Further considerations of Dynamic B_0
Jan 2018

James Ianelli

Motivation

- Poor estimates of stock-recruit relationships
- Clear suggestion of change in mean recruitment

Background

- "Dynamic Bzero" computation added to Gmacs and presented for SMBKC in Sept 2017

```
1536    dvar4_array ftmp(1,nsex,syr,nyr,1,nseason,1,nclass);          ///> Fishing mortality
1537    ftmp = F;
1538    F.initialize();
1539    calc_total_mortality();
1540    calc_initial_numbers_at_length();
1541    update_population_numbers_at_length();
1542    sd_log_dyn_Bzero = log(calc_ssb())(syr+1,nyr);
1543    sd_log_dyn_Bzero = (sd_log_ssb(syr+1,nyr)) - (sd_log_dyn_Bzero);
1544    F = ftmp;
1545    calc_total_mortality();
1546    calc_initial_numbers_at_length();
1547    update_population_numbers_at_length();
```

Previous studies and discussions

Shifts in Stock Productivity: On the Use of 'Dynamic' Management Metrics

Aaron Berger, Ian Taylor, Z. Teresa A'mar and Melissa Haltuch

PFMC Productivity Workshop, December 6-8, 2016

- *MacCall et al. 1985*

- *Field et al. 2010*

- *Berger et al. 2013*

- *Many assessments* *grey literature...*
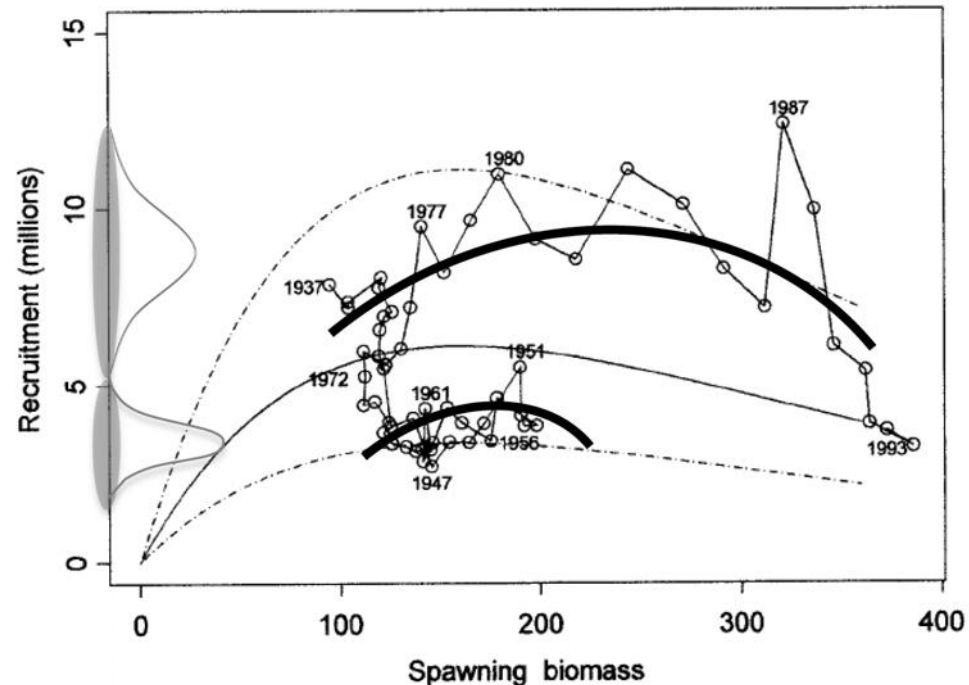
Berger et al.
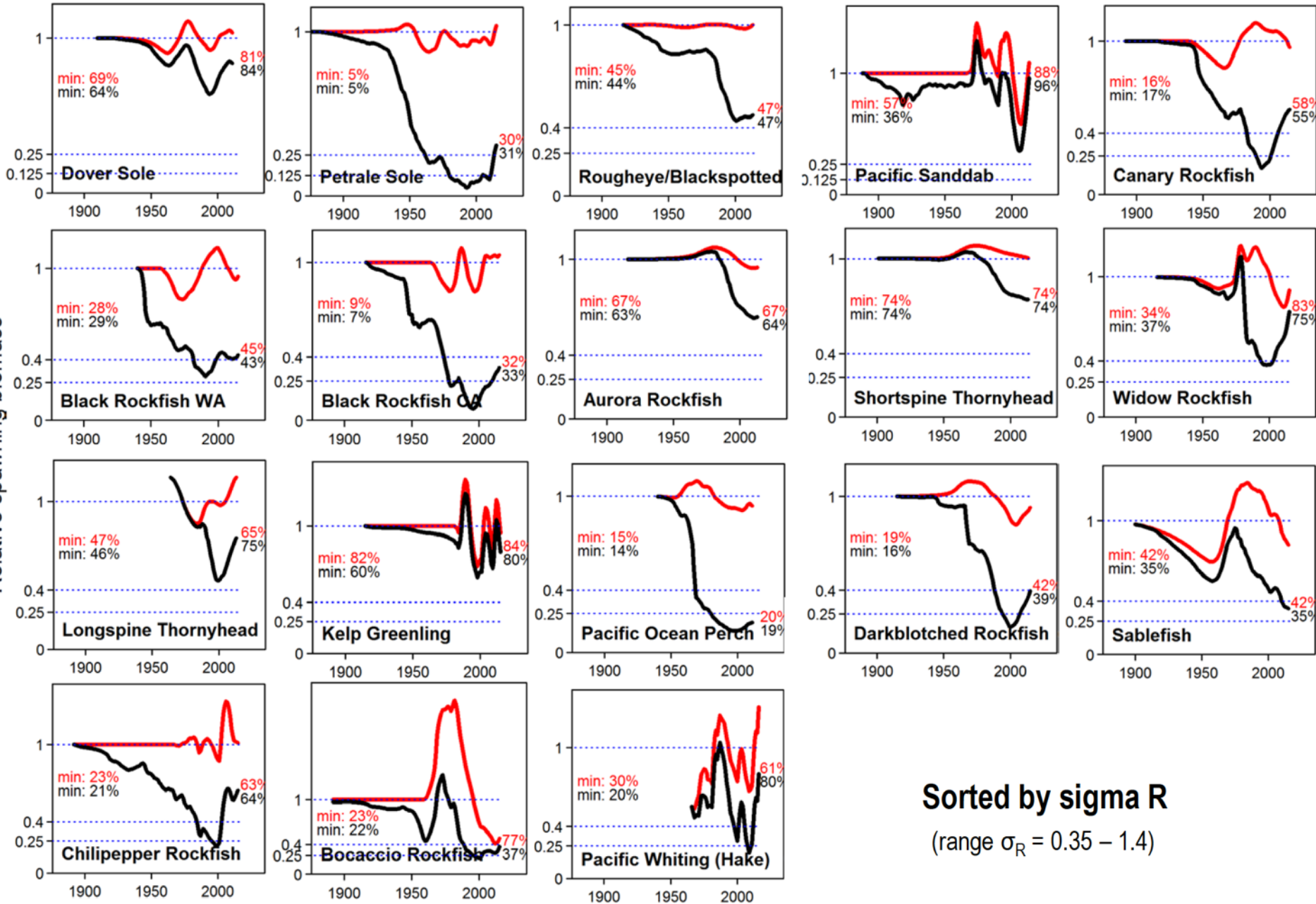
- Many examples
  - Vert pre et al. 2013 http://www.jstor.org/stable/41992117
  - Folke et al. 2004 (http://www.jstor.org/stable/30034127)
  - Scheffer and Carpenter 2003 (doi:10.1016/j.tree.2003.09.002)
  - Parma 2002 (Bulletin Marine Science 70(2))

Berger et al.

Relative spawning biomass

Dover Sole — min: 69% / min: 64% — 81% / 84%
Petrale Sole — min: 5% / min: 5% — 30% / 31%
Rougheye/Blackspotted — min: 45% / min: 44% — 47% / 47%
Pacific Sanddab — min: 57% / min: 36% — 88% / 96%
Canary Rockfish — min: 16% / min: 17% — 58% / 55%
Black Rockfish WA — min: 28% / min: 29% — 45% / 43%
Black Rockfish OR — min: 9% / min: 7% — 32% / 33%
Aurora Rockfish — min: 67% / min: 63% — 67% / 64%
Shortspine Thornyhead — min: 74% / min: 74% — 74% / 74%
Widow Rockfish — min: 34% / min: 37% — 83% / 75%
Longspine Thornyhead — min: 47% / min: 46% — 65% / 75%
Kelp Greenling — min: 82% / min: 60% — 84% / 80%
Pacific Ocean Perch — min: 15% / min: 14% — 20% / 19%
Darkblotched Rockfish — min: 19% / min: 16% — 42% / 39%
Sablefish — min: 42% / min: 35% — 42% / 35%
Chilipepper Rockfish — min: 23% / min: 21% — 63% / 64%
Bocaccio Rockfish — min: 23% / min: 22% — 77% / 37%
Pacific Whiting (Hake) — min: 30% / min: 20% — 61% / 80%

Sorted by sigma R

(range σ_R = 0.35 − 1.4)

Berger et al.

Pacific Sardine

- SSB/SSBvirgin
- SSB/SSBdynamic
- cutoff

36%
23%

Pacific Mackerel

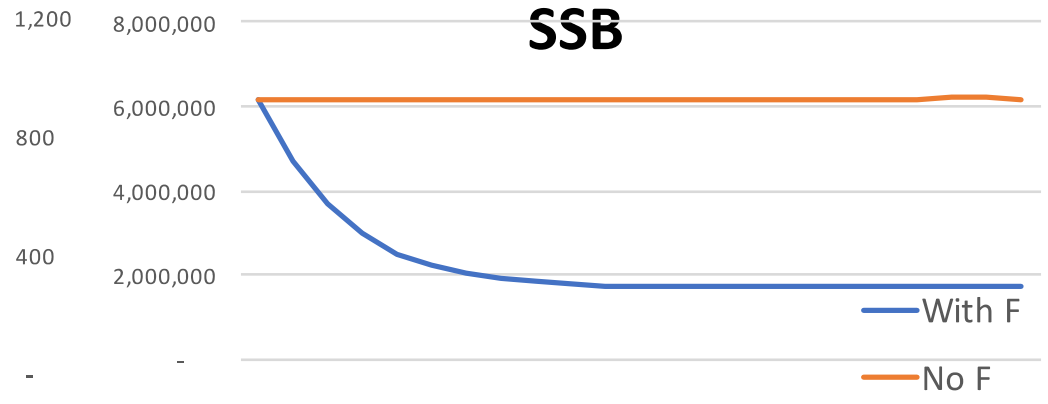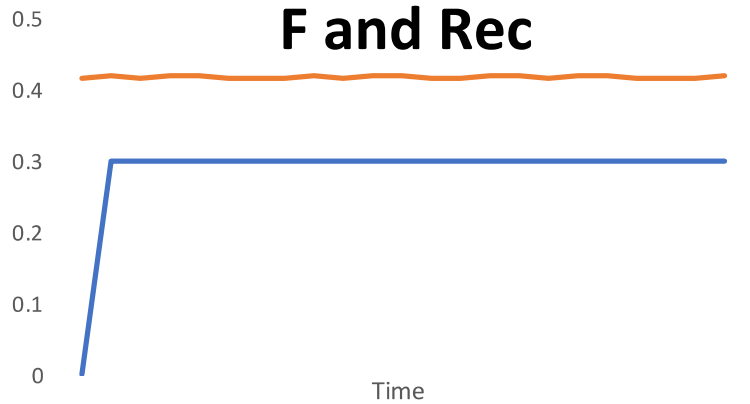- SSB/SSBvirgin
- SSB/SSBdynamic
- cutoff

32%
9%

Berger et al.

- Species and management context important
  - One size fits all approach unlikely
- Need to evaluate alternative harvest policies using dynamic approach (MSE)
- Static or equilibrium approach unsuitable ... ***where recruitment is largely dependent on environment***
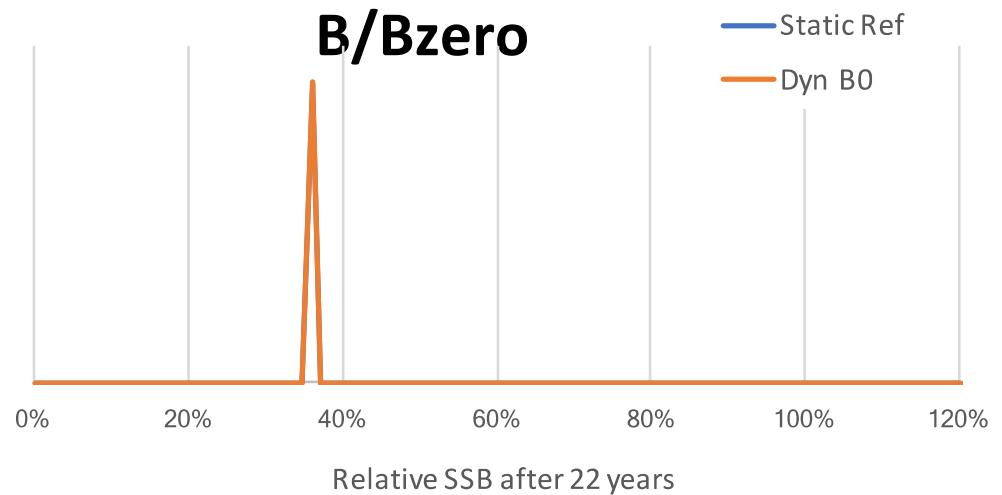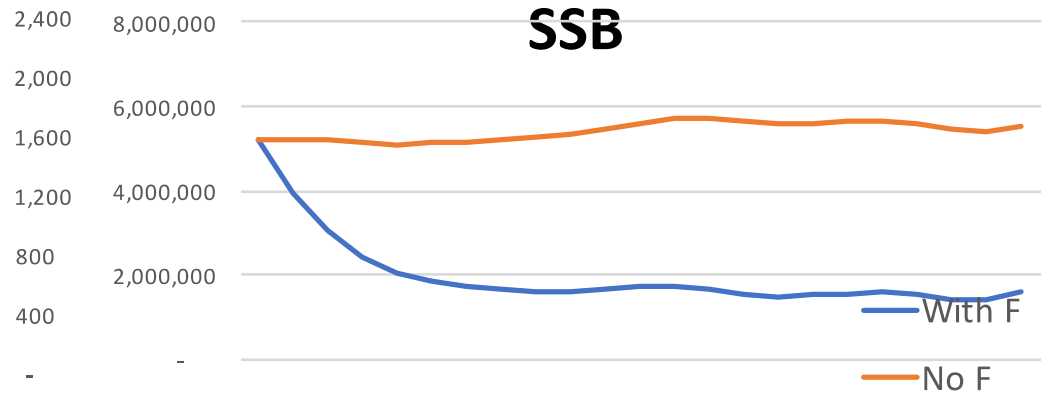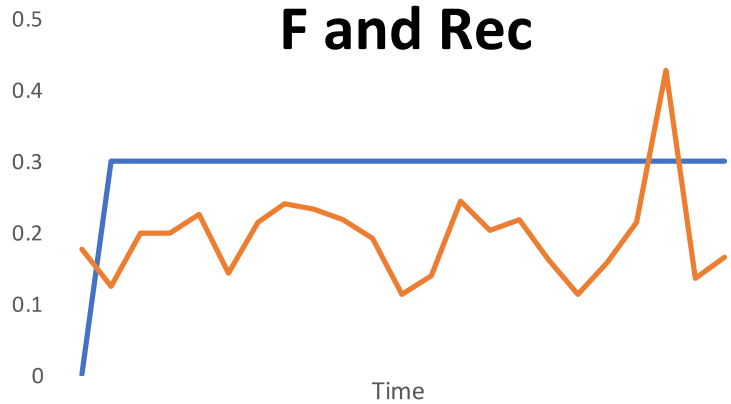- ...

Spreadsheet simulations

F and Rec

(chart with y-axis labeled 0, 0.1, 0.2, 0.3, 0.4, 0.5 on left; 400, 800, 1,200 on right; x-axis labeled "Time")

SSB

(chart with y-axis labeled -, 2,000,000, 4,000,000, 6,000,000, 8,000,000)

With F

No F

Main controls

Framp	F	△R	SigR
FALSE	0.3	1	0.06

B / B0

	Static	Dyn
Mean	35%	35%
CV	1%	1%

B/Bzero

Static Ref

Dyn B0

(chart with x-axis labeled 0%, 20%, 40%, 60%, 80%, 100%, 120%)

Relative SSB after 22 years

W/ recruitment variability

F and Rec

SSB

With F
No F

Main controls

Framp	F	△R	SigR
FALSE	0.3	1	0.6

B / B0

	Static	Dyn
Mean	37%	35%
CV	14%	8%

B/Bzero

Static Ref
Dyn B0

Relative SSB after 22 years

And some more…

F and Rec

SSB
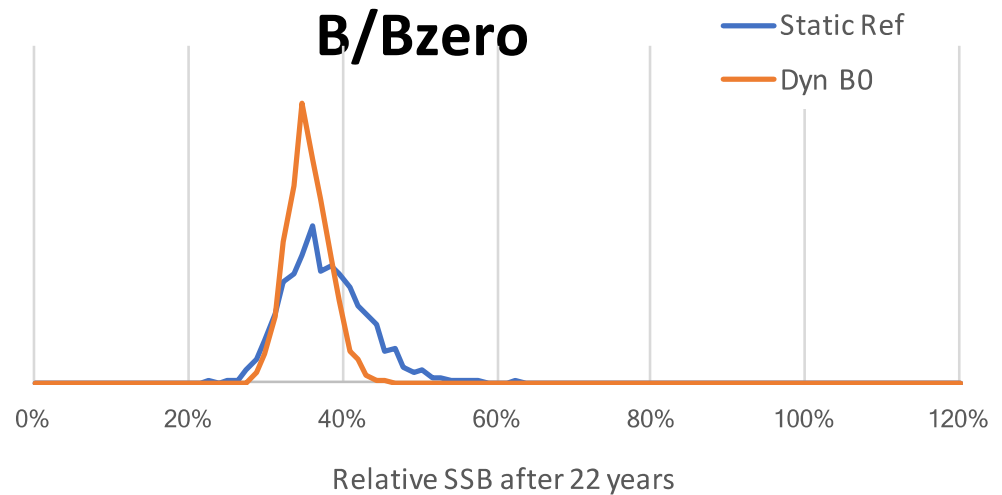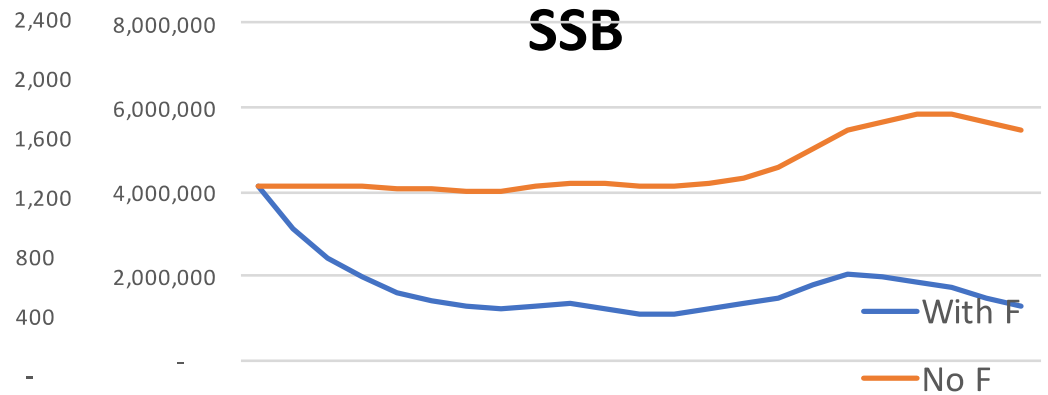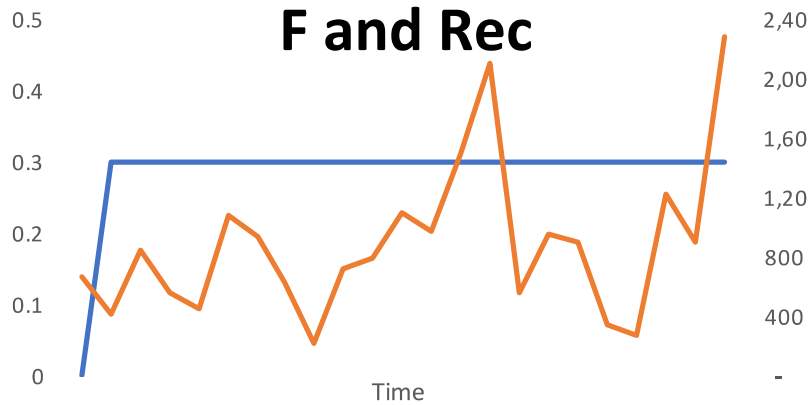
Main controls

Framp	F	△R	SigR
FALSE	0.3	1	0.9

B / B0

	Static	Dyn
Mean	48%	35%
CV	34%	18%

B/Bzero

Static Ref
Dyn B0

Relative SSB after 22 years

With F
No F

Time
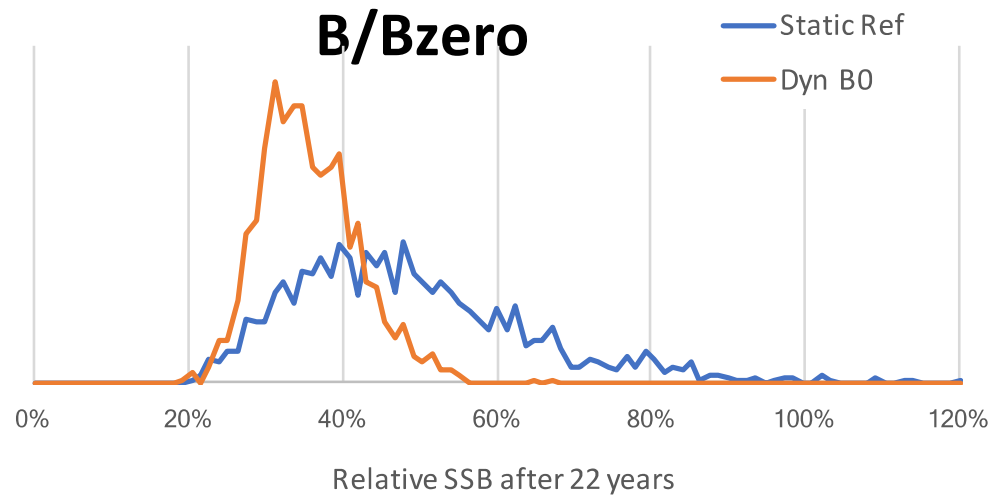
Regime change...recruits down

F and Rec

SSB
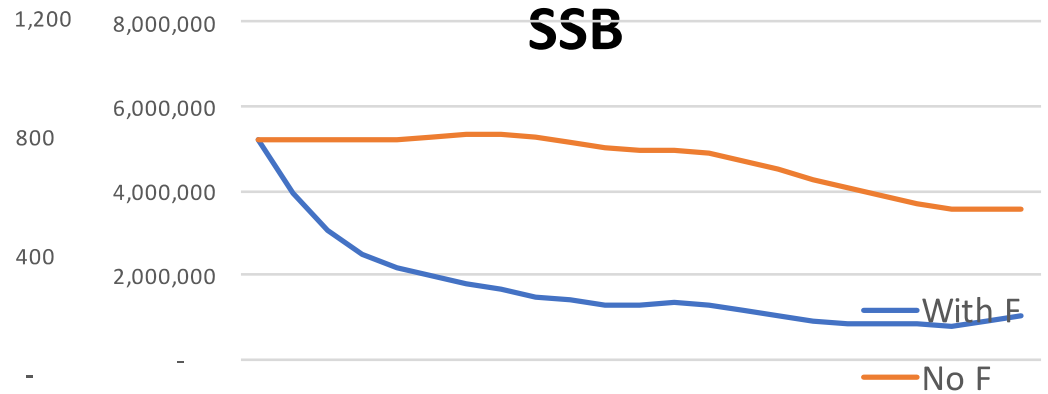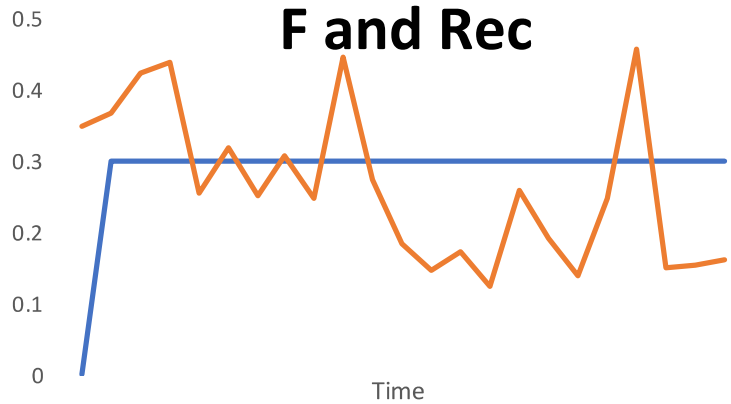
Main controls

Framp		F	△R	SigR
FALSE		0.3	0.5	0.6

B / B0

	Static	Dyn
Mean	19%	29%
CV	13%	9%

B/Bzero

With F

No F

Static Ref

Dyn B0

Relative SSB after 22 years
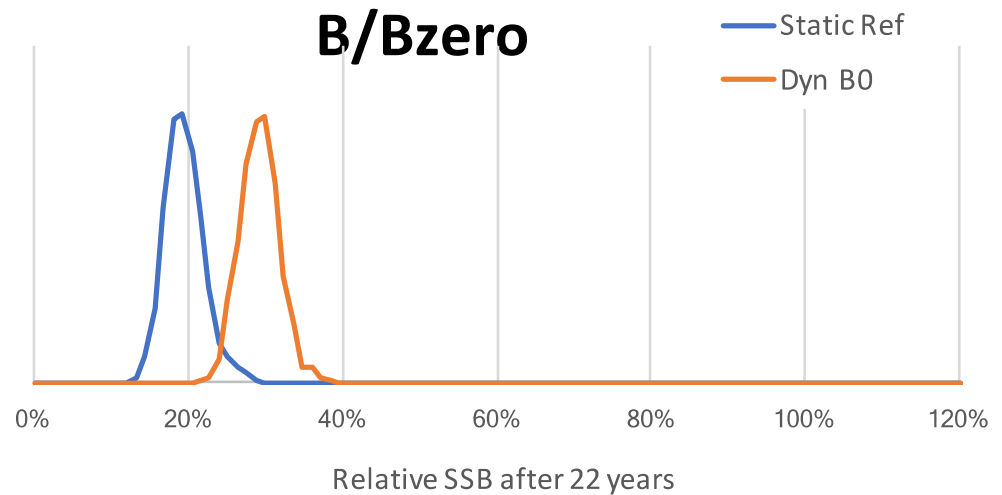
Regime change...recruits up

F and Rec

SSB
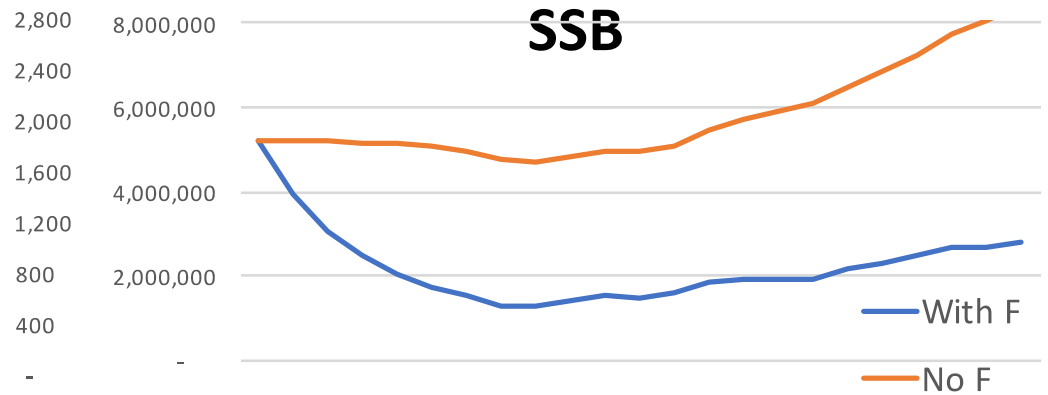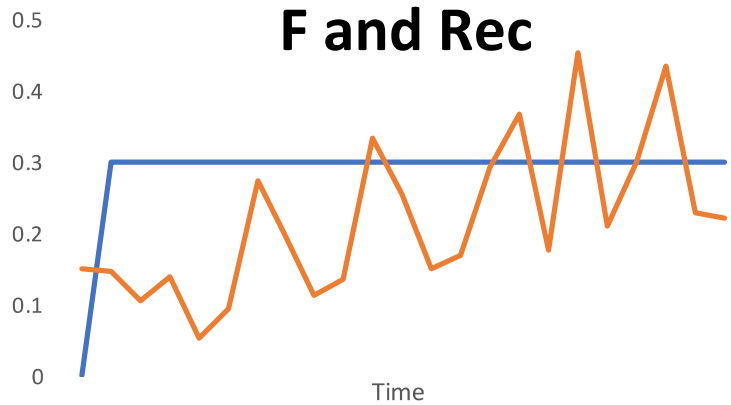
Main controls

Framp	F	△R	SigR
FALSE	0.3	2	0.6

B / B0

	Static	Dyn
Mean	74%	39%
CV	13%	7%

B/Bzero

Relative SSB after 22 years

F and Rec

SSB
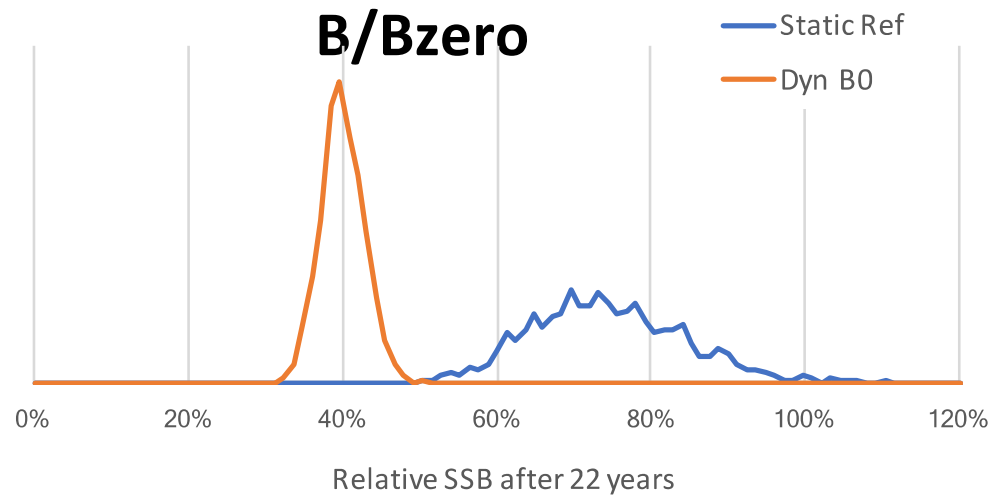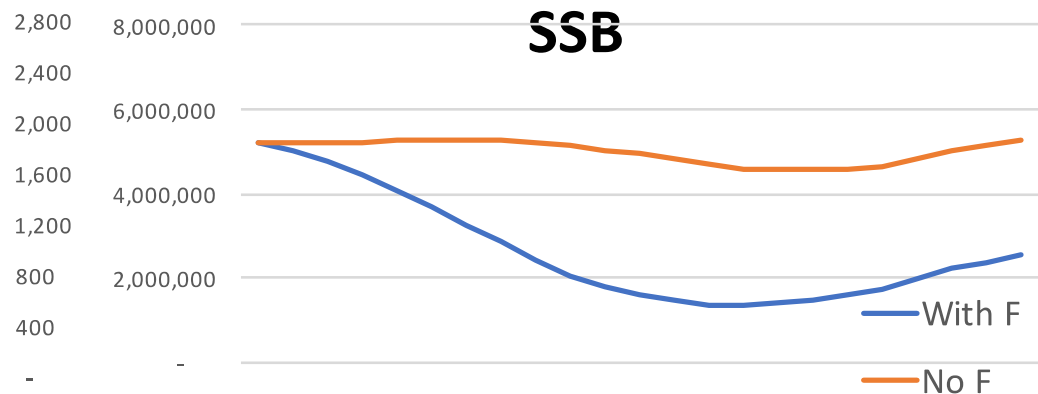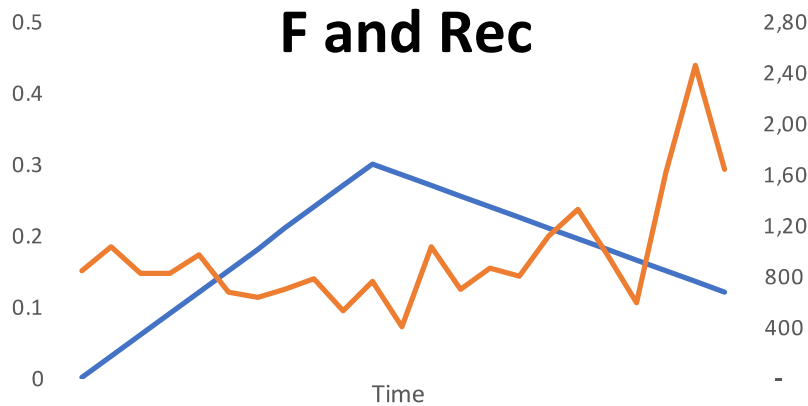
Main controls

Framp	F	△R	SigR
TRUE	0.3	1	0.6

B / B0

	Static	Dyn
Mean	51%	48%
CV	12%	5%

B/Bzero

With F
No F
Static Ref
Dyn B0

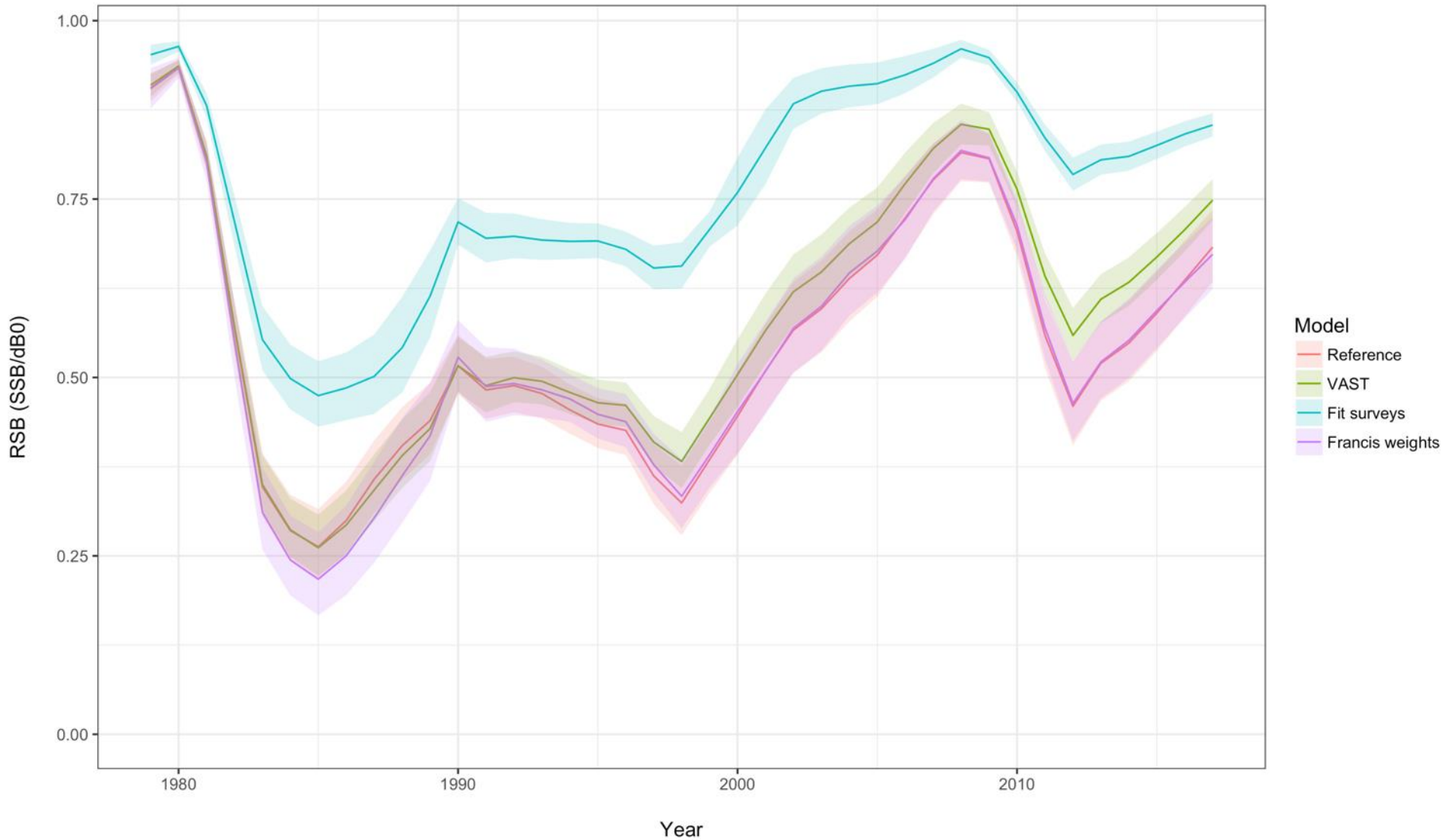Relative SSB after 22 years
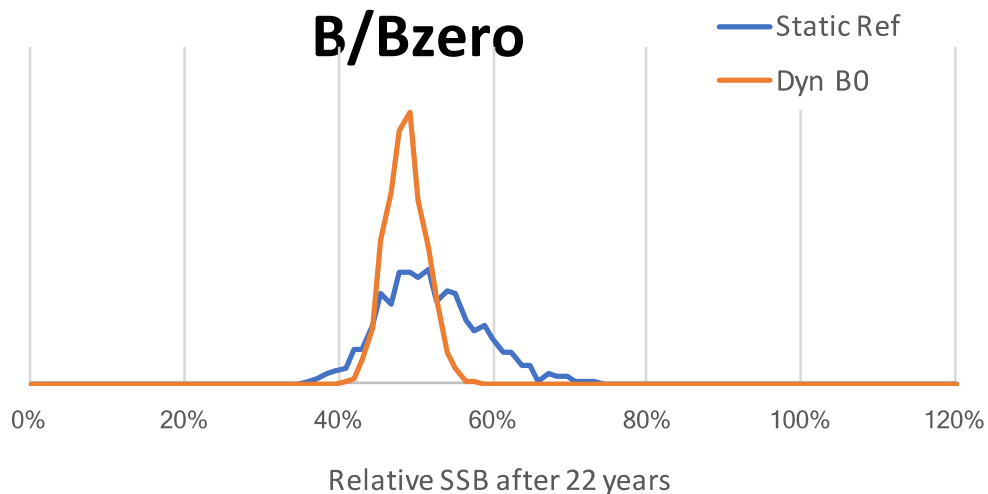
Case for SMBKC

Data by type and year
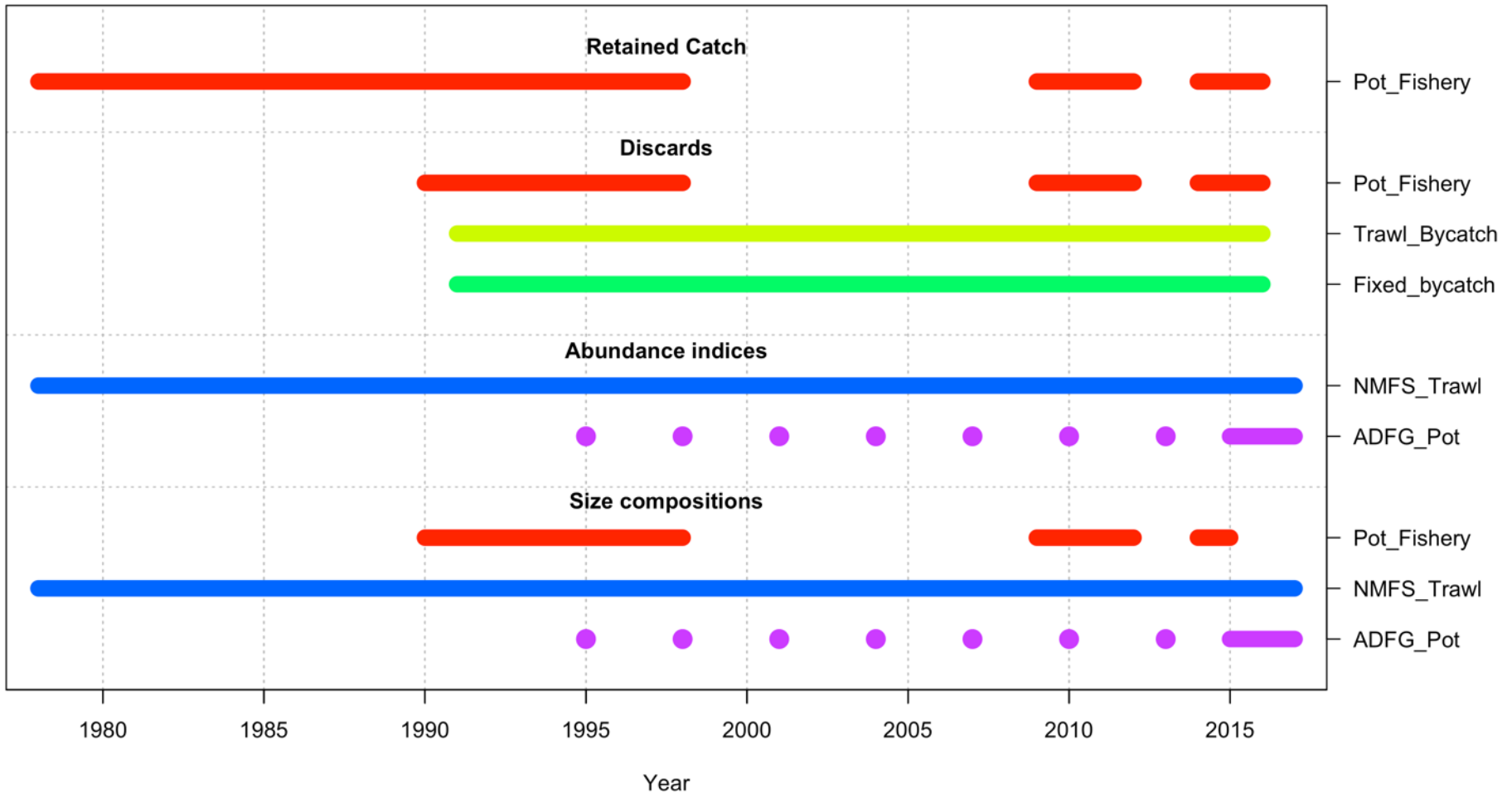
Case for SMBKC DynB_0 time series

Take home / discussion

For SMBKC time series presentation confusing...
- Distribution of recent year (or average over recent subset of years) perhaps better

Avoids issue of period over which to average SSB
- I.e., for reference calculations used in crab

Provides focus on fishing impacts
- Rather than declines due to distribution shifts or other environmental effects

Requires fewer assumptions wrt relative SSB estimates
- But many of the same assumptions (M, estimated R, etc)

Perhaps considered as supplemental to status determination
- Given some flexibility in MSA reauthorization?