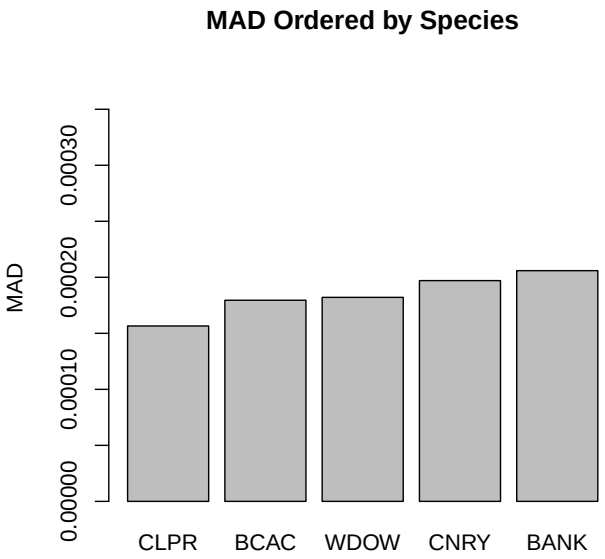
M4HC1



M4HC3

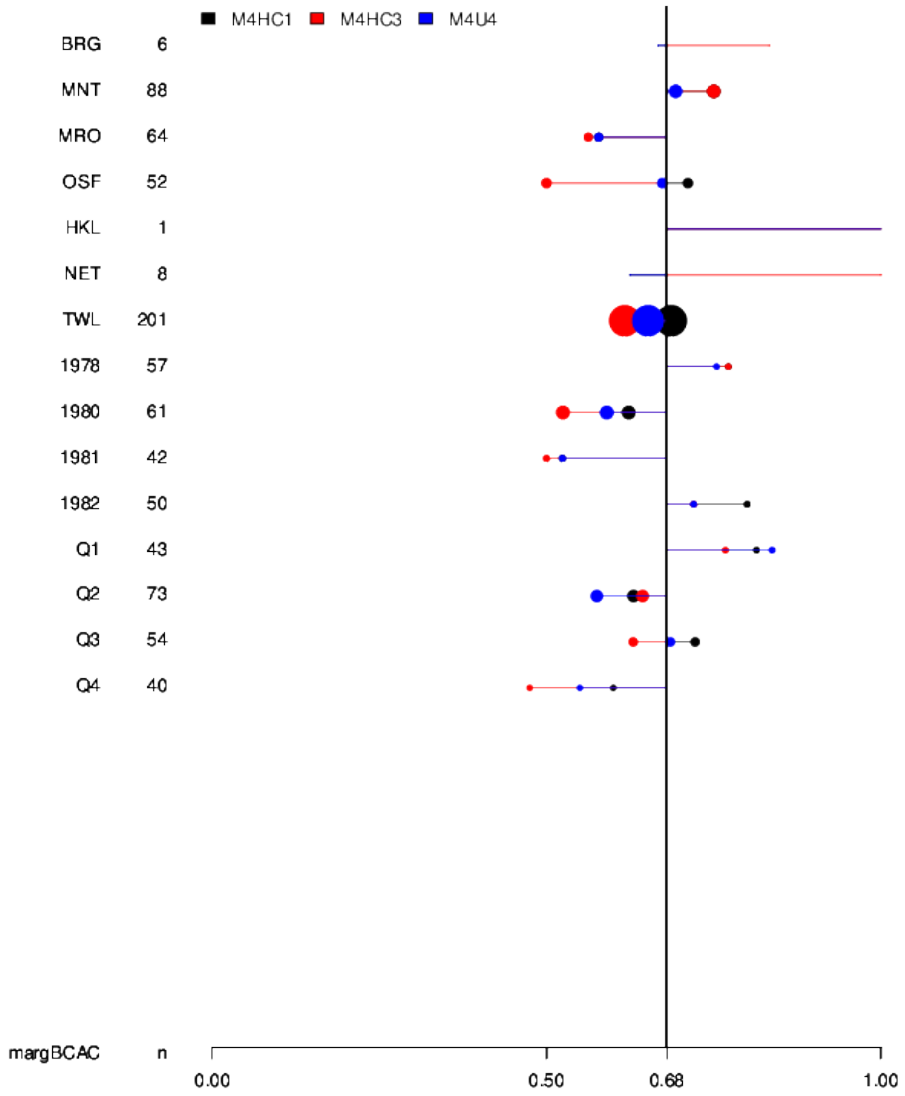


M4U4

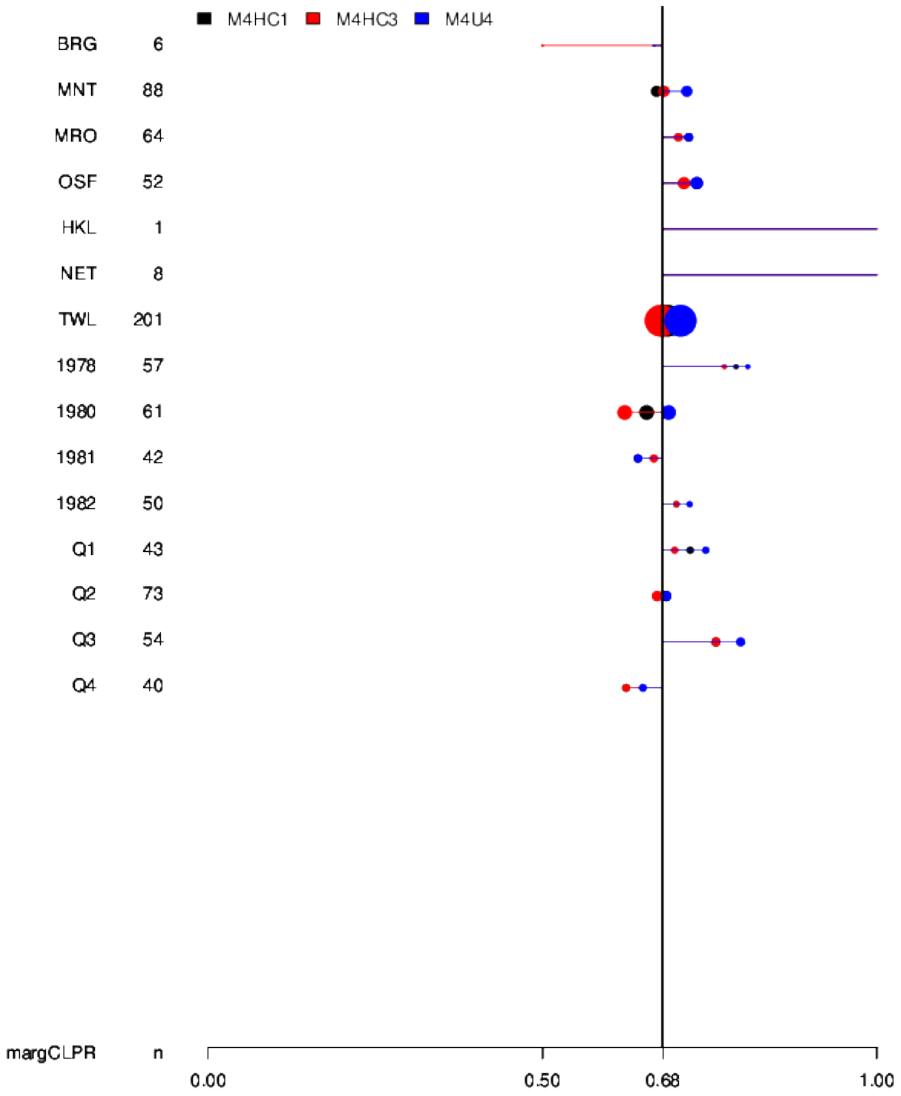


Combined

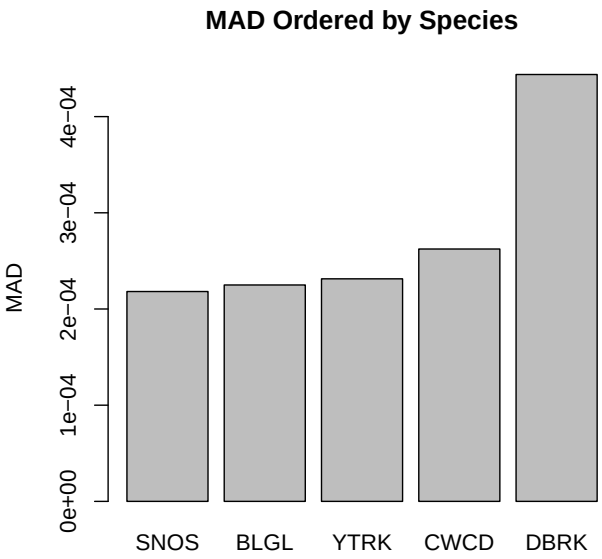
MCAT 253

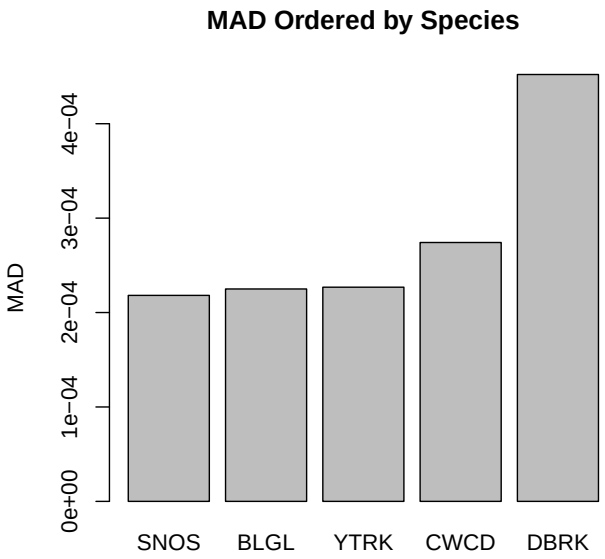

M4HC1
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00

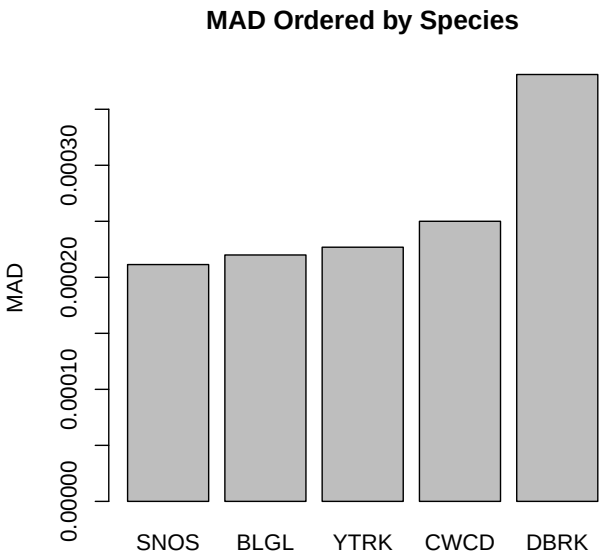
MCAT 253


M4HC1
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

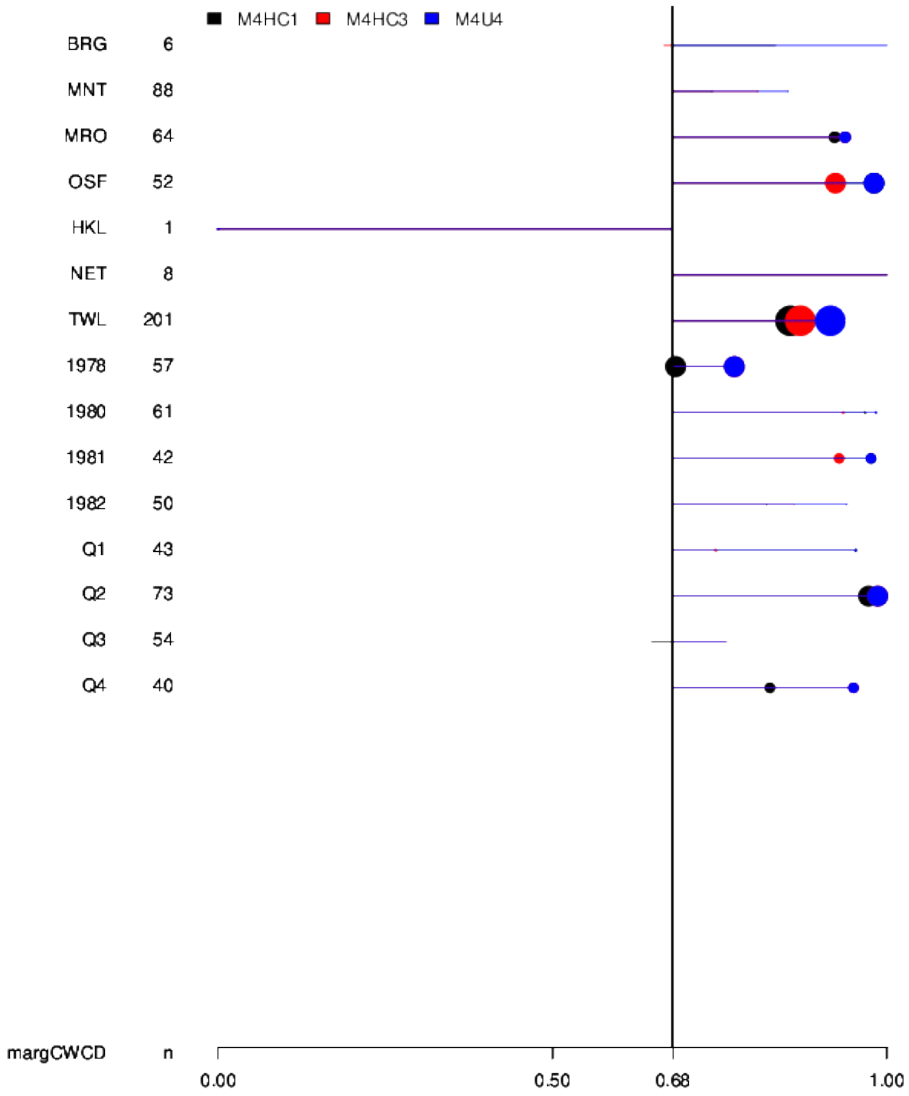






Combined

MCAT 253


M4HC1
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
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0.50
0.68
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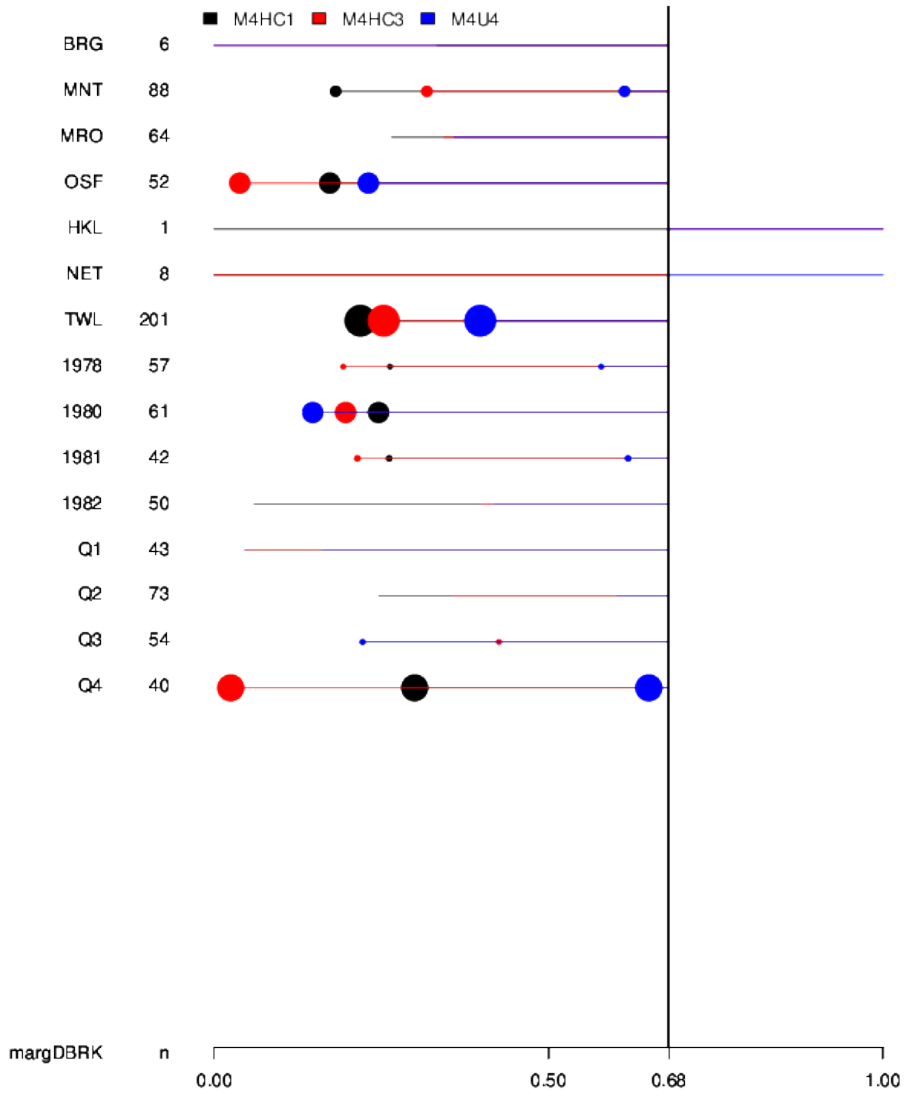
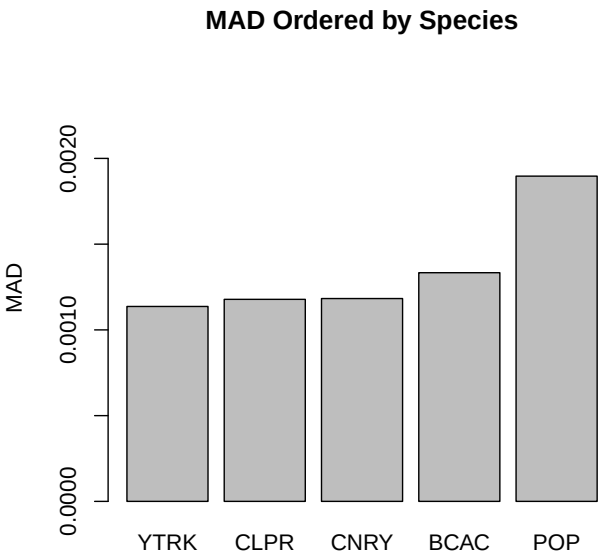
MCAT 253

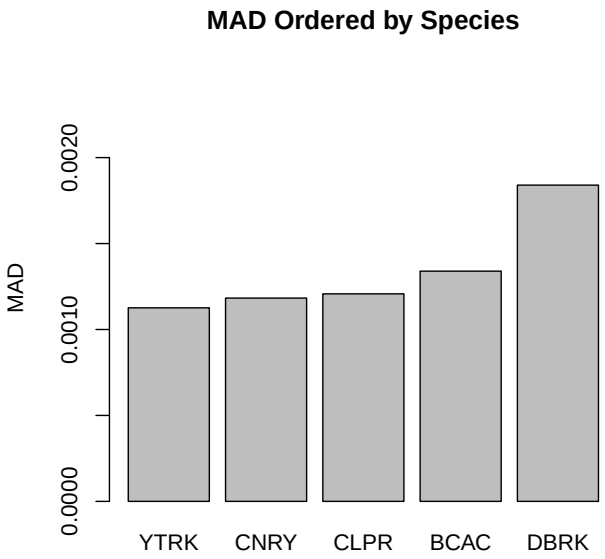

M4HC1
M4HC3
M4U4
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

	M4IG	M4HC1	M4HC3	M4U4
Δ DIC	0.18	176.33	0.2	0
Δ WAIC	0.08	69.19	0.08	0

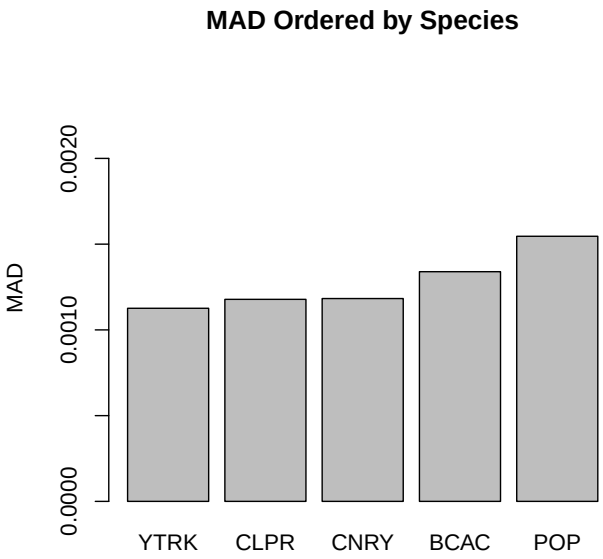
M4HC1



M4HC3

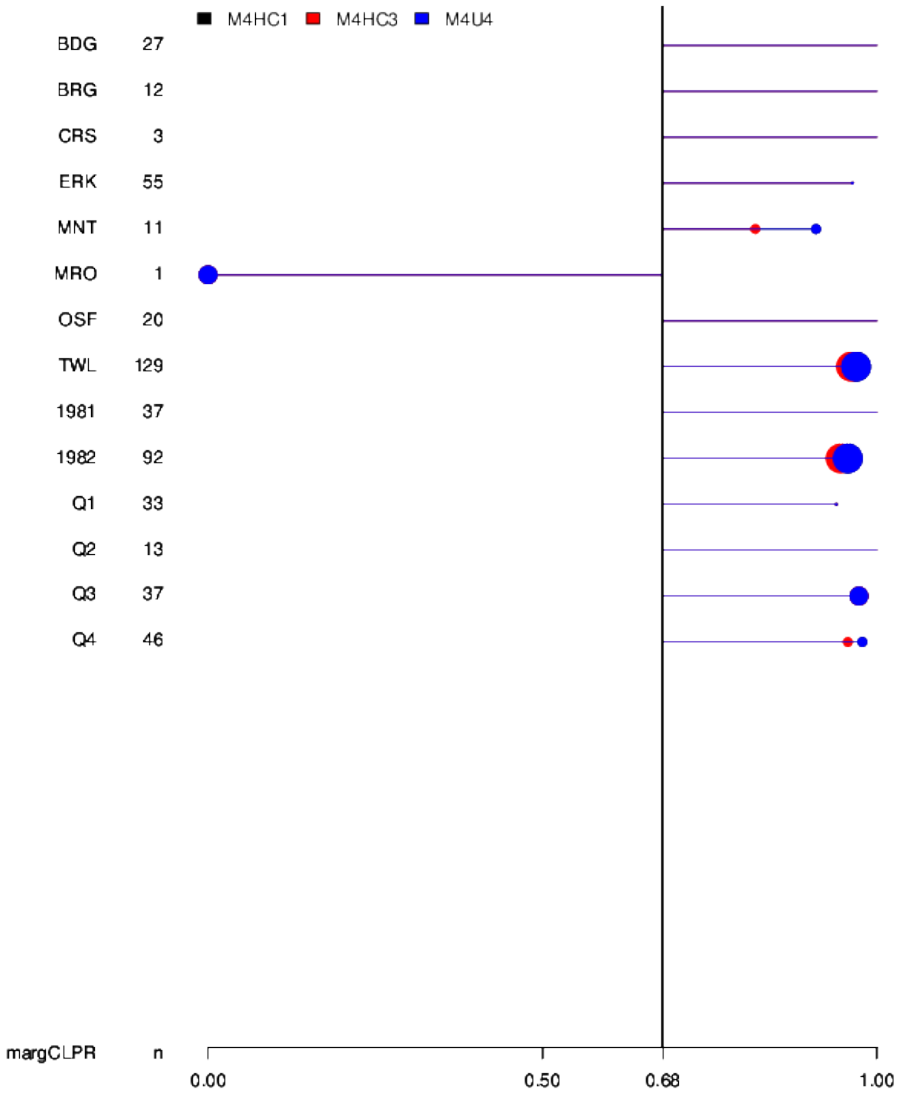


M4U4



Combined

MCAT 269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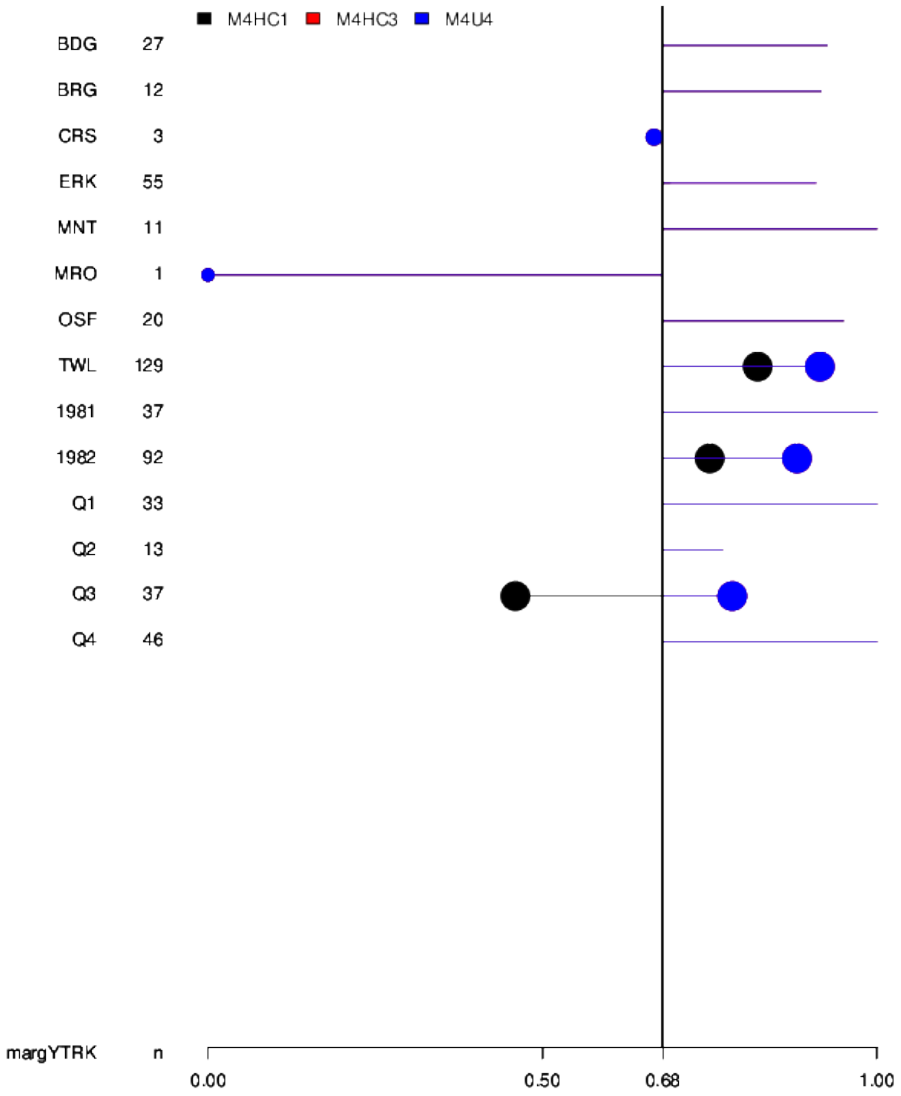
M4HC3
M4U4
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margCLPR n
0.00
0.50
0.68
1.00

MCAT 269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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
margYTRK n
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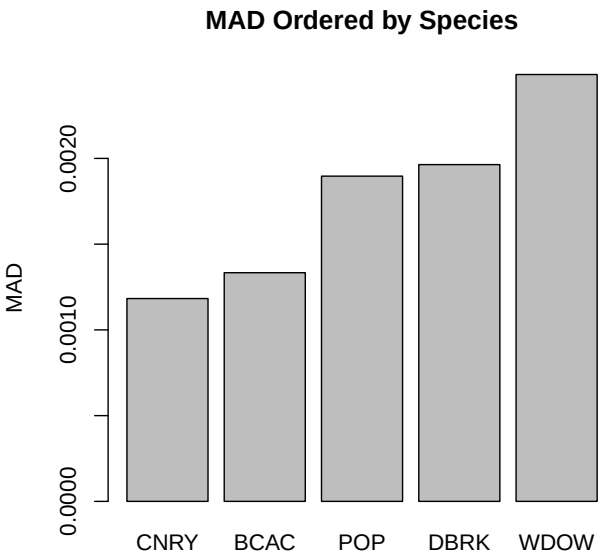
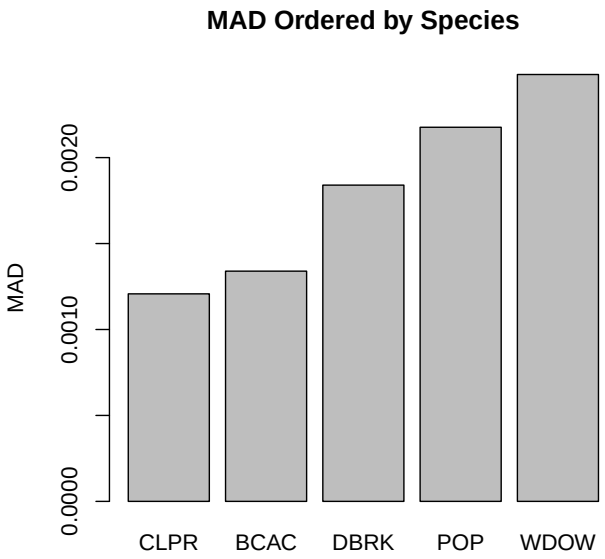
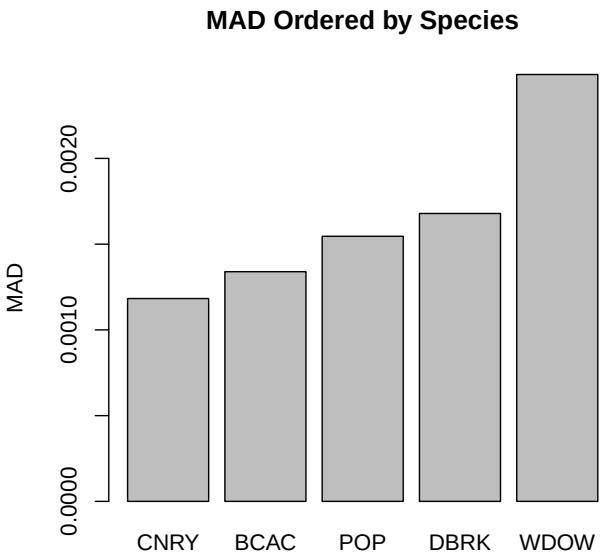
0.68
1.00

M4HC1 M4HC3 M4U4







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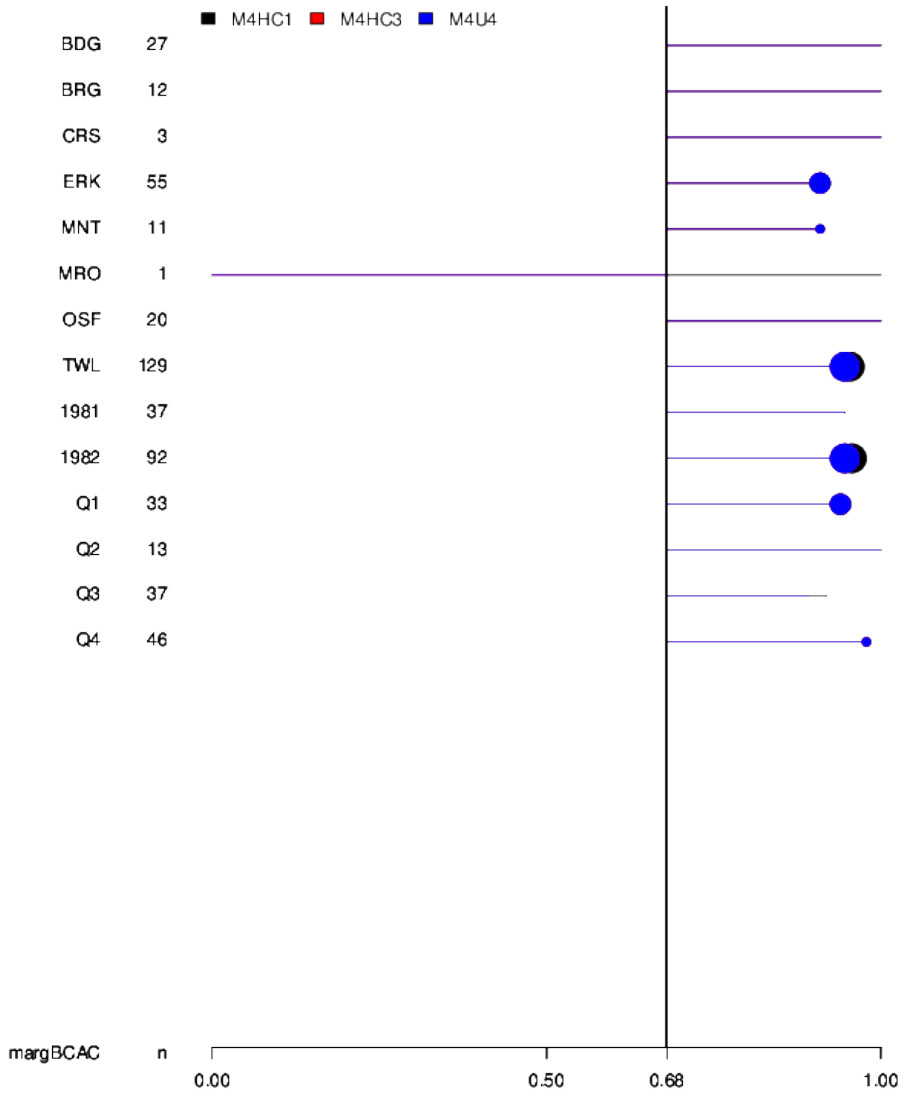
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M4HC3
M4U4
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BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margBCAC n
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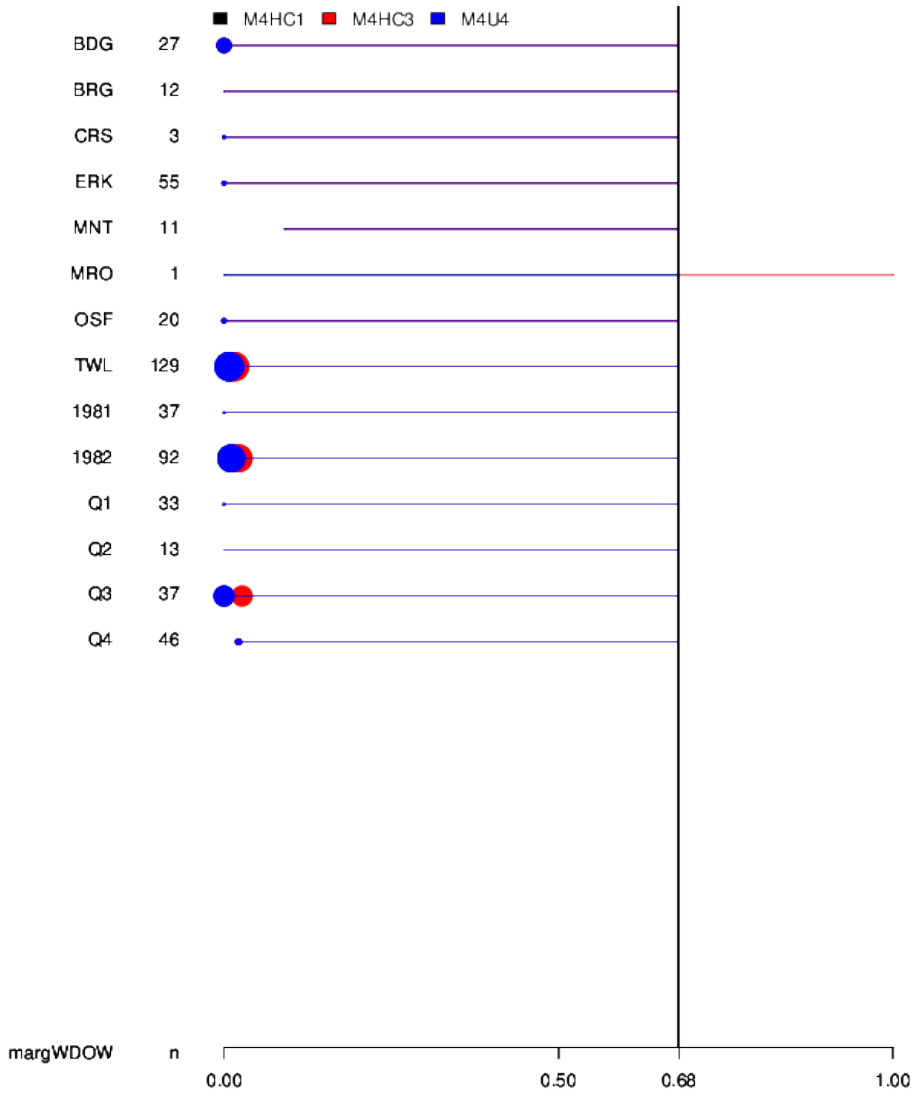
0.50
0.68
1.00

MCAT 269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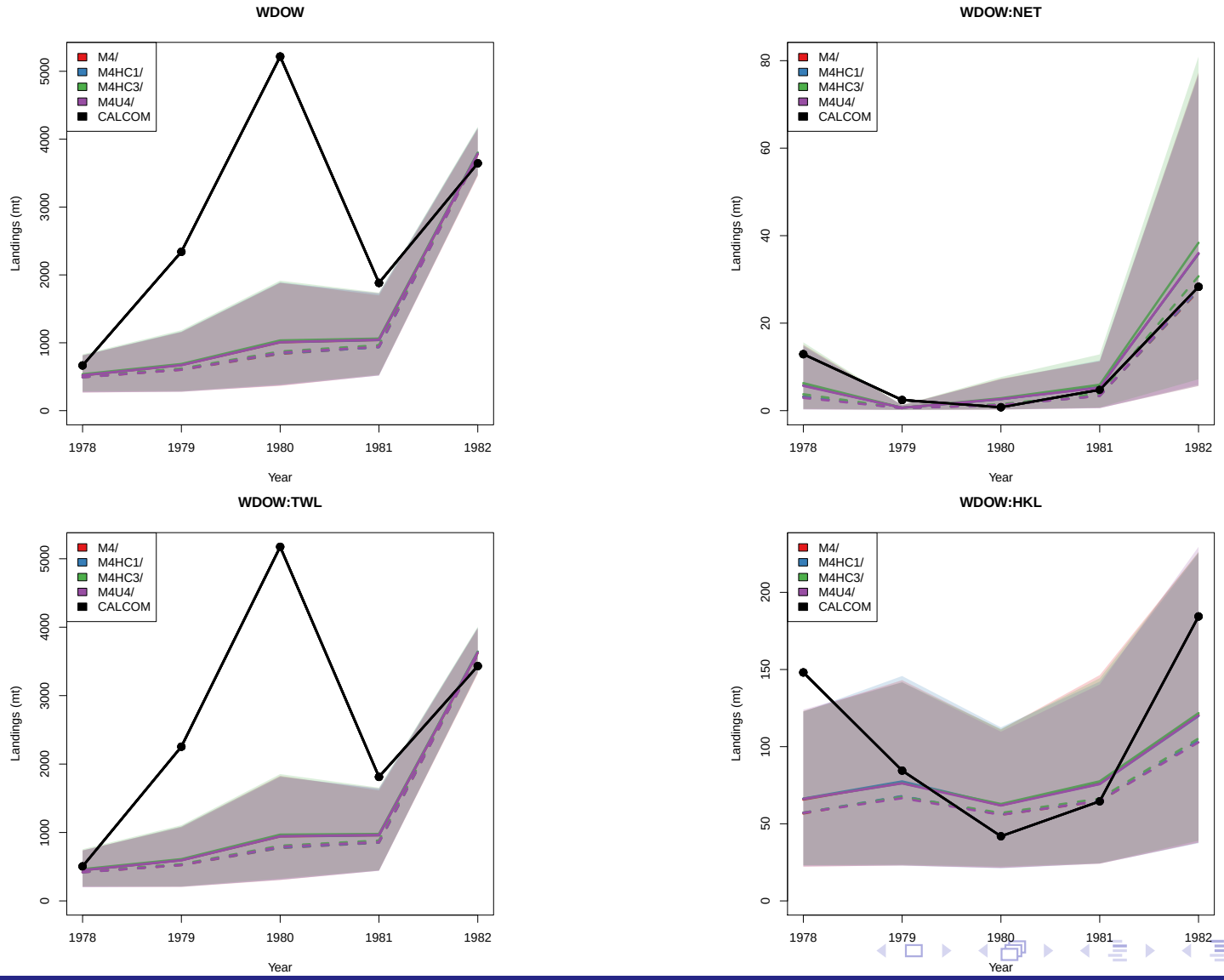
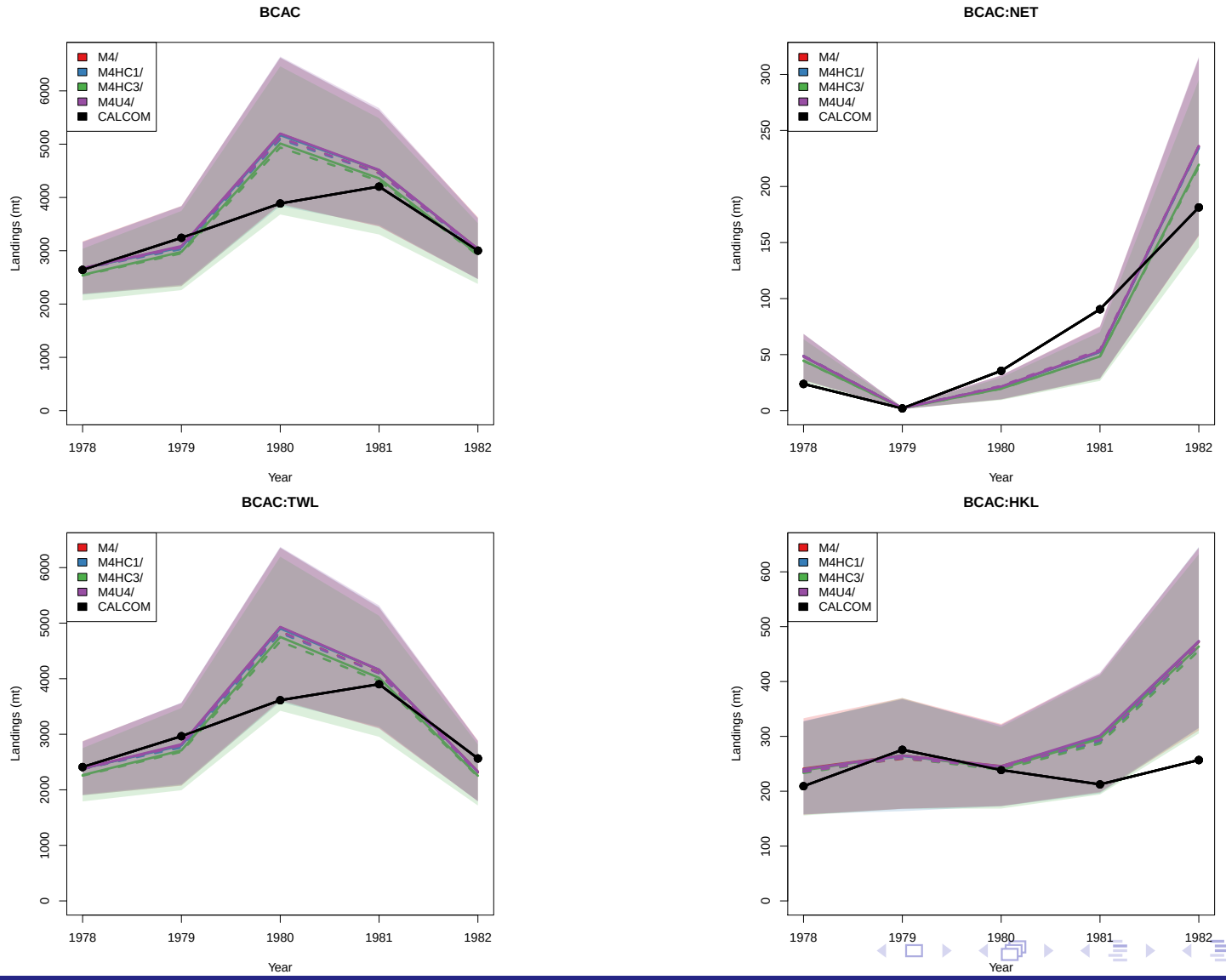
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margWDOW n
0.00
0.50
0.68
1.00

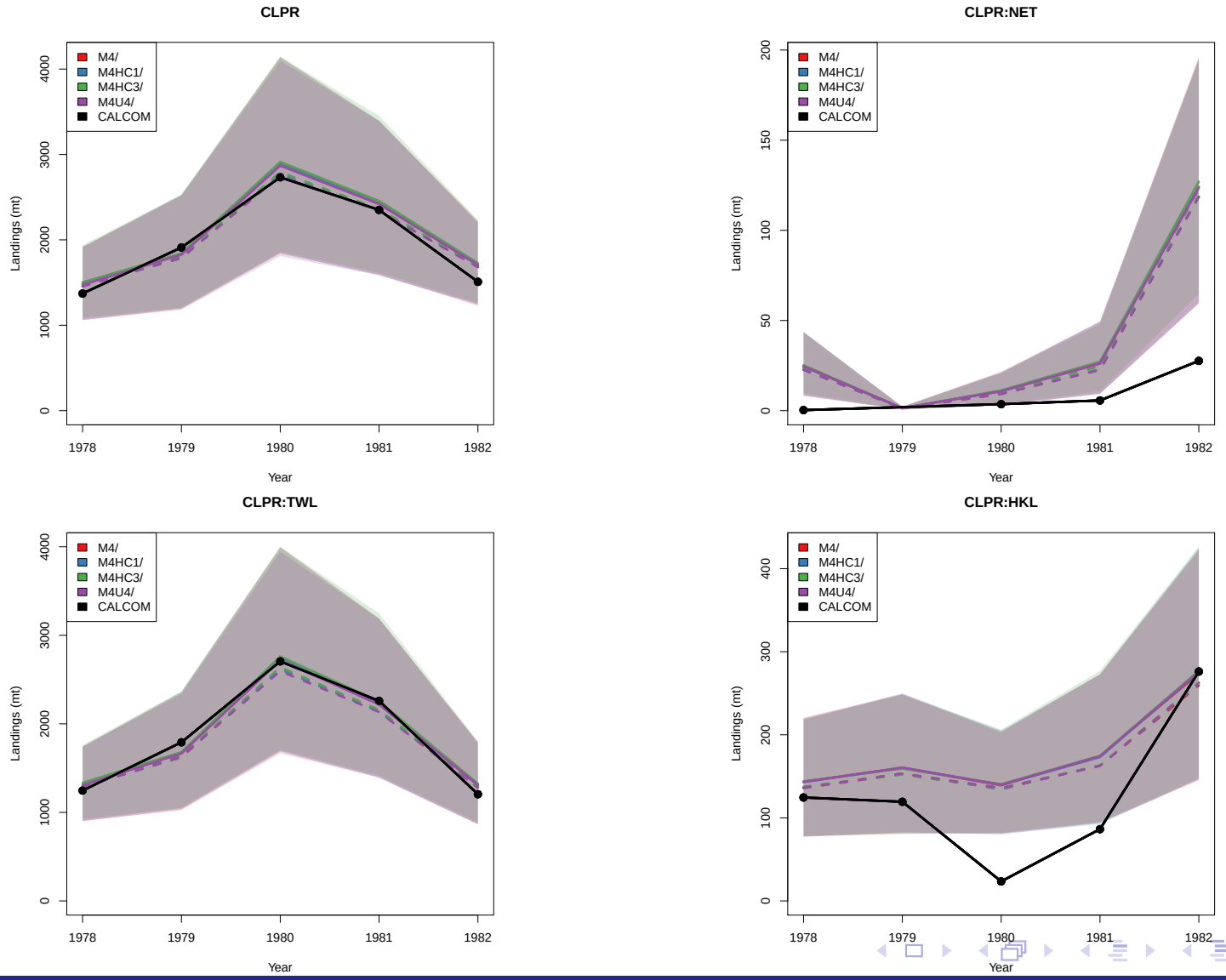
Landings Sensitivity



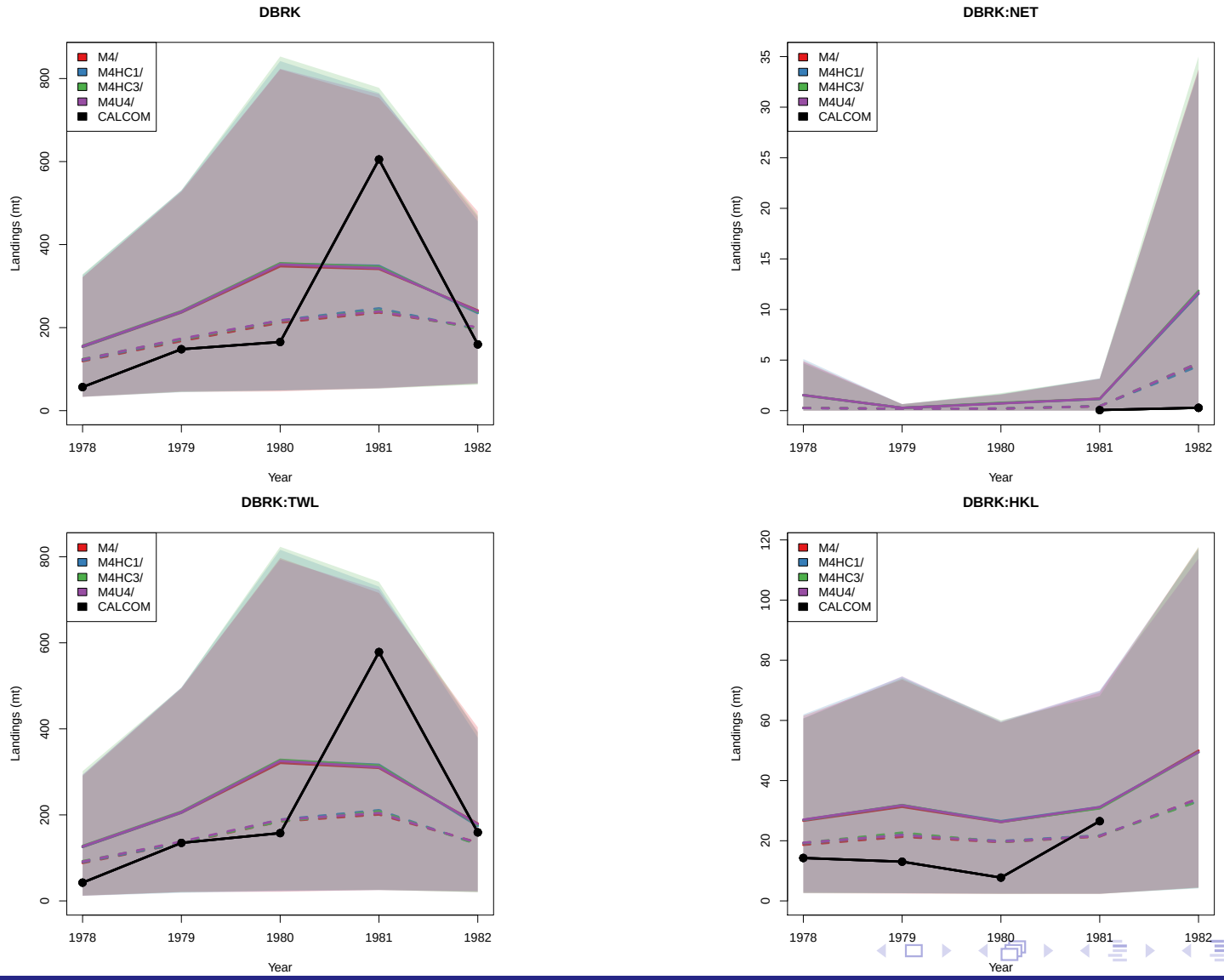
Landings Sensitivity



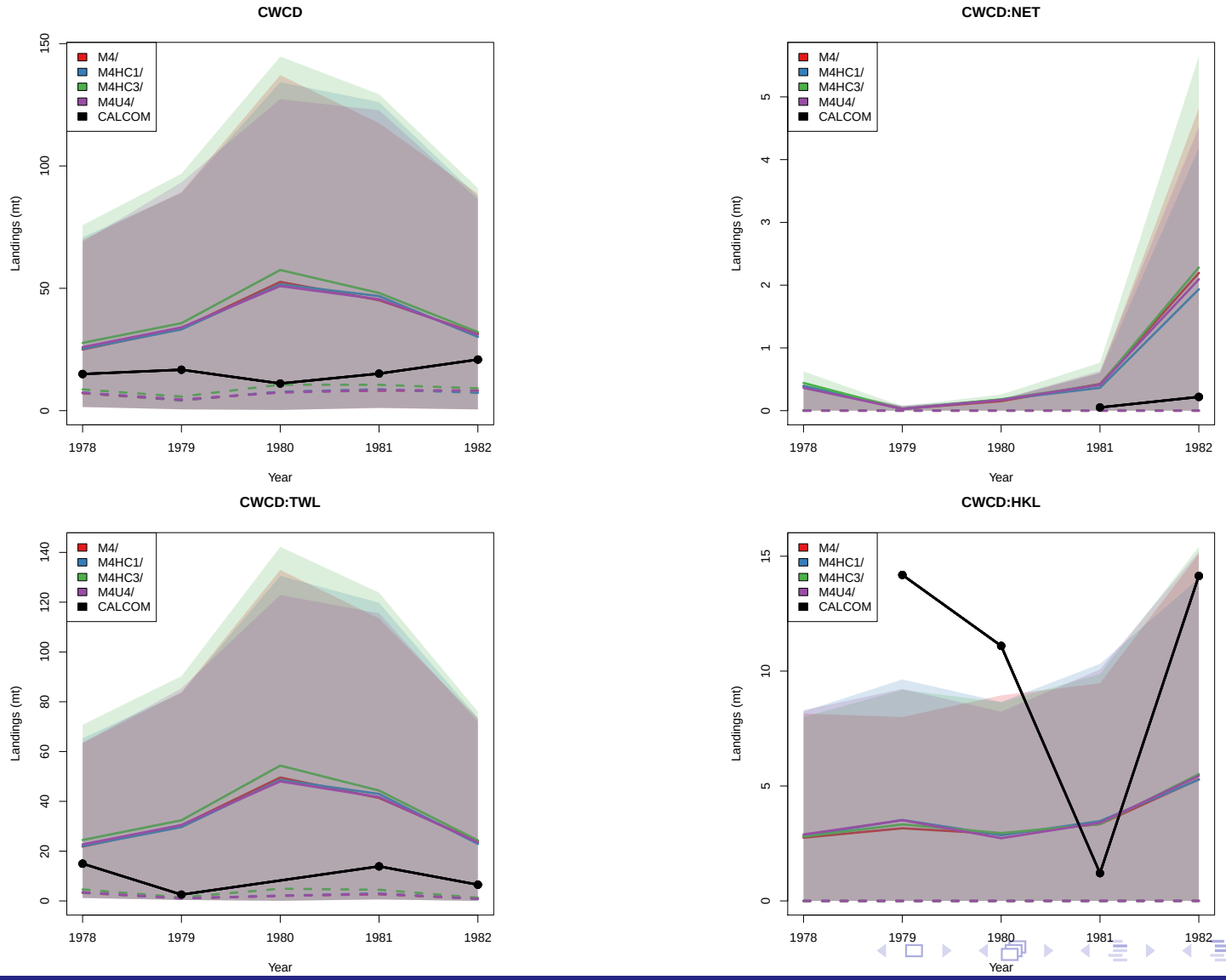
Landings Sensitivity



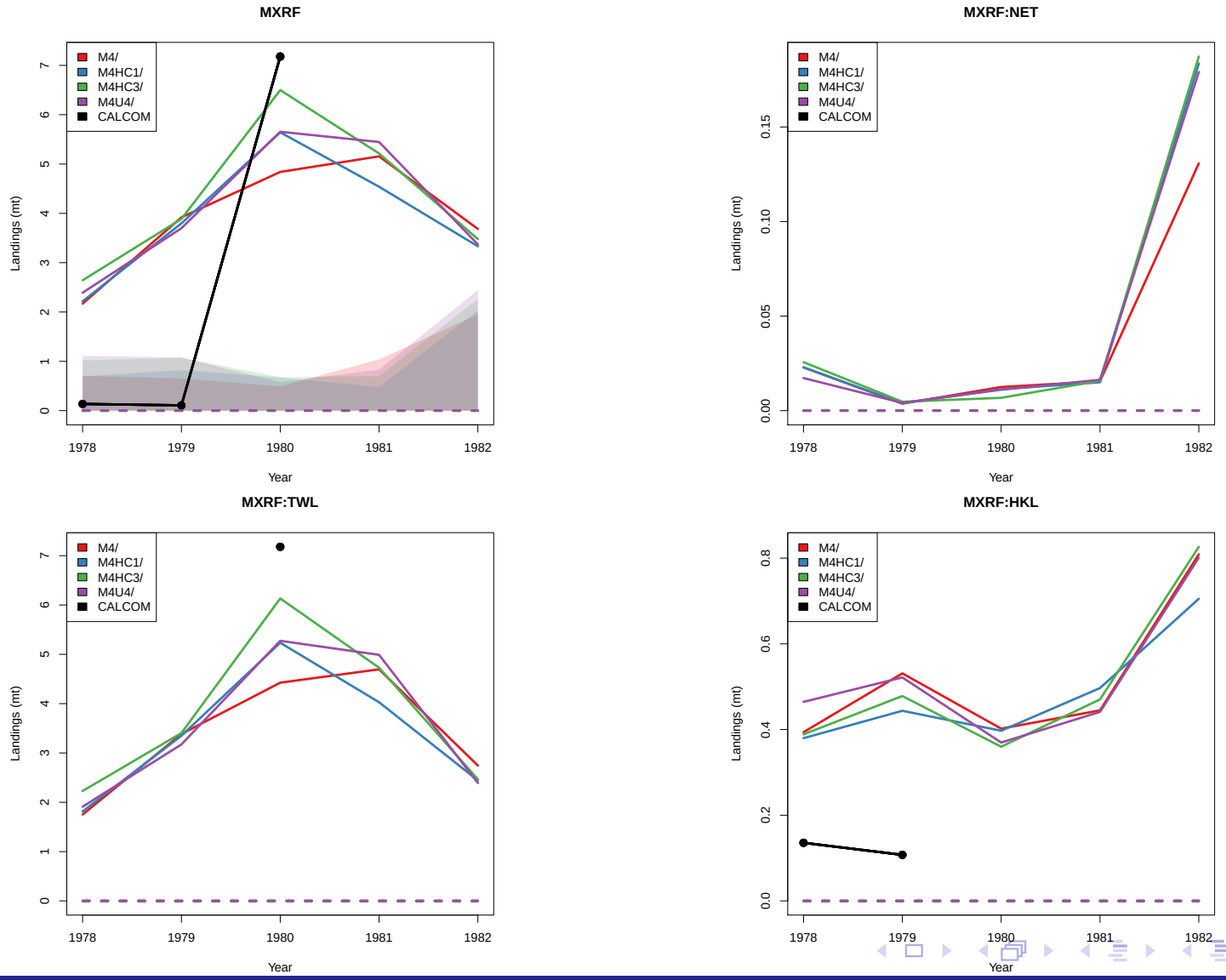
Landings Sensitivity



Landings Sensitivity



Landings Sensitivity



Prior Summary

- In a data-rich setting, the prior has little influence on performance.
- In a data-poor setting, the U4 prior often performs well.
- Despite better performance, the U4 prior is less stable in a data-poor setting.

MCAT 250 Combined Plots

MCAT 253 Combined Plots

MCAT 269 Combined Plots

All Species Landings

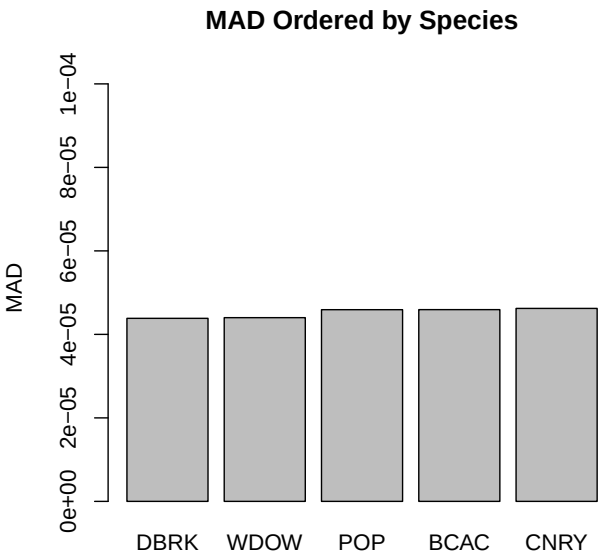
Request: Explore various two-way interactions (beyond the current explorations; e.g., Species : Port and Species : Gear).

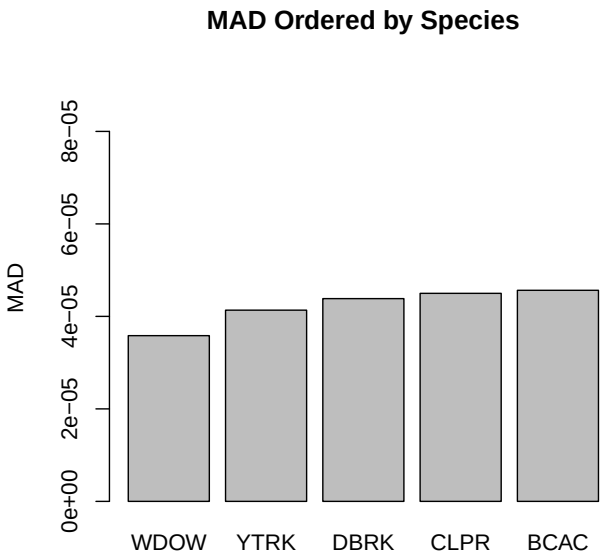
Rationale: The Team did not have time to search across the multitude of possible interaction terms that they could have included in the model. From various anecdotal comments made during the review it seemed likely that the model would benefit from the inclusion of other interaction terms. Explorations with the diagnostic template may suggest potentially beneficial terms.

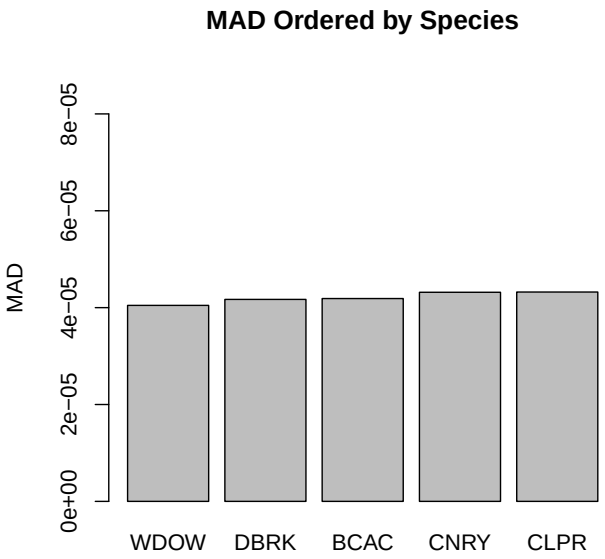
Response: The following slides show the diagnostic plots as applied to models exploring the inclusion of species:port and species:gear interaction terms.

	M4	M4SG	M4SP
Δ DIC	58229.78	21403.07	0
Δ WAIC	24203.2	10186.57	0

M4 M4SG M4SP

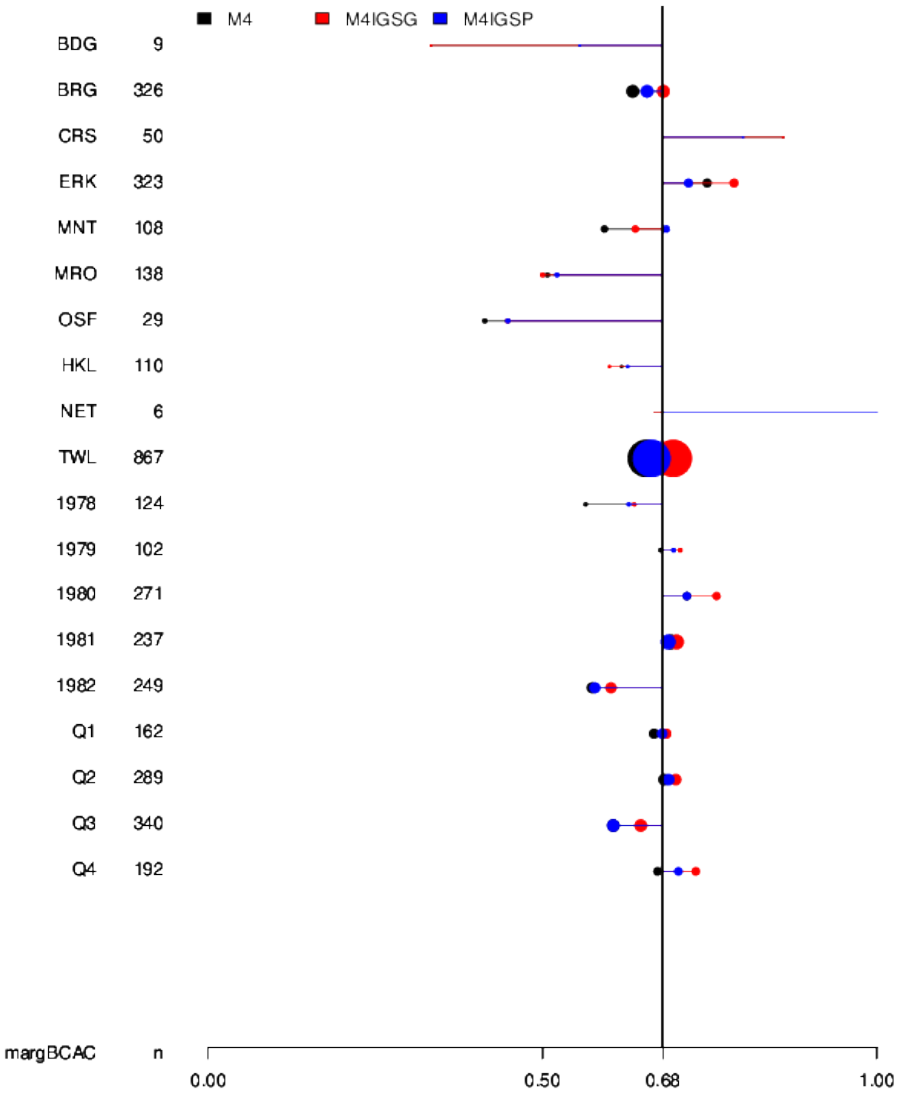




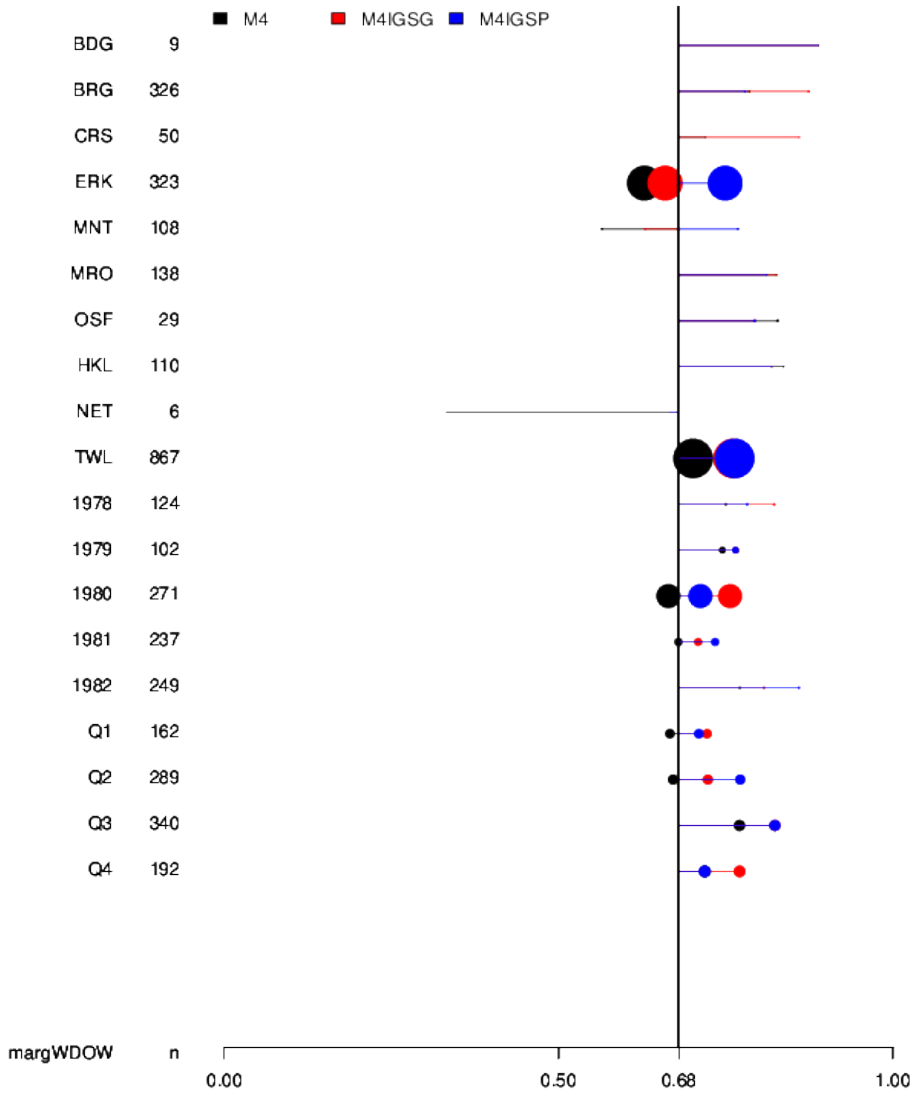


Combined

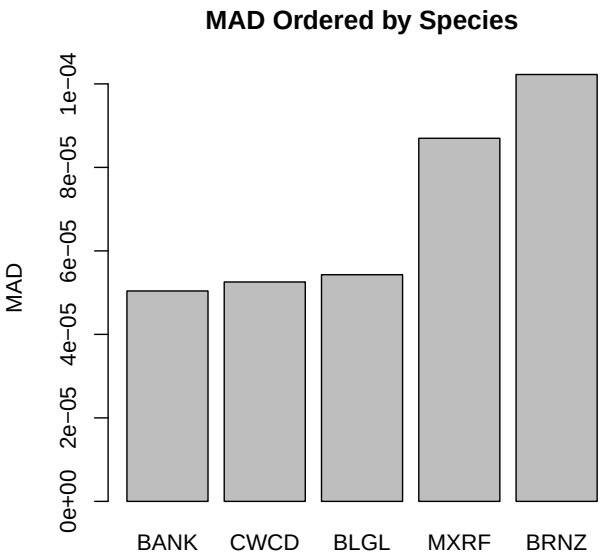
MCAT 250

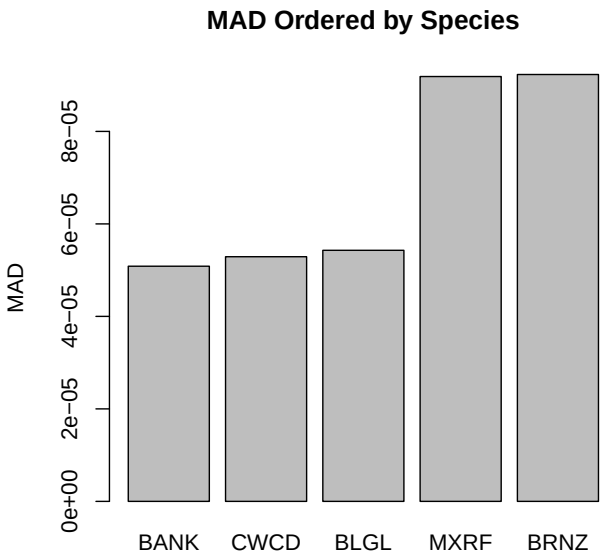

M4
M4IGSG
M4IGSP
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margBCAC n
0.00
0.50
0.68
1.00

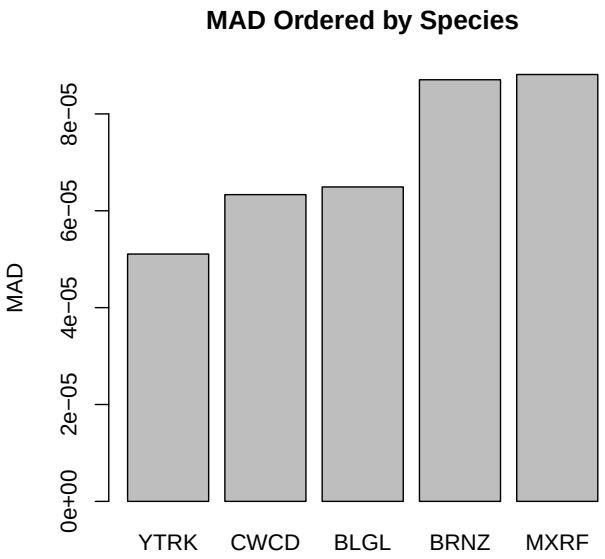
MCAT 250


M4
M4IGSG
M4IGSP
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

M4 M4SG M4SP

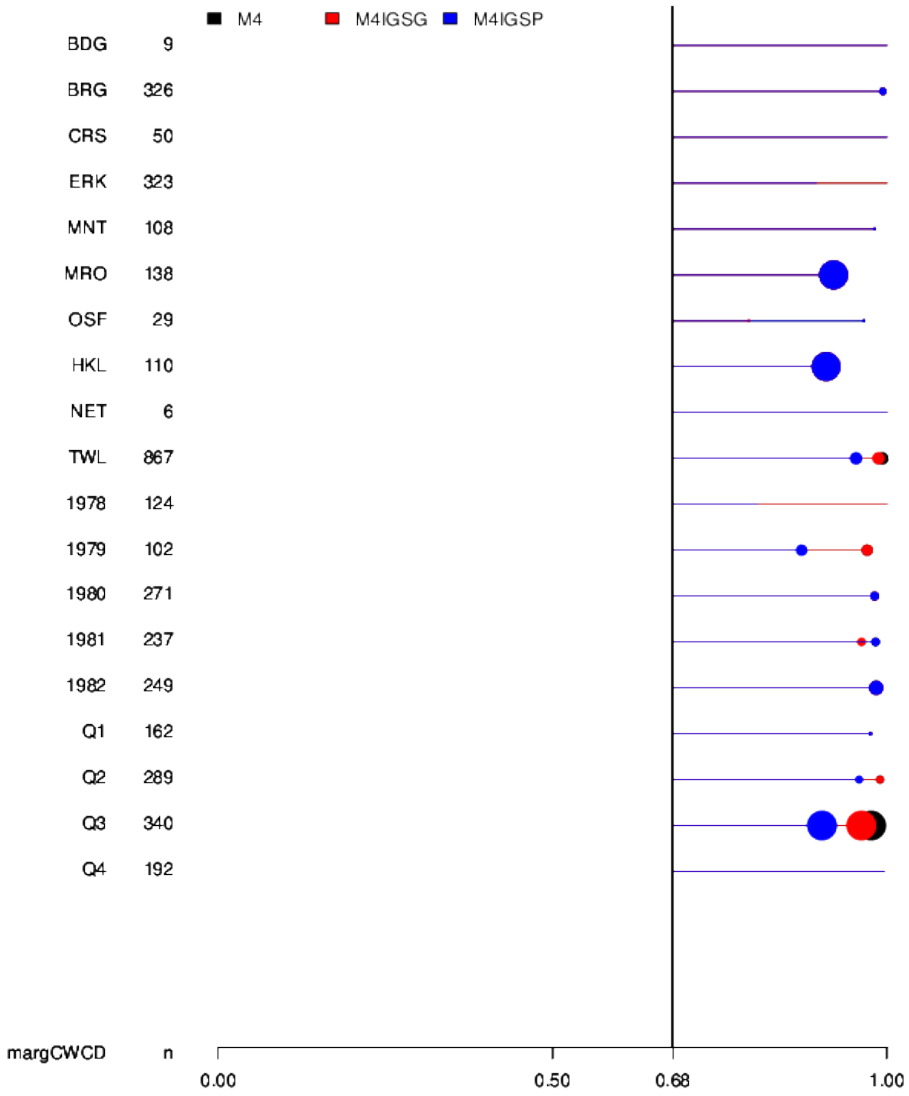




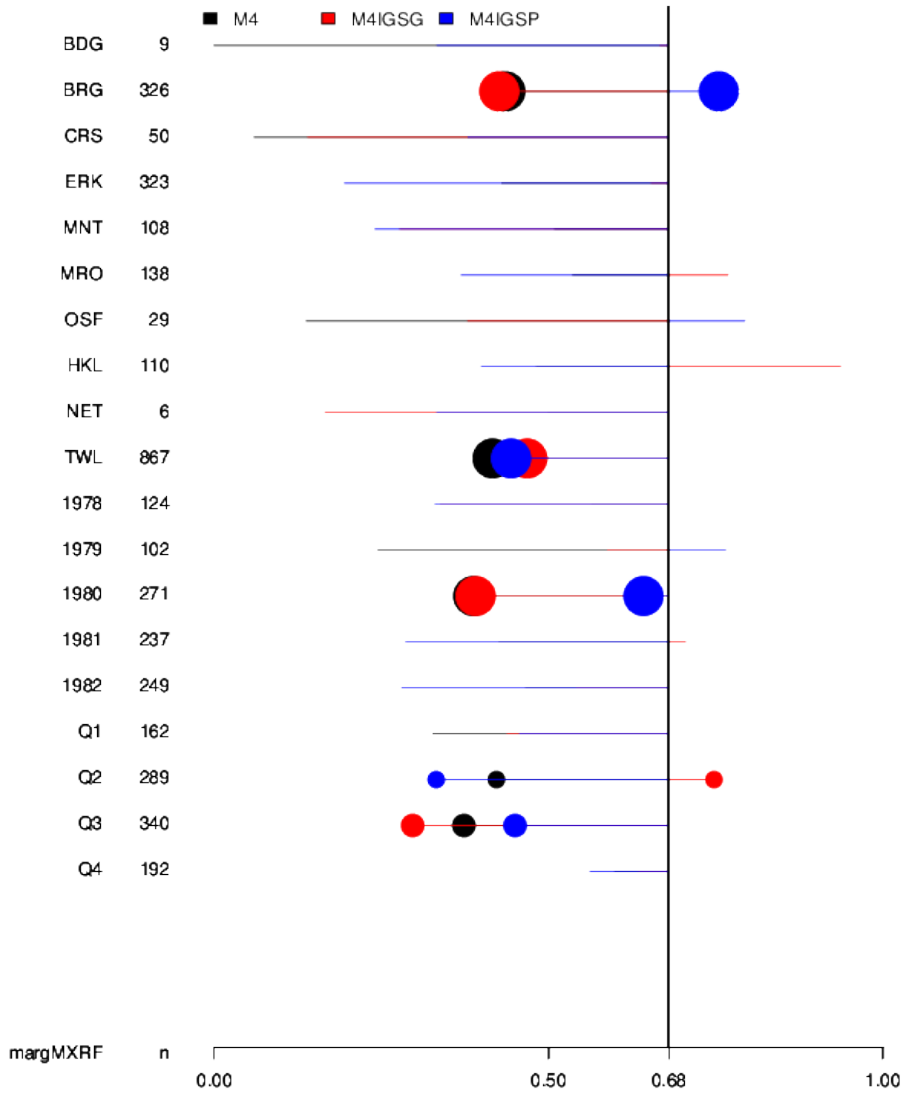


Combined

MCAT 250

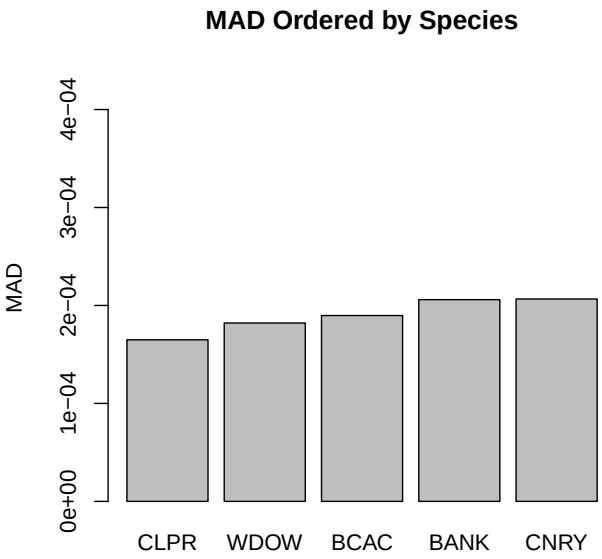

M4
M4IGSG
M4IGSP
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margCWCD n
0.00
0.50
0.68
1.00

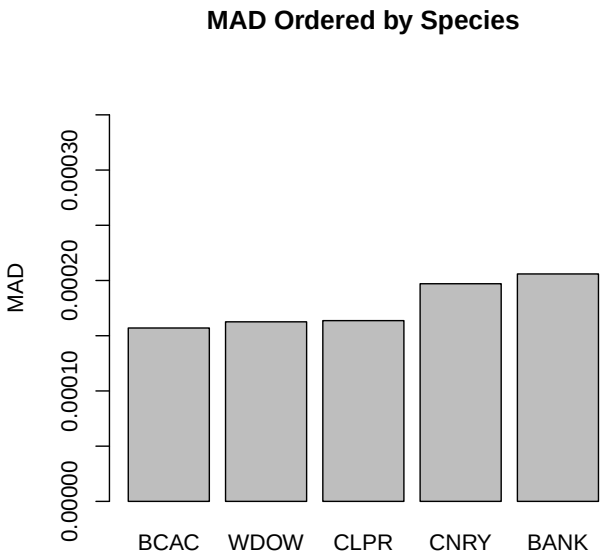
MCAT 250

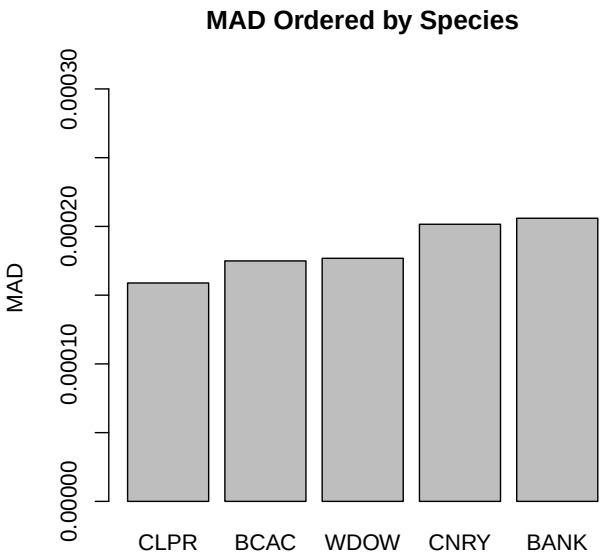

M4
M4IGSG
M4IGSP
BDG 9
BRG 326
CRS 50
ERK 323
MNT 108
MRO 138
OSF 29
HKL 110
NET 6
TWL 867
1978 124
1979 102
1980 271
1981 237
1982 249
Q1 162
Q2 289
Q3 340
Q4 192
margMXRF n
0.00
0.50
0.68
1.00

	M4	M4SG	M4SP
Δ DIC	403.42	308.65	0
Δ WAIC	872.35	778.17	0

M4 M4SG M4SP

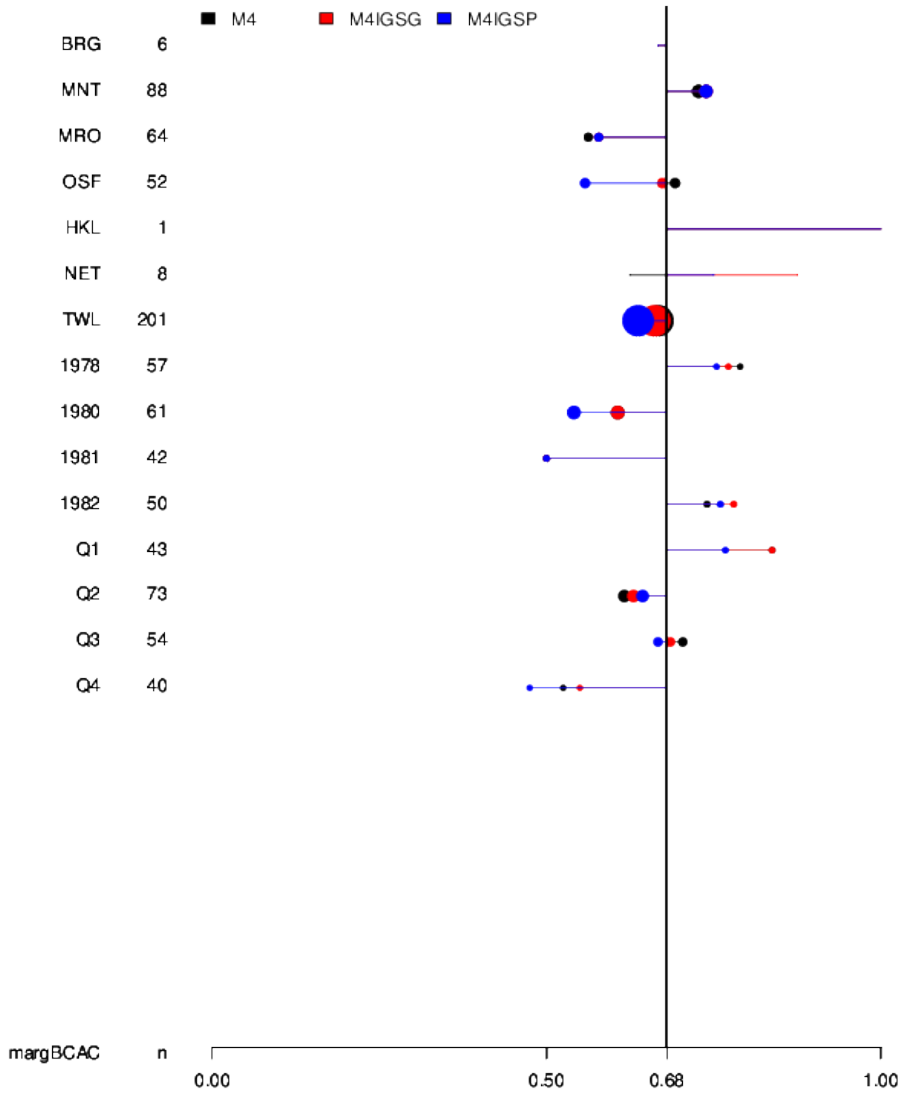






Combined

MCAT 253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M4IGSP
BRG 6
MNT 88
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
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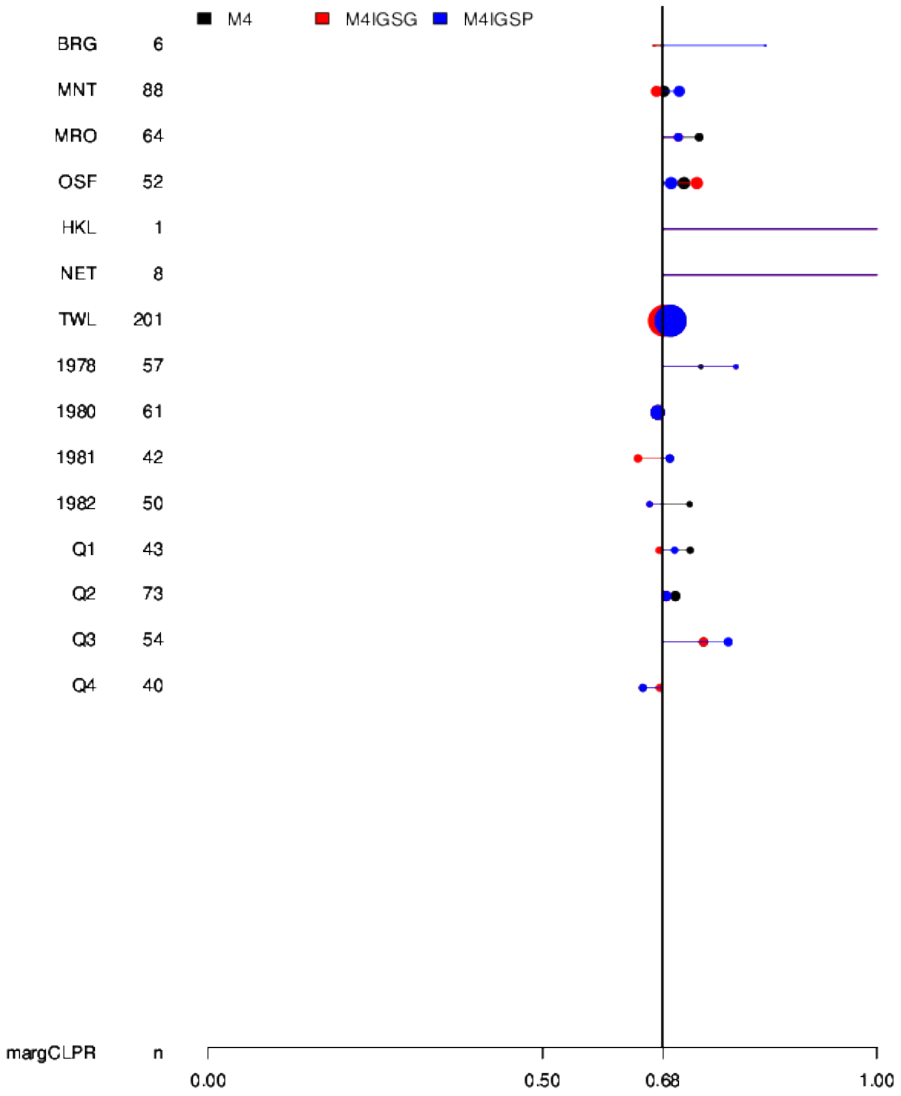
Q1 43
Q2 73
Q3 54
Q4 40
margBCAC n
0.00
0.50
0.68
1.00

MCAT 253


M4
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BRG 6
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1978 57
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Q3 54
Q4 40
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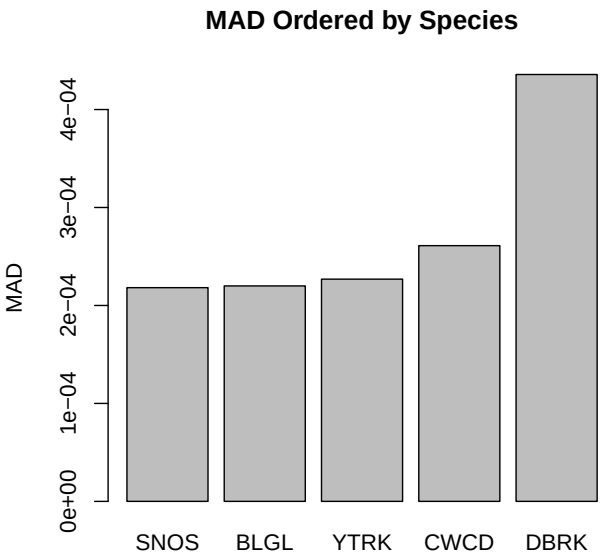
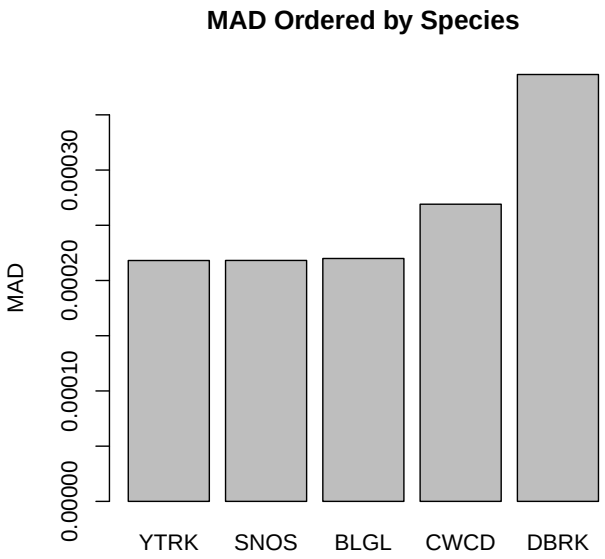
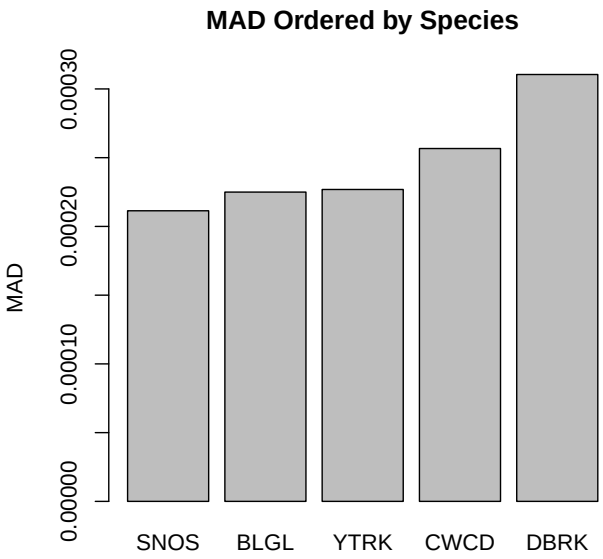
0.50
0.68
1.00

M4 M4SG M4SP







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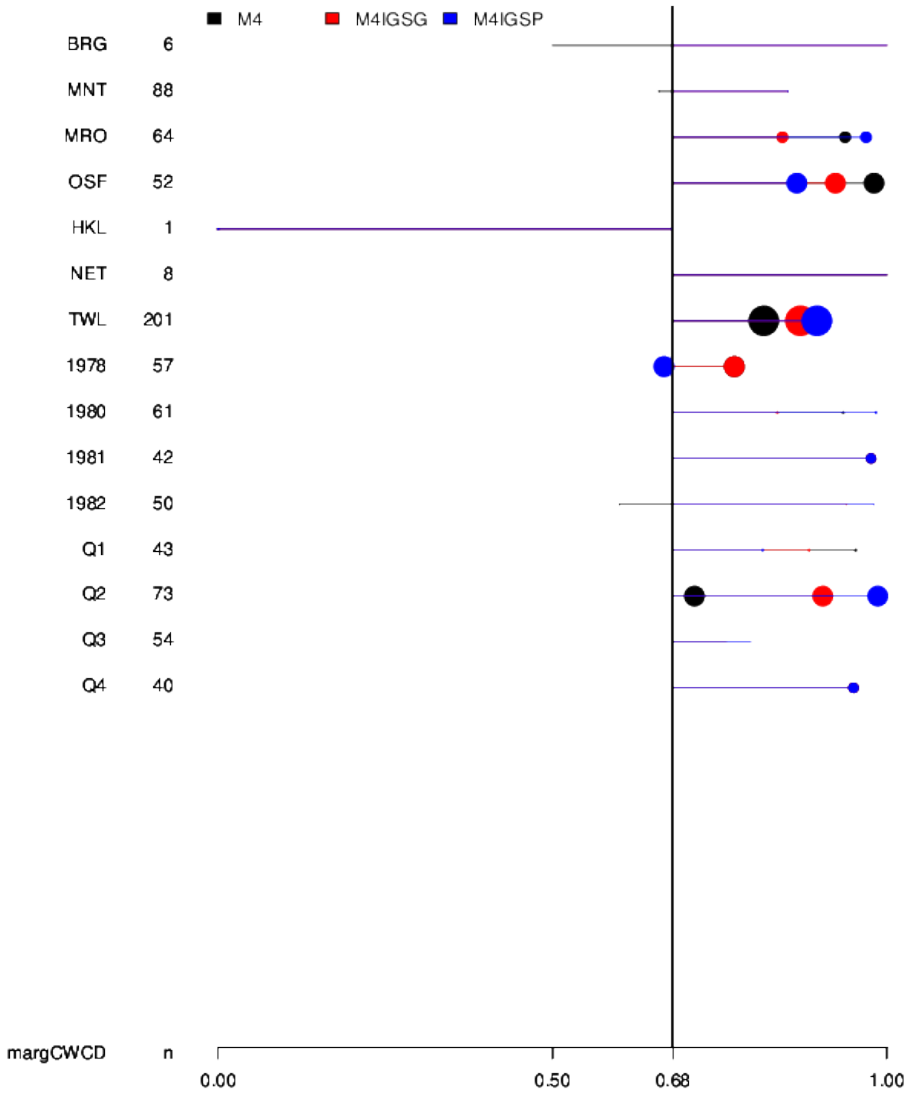
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M4IGSP
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Q3 54
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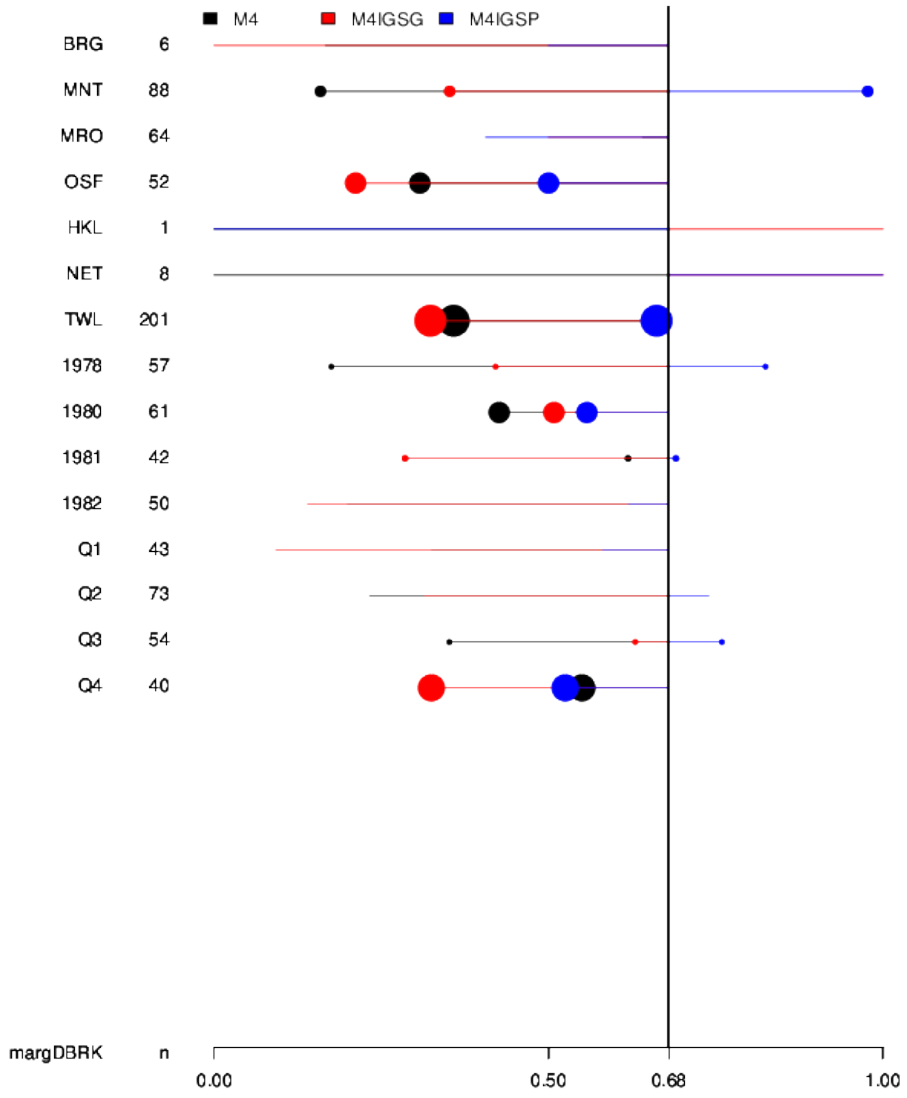
MCAT 253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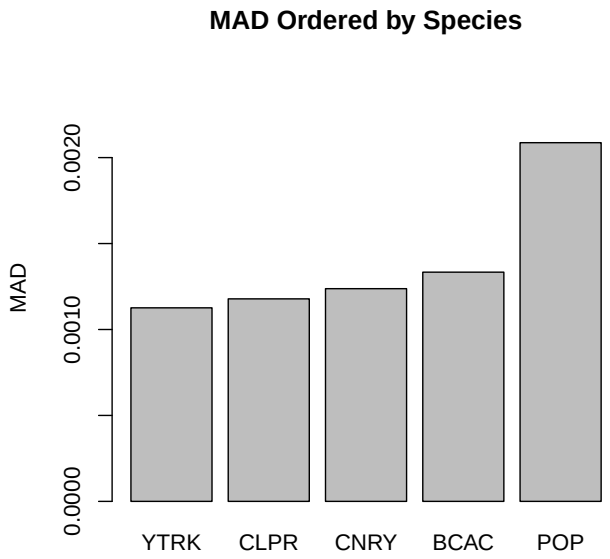
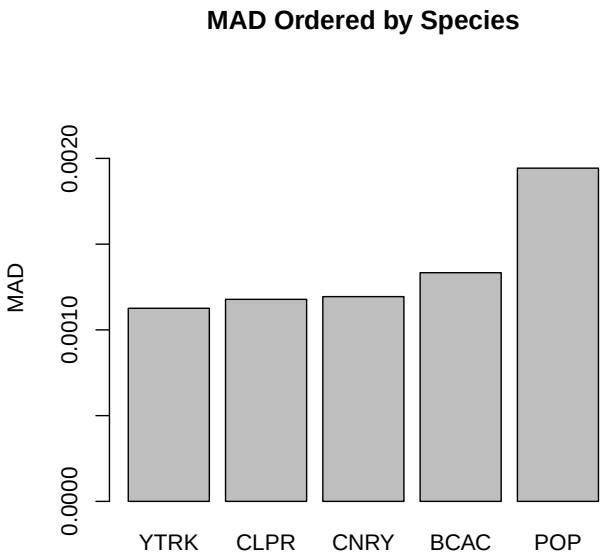
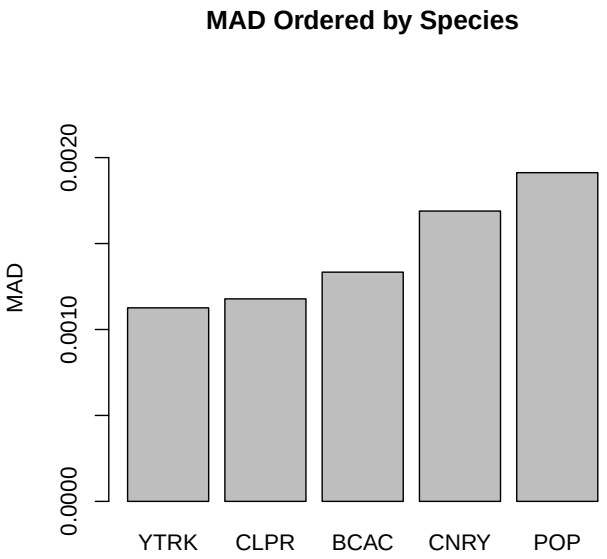
MRO 64
OSF 52
HKL 1
NET 8
TWL 201
1978 57
1980 61
1981 42
1982 50
Q1 43
Q2 73
Q3 54
Q4 40
margDBRK n
0.00
0.50
0.68
1.00

	M4	M4SG	M4SP
Δ DIC	0	0.31	182.15
Δ WAIC	0	0.13	68.48

M4 M4SG M4SP

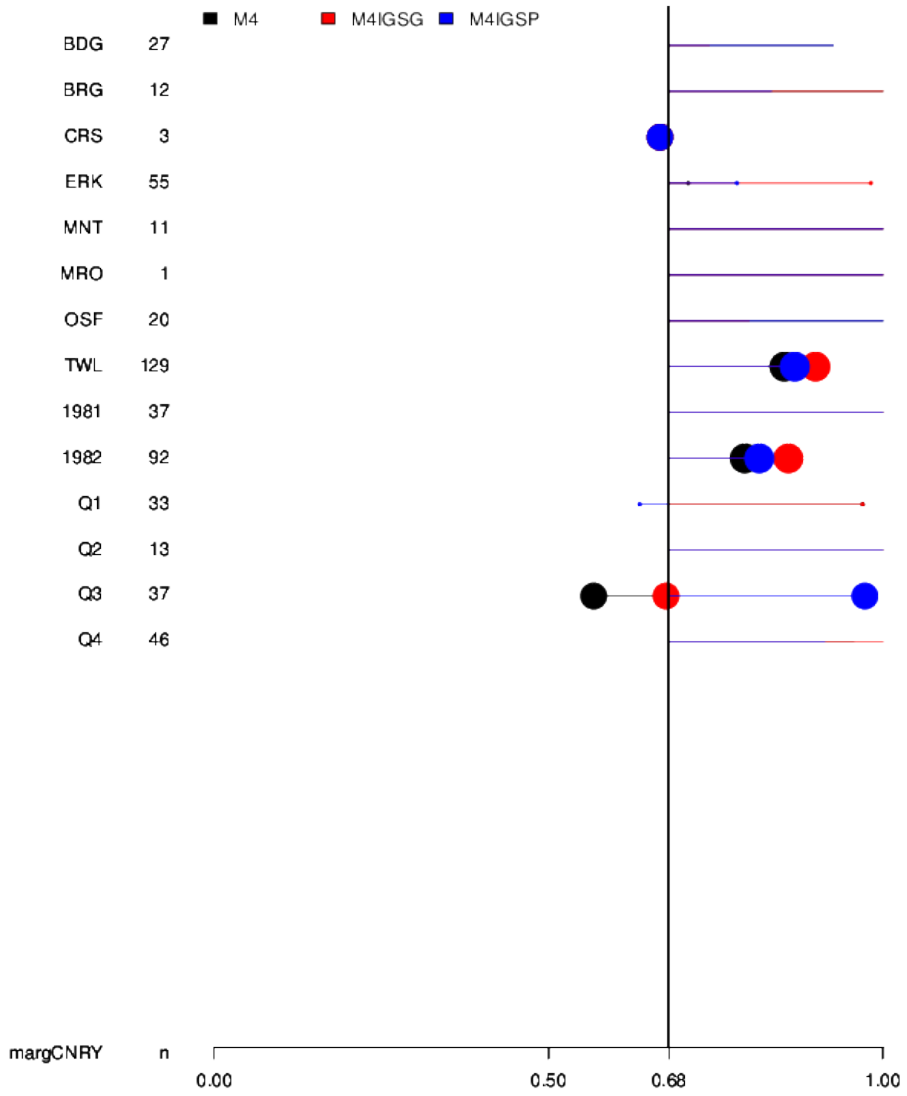




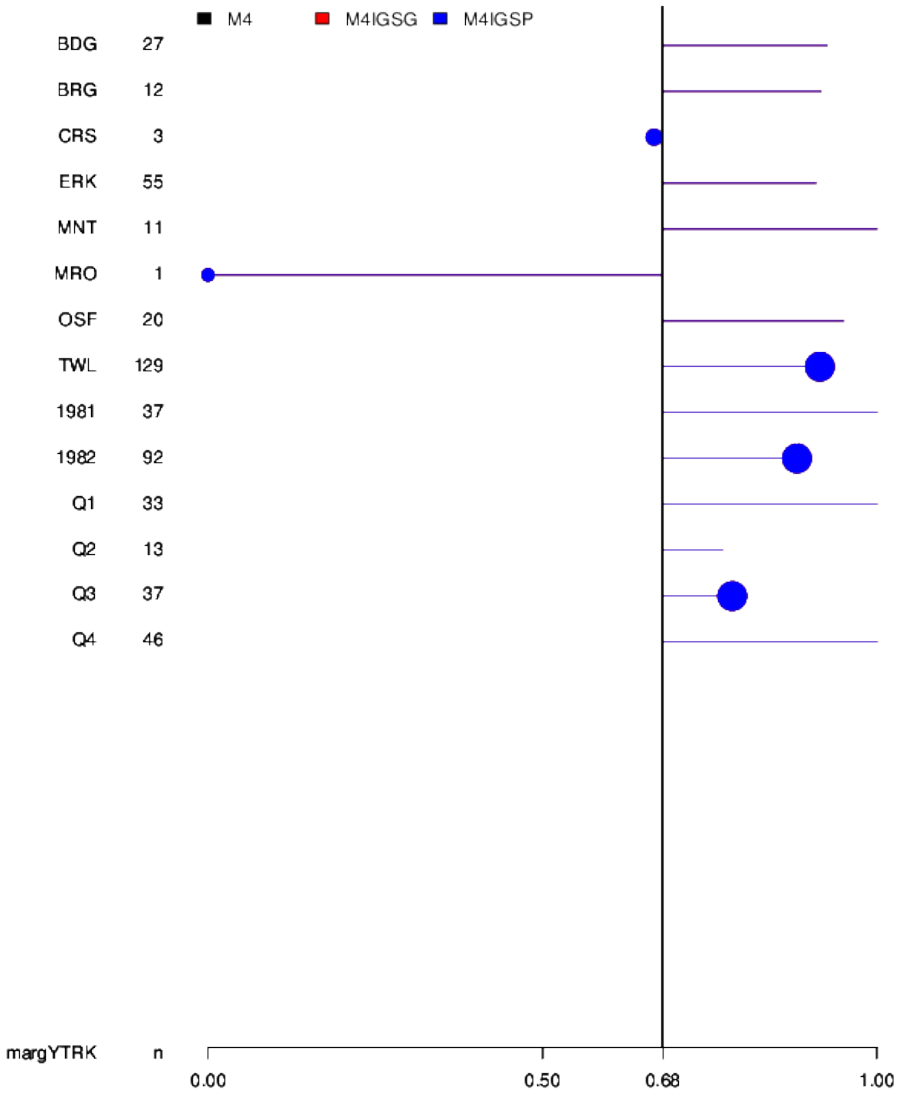


Combined

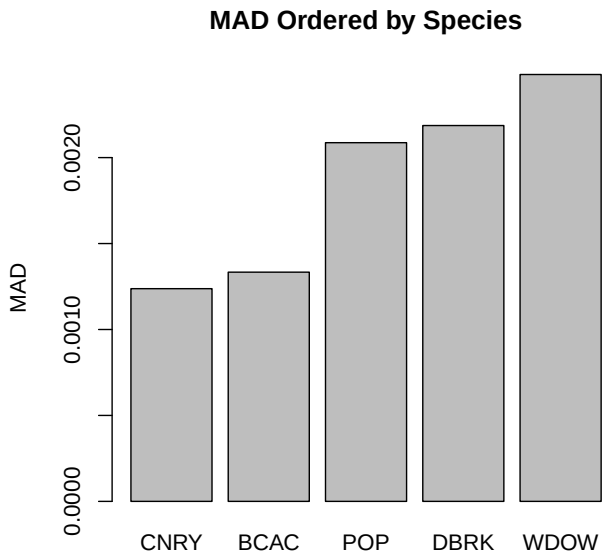
MCAT 269

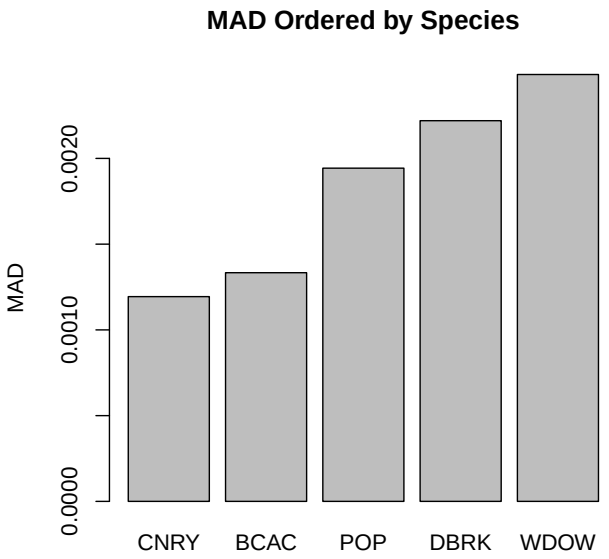

M4
M4IGSG
M4IGSP
BDG 27
BRG 12
CRS 3
ERK 55
MNT 11
MRO 1
OSF 20
TWL 129
1981 37
1982 92
Q1 33
Q2 13
Q3 37
Q4 46
margCNRY n
0.00
0.50
0.68
1.00

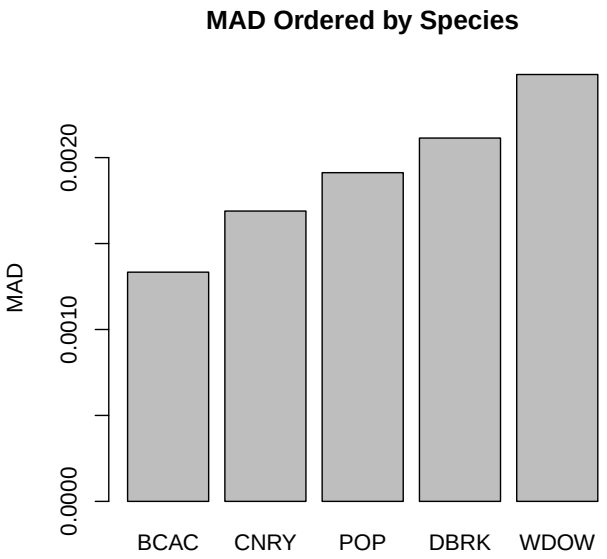
MCAT 269


M4
M4IGSG
M4IGSP
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
margYTRK n
0.00
0.50
0.68
1.00

M4 M4SG M4SP

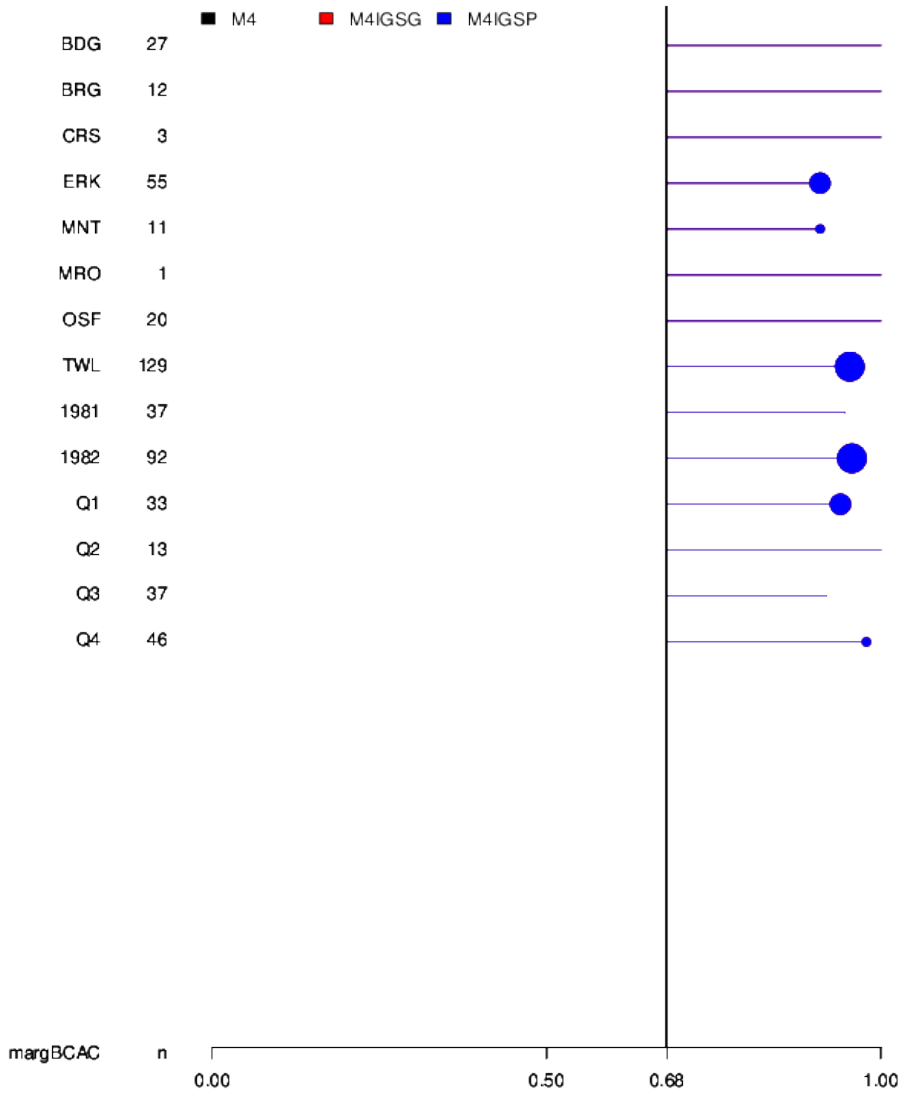




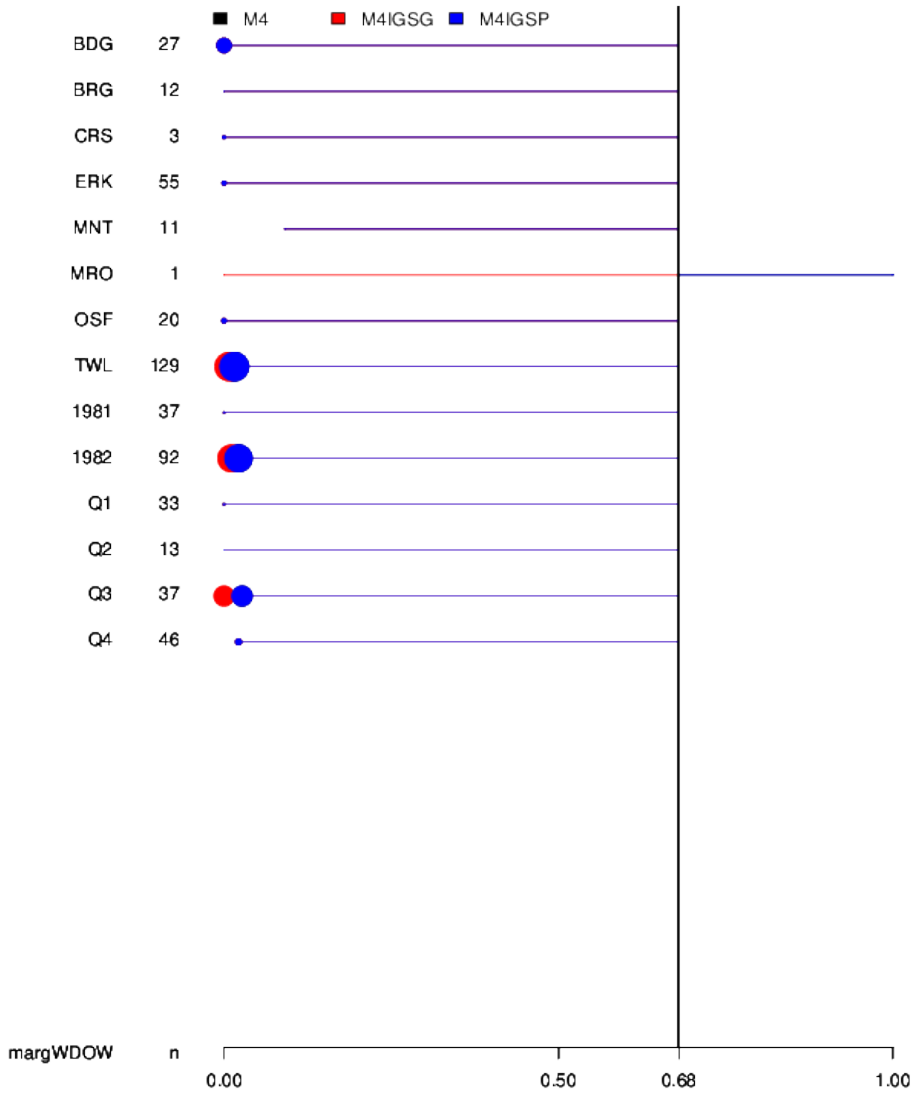


Combined

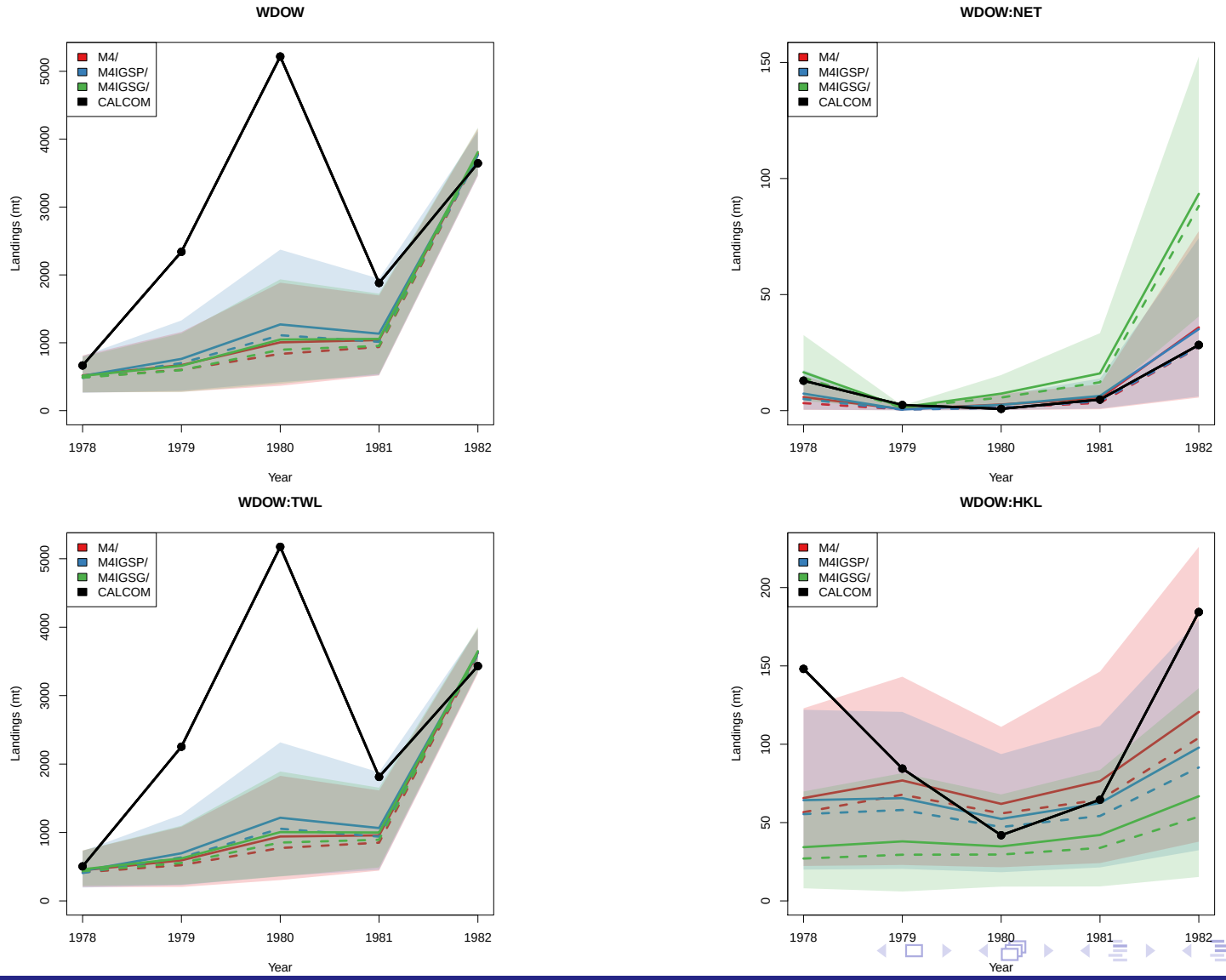
MCAT 269


M4
M4IGSG
M4IGSP
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

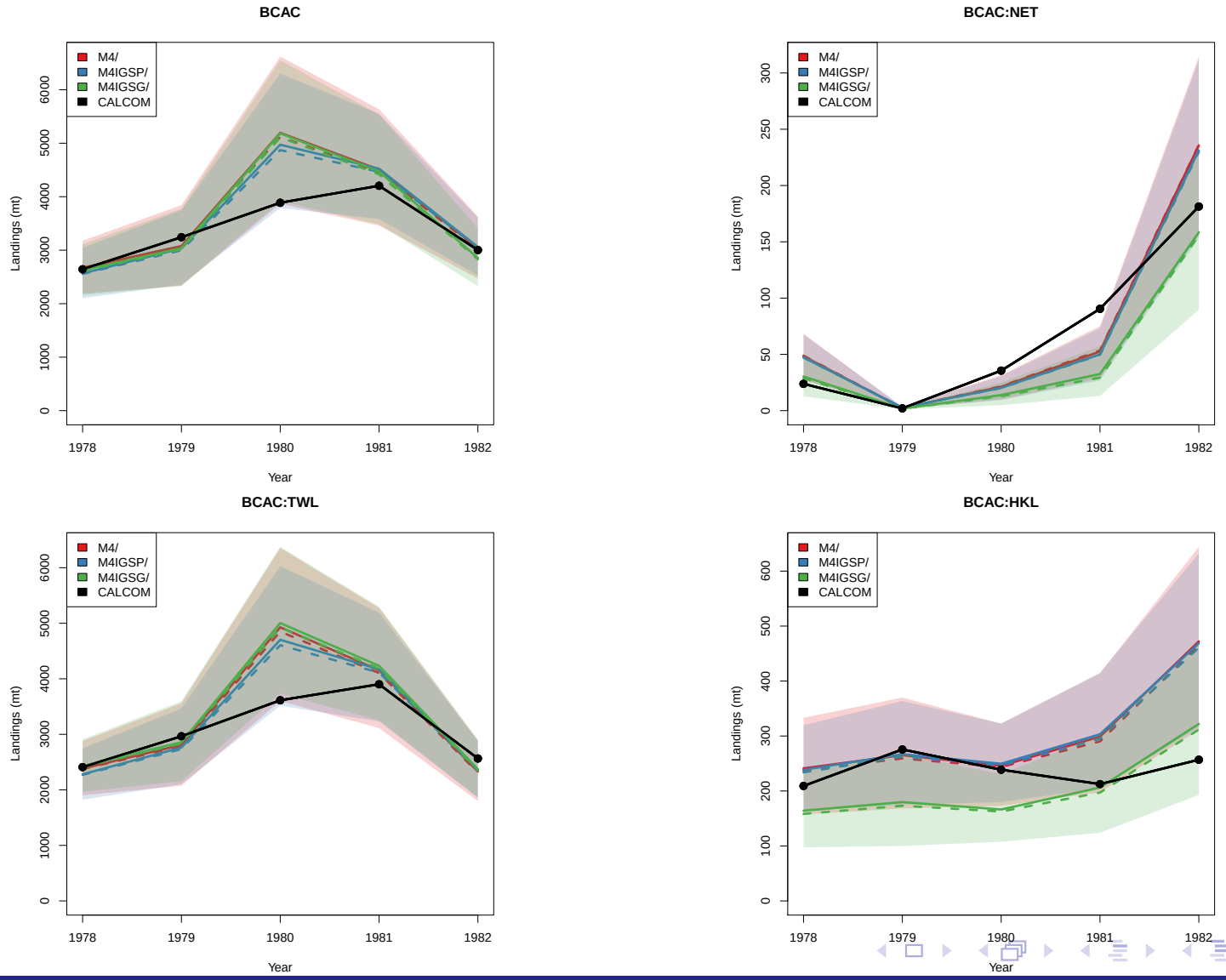
MCAT 269


M4
M4IGSG
M4IGSP
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

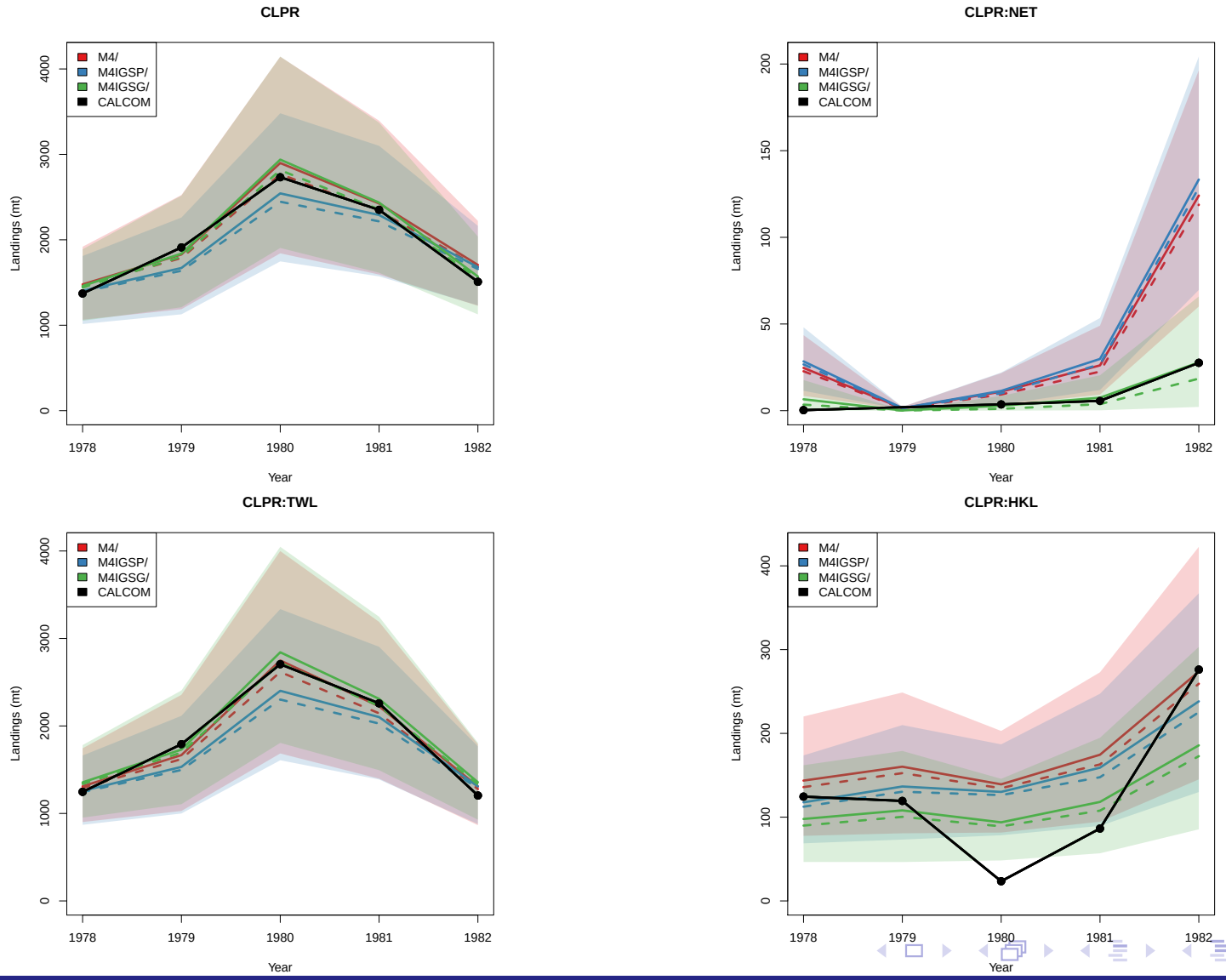
Landings Sensitivity



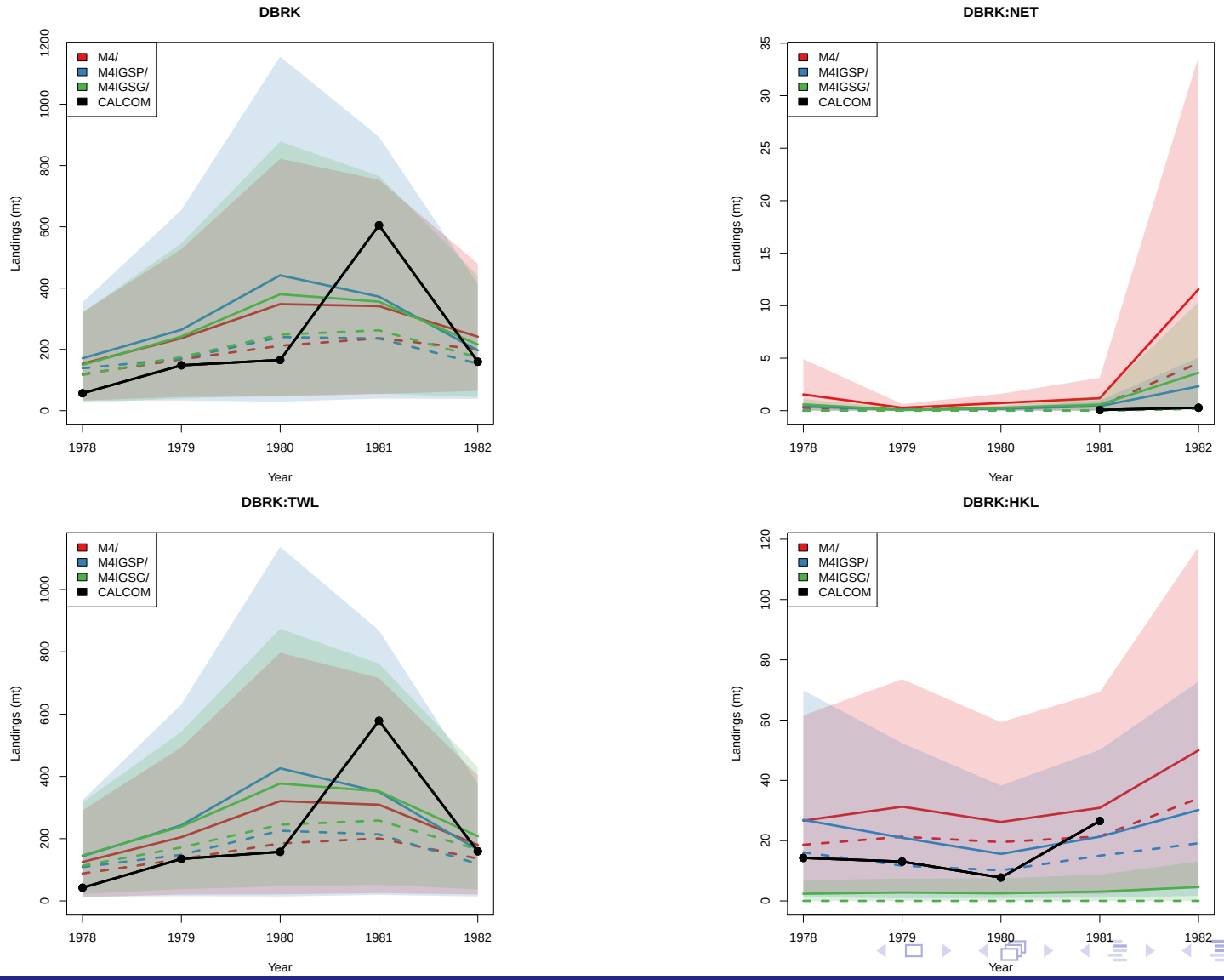
Landings Sensitivity



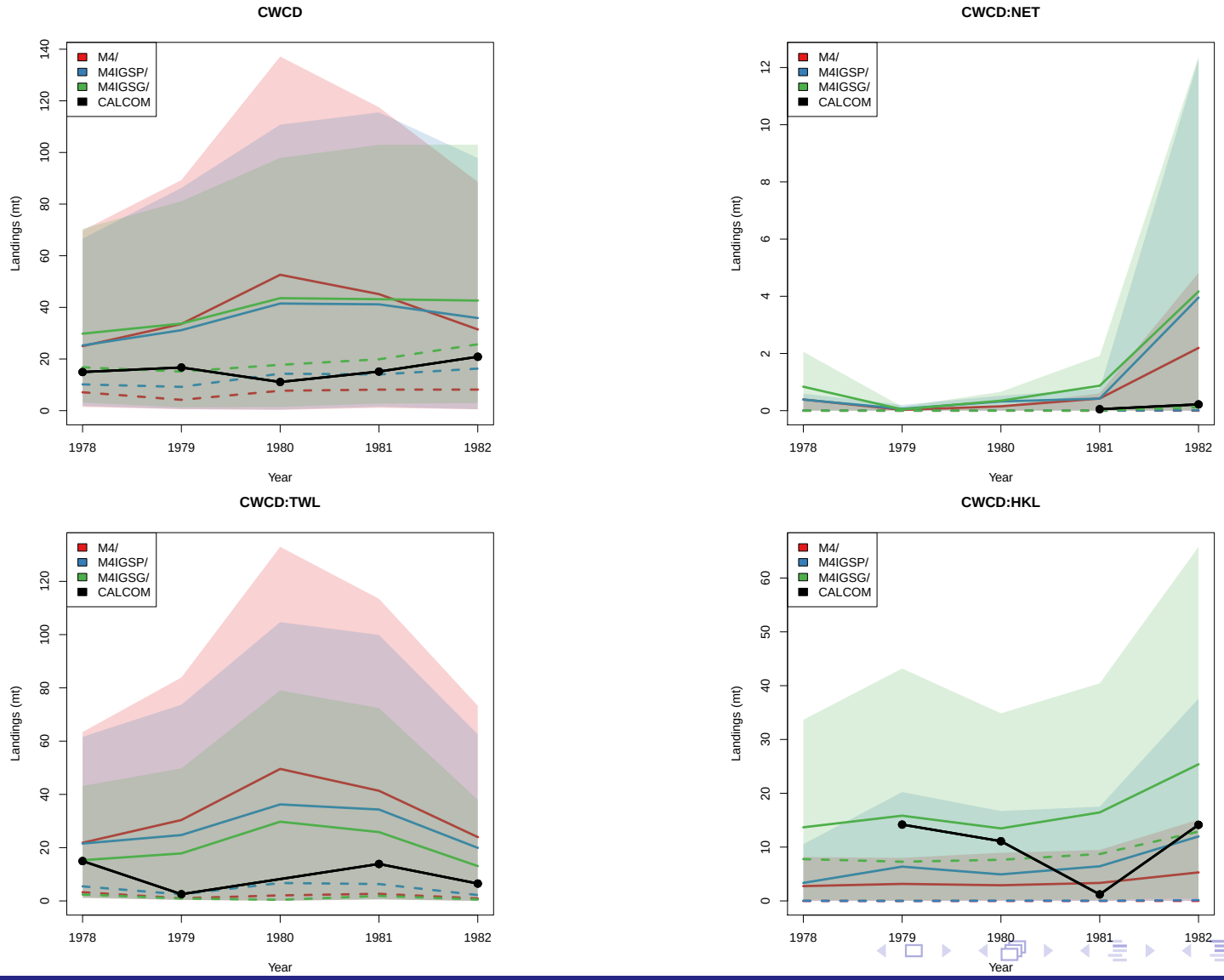
Landings Sensitivity



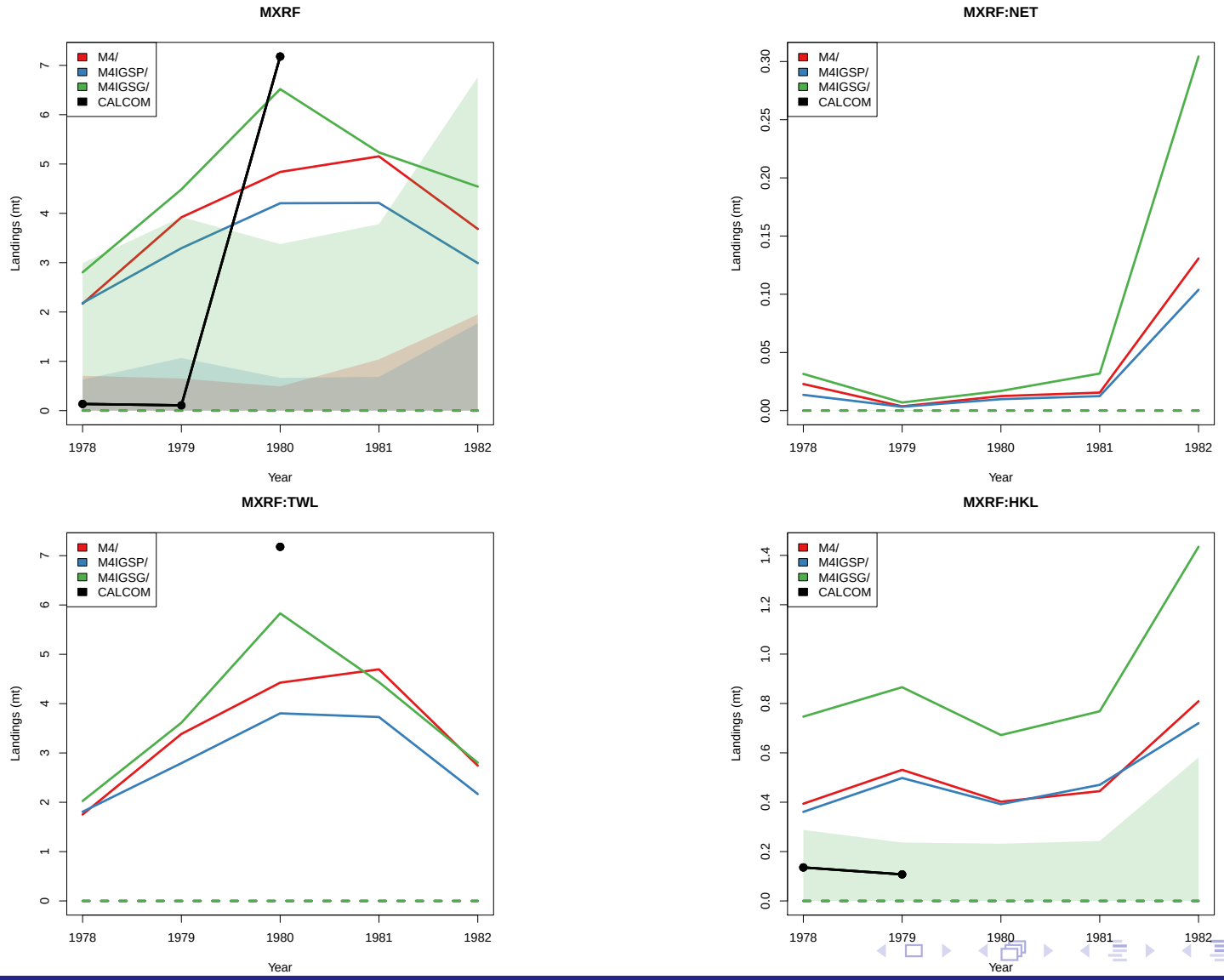
Landings Sensitivity



Landings Sensitivity



Landings Sensitivity



Interaction Summary

- Both Species:Gear and Species:Port interactions may be appropriate.
- Interactions appear to be market category dependent.
- Possibly include both with shrinkage priors to allow each to fit on a MCAT-to-MCAT basis.
  - 250 253 269
  - Landings

MCAT 250 Combined Plots

MCAT 253 Combined Plots

MCAT 269 Combined Plots

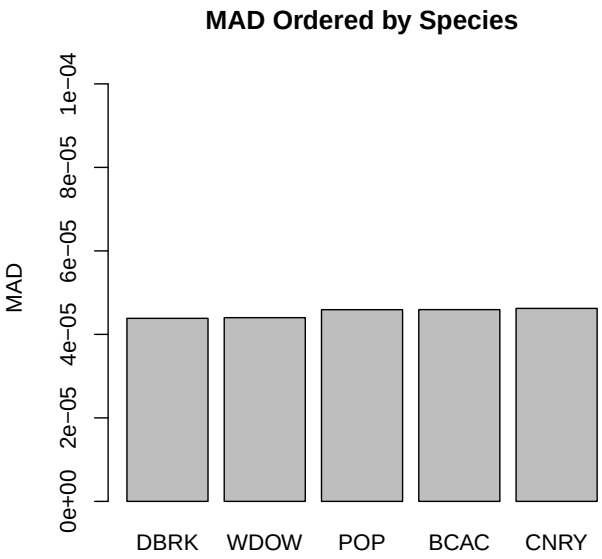
All Species Landings

Request: Explore an alternative time block: an extension of 1983 and 1984 to the first time block.

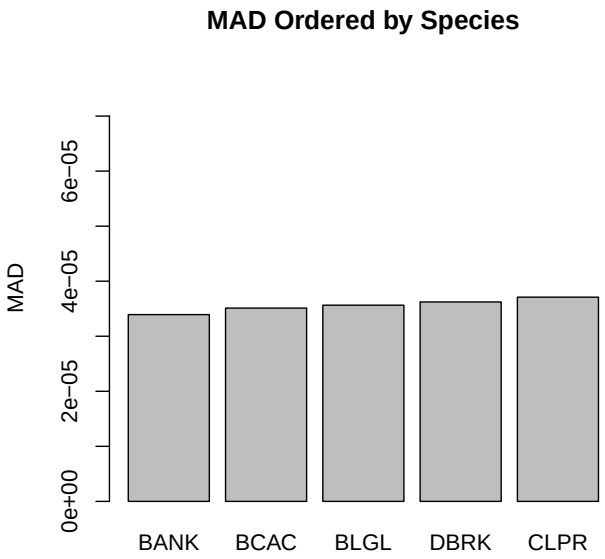
Rationale: The panel expressed concerns about how the model would perform when applied to shorter time periods, as will occur when the model is used with data more recent than 1990. Results from the above recommendation could be compared to the results from the current two time blocks (1978-1982; 1983-1990) to explore how fits to data from the late period degrade when the model for the late period is based on fewer years of data. Also, comparisons of the two forms of blocking serve as a sensitivity evaluation of the selection of the block boundary, which was chosen on a fairly arbitrary basis.

Response: The following slides show the diagnostic plots as applied to model M4 when fit to data from 78-82 as well as data from 78-83, 78-84, and 78-85.

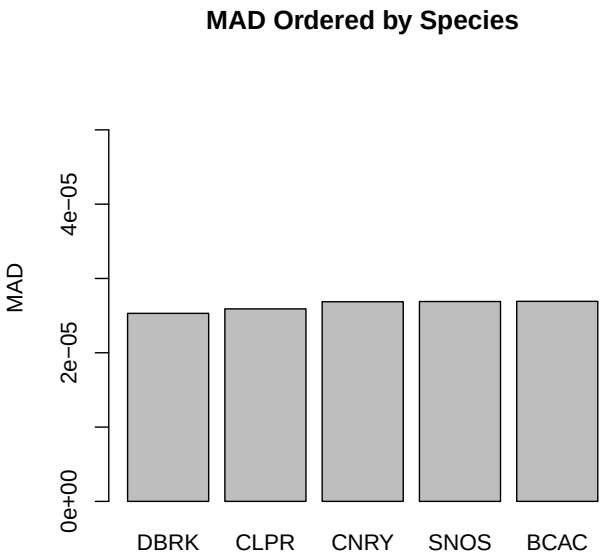
78-82



78-83

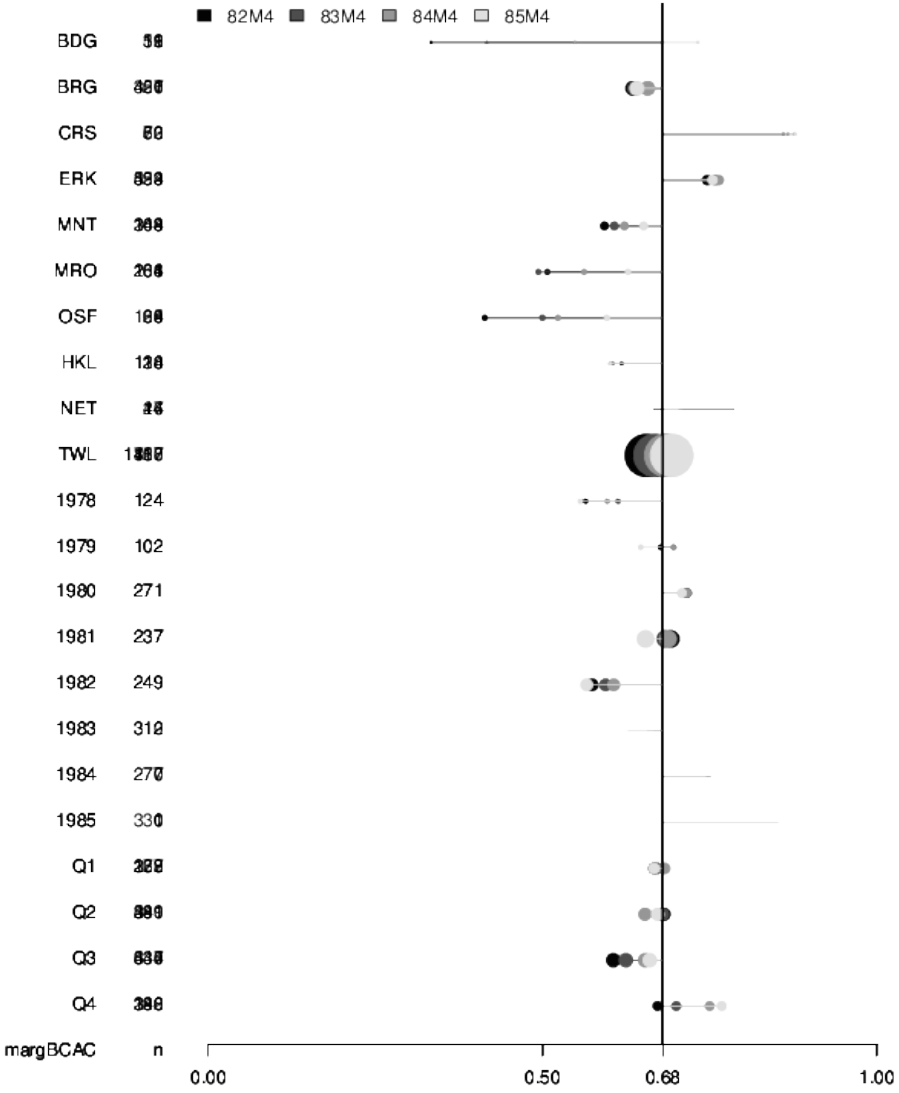


78-84

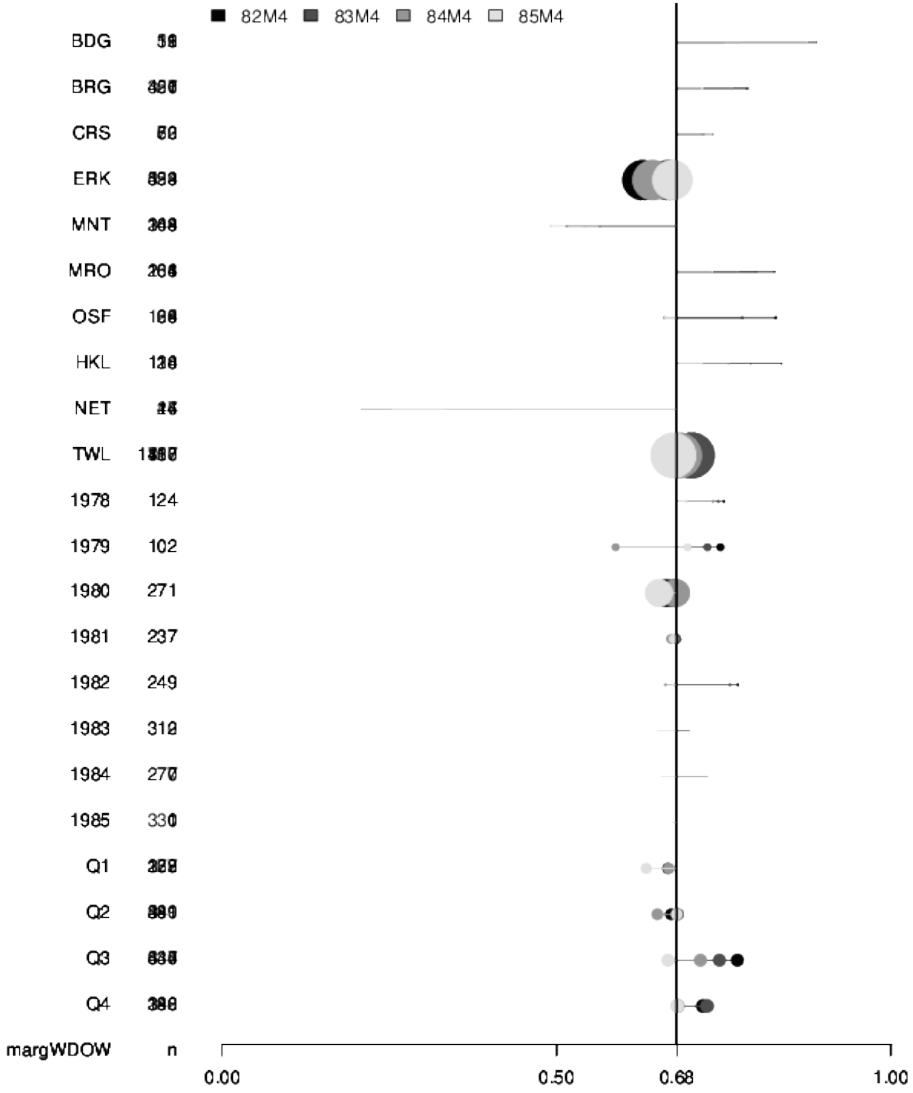


Combined

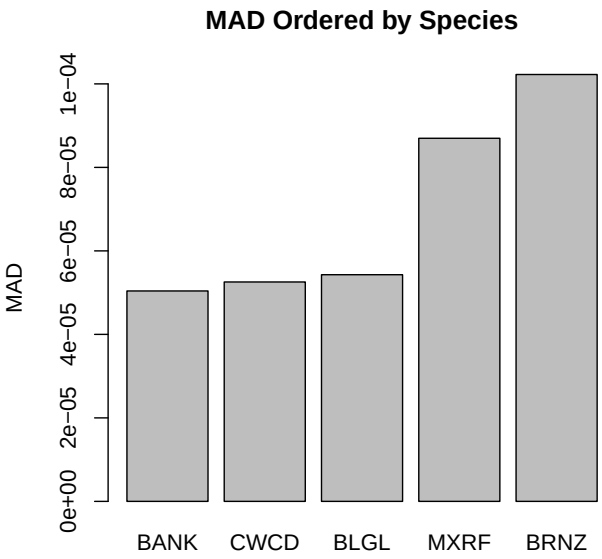
MCAT 250


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
HKL
NET
TWL
1978 124
1979 102
1980 271
1981 237
1982 249
1983 312
1984 270
1985 330
Q1
Q2
Q3
Q4
margBCAC n
0.00
0.50
0.68
1.00

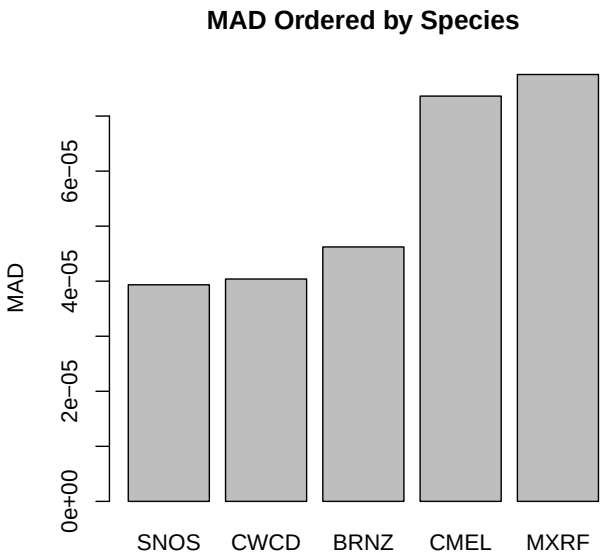
MCAT 250


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
HKL
NET
TWL
1978 124
1979 102
1980 271
1981 237
1982 249
1983 312
1984 270
1985 330
Q1
Q2
Q3
Q4
margWDOW n
0.00
0.50
0.68
1.00

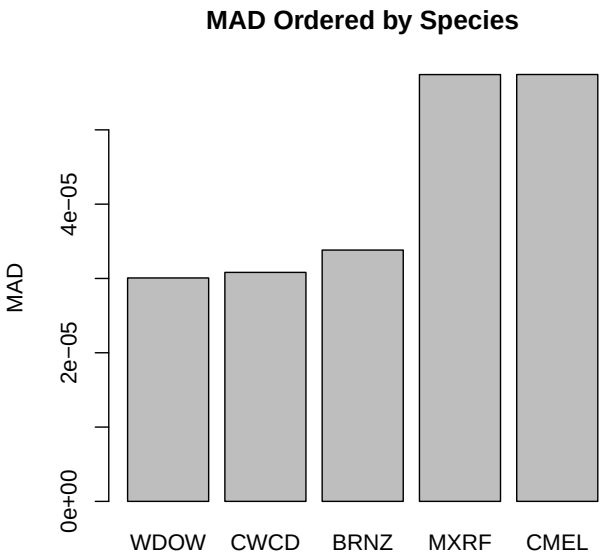
78-82



78-83

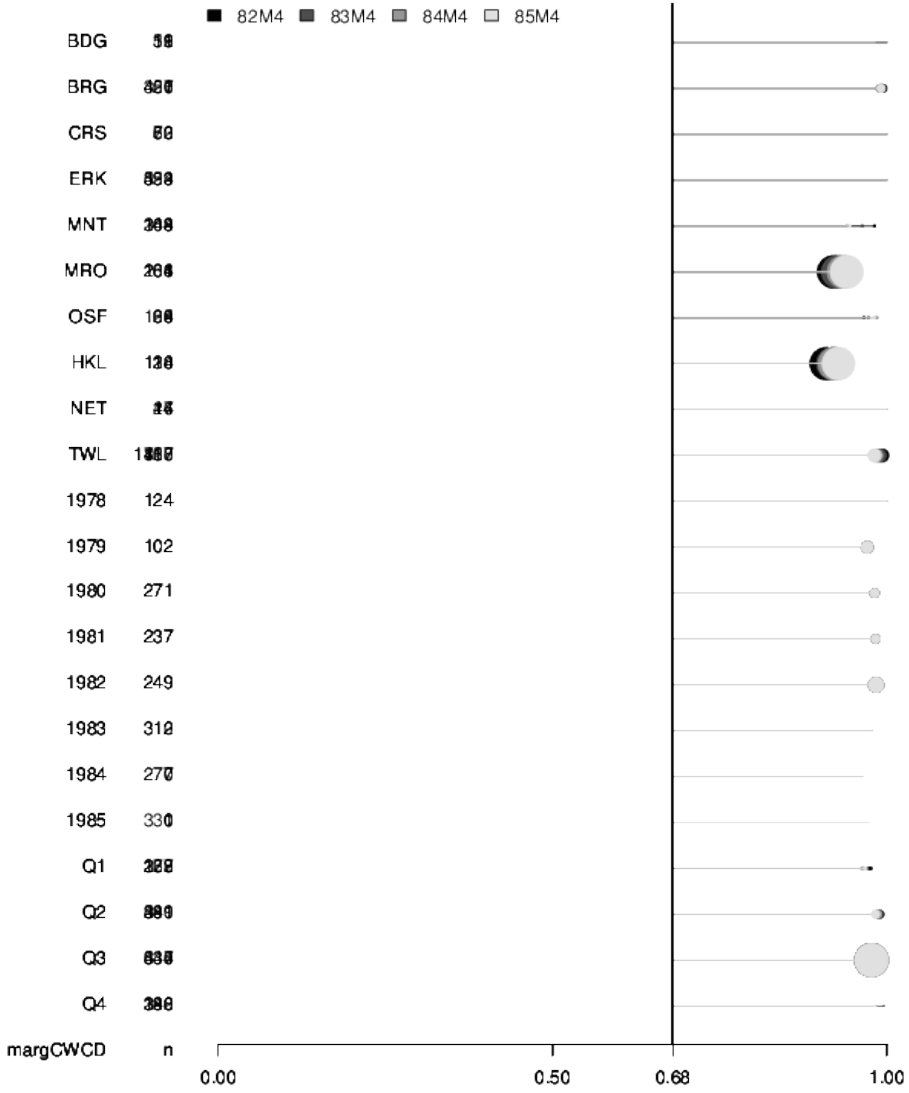


78-84

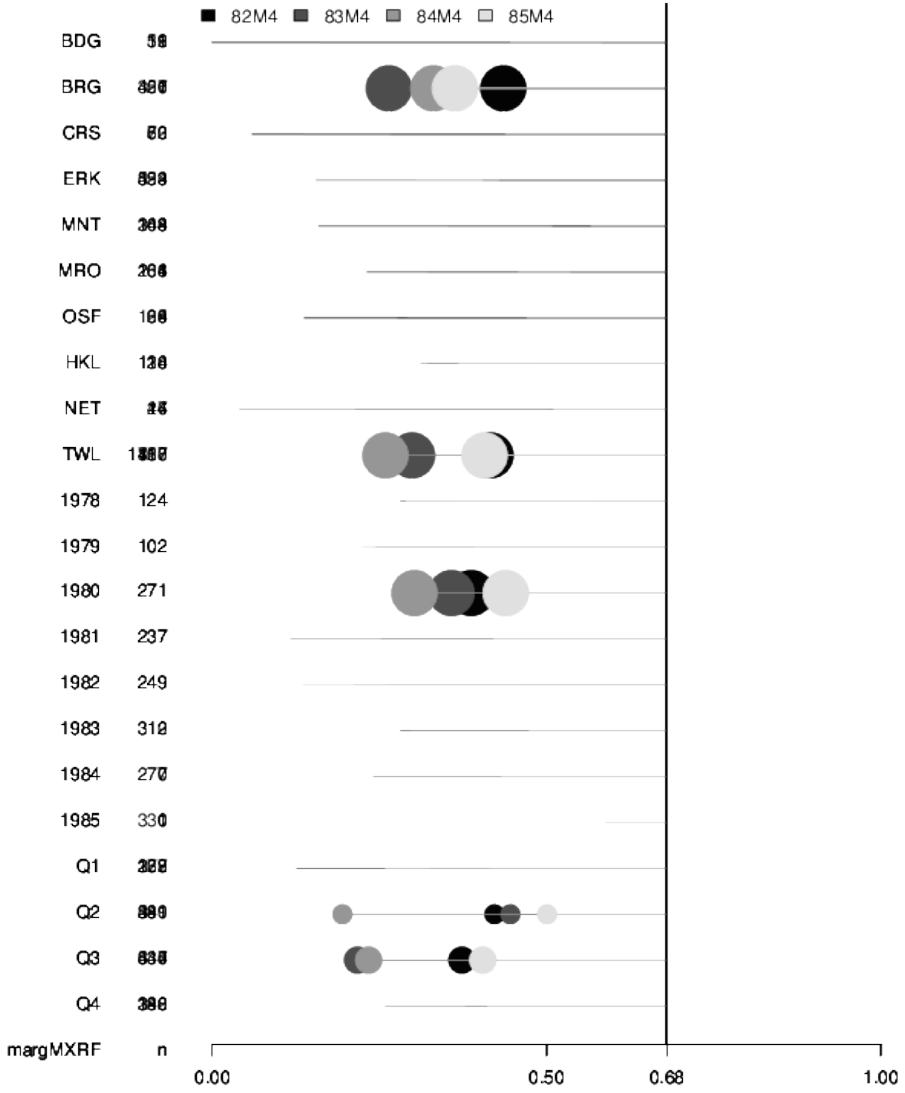


Combined

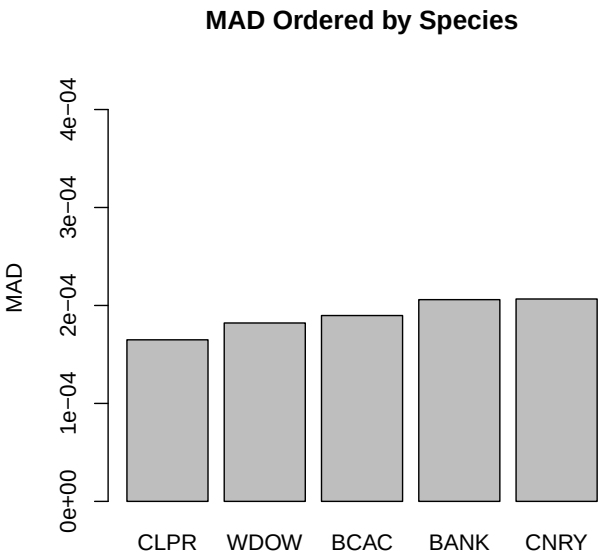
MCAT 250


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
HKL
NET
TWL
1978 124
1979 102
1980 271
1981 237
1982 249
1983 312
1984 270
1985 330
Q1
Q2
Q3
Q4
margCWCD n
0.00
0.50
0.68
1.00

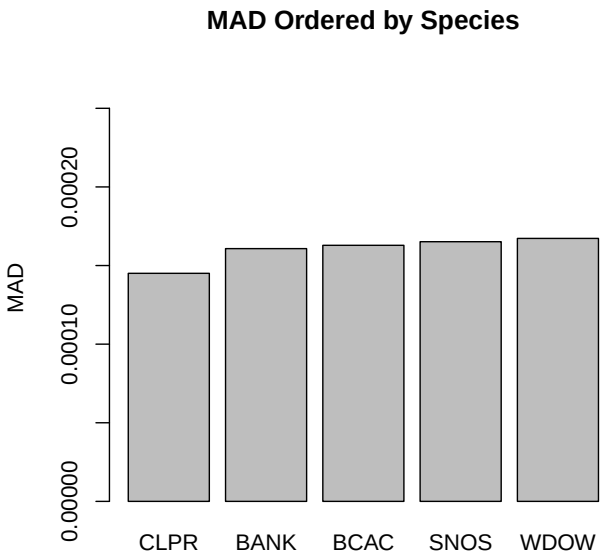
MCAT 250


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
HKL
NET
TWL
1978 124
1979 102
1980 271
1981 237
1982 249
1983 312
1984 270
1985 330
Q1
Q2
Q3
Q4
margMXRF n
0.00
0.50
0.68
1.00

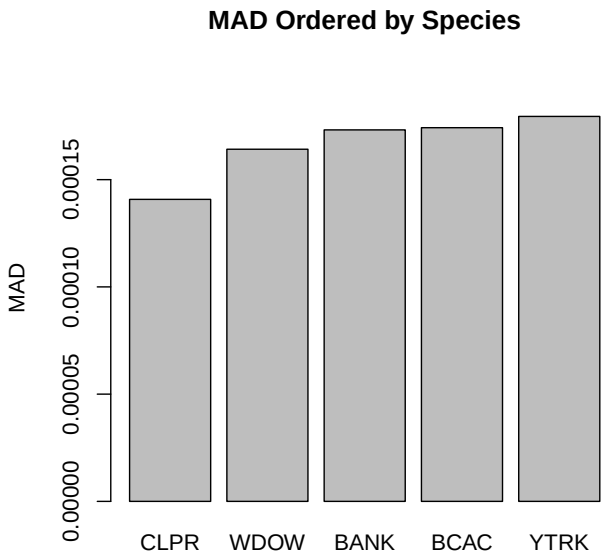
78-82



78-83

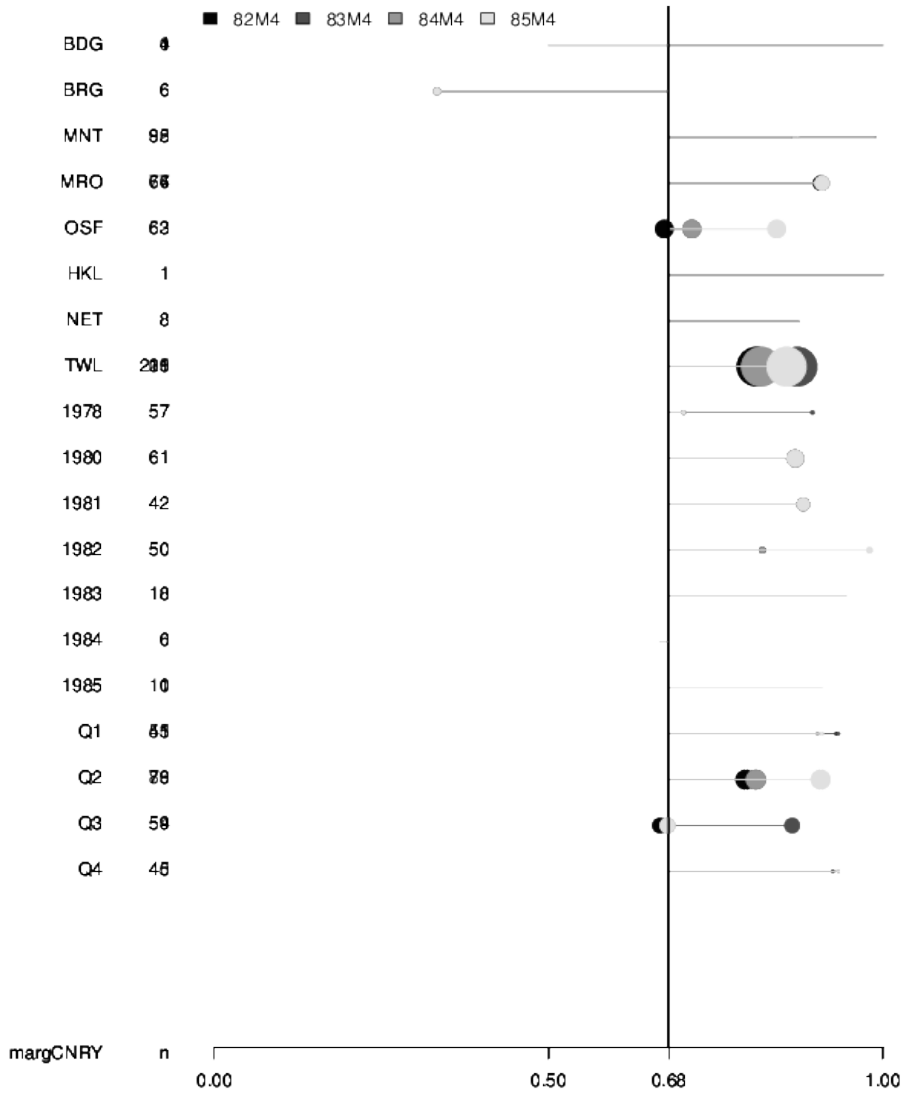


78-84

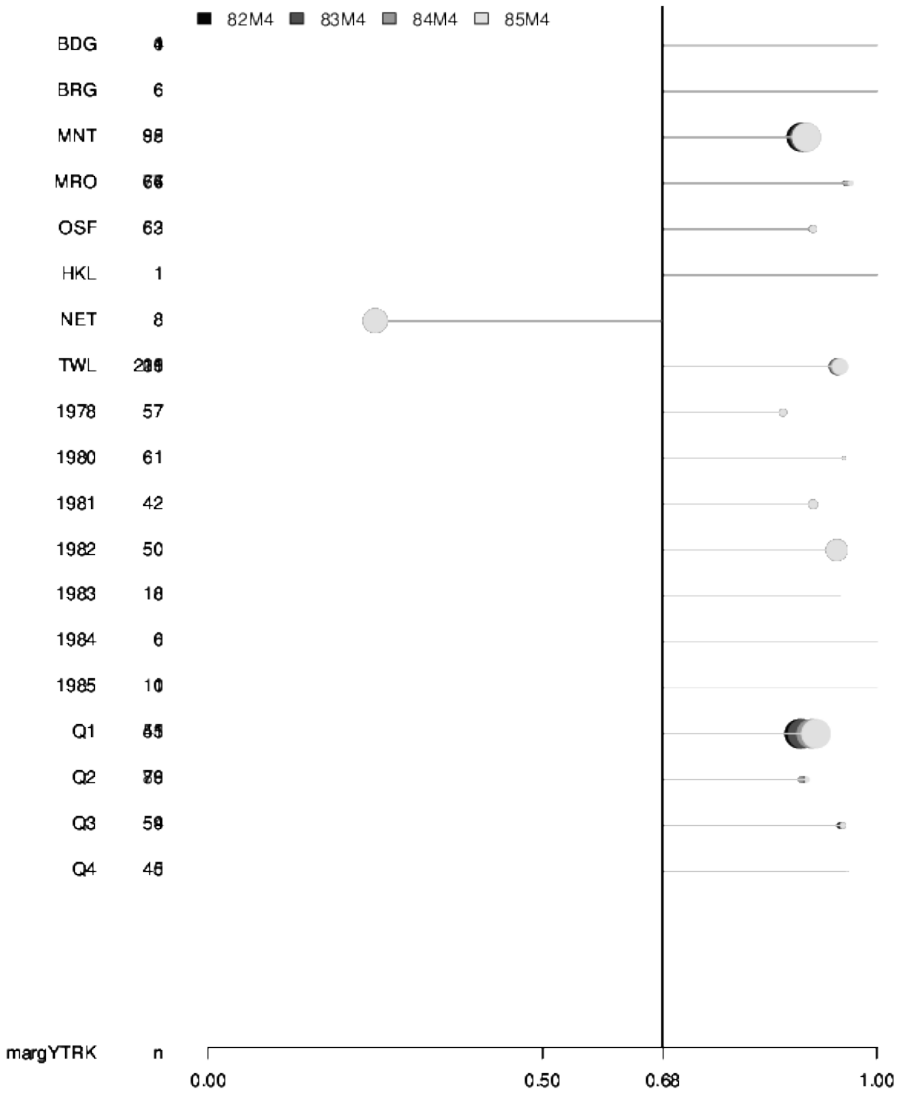


Combined

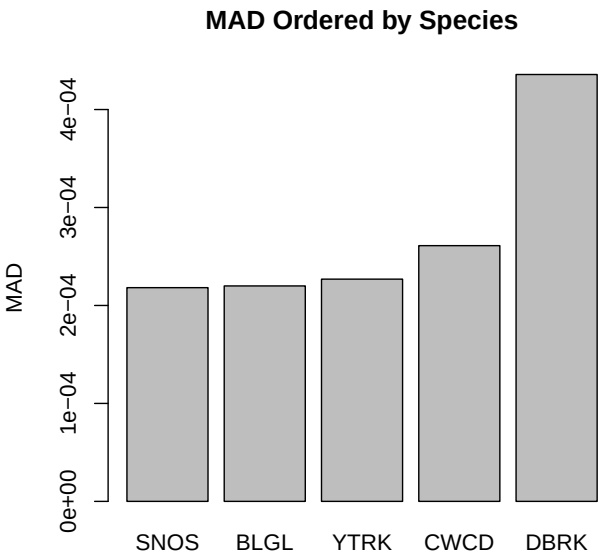
MCAT 253

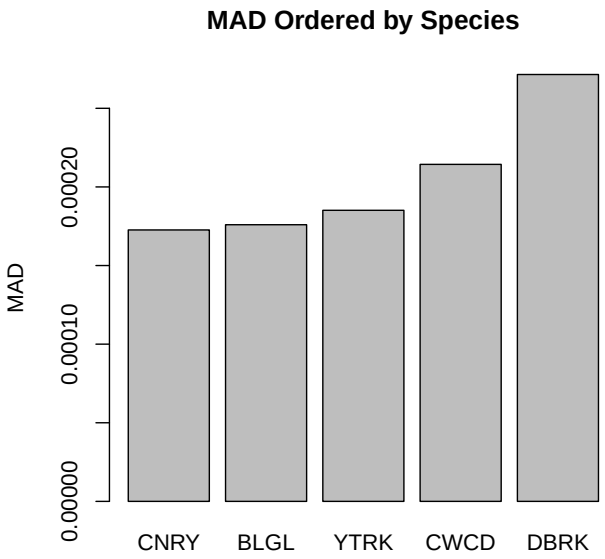

82M4
83M4
84M4
85M4
BDG
BRG
MNT
MRO
OSF
HKL
NET
TWL
1978
1980
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margCNRY
n
0.00
0.50
0.68
1.00

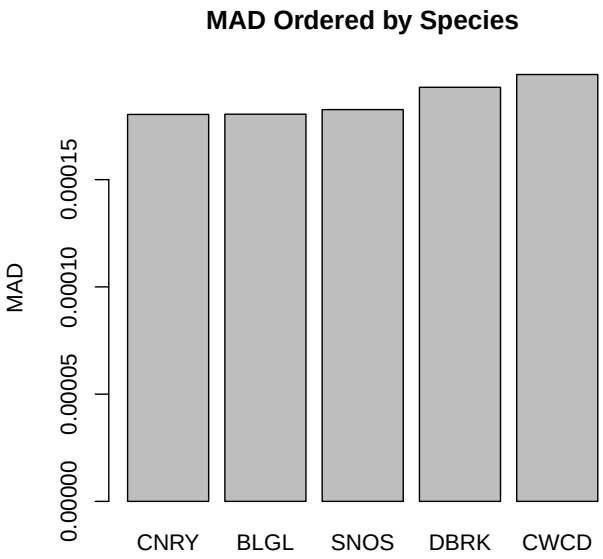
MCAT 253


82M4
83M4
84M4
85M4
BDG
BRG
MNT
MRO
OSF
HKL
NET
TWL
1978
1980
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margYTRK
n
0.00
0.50
0.68
1.00

78-82 78-83 78-84

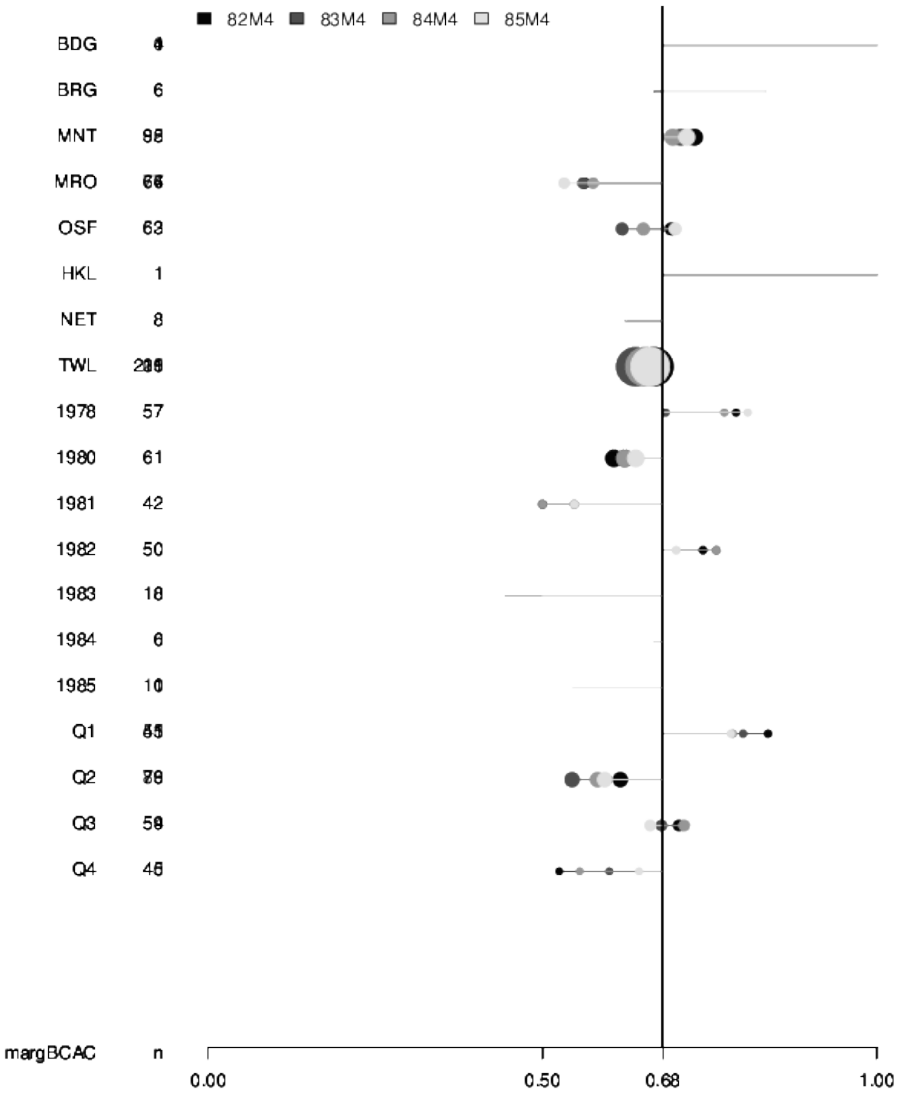




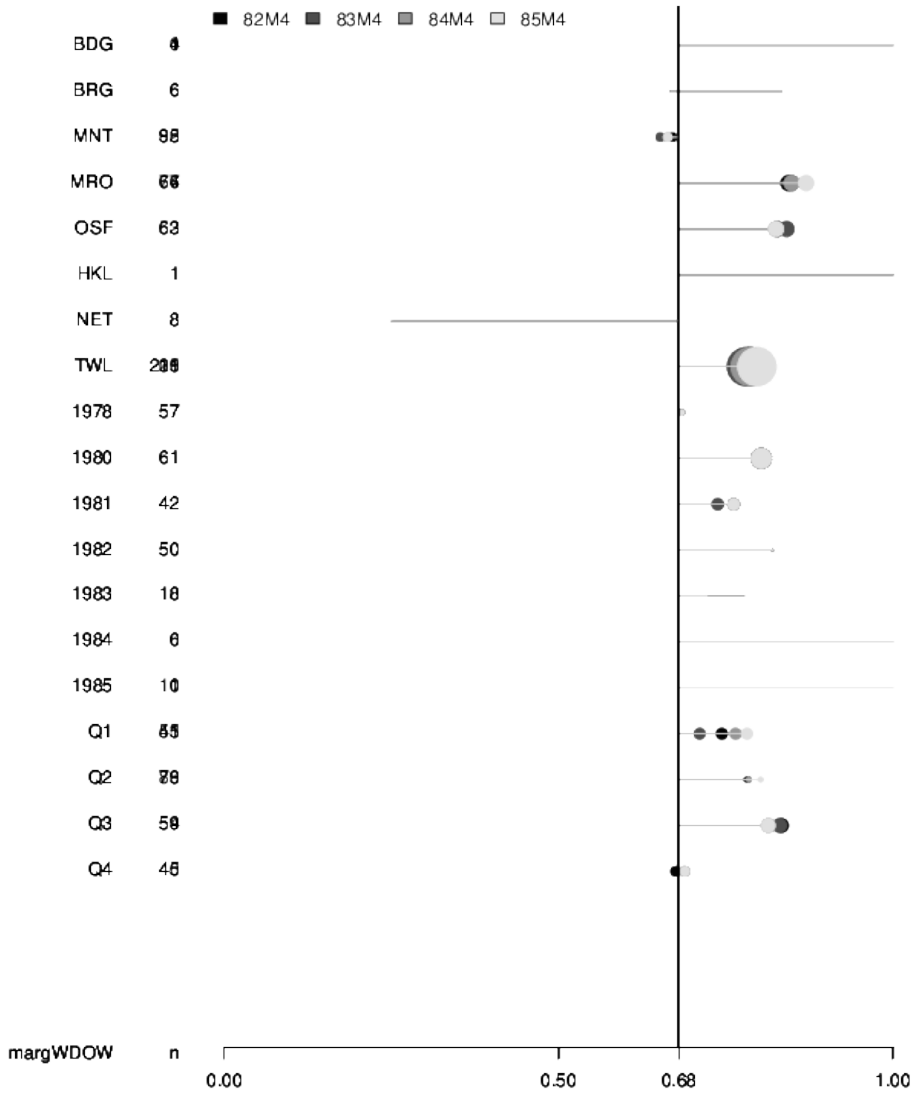


Combined

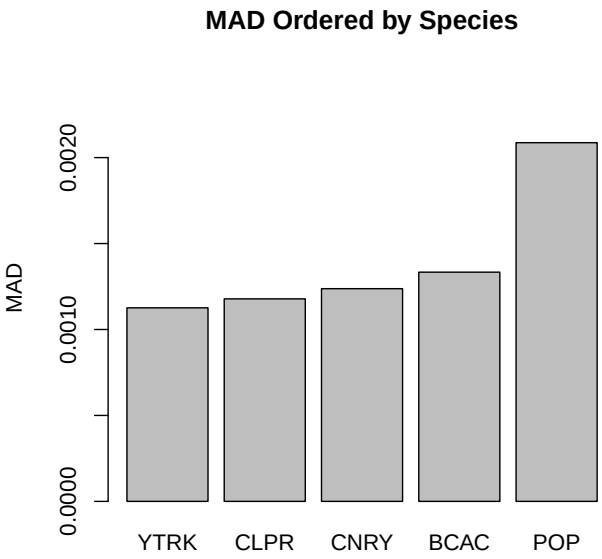
MCAT 253

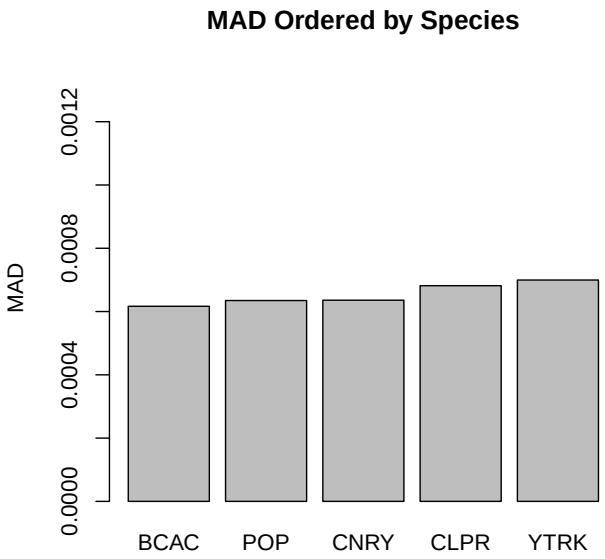

82M4
83M4
84M4
85M4
BDG
BRG
MNT
MRO
OSF
HKL
NET
TWL
1978
1980
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margBCAC
n
0.00
0.50
0.68
1.00

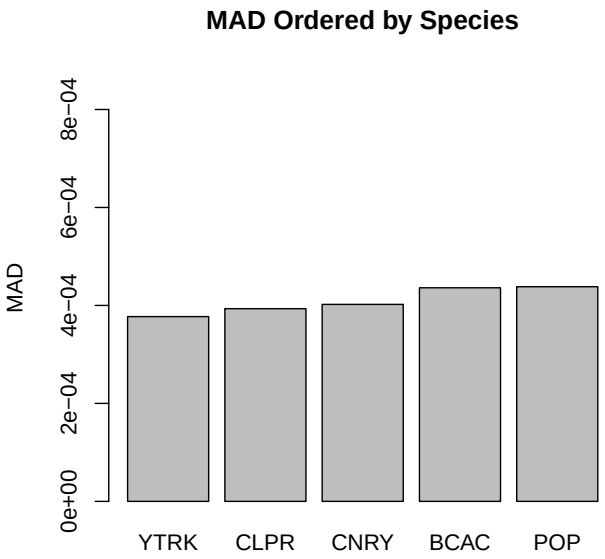
MCAT 253


82M4
83M4
84M4
85M4
BDG
BRG
MNT
MRO
OSF
HKL
NET
TWL
1978
1980
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margWDOW
n
0.00
0.50
0.68
1.00

78-82	78-83	78-84

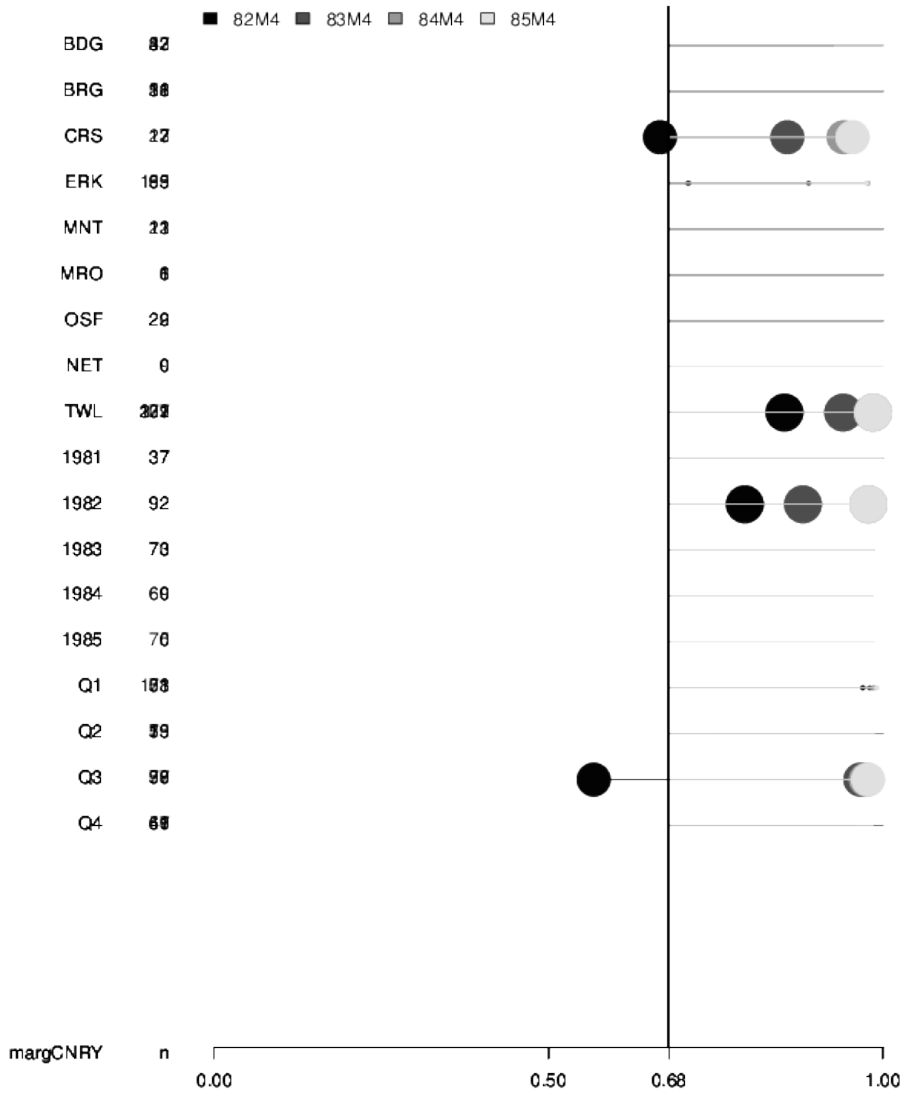




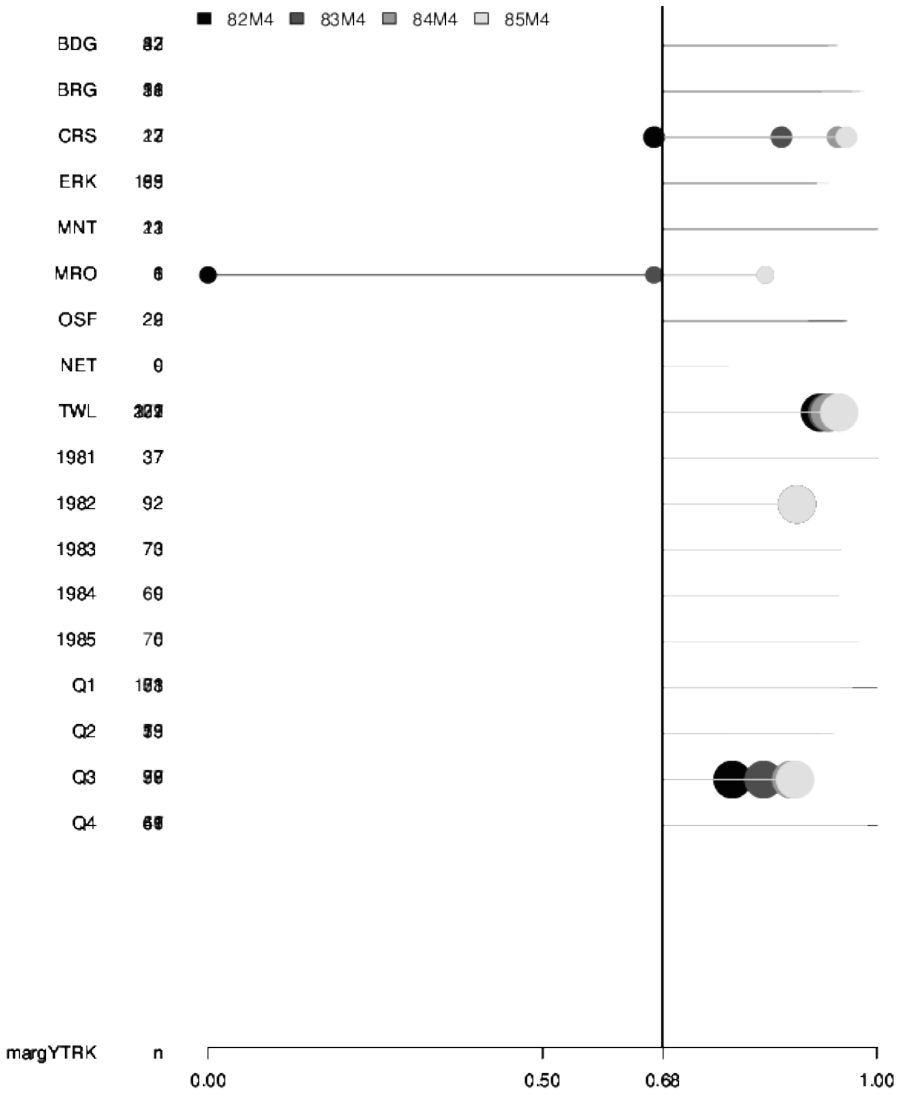


Combined

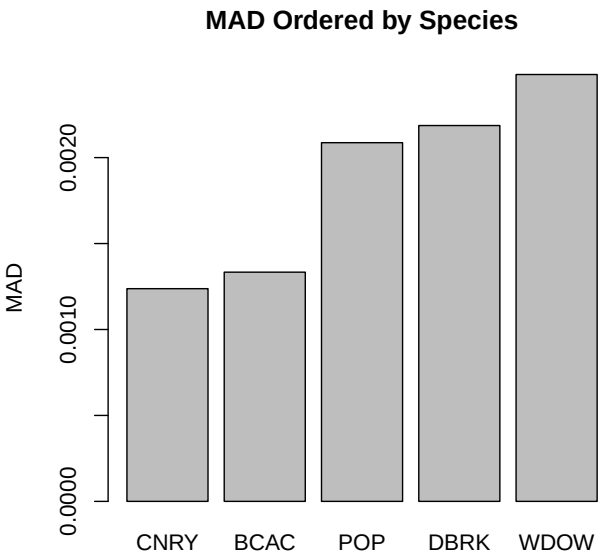
MCAT 269


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
NET
TWL
1981 37
1982 92
1983
1984
1985
Q1
Q2
Q3
Q4
margCNRY n
0.00
0.50
0.68
1.00

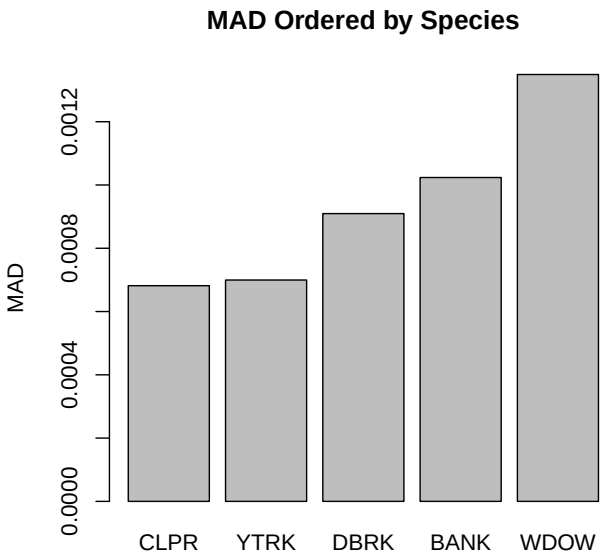
MCAT 269


82M4
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
NET
TWL
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margYTRK
n
0.00
0.50
0.68
1.00

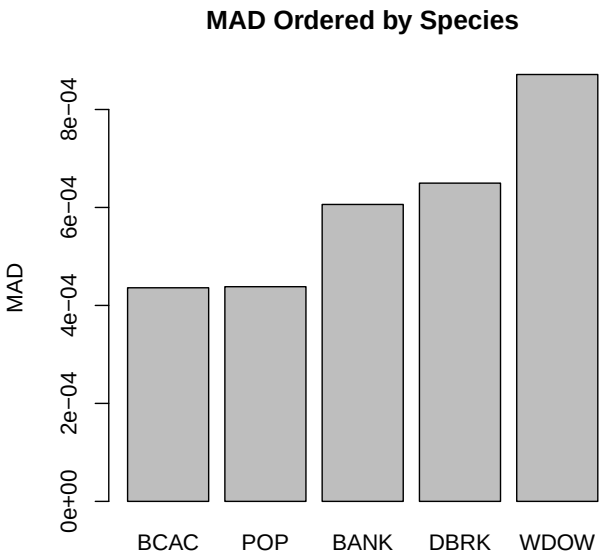
78-82



78-83

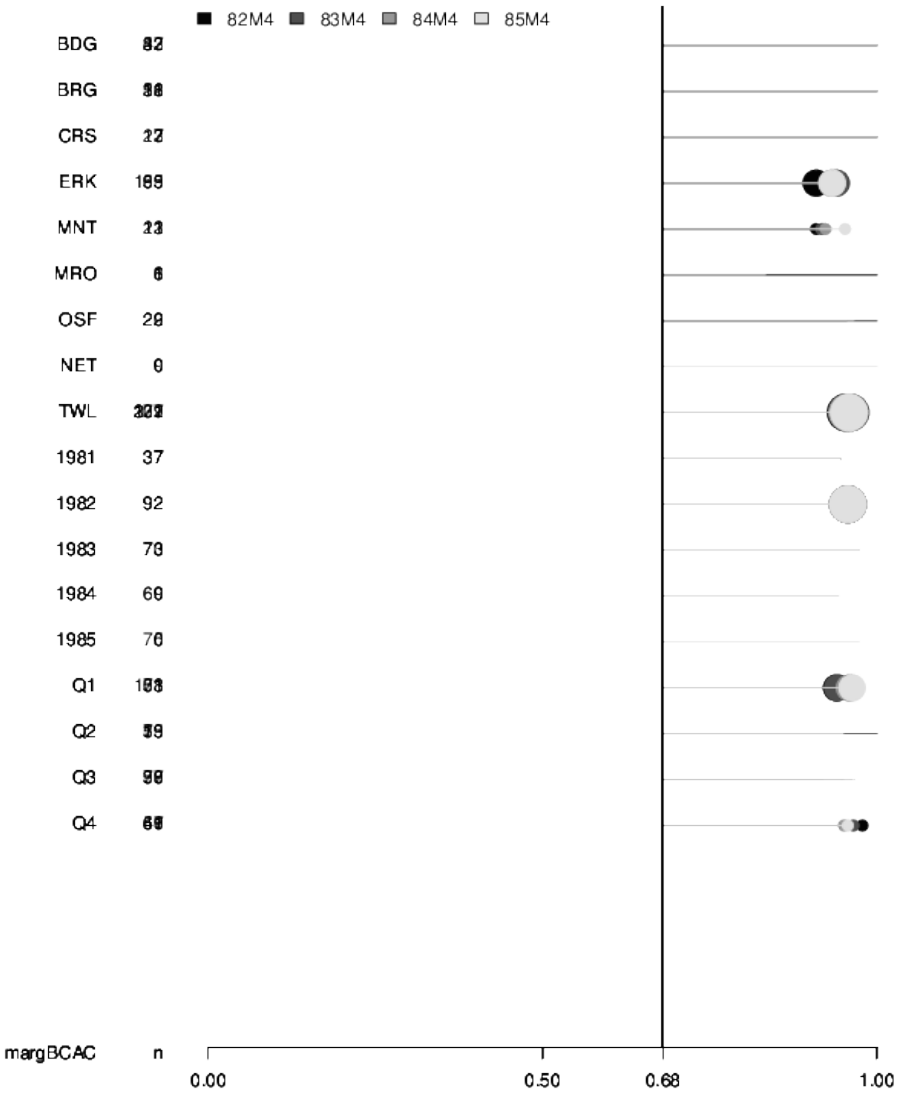


78-84



Combined

MCAT 269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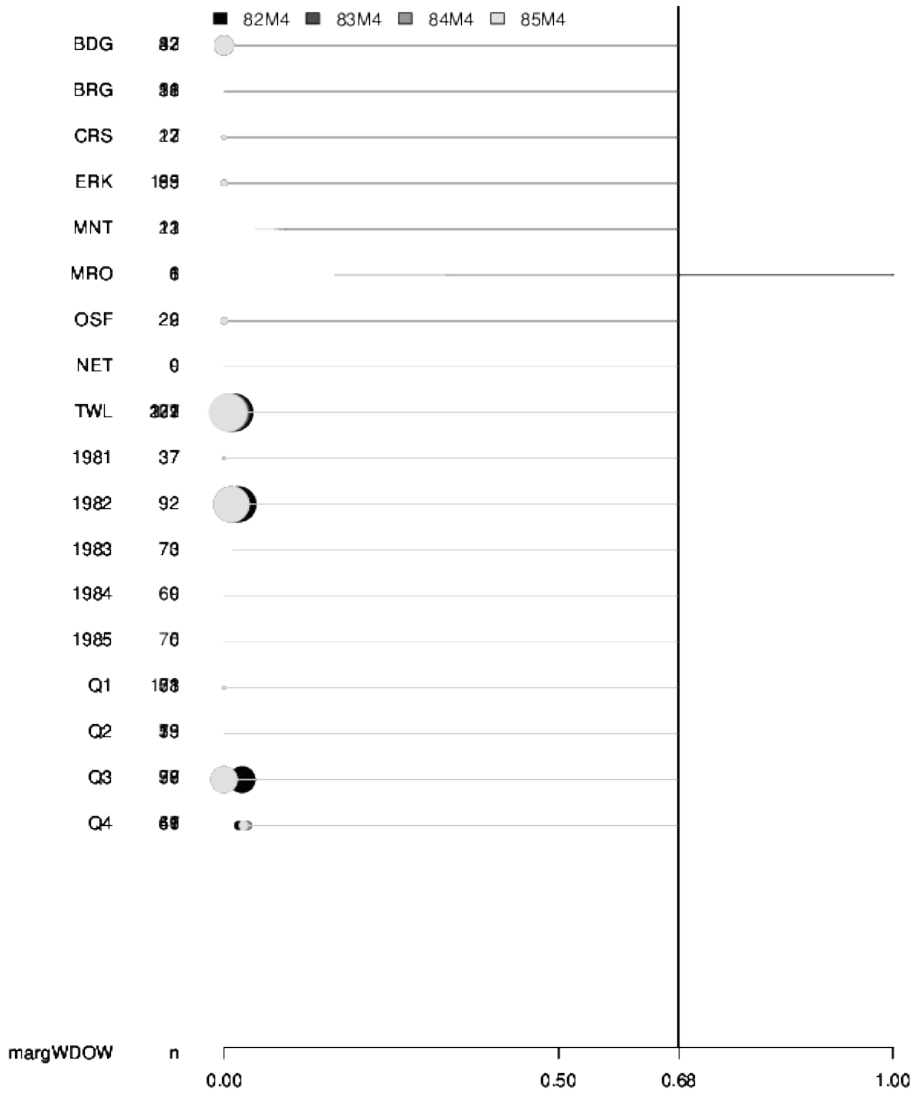
83M4
84M4
85M4
BDG
BRG
CRS
ERK
MNT
MRO
OSF
NET
TWL
1981
1982
1983
1984
1985
Q1
Q2
Q3
Q4
margBCAC
n
0.00
0.50
0.68
1.00

MCAT 269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83M4
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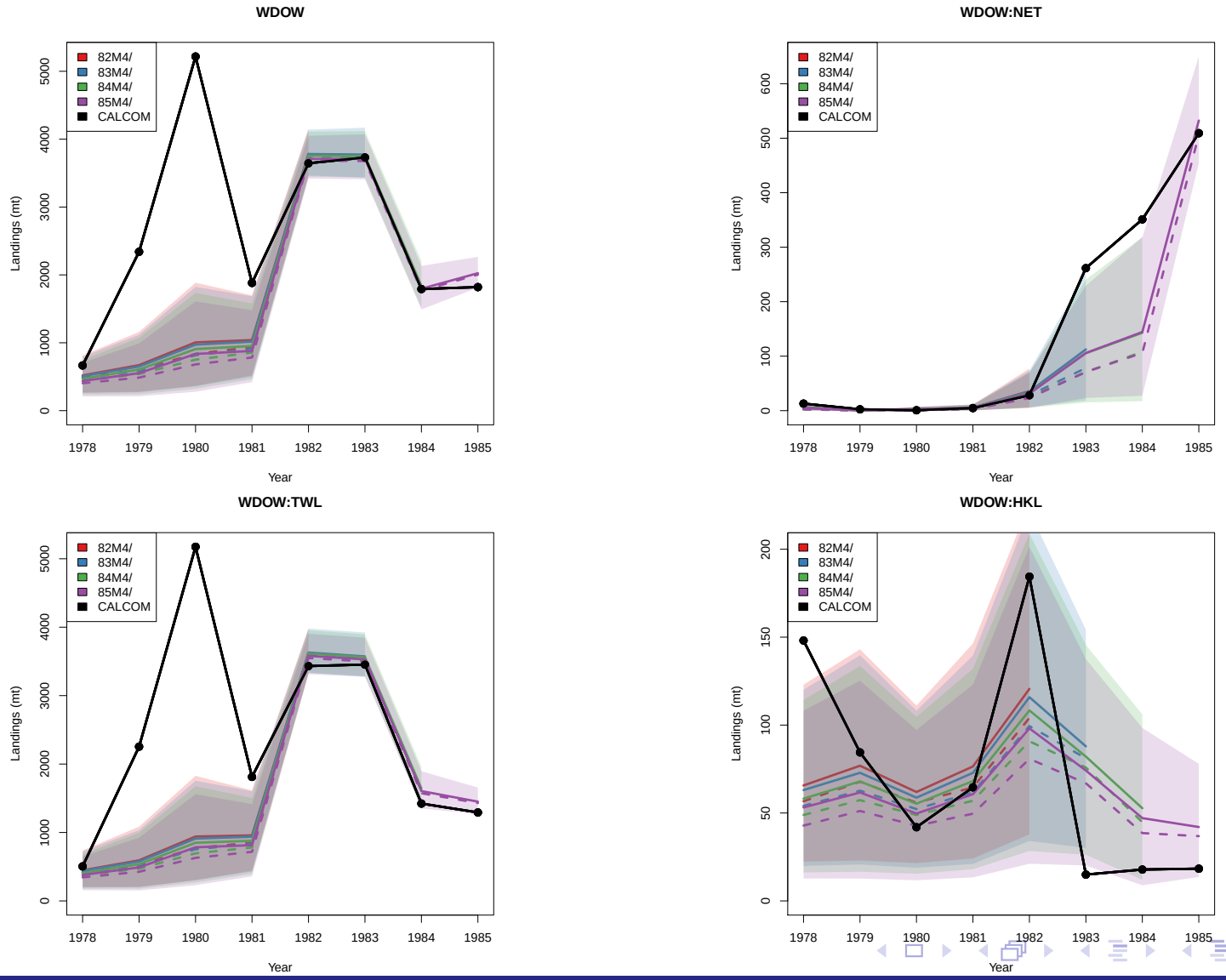
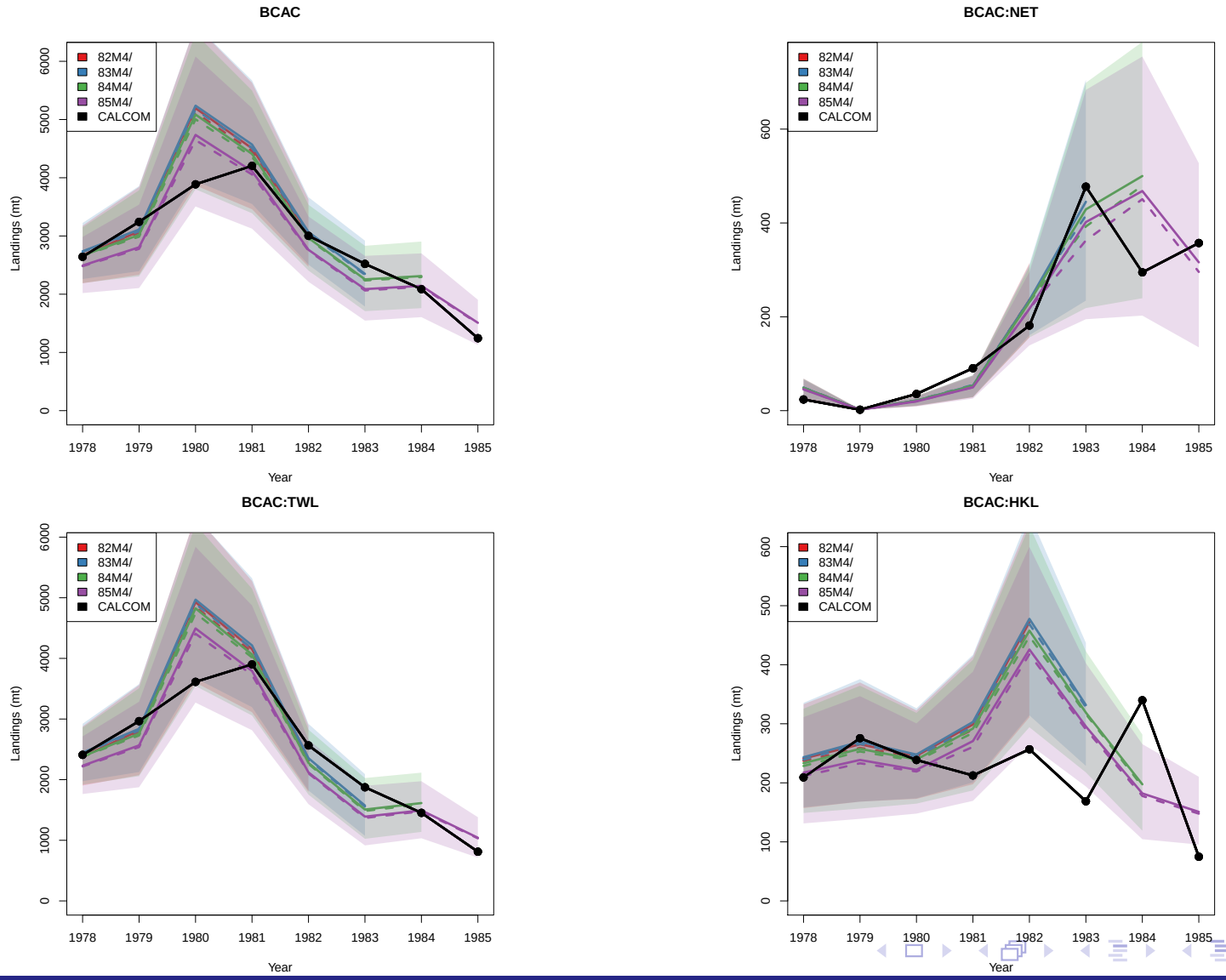
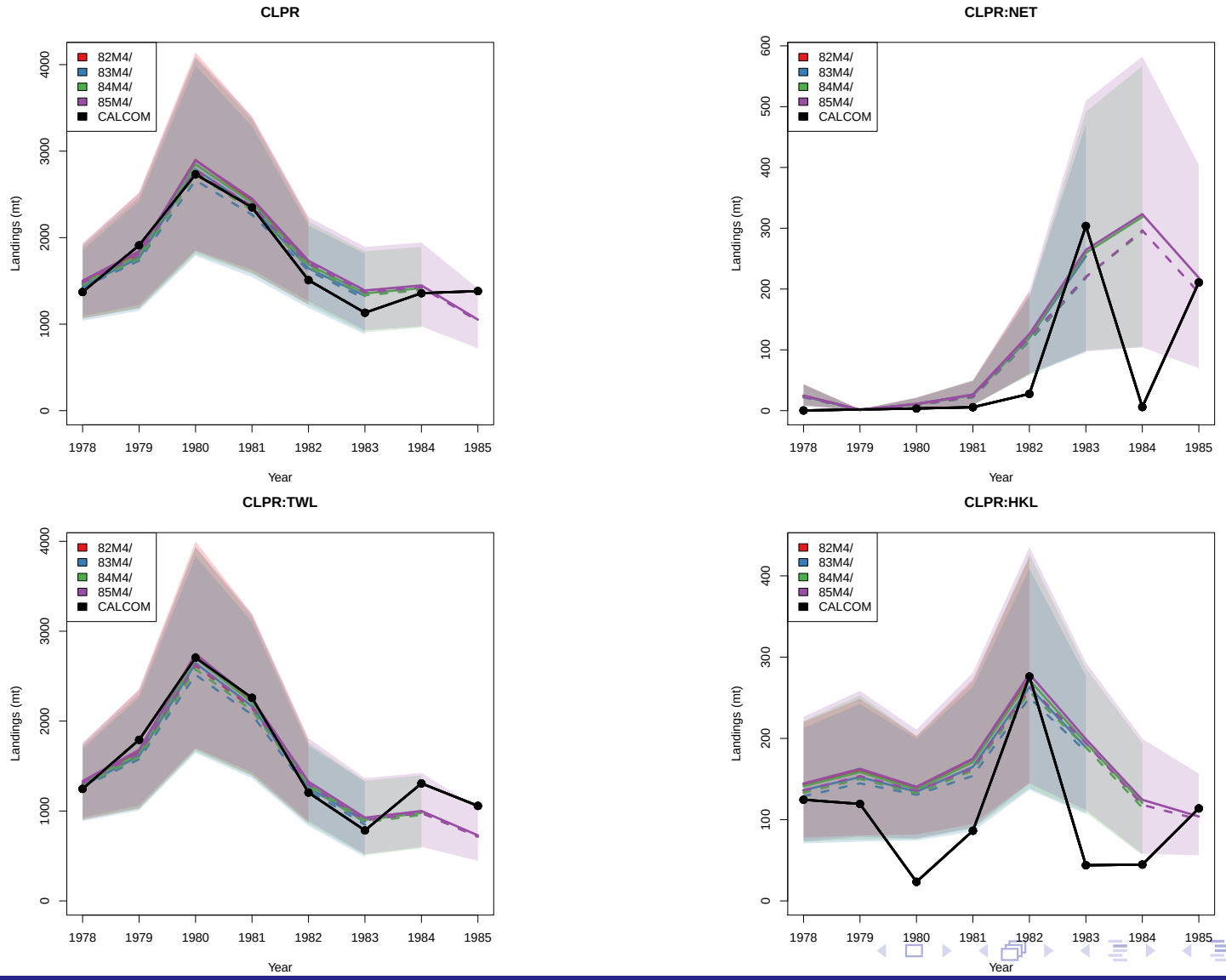
Landings Sensitivity



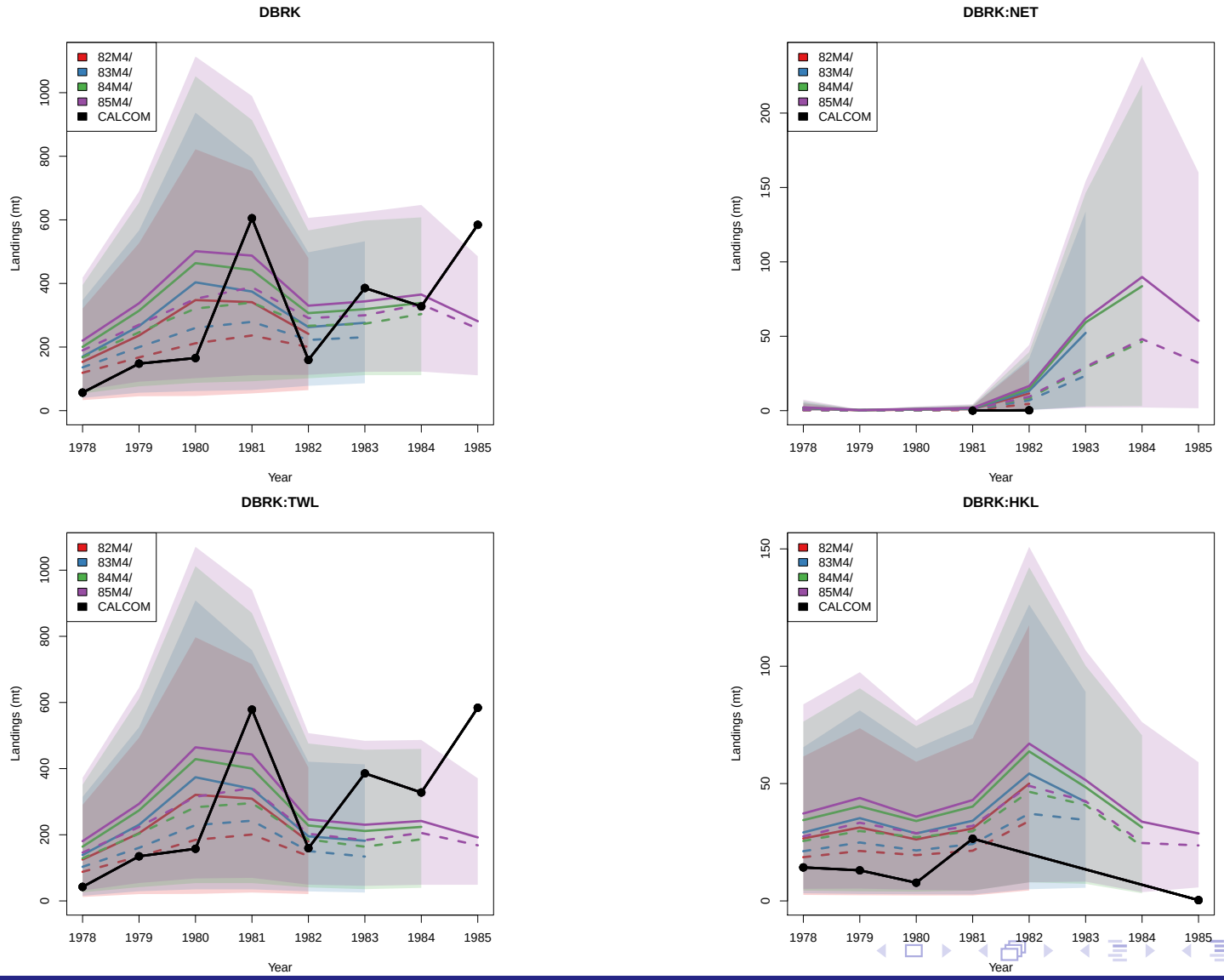
Landings Sensitivity



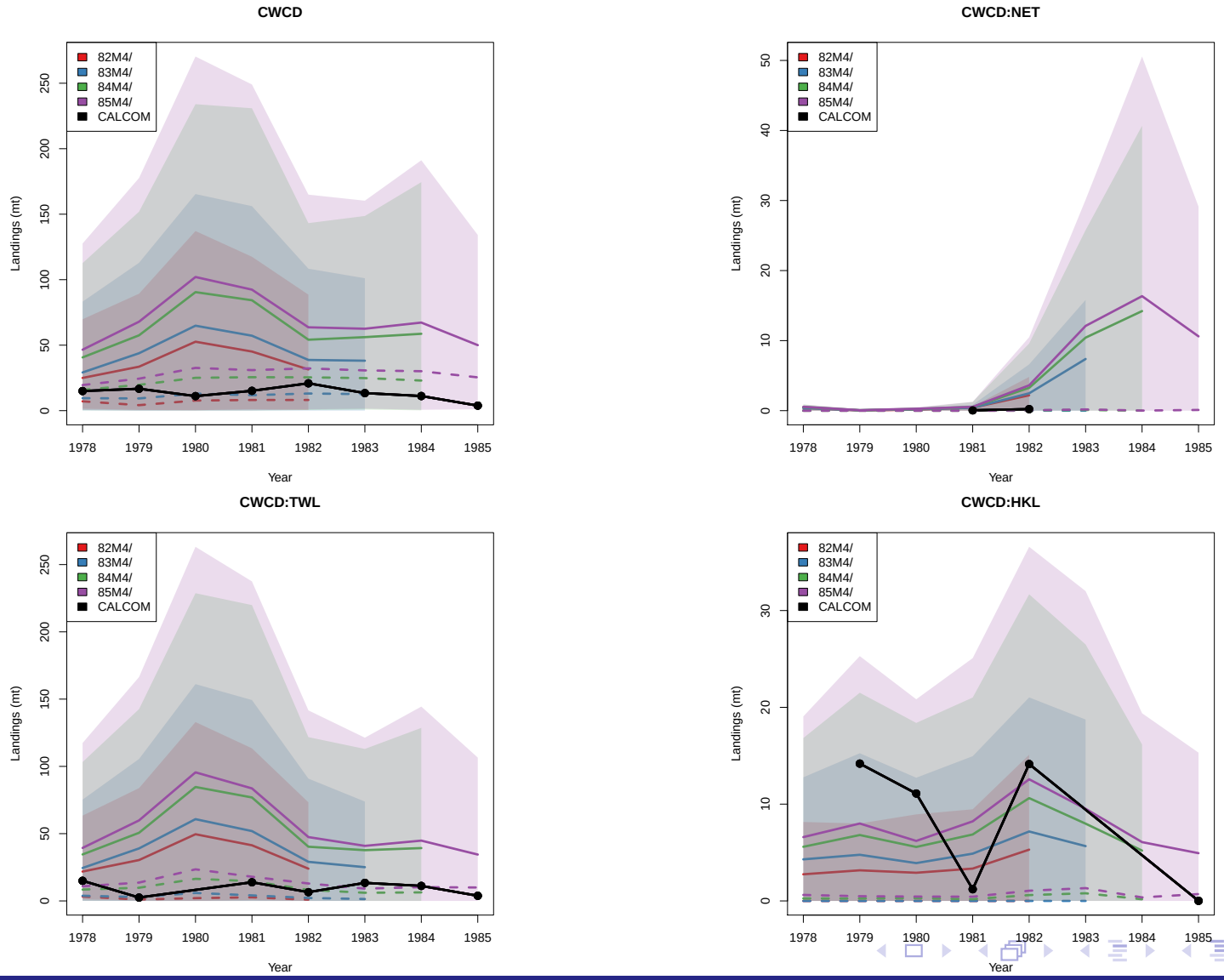
Landings Sensitivity



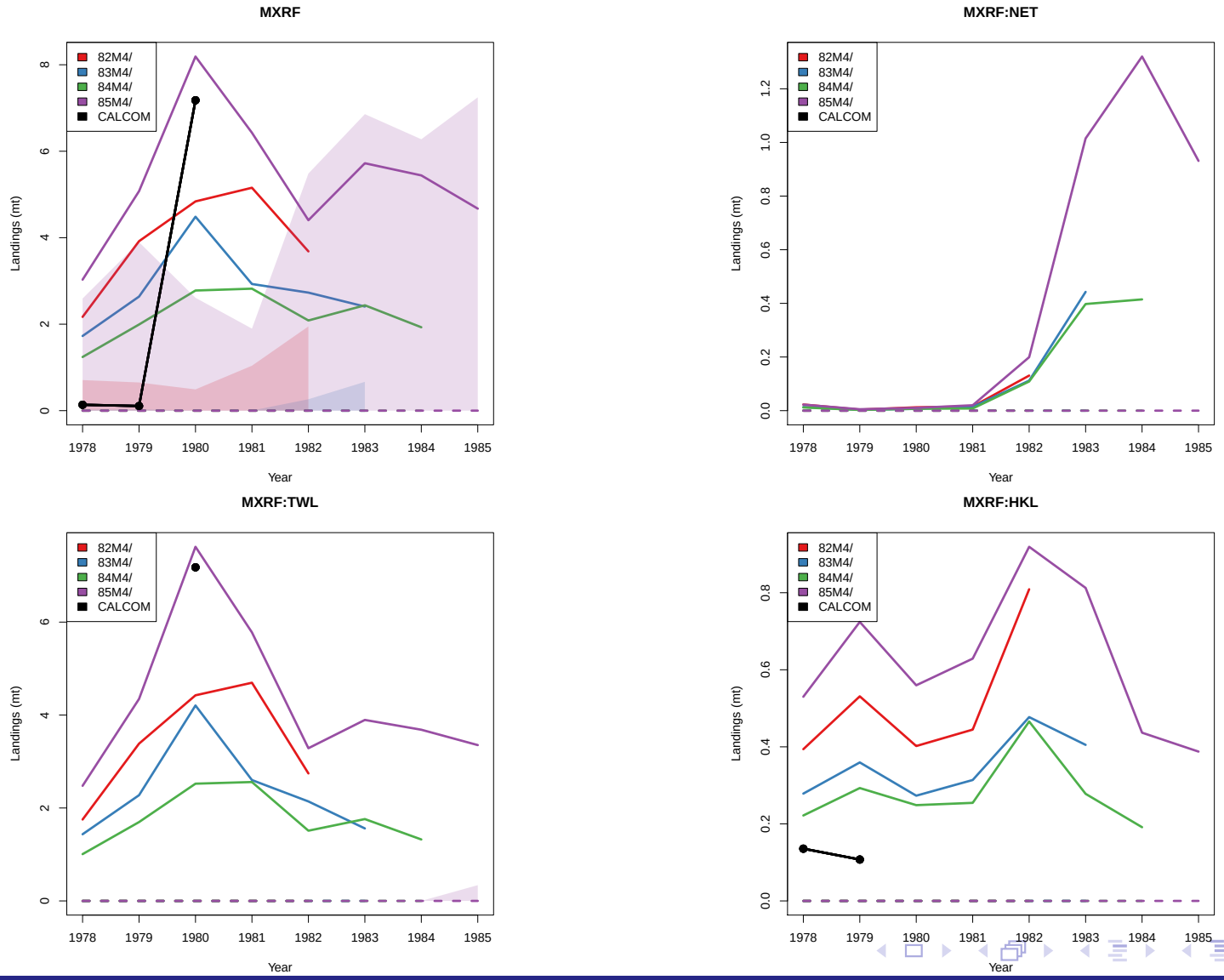
Landings Sensitivity



Landings Sensitivity



Landings Sensitivity



Time Blocking Summary

- The presented model is reasonably robust to time blocking decisions.
- MCATs 250 and 253 show small shifts in performance.
- MCAT 269 shifts performance to a greater extent.

MCAT 250 Combined Plots

MCAT 253 Combined Plots

MCAT 269 Combined Plots

All Species Landings

For the sake of clarifying the correlation structure implied by the Multinomial-Poisson Transformation, consider the following:

$$X_1 \sim \text{Poisson}(\theta_1) \quad X_2 \sim \text{Poisson}(\theta_2)$$

The random variables X_1 and X_2 *are not* necessarily negatively correlated. They simply allow us to learn θ_1 and θ_2. θ_1 and θ_2 *are not* necessarily negatively correlated. However, via the Multinomial-Poisson transformation ($f(\boldsymbol{x}) = \frac{x_i}{\sum_j x_j}$), θ_1 and θ_2 jointly contain the same information as the Multinomial $\boldsymbol{\pi}$ parameter. The individual components of $\boldsymbol{\pi}$ *are* neccesarily negatively correlated (I prove this later). The componentes of a new (multivariate) random variable $\boldsymbol{Y} \sim \text{MN}(\boldsymbol{\pi})$ *are* necessarily negatively correlated.

In our modeling strategy we replace the Poisson distributions with Beta-Binomial distributions,

$$X_1 \sim \mathrm{BB}(\theta_1, \rho) \quad X_2 \sim \mathrm{BB}(\theta_2, \rho).$$

Just as in the previous slide, the random variables X_1 and X_2 *are not* necessarily negatively correlated. θ_1 and θ_2 *are not* necessarily negatively correlated. However computing species compositions using the $f(\boldsymbol{x}) = \frac{x_i}{\sum_j x_j}$ transformation, provides negative correlation among our species compositions, just as it does in the previous case. In the next slides I show that it is the structure of the $f(\boldsymbol{x}) = \frac{x_i}{\sum_j x_j}$ transformation that produces this negative correlation. The Multinomial-Poisson transformation is only special in that it's particular application of this transformation among the parameters of Poisson distributions, analytically results in the Multinomial distribution. The particular form of the Poisson distribution is not required to guarantee negative correlation, the transformation itself provides the negative correlation.

Species Comps are Negatively Correlated.

Consider a two species system.

$$\pi_1 = \frac{x_1}{x_1 + x_2} \quad \pi_2 = \frac{x_2}{x_1 + x_2} \quad \Rightarrow \quad \pi_1 + \pi_2 = 1$$

We seek to show $Corr(\pi_1, \pi_2) < 0$.

$$Corr(\pi_1, \pi_2) = \frac{Cov(\pi_1, \pi_2)}{\sigma_{\pi_1}\sigma_{\pi_2}} \quad \sigma_{\pi_1} \geq 0, \ \sigma_{\pi_2} \geq 0$$

$$Corr(\pi_1, \pi_2) \leq 0 \iff Cov(\pi_1, \pi_2) \leq 0$$

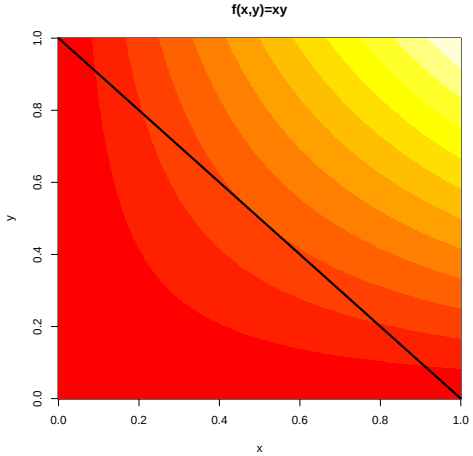
$$Cov(\pi_1, \pi_2) = \mathbb{E}[(\pi_1 - \mathbb{E}[\pi_1])(\pi_2 - \mathbb{E}[\pi_2])]$$
$$= \mathbb{E}[\pi_1\pi_2] - \mathbb{E}[\pi_1]\mathbb{E}[\pi_2]$$

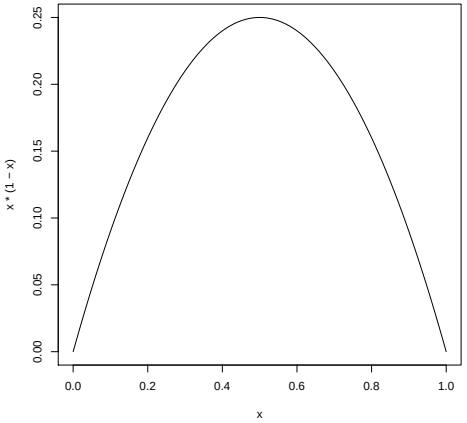
$$Cov(\pi_1, \pi_2) \leq 0 \iff \mathbb{E}[\pi_1]\mathbb{E}[\pi_2] \geq \mathbb{E}[\pi_1\pi_2]$$

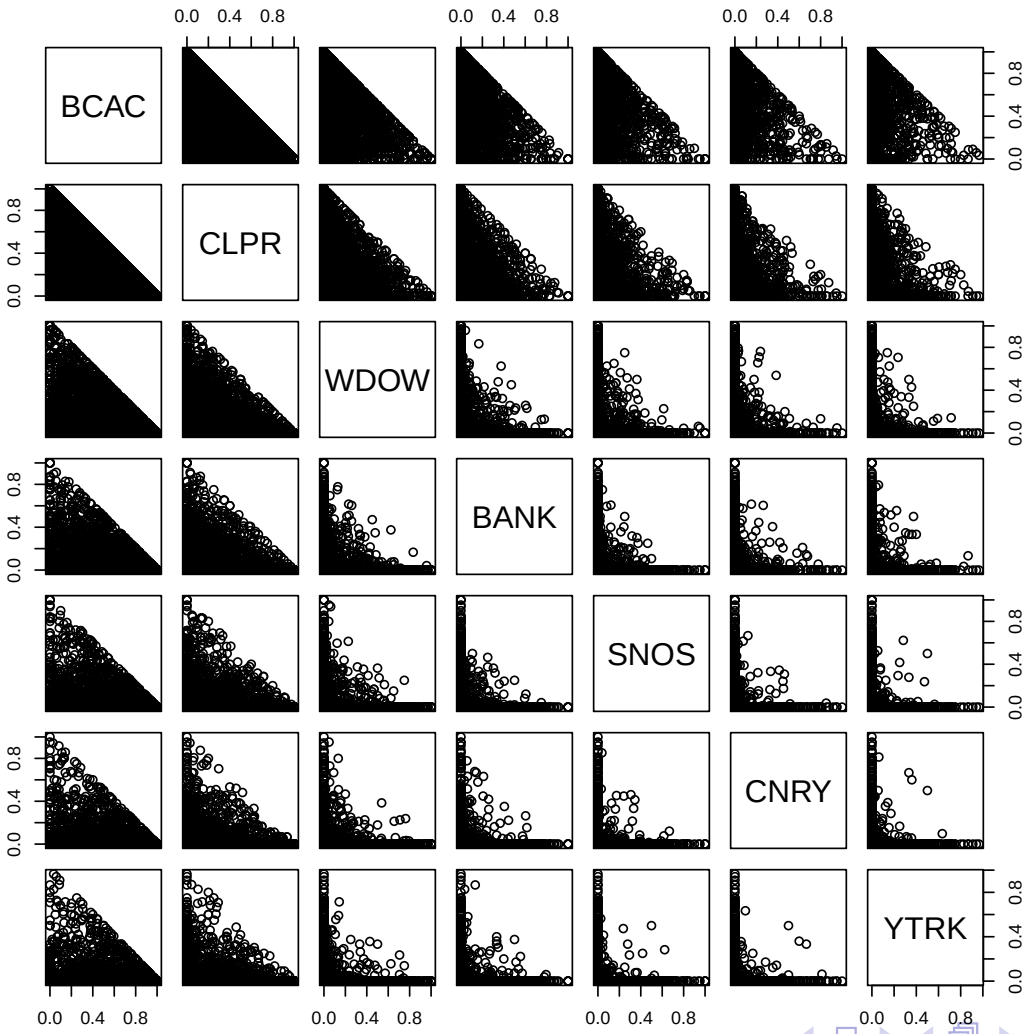
Now consider $f(x, y) = xy$ such that $x+y = 1$, $x \geq 0$, and $y \geq 0$.
Jensen's Inequality for f is:

$$f(\mathbb{E}[x], \mathbb{E}[y]) \geq \mathbb{E}[f(x, y)] \qquad (1)$$

Applying (1) to π gives $\mathbb{E}[\pi_1]\mathbb{E}[\pi_2] \geq \mathbb{E}[\pi_1\pi_2]$, with equality only when π is a constant.
Thus $Cov(\pi_1, \pi_2) < 0$ and $Corr(\pi_1, \pi_2) < 0$.






BCAC
CLPR
WDOW
BANK
SNOS
CNRY
YTRK
0.0 0.4 0.8

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

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

$$\pi_{jk} = \frac{y_{jk}}{\sum_j y_{jk}} \quad \boldsymbol{y}_k \neq \mathbf{0}. \tag{2}$$

The predictive mean for species j is,

$$\hat{\pi}_j = \frac{\sum_k^K \pi_{jk}}{K}. \tag{3}$$

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,

$$f(\mathbb{E}[\boldsymbol{x}]) \geq \mathbb{E}[f(\boldsymbol{x})]. \tag{4}$$

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 (4) to $\boldsymbol{\pi}$ gives

$$\mathbb{E}[\pi_l]\mathbb{E}[\pi_m] \geq \mathbb{E}[\pi_l \pi_m] \tag{5}$$

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

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