A description of the current harvest policy for Pacific halibut

Allan Hicks

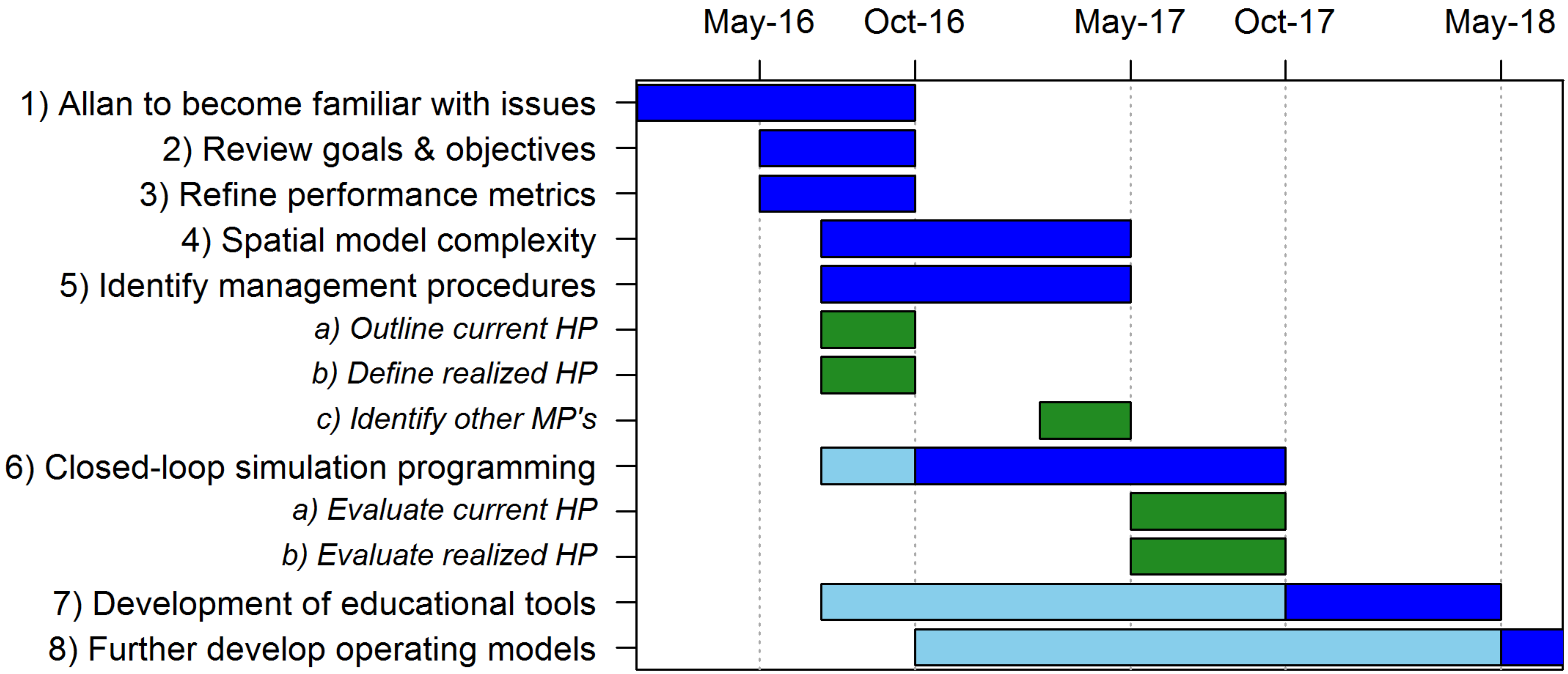
With help from any others

MSAB Meeting

October 2016

INTERNATIONAL PACIFIC HALIBUT COMMISSION

Gantt chart



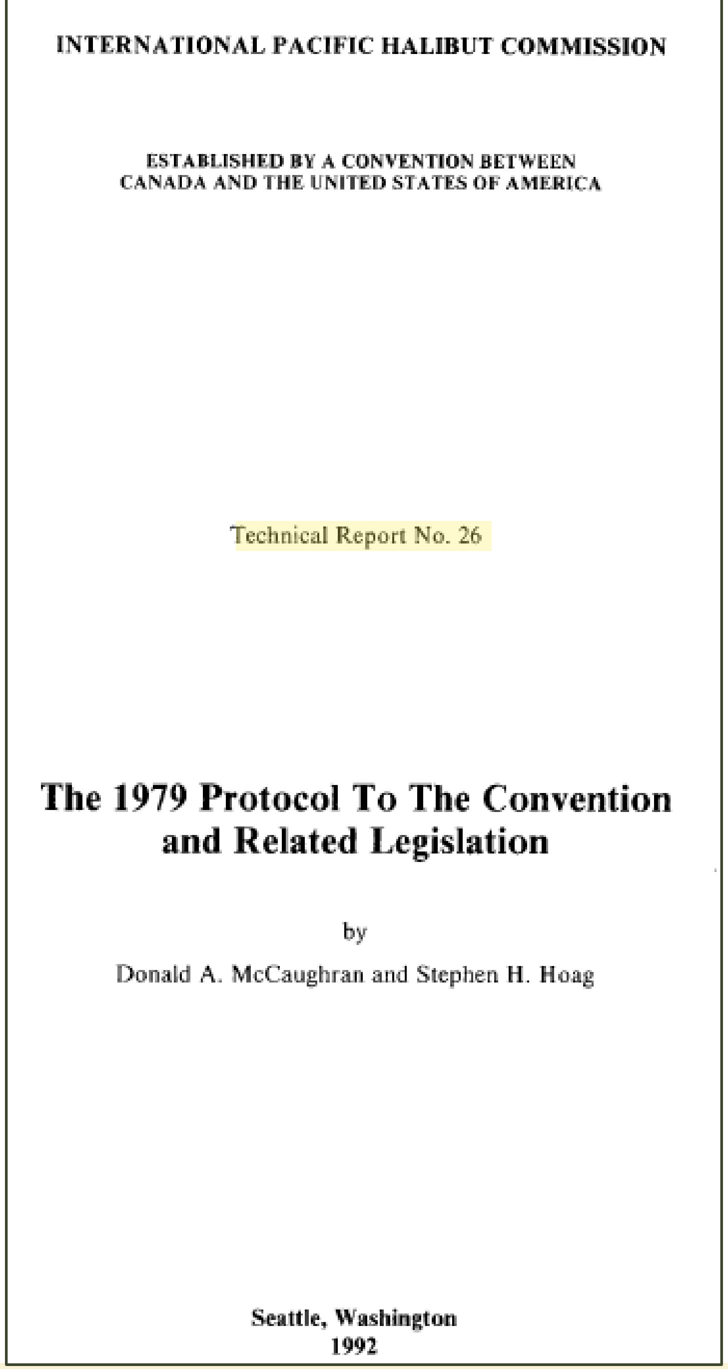
May-16
Oct-16
May-17
Oct-17
May-18
1) Allan to become familiar with issues
2) Review goals & objectives
3) Refine performance metrics
4) Spatial model complexity
5) Identify management procedures
a) Outline current HP
b) Define realized HP
c) Identify other MP's
6) Closed-loop simulation programming
a) Evaluate current HP
b) Evaluate realized HP
7) Development of educational tools
8) Further develop operating models

Outline

- A background of IPHC legislation and harvest policy
- A description of the current harvest policy
- How managers have implemented the harvest policy
- Some criticisms of the current harvest policy
- Bycatch management as an example of scenarios vs. procedures
- Mapping the current harvest policy to account for total mortality

Some history of legislation

- 1923 Convention
  - 3-month closure in winter
  - Four commissioners
- 1930 Convention
  - Establish regulatory areas, limit catch, regulate licensing, collect stats, regulate gear
- 1937 Convention
  - More effective control of incidental catch while fishing for other species during closed season
- 1953 Convention
  - Named the International Pacific Halibut Commission
  - Maintain stock at levels that support maximum sustainable yield
  - Managed with time and area closures
  - Six commissioners
  - U.S. Presidential authority delegated to Secretary of State
- 1979: A protocol to 1953 Convention
  - M-S act required renegotiation of international treaties
  - Managing on the basis of optimum yield
  - Phase-out reciprocal fishing privileges
- 1982: Northern Pacific Halibut Act
  - Necessary US legislation to give effect to 1979 protocol



INTERNATIONAL PACIFIC HALIBUT COMMISSION

ESTABLISHED BY A CONVENTION BETWEEN
CANADA AND THE UNITED STATES OF AMERICA

Technical Report No. 26

The 1979 Protocol To The Convention and Related Legislation

by

Donald A. McCaughran and Stephen H. Hoag

Seattle, Washington
1992

A little background to the current halibut treaty

- Jurisdiction over Canadian and U.S. fishery for halibut
- Can prohibit retention of incidentally caught halibut in CAN and US
  - A limit to incidental catch must be accepted by contracting parties
  - In US, regional councils responsible for management of non-halibut fisheries

It quickly becomes complicated

An excerpt from the BSAI FMP

Conflicting objectives

As long as **Council and IPHC objectives** concerning halibut utilization **remain similar**, **coordination** between the two organizations **is easily affected**.

Should halibut management **philosophies diverge** – for example, because the broader-based Council constituency objects to constraints on fishery development caused by overriding halibut-saving measures – a major social, political, and, perhaps, diplomatic (because of Canadian involvement in IPHC and in the halibut fishery) **confrontation could be precipitated**.

Interactions between regions

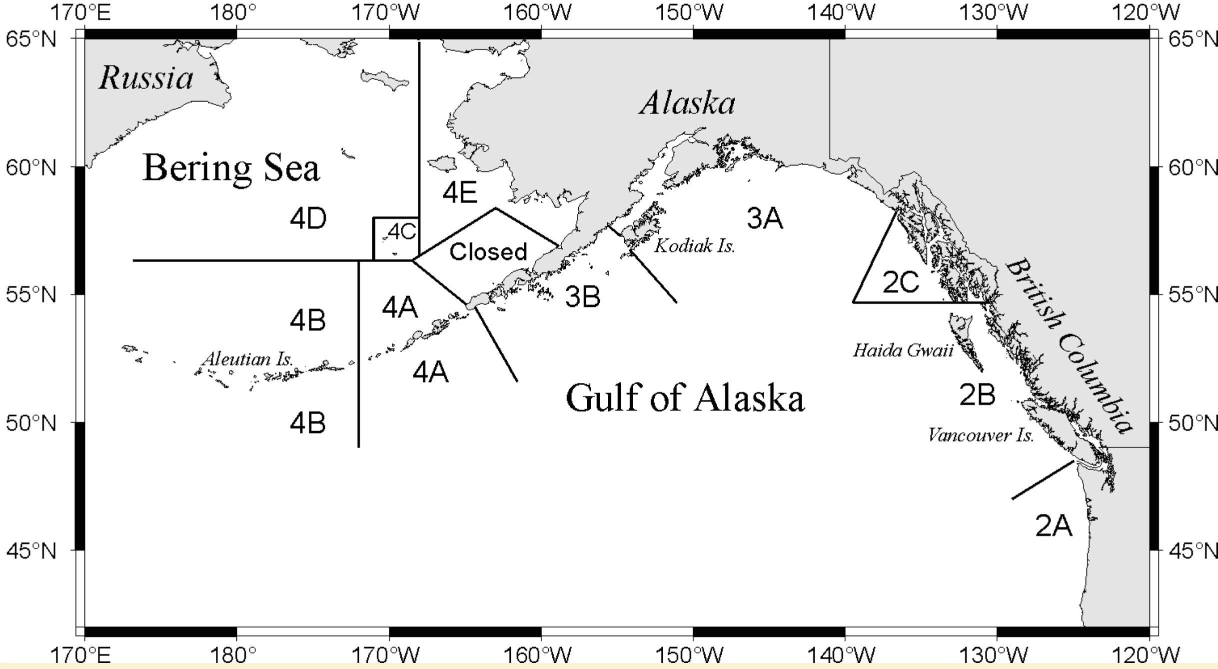
Furthermore, management **actions taken in the Bering Sea** that adversely affect halibut are **likely to have a significant impact on the Gulf of Alaska** halibut stock and fishery because of the interchange of halibut between the two regions.

A little background on IPHC harvest policy

- Assessments
  - 1989 to 2006: individual assessments in each regulatory area
  - 2007 onward: coastwide assessment apportioned by survey estimates
- Size limit
  - 26 inches in 1940
  - Increased to 32 inches from 26 inches in 1973 for areas 2 and 3
  - All areas had a 32 inch size limit in 1974
- Harvest rates
  - Used since 1985, starting at 35% and decreasing since
- Conditional Constant Catch
  - A ceiling catch that is modified by a constant harvest rate when abundance is low
  - Not formally implemented
- Slow Up Fast Down → Slow Up Full Down (SUFD)
  - Utilized in 2001 as a formalization of the Commission process
  - Official in 2007
  - Change in catch phased in over time
    - 50% of recommended reduction
    - 33% of recommended increase
  - Suspended in 2011 due to a series of biomass declines
- Simulation studies
  - First one in 1968 by Southward
  - Many other simulation studies related to harvest policy (Parma, Hare, Clark)

A little background on IPHC harvest policy

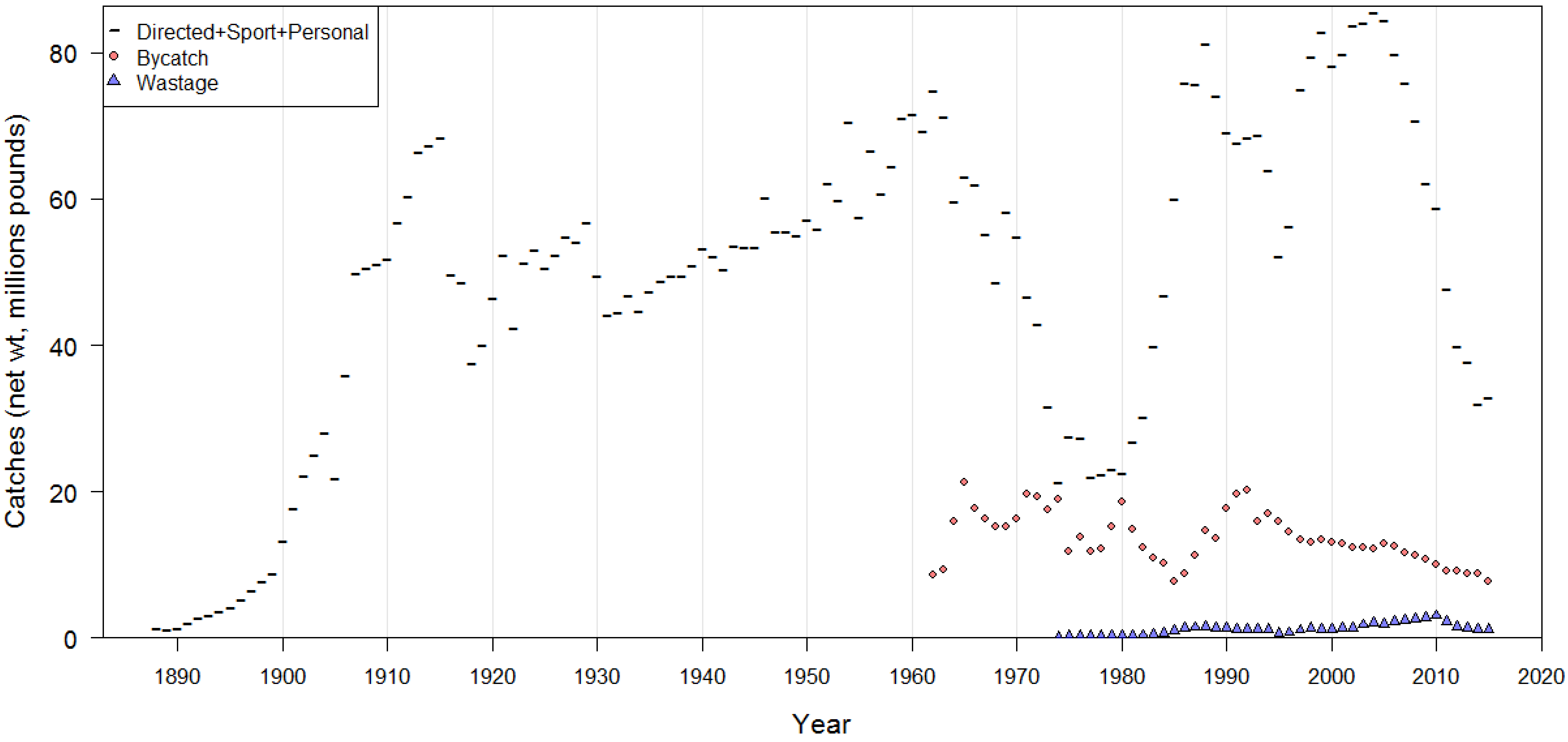
- Regulatory areas and closures commonly used to manage catch
  - 3 month winter closure started in 1923
  - Closed area in Bering Sea to protect nursery area (Commission, 1967)
- Only longline (and some pot) gear legal
  - Trawl gear must discard all halibut
- IFQ/ITQ in AK and BC, short openers in WA/OR/CA
- Recreational, personal use/subsistence managed differently by area
  - Catch sharing plans (CSP)
    - Areas 2A, 2C, 3A, 4CDE
  - Regulatory authority
    - Area 2B



A little background on IPHC harvest policy

- Halibut can survive after being caught and released
  - Discard mortality rates (DMR) by fishery are used as a post-release mortality rate
- Wastage
  - Halibut caught in the directed fishery that die but are not landed
  - Partly due to minimum size limit
    - Other wastage comes from release of O32 fish and lost gear
- Bycatch
  - Halibut caught in non-directed fisheries that die
  - Prohibited to retain, except in a few donation cases
  - Negligible until 1960's
    - Major fisheries for other groundfish species began

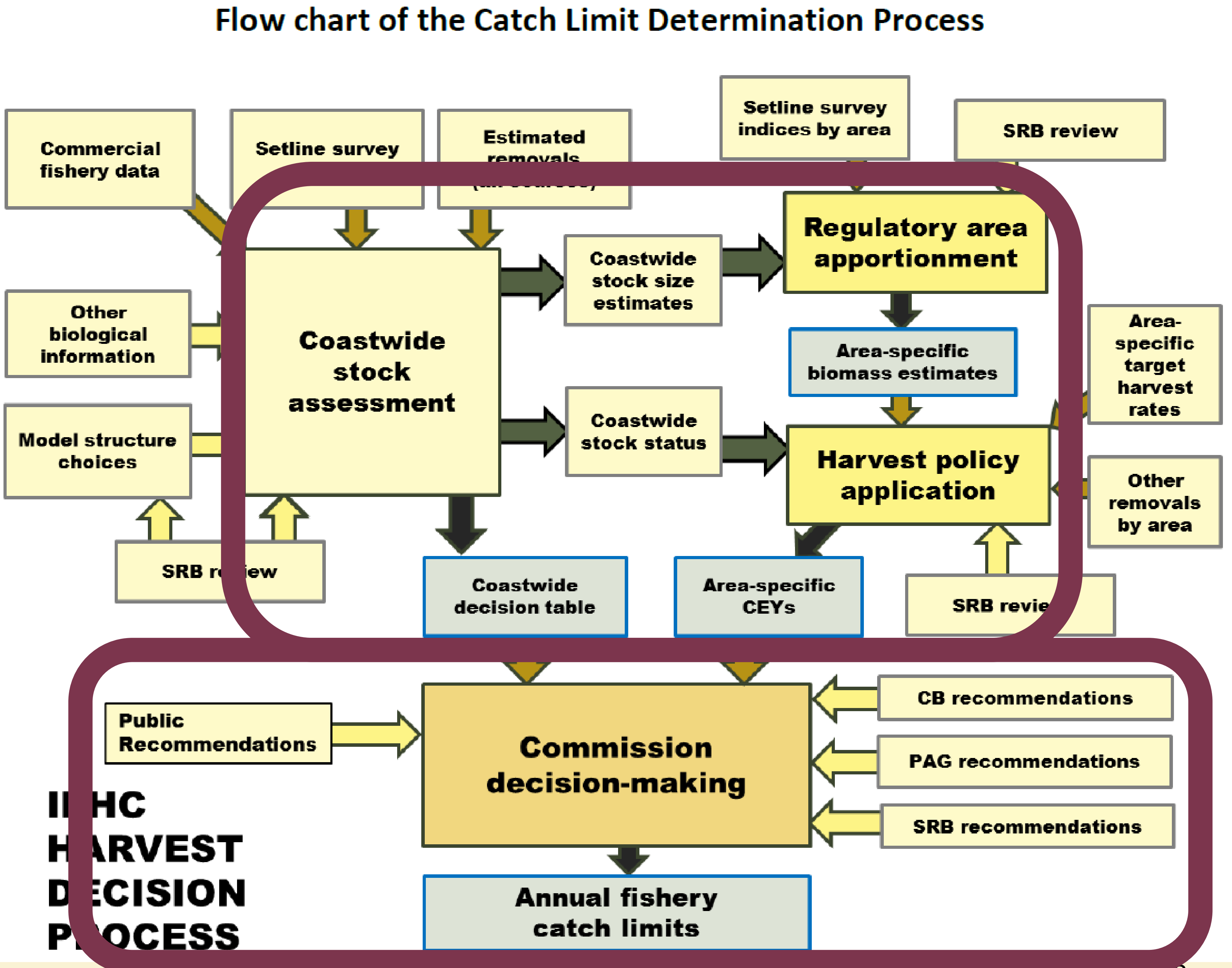
Sources of fishery mortality



Managing bycatch

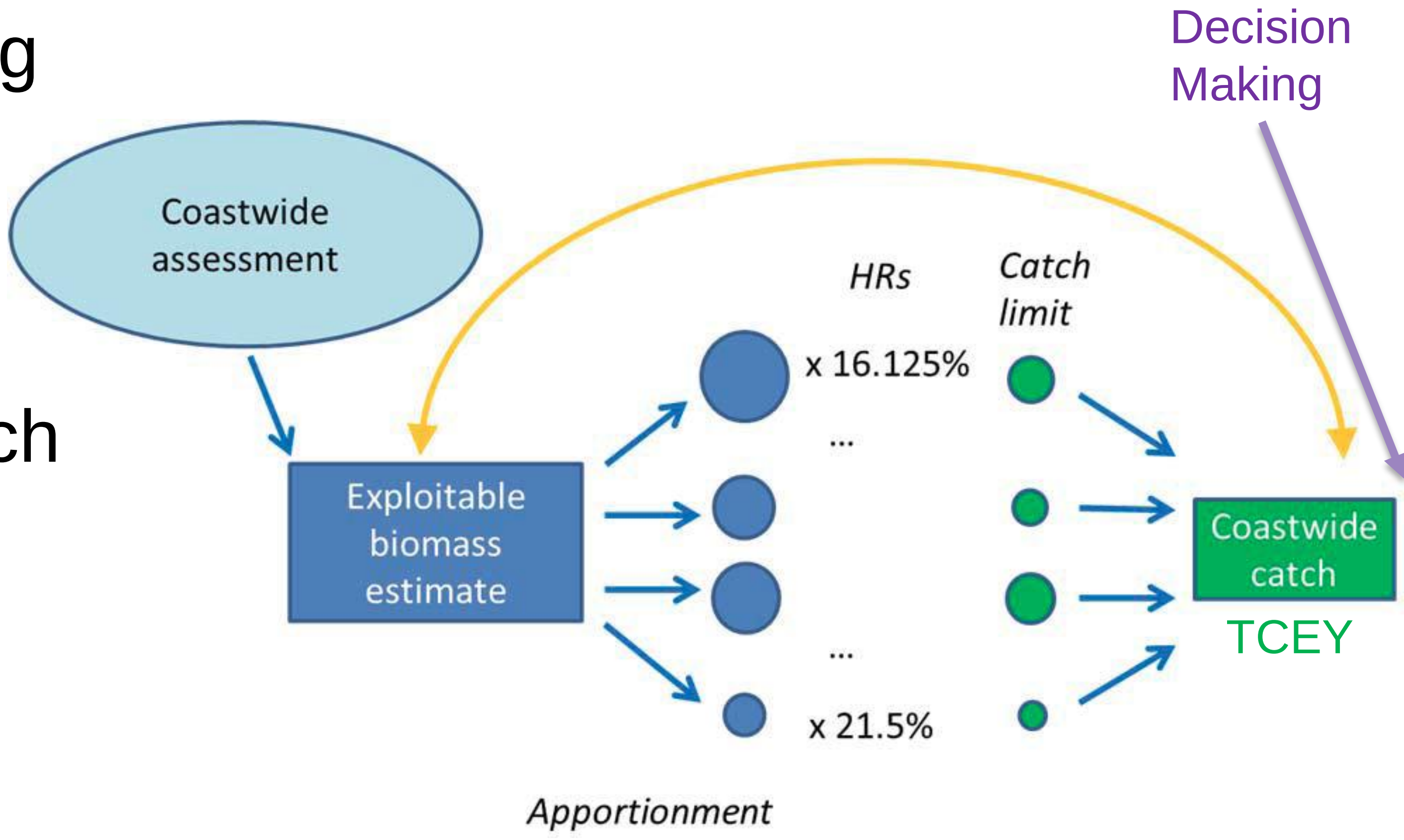
- Methods range from
  - Individual Bycatch Quota (IBQ) in 2A trawl fishery
  - Individual Transferable Vessel Quota (ITVQ) in BC H&L and trap fisheries
    - O32 retained and discarded
    - U32 accounted for by a pre-quota reduction
  - Fleet limit, individual vessel caps, ITQ transfer in BC trawl fisheries
    - 100% observer coverage
  - Prohibited Species Catch (PSC) limit in many Alaskan fisheries
    - And complicated regulatory processes
  - Excluder devices in some fisheries (e.g., shrimp trawl)
- Discard mortality rates (DMRs) vary from 4-100% by fishery

Catch Limit Determination



Current harvest policy

- Size limit of 32”
  - O32: halibut 32” and greater
- Cannot legally retain incidental catch in non-directed fisheries
- Winter season closed to fishing
- Exploitable biomass apportioned among areas
- Area-specific harvest rates determine regulatory area catch
- A control rule reduces the harvest rate when coastwide biomass is low



Current harvest policy: Coastwide assessment

- Coastwide assessment is an ensemble of four models
  - Short and long time-series
  - Coastwide fleets and areas-as-fleets
  - Results are combined creating a distribution of outcomes
    - Can be summarized in many ways including a distribution of derived outcomes

Current harvest policy: Exploitable biomass

- Exploitable biomass has been referred to as EBio
- Used to calculate regulatory area catch limits
- A product of selectivity, weight, and numbers
  - Summed over age and sex
  - Year specific

$$EB_y = \sum_{sex} \sum_{age} s_{sex,a,y} w_{sex,a,y} n_{sex,a,y}$$

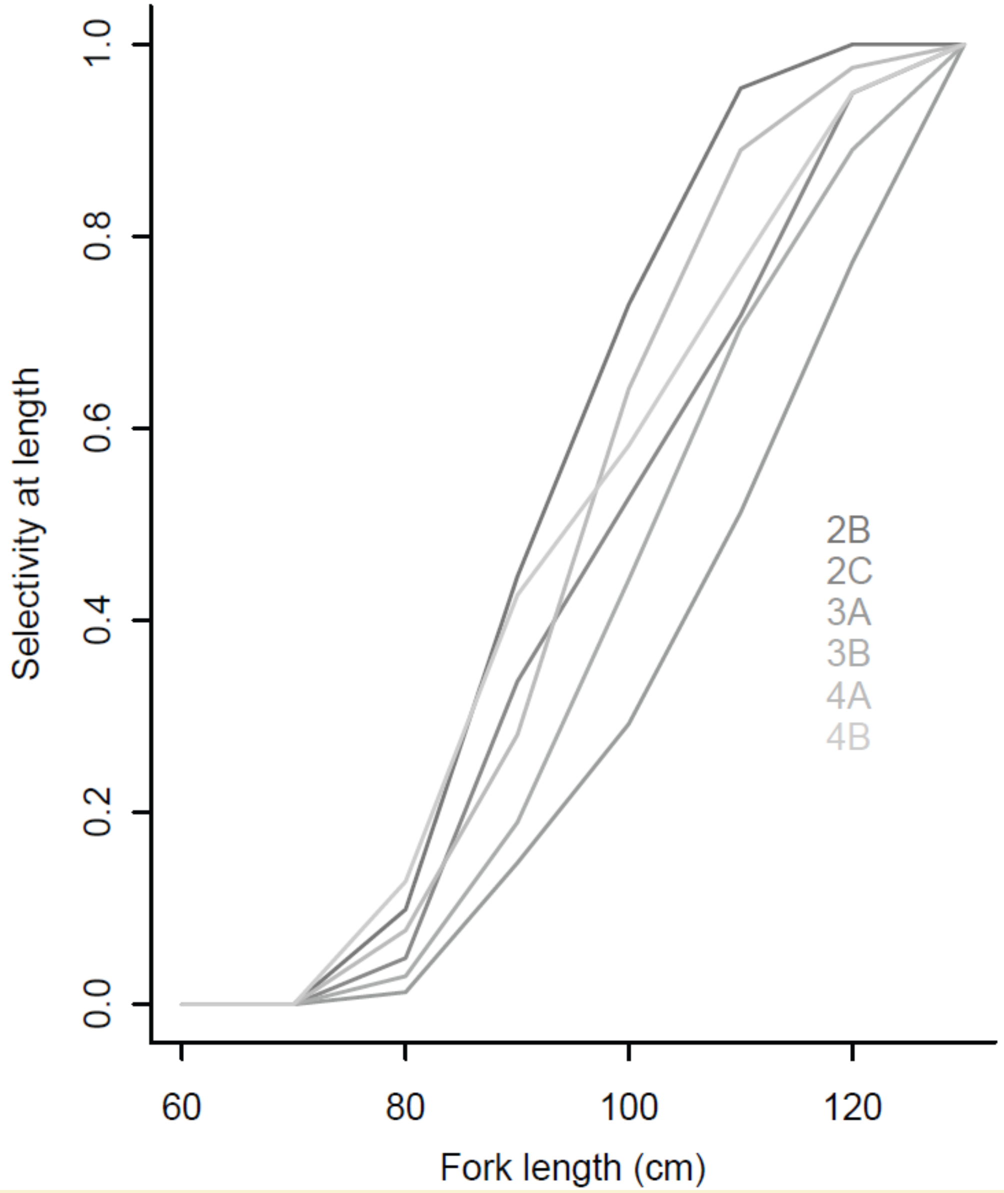
- Weight-at-age is from the data
- Numbers-at-age are from the assessment
- Selectivity is externally derived

Exploitable Biomass

A specific concept from the IPHC's harvest policy: the portion of the total stock biomass included in the current harvest policy calculations.

Current harvest policy: Exploitable biomass

- Selectivity
  - Calculated external to the assessment
  - Used to be length-based and area-specific before 2006
  - A single length-based curve since the coastwide assessment model
  - Converted to age-based in 2012



Current harvest policy: Exploitable biomass

- Selectivity for EBio
  - Converted to age-based in 2012
  - Needs to be updated with changes in size-at-age
  - A divergence between EBio in simulations, assessment, and harvest policy

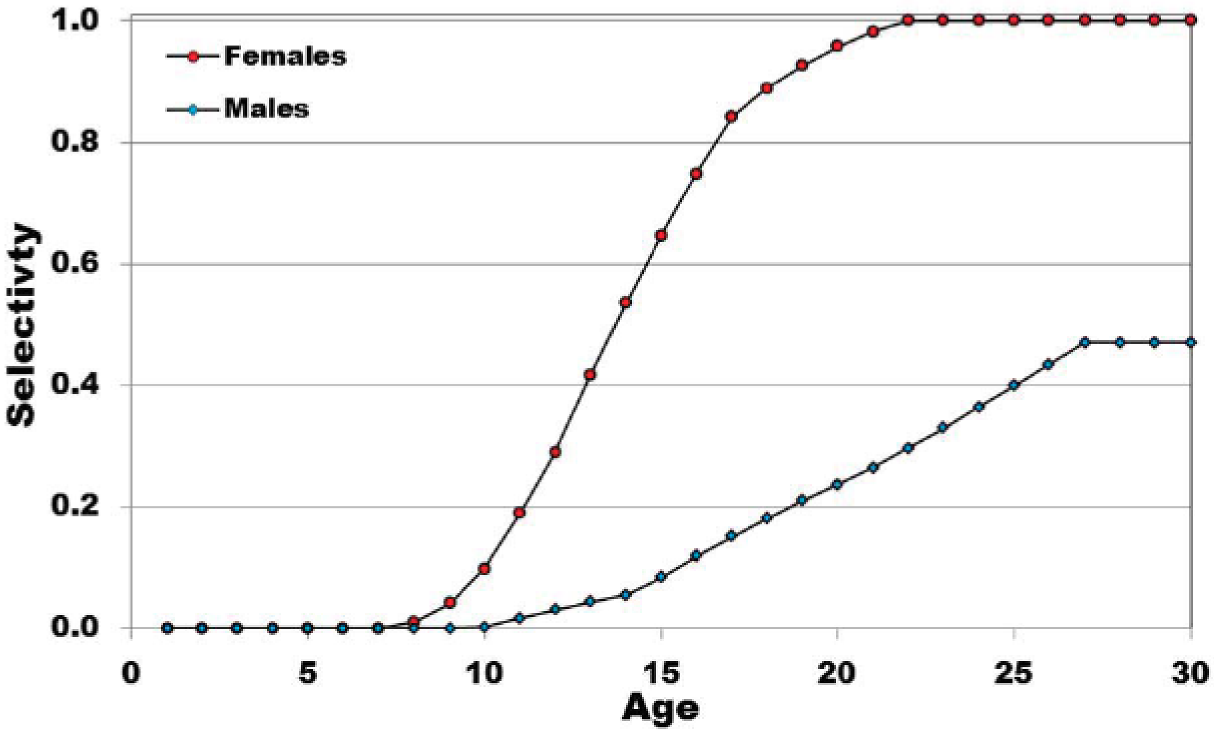


Figure 107. Terminal year selectivity pattern assigned to the exploitable biomass calculation, consistent with the existing IPHC harvest policy.

A140

IPHC Report of Assessment and Research Activities 2015

What is selectivity?

- Catch-at-age is determined from
  - Numbers-at-age (N_a)
  - Weight-at-age (w_a)
  - Fishing mortality-at-age (F_a)

$$C_a = N_a w_a F_a$$

- Fishing mortality-at-age can be split into
  - Fishing mortality (F)
  - Selectivity-at-age (s_a)

$$C_a = \overbrace{N_a w_a s_a}^{\text{“EBio”}} F$$

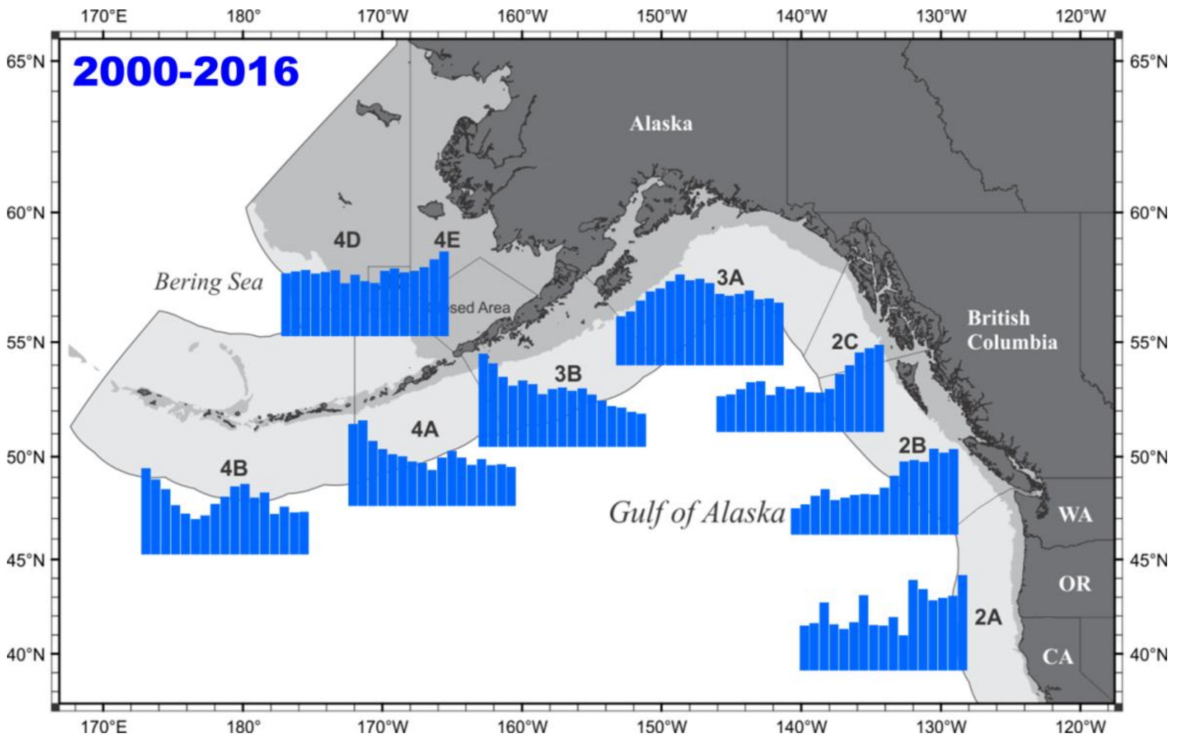
- F is the fishing mortality for a fully selected fish and is commonly parameterized using
  - Exploitation rate (or harvest rate)
  - Instantaneous F (Baranov’s equation)

What Ebio is not

- It is not O26 or O32 biomass
- It is not the proportion of the stock that the fishery encounters
- It is not selectivity from the current assessment
- It is not what you think it is

Current harvest policy: Apportionment

- Setline survey mean WPUE index used to estimate distribution of stock among regulatory areas
  - O32 halibut
  - Weighted by bottom area
  - Adjustments for survey timing and hook competition
  - Bering Sea trawl survey calibrated to provide density estimates in Eastern Bering Sea when setline survey does not survey there
  - NMFS West Coast trawl survey used for a density estimate south of 40°N
  - Three year weighting: 75:20:5% for current and previous two years



Proportion of biomass in each area

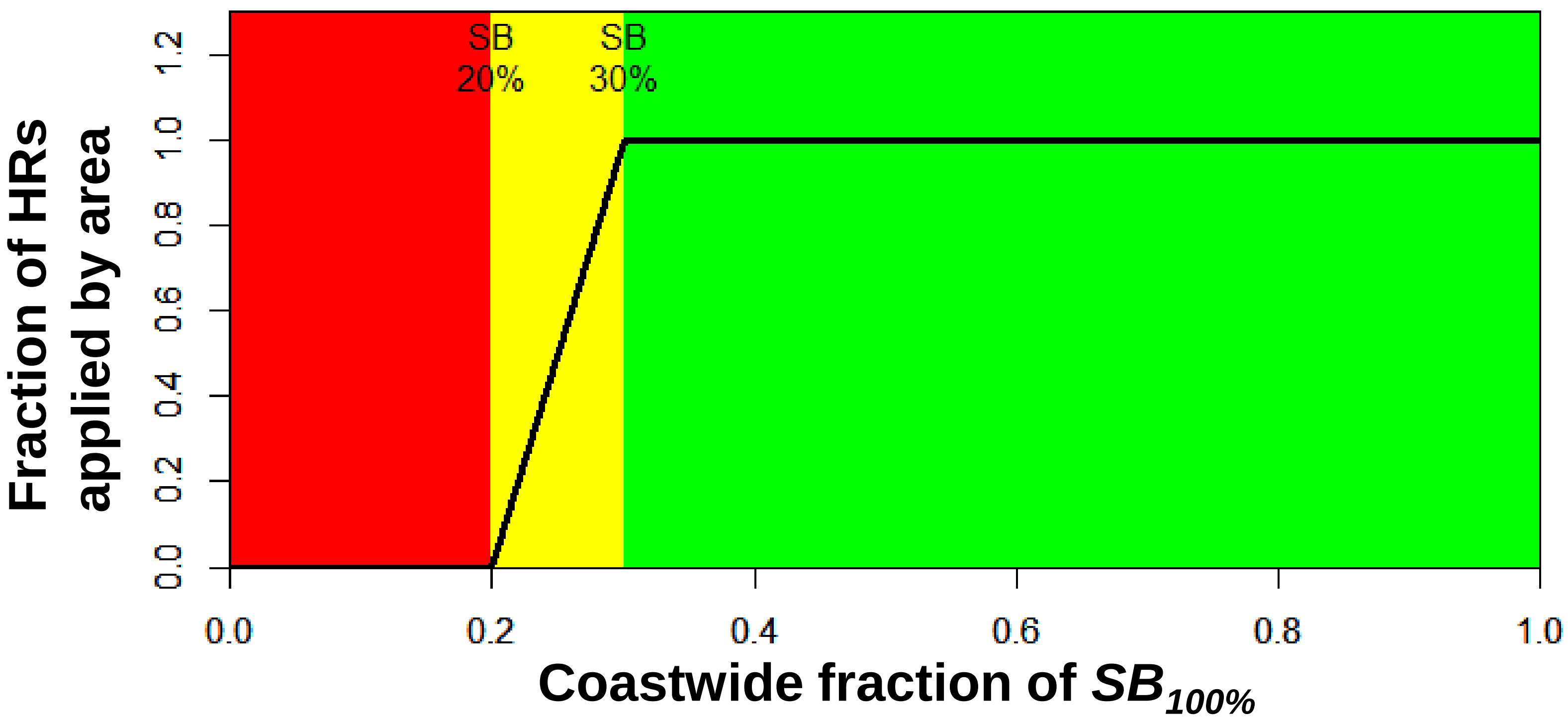
Current harvest policy: Harvest rates

- 16.125% (Areas 3B, 4A, 4B, and 4CDE)
- 21.5% (Areas 2A, 2B, 2C and 3A)
- Developed based on simulations of “core” areas and equilibrium models
  - Clark & Hare (2006), Hare (2011)
- O26 fish (2011)
  - O32 harvest rates were 20% and 15%
- 16.125% harvest rate based on YPR and presence of small fish
- SPR about 32% with these harvest rates

- But, these harvest rates and EBio are explicitly linked
  - One cannot change without the other changing

Current harvest policy: Control rule

- The method for determining the catch limits
  - *The exact definition of "control rule" is up for debate*
- The harvest rates determine catch limits in each regulatory area
  - Harvest rates adjusted at low stock status



Current harvest policy: Reference points

- Unfished spawning biomass
  - Equilibrium stock size without fishing relative to
  - Poor recruitment
    - Mean recruitment at age 6
    - Linked to PDO
  - Good size-at-age

$$SB = \bar{R}\, SBR = \bar{R} \sum N_a \omega_a w_a$$

N_a: numbers-at-age (per recruit)

ω_a: maturity-at-age

w_a: weight-at-age

  - If size-at-age is density-dependent
    - good size-at-age should occur with poor recruitment

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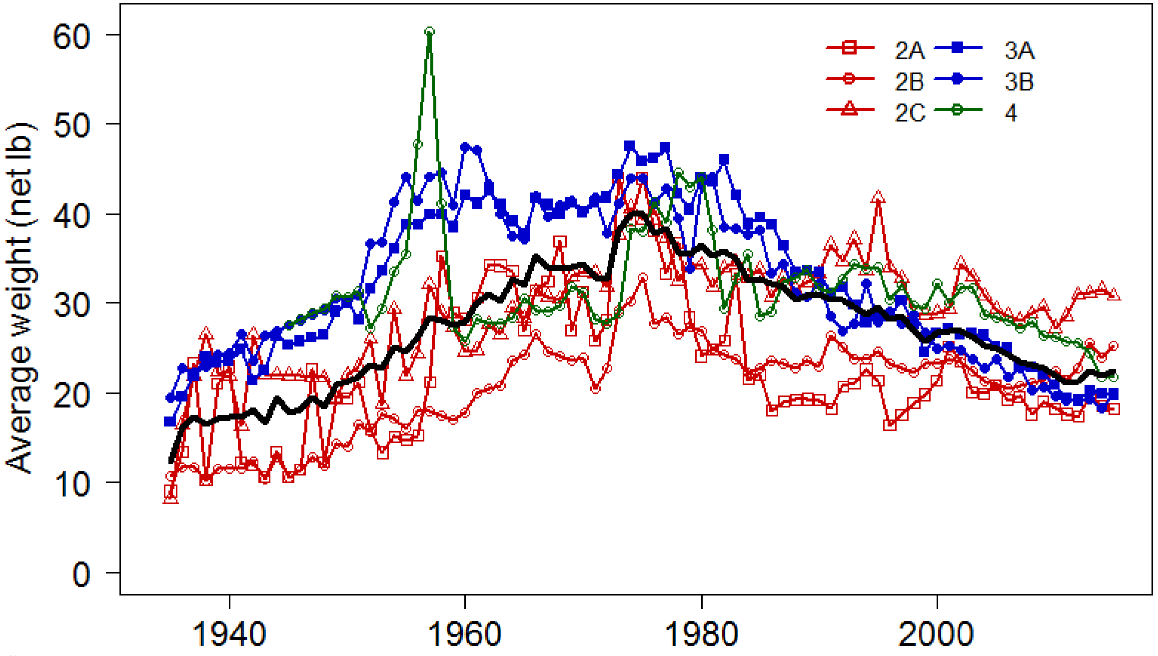
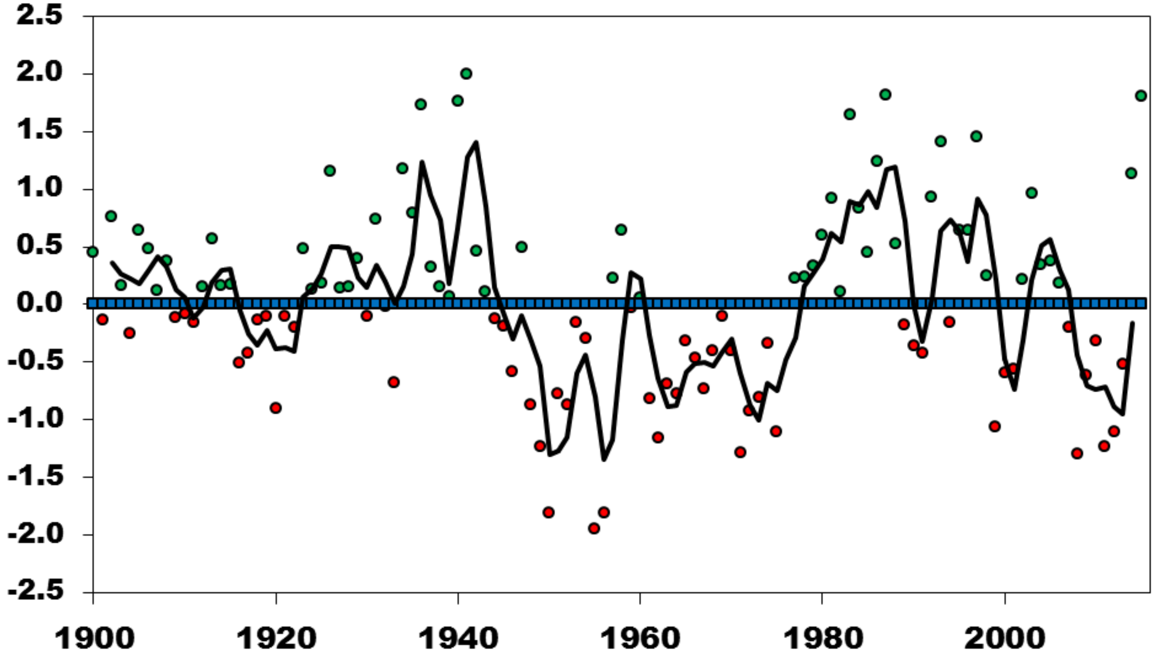




Current harvest policy: Regulatory area catch limits

- CEY (Constant Exploitation Yield)
  - A combination of apportionment and harvest rates
  - TCEY (Total CEY)
    - The amount of yield greater than 26 inches in length
  - FCEY (Fishery CEY)
    - The amount of yield for the directed fisheries (O32)
  - *Note that CEY does not contain all sizes and sources*

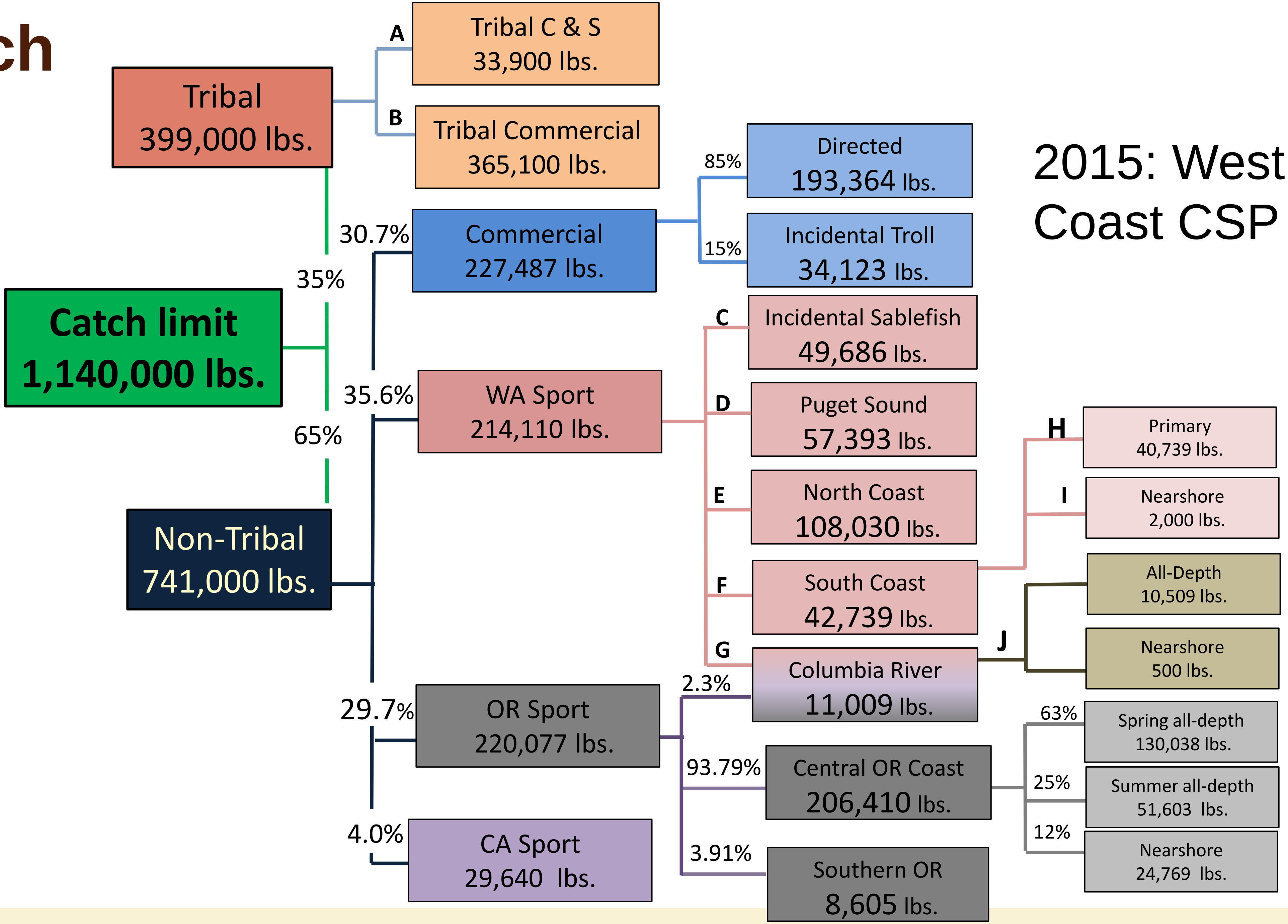
Blue line

- Catch levels consistent with the current harvest policy
- Five objectives
  - Avoid very low stock sizes
  - Mostly avoid low stock sizes
    - <SB30% less than 2/10 years in long term
  - Achieve most of MSY
    - 8/10 years in long term
  - Reduce variability in catch
  - Distribute removals in proportion to current stock
    - Preserved biocomplexity, the portfolio strategy

- No target stock size
- No overfishing limit

Annual Catch Limits

- Commission decides on area-specific catch limits
- Commission also approves the allocation
  - CSP or regulatory action



2015: West Coast CSP

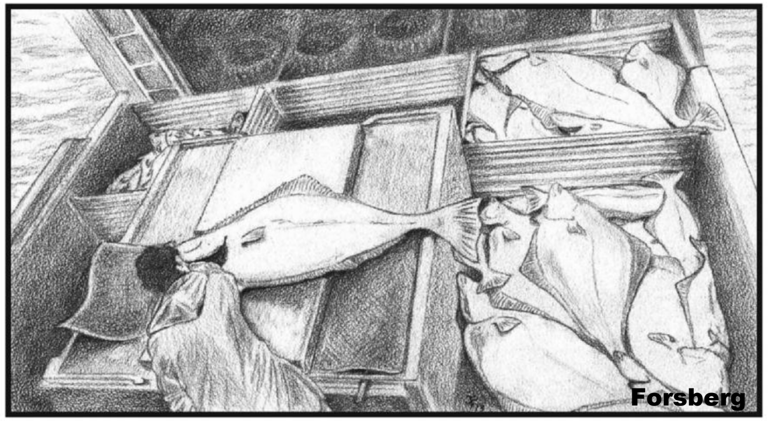
Annual catch limits

Estimated Yield (TCEY)

O26 Non-IPHC regulated removals

- Wastage
- Bycatch in non-halibut fisheries
- Unguided sport fishing (Alaska only)
- Personal use and subsistence

Directed Fisheries (O26 FCEY)

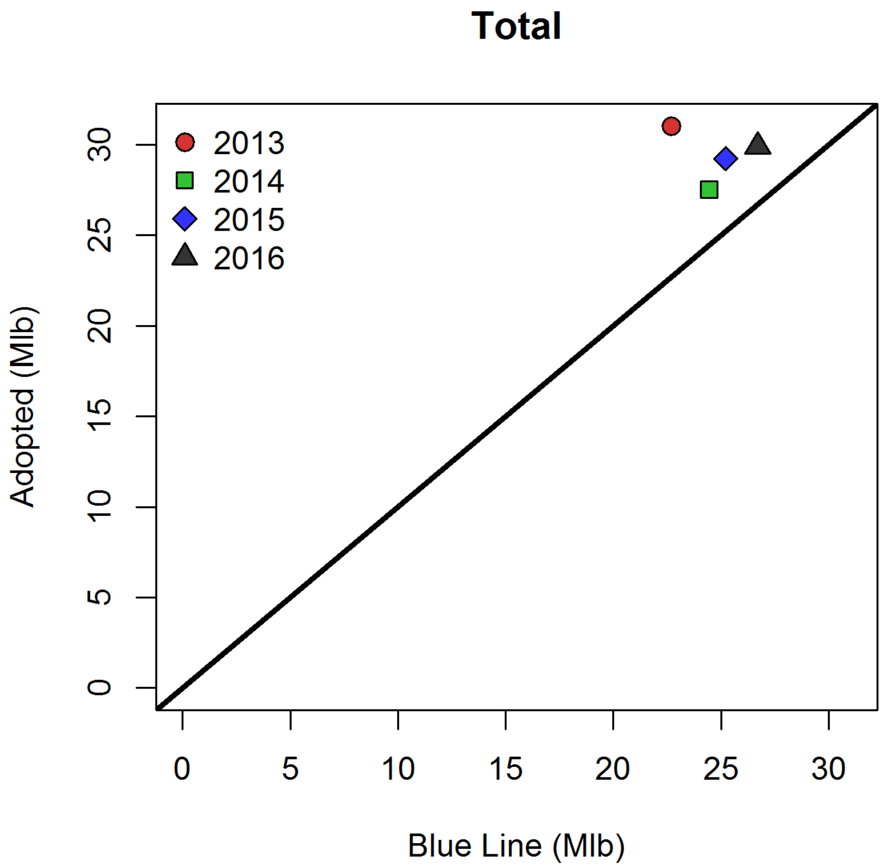


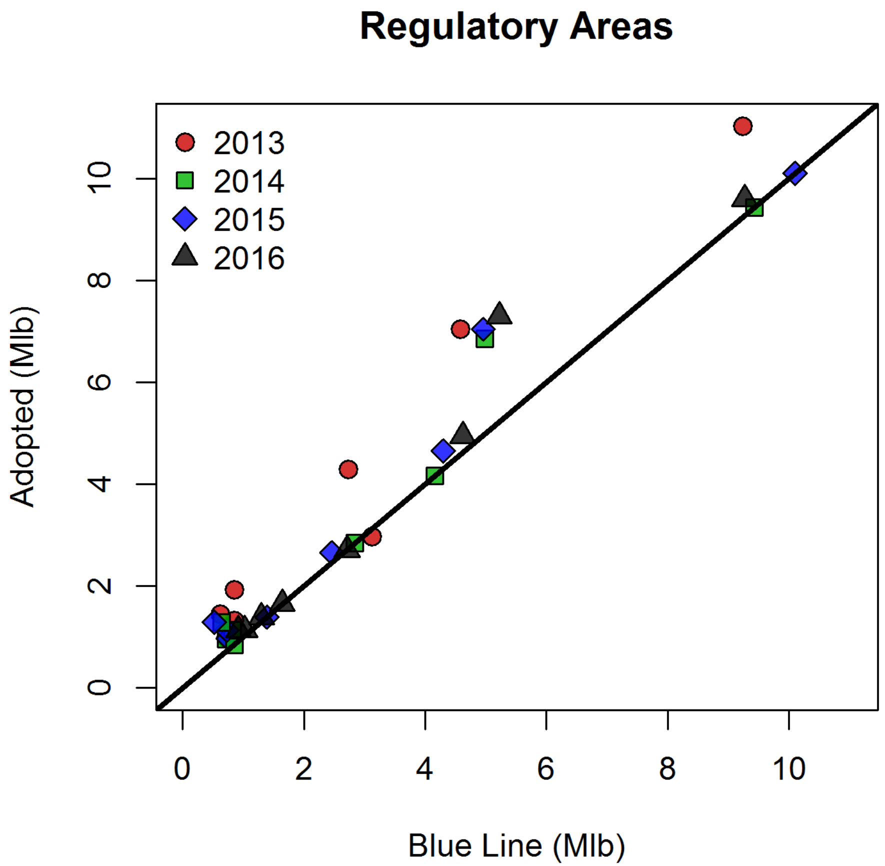
2016 Blue Line Catch Table

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O26 Non-FCEY									
Comm. Wastage	0.02	0.17	NA	NA	0.18	0.06	0.03	0.05	0.52
Bycatch	0.09	0.30	0.01	1.34	0.53	0.46	0.19	2.48	5.42
Sport (+wastage)	NA	NA	1.14	1.48	0.01	0.02	0	0	2.65
Pers./Subs.	NA	0.41	0.43	0.23	0.02	0.01	0	0.08	1.17
Total Non-FCEY	**0.12**	**0.88**	**1.58**	**3.05**	**0.74**	**0.55**	**0.23**	**2.61**	**9.76**
O26 FCEY									
Comm. Wastage	NA	NA	0.11	0.44	NA	NA	NA	NA	0.55
CSP Sport (+wastage)	0.44	0.81	0.85	1.77	NA	NA	NA	NA	3.86
Pers./Subs.	0.03	NA	NA	NA	NA	NA	NA	NA	0.03
Comm. Landings	0.55	4.41	3.67	7.16	2.67	1.30	0.91	1.44	22.11
Total FCEY	**1.02**	**5.22**	**4.63**	**9.37**	**2.67**	**1.30**	**0.91**	**1.44**	**26.56**
TCEY	**1.13**	**6.1**	**6.21**	**12.43**	**3.41**	**1.85**	**1.14**	**4.05**	**36.31**
U26									
Comm. wastage	0	0	0	0.02	0.03	0.01	0	0	0.07
Bycatch	0	0.03	0	0.60	0.20	0.19	0.04	1.25	2.32
Total U26	**0**	**0.04**	**0**	**0.63**	**0.23**	**0.19**	**0.04**	**1.26**	**2.39**
Total Mortality	**1.14**	**6.13**	**6.22**	**13.05**	**3.64**	**2.05**	**1.18**	**5.30**	**38.7**

The realized harvest policy

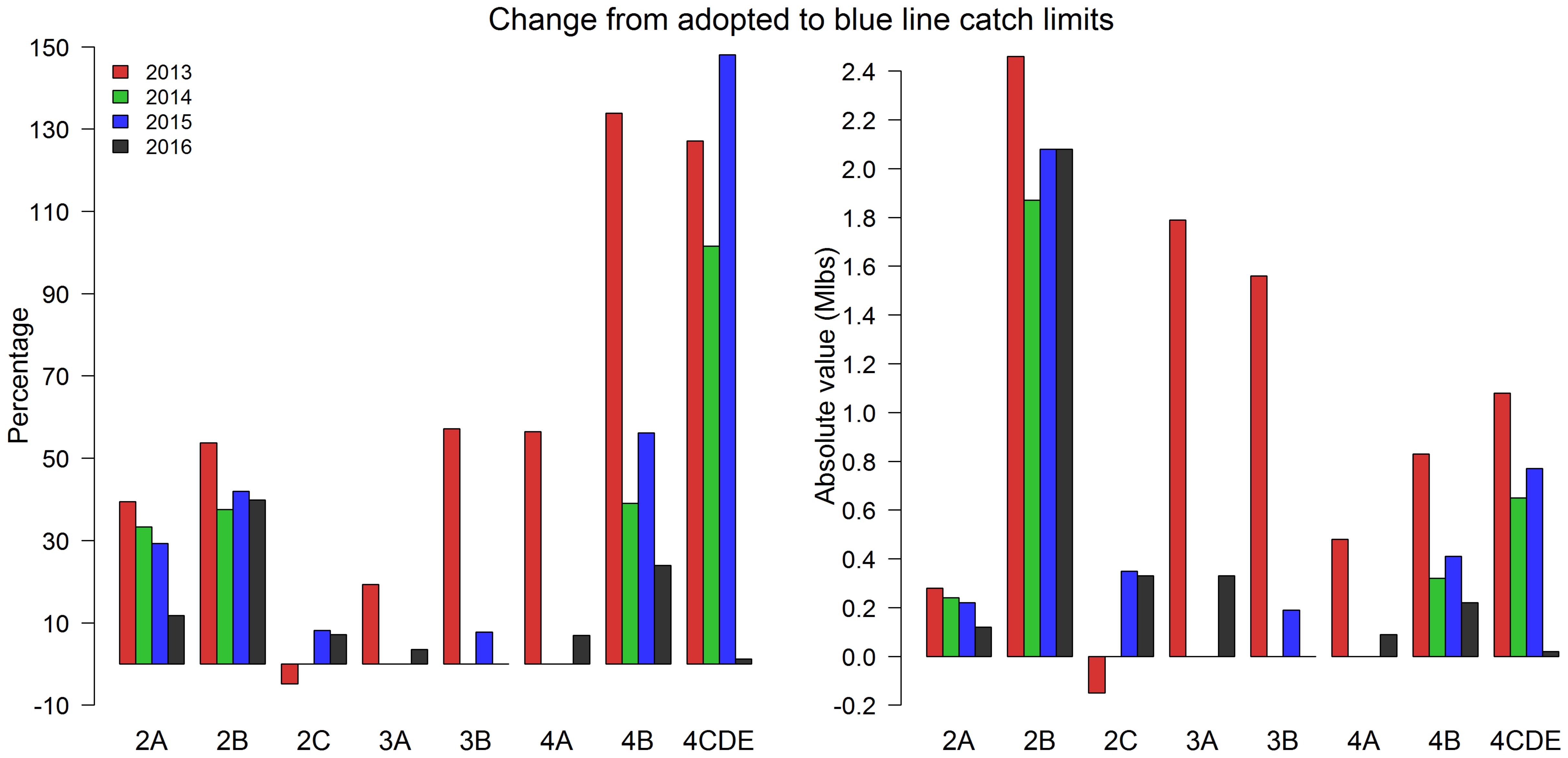
- Recommended catches are presented, along with the blue line
- What has realized management been?





Thanks to Ian for these data

The realized harvest policy (by area)



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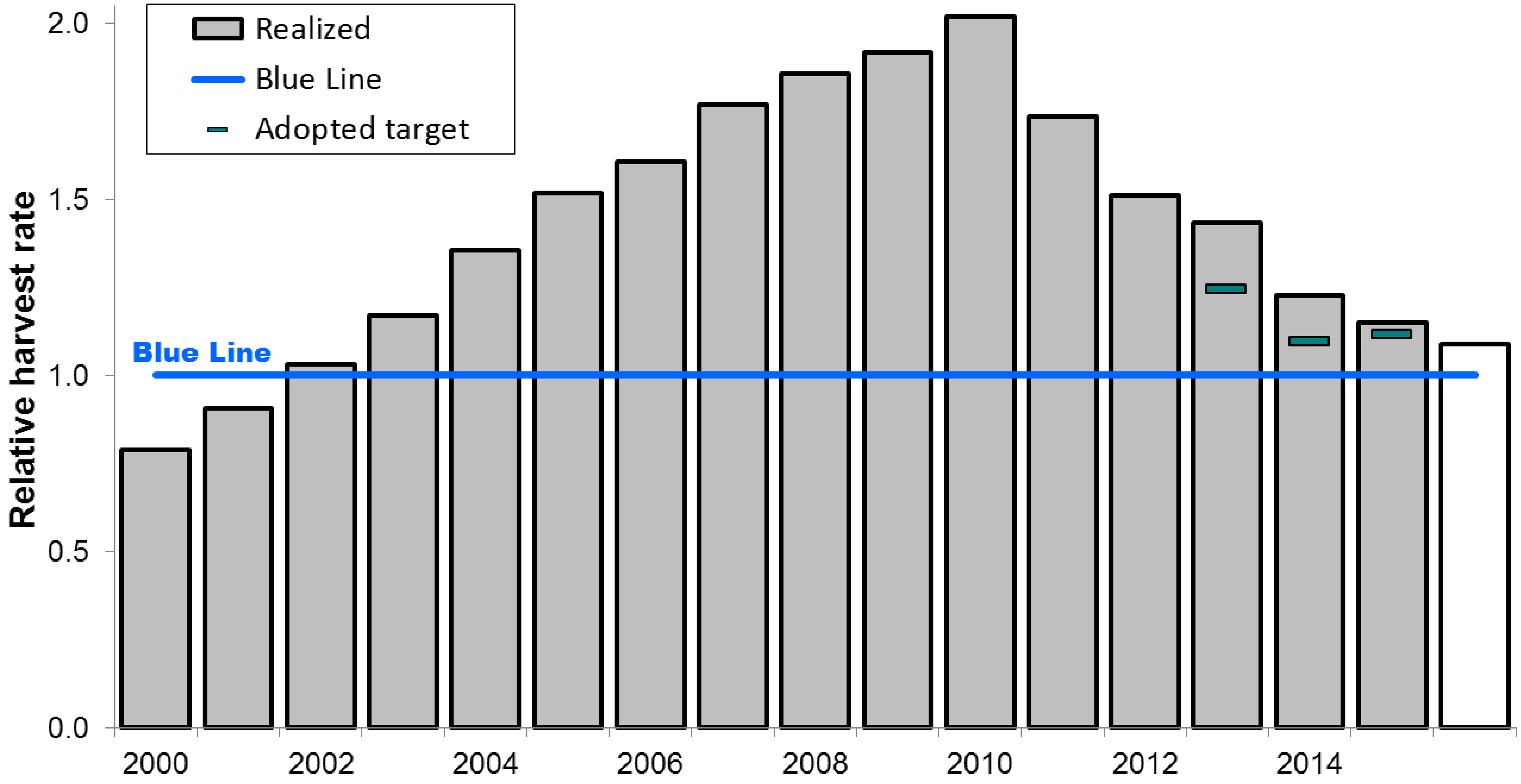
Retrospective look at harvest rates



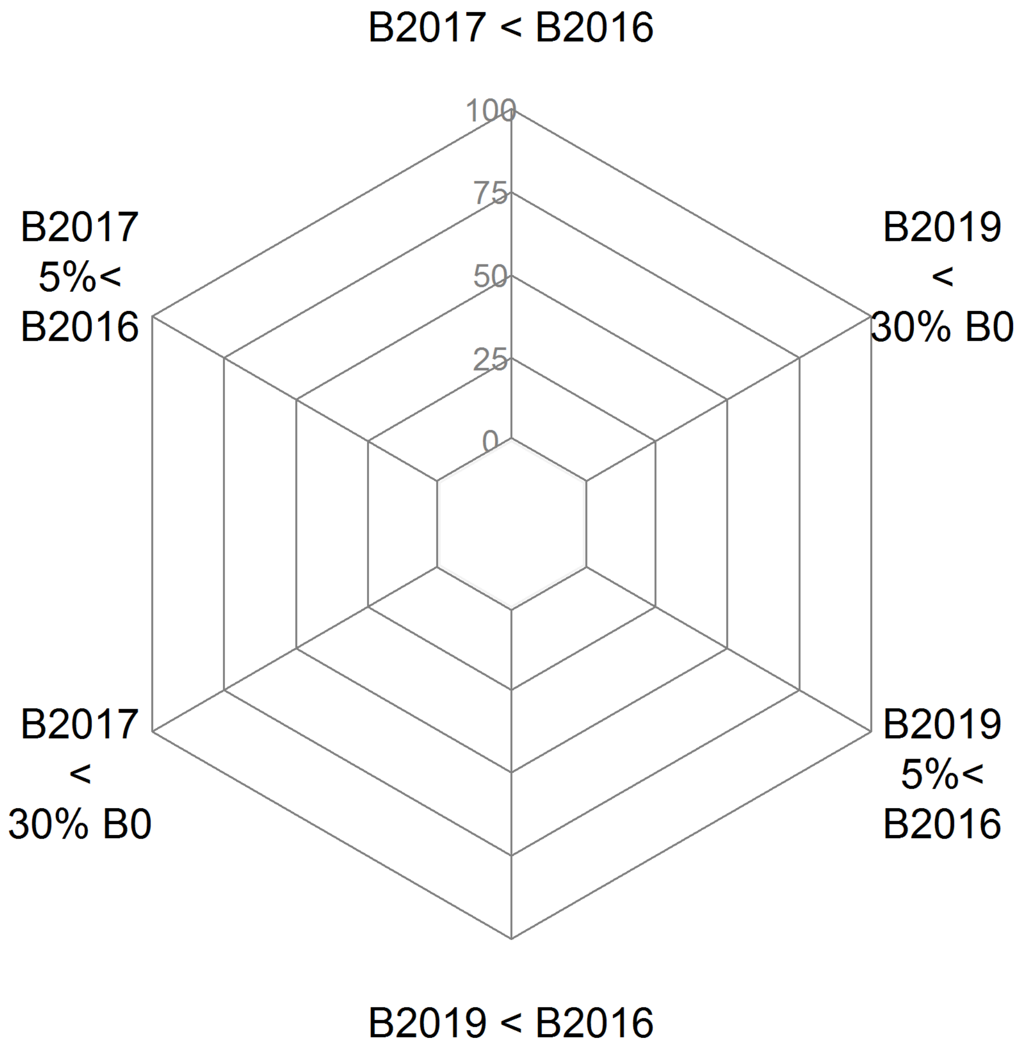
Produced by Ian Stewart after the 2016 annual meeting

Decisions based on risk

				Stock Trend				Stock Status				Fishery Trend				Fishery Status
				Spawning biomass				Spawning biomass				Fishery CEY from the harvest policy				Harvest rate
				in 2017		in 2019		in 2017		in 2019		in 2017		in 2019		in 2016
2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	is less than 2016	is 5% less than 2016	is less than 2016	is 5% less than 2016	is less than 30%	is less than 20%	is less than 30%	is less than 20%	is less than 2016	is 10% less than 2016	is less than 2016	is 10% less than 2016	is above target
No removals	0.0	0.0	$F_{100\%}$	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	0
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
	20.0	8.2	$F_{68\%}$ 49%-75%	<1	<1	3	<1	2	<1	1	<1	<1	<1	<1	<1	<1
	30.0	18.0	$F_{58\%}$ 39%-67%	3	<1	28	9	2	<1	2	<1	4	2	5	2	7
Blue Line	38.7	26.6	$F_{51\%}$ 33%-61%	19	<1	45	32	2	<1	6	<1	44	33	44	35	50
status quo FCEY	41.4	29.2	$F_{49\%}$ 31%-59%	28	<1	48	38	3	<1	7	<1	53	44	50	44	62
2016 Adopted	41.9	29.9	$F_{49\%}$ 31%-59%	29	<1	49	39	3	<1	7	<1	55	46	51	45	64
Maintain 2015 SPR	42.9	30.7	$F_{48\%}$ 30%-58%	32	<1	50	40	3	<1	8	<1	58	49	53	48	68

Plotting decisions based on risk

- A radar plot showing the risk for five performance metrics
  - Stock trend and status



Plotting decisions based on risk

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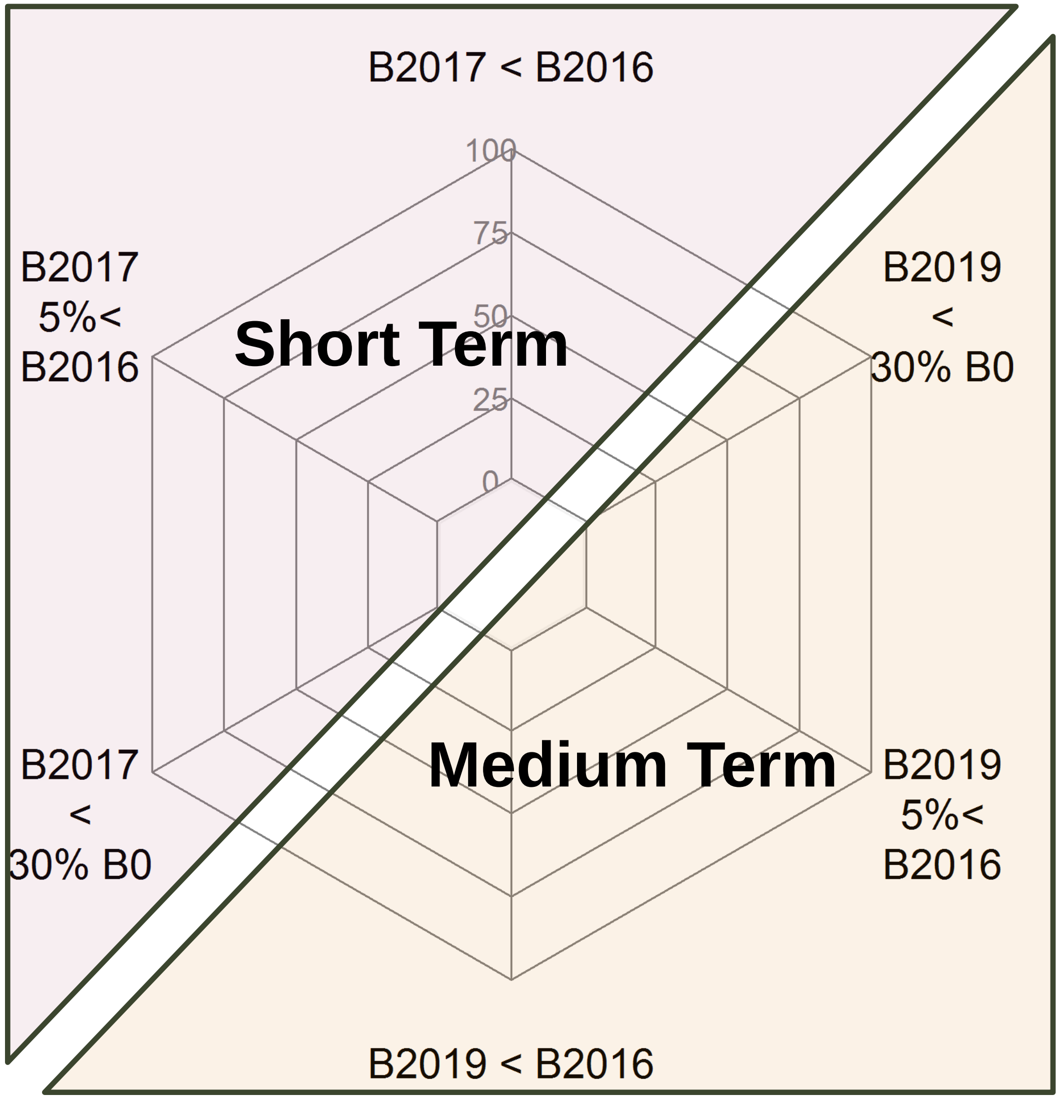
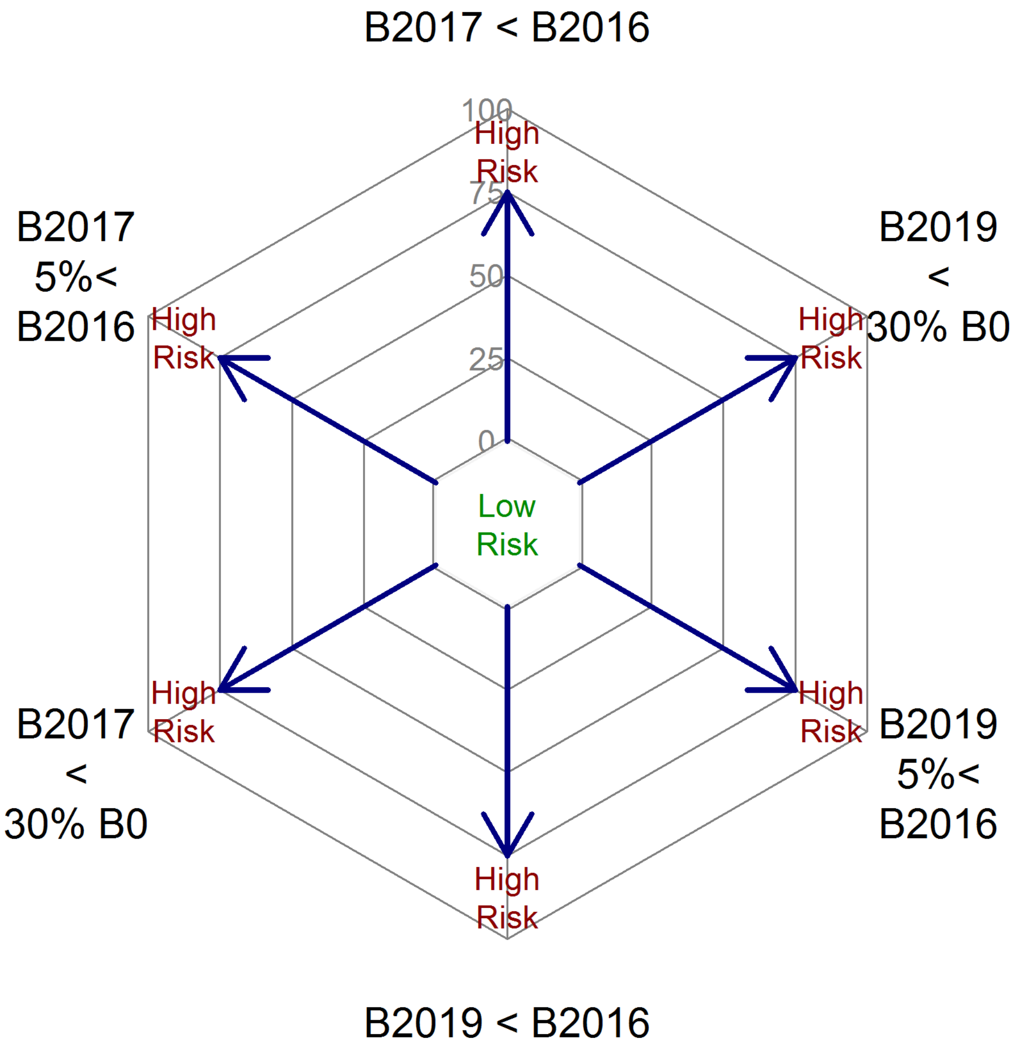


Plotting decisions based on risk

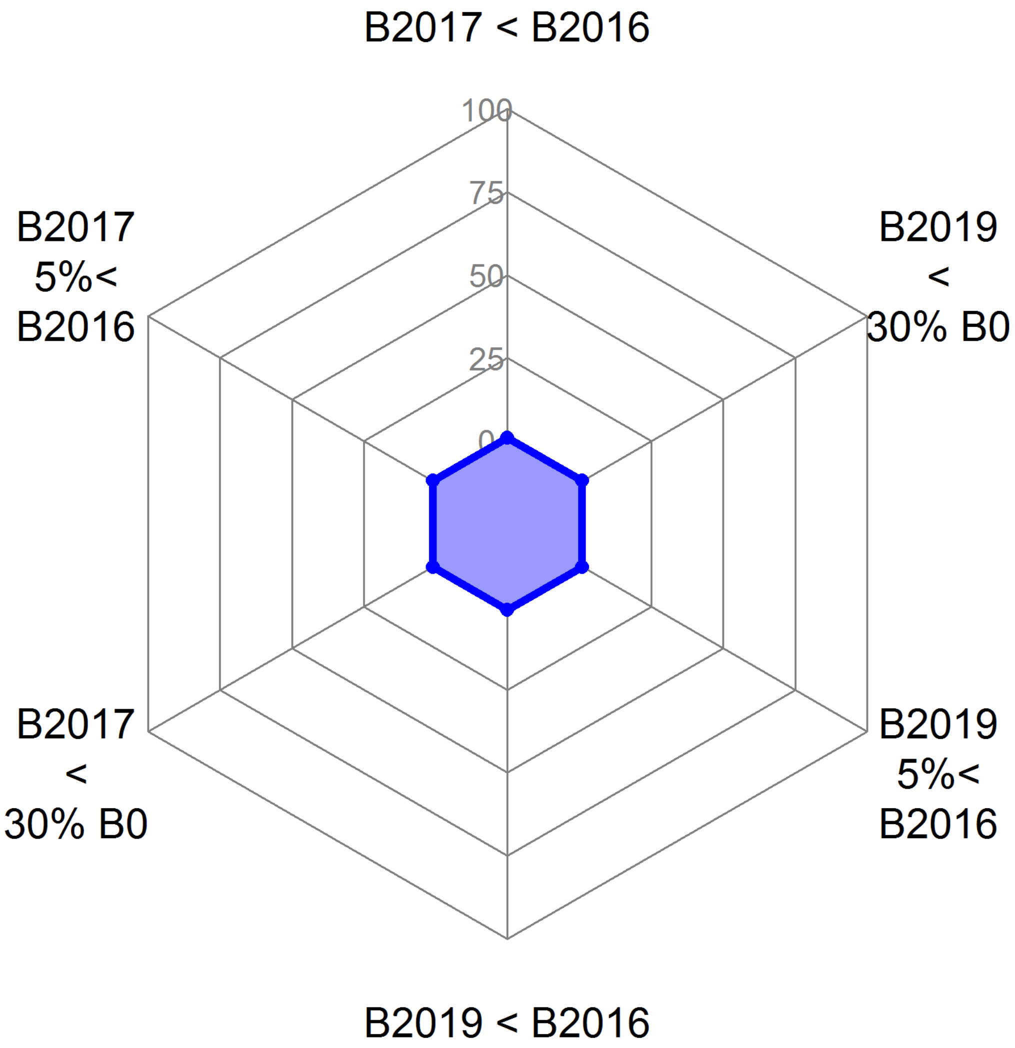
- A radar plot showing the risk for five performance metrics
  - Stock trend and status
- Farther from the center indicates greater risk



Example of plotting decisions based on risk

2016: No removals

2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	Stock Trend: Spawning biomass in 2017 is less than 2016	Stock Trend: Spawning biomass in 2017 is 5% less than 2016	Stock Trend: Spawning biomass in 2019 is less than 2016	Stock Trend: Spawning biomass in 2019 is 5% less than 2016	Stock Status: Spawning biomass in 2017 is less than 30%	Stock Status: Spawning biomass in 2017 is less than 20%	Stock Status: Spawning biomass in 2019 is less than 30%	Stock Status: Spawning biomass in 2019 is less than 20%
No removals	**0.0**	**0.0**	$F_{100\%}$	**<1**	**<1**	**<1**	**<1**	**1**	**<1**	**<1**	**<1**
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%	<1	<1	<1	<1	1	<1	<1	<1
	20.0	8.2	$F_{68\%}$ 49%-75%	<1	<1	3	<1	2	<1	1	<1
	30.0	18.0	$F_{58\%}$ 39%-67%	3	<1	28	9	2	<1	2	<1
Blue Line	38.7	26.6	$F_{51\%}$ 33%-61%	19	<1	45	32	2	<1	6	<1
status quo FCEY	41.4	29.2	$F_{49\%}$ 31%-59%	28	<1	48	38	3	<1	7	<1
2016 Adopted	41.9	29.9	$F_{49\%}$ 31%-59%	29	<1	49	39	3	<1	7	<1



Example of plotting decisions based on risk

2016: FCEY = 0

2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	Stock Trend: Spawning biomass in 2017 is less than 2016	Stock Trend: Spawning biomass in 2017 is 5% less than 2016	Stock Trend: Spawning biomass in 2019 is less than 2016	Stock Trend: Spawning biomass in 2019 is 5% less than 2016	Stock Status: Spawning biomass in 2017 is less than 30%	Stock Status: Spawning biomass in 2017 is less than 20%	Stock Status: Spawning biomass in 2019 is less than 30%	Stock Status: Spawning biomass in 2019 is less than 20%
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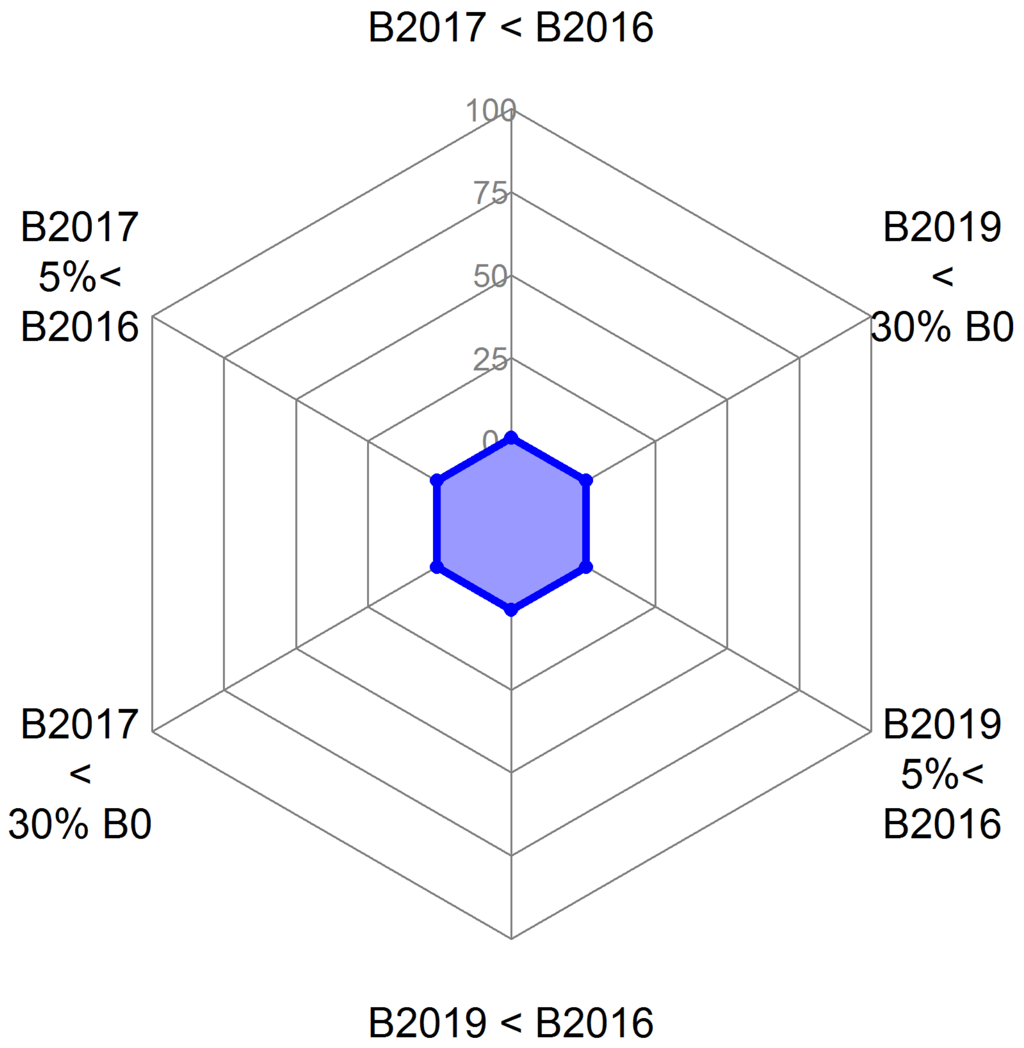

Example of plotting decisions based on risk

2016: Blue Line

2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	Stock Trend: Spawning biomass in 2017 is less than 2016	Stock Trend: Spawning biomass in 2017 is 5% less than 2016	Stock Trend: Spawning biomass in 2019 is less than 2016	Stock Trend: Spawning biomass in 2019 is 5% less than 2016	Stock Status: Spawning biomass in 2017 is less than 30%	Stock Status: Spawning biomass in 2017 is less than 20%	Stock Status: Spawning biomass in 2019 is less than 30%	Stock Status: Spawning biomass in 2019 is less than 20%
No removals	0.0	0.0	$F_{100\%}$	<1	<1	<1	<1	1	<1	<1	<1
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%	<1	<1	<1	<1	1	<1	<1	<1
	20.0	8.2	$F_{68\%}$ 49%-75%	<1	<1	3	<1	2	<1	1	<1
	30.0	18.0	$F_{58\%}$ 39%-67%	3	<1	28	9	2	<1	2	<1
Blue Line	38.7	26.6	$F_{51\%}$ 33%-61%	19	<1	45	32	2	<1	6	<1
status quo FCEY	41.4	29.2	$F_{49\%}$ 31%-59%	28	<1	48	38	3	<1	7	<1
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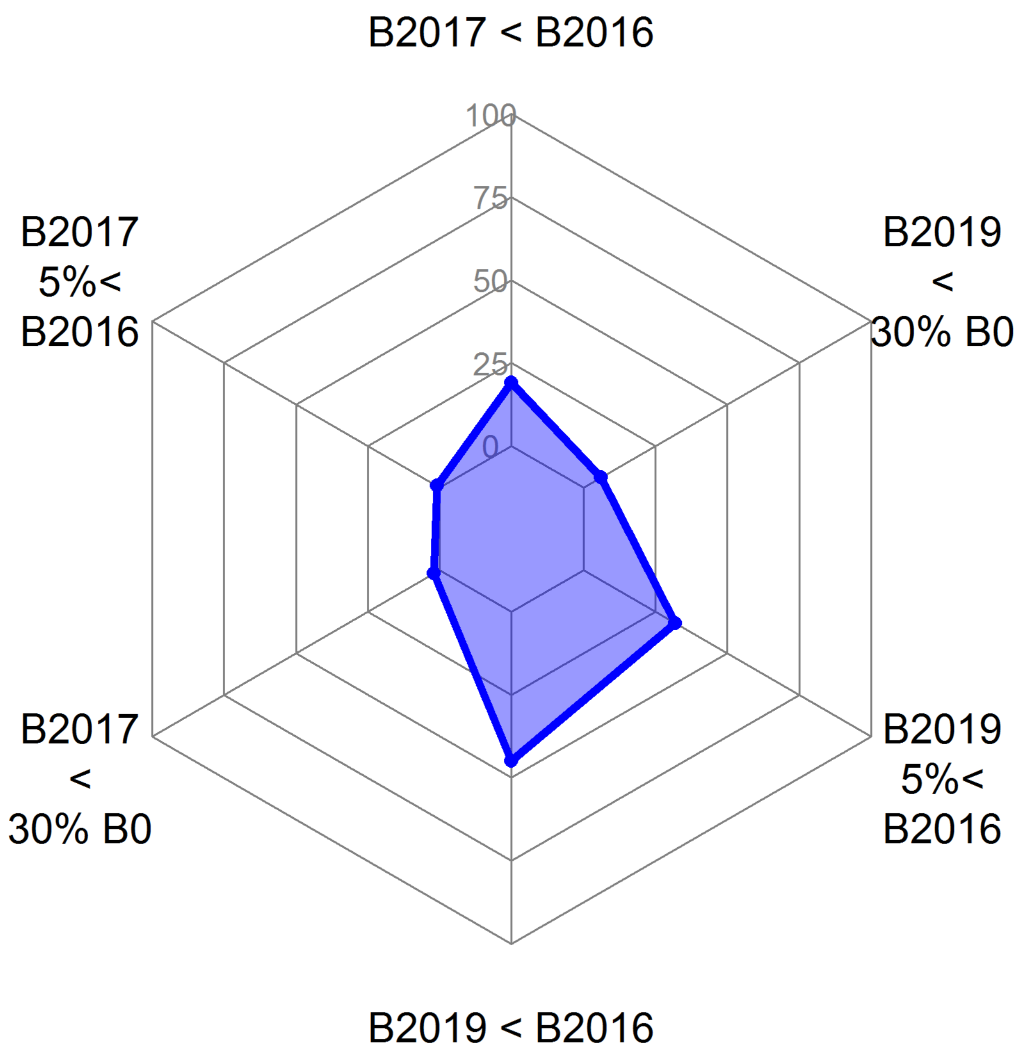

Example of plotting decisions based on risk

2016: Decision

				Stock Trend				Stock Status			
				Spawning biomass				Spawning biomass			
				in 2017		in 2019		in 2017		in 2019	
2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	is less than 2016	is 5% less than 2016	is less than 2016	is 5% less than 2016	is less than 30%	is less than 20%	is less than 30%	is less than 20%
No removals	0.0	0.0	$F_{100\%}$	<1	<1	<1	<1	1	<1	<1	<1
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%	<1	<1	<1	<1	1	<1	<1	<1
	20.0	8.2	$F_{68\%}$ 49%-75%	<1	<1	3	<1	2	<1	1	<1
	30.0	18.0	$F_{58\%}$ 39%-67%	3	<1	28	9	2	<1	2	<1
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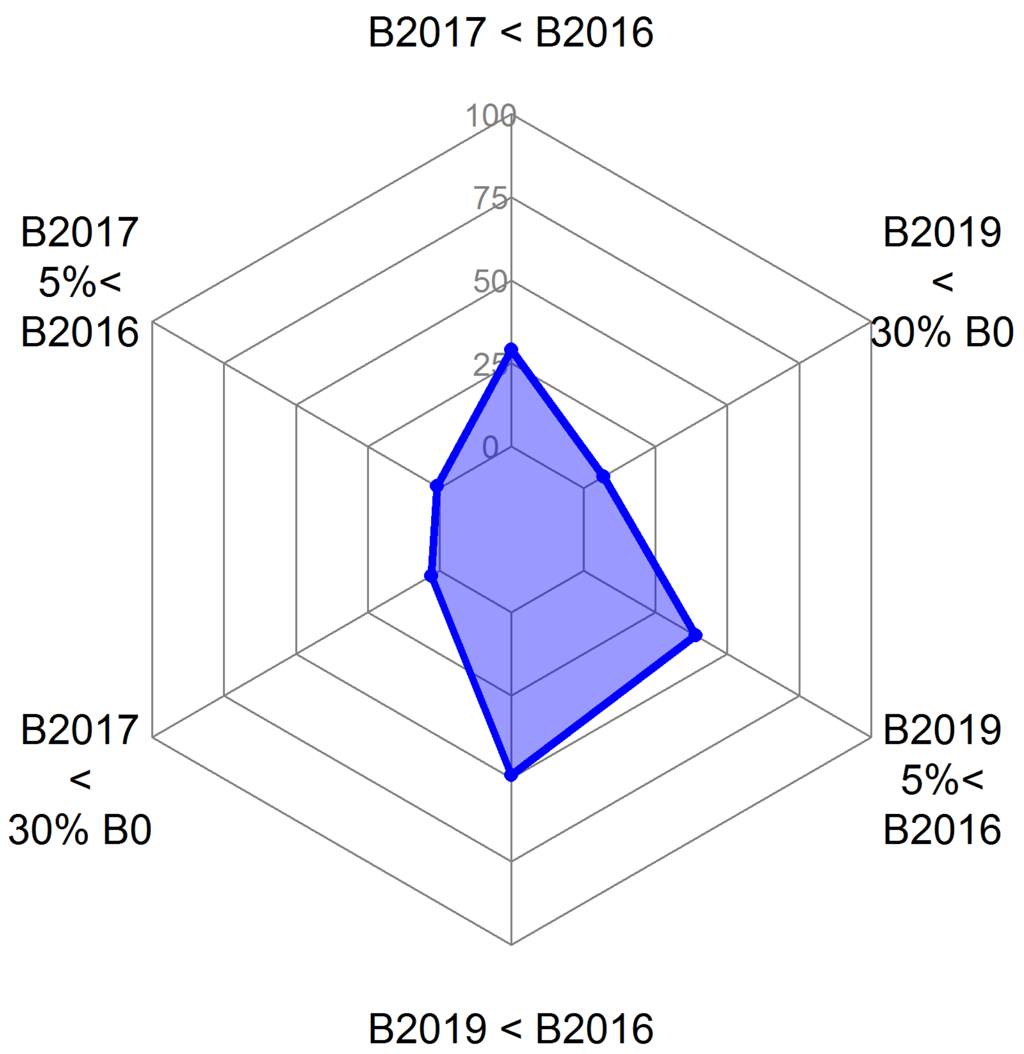
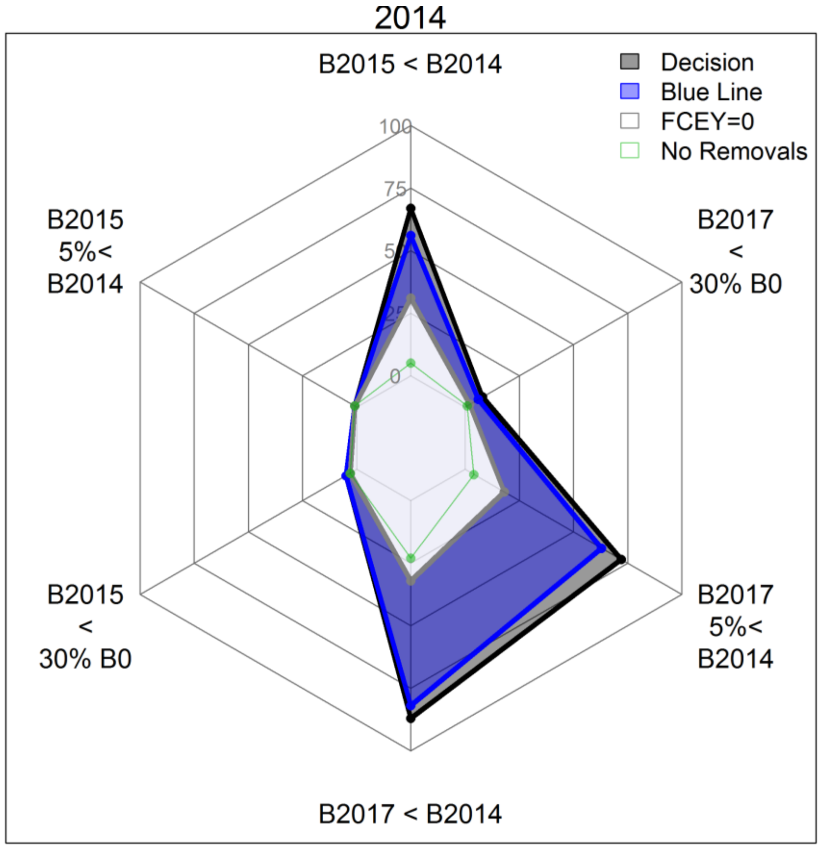
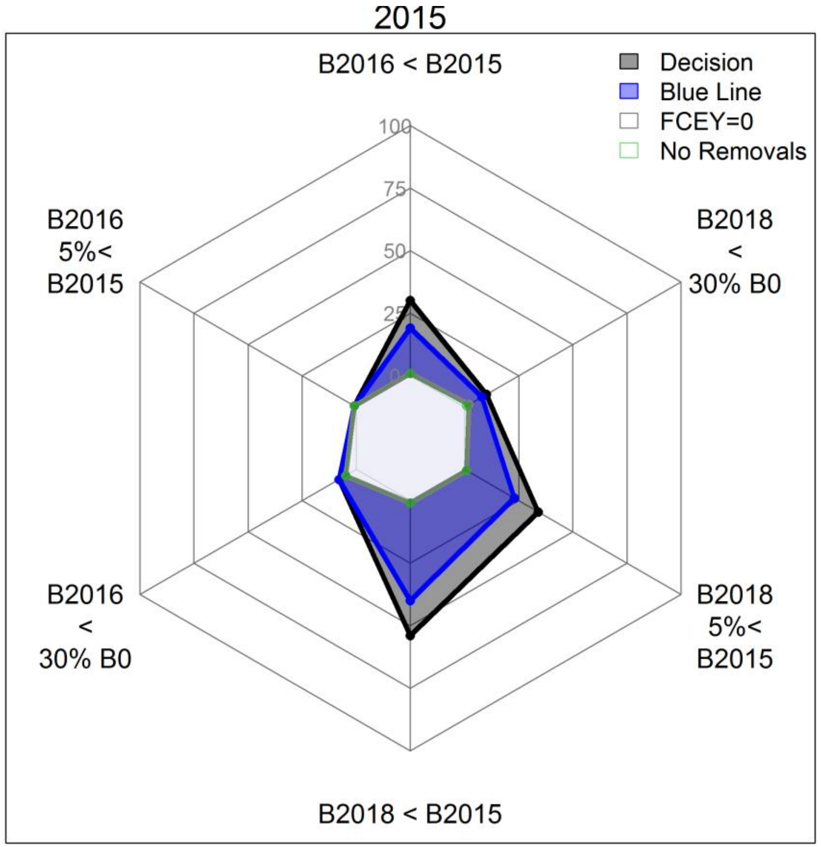
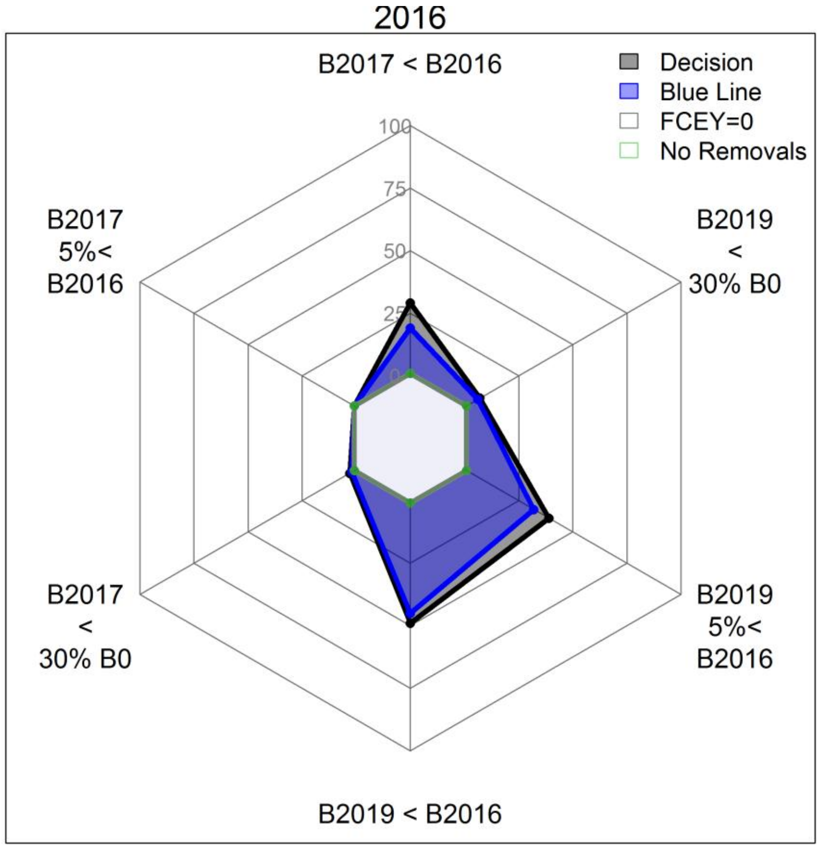


The realized harvest policy (risk)







Realized harvest policy: Conclusions

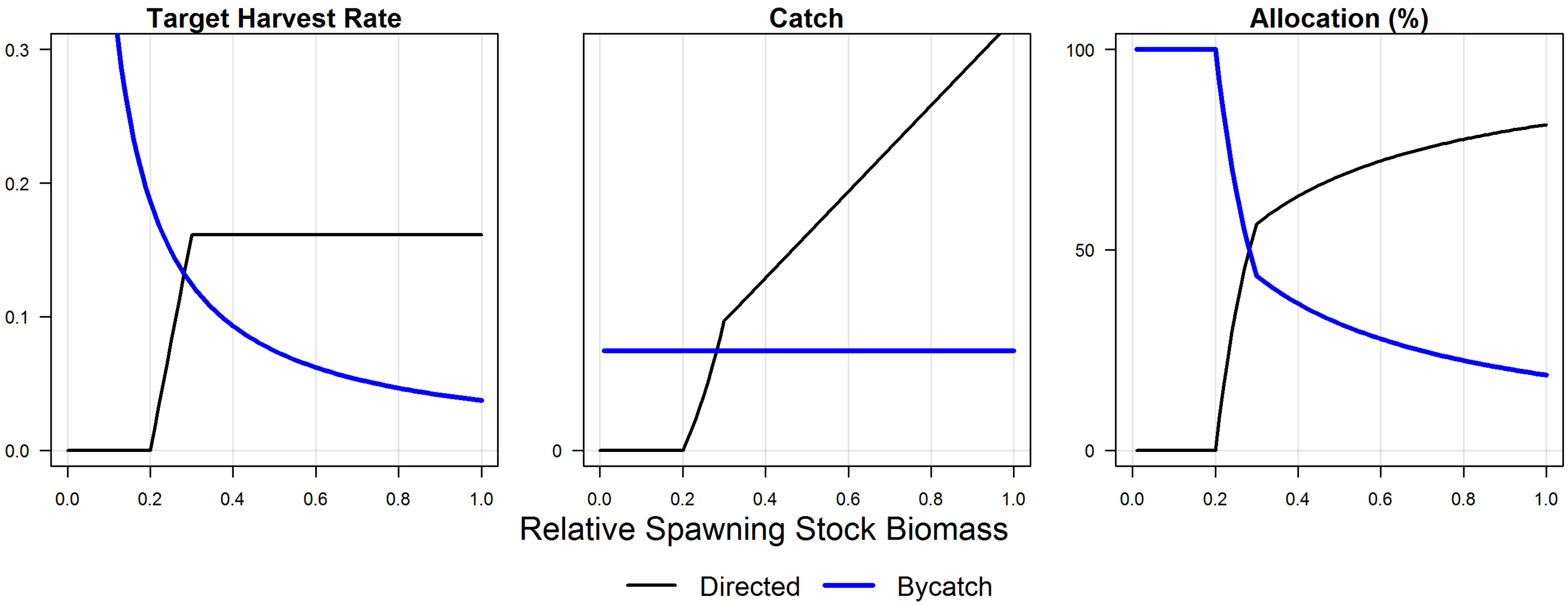
Based on the last 3 years

- Adopted catches are typically slightly higher than blue line
  - Area specific differences
- In terms of risk
  - Decisions have been slightly riskier than blue line
  - Accept greater risk in medium-term (+3 years)
  - Similar across the 3 years

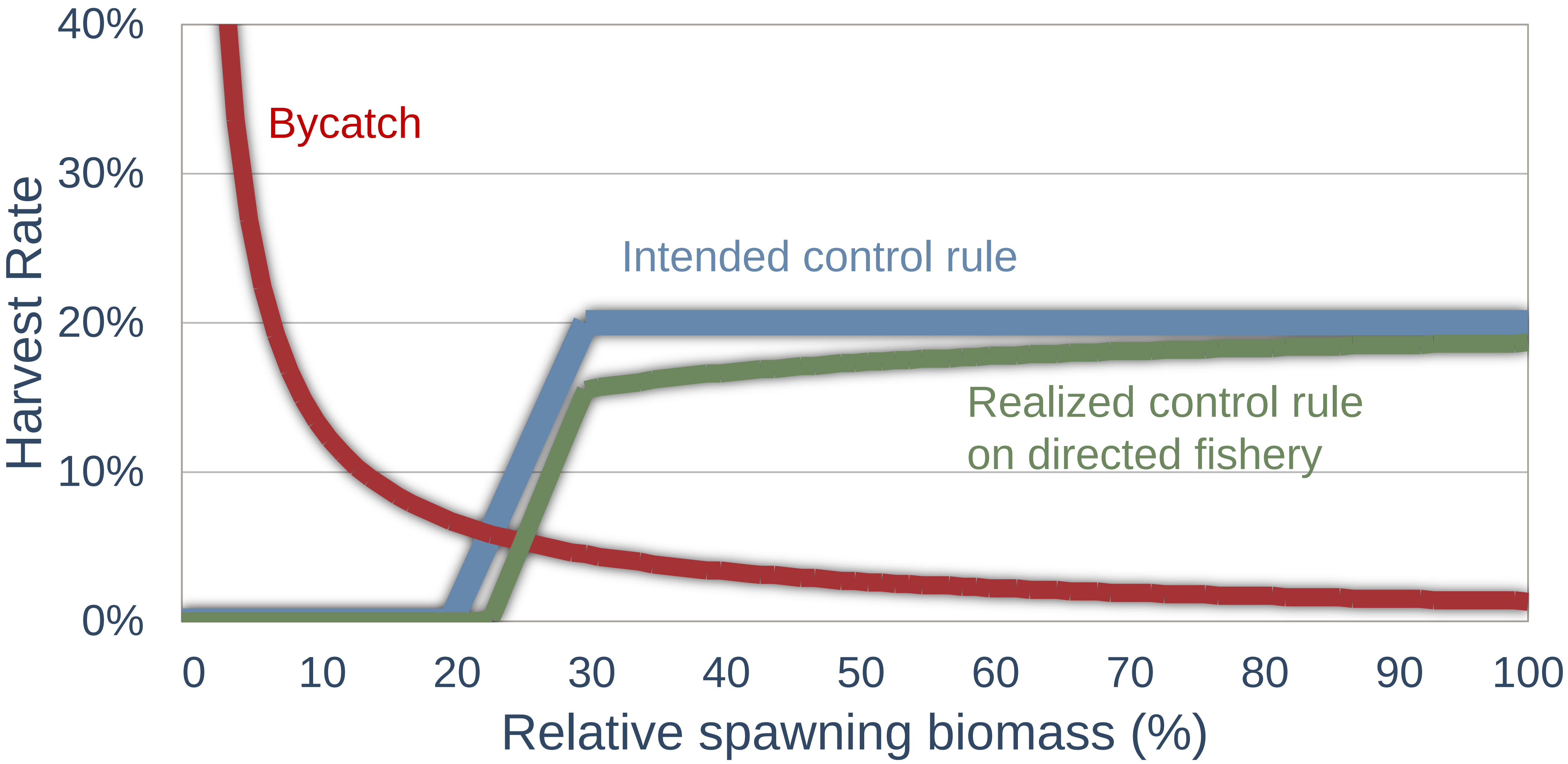
Some criticisms of the current harvest policy

- Apportion to areas from a coastwide assessment, which is then summed back to coastwide catch
- Total mortality is not accounted for
  - U26 mortality can vary with no change to the harvest policy
- Exploitable biomass is confusing and may be out of date
- Season opening and closing may result in interception of fish not accounted for by apportionment (seasonal movement)
- Non-regulated catch is prioritized
  - Subtracted from TCEY to get FCEY
  - Conservation concern has been put on directed fishery

Harvest rates, catch, and allocation

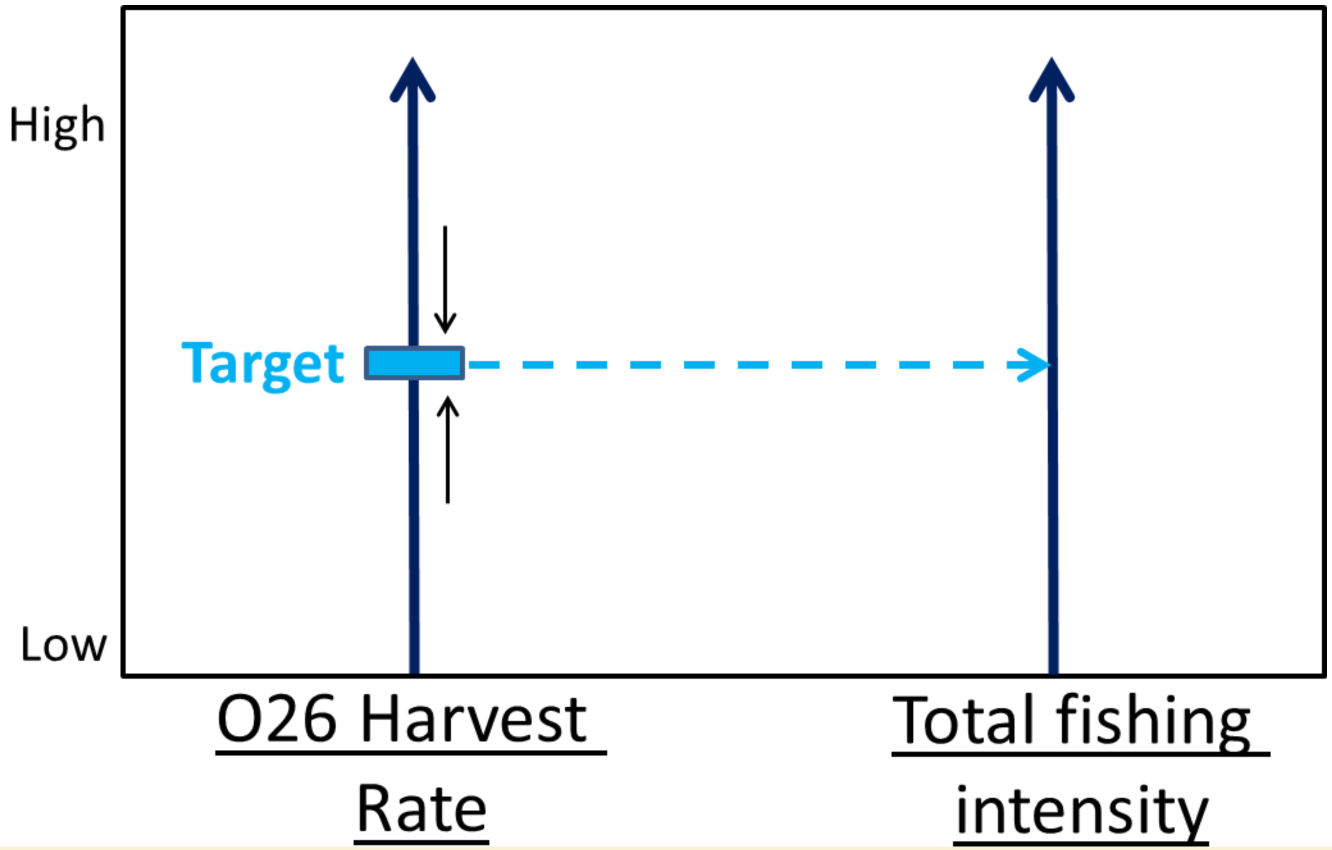


Realized control rule



Total catch accounting

- O26 mortality is accounted for in the FCEY
  - TCEY remains unchanged regardless of bycatch amount
  - U26 mortality is accounted for in subsequent years, when its effect on productivity is realized



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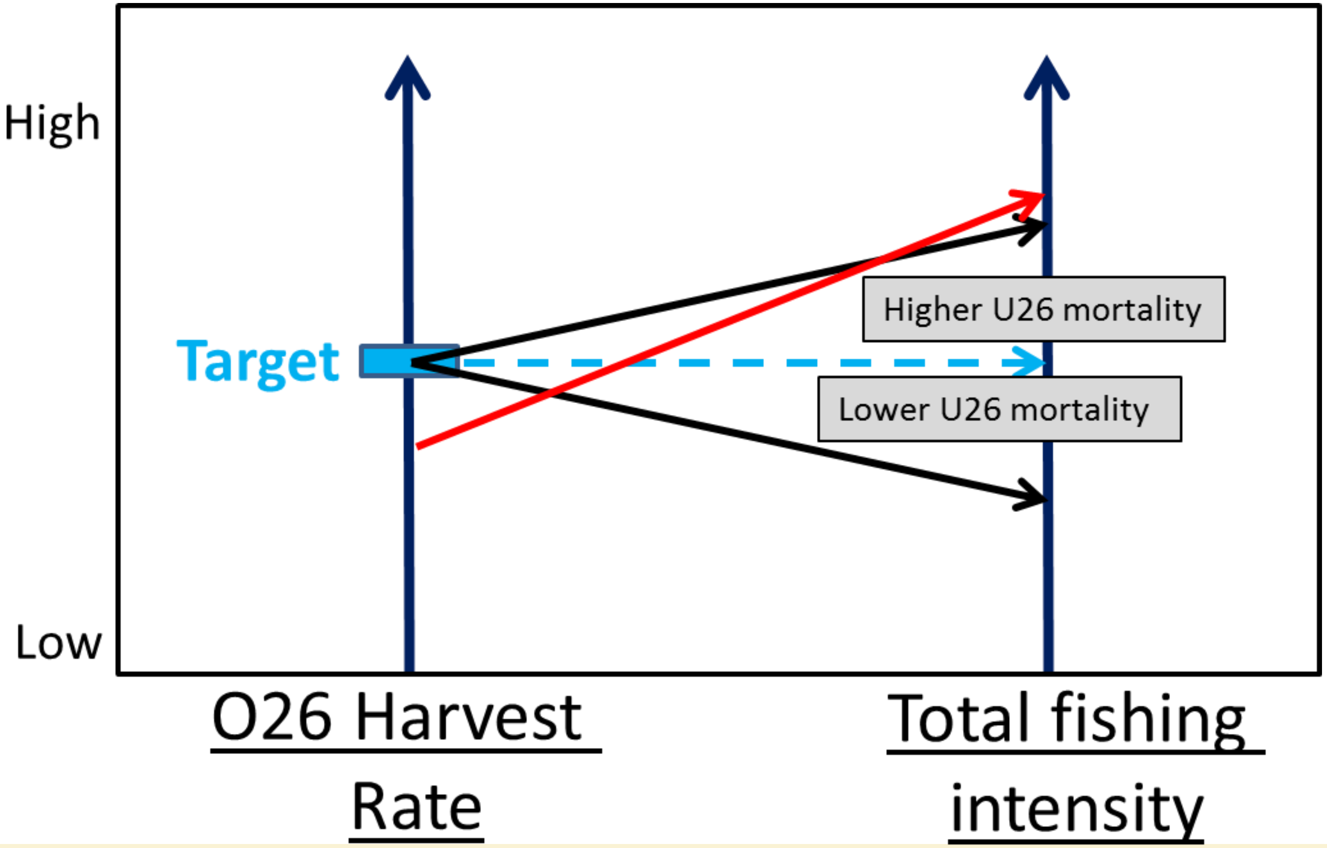
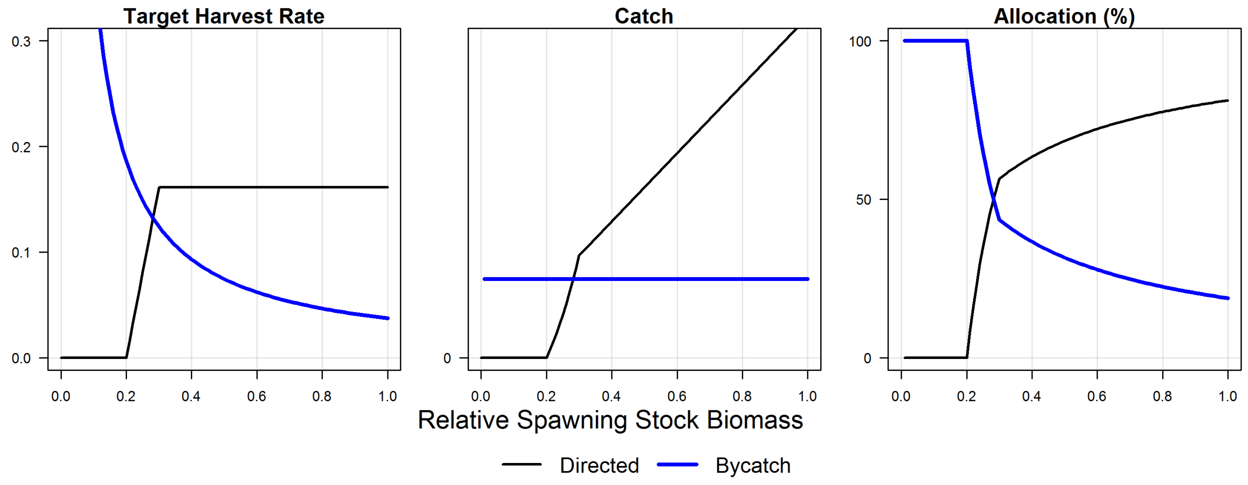


2016 Blue Line Catch Table

	2A	2B	2C	3A	3B	4A	4B	4CDE	Total
O26 Non-FCEY									
Comm. Wastage	0.02	0.17	NA	NA	0.18	0.06	0.03	0.05	0.52
Bycatch	0.09	0.30	0.01	1.34	0.53	0.46	0.19	2.48	5.42
Sport (+wastage)	NA	NA	1.14	1.48	0.01	0.02	0	0	2.65
Pers./Subs.	NA	0.41	0.43	0.23	0.02	0.01	0	0.08	1.17
Total Non-FCEY	**0.12**	**0.88**	**1.58**	**3.05**	**0.74**	**0.55**	**0.23**	**2.61**	**9.76**
O26 FCEY									
Comm. Wastage	NA	NA	0.11	0.44	NA	NA	NA	NA	0.55
CSP Sport (+wastage)	0.44	0.81	0.85	1.77	NA	NA	NA	NA	3.86
Pers./Subs.	0.03	NA	NA	NA	NA	NA	NA	NA	0.03
Comm. Landings	0.55	4.41	3.67	7.16	2.67	1.30	0.91	1.44	22.11
Total FCEY	**1.02**	**5.22**	**4.63**	**9.37**	**2.67**	**1.30**	**0.91**	**1.44**	**26.56**
TCEY	**1.13**	**6.1**	**6.21**	**12.43**	**3.41**	**1.85**	**1.14**	**4.05**	**36.31**
U26									
Comm. wastage	0	0	0	0.02	0.03	0.01	0	0	0.07
Bycatch	0	0.03	0	0.60	0.20	0.19	0.04	1.25	2.32
Total U26	**0**	**0.04**	**0**	**0.63**	**0.23**	**0.19**	**0.04**	**1.26**	**2.39**
Total Mortality	**1.14**	**6.13**	**6.22**	**13.05**	**3.64**	**2.05**	**1.18**	**5.30**	**38.7**

An example of a concern for multiple fisheries

- Prohibited Species Catch (PSC) of Pacific halibut in BS/AI
  - A constraint in Alaska groundfish fisheries
  - Affects directed fishery (likely in all Areas)
- As halibut declines
  - PSC is a larger proportion of the total removals
- As halibut increases
  - PSC constrains non-directed fisheries
- Mortality of young fish in the BS/AI may have downstream affects and reduce opportunities in all Regulatory Areas



Abundance-based PSC limits in the Bering Sea/Aleutian Islands

- A working group formed by the NPFMC
  - Identify or develop an index that can scale PSC limit in BSAI
  - Develop a control rule that defines how it is scaled
  - Identify alternatives to test and present to Council in October 2016

- We realized that it is a bigger issue than the Council may have anticipated
  - IPHC halibut management and NPFMC PSC management in the BSAI FMP operate at different spatial scales because of the distribution and movement of halibut
  - A coastwide issue for IPHC given movement of Pacific halibut
  - A multi-agency, international issue between NPFMC and IPHC

Linking tasks to objectives

Council Objectives →

Tasks ↓	Index to abundance	Protect SSB at low levels	Flexibility in groundfish operations	Directed halibut fishery opportunity	Stability of PSC limits
Abundance index (Section 5)	✓				
Control rule (Section 6)	✓	✓	✓	✓	✓
Mgt issues (Section 7)			✓		

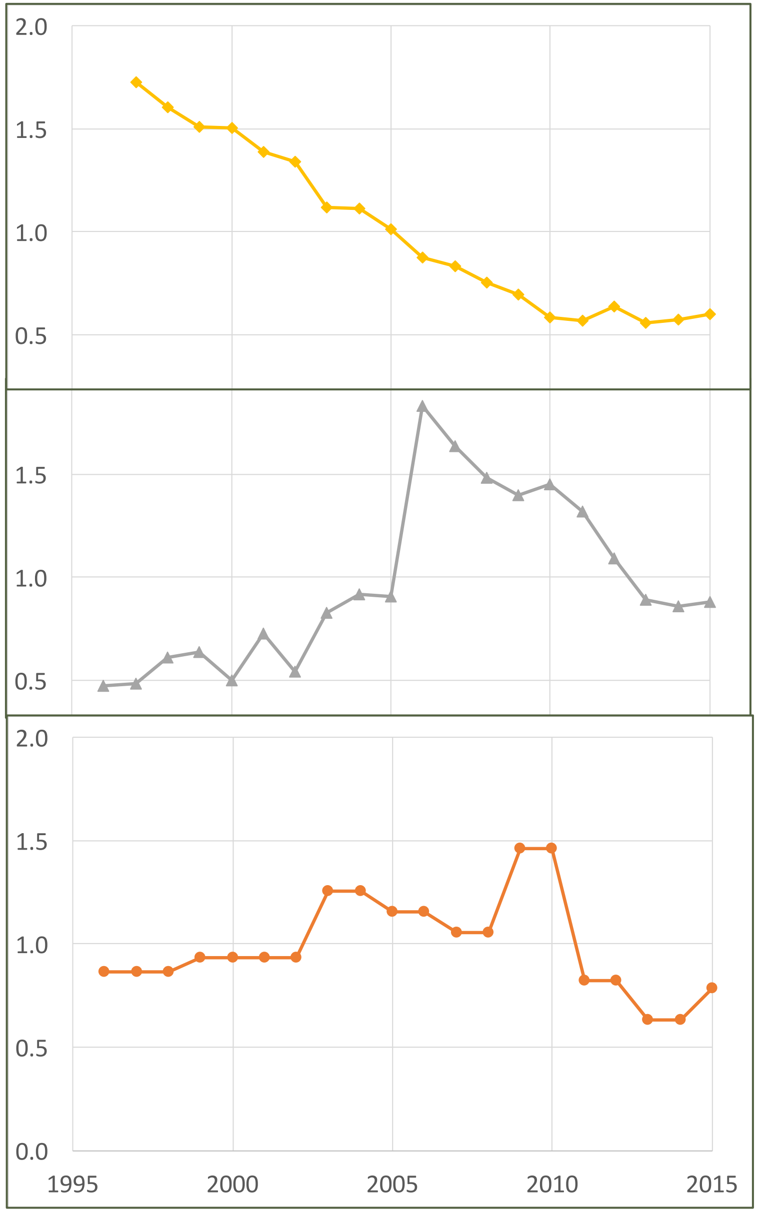
Index of abundance

Objectives for candidate abundance-based index

1. Addresses older and younger population components
2. Considers the coastwide geographic range
3. Considers the coastwide stock status
4. Addresses recruitment differences in the BSAI and GOA
5. Components are available in a timely manner for Council harvest specifications
6. Information to derive the index is easily accessible

Components of the recommended index

- IPHC setline survey
  - O32, biomass
  - Coastwide, older fish
- EBS bottom trawl survey
  - Numbers, younger fish
  - Local abundance
  - Incoming recruitment
- GOA bottom trawl survey
  - Numbers, younger fish
  - Incoming recruitment



ABM index

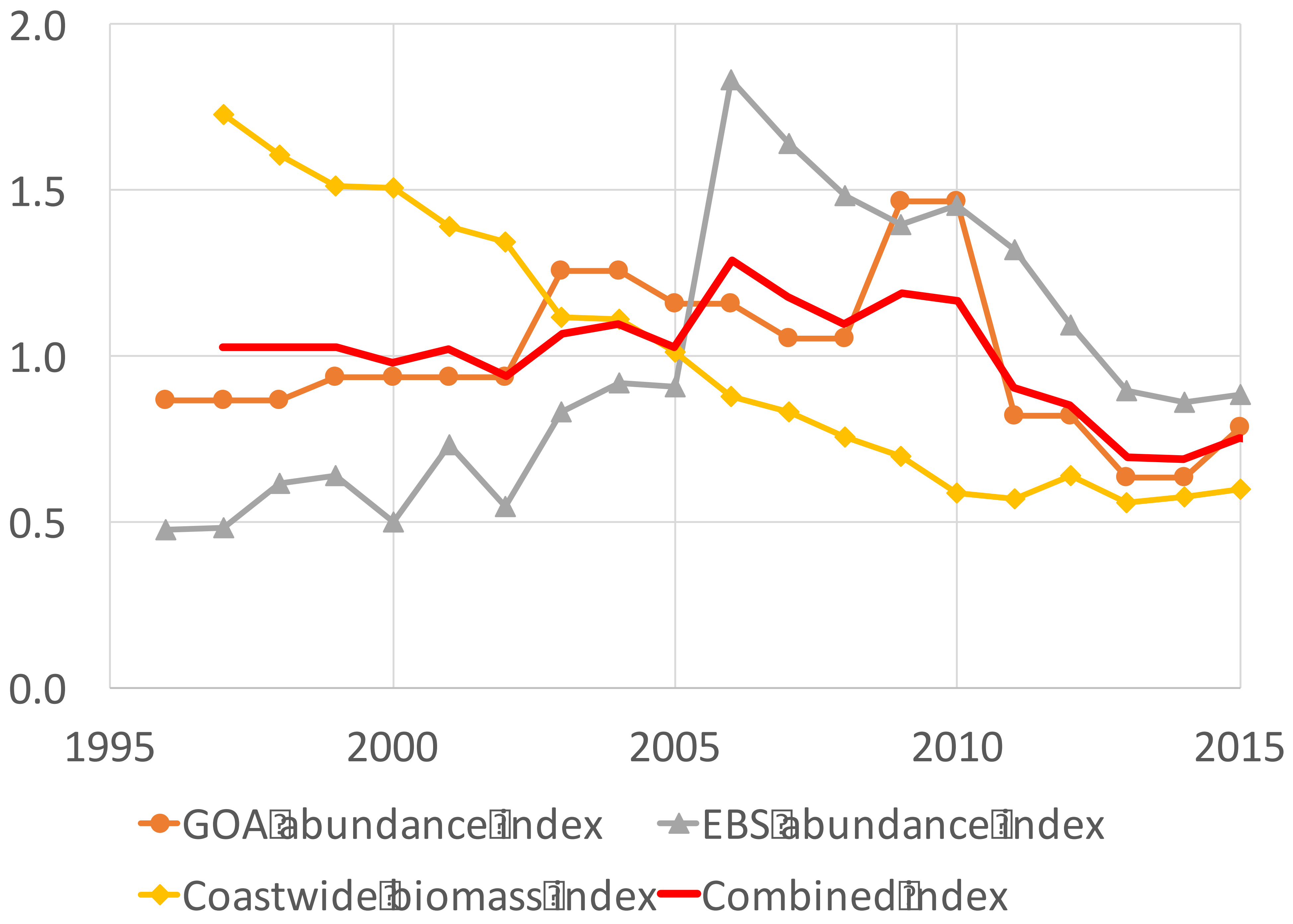
- Mean of the three standardized indices:

$$x_y = \frac{S_y}{\bar{S}} + \frac{B_y}{\bar{B}} + \frac{G_y}{\bar{G}}$$

$$I_y = {x_y}/{3}$$

- S_y is the weight-per-unit-effort measure from the IPHC setline survey
- B_y is the numbers estimated from the EBS shelf bottom trawl survey
- G_y is the numbers estimated from the GOA bottom trawl survey for year y
- Mean of each index (e.g., $\bar{S}$) is the mean over the defined years
- Integrated index (I_y) is the standardized annual mean of these three indices

ABM Index


2.0
1.5
1.0
0.5
0.0
1995
2000
2005
2010
2015
GOA abundance index
EBS abundance index
Coastwide biomass index
Combined index

Potential downfalls

- GOA survey is biennial
- Some aspects covered by more than one source
  - O32 halibut in BSAI trawl survey and setline survey
  - May lend more weight to that component
- Possibly asymmetric relationships
  - A low index in BS likely indicates low recruitment in BS
  - A high index in BS may not always indicate a high recruitment that contributes to later biomass
    - Likely a higher uncertainty if high values will transpire into O32 biomass
- The recommended integrated index does not specifically address the availability of halibut to the directed fishery in the Bering Sea
  - Addressed partially because the PSC limit decreases as indices decline
    - But the directed fishery quota in BS would also
  - Some of this may be addressed with the control rule

Control Rule Development

Considerations

- Shape of control rule
- Starting point
- Min/max PSC (floor and ceiling)
- Stability

Examples of control rules

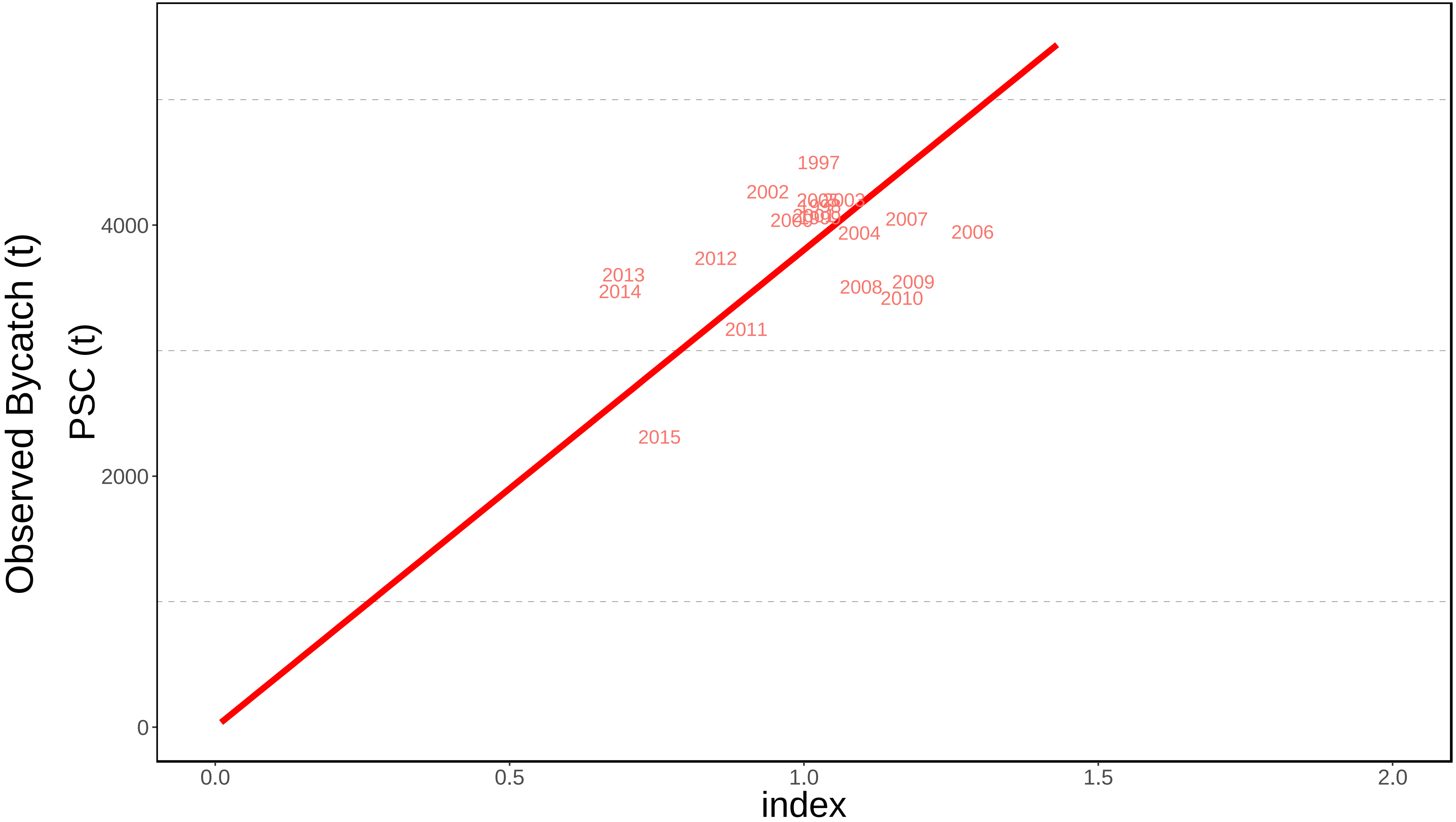
- Could use bycatch observations to form the scale and slope of the control rule

	Bycatch data used	*Referred to as:*
Bycatch Control Rule 1	Total mortality 1997-2015; no floor or ceiling	BCR1
Bycatch Control Rule 2	Total mortality 1997-2015; floor @20% < lowest bycatch year; ceiling @20%>highest bycatch year	BCR2
Bycatch Control Rule 3	Total mortality 2008-2015; no floor or ceiling	BCR3

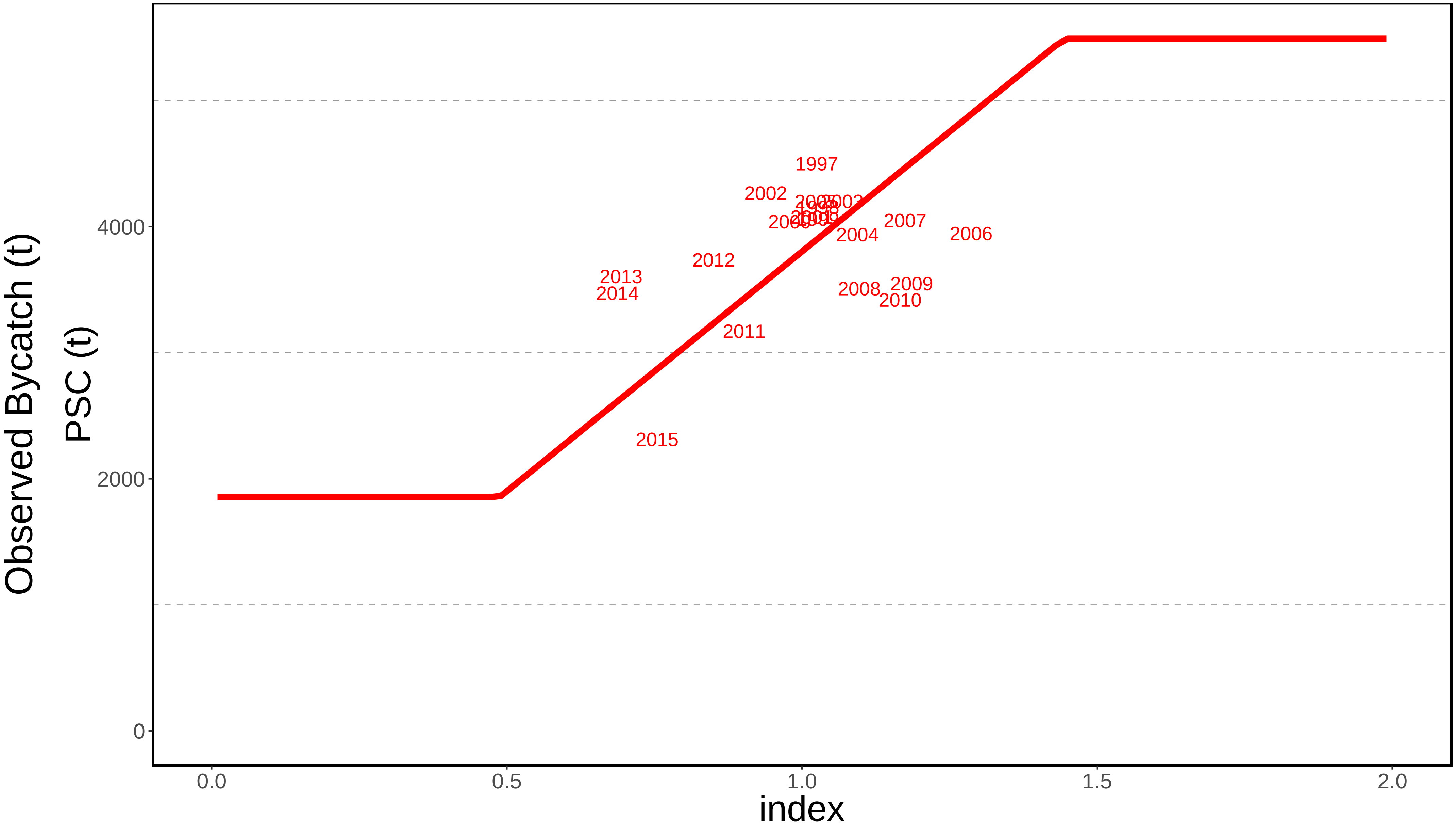
BCR1

Observed bycatch plotted against historical index

(1997 to 2015)



BCR2

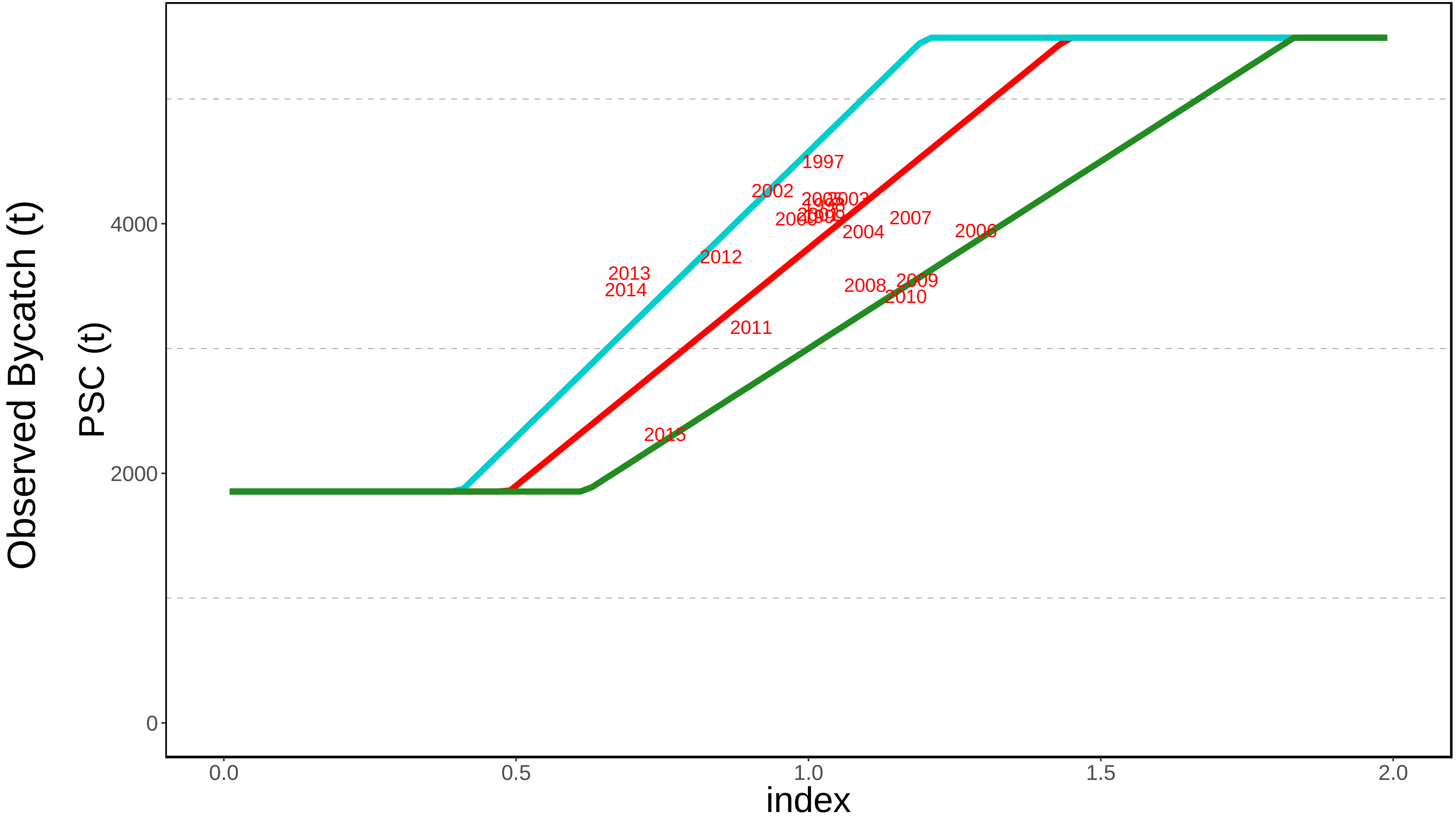


Add ceiling and floor

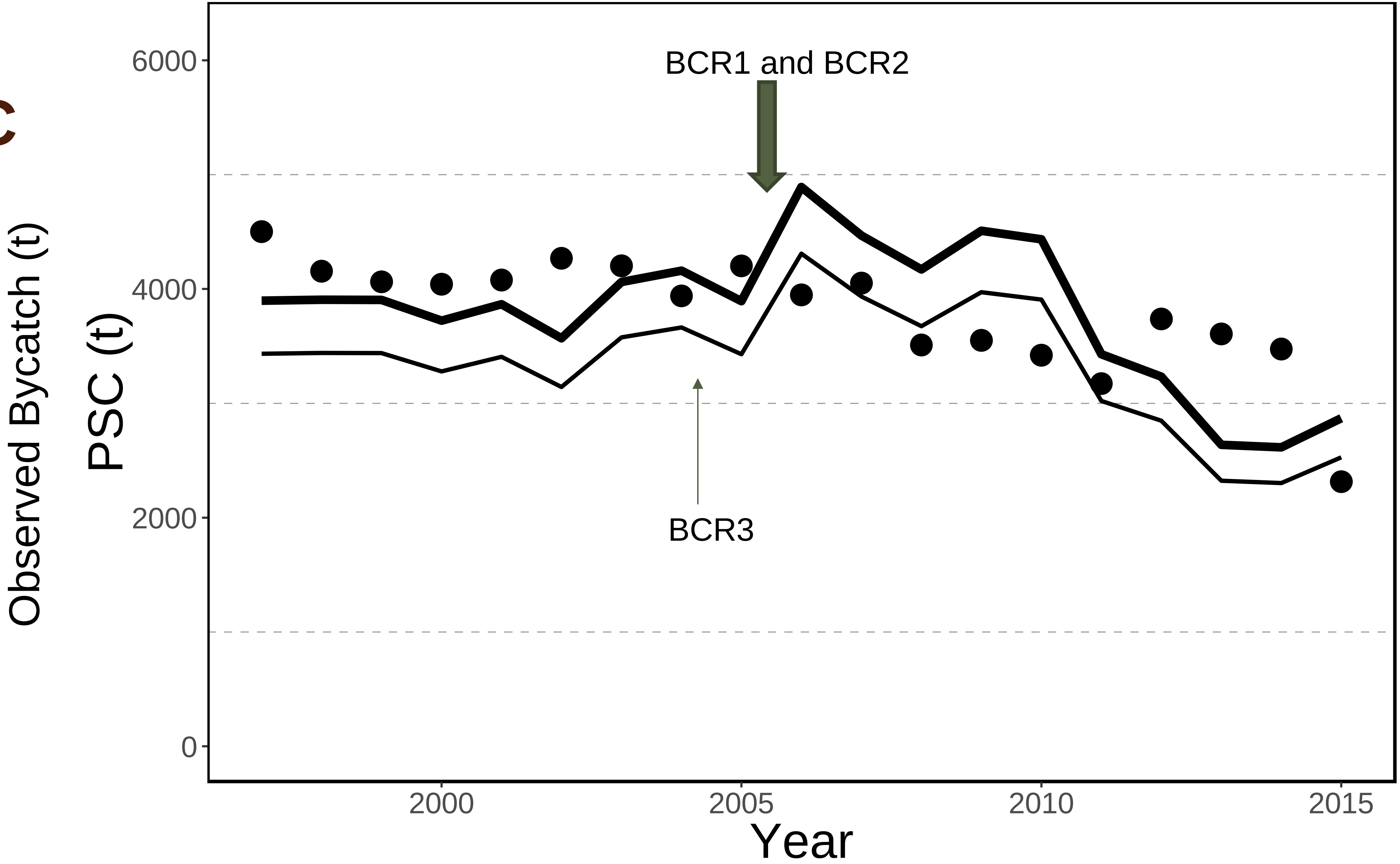
Change slope

Observed bycatch plotted against historical index

(2008 to 2015)

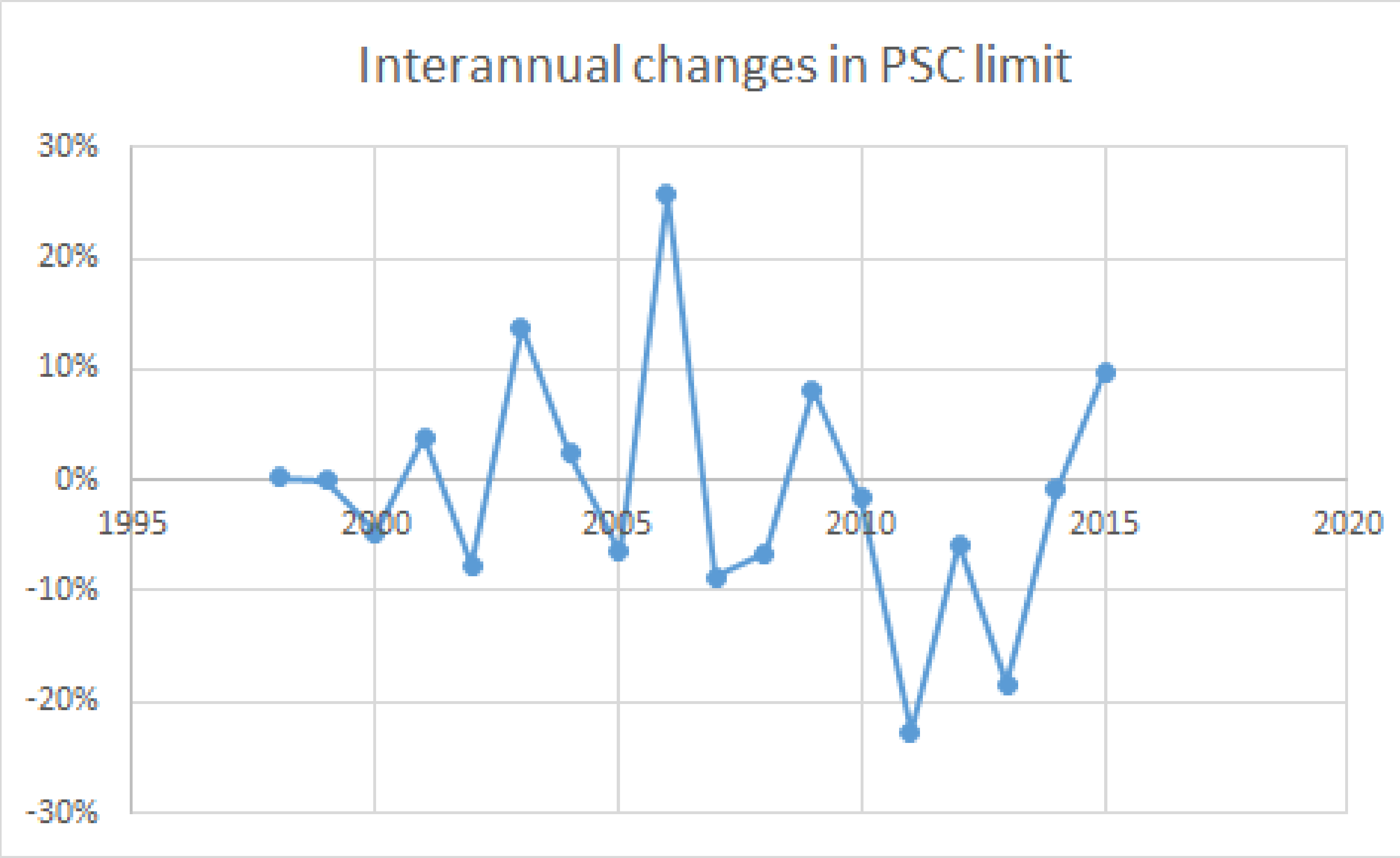


ABM PSC limit



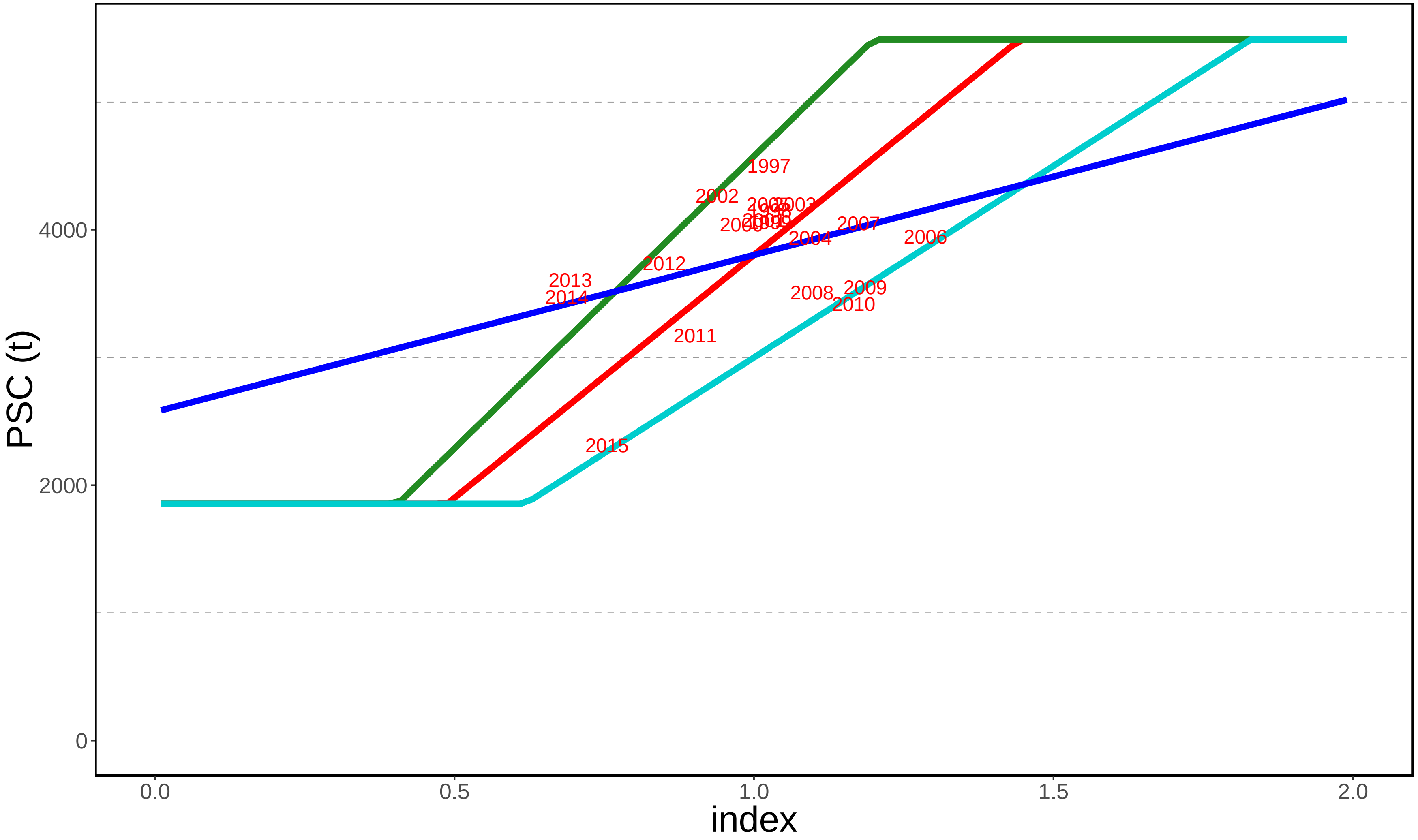
Stability

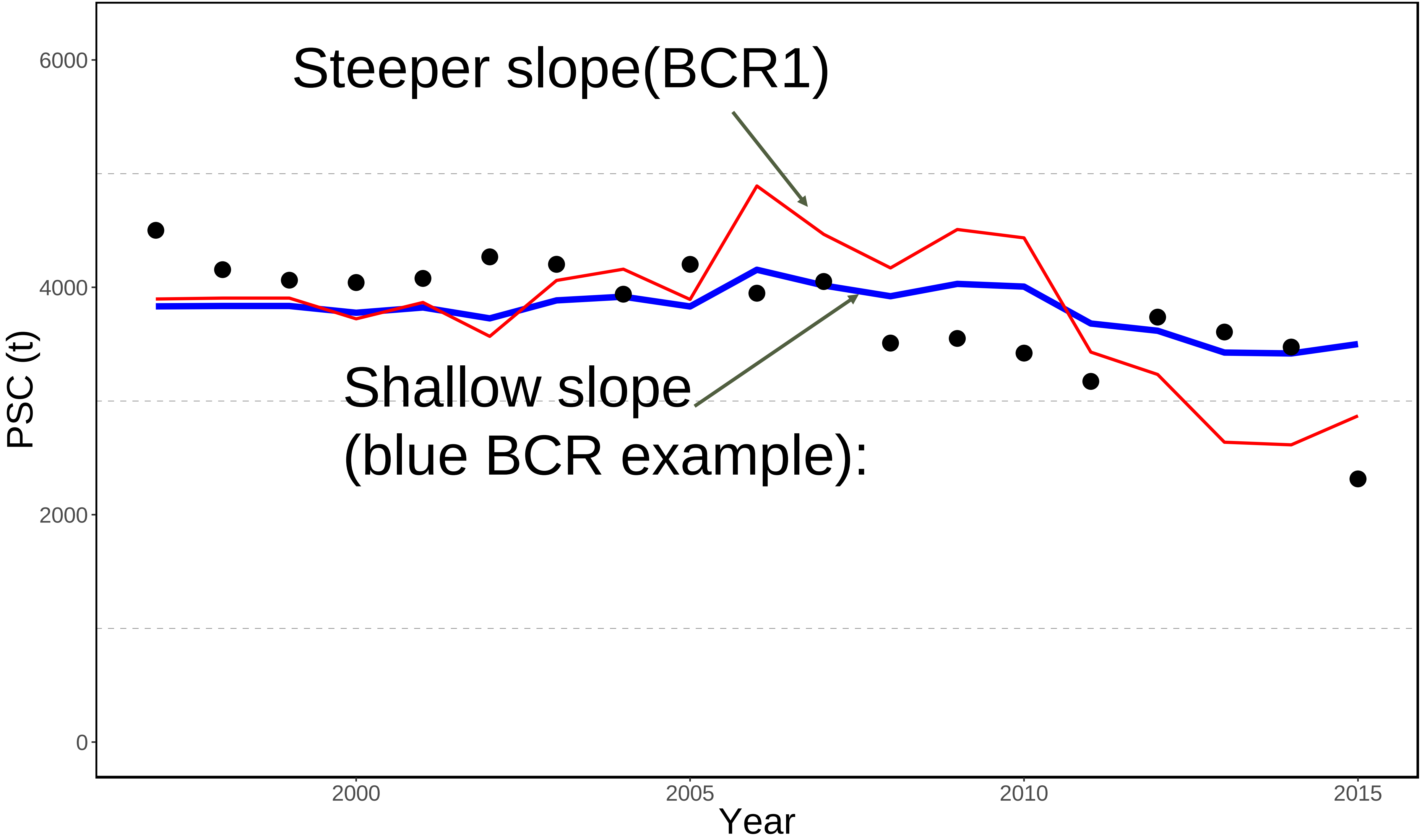
- Historical “what-if” changes in integrated index
- High variability



Moderate changes in PSC limits

- Can change slope of control rule



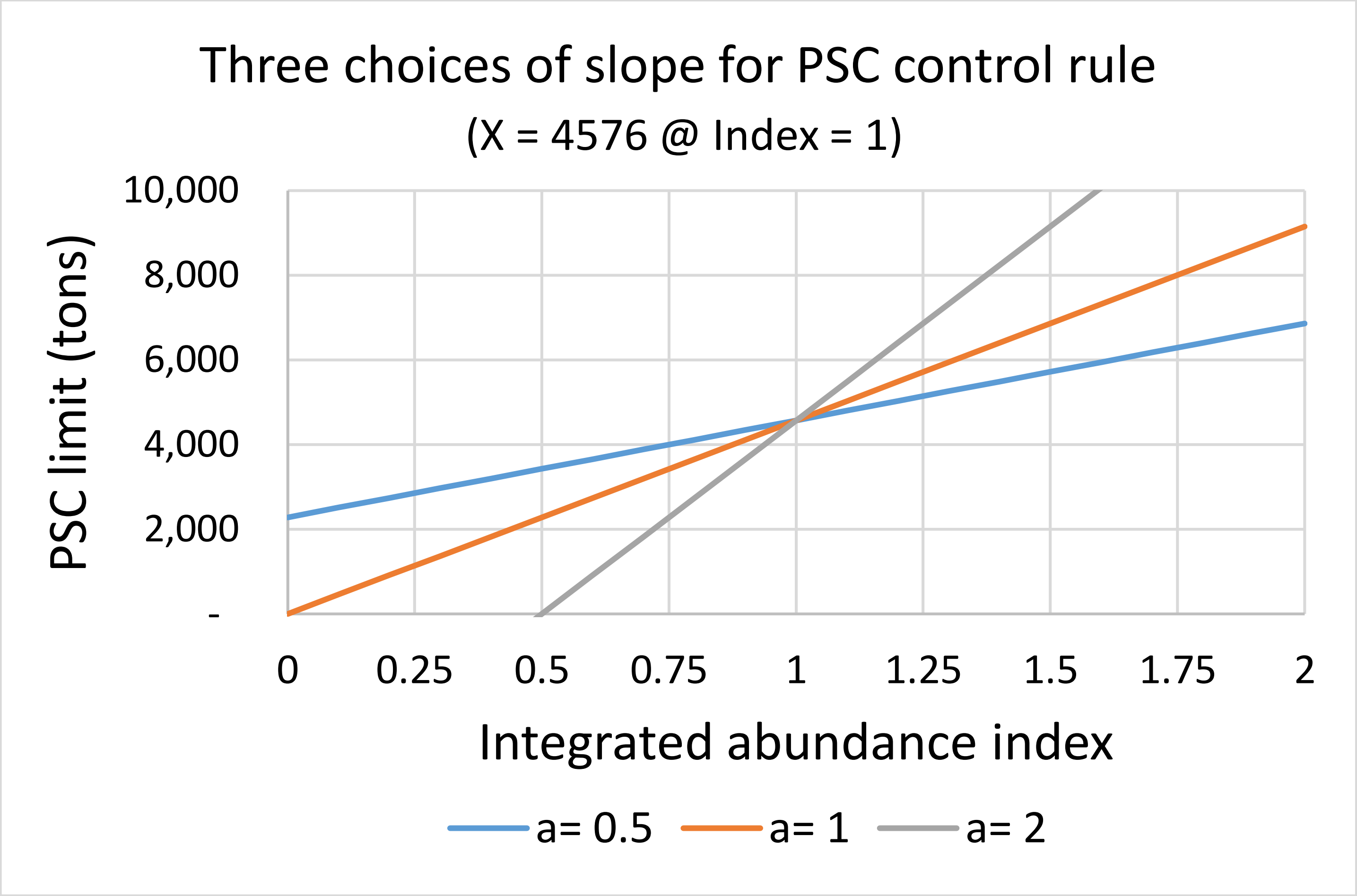


Steeper slope(BCR1)
Shallow slope
(blue BCR example):
6000
4000
2000
0
PSC (t)
2000
2005
2010
2015
Year

Potential decision points

- $PSC_{y+1} = (1 - (1 - I_y)a)X$

- I_y is index
- *a* is slope
- *X* is PSC limit at



Public meeting (September 12, 2016)

- Well attended by a diverse group of people
- The following concerns were voiced
  1. There is an implicit weighting in the index
  2. The directed fishery in 4CDE is not specifically addressed
  3. The control rule could incorporate other factors
     a) e.g., weight-at-age, apportionment

Objectives defined by NPFMC (October 2016)

- Develop an index to halibut abundance
- Protect Spawning Stock Biomass at low levels of abundance
- Provide flexibility in groundfish operations (related to achieving OY on an annual basis)
- Provide directed fishing opportunities
- Provide stability in variability of PSC limits

Direction provided by NPFMC (October 2016)

- Develop performance metrics and quantitative tools to evaluate the tradeoffs between the competing objectives for this action.
- Develop abundance indices and associated controls rules together.
- 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.
- 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.

Considerations for IPHC

1. An objective or objectives for halibut bycatch mortality, as they pertain to halibut and groundfish management.
2. Agreement on a starting point and range of actual bycatch mortality against which future levels will be determined.
3. Agreement on the sharing for relative harvest (removals) among sectors
4. An index of abundance that will be used to scale halibut bycatch mortality.
5. The control rules for implementing ABM of bycatch mortality.

Concerns for IPHC

- Protect halibut spawning biomass
- Provide opportunity for the directed fisheries
- Incorporate objectives for the directed fishery in 4CDE
- Maintain incentives to keep bycatch low

ABM: How is the MSAB involved

Use of IPHC MSE in impact analysis

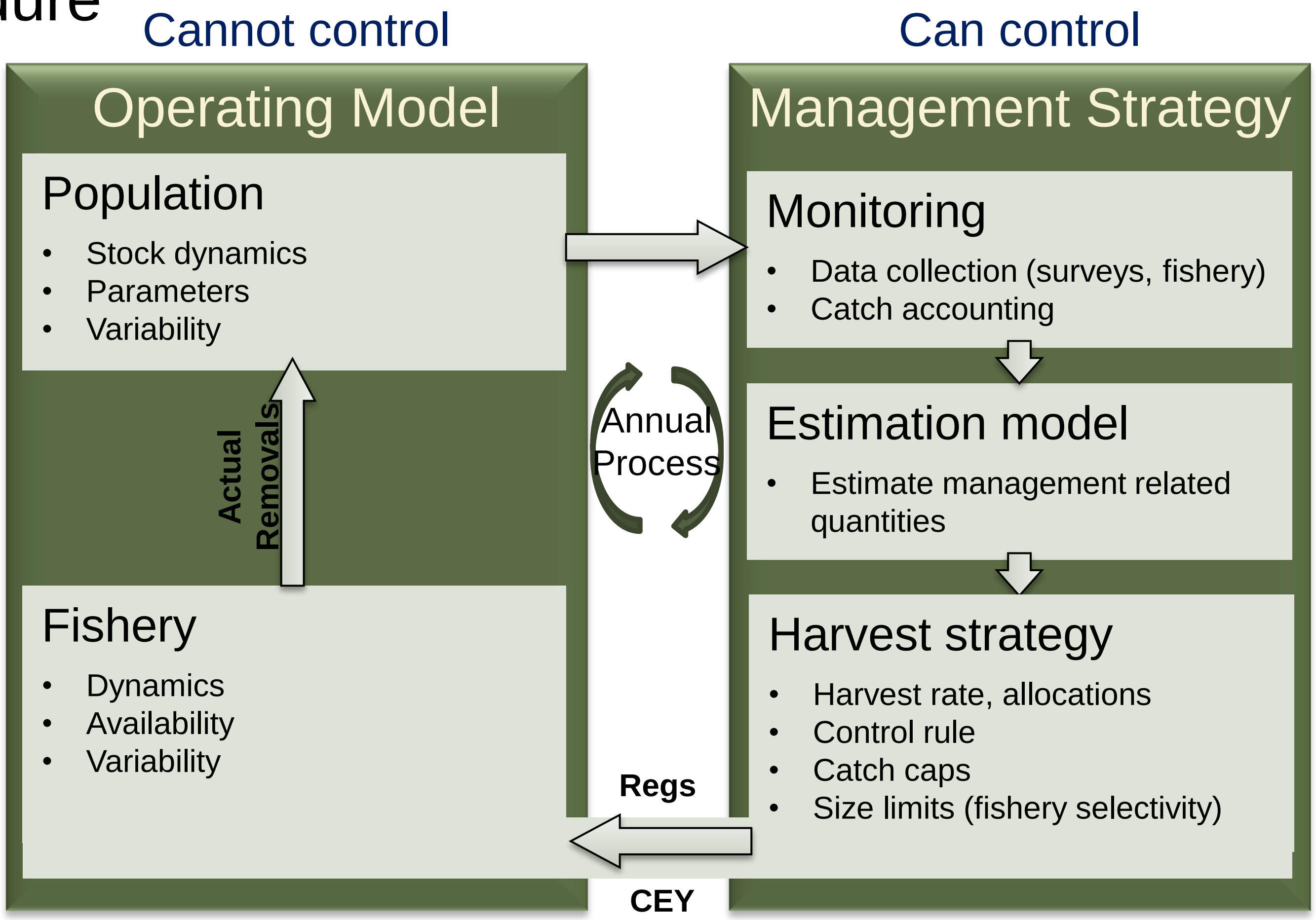
- Two year workplan involves developing a full closed-loop simulation with a coastwide single-area operating model, and working towards a coastwide multi-area model
- The ABM topic can be easily evaluated once this framework is in place
- Unlikely to be fully evaluated until after 2017

MSAB and ABM of PSC limits

- This is a topic that affects the directed fishery
- An MSAB directive is to evaluate the current harvest policy
  - How bycatch is specifically managed may not be a component of the IPHC harvest policy, but the effect of bycatch removals are important
- Advice from MSAB desired by Commissioners
  - What are the goals of the directed fishery in relation to ABM of PSC limits
  - How do PSC limits affect the directed fishery
  - What analysis can/will be done to address this issue

MSAB: bycatch

- The MSAB is focused on the directed fishery
- Current plan is to treat “bycatch” as a scenario in the operating model
  - Not a specific management procedure
- We can treat bycatch as scenarios (cannot control)
  - This will provide a range of possible bycatch limits



Bycatch as scenarios

- Not interested in how the PSC management procedure performs
- Are interested in how the other management procedures perform given a range of bycatch scenarios
- We will need to define two or more scenarios
  1. Fixed PSC limit
  2. Simple ABM management
  3. Complex ABM management
  4. …
  - Can look at each scenario individually or integrate over them to develop a harvest policy that is robust to various bycatch scenarios

The goal of MSE is to develop robust harvest strategies

All mortality matters

- Regardless of how bycatch is managed, removals of all sizes and from all sources affects the halibut population
- All mortality is not currently managed
  - Effects of U26 mortality are delayed
  - Cannot set an accurate fishing mortality
  - Difficult to account for bycatch removals and determine effects of bycatch
- A harvest policy that accounts for all mortality will make it easier to
  - Accurately manage to a specific fishing mortality
  - Incorporate effects of all fisheries (non-directed and directed)
  - Test and evaluate performance against multiple objectives

Managing on total mortality

- Earlier assessments included only age 8 and older halibut
- Those were updated to include age 6 and older
- Then, management was based on O32 mortality
- In 2011, updated management for O26 mortality
- Now, why not manage on OZero (over zero) mortality
  - Account for all removals across all fleets
  - Need a measure that accounts for all sizes and sources
    - Selectivity varies by fleet, thus harvest rates are not comparable

Measures to account for total mortality

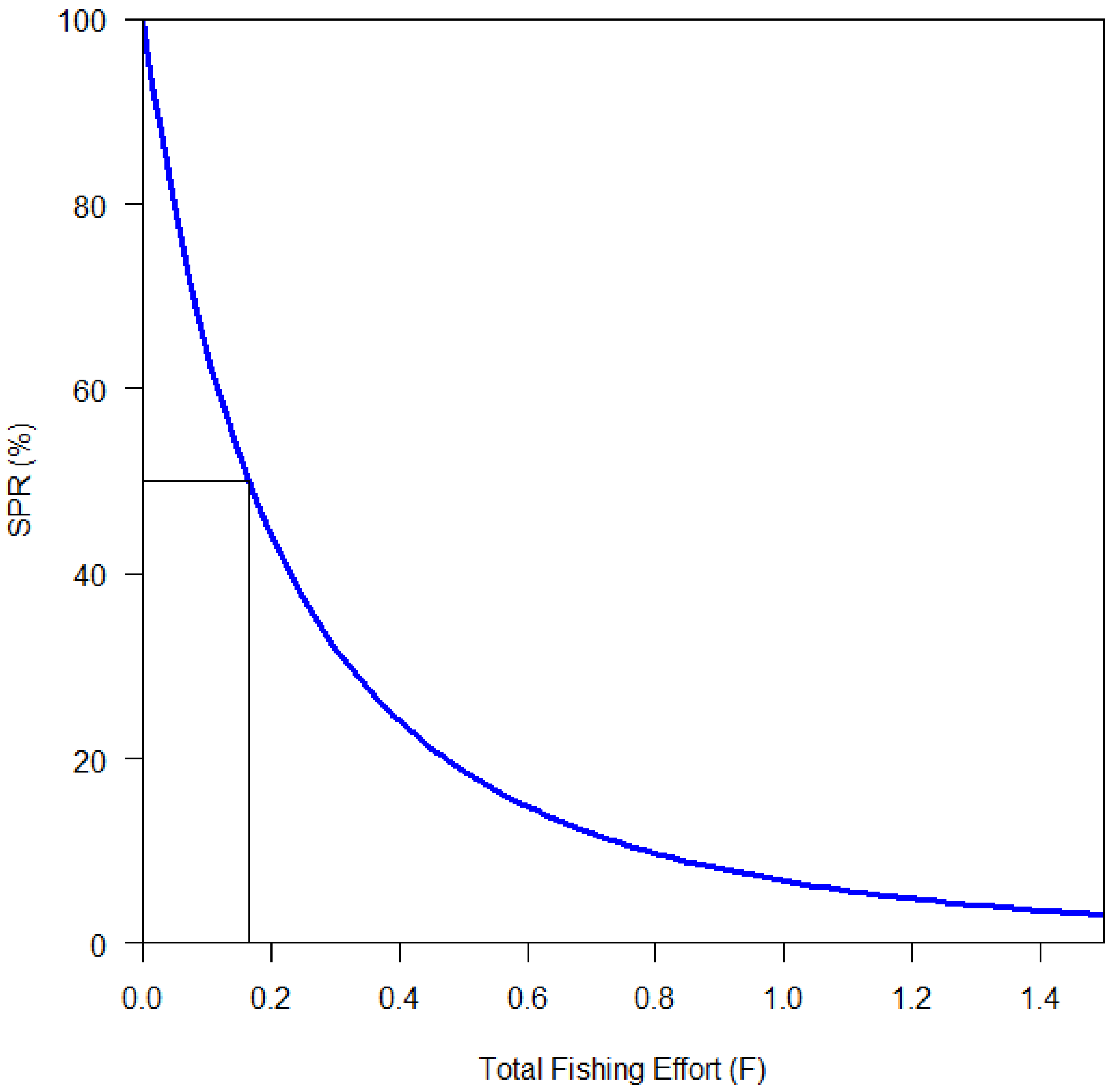
- Spawning-exploitation harvest rate
  - Amount of spawning biomass exploited in a year
  - One minus (SB at end of year/SB without fishing at end of year)
- Many other metrics have potential
- Spawning Potential Ratio (SPR)
  - An equilibrium concept that accounts for all mortality across all sources
  - The reduction in equilibrium spawning potential due to fishing
  - A measure that has been reported in recent decision tables

Spawning Potential Ratio (SPR)

- Spawning Biomass Per Recruit with fishing *divided* by
  Spawning Biomass Per Recruit with no fishing
  - An equilibrium concept
- Find a fishing rate that results in a specific SPR
  - $F_{SPR=XX\%}$
- Need to know
  - Selectivity for each fishery
  - Allocation or apportionment across fisheries
  - Natural mortality
  - Mean weight-at-age
- Provides a measure of fishing intensity on all sizes over all fisheries

SPR

- SPR is a function of fishing effort
  - The percentage of unfished Spawning Potential resulting from a specific level of fishing effort



SPR has been reported for last 2 years

2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity	Stock Trend: Spawning biomass in 2017 is less than 2016	Stock Trend: Spawning biomass in 2017 is 5% less than 2016	Stock Trend: Spawning biomass in 2019 is less than 2016	Stock Trend: Spawning biomass in 2019 is 5% less than 2016	Stock Status: Spawning biomass in 2017 is less than 30%	Stock Status: Spawning biomass in 2017 is less than 20%	Stock Status: Spawning biomass in 2019 is less than 30%	Stock Status: Spawning biomass in 2019 is less than 20%	Fishery Trend: Fishery CEY from the harvest policy in 2017 is less than 2016	Fishery Trend: Fishery CEY from the harvest policy in 2017 is 10% less than 2016	Fishery Trend: Fishery CEY from the harvest policy in 2019 is less than 2016	Fishery Trend: Fishery CEY from the harvest policy in 2019 is 10% less than 2016	Fishery Status: Harvest rate in 2016 is above target
No removals	0.0	0.0	$F_{100\%}$	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	0
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
	20.0	8.2	$F_{68\%}$ 49%-75%	<1	<1	3	<1	2	<1	1	<1	<1	<1	<1	<1	<1
	30.0	18.0	$F_{58\%}$ 39%-67%	3	<1	28	9	2	<1	2	<1	4	2	5	2	7
Blue Line	38.7	26.6	$F_{51\%}$ 33%-61%	19	<1	45	32	2	<1	6	<1	44	33	44	35	50
status quo FCEY	41.4	29.2	$F_{49\%}$ 31%-59%	28	<1	48	38	3	<1	7	<1	53	44	50	44	62
2016 Adopted	41.9	29.9	$F_{49\%}$ 31%-59%	29	<1	49	39	3	<1	7	<1	55	46	51	45	64
Maintain 2015 SPR	42.9	30.7	$F_{48\%}$ 30%-58%	32	<1	50	40	3	<1	8	<1	58	49	53	48	68
	50.0	37.6	$F_{43\%}$ 27%-54%	45	3	64	48	3	<1	14	<1	90	74	82	68	96
	60.0	47.4	$F_{41\%}$ 23%-50%	50	22	73	55	4	<1	23	1	>99	99	>99	97	>99
				a	b	c	d	e	f	g	h	i	j	k	l	m

F_{SPR}

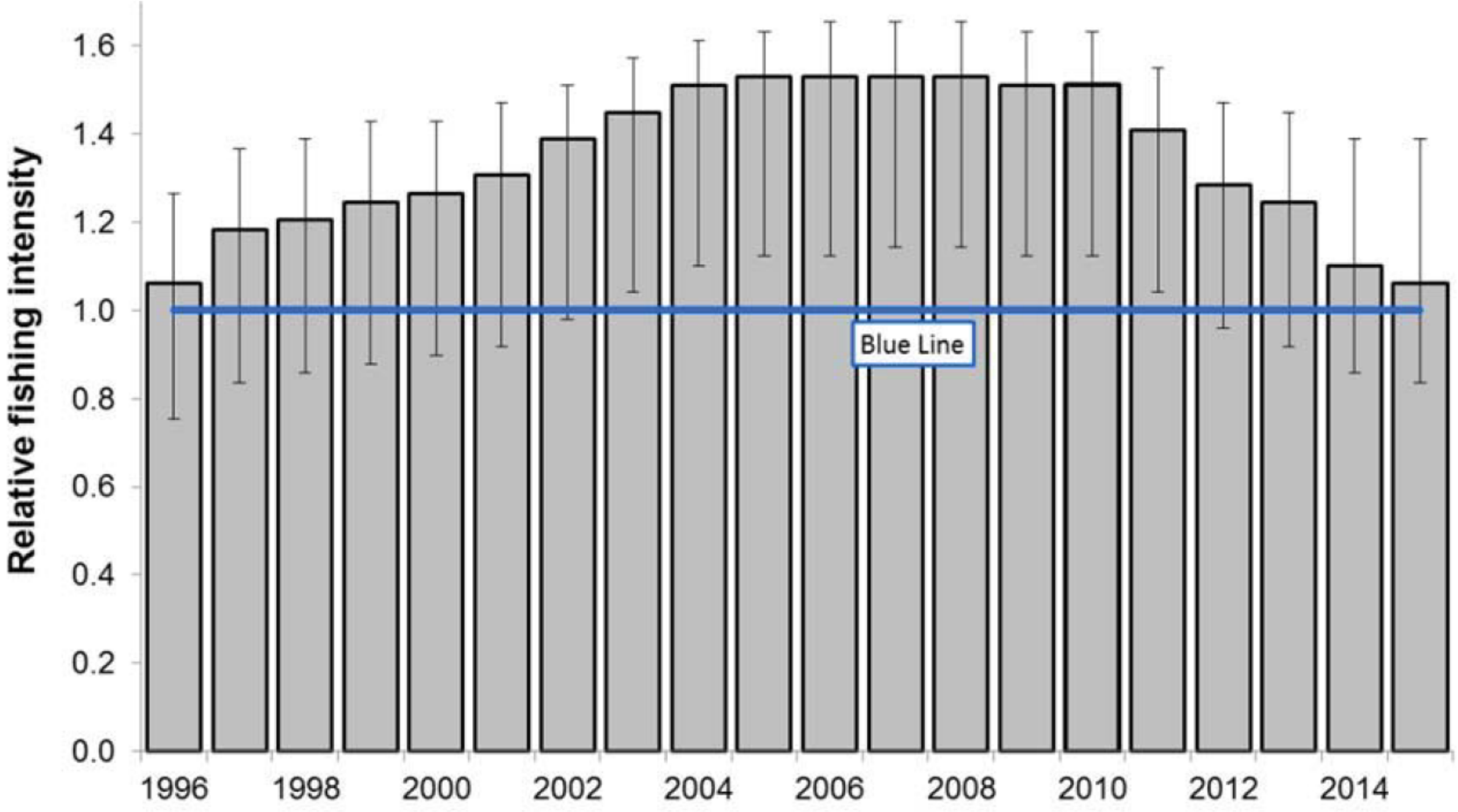
- Lower SPR means more exploited

Year	Blue Line	Adopted
2015	$F_{46\%}$	$F_{44\%}$
2016	$F_{51\%}$	$F_{49\%}$

2016 Alternative	Total removals (M lb)	Fishery CEY (M lb)	Fishing intensity
No removals	0.0	0.0	$F_{100\%}$
FCEY = 0	11.6	0.0	$F_{79\%}$ 60%-84%
	20.0	8.2	$F_{68\%}$ 49%-75%
	30.0	18.0	$F_{58\%}$ 39%-67%
Blue Line	38.7	26.6	$F_{51\%}$ 33%-61%
status quo FCEY	41.4	29.2	$F_{49\%}$ 31%-59%
2016 Adopted	41.9	29.9	$F_{49\%}$ 31%-59%
Maintain 2015 SPR	42.9	30.7	$F_{48\%}$ 30%-58%
	50.0	37.6	$F_{43\%}$ 27%-54%
	60.0	47.4	$F_{41\%}$ 23%-50%

Retrospective Fishing Intensity

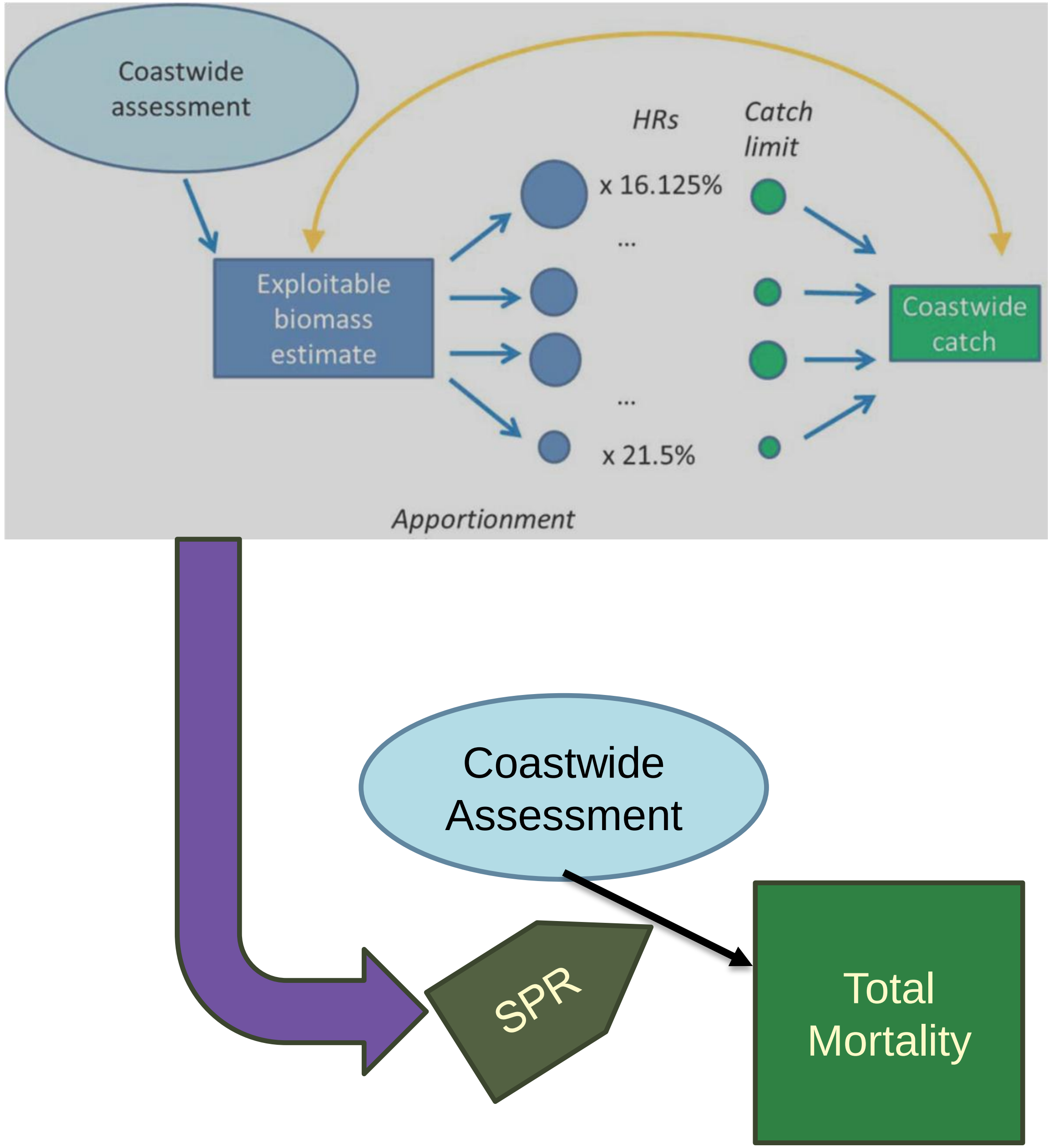
Higher means higher effort



Time-series of estimated coastwide harvest rates (bars) relative to the target harvest rate for all sizes and sources of removals projected for the 2016 Blue Line ($F_{51\%}$). *RARA 2015*

Mapping the current HP to account for total mortality

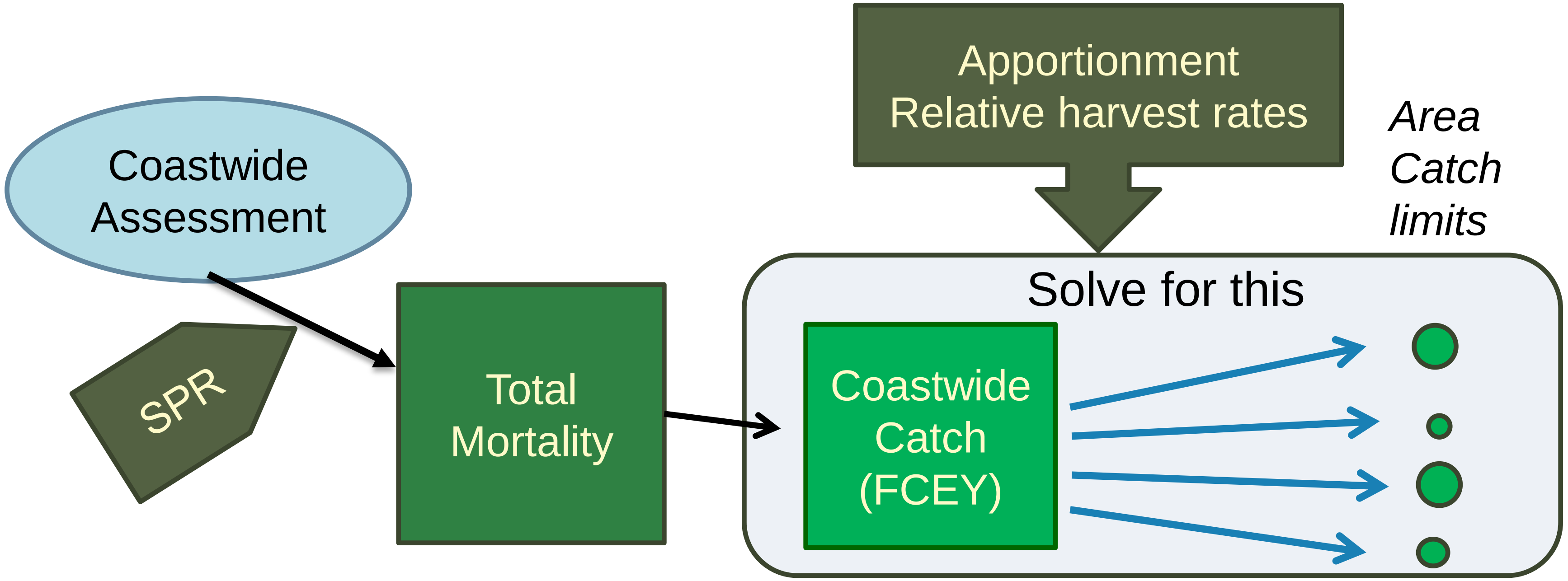
- SPR is already associated with the harvest policy
  - Changes slightly from year to year
  - Can provide an indication of a reasonable range associated with the blue line
  - It can be used to define total mortality
    - Accounting for all fisheries and sizes
  - Ian has worked out all details needed to completely map over without changing the harvest policy
- Need to know
  - Selectivity for each fishery (estimated in assessment)
  - Natural mortality (estimated in assessment)
  - Mean weight-at-age (used in assessment)
  - Apportionment (survey biomass and harvest rates)



A change in thinking to account for total mortality

Details

- Determination of coastwide FCEY from Total Removals
  - Solve using
    - Apportionment with the survey biomass (as is currently done)
    - Incorporate relative harvest weights between Areas (as currently used)



SPR summary

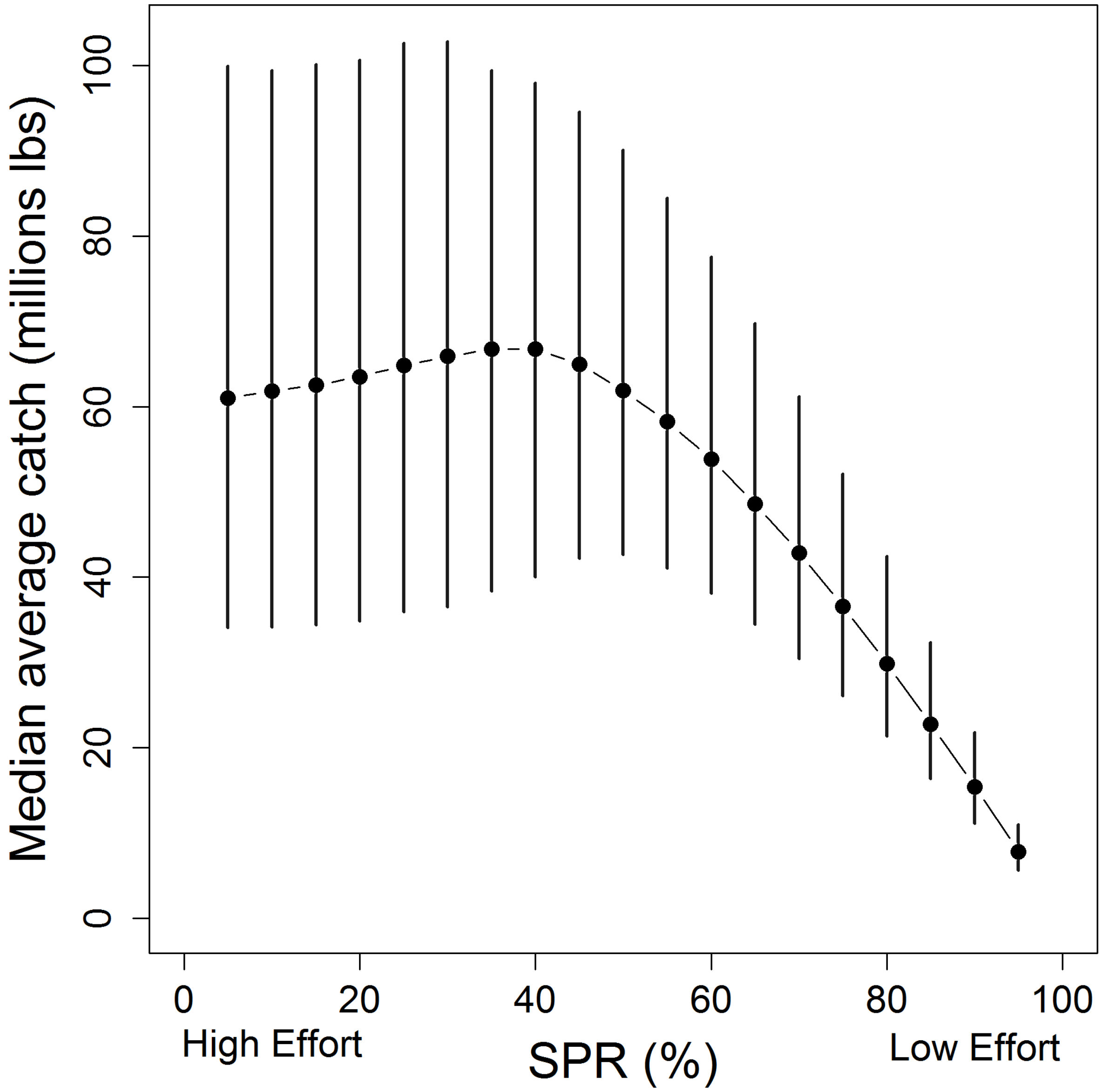
- Mortality of all sizes and sources is accounted for (OZero)
- *Ebio* is no longer necessary
- Specific harvest rates are not necessary
  - Relative harvest rates still apply to apportionment
- A SPR-based harvest policy is the way to account for total mortality

Moving forward

1. SPR based harvest policy is easy to test with an MSE
2. Can introduce implementation error to account for decision making

Methods

- Single-area coastwide operating models
- Closed-loop simulations



SPR-based goals and plans

- Timeline for evaluating a SPR-based harvest policy
  - October 2016 MSAB meeting
    - Explain the concepts
  - January 2017 Annual Meeting
    - Keep reporting SPR in decision table
    - MSAB make a recommendation regarding SPR-based management & blue-line
  - May 2017 MSAB meeting
    - Define the operating models and simulation process
    - Determine specific alternatives to test
  - October 2017 MSAB meeting
    - Present reviewed analyses and performance of alternatives
  - January 2018 Annual Meeting
    - MSAB present results to Commissioners and recommend a SPR for blue-line
  - May 2018 MSAB meeting
    - Continue to evaluate SPR options and additional harvest strategies
    - Other improvements to operating models and alternatives

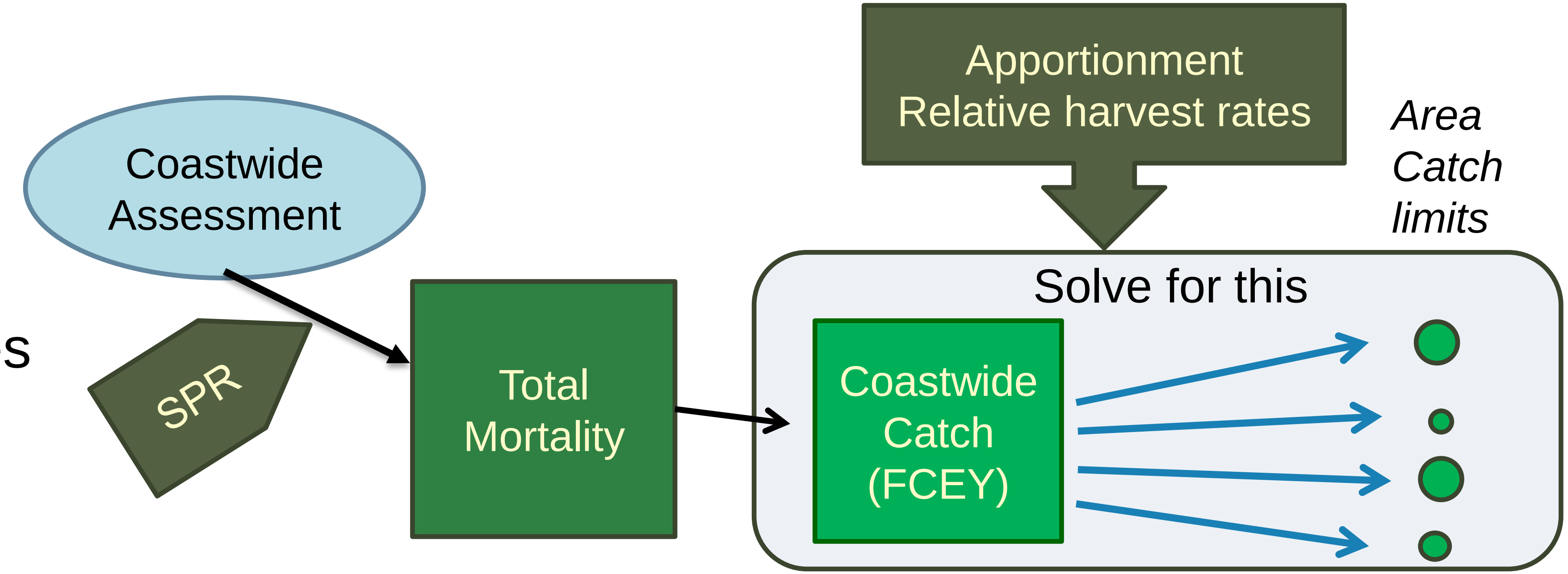
Current considerations for MSAB

1. SPR-based management
2. ABM for PSC limits in BS/AI

MSAB considerations (SPR)

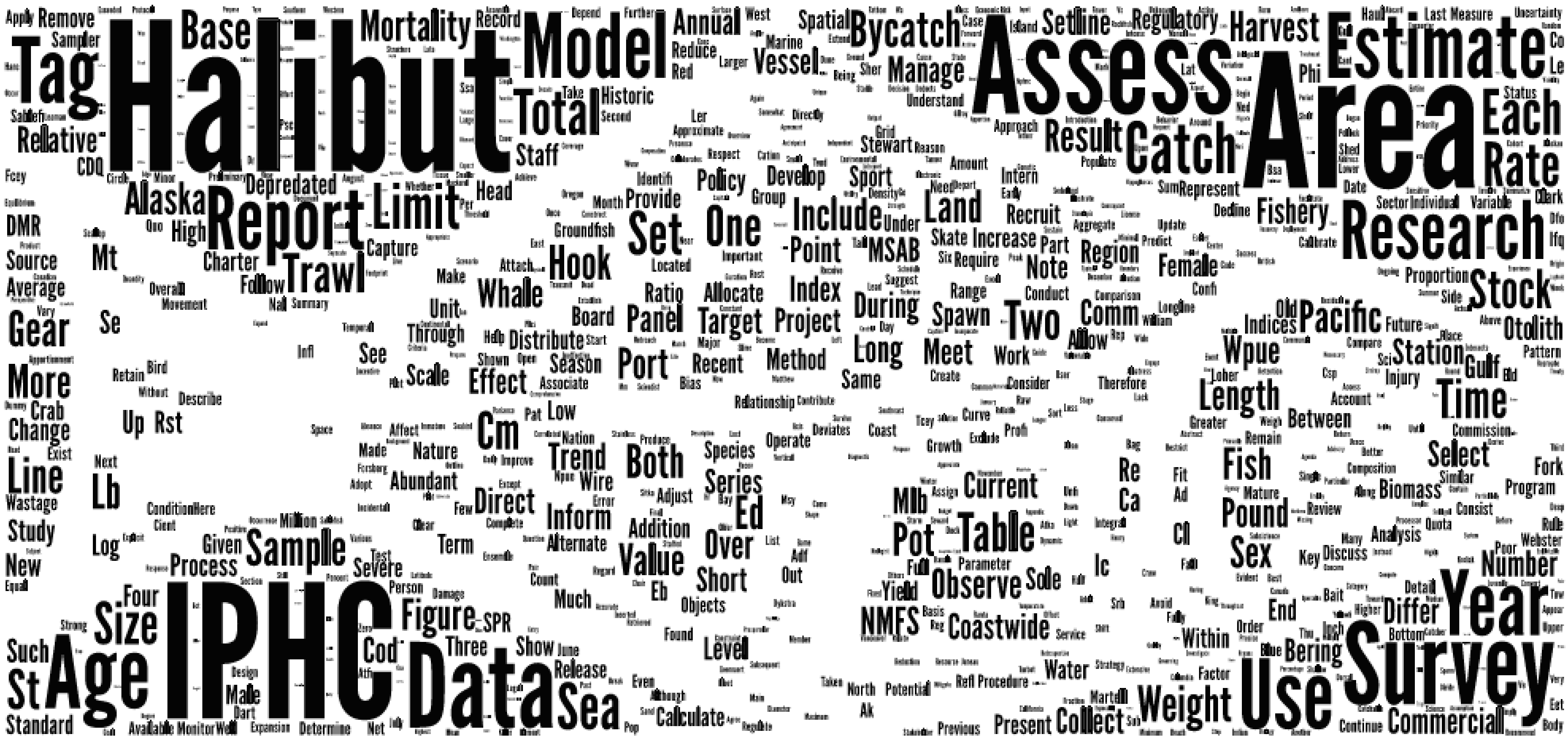
- Is an SPR-based approach worth considering and testing?
  - It is one part of many management procedures
  - Accounts for total mortality
  - Eliminates some possibly outdated aspects of the current harvest policy

O32, ~~O26, U26~~
~~EBio~~
Apportionment
Relative harvest rates
Control rule
Reference points



MSAB considerations (ABM)

- Is it an MSAB objective to evaluate management procedures related to PSC limits?
- Commissioners have requested advice for three questions
  - What are goals/objectives of directed fishery in relation to bycatch in BS/AI?
  - How can we determine effects of bycatch removals on directed fishery?
  - What analyses and advice can the MSAB provide to assist with this question?



Word cloud based on 2015 RARA