Science, Service, Stewardship

Management strategy evaluation for the Gulf of Alaska walleye pollock fishery: how persistent are the environmental-recruitment links?

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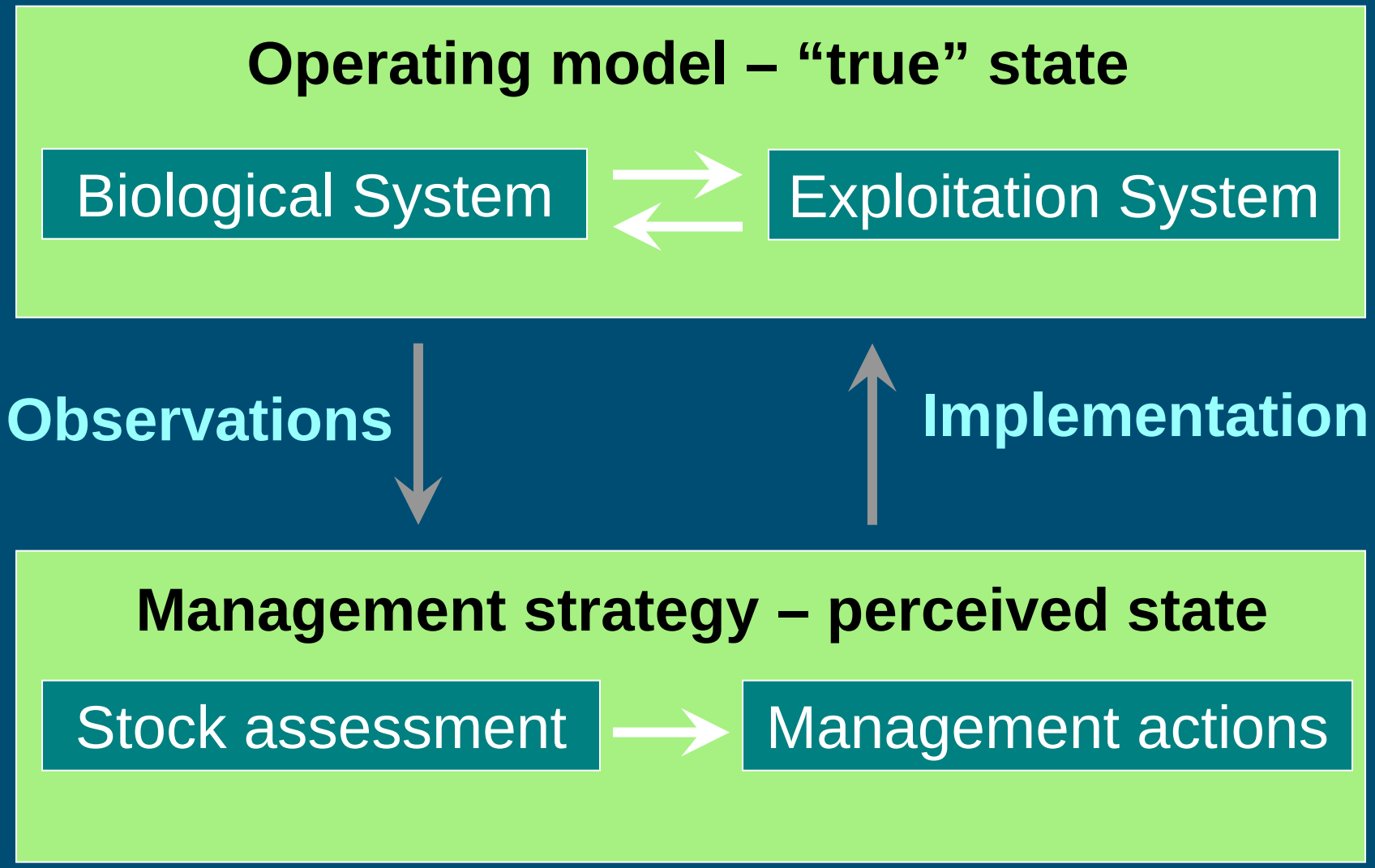
Alaska Fisheries Science Center

19 May 2012

NOAA FISHERIES SERVICE

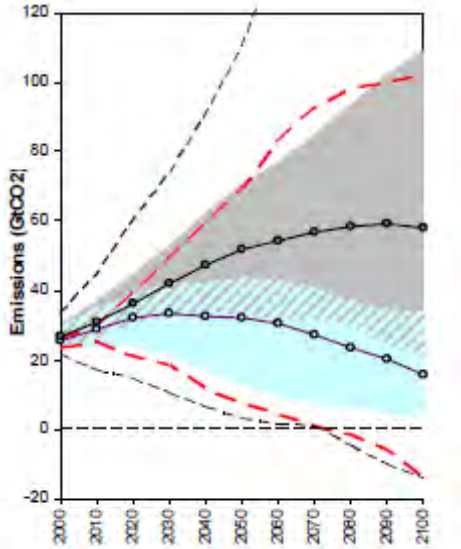
The MSE framework

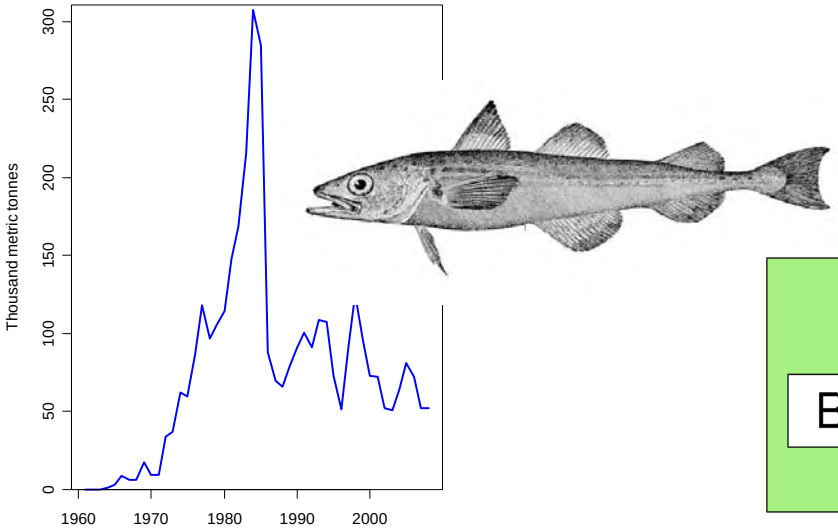


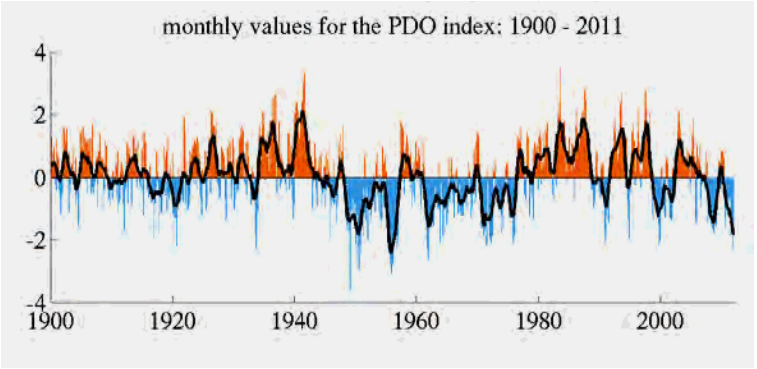
From Fromentin and Kell, 2007

Operating model conditioned on historical data

IPCC model output







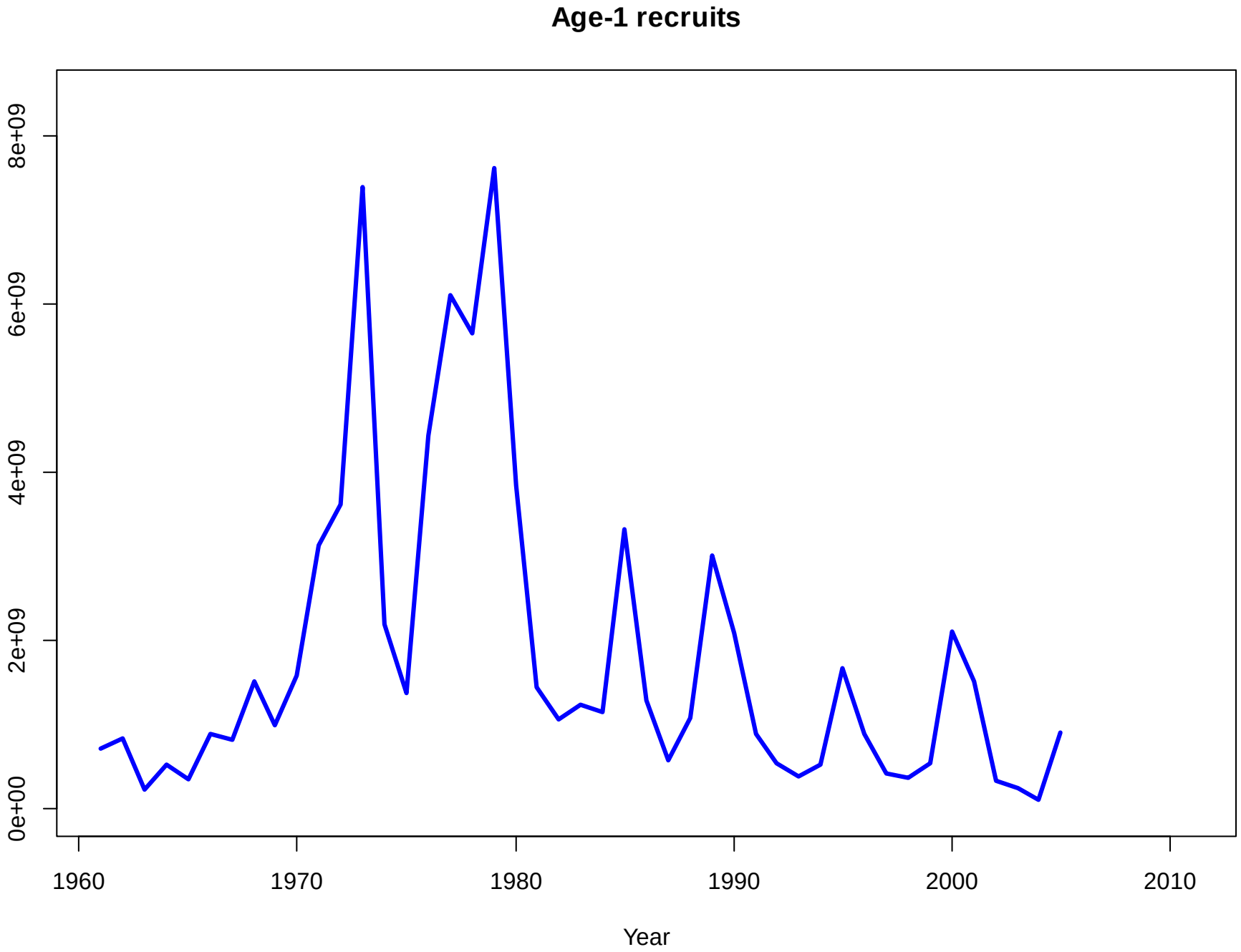
Operating model – "true" state

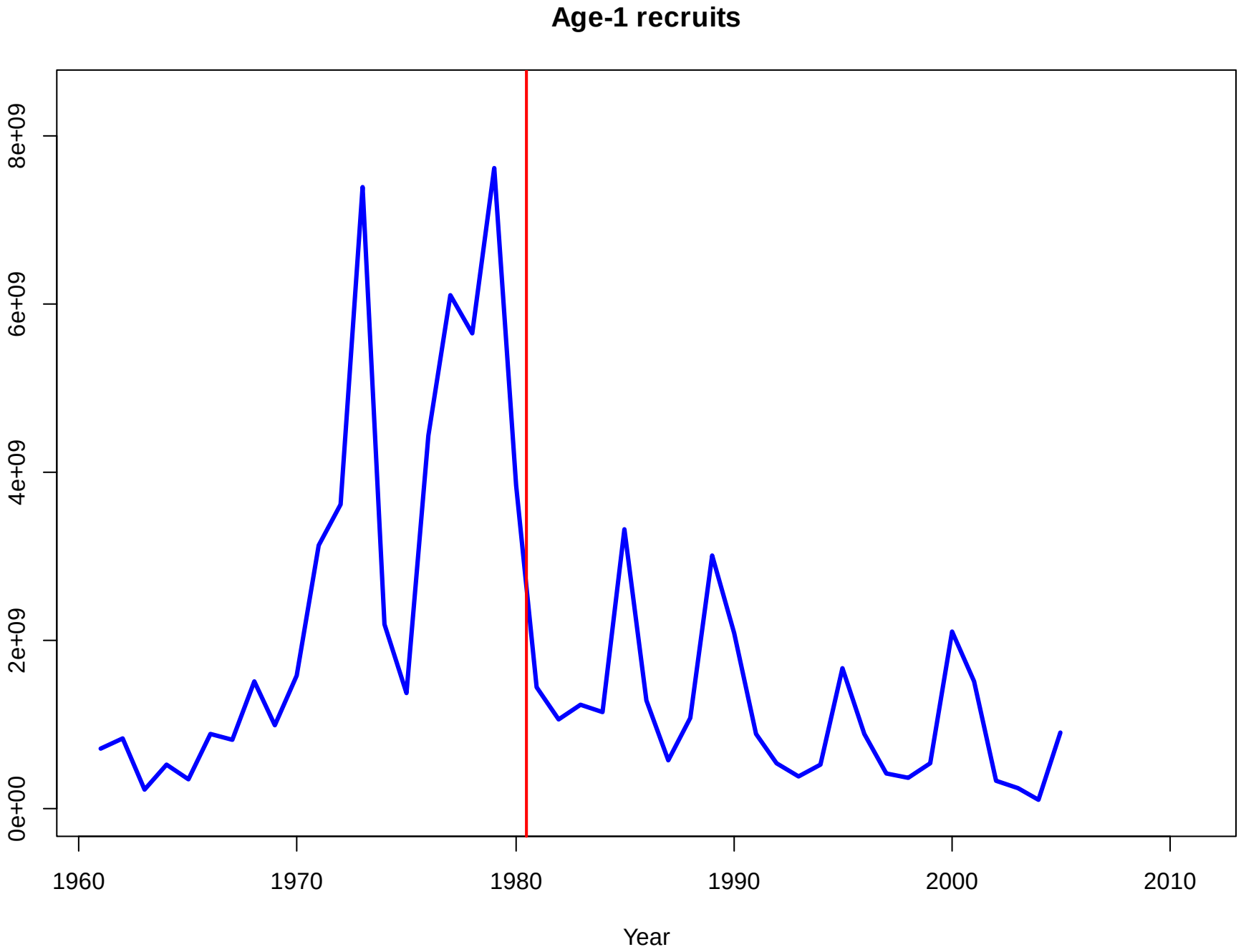
Biological System ⇄ Exploitation System

Observations ↓ ↑ **Implementation**

Management strategy – perceived state

Stock assessment → Management actions


Age-1 recruits
0e+00
2e+09
4e+09
6e+09
8e+09
1960
1970
1980
1990
2000
2010
Year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Data used for 1960 – 2005

- Data used for the stock assessment
  - Biological data
  - Fishery and survey data
- Monthly environmental indices
  - Precipitation on Kodiak Island
  - Wind mixing energy in Shelikof Strait
  - SST at the outlet of Shelikof Strait
    - ICOADS 2-degree ERSST v3
  - Seasonal, normalized

Estimated within the model

$$\ln(R_{y+1}) = \ln \bar{R}_1 + \sum_j a_j Index_{j,y} + \varepsilon_y$$

Winter precipitation - positive

Summer precipitation - negative

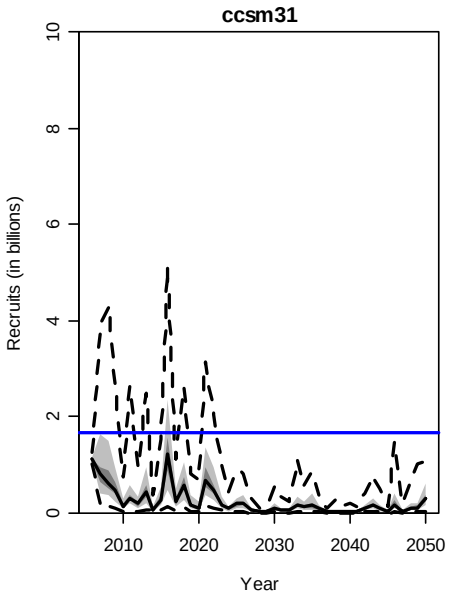
Spring SST - **negative**

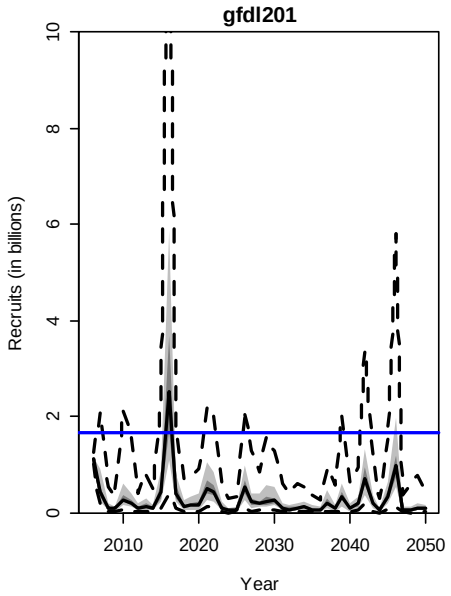
Summer SST - positive

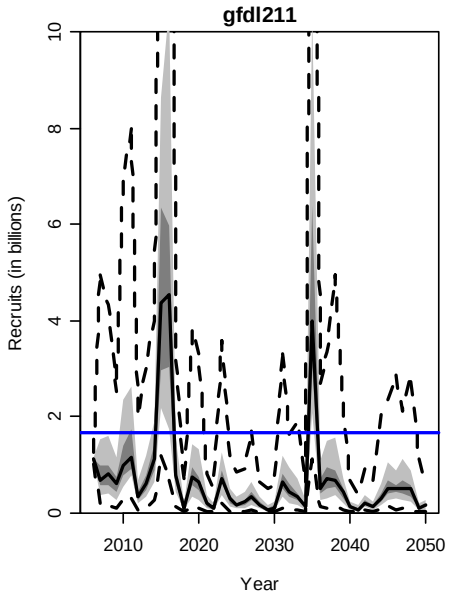
Autumn SST – negative

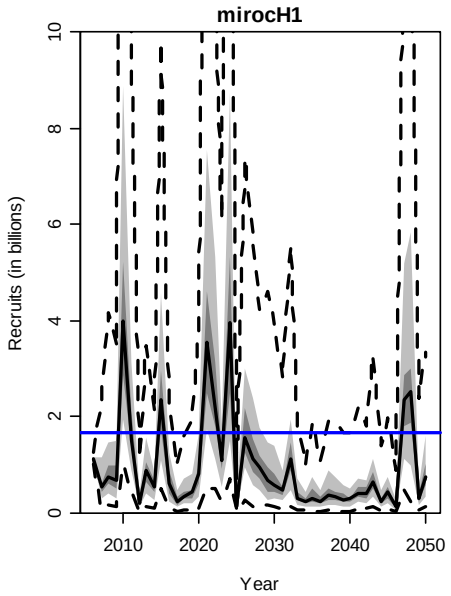
Projected through 2050 with IPCC A1B

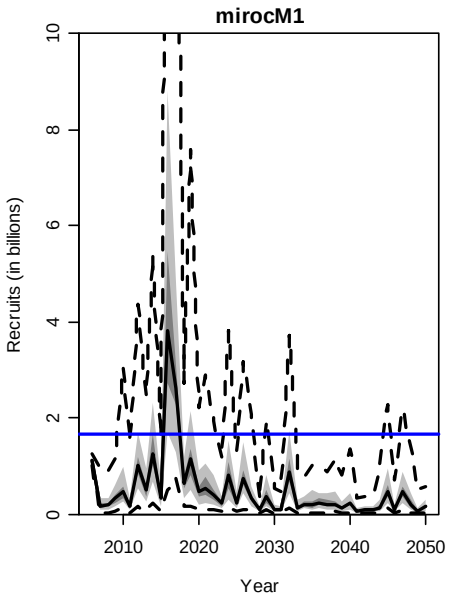
Projected age-1 recruits

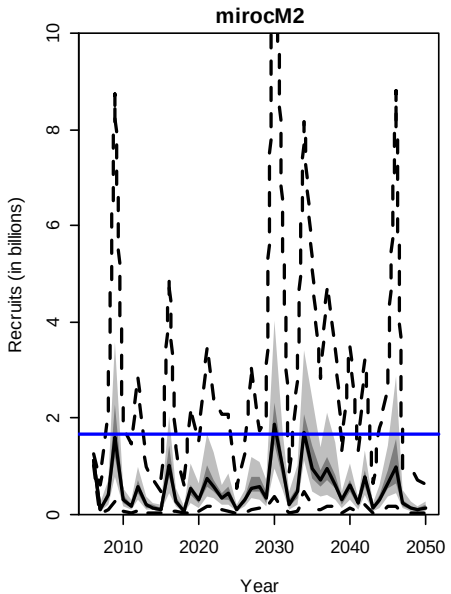


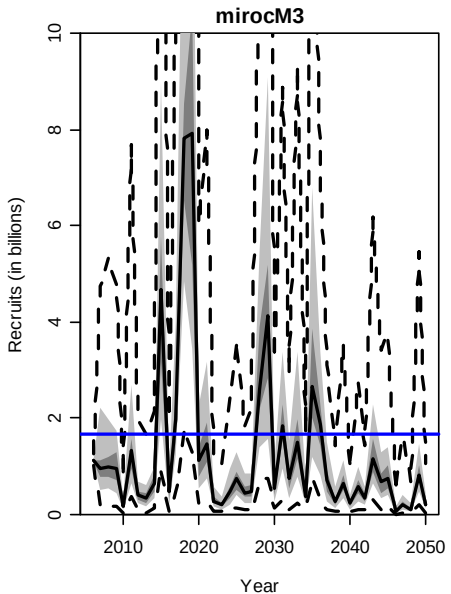


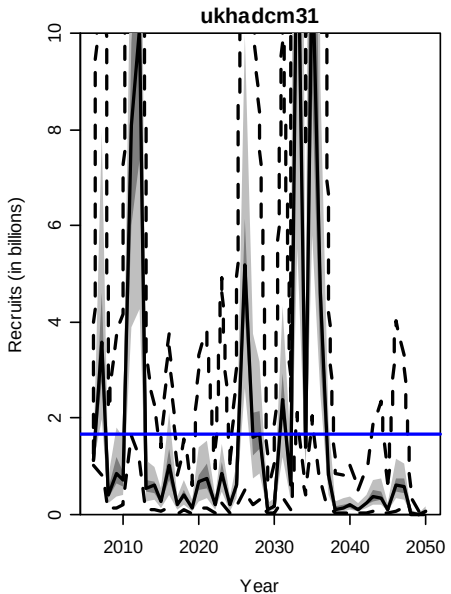








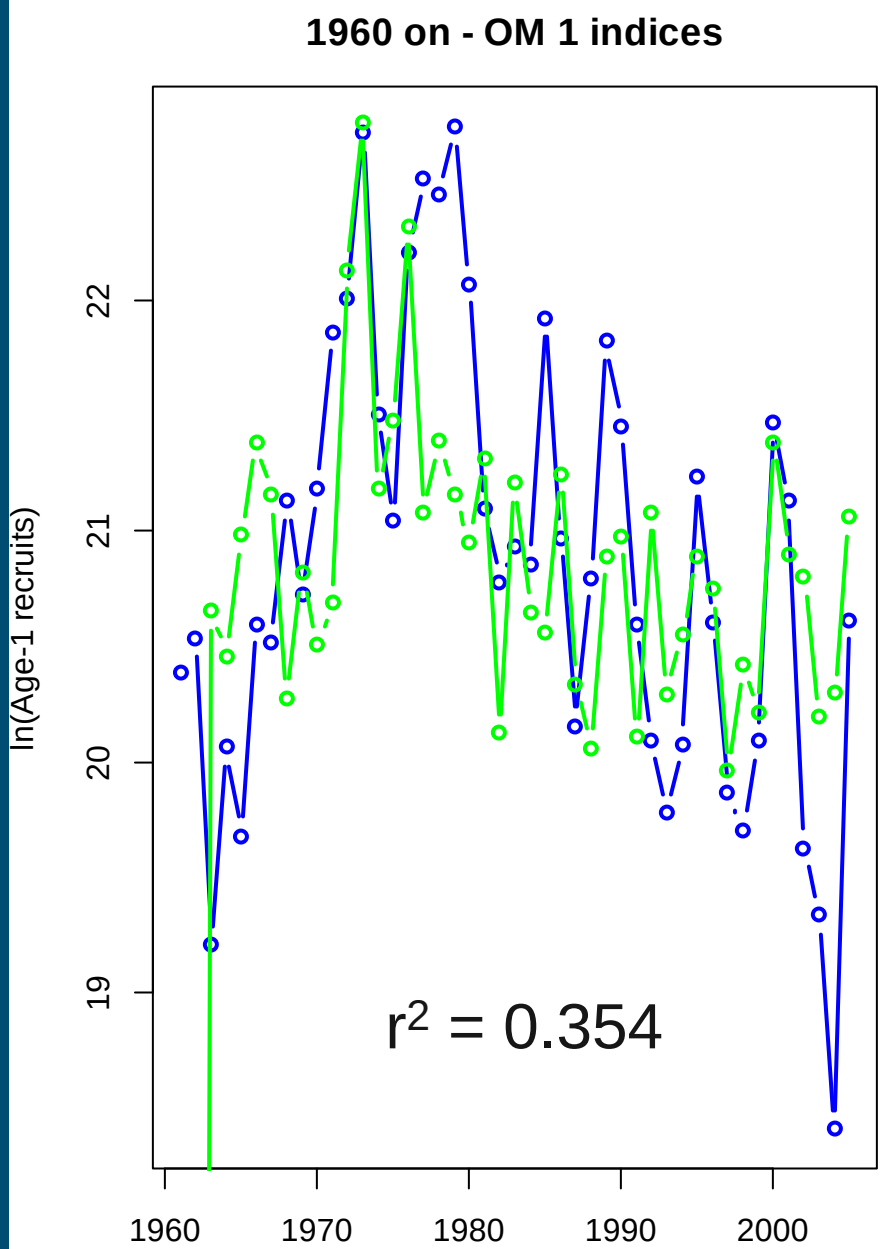


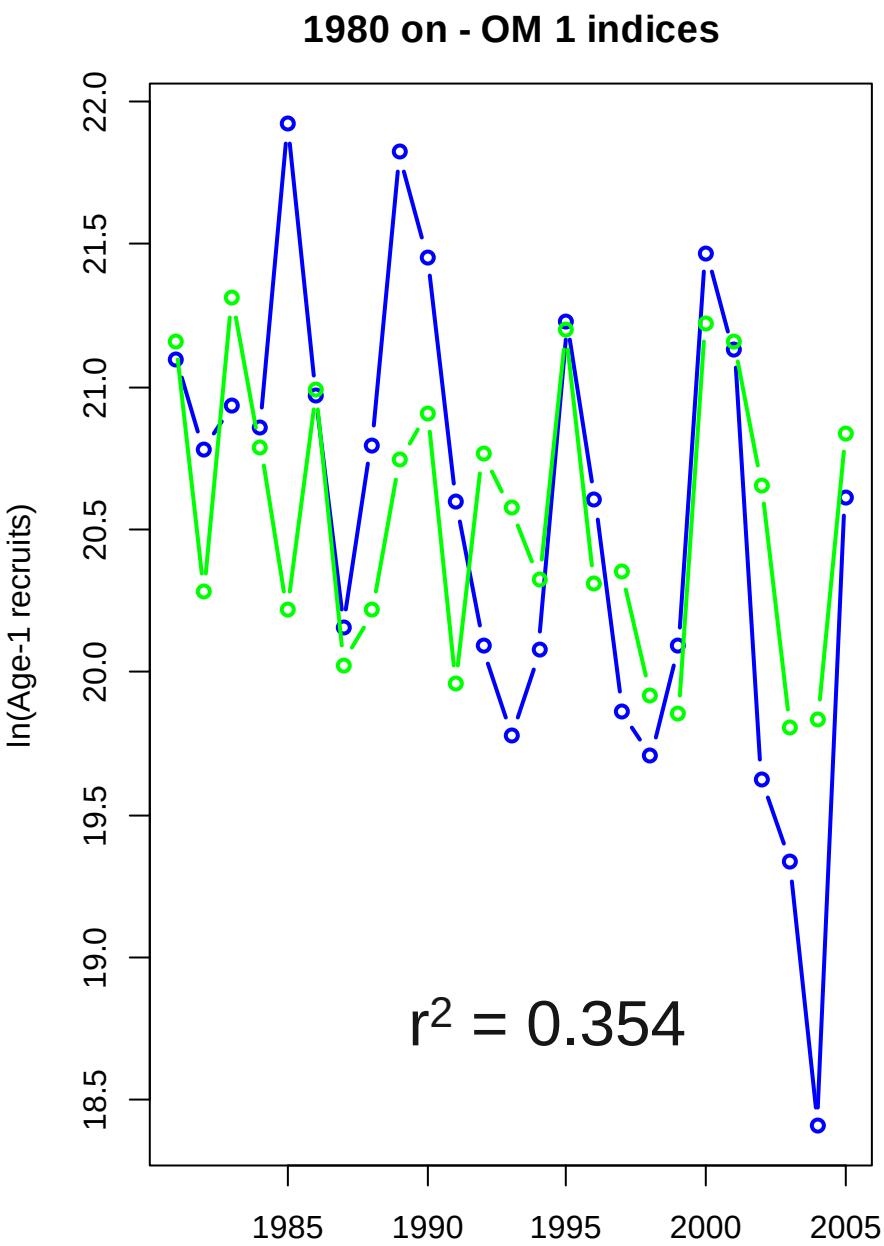


Alternative approach

Simple linear models independent of the population dynamics model

Estimated outside of the model





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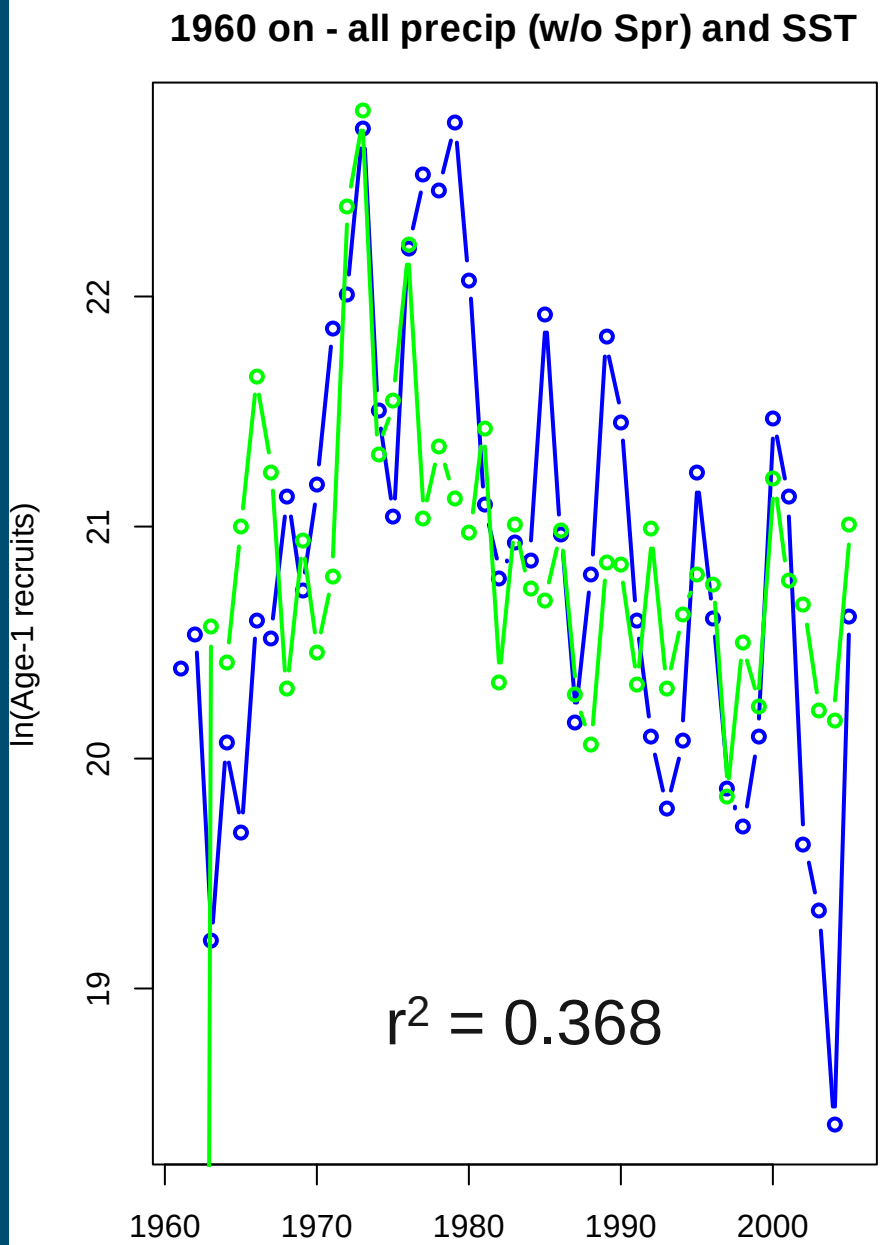
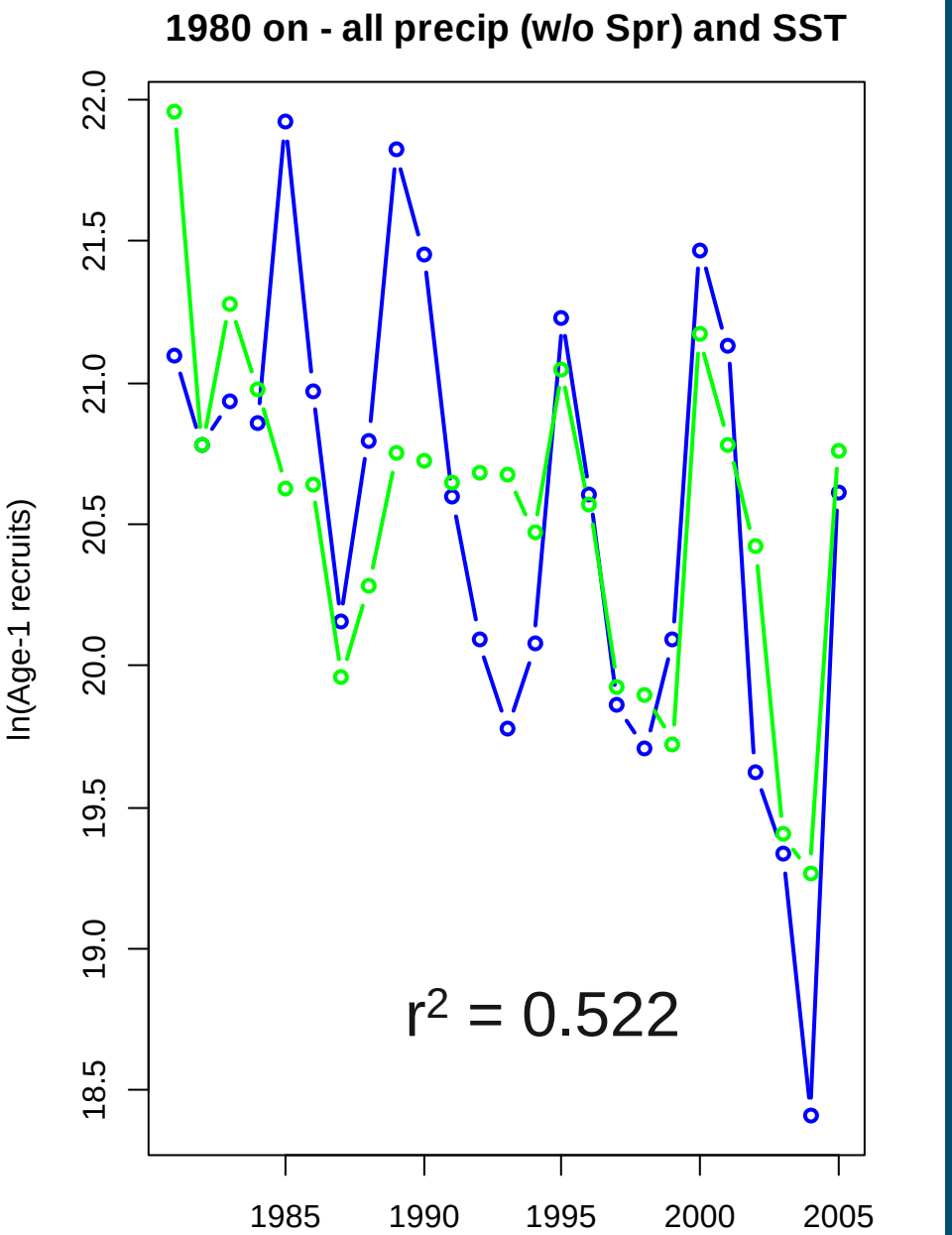
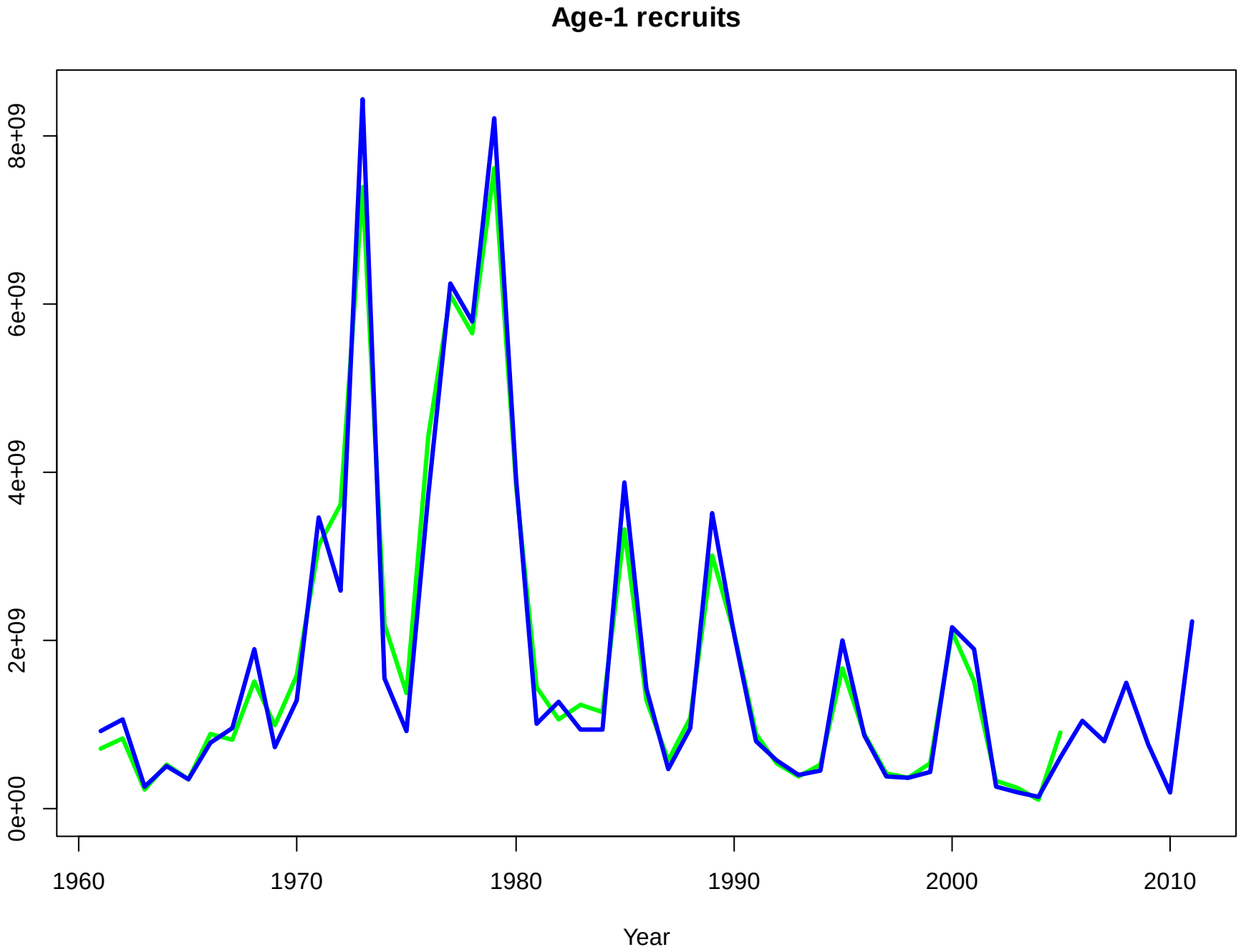




Summary with 2005 data

- Previous model
  - Winter precipitation - positive
  - Summer precipitation - negative
  - Spring SST - **negative**
  - Summer SST - positive
  - Autumn SST - negative
- New model includes
  - Autumn precipitation - negative
  - Winter SST - negative

Current results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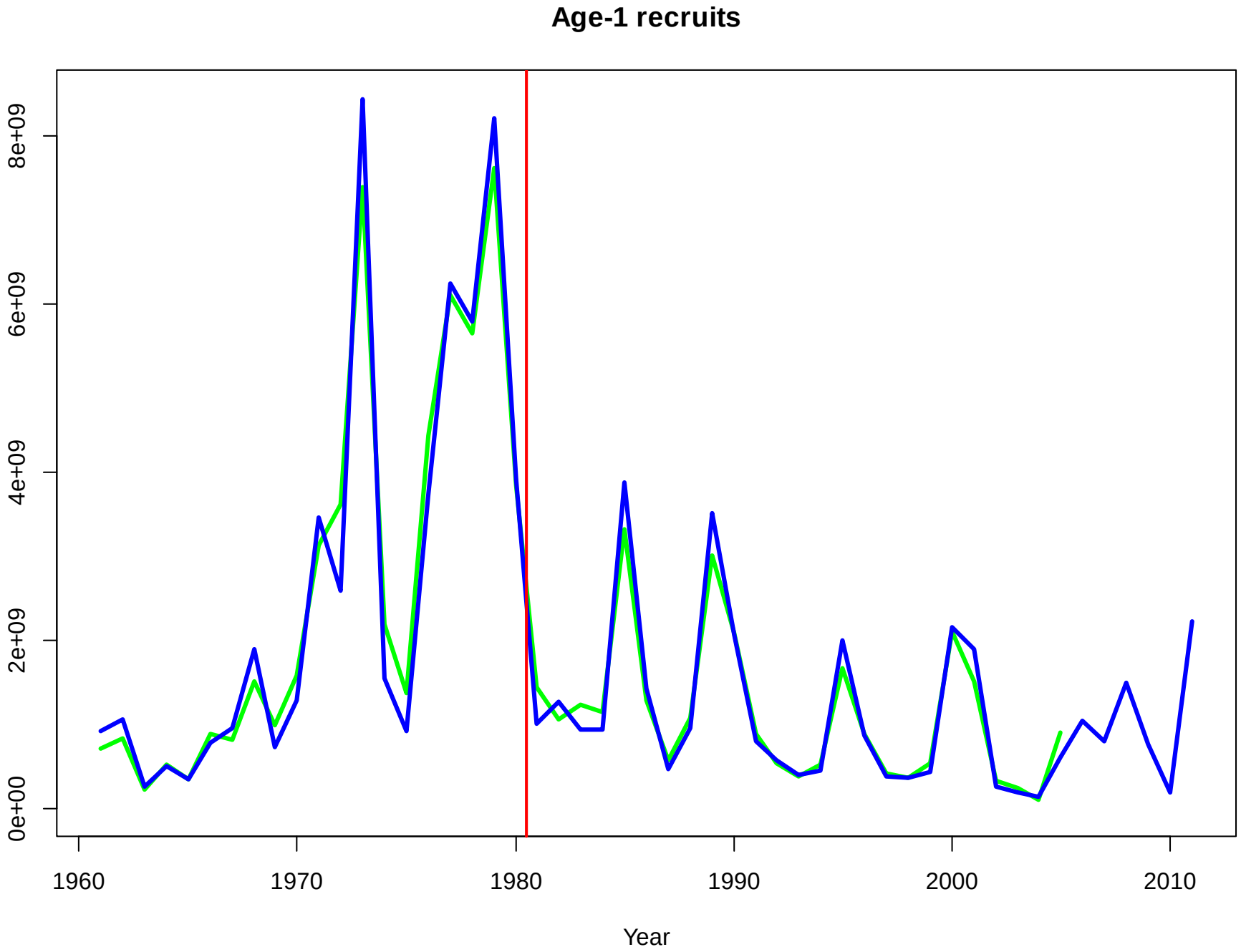
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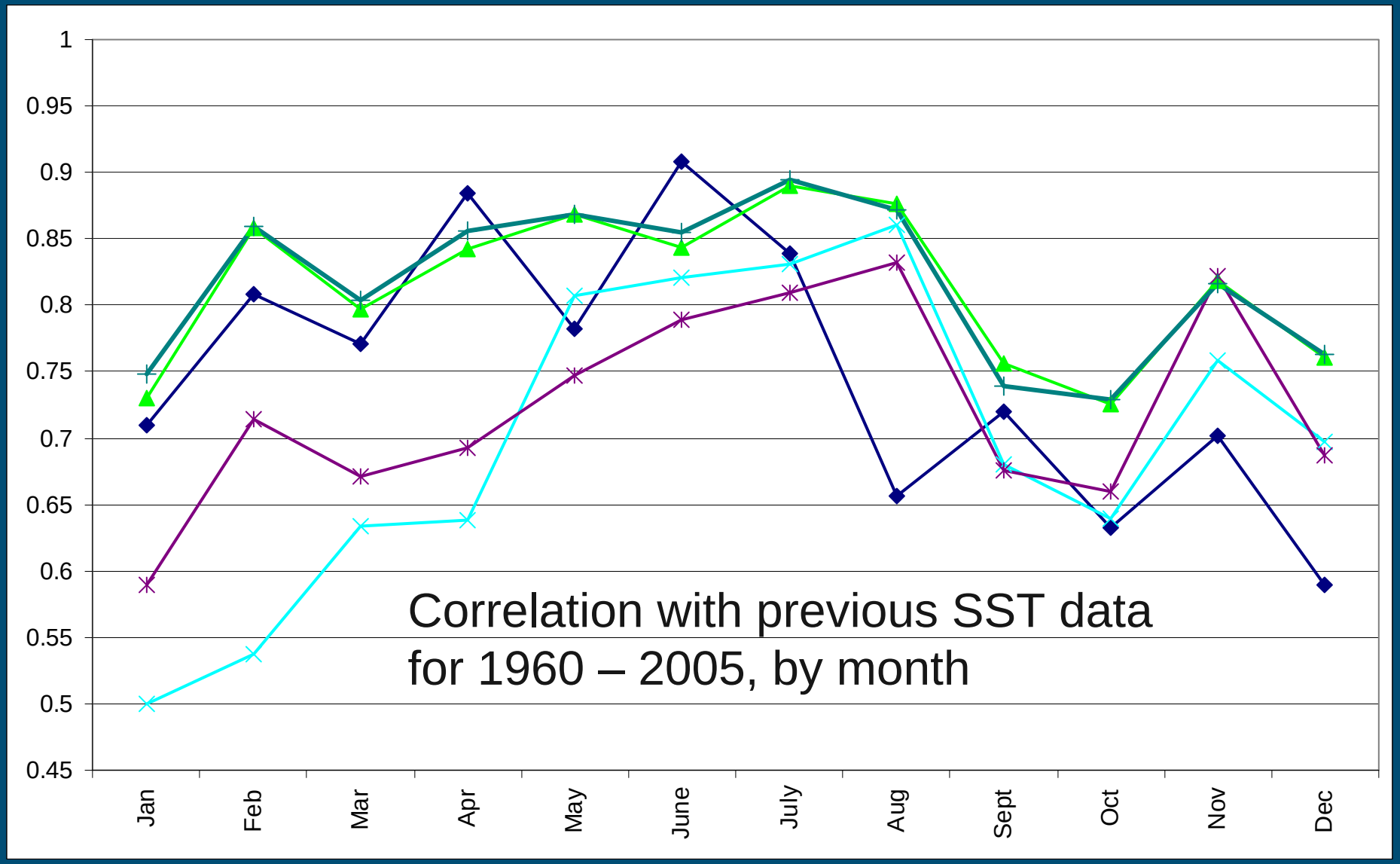
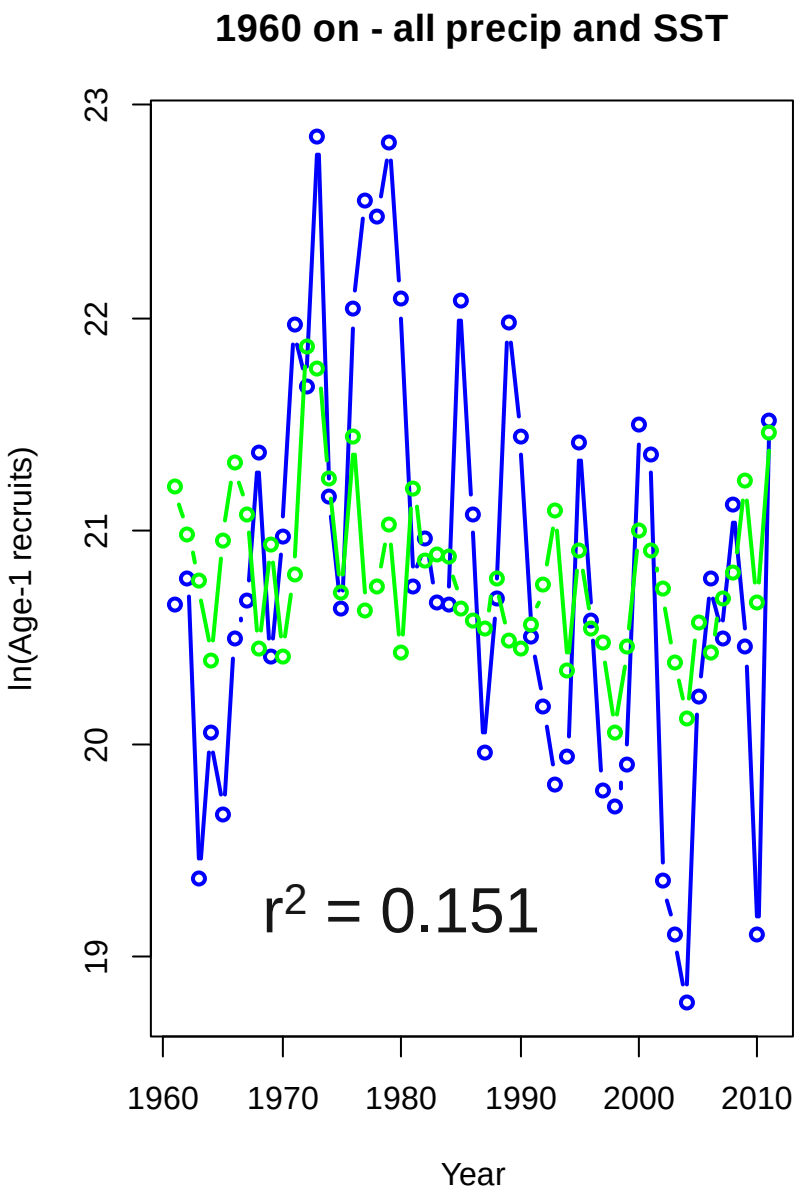
Data used for 1960 – 2011

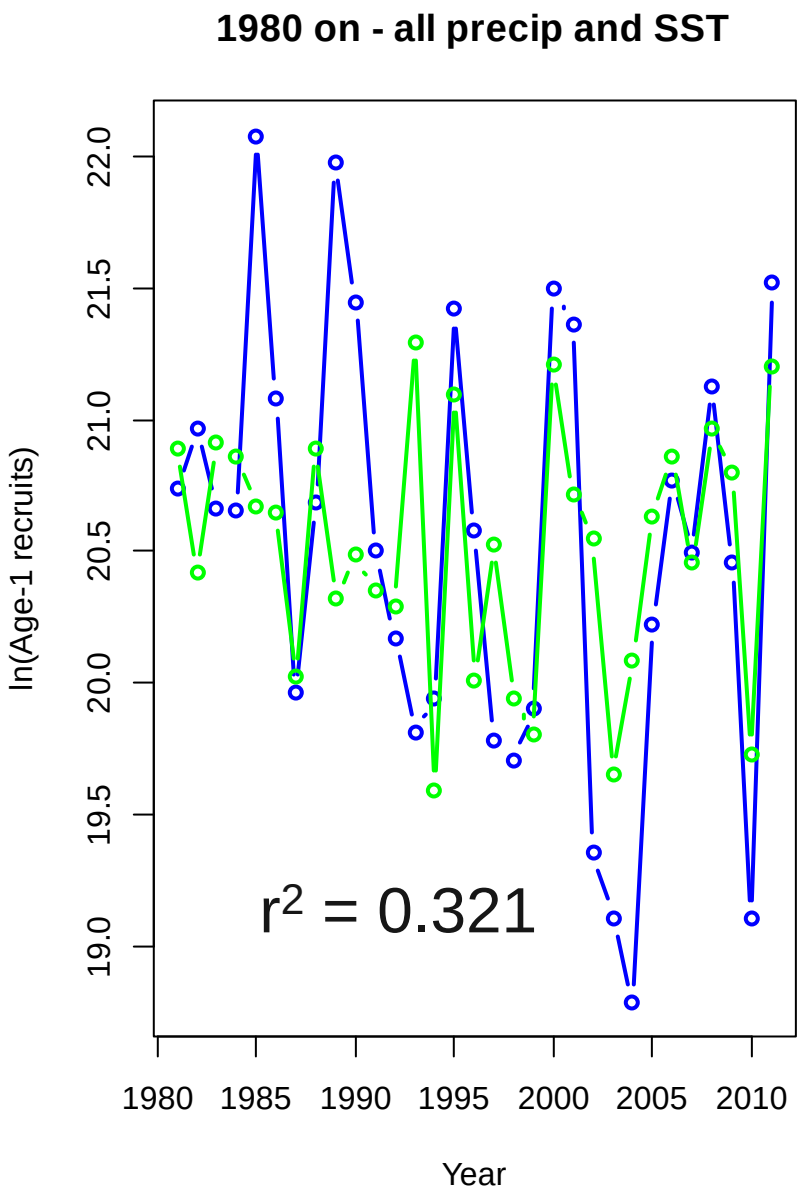
- Data used for the stock assessment
  - Biological data
  - Fishery and survey data
- Monthly environmental indices
  - Precipitation on Kodiak Island
  - Transport at the outlet of Shelikof Strait
    - SODA model output of *U* and *V*, 1960 – 2008
  - SST at the outlet of Shelikof Strait
    - ICOADS 2-degree ERSST v3b

Previous vs. current SST data



Estimated outside of the model





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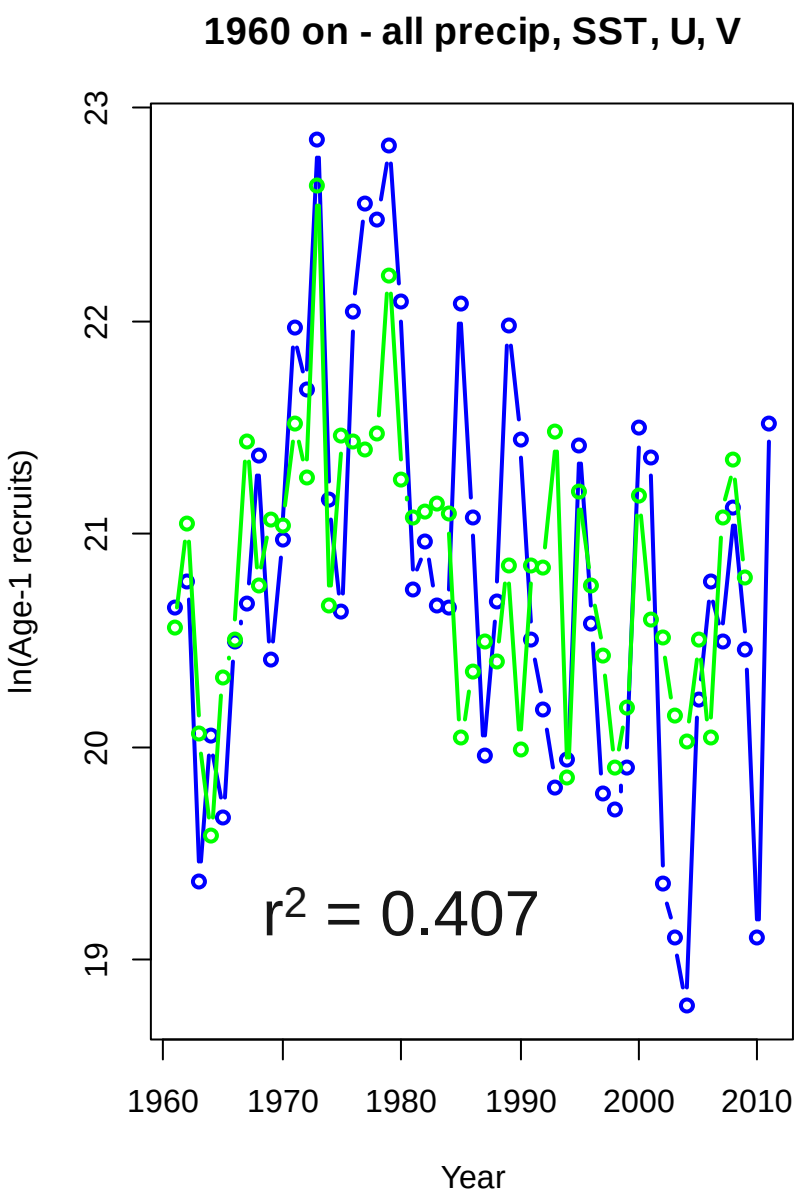

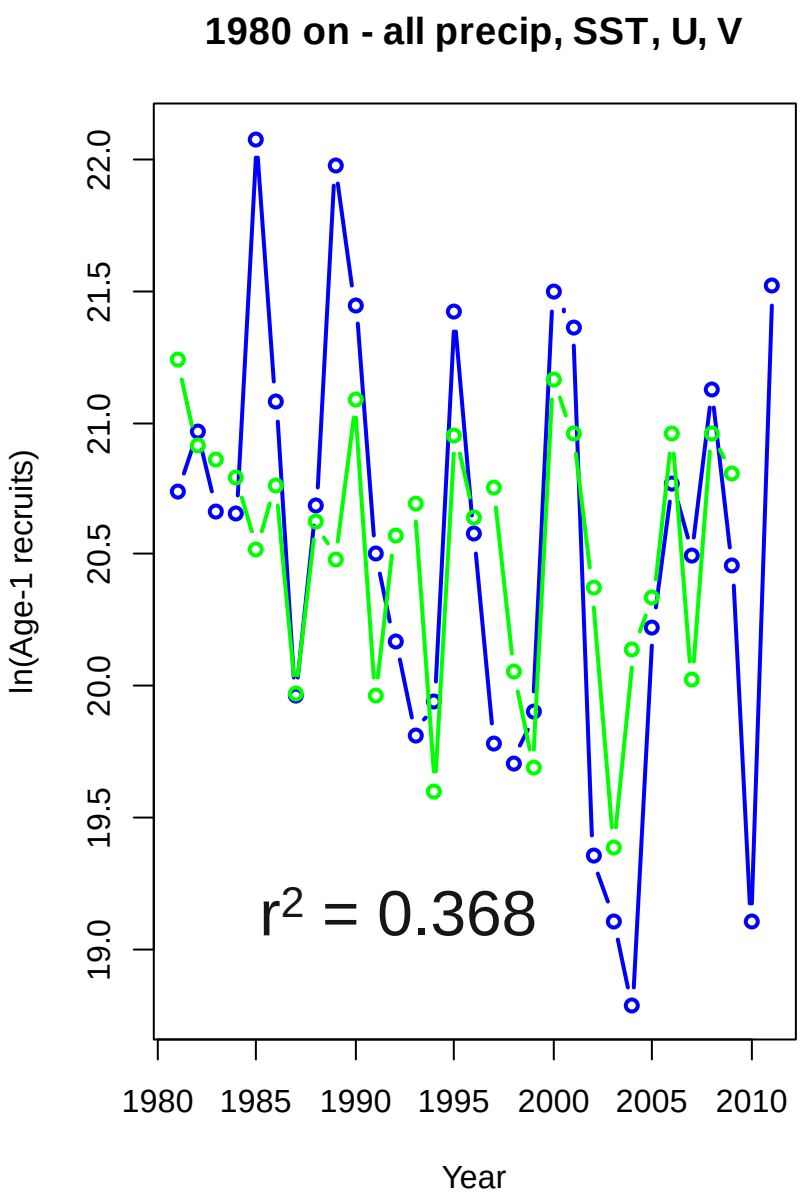

Summary for 1980 on

- 2005 estimated recruits and 2005 env data
  - Indices from previous study (5): 35% of var
  - Precipitation (3) and SST (4): 50% of var
- 2005 estimated recruits and 2011 SST data
  - All precipitation and SST: 27% of var
- 2011 estimated recruits and 2011 data
  - All precipitation and SST: 32% of var
  - All precipitation, SST, and transport: 28% of var
  - All precipitation, SST, U, V: 36% of var

Next steps

- Include additional local-scale indices
  - Doyle et al. 2009
- Examine alternative hypotheses
  - Stock-recruit relationships
  - Other functional forms
- Goal: explain 50+% of variability with the fewest number of environmental indices

Thank you!