Evaluating alternatives for the Mid-Atlantic ABC control rule

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Presentation to the MAFMC

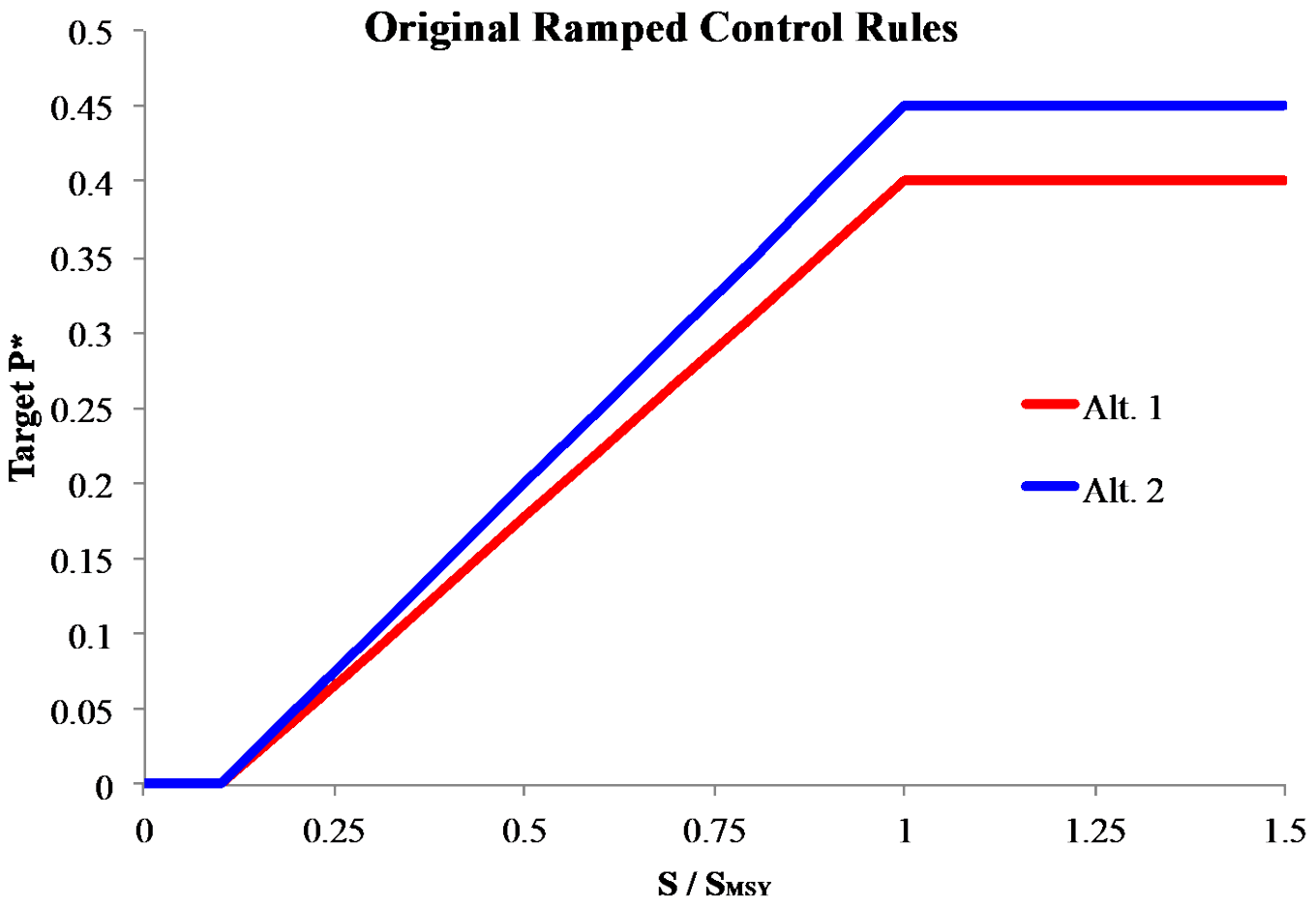
Objective

Previously compared the performance of 5 control rules for setting the acceptable biological catch (ABC) for Mid-Atlantic fisheries using a management strategy evaluation simulation model

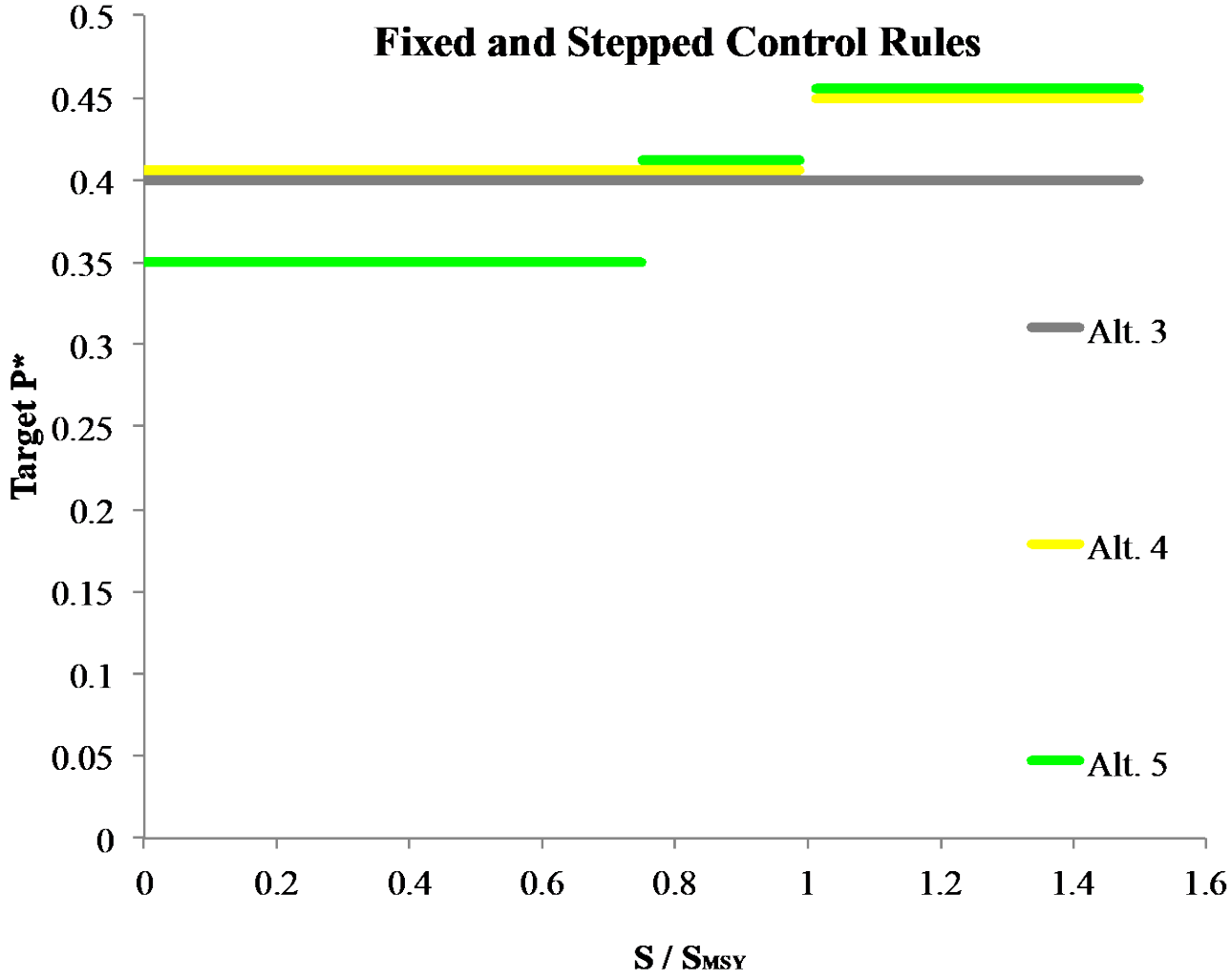
- Summer flounder 
- Scup 
- Butterfish 

Current work includes three new control rules, updated information for summer flounder and scup, and modifications in the way productivity changes in the future

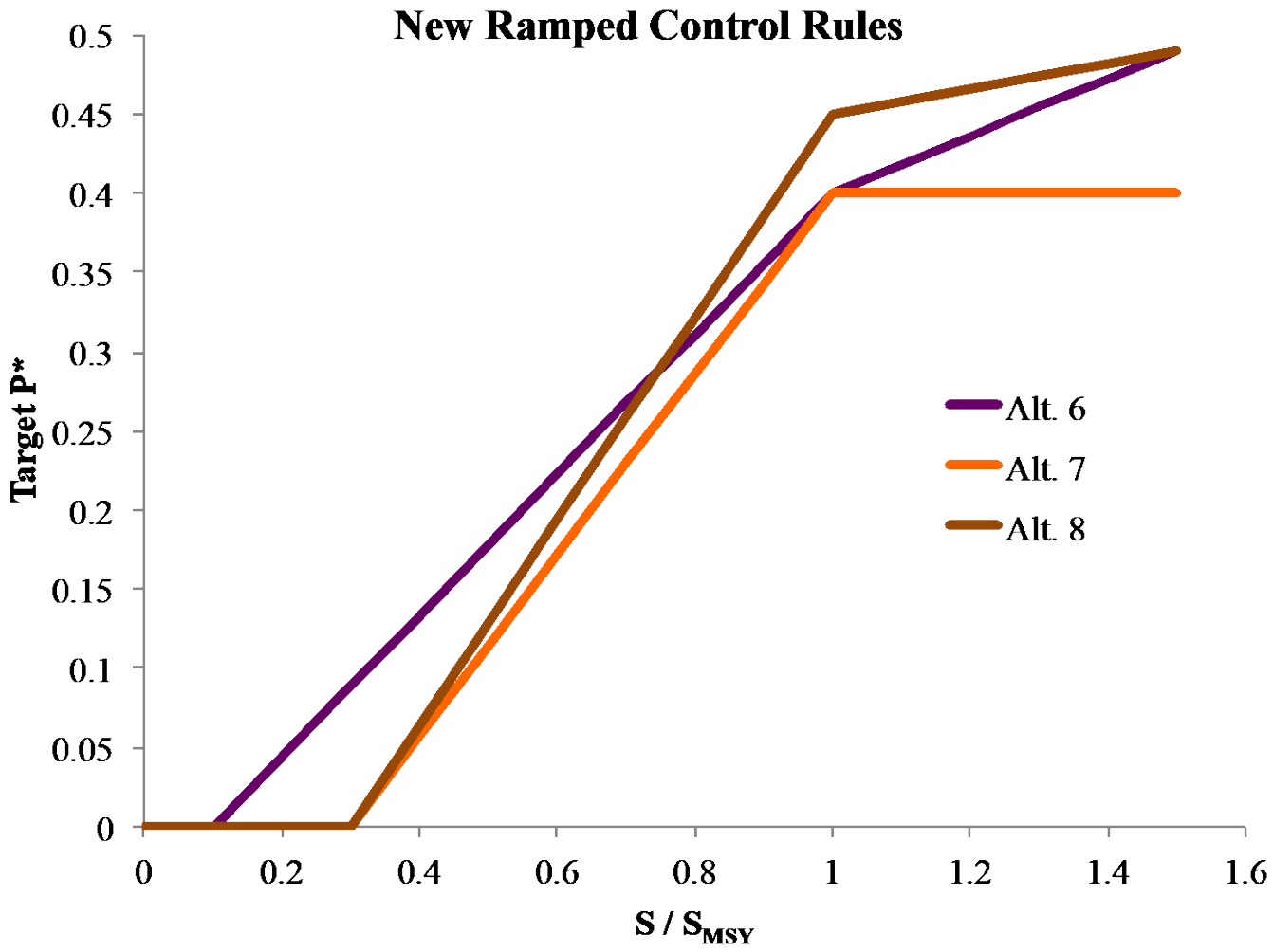
Original Options (Alternatives 1 and 2)



Original Options (Alternatives 3, 4, and 5)



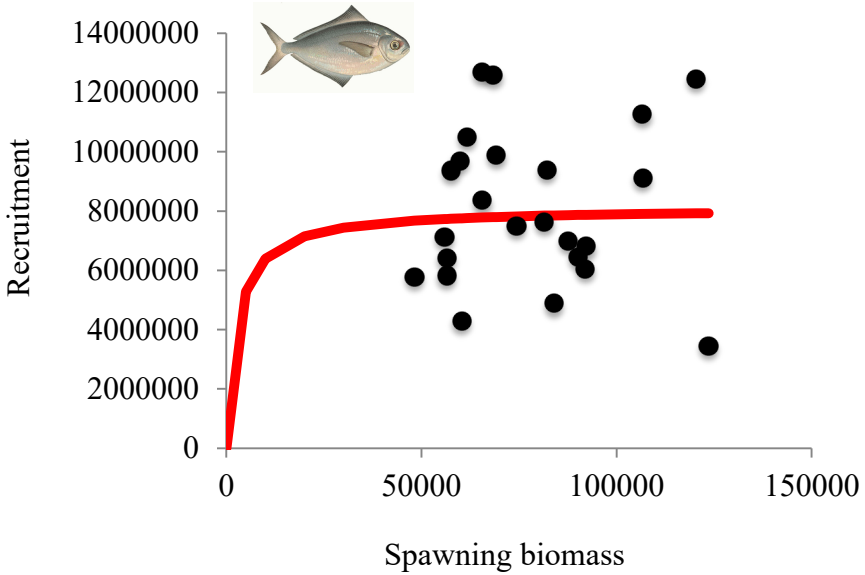
New options being explored (Alternatives 6, 7, and 8)

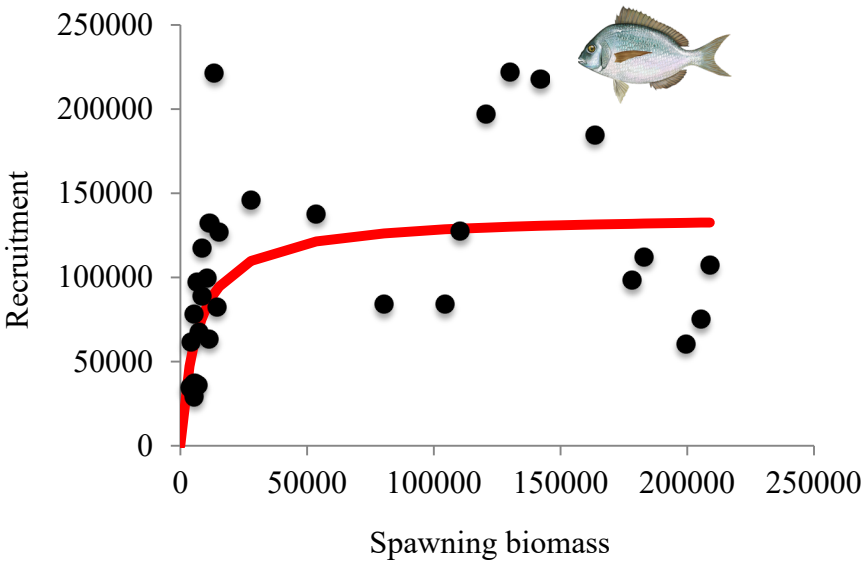


Model Basics

- Use information from the most recent assessment as the "true" historical dynamics
  - Interannual variability in recruitment
- Generate survey and fishery data based to be used in an age-structured stock assessment model to estimate
  - 2 years for summer flounder and scup
  - 3 years for scup and butterfish
- Productivity runs
  - "Average" – future productivity (M and recruitment) comparable to past levels
  - "Good" – higher recruitment and reduced natural mortality
  - "Poor" – lower recruitment and increased natural mortality
- The specified ABC is caught each year
- Control rule continues to be applied even if stock becomes overfished

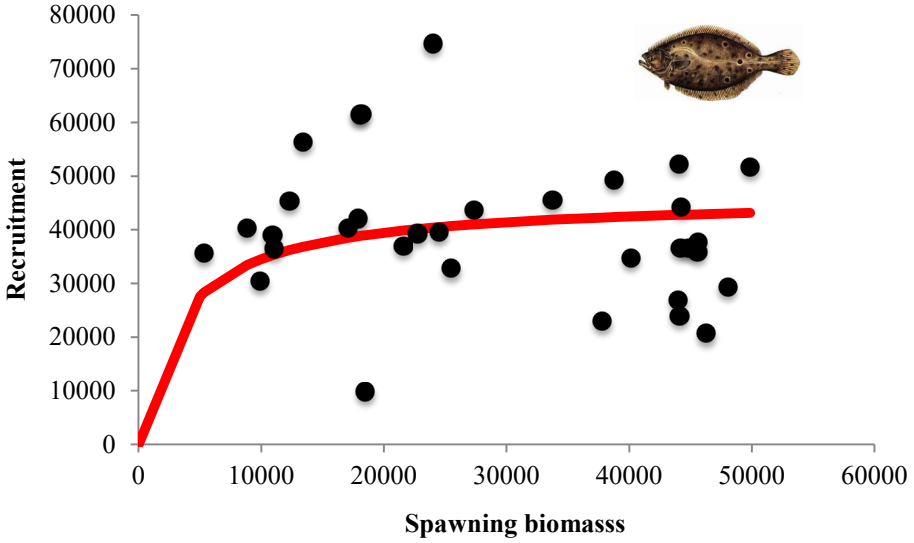
Stock-recruit relationships





Observed recruitment

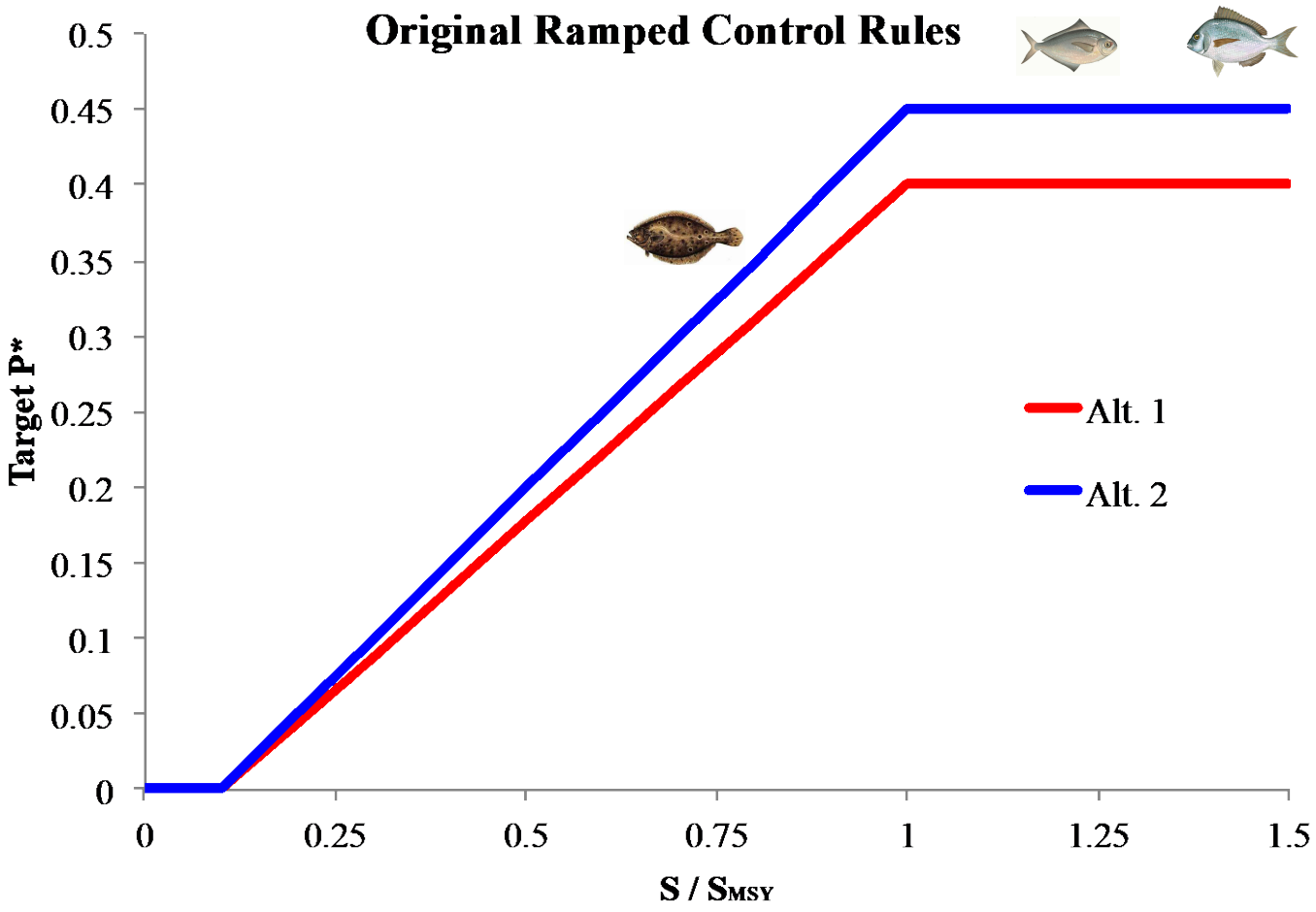
Estimated stock-recruit relationship



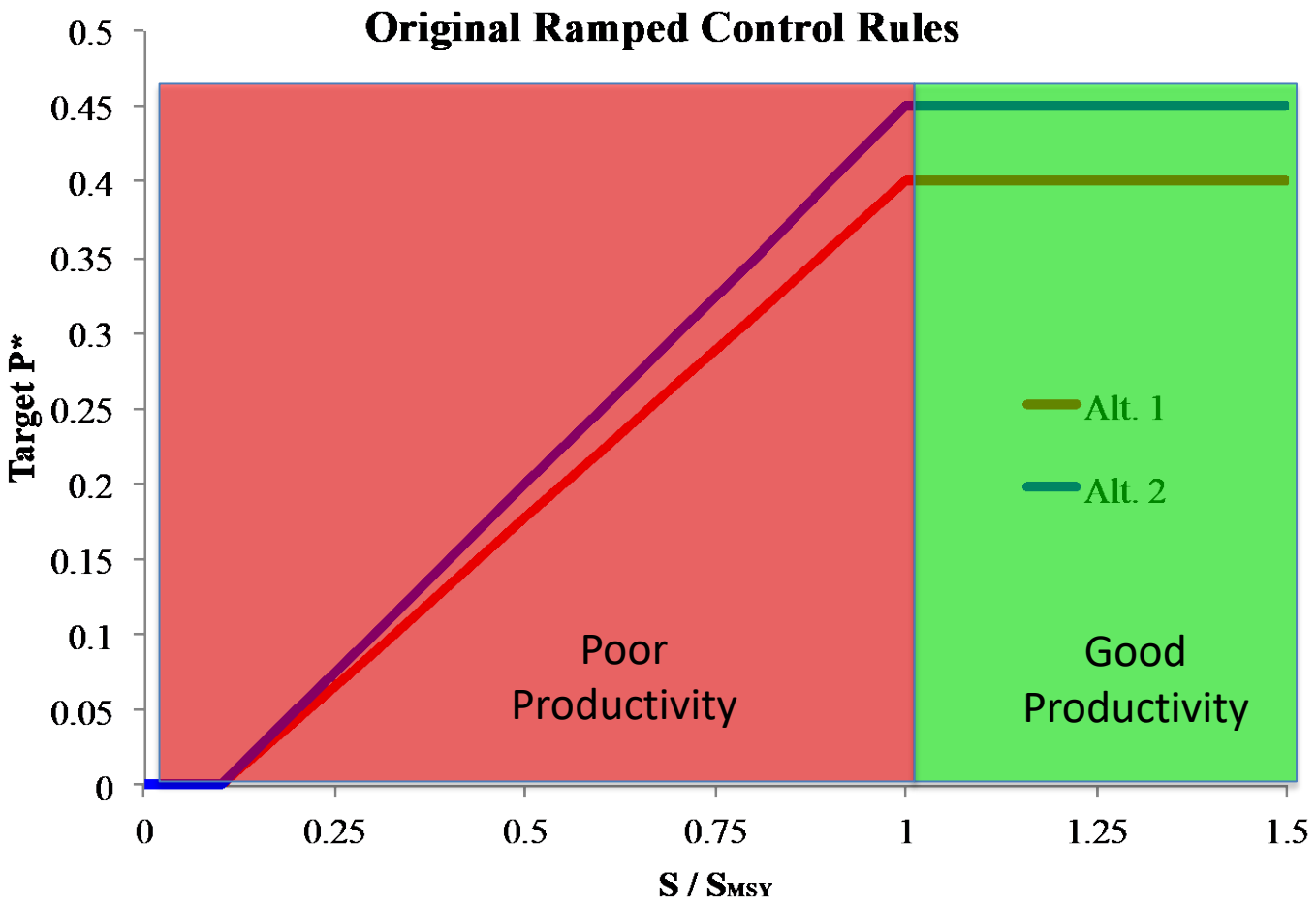
Performance measures

- Average catch
  - Short-term (first 5 years)
  - Long-term (final 20 years)
- Variability in catch
  - Average change between years
  - Maximum change between years
- Overfishing probability
- Probability of becoming overfished

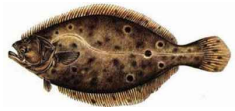
Results are impacted by current stock biomass

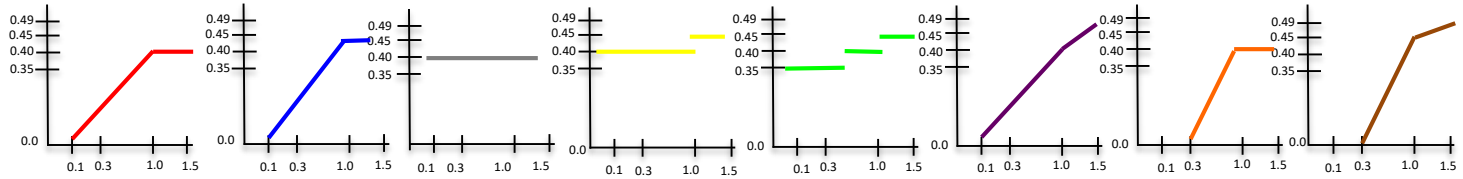


Results are also impacted by future productivity

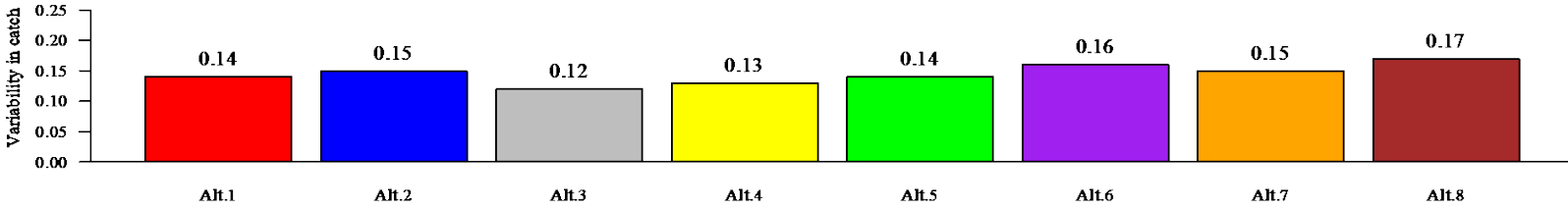


Average relative change in catch

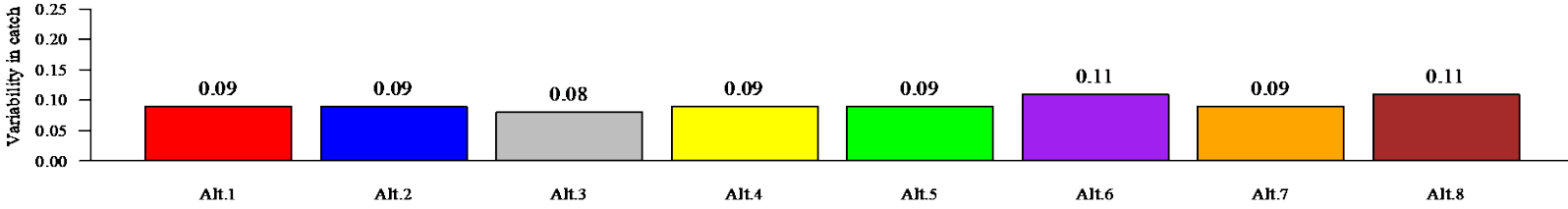




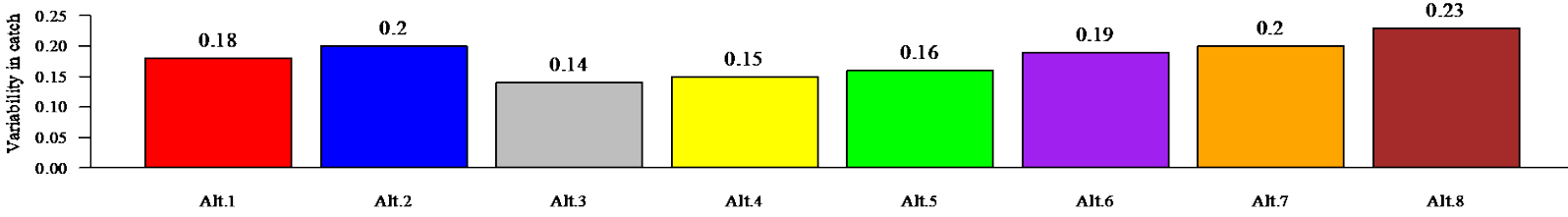
Summer flounder, average productivity



Summer flounder, good productivity



Summer flounder, poor productivity



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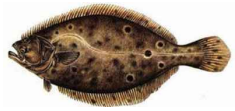
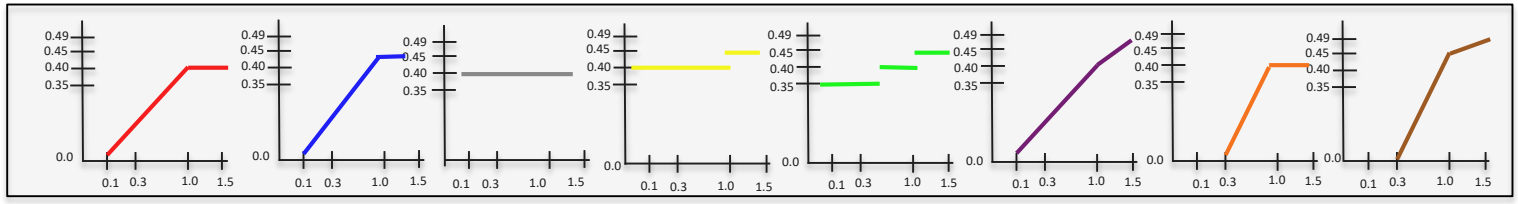
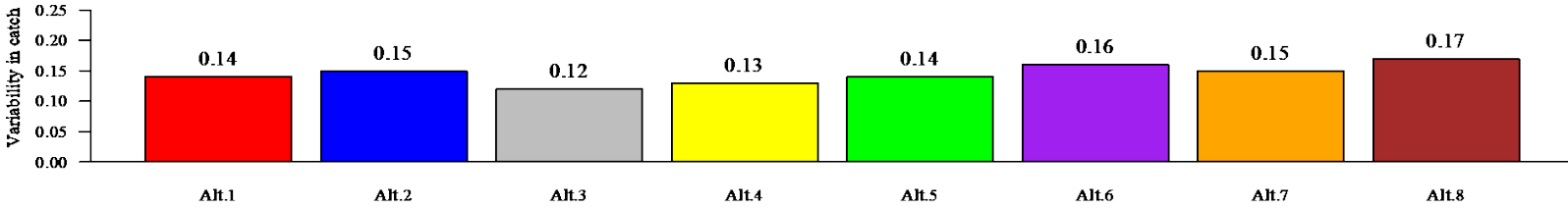




Summer flounder, average productivity



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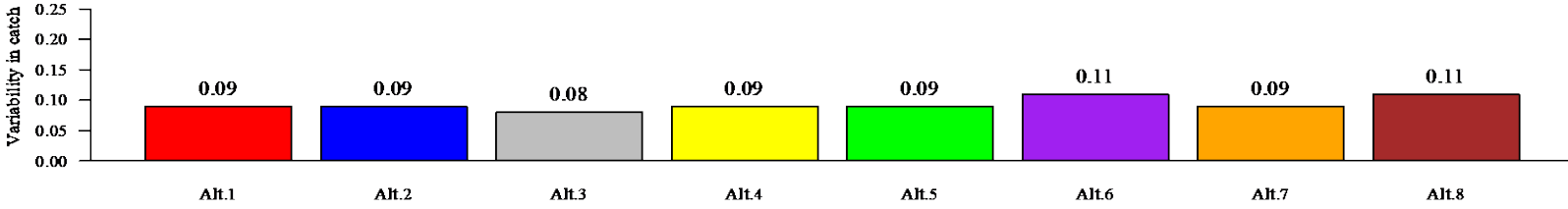
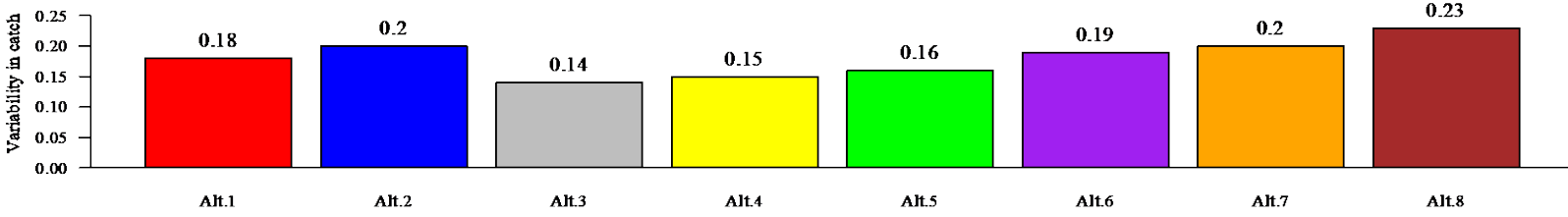
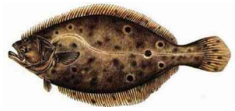


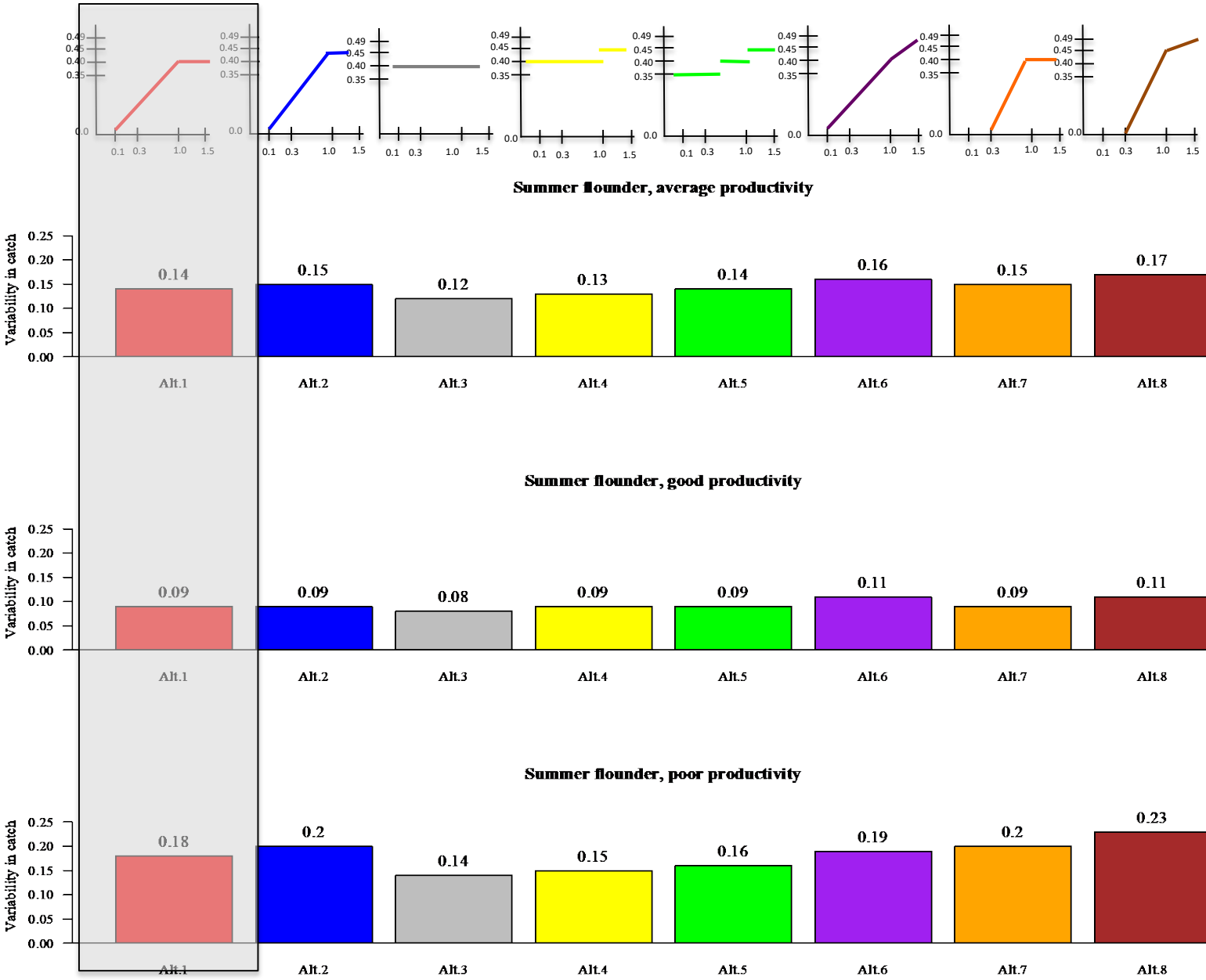
Summer flounder, poor productivity



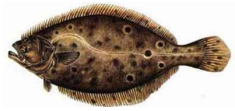
Average relative change in catch



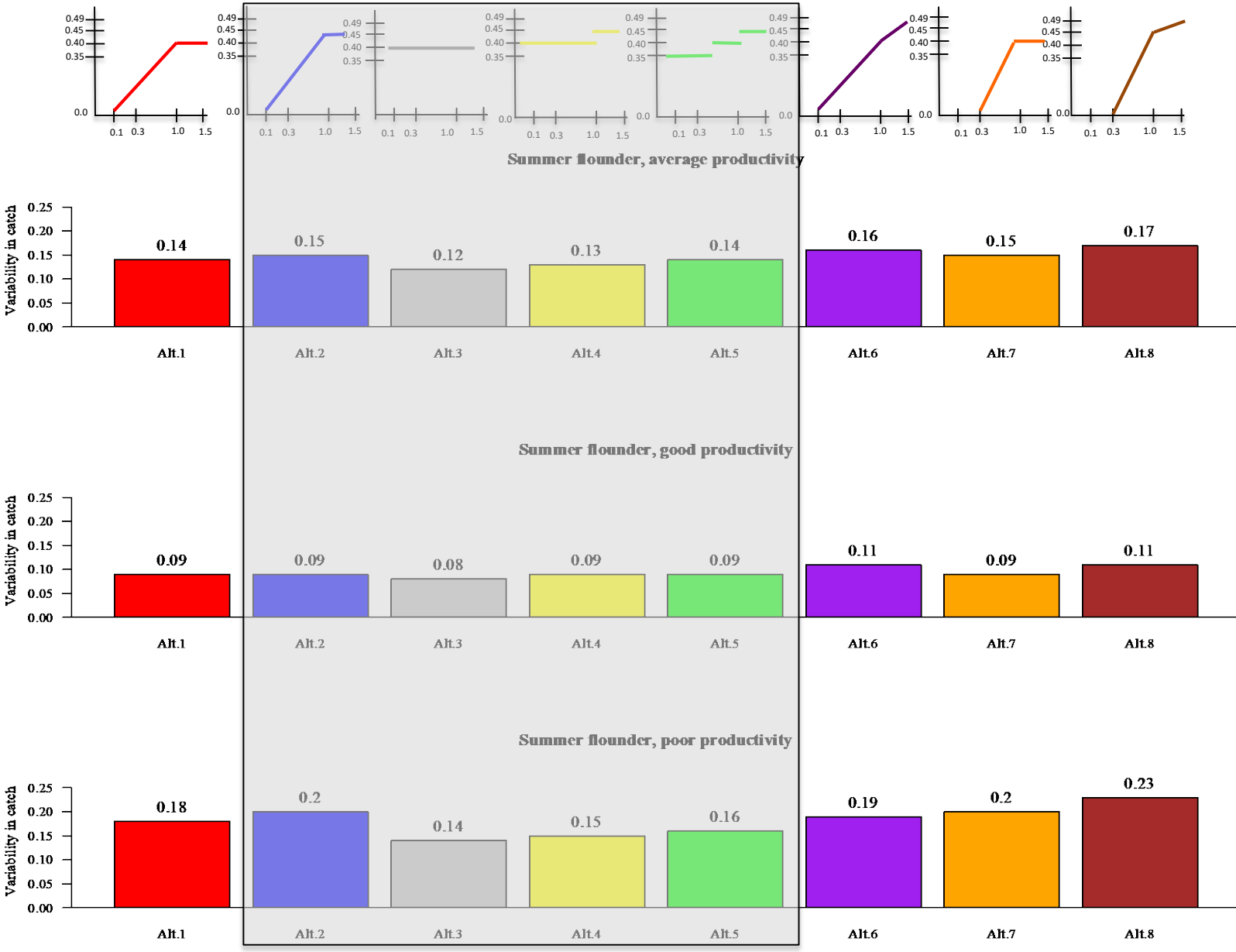
Current control rule



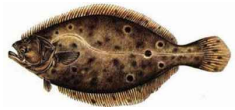
Average relative change in catch



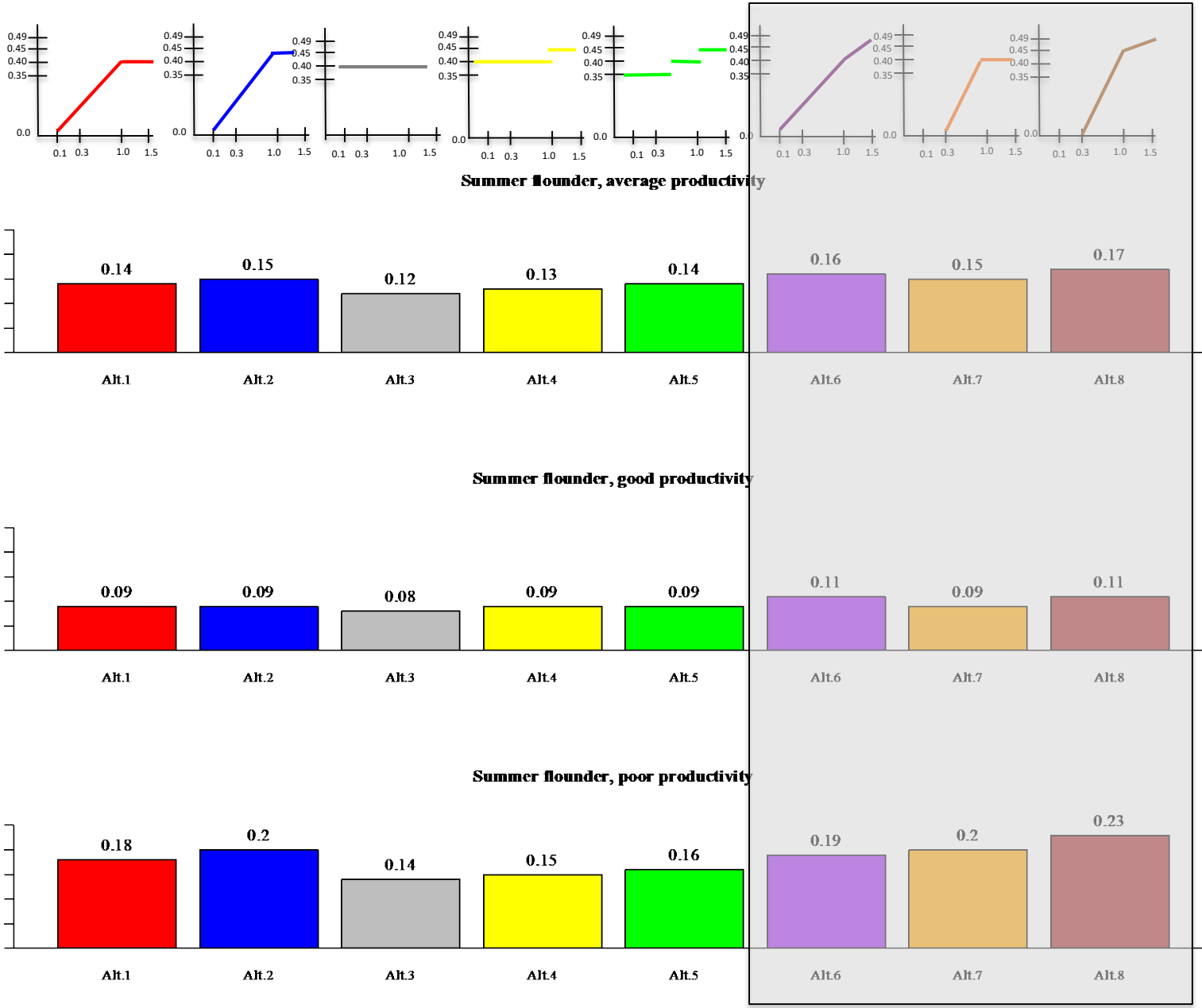
Explored last time



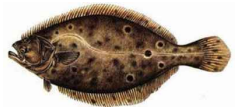
Average relative change in catch

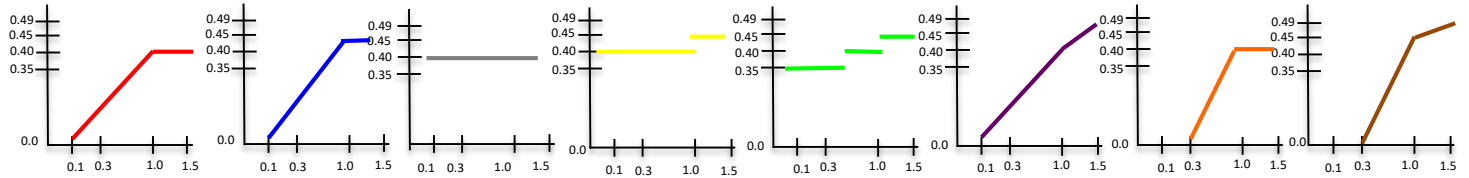


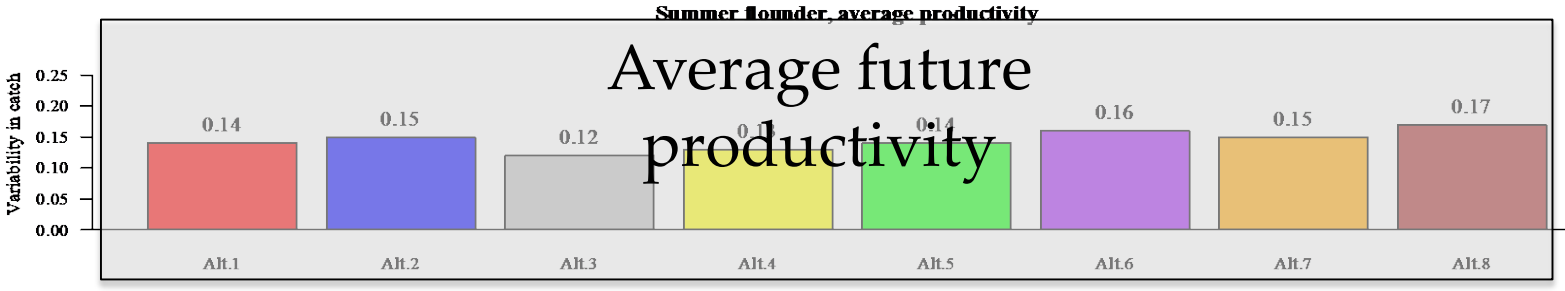
New options



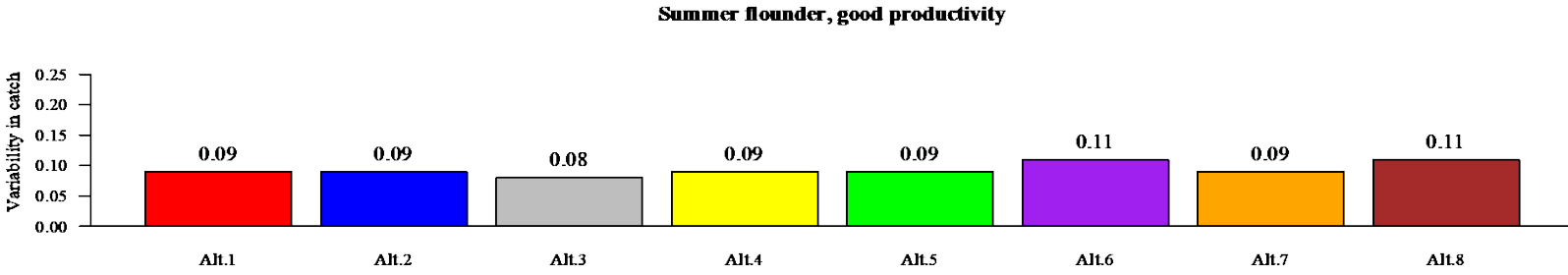
Average relative change in catch

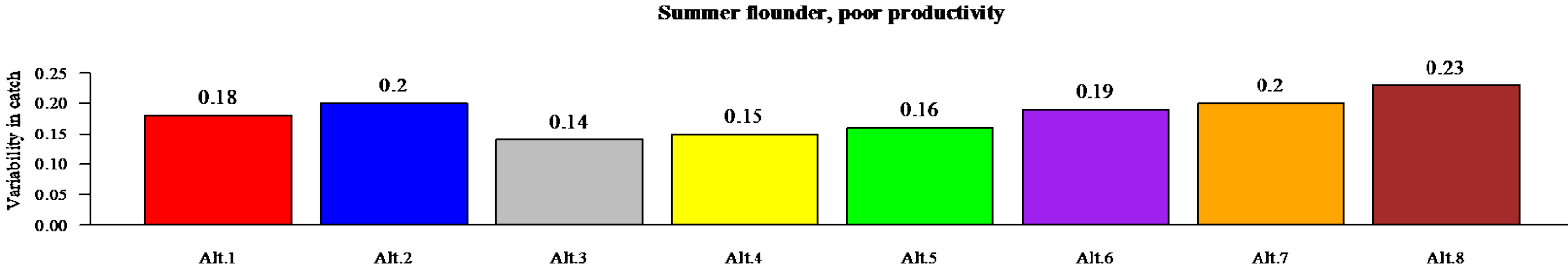




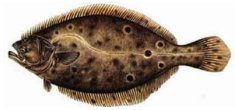


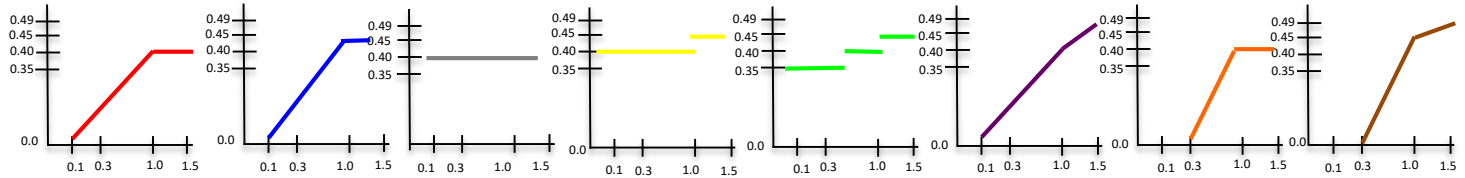
Average future productivity





Average relative change in catch





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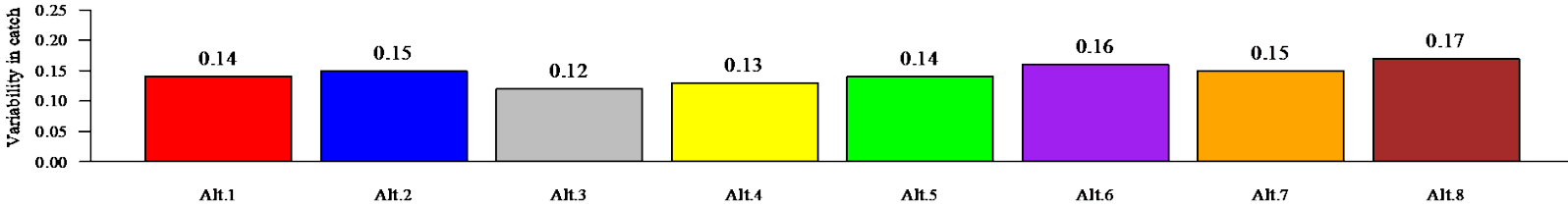
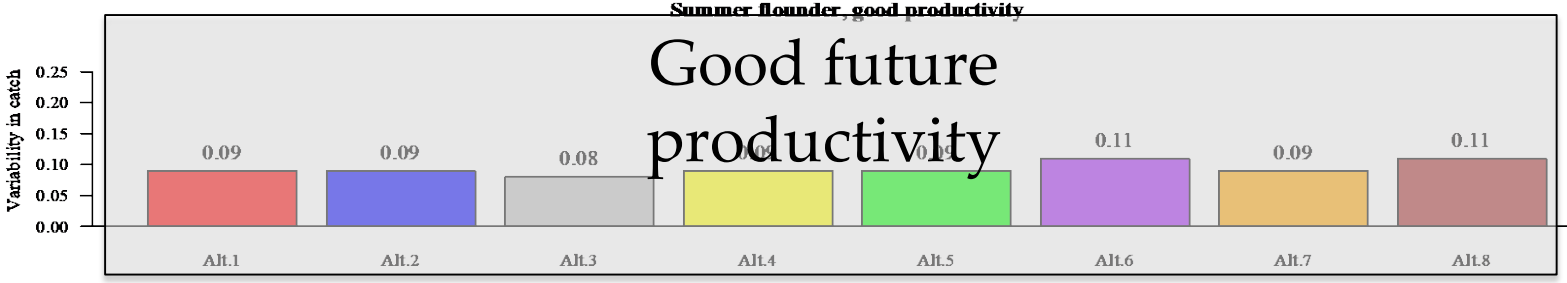


Summer flounder, good productivity

Good future productivity



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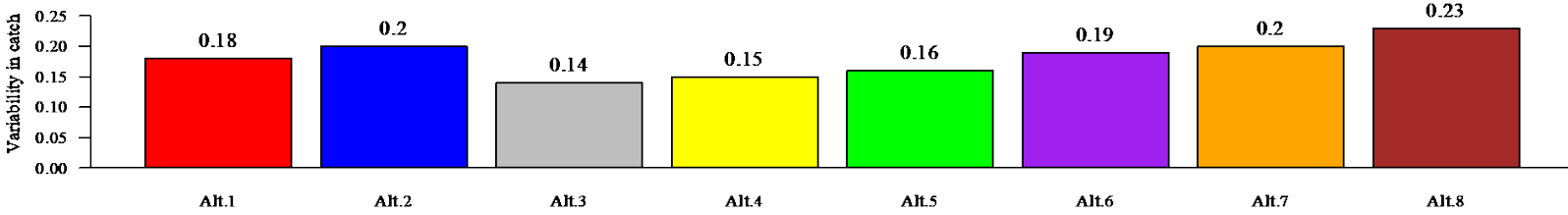

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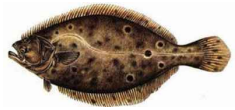
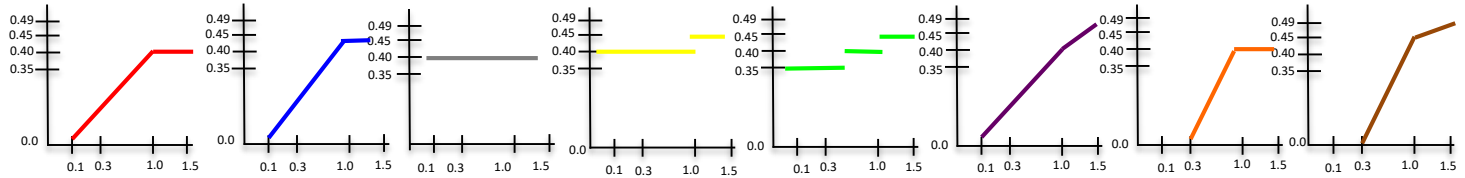
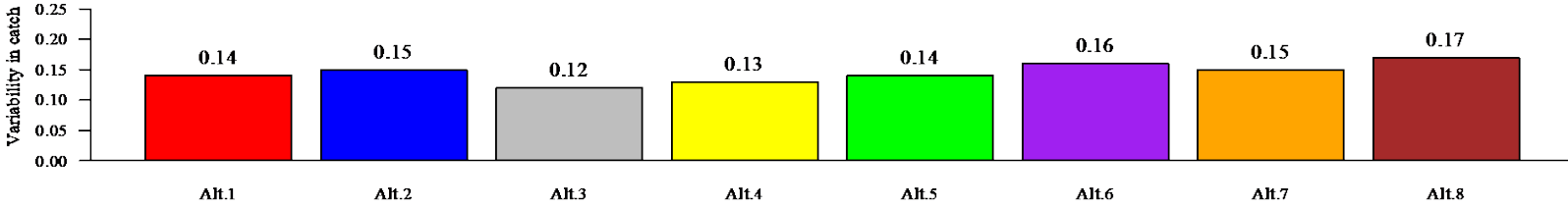
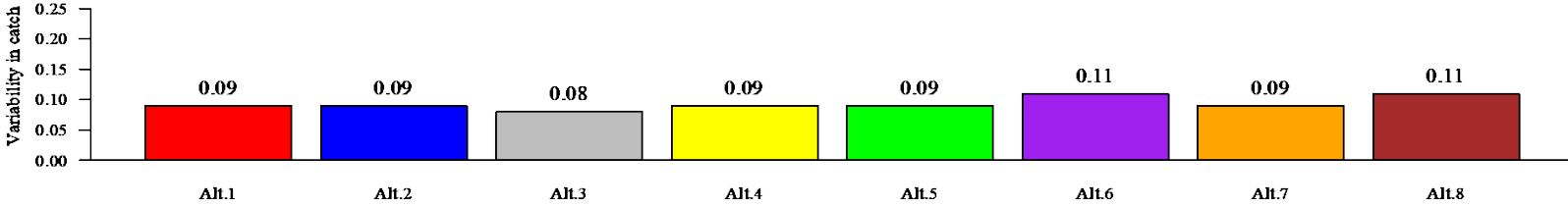




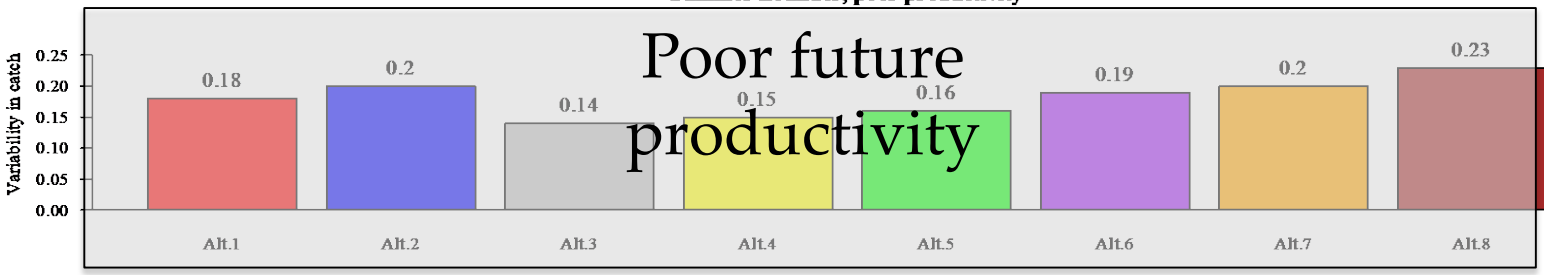
Summer flounder, average productivity



Summer flounder, good productivity

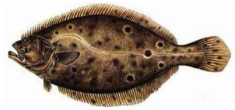


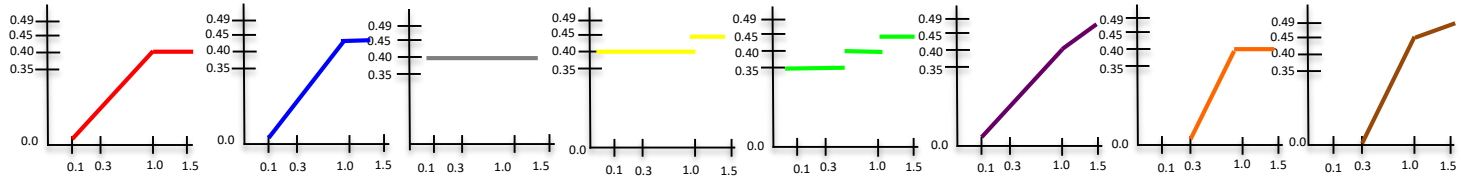
Summer flounder, poor productivity



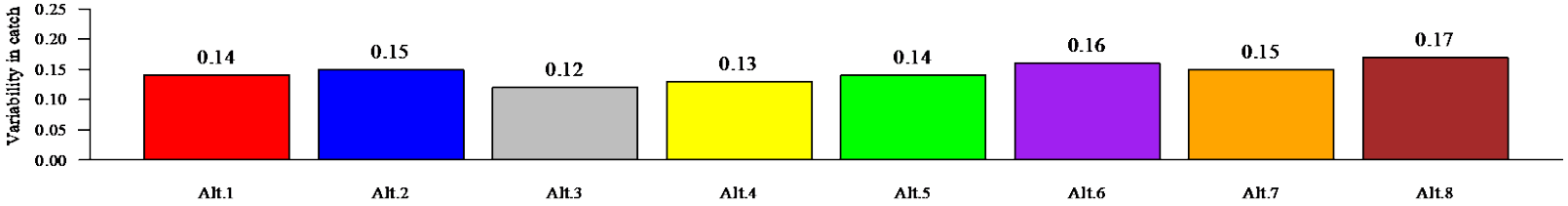
Poor future productivity

Average relative change in catch

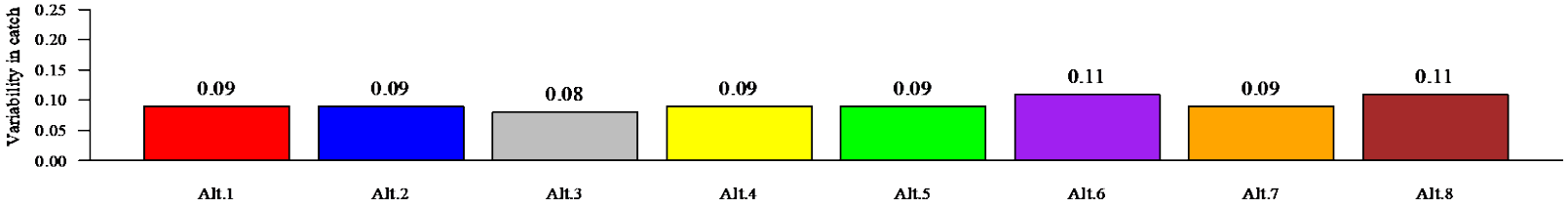




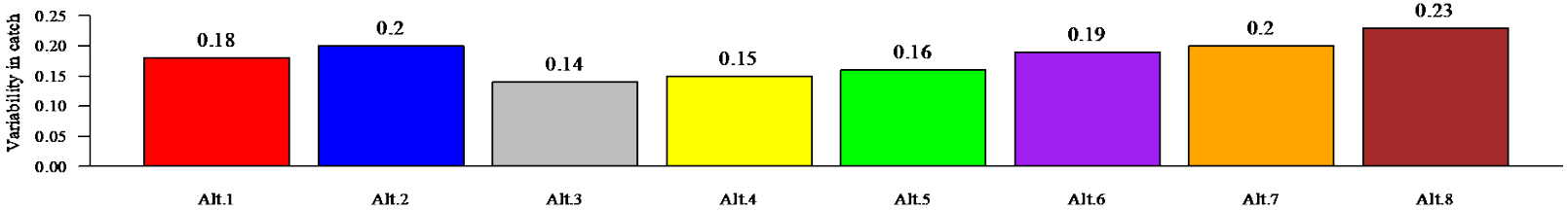
Average future productivity



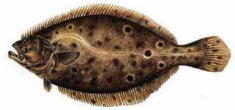
Good future productivity

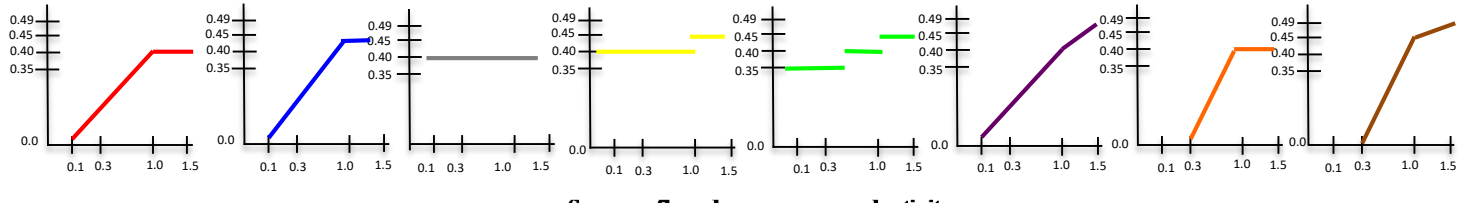


Poor future productivity

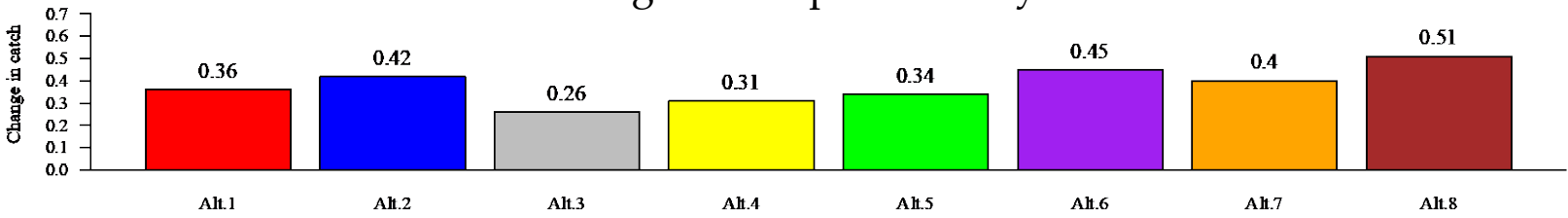


Maximum change in catch





Average future productivity



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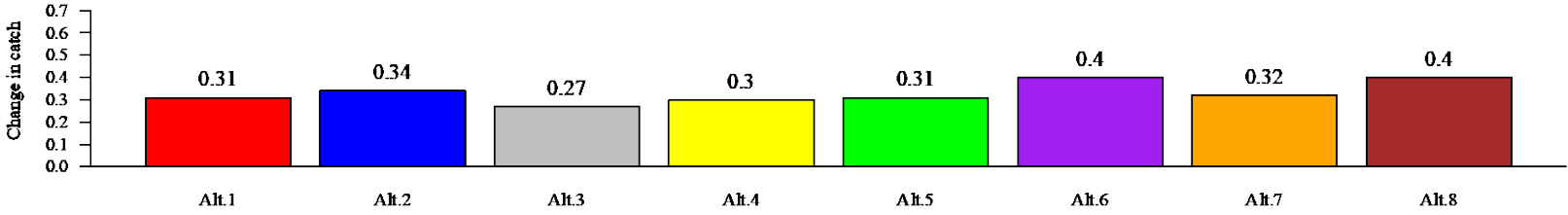
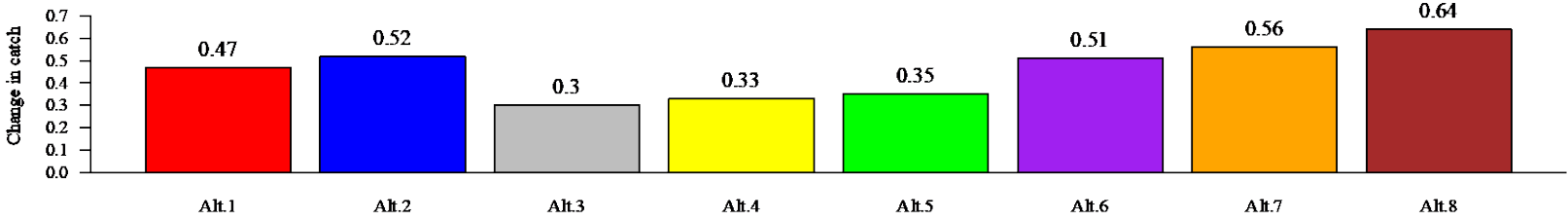
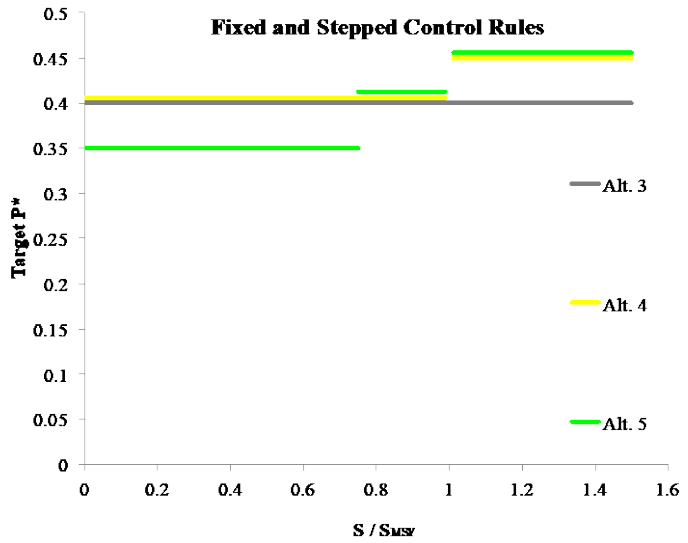


Poor future productivity

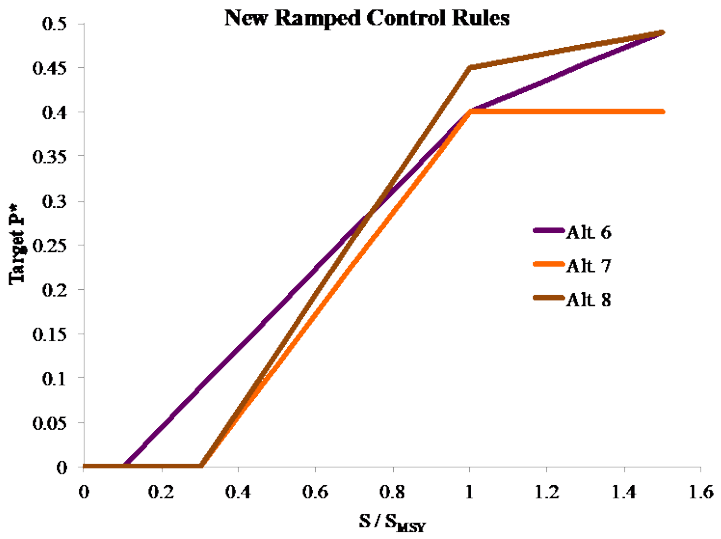


Variability in catch

- Ramped options have more variable catch than fixed / stepped control rules, particularly under poor productivity

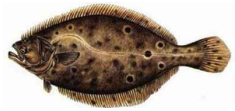


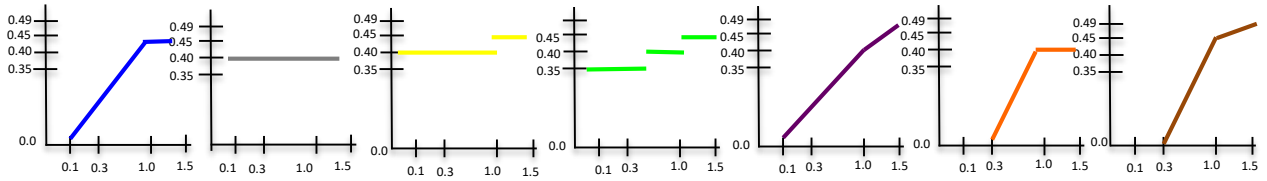
- The steeper the slope of the ramp, the more variable the catch (Alt. 7 and 8)



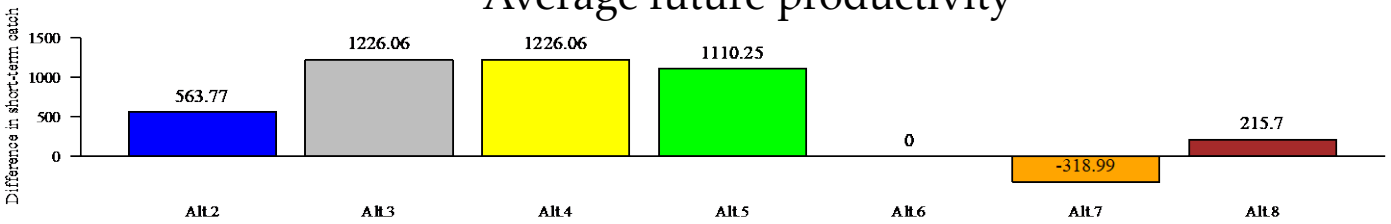
Short- and Long-Term Catch

Difference in short-term catch (mt) relative to current CR

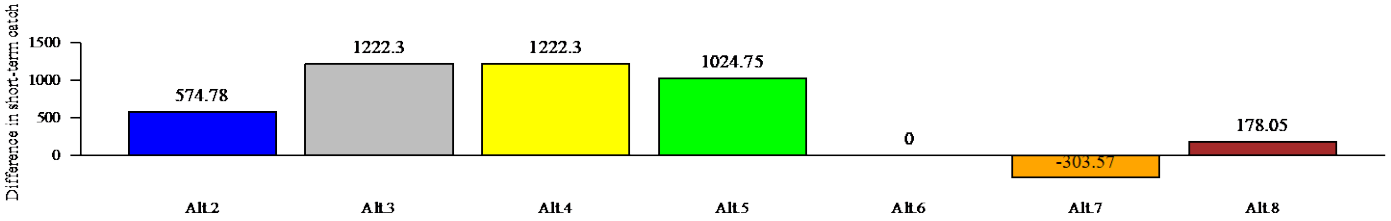




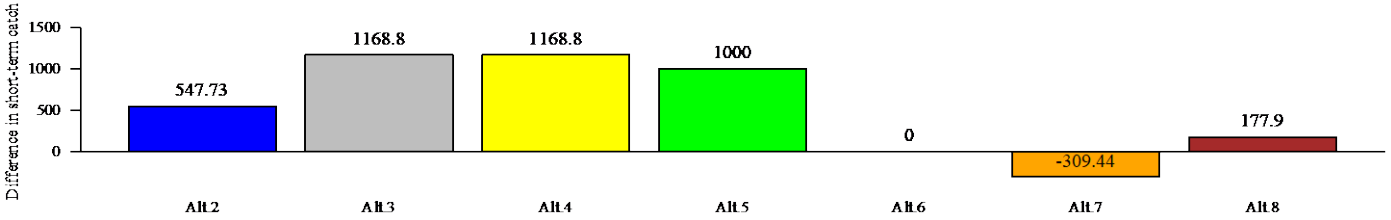
Average future productivity



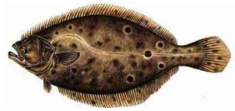
Good future productivity

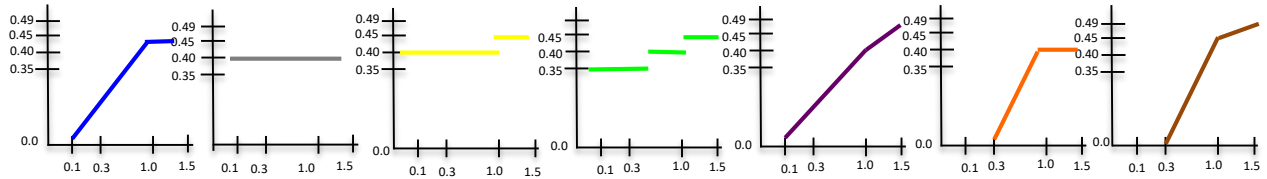


Poor future productivity

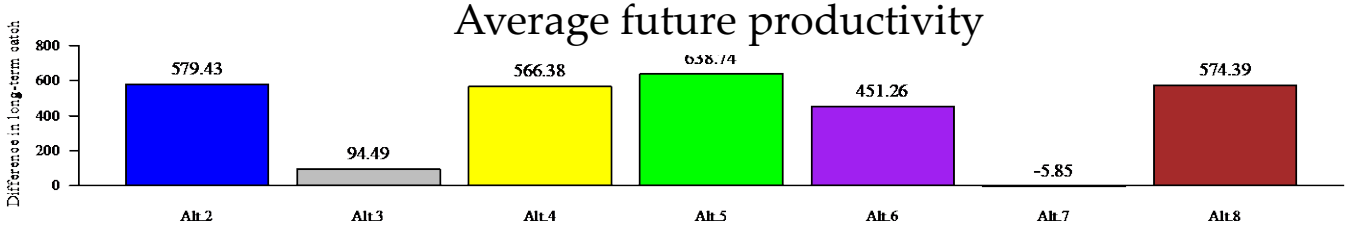


Difference in long-term catch (mt) relative to current CR

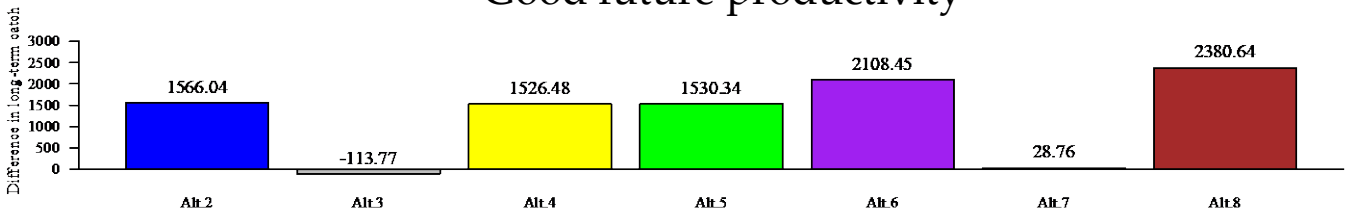




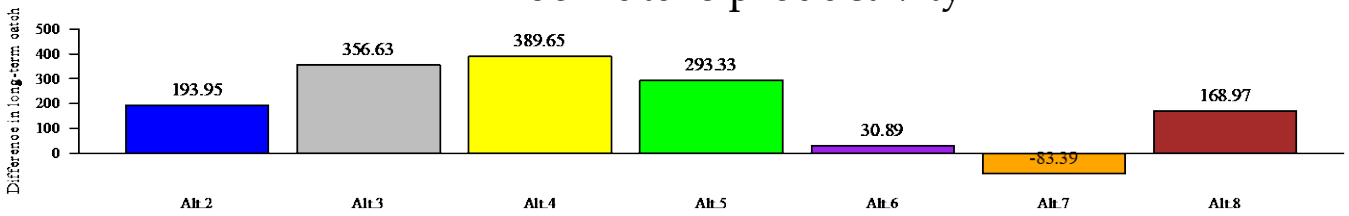
Average future productivity



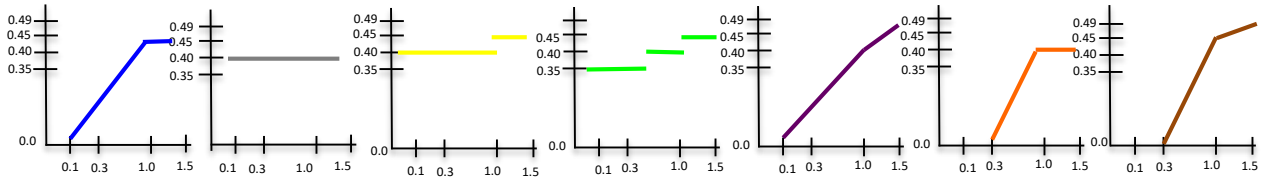
Good future productivity



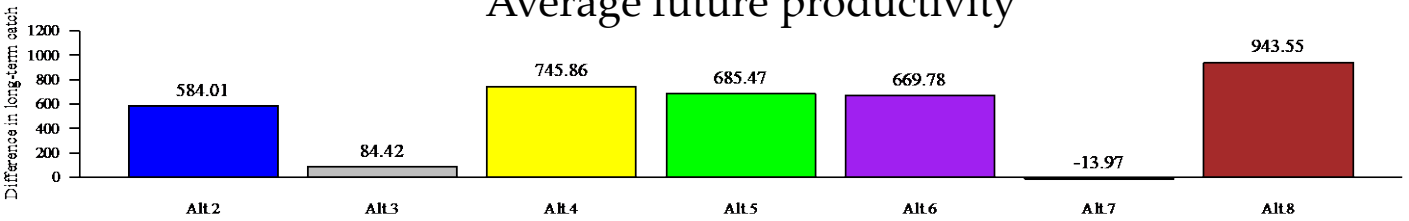
Poor future productivity



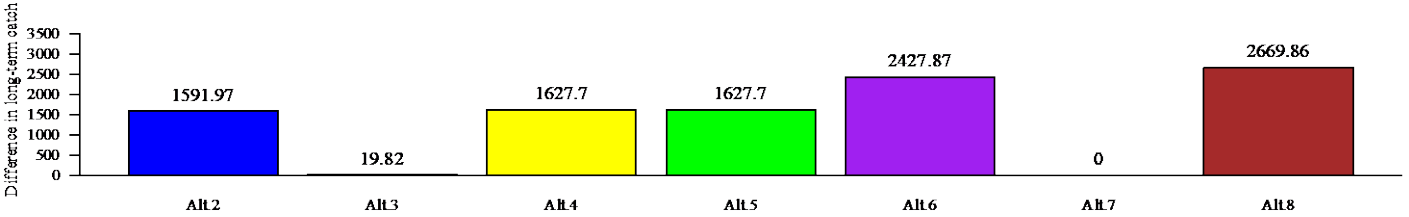
Difference in long-term catch (mt) relative to current CR



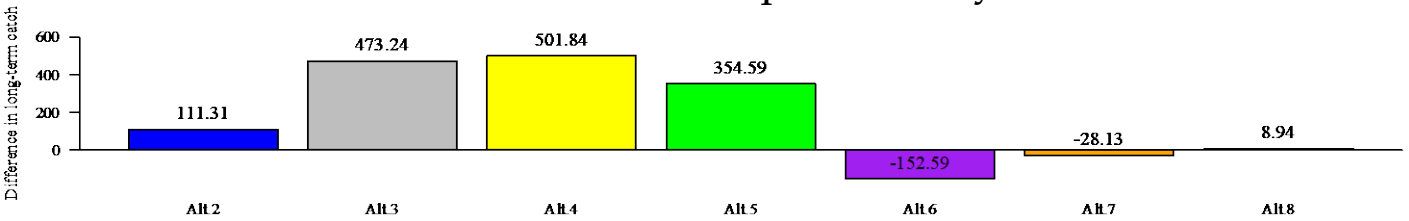
Average future productivity



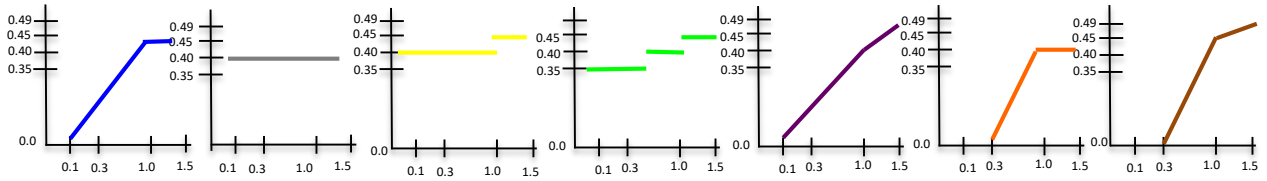
Good future productivity



Poor future productivity

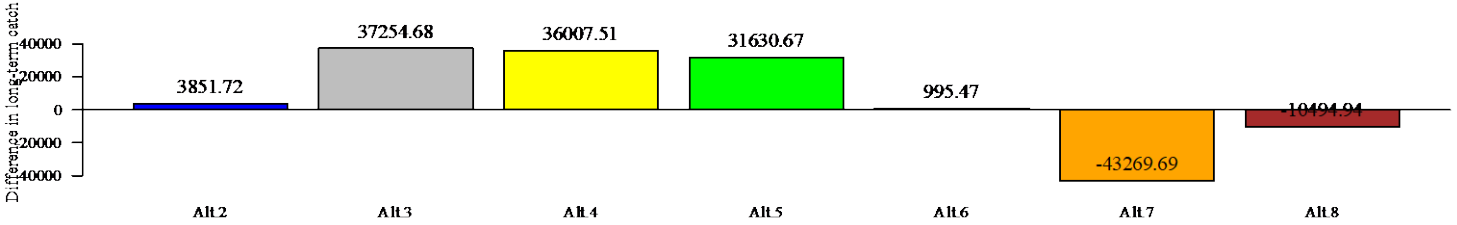


Difference in long-term catch (mt) relative to current CR

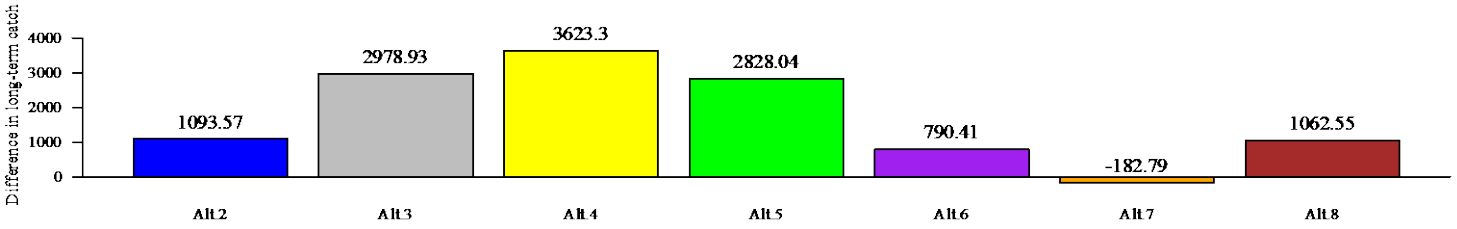


Average future productivity

Good future productivity



Poor future productivity



Catch Summary

- The stepped control rules with max P* = 0.45 (Alt. 4 and 5) had consistently high catch across productivity scenarios
  - Highest catch for butterfish across productivity scenarios
  - Highest short-term catch for summer flounder

- Highest P* targets (Alt. 6 and 8) only result in highest yield for summer flounder under good productivity, and for scup under average and good productivity, but these options had low yield under poor productivity across stocks, and also some of the lowest short-term catch for summer flounder

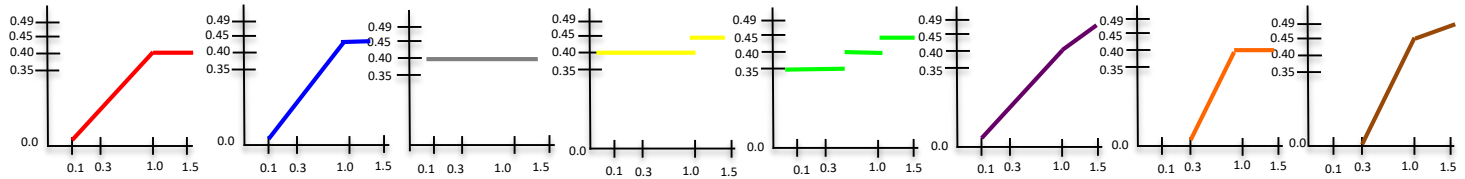
- Of the ramped control rules. Alternative 2 had the highest short-term catch for summer flounder, and higher yield across stocks under poor productivity

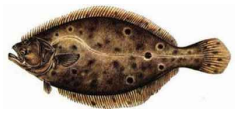
Risks:

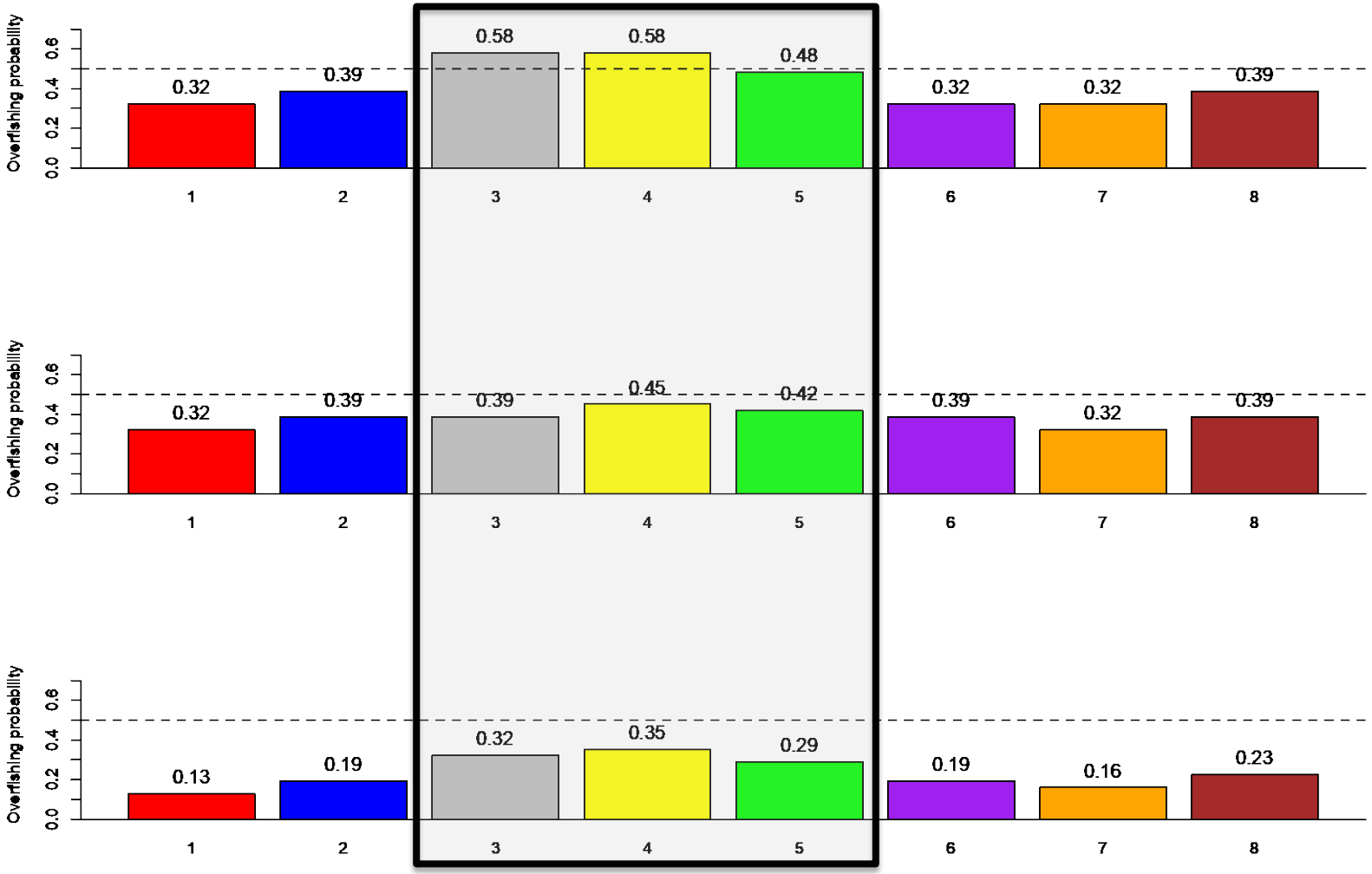
Probability of overfishing ($F > F_{MSY}$)

Probability of causing the to stock to become overfished ($S < 50\%\ S_{MSY}$)

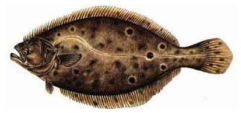
Overfishing probability when productivity is poor

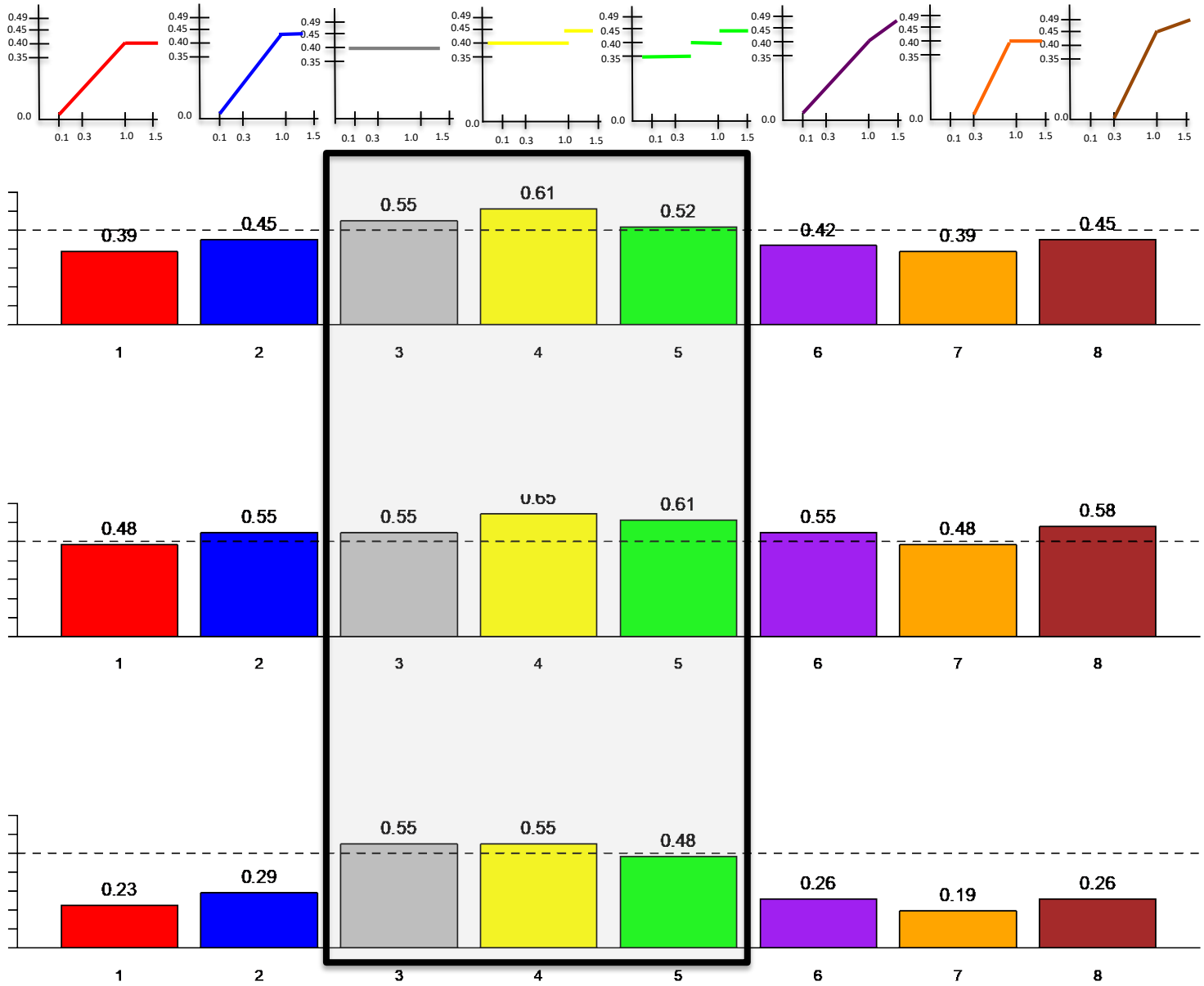




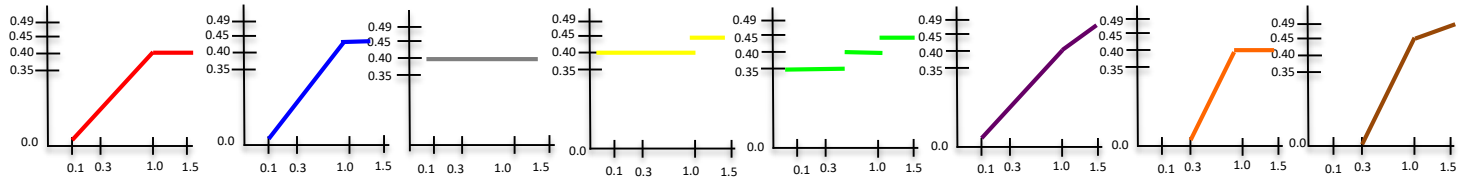


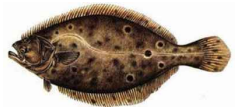
Overfishing probability when assessments overestimate biomass

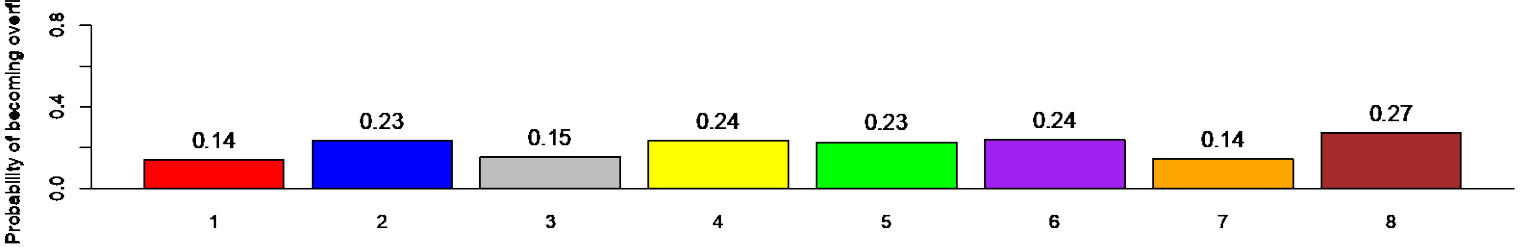


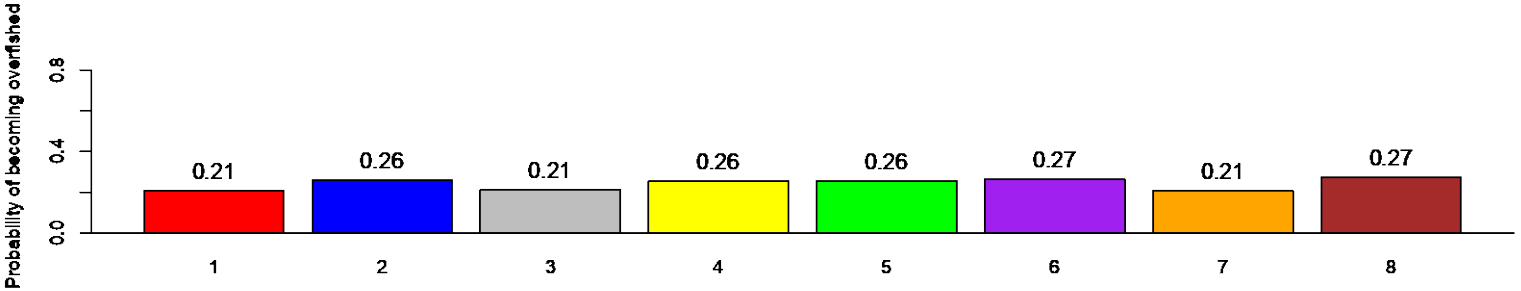


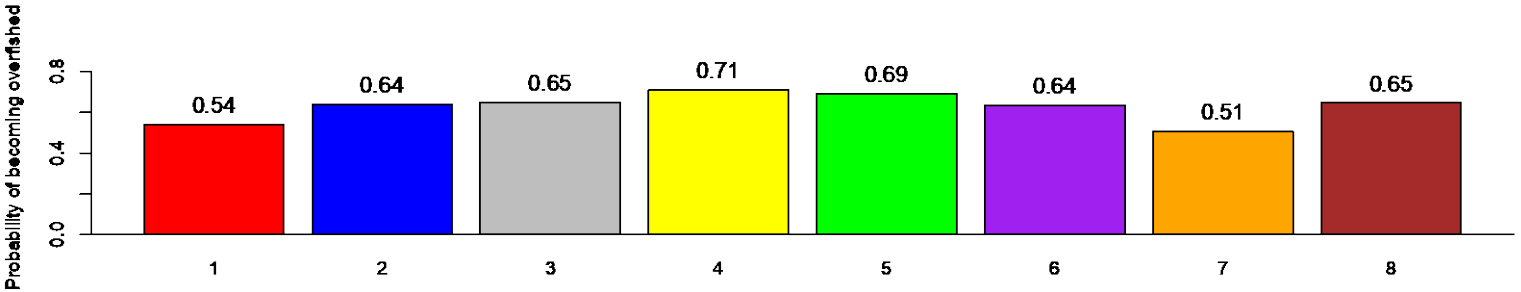
Prob. of becoming overfished under average productivity



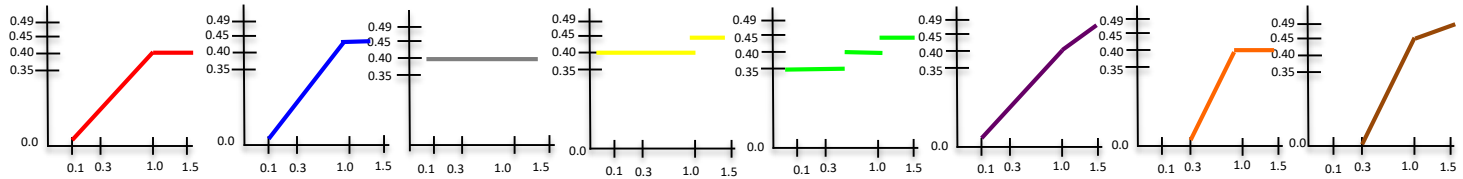


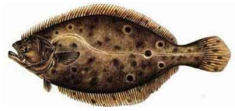






Prob. of becoming overfished under average productivity





Poor future productivity

Probability of becoming overfished

0.72 0.8 0.87 0.87 0.84 0.75 0.71 0.78

1 2 3 4 5 6 7 8

Poor future productivity

Probability of becoming overfished

0.55 0.61 0.57 0.63 0.62 0.6 0.55 0.63

1 2 3 4 5 6 7 8

Good future productivity

Probability of becoming overfished

0.03 0.04 0.15 0.16 0.12 0.02 0.02 0.02

1 2 3 4 5 6 7 8

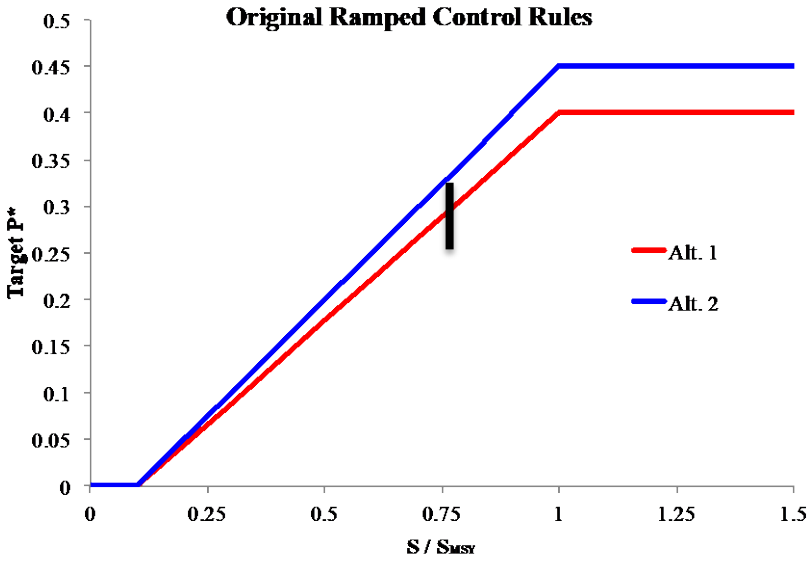
Risk summary

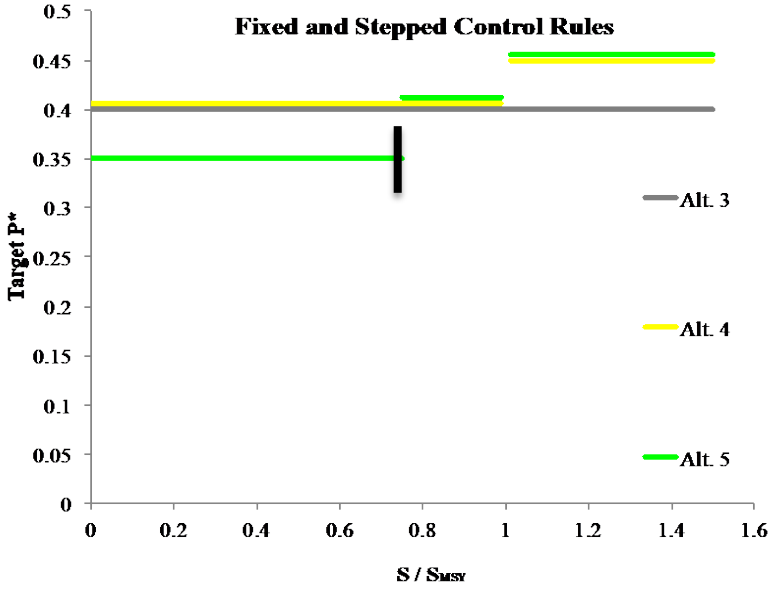
- All control rules limited overfishing below the 50% threshold under average productivity
- Increased risk of overfishing under poor productivity across stocks and when assessments overestimated biomass, often exceeding the 50% threshold
- Risk of becoming overfished highest for stepped options under poor productivity for summer flounder and scup, and good productivity for butterfish

Which Control Rule is Best?

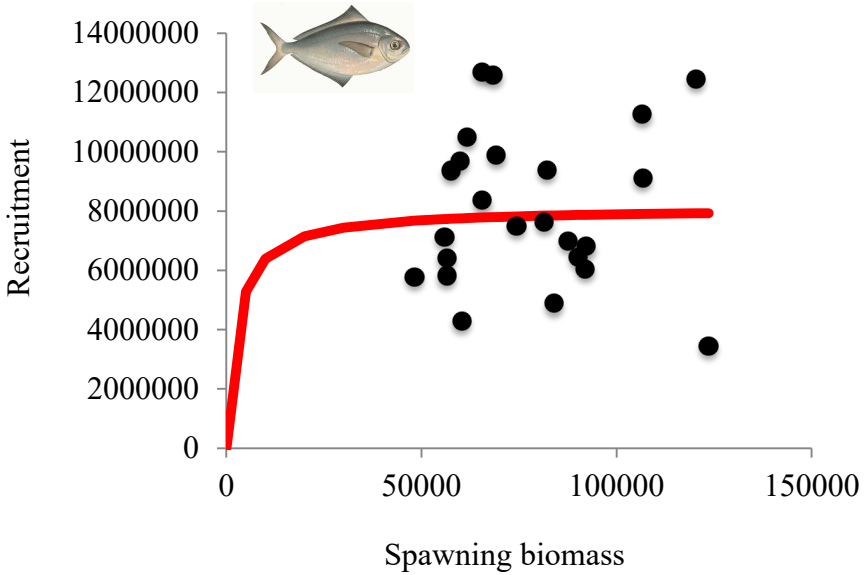
- Depends on your objectives and how you weigh the tradeoffs
- Stepped Alternatives 4 and 5 result in consistently high catch with low variability, but they are the most risky in terms of overfishing (Alt. 5 is the least risky of the two at low stock sizes), and generally have the highest risks of causing the stock to become overfished
- Ramped control rules provide more protection when things go awry (declining productivity / assessment bias), but yield can be more variable when biomass is below the target. Of the ramped control rules, Alternative 2 performs best at allowing high catches under varying conditions, albeit with slightly higher risks.

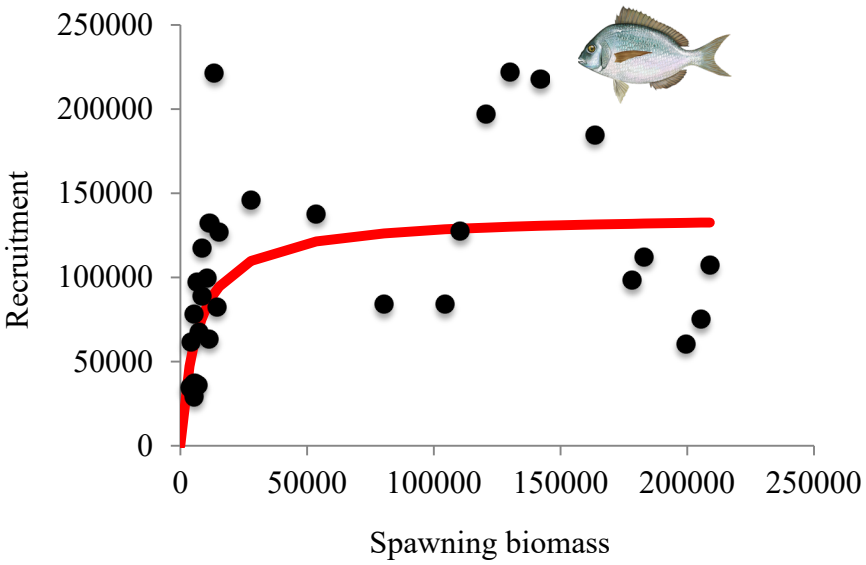
Stepped options have the potential to put additional scrutiny on assessment results and reference points





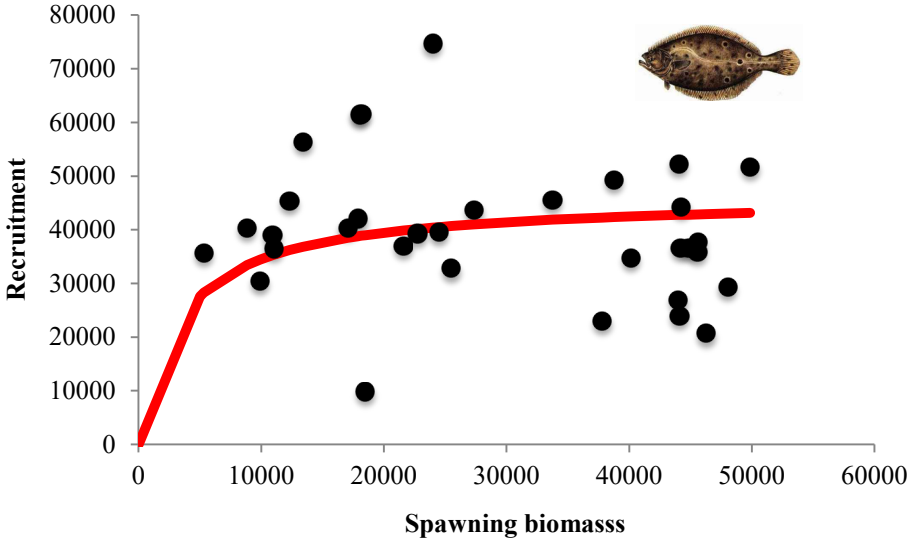
Ramped options may be better suited for Mid-Atlantic stocks with lower productivity at low stock sizes





Observed recruitment

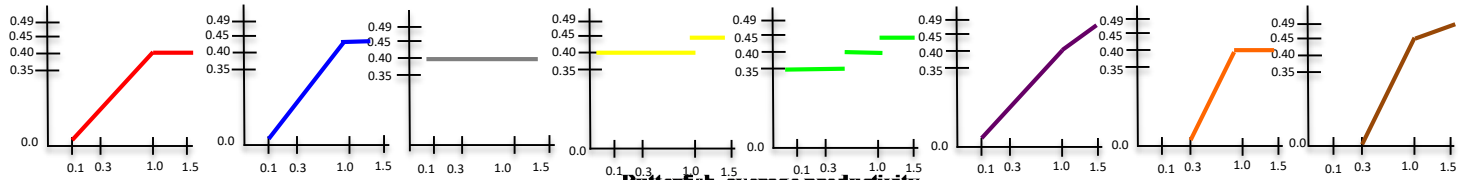
Estimated stock-recruit relationship

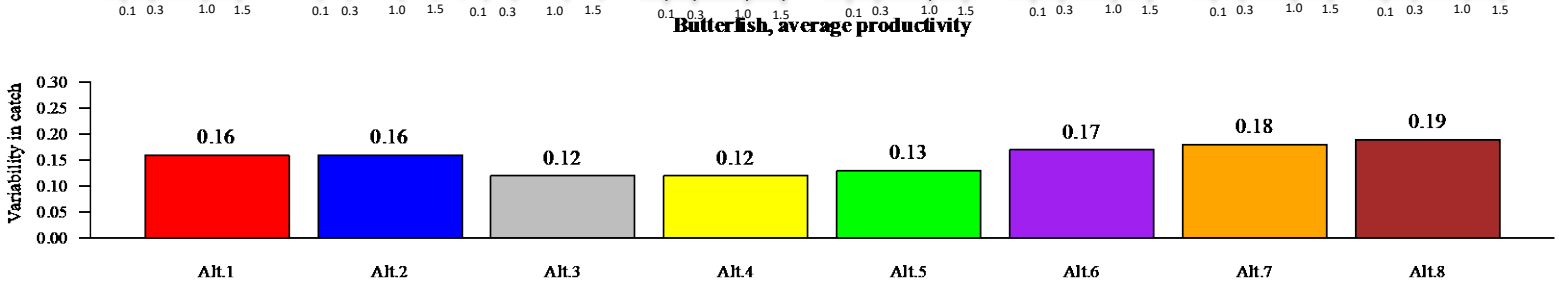


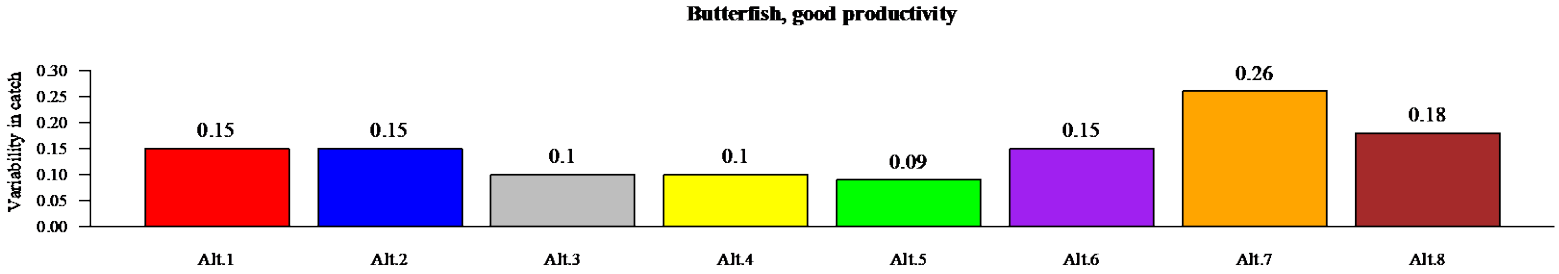
Questions?

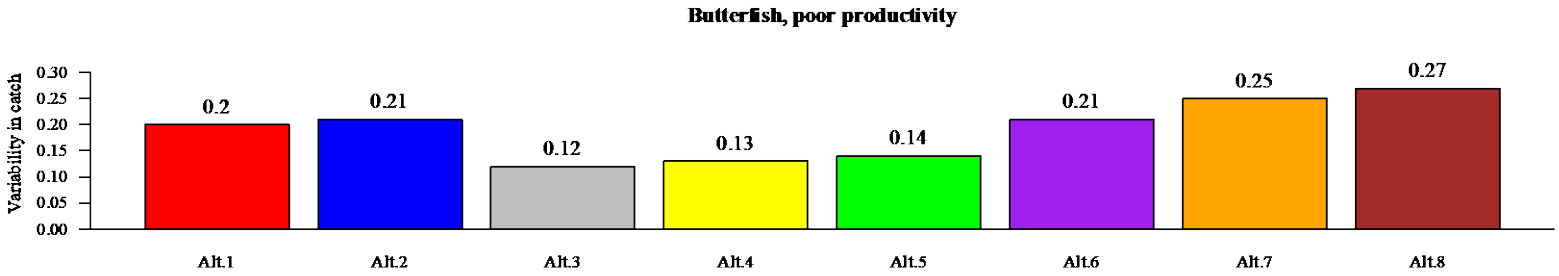
Average change in catch

Average relative change in catch

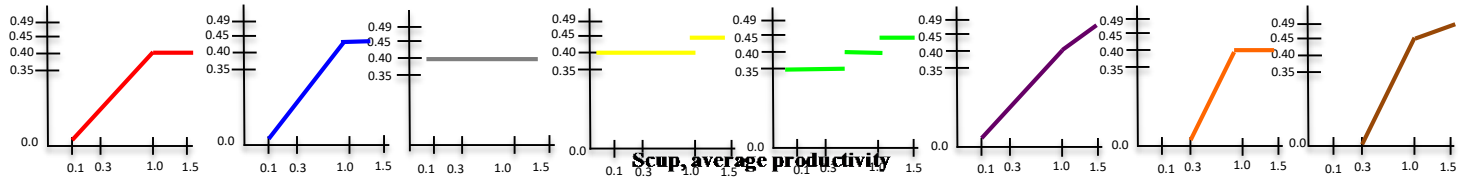


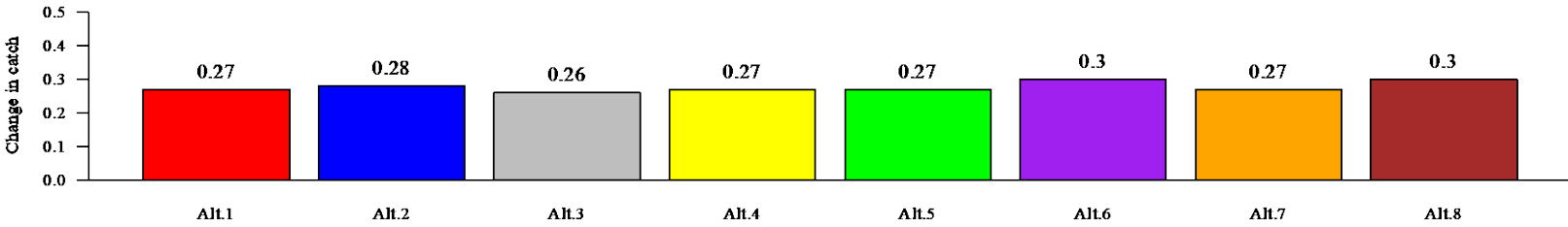


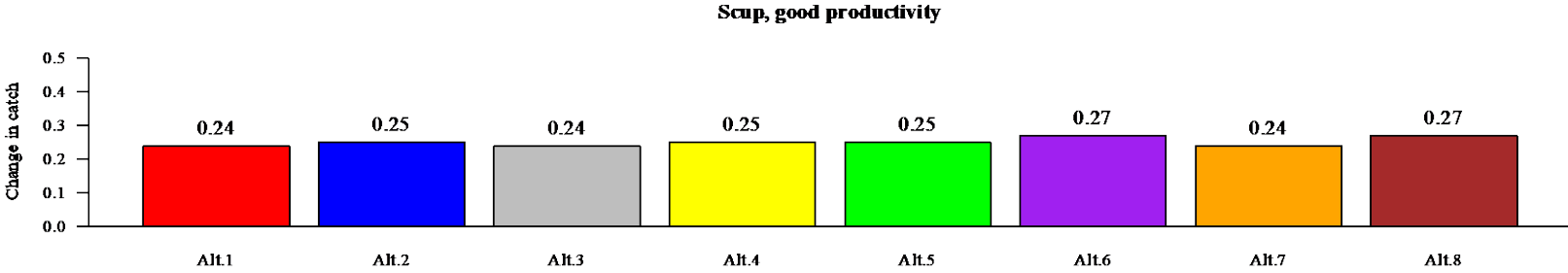


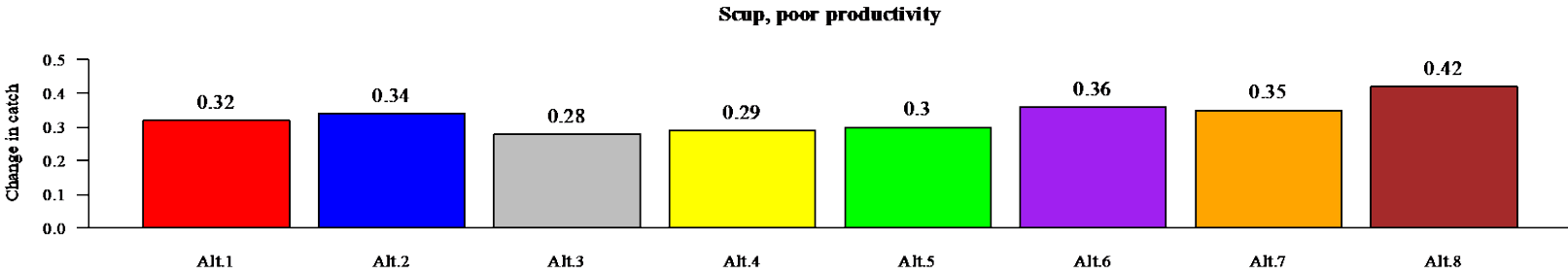


Average relative change in catch



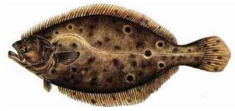


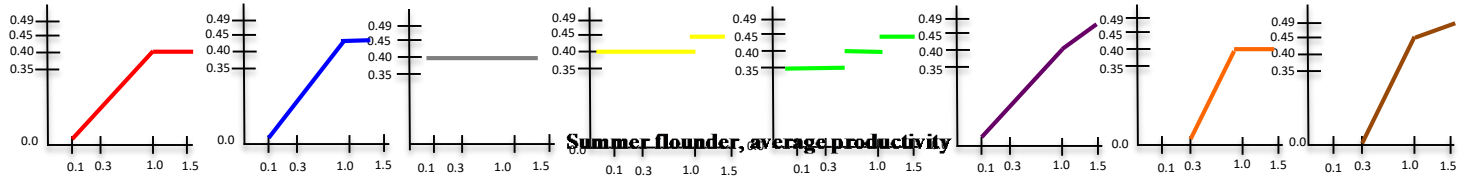


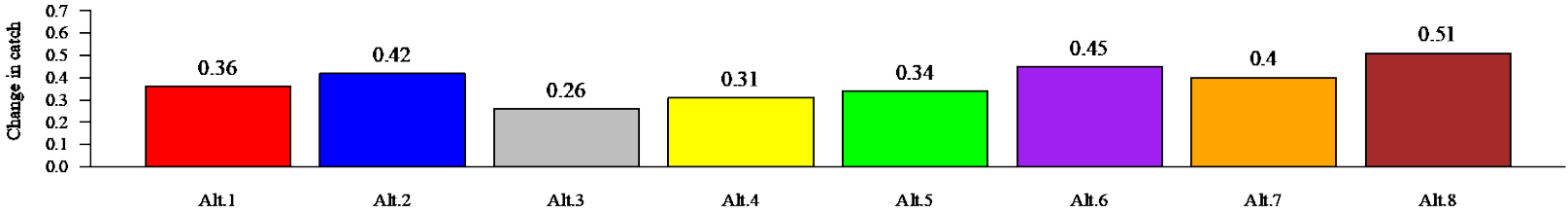


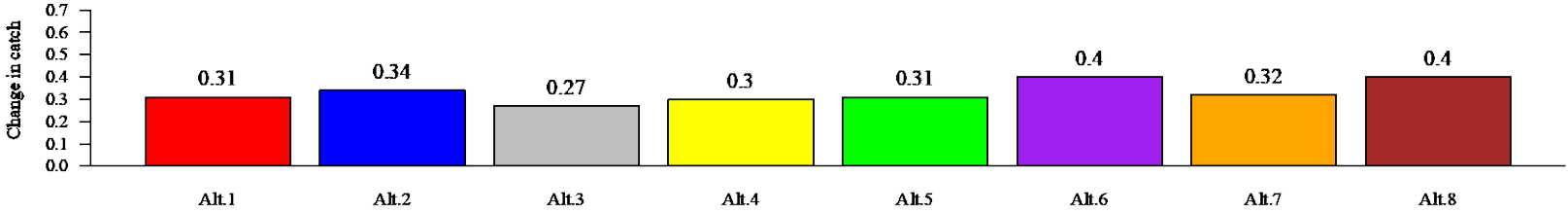
Max. change in catch

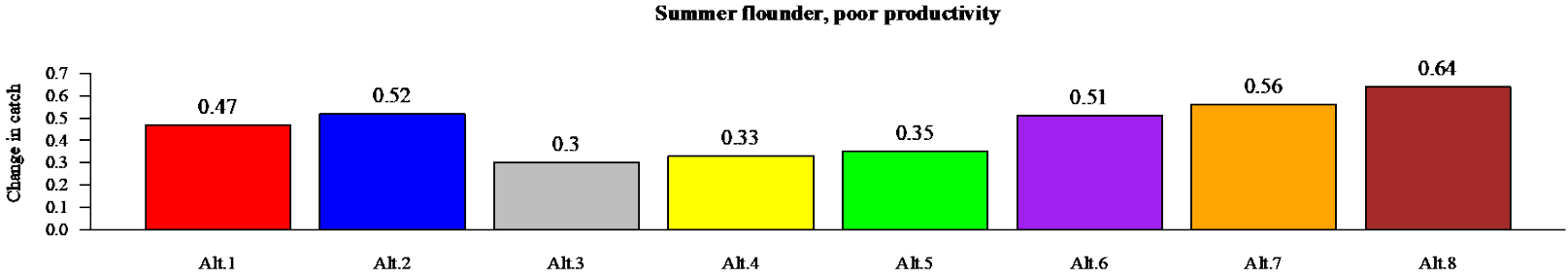
Maximum change in catch



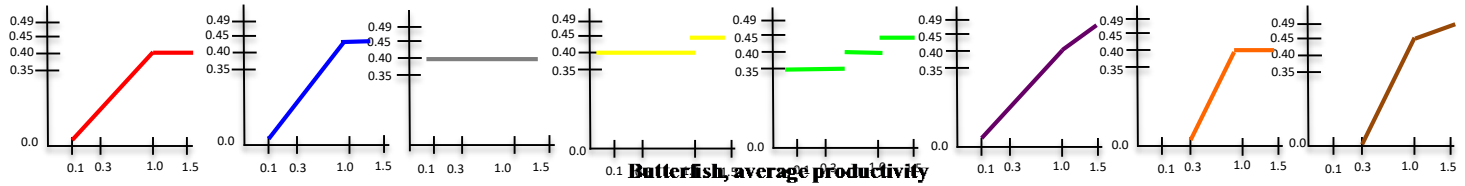


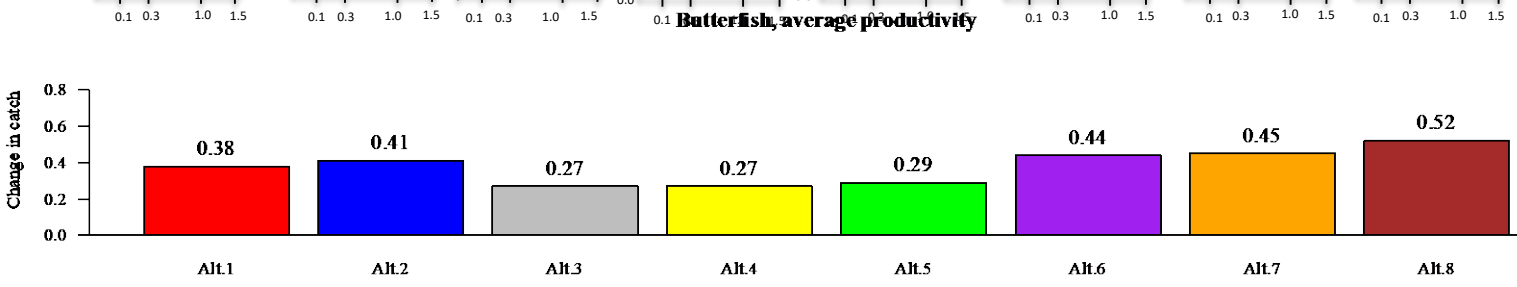


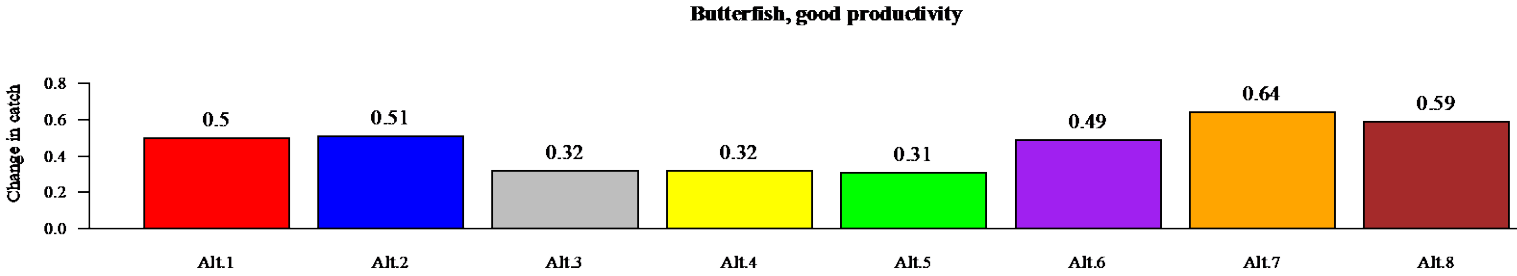


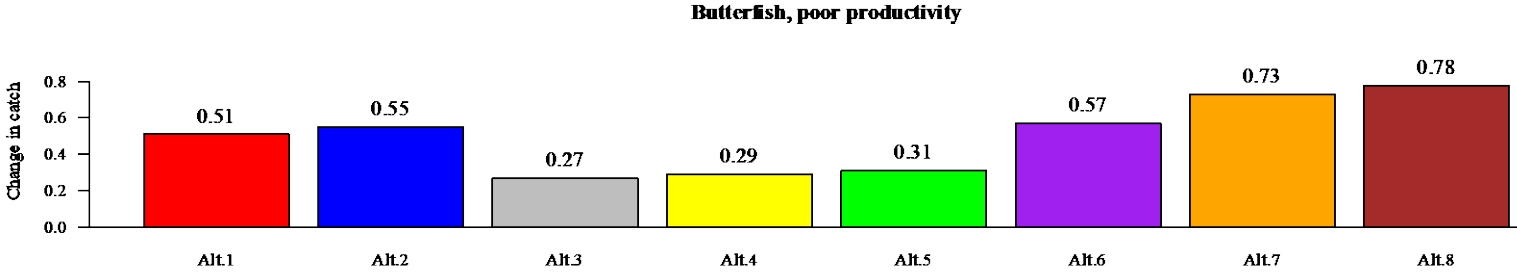


Maximum change in catch

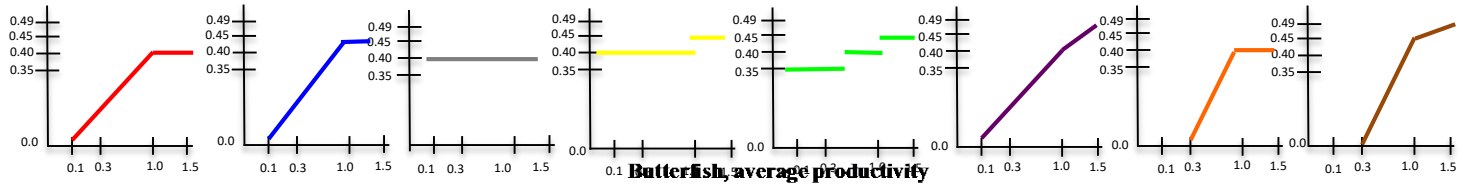




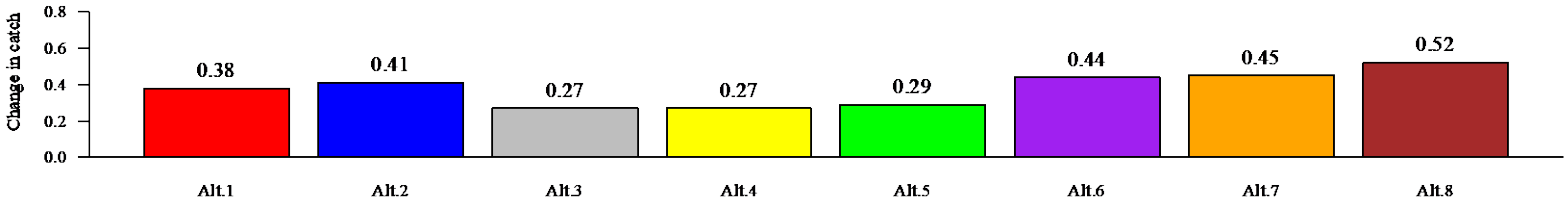




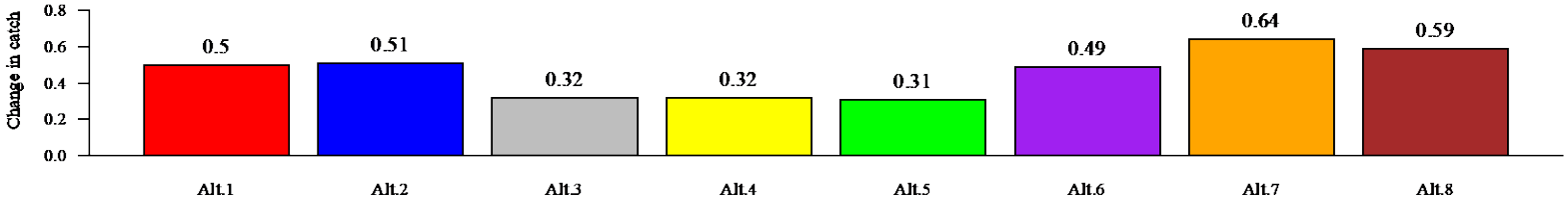
Maximum change in catch



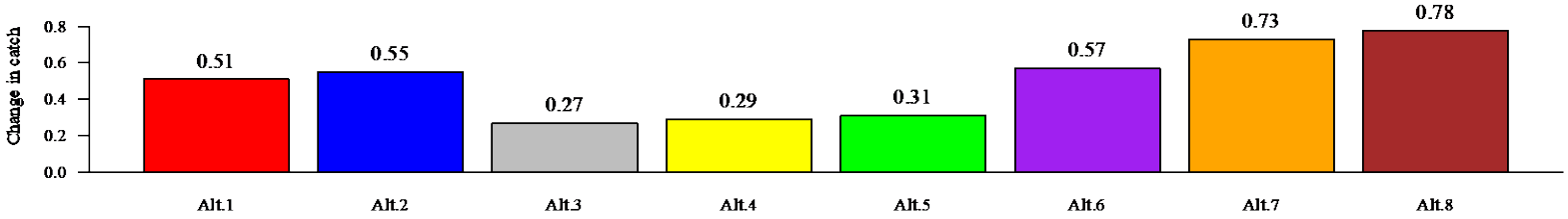
Butterfish, average productivity



Butterfish, good productivity

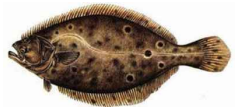


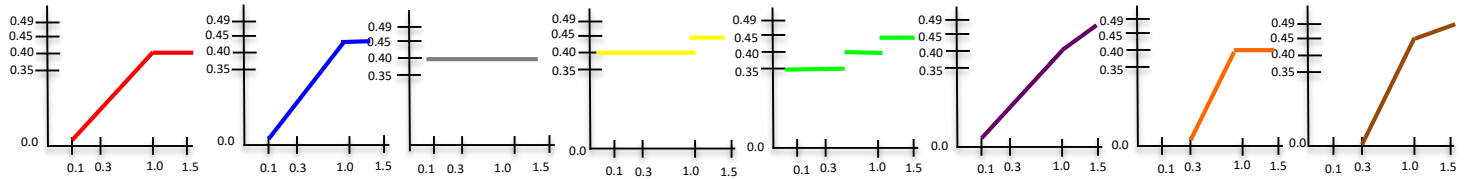
Butterfish, poor productivity



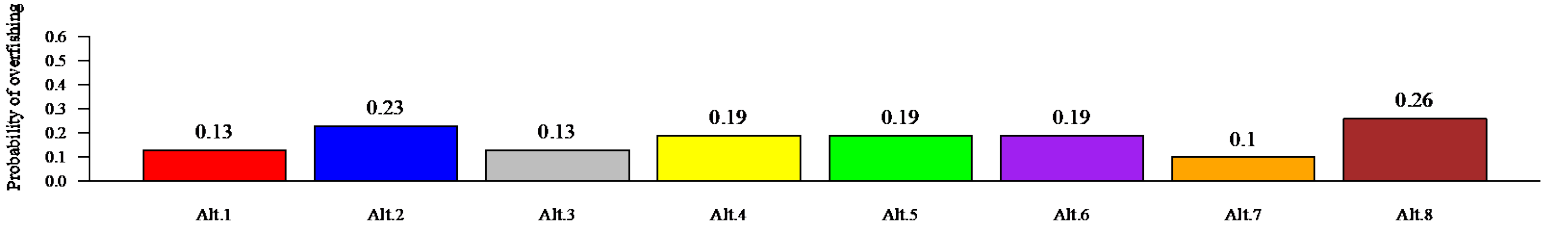
OVERFISHING PROB.

Probability of overfishing

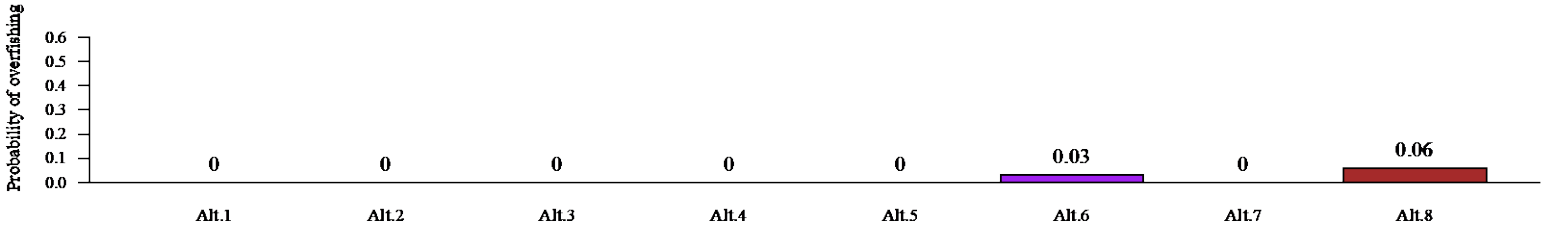




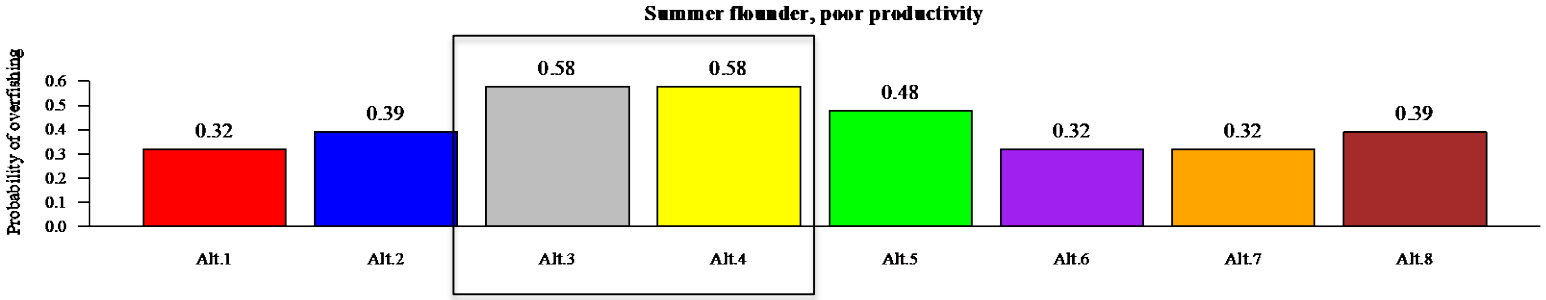
Summer flounder, average productivity



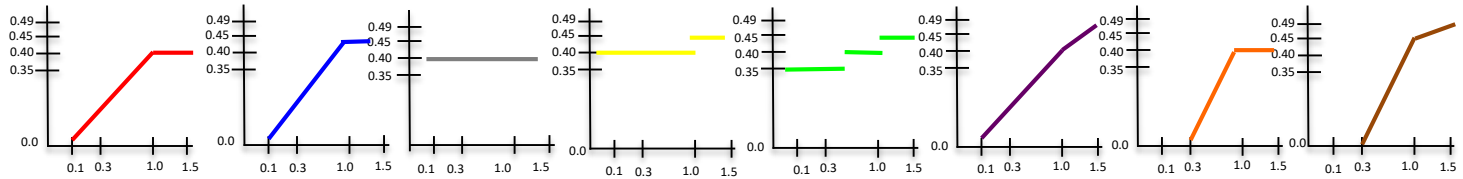
Summer flounder, good productivity



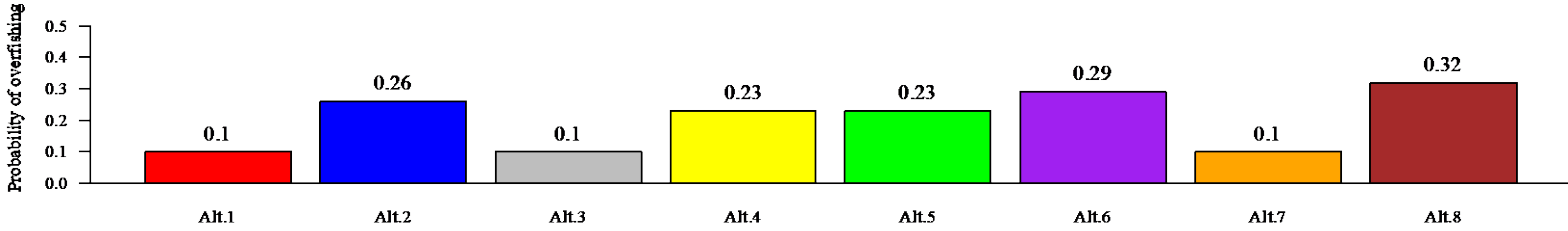
Summer flounder, poor productivity



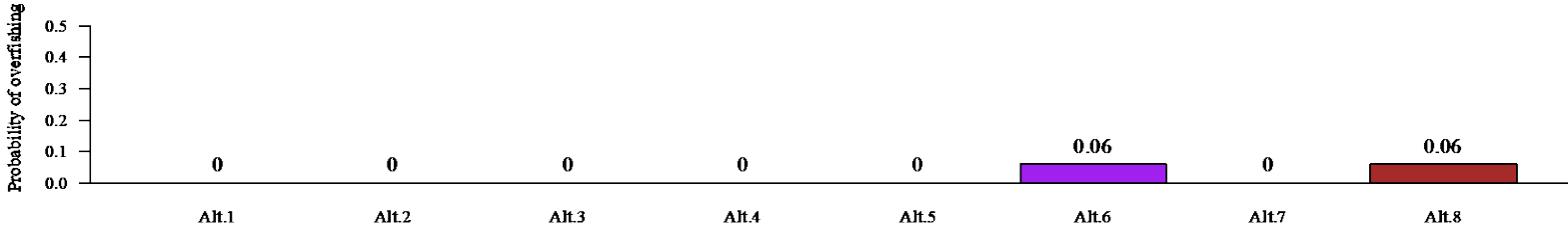
Probability of overfishing



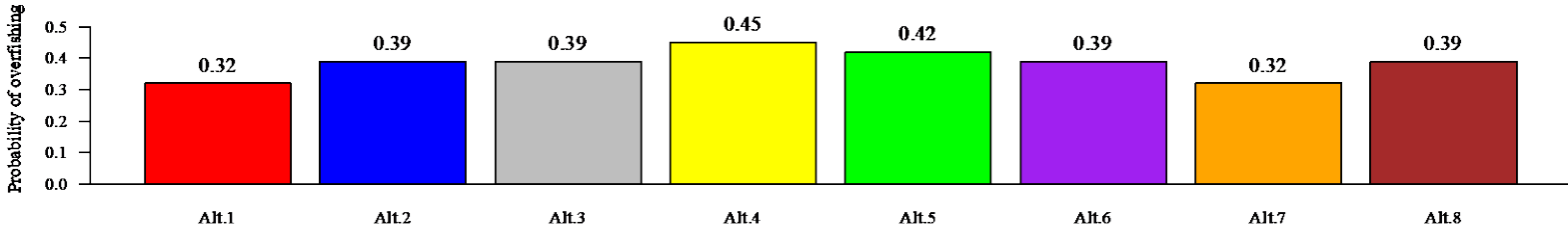
Scup, average productivity



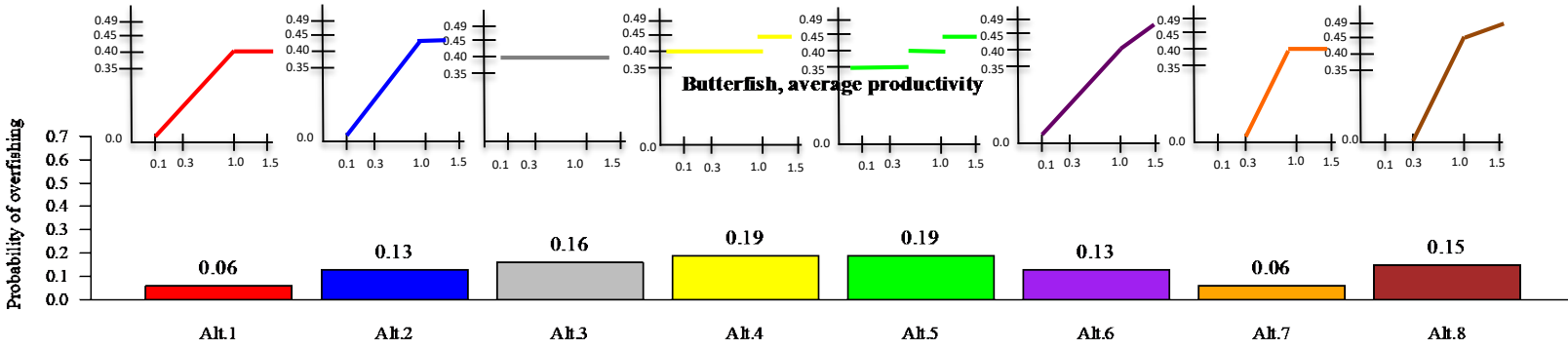
Scup, good productivity

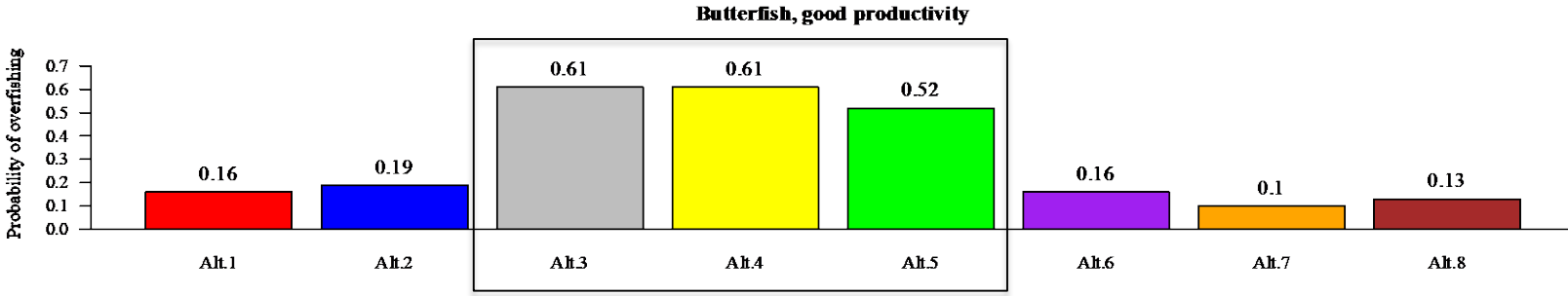


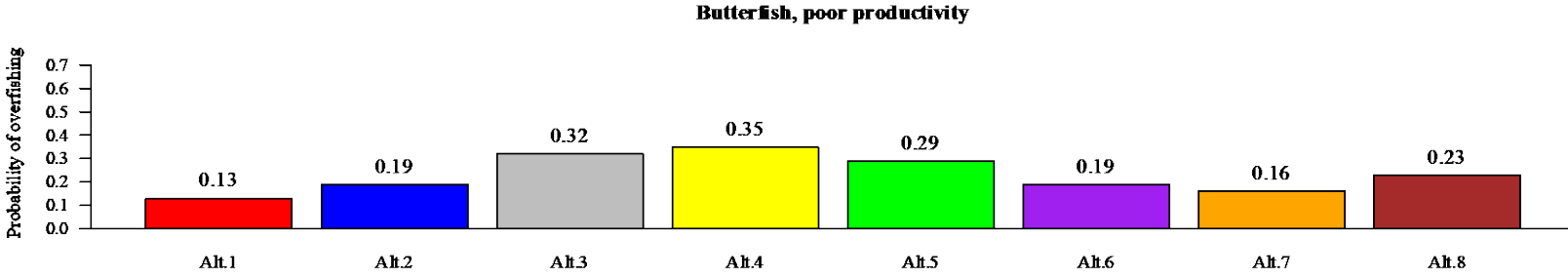
Scup, poor productivity



Probability of overfishing

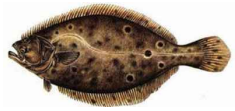


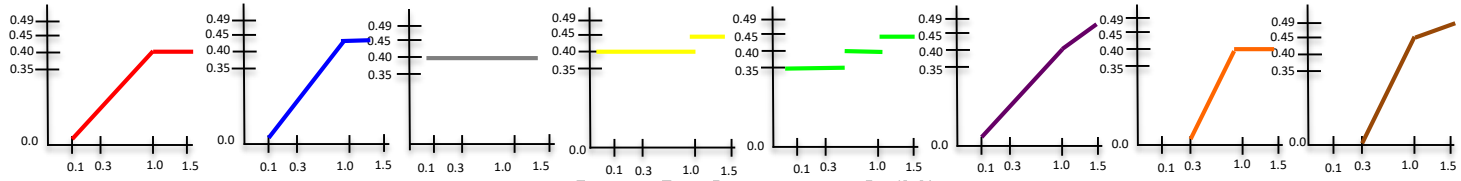


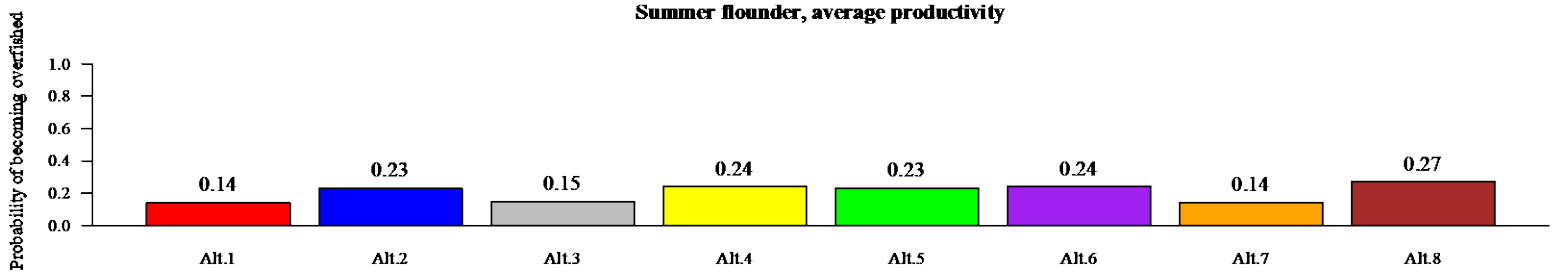


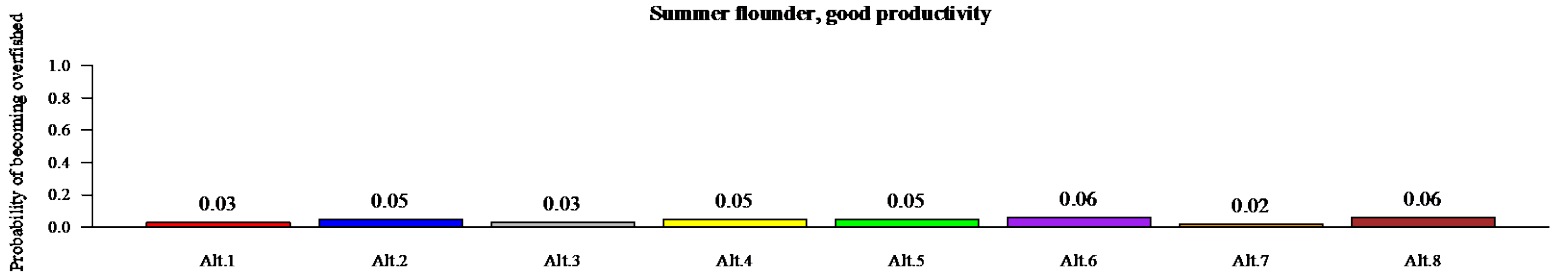
OVERFISHED PROB

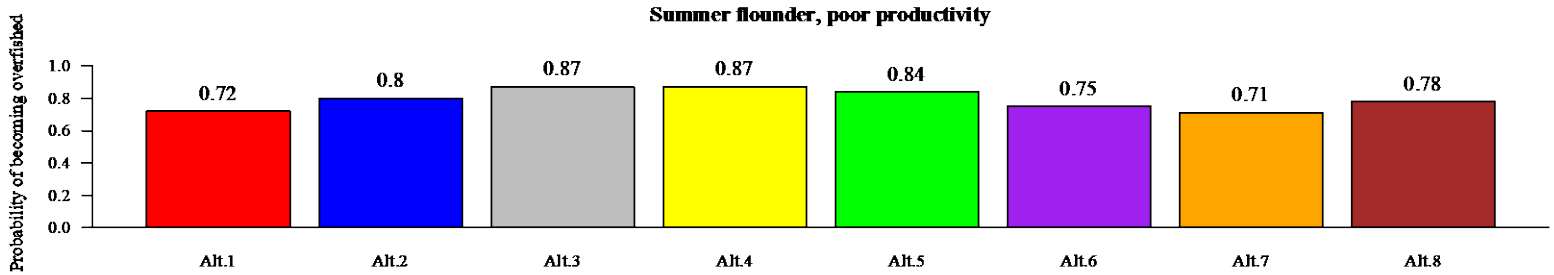
Probability of becoming overfished



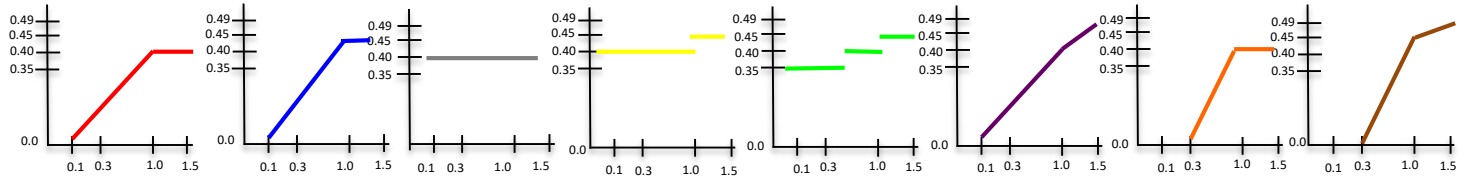


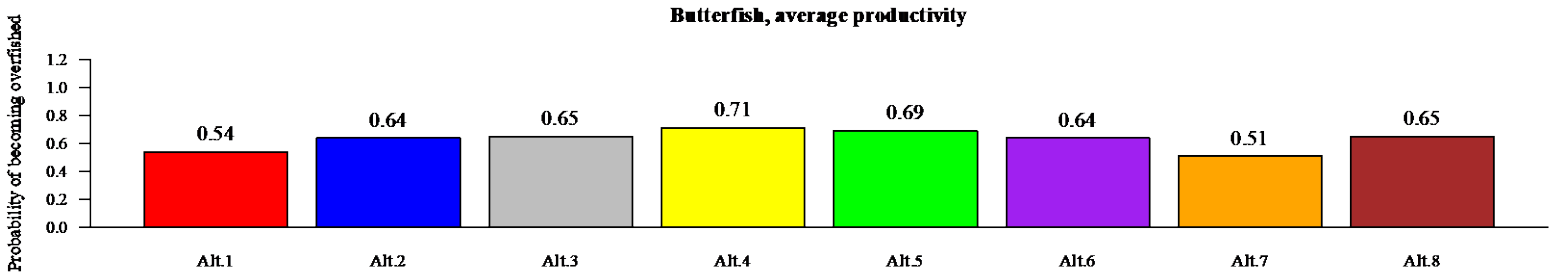


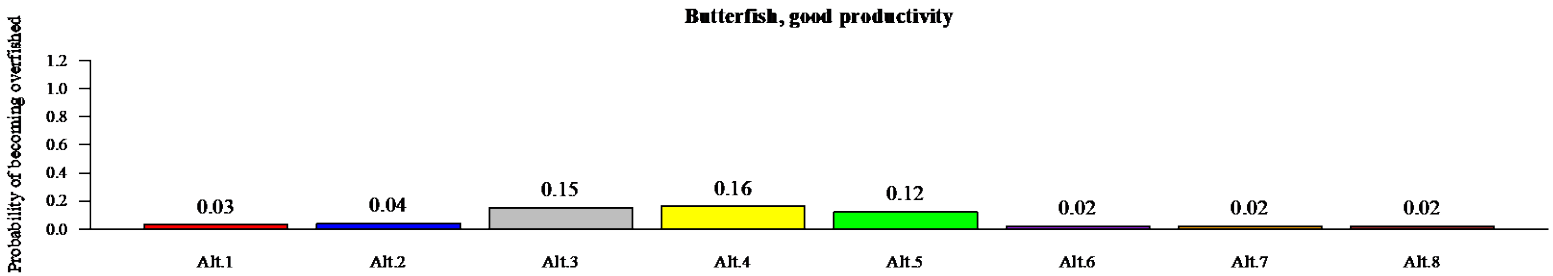


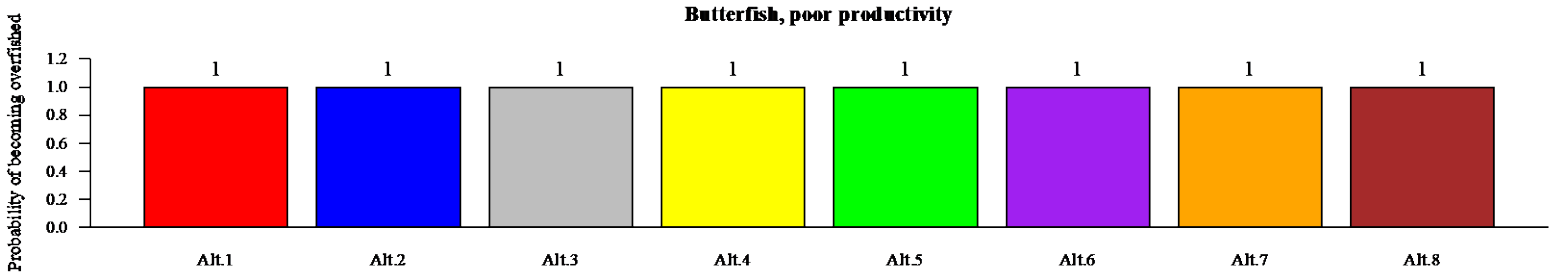


Probability of becoming overfished

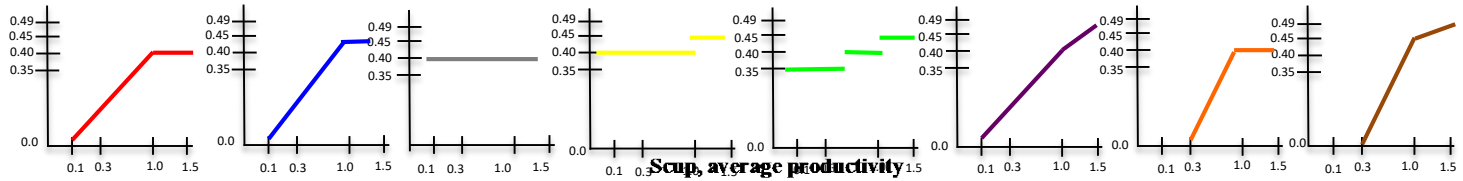


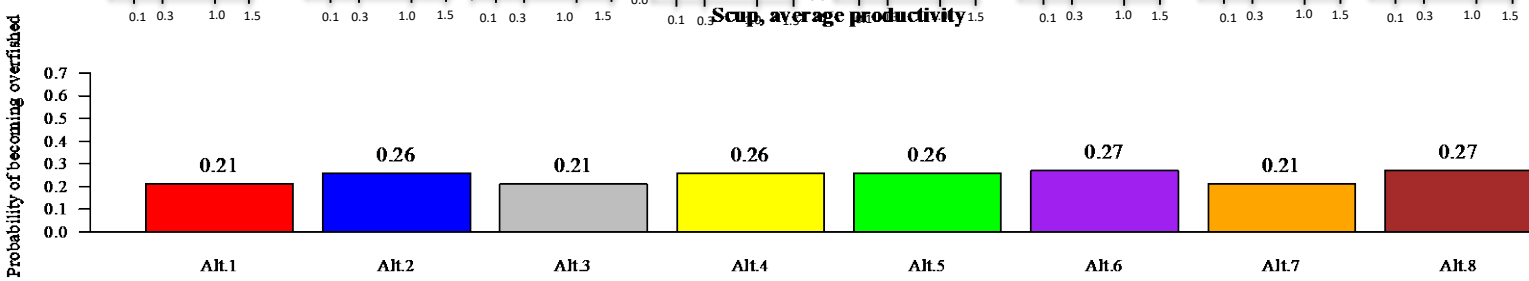


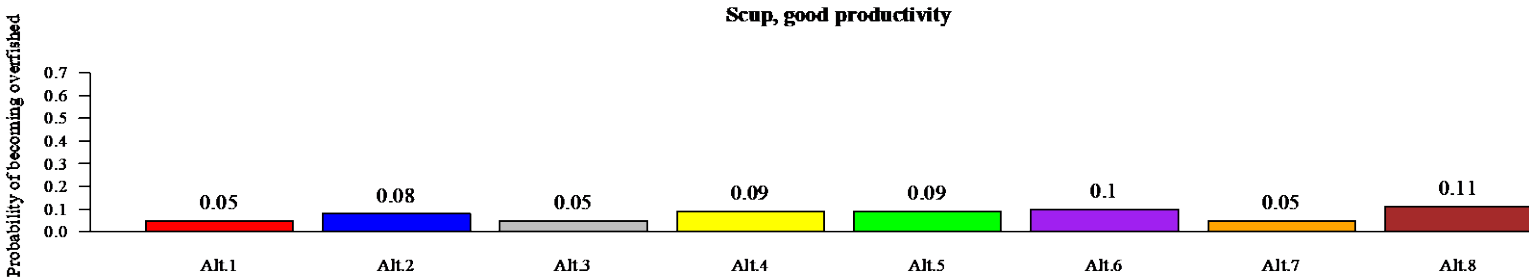




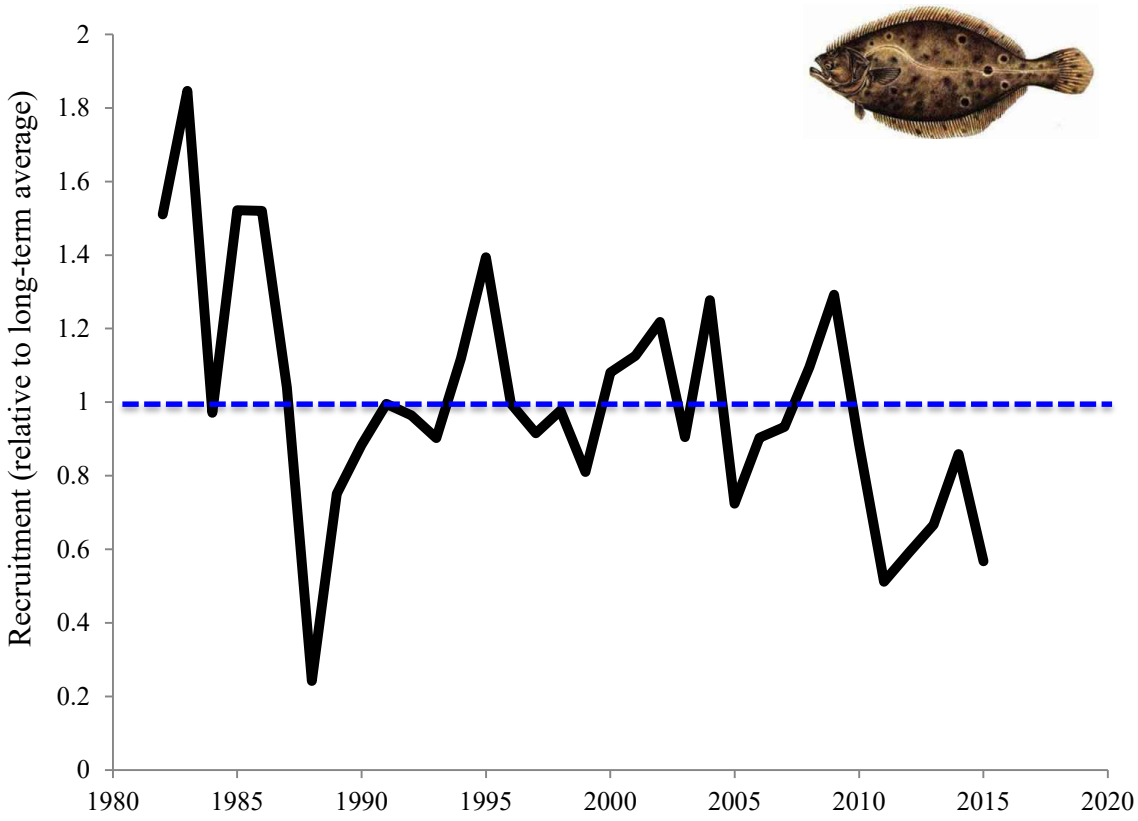
Probability of becoming overfished

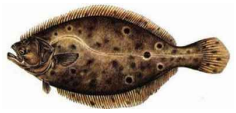






Recruitment trends





CR	Alt. 1	Alt. 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Max P*	0.4	0.45	0.4	0.4	0.45	0.49	0.49	0.4
Min P*	0	0	0.4	0.4	0.35	0	0	0
Closure	10% Smsy	10% Smsy	-	-	-	10% Smsy	30% Smsy	30% Smsy

PM	Productivity							
	Average	9,266	493	881	881	881	493	232	-336
Mean C	Good	9,428	692	1,022	1,062	1,062	718	377	-213
(First 5)	Poor	8,755	537	971	971	970	537	264	-336
	Average	13,373	555	161	383	566	596	627	1
Mean C	Good	21,524	1,650	6	1,717	1,717	2,042	1,979	29
(Last 20)	Poor	7,469	88	312	312	123	162	184	-138
	Average	0.13	0.02	-0.02	0.00	0.00	0.02	0.03	0.01
C variability	Good	0.08	0.01	-0.01	0.00	0.00	0.01	0.02	0.01
	Poor	0.18	0.02	-0.03	-0.02	-0.02	0.02	0.05	0.02
	Average	0.1	0.16	0.00	0.16	0.17	0.22	0.24	0.00
Pr(overfishing)	Good	0	0.03	0.00	0.03	0.03	0.15	0.15	0.00
	Poor	0.39	0.08	0.34	0.34	0.22	0.09	0.05	0.00
	Average	0.28	0.10	0.00	0.08	0.08	0.12	0.10	0.00
Pr(overfished)	Good	0.06	0.02	0.00	0.02	0.02	0.08	0.04	0.00
	Poor	0.8	0.12	0.10	0.14	0.12	0.12	0.12	0.00