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

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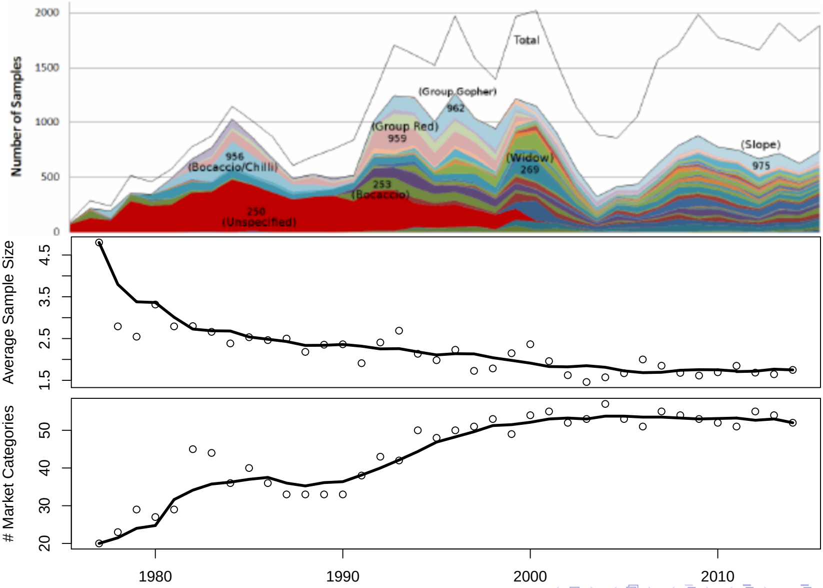
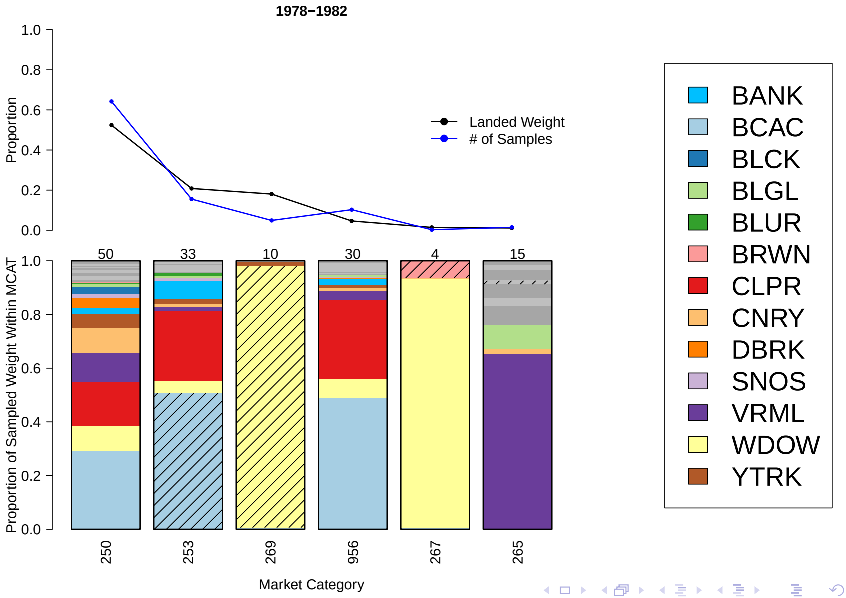
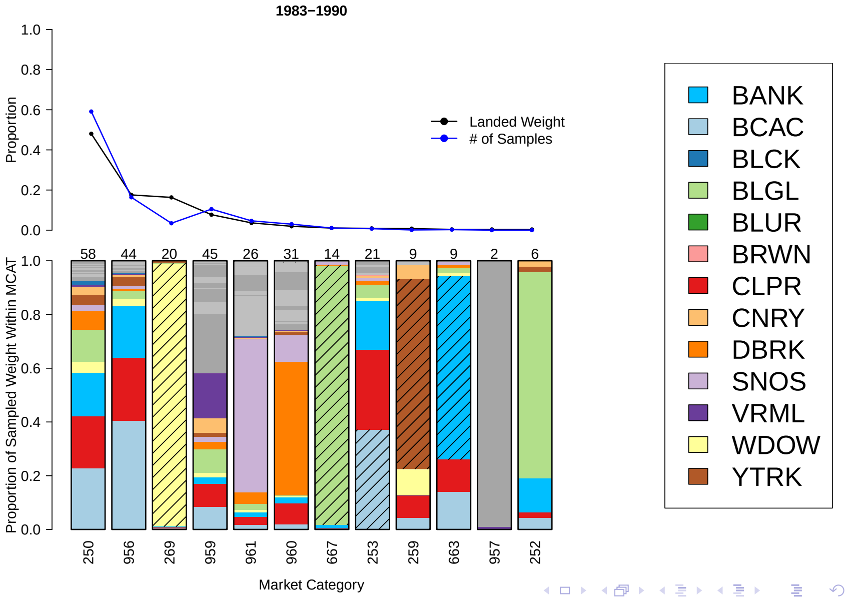
UCSC :: CSTAR :: SWFSC :: NMFS

28 March 2018


2000
1500
1000
500
0
Number of Samples
Total
(Group Gopher)
962
(Group Red)
959
956
(Bocaccio/Chilli)
(Widow)
269
253
(Bocaccio)
250
(Unspecified)
(Slope)
975
Average Sample Size
1.5
2.5
3.5
4.5
Market Categories
20
30
40
50
1980
1990
2000
2010


1978−1982
Proportion
1.0
0.8
0.6
0.4
0.2
0.0
Landed Weight
# of Samples
50
33
10
30
4
15
Proportion of Sampled Weight Within MCAT
250
253
269
956
267
265
Market Category
BANK
BCAC
BLCK
BLGL
BLUR
BRWN
CLPR
CNRY
DBRK
SNOS
VRML
WDOW
YTRK


1983–1990
Proportion
1.0
0.8
0.6
0.4
0.2
0.0
Landed Weight
# of Samples
58 44 20 45 26 31 14 21 9 9 2 6
Proportion of Sampled Weight Within MCAT
250 956 269 959 961 960 667 253 259 663 957 252
Market Category
BANK
BCAC
BLCK
BLGL
BLUR
BRWN
CLPR
CNRY
DBRK
SNOS
VRML
WDOW
YTRK

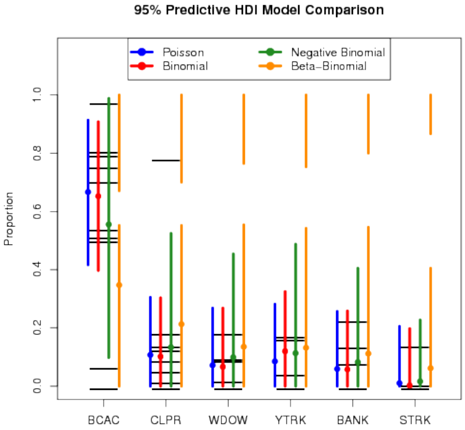
sparce data -¿ Pooling and heirarchical models

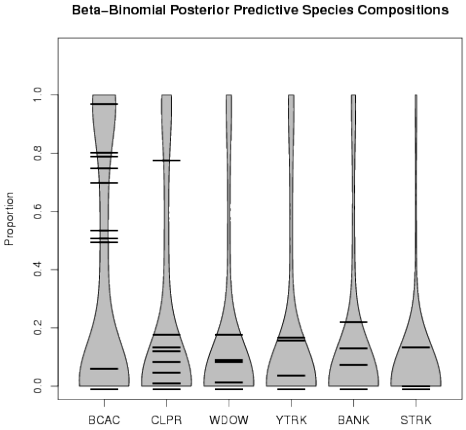
integer overdispersion (Motivate next slide)

Likelihood

y_{ij}: i^{th} sample of the j^{th} species' integer weight from market category 250, in the Monterey port complex trawl fishery for the second quarter of 1982.

$$y_{ij} \sim \text{Pois}(\theta_j) \quad y_{ij} \sim \text{Bin}(\theta_j) \quad y_{ij} \sim \text{NB}(\theta_j, \phi) \quad y_{ij} \sim \text{BB}(\theta_j, \phi)$$


95% Predictive HDI Model Comparison
Poisson
Binomial
Negative Binomial
Beta–Binomial
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
BCAC
CLPR
WDOW
YTRK
BANK
STRK


Beta–Binomial Posterior Predictive Species Compositions
Proportion
0.0
0.2
0.4
0.6
0.8
1.0
BCAC
CLPR
WDOW
YTRK
BANK
STRK

	Poisson	Binomial	NB	BB
MSE	0.06412	0.06264	0.05171	0.04479
Δ DIC	1001.41	1230.60	5.03	0
Δ WAIC	1079.95	1323.75	3.43	0
$pr(M\|y)$	≈ 0	≈ 0	$\approx 10^{-7}$	$\approx 1 - 10^{-7}$

Beta-Binomial Model

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

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

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

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

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

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

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

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

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

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

Time Model

(M1)

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

(M2)

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

(M3)

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

(M4)

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

(M5)

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

(M6)

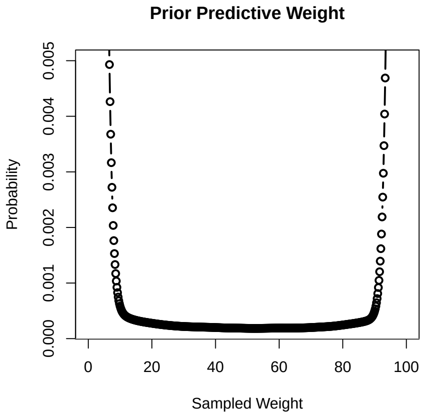
$$\beta^{(t)}_{m\eta} = \beta^{(y:q)}_{m\eta}$$
$$\beta^{(y:q)}_{m\eta} \sim N(0, v_m)$$

Priors

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

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

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



1978-1982

	M1	M2	M3	M4	M5	M6
MSE	0.12725	0.12704	0.12680	0.12237	0.12724	0.12657
Δ DIC	2558.56	2259.94	2013.21	0	2175.32	2174.71
Δ WAIC	2562.65	2263.58	2009.32	0	2171.18	2170.56
$pr(M\|y)$	≈ 0	≈ 0	≈ 0	≈ 1	≈ 0	≈ 0

1983-1990*

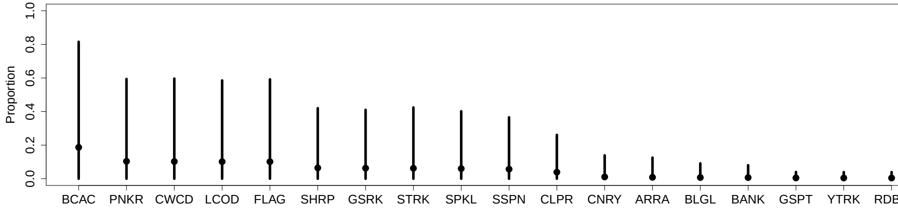
	M1	M2	M3	M4	M5	M6
MSE	0.12724	0.12704	0.12680	0.12237	0.12723	0.12657
Δ DIC	2558.56	2259.94	2013.21	0	2175.32	2174.71
Δ WAIC	2562.65	2263.58	2009.32	0	2171.18	2170.56
$pr(M\|y)$	≈ 0	≈ 0	≈ 0	≈ 1	≈ 0	≈ 0

Posterior Predictive Weight

$$p(y^*_{jklm\eta}|\mathbf{y}) = \iint \mathrm{BB}\left(y^*_{jklm\eta}|\mu_{jklm\eta}, \sigma^2_{jklm\eta}\right) P\left(\mu_{jklm\eta}, \sigma^2_{jklm\eta}|\mathbf{y}\right) d\mu_{jklm\eta} d\sigma^2_{jklm\eta}$$

$$\pi^*_{jklm\eta} = \frac{y^*_{jklm\eta}}{\sum_j y^*_{jklm\eta}} \quad \mathbf{y}^*_{klm\eta} \neq \mathbf{0}$$

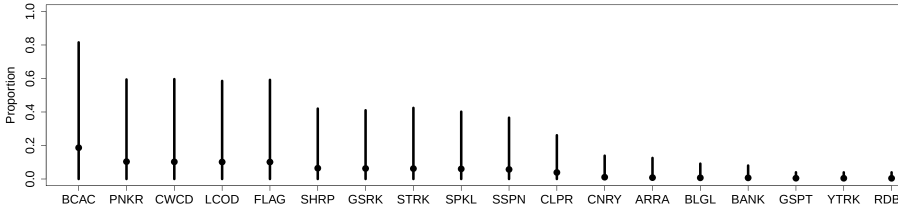
motivate prediction for filling holes/hindcasting
show a 100 pound BCAC distribution



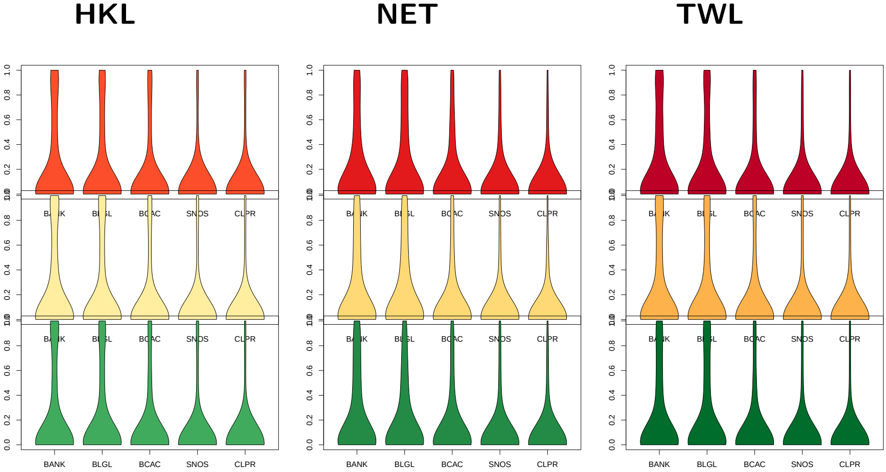
Species Composition

$$\pi^*_{jklm\eta} = \frac{y^*_{jklm\eta}}{\sum_j y^*_{jklm\eta}} \quad \mathbf{y}^*_{klm\eta} \neq \mathbf{0}$$

show a BCAC species comp distribution

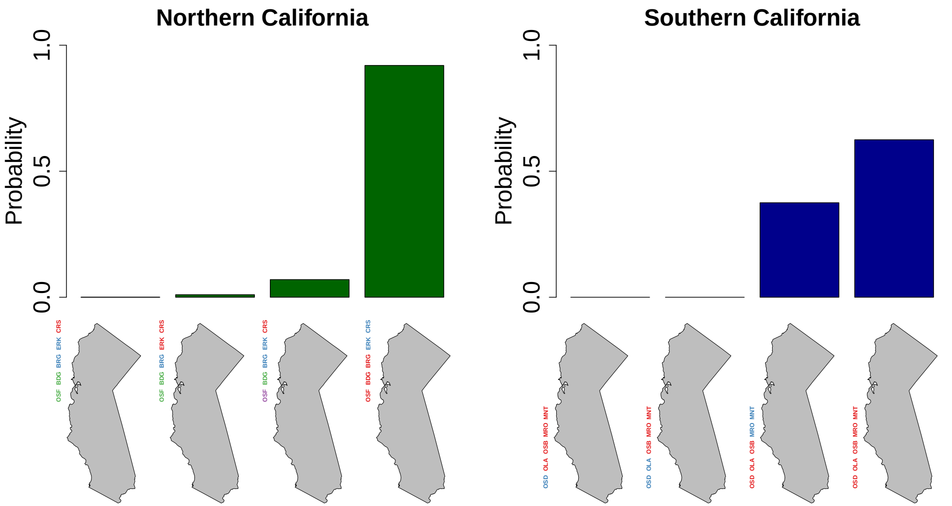


show sppComp distribution for some strata



Expansion

instructive example of port pooling w/ Bell number and constraints


Northern California
Probability
0.0
0.5
1.0
OSF BDG BRG ERK CRS
OSF BDG BRG ERK CRS
OSF BDG BRG ERK CRS
OSF BDG BRG ERK CRS
Southern California
Probability
0.0
0.5
1.0
OSD OLA OSB MRO MNT
OSD OLA OSB MRO MNT
OSD OLA OSB MRO MNT
OSD OLA OSB MRO MNT

Bayesian Model Averaging (BMA)

Consider a set of Models (M) indexed by ι:

$$\omega_\iota = Pr(M_\iota|y) = \frac{p(y|M_\iota)p(M_\iota)}{\sum_\iota p(y|M_\iota)p(M_\iota)}$$

$$\bar{p}(\boldsymbol{\theta}|\mathbf{y}) = \sum_\iota \omega_\iota p(\boldsymbol{\theta}|\mathbf{y}, M_\iota)$$

if f only depends on M through $\boldsymbol{\theta}$, then

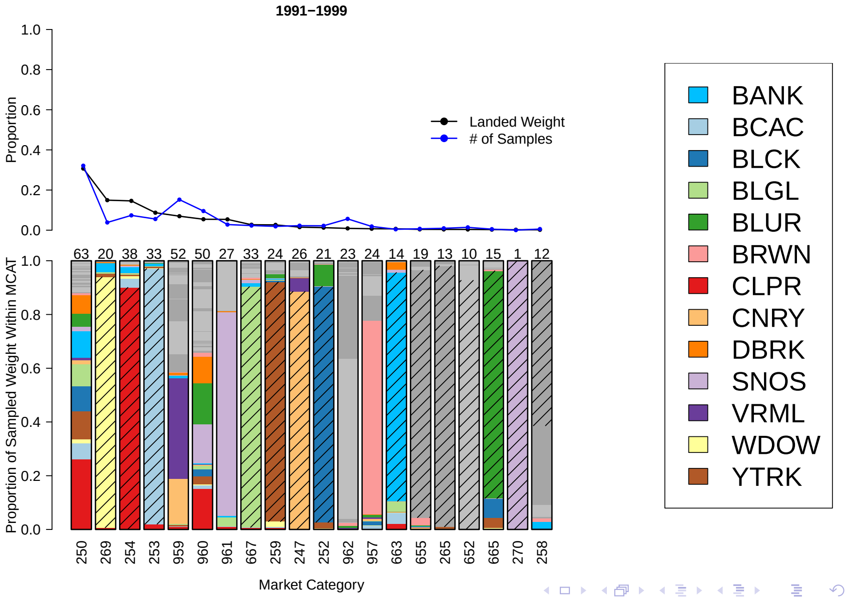
$$\bar{p}(y^*|\mathbf{y}) = \int f(y^*|\boldsymbol{\theta})\bar{p}(\boldsymbol{\theta}|\mathbf{y})\mathbf{d}\boldsymbol{\theta}$$

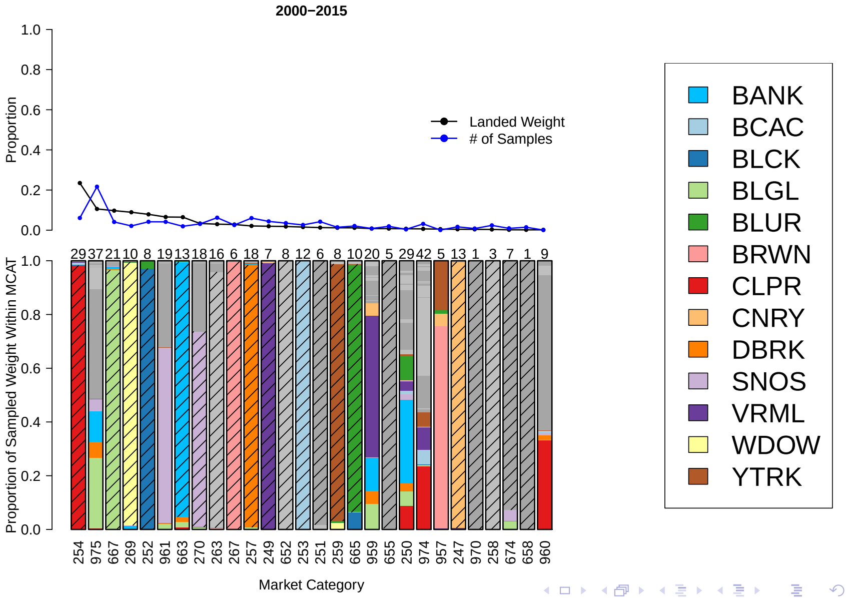
* Hoeting, J. A., Madigan, D., Raftery, A. E., and Volinsky, C. T. (1999). Bayesian model averaging: a tutorial. *Statistical science*, 382-401.

MCAT 250										
ω	0.32	0.14	0.13	0.12	0.02	0.02	0.02	0.02	0.02	0.02
CRS										
ERK										
BRG										
BDG										
OSF										
MNT										
MRO										
OSB										
OLA										
OSD										

select port pooling results

- Red stuff
- Species Composition Proof


1991–1999
Proportion
1.0
0.8
0.6
0.4
0.2
0.0
Landed Weight
# of Samples
63 20 38 33 52 50 27 33 24 26 21 23 24 14 19 13 10 15 1 12
Proportion of Sampled Weight Within MCAT
250 269 254 253 959 960 961 667 259 247 252 962 957 663 655 265 652 665 270 258
Market Category
BANK
BCAC
BLCK
BLGL
BLUR
BRWN
CLPR
CNRY
DBRK
SNOS
VRML
WDOW
YTRK


2000−2015
Proportion
Landed Weight
# of Samples
Proportion of Sampled Weight Within MCAT
29 37 21 10 8 19 13 18 16 6 18 7 8 12 6 8 10 20 5 29 42 5 13 1 3 7 1 9
254 975 667 269 252 961 663 270 263 267 257 249 652 253 251 259 665 959 655 250 974 957 247 970 258 674 658 960
Market Category
BANK
BCAC
BLCK
BLGL
BLUR
BRWN
CLPR
CNRY
DBRK
SNOS
VRML
WDOW
YTRK