Sablefish apportionment

An overview of the need for analyses, the methods, the results and metrics proposed for evaluating alternatives.

Day Schedule

9:00 – 9:15 am	Meeting begins, Introductions
9:15 – 10:30 am	Presentations on sablefish and simulations
10:30 – 10:45 am	Short break
10:45 am – 12 pm	Presentations, continued
12 – 1:30 pm	Break for lunch (on your own)
1:30 – 3 pm	Back for further presentations and discussions, as needed
~3 pm	Short break (as needed)
4:30 pm	Adjourn

Welcome

- Bathrooms, Emergency exit info,
- On the webinar? Please mute your phone AND computer
- WiFi password
- Please ask questions at ANY TIME today.
- Introductions

Goals for today

- Get your feedback about what metrics or results are important to you
  - Want to be able to summarize your thoughts and concerns (to the extent I can) in my write up of this
- Answer questions about the analyses and results
- Determine if there are other things I need to look at or different ways to show the results that will help us convey the information to those making decisions

Timeline

- Today → March: Get your feedback, work on a few more analyses
- Tomorrow → August: Write all of this up for a written report to submit to the Plan Team in September
- September: Present paper to Plan Team, along with a recommendation of our 2-4 ‘best’ apportionment types given the concerns we’ve heard
- November/December: Plan Team, SSC, AP, Council all receive SAFE report with apportionment final appendix (or just final apportionment document from September) and decide on apportionment of ABC

Focus questions

- Are the criteria (‘performance metrics’) we use to show pros and cons of apportionment types relevant to you?
- Am I missing something that would help you determine a preference between apportionment type options?
- What parts of this process need better/more explanation?
- Based on what you’ve seen today, which apportionment type (or types) appeal to you most, and why?

Review: Sablefish stock assessment

- Brief overview of the 2019 sablefish assessment

Apportionment of sablefish ABC

History and context – ~ 4 slides

Apportionment – Definitions and Background

What we are talking about today:

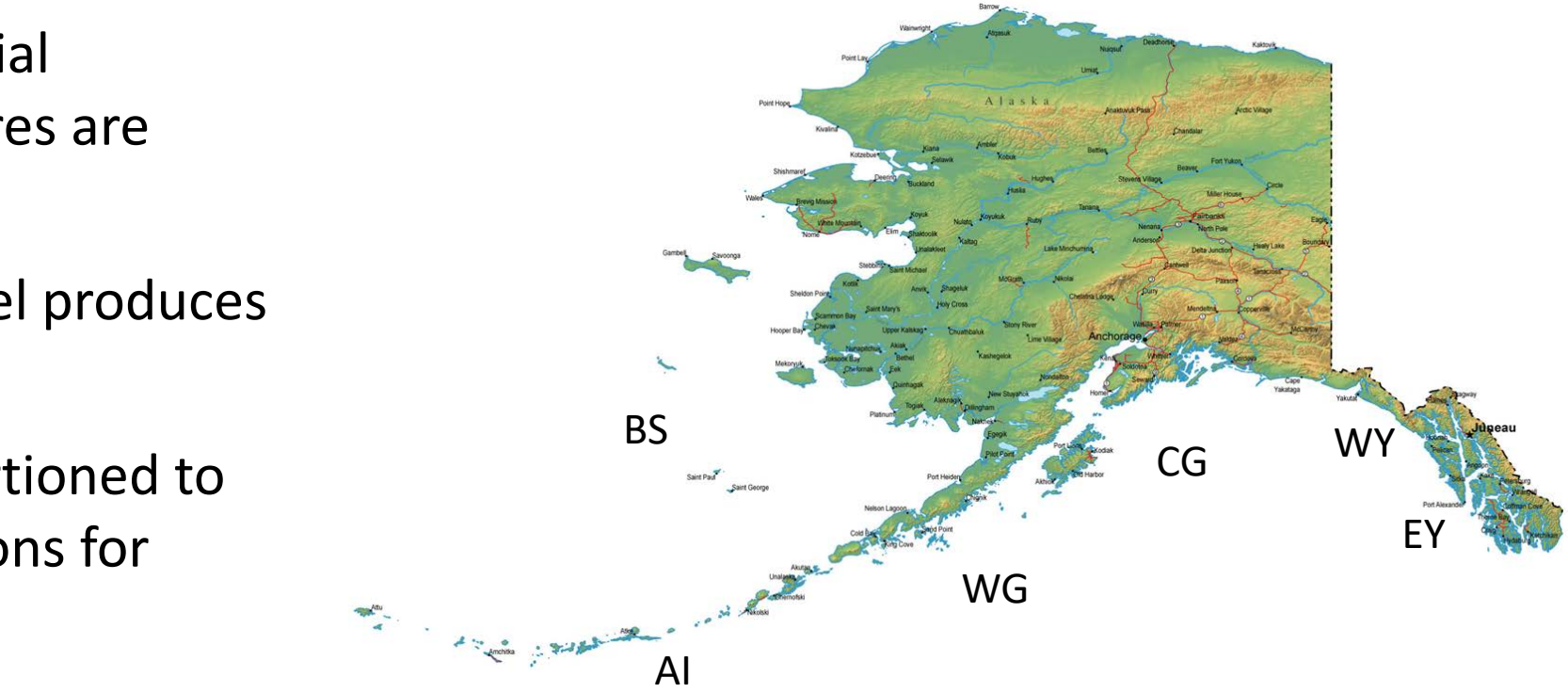
- Apportionment – how we divide ABC (Allowable Biological Catch) into management areas

Not analyzing:

- Allocation – splitting between sectors (like fixed gear and trawl)
- NPFMC harvest control rule or Tier system

Why look at sablefish apportionment?

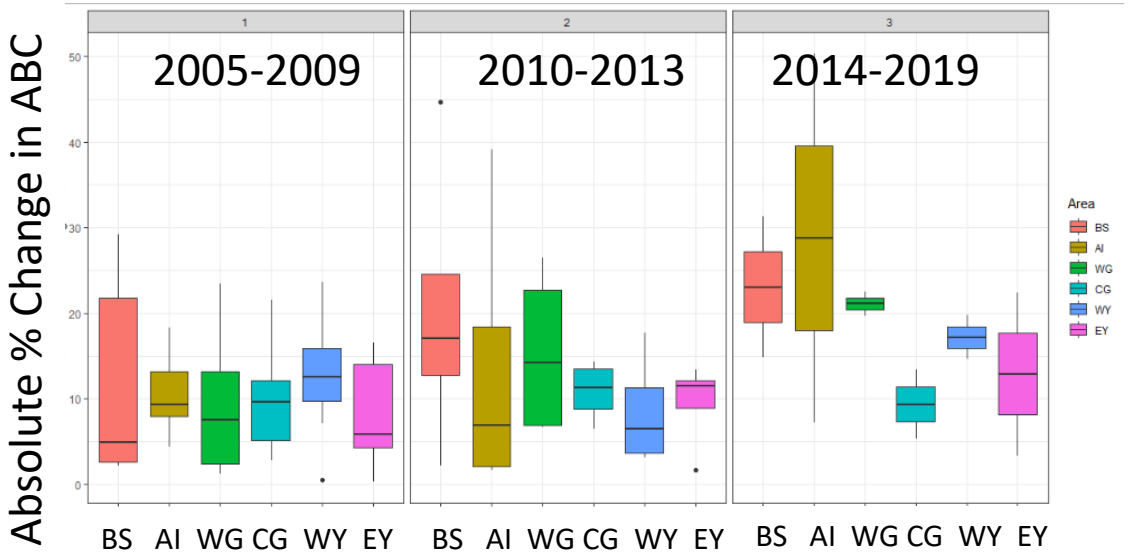
- IFQ program has a spatial component: quota shares are region-specific
- Stock assessment model produces a single ABC
- ABC needs to be apportioned to management sub-regions for quota division



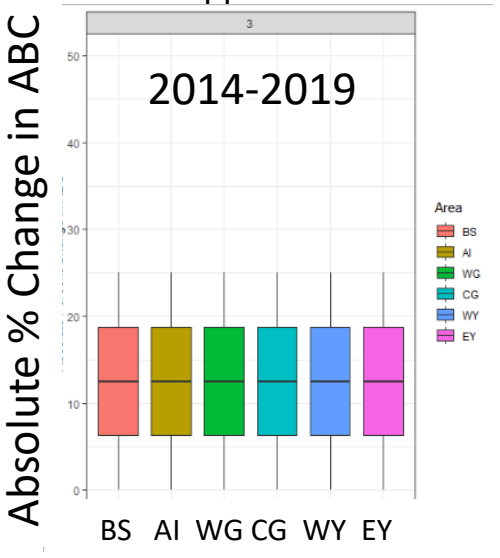
Recent apportionment history

1999-2013	ABC Apportionment via weighed moving average of fishery and survey data: “NPFMC” apportionment
2010-2013	Apportionment becoming more variable between years
2014 - 2020	Apportionment to management areas ‘fixed’ for 2014 and onward at the 2013 apportionment proportions

“NPFMC” Apportionment



“Fixed” Apportionment



What are some potential causes for instability in apportionment?

NPFMC apportionment – let's look at the components…

- Survey numbers,
  - Alternating years for BS and AI survey, whale depredation
- Fishery CPUE
  - whale depredation, lower sample size (higher variability)
- Sablefish movement
- Sablefish recruitment

Apportionment Simulations

Conceptual overview of simulation – in about 3 slides

‘Apportionment Simulations’ components

What’s an OM – Operating Model?

- A ‘created’ population (of sablefish) where we specify the important details (birth rate/recruitment, natural mortality, etc)

What’s an EM – Estimation Model?

- Our sablefish stock assessment (simplified)

What’s a management procedure?

- The process of collecting data about the OM fish/fishery, assessing the population (EM), and applying harvest regulation(s) – including applying our Tier system and apportionment

How does it all fit together to answer the question(s) we are asking?

OM

- Create a population of fish that ‘look’ and perform like sablefish
- Six management areas, with movement between them
- Simulate a survey and collect data to use in the EM
- Collect and retain the OM population ‘true’ details
- Abundance and biomass (by age)
- Harvest rate

EM

- Slightly simplified version of our sablefish stock assessment model
- Collect and retain the EM assessment model output
- Estimated abundance and biomass (by age)
- Estimated harvest rate
- ABC and how it was apportioned to management areas

The OM-EM loop:

- For **each** of the 10 apportionment types: 175 replicates that are 23 years of forward simulation of the OM population and EM assessment
- Can compare the EM estimates to the ‘true’ OM
- Do this for every apportionment type we want to examine

A lot more details in the 2019 Sablefish SAFE (Appendix 3D)

Apportionment types

These are the different ways of apportioning ABC we used in simulations – 1 slide

Apportionment types

1. Equal: Each region receives 1/6 of the ABC.
2. Fixed: The apportionment proportions from the 2013 assessment that have been applied as fixed proportions for 2014-2018.
3. Equilibrium: Based on the stationary distribution of the movement rates.

Proportions to each area are the same every year

4. NPFMC: A 5-yr exponentially weighted moving average of fishery and survey indices; survey weight is 2x fishery weight.
5. Exp_survey_wt: Similar to 'NPFMC' option but using survey index only.
6. Exp_fishery_wt: Similar to 'NPFMC' option but using fishery index only.
7. Non-Exp_NPFMC: A 5-yr moving average of fishery and survey indices.
8. Partial_fixed: BS and AI receive 10% of the ABC each, WG, CG, WY, and EY are apportioned based on NPFMC method.

Tied to a survey or fishery index – variation on a weighted method

9. Age_based: Based on the proportions of fish at age of 50% maturity in each area - i.e. areas with greater proportion of fish at age of 50% maturity or greater will be apportioned a greater proportion of ABC.
10. Term_LLsurv: Terminal year of longline survey (no exponential weighting).

Oddballs

Apportionment simulation results

Results and the metrics we have to help compare the pros and cons of each apportionment type

What are the tradeoffs of alternative types of apportionment of ABC to management areas?

- Sustainability – stay above biological reference points
- Stability – year-to-year change in ABC
- Social-Economic – value, age of fish in each area, etc.

Master tables of results

- Separate handout (for those in person) showing many of these results in one place, in two different ways
  - Summary Table A
  - Summary Table B
- Also available from the Council website, same location as this presentation.

Concern about catching small fish

Issue:

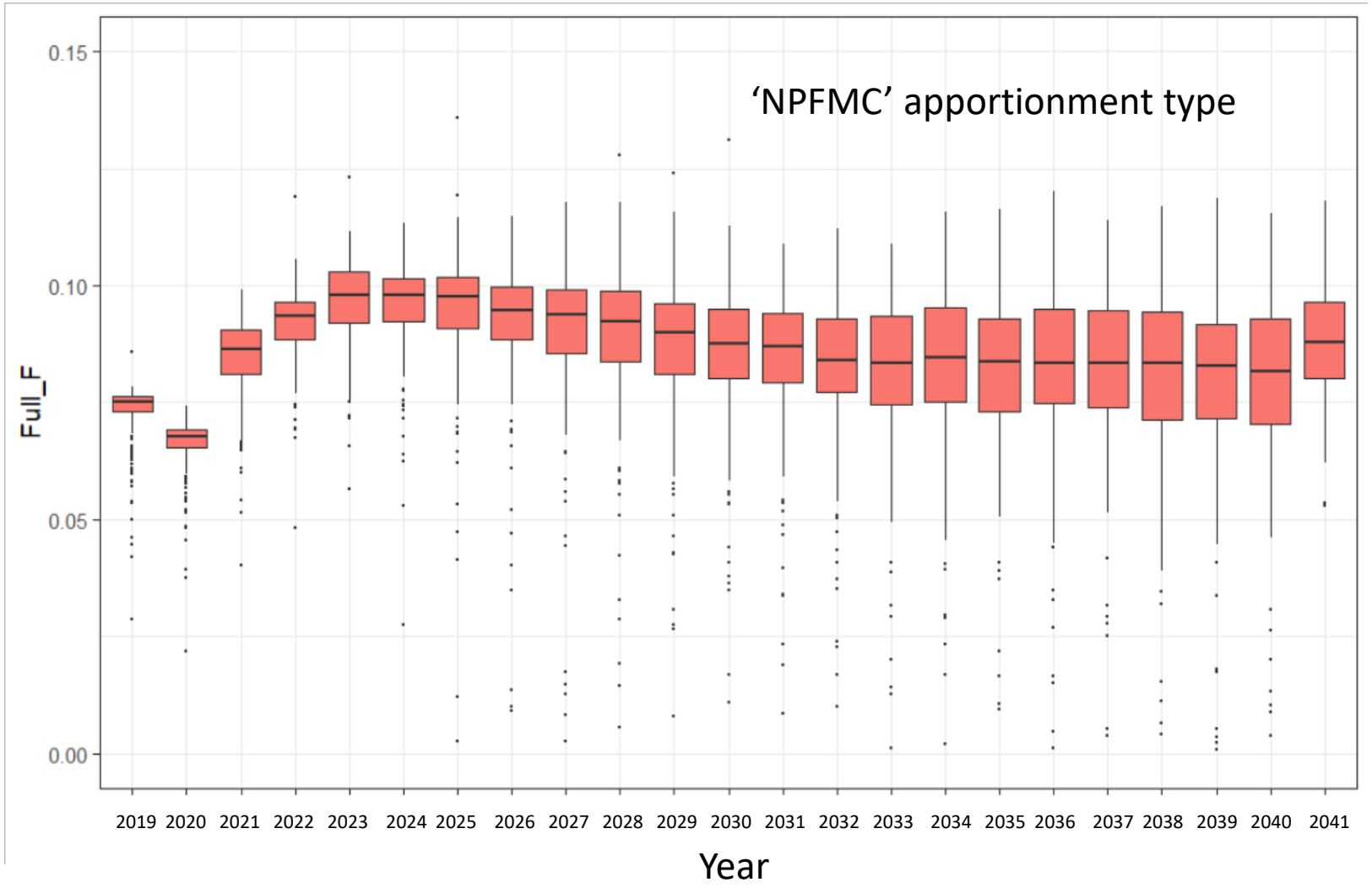
Concern about young fish being caught before they mature.

Approach:

Examine exploitation – the proportion of ‘true’ (OM) population caught by age and area

Estimated exploitation rate (from the EM)

- Simulated exploitation rates generally quite low, regardless of apportionment type – average is around 10%
- Cannot get exploitation by area from the stock assessment/EM

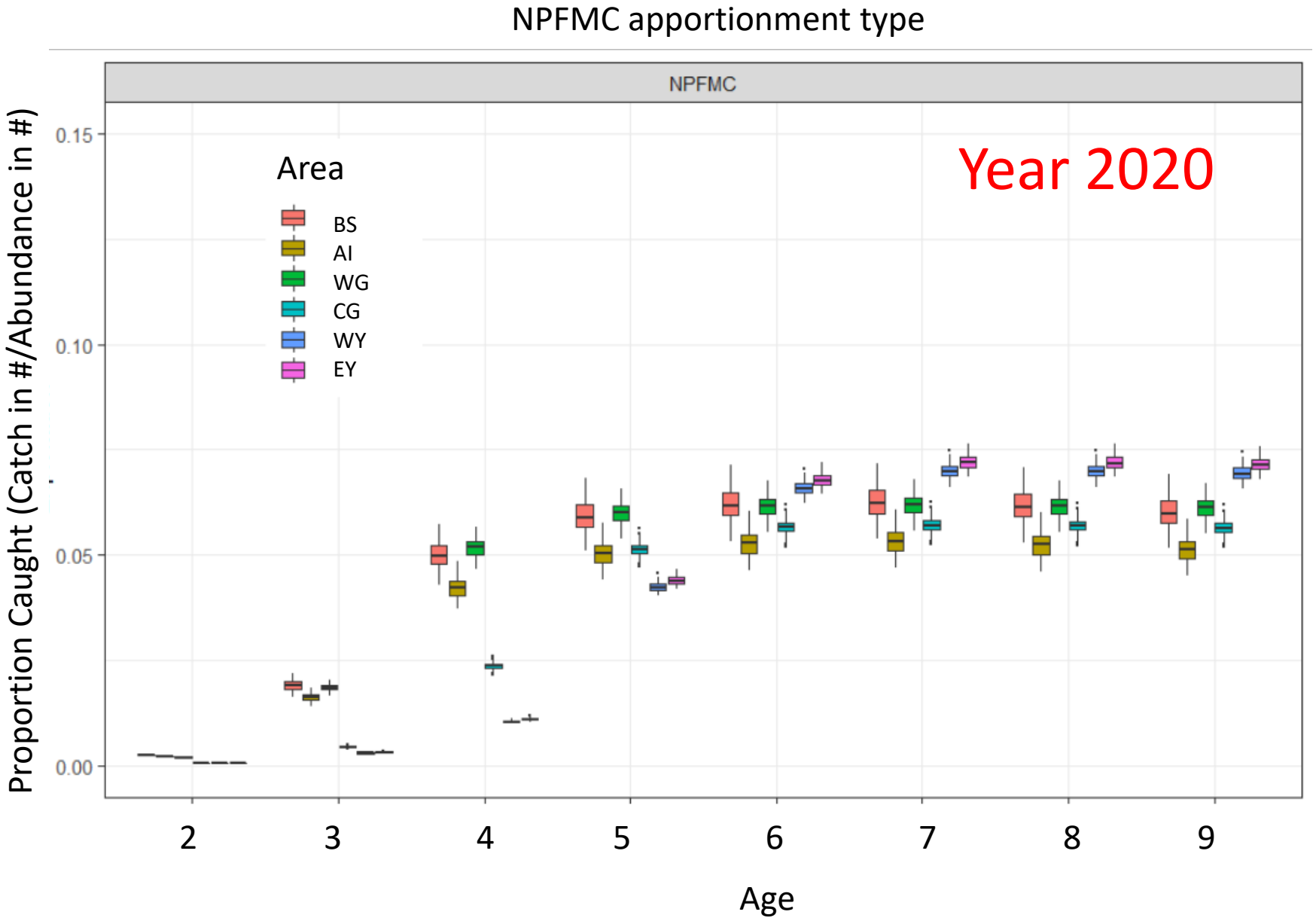


Issue:

Concern about young fish being caught before they mature.

Look at the OM population:

- Very low (<5%) exploitation of age 2 (~18 inch) and 3 (~21 inch) fish in all areas.
- Age 4 fish in the west (BS-AI-WG) have higher exploitation than ‘east’ areas
- Age 4 fish are 6-8% of the OM population in 2020 (on average)



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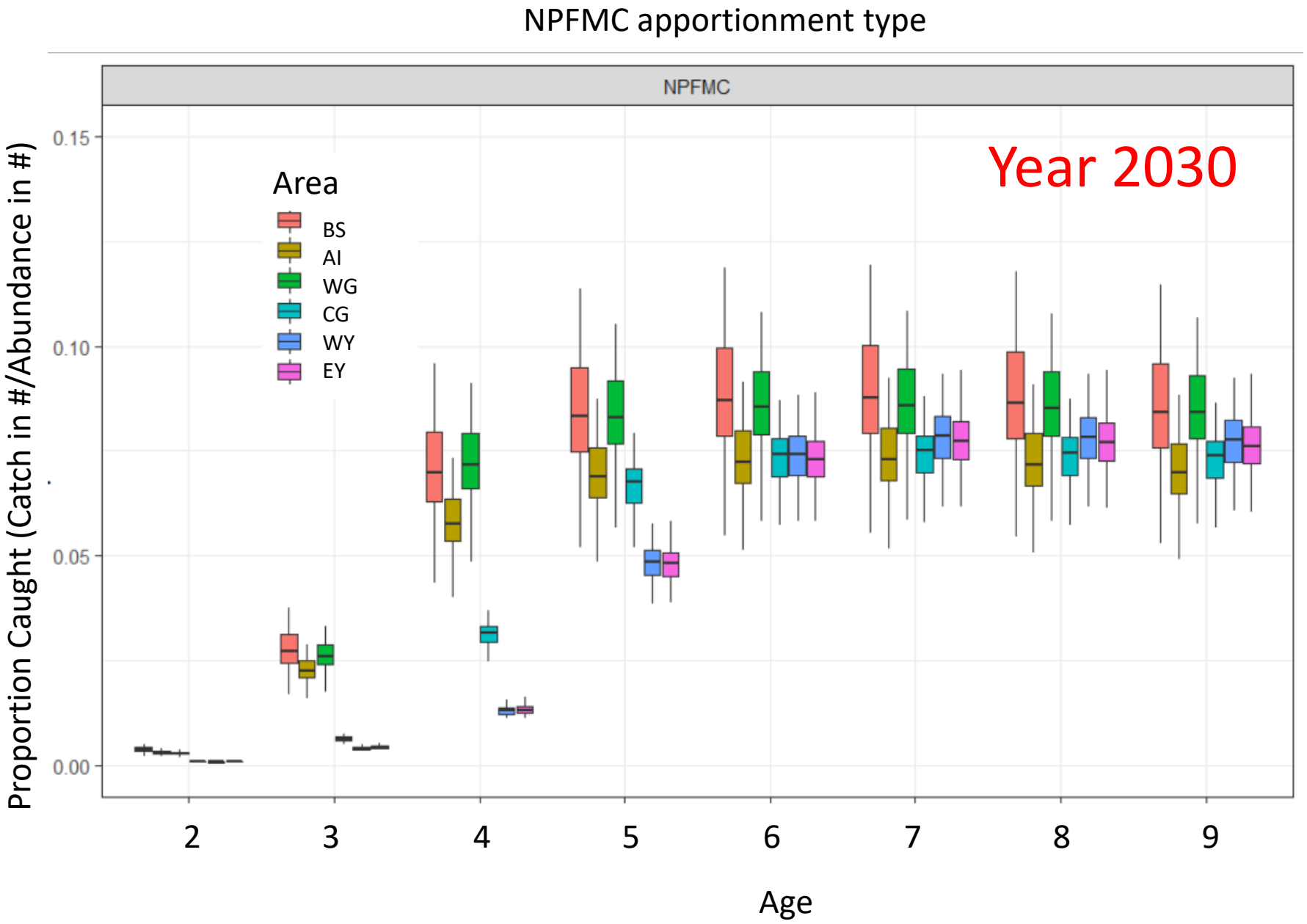
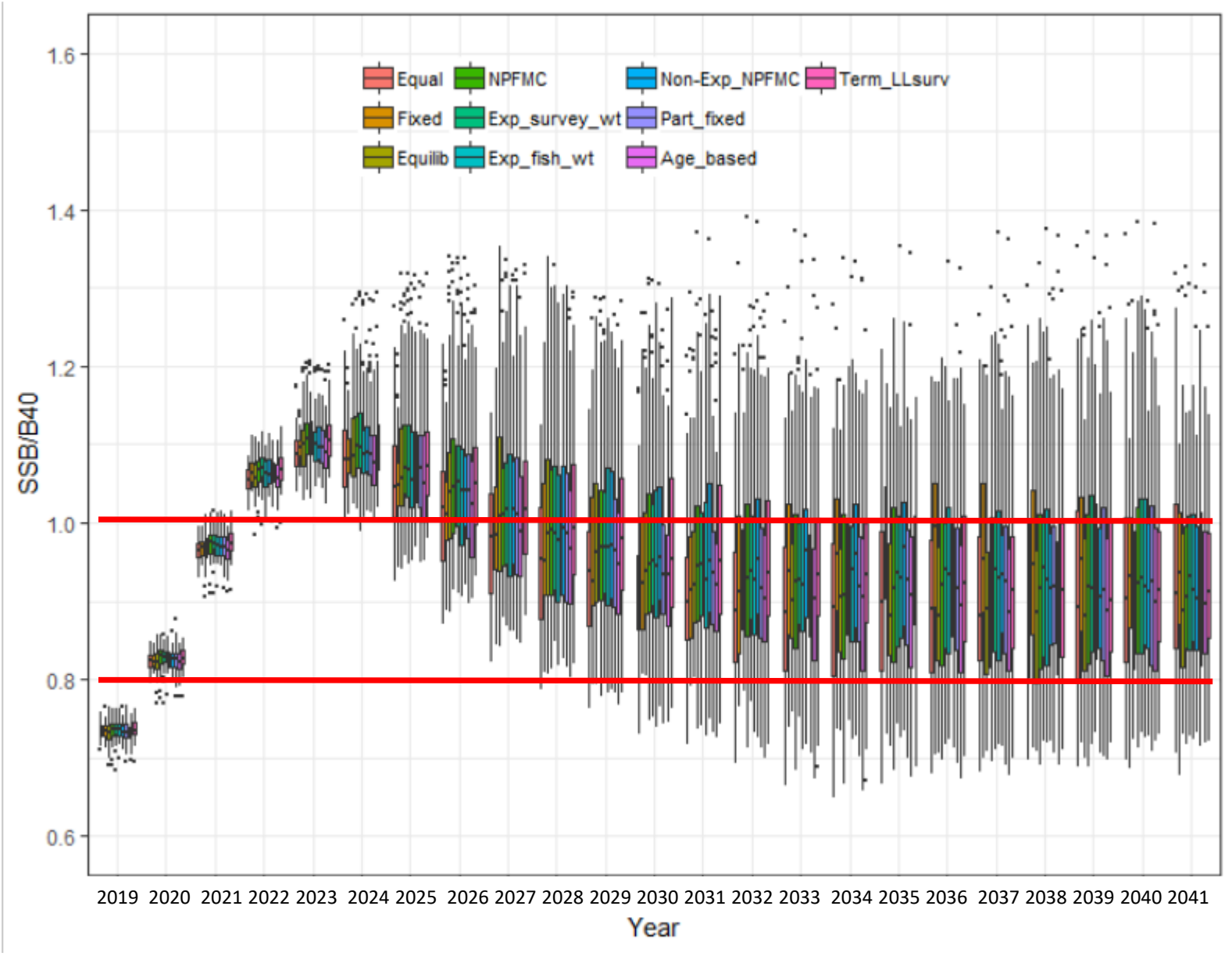


Long term projections & sustainability

Long term simulation outcomes

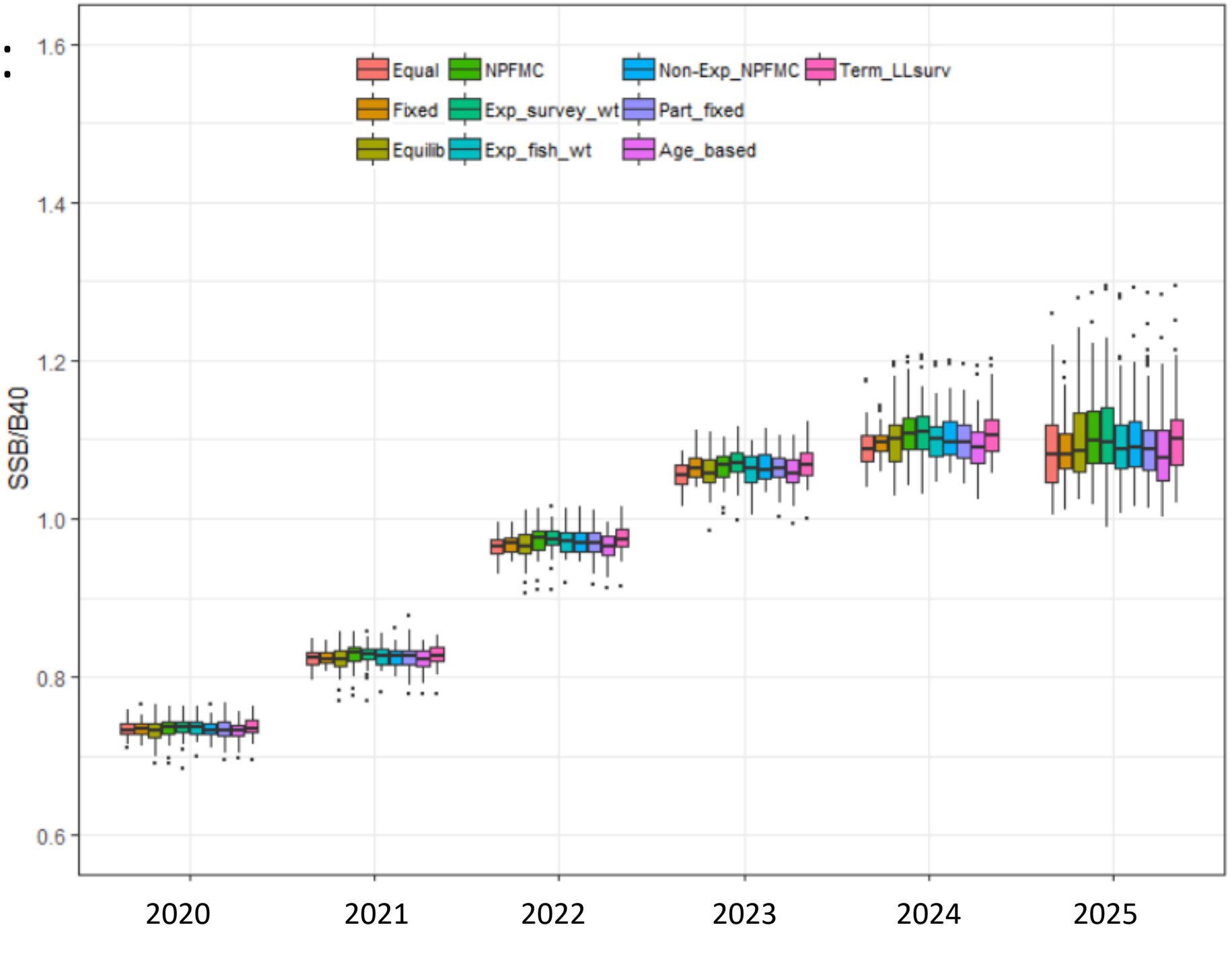
- No major red flags
- NPFMC harvest control rule dominates
- Zoom in on early years next



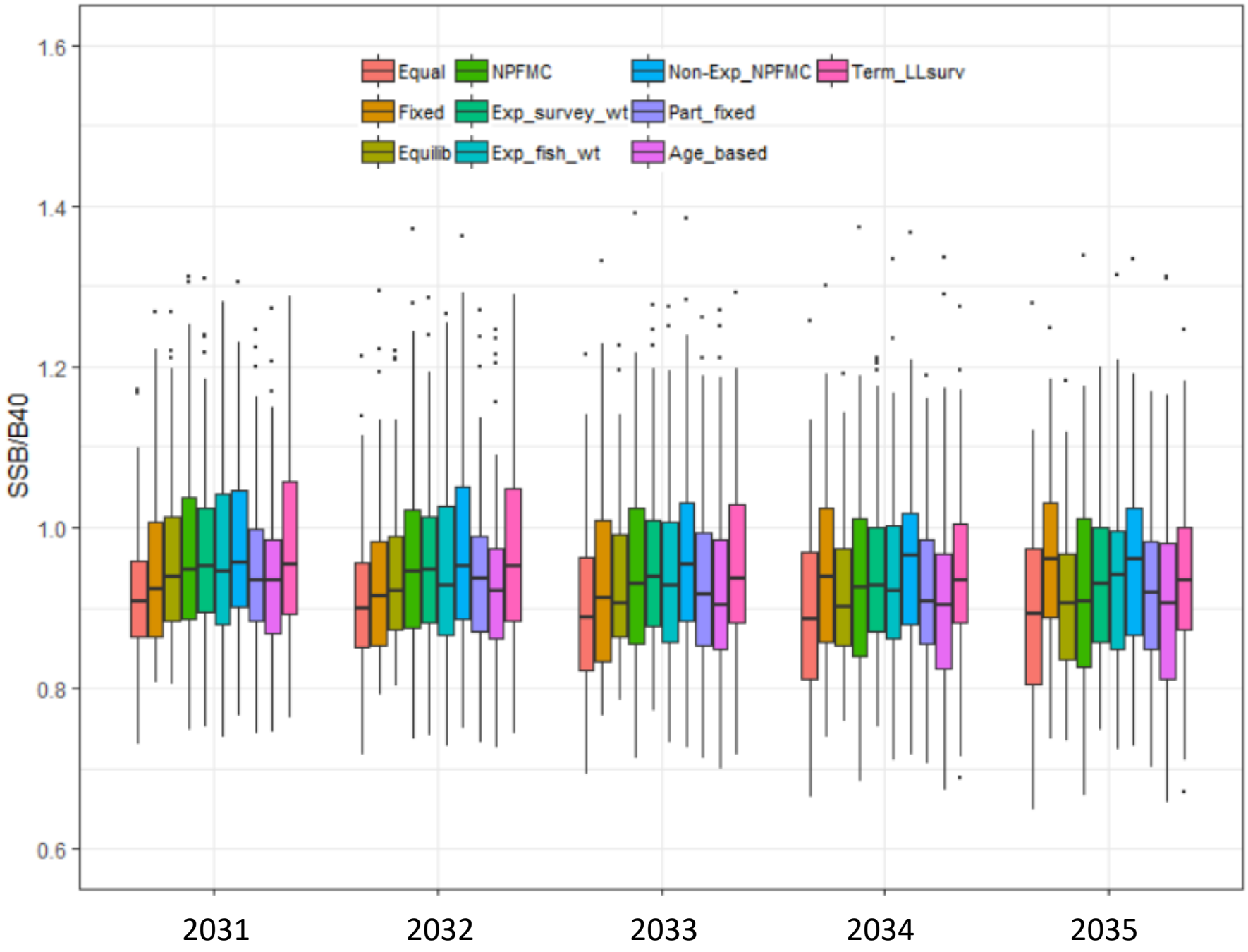
Sustainability: SSB/B_{40}

Zoom in on first few years.

- Very minor differences between apportionment types.
- Values increasing as the recent large year classes mature.



Sustainability: SSB/B_{40}



Sustainability conclusion

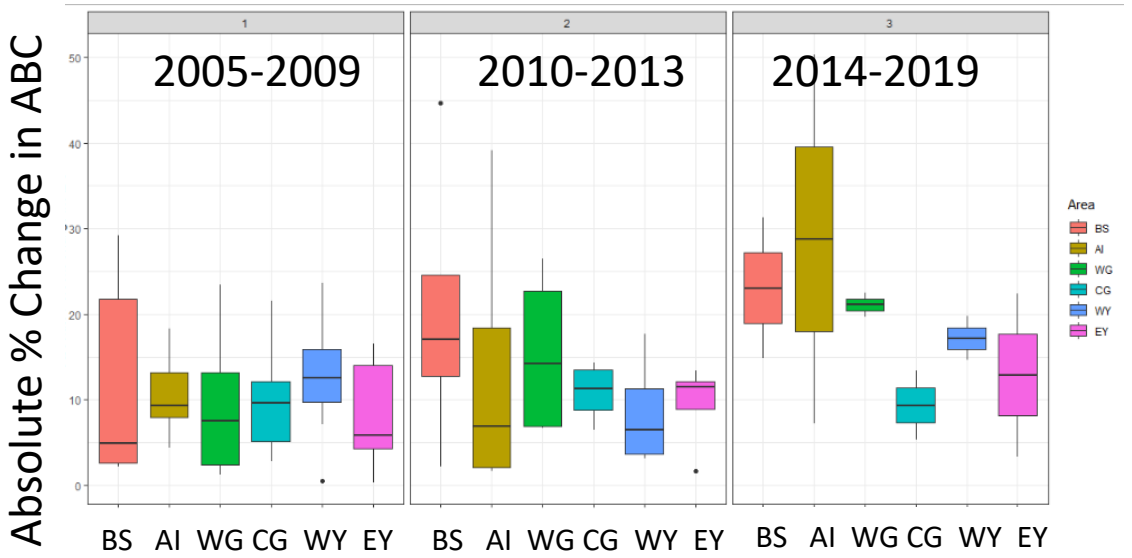
- Given the assumptions in the operating model (our simulated population's traits), there's no indication that one apportionment type is better than others from a sustainability perspective (if SSB/B40 is your metric).
- Other sustainability outcomes we can look at:
  - Depletion (see slide 61)
  - How well apportionment to areas matches the population in areas (see slides 62-63)
- Are you concerned about this conclusion? Do you want to see or discuss more about biological sustainability and apportionment? Do you want to see either of the additional results named above?

‘Stability’ of ABC

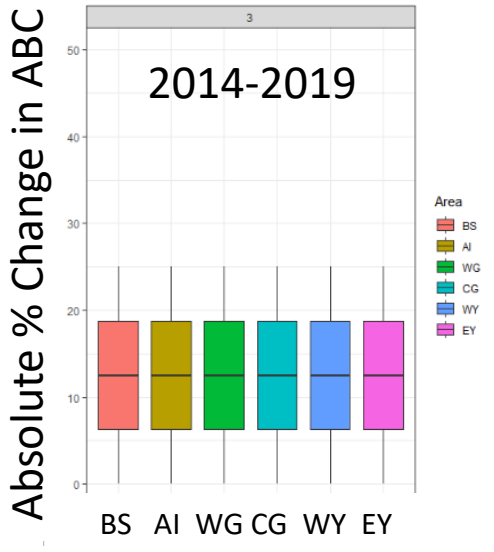
Recent apportionment history

- Total ABC changes ~8-12% per year historically
- Can be greater: 2020 ABC was potentially 56% increase from 2019 ABC
- Individual management areas can see much greater change in ABC year-to-year

"NPFMC" Apportionment



"Fixed" Apportionment



Percent of years and replicates where ABC changes by less than 20%

Equal	Fixed	Equilib	NPFMC	Exp surv_wt	Exp fish_wt	Non-Exp NPFMC	Part-fixed	Age-based	Term LLsurv
86.4	90.6	91.8	90.4	90.5	89.1	90	91.2	88	85.8

- BLUE = more stable, RED = less stable.
- Equilibrium and Partially Fixed are the most stable overall when your tolerance for ‘stable’ is reducing the frequency of ABC changes of more than 20% from year to year.
- What is an important threshold – 20%? Or something else?

Percent of years and replicates where ABC changes by less than 20% - by management area

	Equal	Fixed	Equilib	NPFMC	Exp surv_wt	Exp fish_wt	Non-Exp NPFMC	Part-fixed	Age-based	Term LLsurv
BS	82.3	86.9	87.4	83.9	84.1	83.1	87.6	88.2	78.2	75.1
AI	82.3	86.9	87.4	85.5	85.5	84.0	87.6	84.4	85.3	77.9
WG	82.3	86.9	87.4	86.3	87.2	84.9	85.8	82.0	82.2	84.2
CG	82.3	86.9	87.4	87.1	87.1	85.9	87.0	87.4	85.7	85.9
WY	82.3	86.9	87.4	87.2	87.3	89.9	87.0	83.6	88.1	86.0
EY	82.3	86.9	87.4	87.5	87.1	90.3	87.4	84.2	89.7	85.1

- Colored over rows – High numbers (BLUE) are ‘better’ – more stable.

Variability conclusion

- The Equilibrium and Partially Fixed apportionment types are fairly stable when considering all areas, with several others than come in close – Fixed, NPFMC, Exp_survey, and Non-Exp_NPFMC. For individual areas, stability varies between apportionment types and the only clear 'loser' for all areas is the Terminal LL survey and Equal apportionment types.
- Other stability outcomes we can look at:
  - The mean absolute percent change in ABC summed over areas (see slide 64)
  - The mean absolute percent change in ABC for each area and apportionment method (see slide 65)
  - Percent of years and replicates where ABC changes by less than [10, 15, 30, 40, 50]% (see slide 66)
  - Deeper dive on stability by area as a figures instead of tables (see slides 67-69)
- Are you concerned about this conclusion? Do you want to see or discuss more about variability and apportionment? Do you want to see any of the additional results named above?

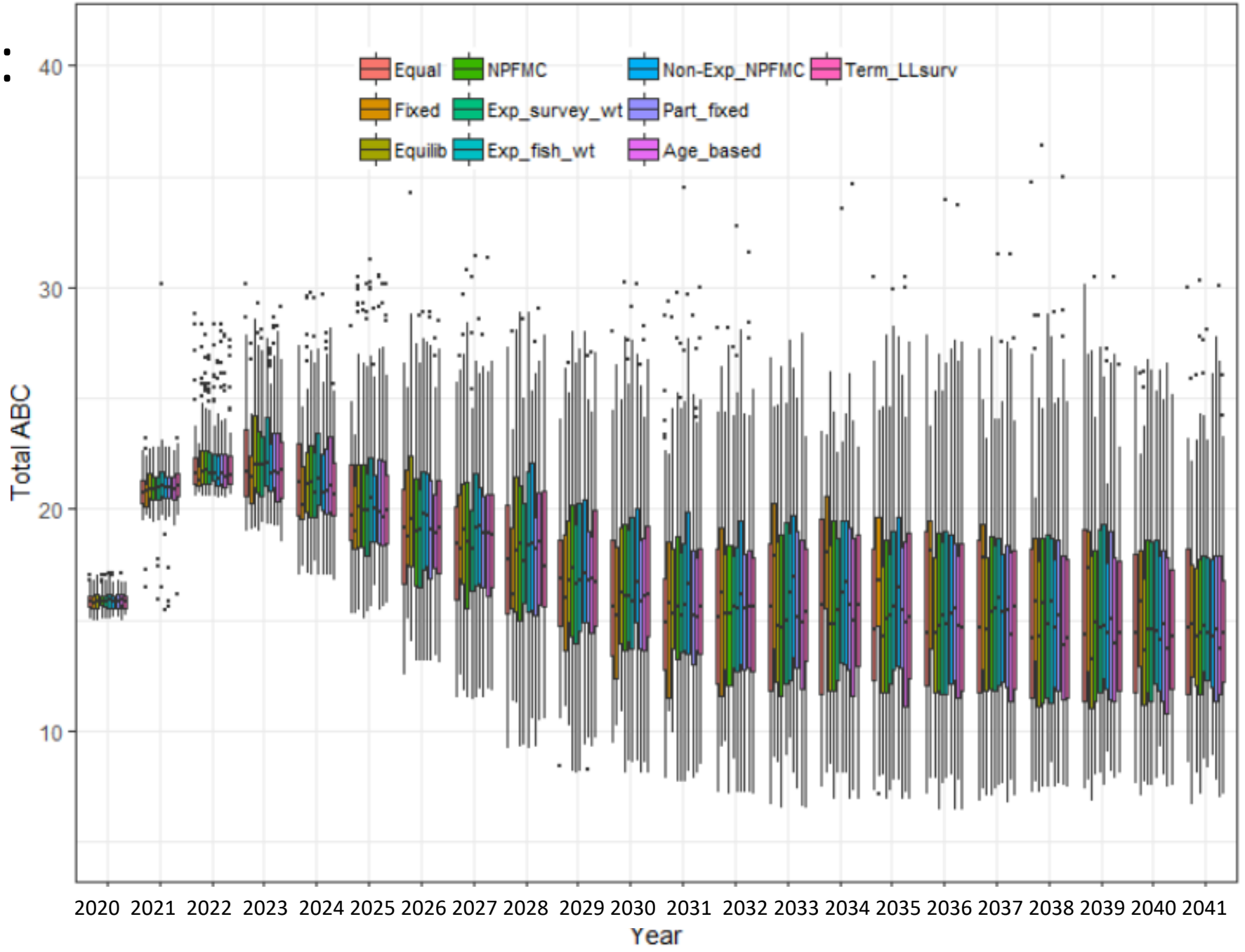
Social/Economic

Social/Economic: Total ABC

Similar central tendencies (mean, median) in Total ABC amount

Large potential range of ABCs over all the years and replicates, and for all apportionment types.

Zoom in on the first few years next…

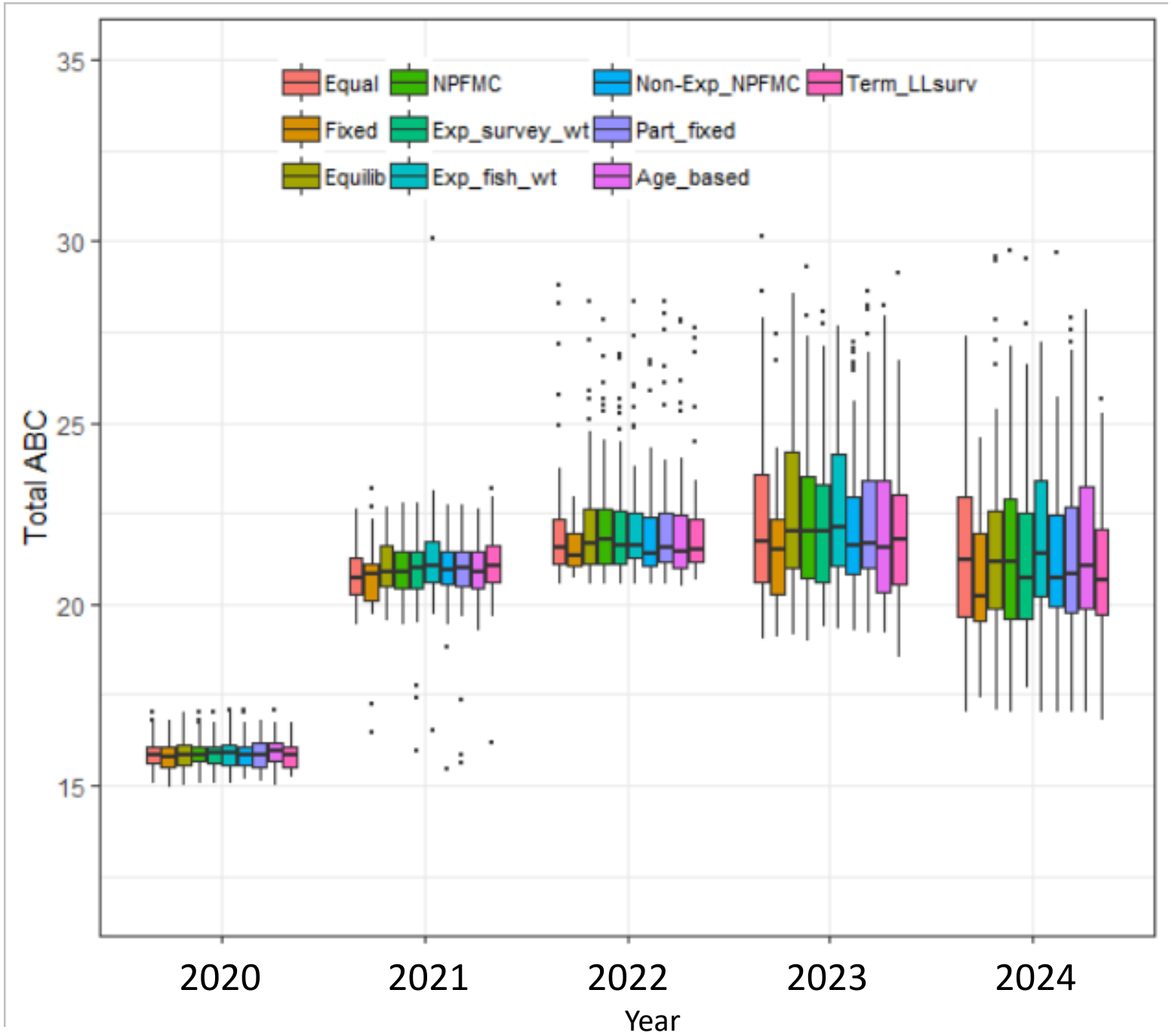


Social/Economic: Total ABC

Similar central tendencies (mean/median) for ABC for all apportionment types.

Range of potential ABC values increases over all the years and replicates.

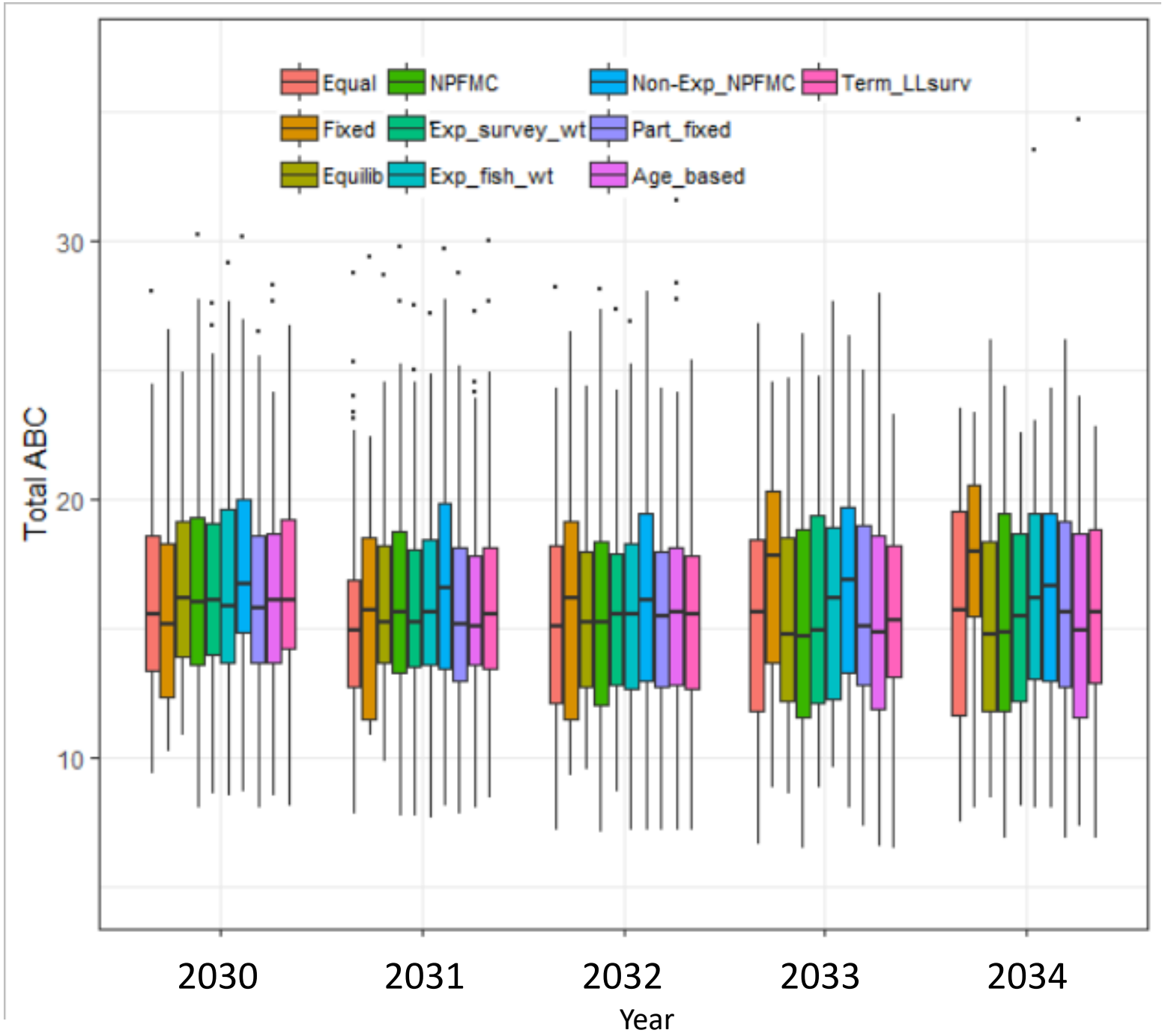
Zoom in on some ‘middle’ years next…



Social/Economic: Total ABC

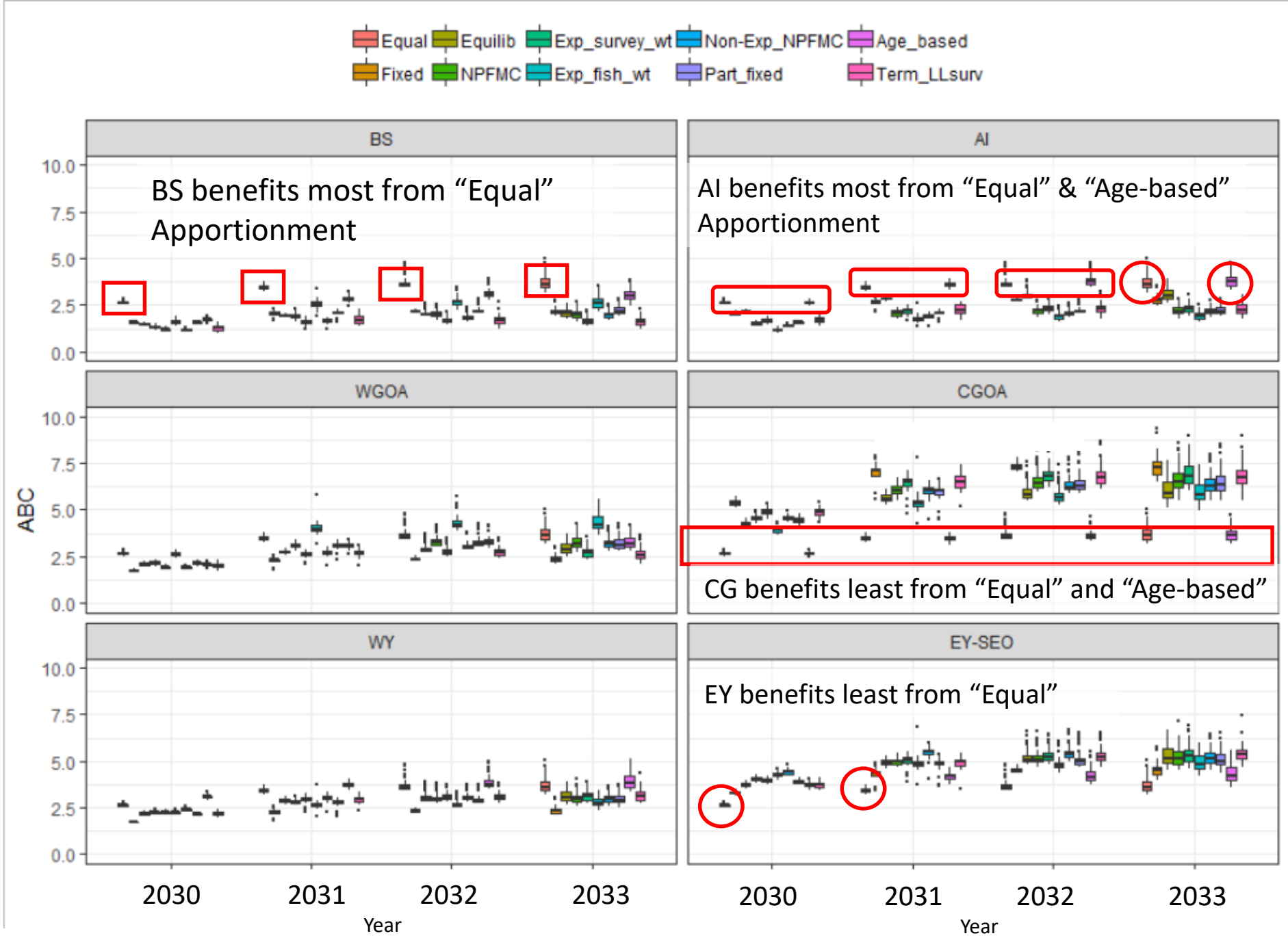
Similar central tendencies (mean/median) for ABC for all apportionment types.

Large potential range of total ABC for all these years and replicates for all apportionment types.



ABC by area

Apportionment affects management areas differently in the medium-long term.



Social/Economic conclusion

- Total ABC is has a wide range of potential values for all apportionment types, and the central tendency has some differences between the apportionment types. ABC apportioned to management areas can be very different between apportionment types.
- Other Social/Economic outcomes we can look at:
  - The proportion of forward projecting years where ABC in each region is greater than a specified threshold (see slides 71)
  - Median age of fish in each management area (from the OM, see slides 72-73)
  - Median age of catch in each management area (from the OM, see slides 74-75)
  - Median value of catch in each management area (see slides 76-77)

Are you concerned about these results? Do you want to see or discuss more about social/economic outcomes for apportionment? Do you want to see any of the additional results named above?

Results tables – Summary Table A and B

Two tables – results in different ways

- No ‘magic bullet’ answer to which apportionment type is best.
- Pros and cons to each, and the best options depends on what you care about most
  - Which management area you are concerned about
  - Whether you are more concerned with stability or economics or sustainability

Additional work in progress

- Examine alternative recruitment scenarios
  - Low recruitment
  - Stock-recruitment relationship

Focus questions

- Are the criteria (‘performance metrics’) we use to show pros and cons of apportionment types relevant to you?
- Am I missing something that would help you determine a preference between apportionment type options?
- What parts of this process need better/more explanation?
- Based on what you’ve seen today, which apportionment type (or types) appeal to you most, and why?

End of presentation

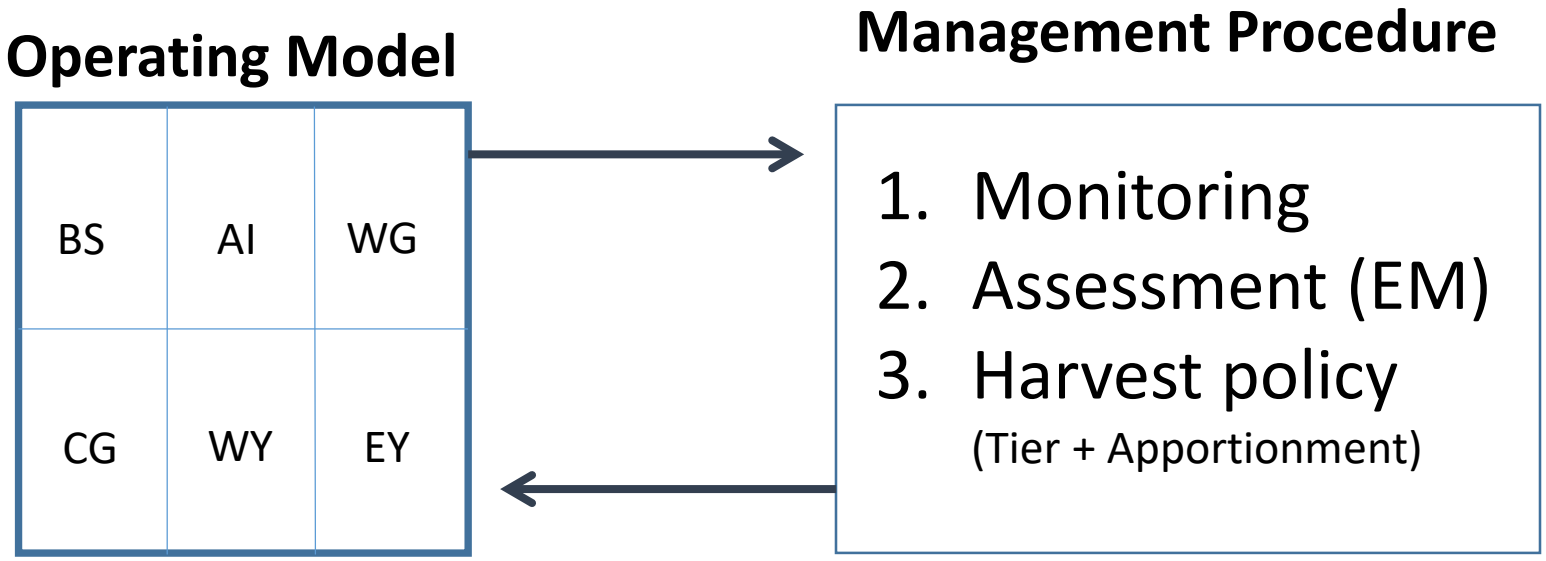
Dig deeper slides next

Digging deeper: more slides

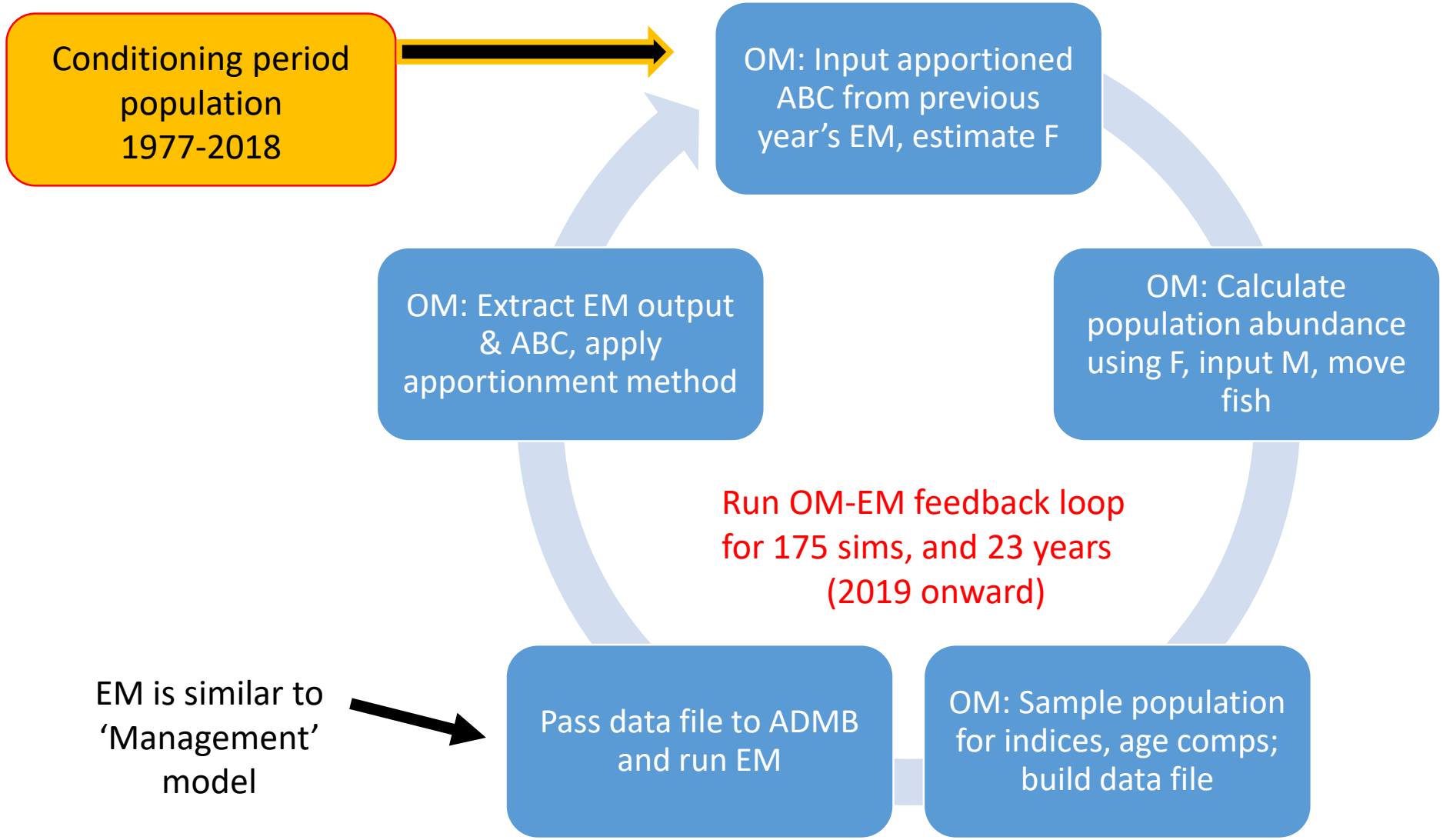
Model details

The nerdy bits.

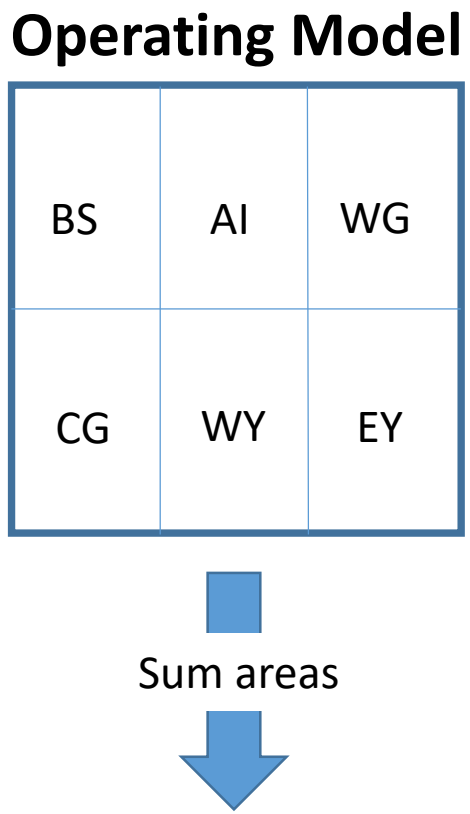
Apportionment simulation loop



Methods – OM-EM feedback



Apportionment simulation component - OM



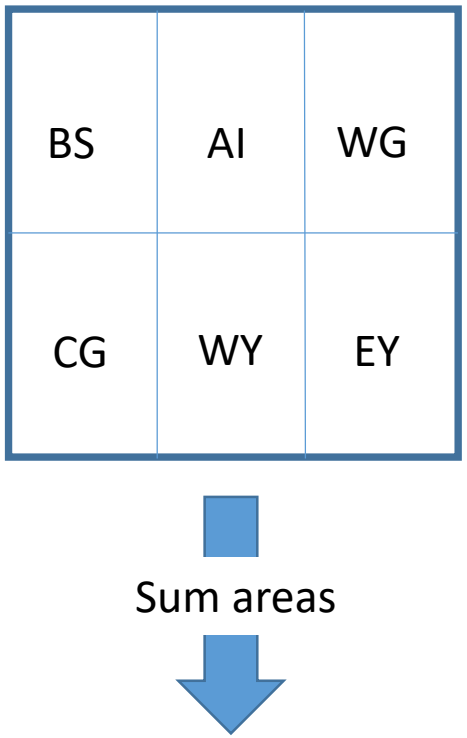
Inside any given area of the OM, we:

- Create fish each year via recruitment
- Remove fish via natural mortality and fishery harvest
- Move fish between management areas

We track the number and biomass of fish in this simulated world and this becomes our ‘truth’ against which we compare our stock assessment.

Apportionment simulation

Operating Model



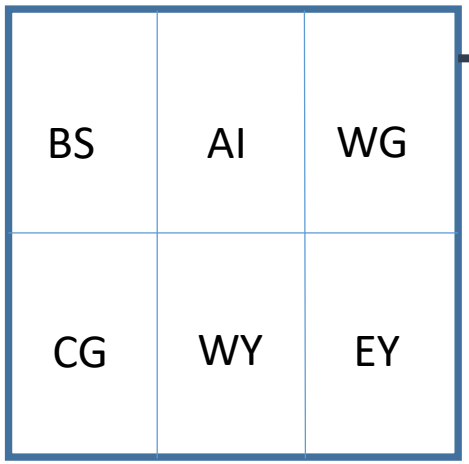
Each year that we simulate in the OM, we:

- Sample each area with a simulated survey and fishery (Monitoring)
- This gives us simulated data
  - Survey index of abundance
  - Fishery catches
  - Age composition data
- These data are used to conduct a stock assessment of our OM population.

Because we know the ‘truth’ of the population, we can test how well our EM (stock assessment) does at representing (simulated) reality

Apportionment simulation loop

Operating Model

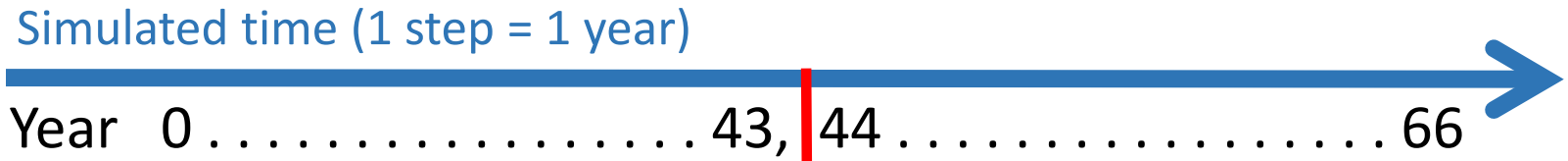


Management Procedure

1. Monitoring (Sample our OM simulated fish)
   use that data to
2. Conduct stock assessment (EM)
   to the population, inside the stock assessment, we apply the
3. Harvest policy (Tier level rules + Apportionment of ABC to management areas)
   ABC determines how many fish are harvested and removed from the OM population

1 trip around this loop =
1 year of FORWARD simulation

Apportionment simulation



OM Population set up
Creates the historic population
Years = 1976-2019

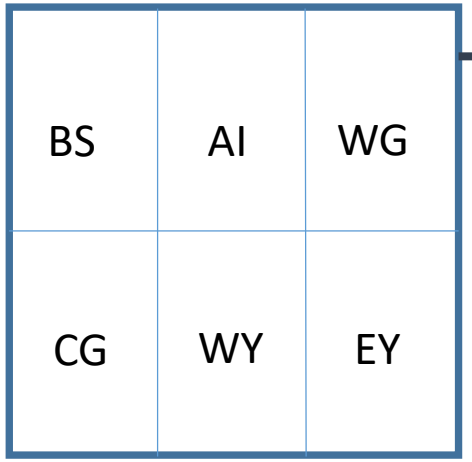
Forward simulation of OM:
Loop OM and Mgmt Procedure
(monitor, assess, harvest policy)
Years = 2020 – 2042 (23 years)

Force the population to look like sablefish by specifying the OM

Apply one apportionment policy for each 0-151+ year MSE

Spatial mismatch: Apportionment simulation loop

Operating Model



Management Procedure

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   ABC determines how many fish are harvested and removed from the OM population

Spatial process:
6 mgmt. areas

One area

Spatial process:
6 mgmt. areas needed because of IFQ program

Caveats and important OM details

- The NPFMC Tier 3 harvest control rules are still in place and used for determining ABC in the EM, we are only simulating different methods for apportioning ABC to management areas.
- We assume ABC=TAC and 100% of apportioned ABC is caught in each region.
- We do not correct for whale depredation in the ABC or survey index.
- Recruitment for the 2014 year class has been reduced in the conditioning period to 50 million to improve EM convergence and reduce crashing.
- Recruitment draws for the forward projecting period are also capped at 50 million.

Additional results slides

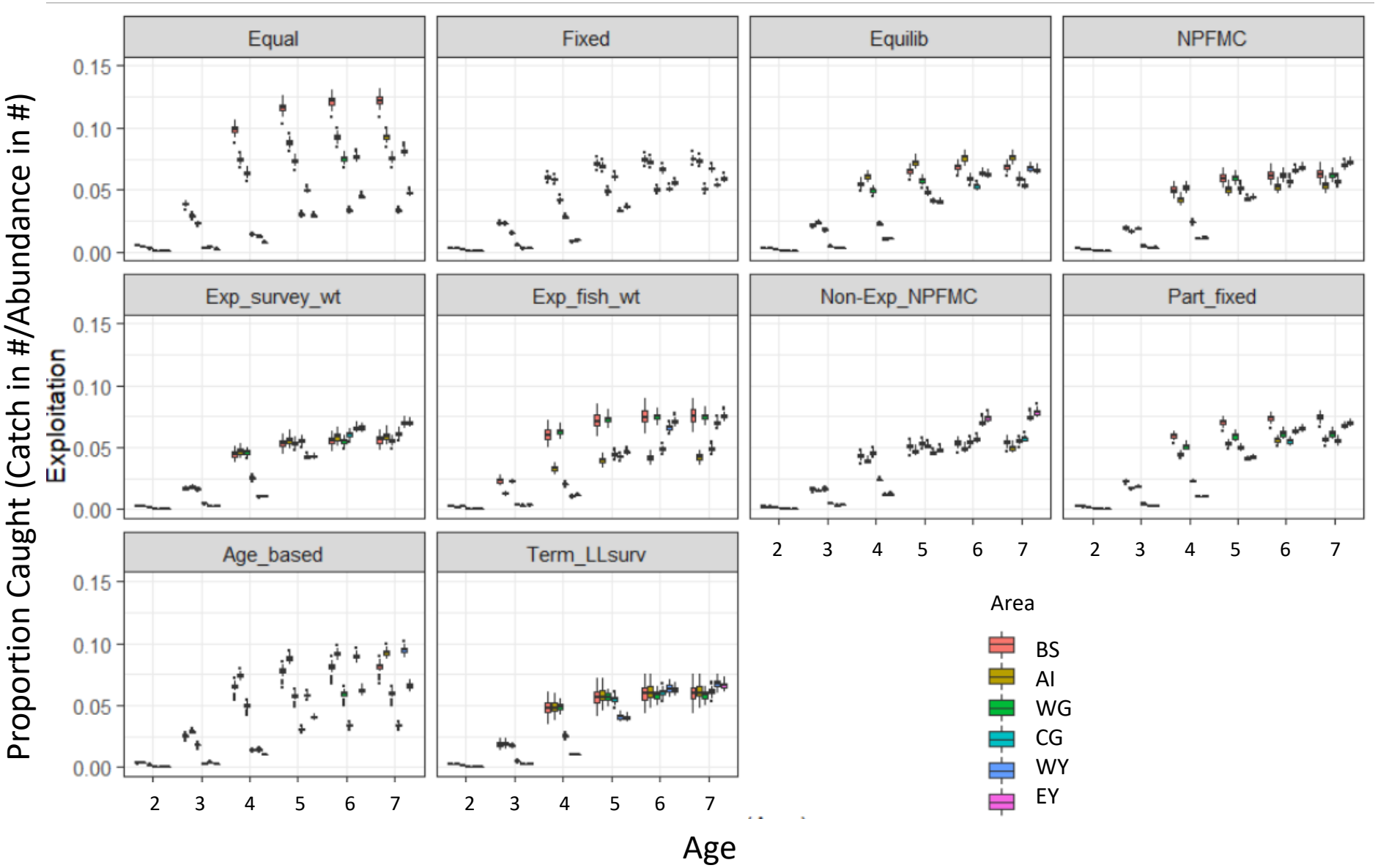
Issue:

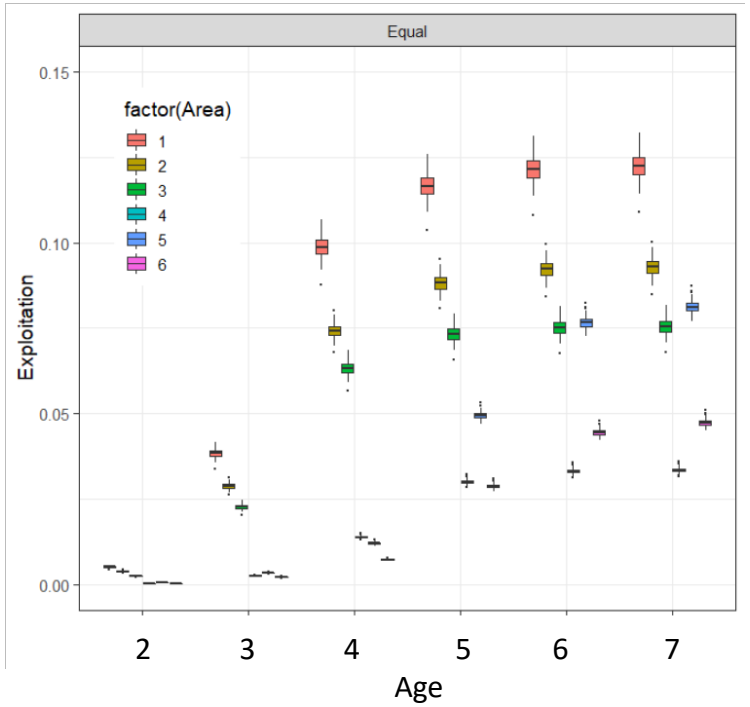
Concern about young fish being caught before they mature.

Approach:

Examine proportion of ‘true’ population caught by age and area

Year 2020

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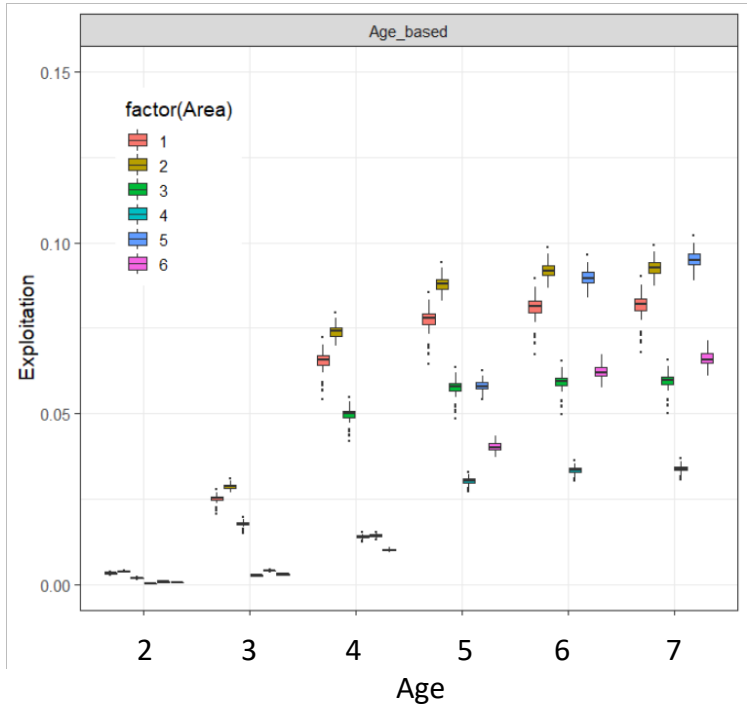
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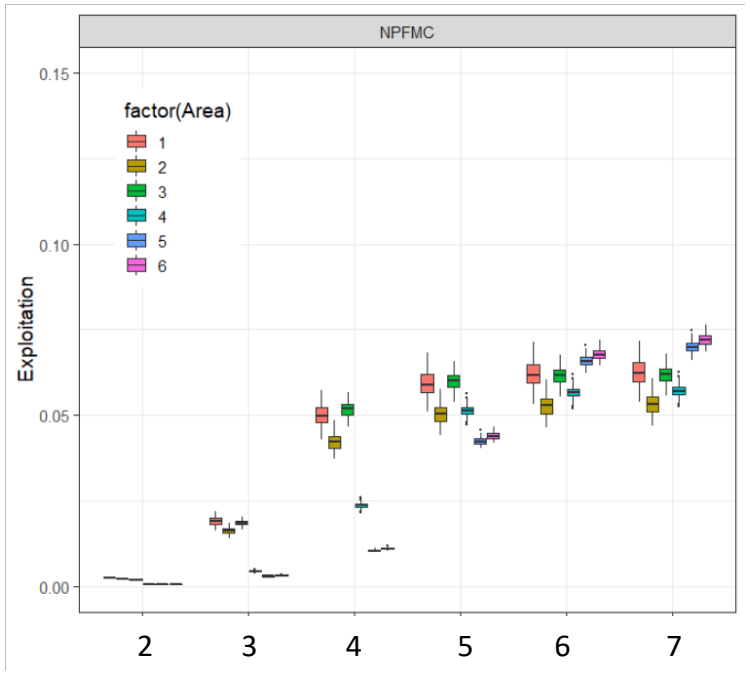
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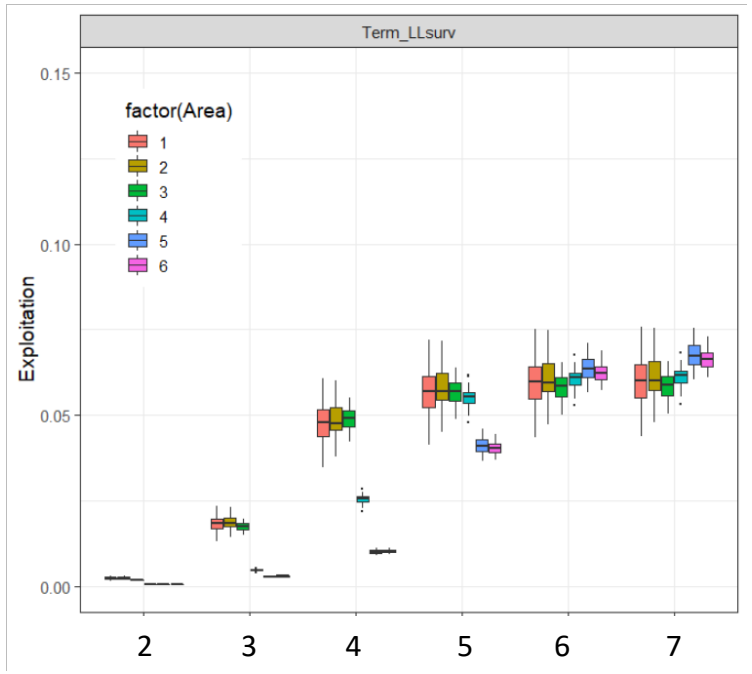
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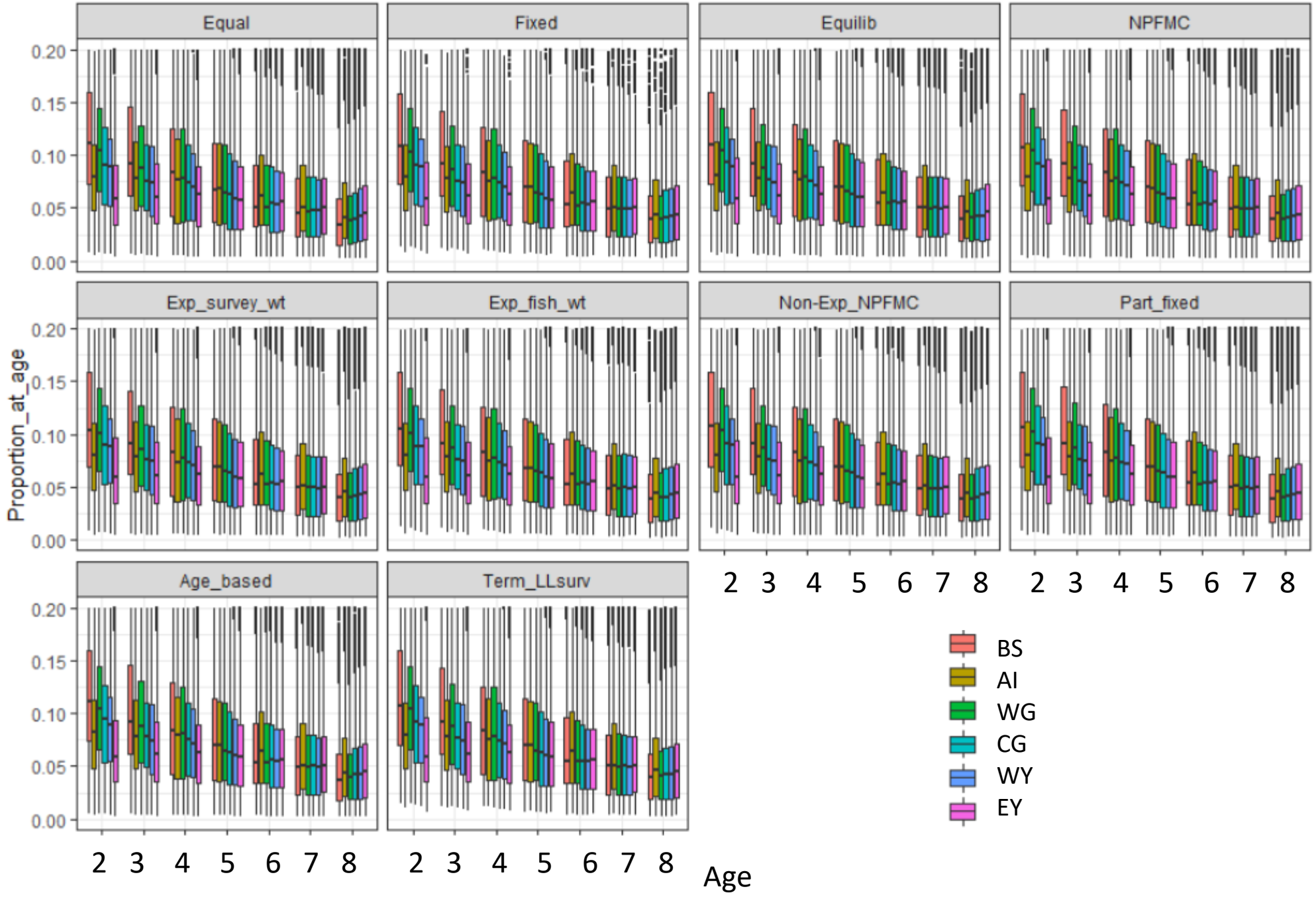
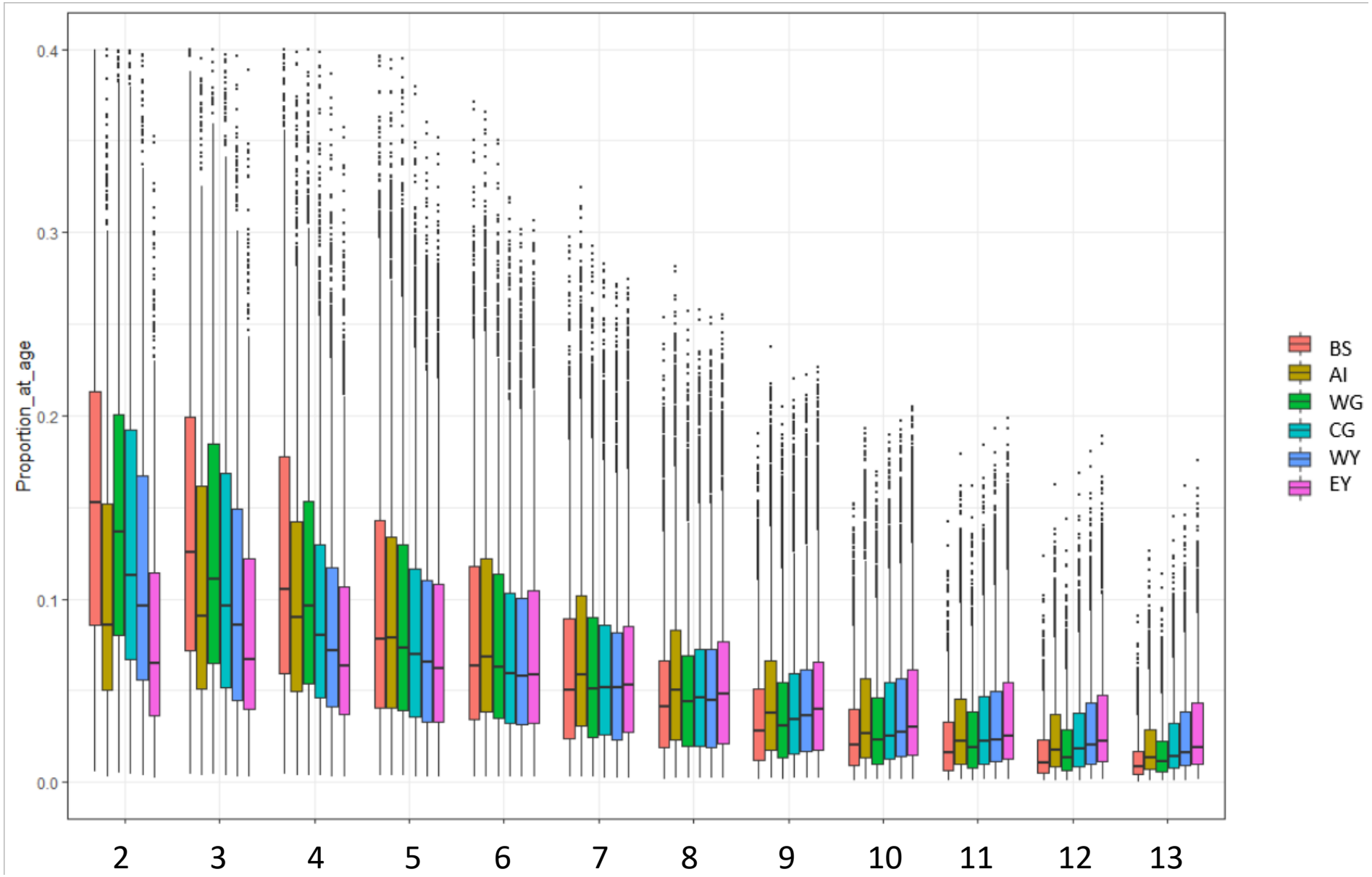
Age

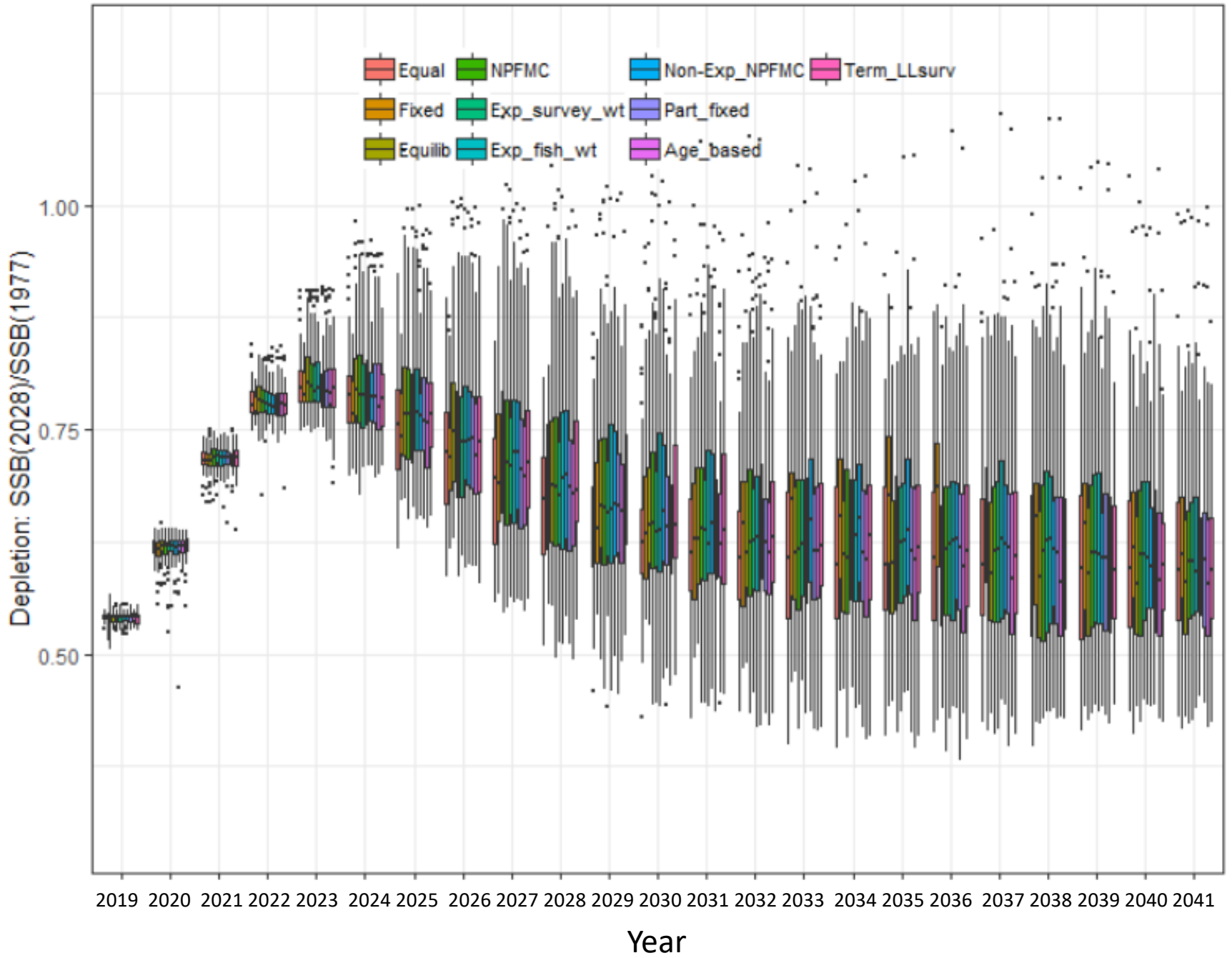
Proportion of OM population at each age



Proportion of population at each age (NPFMC only)



Sustainability: Depletion $SSB_{end\_year}/SSB_{1977}$



Sustainability: Track ‘true’ population biomass

Mean absolute percent match between ‘true’ SSB proportions by area and ABC proportion apportioned by area.

High % similarity means you are apportioning ABC similarly to how the fish are actually distributed.

CPUE issue if mismatch between apportionment and biomass?

	Apportionment type	% Similarity	
Unchanging ABC proportions for areas	Equal	41.8	Poor match
	Fixed	69	
	Equilib	71.3	
Tied to a survey or fishery index – variation on a weighted method	NPFMC	83.4	
	Exp_survey_wt	89.4	Good match
	Exp_fish_wt	69.8	
	Non-Exp_NPFMC	83.7	
	Part-fixed	77.3	
Oddballs	Age_based	52	Poor match
	Term_LLsurv	89.1	Good match

Sustainability: Track ‘true’ population biomass

Best match between true population and apportionment proportions by area (mean over years)

- Might be informative if you have special concern about an area (due to spawning or need to protect)

Area	Apportionment method
BS	Term_Llsurv
AI	Exp_fish_wt
WG	Fixed
CG	Part_fixed
WY	Equal
EY	Term_Llsurv

Stability: Absolute percent change in ABC

Average absolute percent change in ABC values across years, areas and simulations, for years 2021-2041.

	% Change	% Stability
Equal	11.6	88.4
Fixed	9.6	90.4
Equilib	9.6	90.4
NPFMC	10.3	89.7
Exp_survey_wt	10.2	89.8
Exp_fish_wt	10.8	89.2
Non-Exp_NPFMC	10.2	89.8
Part_fixed	9.9	90.1
Age_based	10.7	89.3
Term_LLsurv	11.3	88.7

Stability: Absolute percent change in ABC

Average absolute percent change in ABC values looking across years and simulations, for years 2021-2041, BY AREA.

Average absolute % change, 2021-2041

	Equal	Fixed	Equilib	NPFMC	Exp-survey-wt	Exp-fish-wt	Non-Exp-NPFMC	Part-fixed	Age-based	Term-LLsurv
BS	11.6	9.6	9.6	11.4	11.3	11.8	11.1	9.8	12.8	14.1
AI	11.6	9.6	9.6	10.8	10.7	11.3	10.4	9.8	10.2	12.9
WG	11.6	9.6	9.6	10.5	10.3	11.1	10.6	10.7	11.3	11.1
CG	11.6	9.6	9.6	10.0	9.8	10.4	9.7	10.0	10.1	10.1
WY	11.6	9.6	9.6	9.7	9.5	10.1	9.6	9.7	9.7	10.0
EY	11.6	9.6	9.6	9.4	9.4	9.8	9.6	9.4	9.8	9.7

ABC Stability

- Proportion of *year-area-replicate* combination where ABC change is less than the threshold

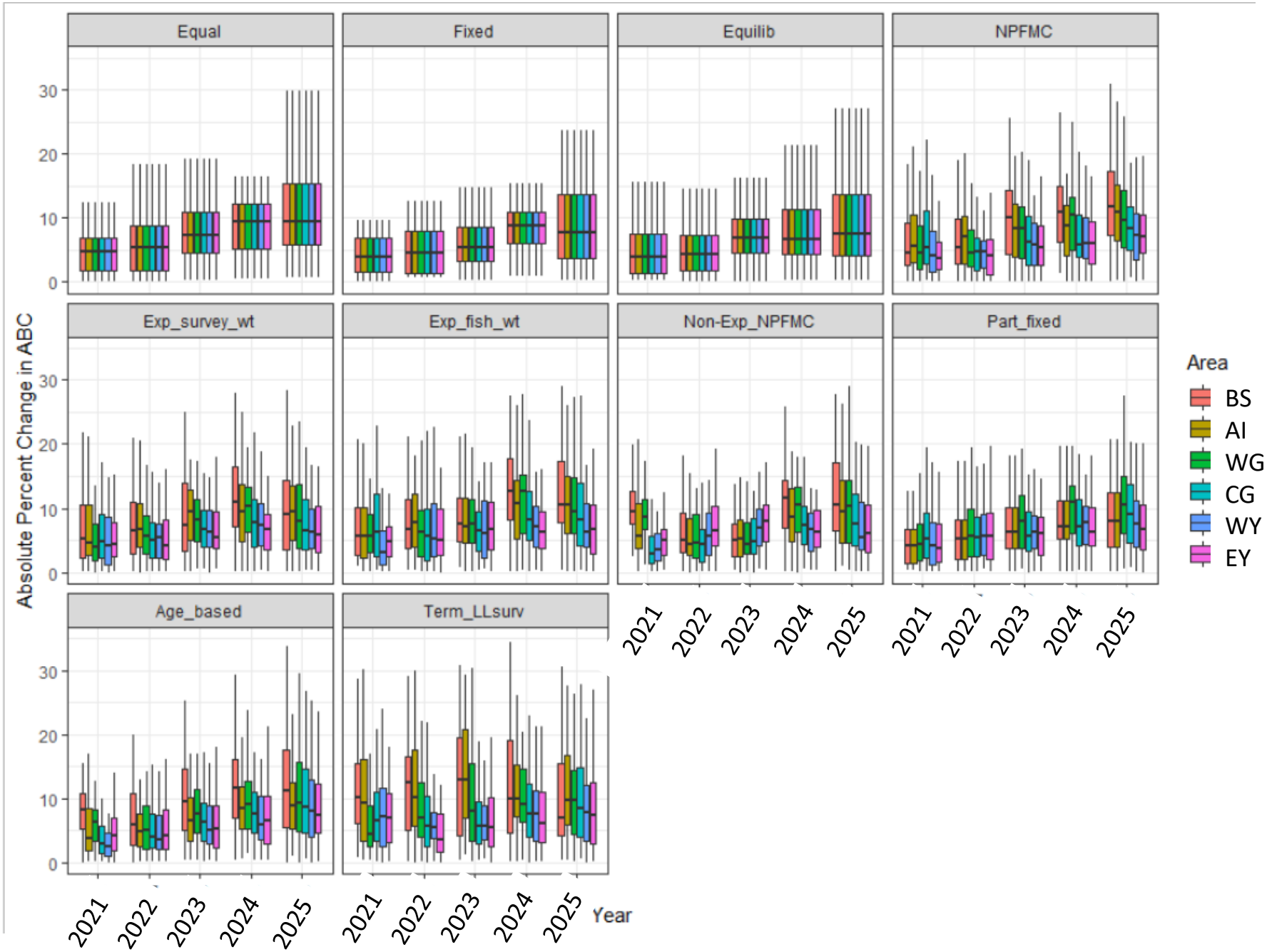
	Threshold % (interannual change is less than x%)					
Apportionment	**10**	**15**	**20**	**30**	**40**	**50**
Equal	0.543	0.758	0.864	0.951	0.973	0.982
Fixed	0.643	0.830	0.906	0.969	0.983	0.991
Equilib	0.615	0.831	0.918	0.971	0.988	0.992
NPFMC	0.595	0.805	0.904	0.965	0.981	0.987
Exp_survey_wt	0.593	0.804	0.905	0.966	0.984	0.992
Exp_fish_wt	0.560	0.776	0.891	0.961	0.982	0.990
Non-Exp_NPFMC	0.594	0.809	0.900	0.968	0.986	0.992
Part_fixed	0.614	0.818	0.912	0.967	0.983	0.989
Age_based	0.581	0.776	0.880	0.958	0.982	0.991
Term_LLsurv	0.559	0.743	0.858	0.954	0.977	0.988

Red = BAD: less stable, more years and areas have big changes in ABC

Blue = GOOD: more stable, fewer years and areas have big changes in ABC

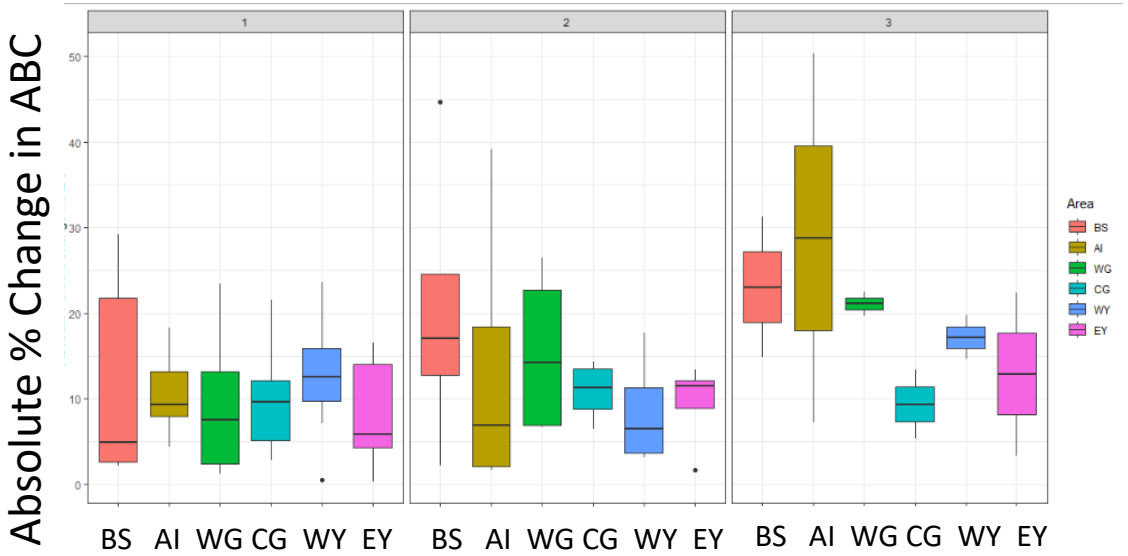
Stability in ABC from year to year

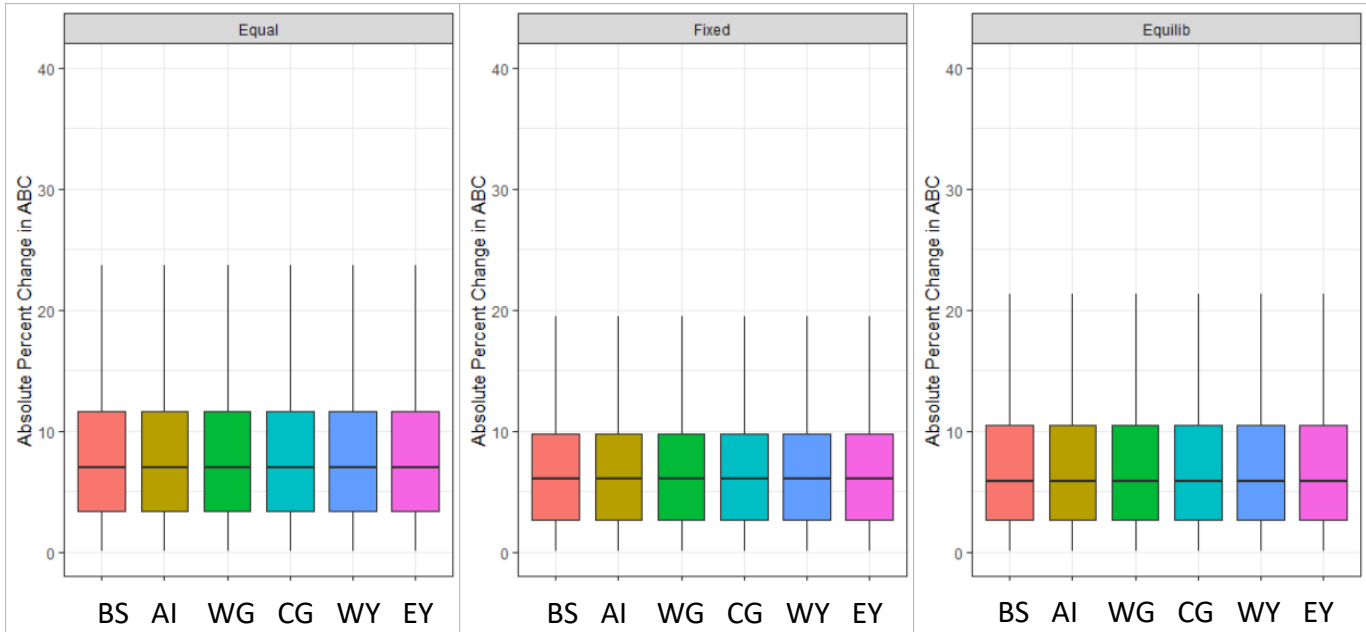
Absolute percent change in ABC – by area and by apportionment type

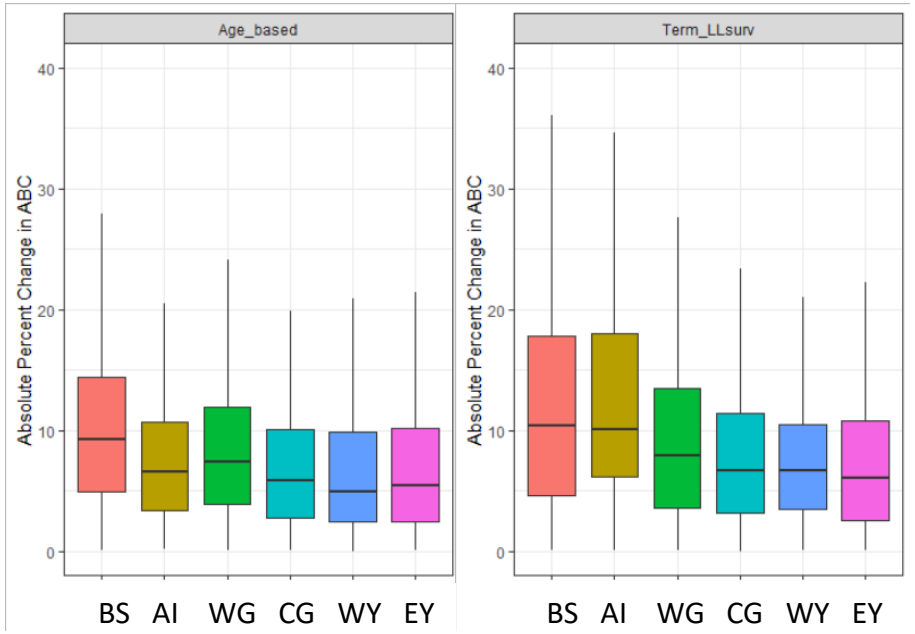


Stability by area and apportionment type: 2021-2025

"NPFMC" Apportionment – Historic reference

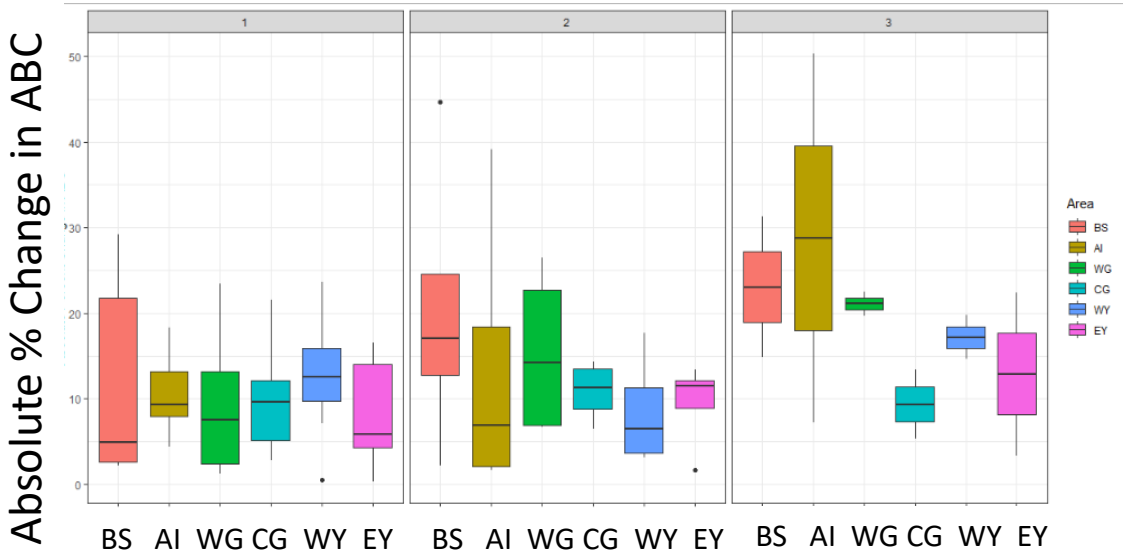


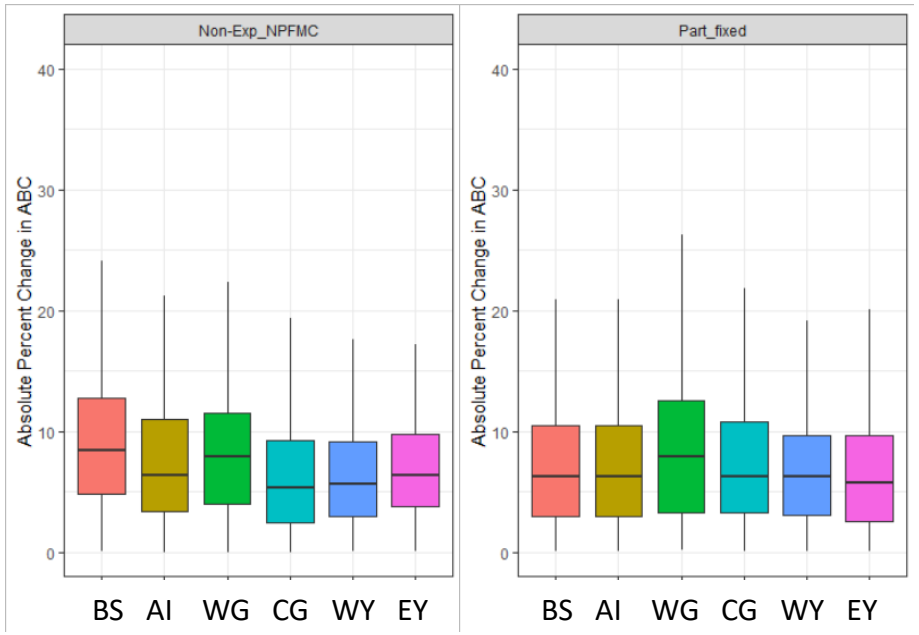


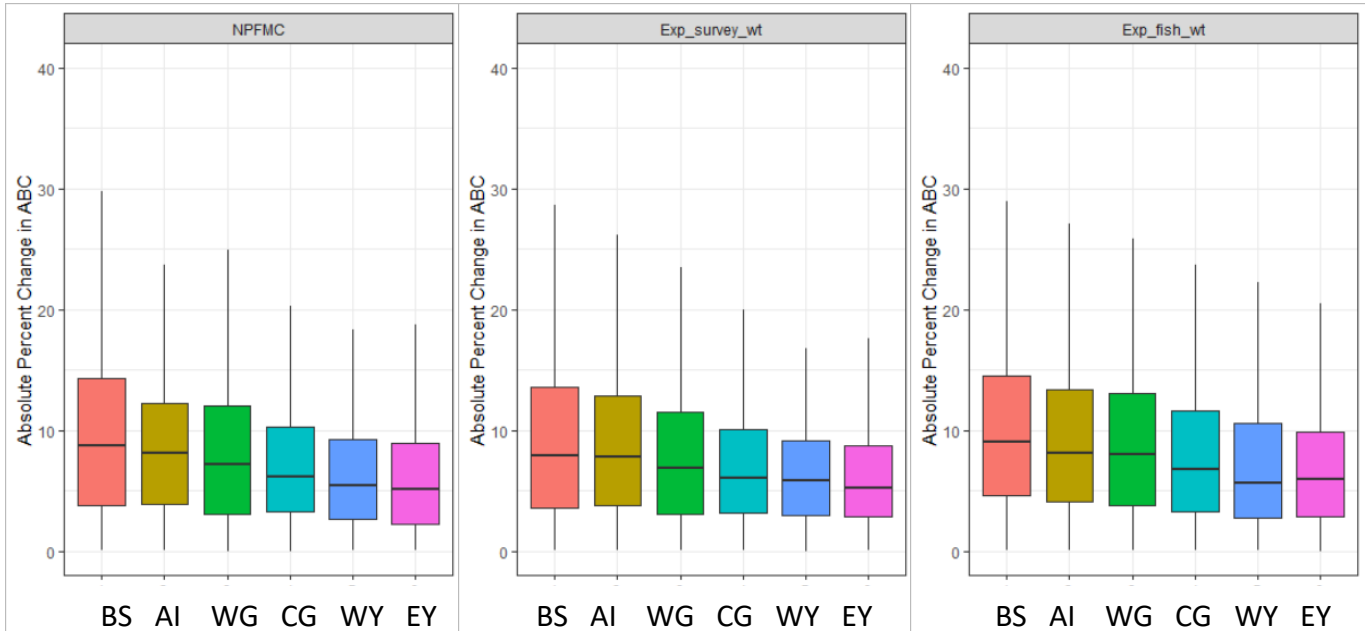


Stability by area and apportionment type: 2021-2025

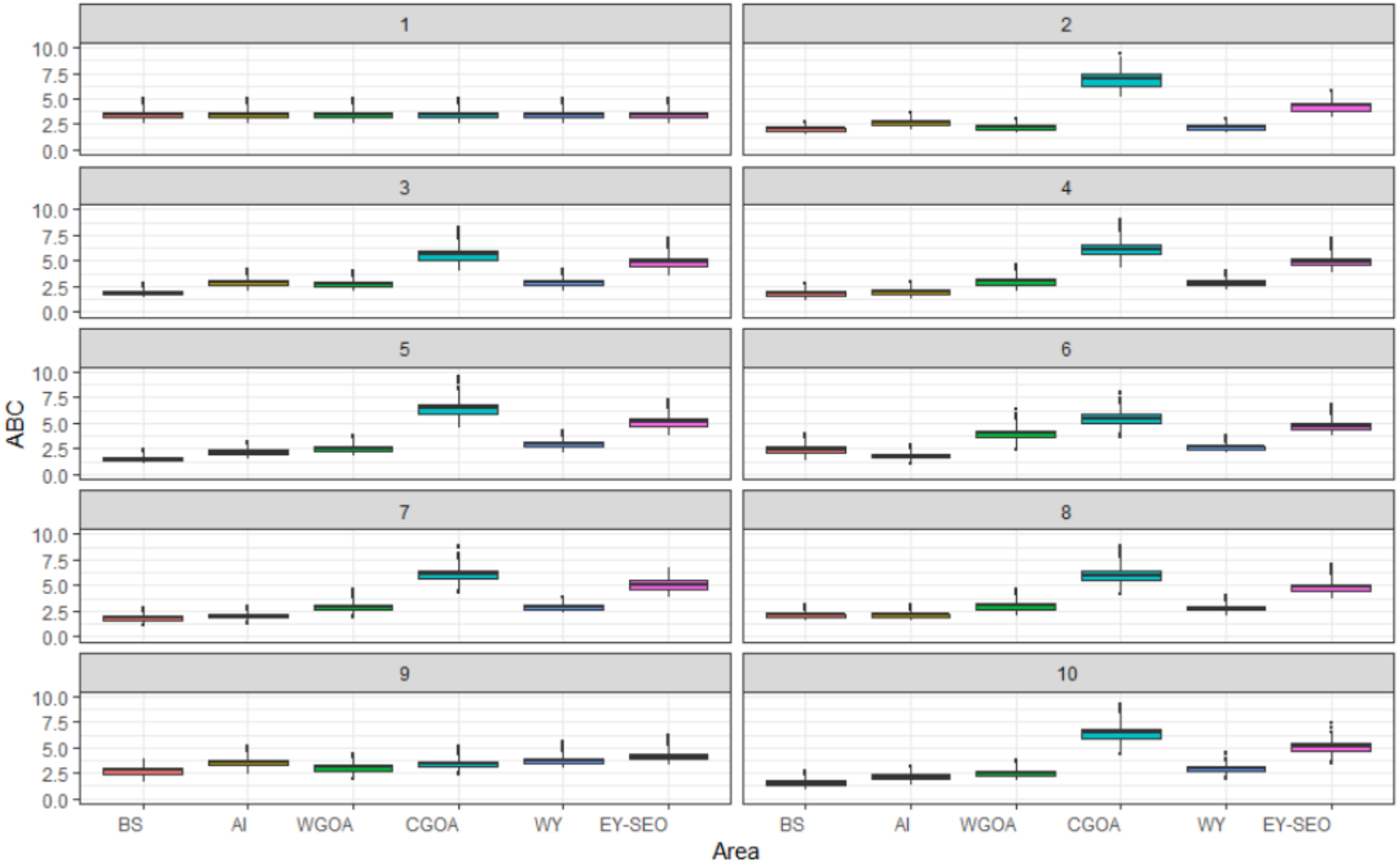
"NPFMC" Apportionment – Historic reference







Social/ Economic: Mean ABC by area over years 2019-2025



Social/Economic : Thresholds

1) Is this way of comparing apportionment types meaningful to you?

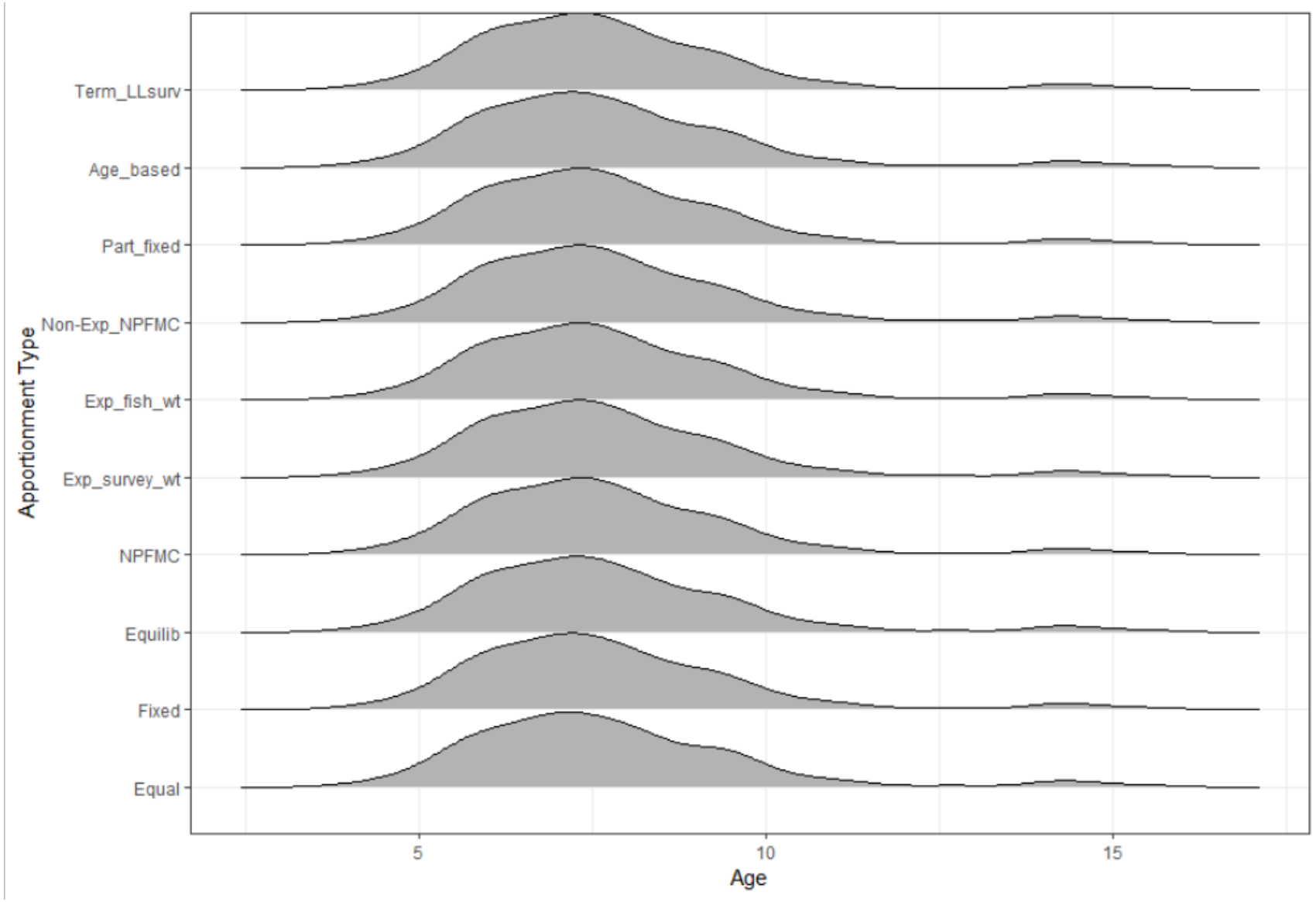
2) If yes, what is a meaningful threshold value overall and for each area?

- Current thresholds ABC for areas combined = 10.26 kt (this is the minimum total ABC, historically)
  - Is there another value that would be better?
- Current threshold for any single area = 0.84 kt (this is the lowest catch in any year from all areas)
  - Results not shown

	Proportion years and areas where total **ABC > 10.26 kt**
Equal	93%
Fixed	95%
Equilib	94%
NPFMC	93%
Exp_survey_wt	95%
Exp_fish_wt	95%
Non-Exp_NPFMC	95%
Part_fixed	95%
Age_based	93%
Term_LLsurv	94%

Social/Economic : Mean age of fish in population

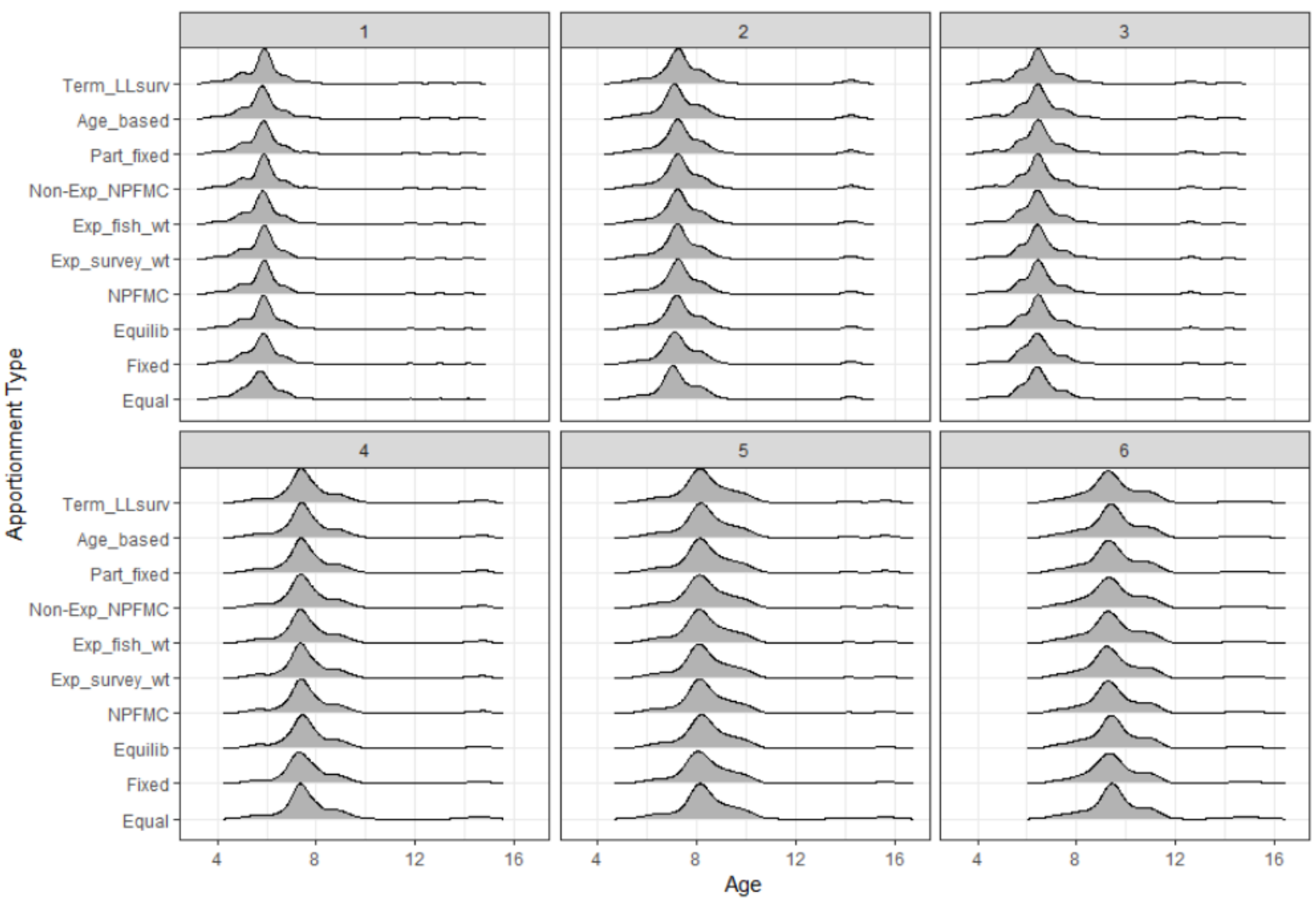
No appreciable difference in the mean age (or distribution of ages) of fish in the population for the different apportionment types.



Social/Economic : Mean age of fish in population (by area)

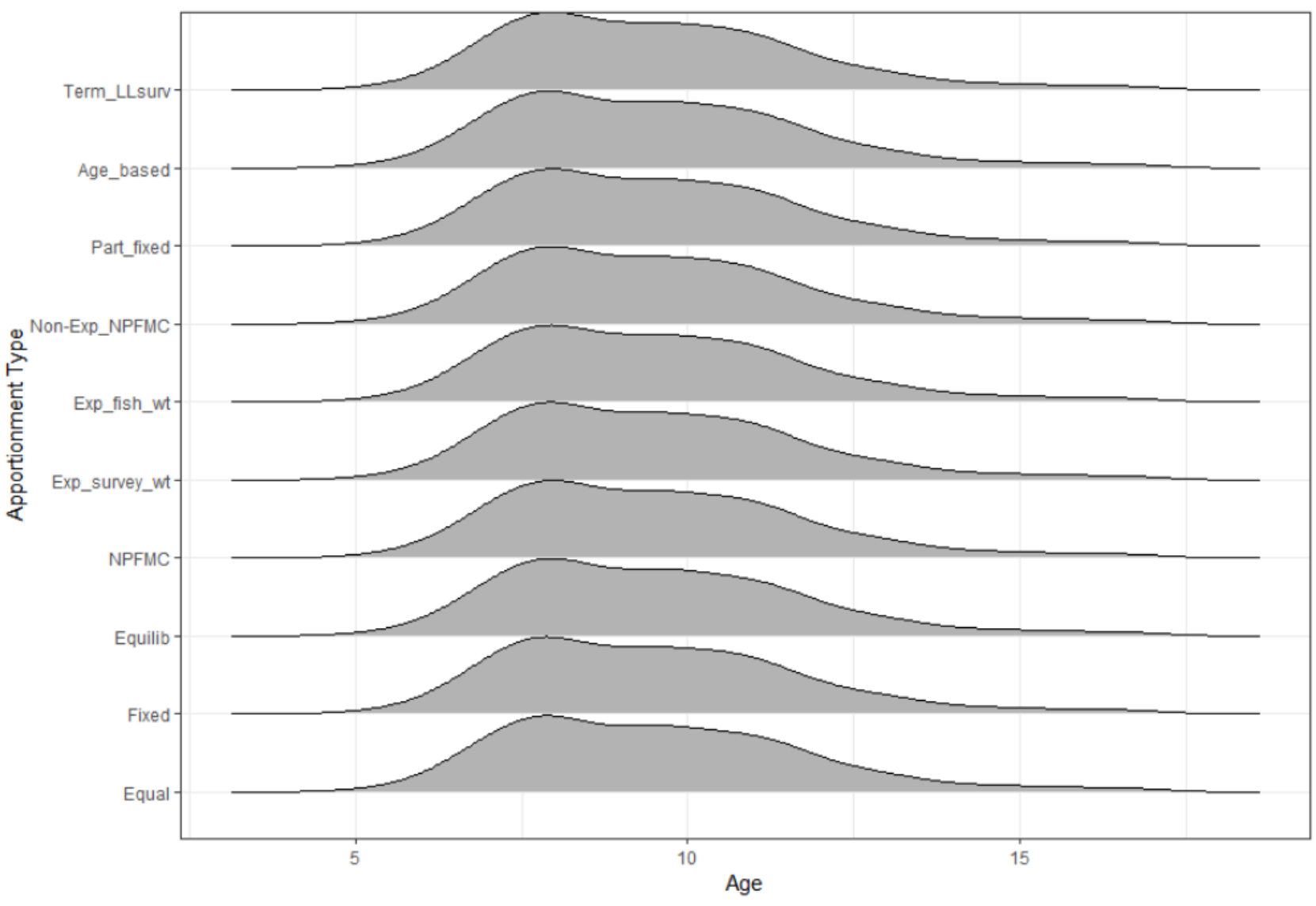
Mean age and distribution of ages of fish different between management areas.

- Some differences between areas
- Not much difference for a given area between apportionment types.



Social/Economic : Mean age of fish in catch

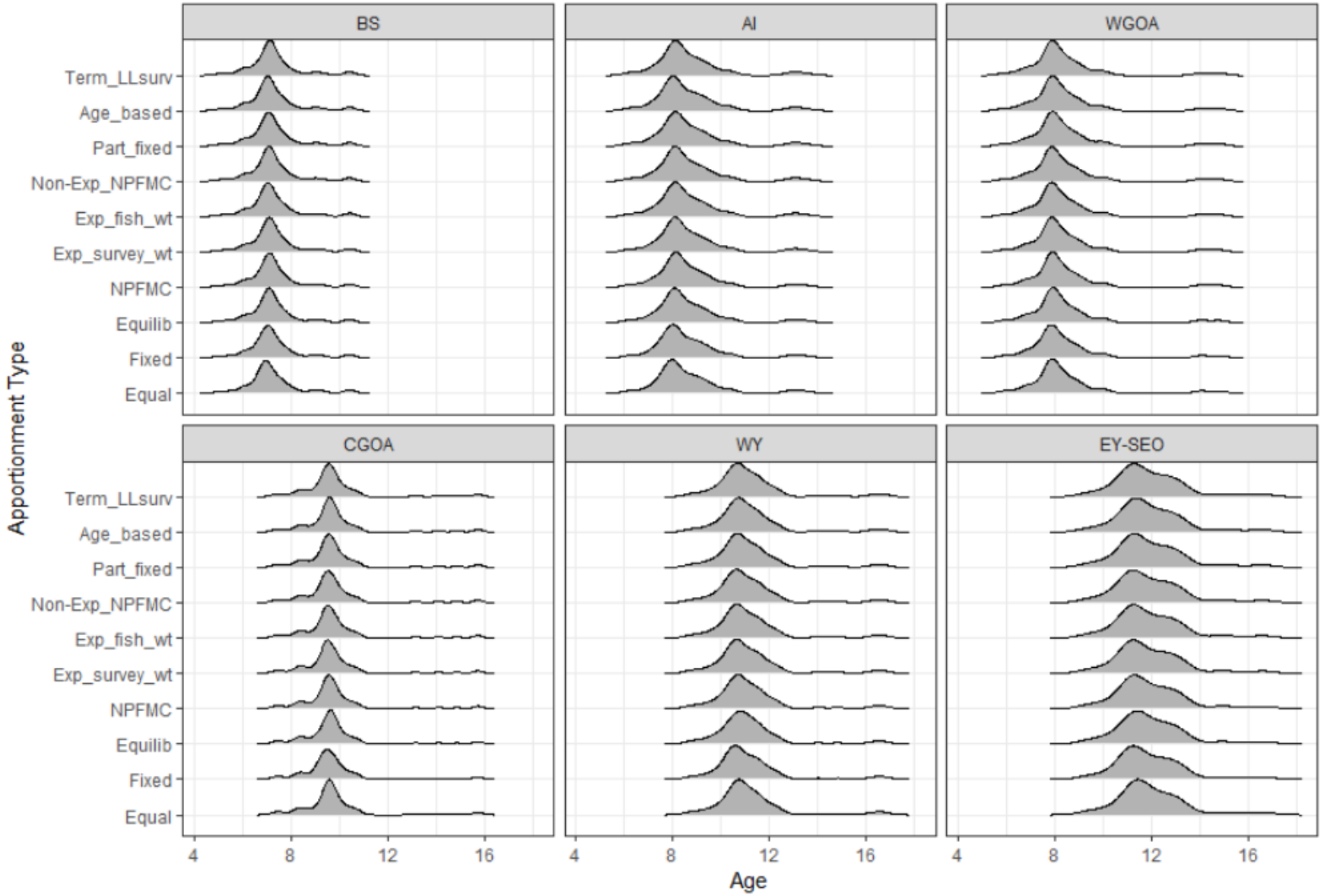
No appreciable difference in the mean age (or distribution of ages) of fish in the catches for the different apportionment types.



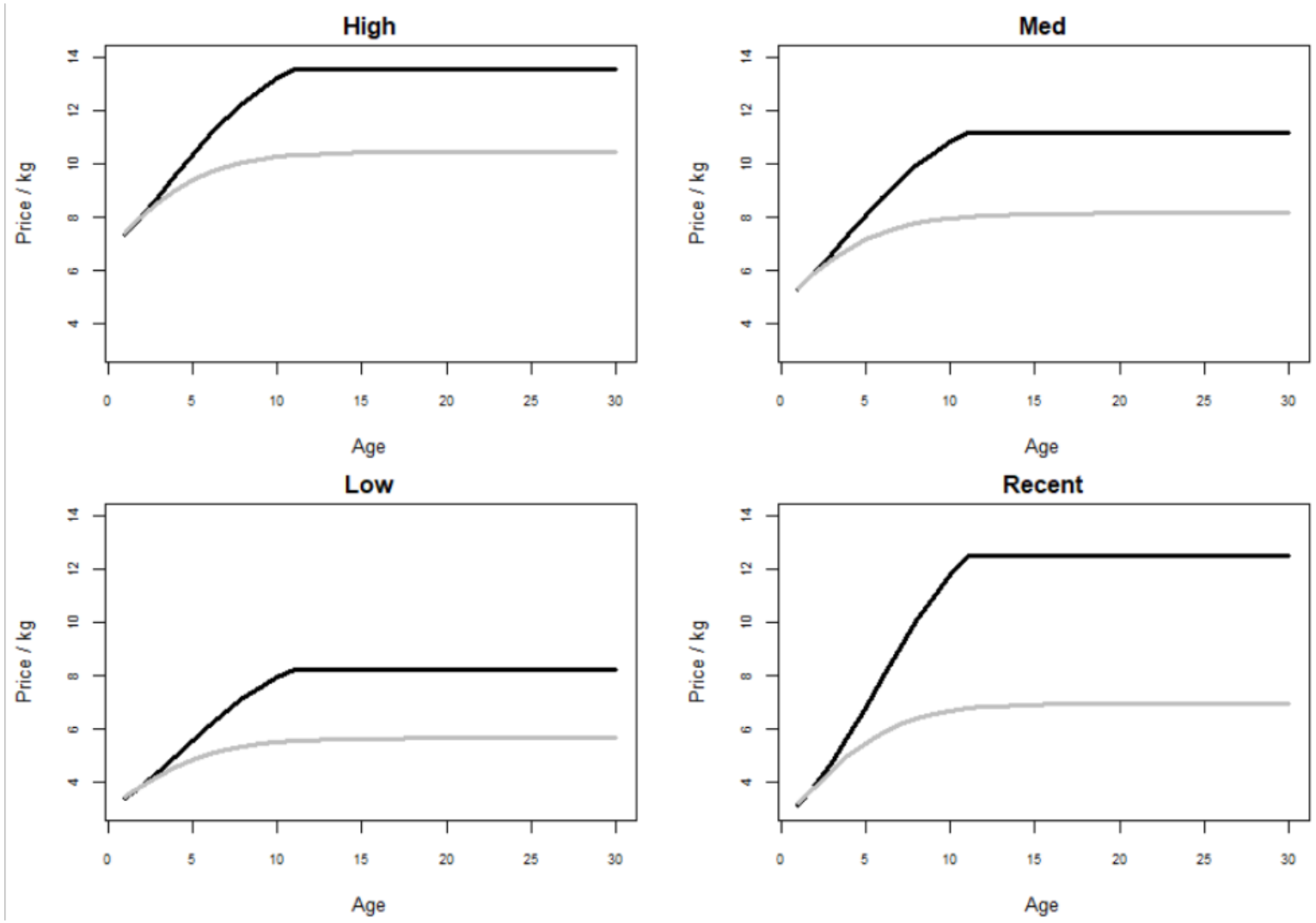
Social/Economic : Mean age of fish in catch (by area)

Mean age and distribution of ages of fish different between management areas.

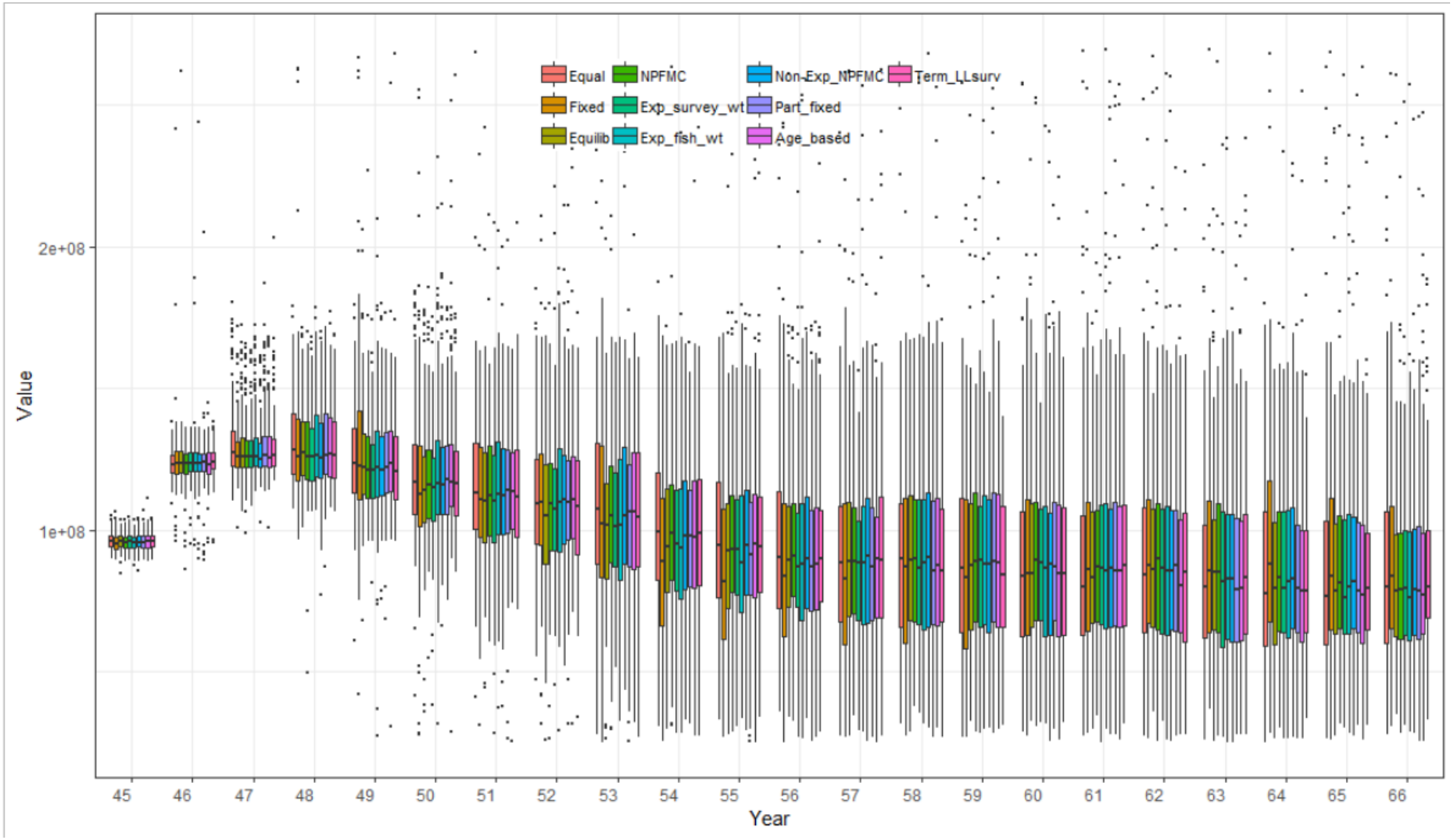
- Differences between areas, but not much difference in a given area between apportionment types.



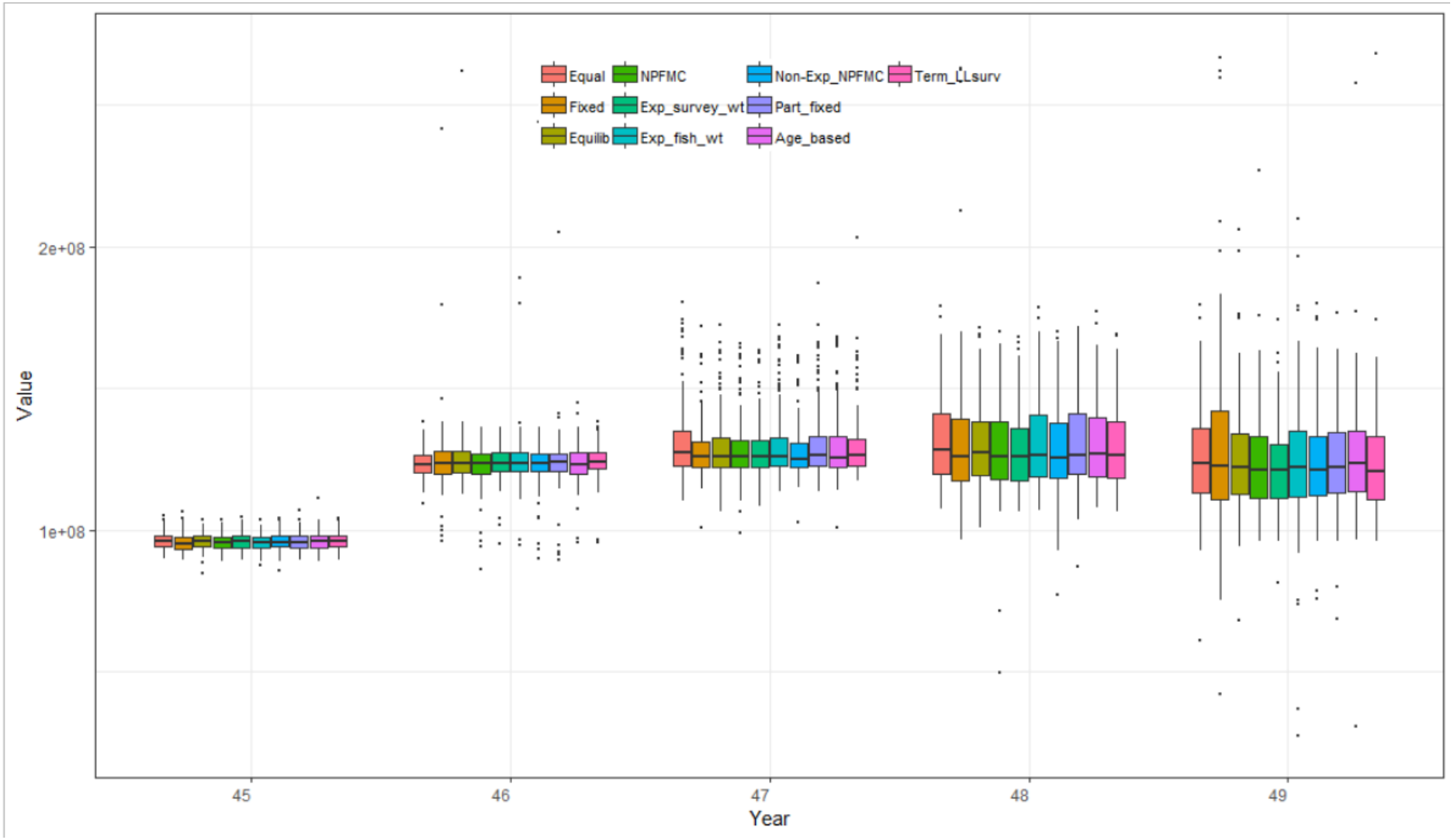
Social/Economic : Mean value of catch (value scenarios)



Social/Economic : Mean value of catch for "Medium" price per pound



Zoom in early years (2021-2025) ‘Medium’ Value



Zoom in early years (2030-2035) ‘Medium’ Value