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

```c
1536 dvar4_array ftmp(1,nsex,syr,nyr,1,nseason,1,nclass);          //> Fishing mortality
1537 ftmp = F;
1538 F.initialize();
1539
calc_total_mortality();
calc_initial_numbers_at_length();
update_population_numbers_at_length();
sd_log_dyn_Bzero = log(calc_ssb())(syr+1,nyr);
sd_log_dyn_Bzero = (sd_log_ssb(syr+1,nyr)) - (sd_log_dyn_Bzero);
F = ftmp;
calc_total_mortality();
calc_initial_numbers_at_length();
update_population_numbers_at_length();
```
Previous studies and discussions

- MacCall et al. 1985
- Field et al. 2010
- Berger et al. 2013
- Many assessments grey literature...
Berger et al.

• Many examples
  Folke et al. 2004 (http://www.jstor.org/stable/30034127)
  Parma 2002 (Bulletin Marine Science 70(2))
Sorted by sigma $R$
(range $\sigma_R = 0.35 - 1.4$)
Berger et al.

Pacific Sardine
- SSB/SSB\text{virgin}
- SSB/SSB\text{dynamic}
- cutoff

- 36%
- 23%

Year

Pacific Mackerel
- SSB/SSB\text{virgin}
- SSB/SSB\text{dynamic}
- cutoff

- 32%
- 9%

Year

Acknowledgement: Kevin Hill SWFSC
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**

**Main controls**

<table>
<thead>
<tr>
<th>Framp</th>
<th>F</th>
<th>ΔR</th>
<th>SigR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALSE</td>
<td>0.3</td>
<td>1</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**B / B0**

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>CV</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

**SSB**

**B/Bzero**

- With F
- No F
- Static Ref
- Dyn B0

Relative SSB after 22 years
W/ recruitment variability

Main controls

<table>
<thead>
<tr>
<th>Framp</th>
<th>F</th>
<th>∆R</th>
<th>SigR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALSE</td>
<td>0.3</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

B / B0

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>CV</td>
<td>14%</td>
<td>8%</td>
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B/Bzero

Relative SSB after 22 years

F and Rec

SSB

With F

No F
And some more...

### F and Rec

![Graph showing F and Rec over time](image)

### Main controls

<table>
<thead>
<tr>
<th>Framp</th>
<th>F</th>
<th>$\Delta R$</th>
<th>SigR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALSE</td>
<td>0.3</td>
<td>1</td>
<td>0.9</td>
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</table>

### B / B0

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>48%</td>
<td>35%</td>
</tr>
<tr>
<td>CV</td>
<td>34%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Regime change...recruits down

**F and Rec**

**Main controls**

<table>
<thead>
<tr>
<th>Framp</th>
<th>F</th>
<th>ΔR</th>
<th>SigR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALSE</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
</tr>
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</table>

**B / B0**

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>19%</td>
<td>29%</td>
</tr>
<tr>
<td>CV</td>
<td>13%</td>
<td>9%</td>
</tr>
</tbody>
</table>

**SSB**

- **With F**
- **No F**

**B/Bzero**

- **Static Ref**
- **Dyn B0**

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

F and Rec

Main controls

Framp | F | ΔR | SigR
--- | --- | --- | ---
FALSE | 0.3 | 2 | 0.6

B / B₀

<table>
<thead>
<tr>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>74%</td>
</tr>
<tr>
<td>CV</td>
<td>13%</td>
</tr>
</tbody>
</table>

B/B₀

SSB

Relative SSB after 22 years

With F

No F
### Main controls

<table>
<thead>
<tr>
<th>Framp</th>
<th>F</th>
<th>△R</th>
<th>SigR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRUE</td>
<td>0.3</td>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

### B / B₀

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Dyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>51%</td>
<td>48%</td>
</tr>
<tr>
<td>CV</td>
<td>12%</td>
<td>5%</td>
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</table>
Case for SMBKC

Data by type and year

- Retained Catch
- Discards
- Abundance indices
- Size compositions

Year:
- 1980
- 1985
- 1990
- 1995
- 2000
- 2005
- 2010
- 2015

Types:
- Pot_Fishery
- Trawl_Bycatch
- Fixed_bycatch
- NMFS_Trawl
- ADFG_Pot
Case for SMBKC Dyn$B_0$ 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?