Abundance based management alternatives for Pacific halibut PSC

C-7

Timeline / Council actions (in current discussion paper)

April 2016

- purpose and need statement
- explore weightings on IPHC stock assessment and EBS trawl survey
- public review workshop of paper prior to Council meeting in October

October 2016

- workshop on discussion paper (September 2016)
- 5 Objectives confirmed for action
- consider broader range of indices and BCRs (SSC 2d and 3d)
- develop draft performance metrics w/ public input

February 2017

- Public workshop to solicit input on draft Overarching goals, measurable objectives and associated performance metrics for analysis

April 2017

- Alternative development
  "Strawman" alternatives for illustration to aid selection of indices and control rules

Future meeting (2017 anticipated)

- Refinement of alternatives for analysis

Recap from previous discussion papers and outcomes

April 2016 (last year):

- Potential indices to use
- PSC set to weighted combinations

1. previous year PSC,
2. EBS trawl survey and
3. IPHC SSB trends

(BCR1, BCR2 etc in appendix)

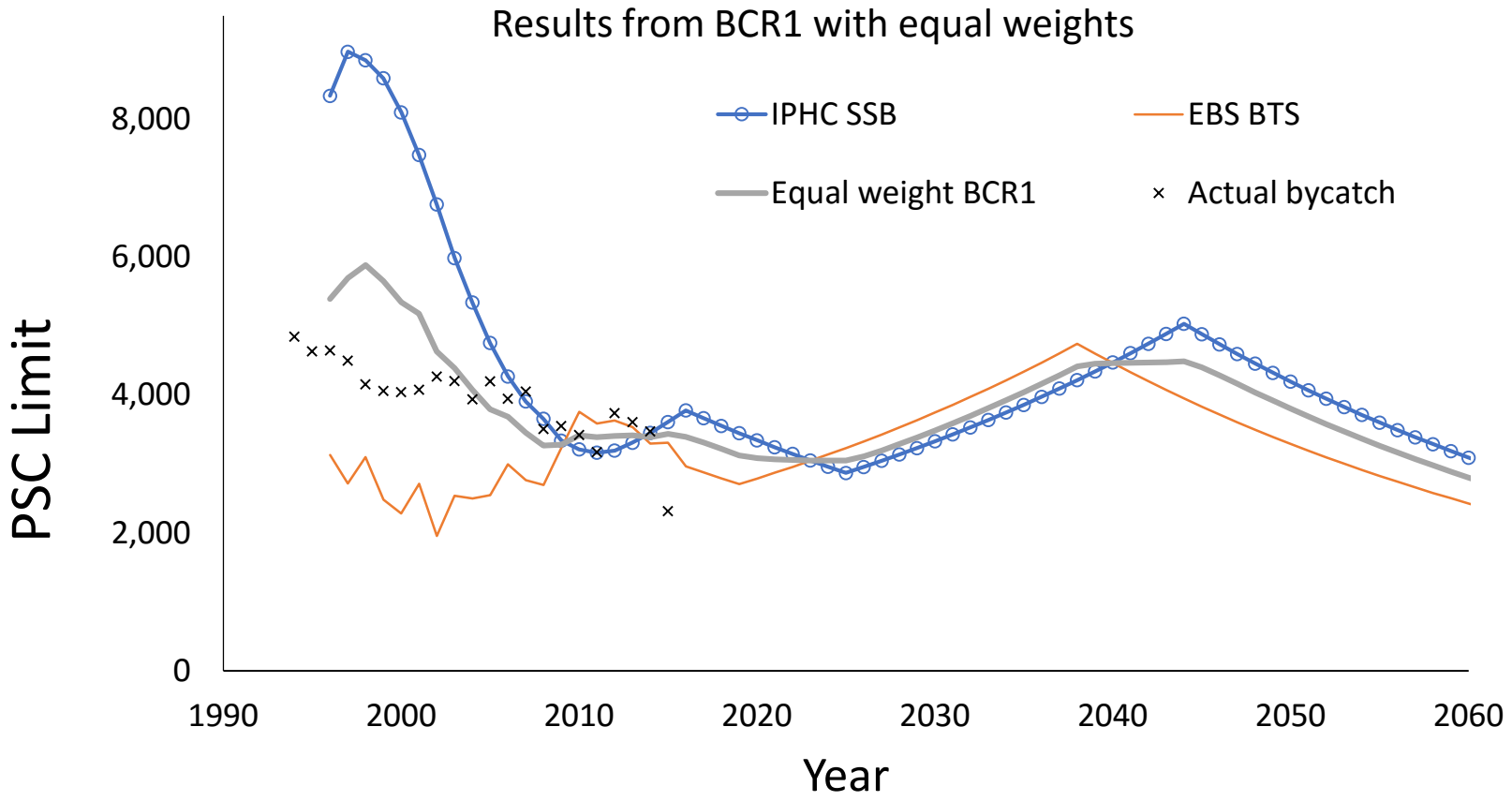


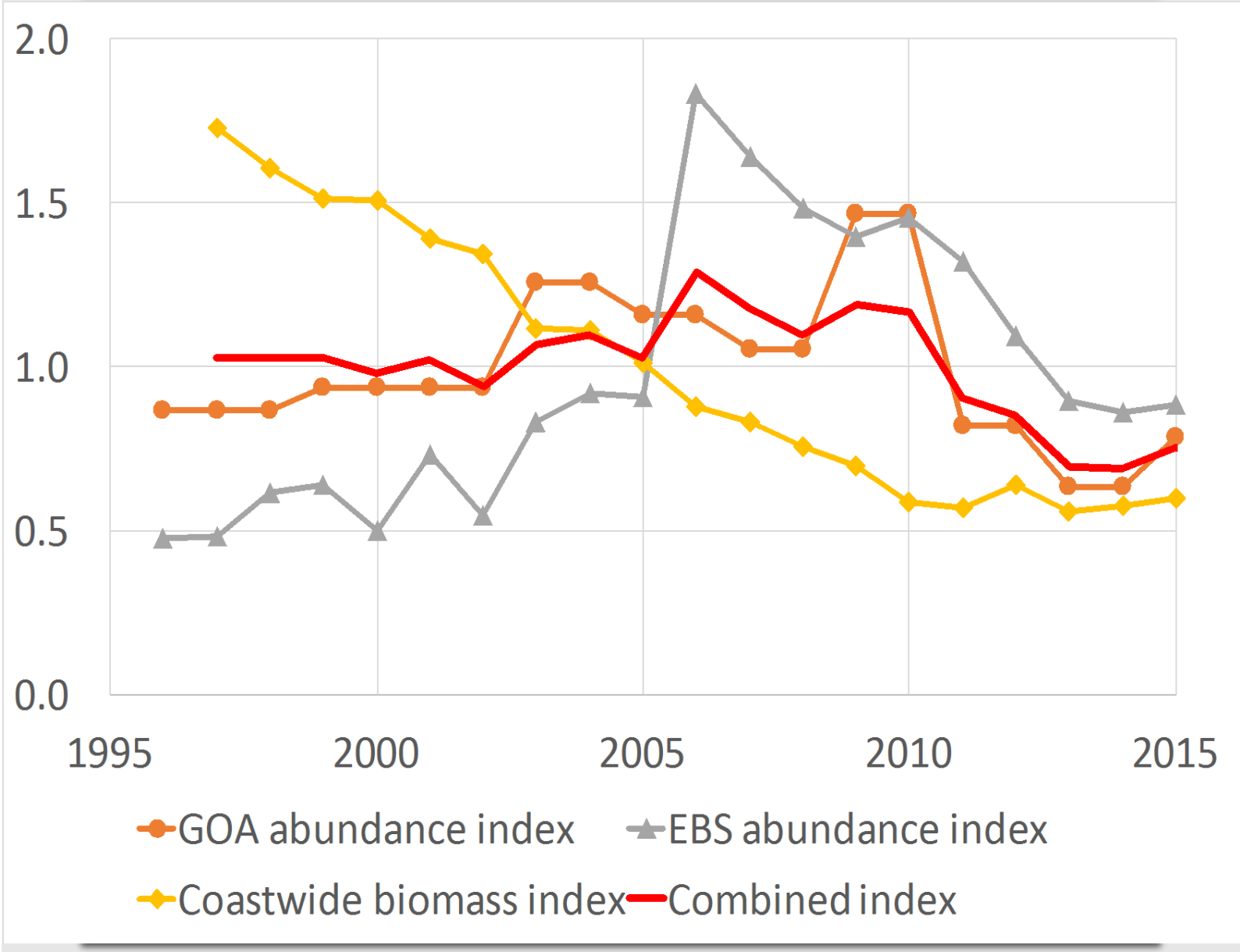
Figure 15. Example BCR1 (grey line, bottom panel) with equal weights based on hypothetical index trajectories (top panel). Note that in the bottom panel, the blue and orange lines were computed as and , respectively.

April 2016 requests to workgroup

- Focus analysis on the use of the NMFS eastern Bering Sea shelf trawl survey and the biomass estimate from the IPHC stock assessment as potentially appropriate indices and explore a variety of assumptions on the appropriate weighting of indices, including using each index as a bookend.
- If time available, focus on potential advantages and challenges of incorporating additional surveys (e.g., the Bering Sea shelf, Aleutian Islands, NMFS Sablefish longline survey, and Gulf of Alaska trawl surveys to develop an Alaska-wide index of abundance), and the Integrated Model-based index approach outlined in Section 3.4 of the paper.
- Draft purpose and need

October 2016 discussion paper

- Integrated index and objectives for candidate indices
- Considerations for control rule development: features of CRs (floors, ceilings, slope, starting point)
- Used Draft purpose and need to establish Council's objectives (overarching goals)



October 2016 indices and ABM

- Addressed older and younger population components
- Considered the coastwide geographic range
- Considered the coastwide stock status
- Addressed recruitment differences in the BSAI and GOA
- Information to derive the index was available in a timely manner for Council harvest specifications
- Information to derive the index easily accessible

October 2016 Council meeting

- Develop performance metrics and quantitative tools to evaluate the tradeoffs between the competing objectives for this action
- Develop abundance indices and associated control rules
- Develop a broader suite of halibut abundance indices and control rules as outlined by the SSC.
  - Specifically, evaluate different indices that can be used to meet the Council's objectives, which could then be combined in a control rule or decision making framework. s
- Evaluate developing control rules that could be combined in a 2-or 3-dimensional framework for setting PSC as outlined by the SSC
- Evaluate developing separate control rules for the hook and line and trawl fisheries that could be used to establish PSC limits

Current discussion paper

ABM = Abundance based management

[for Pacific halibut PSC limits]

Document roadmap

Description of section as it relates to the development of ABM examples	Is this a general or detailed (computational) item?
Purpose and Need statement and 5 Objectives (also noted as 'overarching goals')	General used to guide formulations of ABM examples
Background on previous Council discussion papers and ABM considerations	General to provide context to multi-index/multi-control rule ABM examples
Principles used to develop and evaluate ABM examples	General (for list) General (as applied to individual ABM examples)
Framework for development of ABM examples	General: includes list of indices, description of what is a control rule
Strawman alternatives **ABM1, ABM2, ABM3, ABM4**	General description of indices within each ABM example
ABM examples	Detailed description of indices used and computational equations for the control rules applied
Comparison across the ABM1-ABM4 examples	Detailed based on Sections 3.1-3.4 computations

Council objectives from the Purpose and Need
Overarching goals

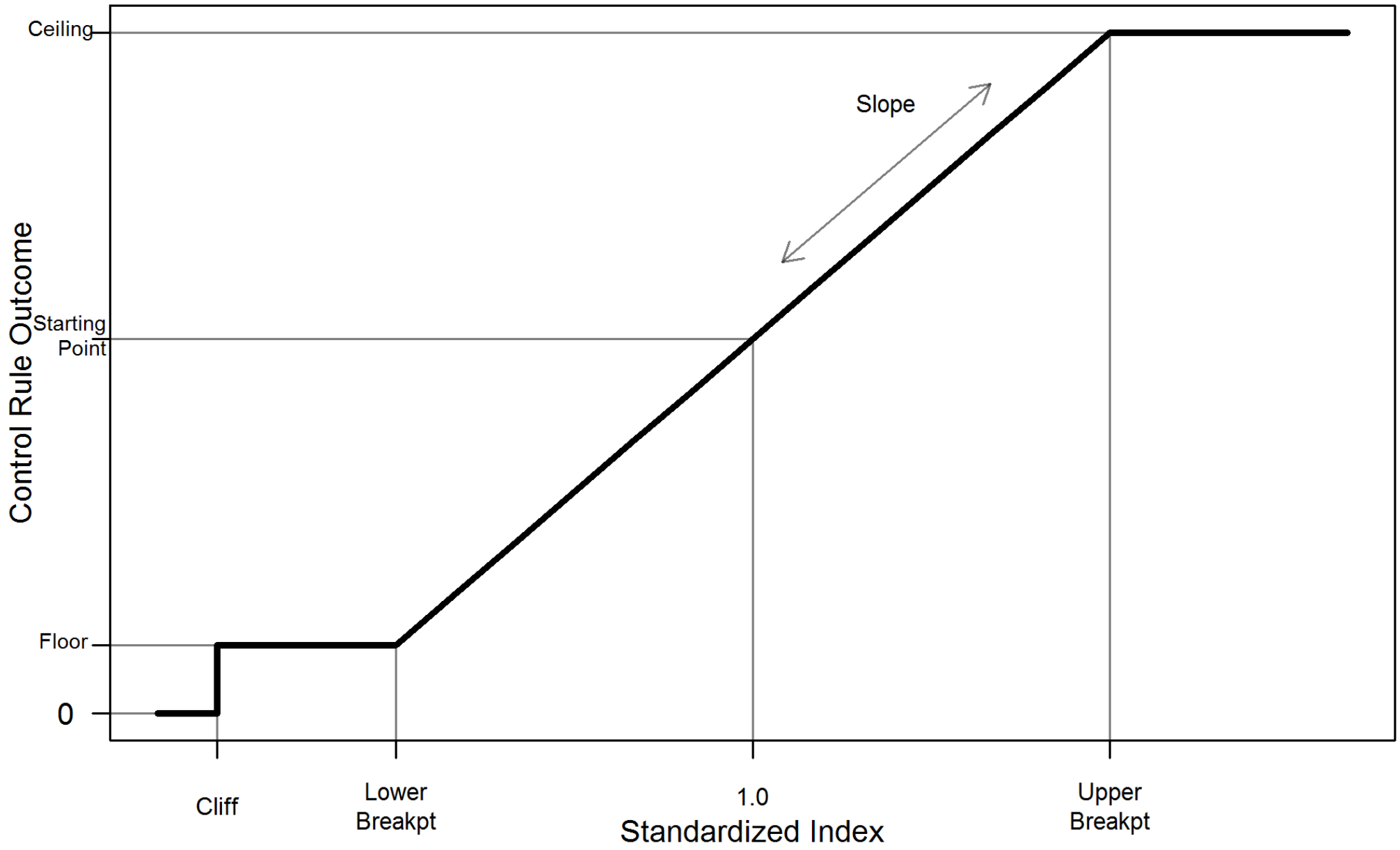
- Halibut PSC limits should be indexed to halibut abundance
- Halibut spawning stock biomass should be protected especially at lower levels of abundance
- There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high
- Provide for directed halibut fishing operations [in the Bering Sea]
- Provide for some stability in PSC limits on an inter-annual basis

February 2017 workshop

- To solicit input to identify measurable objectives and appropriate metrics for the development of alternative management measures for BSAI halibut PSC limits.

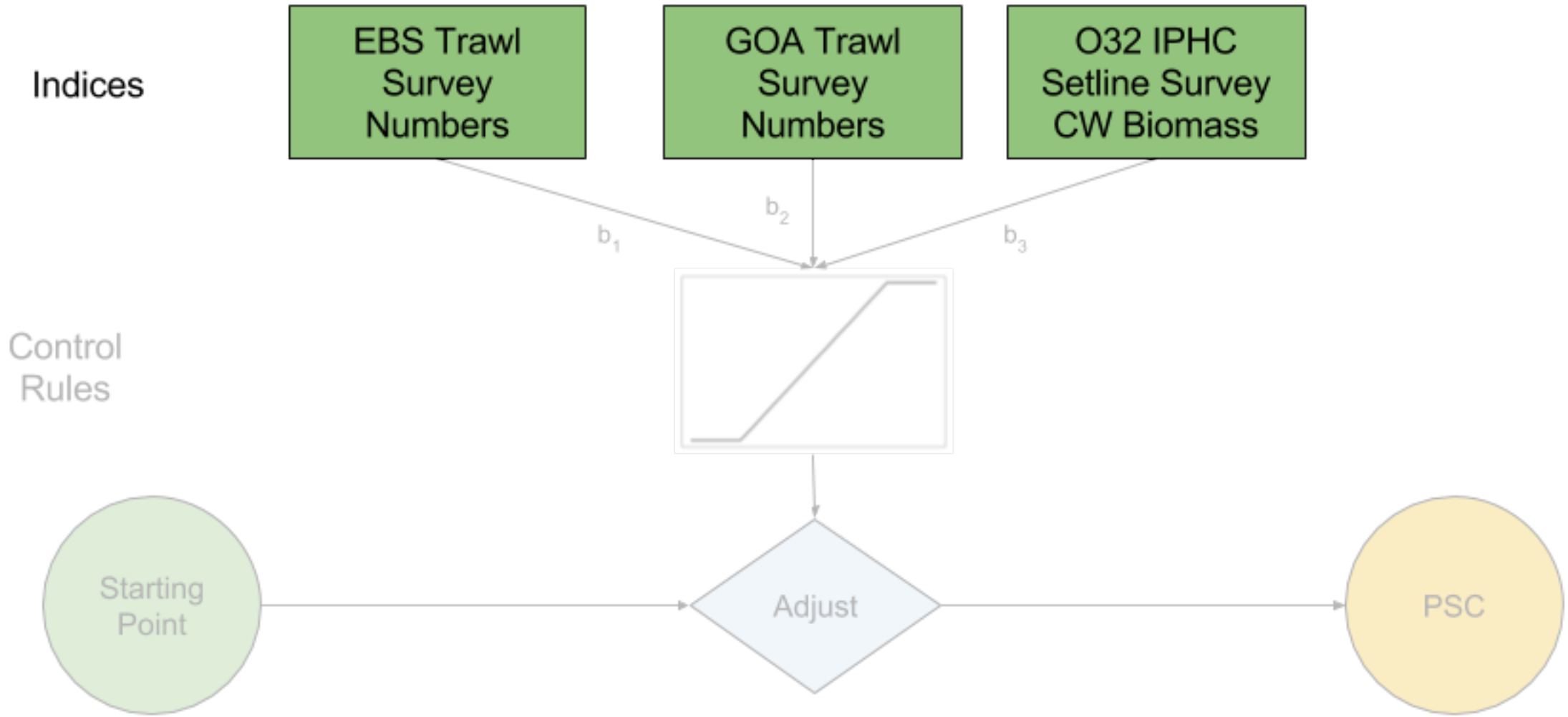
Linking with past discussions/ABM

Control rule illustrated



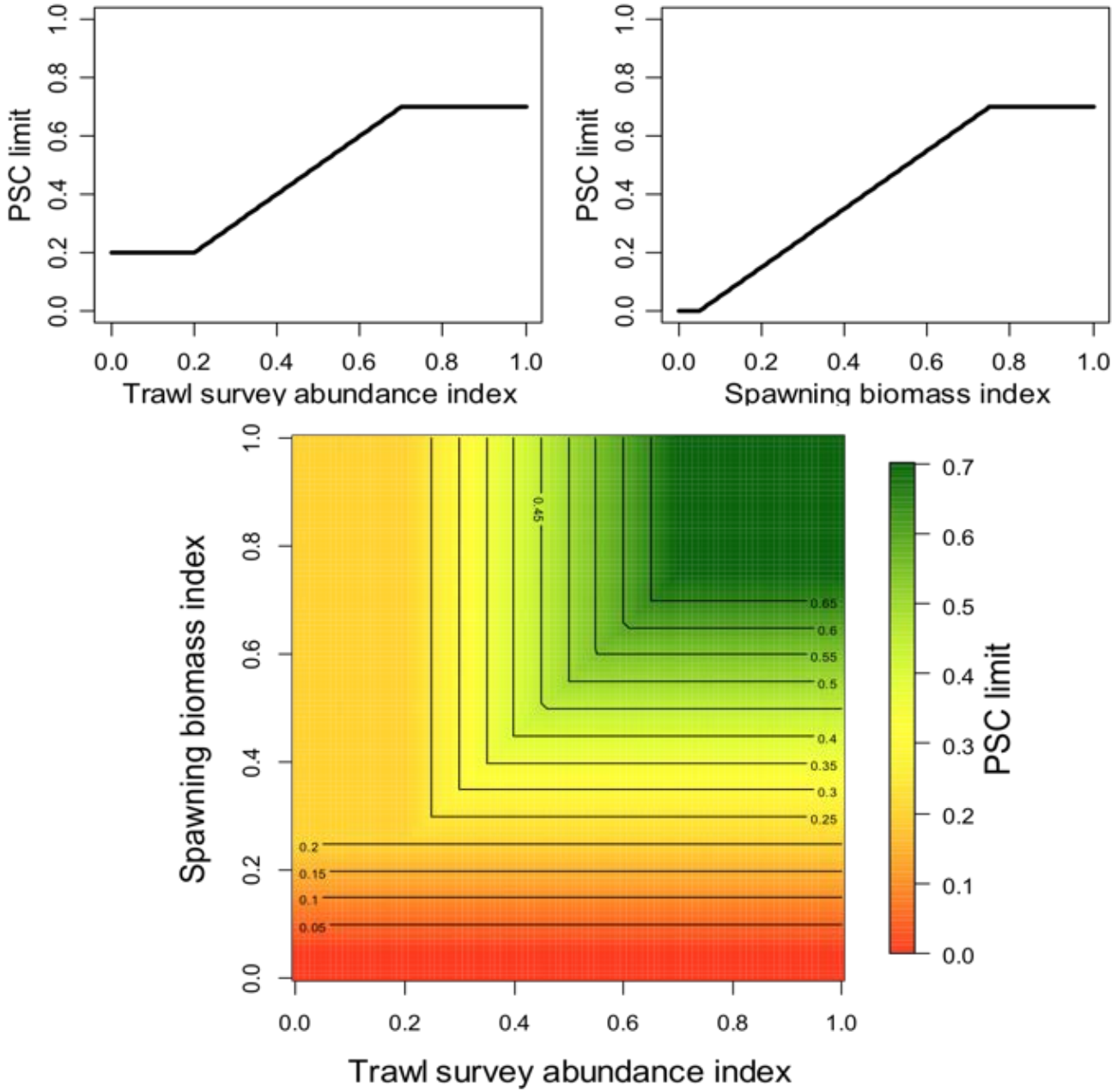
Indices and ABM index provided in October 2016

Schematic

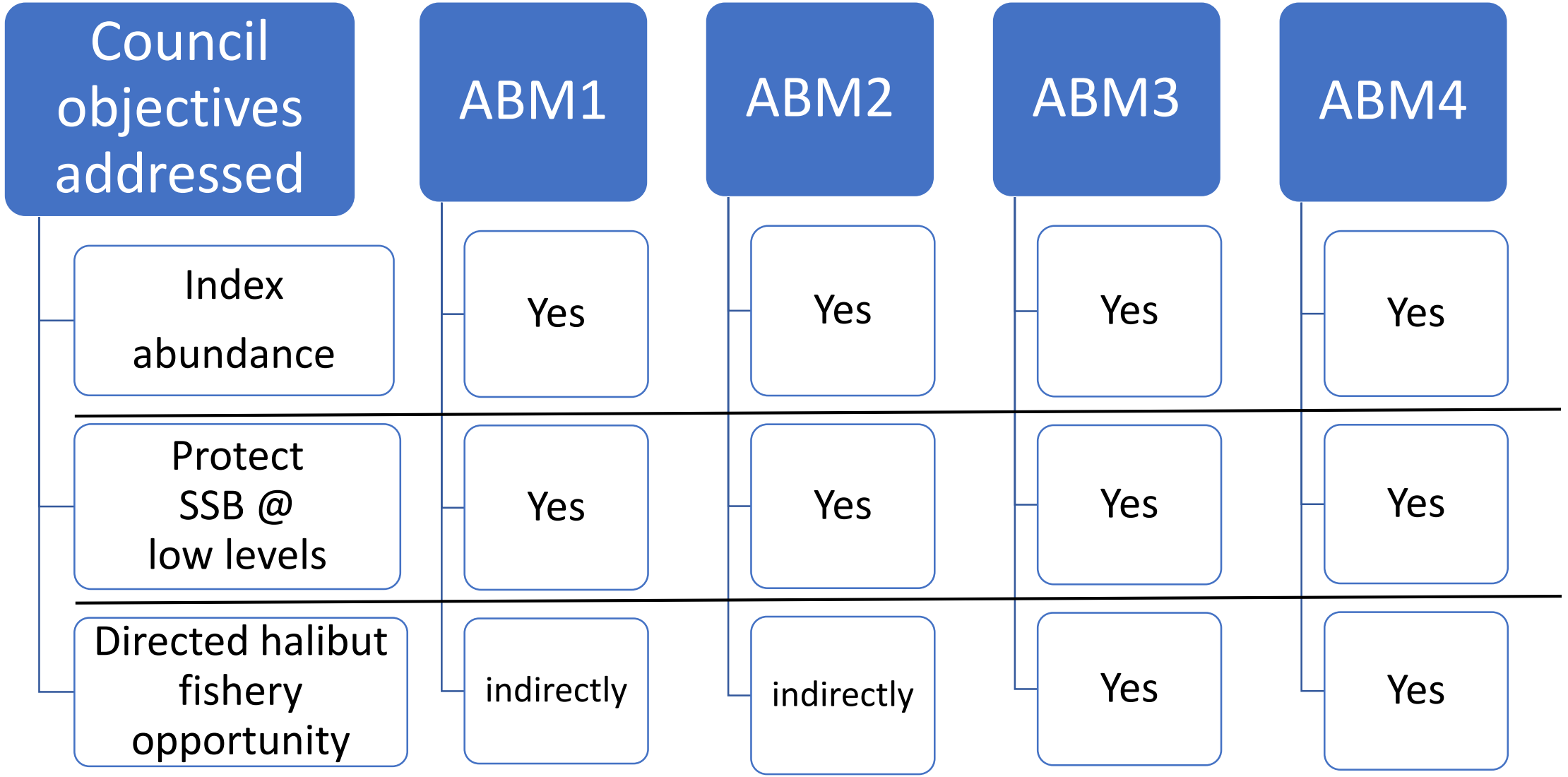


SSC feedback

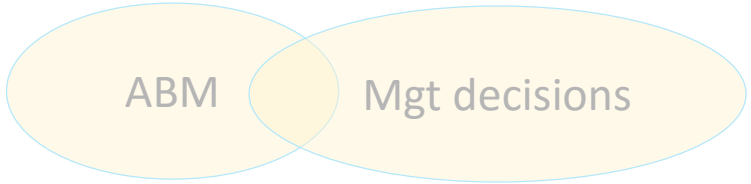
- Apply rules differently
- “Multi-dimensional”



Strawman alternatives



Principles and considerations used in developing approaches

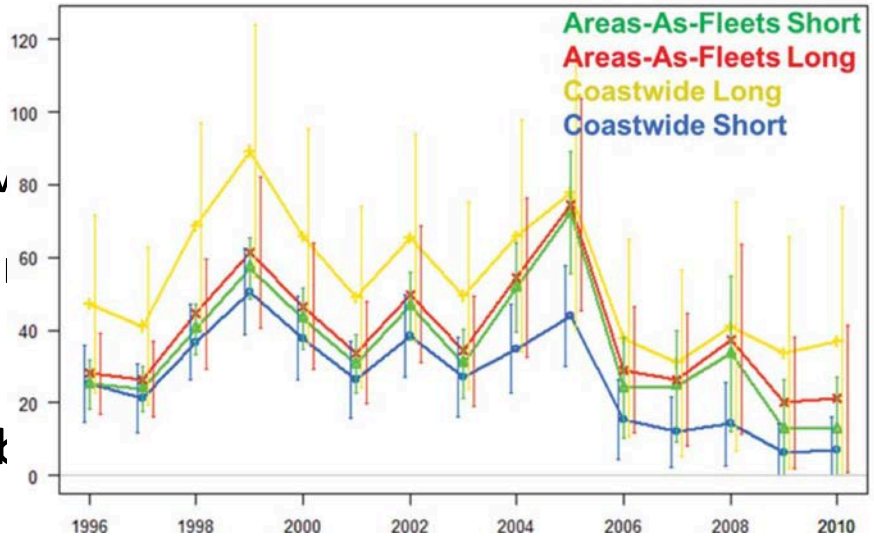


The ABM index should

1. **be independent of management decisions**
2. with control rules be **parsimonious, easy to understand and implement** in a timely m
3. require **few assumptions**
4. consider **Pacific halibut recruitment** (e.g., smaller halibut) to ensure future healthy coastwide halibut spawning biomass
5. **consider O32 (or O26) Pacific halibut biomass** in the Bering Sea to provide for opportunity to the directed halibut fishery

Specific to data…

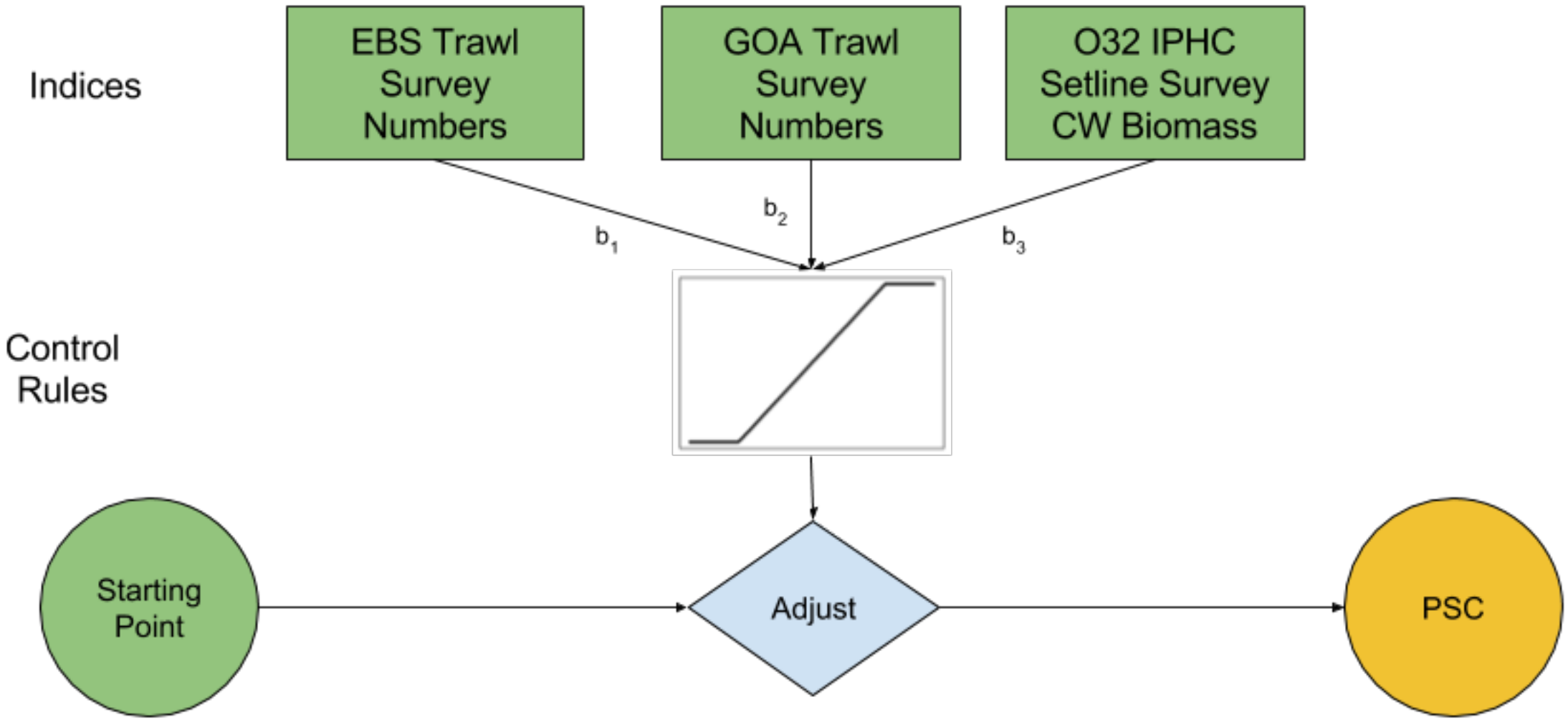
6. a **proxy for Pacific halibut spawning biomass** is the IPHC setline surv
7. **in each Regulatory Area,** the IPHC setline survey provides an O26 (o
8. for **coastwide spawning biomass**, the IPHC stock assessment
9. the PSC limit should **be responsive to changes in the total halibut ab** groundfish fisheriess

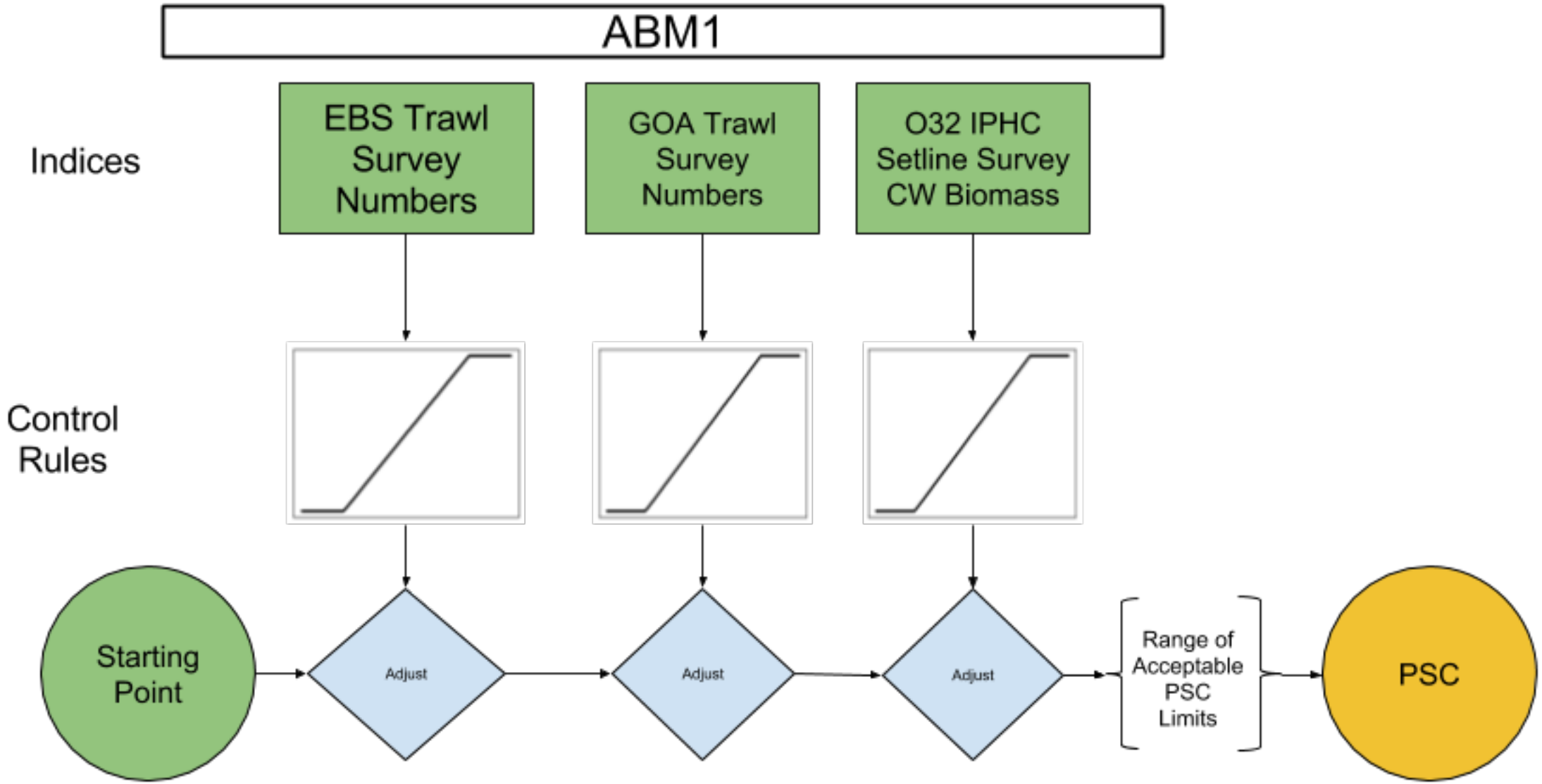


ABM 1: the integrated index (proposed in Oct) re-formulated into a multi-dimensional control rule

- EBS shelf trawl survey
  - Purpose: indexes halibut number available to the bycatch and directed fisheries in the EBS
- GOA trawl survey
  - Purpose: Indexes recruitment in the GOA and downstream success of young fish initially occurring in the EBS
- Coastwide O32 IPHC setline survey
  - Purpose: Indexes health of female spawning biomass; the O32 setline survey is dominated by female fish that are mostly mature

Review: Diagram of October 2016 ABM




ABM1
Indices
EBS Trawl Survey Numbers
GOA Trawl Survey Numbers
O32 IPHC Setline Survey CW Biomass
Control Rules
Starting Point
Adjust
Adjust
Adjust
Range of Acceptable PSC Limits
PSC

ABM1: All of the equations at once

$$c_t = PSC_0 \prod_k \left[1 - (1 - x_{k,t})\, b_k\right]$$

$$PSC_t = \begin{cases} PSC_{min} & c_t < PSC_{min} \\ c_t & PSC_{min} < c_t < PSC_{max} \\ PSC_{max} & c_t > PSC_{max} \end{cases}$$

$$x_{k,t} = \begin{cases} x_{k,min} & x_{k,t} < x_{k,min} \\ x_{k,t} & x_{k,min} < x_{k,t} < x_{k,max} \\ x_{k,max} & x_{k,t} > x_{k,max} \end{cases}$$

ABM1: Floors and ceilings on each index ($x_{k,t}$)

Index k at time t after applying floors and ceilings

$$x_{k,t} = \begin{cases} x_{k,min} & x_{k,t} < x_{k,min} \\ x_{k,t} & x_{k,min} < x_{k,t} < x_{k,max} \\ x_{k,max} & x_{k,t} > x_{k,max} \end{cases}$$

ABM 1 equations: calculating PSC from adjusted indices

Prohibited species catch limit when all indices are at their average value

Product over each index (k)

Index k at time t; floors and ceilings applied

Proportionality constant for index k

$$c_t = PSC_0 \prod_k \left[1 - (1 - x_{k,t})\, b_k\right]$$

PSC_0 …what??

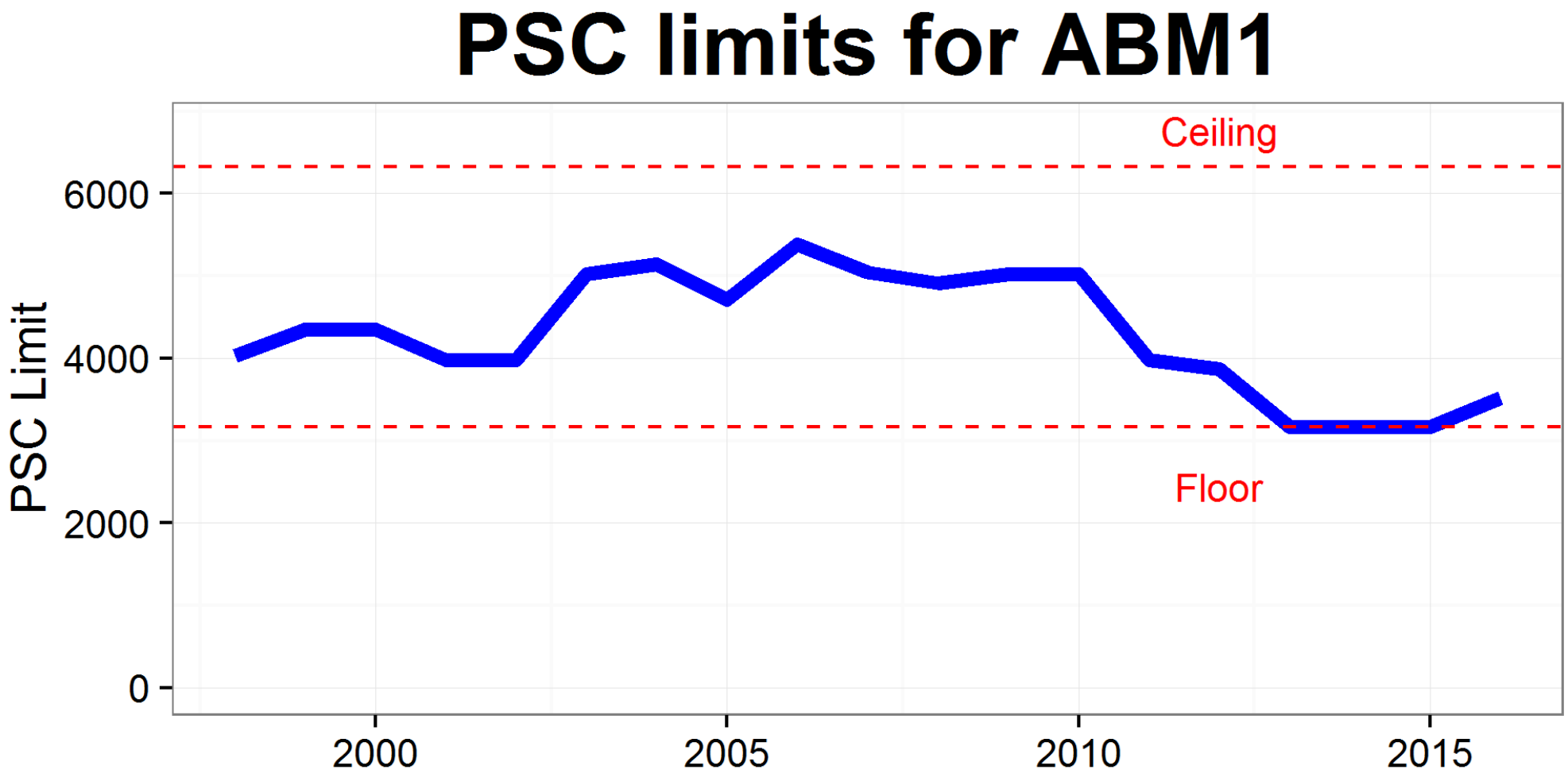
Simply a scalar

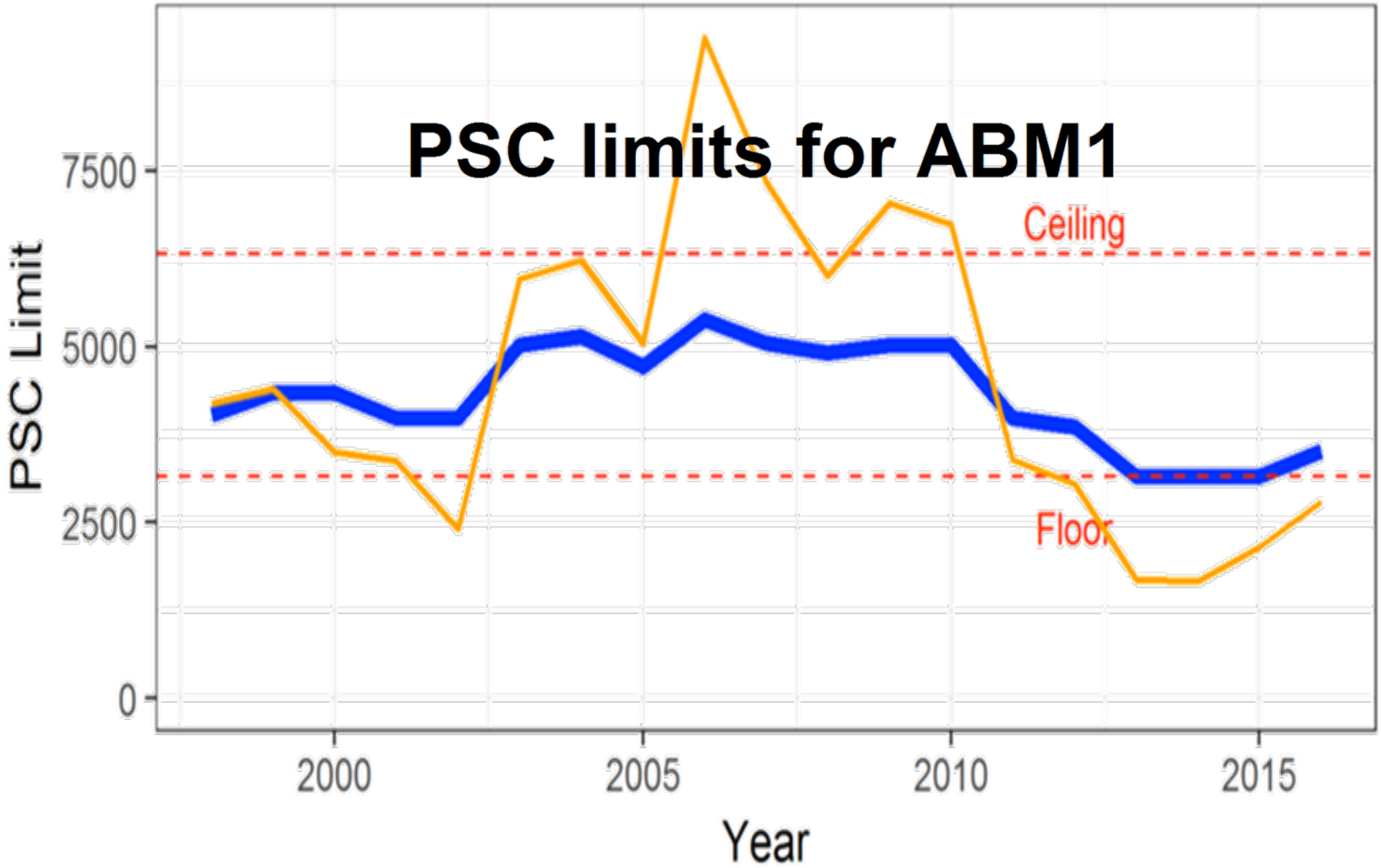
…in our examples set to value that makes PSC cap in 2016 equal to actual PSC cap

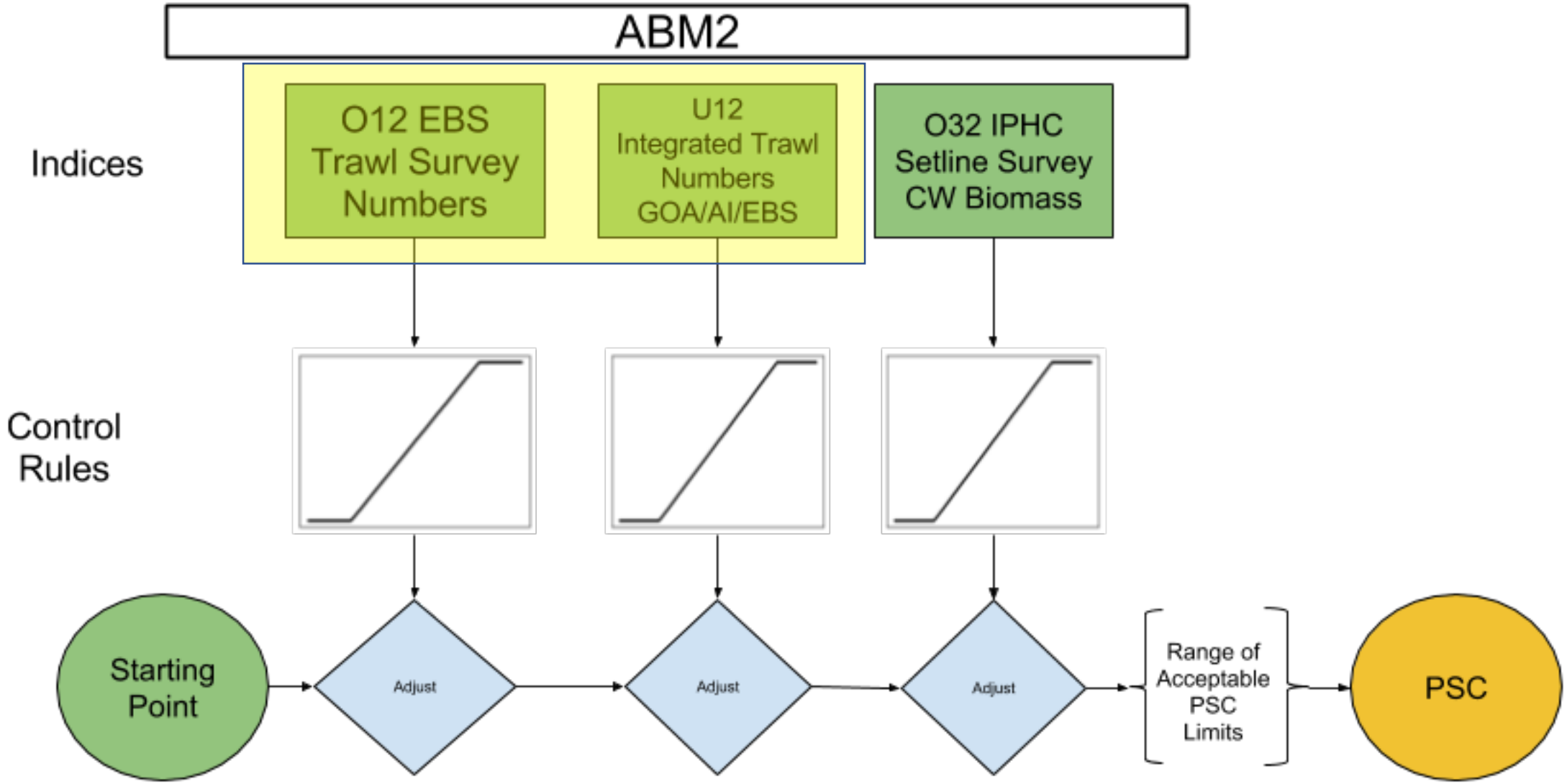
ABM 1: Applying floors and ceilings to the final PSC

$$c_t = PSC_0 \prod_k \left[1 - (1 - x_{k,t})\, b_k\right]$$

$$PSC_t = \begin{cases} PSC_{min} & c_t < PSC_{min} \\ c_t & PSC_{min} < c_t < PSC_{max} \\ PSC_{max} & c_t > PSC_{max} \end{cases}$$


PSC limits for ABM1
Ceiling
Floor
PSC Limit
6000
4000
2000
0
2000
2005
2010
2015

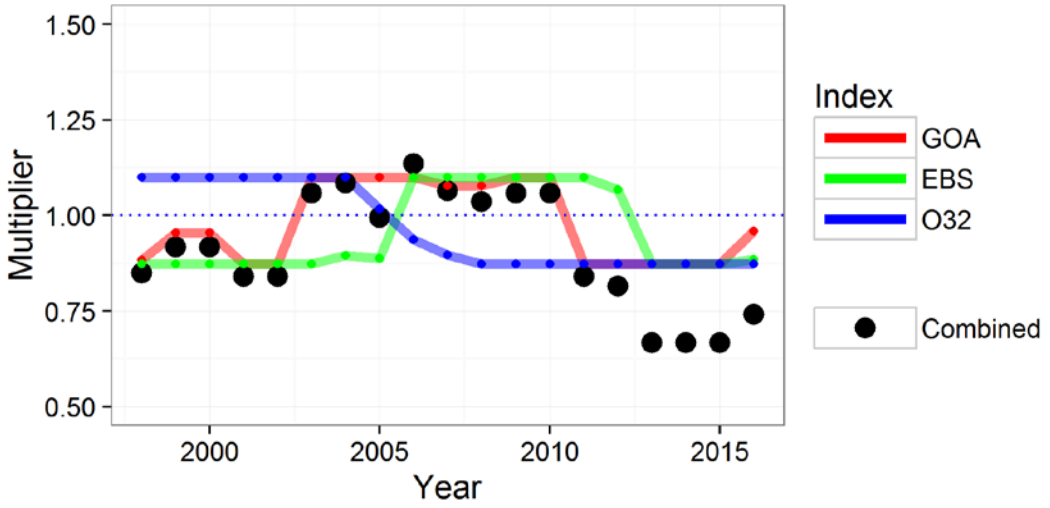

PSC limits for ABM1
PSC Limit
7500
5000
2500
0
Ceiling
Floor
2000
2005
2010
2015
Year


ABM2
Indices
O12 EBS Trawl Survey Numbers
U12 Integrated Trawl Numbers GOA/AI/EBS
O32 IPHC Setline Survey CW Biomass
Control Rules
Starting Point
Adjust
Adjust
Adjust
Range of Acceptable PSC Limits
PSC

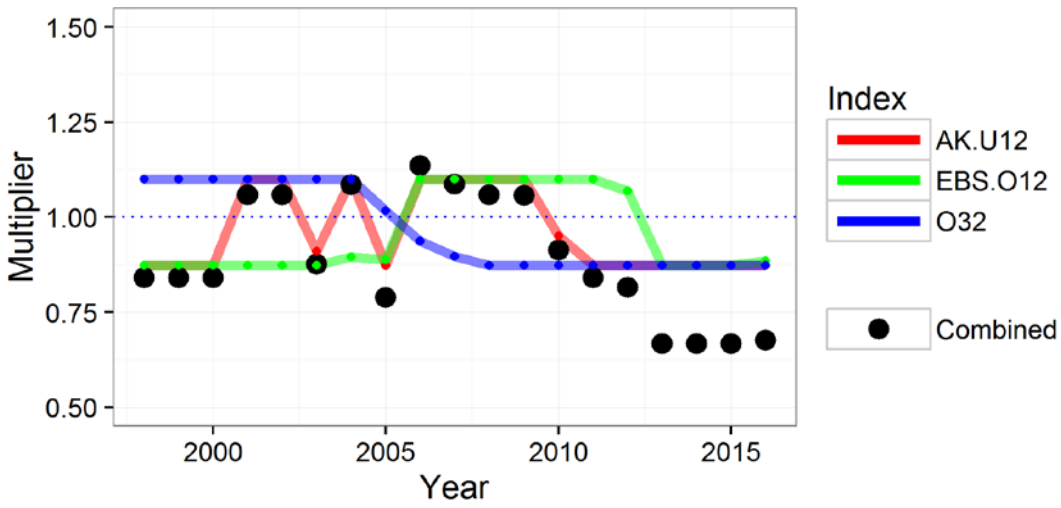
ABM 2: Explicitly accounting for young halibut

- “O12” EBS shelf trawl survey
  - Purpose: indexes halibut number that with U12 relate to trawl abundance
- “U12 GOA/AI/EBS trawl survey
  - Purpose: Indexes recruitment through AK
- Coastwide O32 IPHC setline survey
  - Purpose: Indexes health of female spawning biomass; the O32 setline survey is dominated by female fish that are mostly mature

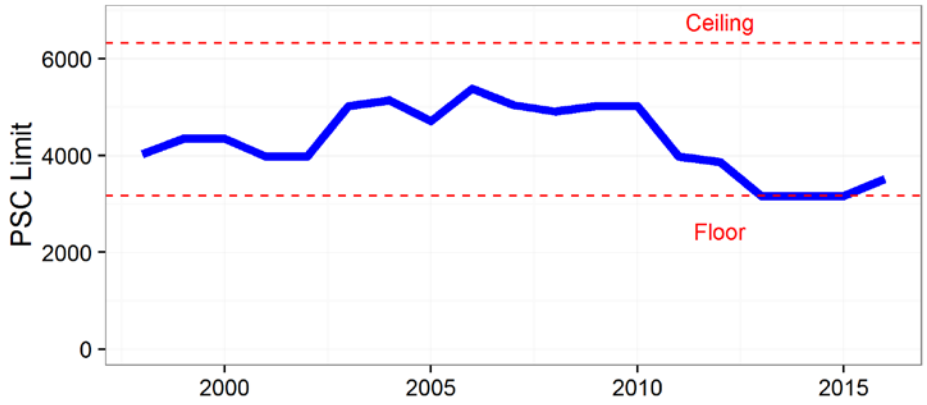
ABM1



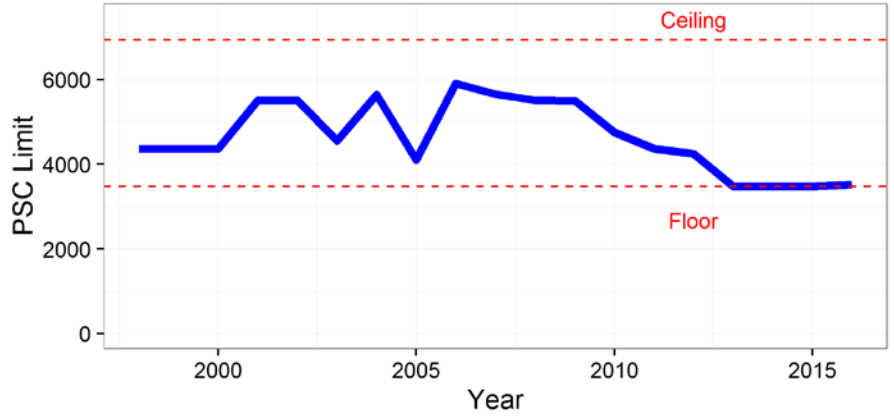
ABM2



PSC limits for ABM1

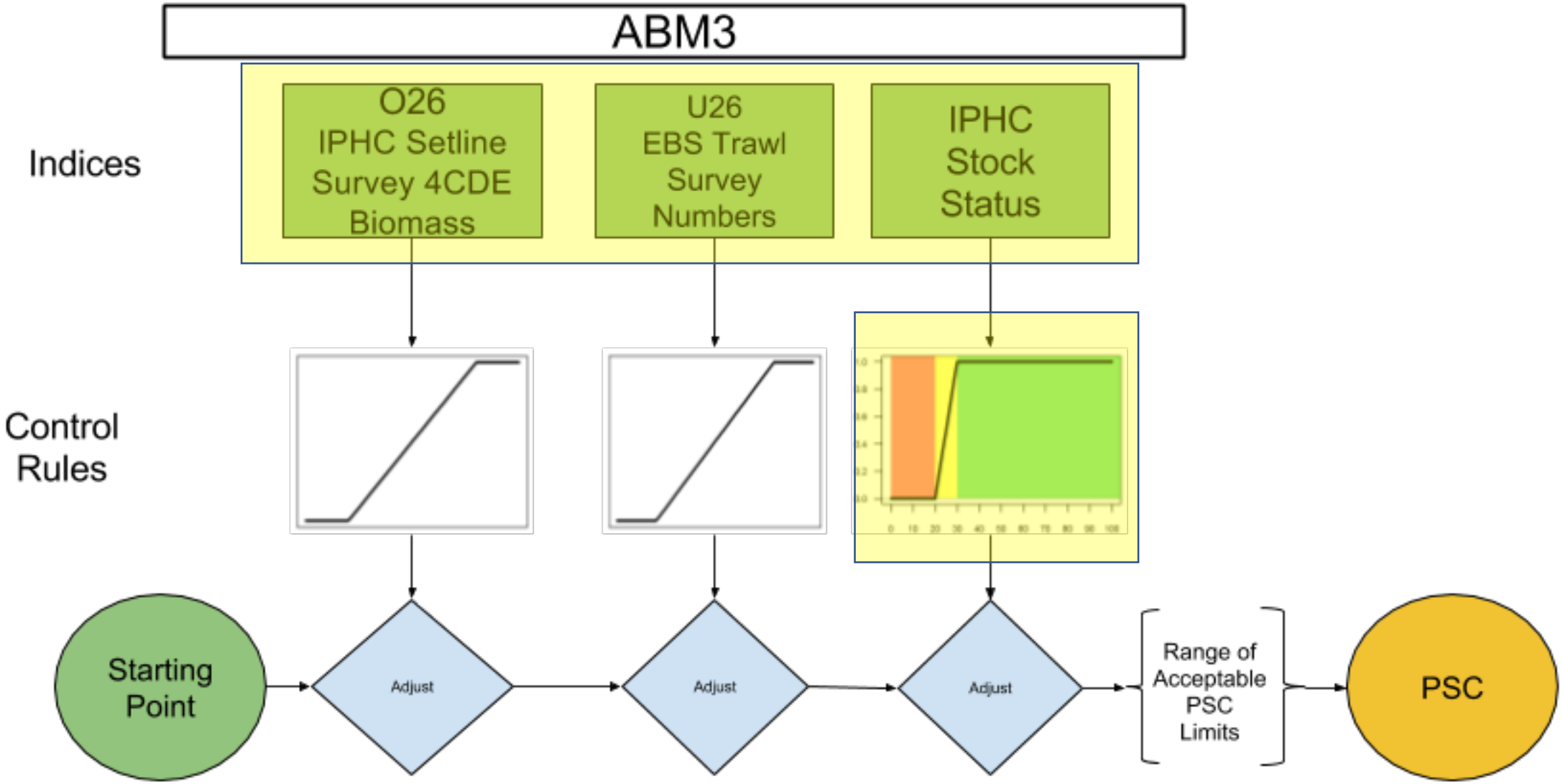


PSC limits for ABM2

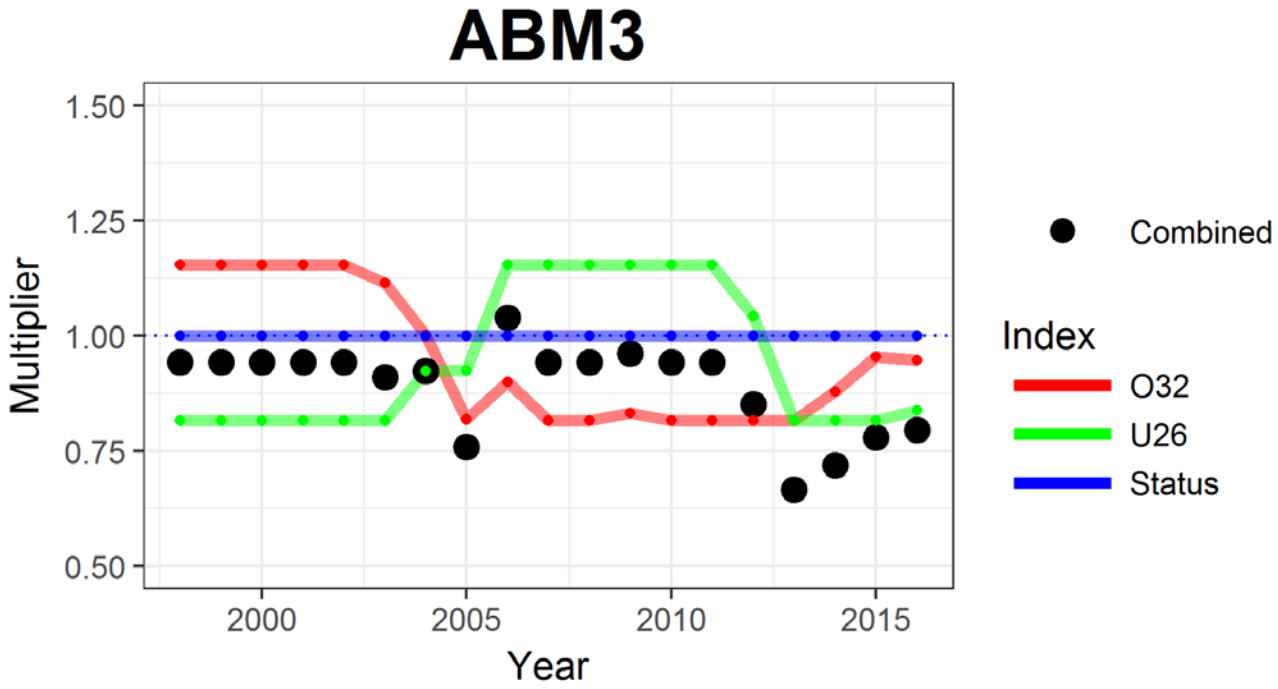


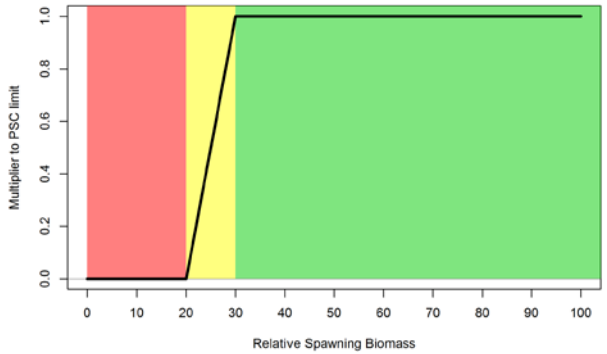
ABM3: Indices for three components

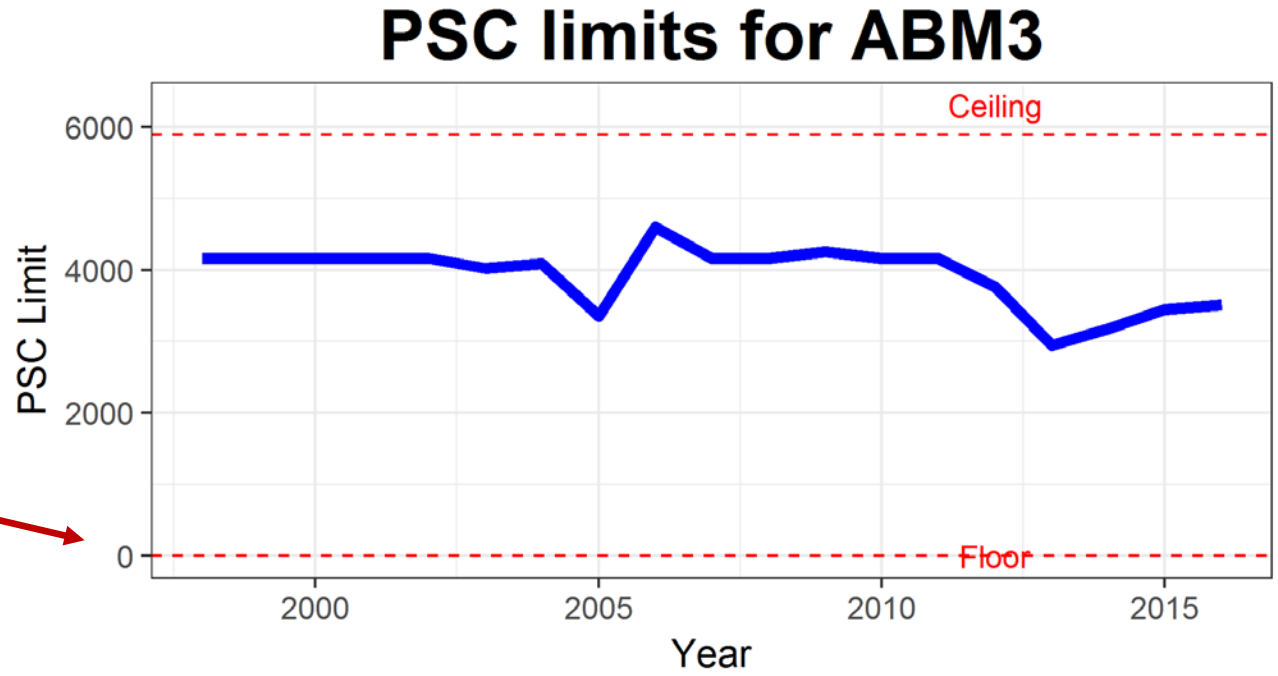
- Three indices used to deviate from starting point
  1. O26 IPHC Setline Survey 4CDE Biomass
     - Related to the goal to provide for directed fishery operations
     - Slope may be less than one to provide more biomass for directed fishery
  2. U26 EBS Trawl Survey Numbers
     - Related to goal to avoid constraining groundfish fisheries especially when halibut abundance is high
  3. IPHC stock status
     - Related to protect spawning biomass, especially at low levels
     - Uses a 30:20 control rule and adjusts the starting point downward only when <30%
     - Not averaged to a range of years, but relative to B_O
     - May want to be consistent with current IPHC management policy


ABM3
Indices
O26
IPHC Setline
Survey 4CDE
Biomass
U26
EBS Trawl
Survey
Numbers
IPHC
Stock
Status
Control
Rules
Starting
Point
Adjust
Adjust
Adjust
Range of
Acceptable
PSC
Limits
PSC

ABM3: Historical example







ABM3

$$c_t = \begin{cases} 0 & x_{3,t} <= 20\% \\ PSC_0 \prod_{k=1}^{2} \left[1 - (1 - x_{k,t})\, b_k\right] \left[-2 + 10 x_{3,t}\right] & 20\% < x_{3,t} < 30\% \\ PSC_0 \prod_{k=1}^{2} \left[1 - (1 - x_{k,t})\, b_k\right] & x_{3,t} >= 30\% \end{cases}$$

then

$$PSC_t = \begin{cases} PSC_{min} & c_t \leq PSC_{min} \\ c_t & PSC_{min} < c_t < PSC_{max} \\ PSC_{max} & c_t \geq PSC_{max} \end{cases}$$

$$x_{k,t} = \begin{cases} x_{k,min} & x_{k,t} < x_{k,min} \\ x_{k,t} & x_{k,min} < x_{k,t} < x_{k,max} \\ x_{k,max} & x_{k,t} > x_{k,max} \end{cases}$$

ABM3: Changing components

- Stock status can easily be substituted with a different SB measure
  - The control rule depends on the IPHC harvest policy, which could change
- A different use of the U26 index is to include it as the proportion of U26 in the EBS trawl survey
  - As the proportion gets smaller, a stair-step control rule adjusts the PSC limit downward

ABM4: Weighting with data

- Three indices used to deviate from starting point
  1. O26 IPHC Setline Survey 4CDE Biomass
     - Related to the goal to provide for directed fishery operations
  2. U26 EBS Trawl Survey Numbers
     - Related to goal to avoid constraining groundfish fisheries especially when halibut abundance is high
  - 1 and 2 are combined into a single multiplier with weighting determined from the proportion of U26 in the survey
    - It puts the weight onto the index of size that is most prevalent, and likely to be encountered by the trawl fishery
    - This could incorporate a control rule as well
  3. IPHC stock assessment coastwide spawning biomass
     - Related to protect spawning biomass, especially at low levels

ABM4

$$c_t = PSC_0 \times x_{1,k}\rho_t \times (1-\rho_t)\, x_{2,t} \times b_3 x_{3,t}$$

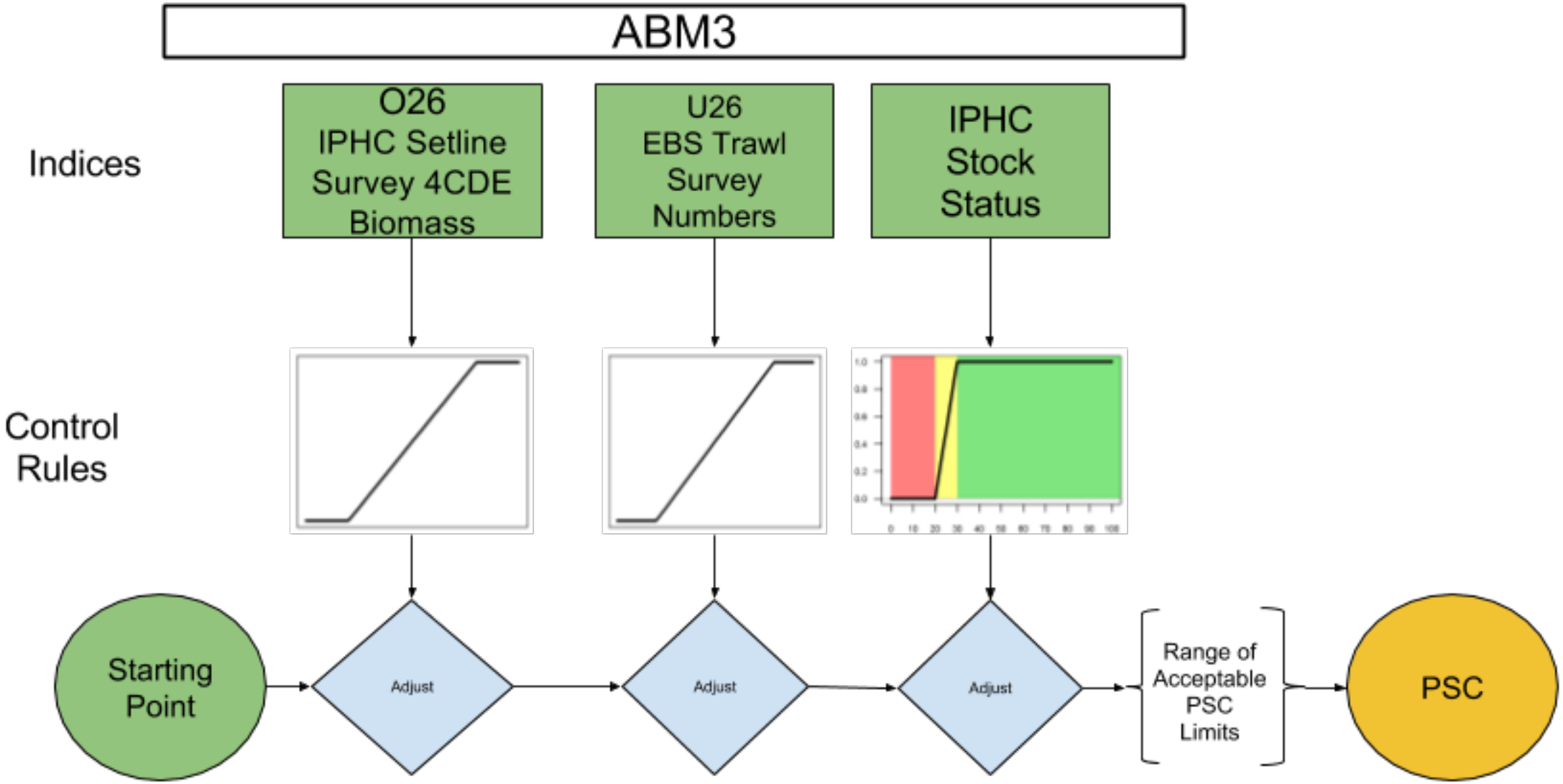
then

$$\rho_t = \frac{x_{1,t}}{x_{1,t} + x_{2,t}}$$

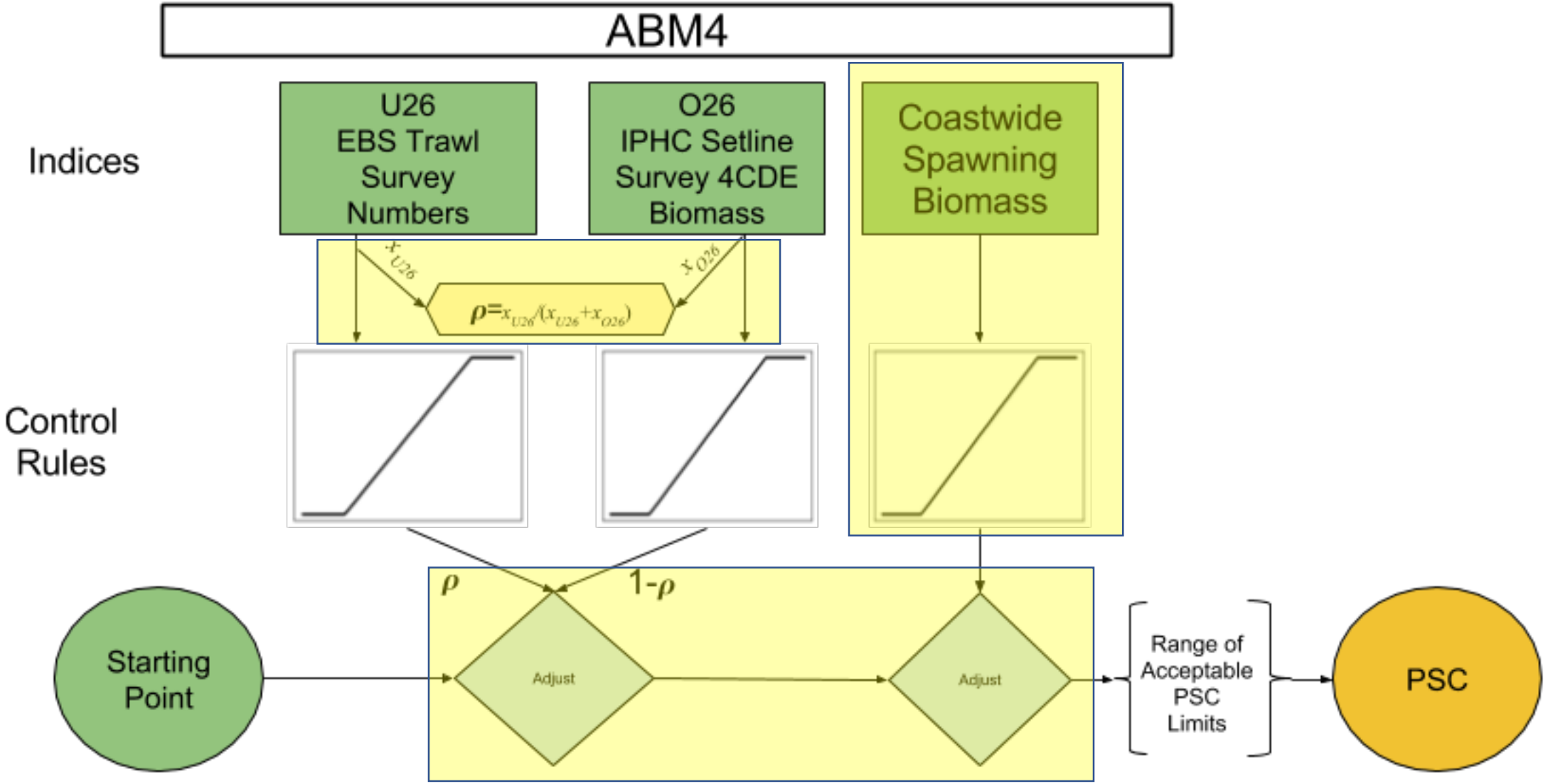
$$PSC_t = \begin{cases} PSC_{min} & c_t \leq PSC_{min} \\ c_t & PSC_{min} < c_t < PSC_{max} \\ PSC_{max} & c_t \geq PSC_{max} \end{cases}$$

$$x_{k,t} = \begin{cases} x_{k,min} & x_{k,t} < x_{k,min} \\ x_{k,t} & x_{k,min} < x_{k,t} < x_{k,max} \\ x_{k,max} & x_{k,t} > x_{k,max} \end{cases}$$

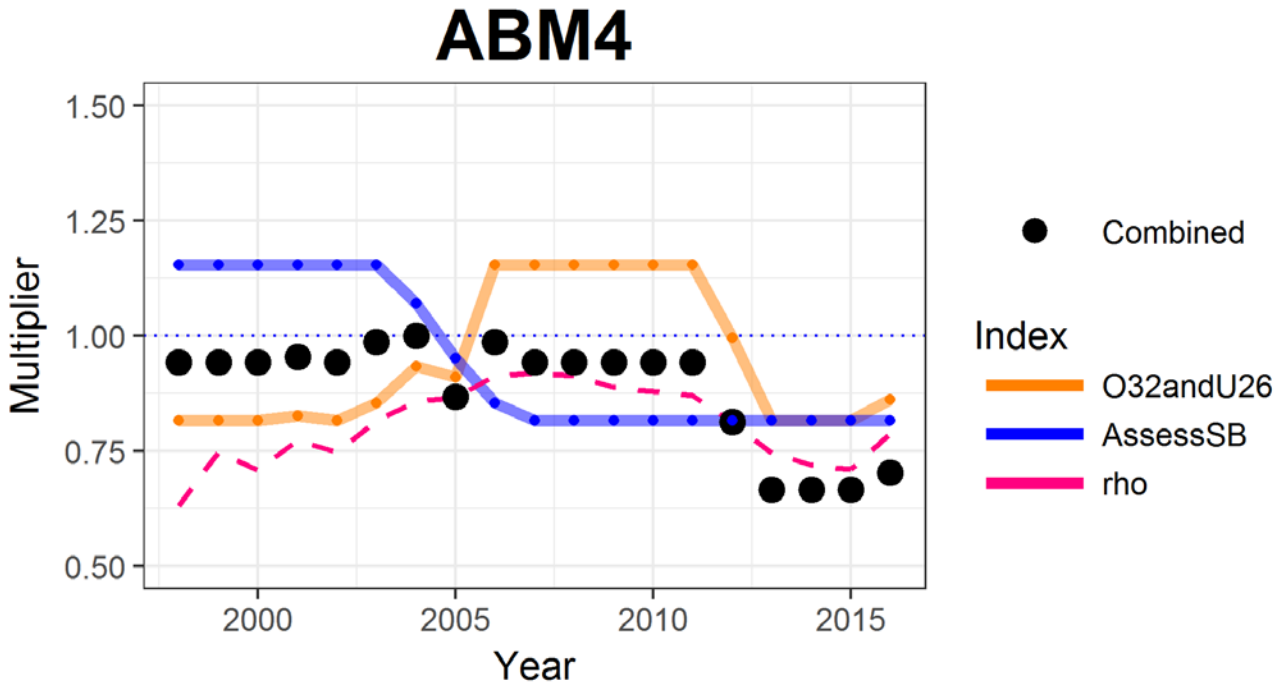
ABM3…

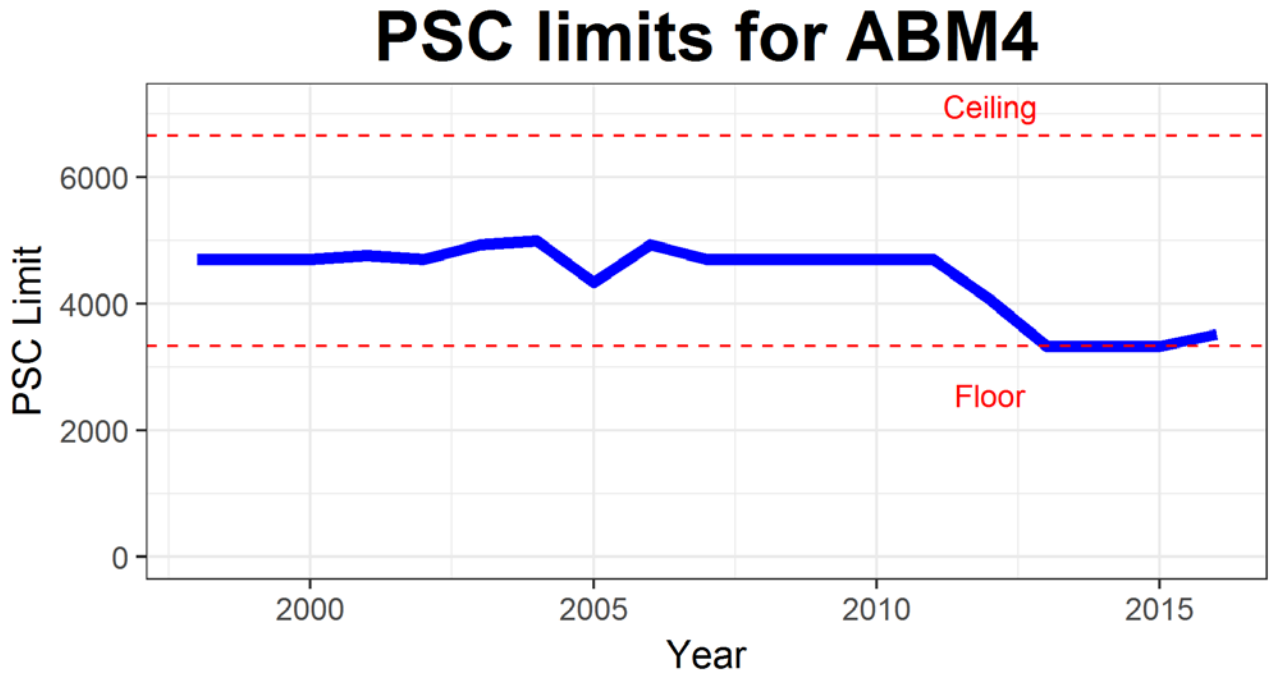

ABM3
Indices
O26
IPHC Setline
Survey 4CDE
Biomass
U26
EBS Trawl
Survey
Numbers
IPHC
Stock
Status
Control
Rules
Starting
Point
Adjust
Adjust
Adjust
Range of
Acceptable
PSC
Limits
PSC

ABM4


ABM4
Indices
U26
EBS Trawl
Survey
Numbers
O26
IPHC Setline
Survey 4CDE
Biomass
Coastwide
Spawning
Biomass
x_{U26}
x_{O26}
$\rho=x_{U26}/(x_{U26}+x_{O26})$
Control
Rules
ρ
1-ρ
Starting
Point
Adjust
Adjust
Range of
Acceptable
PSC
Limits
PSC

ABM4: Historical example





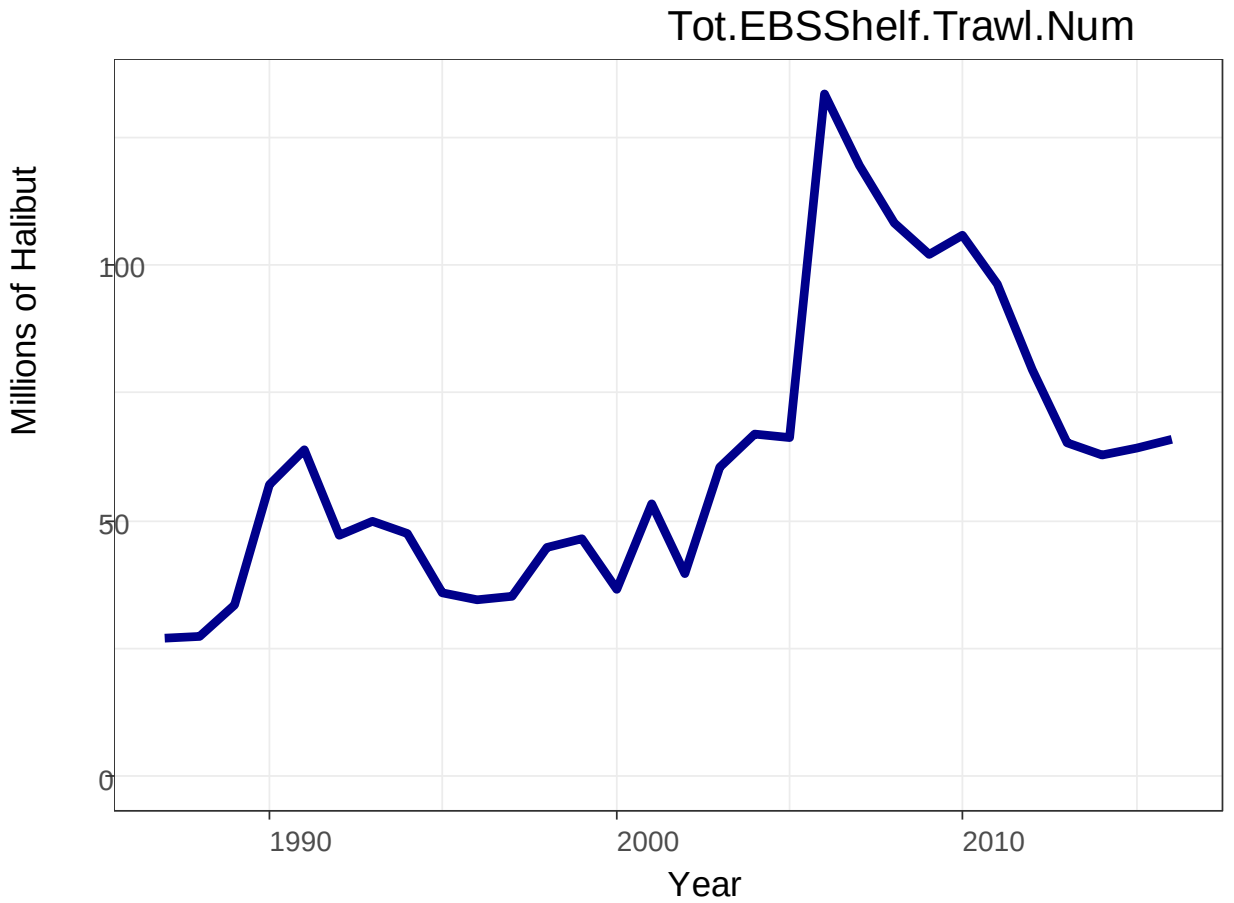
Summary of indices / features over strawman alts

	Strawman Alternatives			
Size Area Type	1	2	3	4
Total numbers in GOA trawl index	X			
Total numbers in EBS shelf trawl survey index	X			
O32 coastwide WPUE from the IPHC setline survey (space-time model)	X	X		
U12 recruitment index from GOA/AI/BS trawl VAST or simple sum		X		
O12 EBS shelf trawl survey		X		
IPHC stock status (function of IPHC SSB)			X	
O26 EBS setline survey index			X	X
U26 EBS shelf trawl survey index			X	X
SSB coastwide IPHC Stock assessment				X
U26 (EBS trawl survey) and O26 (EBS setline) dynamic weighting*				X

An example abundance based management calculation for ABM1

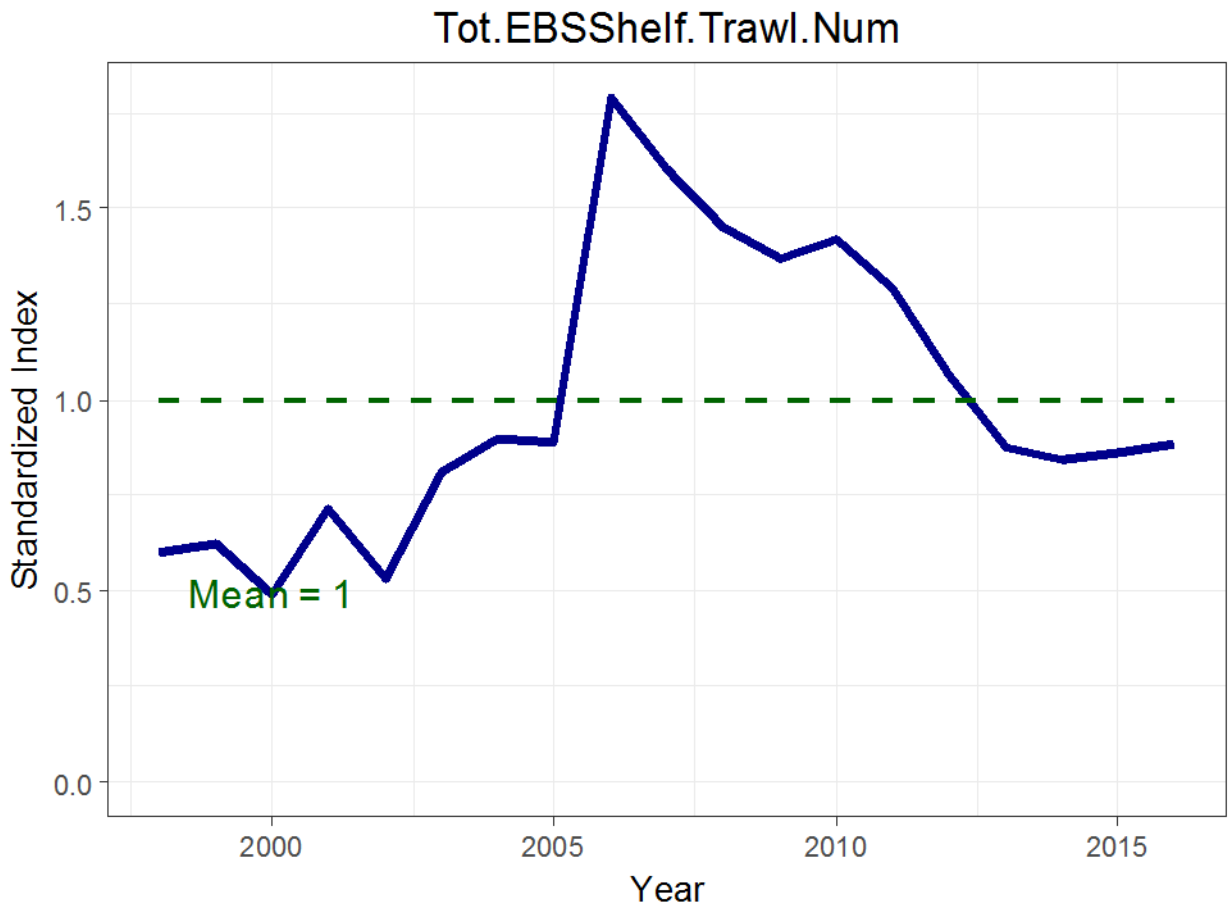
A raw index

- Obtain an index of abundance that relates to the halibut PSC limit such as the total EBS Shelf Trawl Numbers index shown below.



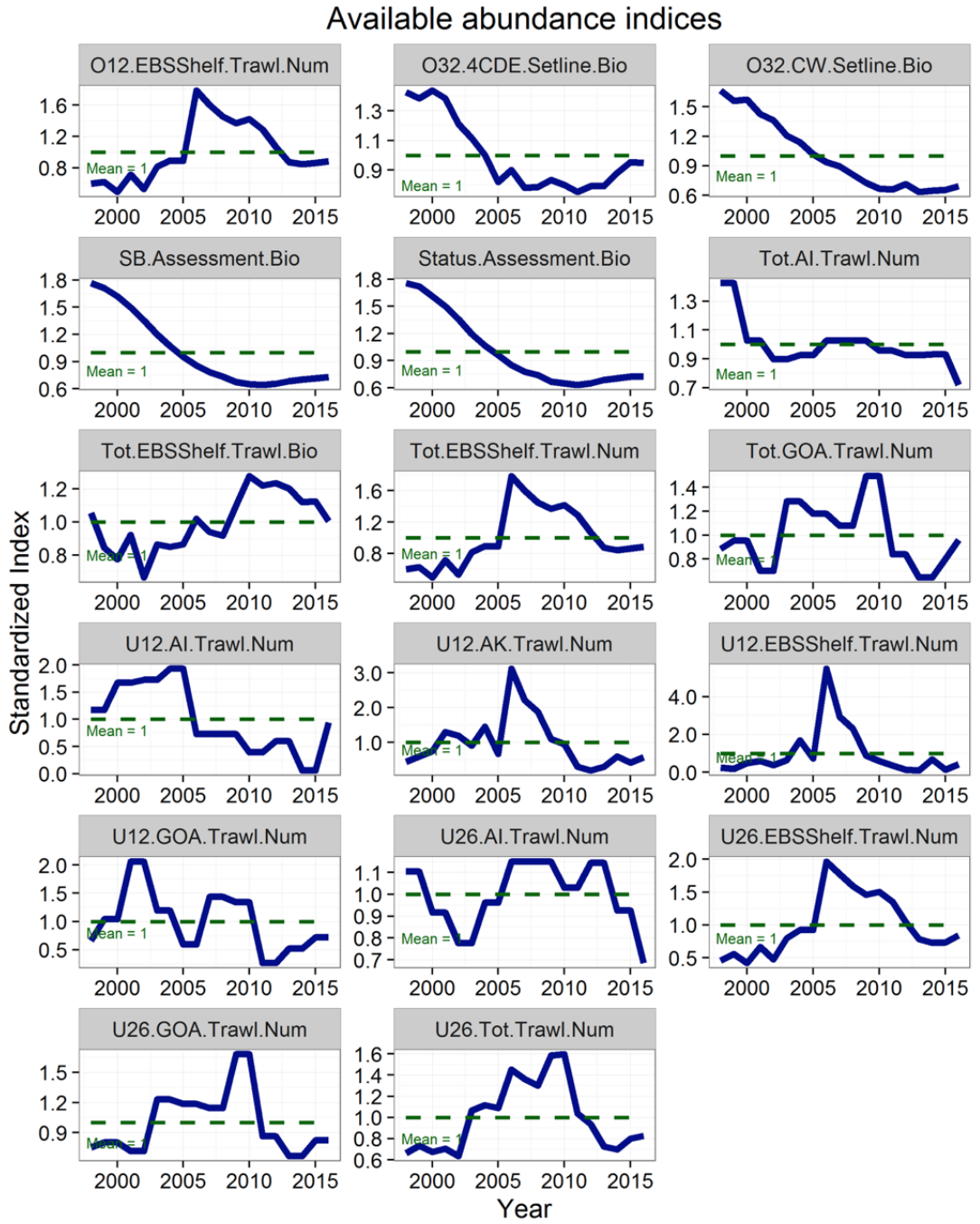
Standardizing an index

- 1998-2016 mean equals 1.0



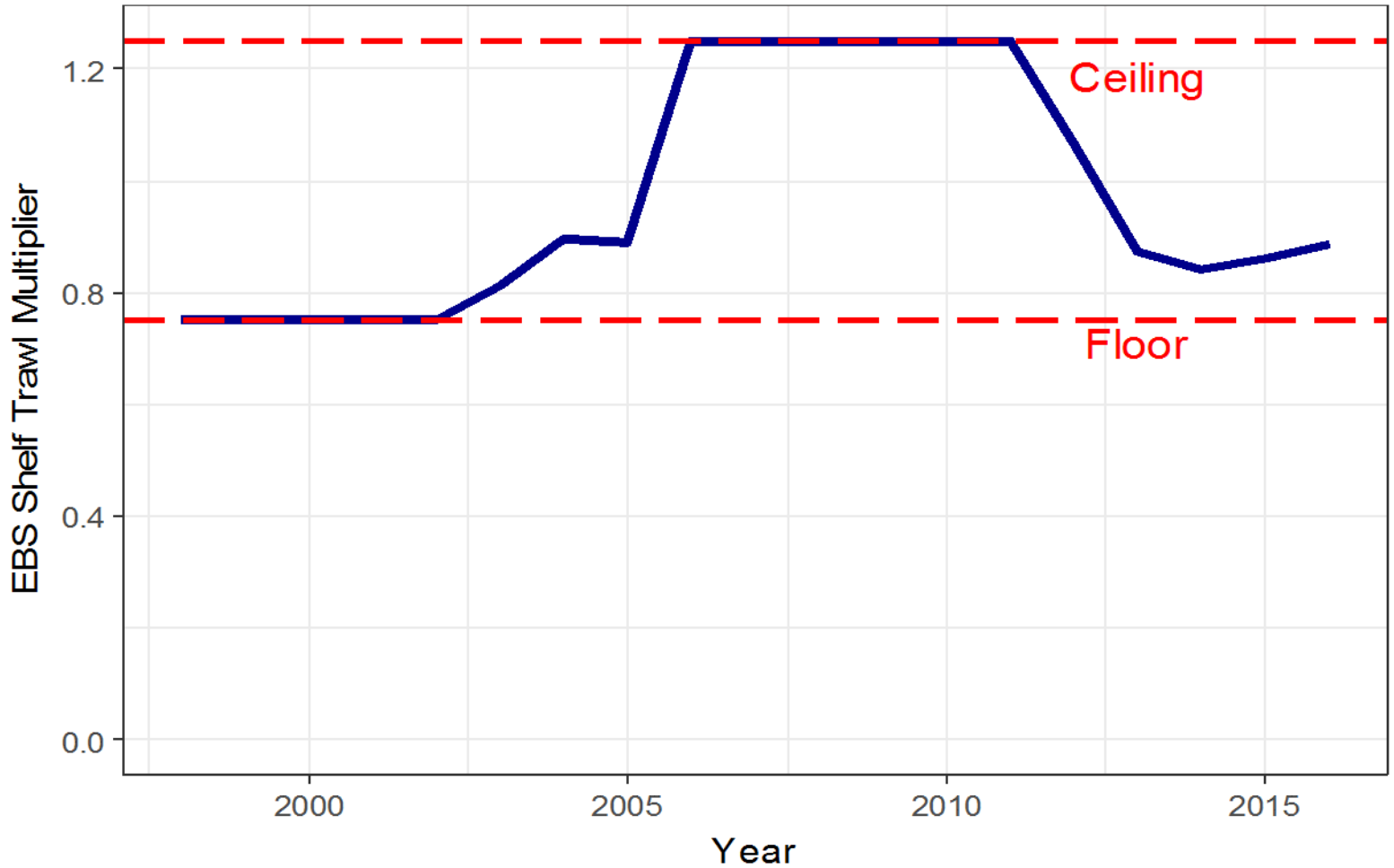
Variety of indices to standardize…

An example abundance based management calculation for ABM1



Range limits on indices

- Floor and ceiling also constrains multiplier (adjustment)

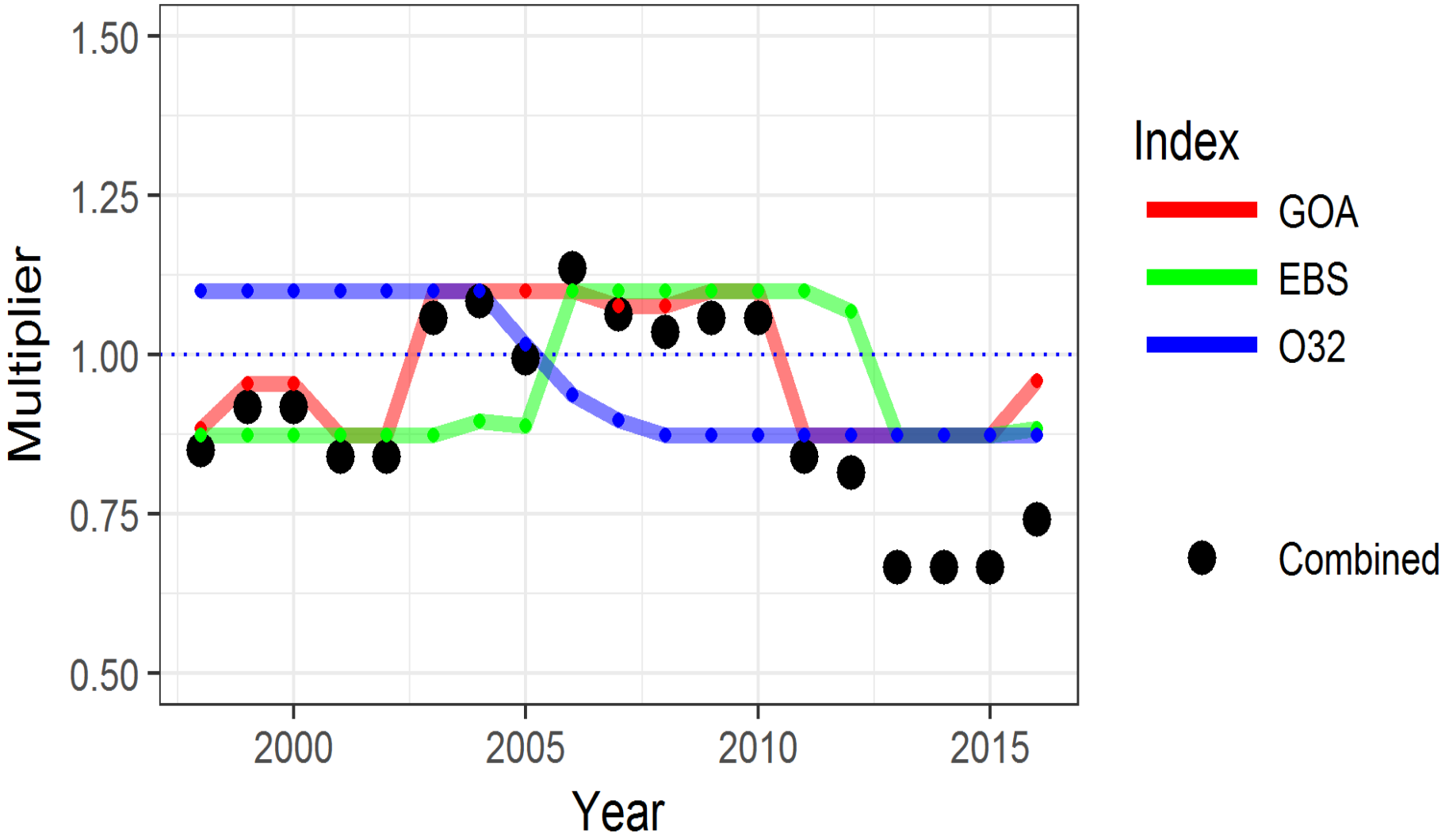


Add other indices

ABM1 uses

- EBS Trawl Survey
- GOA Trawl Survey
- O32 IPHC Setline Survey

Three indices together form “Combined”



Compute PSC_0

- Function of index values, here set to 2016 PSC limit
- PSC_0 is the estimated PSC limit when the overall multiplier is equal to 1.0

$$PSC_0 = \frac{2016\ PSC\ limit}{2016\ Index1\ \times 2016\ Index2\ \times Index3}$$

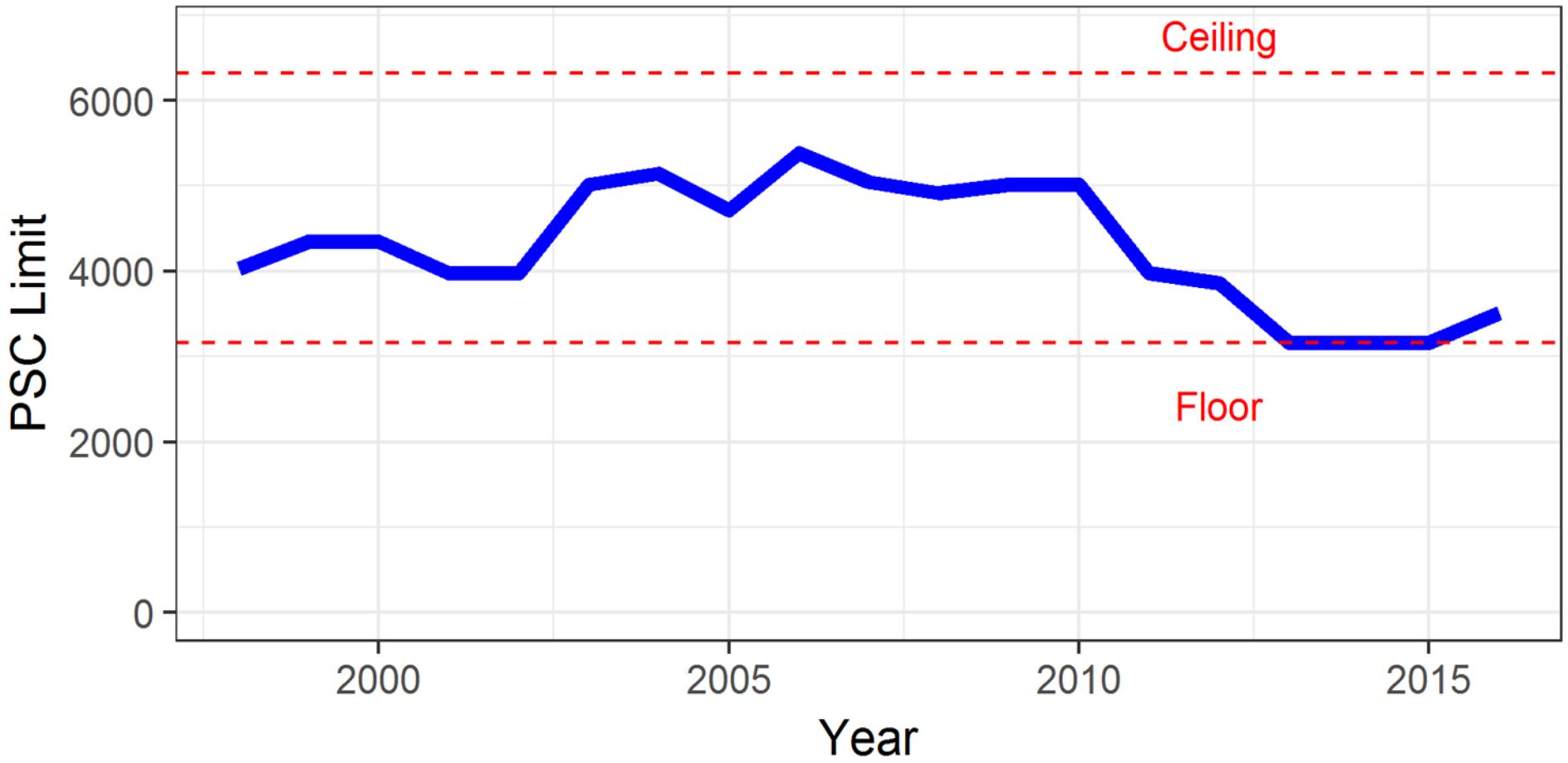
Index	Source		2016 standardized index values
1	EBS Trawl Survey	x_1 =	0.88
2	GOA Trawl Survey	x_2 =	0.96
3	O32 IPHC Setline Survey	x_3 =	0.69*

$$PSC_0 = \frac{3{,}515}{0.88 \times 0.96 \times 0.87^*} = 4{,}783$$

**For this case, value set at index floor (0.87) for ABM1 example. See discussion paper for rationale/explanation*

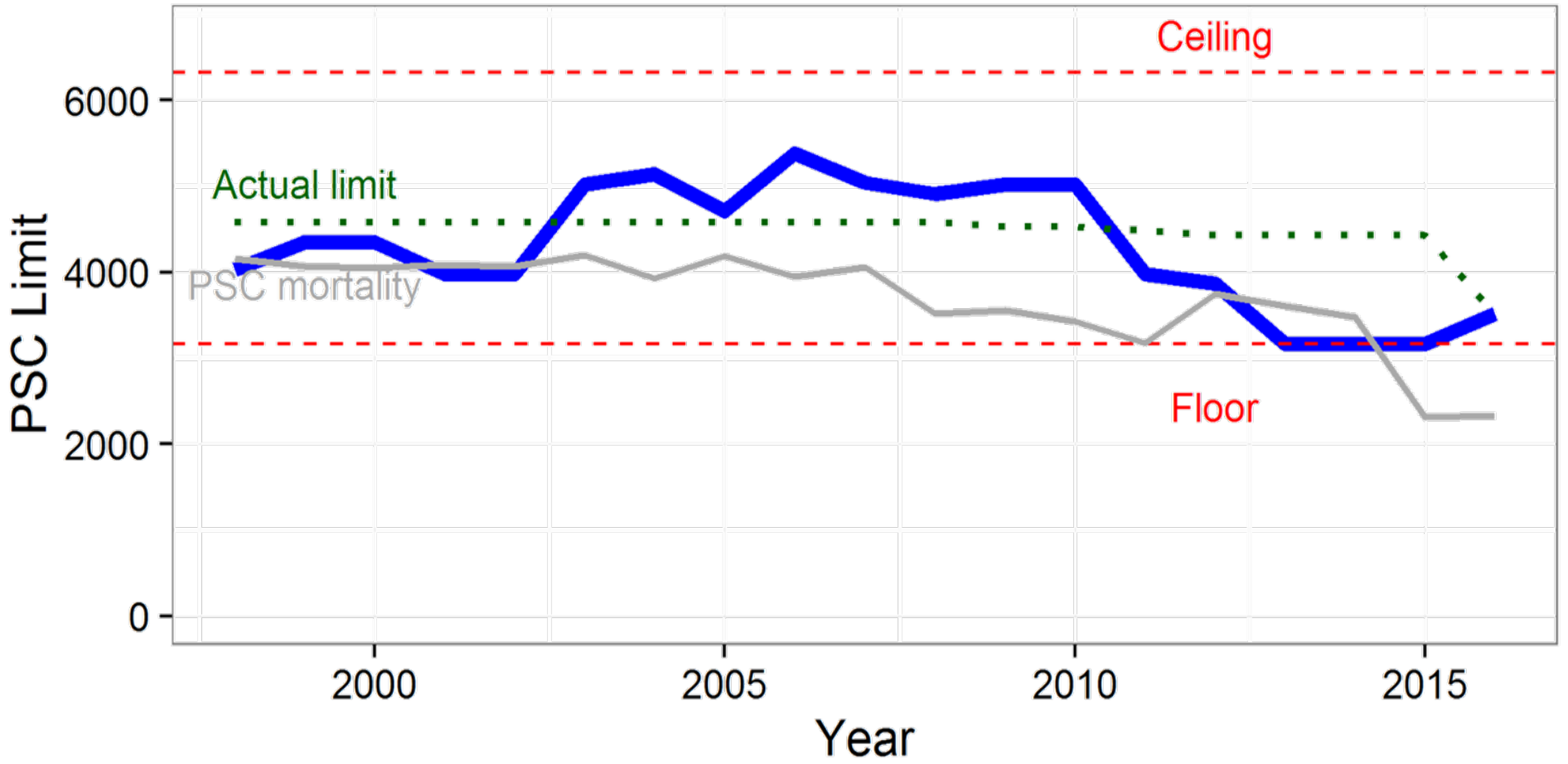
Given PSC_0

- ABM1 example tuned to 2016 yields the following PSC limits

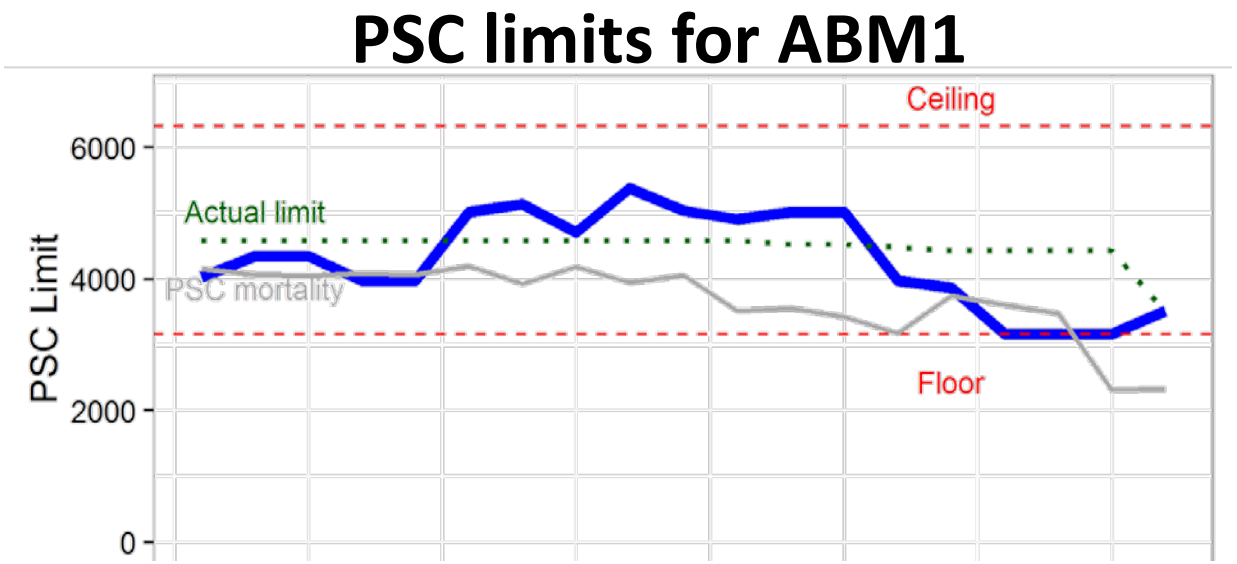


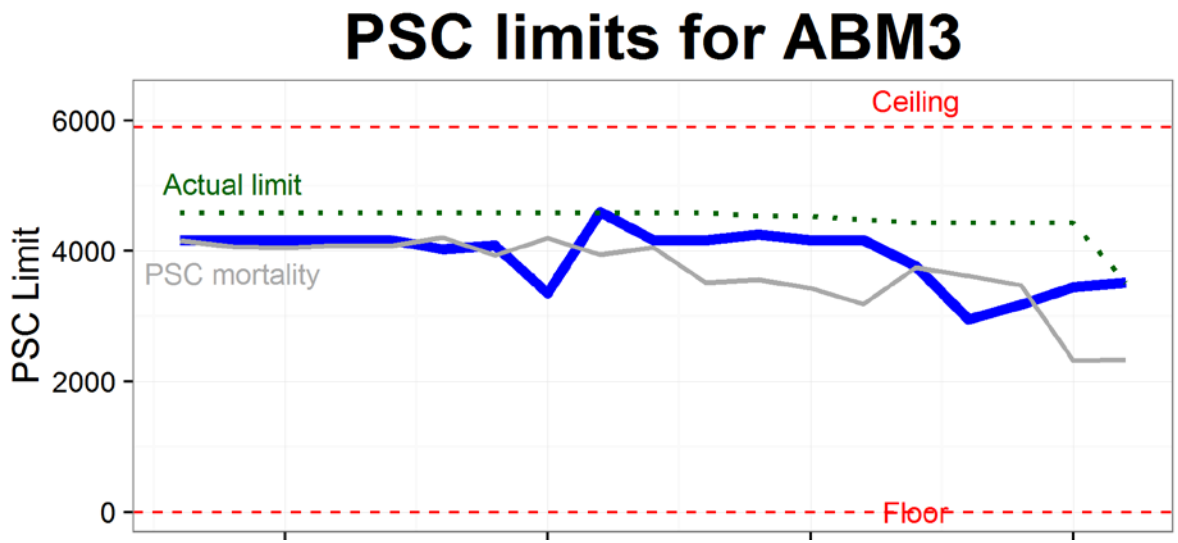
Given PSC_0

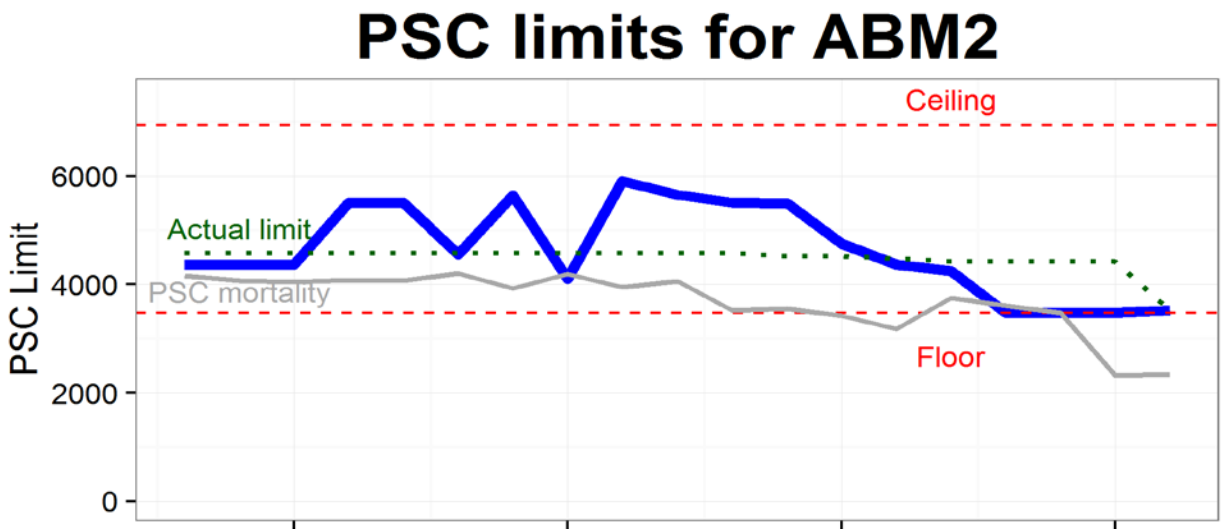
- ABM1 example tuned to 2016 yields the following PSC limits
- With Pacific halibut PSC mortality

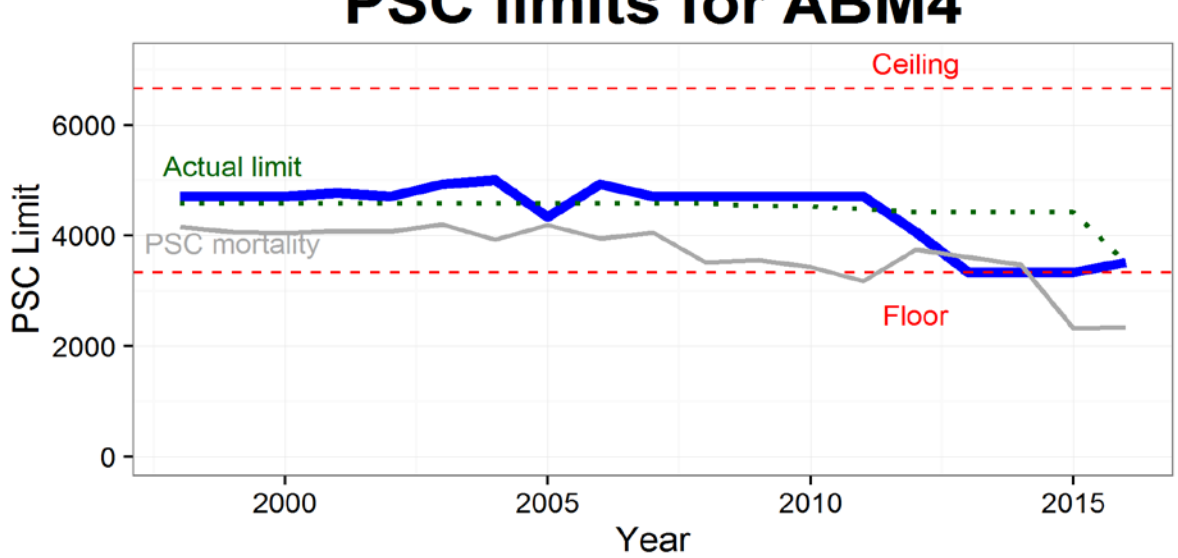


Strawman PSC cap comparisons…









Example PSC limit setting cases (e.g., a future year)

Given $PSC_0 = 4{,}783$ from earlier slide (PSC_{2016}=3,515 for ABM1) then if all three indices are

Above average, e.g.,

$$1.03 \times 1.05 \times 1.1 = 1.19, \text{ then } PSC = 1.19 \times 4{,}783 = 5{,}690$$

Below average, e.g.,

$$0.9 \times 0.93 \times 0.97 = 0.81, \text{ then } PSC = 0.81 \times 4{,}783 = 3{,}883$$

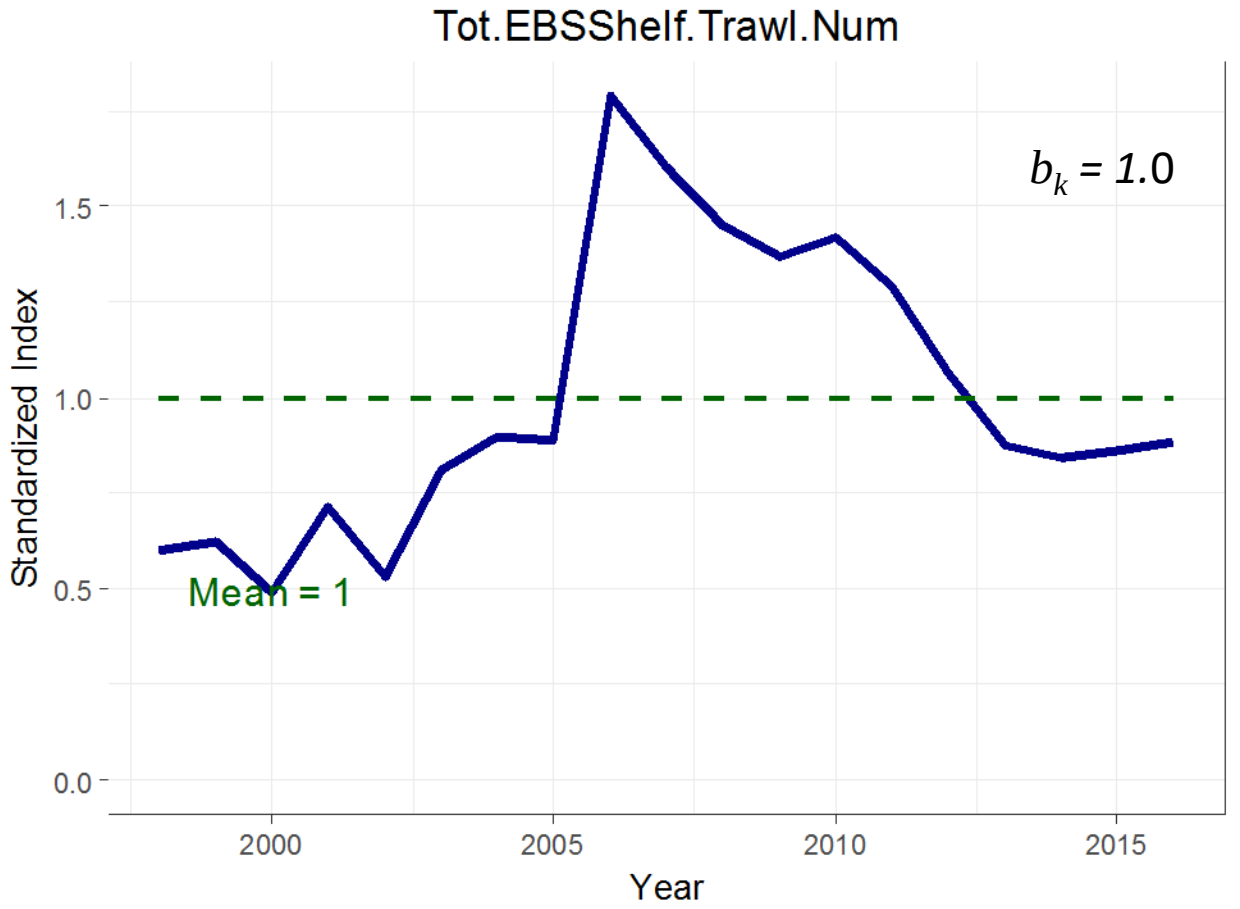
Other considerations

$$c_t = PSC_0 \prod [1 - (1 - x_{k,t})\, b_k]$$

Dialing in *"b_k"* value…

Dialing in "b_k"

If b_k=*1.0* then a 10% change in index *b x* 10% change in adjustment...

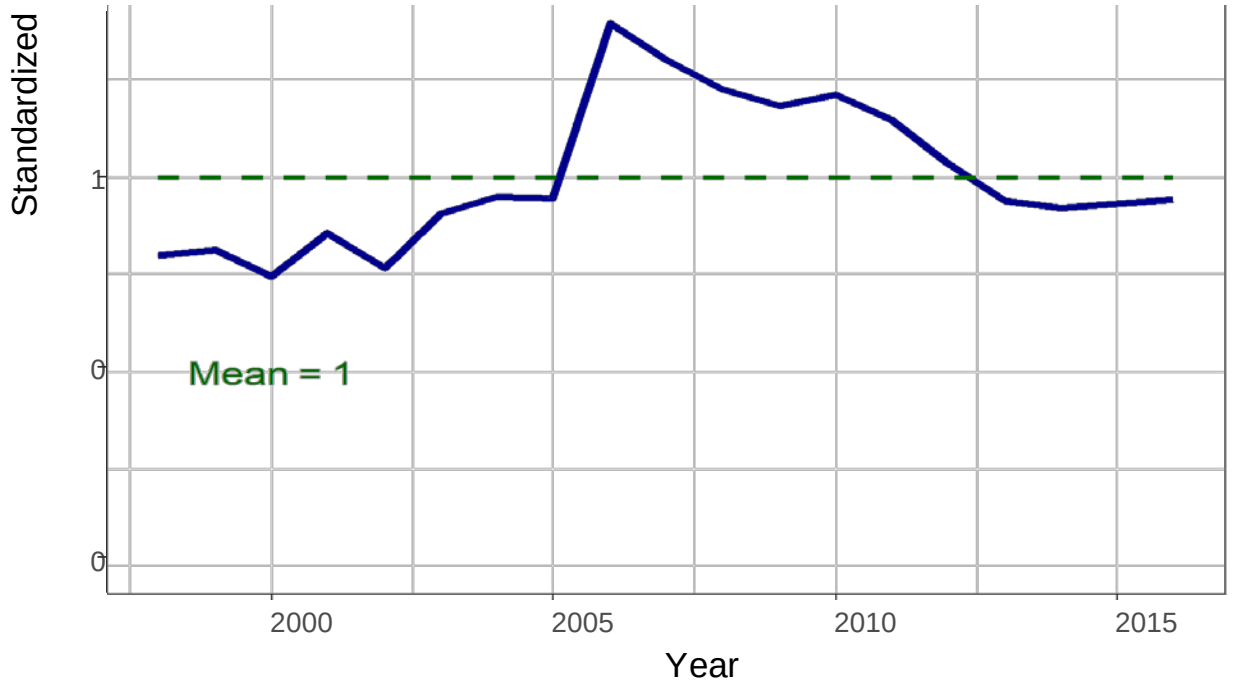


Dialing in "b_k"

If b_k = 0.5…a 10% change in index would result in a 5% change in adjustment

"b_k" basically controls responsiveness to index…

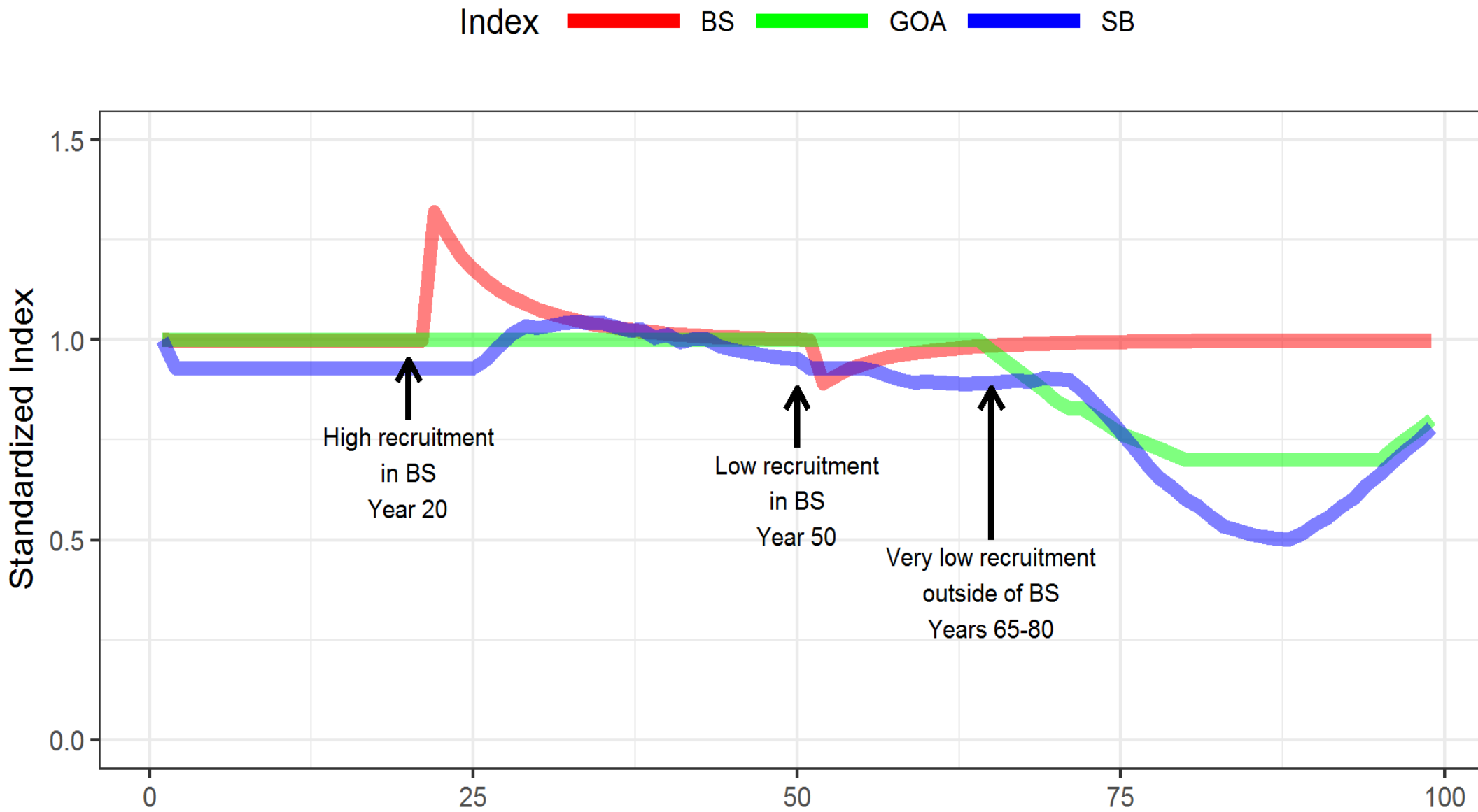
b_k = 0.5



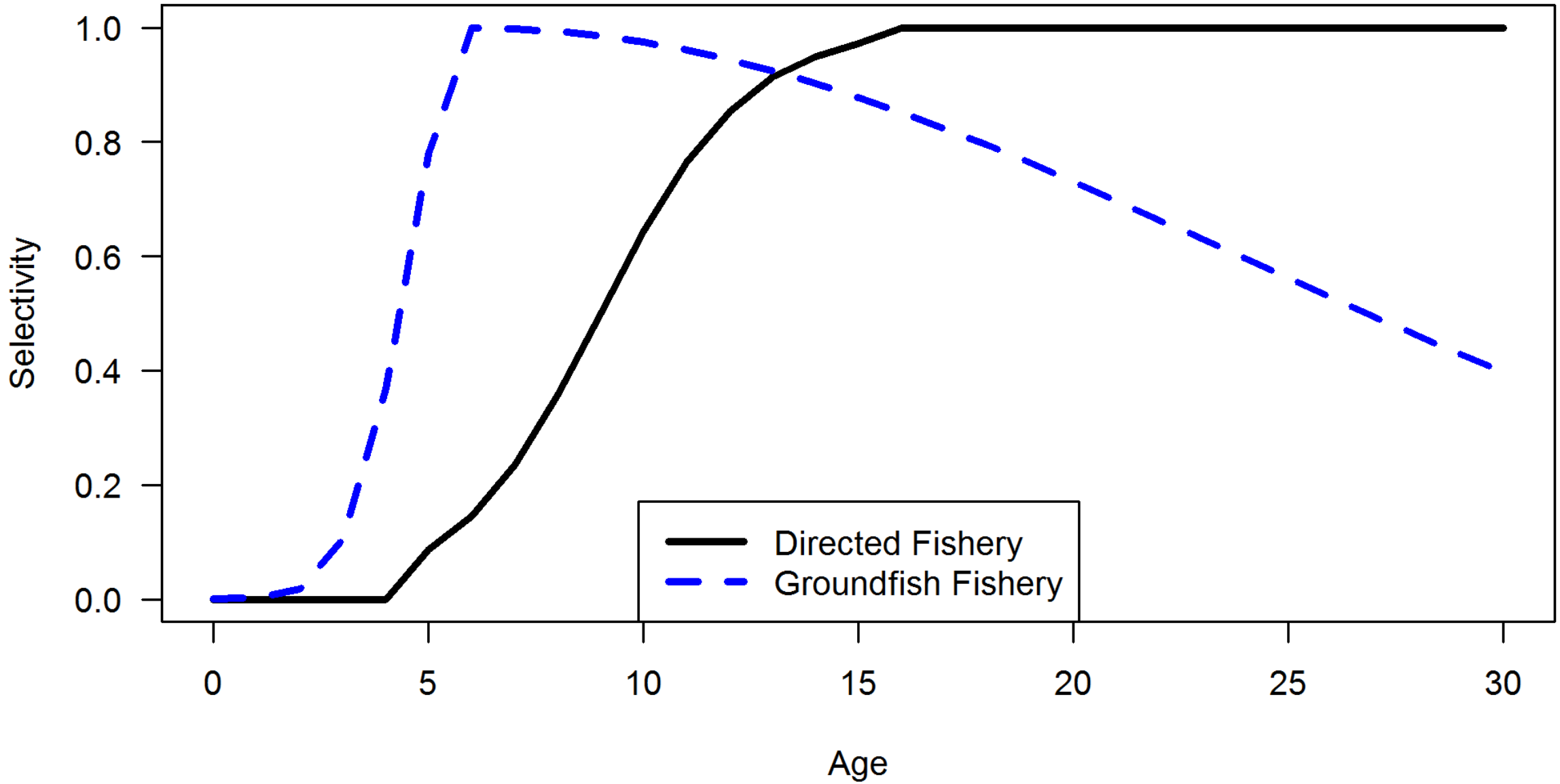
Appendix B. Simulation comparisons

- A very simple simulation of an age-structured population
- To show the effects of recruitment events
- Indices are correlated approximately the way they should be and fishing affects each one
- A “Bering Sea” area and an “outside” area (i.e., GOA)
  - GOA was not specifically modelled, but had a recruitment effect
  - Recruitment in BS didn’t affect GOA, but did affect coastwide spawning biomass

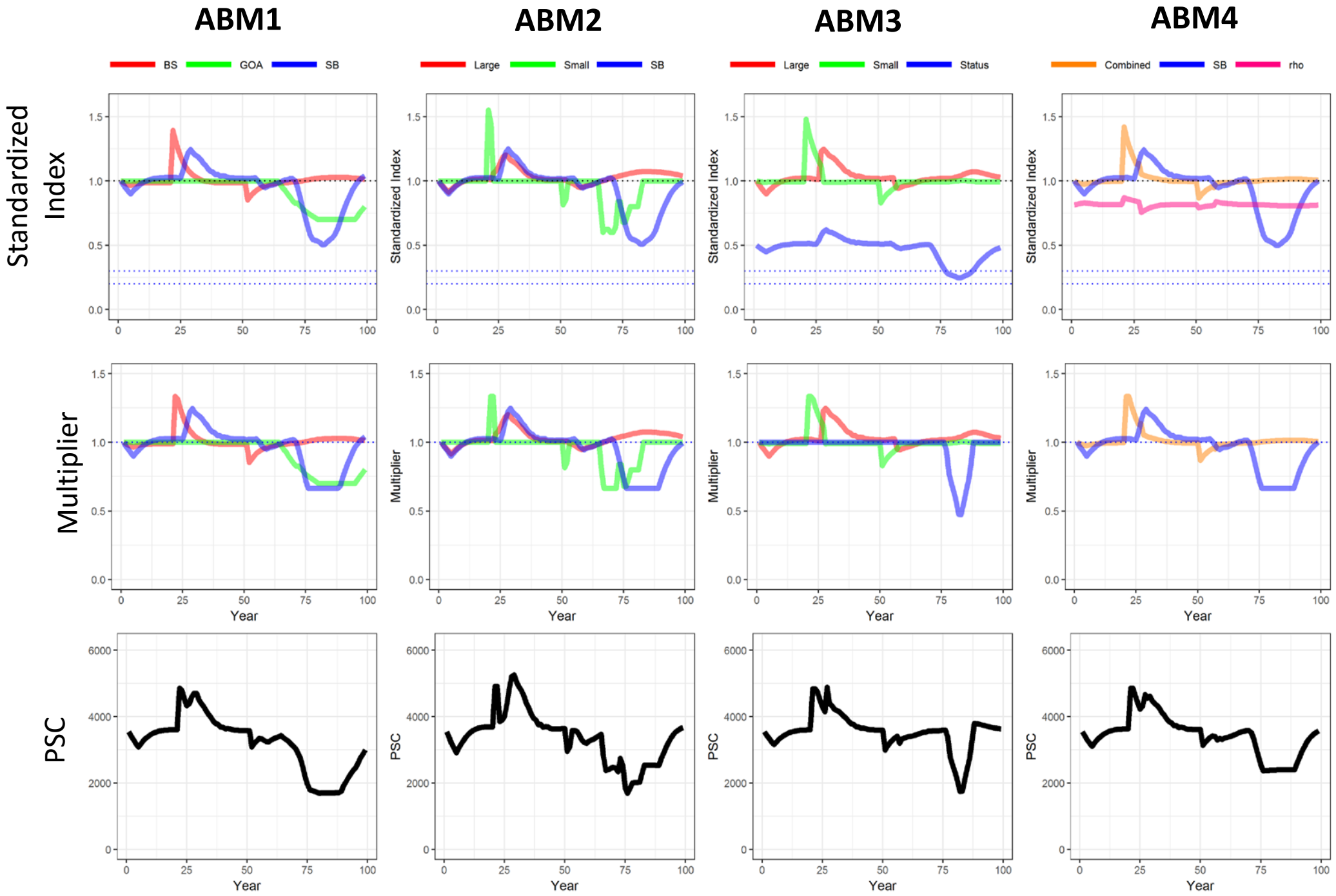
No Fishing Mortality



Selectivity

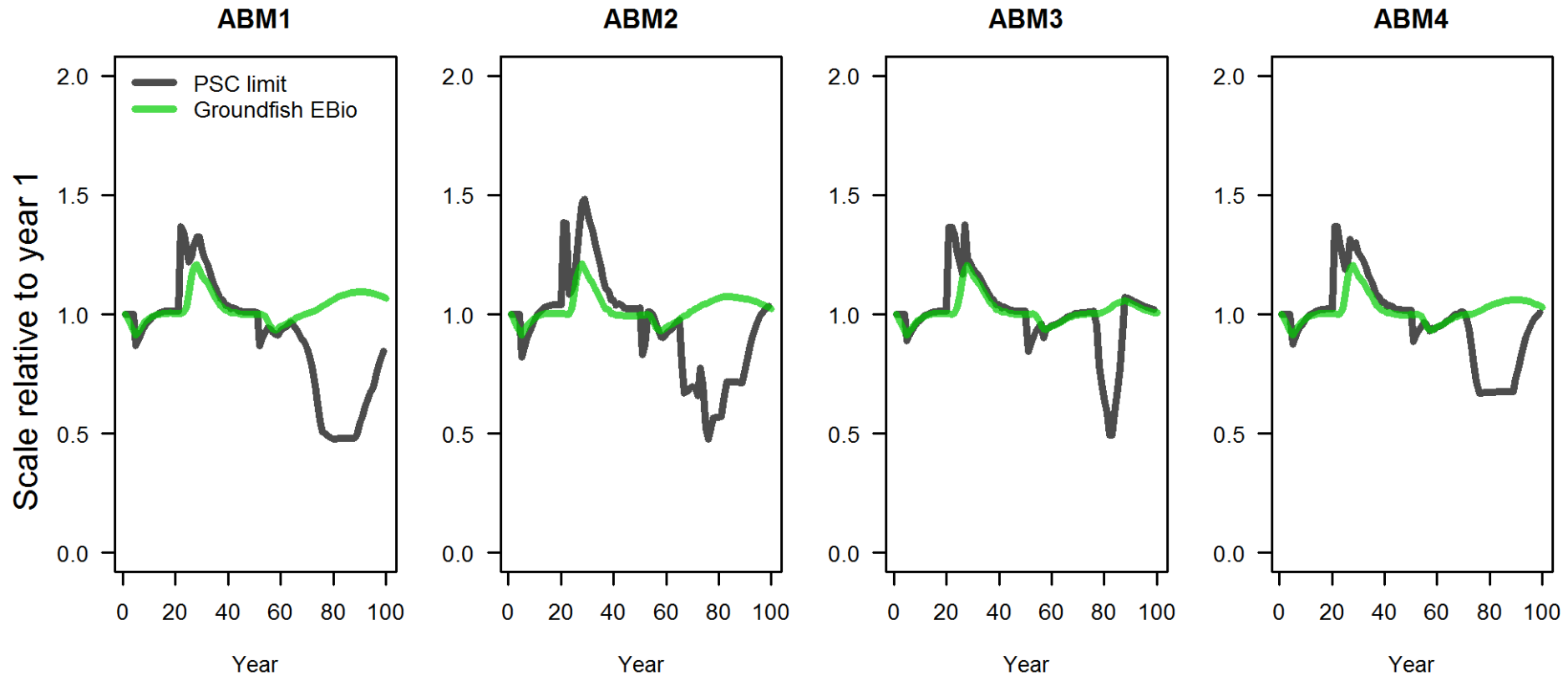


Simulations



Groundfish selected biomass

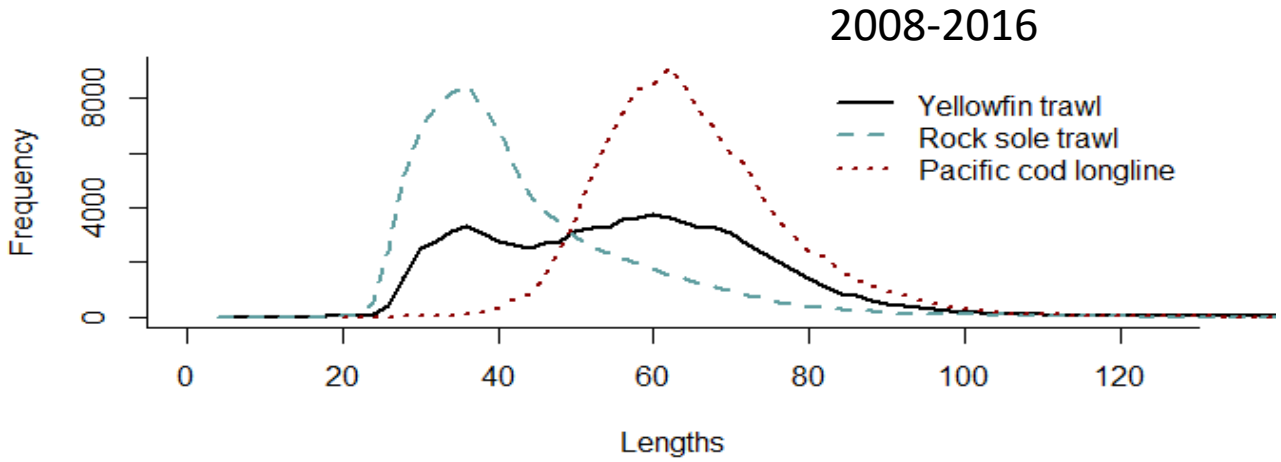
- A look at how encounters of halibut in groundfish fishery **may** correspond to the PSC limit
  - Might be better to look at encounter rates

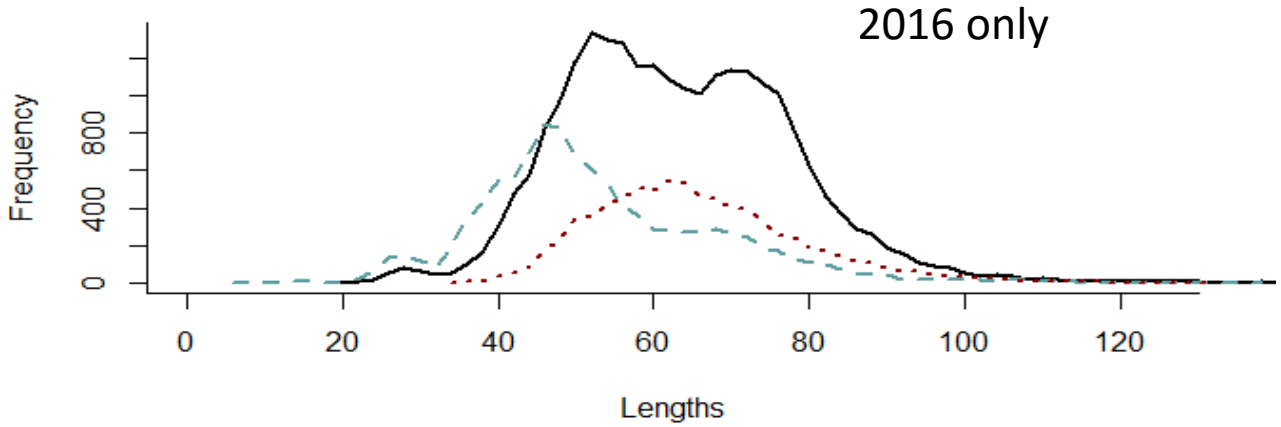


Gear considerations

- Length composition of bycatch varies over gear type; Pcod longline has caught larger halibut on average over time and likely has a different gear-specific SPR rate
- Length composition of halibut bycatch in trawl target fisheries can vary within gear type by target (i.e. yellowfin sole vs. rock sole) and over time
- With gear-specific control rules the status quo proportional allocations of PSC to the groundfish sectors likely would change because the sector PSC limits would no longer be determined as a proportion of the total PSC limit.

Pacific halibut length frequencies by target fishery and gear type





Gear considerations

- Coming up w/ gear-specific indices / control rules possible
  - But time and increased complexity prohibited development

Expansion to GOA

- ABM1 and ABM2
  - could be modified for the GOA by changing the “starting point” or scale of the PSC control rule
- ABM3 and ABM4
  - would require modifications of the indices (2 of the 3 indices currently focus on the EBS, not the GOA in current examples)
  - the “starting point” of the PSC control rule would need to be modified
- Other considerations
  - Observer coverage
  - Management constraints
  - Differences in fleets
  - Analysis results from EBS may not apply to GOA

Feedback from February 2017 workshop

Workshop goals:

- Review the need for goals, measurable objectives and related performance metrics
- Ask questions to assist in the development of measurable objectives and related performance metrics
- Solicit feedback on modifications or additions to these objectives and performance metrics

Performance metrics

- It is important to define detailed management objectives with measurable outcomes
- Each measurable objective has an outcome (“a certain abundance”), a time-frame (“a specified number of years”) and a probability or acceptable risk level
- A performance metric can then be defined to evaluate whether or not a measurable objective has been achieved (e.g., the probability that the spawning stock abundance is above a certain level over a specific number of years)

Performance metrics

- Workshop participants identified many measurable objectives and provided useful feedback for further development of performance metrics that will be used to evaluate the alternatives for analysis
- Examples include
  - indices should consider size composition of PSC and directed catch
  - consider encounter rates of halibut in groundfish fishery as a potential metric
  - develop social and community metrics for groundfish crew jobs and minimum directed fishery harvests for processors to operate
- The working group will continue to develop performance metrics throughout this process to make sure that results can be adequately evaluated against all important objectives

Incentives

Workshop participants noted the need to consider appropriate incentives when designing alternatives for analysis

Suggestions:

- Council should consider the impacts of a floating PSC limit on the incentives for groundfish vessels to avoid halibut
- ABM alternatives should include specific measures to ensure that vessels minimize PSC to the extent practicable at all levels of halibut abundance

Incentives

- The action currently under consideration would index BSAI halibut PSC limits to abundance
- The analysis of alternatives should consider the impacts of this management change on incentives to avoid bycatch at a sector and vessel level
- Some stakeholders suggested the Council could consider developing specific incentive components as part of the ABM action (e.g., require halibut avoidance plan)
- The discussion paper highlights general considerations for developing incentive components in response to this suggestion

Next steps