



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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Diagnostic Tutorial

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

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

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

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

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

$y_{ijklm\eta}$: 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.

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

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

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

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

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





Diagnostic Tutorial

	M4
DIC	38721
WAIC	38725

← click

Text underlined in green

links to the appropriate diagnostics for all species and stratum.

(M4)

$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$

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

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



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 \mathfrak{N} be the nominal level of prediction for a particular model run. The Mean Absolute Deviation (MAD) for species j in stratum i is

$$\text{MAD}_{ij} = \frac{\ell_i}{\sum_i \ell_i} |\mathcal{O}_{ij} - \mathfrak{N}|.$$

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

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Diagnostic Tutorial

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.

Introduction

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Time Model

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Prior Model

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Interaction Model

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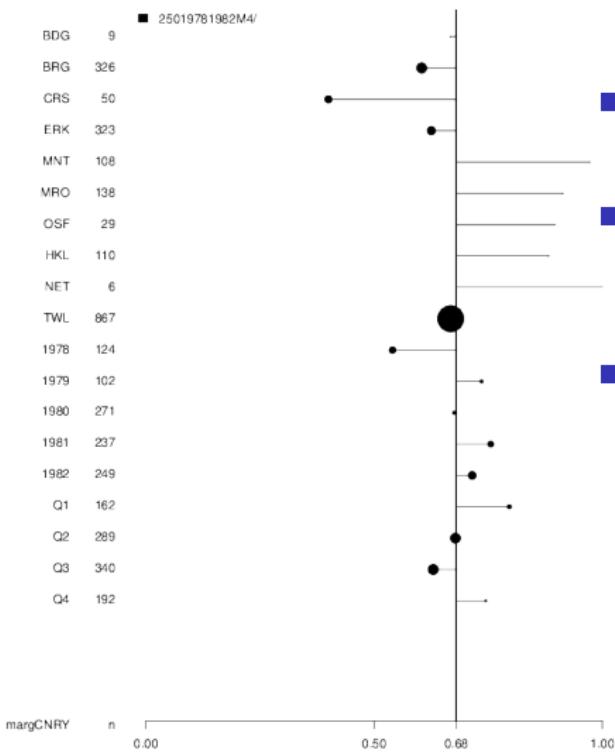
Time Block

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Proofs

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Diagnostic Tutorial



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- 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.

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A 5x5 grid of 25 small circles, arranged in five rows and five columns.

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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



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These tables show the total number of samples for Market Category 253 (Boccaccio) 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: Baccello					
	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
KUPG	1					
LCOD	17	1	2			
LSPN						1
MISC	2					
MKRF				1		
OLIVE	5		4			
QWVS			1			
PDBA	1					1
PNKR	1	2				
POP				1		
PTRL				1		
RDBO	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	
CMEI				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

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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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).

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

	147		175		177
Longnose skate	152	spiny dogfish	unspecifi ed skate	176 big skate	Californi a 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.

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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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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)

$$\beta_{mn}^{(t)} = \beta_m^{(y)} + \beta_n^{(q)}$$

$$\beta_m^{(y)} \sim N(0, 32^2)$$

$$\beta_{\eta}^{(q)} \sim N(0, 32^2)$$

(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)

$$\beta_{m\eta}^{(t)} = \beta_{m\eta}^{(y:q)}$$

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

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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



MCAT 250

M2

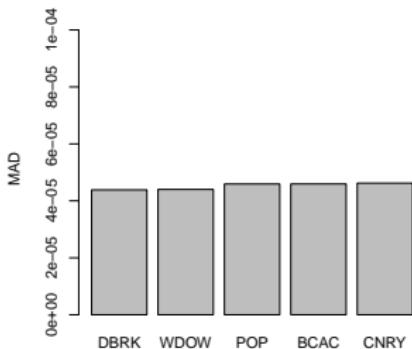
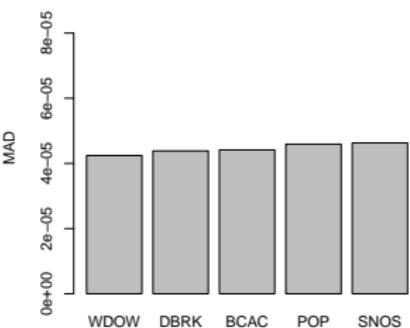
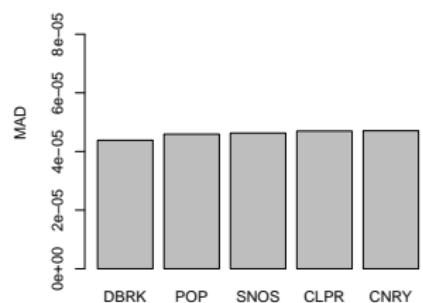
M3

M4

MAD Ordered by Species

MAD Ordered by Species

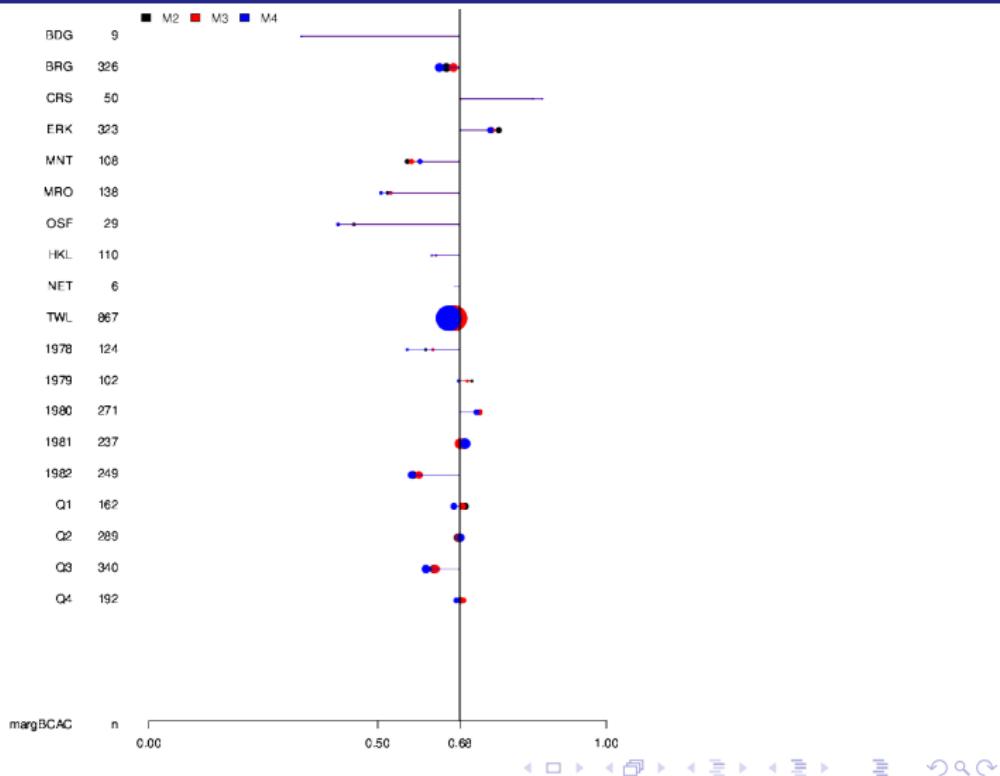
MAD Ordered by Species



Combined

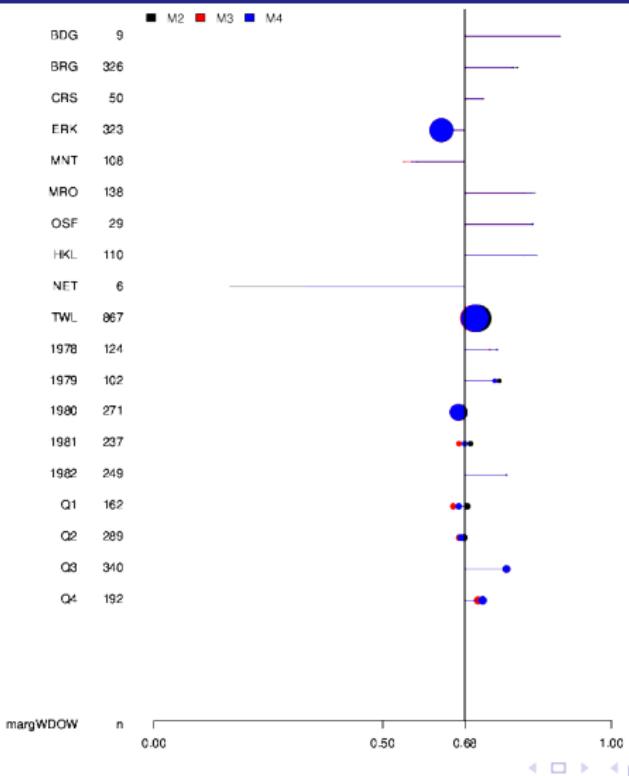


MCAT 250





MCAT 250



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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

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A 5x5 grid of 25 small circles, arranged in five rows and five columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

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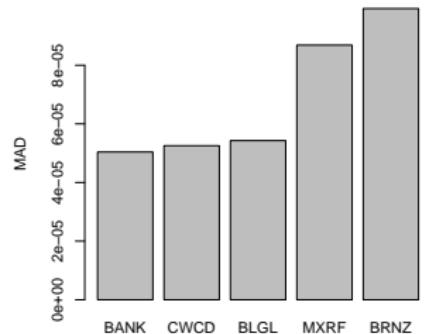
MCAT 250

M2

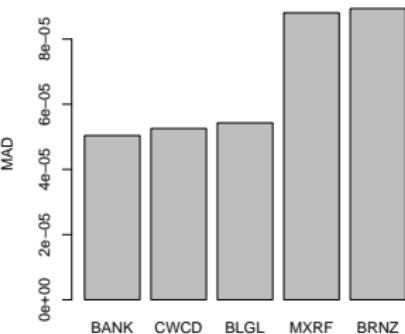
M3

M4

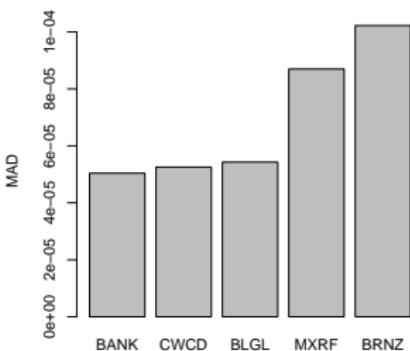
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

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Time Block

Proofs

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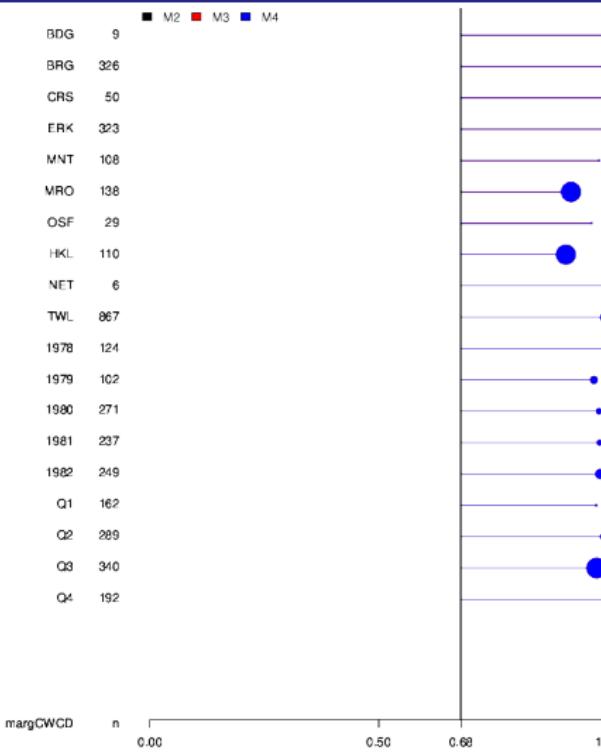
A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

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MCAT 250



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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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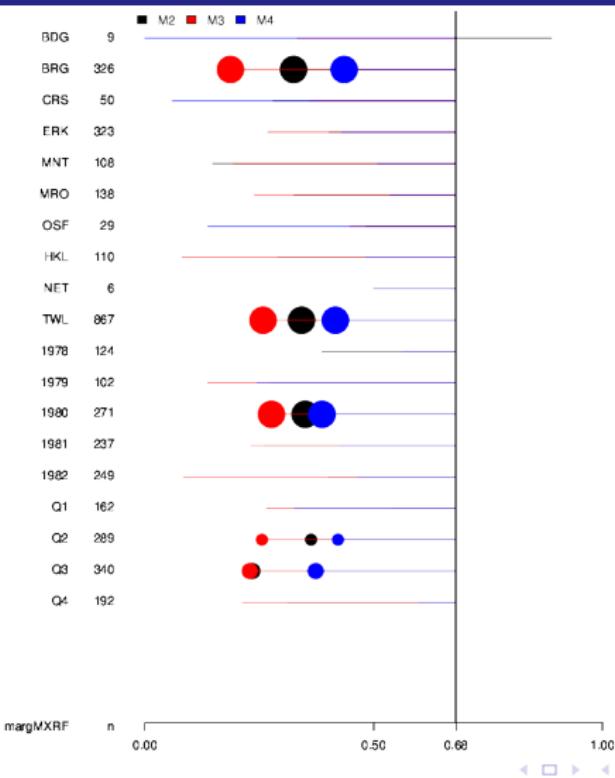
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MCAT 250



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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

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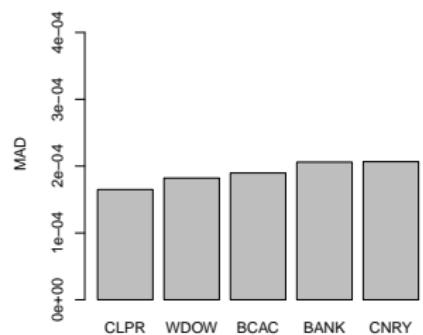
MCAT 253

M4

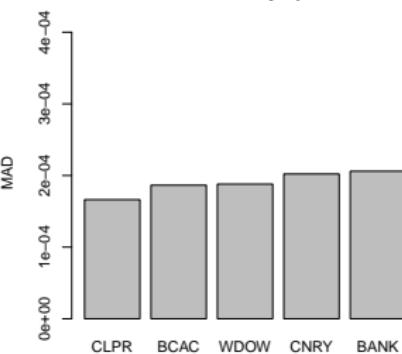
M5

M6

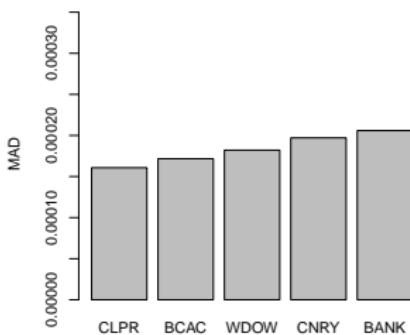
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

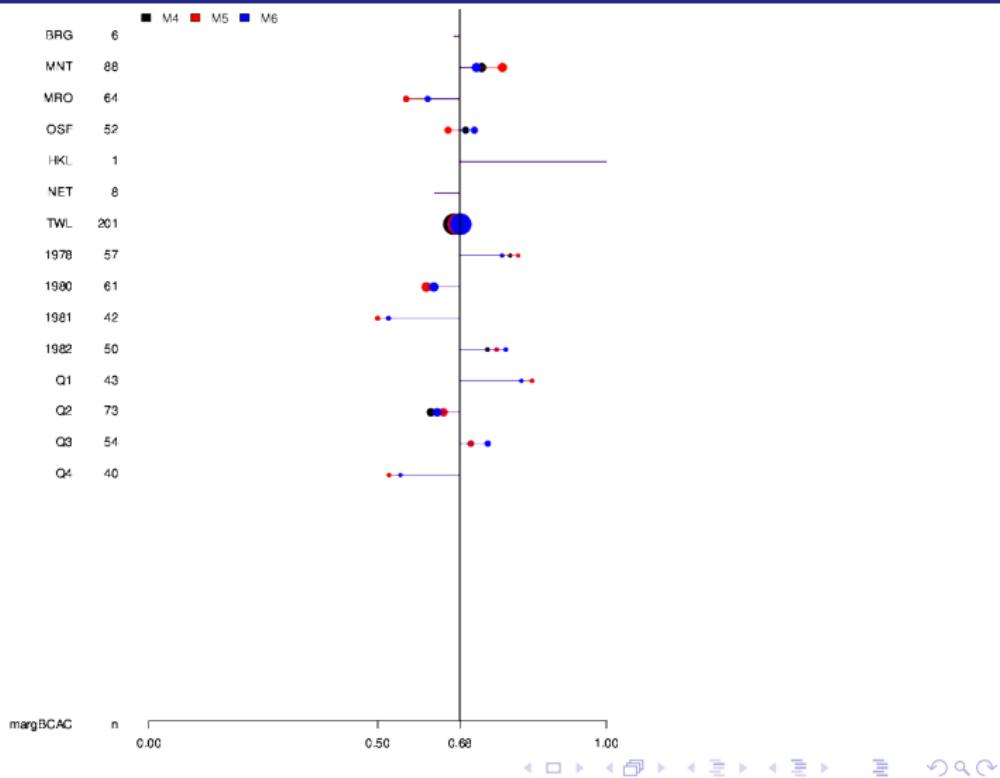
A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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MCAT 253



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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

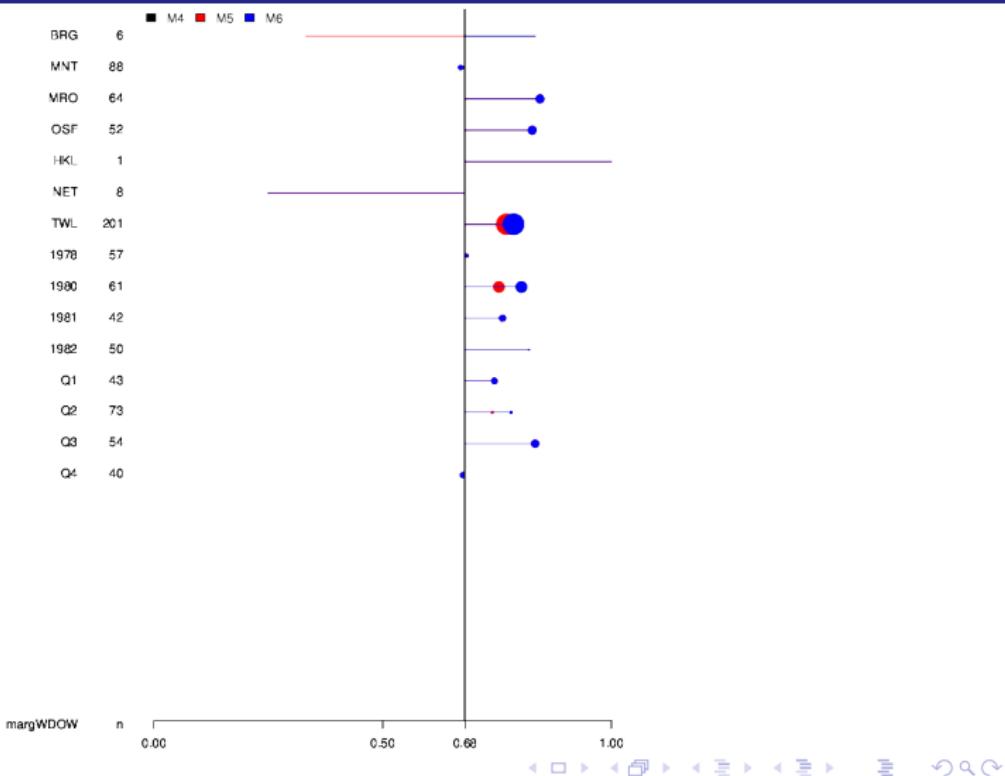
A 4x8 grid of 32 small circles, arranged in four rows and eight columns.

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A 4x3 grid of 12 small circles, arranged in four rows and three columns.

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MCAT 253





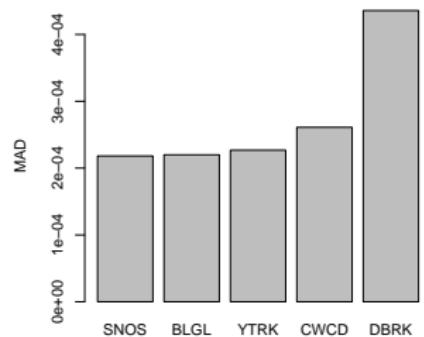
MCAT 253

M4

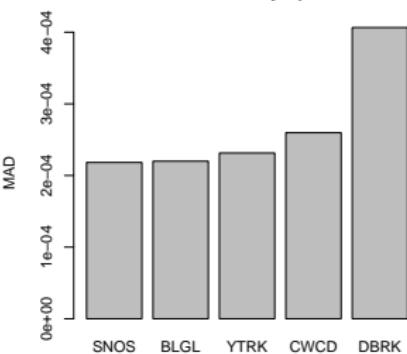
M5

M6

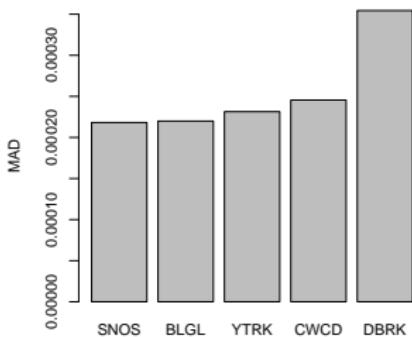
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

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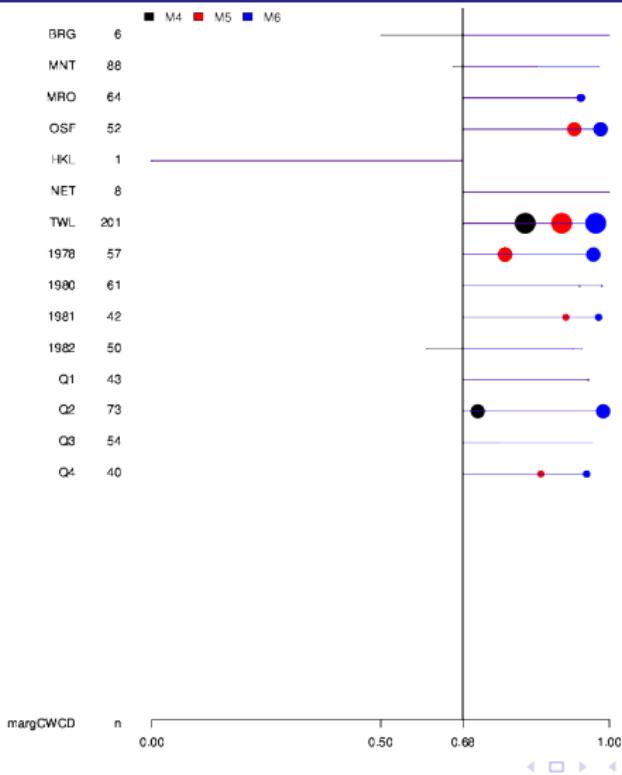
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MCAT 253



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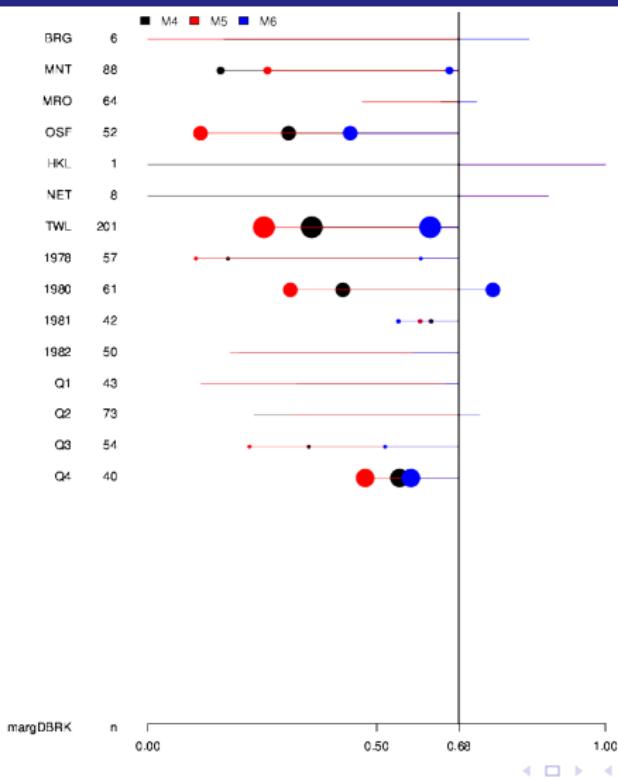
A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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MCAT 253



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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

A 4x4 grid of 16 small circles, arranged in four rows and four columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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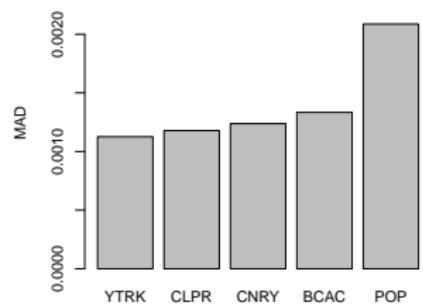
MCAT 269

M4

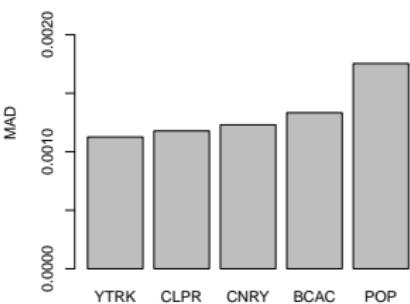
M5

M6

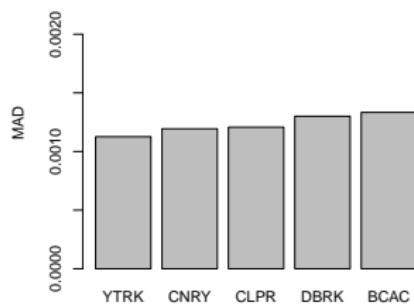
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

A 4x6 grid of circles. The last circle in the bottom row is shaded black.

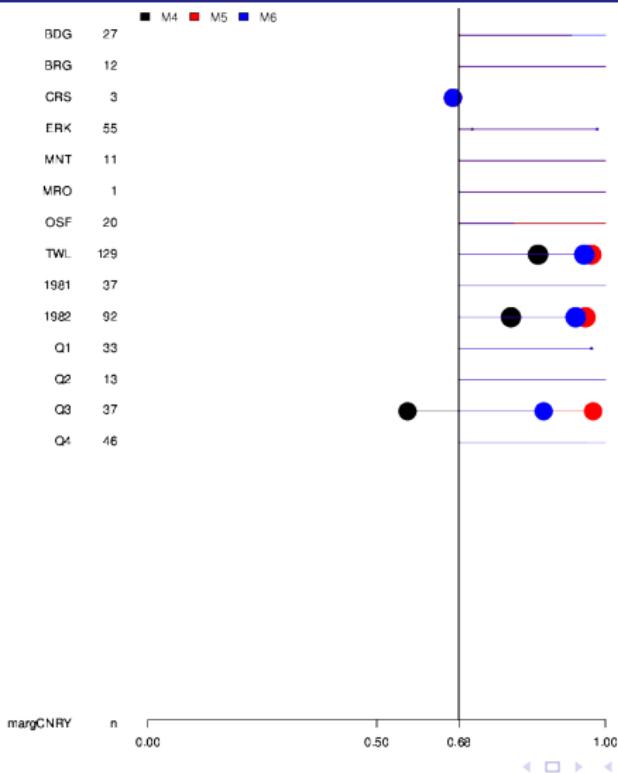
A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

10

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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MCAT 269



Introduction

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Time Model

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Prior Model

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Interaction Model

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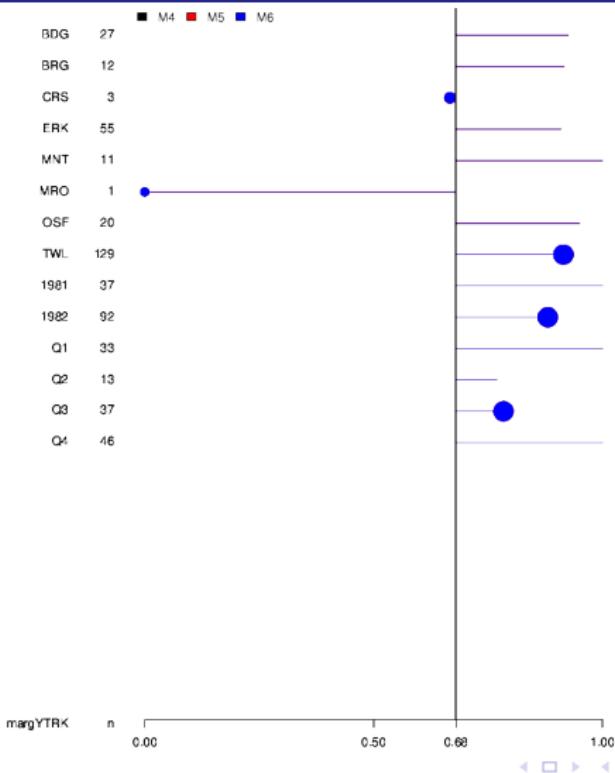
Time Block

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Proofs

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MCAT 269



A 4x4 grid of 16 small circles, arranged in four rows and four columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

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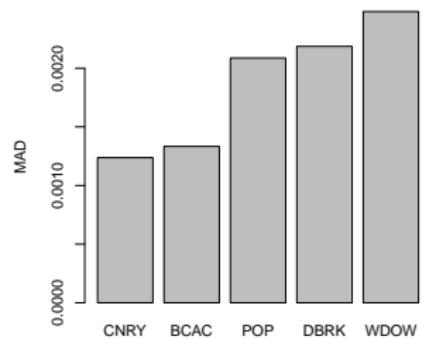
MCAT 269

M4

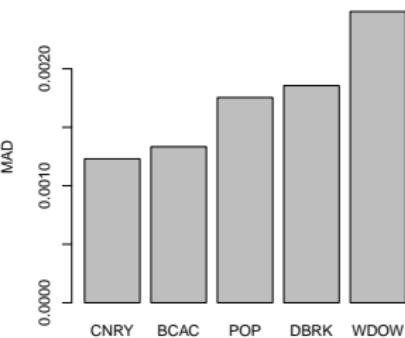
M5

M6

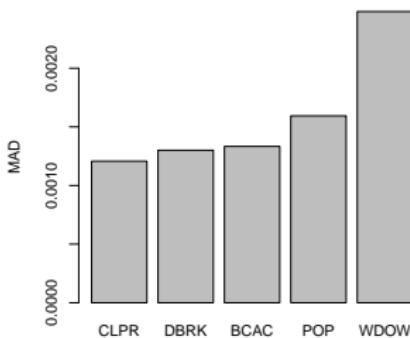
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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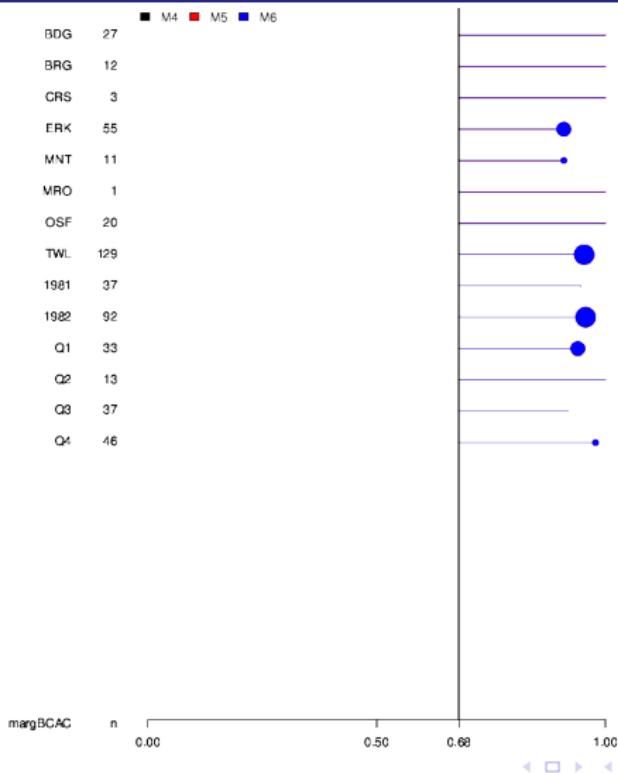
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MCAT 269



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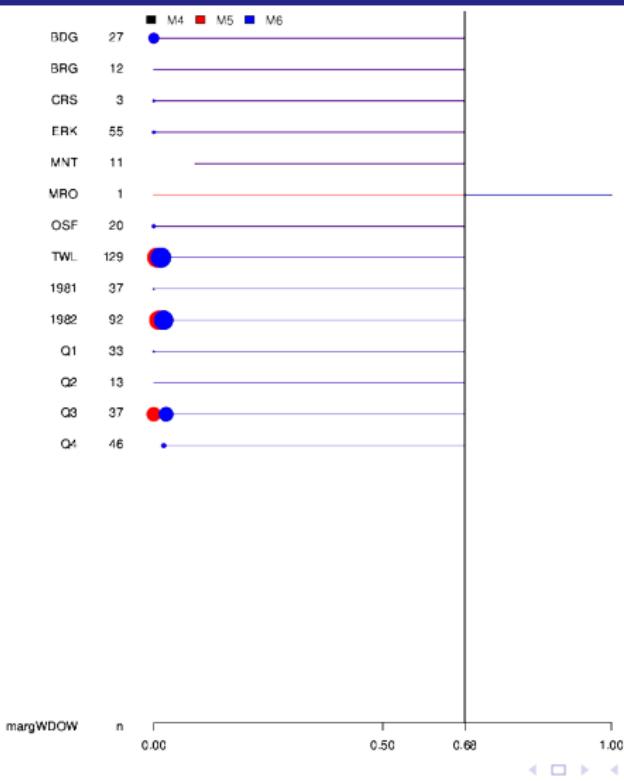
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MCAT 269



Landings Sensitivity

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.

Introduction

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Time Model

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Interaction Model

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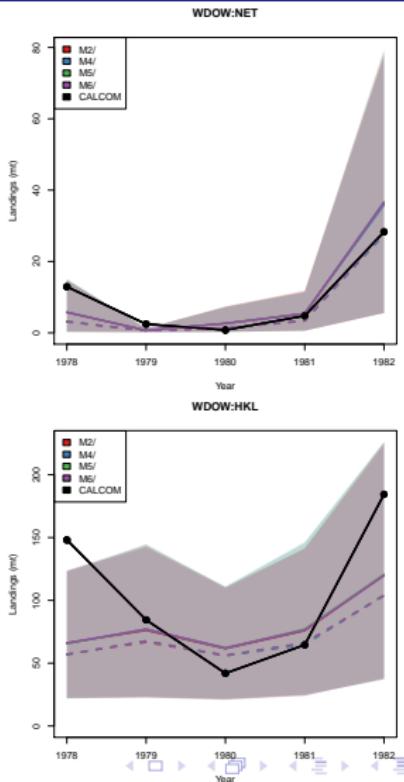
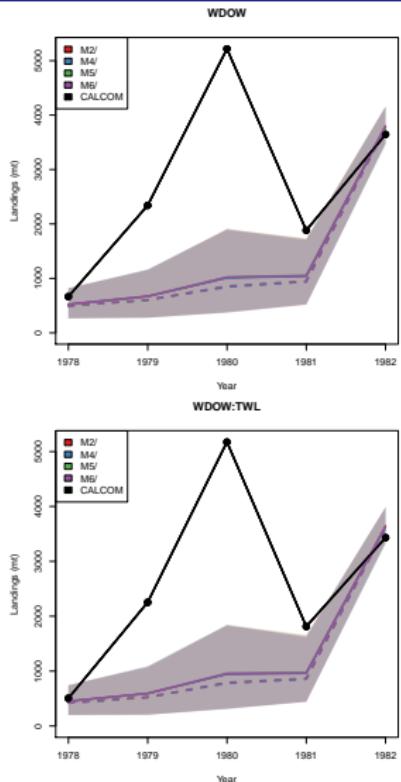
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Landings Sensitivity



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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



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Interaction Model

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Time Block

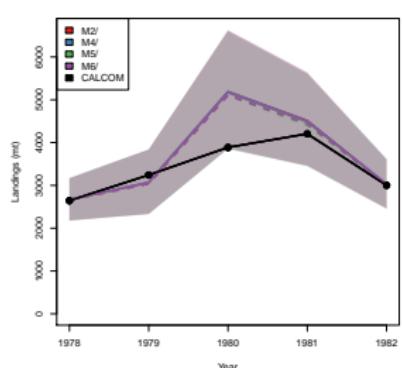
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Proofs

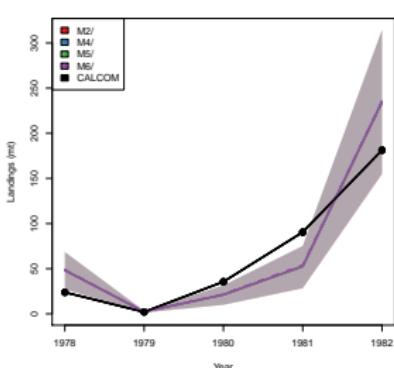
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Landings Sensitivity

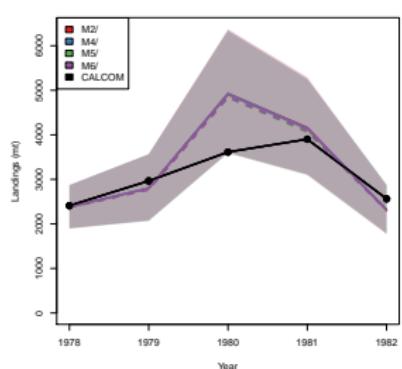
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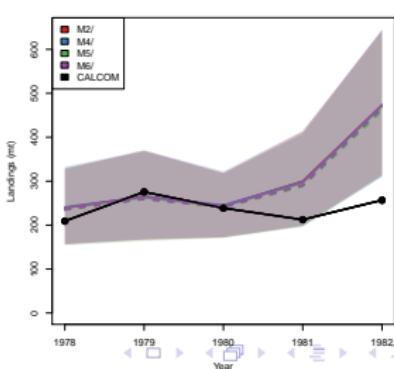
BCAC:NET



BCAC:TWL



BCAC:HKL



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



Introduction

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Time Model

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Interaction Model

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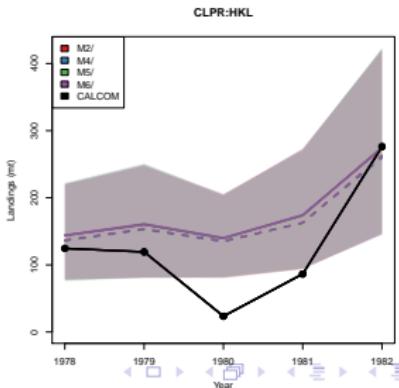
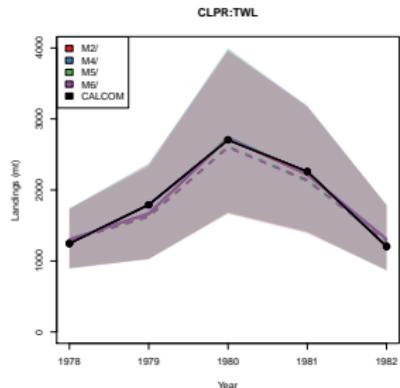
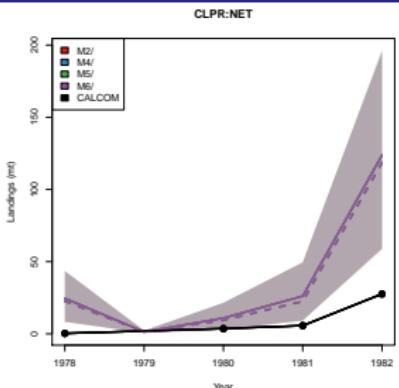
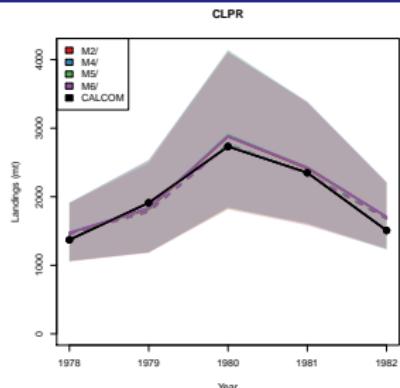
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Proofs

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Landings Sensitivity



Introduction

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Time Model

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Interaction Model

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Time Block

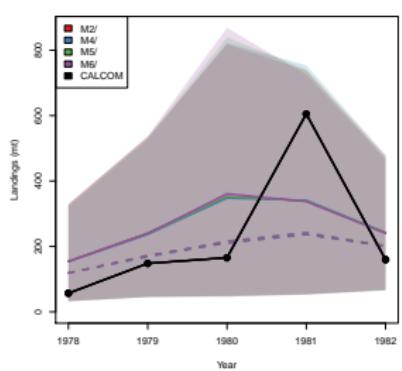
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Proofs

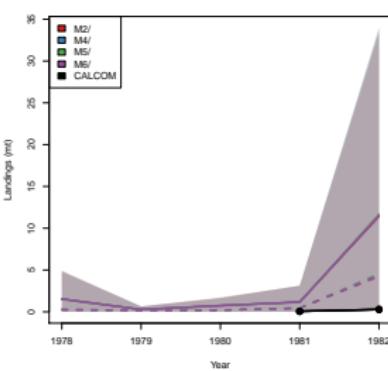
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Landings Sensitivity

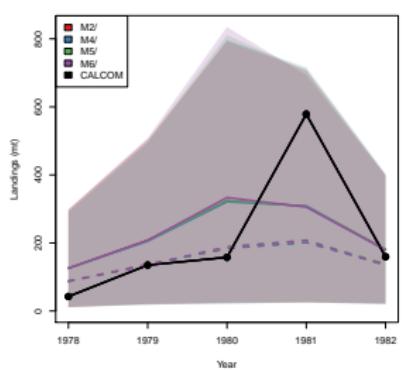
DBRK



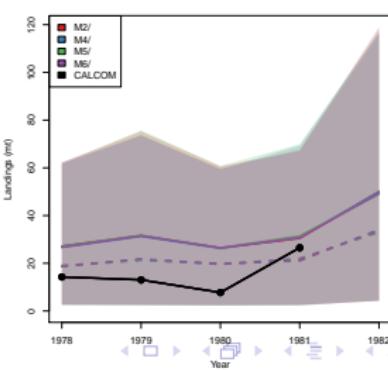
DBRK-NET



DBRK:TWL



DBRK:HKL



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



Introduction

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Time Model

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Prior Model

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Interaction Model

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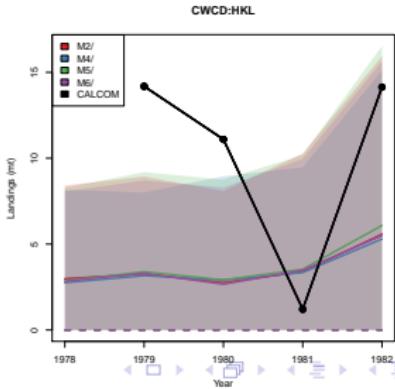
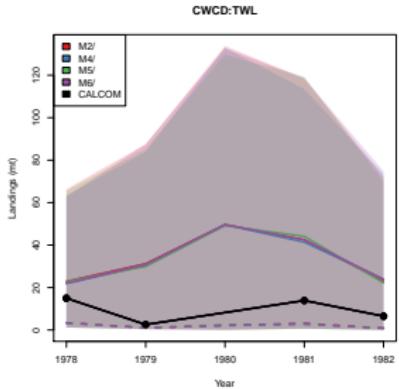
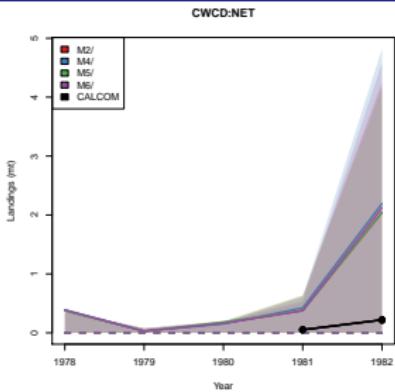
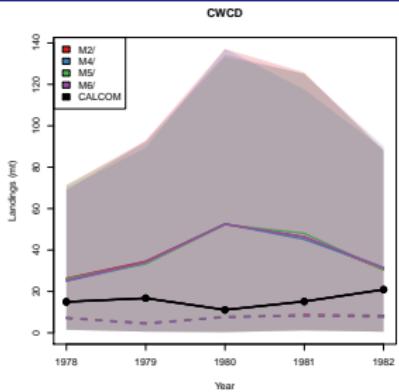
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Proofs

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Landings Sensitivity



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



Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

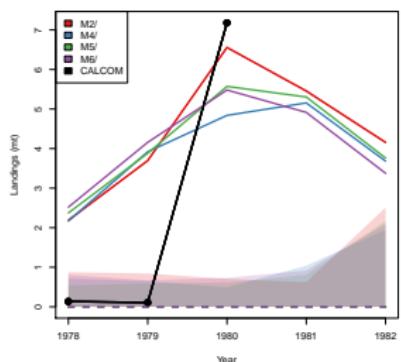
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Proofs

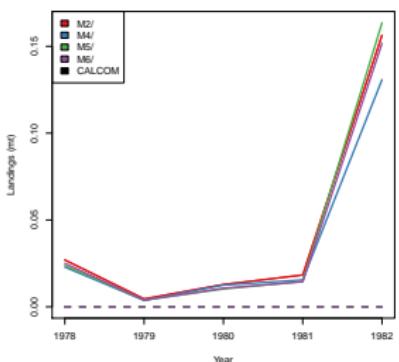
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Landings Sensitivity

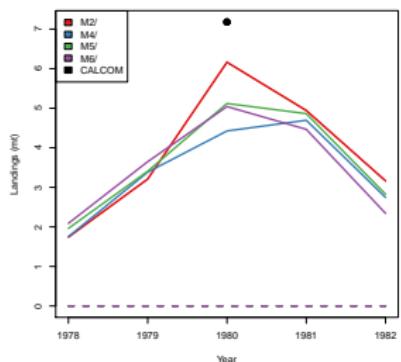
MXRF



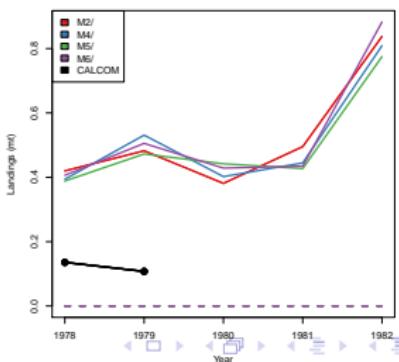
MXRF.NET



MXRF:TWL



MXRF:HKL



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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

$$\beta_0 \propto 1$$

$$\beta_i^{(s)} \sim N(0, 32^2)$$

$$\beta_k^{(p)} \sim N(0, 32^2)$$

$$\beta_I^{(g)} \sim N(0, 32^2)$$

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

$$\text{IG : } \nu \sim \text{Inv-Gamma}(1, 2 \times 10^3) \quad \forall \quad \nu$$

$$\text{HC1 : } \sqrt{v} \sim \text{Half-Cauchy}(10^1) \quad \forall v$$

$$\text{HC3 : } \sqrt{v} \sim \text{Half-Cauchy}(10^3) \quad \forall v$$

$$U4 : \sqrt{v} \sim \text{Uniform}(0, 10^4) \quad \forall v$$

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MCAT 250

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

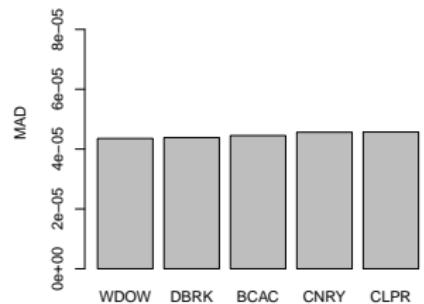
MCAT 250

M4HC1

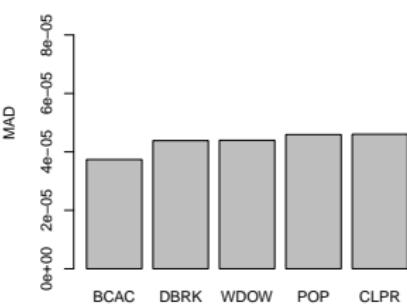
M4HC3

M4U4

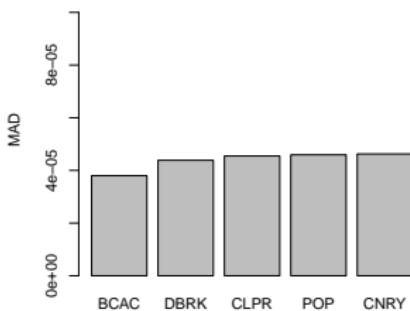
MAD Ordered by Species



MAD Ordered by Species



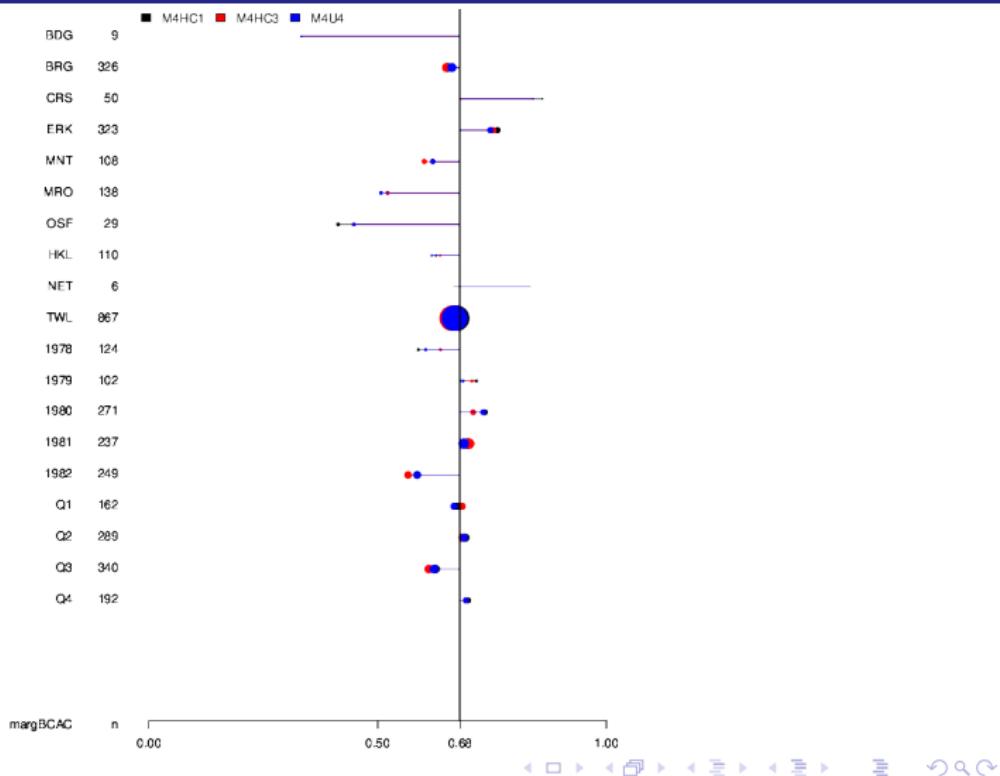
MAD Ordered by Species



Combined



MCAT 250

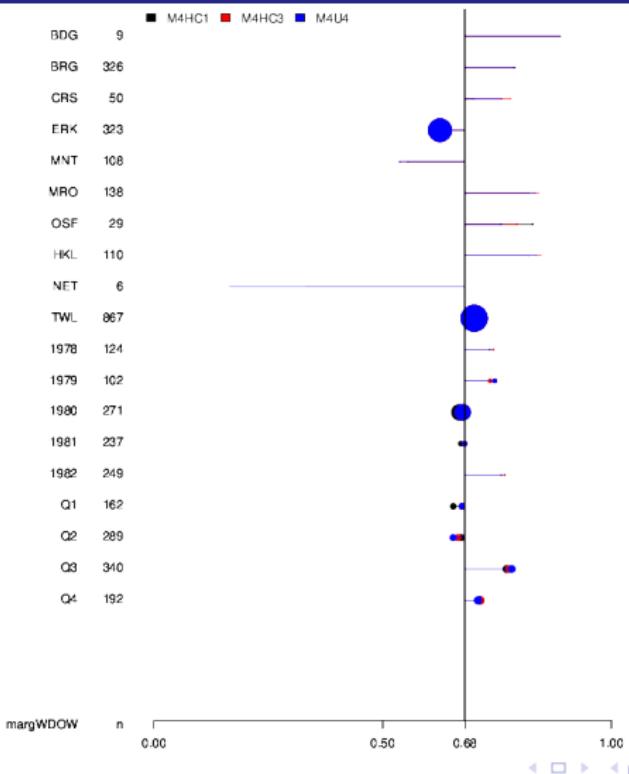


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Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries.



MCAT 250



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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

Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

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Proofs

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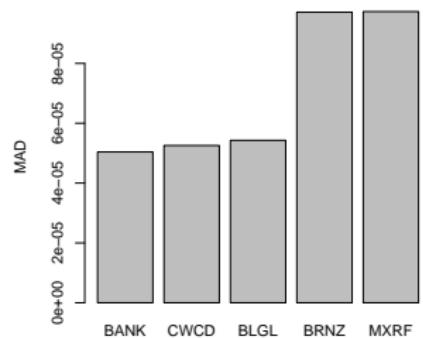
MCAT 250

M4HC1

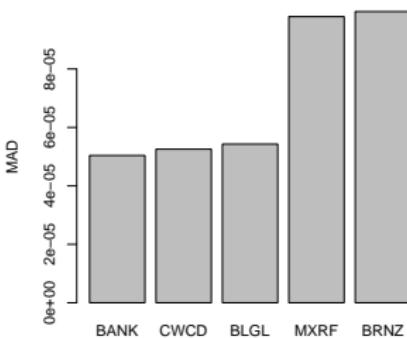
M4HC3

M4U4

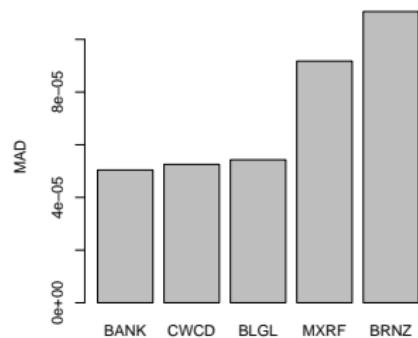
MAD Ordered by Species



MAD Ordered by Species



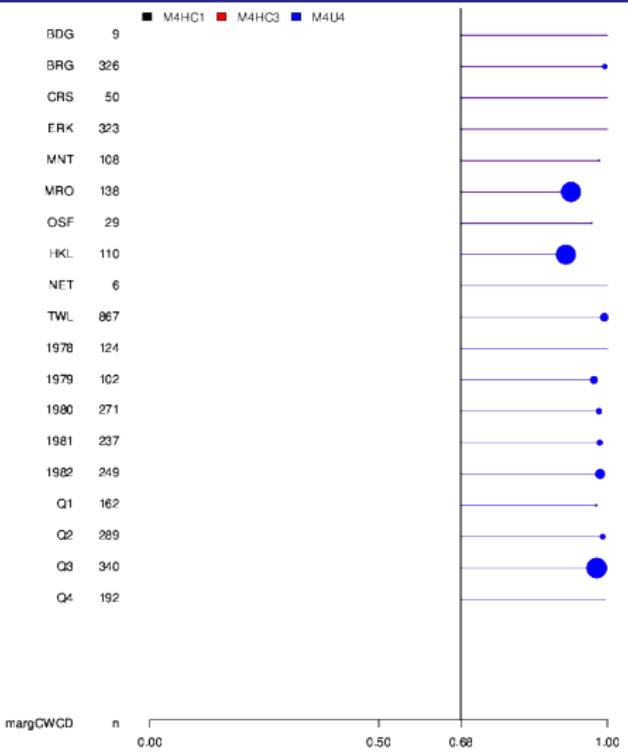
MAD Ordered by Species

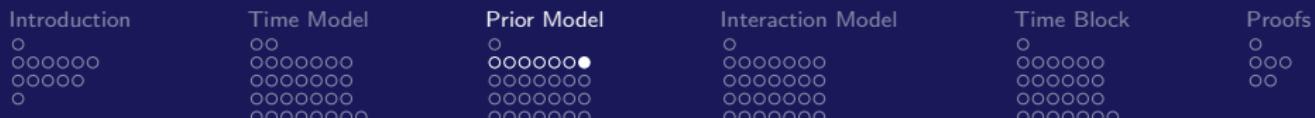


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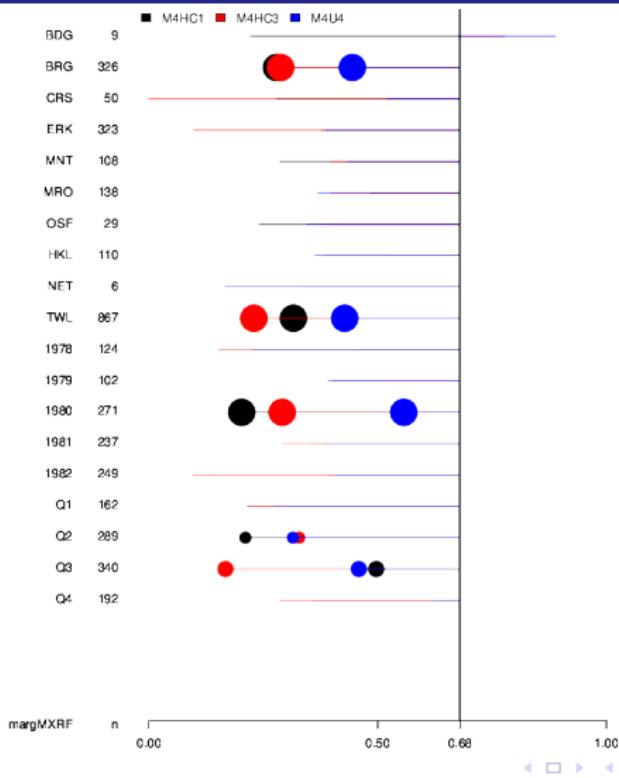


MCAT 250





MCAT 250



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

Introduction

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Time Model

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Prior Model

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Interaction Model

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Proofs

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MCAT 253

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

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A 4x3 grid of 12 small circles, arranged in four rows and three columns.

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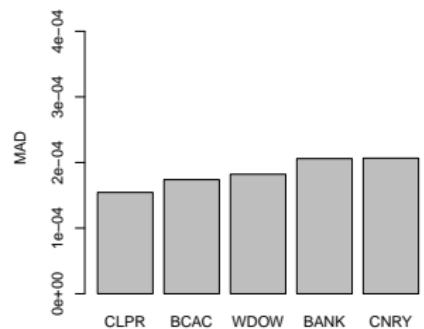
MCAT 253

M4HC1

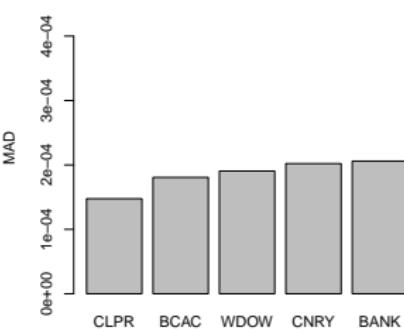
M4HC3

M4U4

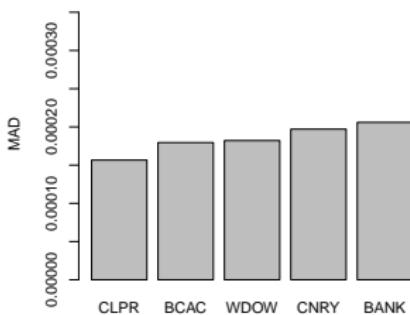
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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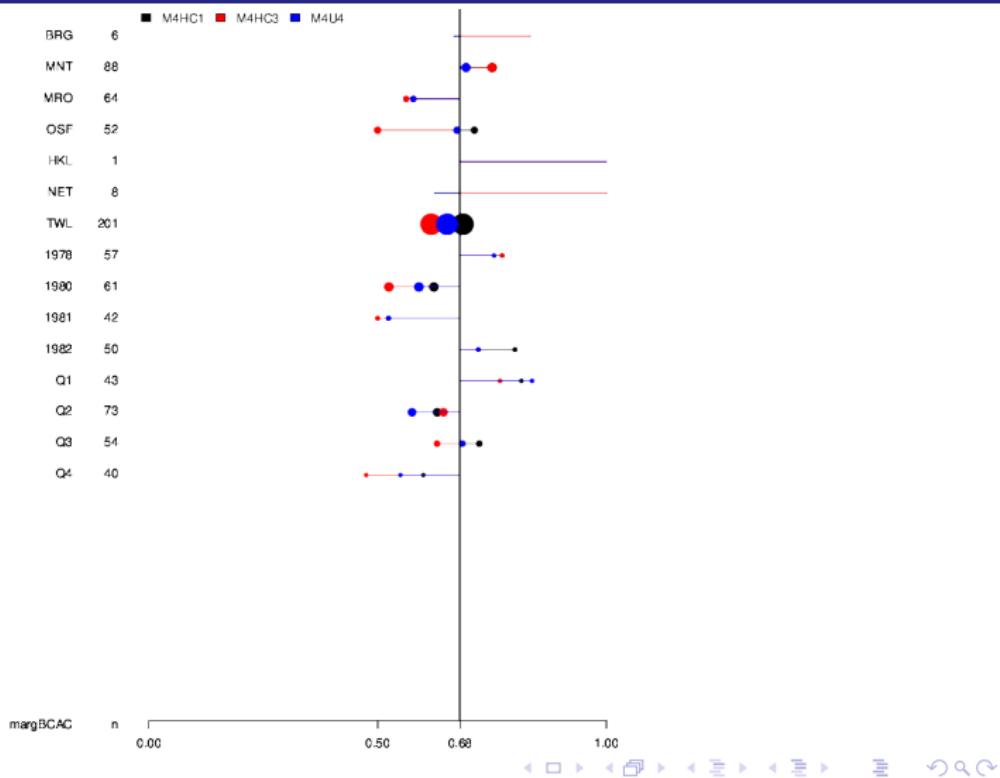
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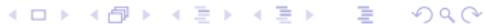
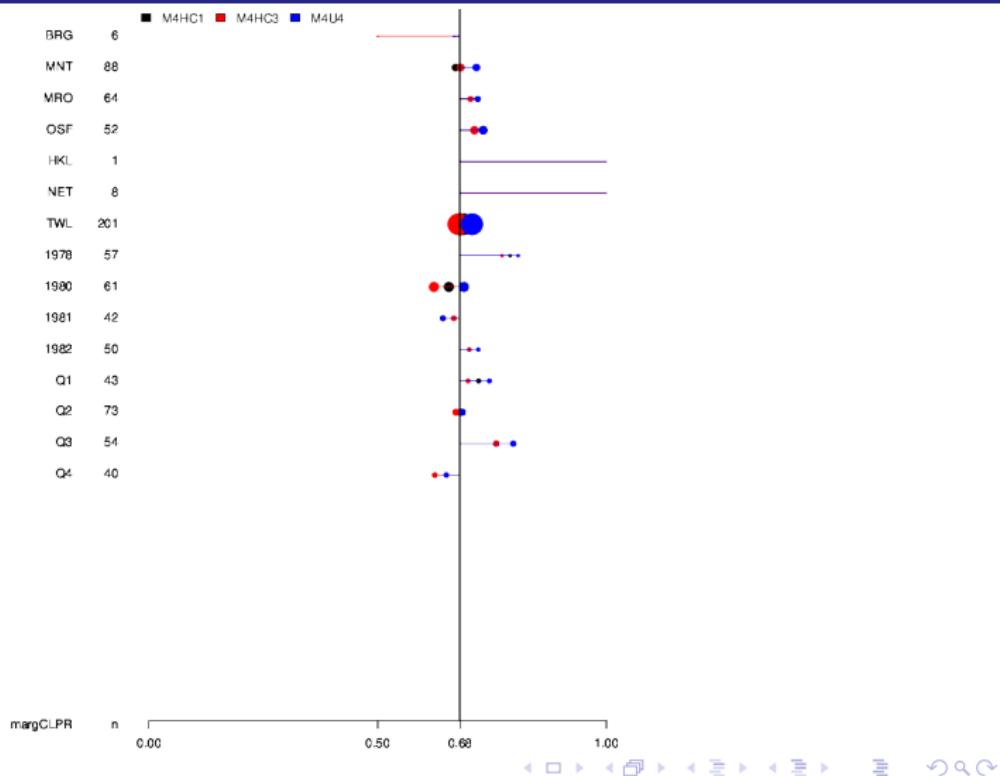
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MCAT 253





MCAT 253



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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

Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

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Proofs

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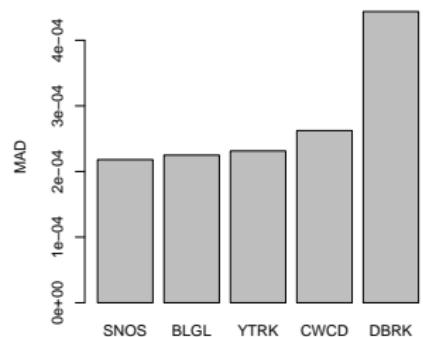
MCAT 253

M4HC1

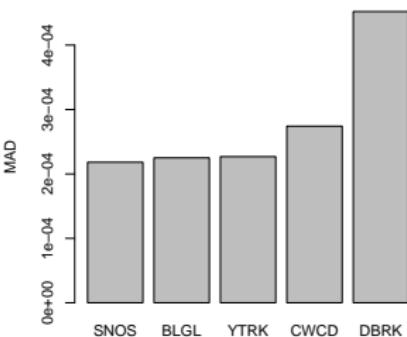
M4HC3

M4U4

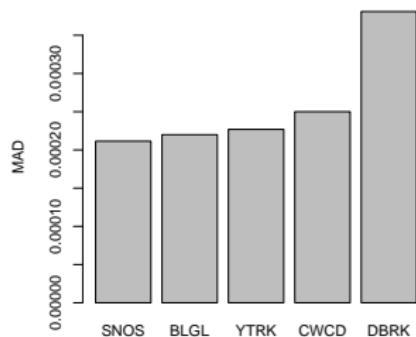
MAD Ordered by Species



MAD Ordered by Species



MAD Ordered by Species



Combined

Introduction

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Time Model

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Prior Model

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Interaction Model

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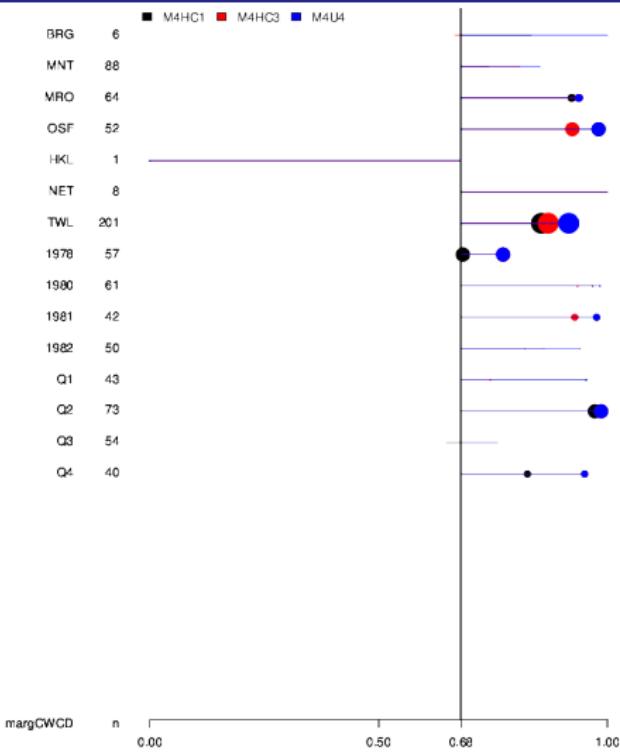
Time Block

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Proofs

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MCAT 253



Introduction

Time Model

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Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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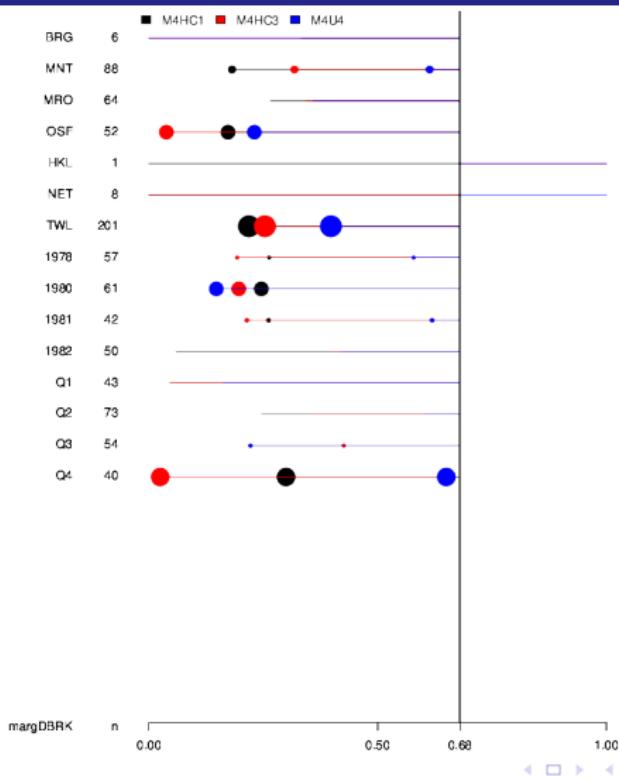
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MCAT 253



Introduction

Time Model

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Time Block

Proofs

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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MCAT 269

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

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

A 4x4 grid of 16 small circles, arranged in four rows and four columns.

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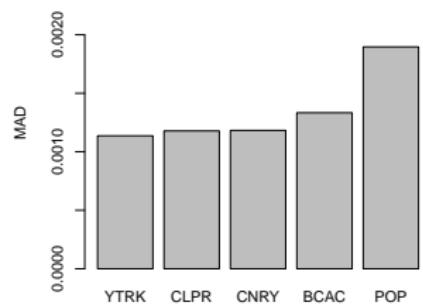
MCAT 269

M4HC1

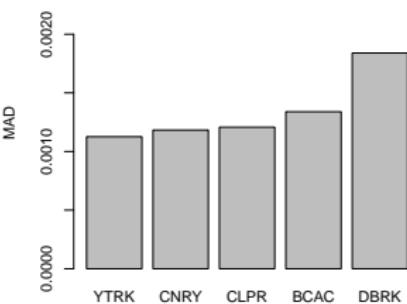
M4HC3

M4U4

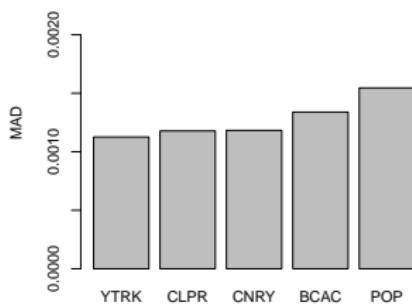
MAD Ordered by Species



MAD Ordered by Species



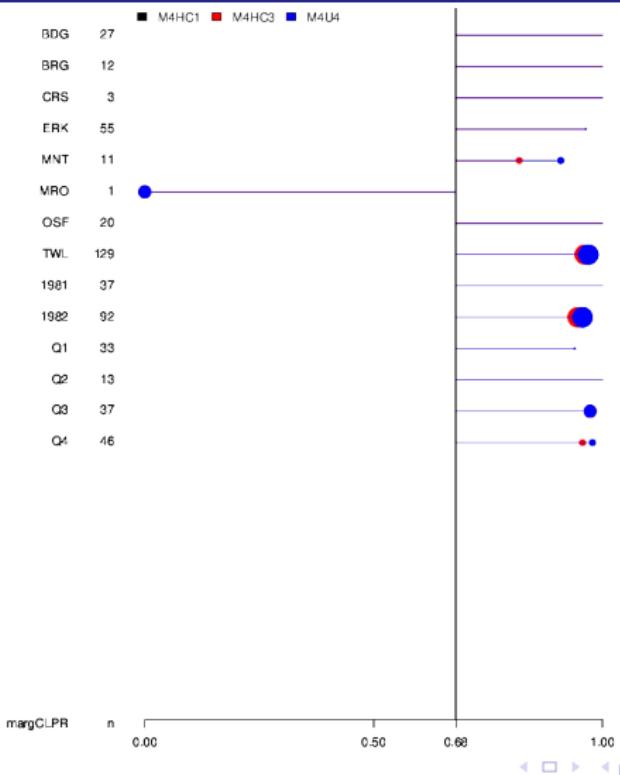
MAD Ordered by Species



Combined



MCAT 269



Introduction

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Time Model

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Prior Model

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Interaction Model

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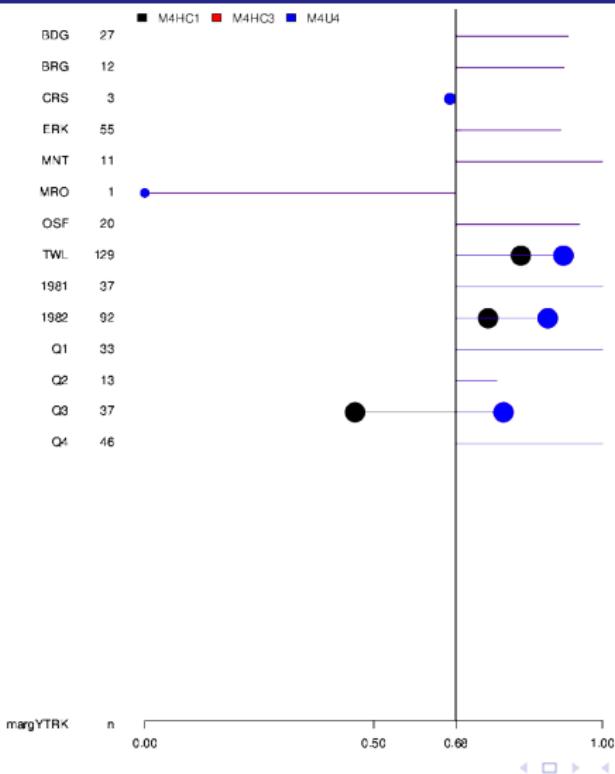
Time Block

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Proofs

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MCAT 269

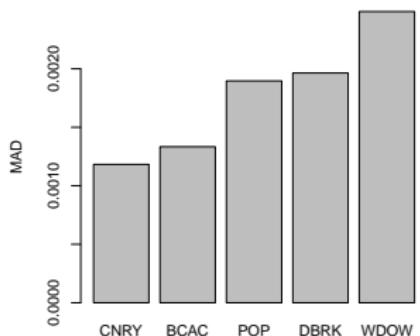


M4HC1

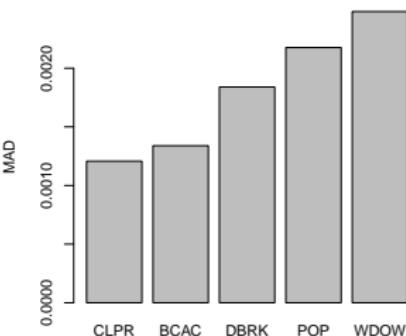
M4HC3

M4U4

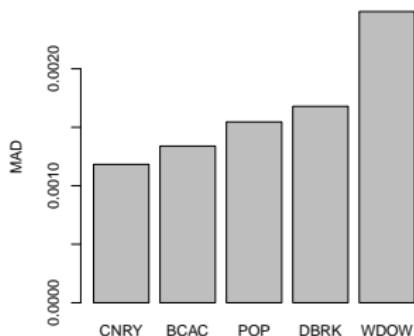
MAD Ordered by Species



MAD Ordered by Species



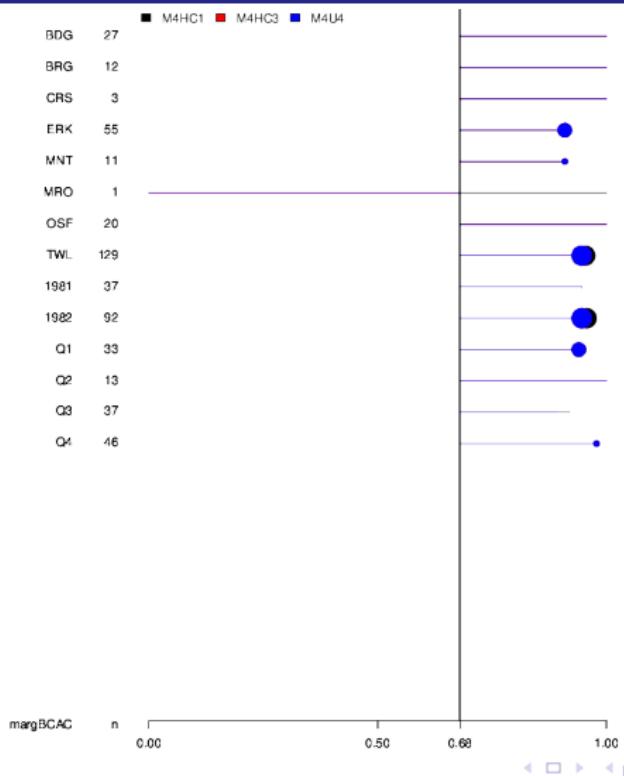
MAD Ordered by Species



Combined



MCAT 269



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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

Introduction

Time Model

Prior Model

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Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

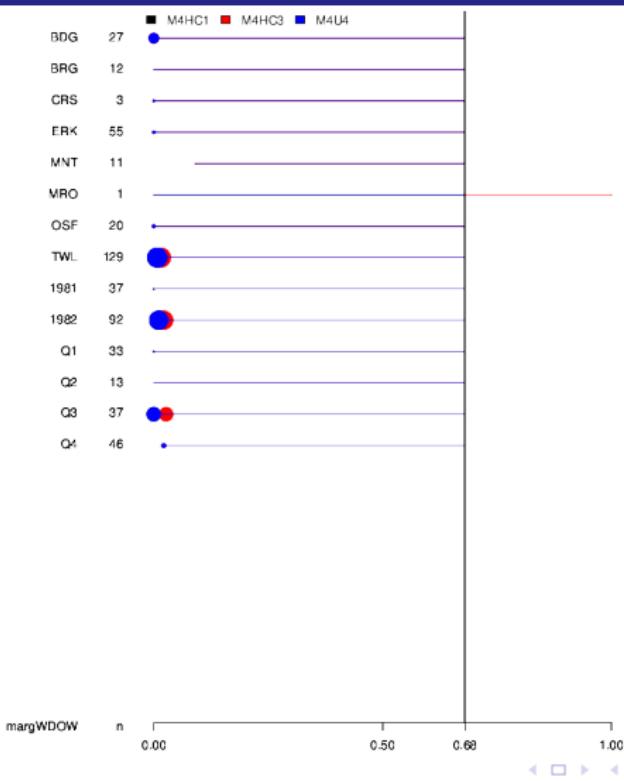
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MCAT 269



Introduction

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Prior Model

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Interaction Model

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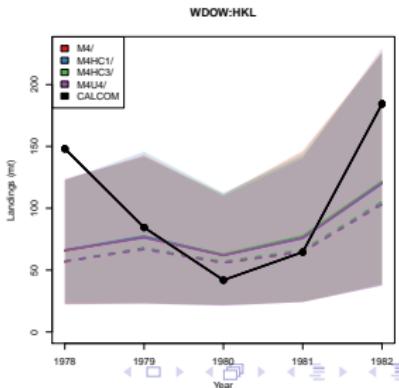
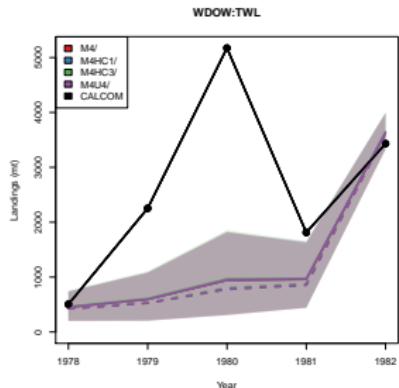
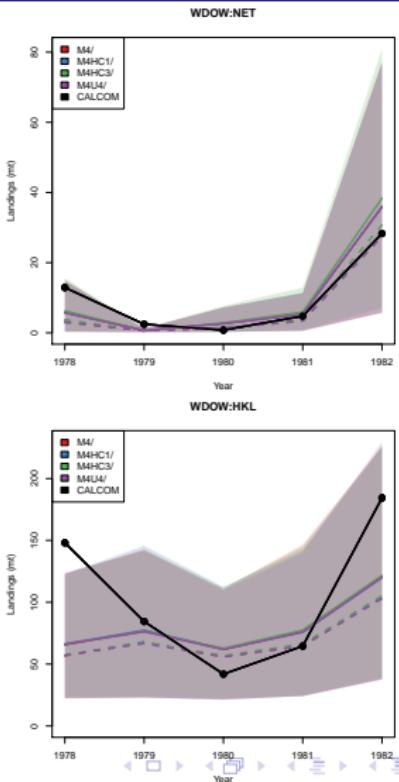
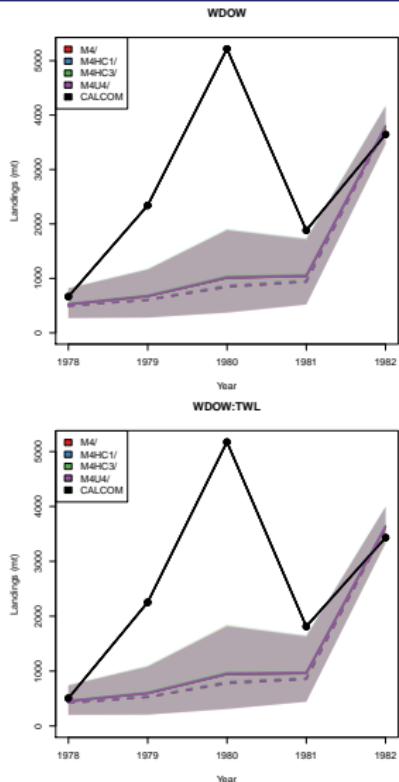
Time Block

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Proofs

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Landings Sensitivity



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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



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Time Model

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Prior Model

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Interaction Model

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Time Block

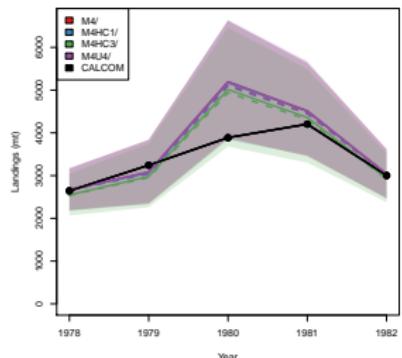
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Proofs

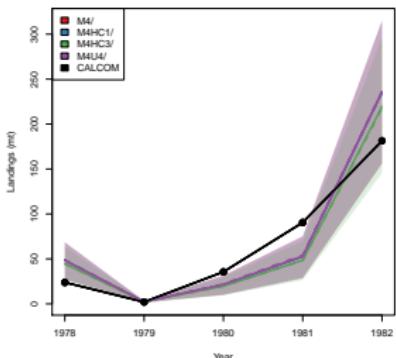
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Landings Sensitivity

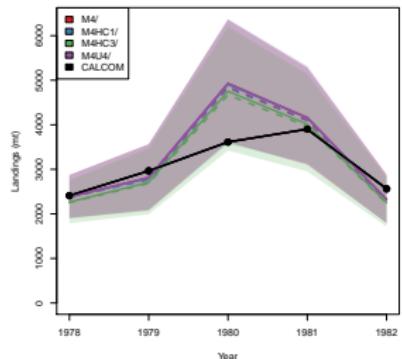
BCAC



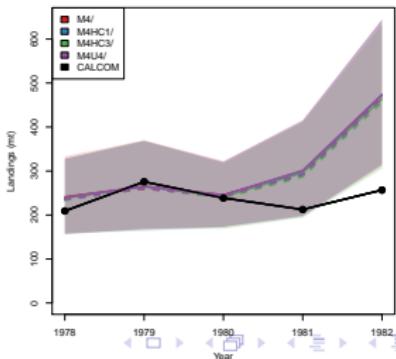
BCAC:NET



BCAC:TWL



BCAC:HKL



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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



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Time Model

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Interaction Model

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Time Block

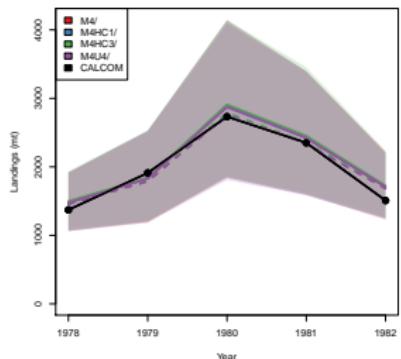
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Proofs

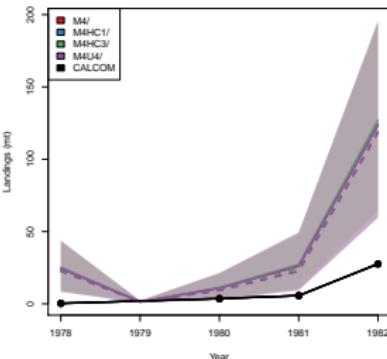
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Landings Sensitivity

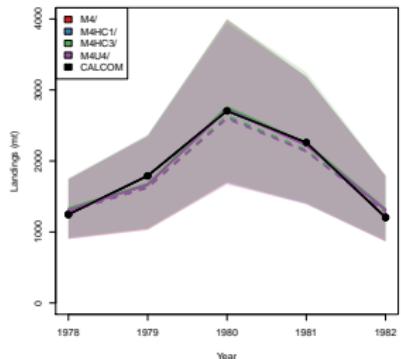
CLPR



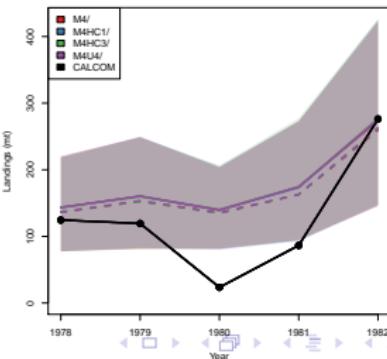
CLPR:NET



CLPR:TWL



CLPR:HKL



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



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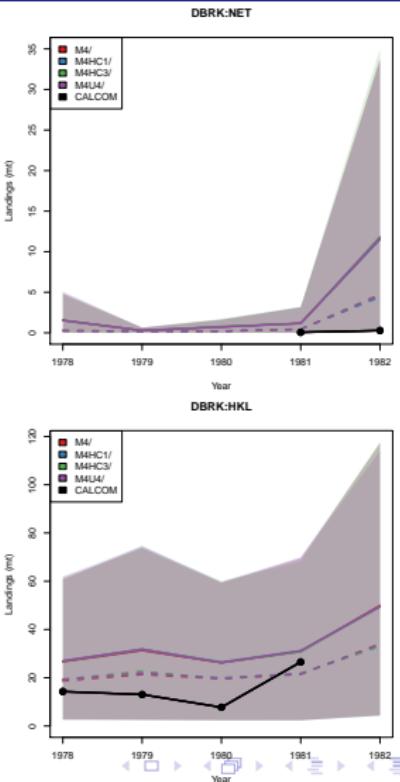
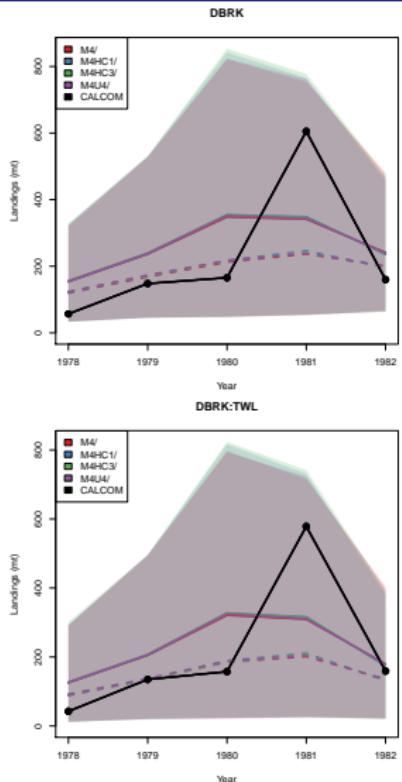
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A 5x5 grid of 25 small circles, arranged in five rows and five columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

Landings Sensitivity



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

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Interaction Model

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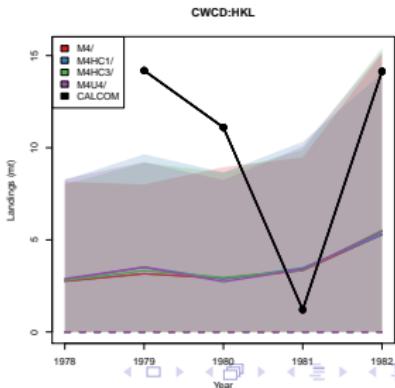
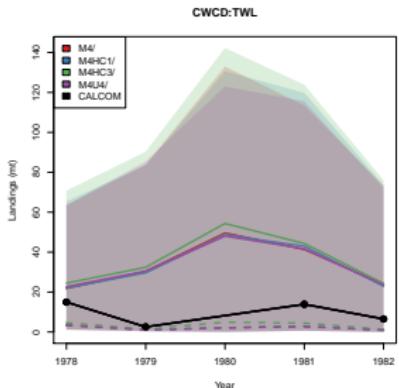
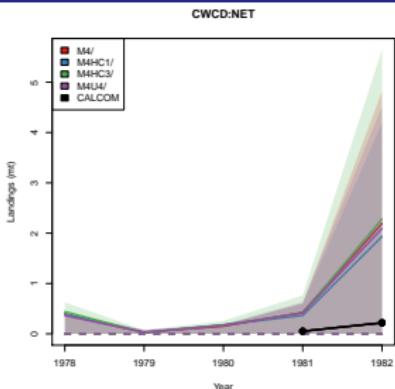
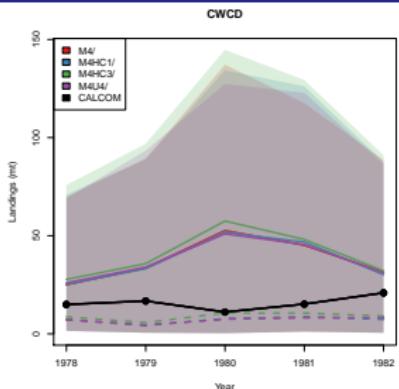
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Proofs

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Landings Sensitivity



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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



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Time Model

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Prior Model

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Interaction Model

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Time Block

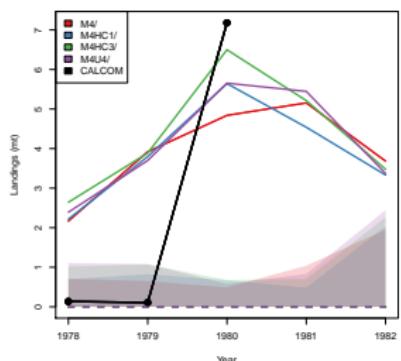
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Proofs

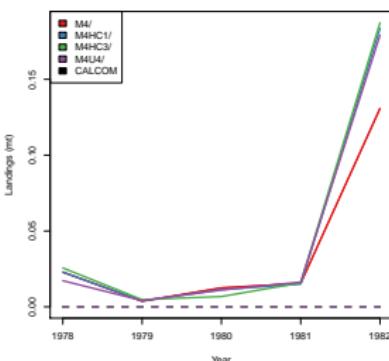
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Landings Sensitivity

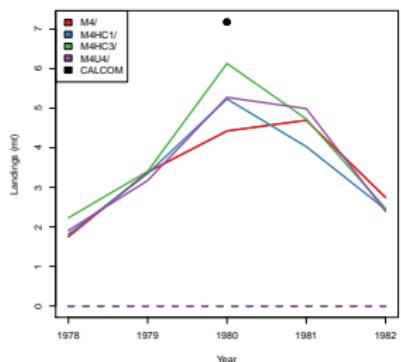
MXRF



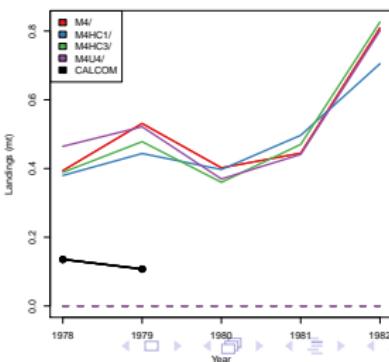
MXRF.NET



MXRF:TWL



MXRF:HKL



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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.

Introduction

Time Model

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Interaction Model

Time Block

Proofs

1

A 4x4 grid of 16 small circles, arranged in four rows and four columns.

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MCAT 250

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

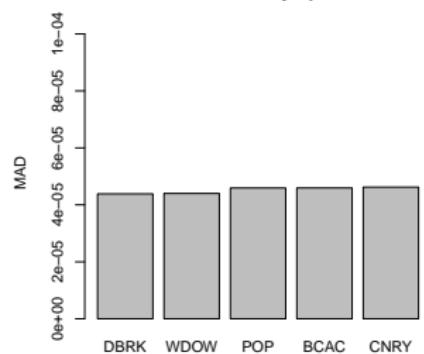
MCAT 250

M4

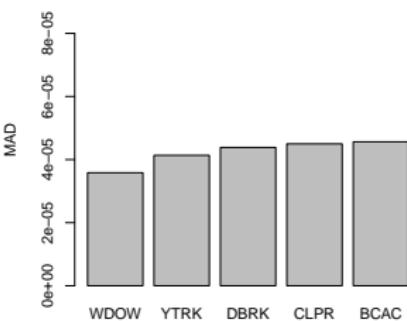
M4SG

M4SP

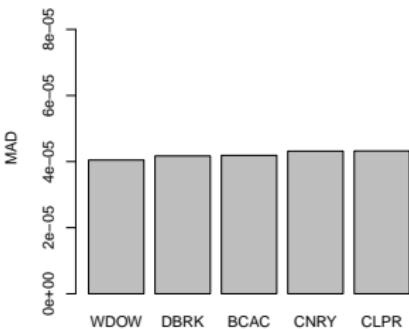
MAD Ordered by Species



MAD Ordered by Species



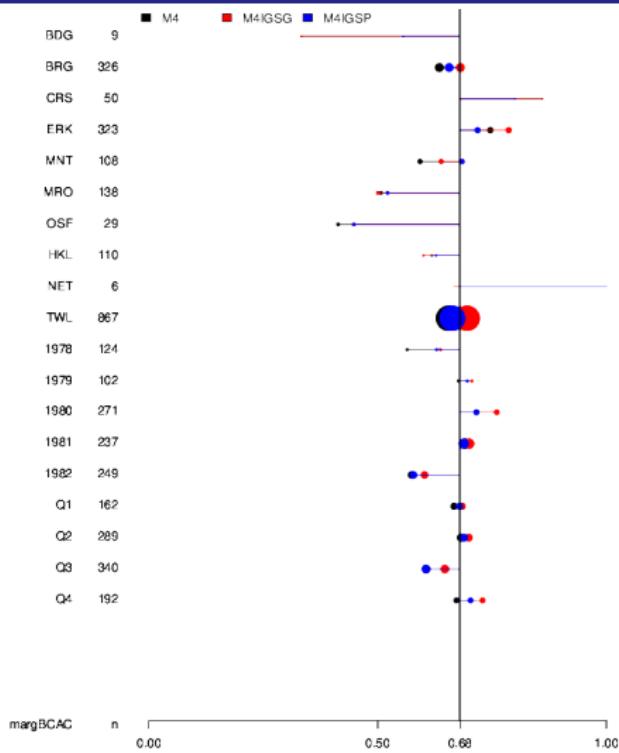
MAD Ordered by Species



Combined



MCAT 250

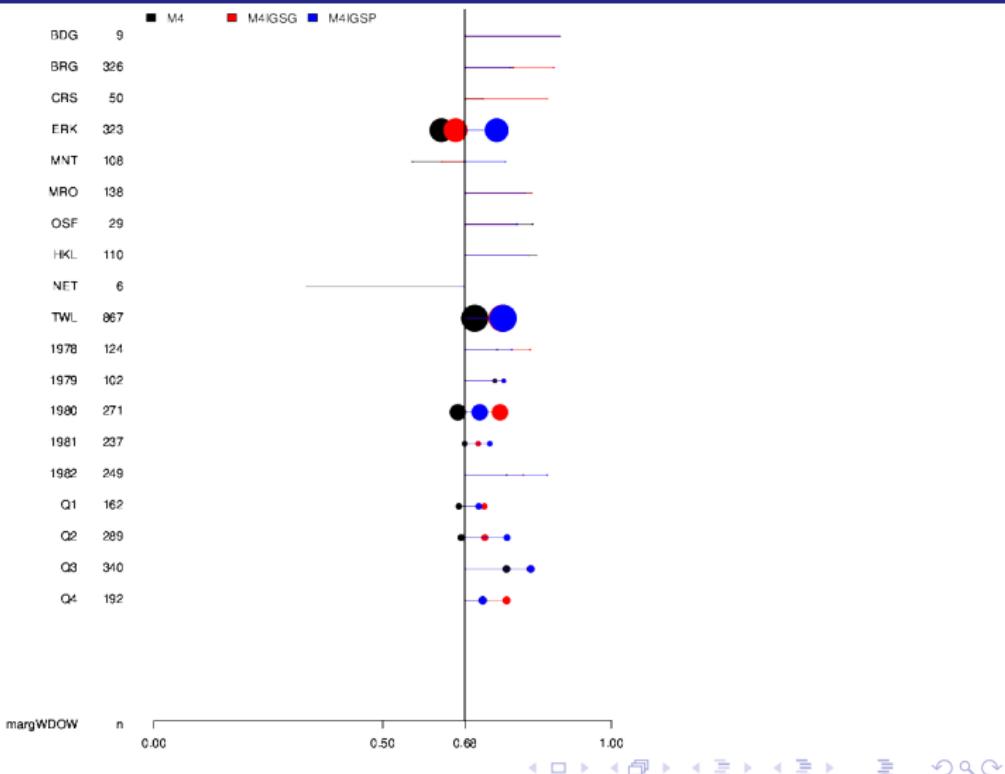


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Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries.



MCAT 250

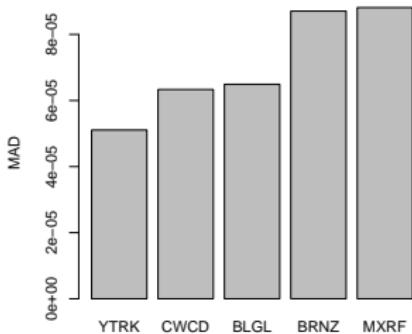
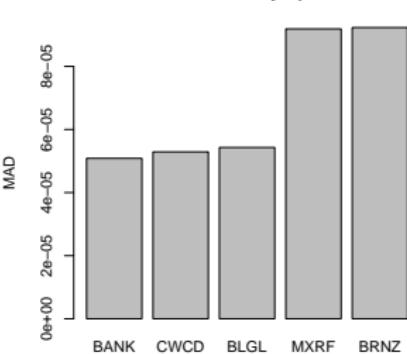
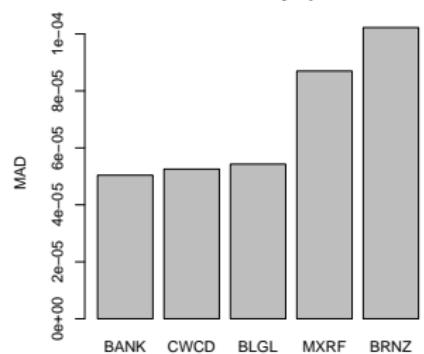


MCAT 250

M4

M4SG

M4SP



Combined

Introduction

Time Model

Prior Model

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Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

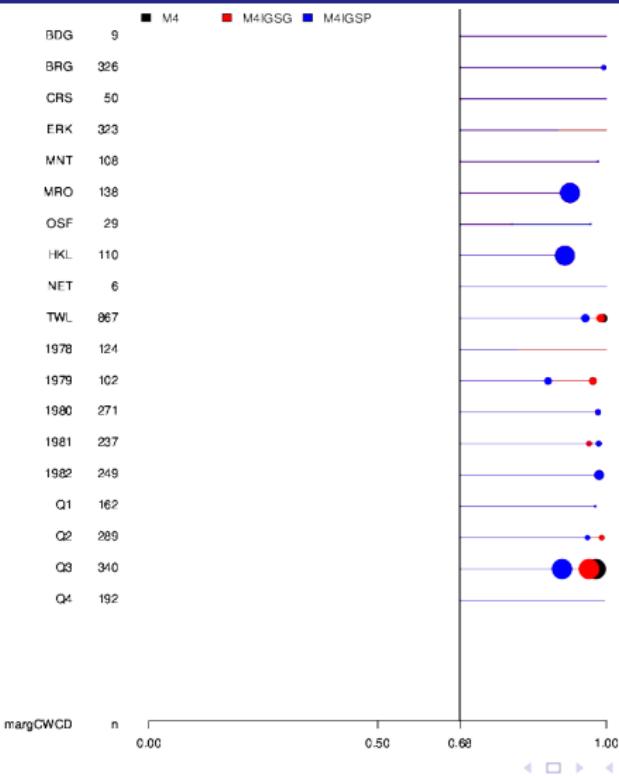
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MCAT 250



Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x4 grid of 16 small circles. The bottom-left circle is shaded dark grey, while the others are white.

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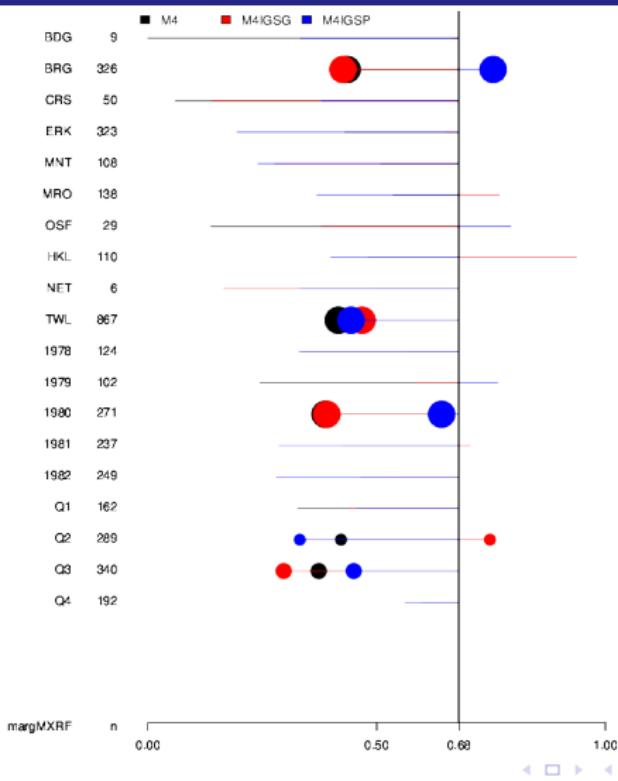
A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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MCAT 250



Introduction

Time Model

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Time Block

Proofs

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A 4x4 grid of 16 small circles, arranged in four rows and four columns.

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MCAT 253

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

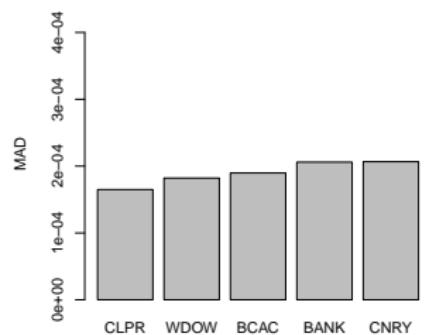
MCAT 253

M4

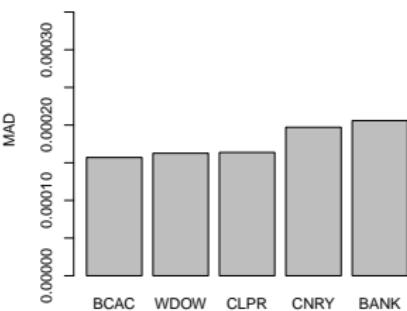
M4SG

M4SP

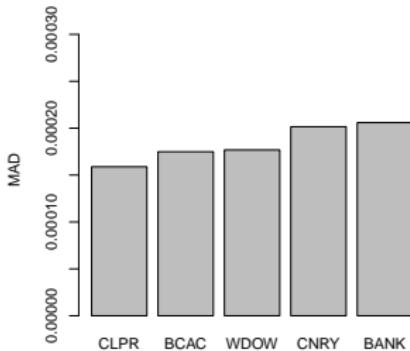
MAD Ordered by Species



MAD Ordered by Species



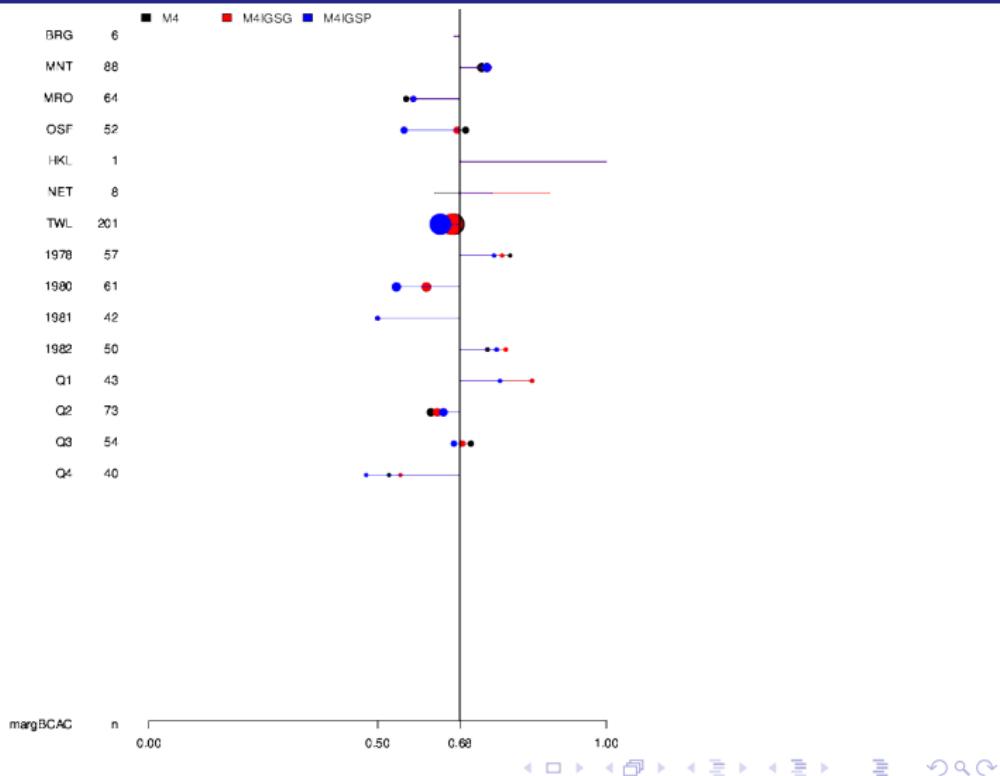
MAD Ordered by Species



Combined

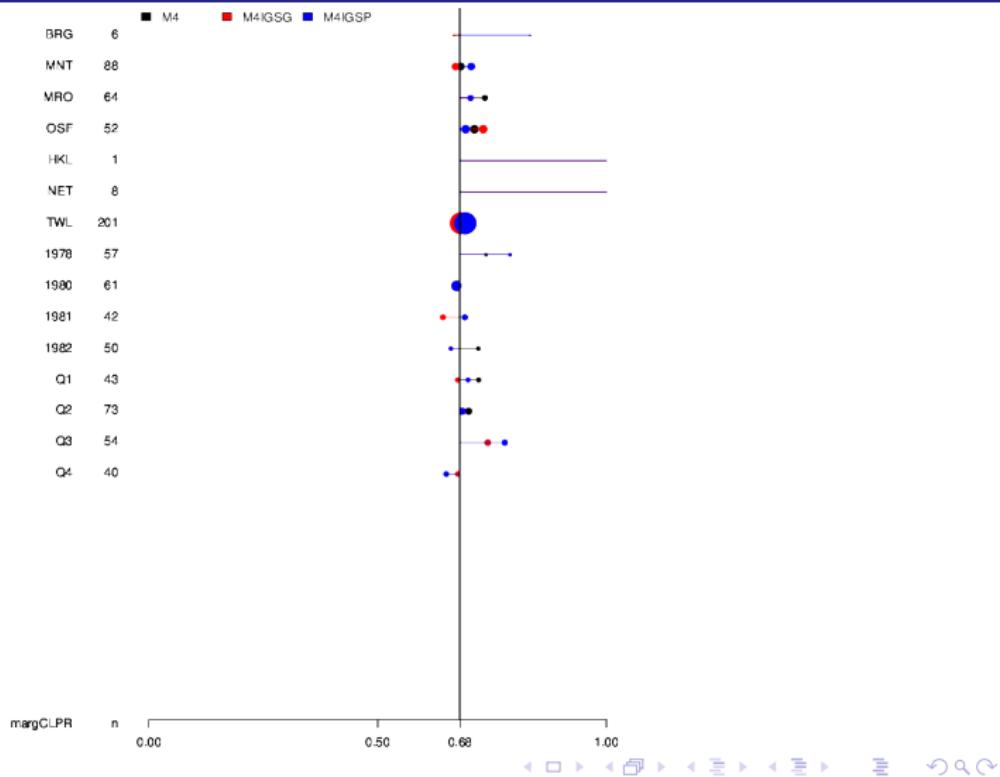


MCAT 253





MCAT 253

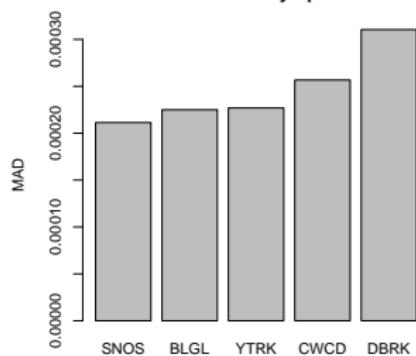
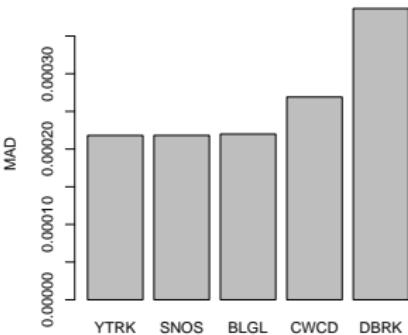
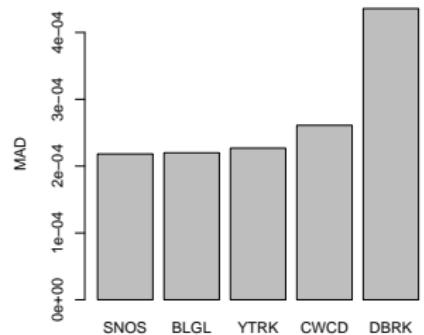


MCAT 253

M4

M4SG

M4SP



Combined

Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

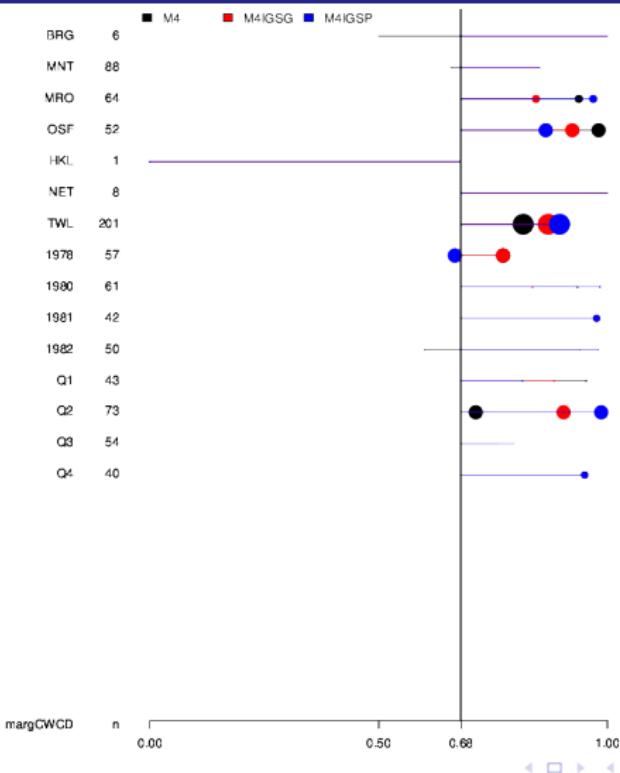
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MCAT 253



Introduction

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Time Model

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Prior Model

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Interaction Model

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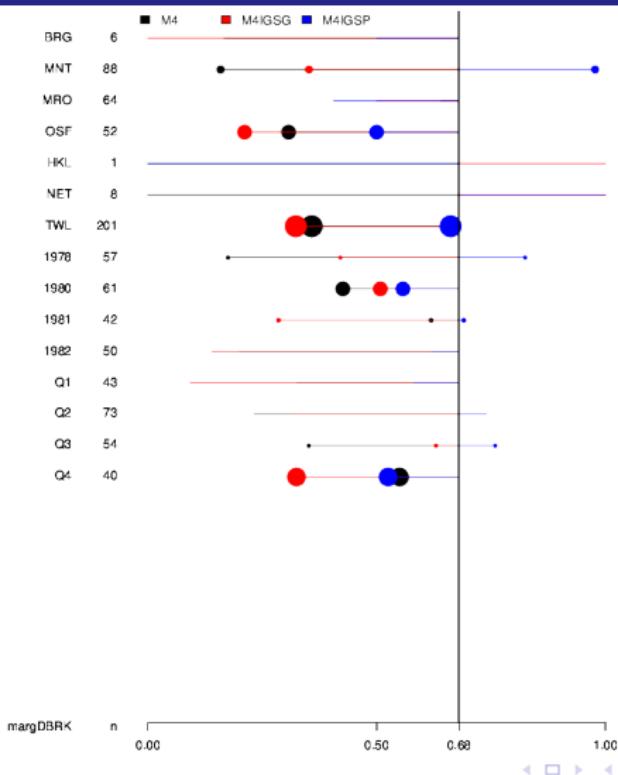
Time Block

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Proofs

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MCAT 253



Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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MCAT 269

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

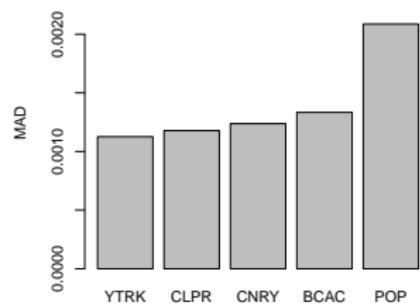
MCAT 269

M4

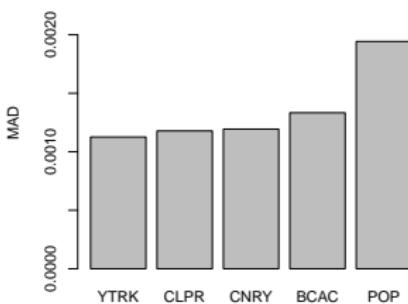
M4SG

M4SP

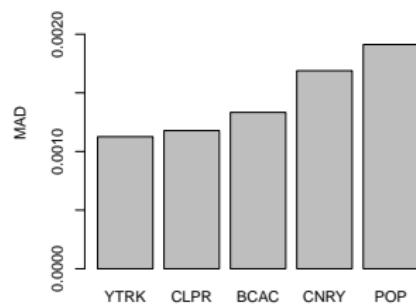
MAD Ordered by Species



MAD Ordered by Species



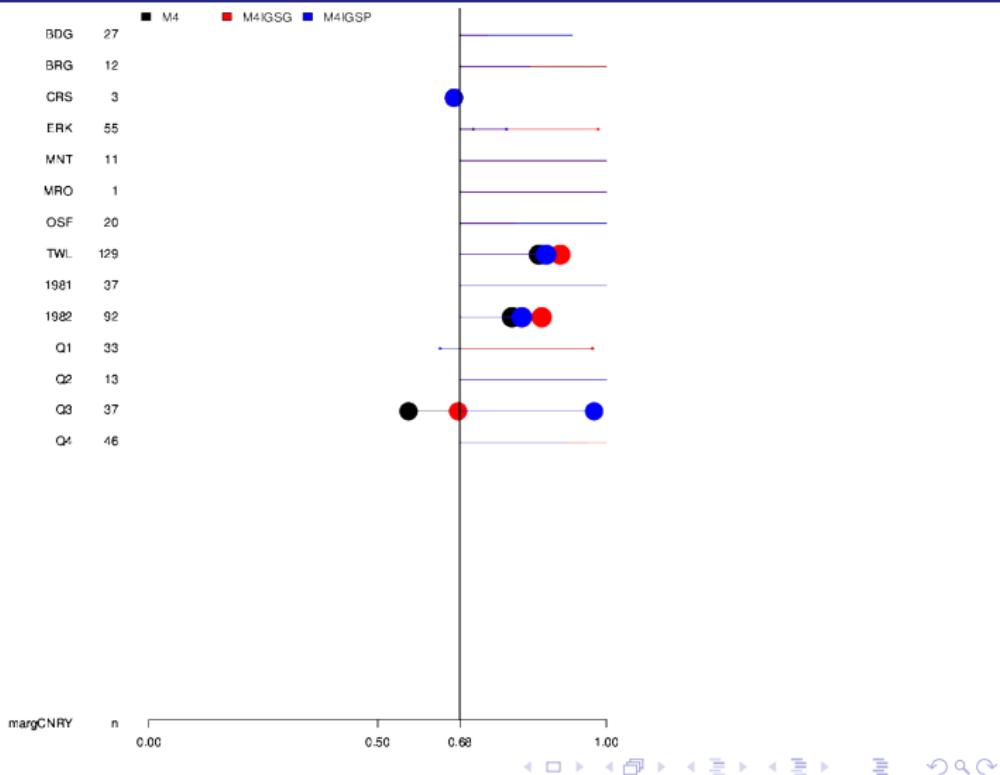
MAD Ordered by Species



Combined



MCAT 269

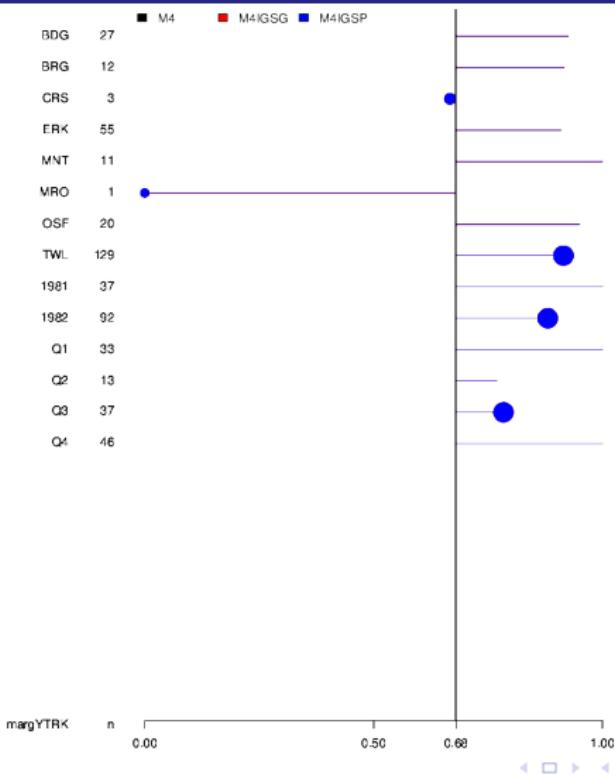


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Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries.



MCAT 269



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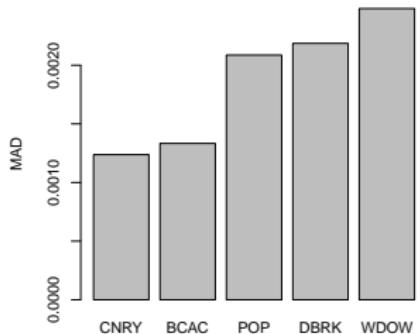
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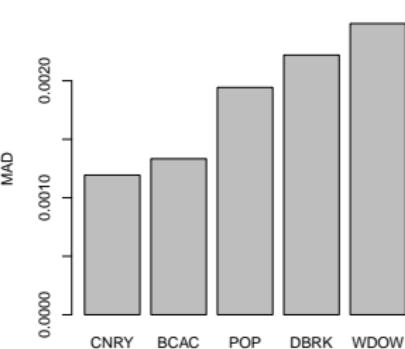
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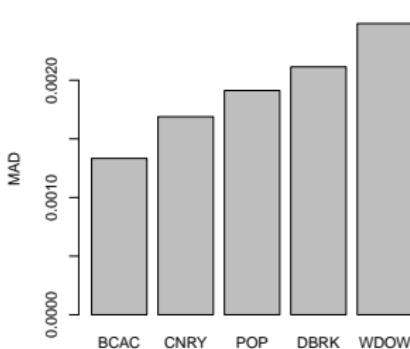
MAD Ordered by Species



MAD Ordered by Species



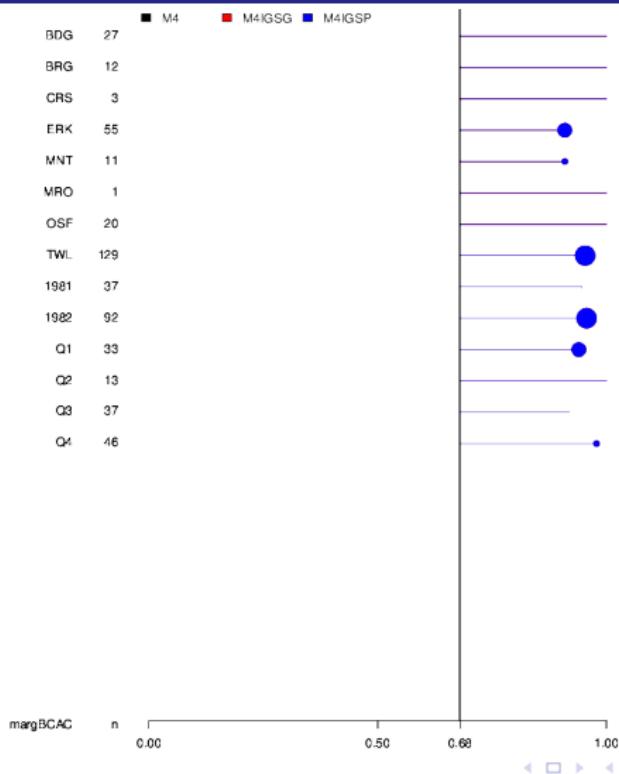
MAD Ordered by Species



Combined

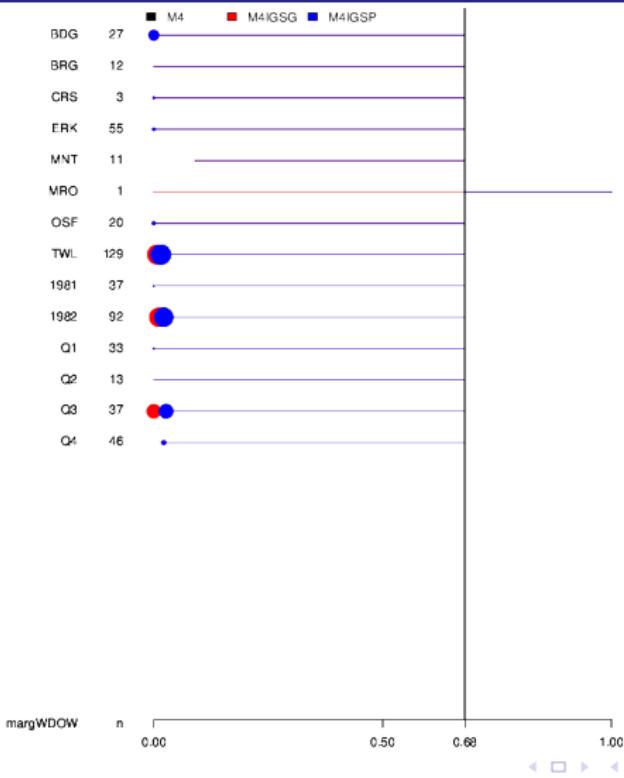


MCAT 269





MCAT 269



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

Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

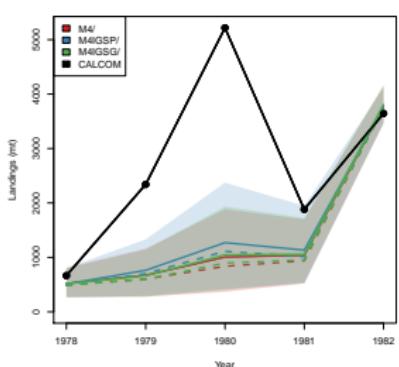
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Proofs

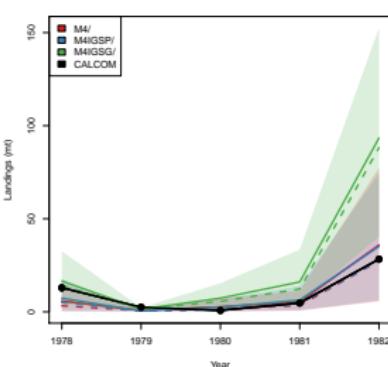
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Landings Sensitivity

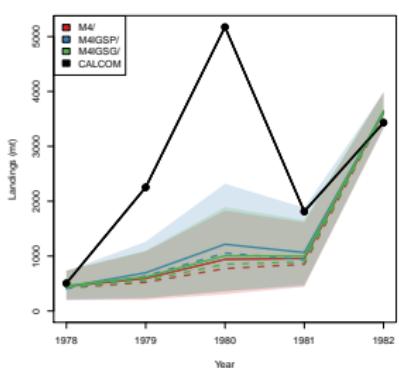
WDOW



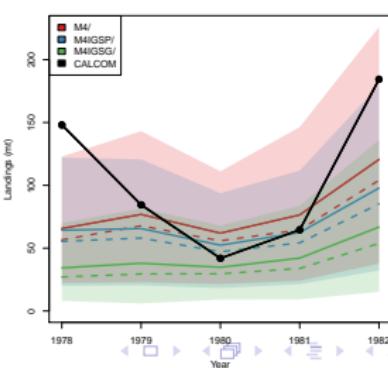
WDOW:NET



WDOW:TWL



WDOW:HKL



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

Introduction

Time Model

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Proofs

A 4x3 grid of 12 small circles, arranged in four rows and three columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

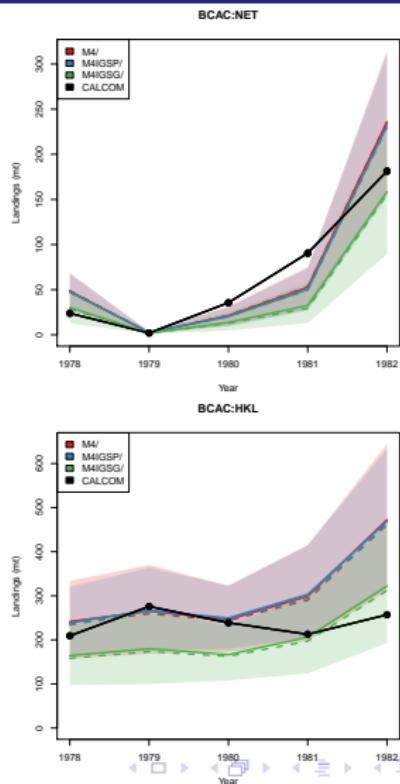
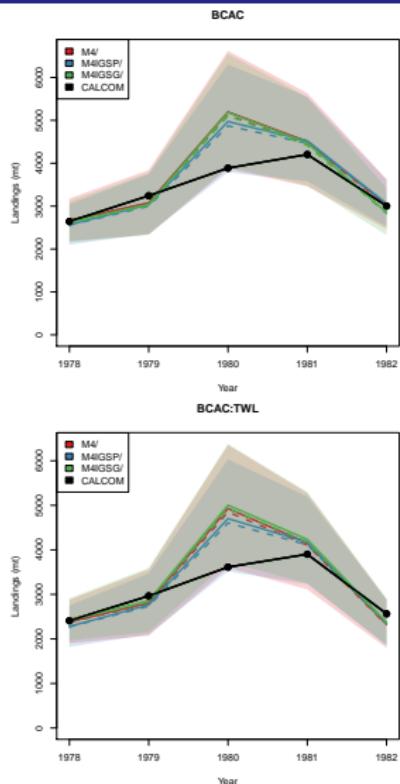
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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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Landings Sensitivity



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

Introduction

Time Model

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Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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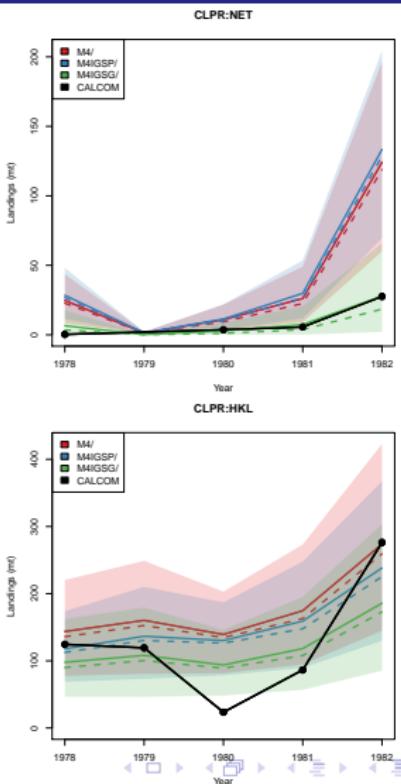
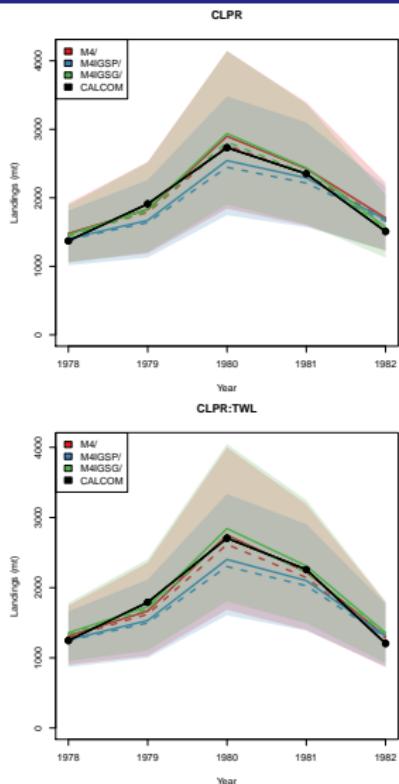
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Landings Sensitivity



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Time Model

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Prior Model

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Interaction Model

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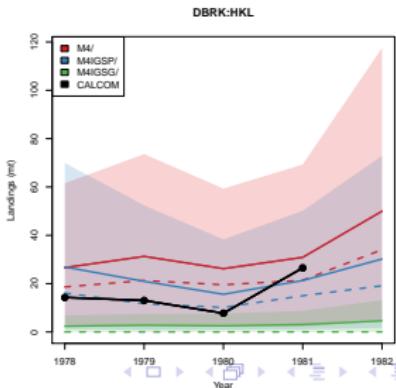
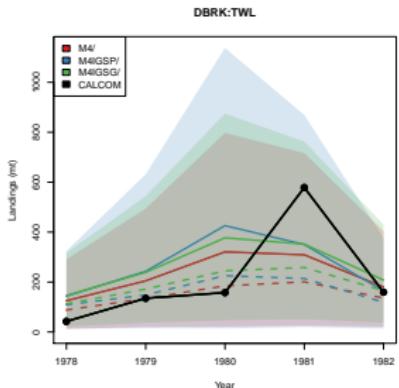
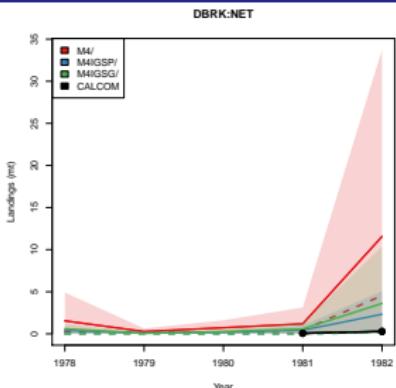
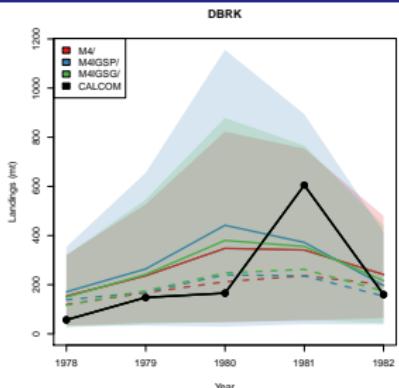
Time Block

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Proofs

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Landings Sensitivity



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Time Model

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Prior Model

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Interaction Model

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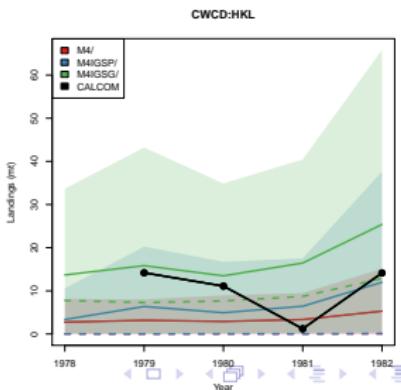
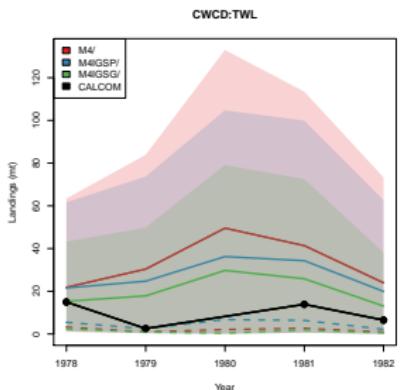
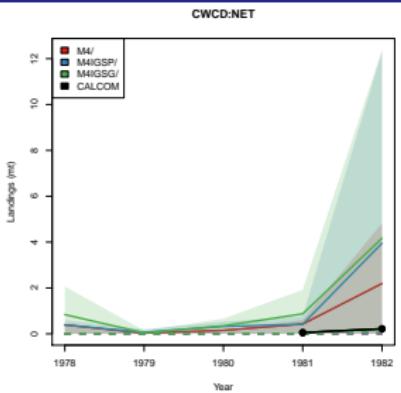
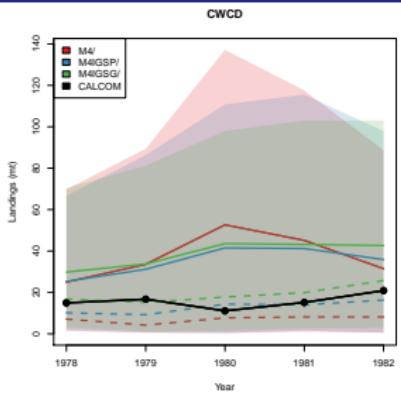
Time Block

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Proofs

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Landings Sensitivity



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Time Model

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Prior Model

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Interaction Model

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Time Block

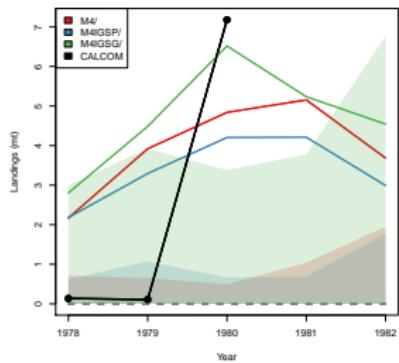
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Proofs

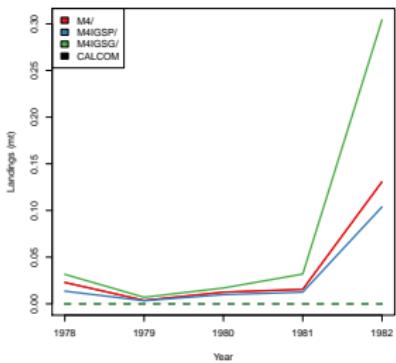
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Landings Sensitivity

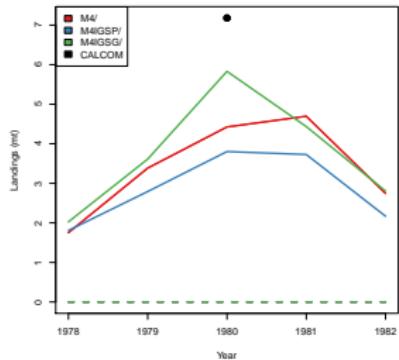
MXRF



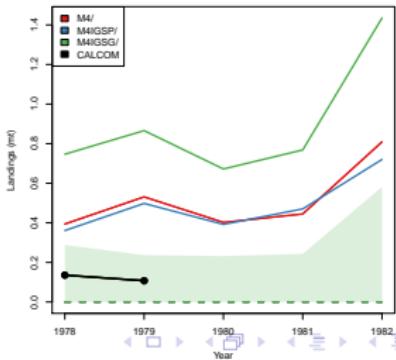
MXRF.NET



MXRF:TWL



MXRF:HKL



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



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.

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.

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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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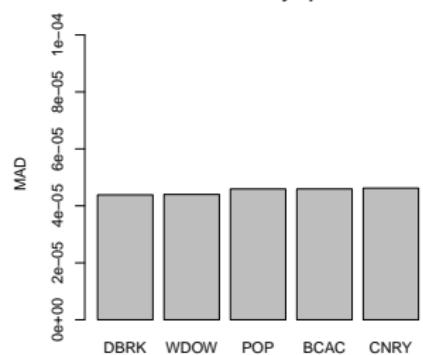
MCAT 250

78-82

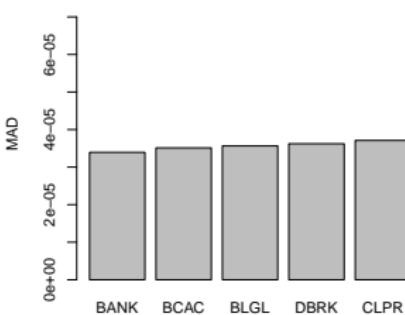
78-83

78-84

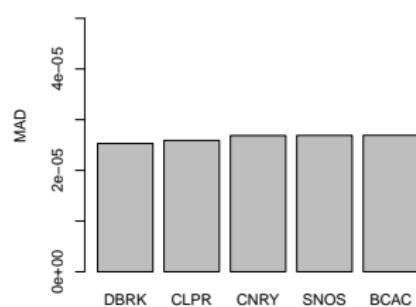
MAD Ordered by Species



MAD Ordered by Species



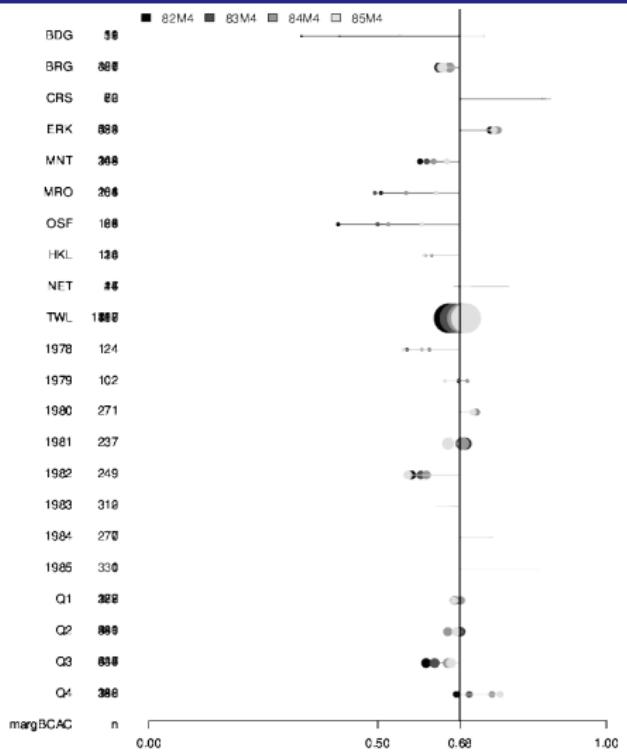
MAD Ordered by Species



Combined



MCAT 250

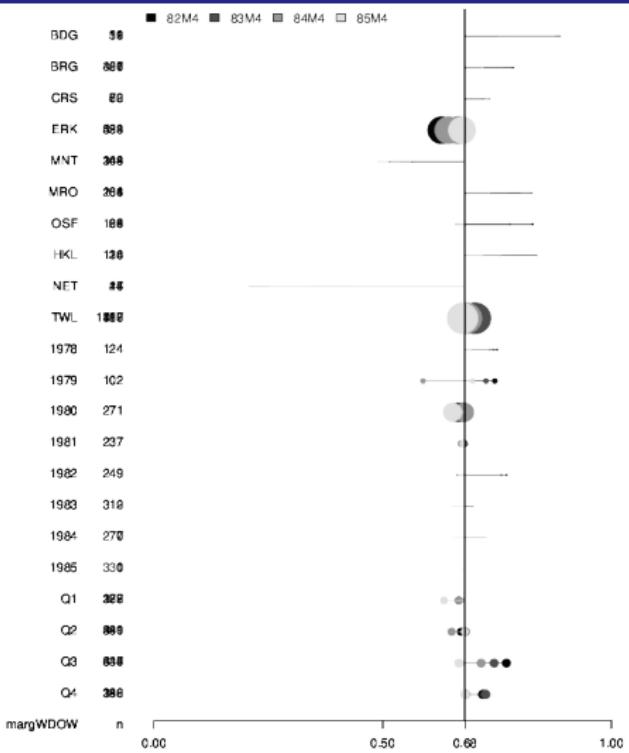


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MCAT 250



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

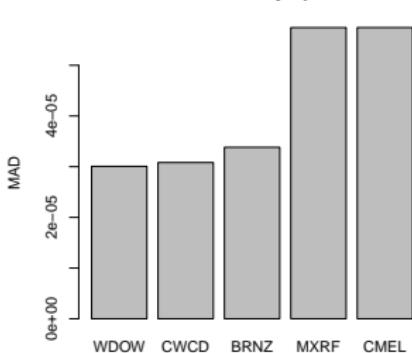
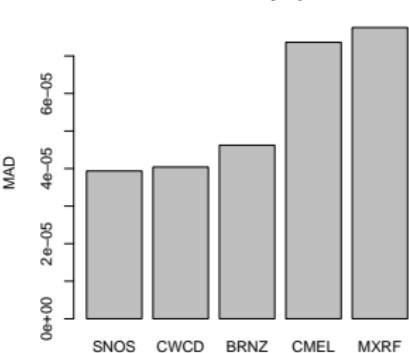
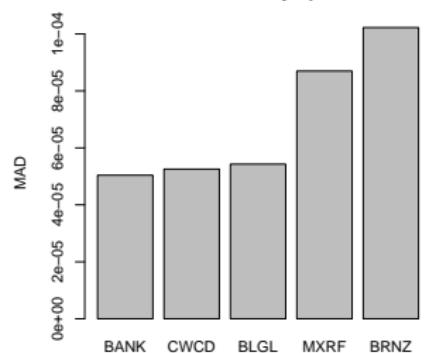
Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries.

MCAT 250

78-82

78-83

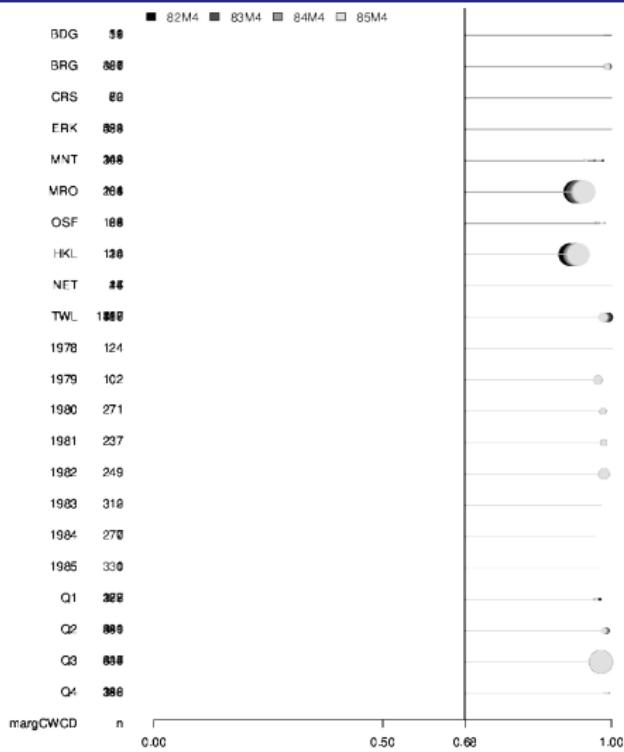
78-84



Combined



MCAT 250



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

Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

10

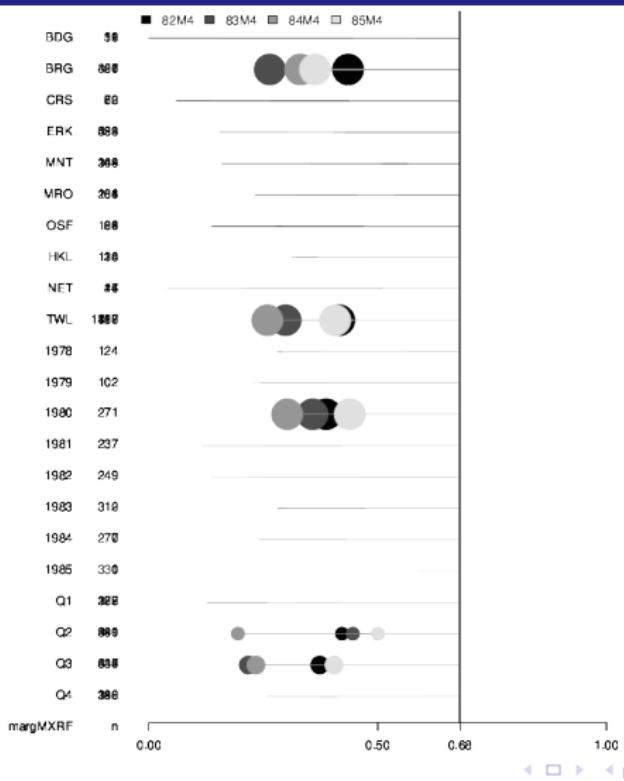
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MCAT 250



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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

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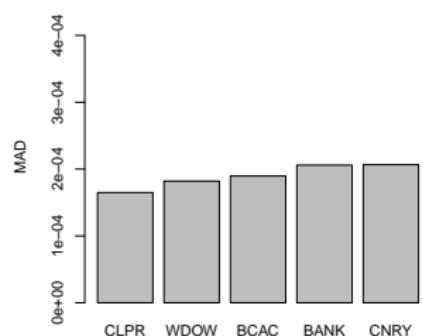
MCAT 253

78-82

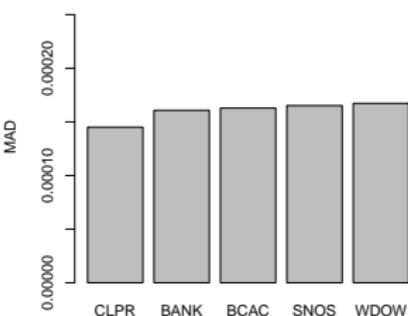
78-83

78-84

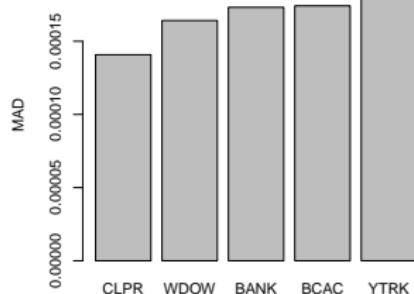
MAD Ordered by Species



MAD Ordered by Species



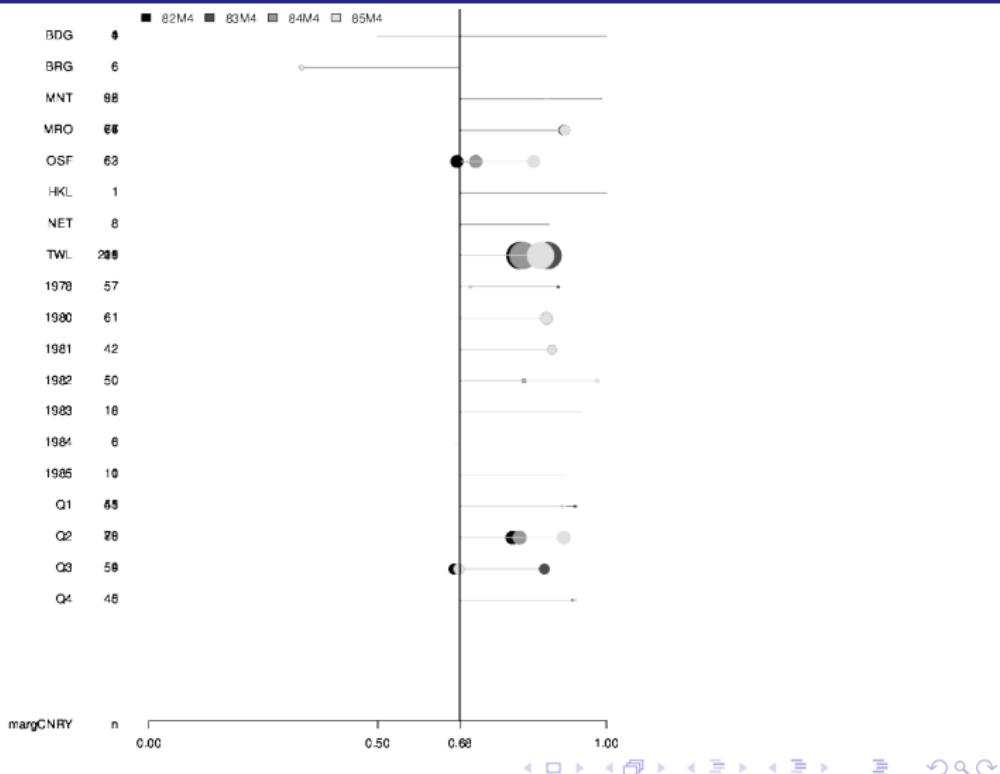
MAD Ordered by Species



Combined



MCAT 253



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

Introduction

Time Model

Prior Model

Interaction Model

Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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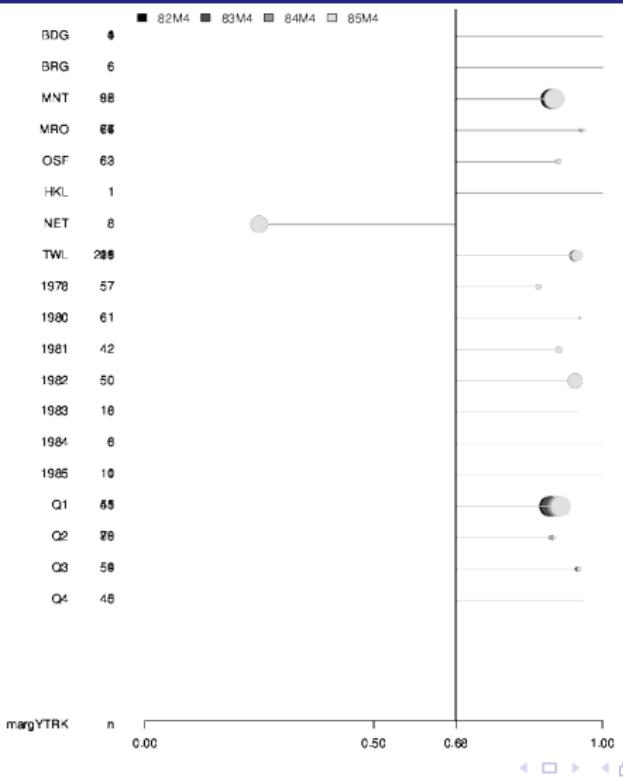
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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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MCAT 253



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A 4x6 grid of 24 small circles, arranged in four rows and six columns.

A 4x7 grid of 28 small circles, arranged in four rows and seven columns.

A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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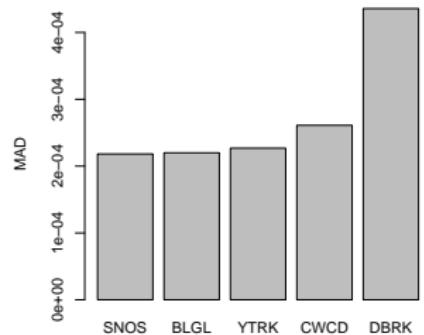
MCAT 253

78-82

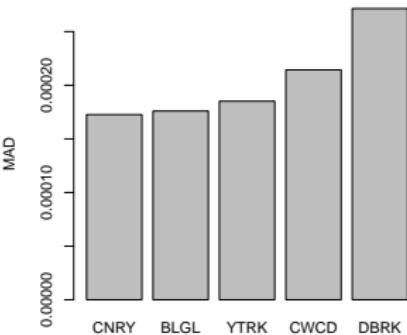
78-83

78-84

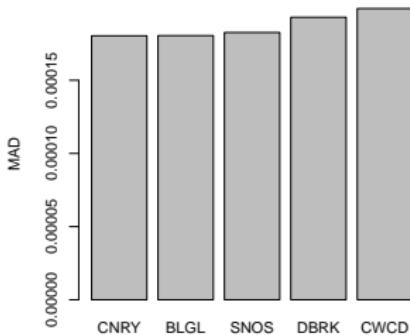
MAD Ordered by Species



MAD Ordered by Species



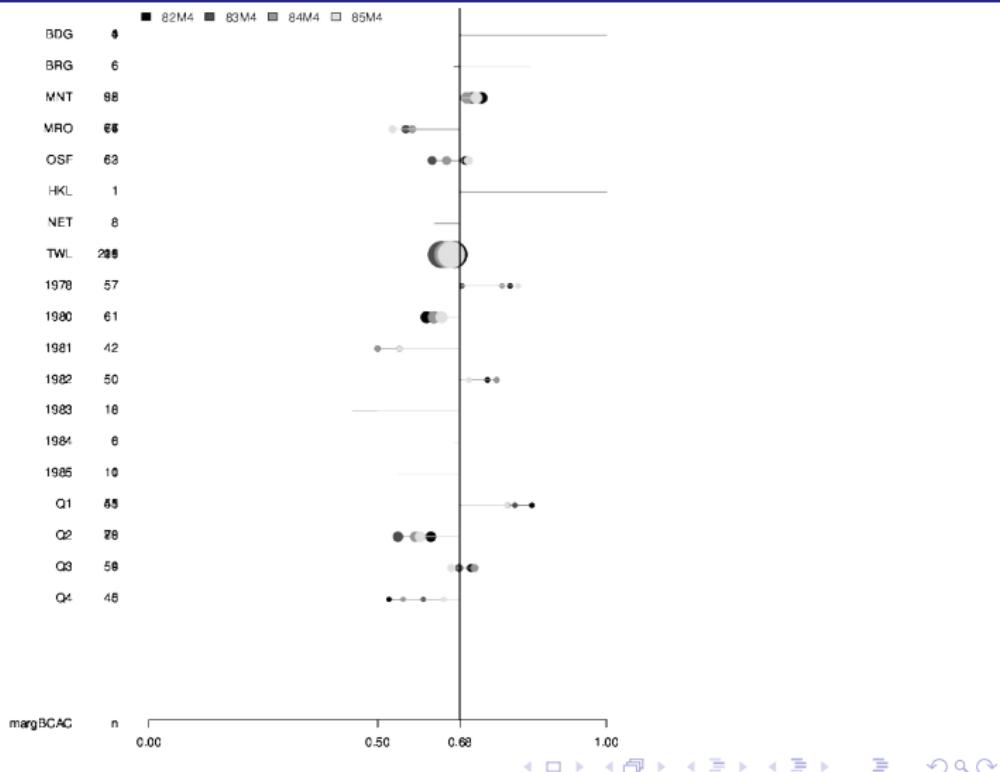
MAD Ordered by Species



Combined



MCAT 253



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Introduction

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Time Model

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Prior Model

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Interaction Model

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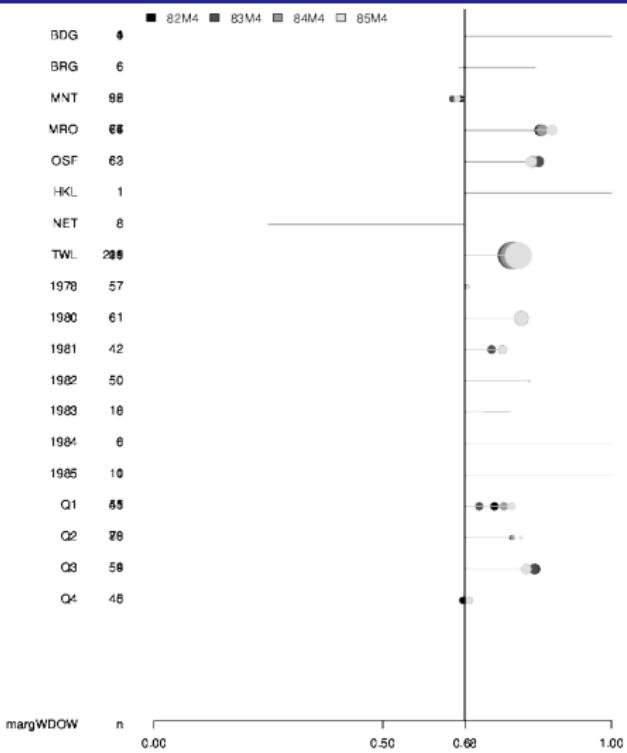
Time Block

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Proofs

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MCAT 253

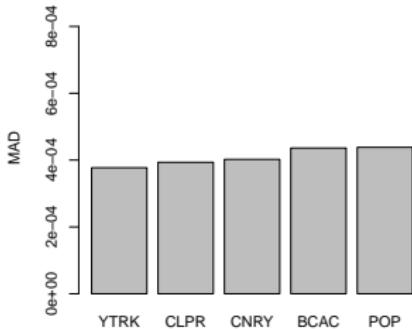
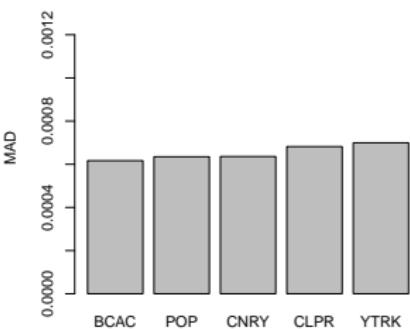
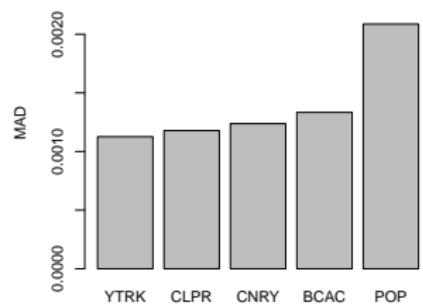


MCAT 269

78-82

78-83

78-84



Combined

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A 4x5 grid of 20 small circles, arranged in four rows and five columns.

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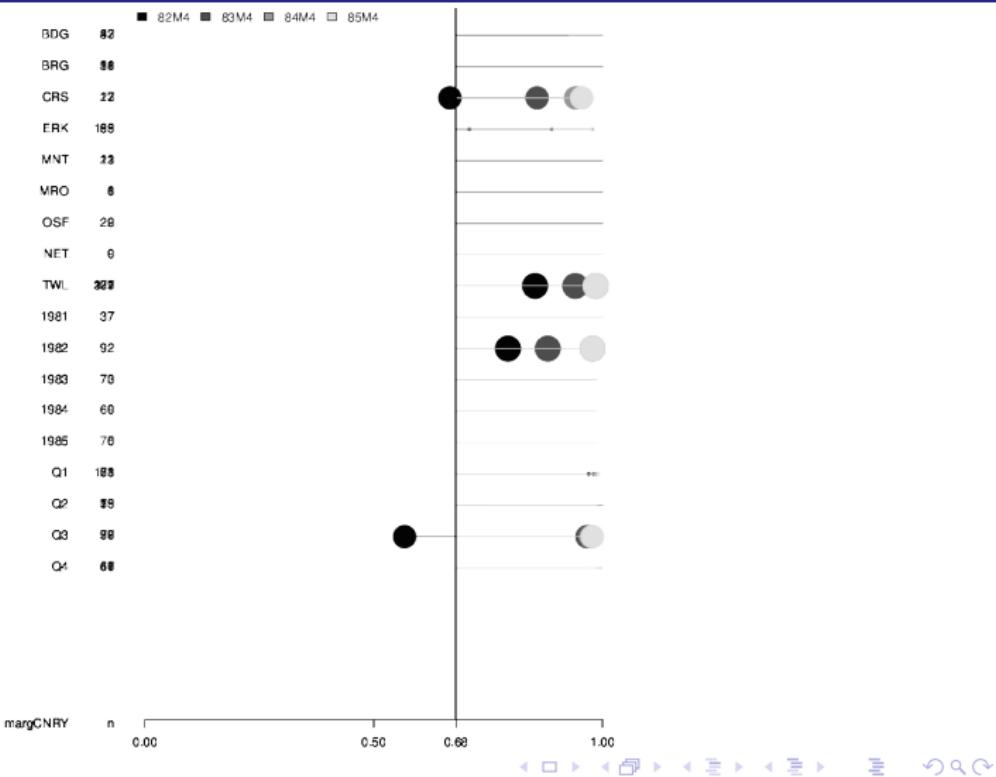
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MCAT 269



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Time Model

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Proofs

A 4x4 grid of 16 small circles. The bottom-left circle is shaded dark grey, while the others are white.

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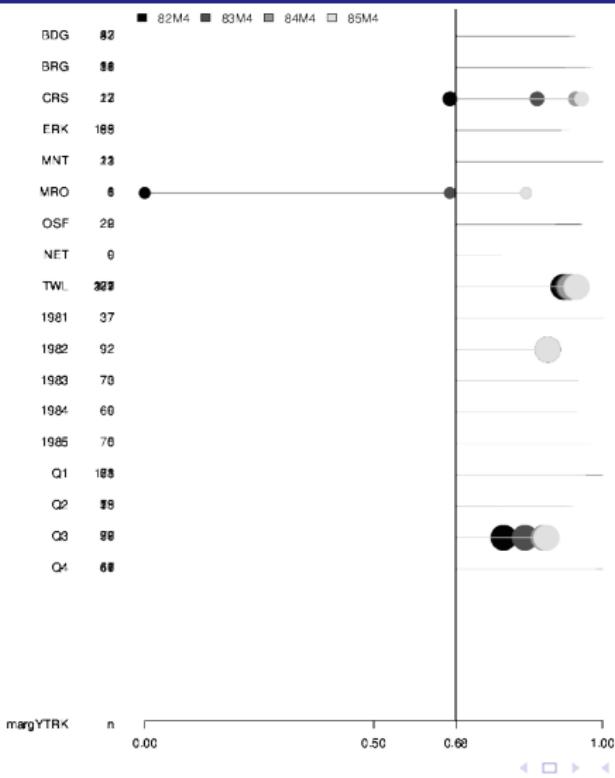
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MCAT 269

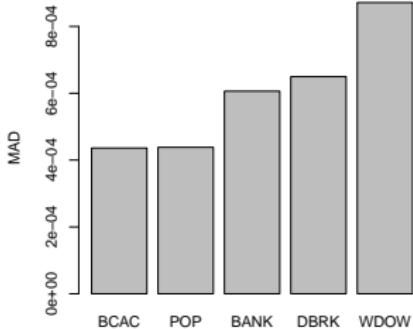
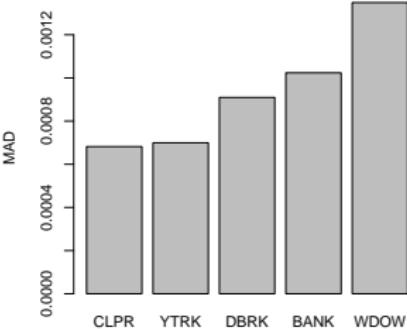
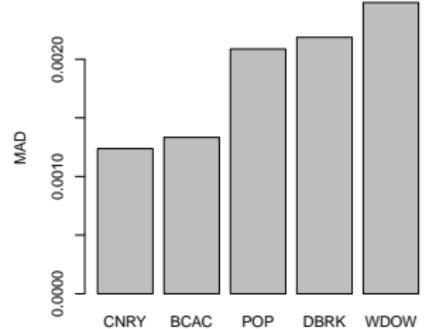


MCAT 269

78-82

78-83

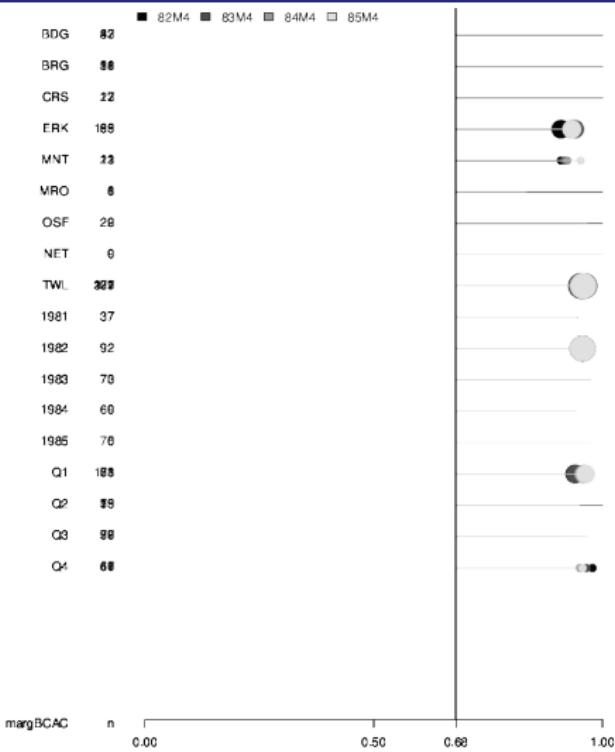
78-84



Combined



MCAT 269



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Time Block

Proofs

A 4x5 grid of 20 small circles, arranged in four rows and five columns.

A 5x5 grid of 25 small circles, arranged in five rows and five columns.

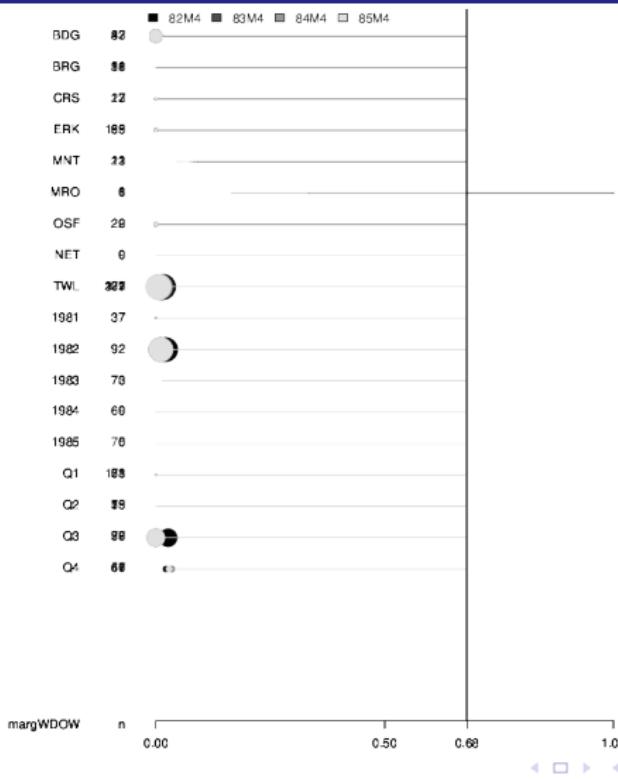
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MCAT 269



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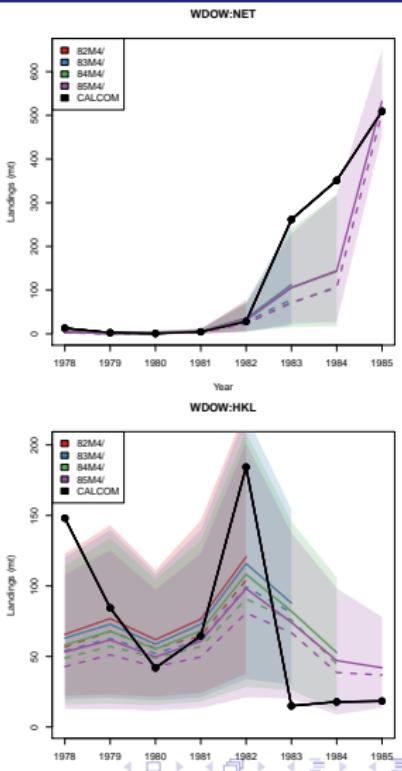
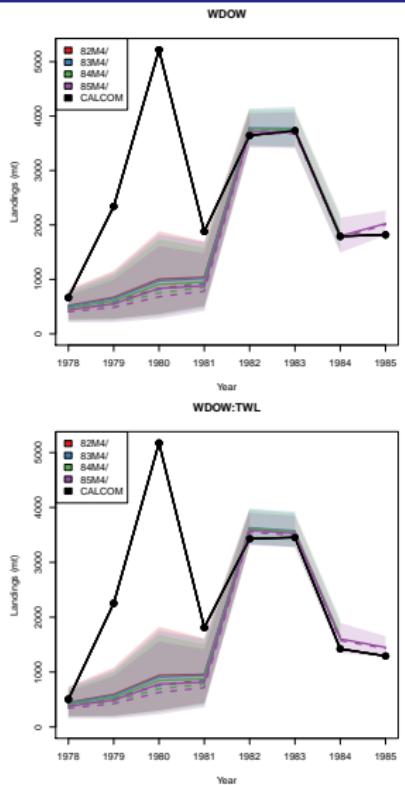
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Landings Sensitivity



Introduction

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Time Model

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Prior Model

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Interaction Model

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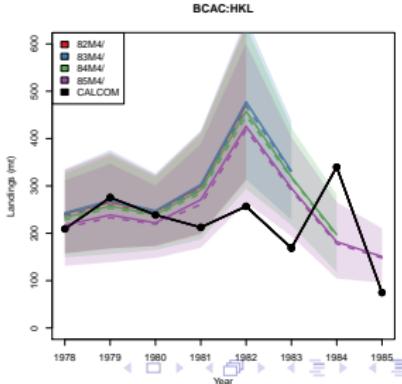
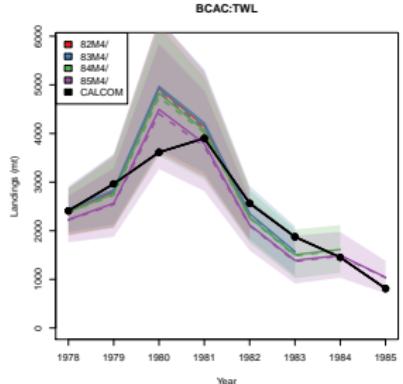
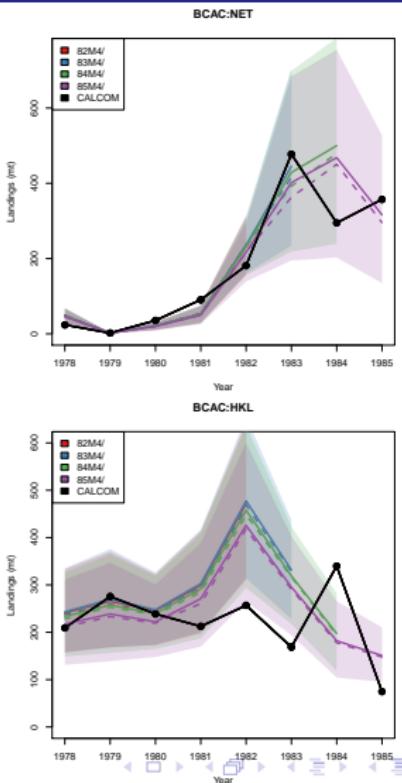
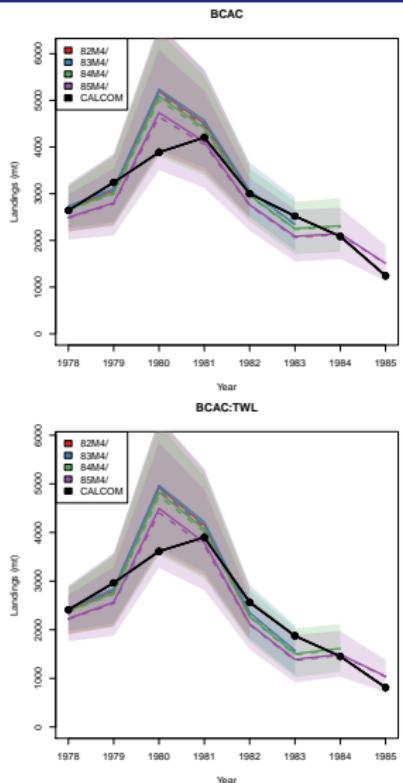
Time Block

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Proofs

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Landings Sensitivity



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Time Model

Prior Model

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Time Block

Proofs

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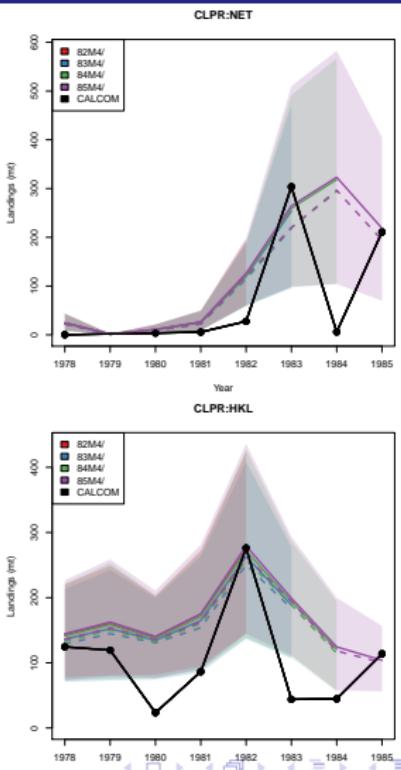
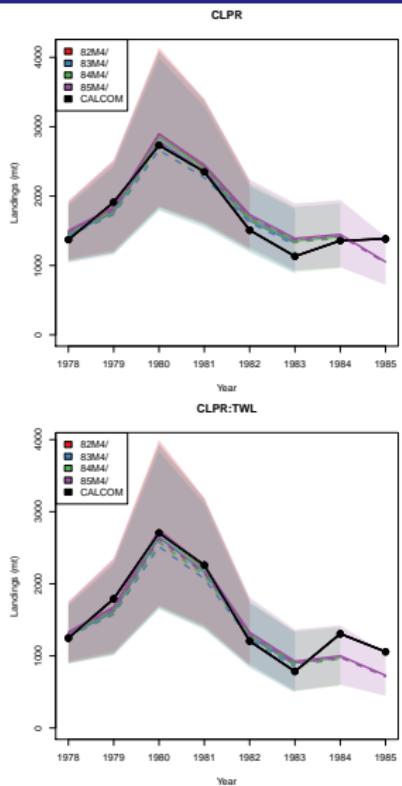
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Landings Sensitivity



Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

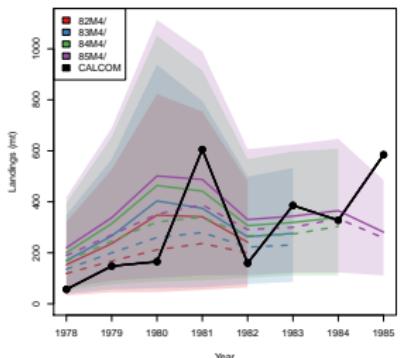
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Proofs

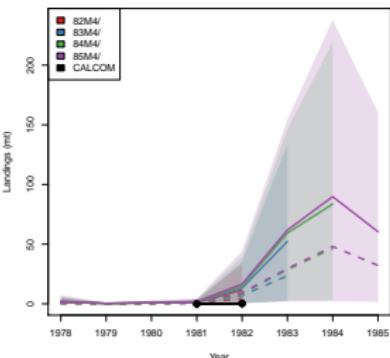
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Landings Sensitivity

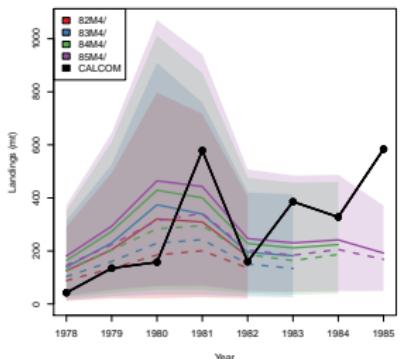
DBRK



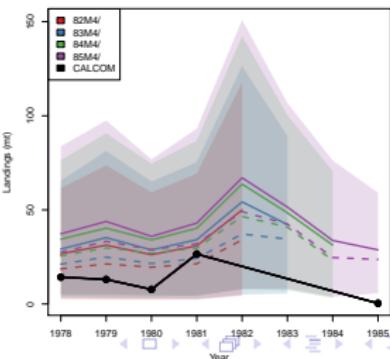
DBRK-NET



DBRK:TWL



DBRK:HKL



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Time Model

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Prior Model

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Interaction Model

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Time Block

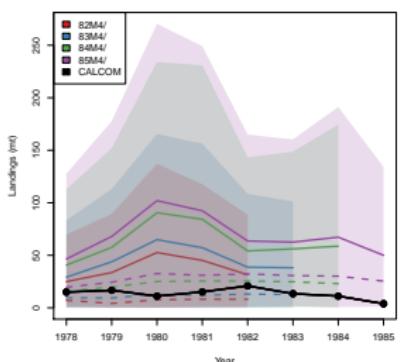
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Proofs

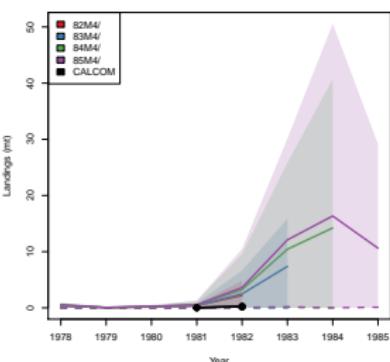
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Landings Sensitivity

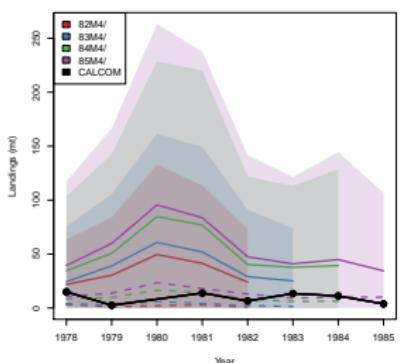
CWCD



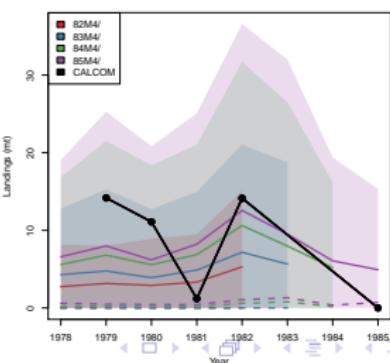
CWCD:NET



CWCD:TWL



CWCD:HKL



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



Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

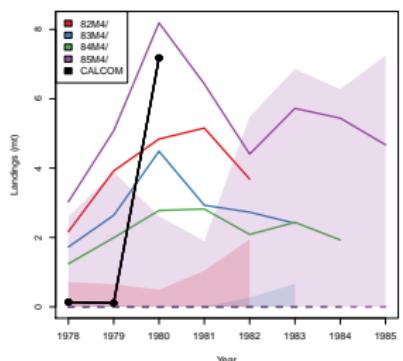
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Proofs

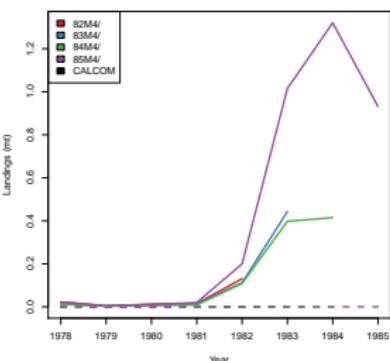
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Landings Sensitivity

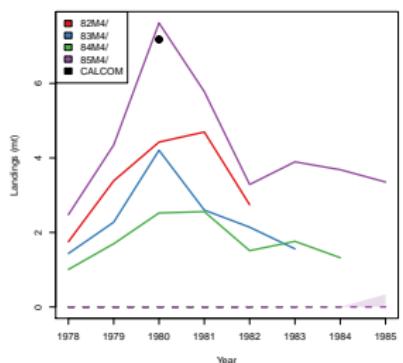
MXRF



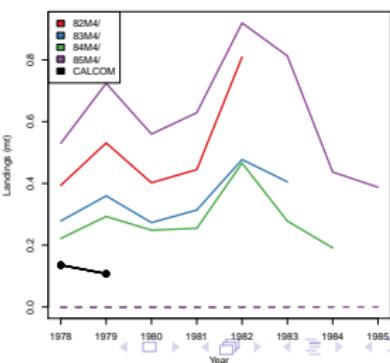
MXRF:NET



MXRF:TWL



MXRF:HKL



Nicholas Grunloh In Cooperation With: E.J. Dick, Don Pearson, John Field, Marc Mangel

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



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



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

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

$$\pi_{jk} = \frac{y_{jk}}{\sum_j y_{jk}} \quad \mathbf{y}_k \neq \mathbf{0}. \quad (1)$$

The predictive mean for species j is,

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

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

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



Species Comps are Negatively Correlated.

Consider a two species system.

$$\pi_1 = \frac{y_1}{y_1 + y_2} \quad \pi_2 = \frac{y_2}{y_1 + y_2} \quad \Rightarrow \quad \pi_1 + \pi_2 = 1$$

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

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

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

$$\begin{aligned} \text{Cov}(\pi_1, \pi_2) &= \mathbb{E}[(\pi_1 - \mathbb{E}[\pi_1])(\pi_2 - \mathbb{E}[\pi_2])] \\ &= \mathbb{E}[\pi_1 \pi_2] - \mathbb{E}[\pi_1] \mathbb{E}[\pi_2] \end{aligned}$$

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

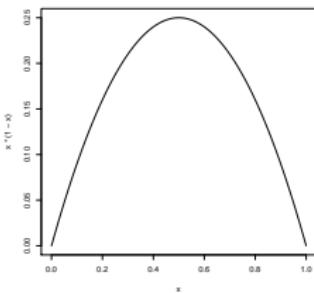
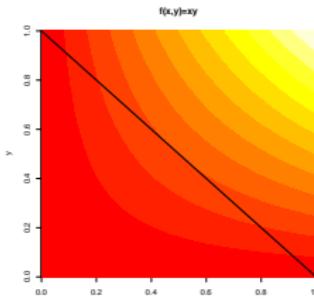
Now consider $f(x, y) = xy$ such that $x+y=1$, $x \geq 0$, and $y \geq 0$.

Jensen's Inequality for f is:

$$f(\mathbb{E}[x], \mathbb{E}[y]) \geq \mathbb{E}[f(x, y)] \quad (3)$$

Applying (3) 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 $\text{Cov}(\pi_1, \pi_2) < 0$ and $\text{Corr}(\pi_1, \pi_2) < 0$.



Introduction

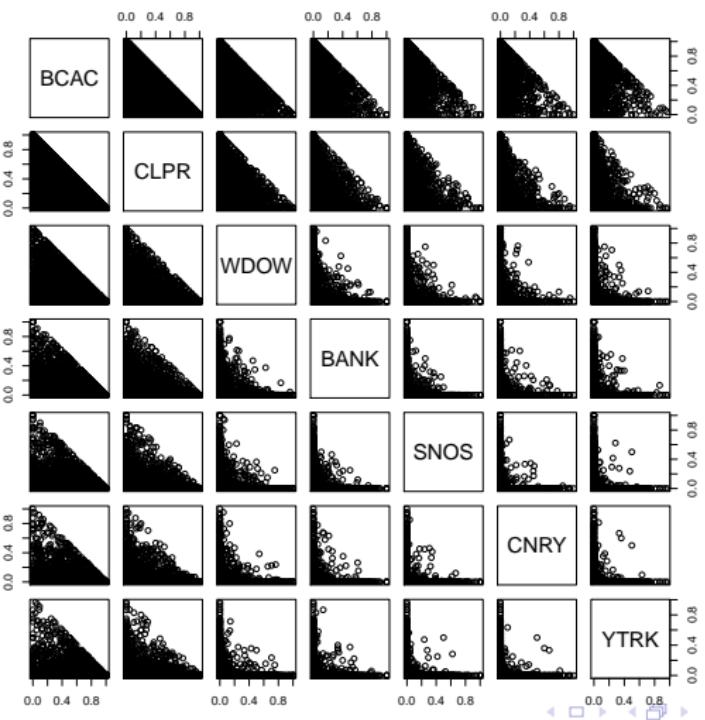
Time Model

Prior Model

Interaction Model

Time Block

Proofs



A 4x6 grid of 24 small circles, arranged in four rows and six columns.

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Proof: Species Comps are Negatively Correlated.

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

Recall:

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

$$\text{Corr}(\pi_I, \pi_m) \leq 0 \iff \text{Cov}(\pi_I, \pi_m) \leq 0$$

$$\text{Cov}(\pi_I, \pi_m) = \mathbb{E}[(\pi_I - \mathbb{E}[\pi_I])(\pi_m - \mathbb{E}[\pi_m])] \\ = \mathbb{E}[\pi_I \pi_m] - \mathbb{E}[\pi_I] \mathbb{E}[\pi_m]$$

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

Introduction

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Time Model

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Prior Model

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Interaction Model

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Time Block

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Proofs

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Proof: Species Comps are Negatively Correlated Cont.

Consider the strictly concave function:

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

Jensen's Inequality for f is,

$$f(\mathbb{E}[\mathbf{x}]) \geq \mathbb{E}[f(\mathbf{x})]. \quad (4)$$

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 π gives

$$\mathbb{E}[\pi_I] \mathbb{E}[\pi_m] \geq \mathbb{E}[\pi_I \pi_m] \quad (5)$$

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

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