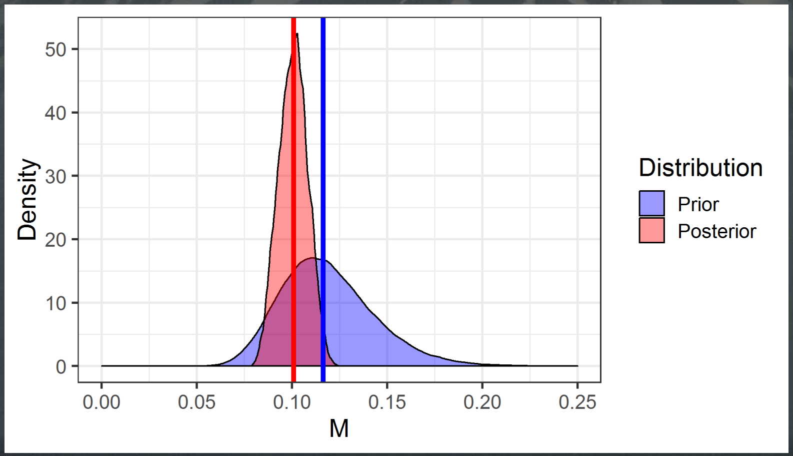
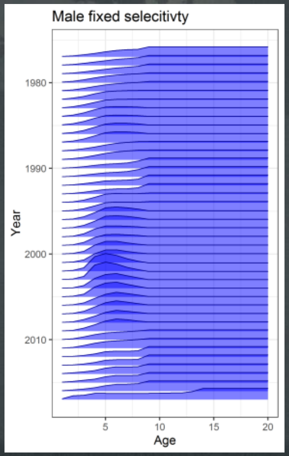
Hanselman, Fenske, Rodgveller, Lunsford

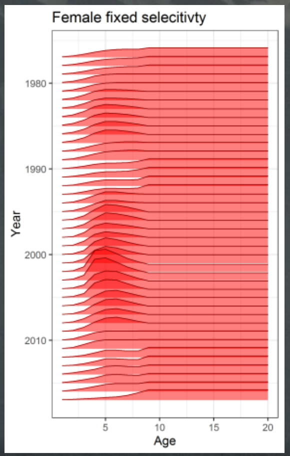
Sablefish modeling update

Natural mortality



Selectivity





Why change models, ever?

- New processes aren’t explained well by old choices
- Better methods are developed
- New literature suggests to
- Accumulation of data allows more estimated parameters
- **Because the SSC/Plan Teams ask!**

Recent comments

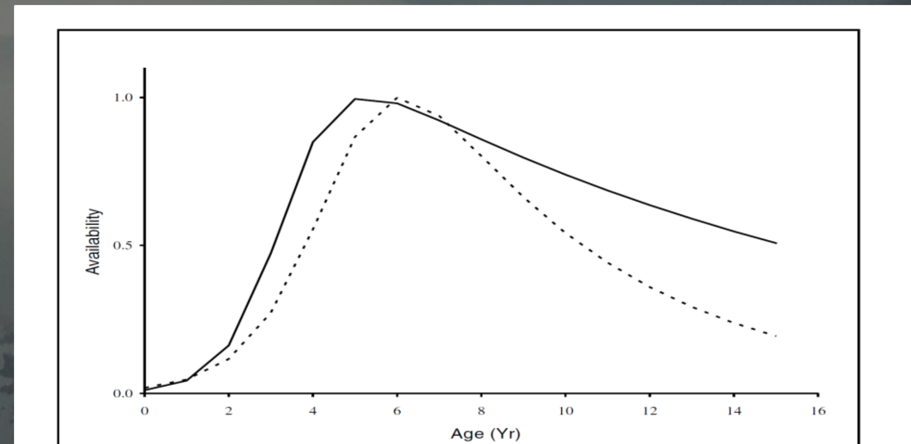
- "…there is room for further improvement through selection of alternative selectivity functional shapes" – Klaer 2016 CIE Report
- "…should better account for uncertainties relating to natural mortality rate…" -Carruthers 2016 CIE Report
- "…include further investigation of the lack of fit to the plus group in recent fishery age compositions, and development of a prior for natural mortality" –SSC Dec. 2017
- "The Teams recommended that further evaluations of selectivity options be pursued." – JGPT Nov. 2017

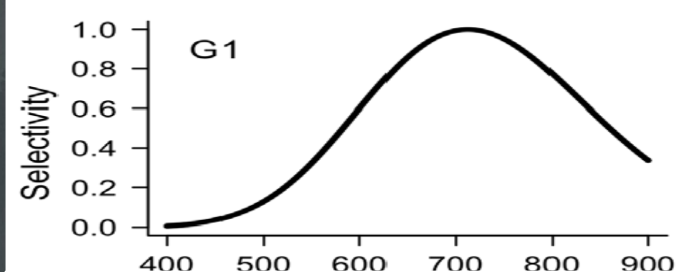
Selectivity

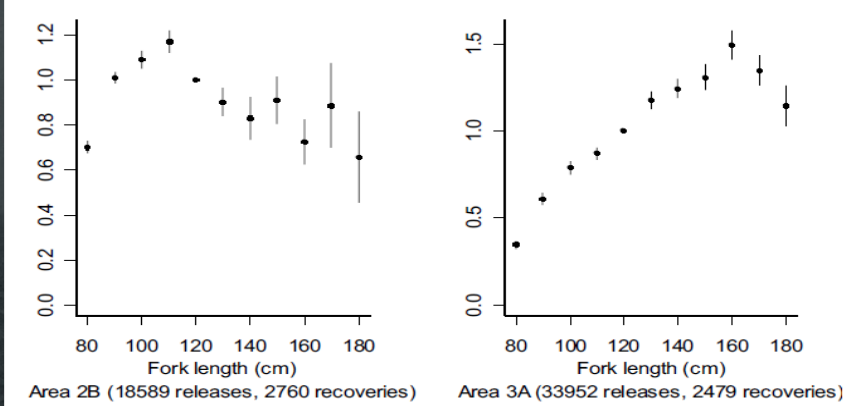
- Most important fishery selectivity is IFQ fixed gear (most of the catch and current)
- Currently asymptotic (logistic)
  - Other studies have found evidence of dome-shaped selectivity for longline gear
- Recent lack of fit to fishery age data (and particularly plus group)
  - Recent large year classes may cause different fishery behavior (spatial avoidance, etc.)

Relevant studies

- Maloney and Sigler (2008)
  - AK sablefish tagging data (exponential logistic)
- Jones and Cox (2018)
  - BC sablefish tagging data (gamma)
- Clark and Kaimmer
  - Halibut tagging data (spatially driven)







Selectivity types

- Parametric functions
  - Logistic, gamma, exponential-logistic
- Non-parametric
  - Selectivity parameters per age, with penalties for dome-shapedness and smoothness
  - Mean selectivity is 1, ages after 15 are set equal to 15
- Time-varying
  - The age at 50% and the peak of the gamma allowed to vary annually
  - Selectivity-at-age parameters were estimated annually or in blocks of several years

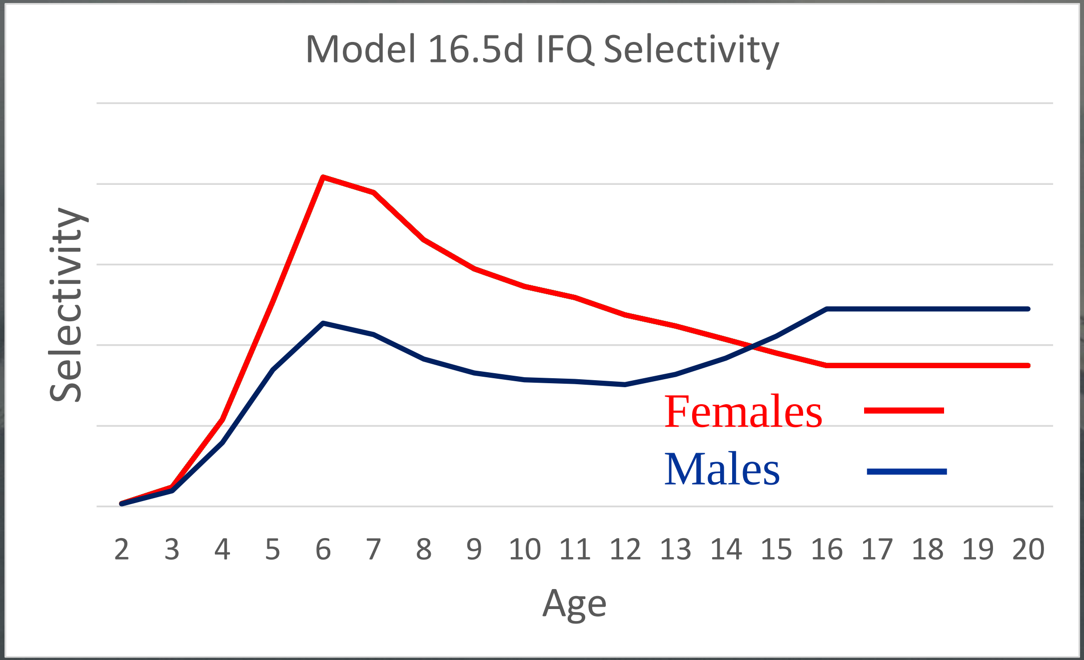
Evaluation

- Plausibility and parsimony (judgment)
- Fit to the plus group
  - SumSquares of the fishery age plus group residuals
- Improvement in likelihood of the fit to the data
  - If the fit is not improved over the base, not useful
- Retrospective performance

Results

- 19 models presented, 7 models fit worse than base
- None of the time-invariant selectivity models appreciably addressed plus group fit
- Time varying models all fit the data better overall and improved the plus group fit to varying degrees
- Retrospective performance for time-varying models was poor relative to the base

“Best” models

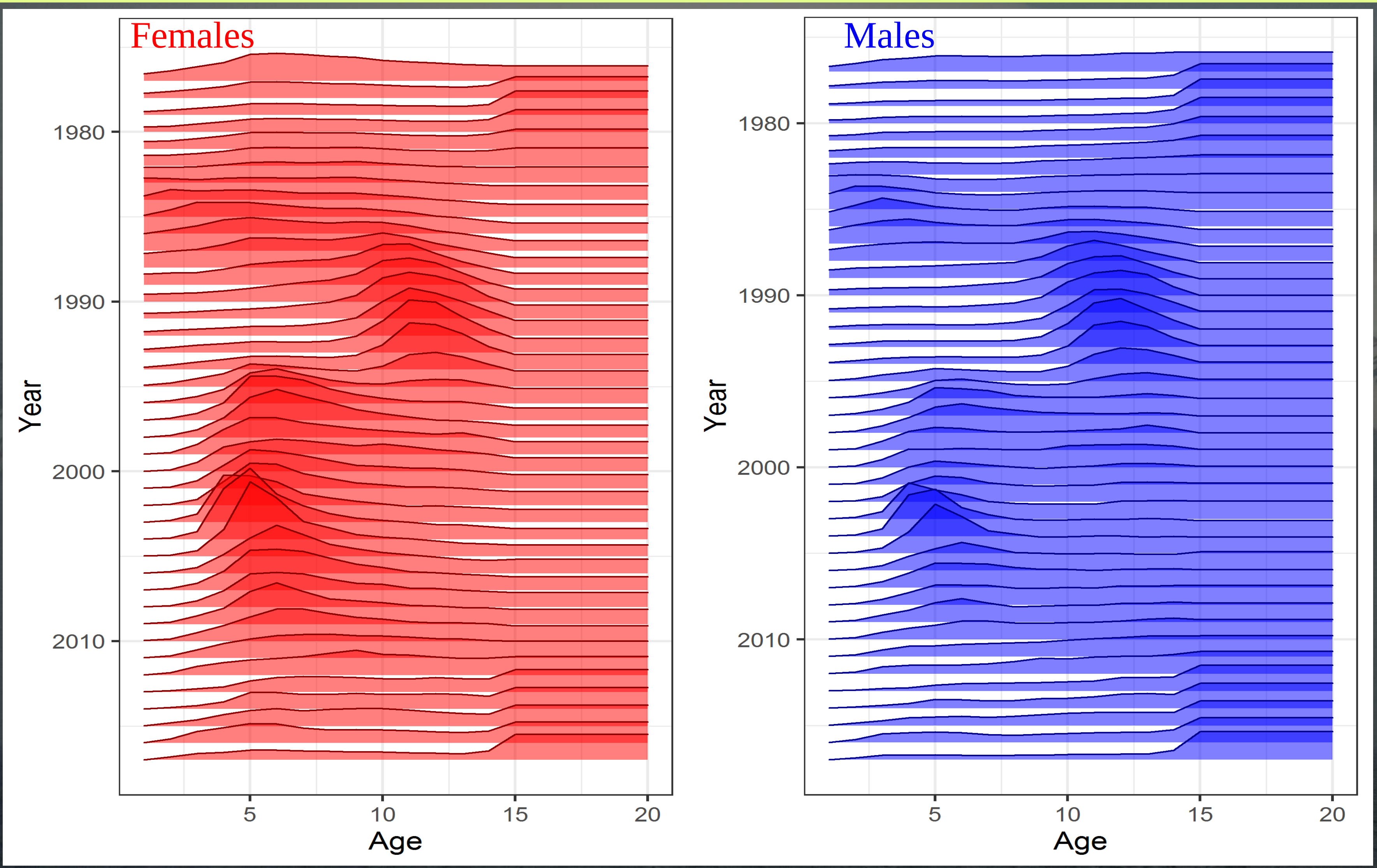


- Time-invariant coefficients (16.5d)
- Plausible, slight improvement in fit, plus group, and retrospective stats

“Best” models

- Time-varying coefficients (16.5n) for all years fixed gear fishery (npar = 1,111)
- Implausible and non-parsimonious?, large improvement in fit, plus group, poor retrospective stats

"Best" models

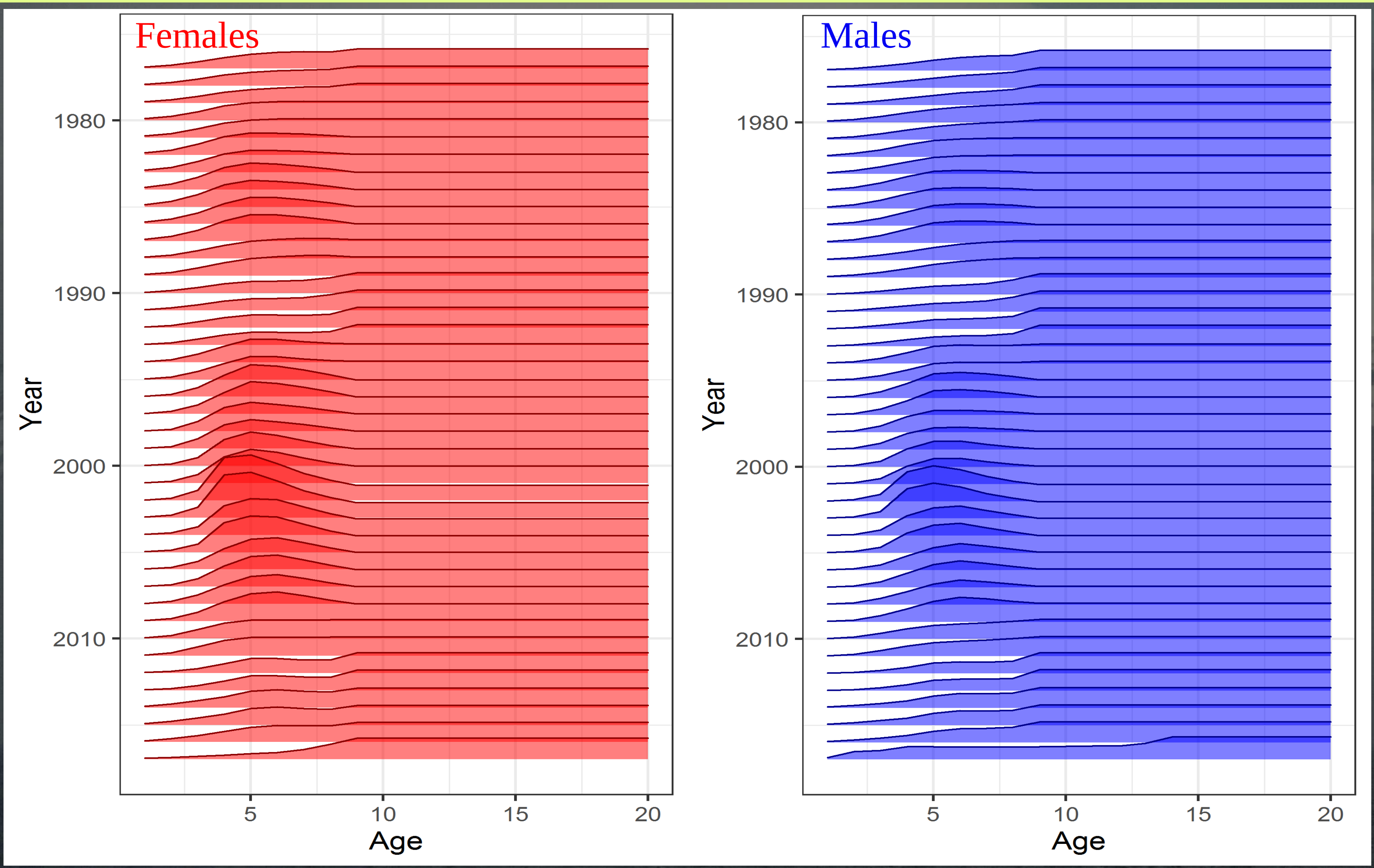


Females
1980
1990
2000
2010
Year
5
10
15
20
Age
Males
1980
1990
2000
2010
Year
5
10
15
20
Age

“Best” models

- Time-varying coefficients (16.5z) for all years fixed gear fishery in 2-year blocks (npar = 691)
- Uses natural mortality prior shown in a minute
- Plausible and intermediate complexity, large improvement in fit, plus group, poor retrospective stats

"Best" models



Selectivity summary

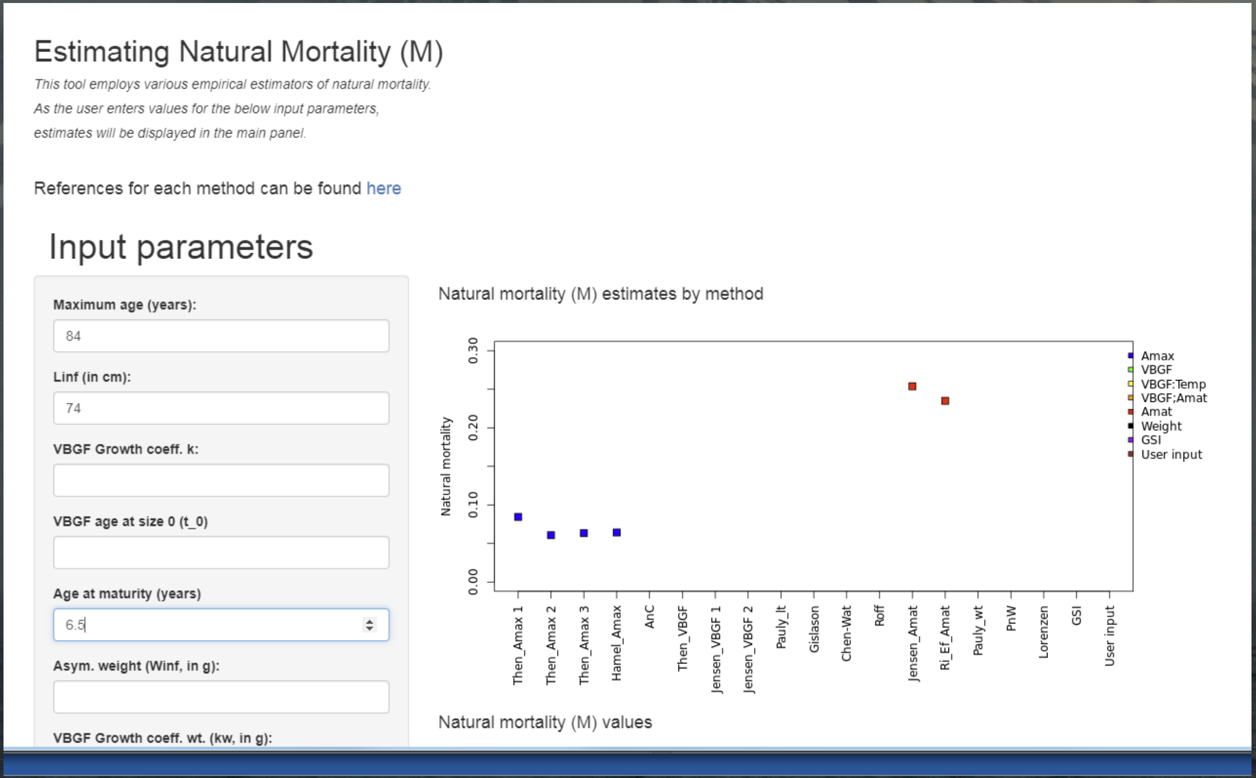
- Models that allowed some dome-shape in fishery selectivity did fit fishery age data better
- Models with time-varying aspects fit the data much better, but at the expense of many more parameters
- Except for the time-varying logistic model, all time-varying models exhibited relatively poor retrospective patterns

Natural mortality

- One of the most important and difficult parameters to estimate has a large effect on scale
- Should be estimable with good catch-at-age data
- Currently estimated (0.10, 10%) = 0.097
  - Previous assessments have fixed M, estimated M with a very precise prior, and gone back and forth.
- Value of 0.10 is from past practice and several early studies (e.g., Johnson and Quinn)
- GOAL: Explore more rigorous methods

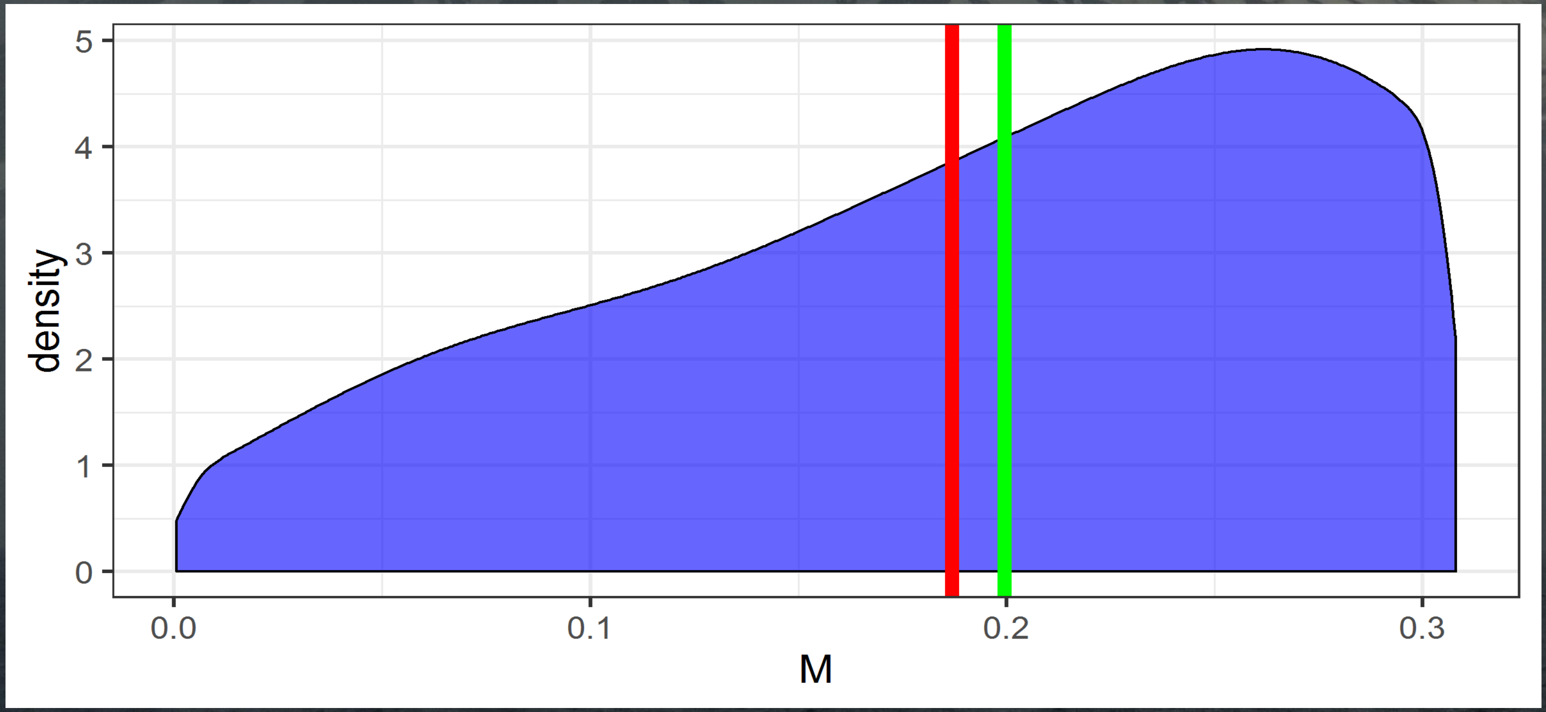
M Step 1

- Use Barefoot Ecologist natural mortality tool developed by Jason Cope



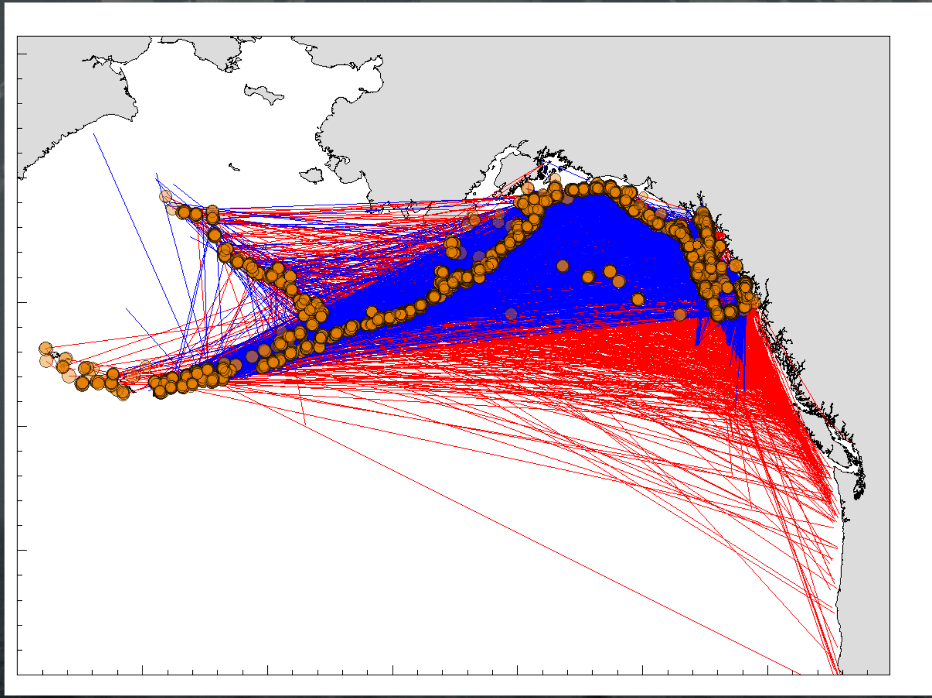
M step 1

- Input life-history information about sablefish
- Aggregates estimates and weights them by data type (max. age is used 4 times the estimators get a weight of 0.25)
- Outputs empirical density samples



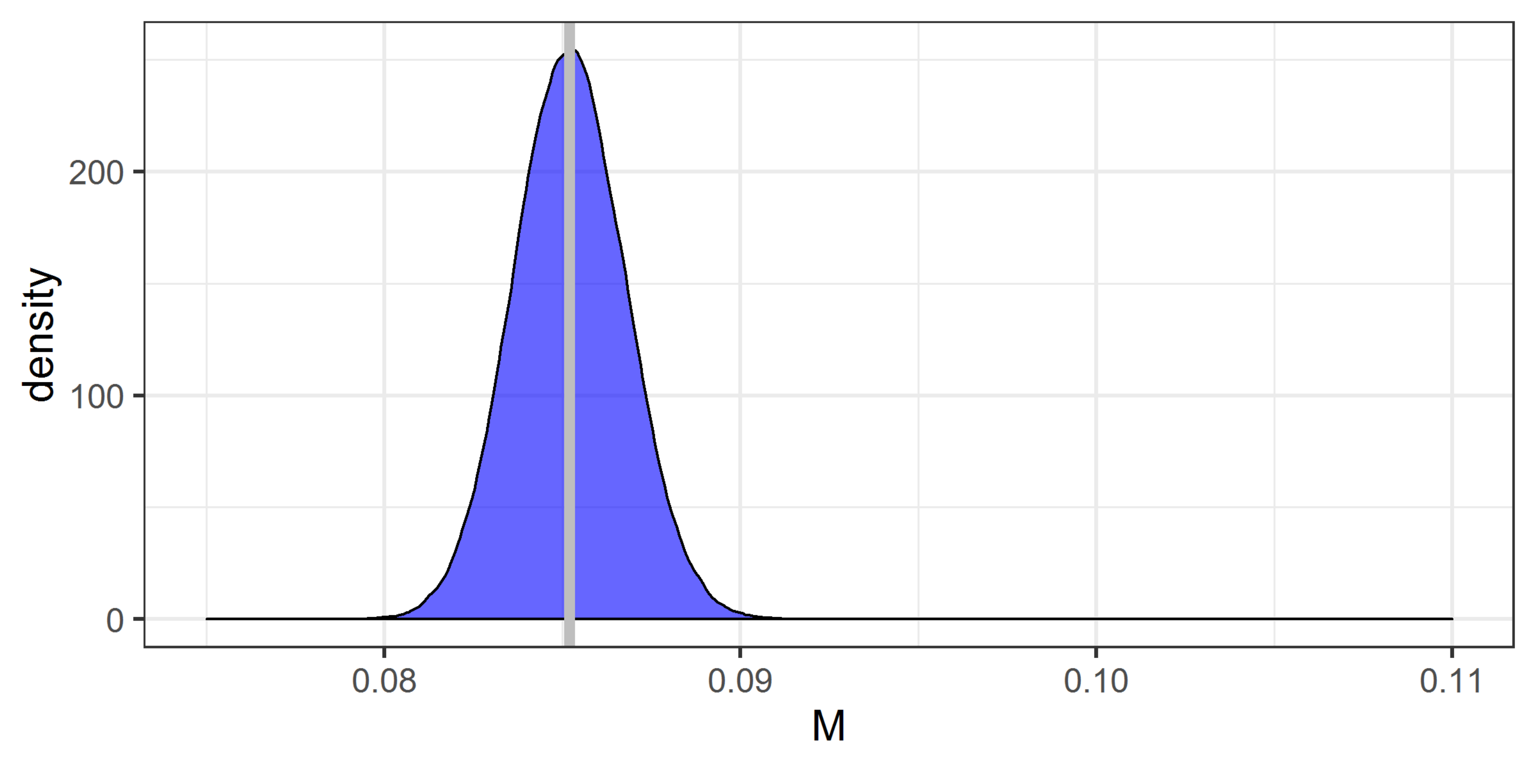
M Step 2

- Estimate M freely in tag-recapture (T-R) movement model (Hanselman et al. 2015)
- Uses data from 1979 - 2011



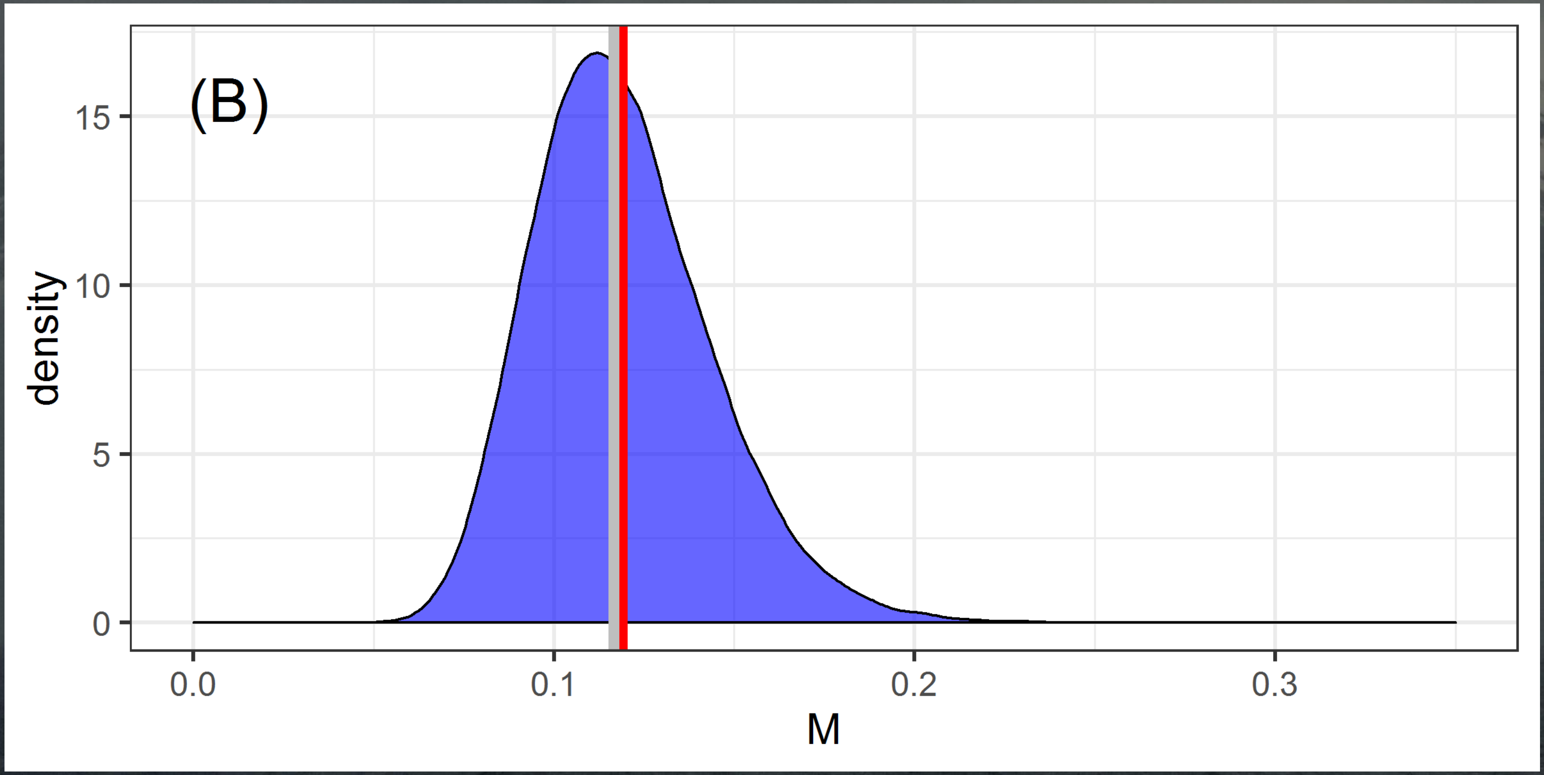
M step 2

Estimate from T-R model very precise



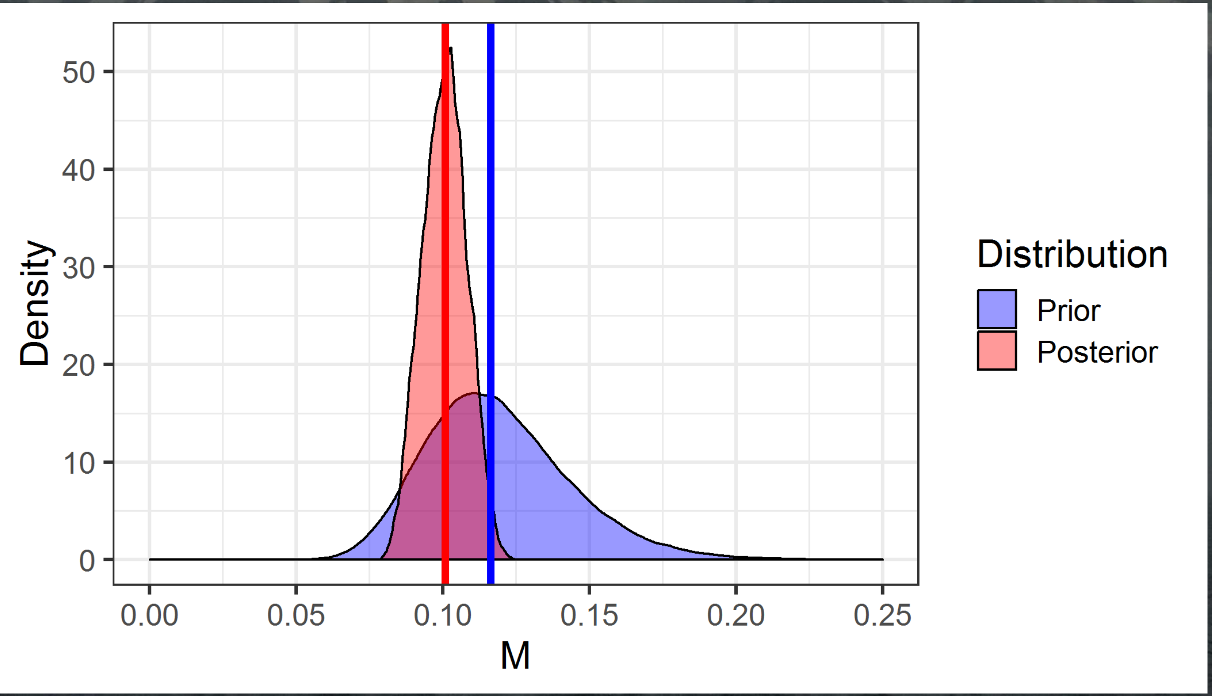
M step 3

Average densities with equal weighting



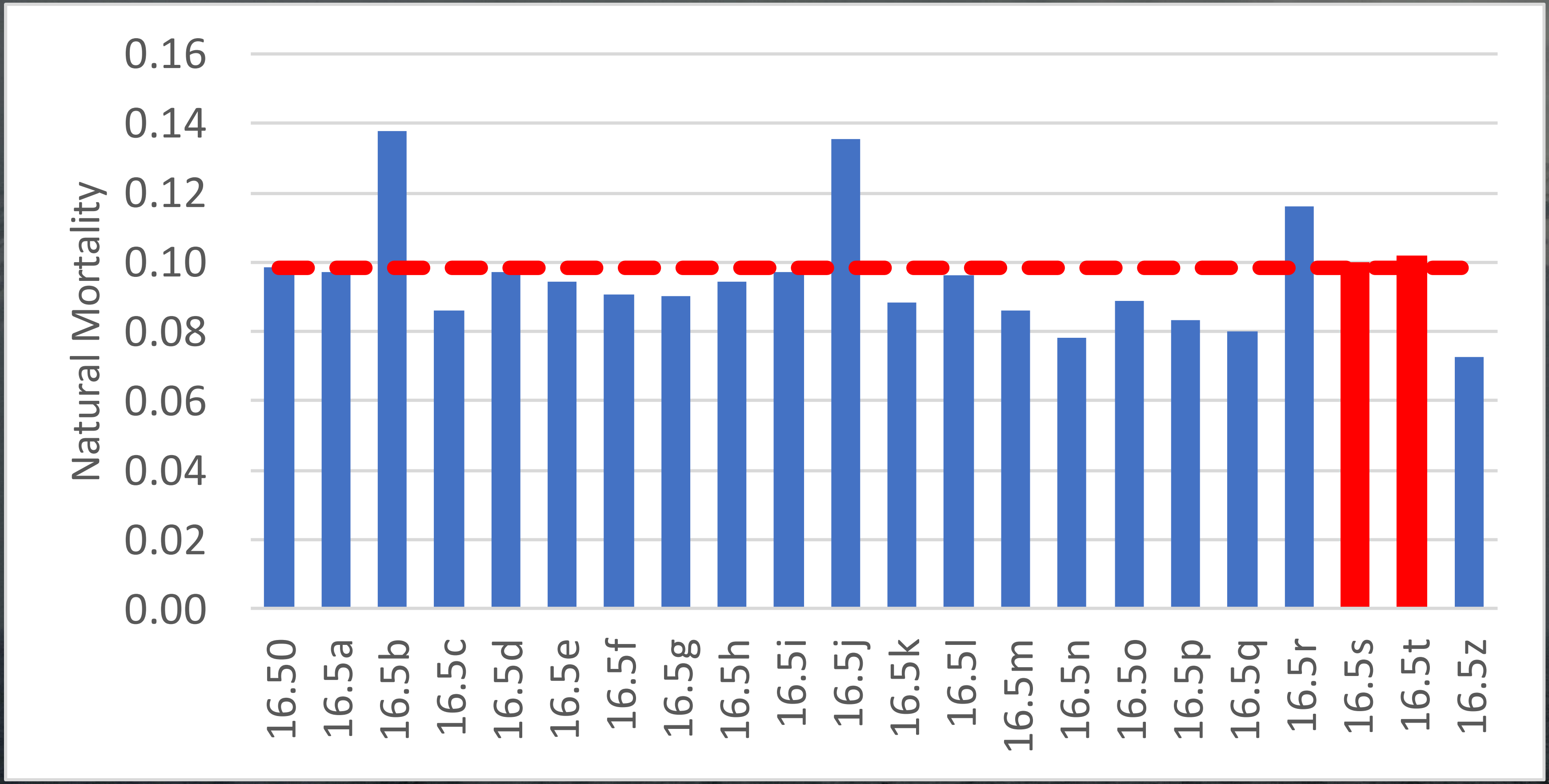
M Step 4

- Stick it in the assessment model
- Compare posterior to prior
- Compare to base and other versions of the model



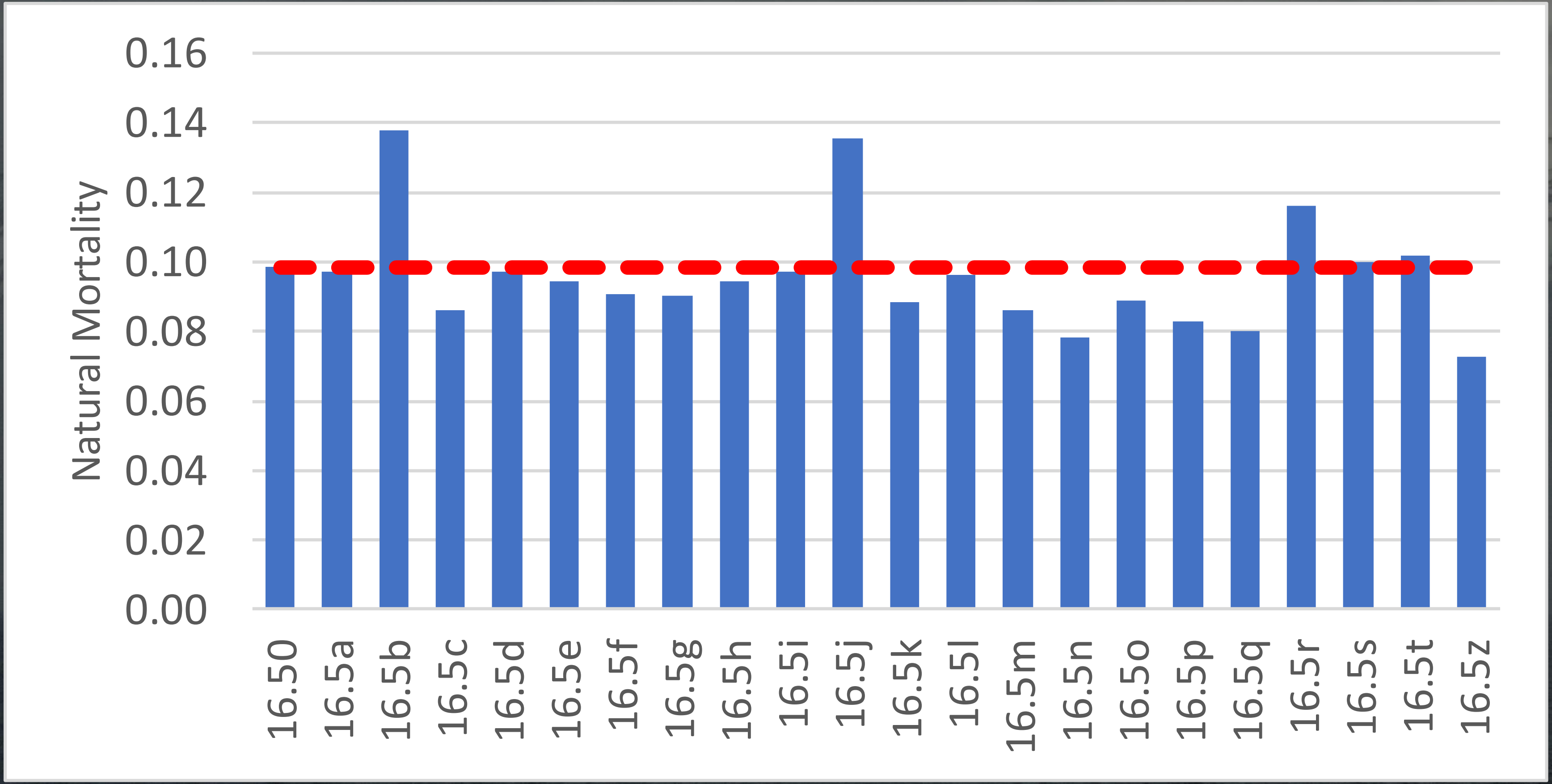
Results

- Models that estimated M, but did not change selectivity gave very similar answers



Results

- All models (except gamma) produced similar estimates of M



Natural mortality summary

- Life history estimators gave widely different answers for *M*
- Tag-recapture estimator was precise and similar to current estimate
- Sablefish age data has solid information about natural mortality
- New prior has little practical implication, but recommend as more rigorous approach

Overall Summary

- Allowing for dome-shaped selectivity in fishery selectivity may be a good idea
- Despite fitting the data better, the time-varying selectivities induced poor retrospective performance.
- Inclusion of natural mortality prior seems like a good (minor) model change to admit more uncertainty

Sablefish apportionment

Kari Fenske, Dana Hanselman, Curry Cunningham, Chris Lunsford, Cara Rodgveller

Dec 2017 SSC:

“The SSC approved the authors and Joint Plan Team’s recommendations for Tier, ABC and OFL. These recommendations include adjustments for the magnitude of the 2014 year-class and whale depredation. The authors and the JPT agreed that the fixed area apportionments used in 2016 should be applied again this year. The author noted that the CIE reviewers concluded that continued use of the fixed area approach did not appear to pose a conservation concern. The SSC notes that the authors have indicated that a complete review of the method to be used for spatial allocation will be forthcoming. The SSC requests conduct of this analysis in 2018*.”*

Apportionment investigations

- Part 1 – Apportionment 'retrospective'
  - Results today
- Part 2 – Apportionment MSE
  - Ongoing, no results to report yet

Author recommendation: Continue static apportionment, while presenting standard (status-quo) apportionment for reference

Apportionment retrospective

- Alternative apportionment options are applied to the ABCs from 2005-2018 assessment
- Examine the resulting ABC for the 6 management areas for each year
- Calculate some performance metrics for potential management objectives
- No feedback loop, so cannot address all potential management objectives this way (no meaningful BRPs/sustainability)

Apportionment options investigated:

Name of method	Description
Status quo	5-yr exponentially weighted moving average of fishery and survey indices; survey weight is 2x fishery weight
Static	The apportionment proportions from the 2013 assessment that have been applied as fixed proportions for 2014-2018
Equal	Each region receives 1/6 of the ABC
Equilibrium	Based on the stationary distribution of the movement rates (using approximate but realistic values for EY and WY until a 6 area movement model is configured. The EG proportion is 0.372 (EY+WY), split 37% to 63% for WY and EY/SEO for now)
Partially fixed	BS and AI receive 10% of the ABC each, WG, CG, WY, and EY are apportioned based on status quo
Non-exp status quo	A 5-yr moving average of fishery and survey indices
Biomass based	Based on the proportion of the estimated biomass in each region from the most recent year of the NMFS sablefish longline survey
Exponential, fishery only	Similar to 'status quo' method but using fishery index only
Exponential, survey only	Similar to 'status quo' method but using survey index only
Maturity based, non-exp	Based on the proportion of females in each region larger than the length at 50% maturity (~65.1 cm) using longline survey data; BS and AI data carried forward from previous sampled year in the 'off' sampling year, 5-year running average
Maturity based, exp	Based on the proportion of females in each region larger than the length at 50% maturity (~65.1 cm) using survey data, BS and AI data carried forward from previous sampled year in the 'off' sampling year, 5-year exponentially weighted running average
Random effects	Apportionment to region based on the proportions of biomass estimated by the RE model applied to the longline survey, using 0.05 CV

Apportionment retrospective results

'Stability' – The proportion of year (2005-2018) and management area combinations where the absolute value of the change in ABC between two adjacent years is less than the % indicated (1% to 50%)

	Maximum absolute interannual change in ABC:							
Apportionment Method:	**1%**	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**50%**
Status quo	6%	24%	54%	73%	86%	90%	97%	100%
Static	15%	23%	54%	85%	100%	100%	100%	100%
Equal	15%	23%	54%	85%	100%	100%	100%	100%
Equilib	15%	23%	54%	85%	100%	100%	100%	100%
Partially fixed	6%	23%	58%	79%	94%	97%	100%	100%
Non-exponential	8%	35%	59%	77%	94%	100%	100%	100%
Biomass based	4%	19%	38%	50%	58%	67%	72%	92%
Exp Fishery wt	1%	22%	49%	74%	92%	97%	100%	100%
Exp Survey wt	1%	24%	50%	72%	79%	87%	91%	100%
Mature	9%	38%	56%	73%	87%	95%	100%	100%
Exp Mature	9%	36%	51%	65%	79%	86%	94%	97%
RE model	4%	24%	38%	51%	60%	67%	72%	92%

Apportionment retrospective results

	Management area					
Apportionment Method:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	West Yakutat	East Yak/SEO
Status quo	3%	2%	5%	3%	3%	0%
Static	0%	0%	0%	0%	0%	0%
Equal	0%	0%	0%	0%	0%	0%
Equilib	0%	0%	0%	0%	0%	0%
Partially fixed	0%	0%	5%	1%	2%	-1%
Non-exponential	1%	1%	1%	0%	1%	-1%
Biomass based	29%	8%	28%	9%	9%	6%
Exp fishery wt	1%	2%	1%	3%	5%	2%
Exp survey wt	9%	3%	8%	3%	4%	0%
Mature	1%	3%	3%	1%	1%	-2%
Exp Mature	11%	0%	9%	3%	1%	0%
RE model	29%	8%	27%	8%	9%	4%

Average (across years 2005-2018) interannual change in proportion of ABC to mgmt. region

Conclusions

- Apportionment retrospective shows some of the tradeoffs of alternative options
  - Most ‘stable’ options are Static, Equal, Equilibrium and maybe Partially fixed and Non-exponential
  - Biomass-based and Random Effects less ‘stable’ but may track biomass if that’s a goal
- None of these address BRPs like whether the apportionment option would have lead to localized depletion or optimizing system yield.

Apportionment MSE

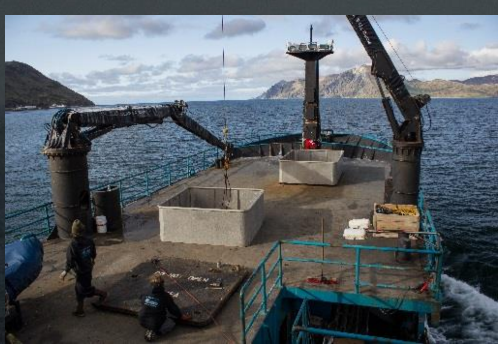
- Work in progress, no results yet.

Tentative timeline:

- November 2018: Continue static apportionment, while presenting standard (status-quo) apportionment for reference.
- Spring 2019: Meet with stakeholders to further refine objectives and metrics to test.
- September 2019: Update Plan Team with preliminary results of simulations for feedback.
- November 2019: Continue with static apportionment unless directed to adopt something early from preliminary results.
- 2020: Finalize MSE, recommend alternatives based on desired properties of apportionment for potential adoption for 2021 fishing season.

Objectives and performance metrics

Management Objective	Performance Metric
Reduce variation in regional ABC changes from year to year.	Performance measure: Percent of time ABC apportioned to a region changes by no more than X%.
Maintain a sustainable population of sablefish for all Alaska	Percent of time spawning biomass is above B40% and B35% for management areas summed.
Maintain a sustainable population of sablefish in each management area	Percent of time spawning biomass is above a specific level (such as B40% or other threshold) for each region.
Maintain a minimum level of harvest ABC in every region.	Percent of time ABC in region r is greater than specified threshold x.
Minimize fishing on immature fish or fish of low economic value.	Proportion of the total population that is larger than the length at 50% maturity for each region. Proportion of catch expected to be above 5 lbs for each region.



For comments, ideas, or questions about

- apportionment options,
- objectives, or
- performance metrics

Please ask now, call, email or catch me at a break!

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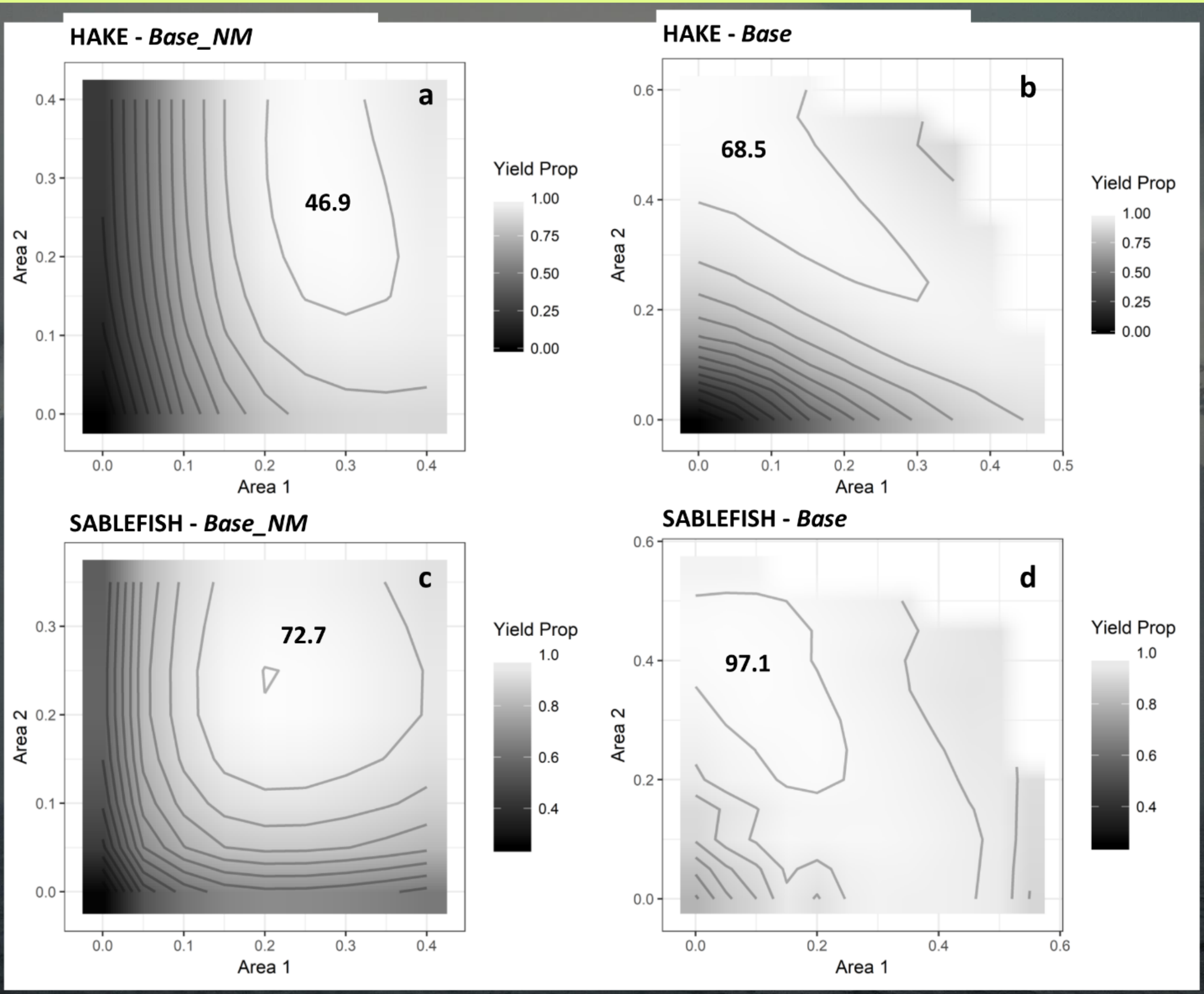
Maintain *X* level of catch/ABC opportunity - "Equality"

…but tied to overall amount of ABC!

	Mean proportion of years and areas that ABC is greater than X tons:								
Apportionment Method:	**100**	**250**	**500**	**1000**	**1250**	**1500**	**1750**	**2000**	**2500**
Status quo	100%	100%	100%	100%	99%	90%	81%	65%	47%
Static	100%	100%	100%	100%	99%	87%	72%	56%	36%
Equal	100%	100%	100%	100%	100%	100%	100%	92%	69%
Equilib	100%	100%	100%	100%	97%	90%	83%	67%	45%
Partially fixed	100%	100%	100%	100%	97%	87%	67%	55%	37%
Non-exponential	100%	100%	100%	100%	99%	90%	76%	65%	50%
Biomass based	100%	100%	100%	97%	92%	86%	73%	64%	45%
Exp Fishery wt	100%	100%	100%	100%	96%	90%	77%	68%	47%
Exp Survey wt	100%	100%	100%	100%	99%	91%	81%	60%	47%
Mature	100%	100%	100%	97%	85%	71%	58%	55%	29%
Exp Mature	100%	100%	100%	96%	87%	67%	59%	53%	32%
RE model	100%	100%	100%	97%	92%	87%	73%	64%	45%

SPASAM



HAKE - Base_NM
a
46.9
Area 2
Area 1
Yield Prop
1.00
0.75
0.50
0.25
0.00
HAKE - Base
b
68.5
Area 2
Area 1
Yield Prop
1.00
0.75
0.50
0.25
0.00
SABLEFISH - Base_NM
c
72.7
Area 2
Area 1
Yield Prop
1.0
0.8
0.6
0.4
SABLEFISH - Base
d
97.1
Area 2
Area 1
Yield Prop
1.0
0.8
0.6
0.4