AIGKC harvest strategy development

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Current Regulations: 5 AAC 34.612

(a)

TAC fixed in regulation

- east of 174° W long.: 3.31 million pounds
- west of 174° W long.: 2.98 million pounds

(b) The department may reduce the harvest levels in (a) of this section based on the best scientific information available, in considering the reliability of the estimates and performance measures, uncertainty as necessary to avoid overfishing, and any other factors necessary to be consistent with sustained yield principles.

Assessment Model

- Previously a Tier 5 stock, average catch OFL
- Stock assessment model approved by CPT/SSC in May/June 2017
  - Now Tier 3
  - Estimates of recruits, mature males, legal males
- State now developing a harvest strategy
  - Now have population estimates from model
  - Goal: TAC respond to population fluctuations
  - Present to BOF at March meeting

Timing mismatch of assessment and TAC setting

- OFL/ABC recommended by CPT in May
- Council/SSC approves OFL/ABC in June
- TAC set in July
- Fishery starts in August

Because the CPT recommends OFL/ABC in May and the fishery ends in May, the ongoing fishery data (most current) is not included in the OFL/ABC.

However, model simulations CAN be completed after the OFL/ABC are approved by the CPT/SSC (but before TAC setting) with the most recent fishery data.

As such, OFL/ABC is lagged by 1 year, but population estimates are not.

Harvest Strategy Core Elements

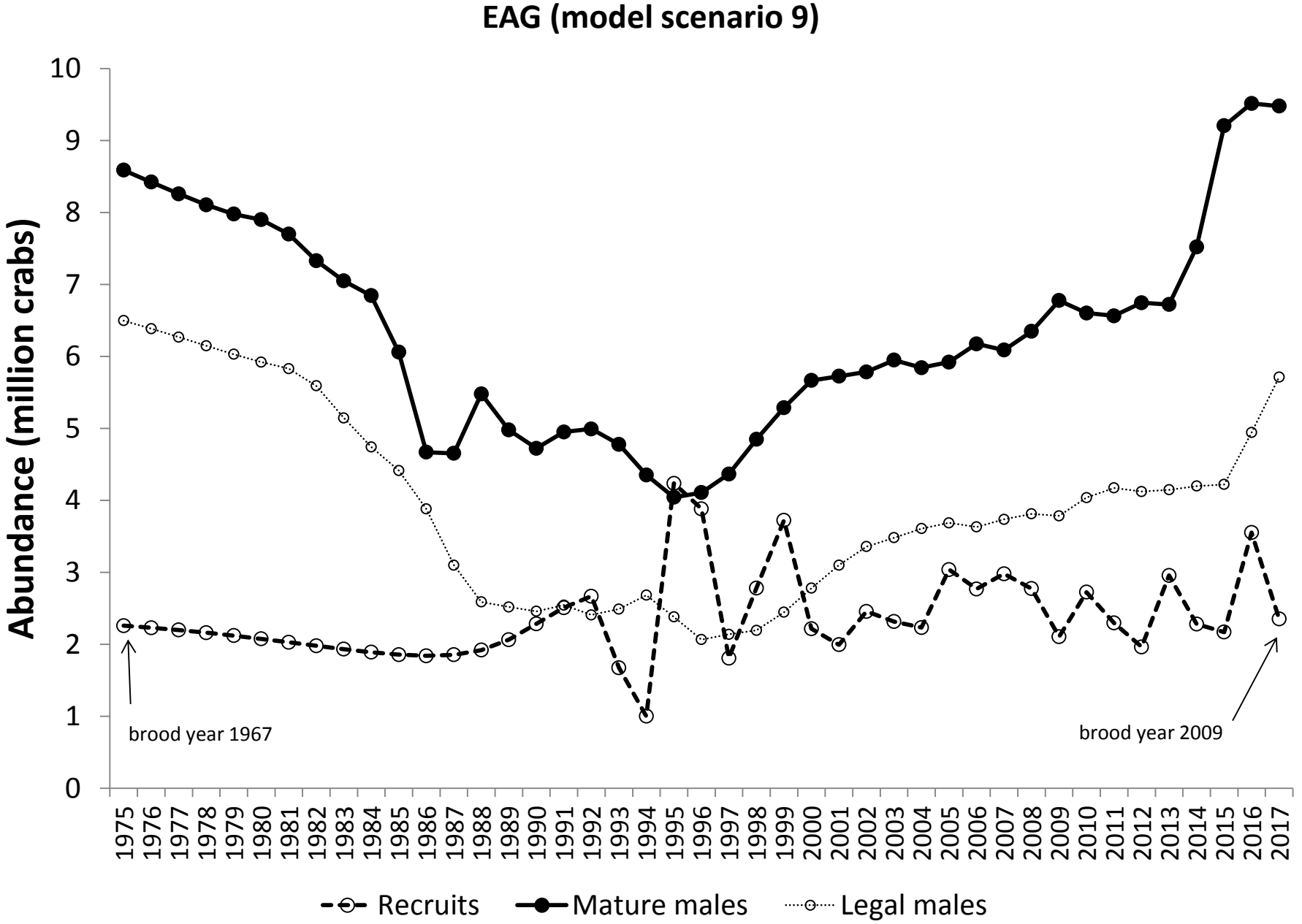
1. Threshold for opening/closing fishery
2. Exploitation rate on mature males
3. Maximum allowable exploitation rate on legal males

Threshold for opening fishery

- Current year point estimate relative to long-term average
  - MMA/MMA_{ave} = 25%?
  - Follows federal assessment F_{OFL} control rule: "critical biomass threshold"
  - Separate for EAG + WAG
- What years should be used for the long-term average (MMA_{ave})?

What years should be used for the long-term average (MMA_{ave})?

"The mean MMB calculation time period should be 1987-2012. This was to avoid highly variable recruitments outside this time period that may interfere with the MMB estimates. This time period was accepted by the May 2017 CPT and the June 2017 SSC." (Shareef Siddeek, pers. comm.)


EAG (model scenario 9)
Abundance (million crabs)
0
1
2
3
4
5
6
7
8
9
10
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
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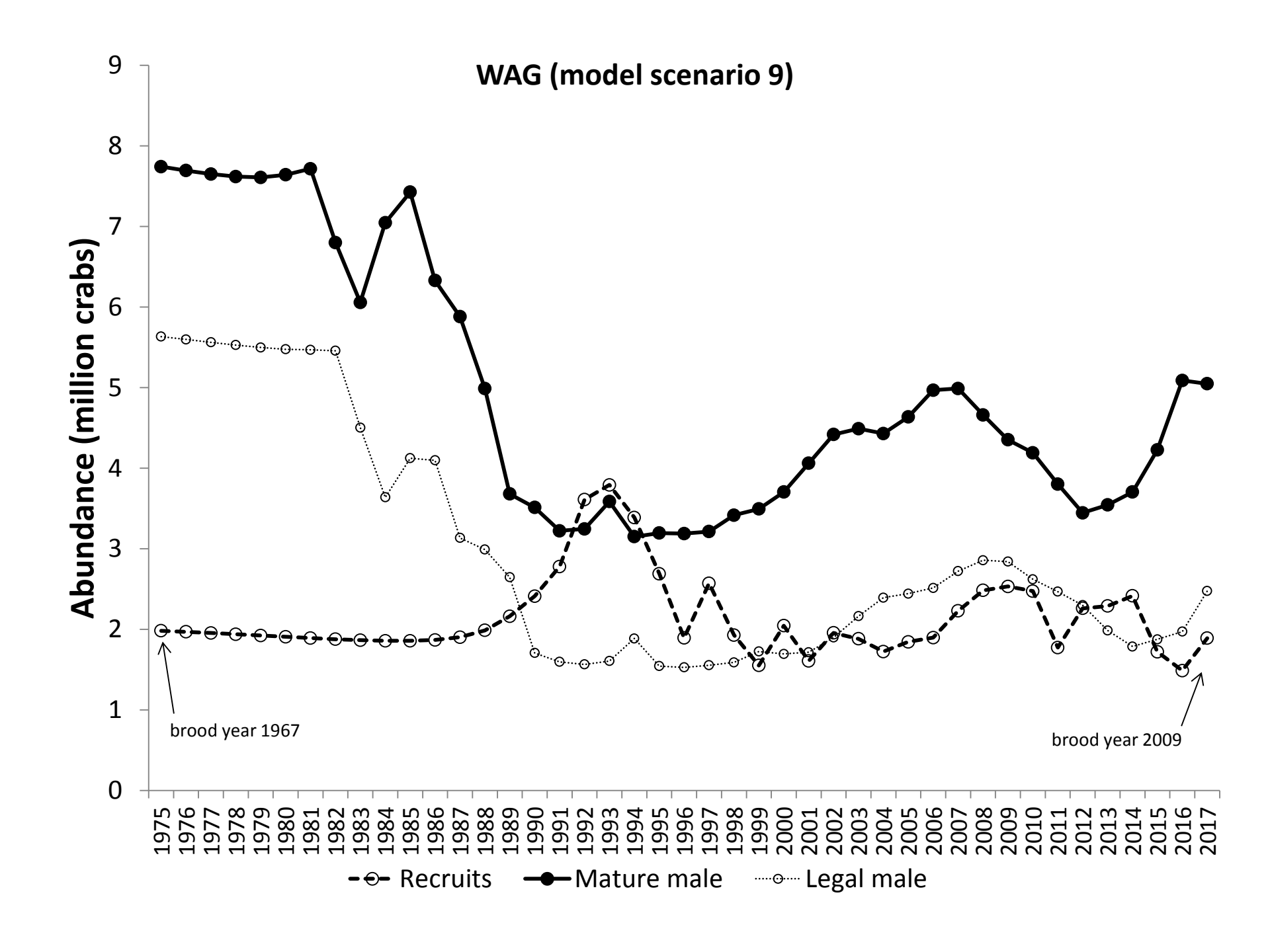
2016
2017
brood year 1967
brood year 2009
Recruits
Mature males
Legal males


WAG (model scenario 9)
Abundance (million crabs)
0
1
2
3
4
5
6
7
8
9
1975
1976
1977
1978
1979
1980
1981
1982
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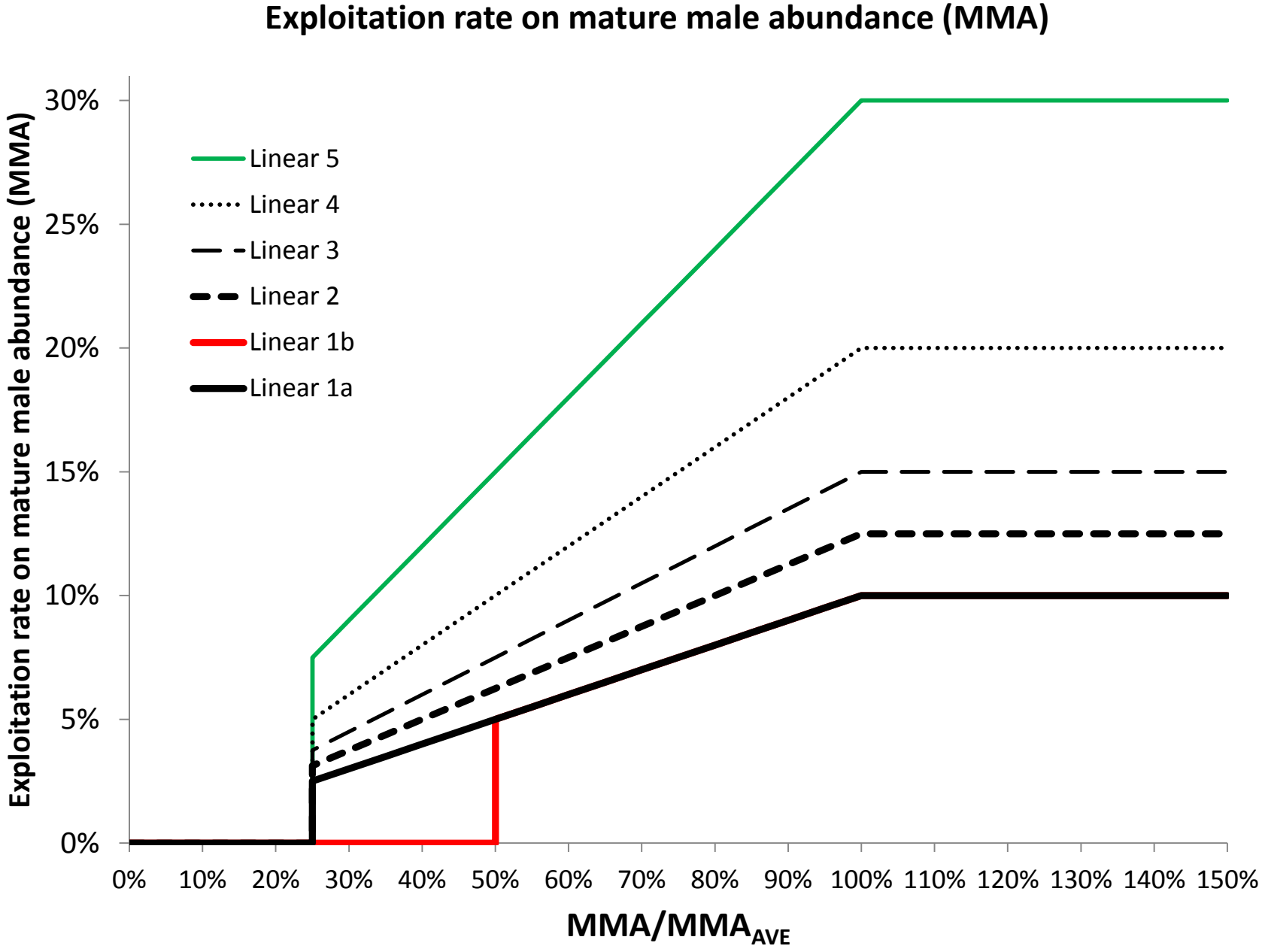
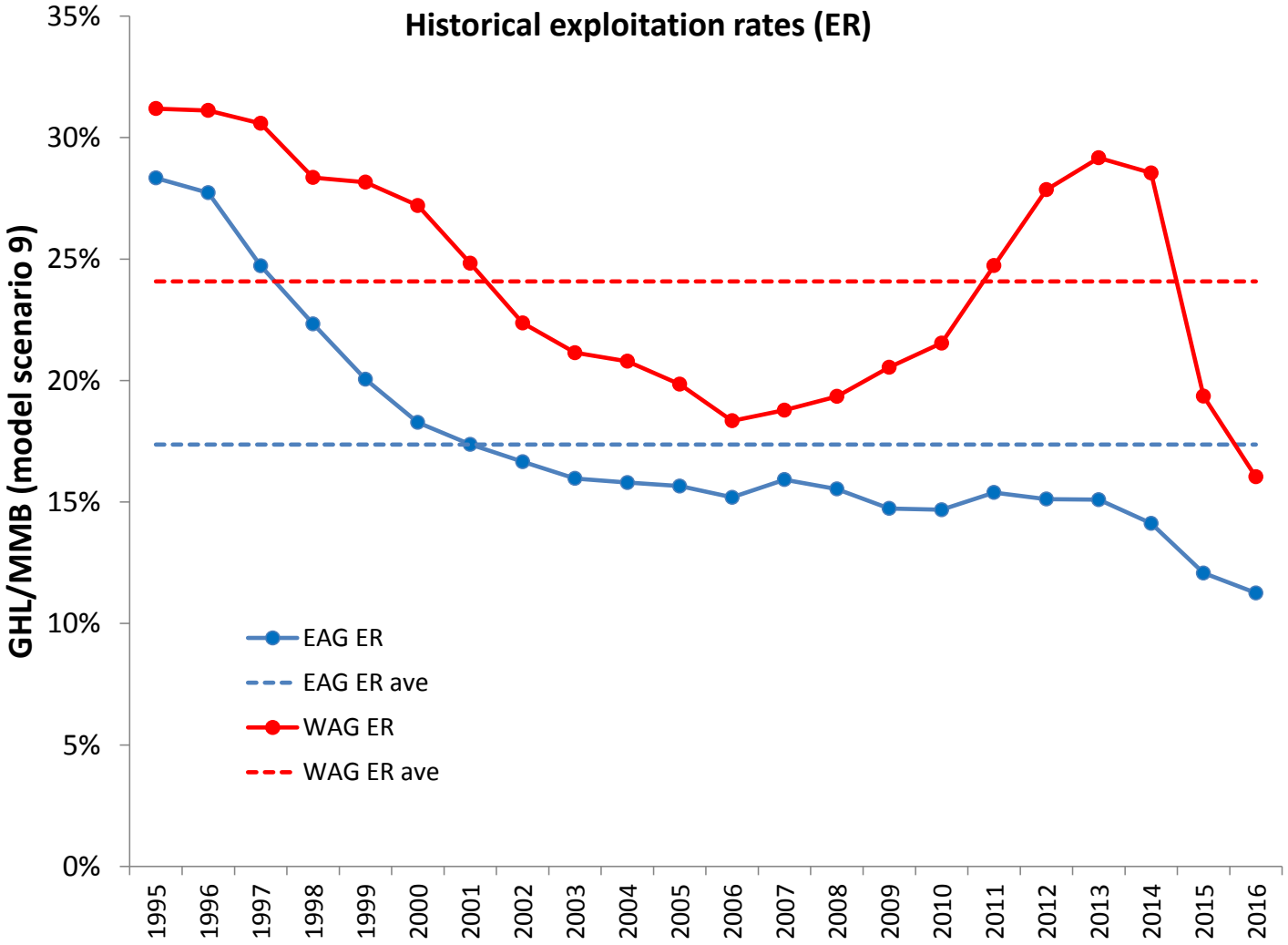
2016
2017
brood year 1967
brood year 2009
Recruits
Mature male
Legal male


Exploitation rate on mature male abundance (MMA)
Exploitation rate on mature male abundance (MMA)
30%
25%
20%
15%
10%
5%
0%
Linear 5
Linear 4
Linear 3
Linear 2
Linear 1b
Linear 1a
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
110%
120%
130%
140%
150%
MMA/MMA$_{AVE}$

How do the proposed exploitation rates in the previous slide compare to historical exploitation rates?

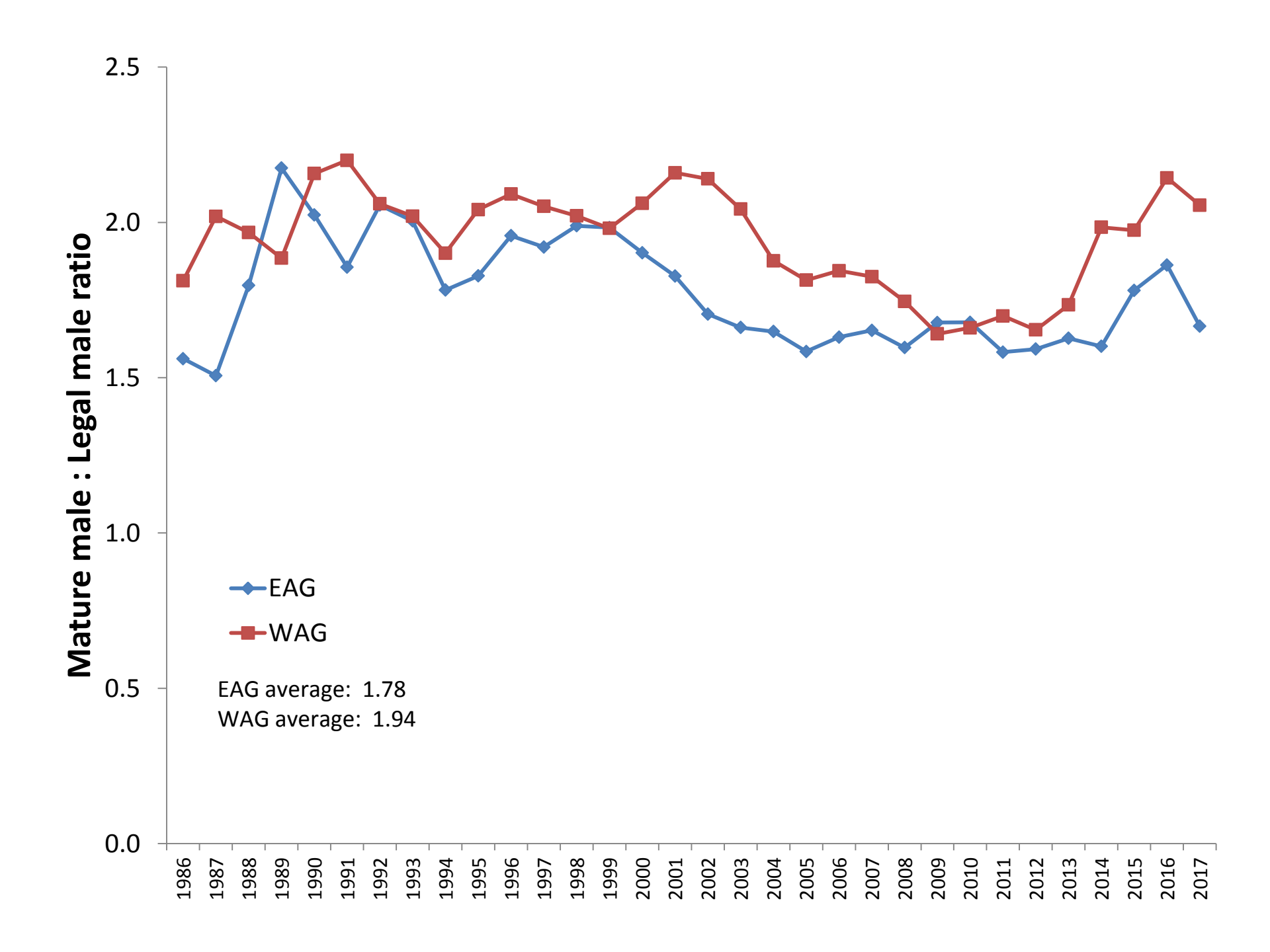


TAC calculation core elements

1. Threshold for opening/closing the fishery
2. Apply exploitation rate to mature male abundance.
3. Convert this to a weight by multiplying the number of crabs by the average legal crab weight (use previous year fishery weight).
4. Cap TAC at maximum exploitation rate on legal males:
   - Protects against over-harvest of legal crabs in years when ratio of mature:legal males is high (i.e., low relative abundance of legals compared to matures)
   - Evaluate 25%, 35%, (?) legal male abundance

Maximum exploitation on legal male abundance

- Because TAC is based on mature male abundance, this measure provides a level of protection against over harvesting legal males when legal males are in relatively low abundance compared to mature males
- Other BSAI crab harvest strategies: BBRKC: 50%, StMatt BKC: 25%, PIBKC: 20%, Tanner: 50%, snow: 58% “exploited” legals
- Evaluate 25%, 35%, (other?) legal male abundance


Mature male : Legal male ratio
2.5
2.0
1.5
1.0
0.5
0.0
EAG
WAG
EAG average: 1.78
WAG average: 1.94
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Maximum exploitation on legal male abundance

If the average ratio of mature males to legal males is approximately 2, then is maximum legal exploitation rate of 2 x mature male exploitation rate an appropriate approach?

Example:

2 x 15% mature male exploitation = 30% cap

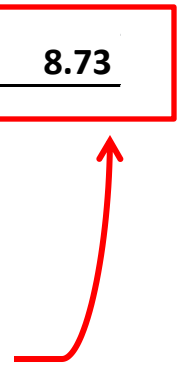
1.8 x 15% mature male exploitation =27% cap

25% or 35% cap is in the ballpark……other values to consider?

What about bycatch mortality?

2017/18 maximum TAC relative to avoiding ABC = 9.999 million lb total fishery mortality

Assumptions		Mortality (million lb)
Assume max mortality in groundfish fisheries, 05/06-16/17 =		0.13
Assume max mortality in other crab fisheries		0.00
	Subtotal	0.13
Remaining for directed (incl. bycatch mort), mill lb (ABC-Subtotal) =	9.87	
Assume maximum (lb discard mort)/(lb retained) in directed fishery, **05/06-16/17** =	0.130	
Maximum TAC = (remaining for directed)/(1+0.130) =		**8.73**



To avoid exceeding the ABC, combined TACs should not exceed this number

Next Steps……

- Evaluation of proposed harvest strategy scenarios
  - Model population projections

Simulation Outlines

Introduction

- Use 2017 model (17AD17) estimated parameters, recruits, and terminal year (2016) abundance
- Project the 2016 abundance for 30 years with 1000 random replicates

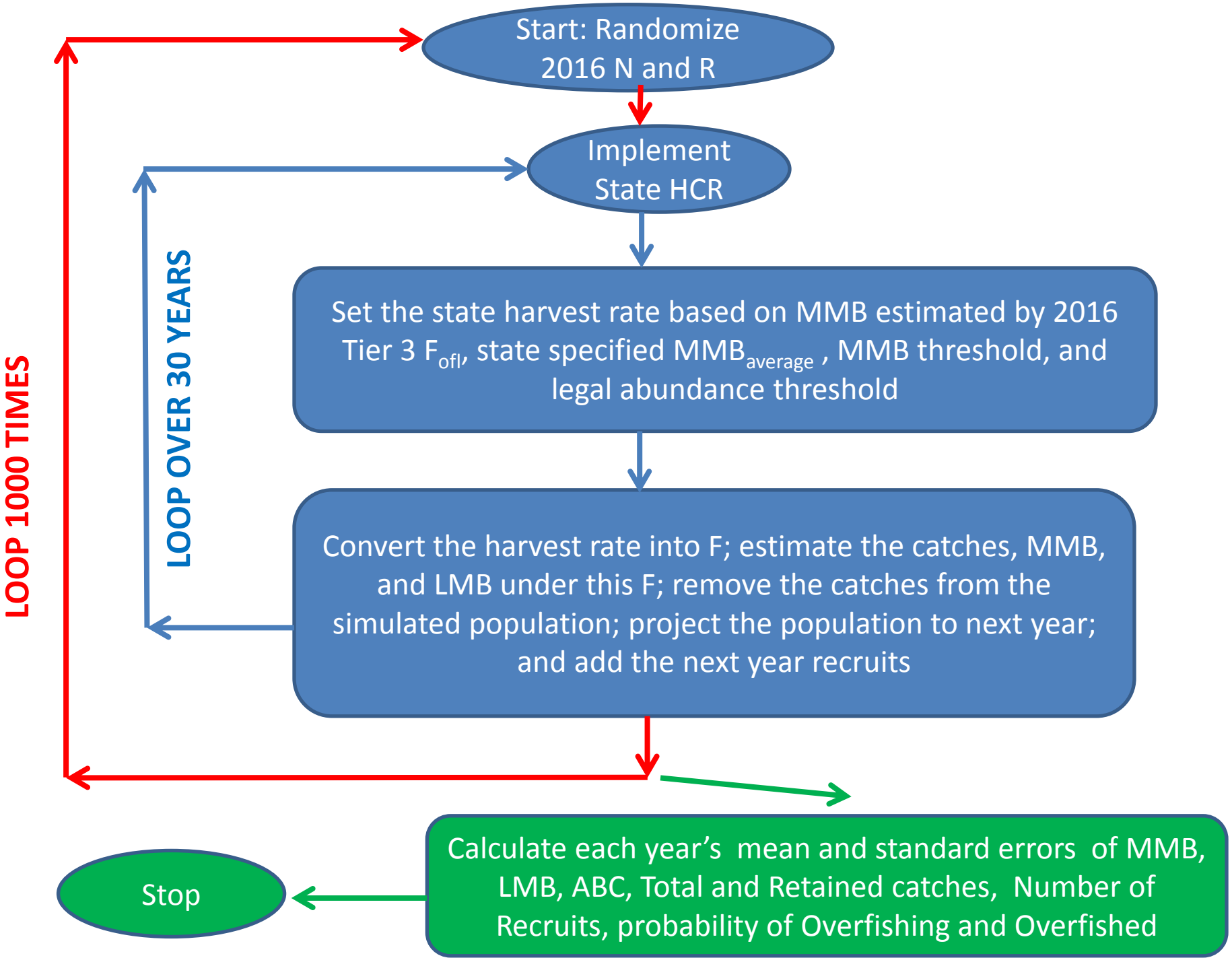
Randomization

- Replicates based on 1000 log normal random errors on estimated abundance and 1000 uniform random errors on estimated number of recruits
- Number of recruits estimated two ways: (1) random choice from 2017 model estimated recruits for 1987-2012; (2) Ricker stock-recruitment model estimated recruits (with 8 year time-lag from spawning year to recruitment year)

Simulation Outlines

Control Rules Used for Projection

- Project the abundance for 30 years, separately under (1) Tier 3 control rule and (2) the state harvest control rule
- (1) (a) Project with no directed fishery (F=0). This is the base projection and approximately equal to dynamic B_0 projection
- (1) (b) Project with $F_{35\%}$, the allowed maximum F for OFL and ABC estimation
- (2) Project with the state harvest control rule (next slide)


Start: Randomize 2016 N and R
Implement State HCR
Set the state harvest rate based on MMB estimated by 2016 Tier 3 F_{ofl}, state specified $MMB_{average}$, MMB threshold, and legal abundance threshold
Convert the harvest rate into F; estimate the catches, MMB, and LMB under this F; remove the catches from the simulated population; project the population to next year; and add the next year recruits
LOOP OVER 30 YEARS
LOOP 1000 TIMES
Calculate each year's mean and standard errors of MMB, LMB, ABC, Total and Retained catches, Number of Recruits, probability of Overfishing and Overfished
Stop

Proposed State Harvest Control Rule

	Sc1a	Sc1b	Sc2	Sc3	Sc4	Sc5a	Sc5b	Sc6	Sc7	Sc8	Sc9
Years for mean MMB (MMB_{ave})	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012	1987–2012
Threshold for opening/closing	25% MMB_{ave}	50% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}	50% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}	25% MMB_{ave}
Exploitation rate when MMB<mean MMB	$\frac{MMB}{MMB_{ave}} \times 0.1$	$\frac{MMB}{MMB_{ave}} \times 0.1$	$\frac{MMB}{MMB_{ave}} \times 0.125$	$\frac{MMB}{MMB_{ave}} \times 0.15$	$\frac{MMB}{MMB_{ave}} \times 0.2$	$\frac{MMB}{MMB_{ave}} \times 0.1$	$\frac{MMB}{MMB_{ave}} \times 0.1$	$\frac{MMB}{MMB_{ave}} \times 0.125$	$\frac{MMB}{MMB_{ave}} \times 0.15$	$\frac{MMB}{MMB_{ave}} \times 0.2$	$\frac{MMB}{MMB_{ave}} \times 0.3$
Max Exploitation rate when MMB≥mean MMB	10%	10%	12.5%	15%	20%	10%	10%	12.5%	15%	20%	30%
Max exploit. rate on legal male abundance	25%	25%	25%	25%	25%	35%	35%	35%	35%	35%	35%

EAG Example Results: From 30-yr Projection: Dynamic B_0

No Directed Fishery						
Year	LMB	95% Lower Limit	95% Upper Limit	MMB	95% Lower Limit	95% Upper Limit
2016	9,581	6,683	13,203	15,036	10,488	20,721
2017	12,719	8,872	17,529	16,433	11,585	22,498
2018	14,686	10,264	20,233	17,402	12,692	23,027
2019	15,731	11,271	21,300	18,075	13,722	23,454
2020	16,350	12,113	21,410	18,555	14,571	23,530
2021	16,760	12,977	21,539	18,906	15,142	23,571
2022	17,062	13,551	21,434	19,152	15,772	23,409
2023	17,279	14,069	21,293	19,331	16,234	23,235
2024	17,436	14,533	21,034	19,464	16,654	22,869
2025	17,549	14,872	20,780	19,572	16,841	22,829
2026	17,639	15,139	20,643	19,652	17,019	22,541
2027	17,712	15,326	20,478	19,695	17,077	22,456
2028	17,762	15,343	20,321	19,712	17,223	22,486
2029	17,778	15,479	20,246	19,734	17,279	22,275
2030	17,788	15,561	20,237	19,756	17,328	22,199
2031	17,801	15,587	20,156	19,781	17,413	22,371
2032	17,820	15,659	20,187	19,803	17,523	22,539
2033	17,841	15,673	20,265	19,812	17,541	22,448
2034	17,857	15,813	20,380	19,816	17,584	22,231
2035	17,858	15,778	20,274	19,828	17,626	22,249
2036	17,865	15,805	20,111	19,836	17,674	22,125
2037	17,873	15,833	20,079	19,840	17,712	22,310
2038	17,880	15,935	20,089	19,836	17,661	22,303
2039	17,878	15,955	20,137	19,837	17,646	22,219
2040	17,877	15,873	20,119	19,835	17,576	22,202
2041	17,875	15,765	20,081	19,836	17,627	22,307
2042	17,874	15,806	20,137	19,837	17,692	22,218
2043	17,875	15,913	20,129	19,843	17,584	22,250
2044	17,876	15,856	20,087	19,851	17,633	22,151
2045	17,887	15,838	20,037	19,842	17,674	22,093

Industry Input

- What does industry want to see in a harvest strategy?
  - General and specific recommendations for analysis
- Continued cooperative survey?
  - Help with spatio-temporal CPUE standardization
  - Bolster assessment data inputs

Feedback?