Halibut Abundance-Based PSC Limits
April 2019 SSC Meeting

Current Working Group Members:

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Agenda

- Review Council Objectives and February Council Outcomes
- Discuss proposed subset of alternatives for analysis
- Review the 2-area halibut-only operating model
- Discuss
  - Modeling decisions
  - Model output
  - Recommended performance metrics
  - Analyzing impacts to groundfish
  - How to assess impacts to the groundfish fishery

Input needed from SSC

- How do we choose biological scenarios so that we have a tractable number of scenarios + sub-set alternatives to run and report on?
- Are there additional performance metrics that are needed?
  - Short and long term (years to define short term)
- Is there any methodology that needs to be adjusted?

Council Objectives

- 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 actions and stakeholder input

February/March

- Council formed stakeholder committee to provide recommended candidate scenarios from existing suite of Alternatives to workgroup
- Committee met to recommend scenarios and work group members requested clarification on specified elements and options
- February Committee meeting and report to Council
- Council modified suite of alternatives to broaden some options to accommodate all stakeholder scenarios as submitted
- Council recommends that the SSC review the proposed (staff and stakeholder) scenarios to provide guidance if additional scenarios should be included in the analysis.
- Late February/early March workgroup met separately with stakeholder groups to receive input on performance metrics
- Workgroup compiled all submitted scenarios as well as additional examples for analysis to best represent range of alternatives for EIS

Alternative Harvest Control Rules recommended for analysis

	Source	Indices	Element 1 (longline)	Element 1 (trawl)	Element 2 (longline)	Element 2 (trawl)	Element 3 (longline)	Element 3 (trawl)	Element 4	Element 5	Element 6	Element 7
Description	**Sub-option**		**Starting point**	**Starting point**	**Ceiling**	**Ceiling**	**Floor**	**Floor**	**Breakpoints**	**Responsiveness**	**% constraint**	
Alternative 1	Status quo											
Alternative 2-1	Base	Gear to gear	710	2,805	894	3,532	355	1,403	none	1:1	15% max	continuous
2-2	A80	Gear to gear	710	2,805	894	3,532	475	1,879	specified values	Stairsteps and flat	2 yr avg index	Look-up
2-3	UCB	Gear to gear	710	2,805	894	3,532	475	1,879	none	1:1	15% max	continuous
2-4	FVOA	Gear to gear	408	1,610	710	2,805	202	798	Starting point	.5 above, 1 below	15% max	continuous

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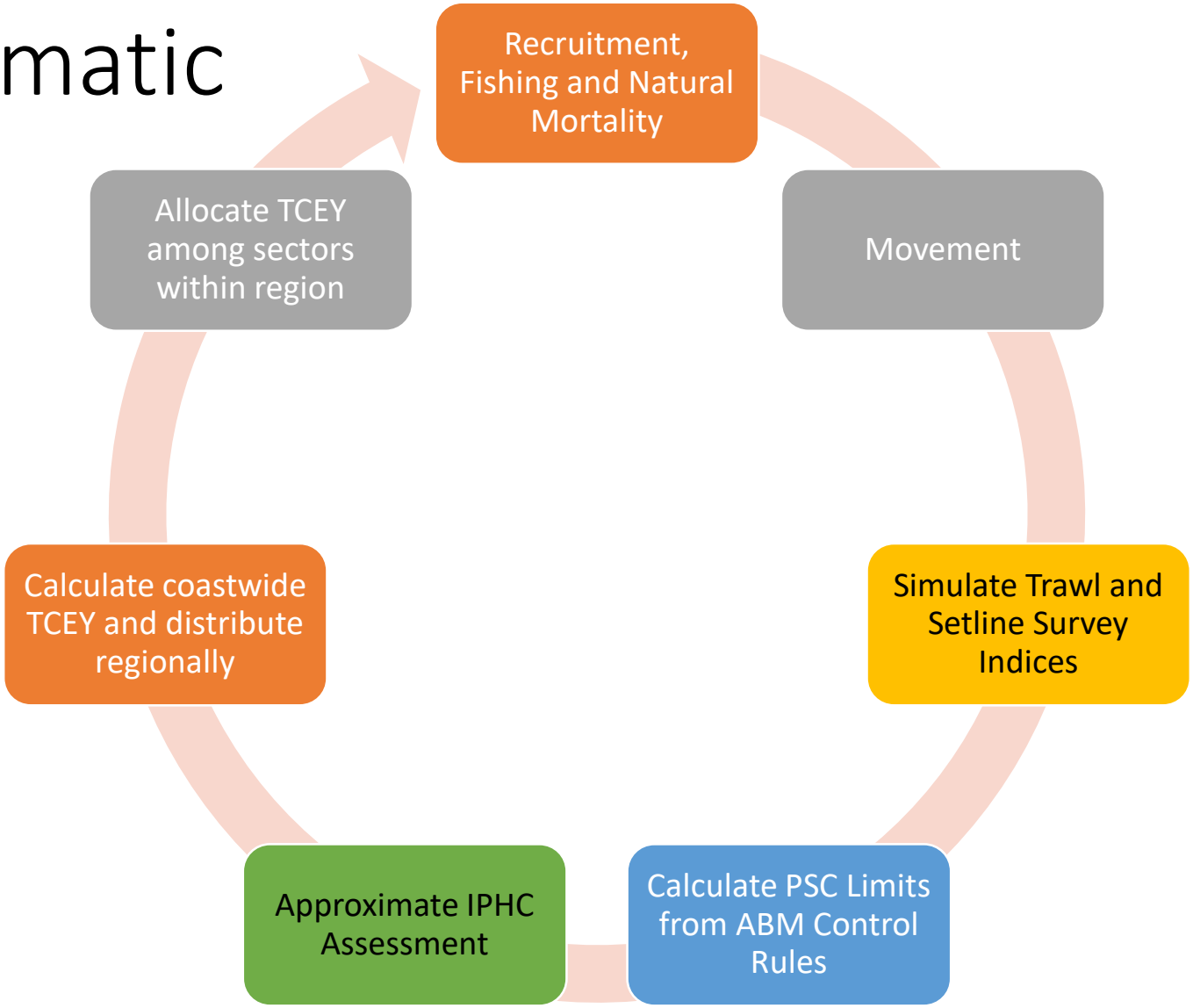
Description	Sub-option		Starting point	Starting point	Ceiling	Ceiling	Floor	Floor	Breakpoints	Responsiveness	% constraint	
Alternative 3	Base	Primary by gear	710	2,805	894	3,532	355	1,403	25%	1:1	15% max	continuous
3-1.a		Primary by gear	710	2,805					25%	Fast up, slow down	15% max	continuous
3-1.b		Primary by gear	710	2,805					25%	1:1	none	continuous
3-1.c		Primary by gear	710	2,805					25%	1:1	15% max	Look up table
3-2	FLC	**Equal weight**	594	2,347	833	3,291	355	1,403	none	1:1 for both indices	15% max	Lookup table
3-3	Directed	**Primary to setline**	395	1563	710	2805	202	798	Mean	0.35 * linear	20% max	continuous

Summary of SSC Recommendations - June 2018

- Move forward with the two-area halibut-only simulation model, noting that more than one approach may be necessary in the long-run
- A management model for setting the Total Constant Exploitation Yield (TCEY) must be developed.
- Halibut PSC limits must be tied to impacts in the groundfish and directed halibut fisheries.
- Additional thought must be given to how uncertainty will be incorporated into the model.

Two-area Model Schematic



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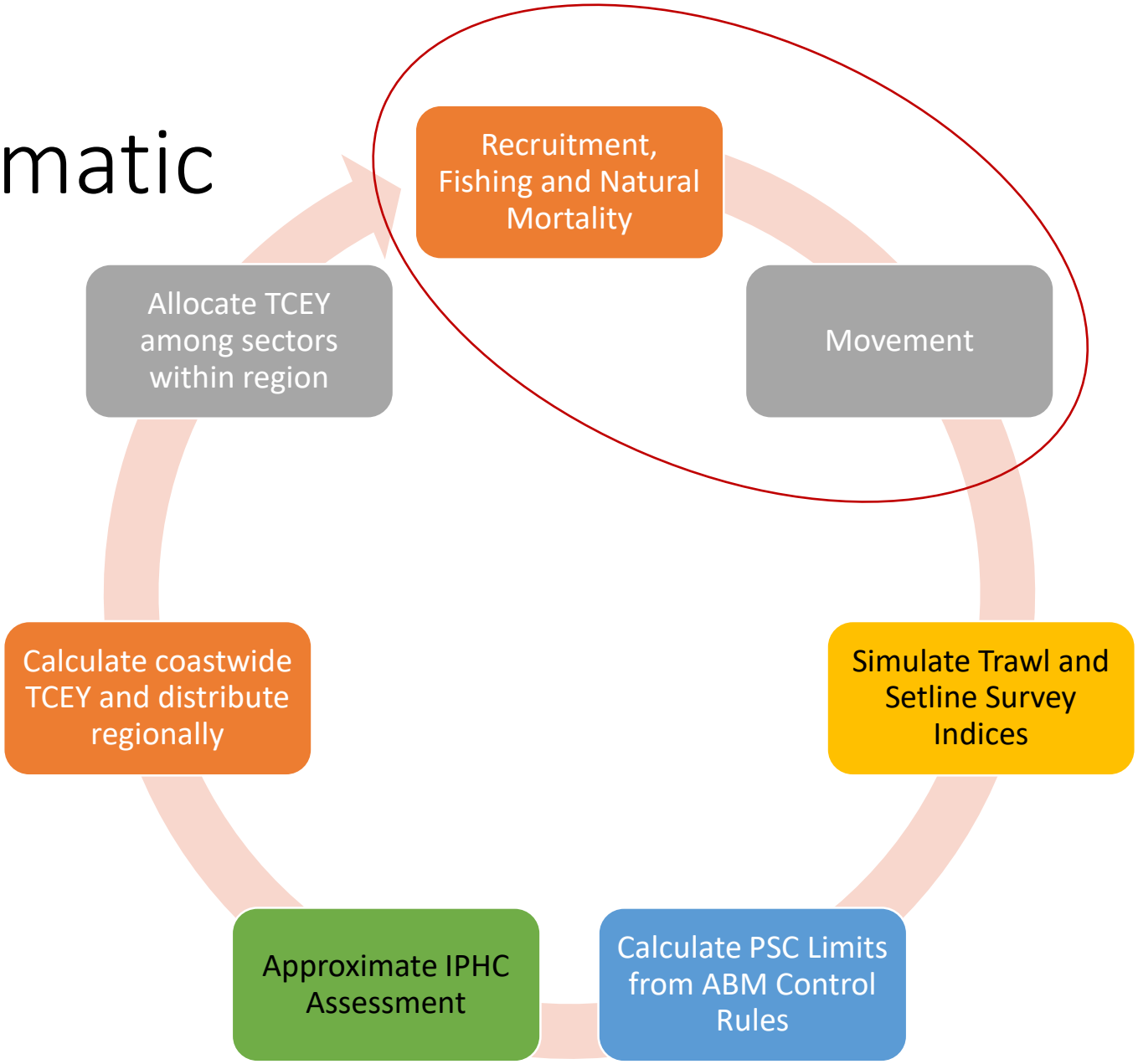
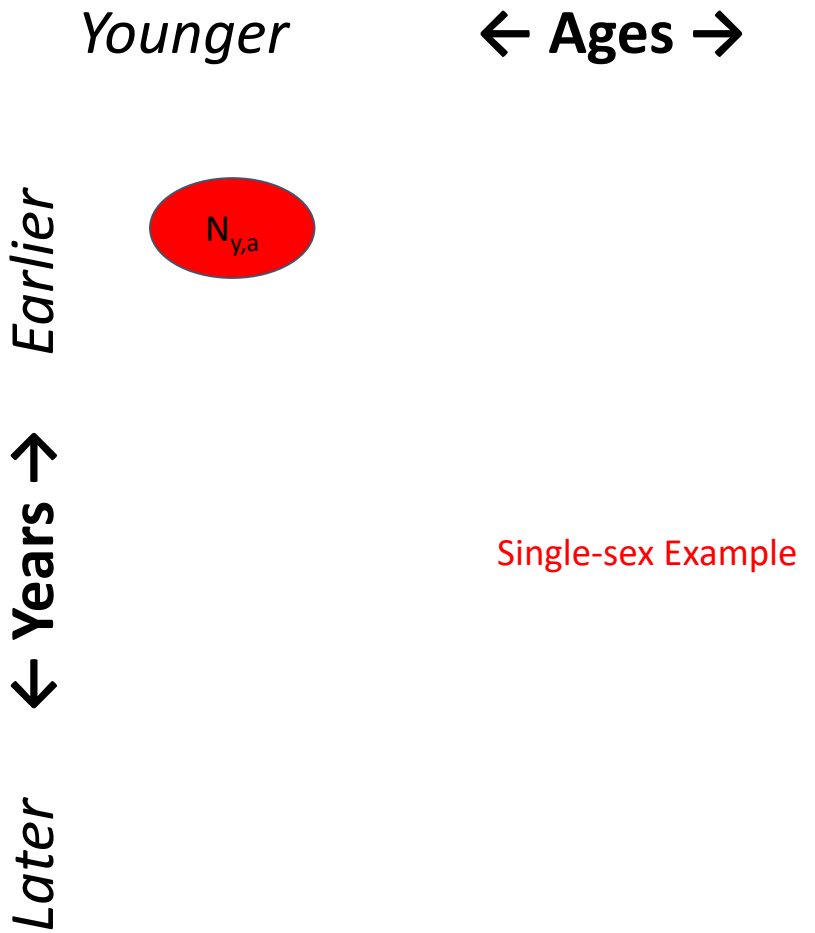


Two-area operating Model (OM) overview

- Sex and age-structured
- 2 Areas
  - BSAI region (4ABCDE)
  - Remaining GOA, BC, West Coast distribution
- Common recruitment
  - Allocated among areas
- 3 Gear types (Selectivity and F_t)
  - Directed Fishery, PSC Trawl, PSC Longline
- Gear-specific Selectivity
- Age-specific movement between areas



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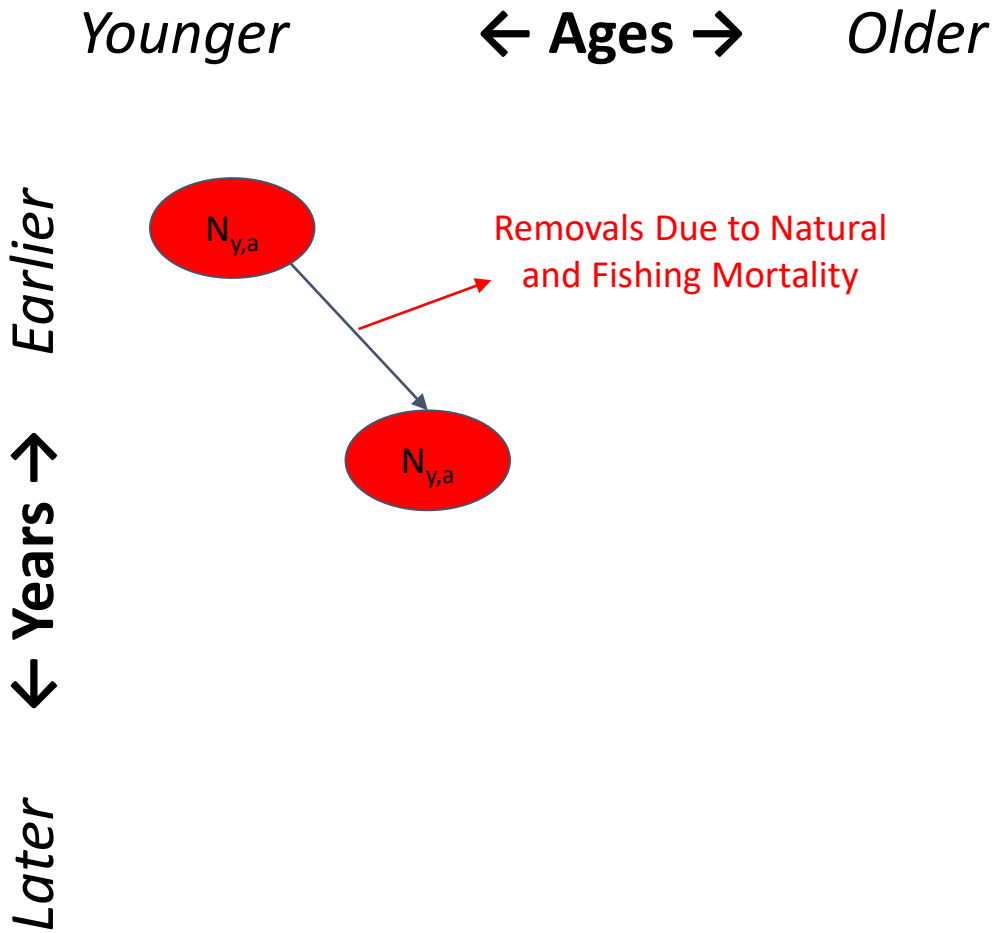

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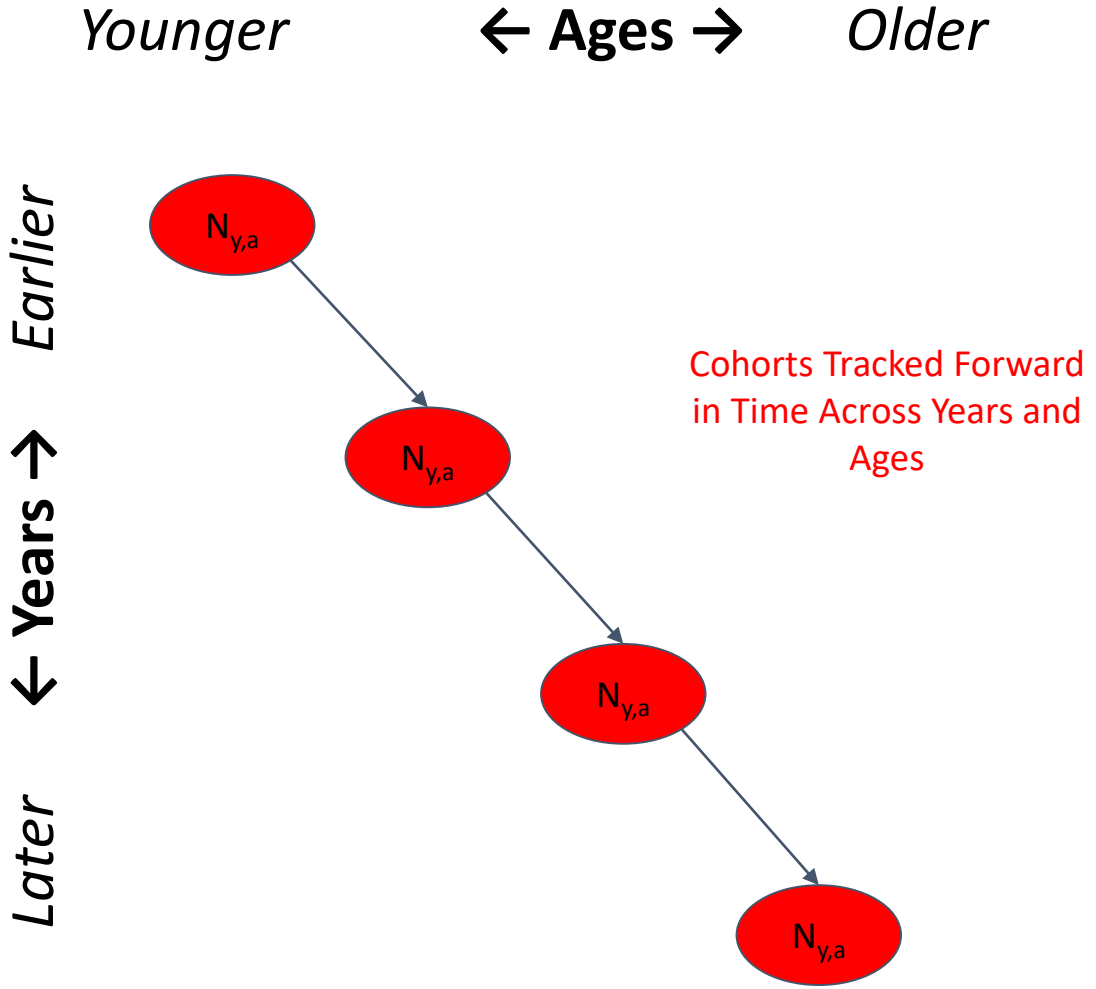

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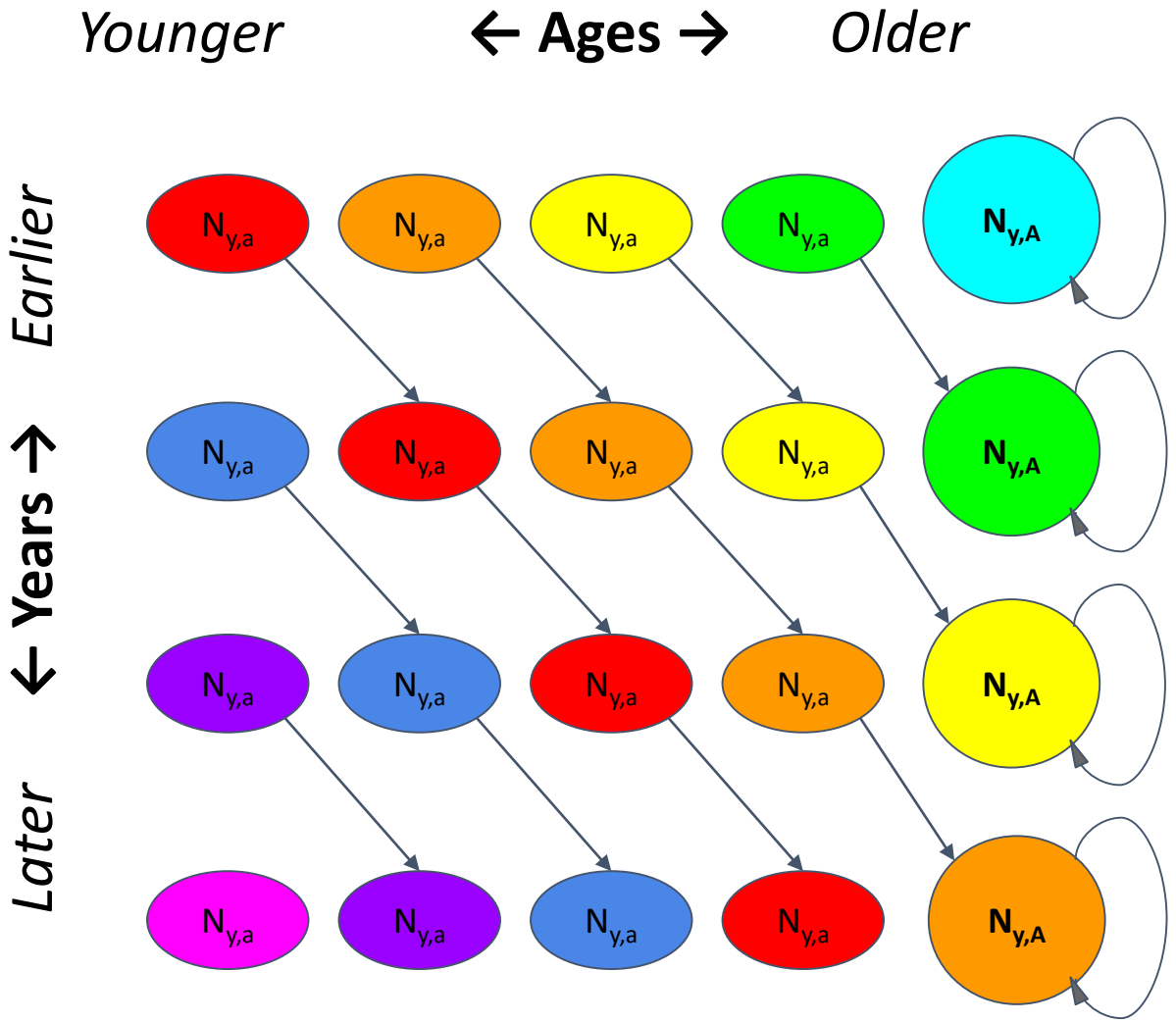
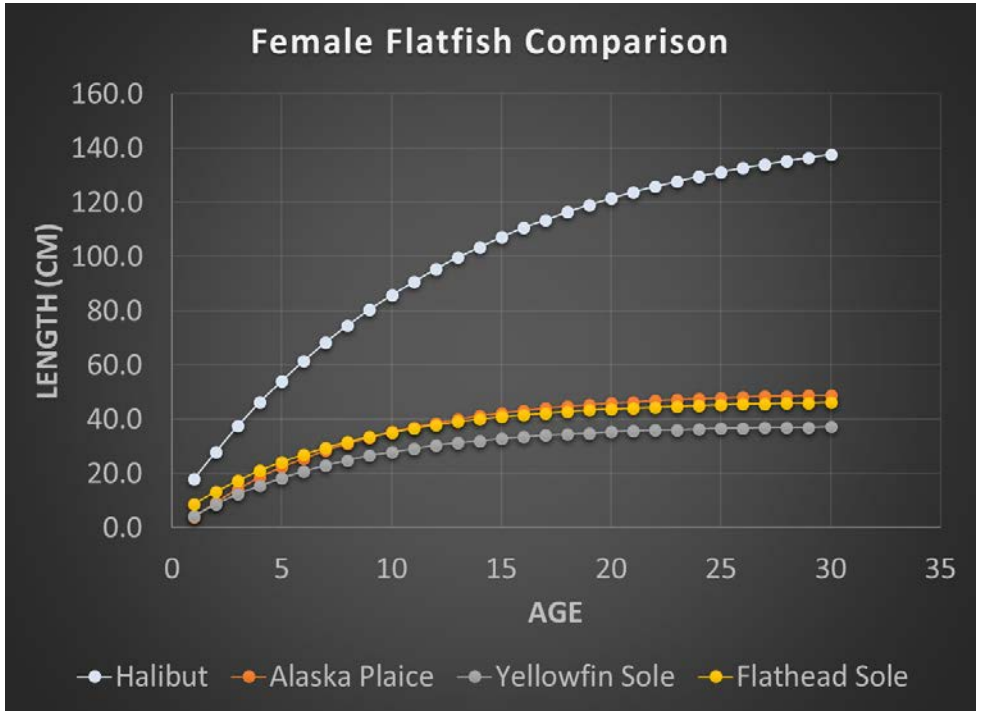
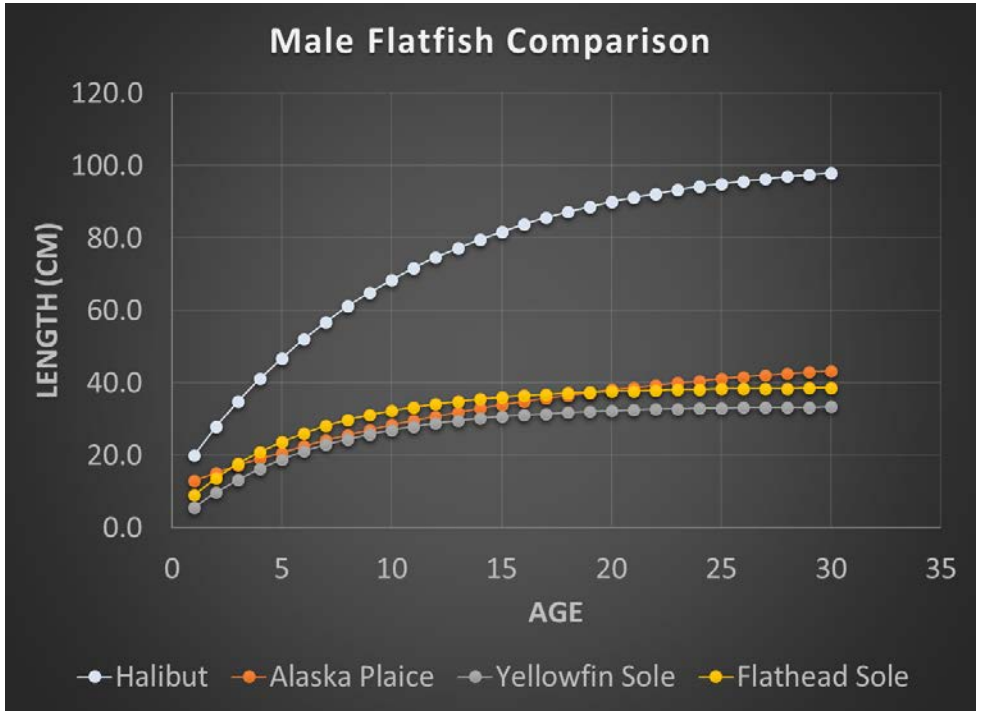


Natural Mortality

- Halibut natural mortality will be fixed at estimates from the IPHC Coastwide Long assessment model:
  - M_{Female}= 0.22
  - M_{Male}=0.17
- Natural mortality is assumed to be independent of age
  - Pacific halibut are larger than most flatfish species at age





Recruitment and Weight-at-Age

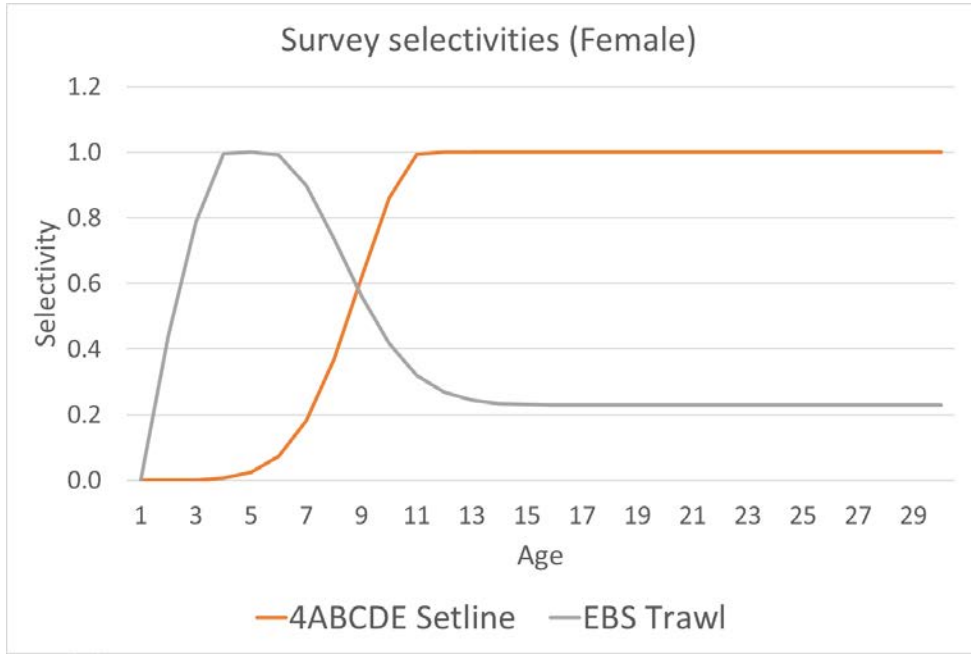
- A “high” recruitment and “low” recruitment scenario will be modeled
- “High” and “low” weight-at-age scenarios will be modeled

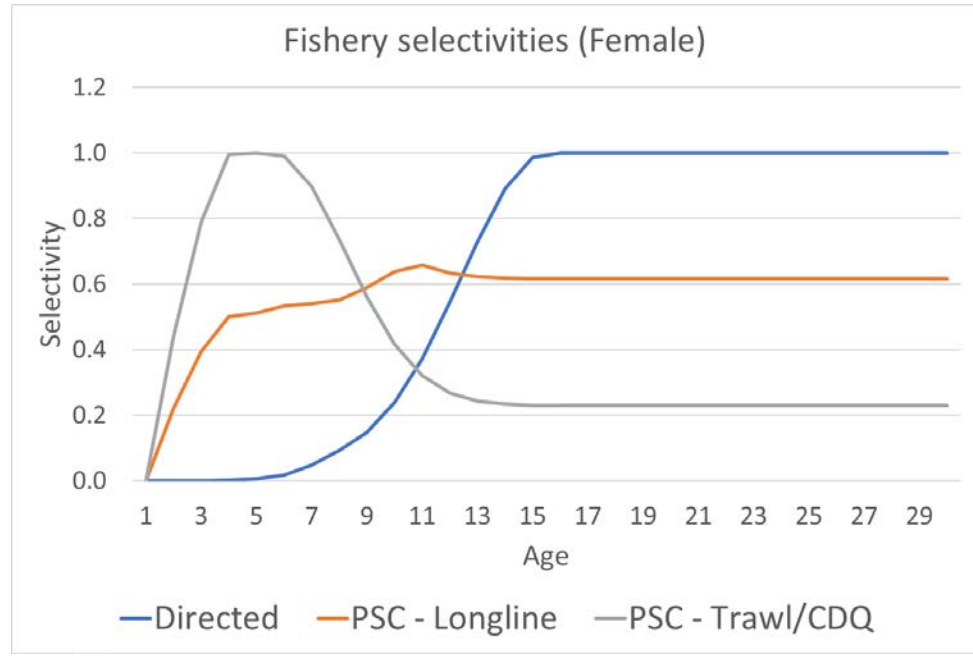
More recruitment details:

- We will use the two R0s estimated in the coastwide long model
- SigmaR = 0.85 (from the coastwide short model, which doesn’t estimate a linkage to the PDO)
- Steepness = 0.75
- Beverton-Holt stock recruit curve

Sector-specific selectivity: uses selectivities from coastwide-long assessment model

- Trawl PSC selectivity:
  - Set equal to trawl survey selectivity
  - Rationale: Best available information on plausible selectivity for trawl PSC alone
- Longline PSC selectivity:
  - Average of the 4ABCDE setline and the BS trawl survey selectivities for most recent year
  - Rationale: % O32 fish in the longline-caught PSC is much lower than for the setline survey, but higher than for trawl PSC. Hooks for Pacific cod are smaller than for the halibut setline survey.
- Directed fishery selectivity:
  - Sex-specific fishing mortality-at-age, summed over commercial, discard, sport, and subsistence values for most recent year
  - Rationale: Uses assessment results directly


Survey selectivities (Female)
Selectivity
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Age
4ABCDE Setline
EBS Trawl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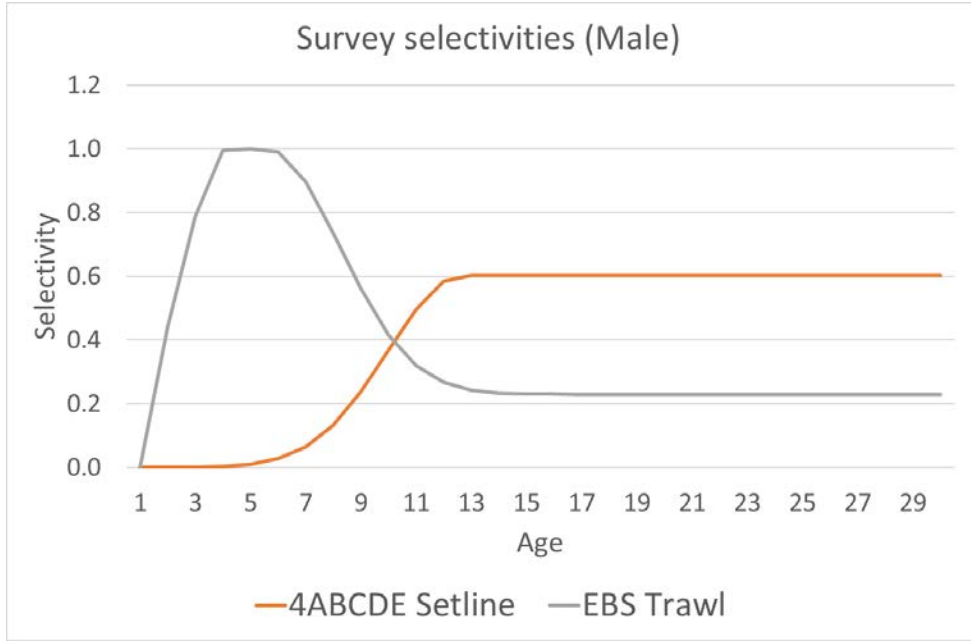
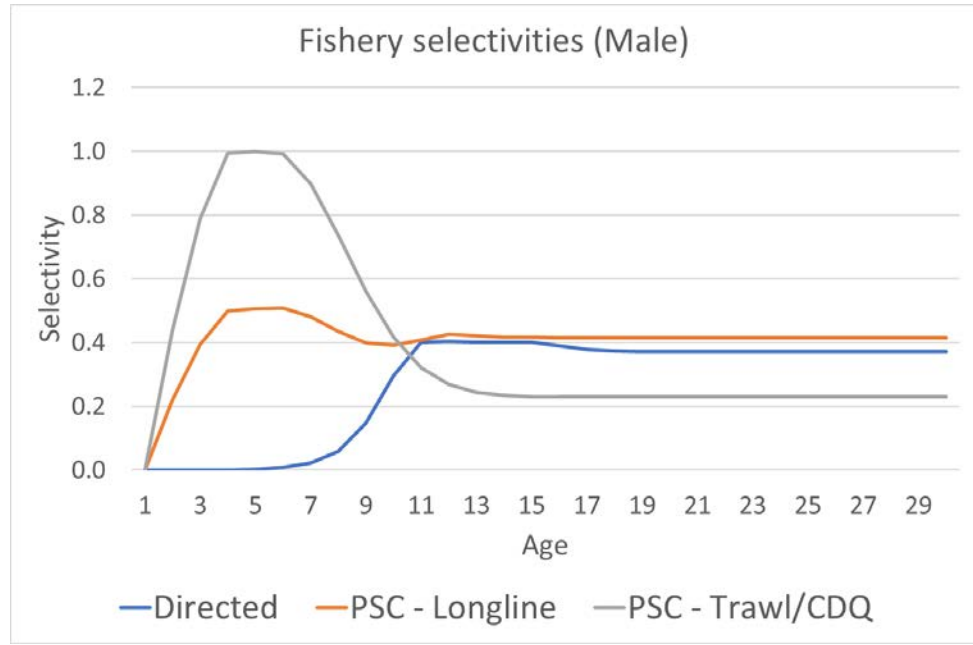
Age
Directed
PSC - Longline
PSC - Trawl/CDQ


Survey selectivities (Male)
Selectivity
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Age
4ABCDE Setline
EBS Trawl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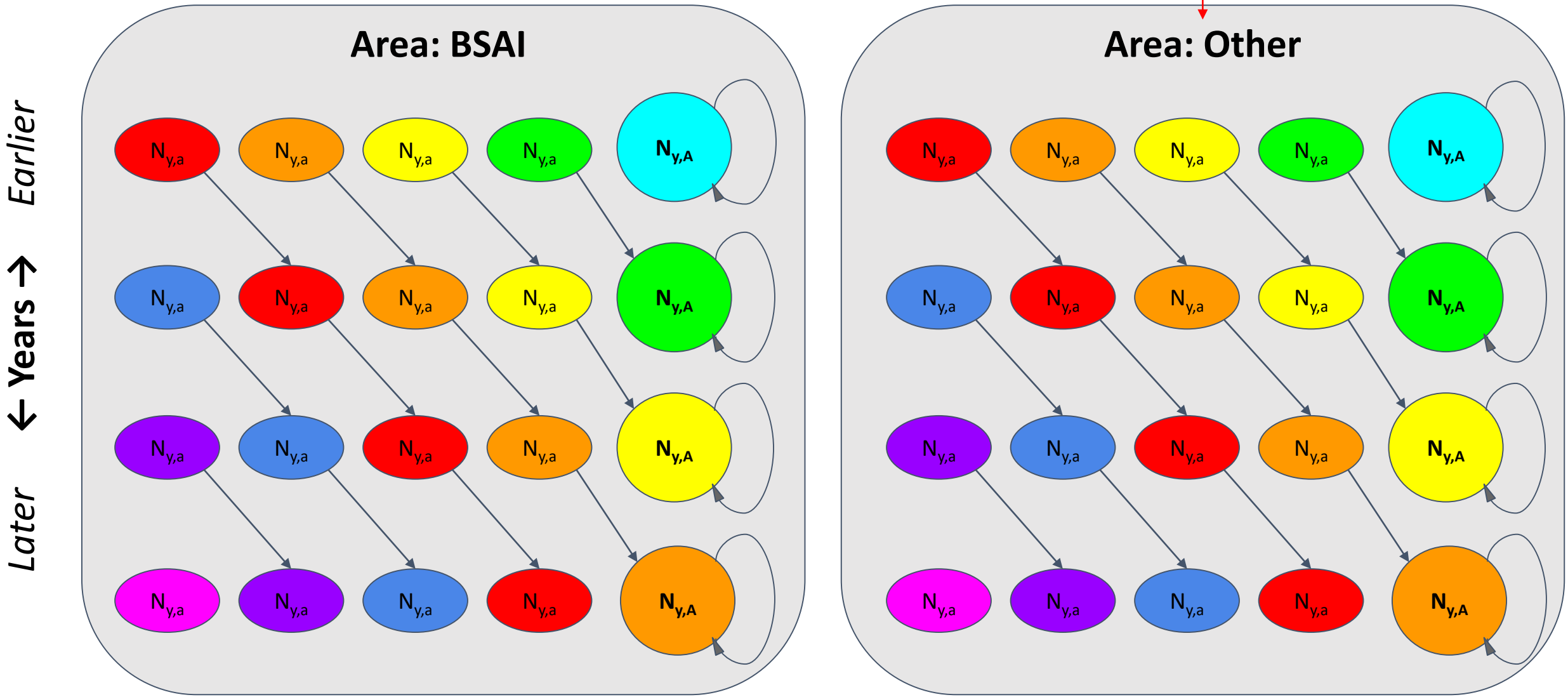
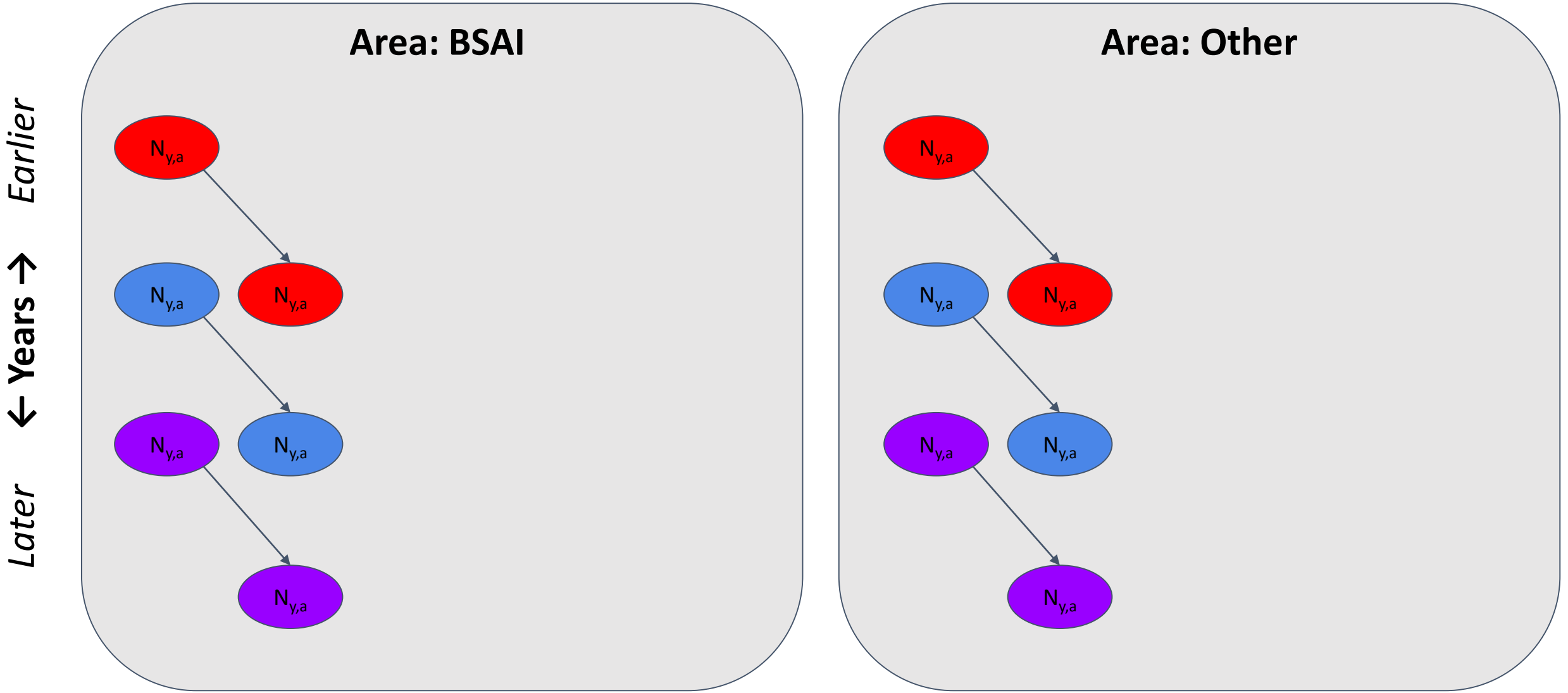
Movement Among Areas

Remaining GOA, BC, West Coast Range



Movement Among Areas

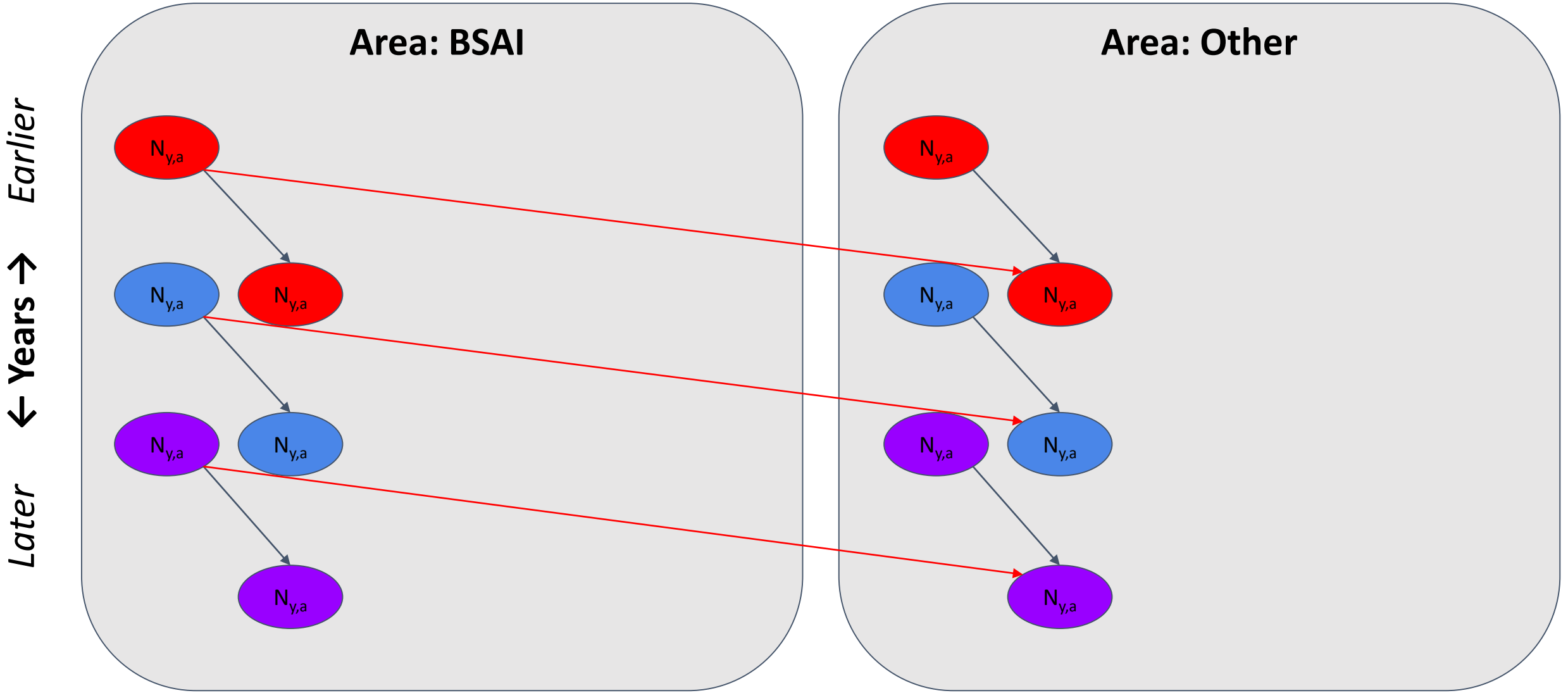
Survival



Movement Among Areas

Survival

Movement **Out** of BSAI

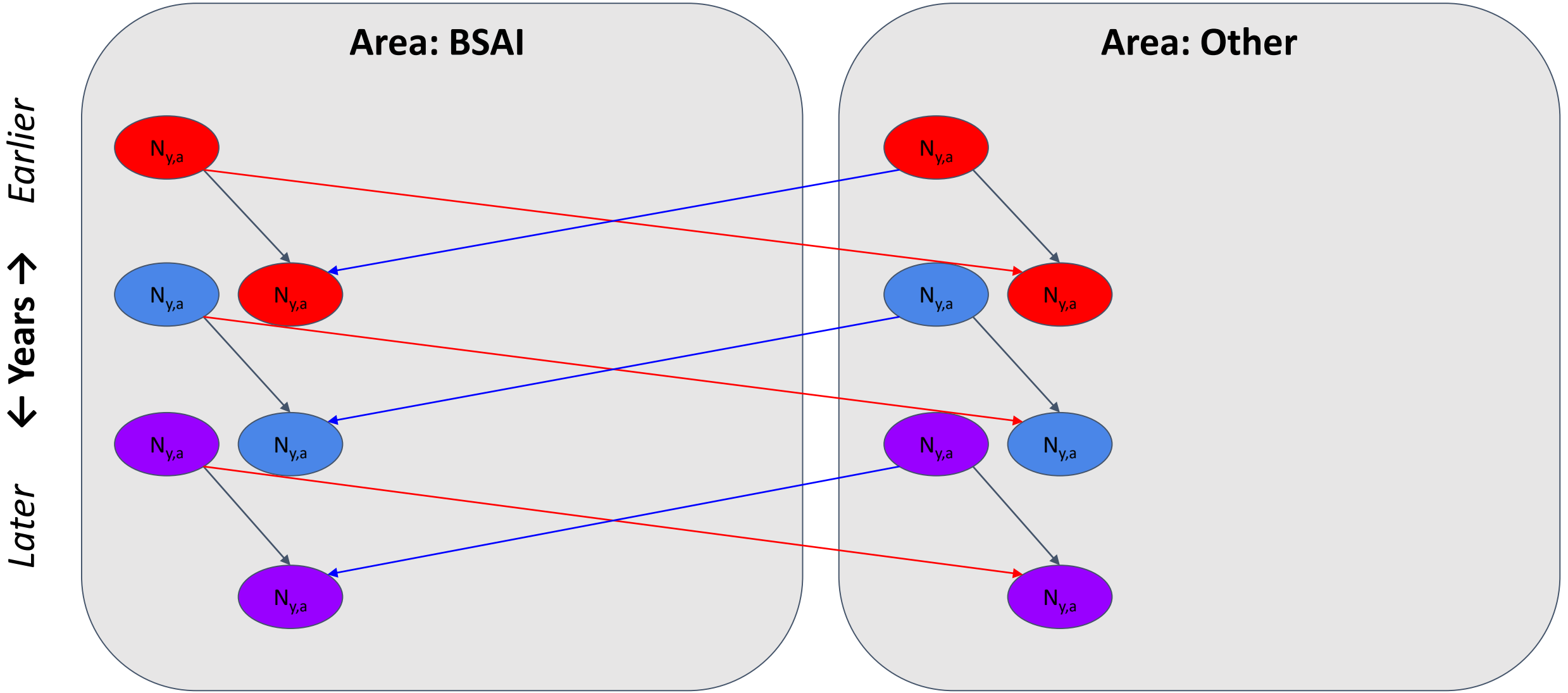


Movement Among Areas

Survival

Movement **Out** of BSAI

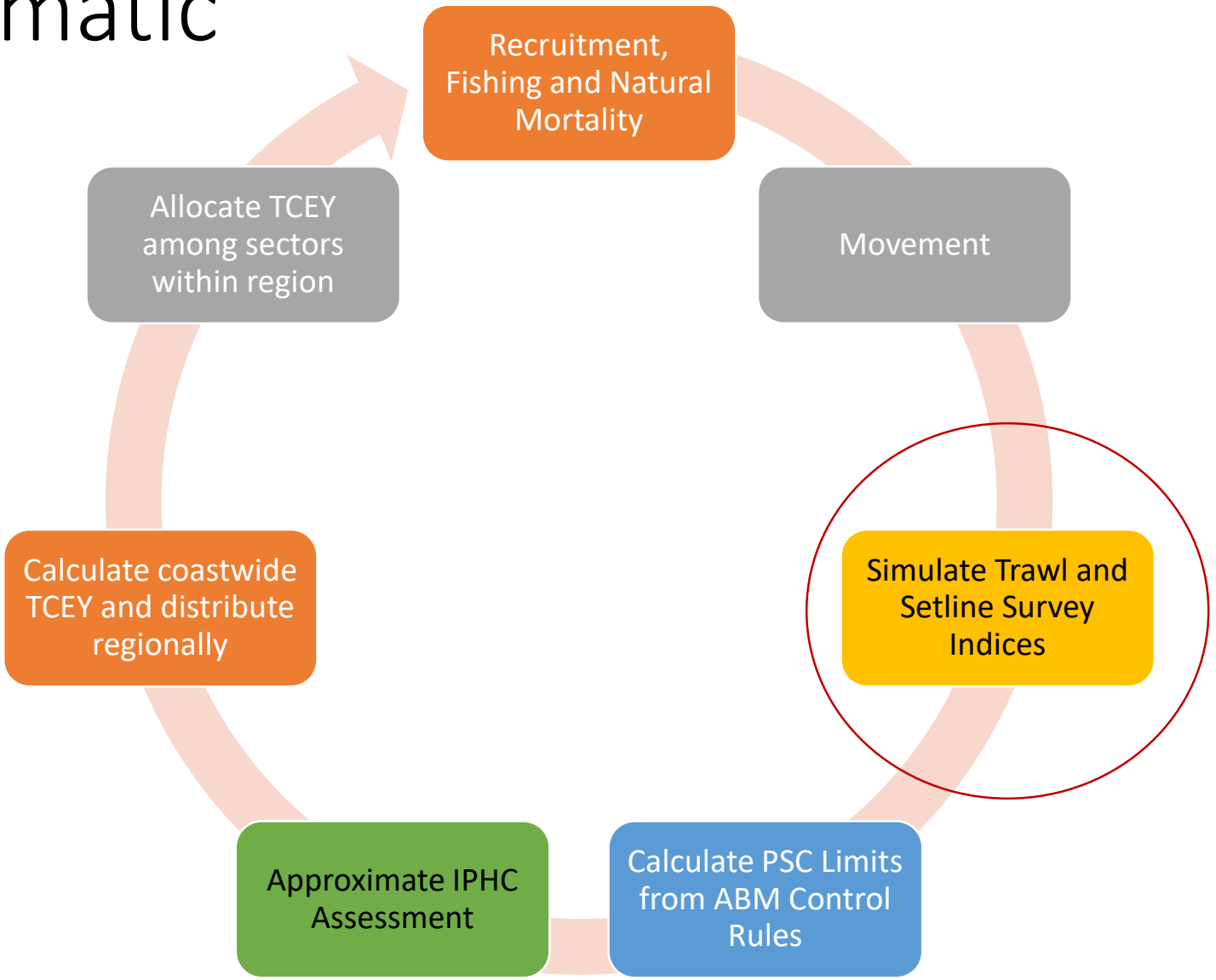
Movement **Into** BSAI



Modeling stock distribution scenarios to calibrate movement + recruitment allocation combinations

- The weight-per-unit-effort from the setline survey, however, gives us a proxy for the coastwide distribution of O26 fish among biological regions, and the range of what has been seen historically, which can be used to define scenarios:
    - High Bering Sea biomass, low coastwide biomass
    - High Bering Sea biomass, high coastwide biomass
    - Low Bering Sea biomass, low coastwide biomass
    - Low Bering Sea biomass, high coastwide biomass
- Combinations of movement + recruitment allocation parameters can be found that lead to these four scenarios under the status quo PSC limits.

Model Schematic



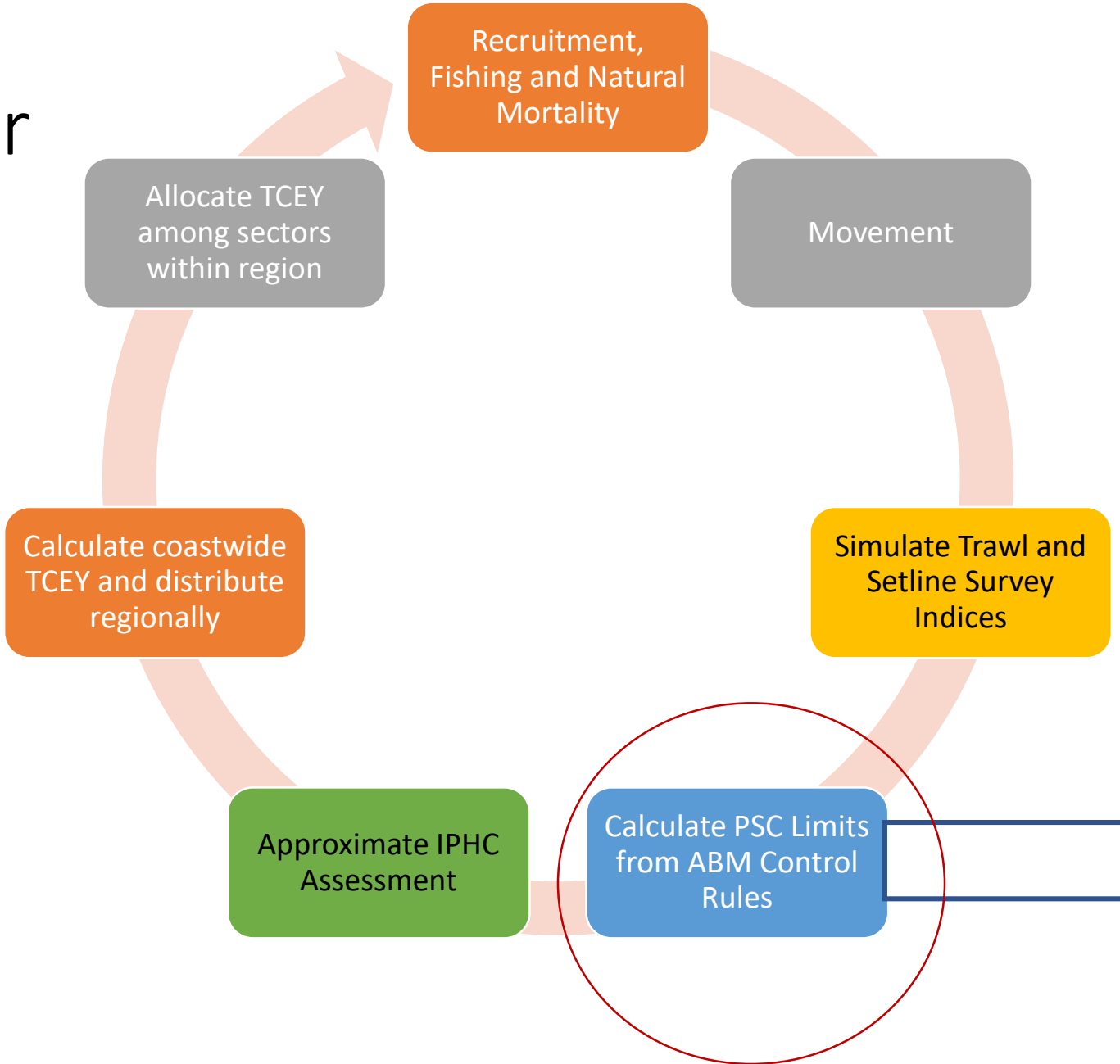
Simulating the Indices

Simulating the indices using lognormal error with the 1998-2018 average CVs for each survey

- Setline Survey CV = 10% (Lag 1 Autocorrelation = 0.77)
- EBS Trawl Survey CV = 7.3% (Lag 1 Autocorrelation = 0.69)

- Autocorrelation will not be specifically modeled, but autocorrelation from indices resulting from simulations can be compared informally to observed autocorrelation

Calculating PSC Limits for the following year

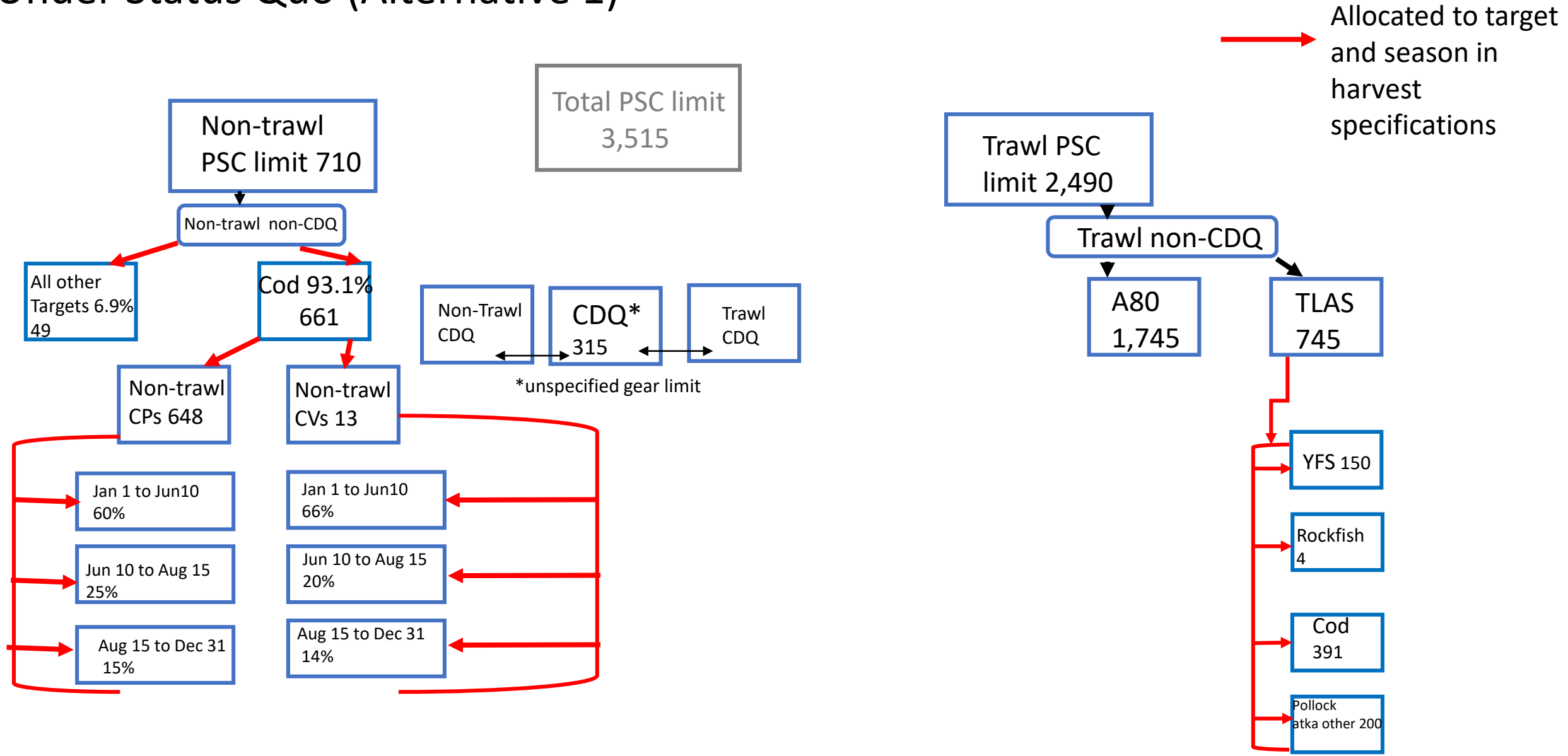


Calculation of distributing PSC limits to sectors for the next year

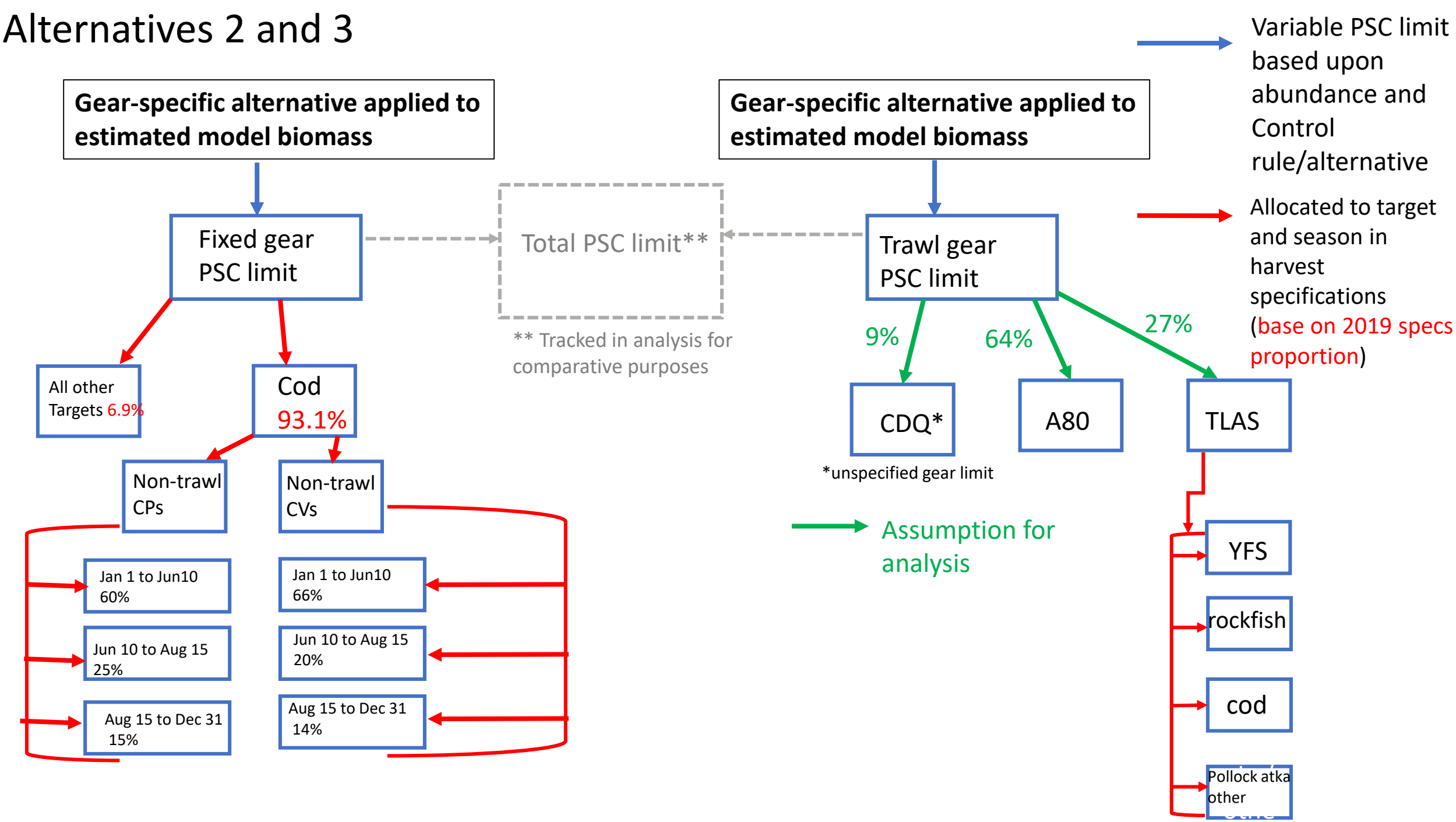
For each alternative in each year this generates:
-PSC limit for all trawl next year
-PSC limit for LL next year

Allocate PSC Among Groundfish Sectors

Under Status Quo (Alternative 1)



Alternatives 2 and 3



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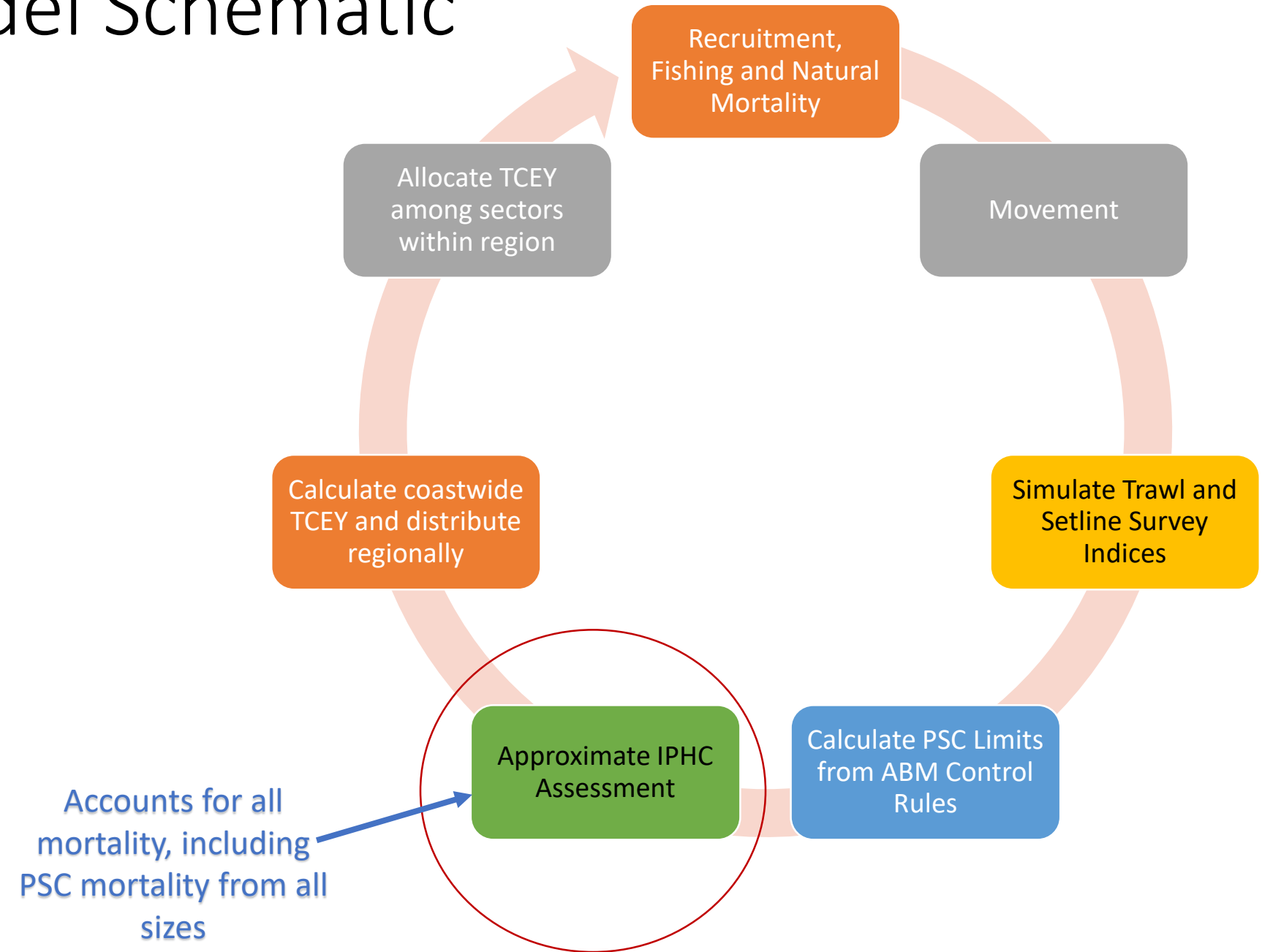


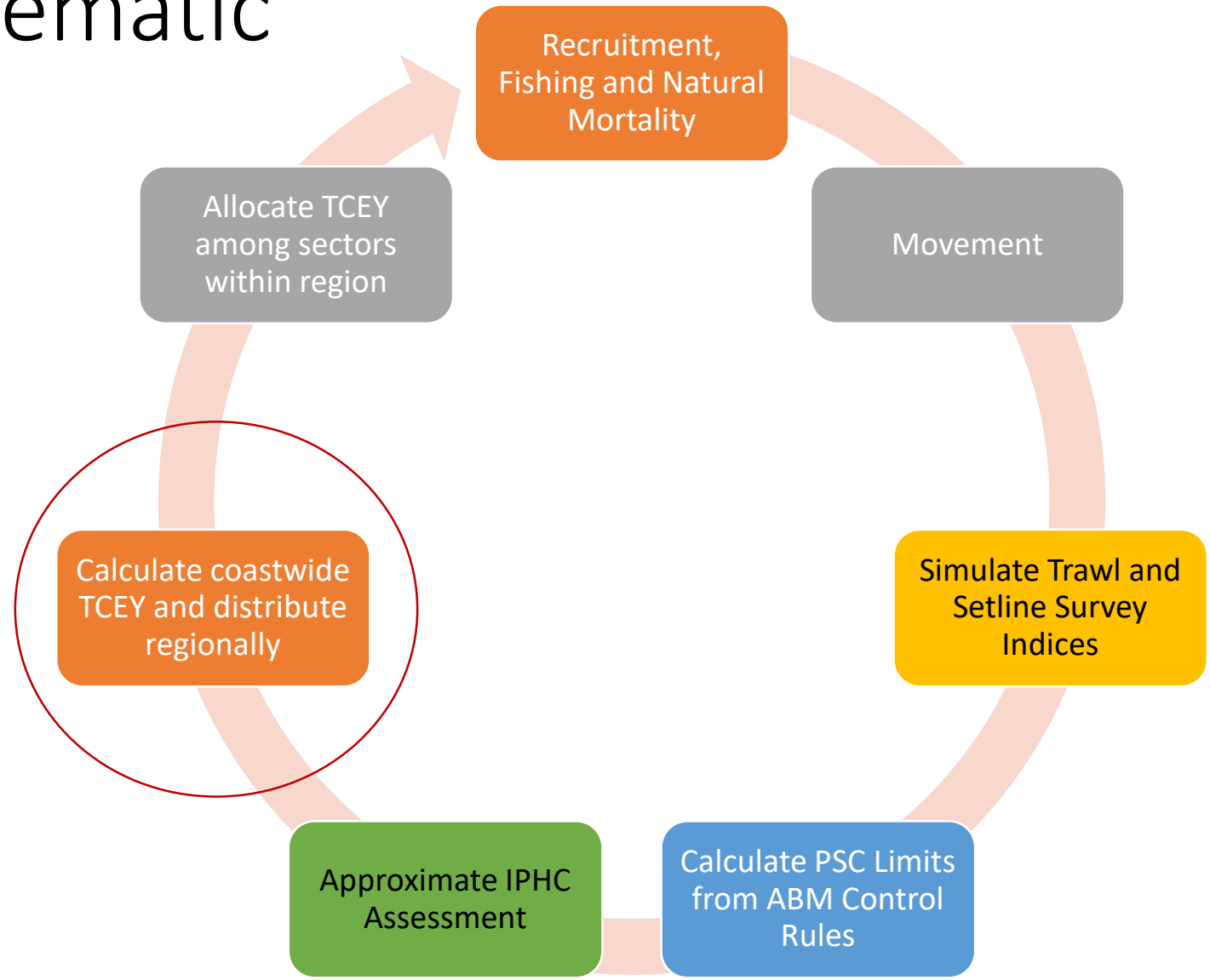
What should we assume about PSC usage relative to the limit?

- Proposal: Use the 3-year average proportion of the PSC usage:PSC limit from the data
  - This assumes that the relationship between usage and limit is independent of the abundance of halibut and the PSC limit itself

Approximate the IPHC Assessment

- True SSB, with autocorrelated lognormal error applied
- Autocorrelation in SSB estimates from the 2018 coastwide long model is 0.862
- Need to define a magnitude of error to apply to coastwide spawning biomass that, combined with autocorrelation, will be the "assessment" step.
- Incorporating autocorrelation in the assessment step is a way to account for the fact that assessment model biases are likely to be consistent from one year to the next

Model Schematic



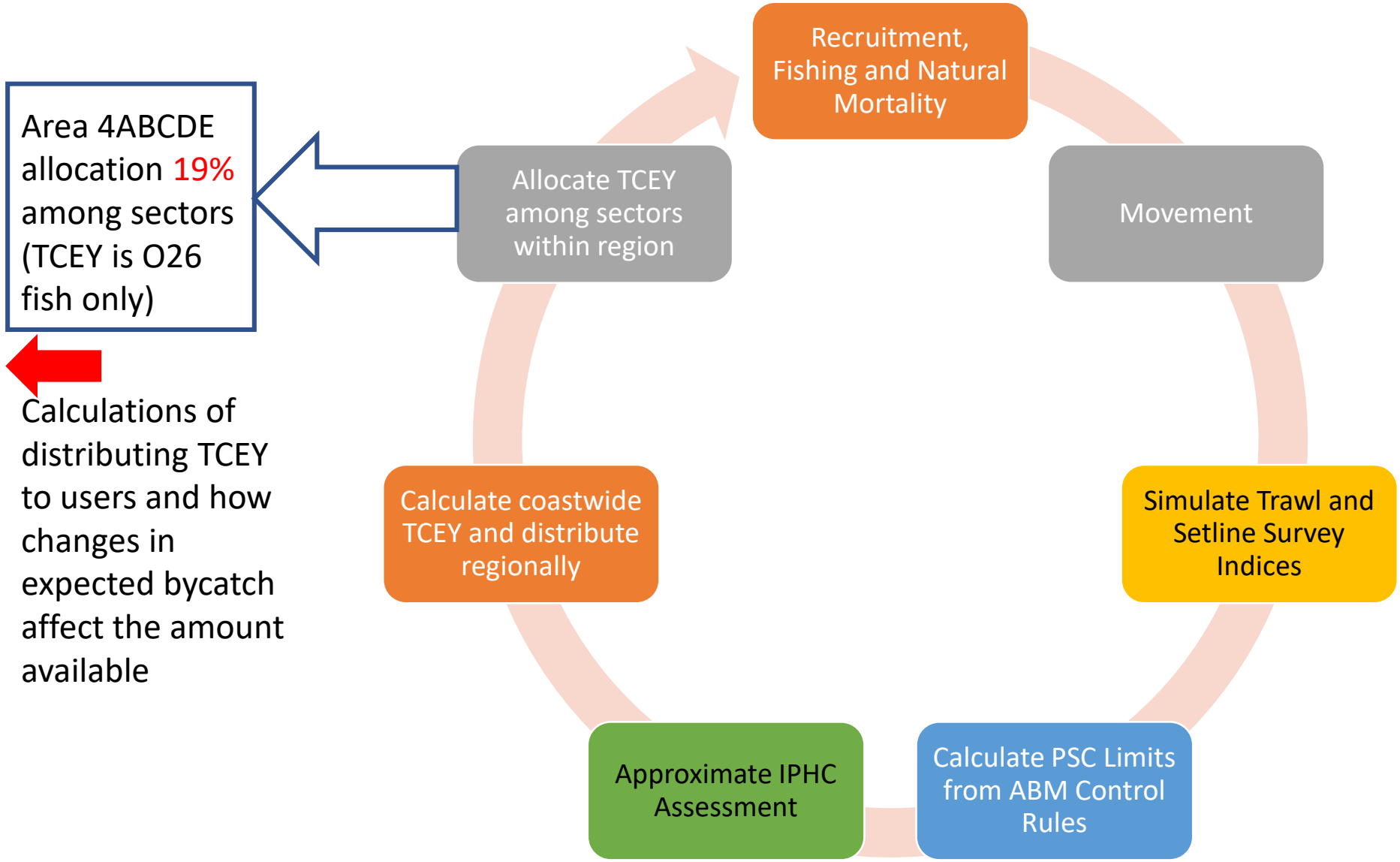
Calculate Coastwide TCEY

- Random Draw for SPR ~ Uniform(40%-46%)
  - This will combine three sources of uncertainty
    - Target SPR in future
    - IPHC agreement with management recommendation
    - Implementation uncertainty is captured in the choice of target SPR
- Apply the 30:20 control rule, where fishing is at the chosen Fspr if spawning biomass is above 30% of unfished
- NOTE: TCEY is only for O26 fish
  - We will use a 1:1 mapping of 26 inch fish to a particular age using a mean length-at-age relationship appropriate for the weight-at-age scenario being modeled, by sex

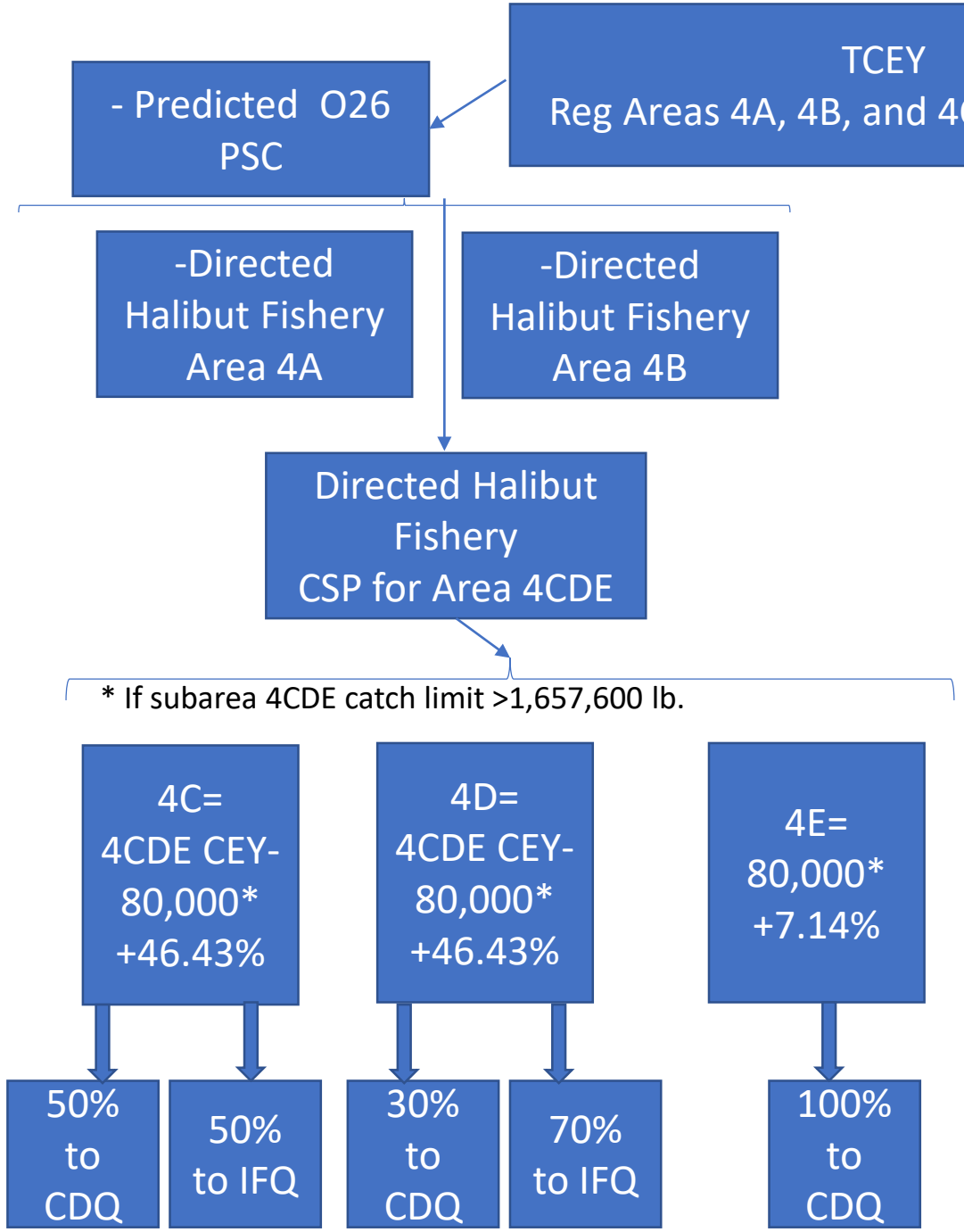
Distribute Coastwide TCEY Regionally

- We will use the proportion of TCEY distributed to the BSAI according to specifications agreed upon by the IPHC in 2019
  - This year's methods for distributing TCEY between the US and Canada is the intended method for four years
  - Decisions about distribution of TCEY among US areas will be made each year, but justification and results may be similar in the future
  - Therefore, the near future distribution of TCEY is more likely to be similar to the 2019 distribution of TCEY than to its distribution in other past years.

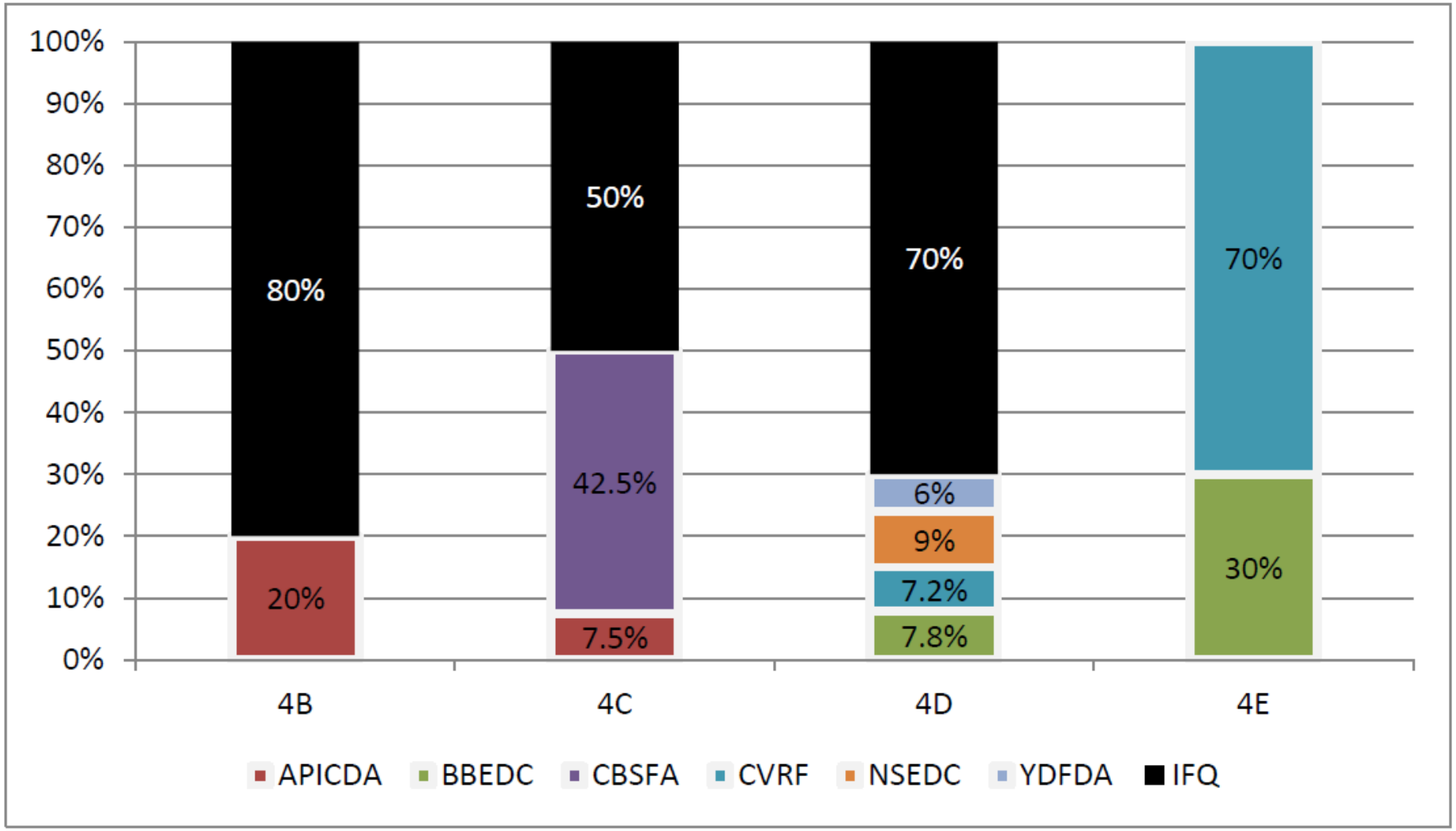
  - **4ABCDE proportion in 2019 = 19%**


Area 4ABCDE allocation 19% among sectors (TCEY is O26 fish only)
Calculations of distributing TCEY to users and how changes in expected bycatch affect the amount available
Allocate TCEY among sectors within region
Recruitment, Fishing and Natural Mortality
Movement
Simulate Trawl and Setline Survey Indices
Calculate PSC Limits from ABM Control Rules
Approximate IPHC Assessment
Calculate coastwide TCEY and distribute regionally

Distribute BSAI TCEY to directed fishery components



- TCEY is O26 inch fish only
- Use a 1:1 mean length-at-age relationship to map O26 to an age of halibut
- Calculate amount of PSC usage from the previous year that was O26
- Subtract last year's O26 PSC usage from the TCEY for the BSAI to find the TCEY for the directed components of the halibut fishery



Source: 2016 CDQ program quota categories, target and non-target CDQ reserves, allocation percentages, and group quotas: https://alaskafisheries.noaa.gov/sites/default/files/reports/annualmatrix2016.pdf

Capturing uncertainty: modeling variability vs scenarios

Modeling Variability

- Estimation error in the assessment step
- Implementation error
- Variability in specifying coastwide TCEY
- Observation error on the survey indices
- Annual recruitment deviations

Modeling Scenarios

- Low and high recruitment
- Low and high weight-at-age
- Relative adult abundance in the BSAI:
  - Low/high in the BSAI + low/high coastwide (4 scenarios)

- **Input needed**: Doing a full cross of modeling scenarios and alternatives would be a very large number of model runs. Can we instead do a base case, and try one scenario at a time?

Model outcomes for each scenario and alternative

- Mean/Median PSC limits, halibut spawning biomass, directed fishery catch + corresponding uncertainty intervals about these quantities

- Catch stability metric for directed halibut fishery, such as AAV

- A stability metric for PSC limits, such as AAV

Performance metrics

- Workshop in February 2017
- Review and feedback on performance metrics June 2017
- Reviewed by stakeholder committee during February 2019 committee meeting
- WG met with stakeholders individually following to help draft their performance metrics for consideration, revised version from 3 groups submitted
- Some additional considerations for analysis also noted in stakeholder feedback

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high	Average PSC limit	NA	short and long term	Average (PSC limit)
	The PSC limit is below the 2016 PSC limit a certain percentage of time.	3,515 t	short and long term	P(PSC limit < 3,515t)
	The PSC limit is below the 2016 PSC catch a certain percentage of time.	2,337 t	short and long term	P(PSC limit < 2,337t)
	Maintain CPUE above a minimum value to reach the TAC (and below PSC)		short and long term	P(CPUE < ???)
	An open groundfish fishery	**Ratio of PSC/target TAC**		**Changes in encounter rates**
	Revenue generated/costs incurred	**Ave sector revenue**	**Short and long term**	**P(revenue < average)**
		Ave sector costs	**Short and long term**	**P(revenue < average)**

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
There should be flexibility provided to avoid unnecessarily constraining the groundfish fishery particularly when halibut abundance is high	**PSC limit >actual use (2015-2017 base) at primary index = 1**			
	PSC limit >actual use (2015-2017 base) at primary index = 1, secondary >1			
	PSC limit >actual use (2015-2017 base) at primary index = 1, secondary <1			
	PSC limit constrained by ceiling			
	PSC limit constrained by floor			
	Annual change in PSC limit			
	PSC limit constraint at % of limit (e.g., ranges of % of limit 80, 90 and when in season it is hit)			

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
Provide for directed halibut fishing operations [in the Bering Sea].	A minimum FCEY in 4CDE			P(FCEY < ???)
	A target FCEY in 4CDE		short and long term	P(FCEY < ???)
	The proportion of the directed fishery catch limit is greater than X% of the total catch limit (floor and ceiling?)		short and long term	P(FCEY/TCEY < ???)
	Area 4 CDE TCEY = 75% of 2018; a range of additional percentages		**Short, medium and long term**	**TBD**
	Area 4 TCEY = zero		**Short, medium and long term**	**TBD**
Maximize directed fishery yield	**Area 4 TCEY > Historic Average 2002-2011; a range of additional historic periods**			

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
Halibut spawning stock biomass should be protected especially at lower levels of abundance	Measure the impact on spawning biomass	NA	short and long term	Fishery-specific SPR
	Not allow the impact on the spawning biomass to exceed a specific level.		short and long term	P(SPR < ???)
	Maintain the spawning biomass above a value		short and long term	P(SB < ???)
	Maintain a diversity of sizes in the population.		long-term	
	Maintain the spawning biomass above critical levels	20% of equilibrium	short and long term	P(SB < 20%)

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
Provide for some stability in PSC limits on an inter-annual basis	Achieve a level of inter-annual variability in PSC levels that is below an acceptable level	NA	short and long term	Average annual variation (AAV) in halibut PSC limit P(AAV < ???%)
				Average annual variation (AAV) in halibut PSC limit with 15% change
				# times 15% change is used
				Change in biomass estimates from surveys (mt and %)

Council Objectives	Measurable objective	Threshold	Time Frame	Performance metric
Halibut limits should be indexed to abundance	The change in PSC limit has a minimum level of variation relative to the indices		General	Slope (b) of combined control rule > ???
	The range of the index for which a minimum level of variation is achieved.		short and long term	P(floor used) P(ceiling used)
	PSC is proportional to halibut abundance		short and long term	PSC limit change relative to halibut biomass
	Incorporate appropriate size ranges to index the important components		short and long term	Indices apply to segments of population (e.g., U12, O26)
	Value of primary index			**P index > < 1**
	Value of secondary index			**P index > < 1**
	Proportion of U26 and O26 in PSC and Surveys			

Some stakeholder feedback (not specific to performance metrics)

- Impacts of cod abundance and distributional changes
  - Impacts of cold pool and distribution of cod
  - Population decline
  - Potentially > constraint on fishery than halibut
    - Exacerbated by multiple other management actions (shift to GHL fishery, TLAS season shortened, management actions on-going and under consideration)
- Changing abundance and distribution of other groundfish species
- Potential for continued BBRKC decline and related impacts on groundfish fishery closures (10 nm strip and/or potential Zone 1 closure)

Other stakeholder feedback (general)

In the analysis compute:

- Probability directed fishery quota below a specified amount

  Could be economic viability amount linked to catch-sharing plan for 4CDE, or a desired quota that would provide economic opportunity for the communities in the Bering Sea and Aleutian Islands

- Median and range of simulated quotas

  Provide insight on directed fishery expectations

- Annual variability in the quota

  provides insight into the stability of the directed fishery – how much the opportunity for the directed fishery could change from year to year

- TCEY proportion of the quota

  Insight on equity of the allocation to the groundfish and directed Pacific halibut fishery

- Proportion of O26 (over 26 inch Pacific halibut) in the PSC (bycatch)
- Extent proposed management program incentivizes trawl fishery

  E.g., use of halibut excluders and deck sorting

Other stakeholder feedback (general)

- Characterize lower and upper bound of a bycatch rate performance metric using 2017 (low) and highest year (high) [Amendment 80]
- Consider transferability of PSC between sectors
- Changes in distribution of halibut due to environmental factors (temperature relationships with encounter rates)
- Changes in survey methodologies and estimation of U26 biomass, change in TCEY methodologies

Assessing impacts to groundfish

- Empirical Approach:
  - Looking at encounter rates under various levels of biomass and at various PSC limits
  - Looking at whether PSC limits emerging from the 2-area halibut-only model are within or outside of the range of limits and usage in the past
- Technical interactions modeling scenarios

Input needed from SSC

- How do we choose biological scenarios so that we have a tractable number of scenarios + sub-set alternatives to run and report on?
- Are there additional performance metrics that are needed?
  - Short and long term (years to define short term)
- Is there any methodology that needs to be adjusted?

End