IPHC Harvest Policy: Background and Evaluation

IPHC Staff – Past and Present

Harvest Policy Framework

- **Policy**: IPHC circa 2006-2013
- **Author/references**: Hare and Clark (2006); deeper references Hare and Clark (2004); Clark and Hare (2001, 2003, 2005)
- **Population model**: sex-specific, core area (2B/2C/3A), coastwide selectivity at length
- **Conservation goal**: avoidance of dropping below SB_{thresh}
- **Reference points**: $Sb_{unfished}(SB_{100})$, SB_{thresh} (SB_{30}), SB_{limit} (SB_{20})
- **Control Rules:** Target Constant Harvest Rate (HR); linear decrease from SB_{thresh} to HR = 0 at SB_{limit}
- **Performance metrics**: Ratio of SB_i/SB_{100}; Percent of time SB < SB_{thresh}; Realized average harvest rate; Variance of average catch; Fraction of max. yield

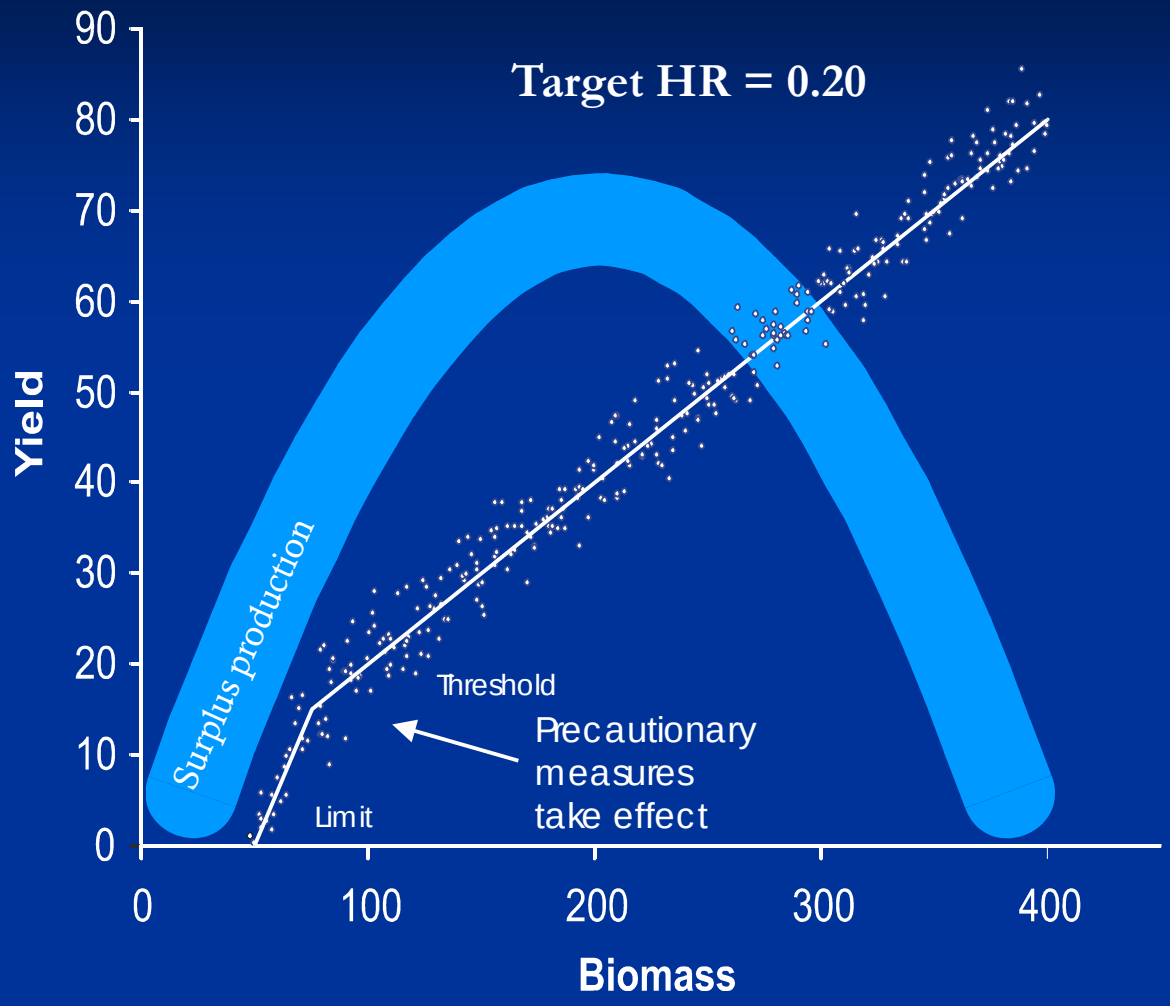
Harvest Policy Framework

- **Population dynamics**
  - **Stock unit analyzed**: Areas 2B/2C/3A
  - **Growth**: Linear two-stage (ages 7-20, 21-max) with time-varying increments within stages
  - **Maturity**: logistic fit to 2002-2003 combined Areas 2B/3A data
  - **Selectivity**: Single, from coastwide assessment model, based on length
  - **Recruitment**: alternating regime-based recruitment with PDO effect on average levels drawn from U(15,30) distribution; variance based on residuals from closed-area fits of average recruitment model (recruitment regimes: 1968-1976 and 1977-2001)
  - **Simulation**: current estimates → run 150 years, then performance averaged over next 100 years, over 200 MC simulations

Harvest Policy Framework

- **Evaluation**
  - **Harvest rate:** Initially recommended HR of 0.20 for core areas (2A-4A); yields SB > SB_{30} 80% of time
  - **Auxiliary analyses**:
    - SPR analysis showed HR of 0.20 yields SPR of 0.35 SPR_{100}
    - Examined relative effects of variable fixed migration schedules and balanced/unbalanced harvest rates on area-specific SB distribution
  - **Non-core areas**:
    - Harvest rate determined from SPR analysis (4B, 4CDE) and progressive application based on empirical observations of stock performance at higher target rates (4A, 3B)

How the IPHC harvest policy works



Surplus production =

Growth

+ Recruitment

- Natural mortality

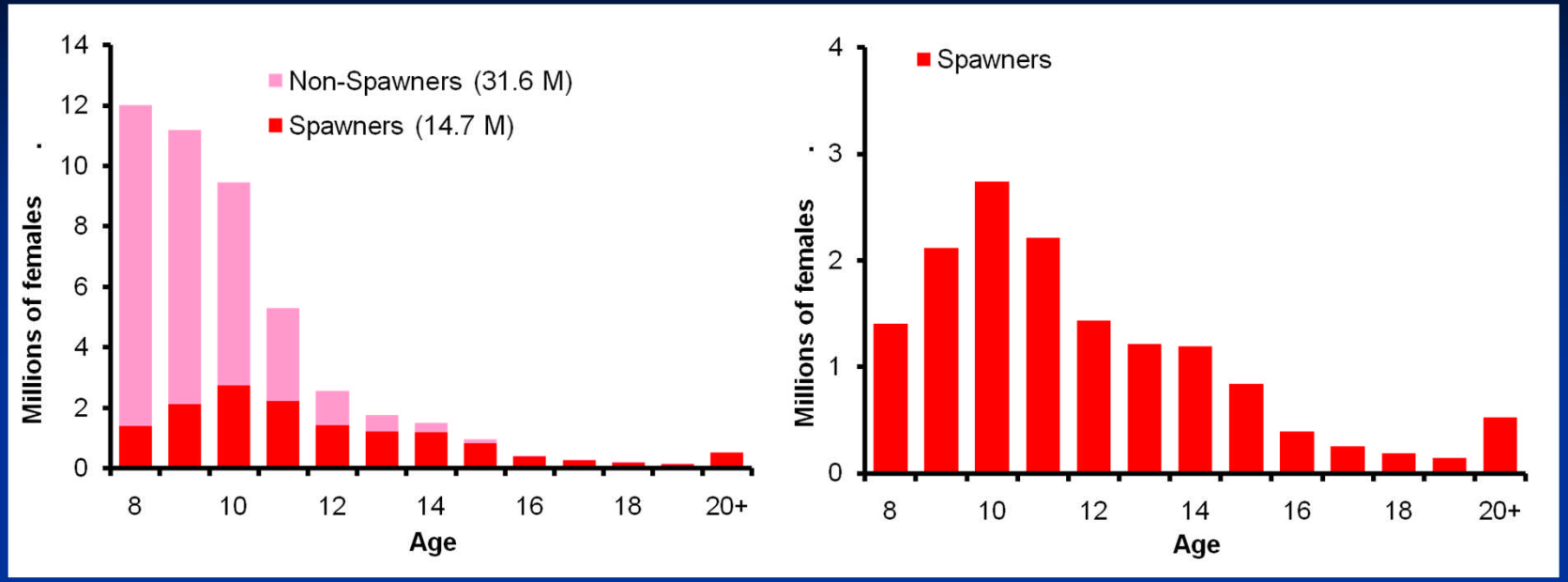
- It is the yield that can be taken such that stock biomass remains at the same level from one year to the next.

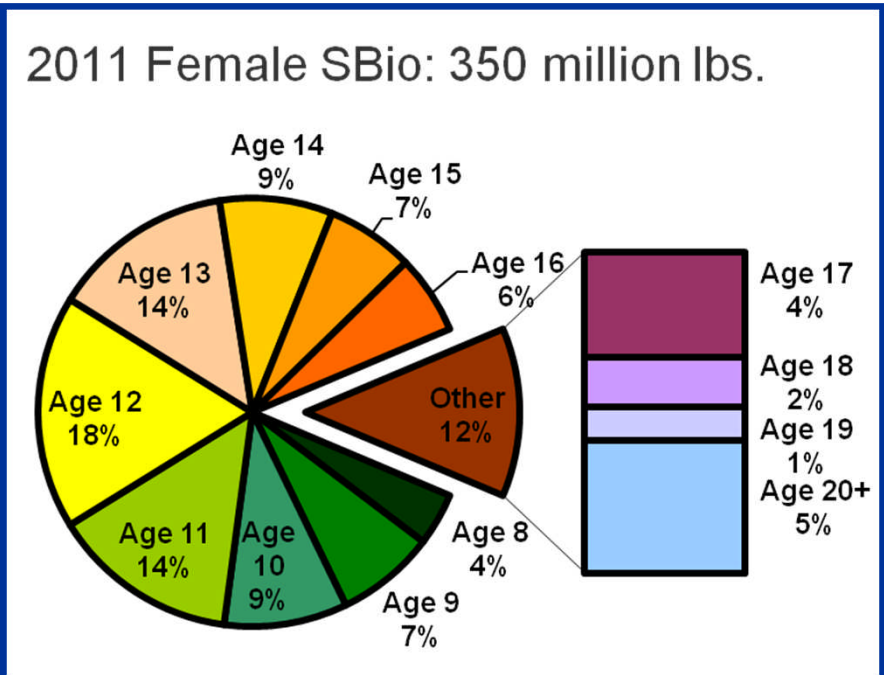
Biomass Reference Points:

Limit = $SBio_{20}$

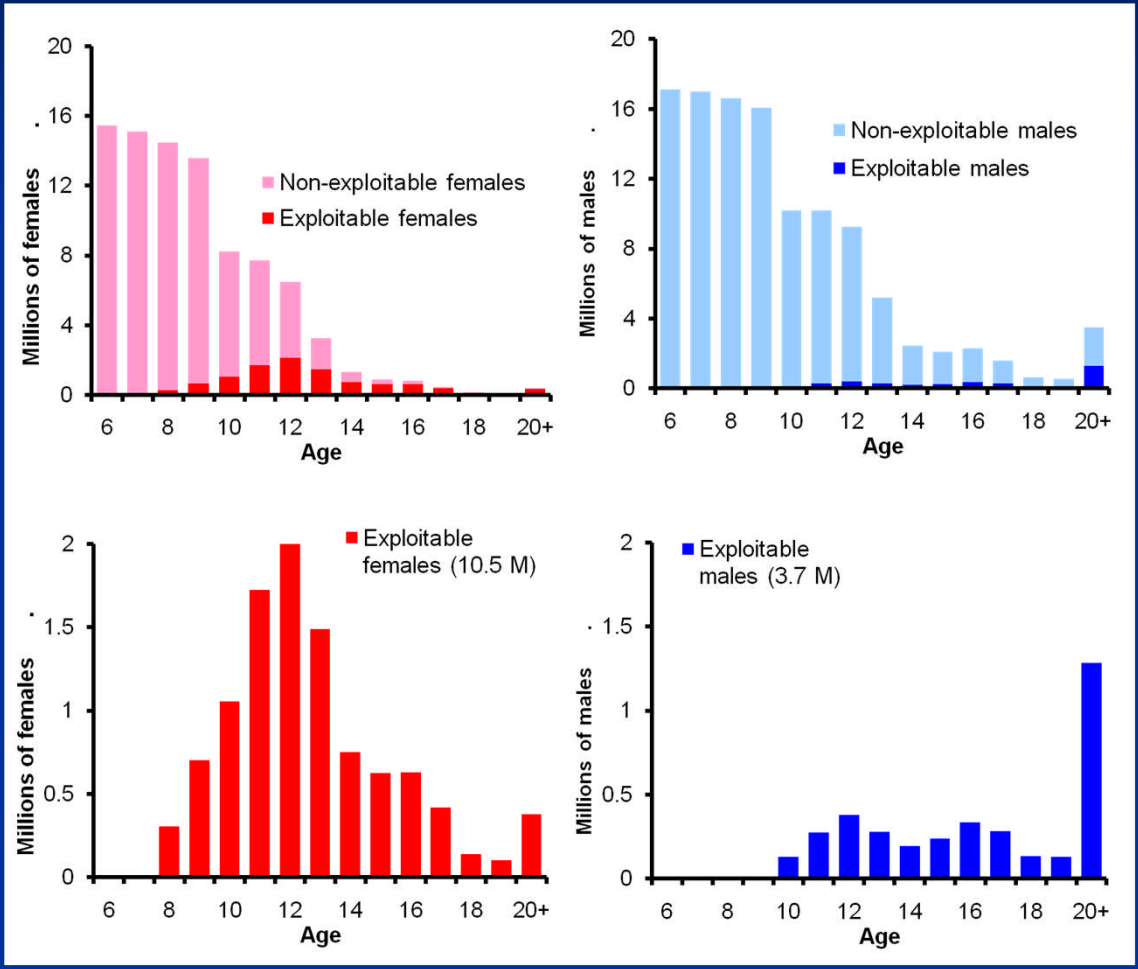
Threshold = $SBio_{30}$

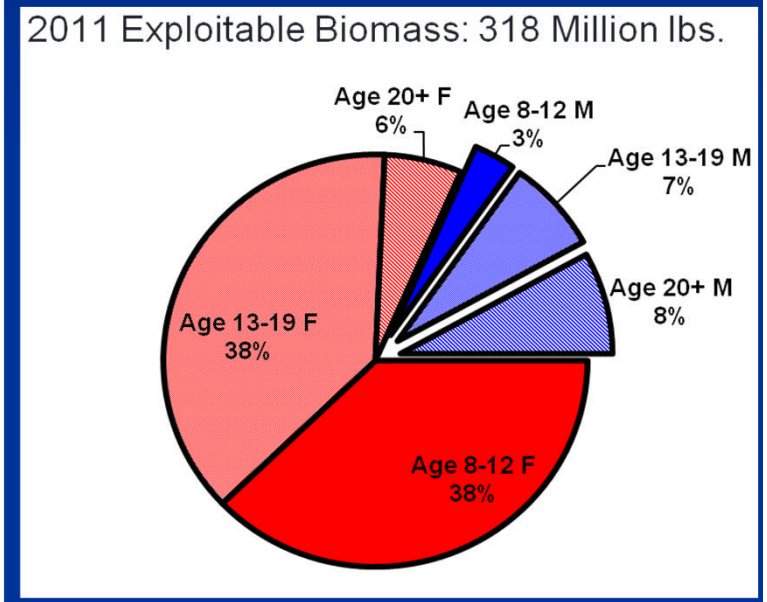
Age composition of Sbio – all females





Sex/Age composition of Ebio – mostly females





Simulation model parameters

- **Recruitment** – alternating regimes drawn from U(15,30)
  - R_{low} = 4.13 M, R_{high} = 13.00, σ_ε=0.25, ρ=0.4, 10% deducted for bycatch

$$R_6 = \exp(\ln(\mu_i) + \varepsilon_t)$$

$$\varepsilon_t = \rho\varepsilon_{t-1} + e_t$$

- **Growth** – Annual increments computed from No. age-10+ fish

$$W_a = W6_y + \sum_{7}^{20} GI_y + \sum_{21}^{a} GI2_y$$

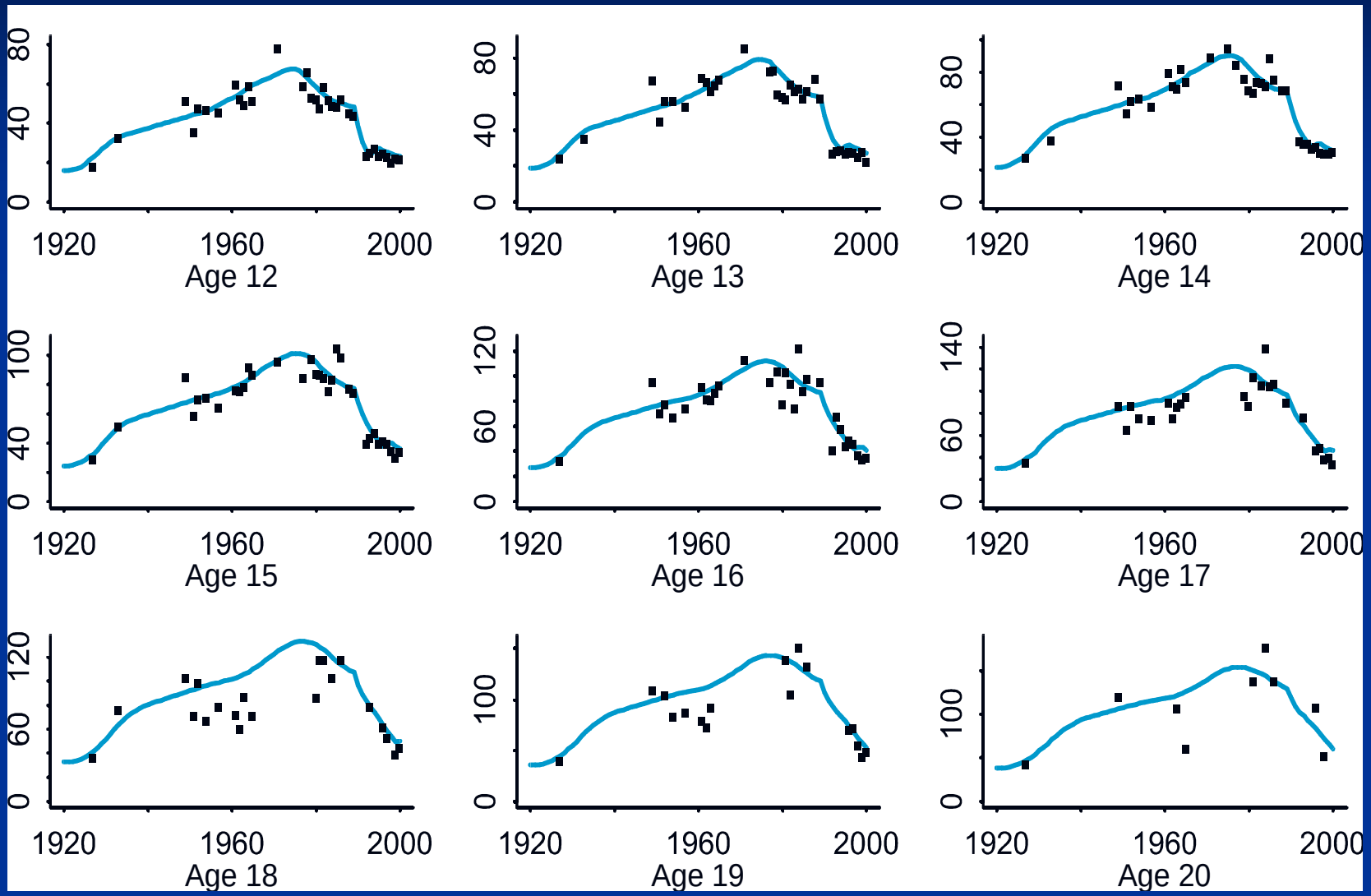
- **Length** – computed from W_a

$$L_a = \sqrt[3.24]{\frac{w_a}{0.00000692}}$$

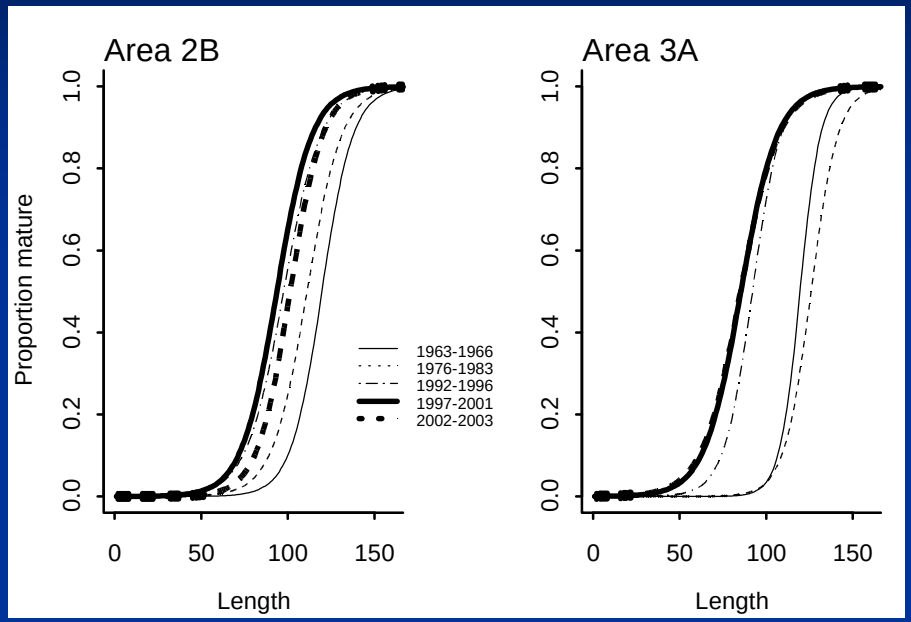
- **Selectivity** – Invariant length-specific as estimated in coastwide SA
- **Maturity** – single schedule estimated from 2002-2003 data

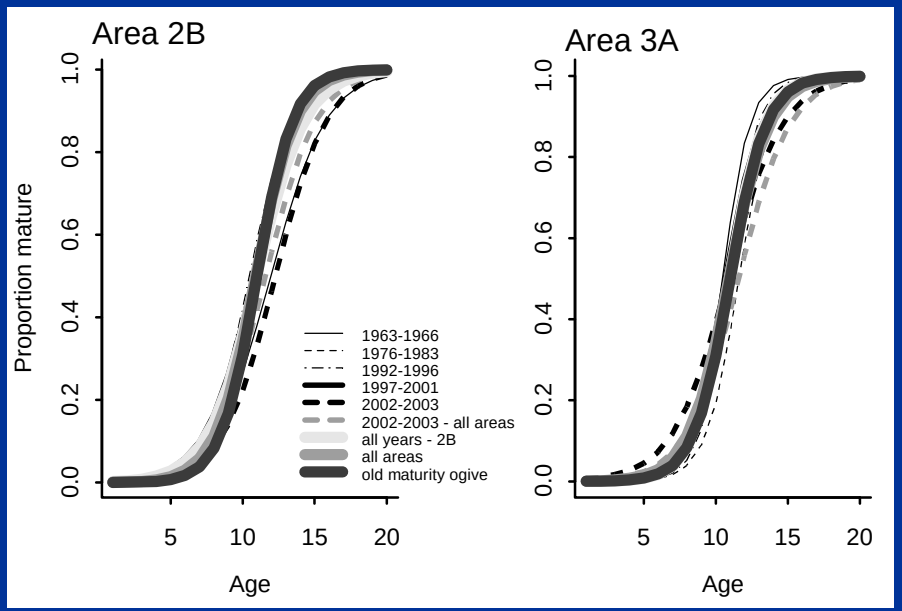
$$p = \frac{1}{1+\exp\left(-0.563\left(A-11.59\right)\right)}$$

Long-term changes in size at age

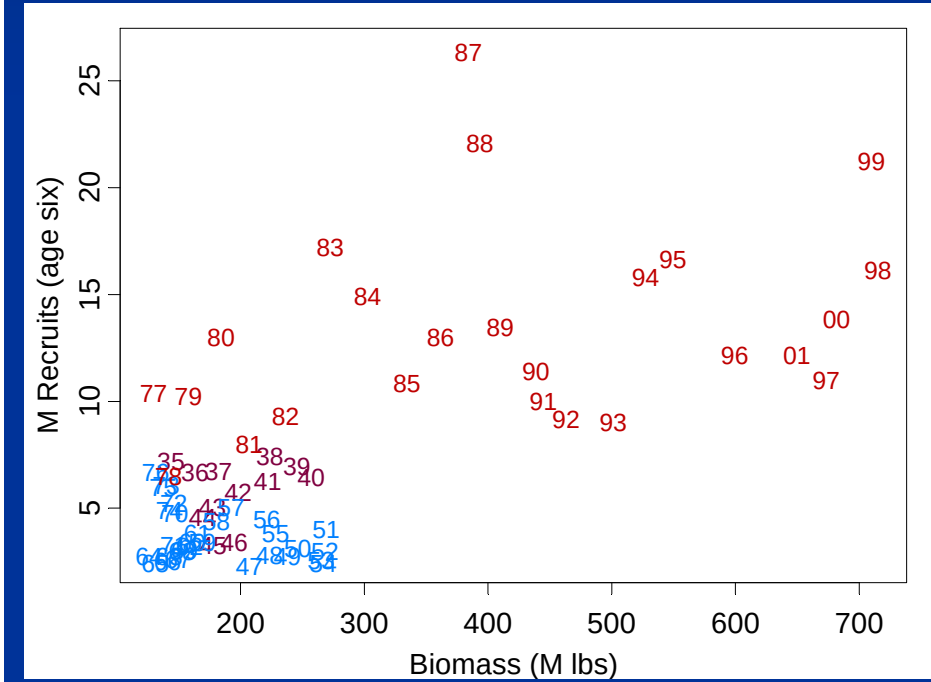


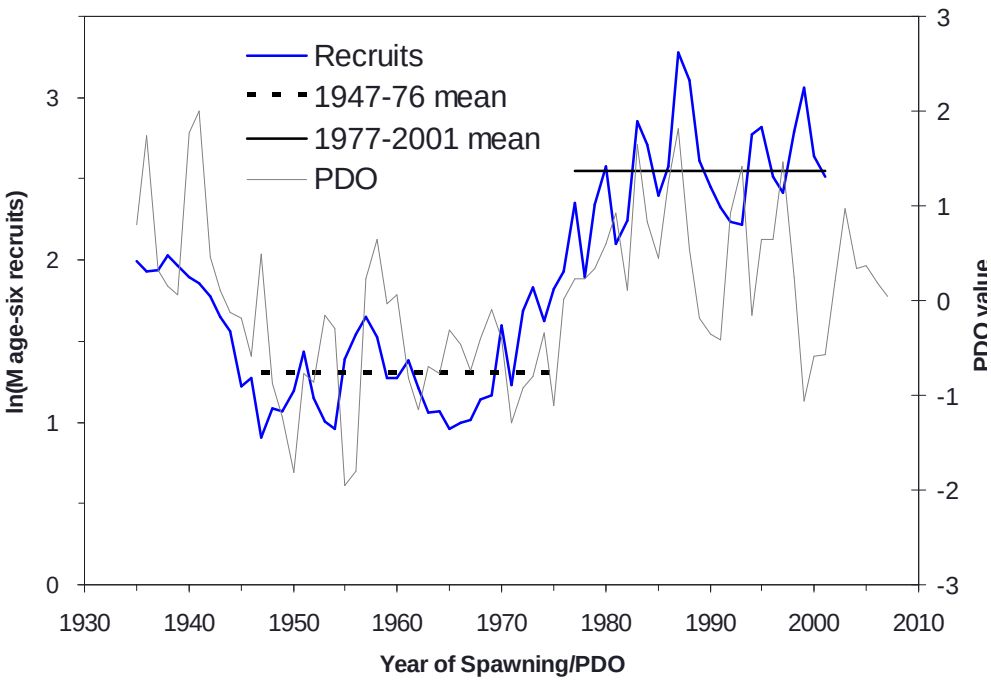
Changes in maturity at age and length



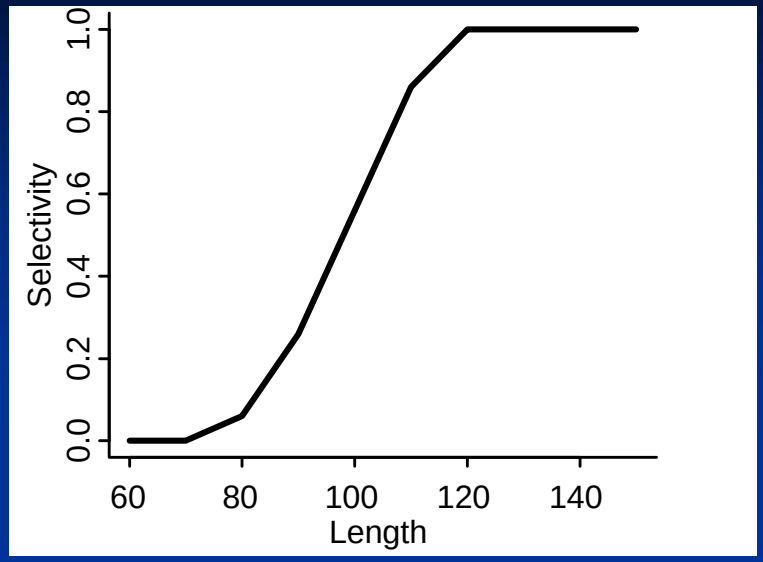


Stock-recruit and PDO-recruit plots

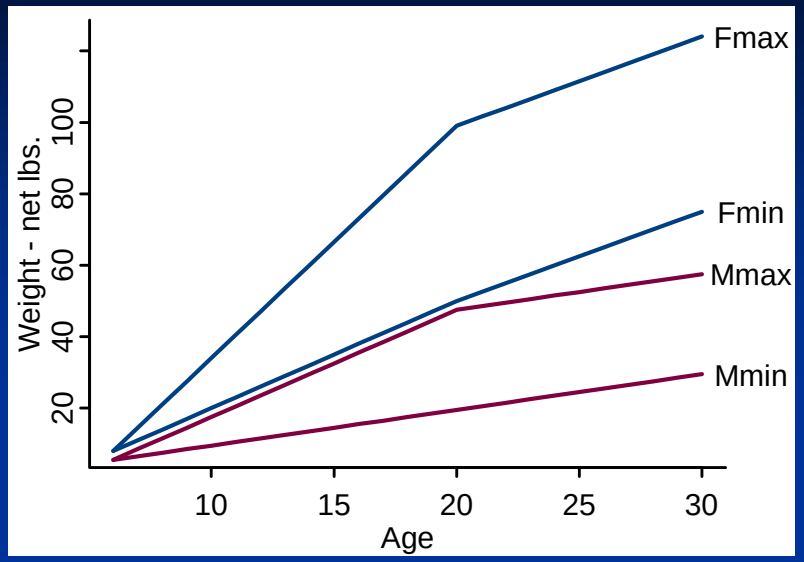




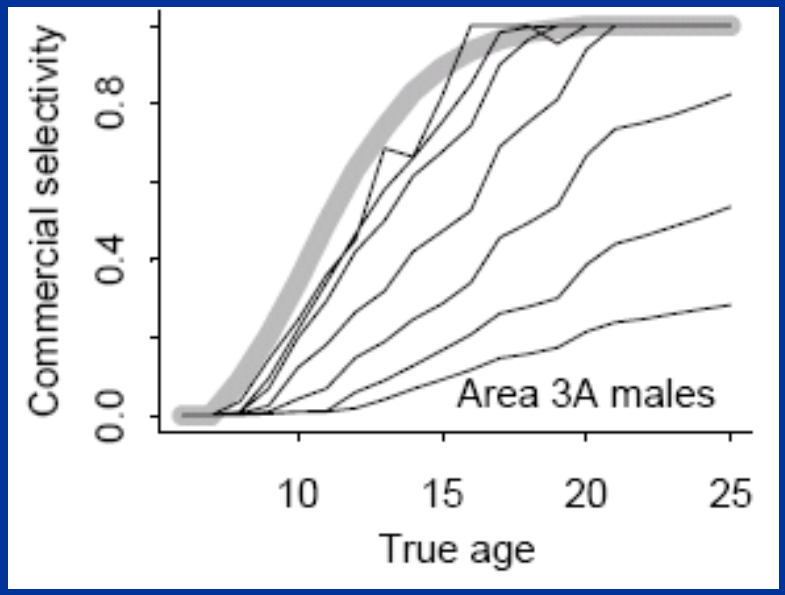
Invariant selectivity (at length)



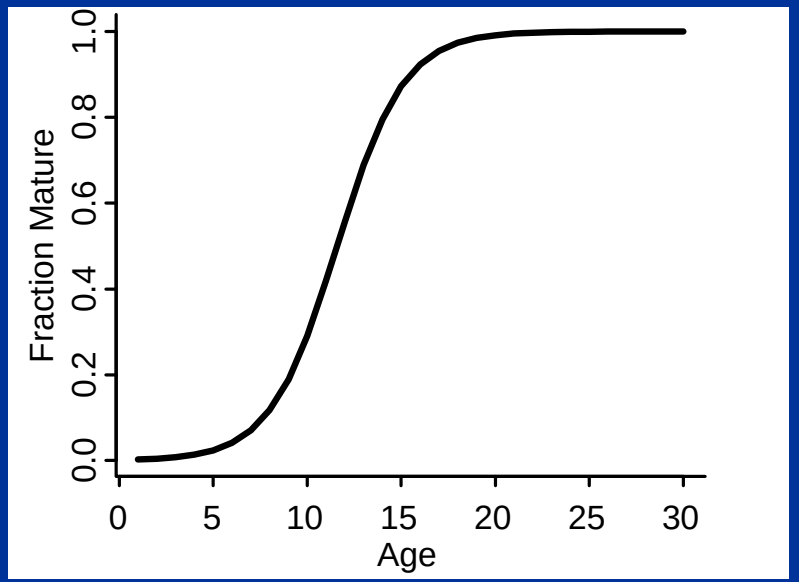
Min. and Max. growth schedules



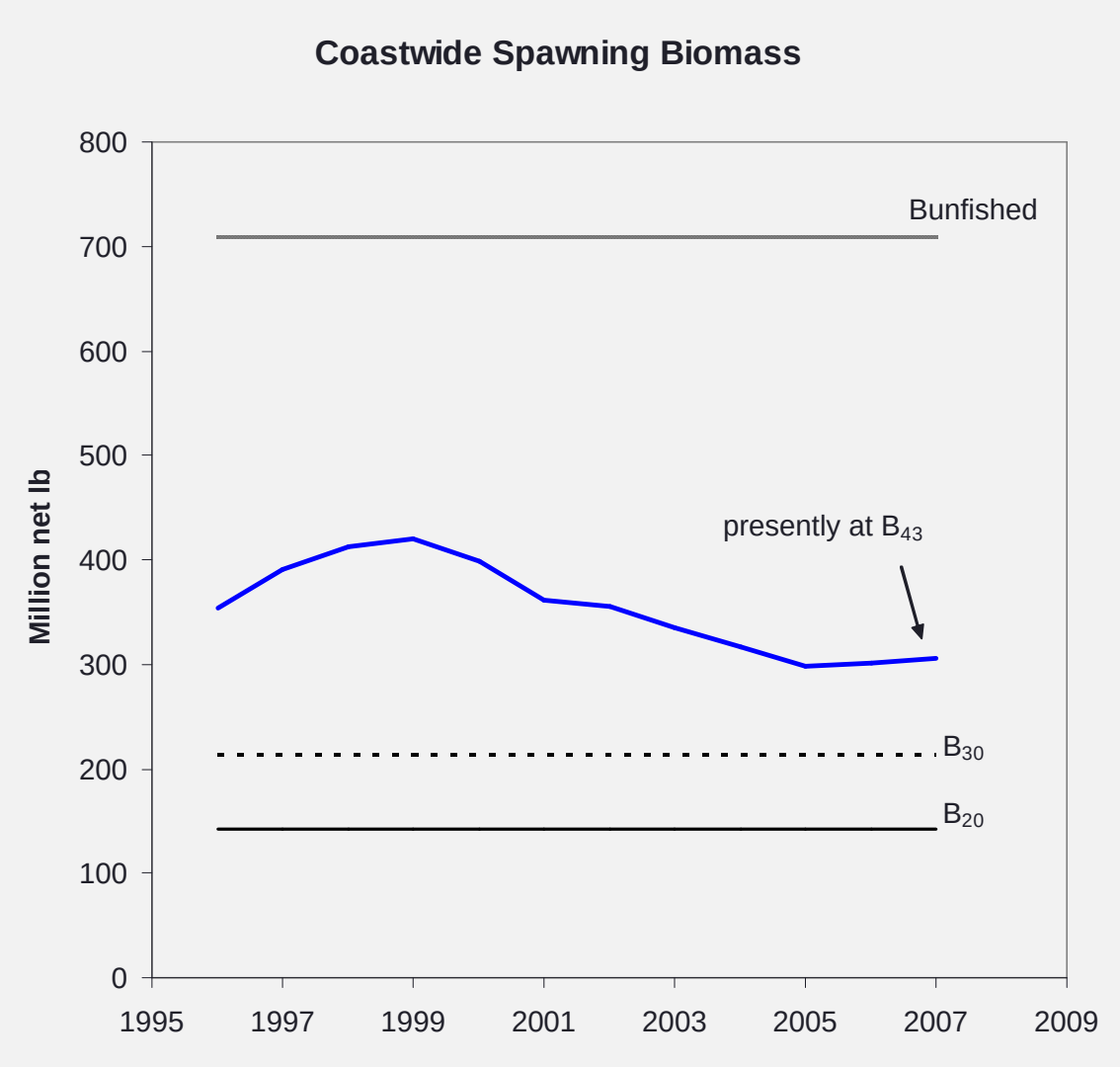
Selectivity at age changes



Invariant maturity ogive



Determination of SBio limit*



Areas 2B/2C/3A

High R	13.000	M age-six R
Low R	4.130	M age-six R
Low/High	0.32	
SBR_{1970s}	118.49	lbs./R
$B_{unfished}$	489	M lbs.
B_{20}	98	M lbs.
$B_{min.obs.}$	64	M lbs. (~B_{13})

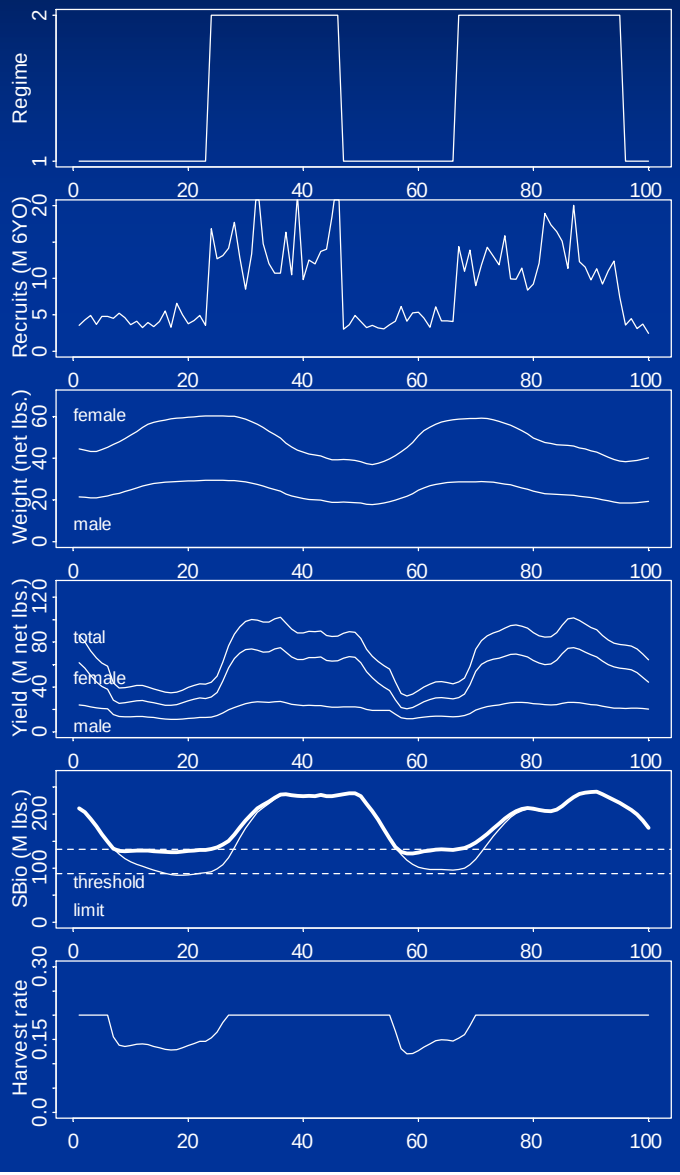
Coastwide

High R	18.85	M age-six R
Low R	5.987	M age-six R
$B_{unfished}$	709	M lbs.
B_{20}	142	M lbs.
B_{30}	213	M lbs.
$B_{current}$	306	M lbs. (~B_{43})

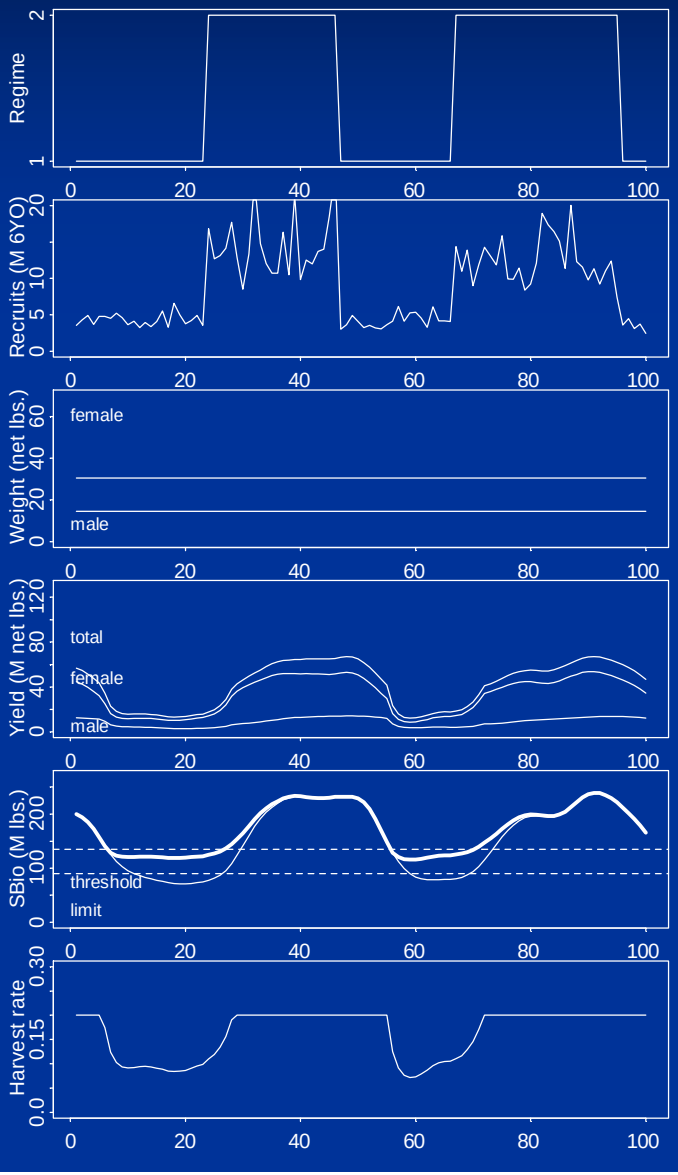
*** Note Ian's concern about current calculation of $SB_{unfished}$ re assumed SAA**

Simulation model run examples

Density dependent growth

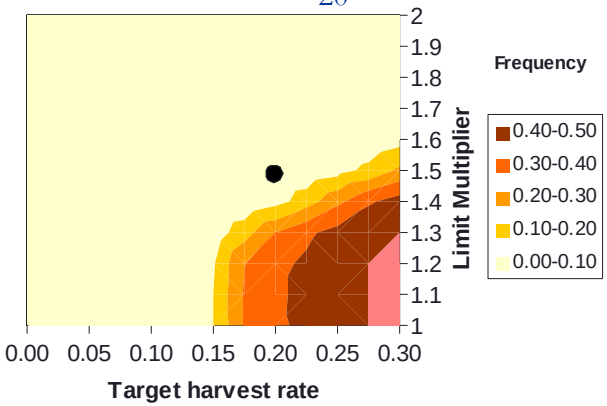


Constant slow growth

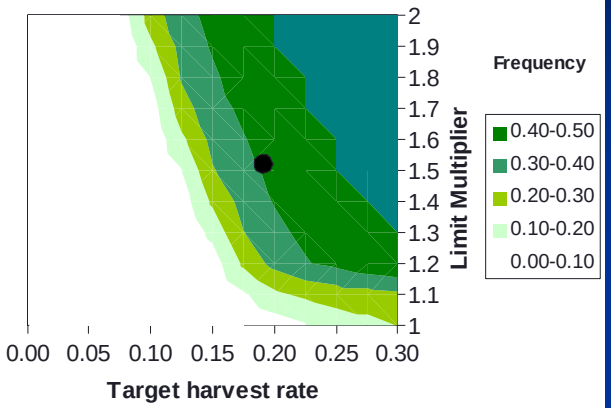


Results – density dependent growth

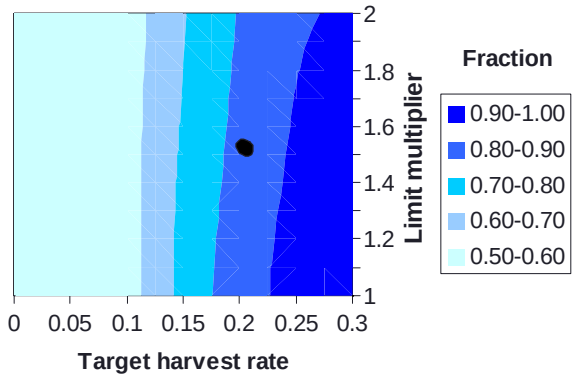
SBio < 1.25*B_{20}



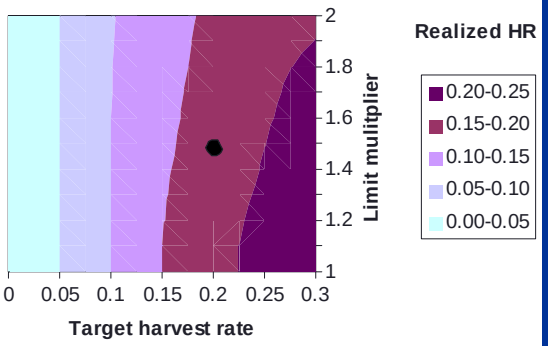
SBio < Threshold



Fraction of Ymax

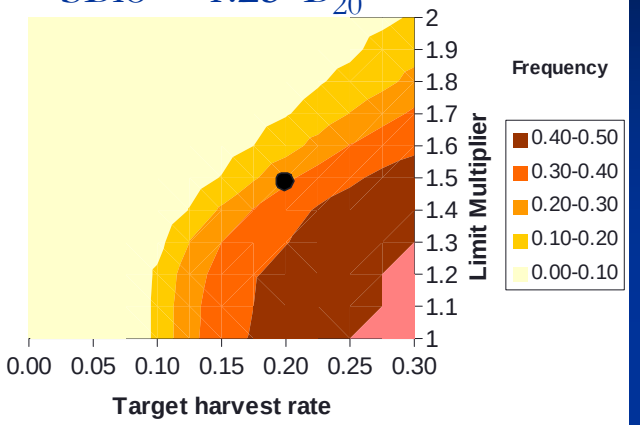


Avg. realized HR

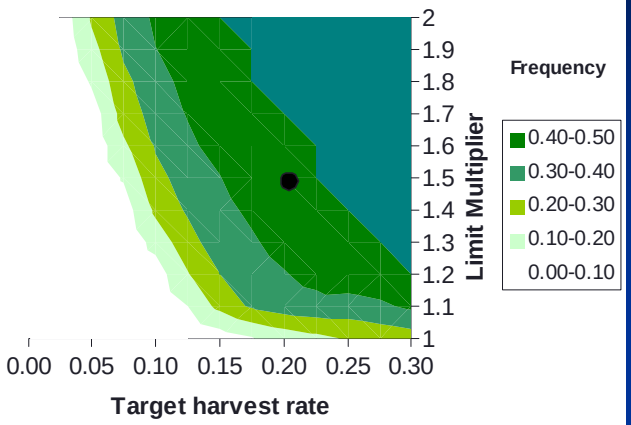


Results – constant slow growth

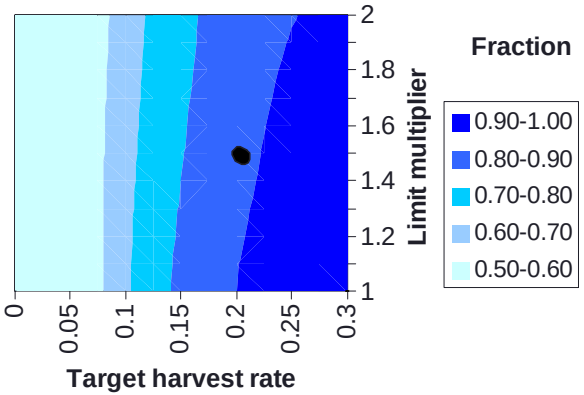
SBio < $1.25*B_{20}$



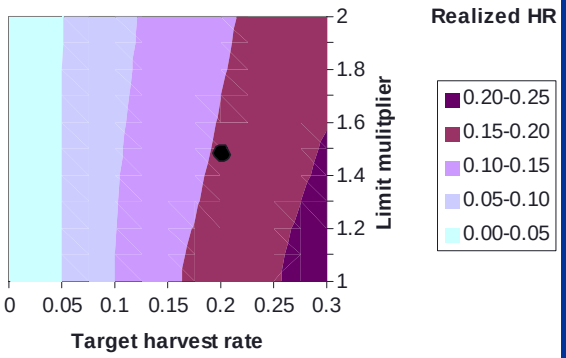
SBio < Threshold



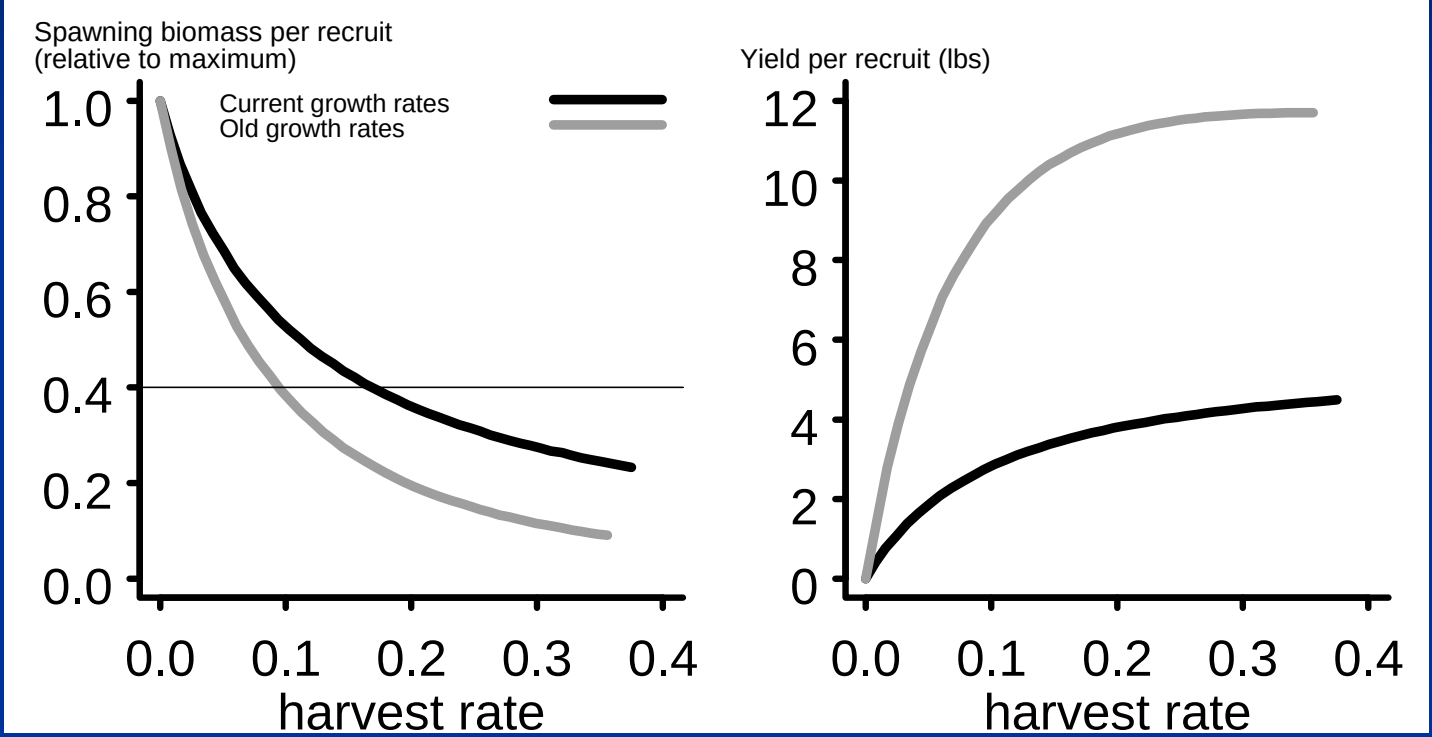
Fraction of Ymax



Avg. realized HR

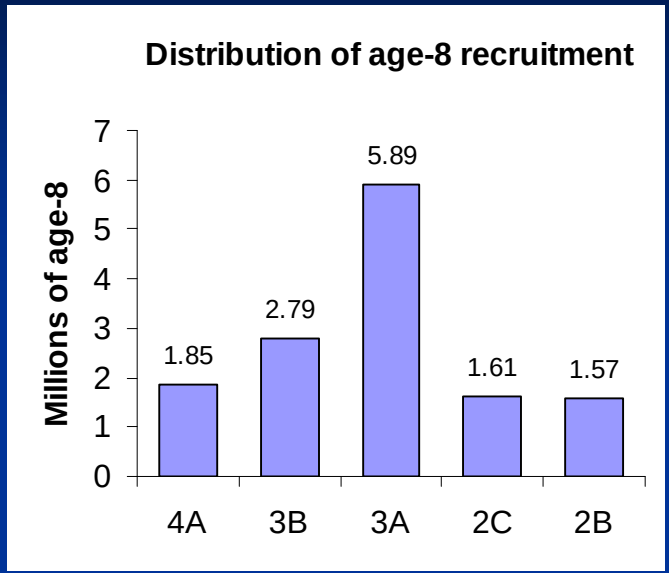


Biological reference point considerations



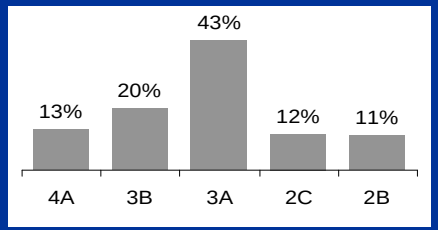
	F_{40}	F_{35}	$F_{0.1}$
Current growth rates	0.16	0.20	0.23
Old growth rates	0.14	0.11	0.16

Spawning biomass distribution

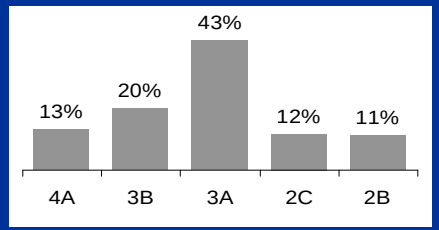


Yield

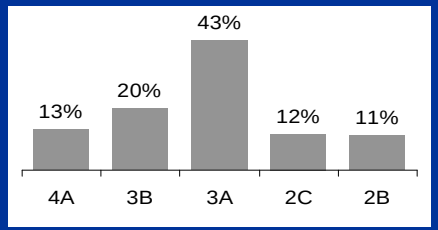
F = 0.0



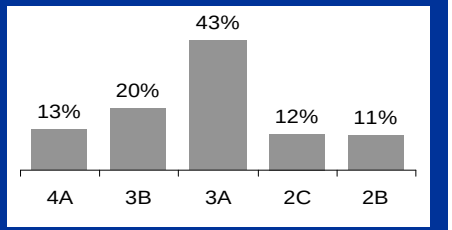
F = 0.1



F = 0.2

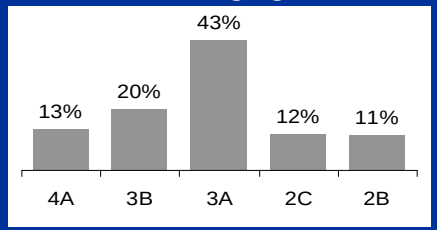


F = 0.3

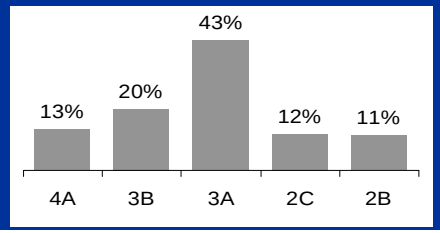


Spawning Biomass

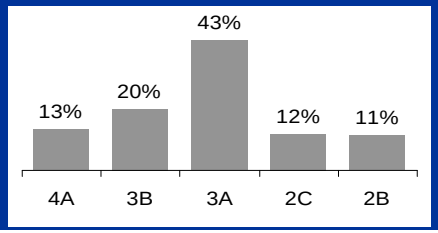
F = 0.0



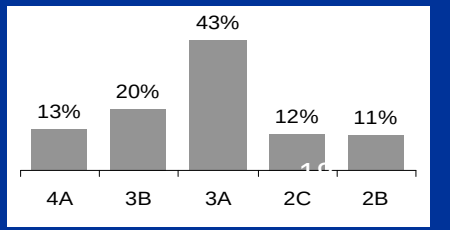
F = 0.1



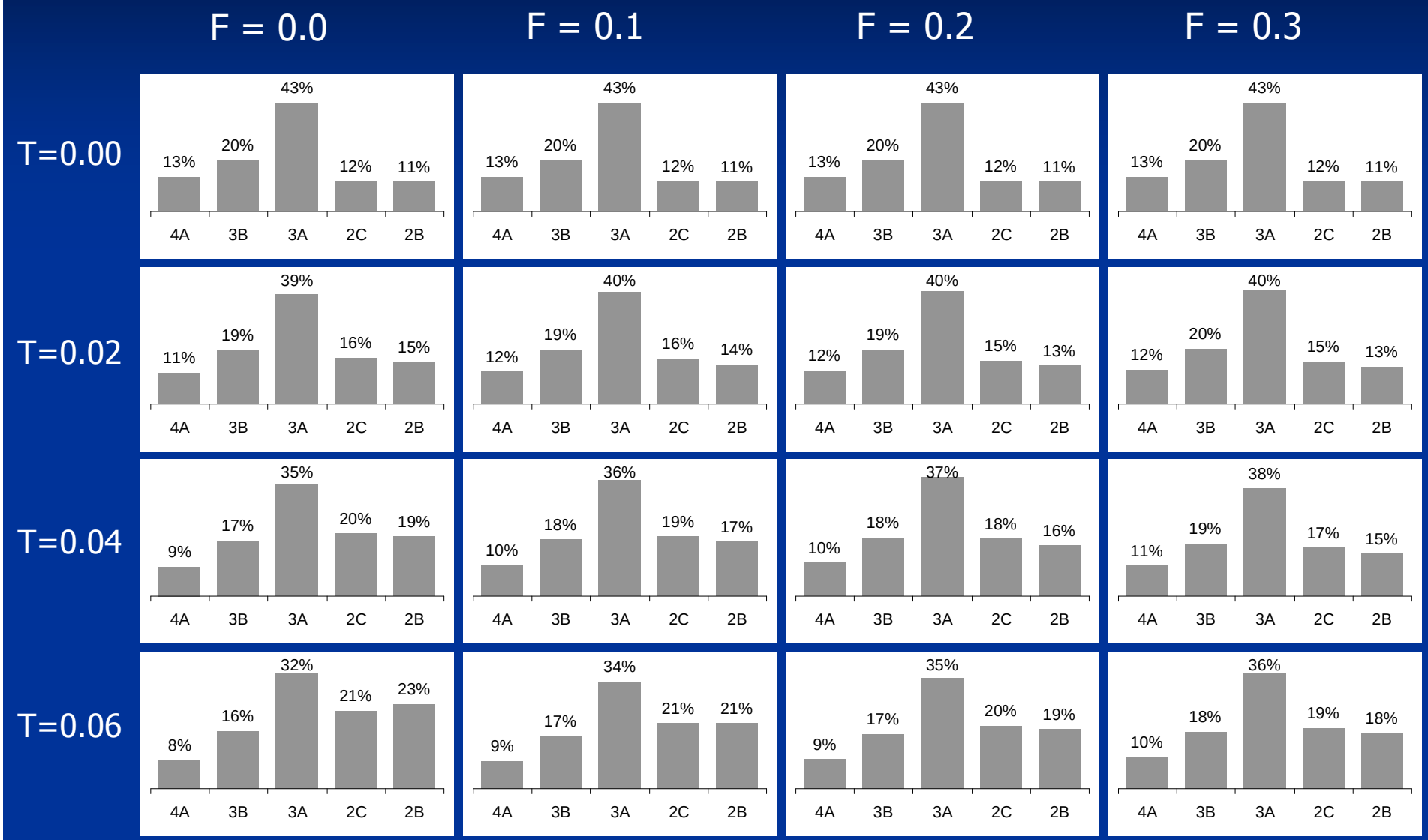
F = 0.2



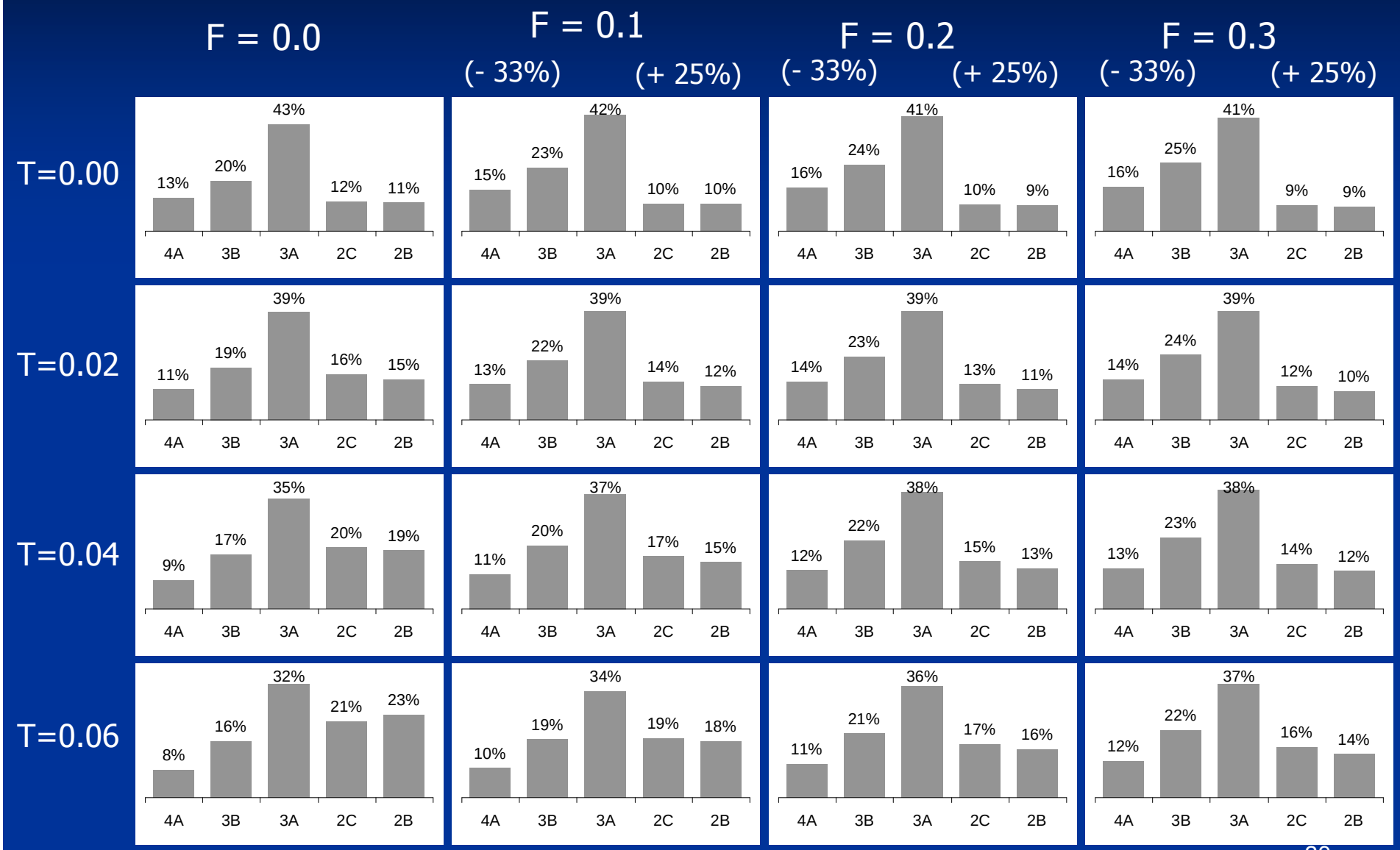
F = 0.3



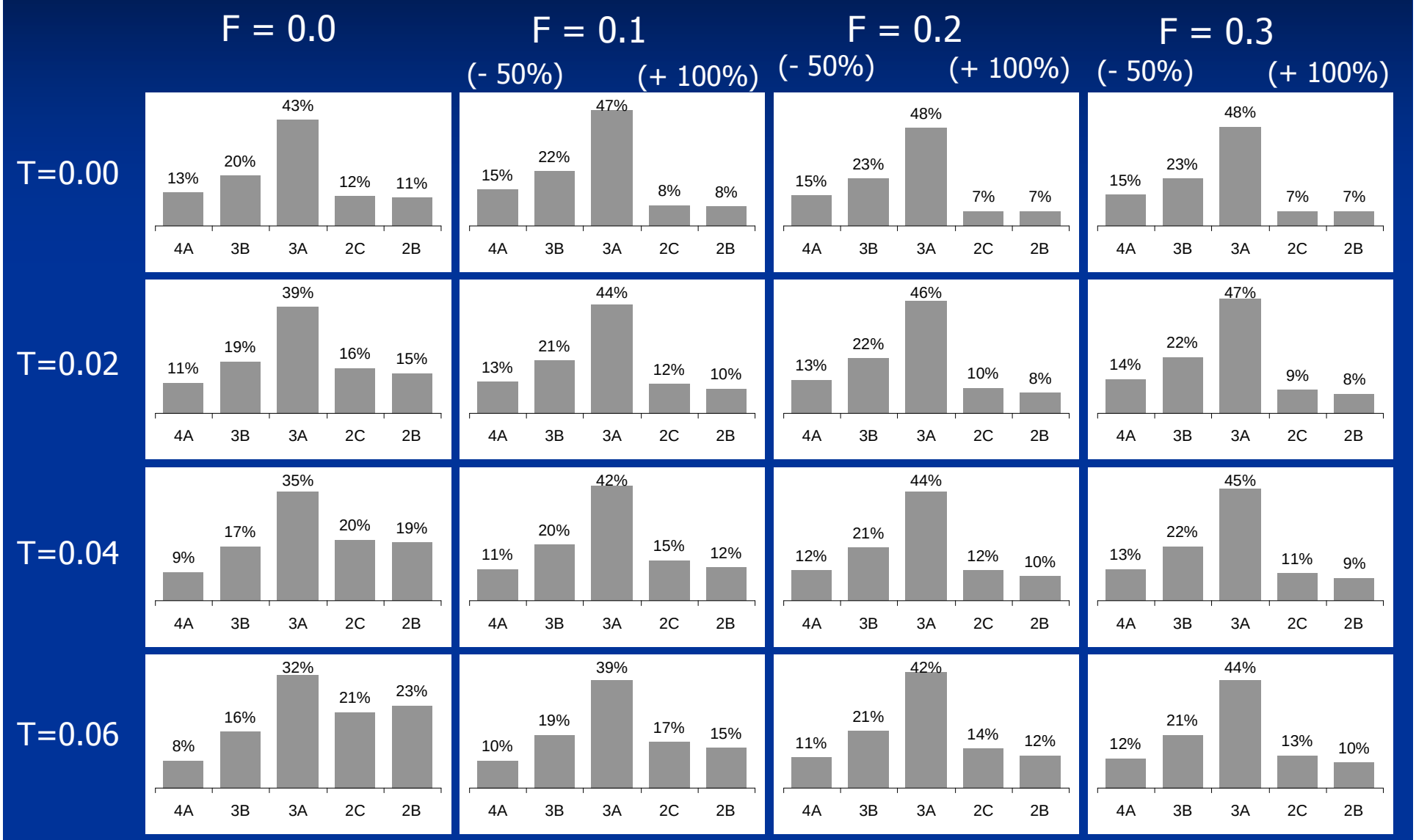
Effect of migration on SBio, equal HRs



Effect of migration on SBio, unequal HRs



Effect of migration on SBio, v. unequal HRs



Harvest rate concerns – 4B and 4CDE

- WPUE trends down sharply (4B improving)
- 4B Recruitment very low relative to habitat: 1/3rd of 4A R and 1/10th of 2B and 2C R
- YPR analysis shows 4B sustainable yield around 1 M lbs.
- 4CDE most similar to 4B
- Recommended HR of 0.15 in 2006

Harvest rate concerns – 4A and 3B

- WPUE trend downward in Area 4A since late 1990s
- WPUE trend continues downward sharply in Area 3B
- Recommended HR of 0.15 since 2007

Existing Harvest Policy Summary

- Based on principles of biological productivity
- Output was a target harvest rate that was evaluated in terms of managing the probability of reaching stock biomass reference points (risk)
- Used similar performance metrics to those being incorporated into the MSE process
- Did not invoke a broad process of assessing and ranking a suite of management objectives or invoke a feedback process
- Did not present or evaluate management objectives and performance metrics in a benefit-risk framework