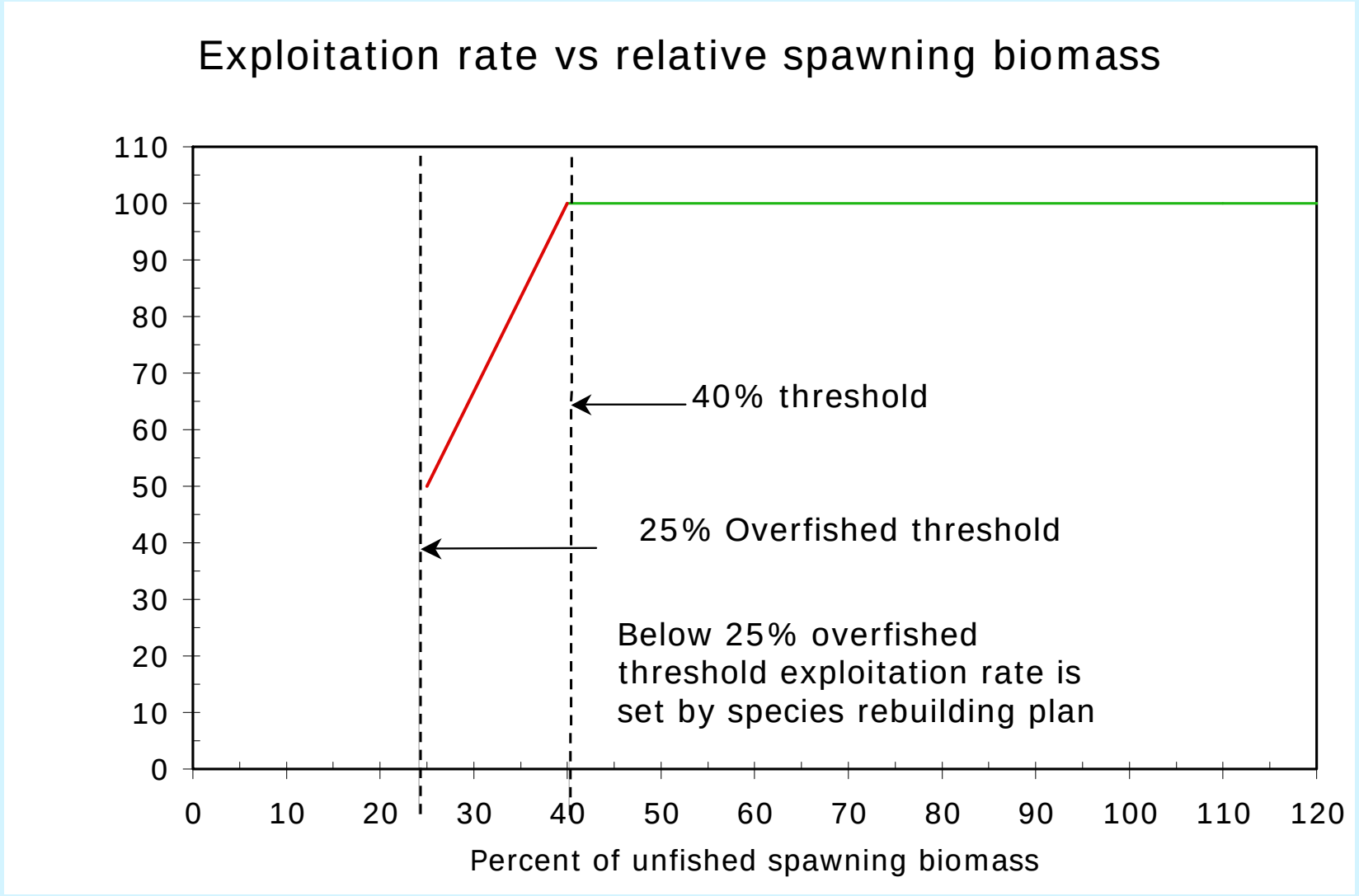
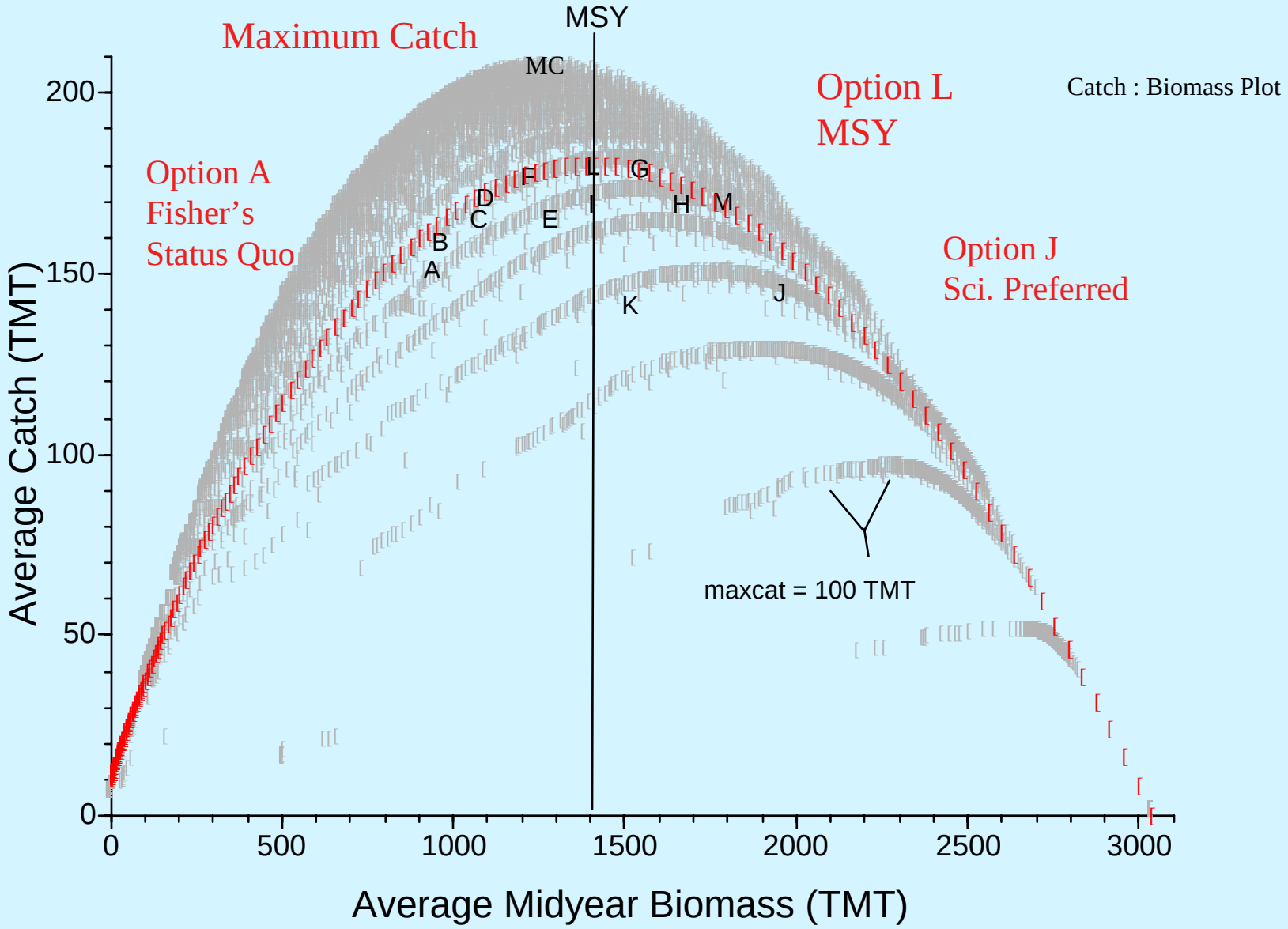
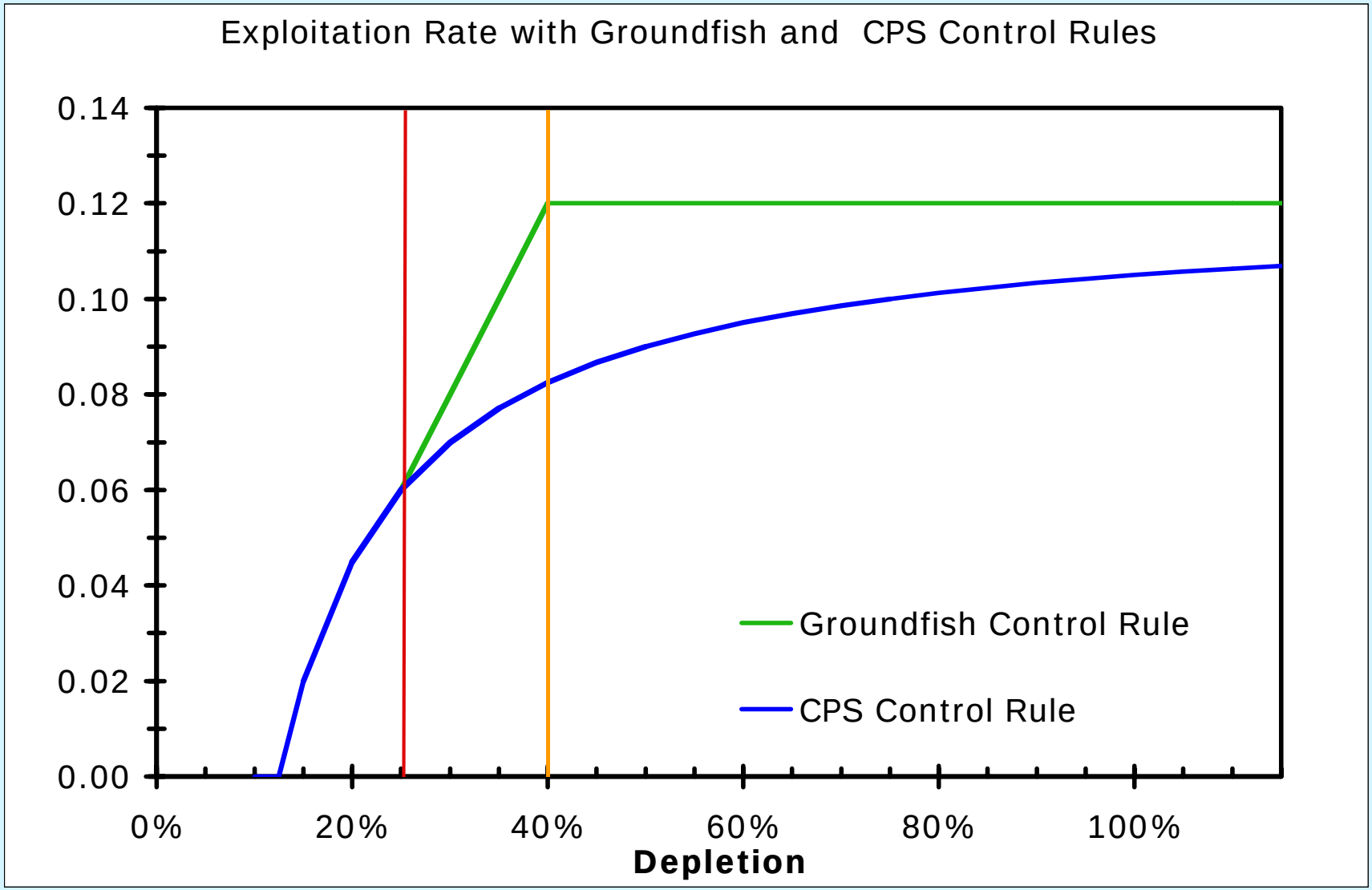
PFMC Control Rule



Sardine Fishery Simulation Results: Average biomass vs average catch for 13 proposed management policies, 240 exploitation rates (0.0025-0.6) and 9260 policies with a wide range of cutoffs (0-1000 TMT), constant fractions (0.05-1.0) and maxcats.(50-1000 TMT).



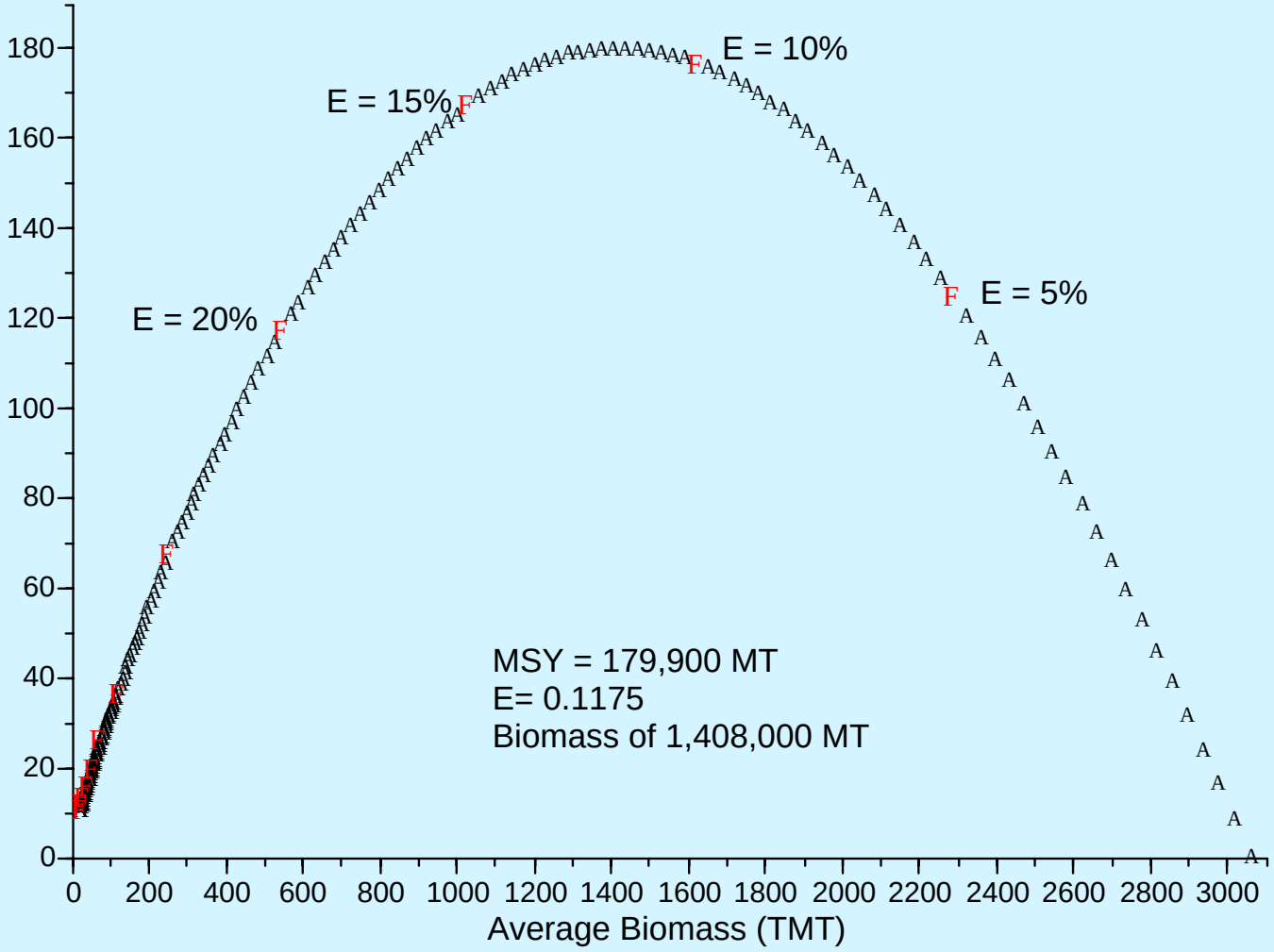
Control Rules



Sardine Exploitation Simulation Run

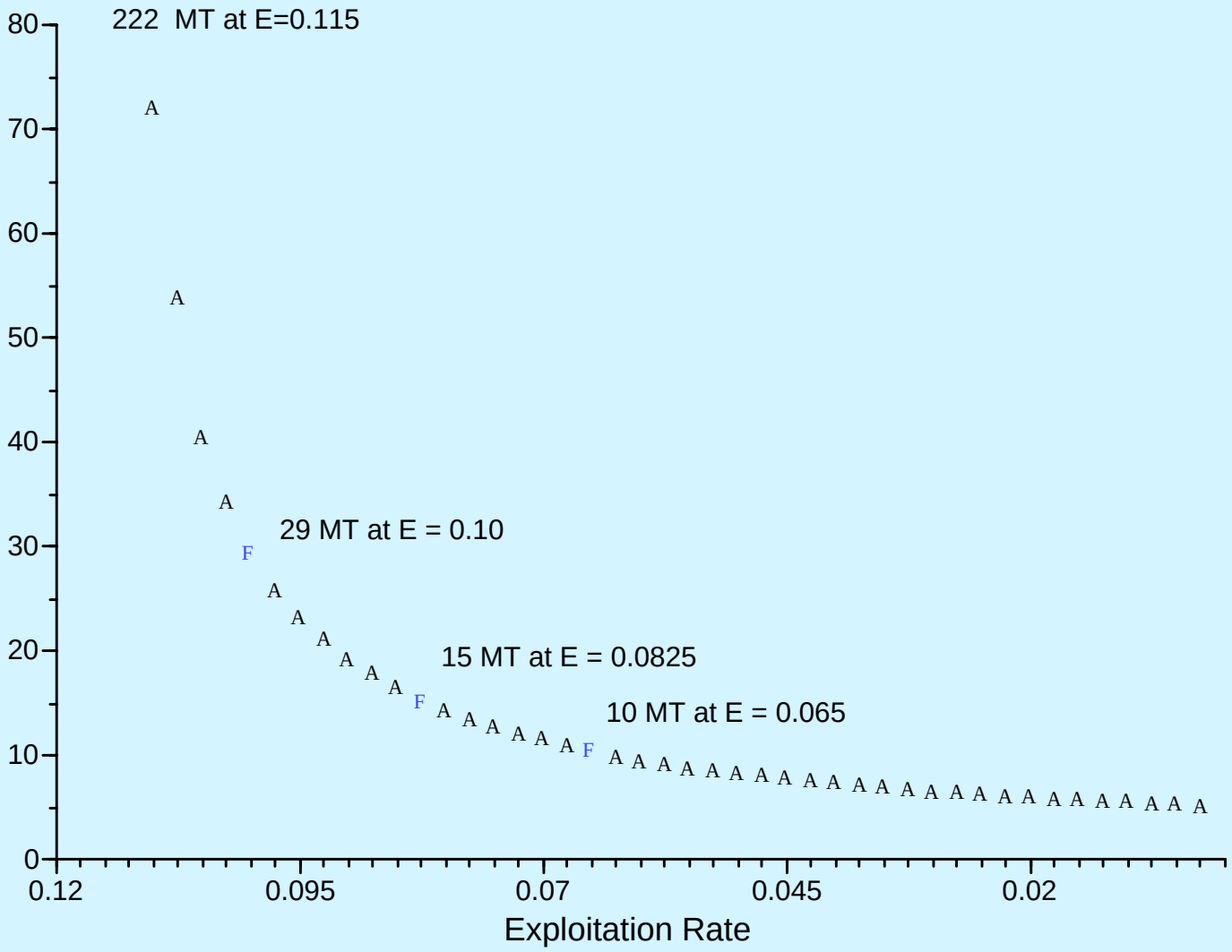
Sardine 1000 year simulations with exploitation rates from 0.0025 to 0.6

(no cutoff or maxcat)



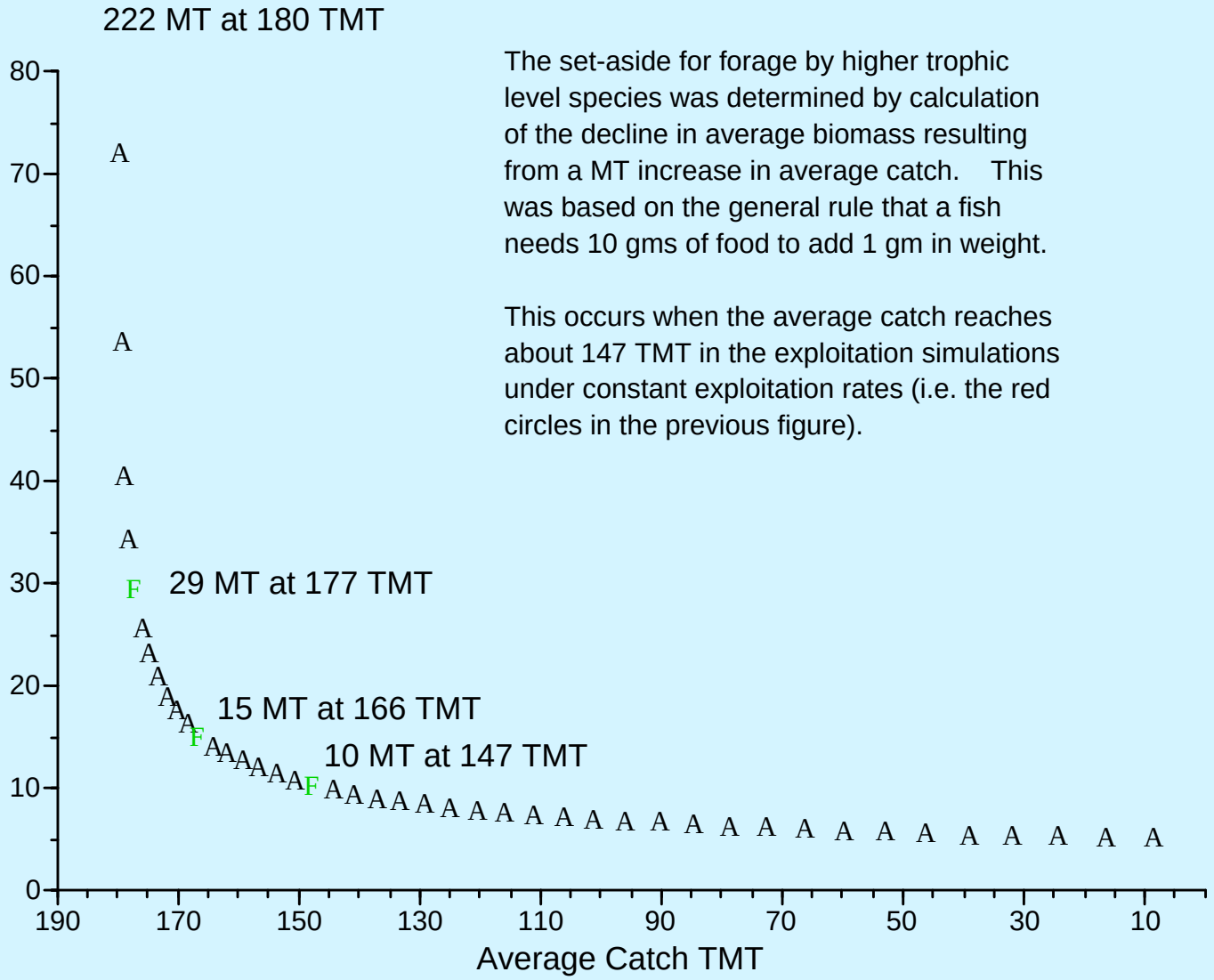
E vs Biomass Loss

A sardine in the catch is worth N sardines in the sea.



Catch increase vs Biomass decline

A bird in the hand is worth two in the bush.
A sardine in the catch is worth N in the sea.



The set-aside for forage by higher trophic level species was determined by calculation of the decline in average biomass resulting from a MT increase in average catch. This was based on the general rule that a fish needs 10 gms of food to add 1 gm in weight.

This occurs when the average catch reaches about 147 TMT in the exploitation simulations under constant exploitation rates (i.e. the red circles in the previous figure).

COMPARISON OF MANGEMENT OPTIONS

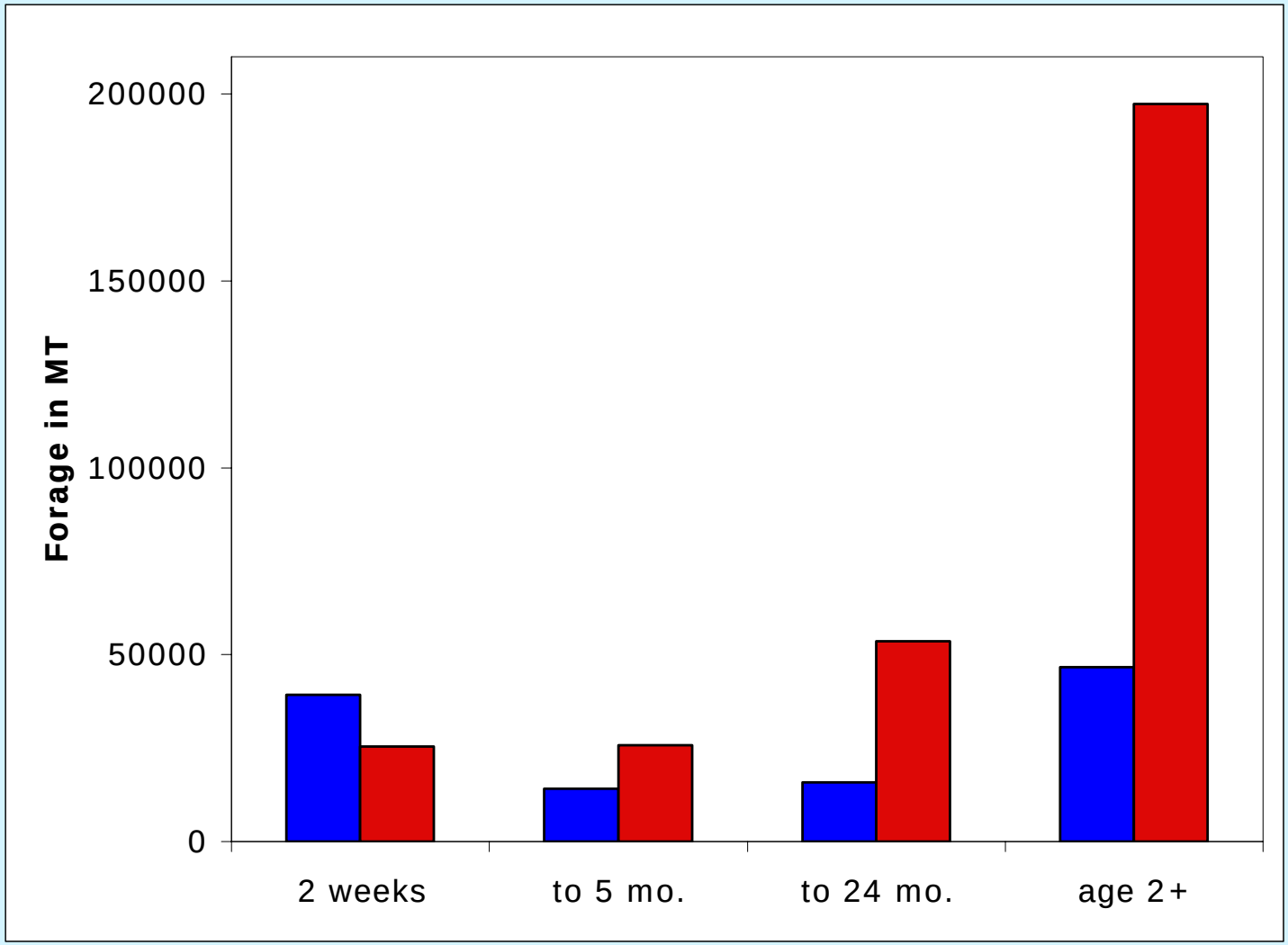
CUTOFF	150	500	150	150
FRACTION	0.1	0.1	0.1	SST
MAXCAT			200	200
AVE. CATCH	177	165	138	145
AVE. BIOMASS	1,427	1,622	1,712	1,951

Units TMT

Sardine Management Options

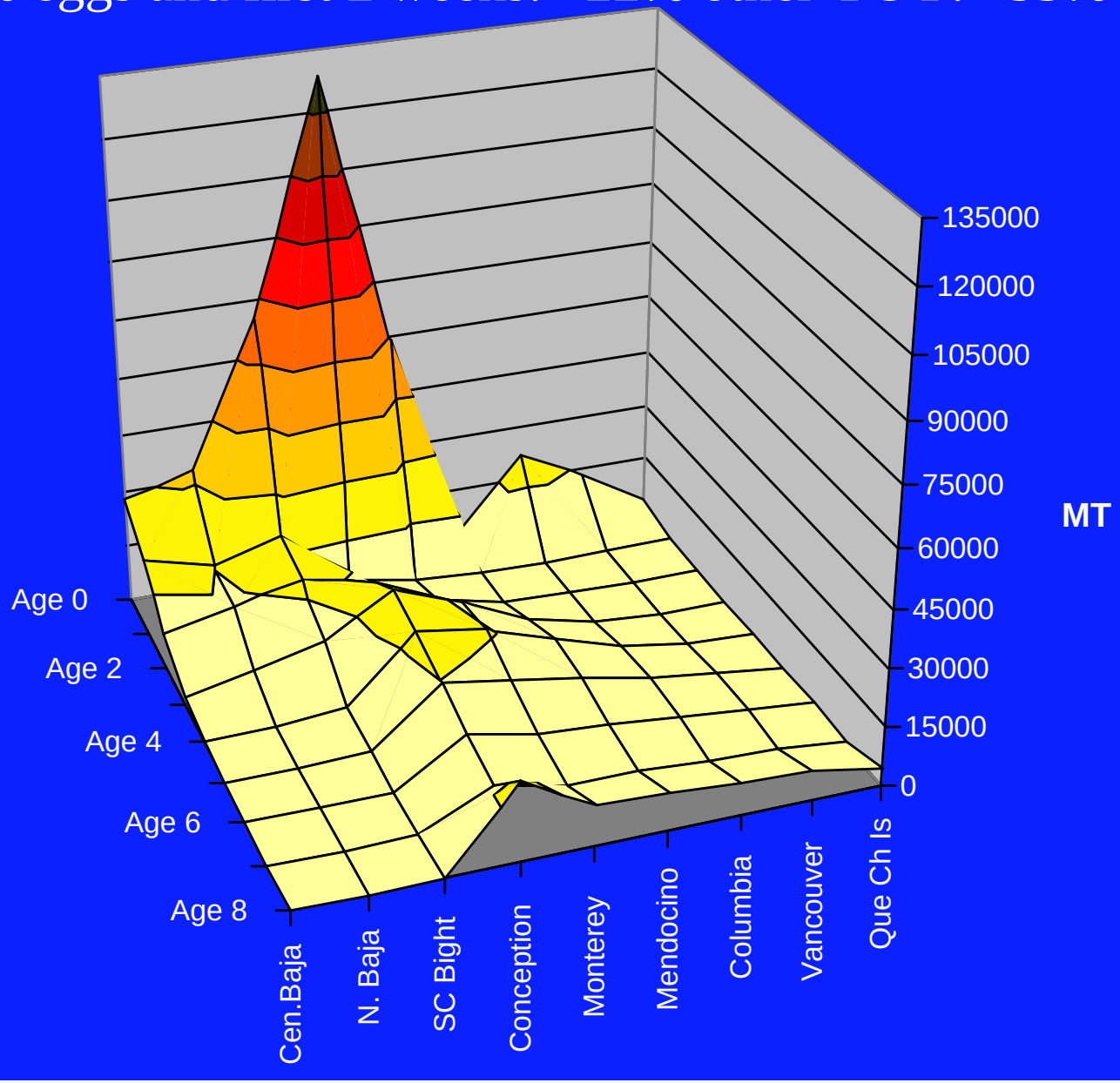
	Max. Catch	Stochastic MSY	Fishermen's Preferred	Science team Preferred
Maxcat	1000	0	400	200
Fraction	0.45	0.12	0.2	0.05-0.15
Cutoff	1000	0	50	150
Ave. catch	208	180	151	145
Median catch	16	128	104	182
SD Catch	306	180	137	67
Ave. Biomass	981	1,408 *	725	1,951
Ave. Depletion	32%	46%	24%	64%
% No catch	47%	0%	5%	0.5%
% Years Bio. > 0.4 MMT	94%	84%	39%	96%
	(Ave. Biomass unfished		3,050)	

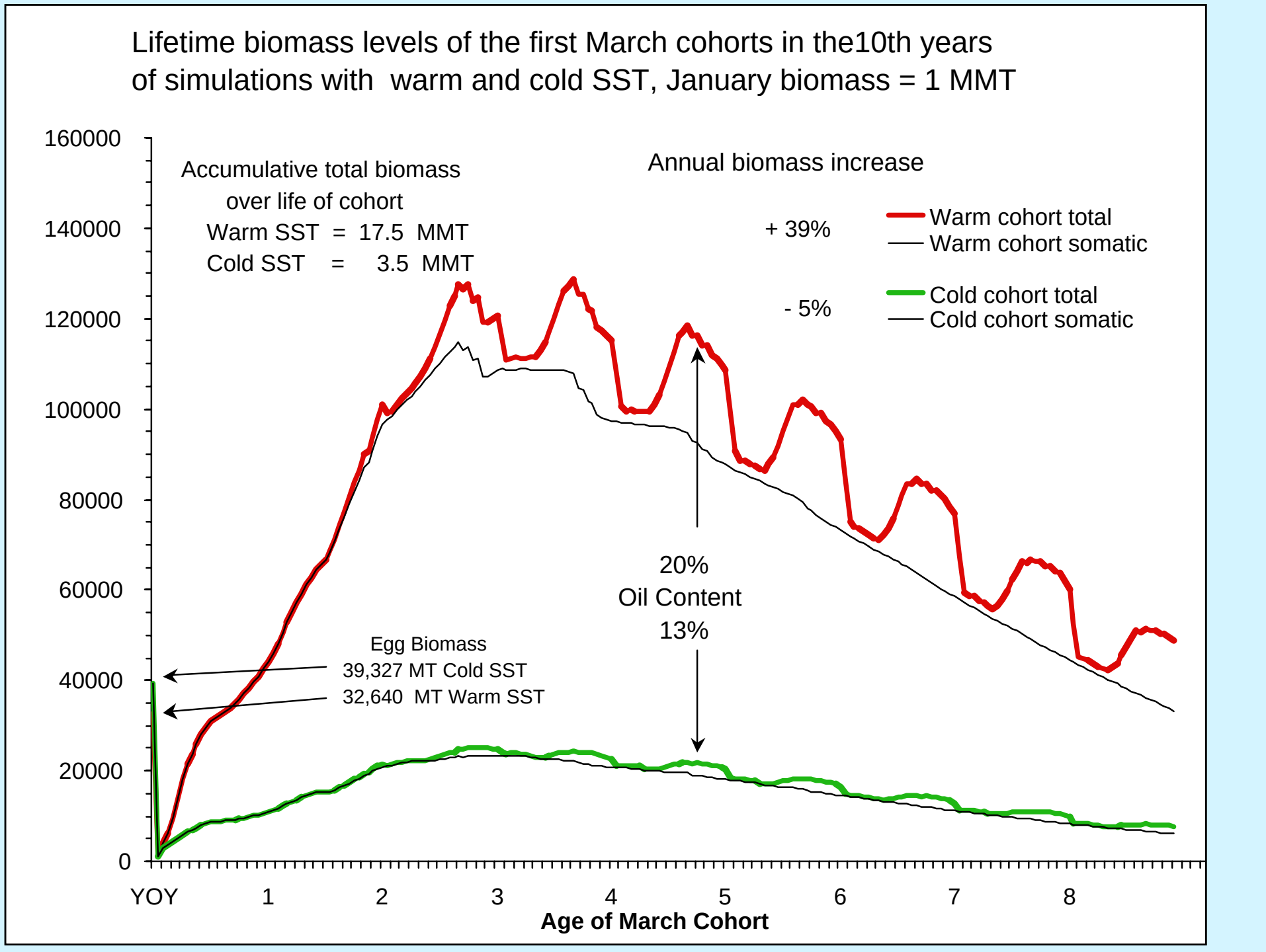
Sardine forage by age from 1 MMTs (age 1+) March (1) cohort with warm and cold simulations



O.76 MMT forage with warm SST and 1 MMT age 1+ biomass

(25% eggs and first 2 weeks: 22% other YOY: 53% age 1+)




Lifetime biomass levels of the first March cohorts in the10th years
of simulations with warm and cold SST, January biomass = 1 MMT
160000
140000
120000
100000
80000
60000
40000
20000
0
Accumulative total biomass
over life of cohort
Warm SST = 17.5 MMT
Cold SST = 3.5 MMT
Annual biomass increase
+ 39%
- 5%
Warm cohort total
Warm cohort somatic
Cold cohort total
Cold cohort somatic
20%
Oil Content
13%
Egg Biomass
39,327 MT Cold SST
32,640 MT Warm SST
YOY
1
2
3
4
5
6
7
8
Age of March Cohort