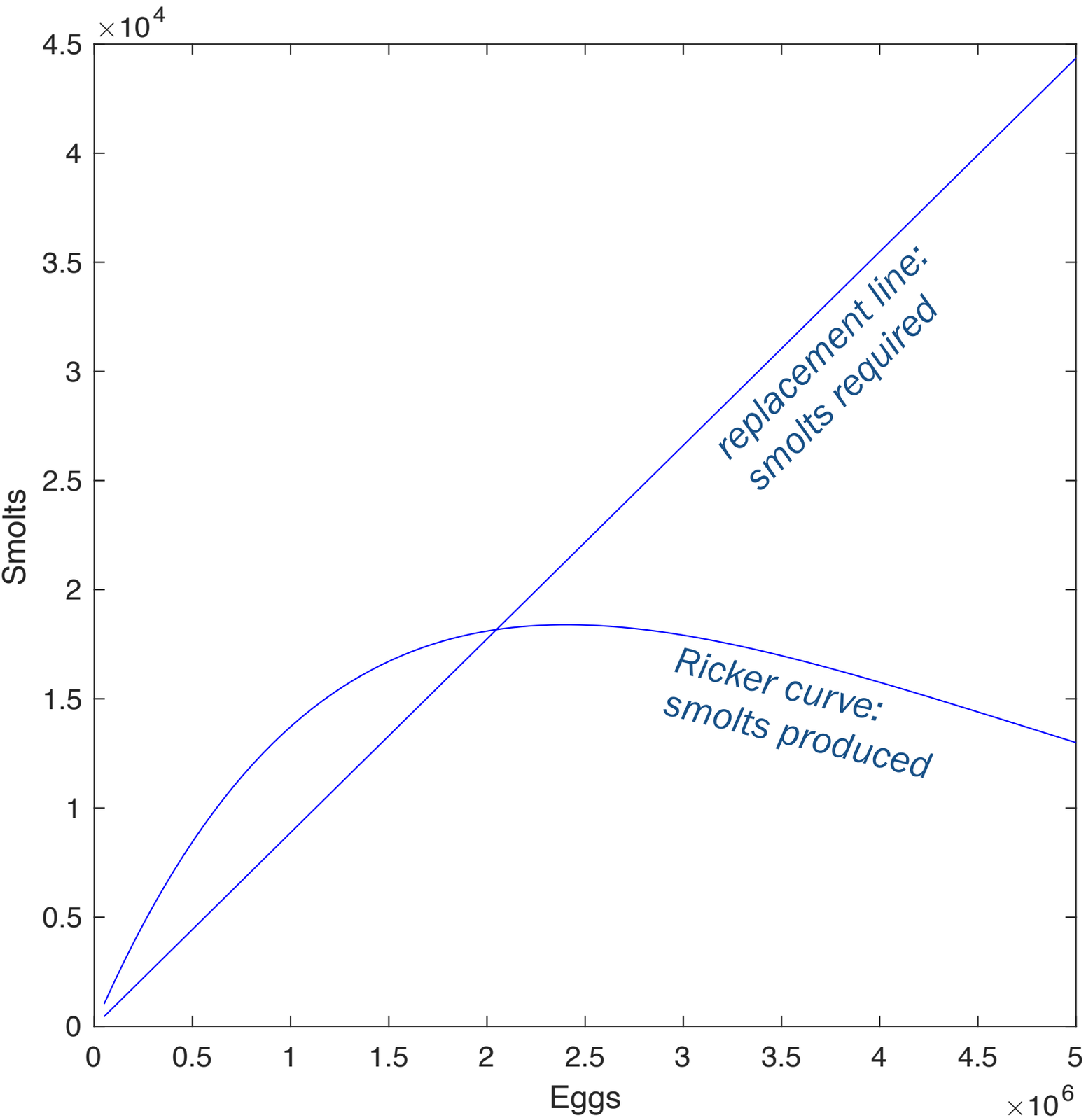
River Bush sensitivity experiments

mortalityFramework v0.8

Mar 2023

The goal: capacity to directly compare effects of changes in

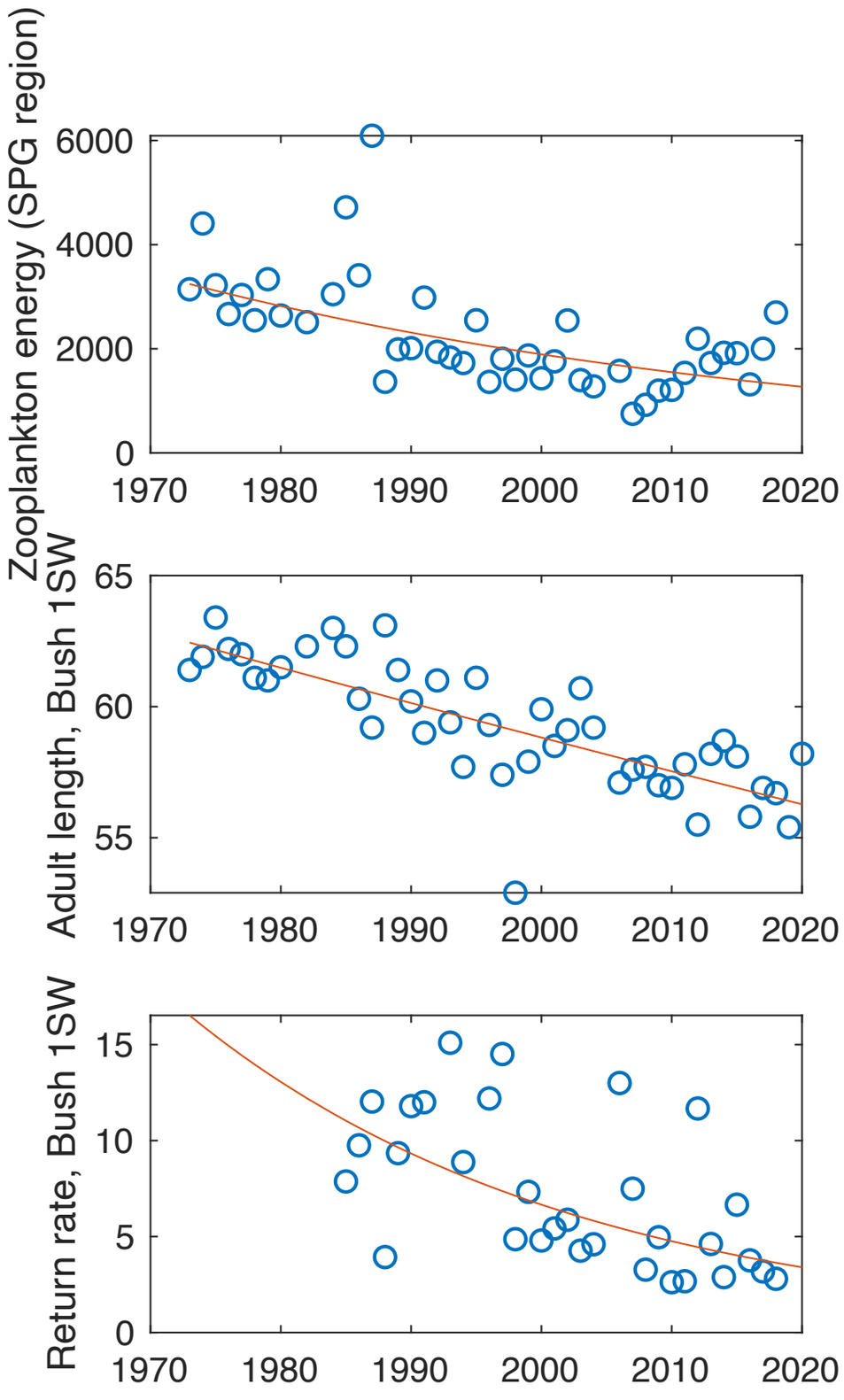
↕ juvenile growth
ocean conditions
in-river adult survival



↕ egg survival
fry survival
parr survival
smolt survival

	Duration	*Growth*	*Mortality*
Egg			constant
Fry		Tuned using parr length	constant
Parr	6, 18, 30 mo	Tuned using smolt length	Ricker; extra 20% for extra year in FW
Smolt			constant
Early post-smolt		Tuned using adult length	Size-dependent (tuned so that 12 → 16 cm smolts = 2x returns)
Late post-smolt			
Adult in open ocean	1–2 SW		Tuned based on 1 vs 2 SW returns
Adult at coast			constant
Adult in river			constant
Next-generation eggs			**Fecundity** based on body weight, sex ratio

in combination, made to match the empirical egg–smolt Ricker



(Tyldesley et al. in prep)

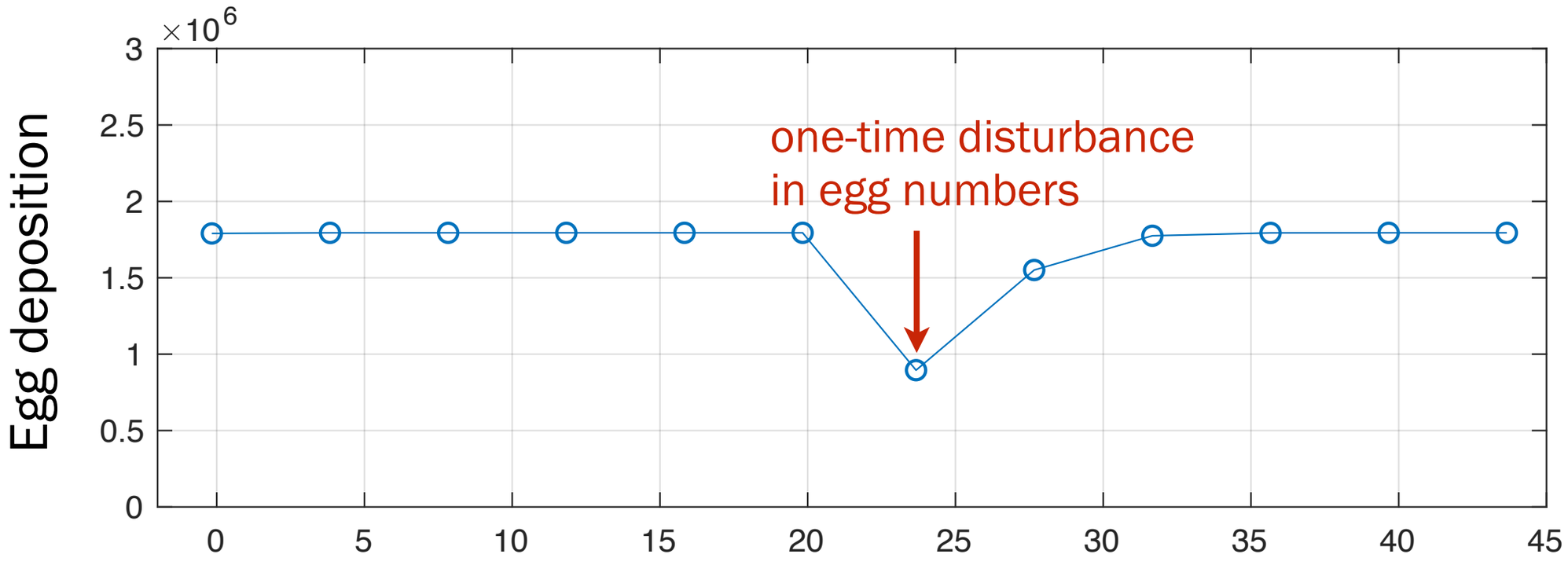
Representing time slices in R. Bush historical data using log-linear fits to the full record (assumes % change/ decade is constant)

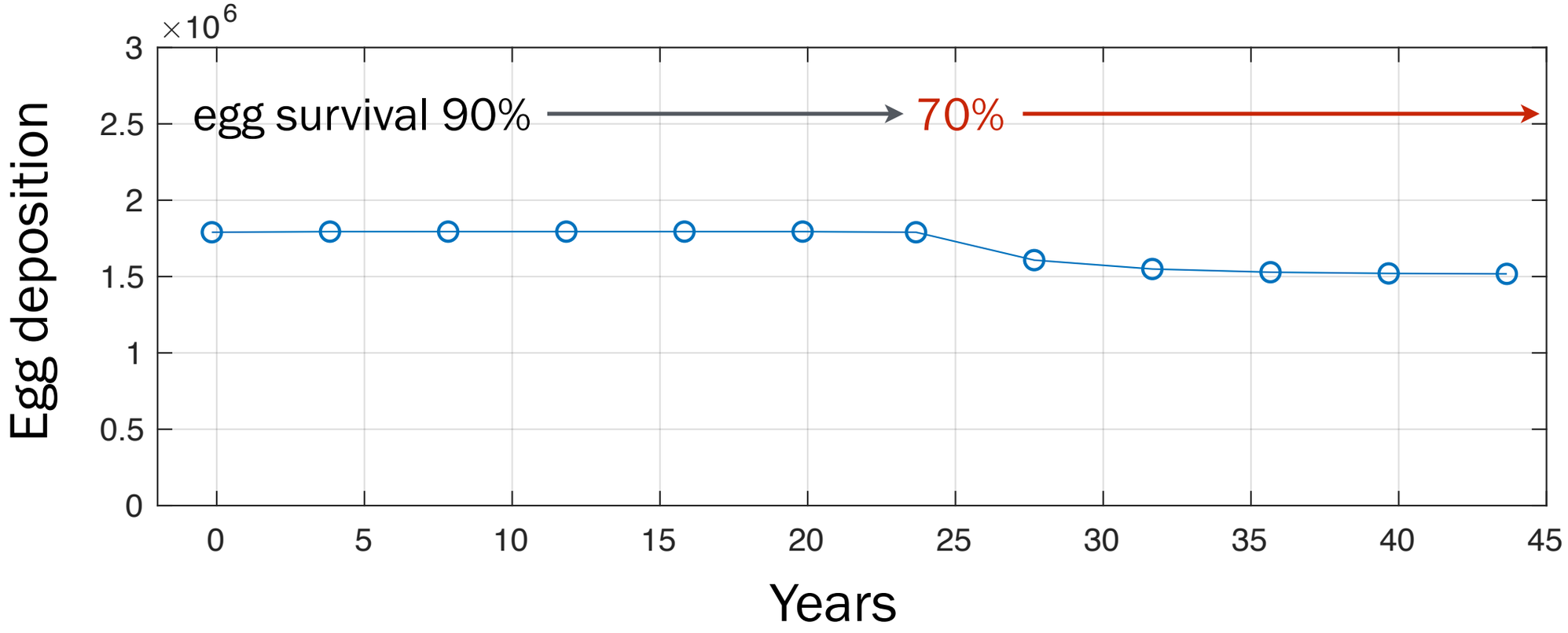
based on log-linear fits (such that trends are %/decade)			trend coeff. (frac per 10 y)
	1985	**2015**	
zooplankton energy (SPG)	2550	1402	-0.019942
smolt length (2yo)	15.9	15.5	-0.0024405
adult length (1SW)	60.8	56.9	-0.0066394
est. egg deposition (M)	1.95	1.95	no trend: long-term avg
smolts (2yo)	19600	19600	no trend: long-term avg
adult returners (1SW)	1670	795	-0.024731
spawning population	1000	1000ish	no trend: long-term avg

↓

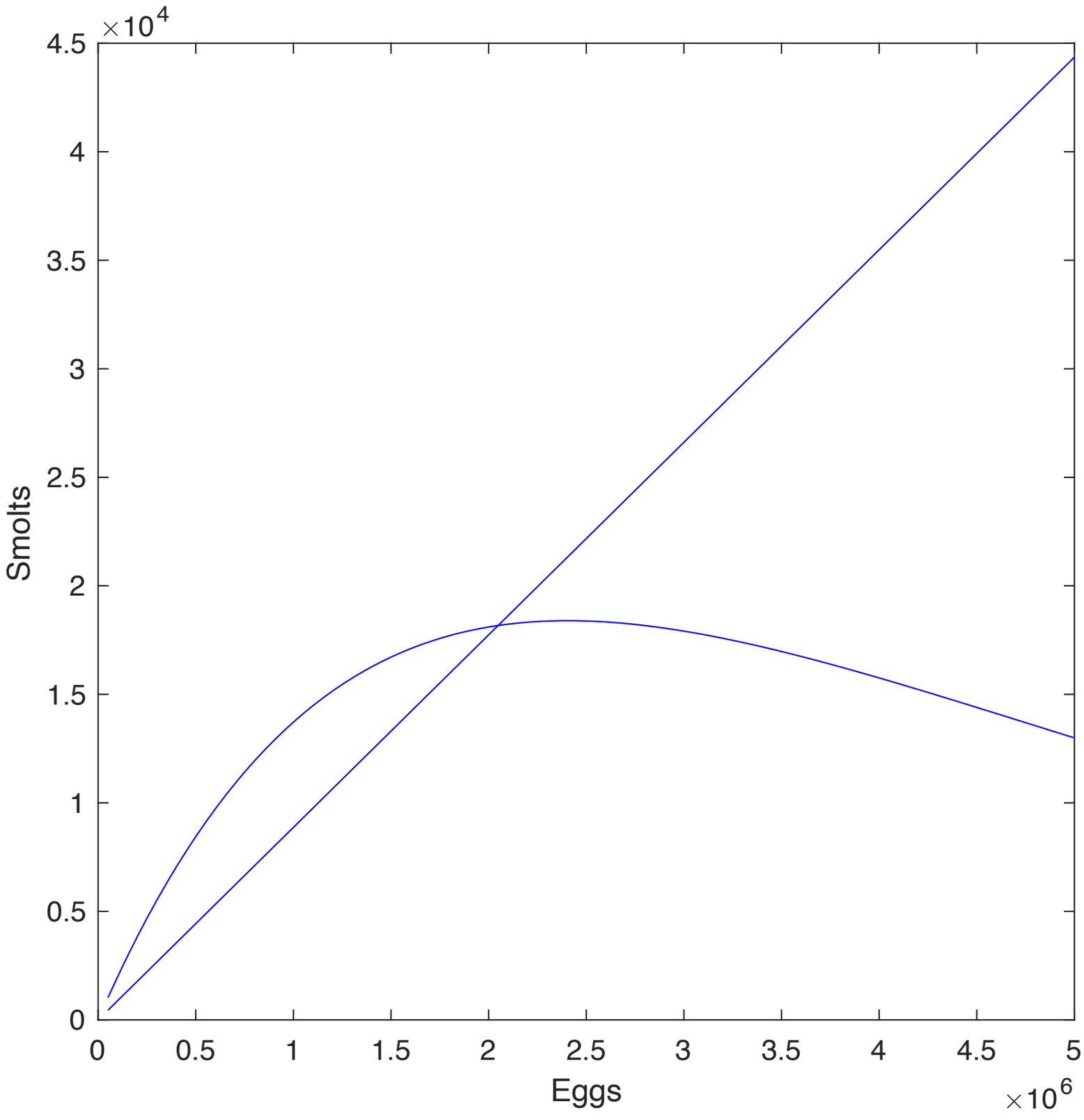
FW survival	***0.010***	***0.010***	
marine survival	***0.085***	***0.041***	
in-river adult survival	***0.599***	~~***1.257***~~	*call this 1*

Tuning targets (easily changed)


×10^6
3
2.5
2
1.5
1
0.5
0
Egg deposition
one-time disturbance
in egg numbers
0
5
10
15
20
25
30
35
40
45


×10^6
3
2.5
2
1.5
1
0.5
0
Egg deposition
egg survival 90%
70%
0
5
10
15
20
25
30
35
40
45
Years

Or run the model one generation for each of many initial egg numbers to produce

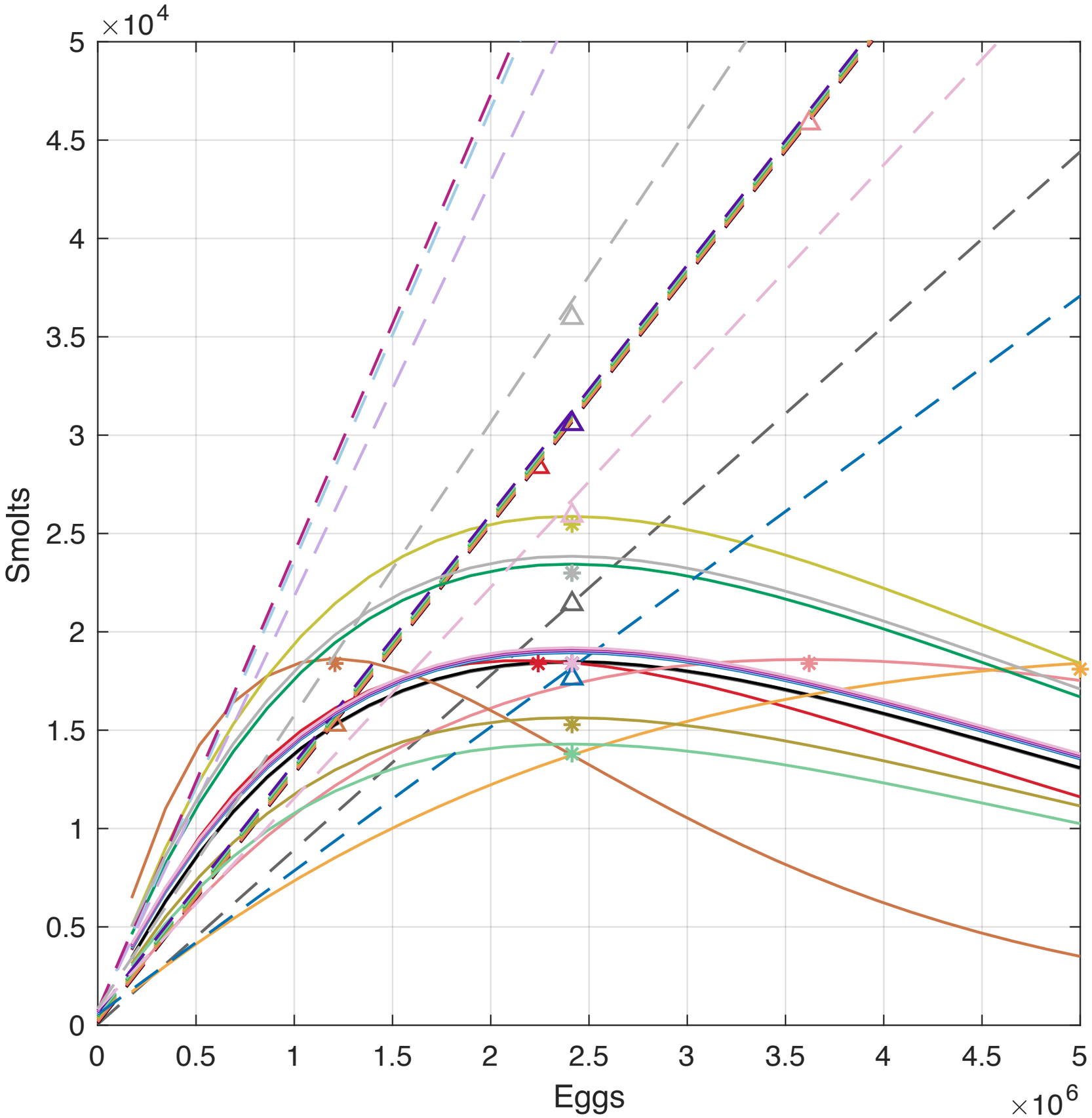


juvenile growth
ocean conditions
in-river adult survival

egg survival
fry survival
parr survival
smolt survival

Sensitivity experiments in mortalityFramework 0.8, Mar 2023

experiment	param 1	value	param 2	value	param 3	value	param 4	value	param 5	value 5
1980s	m_adultRiver	0.4	m_earlyPS_monthly	0.37	dgmaxOc	0.98	dgmaxFry	1.18	dgmaxParr	1.18
2010s-base	m_adultRiver	0	m_earlyPS_monthly	0.44	dgmaxOc	0.91	dgmaxFry	1.14	dgmaxParr	1.14
m egg -	m_egg	0								
m egg +	m_egg	0.4								
m fry -	m_fry	0.9								
m fry +	m_fry	0.98								
m parr -	parr_ricker_alpha	0.6								
m parr +	parr_ricker_alpha	1								
m smolt -	m_smolt	0								
m smolt +	m_smolt	0.4								
m postsmolt -	m_earlyPS_monthly	0.37								
m postsmolt +	m_earlyPS_monthly	0.51								
m returners -	m_adultRiver	0								
m returners +	m_adultRiver	0.4								
g fw -	dgmaxFry	0.95	dgmaxParr	0.95						
g fw +	dgmaxFry	1.2	dgmaxParr	1.2						
SA1	baselineDuration_parr	6								



17 egg–smolt curves/ replacement lines. Don't try to read it— summary follows

slightly jittered since many overlap

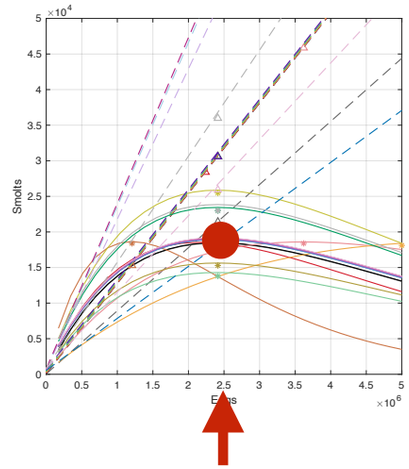
Eggs at max smolt production

$\times 10^6$

5

0

1980s
2010s-base
m egg -
m egg +
m fry -
m fry +
m parr -
m parr +
m smolt -
m smolt +
m postsmolt -
m postsmolt +
m returners -
m returners +
g fw -
g fw +
SA1



Max smolt production

$\times 10^4$

2

1

0

1980s
2010s-base
m egg -
m egg +
m fry -
m fry +
m parr -
m parr +
m smolt -
m smolt +
m postsmolt -
m postsmolt +
m returners -
m returners +
g fw -
g fw +
SA1

Surplus smolt production

$\times 10^4$

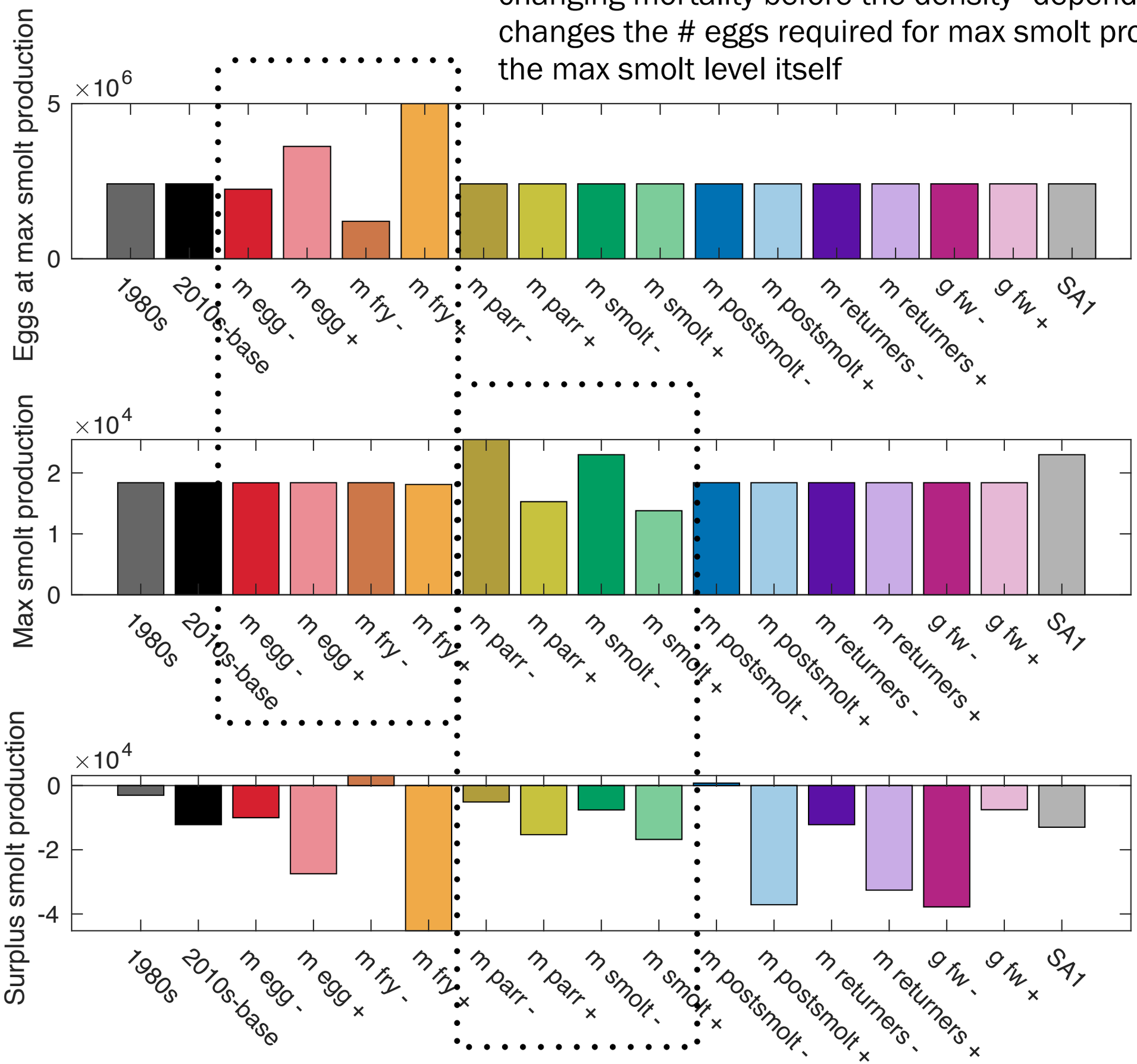
0

-2

-4

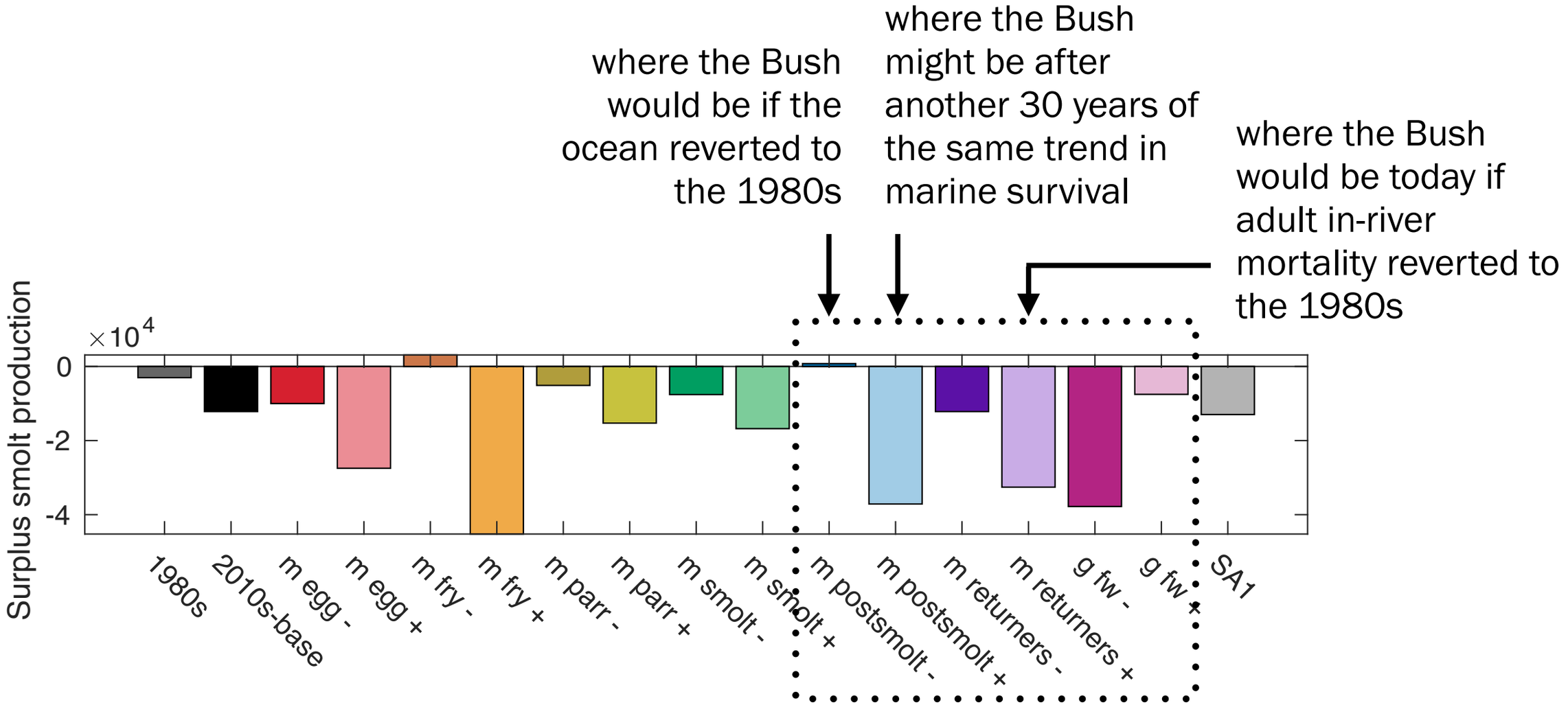
1980s
2010s-base
m egg -
m egg +
m fry -
m fry +
m parr -
m parr +
m smolt -
m smolt +
m postsmolt -
m postsmolt +
m returners -
m returners +
g fw -
g fw +
SA1

changing mortality before the density–dependent stage changes the # eggs required for max smolt production, not the max smolt level itself



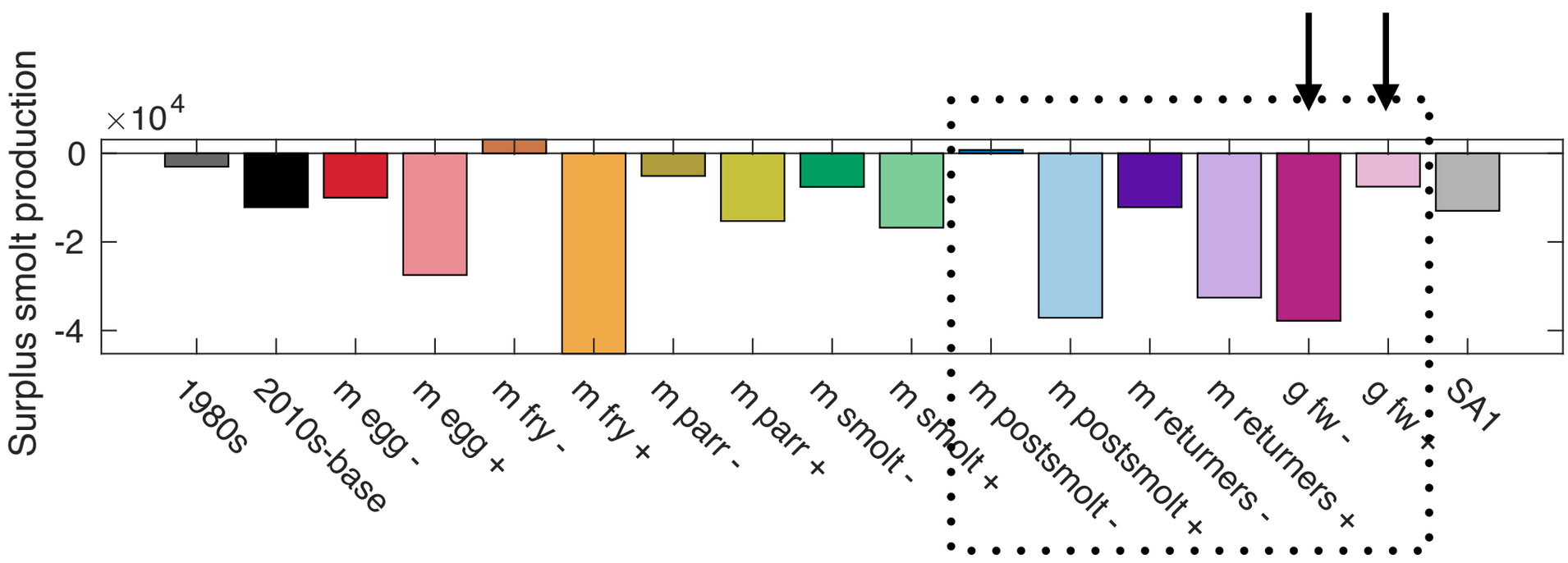
mortality interventions after the density-dependent stage have perhaps smaller effects on surplus (but still significant, comparable to 1980s–2010s differences)

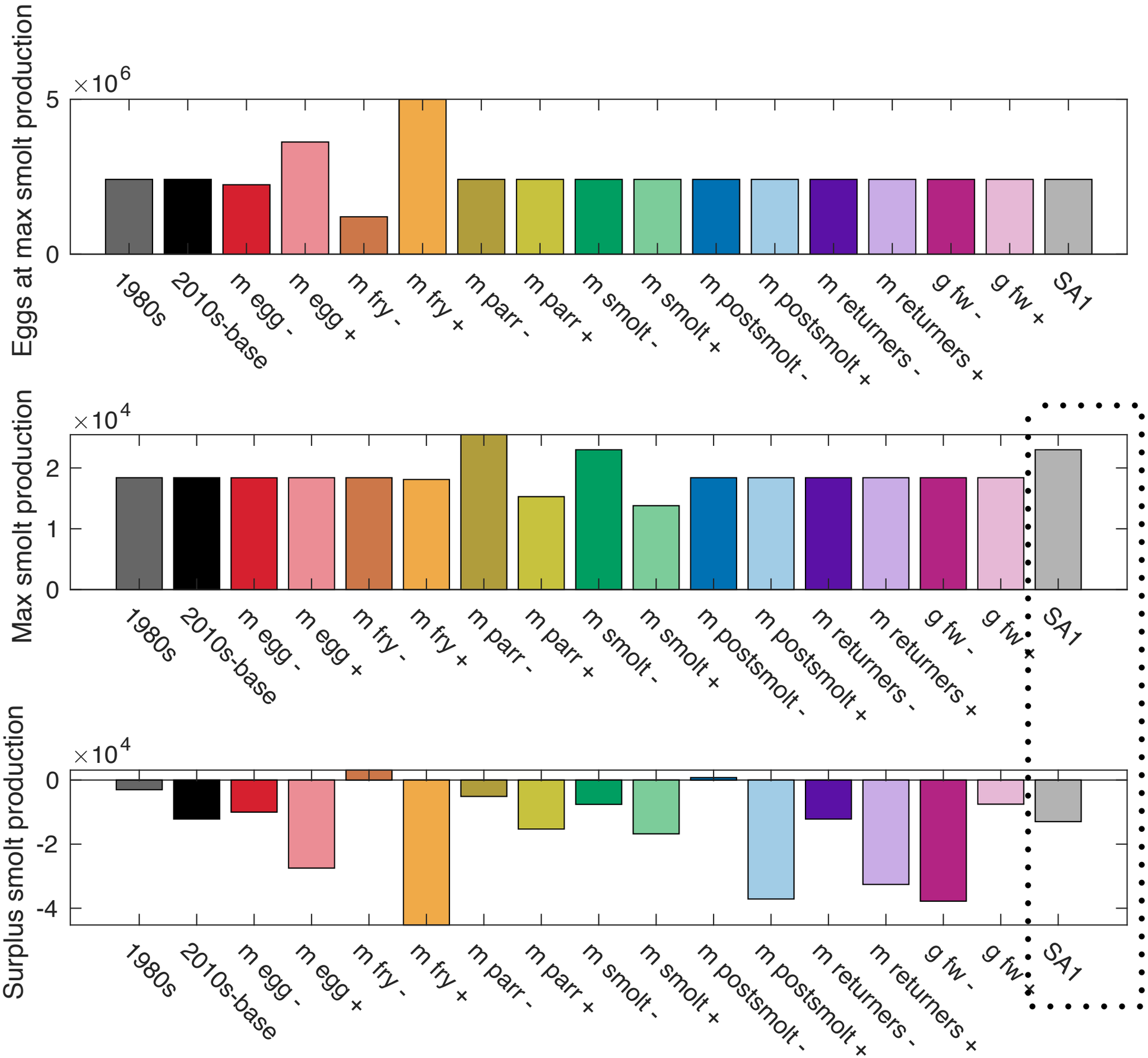
Changes past the juvenile FW stage only show up in the surplus calculation.



Changes past the juvenile FW stage only show up in the surplus calculation.

the carryover effect of juvenile growth on marine mortality is comparable to the effect of ocean conditions per se (unless this sensitivity experiment is scaled badly)





The direct effect of smolt age on mortality (holding growth constant) is not that big, compared to the smolt growth/size effects it's entangled with.