Supplementary Material

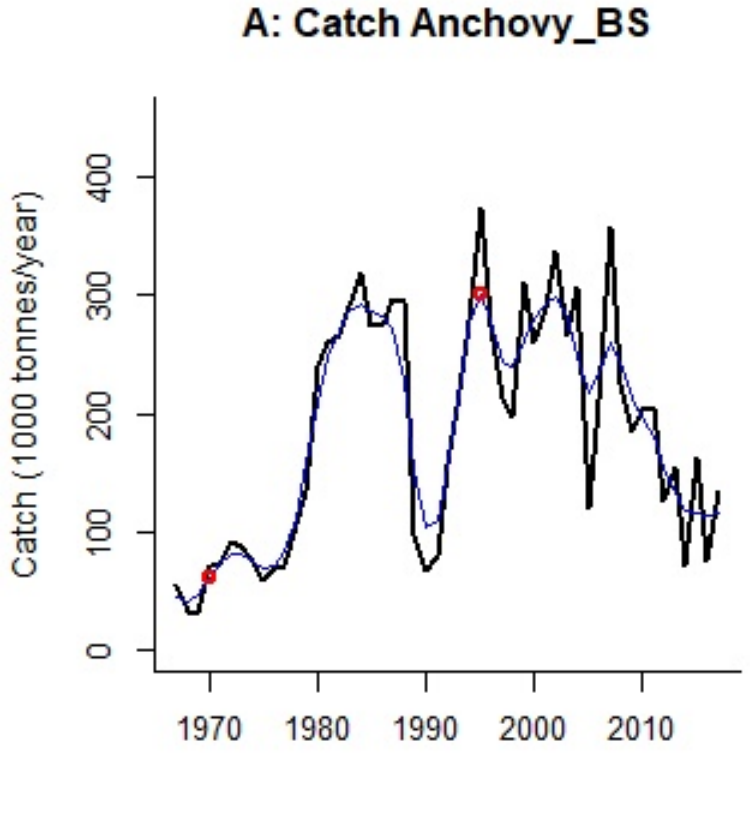
First large-scale Eastern Mediterranean and Black Seas stock assessment reveals total collapse of marine fisheries

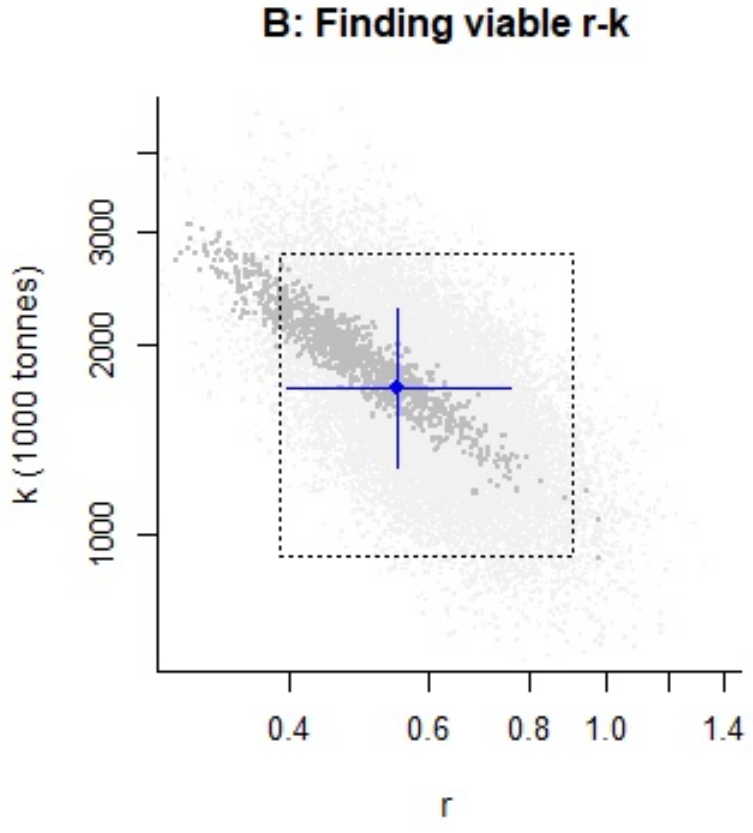
Nazli Demirel, Mustafa Zengin, Aylin Ulman

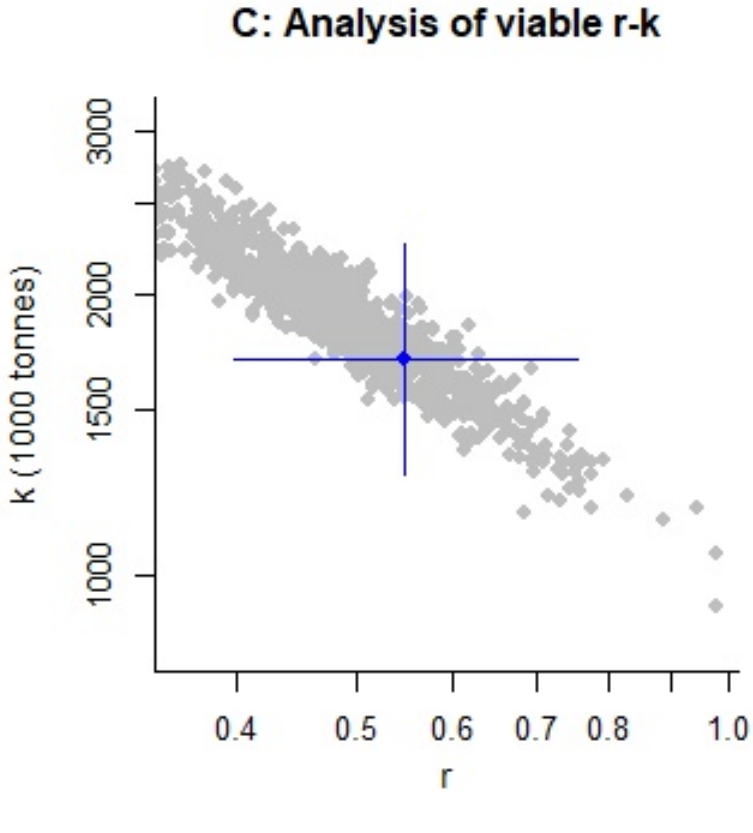
Here we present, all outputs of CMSY stock assessment analysis for 54 stocks from Black, Marmara and Levantine Seas. Each stocks represented with graphs in two pages.

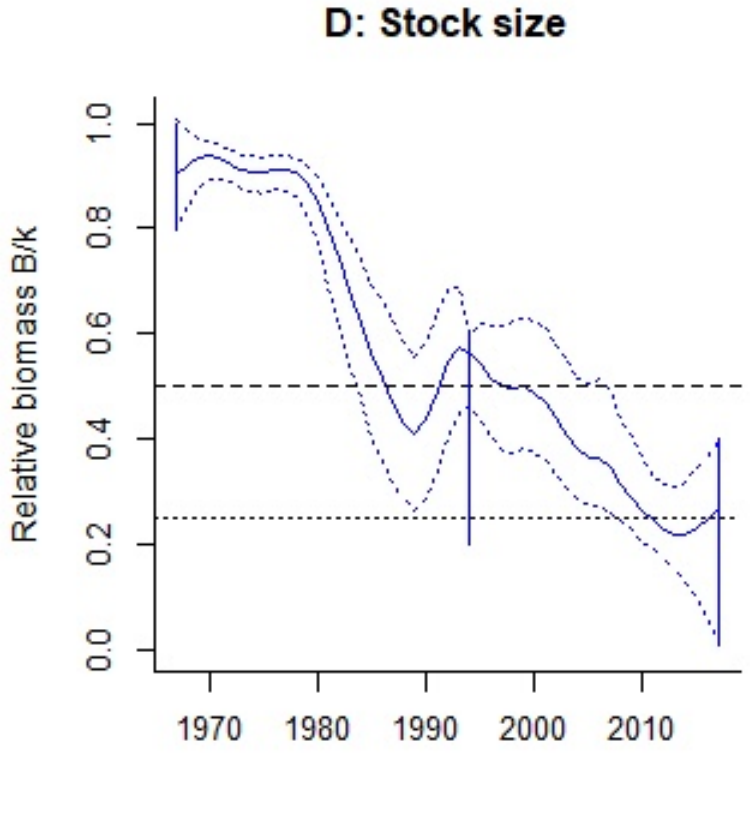
In the first page: Assessments for respective stock (top left) in the respective sea (bottom left). **Panel A** shows in black the time series of catches and in blue the three-years moving average with indication of highest and lowest catch, as used in the estimation of prior biomass by the default rules. **Panel B** shows the explored r-k log space and in dark grey the r-k pairs which were found by the CMSY model to be compatible with the catches and the prior information. **Panel C** shows the most probable r-k pair and its approximate 95% confidence limits in blue. The black dots are possible r-k pairs found by the BSM model, with a red cross indicating the most probable r-k pair and its 95% confidence limits. **Panel D** shows in blue the biomass trajectory estimated by CMSY, scaled to the BSM estimate of Bmsy = 0.5 k, and. Dotted lines indicate the 2.5^{th} and 97.5^{th} percentiles. Vertical blue lines indicate the prior biomass ranges. **Panel E** shows in blue the corresponding harvest rate from CMSY, scaled to the r/2 estimate of BSM, and. **Panel F** shows the Schaefer equilibrium curve of catch/MSY relative to B/k, here indented at B/k < 0.25 to account for reduced recruitment at low stock sizes, the curve shows predictions by CMSY, from first year (square) to last years (triangle).

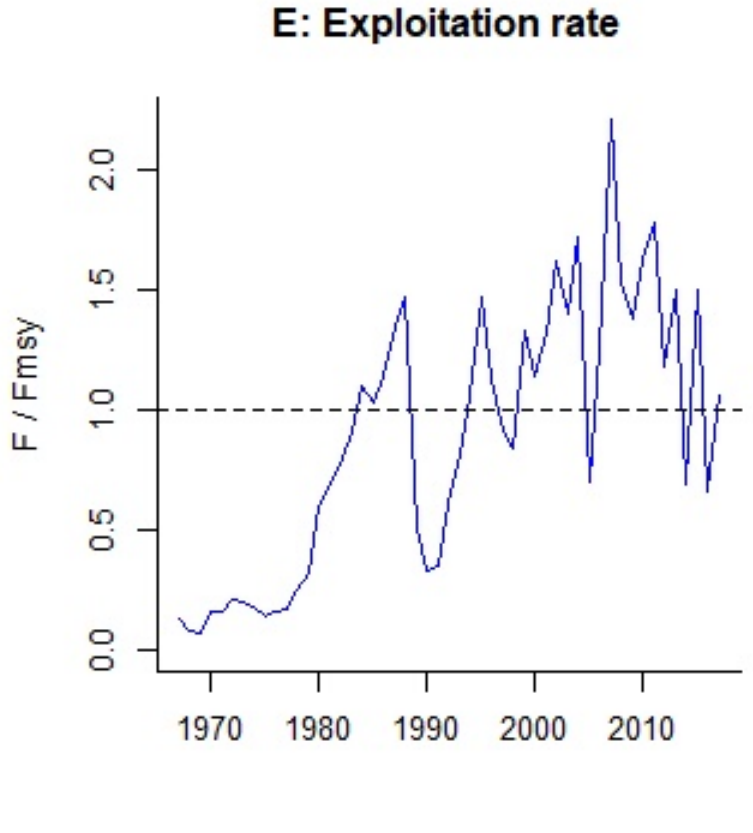
In the second page: Tthe graphs meant to inform management. The upper left panel shows catches relative to the BSM estimate of MSY, with indication of 95% confidence limits in grey. The upper right panel shows the development of relative total biomass (B/B_{msy}), with the grey area indicating uncertainty. The lower left graph shows relative exploitation (F/F_{msy}), with F_{msy} corrected for reduced recruitment below 0.5 B_{msy}. The lower-right panel shows the trajectory of relative stock size (B/B_{msy}) over relative exploitation (F/F_{msy}).

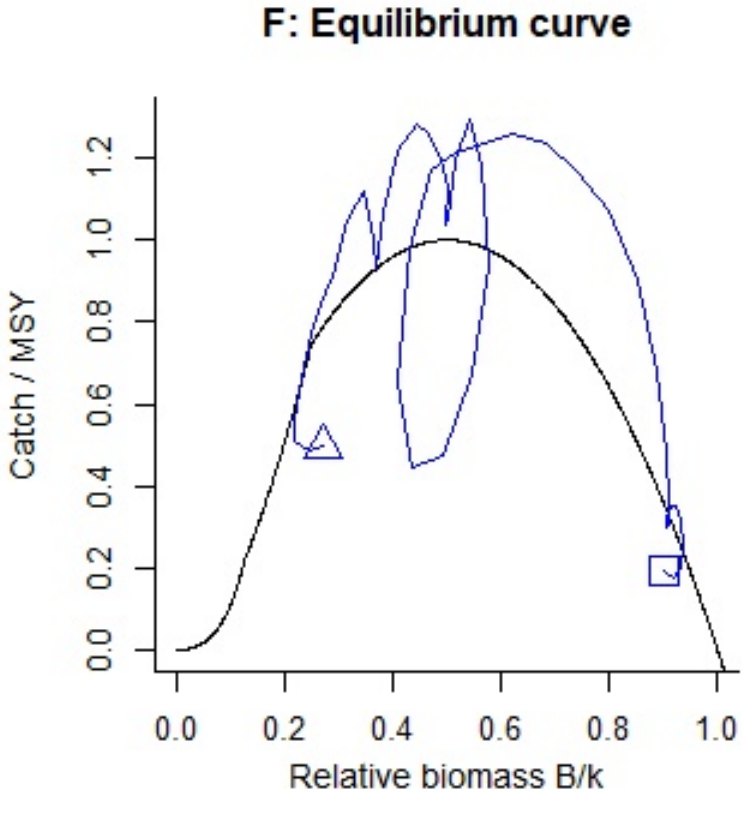

A: Catch Anchovy_BS
Catch (1000 tonnes/year)
0
100
200
300
400
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
1000
2000
3000
0.4
0.6
0.8
1.0
1.4
r

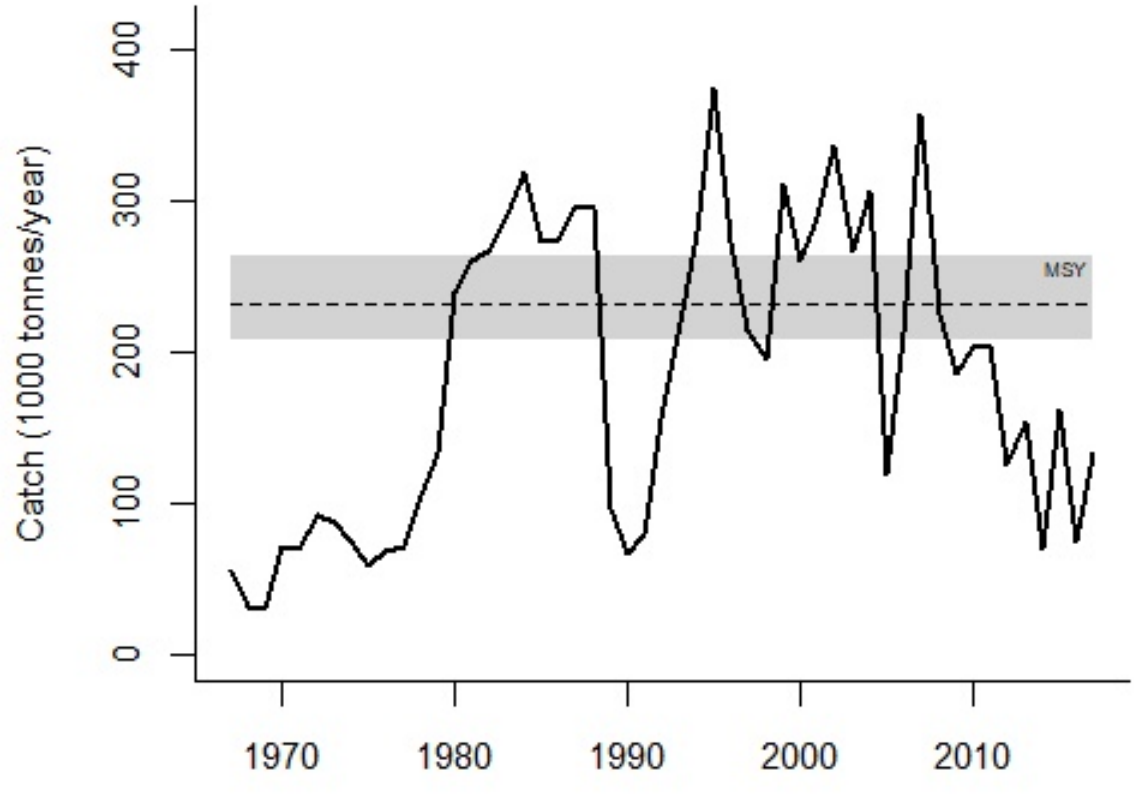

C: Analysis of viable r-k
k (1000 tonnes)
1000
1500
2000
3000
0.4
0.5
0.6
0.7
0.8
1.0
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

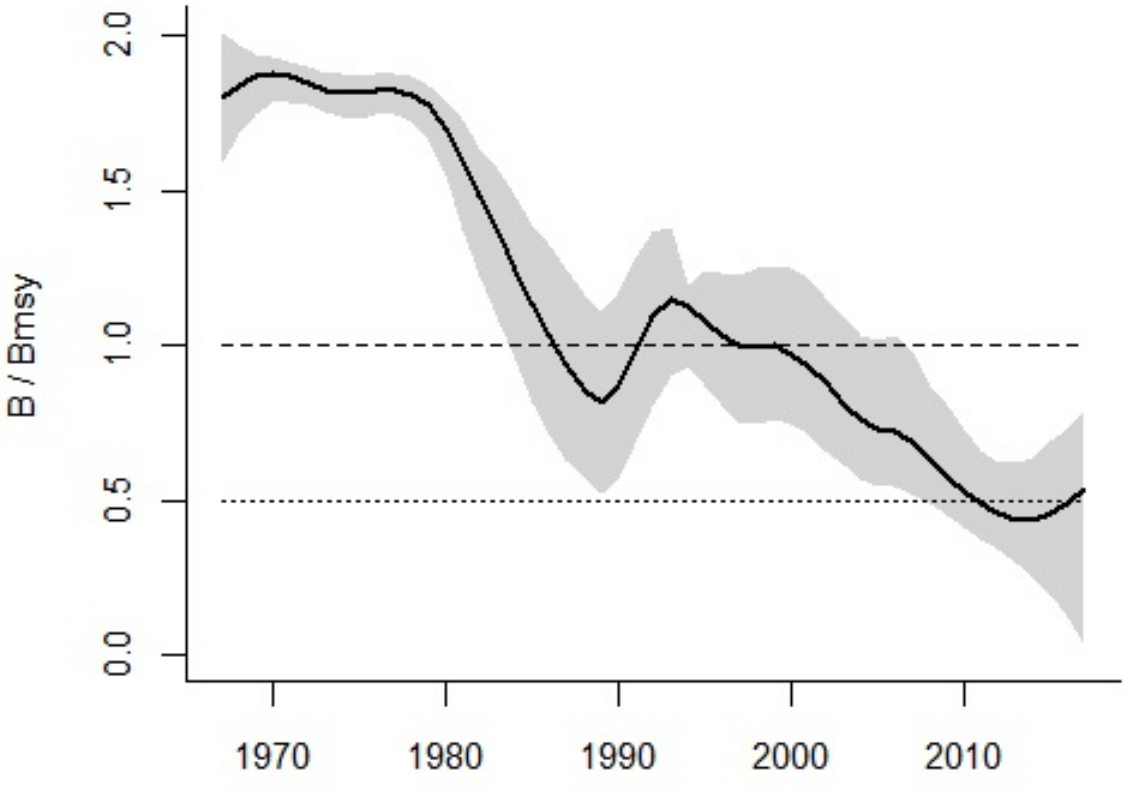

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

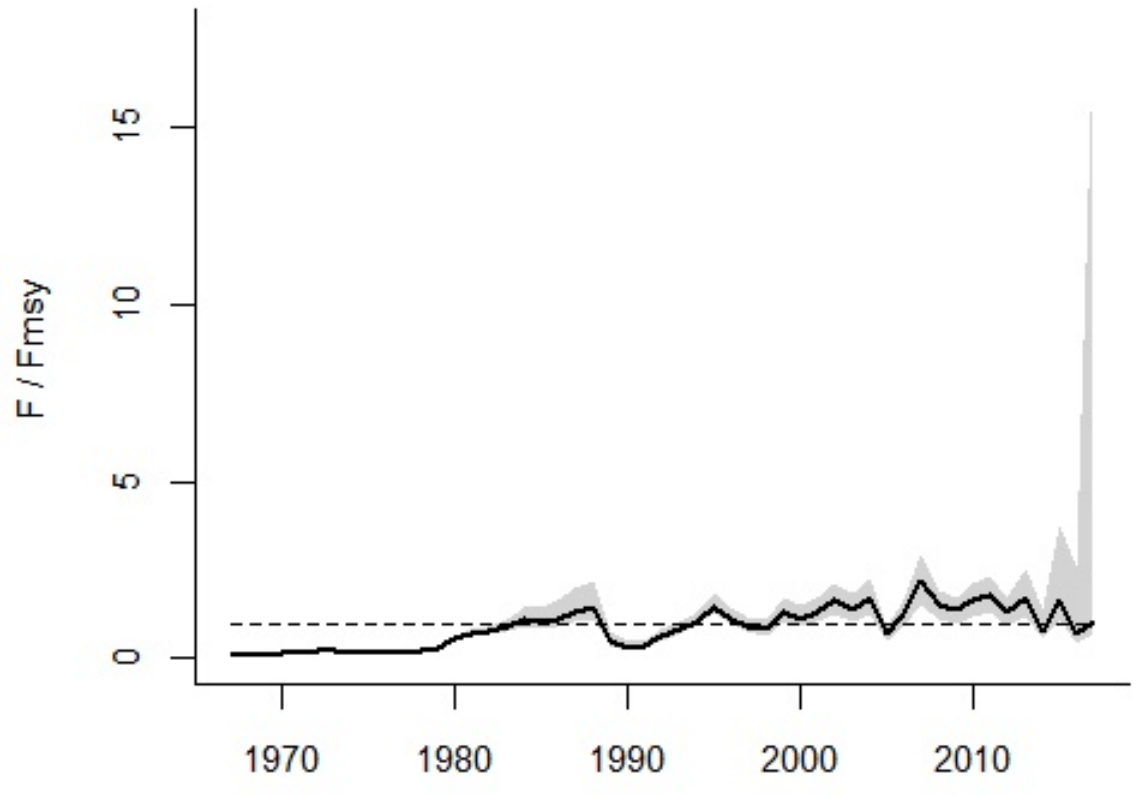
Catch

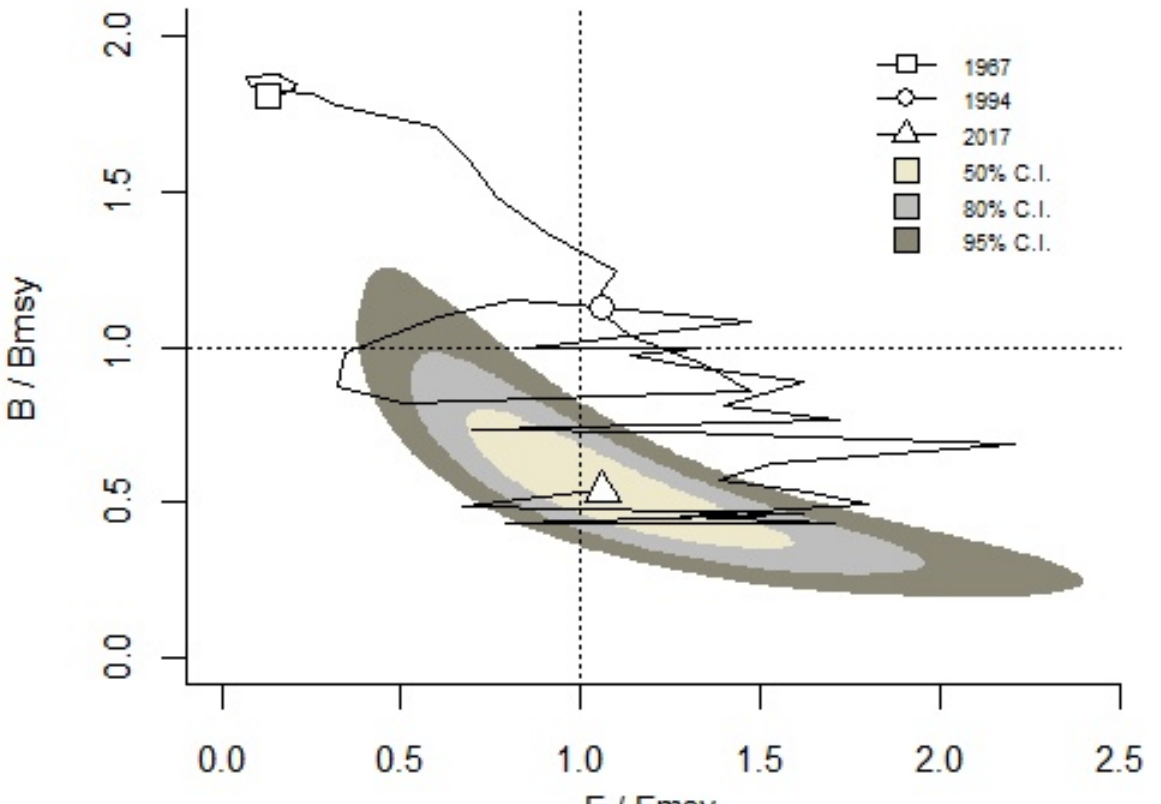


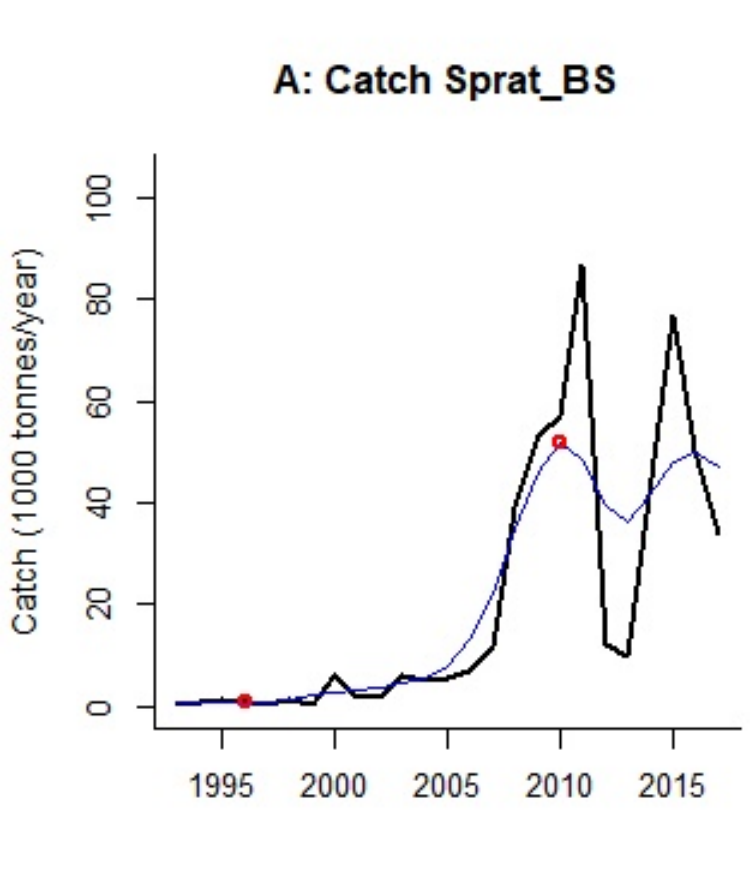
Stock size

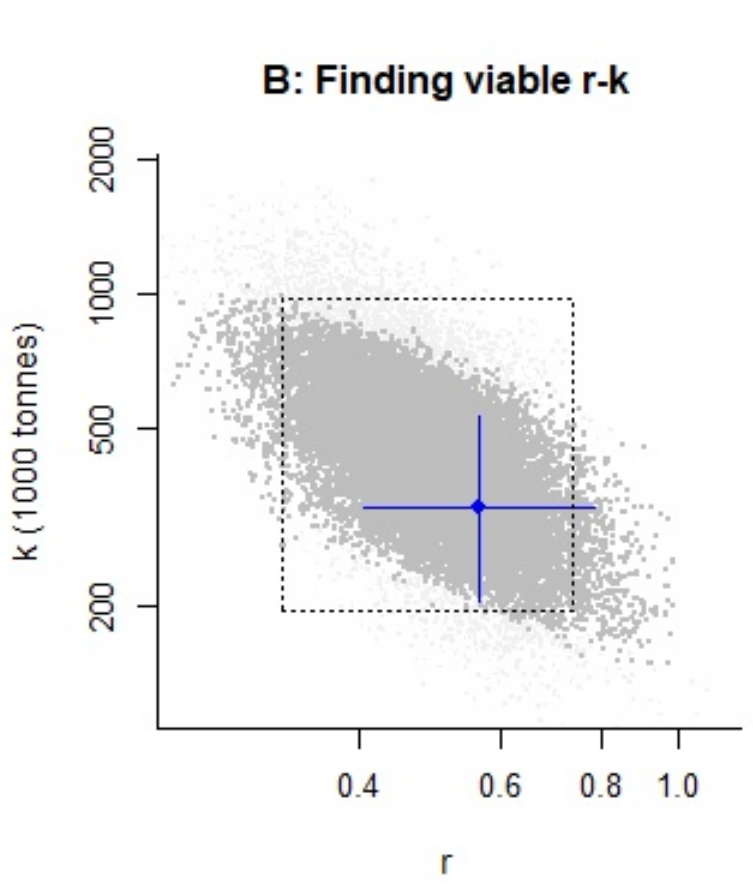


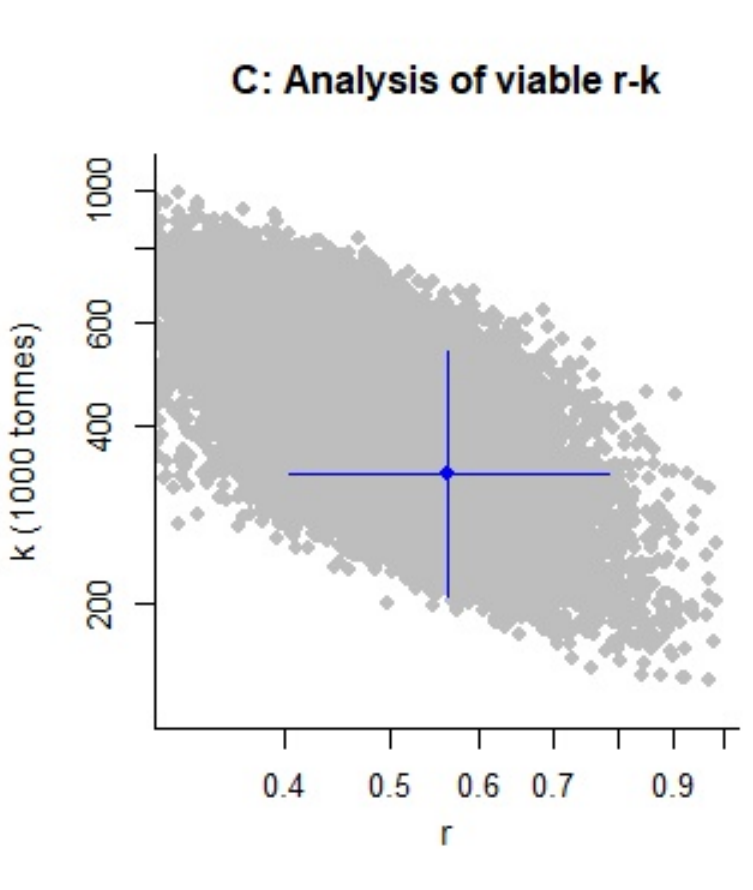
Exploitation

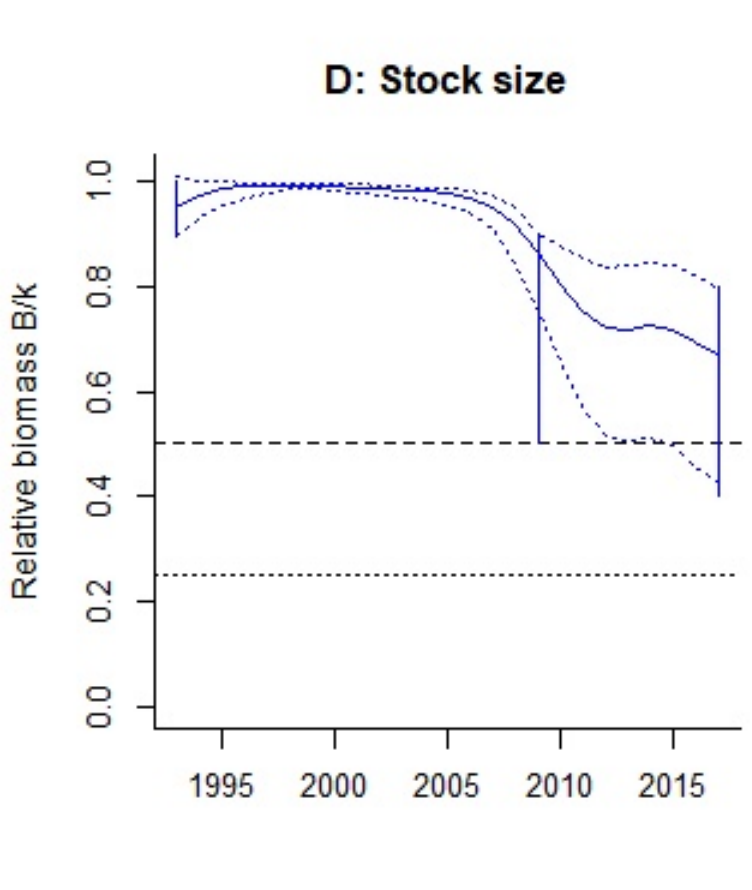


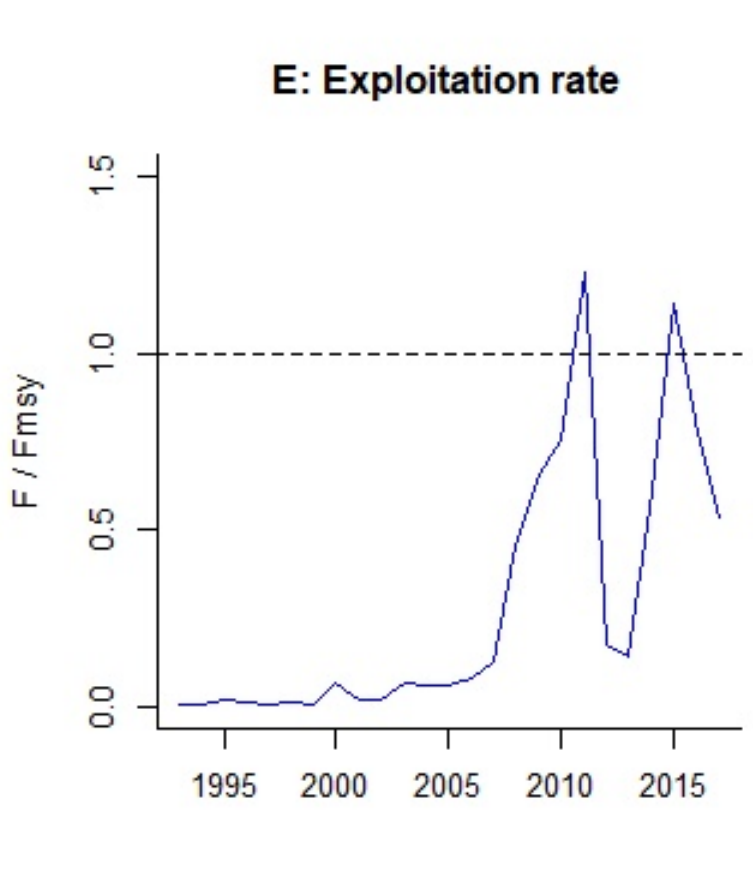


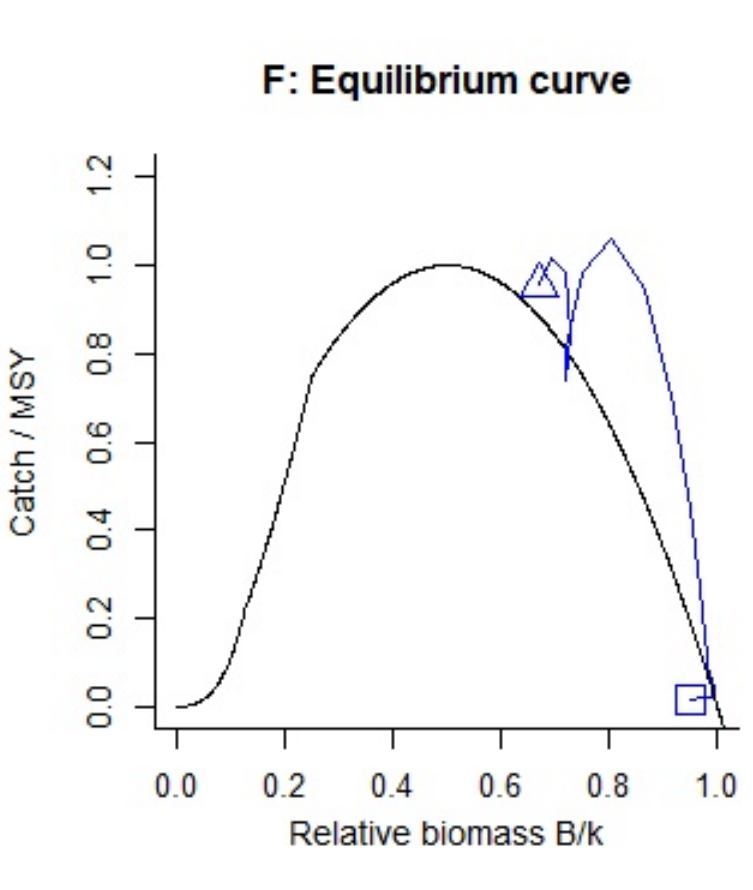

A: Catch Sprat_BS
Catch (1000 tonnes/year)
0
20
40
60
80
100
1995
2000
2005
2010
2015


B: Finding viable r-k
k (1000 tonnes)
200
500
1000
2000
0.4
0.6
0.8
1.0
r

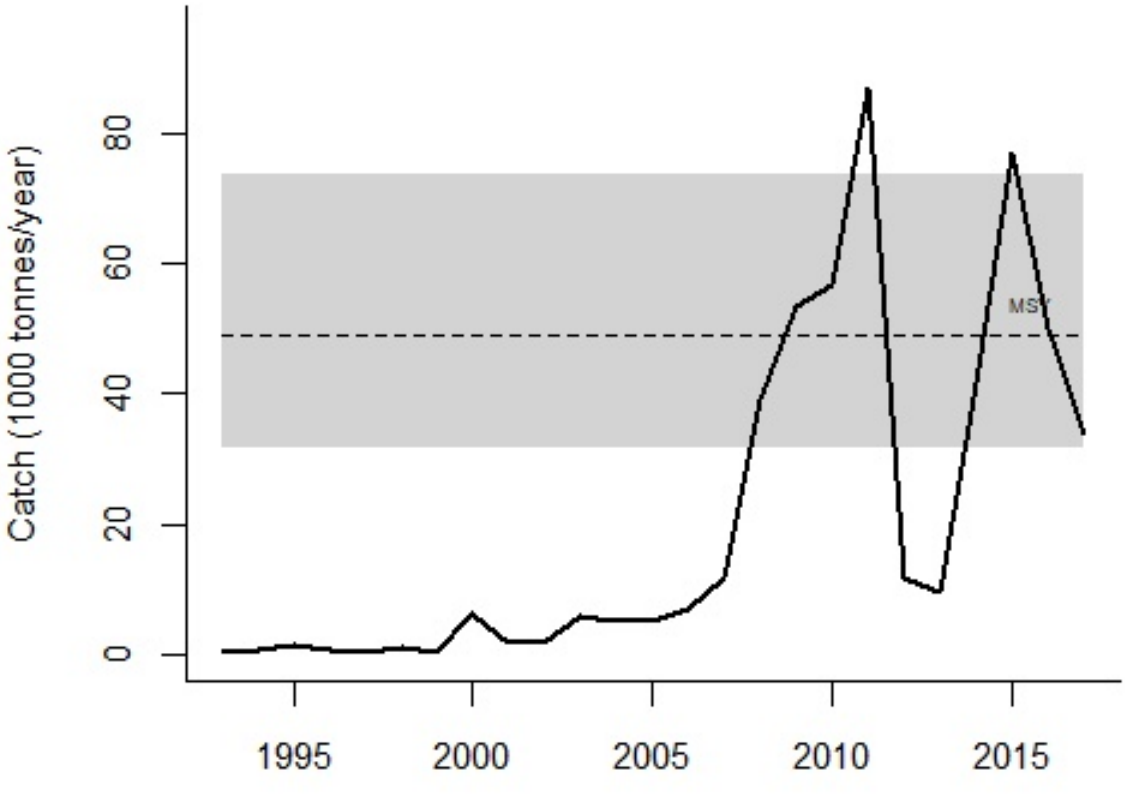

C: Analysis of viable r-k
k (1000 tonnes)
200
400
600
1000
0.4
0.5
0.6
0.7
0.9
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1995
2000
2005
2010
2015

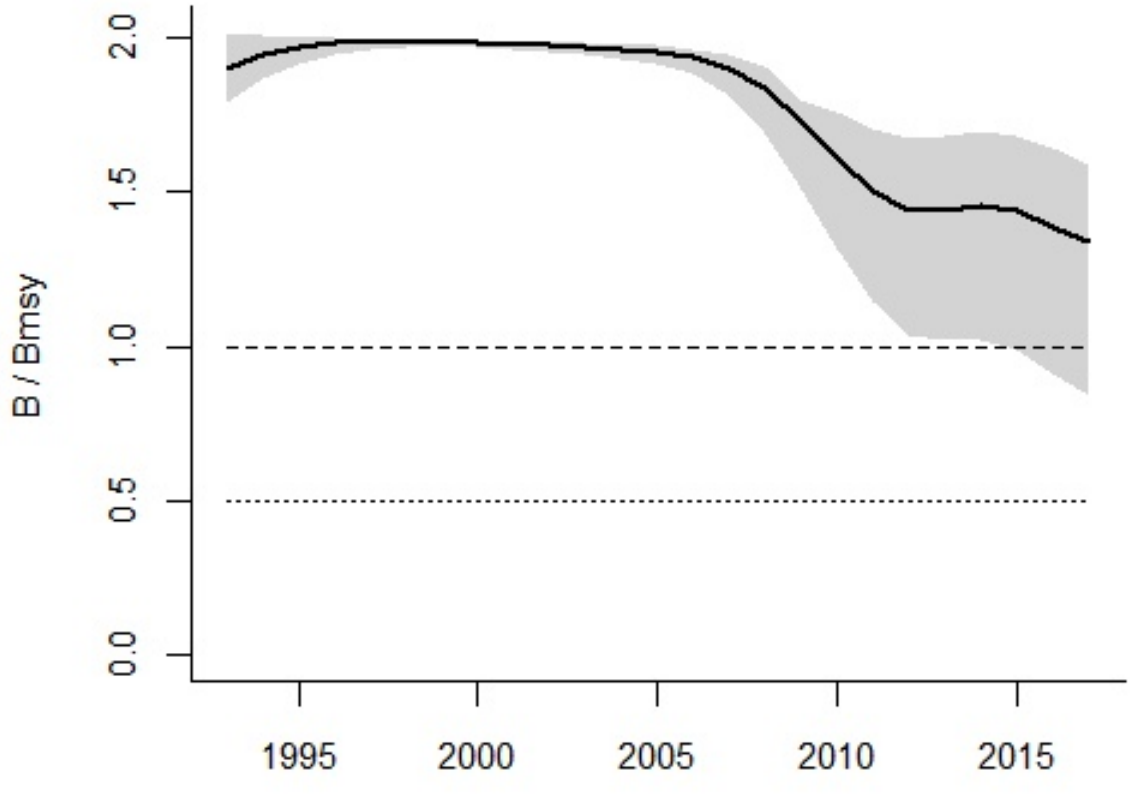

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
1995
2000
2005
2010
2015


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

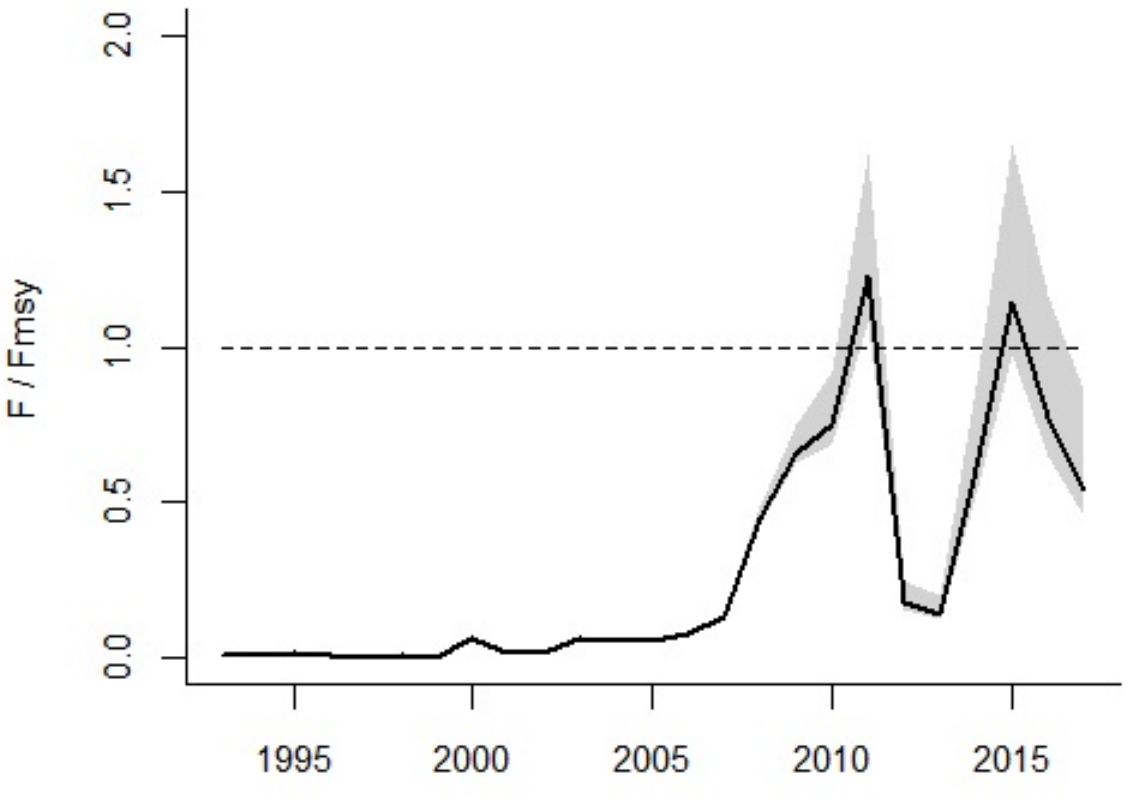
Catch

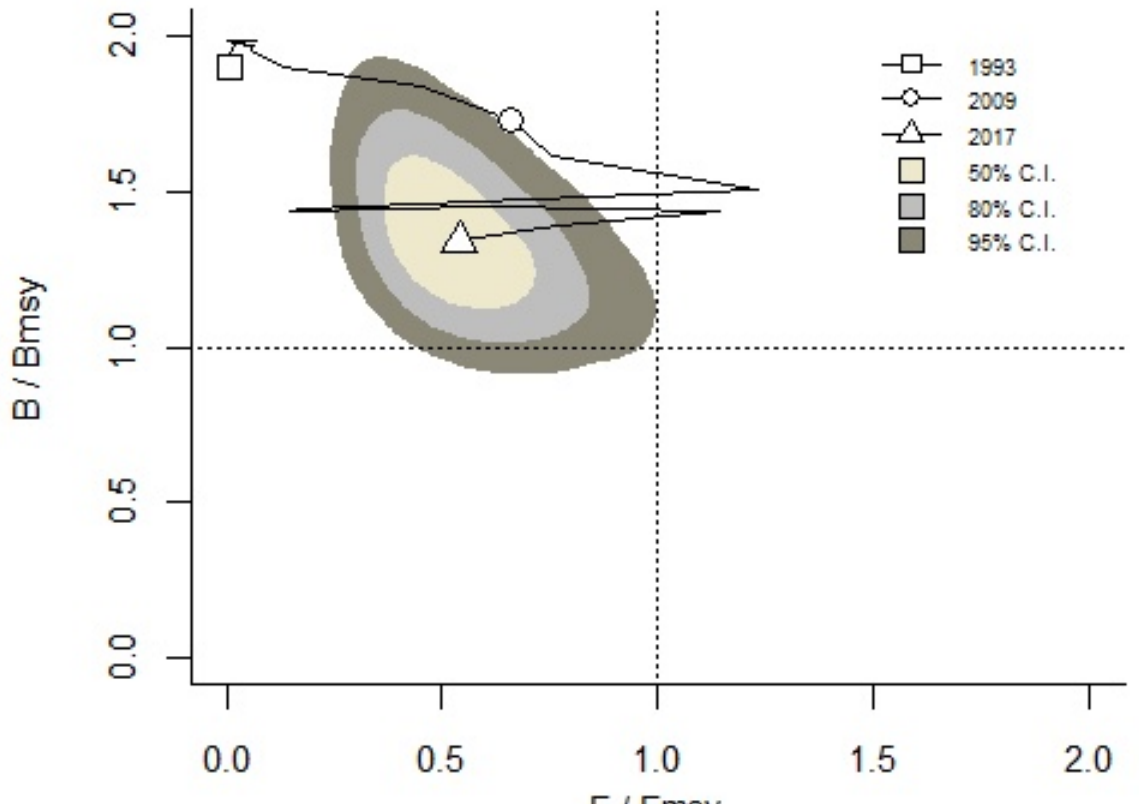


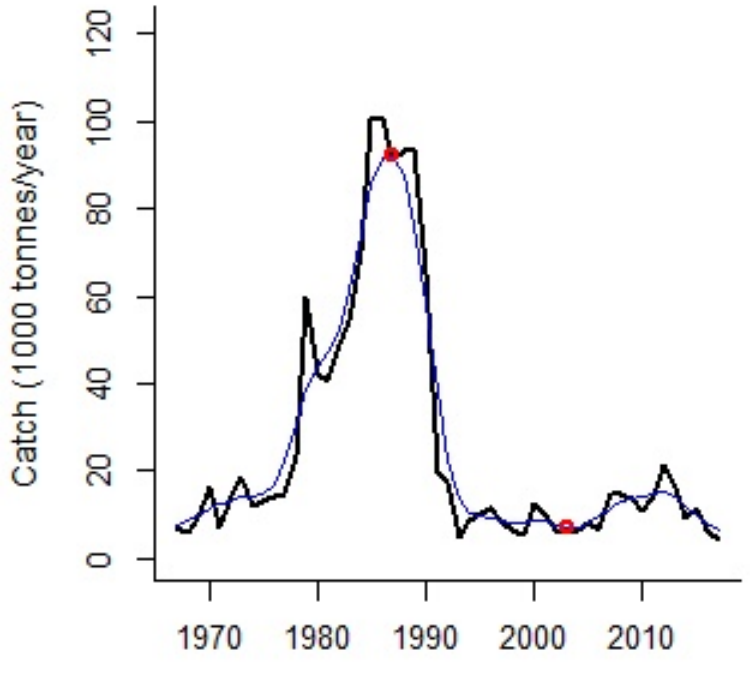
Stock size

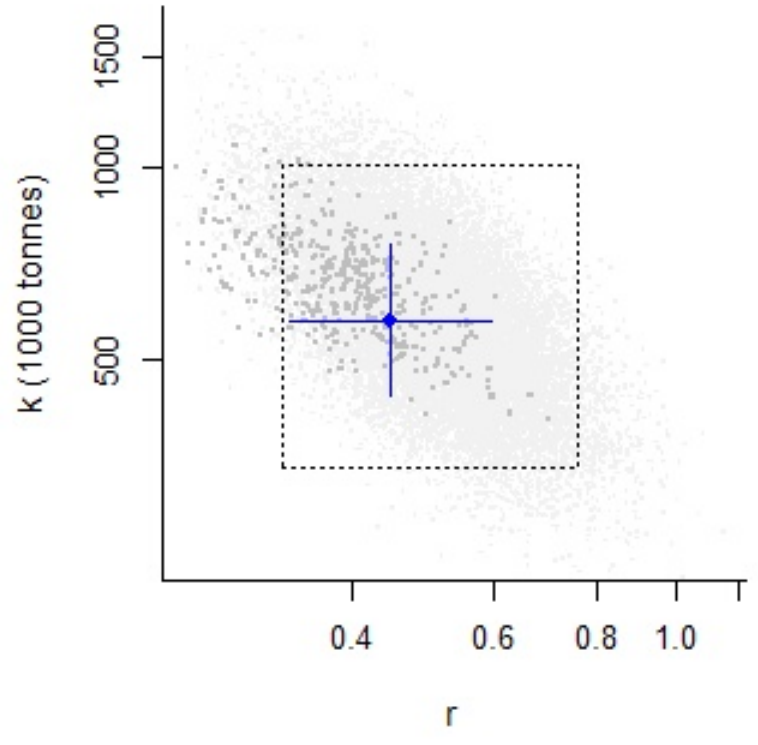


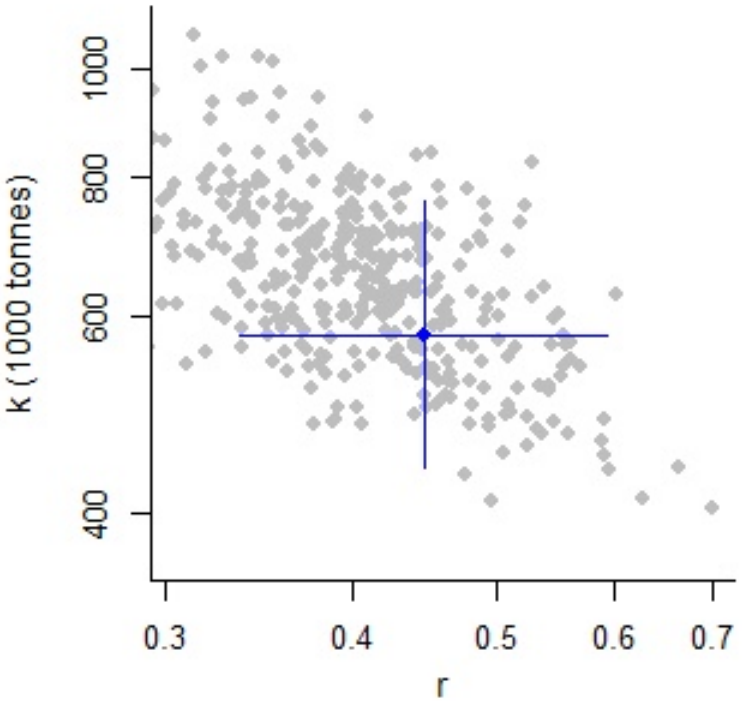
Exploitation

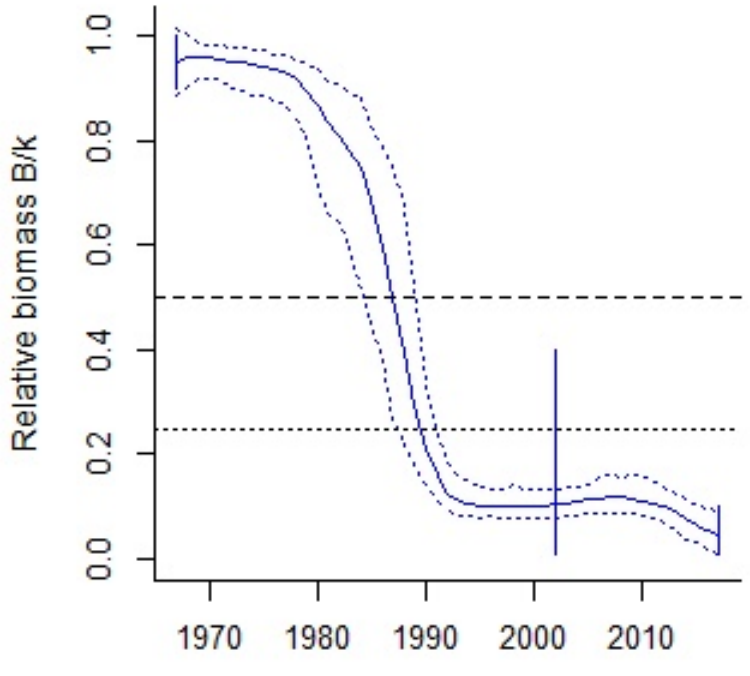


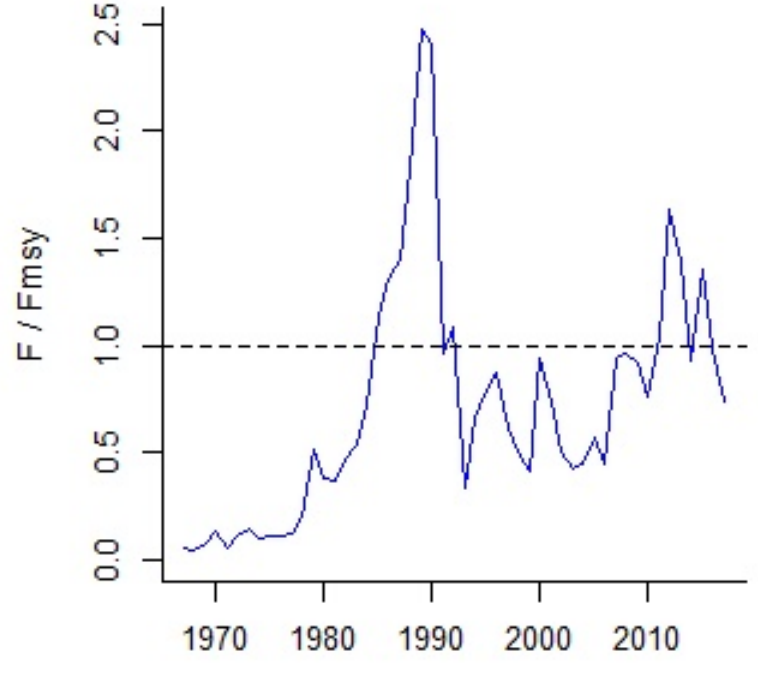


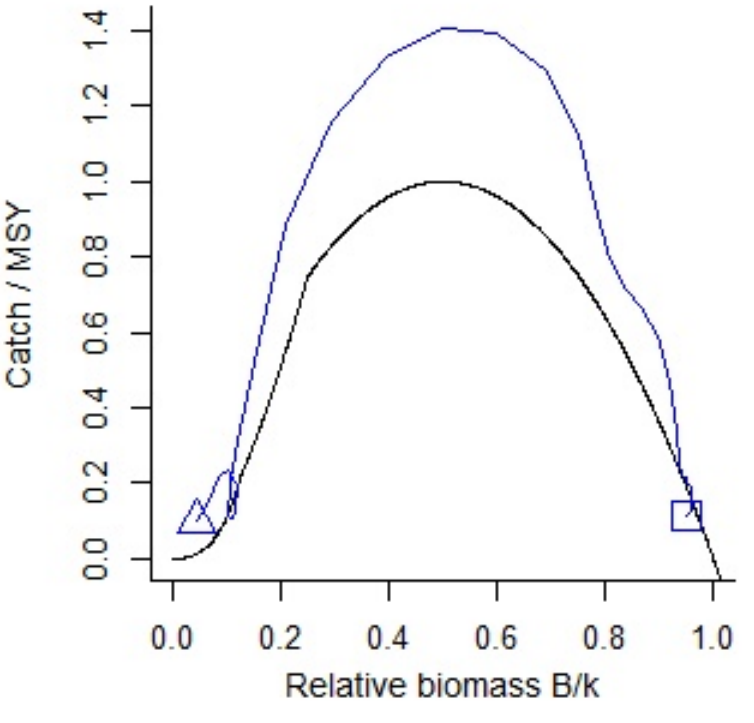

A: Catch MedHMack_BS
Catch (1000 tonnes/year)
0
20
40
60
80
100
120
1970
1980
1990
2000
2010

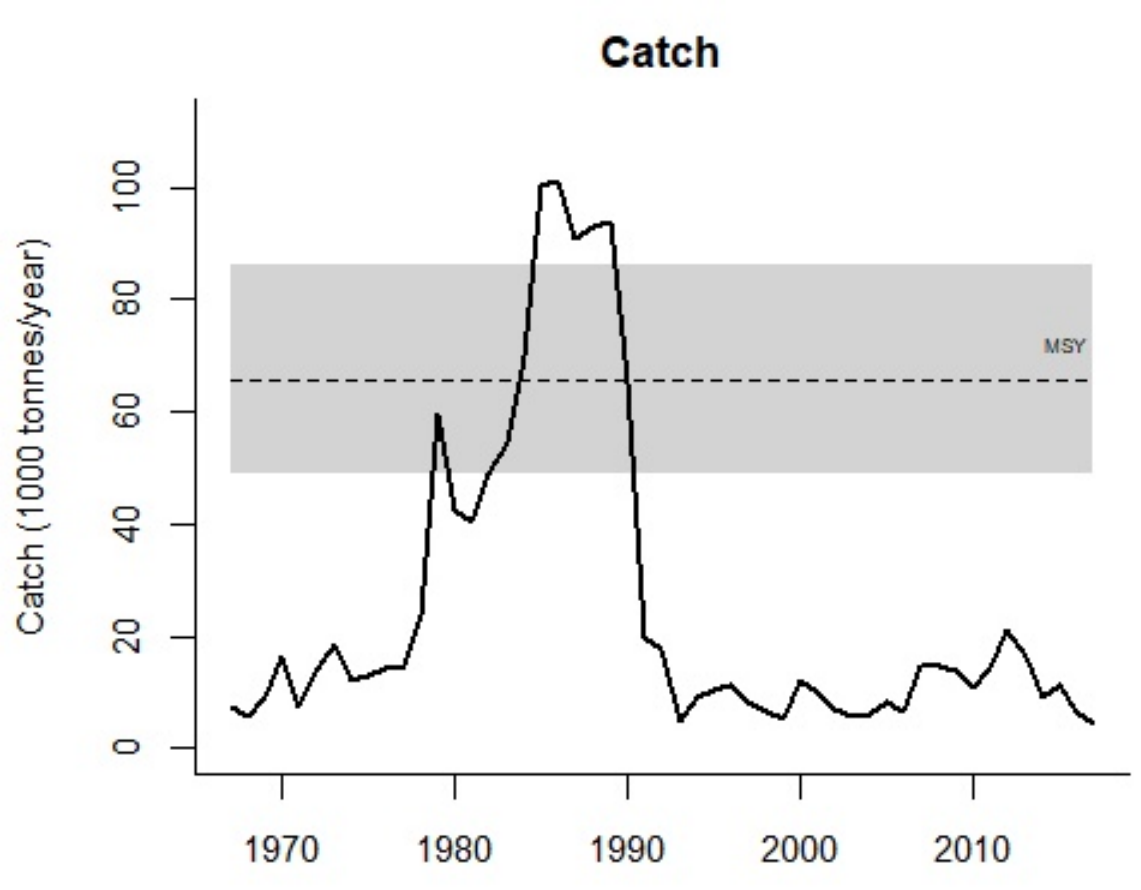

B: Finding viable r-k
k (1000 tonnes)
500
1000
1500
0.4
0.6
0.8
1.0
r

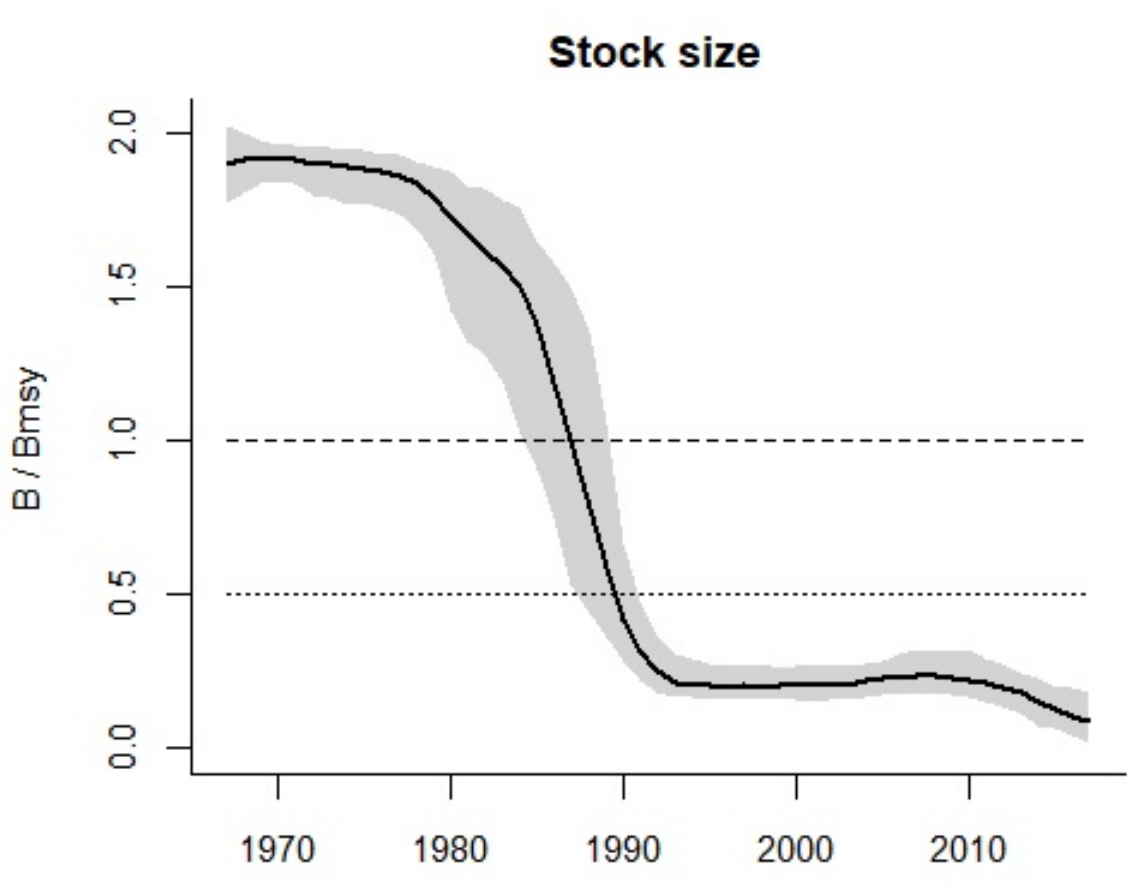

C: Analysis of viable r-k
k (1000 tonnes)
400
600
800
1000
0.3
0.4
0.5
0.6
0.7
r

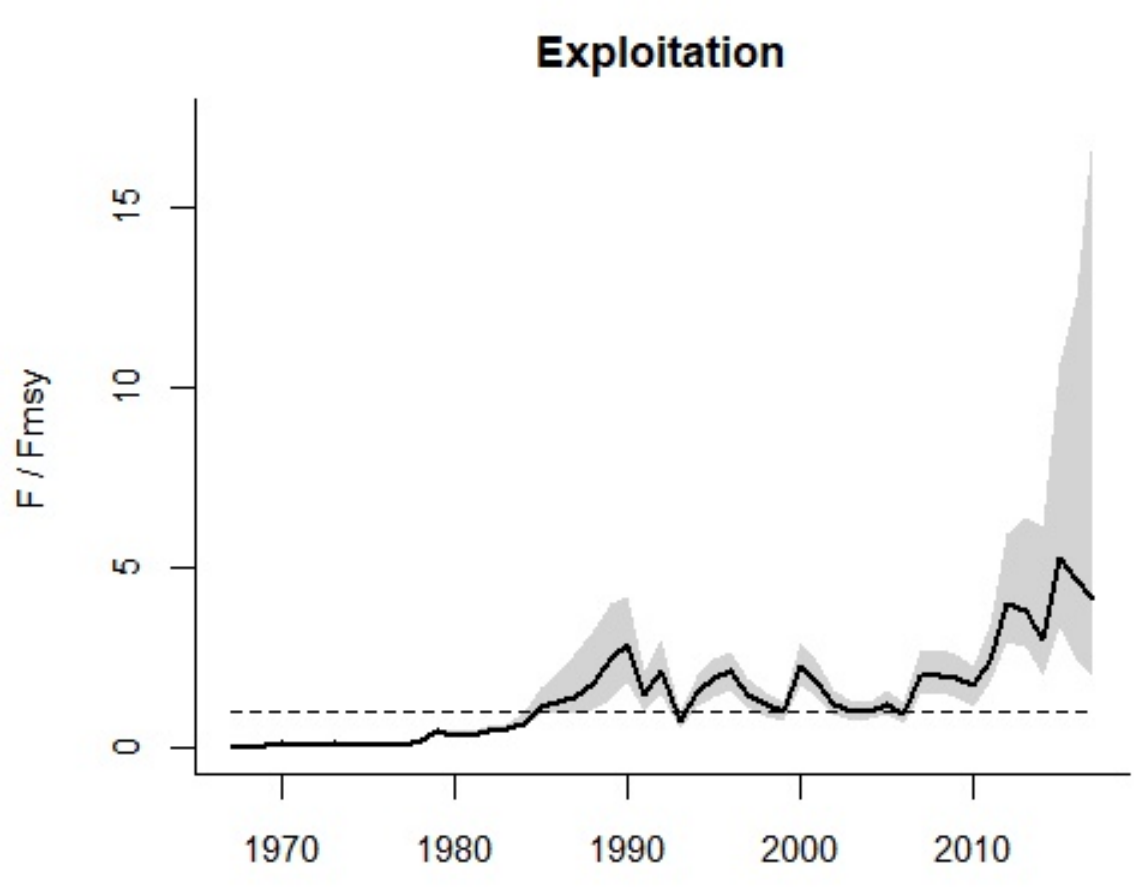

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

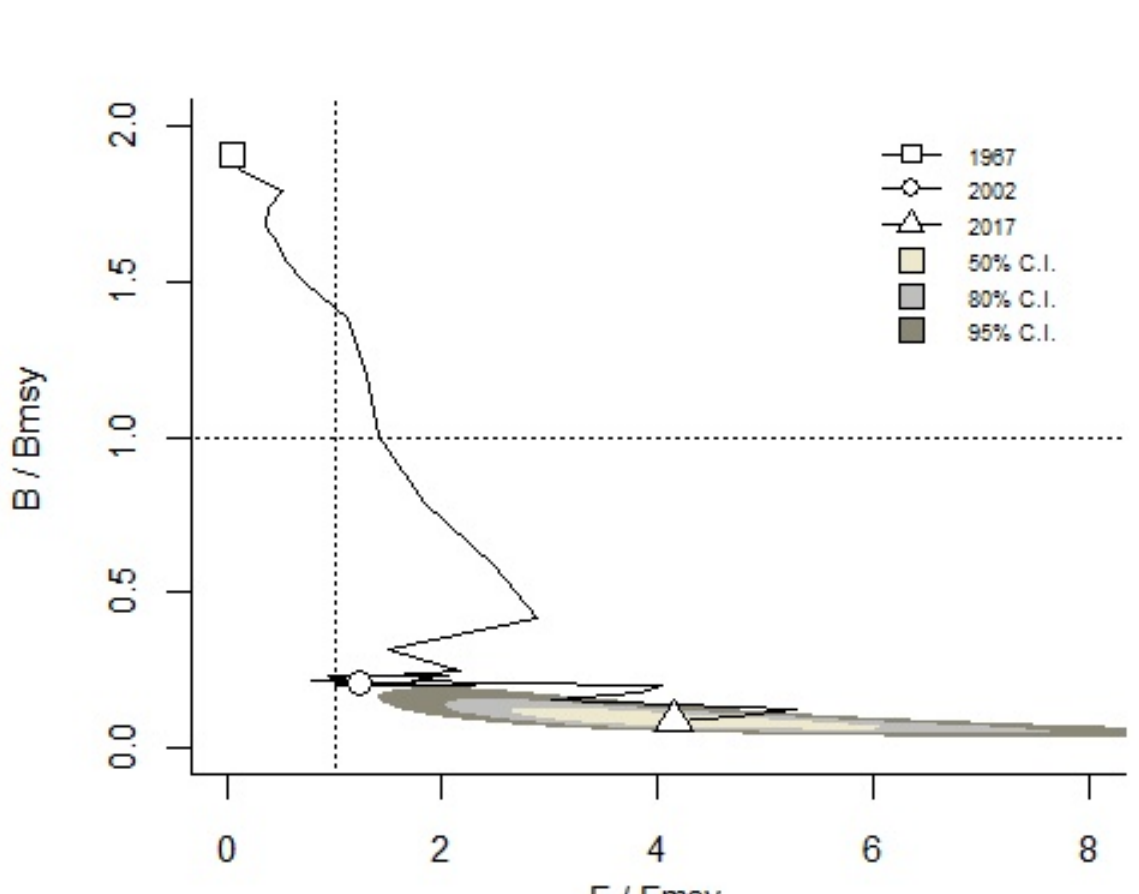

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

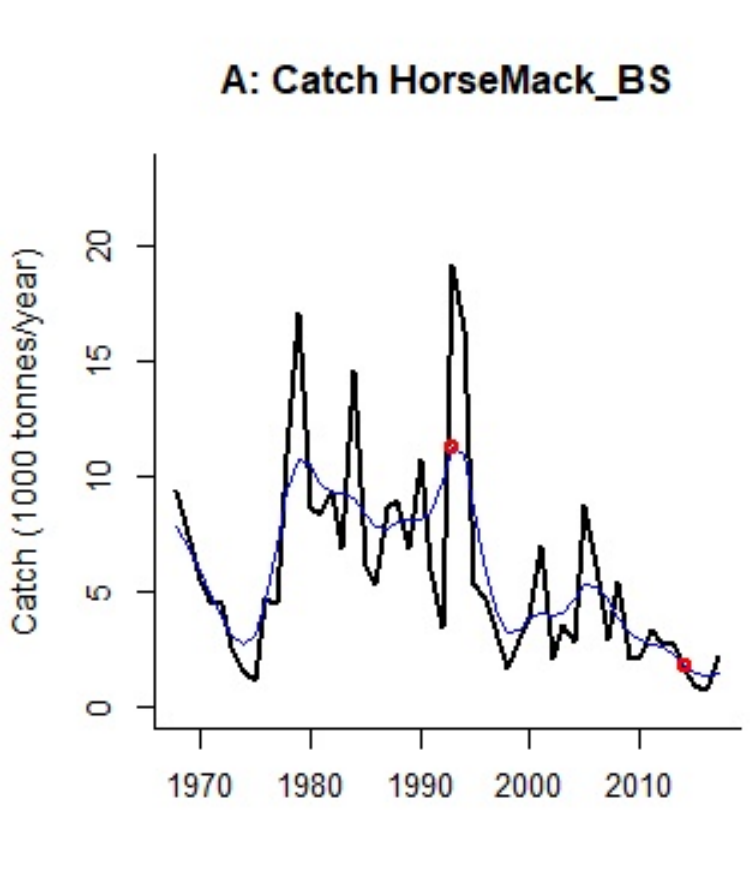

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

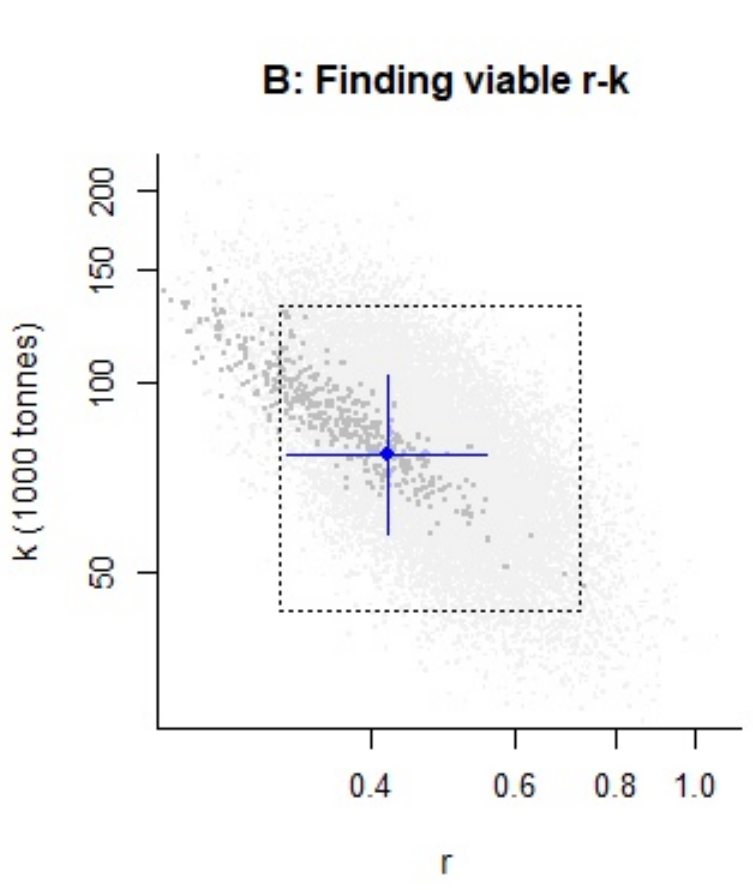

Catch
Catch (1000 tonnes/year)
0
20
40
60
80
100
MSY
1970
1980
1990
2000
2010

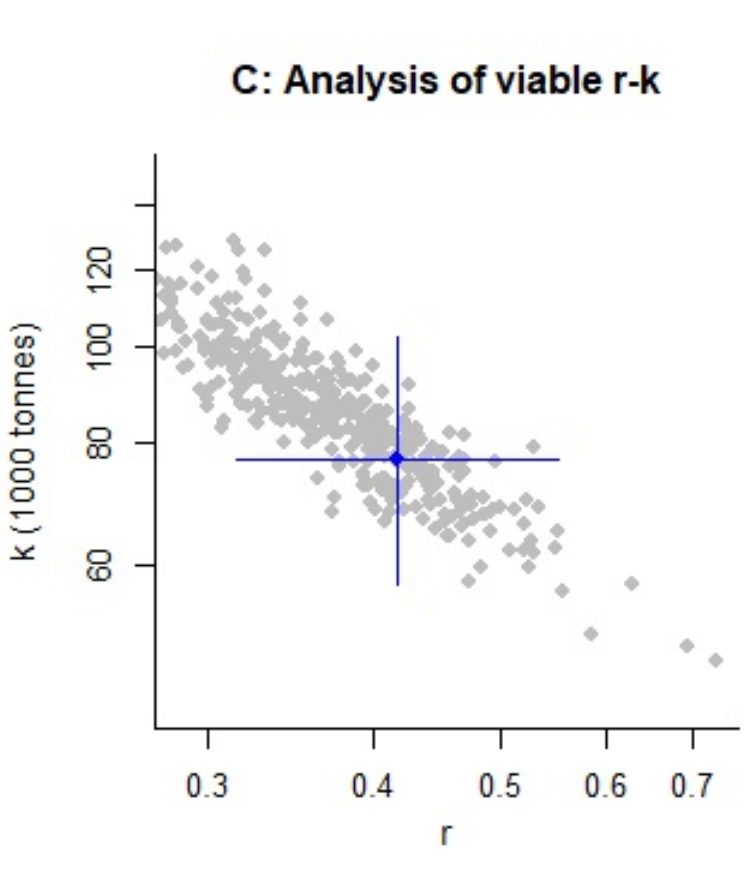

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

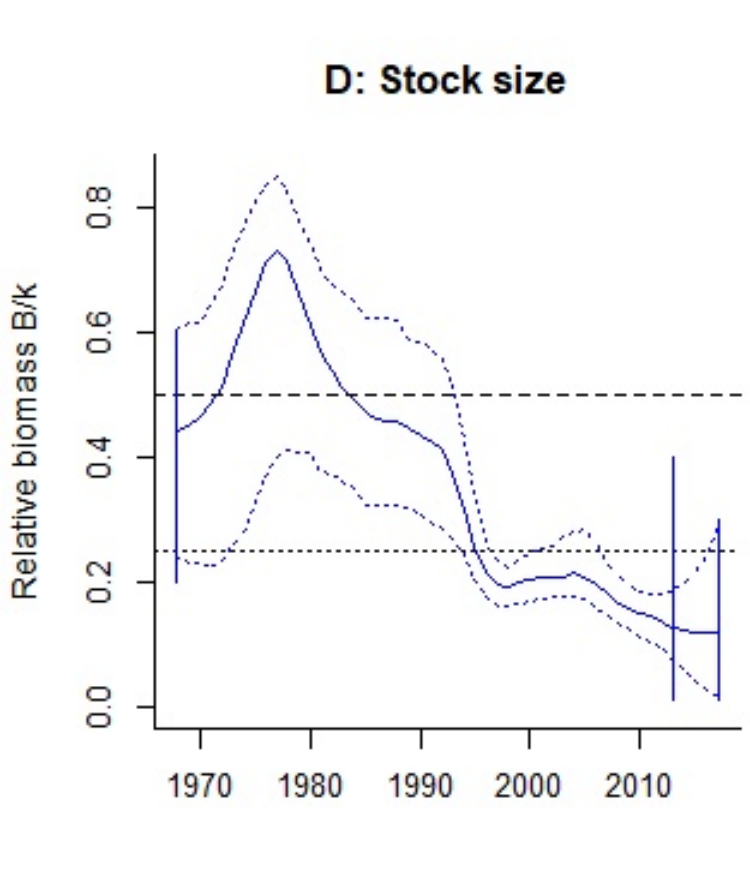

Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

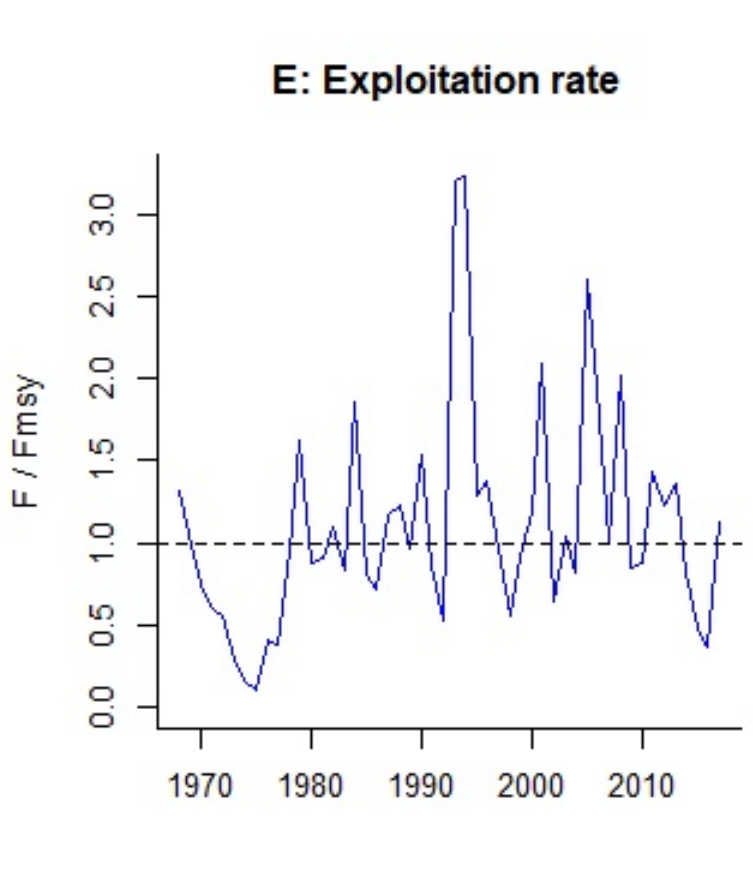

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2002
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

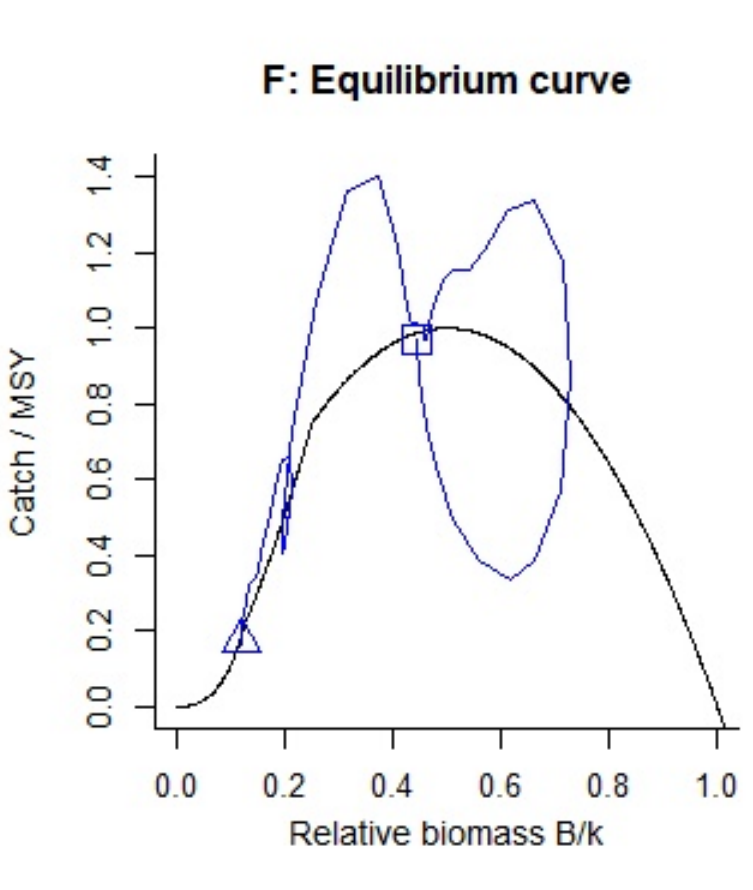

A: Catch HorseMack_BS
Catch (1000 tonnes/year)
0
5
10
15
20
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
0.4
0.6
0.8
1.0
r

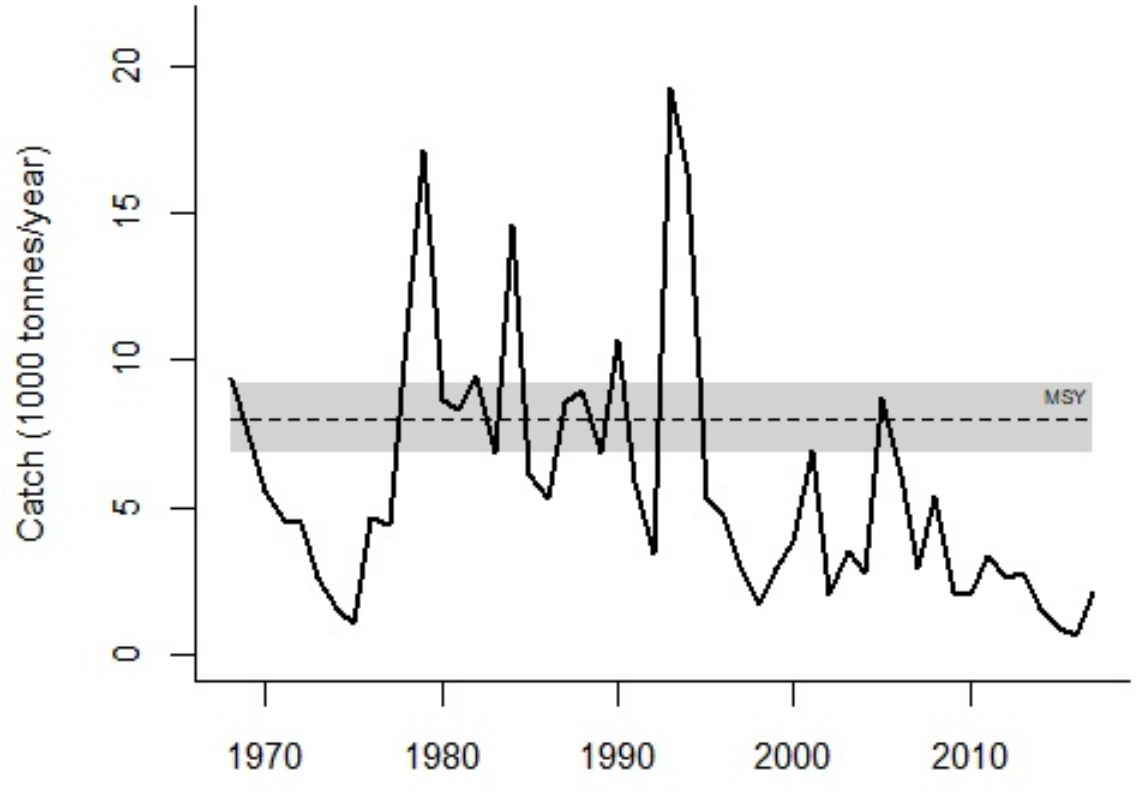

C: Analysis of viable r-k
k (1000 tonnes)
60
80
100
120
0.3
0.4
0.5
0.6
0.7
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

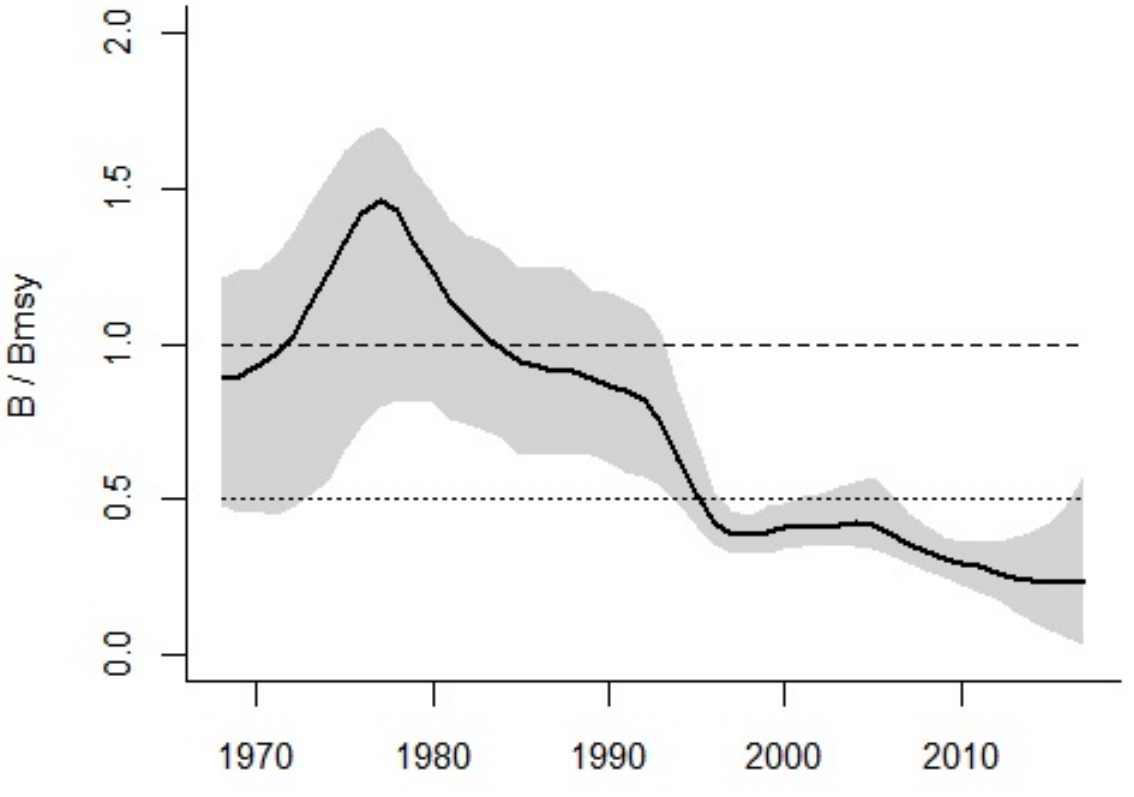

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

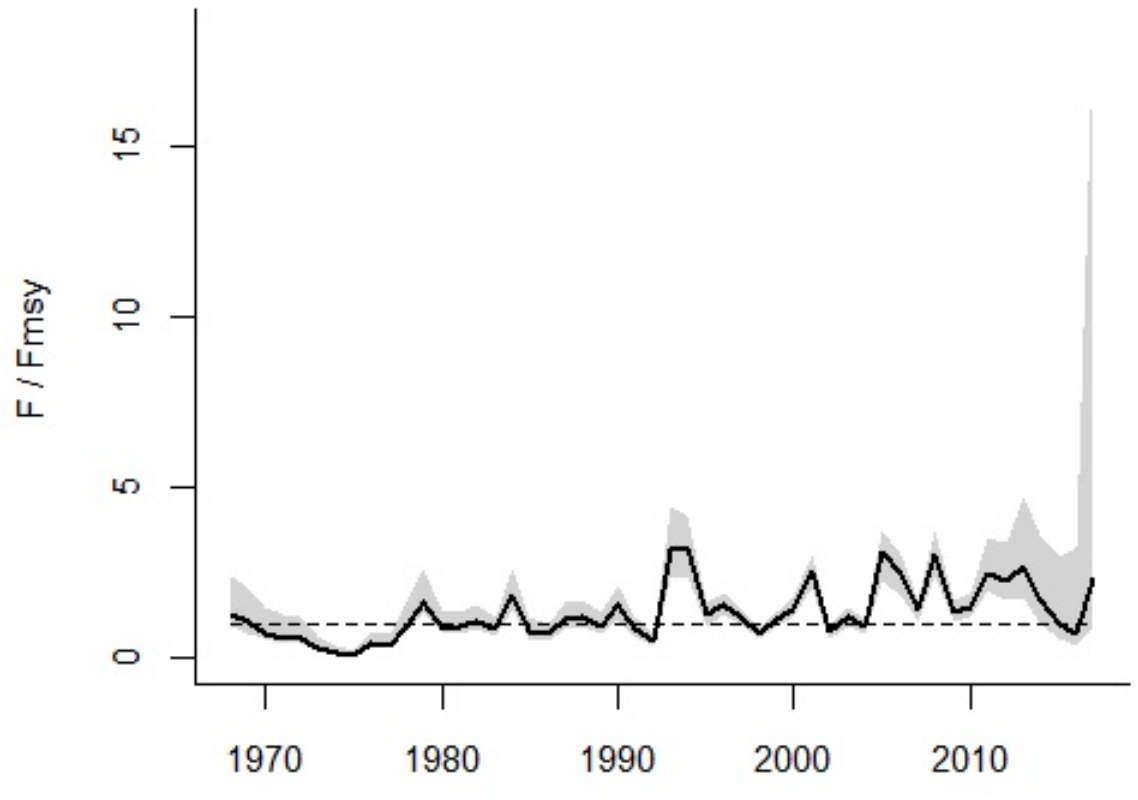
Catch

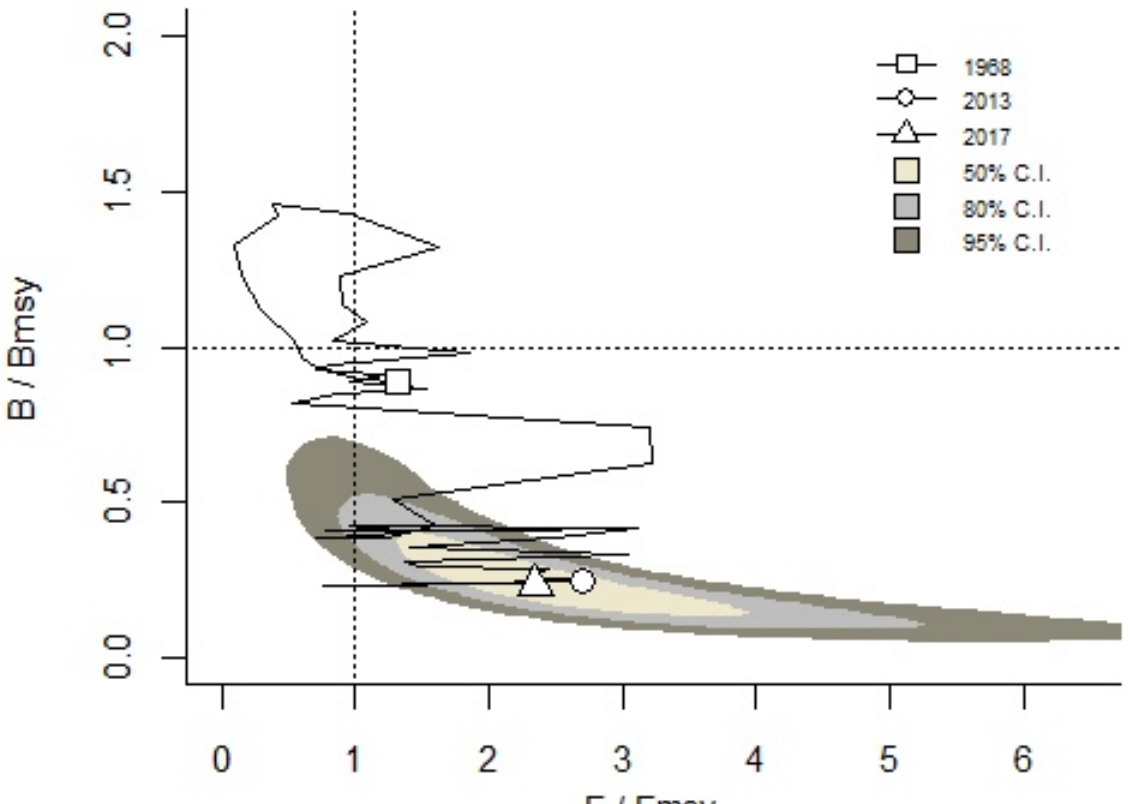


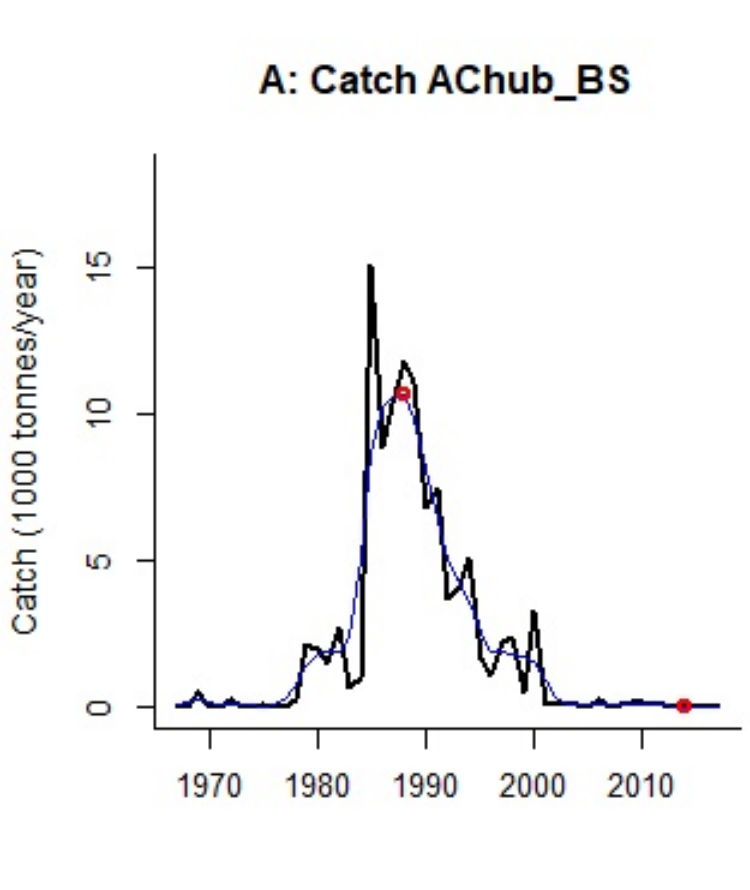
Stock size

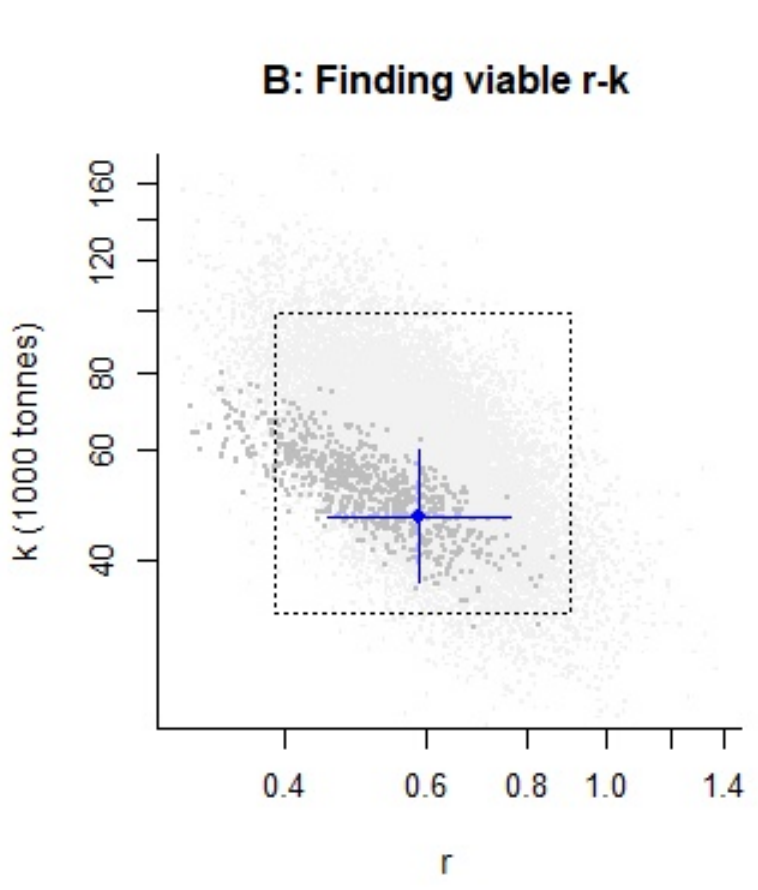


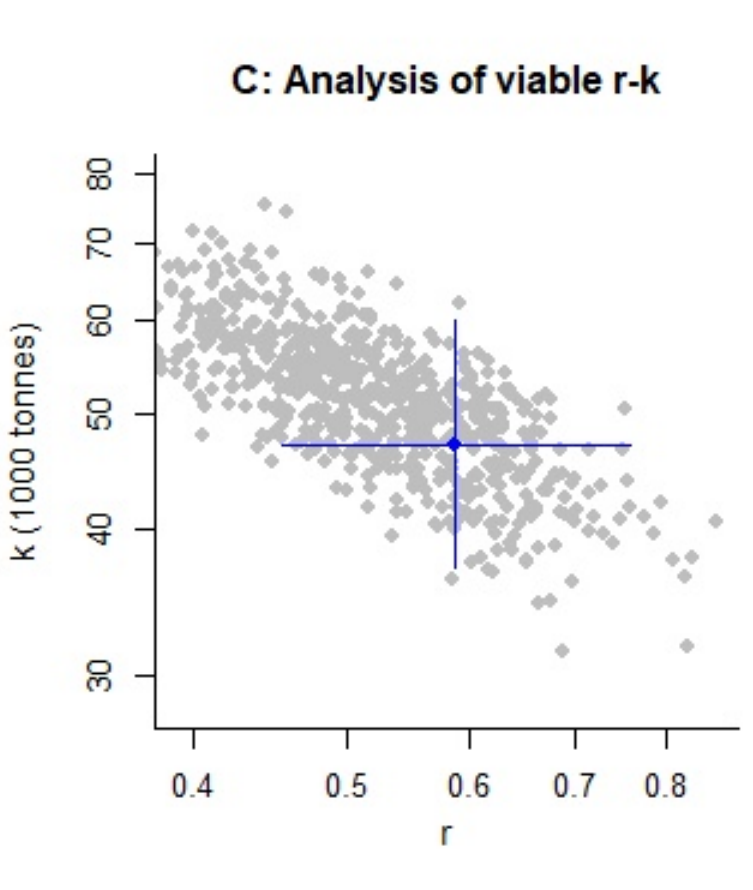
Exploitation

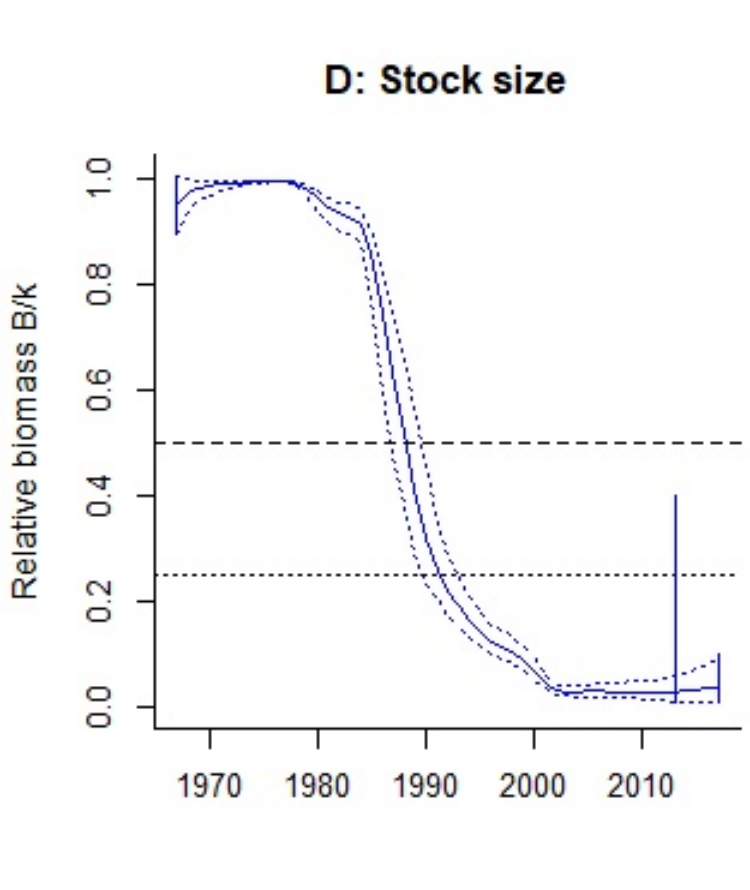


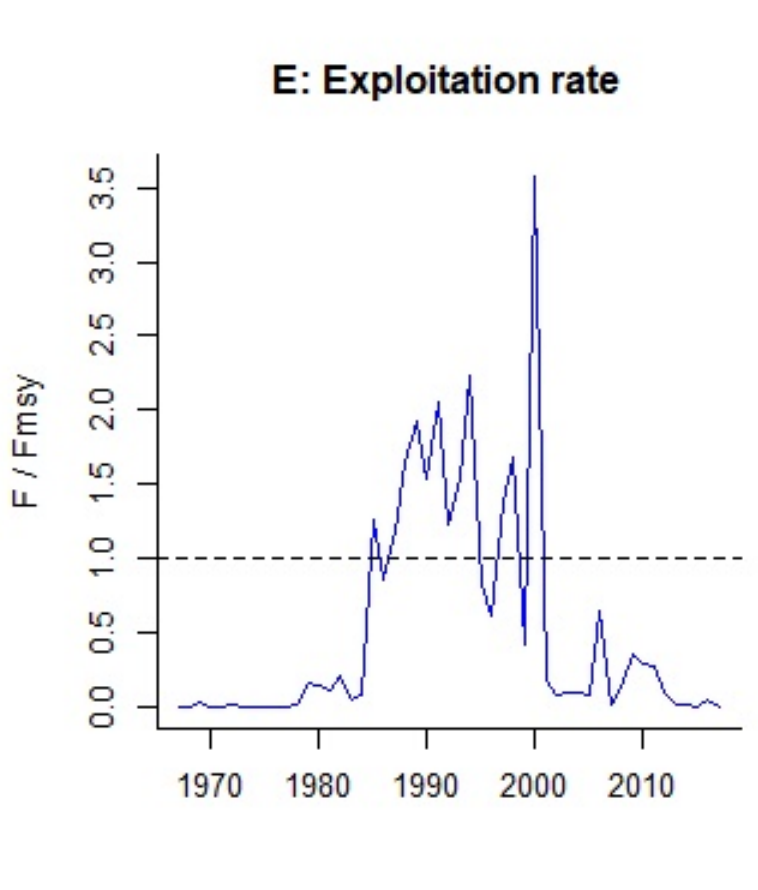


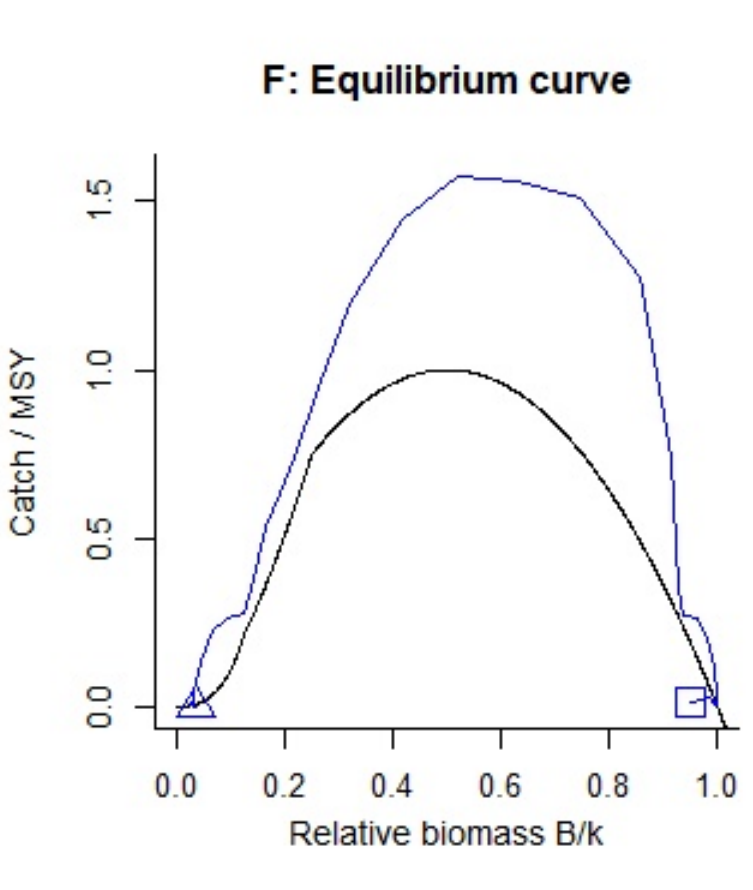

A: Catch AChub_BS
Catch (1000 tonnes/year)
0
5
10
15
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
40
60
80
120
160
0.4
0.6
0.8
1.0
1.4
r

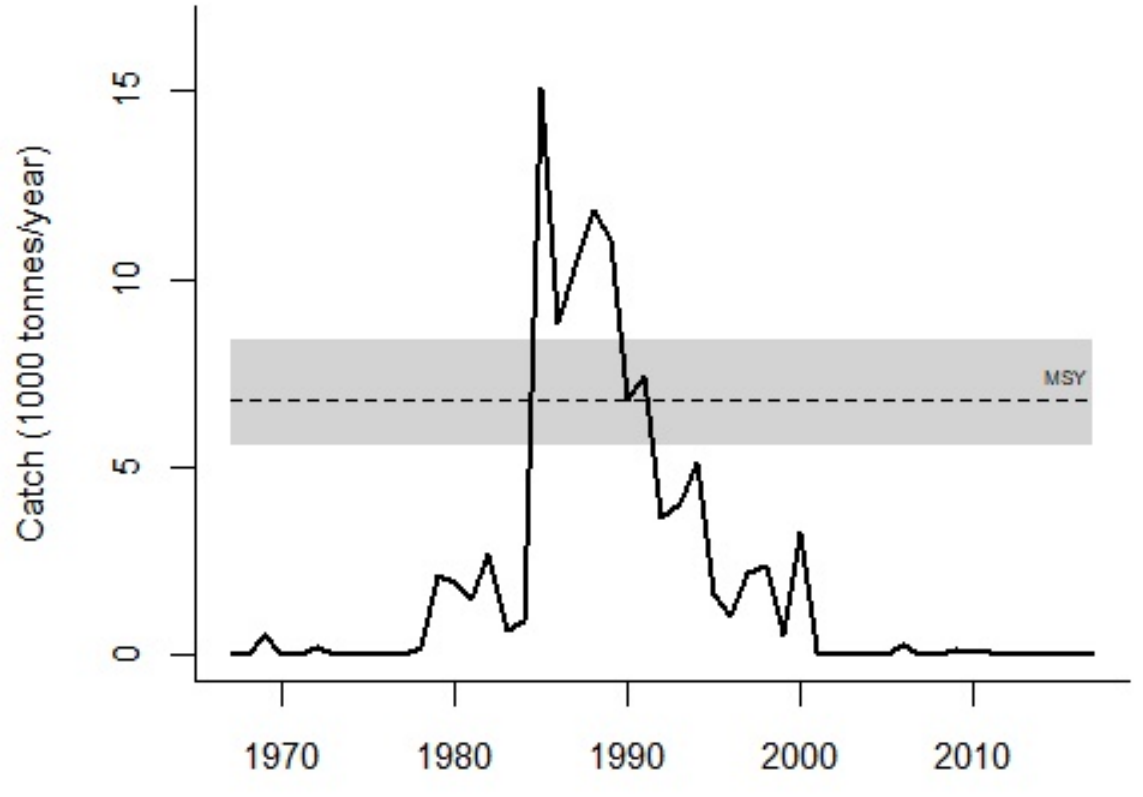

C: Analysis of viable r-k
k (1000 tonnes)
30
40
50
60
70
80
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

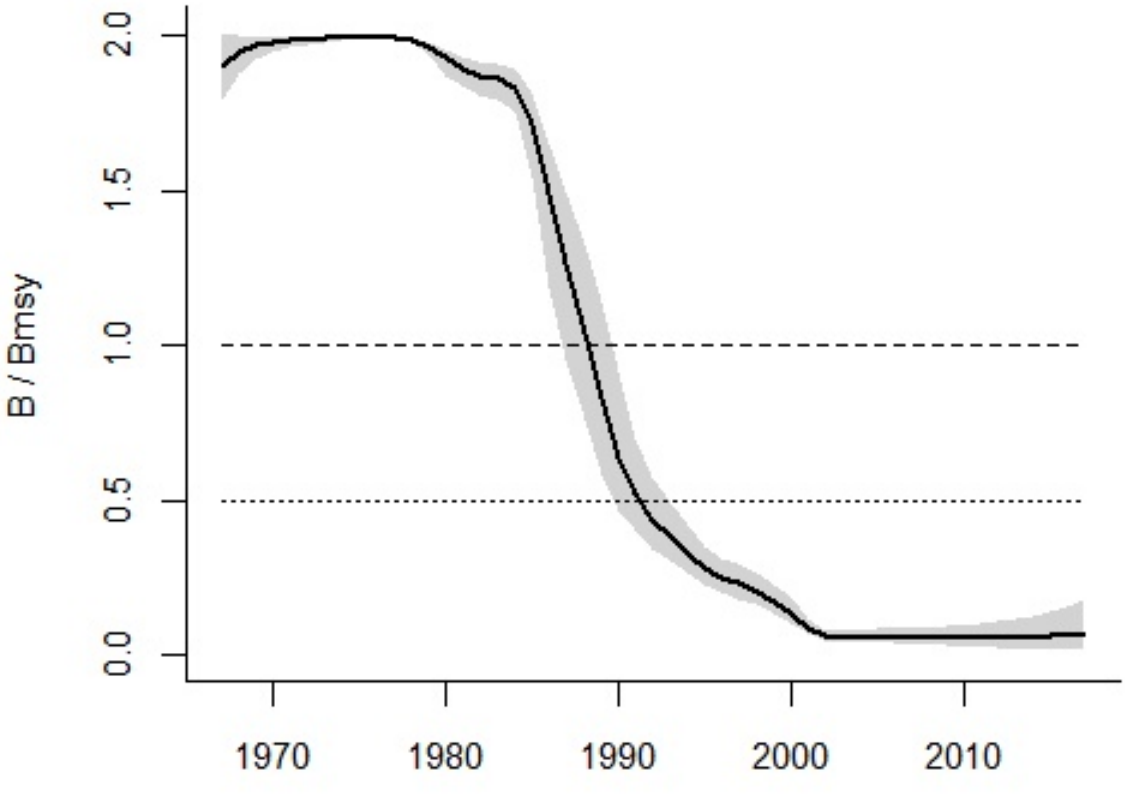

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

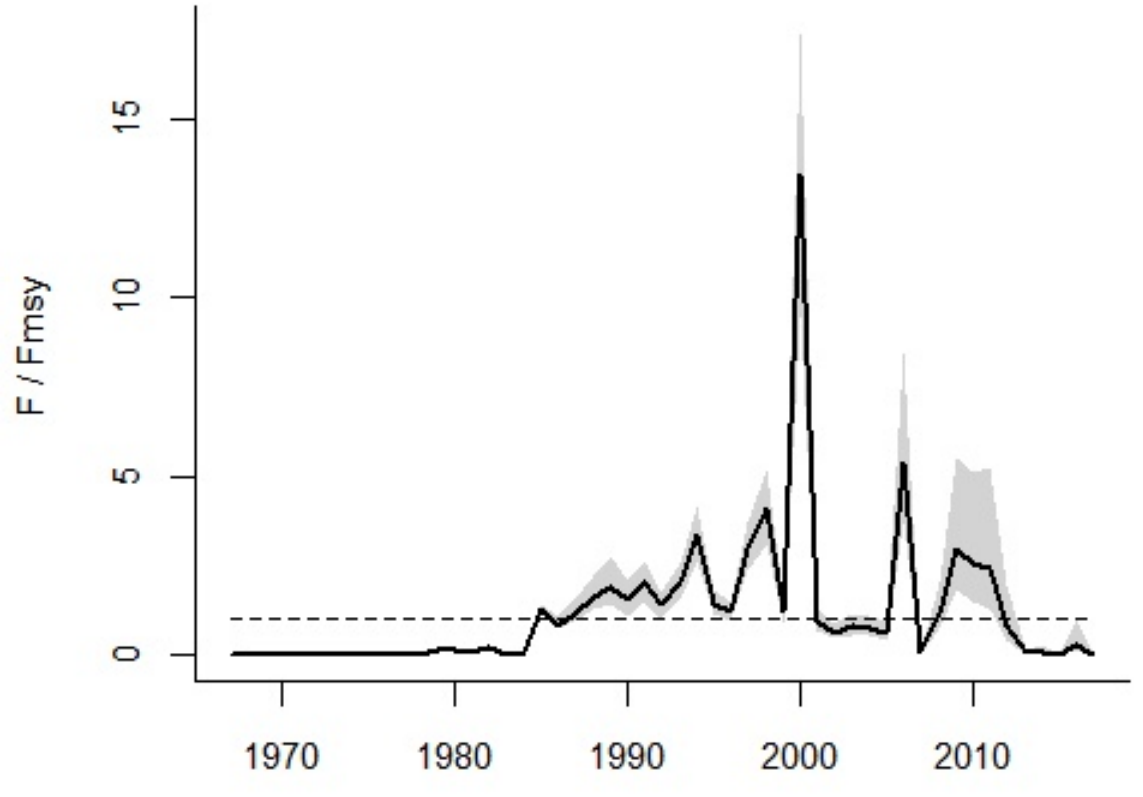
Catch

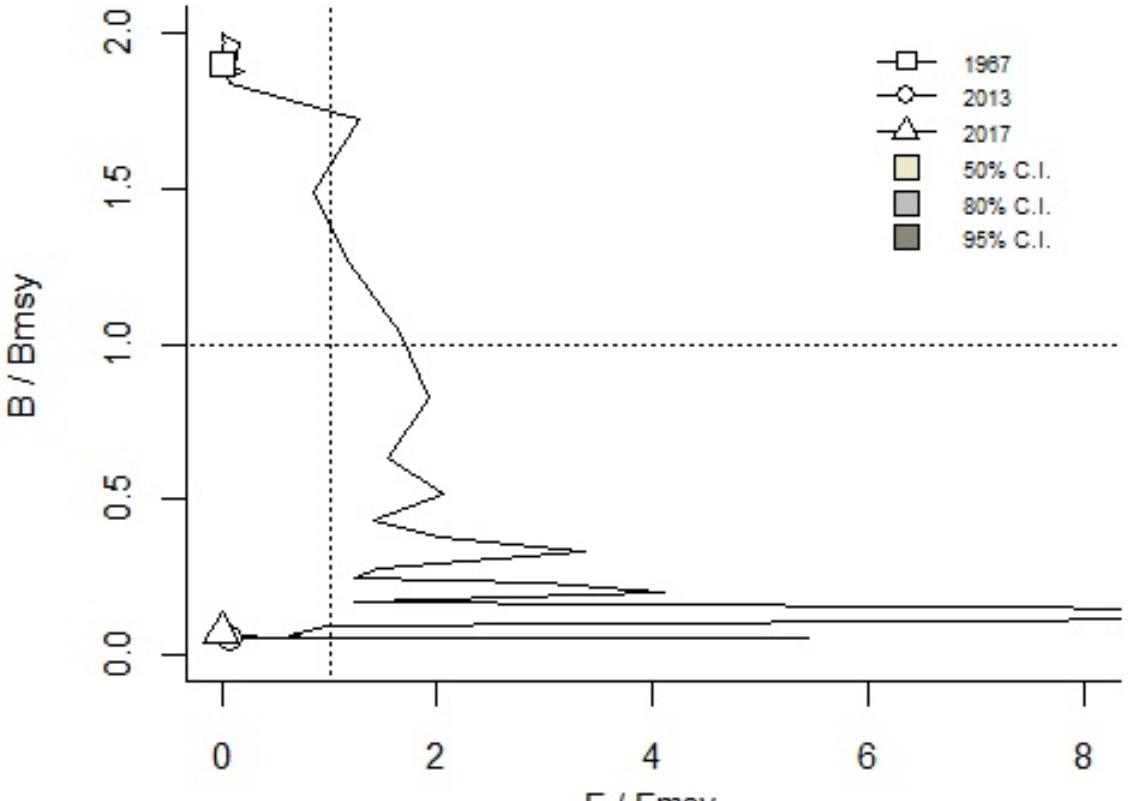


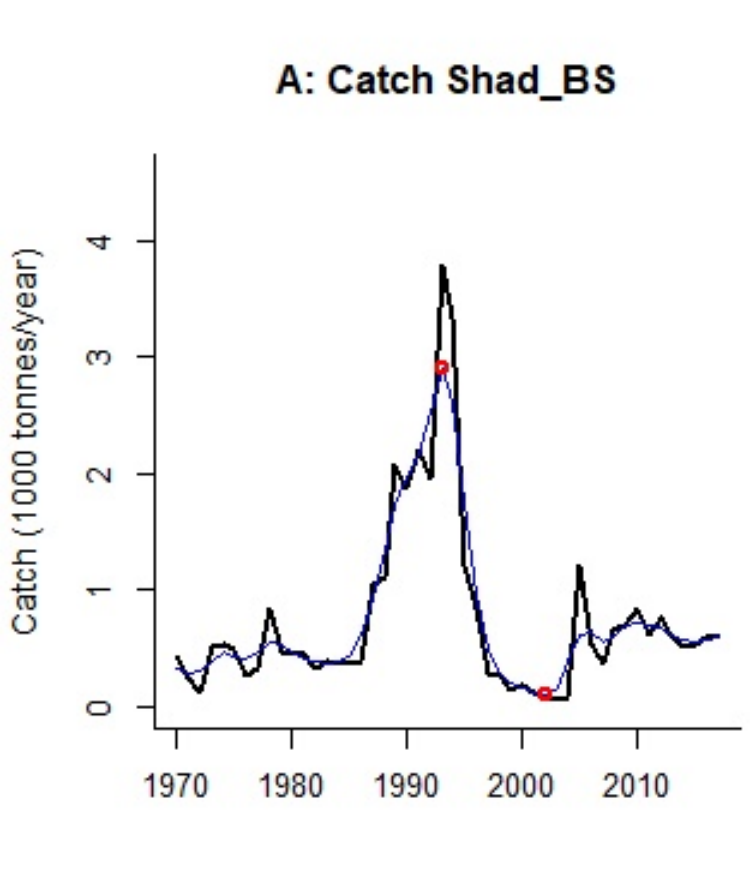
Stock size

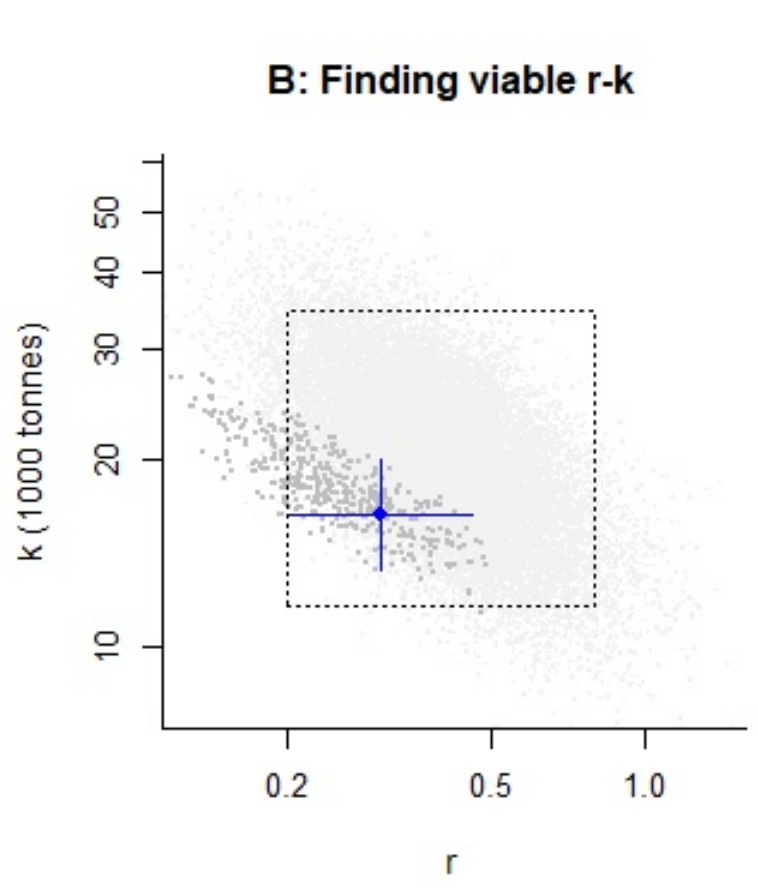


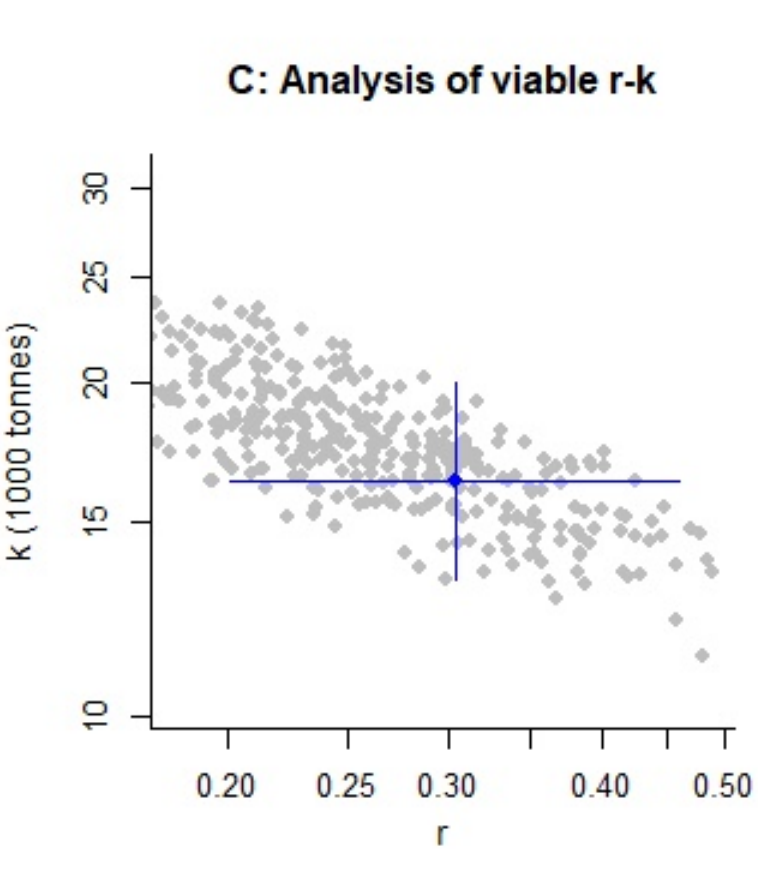
Exploitation

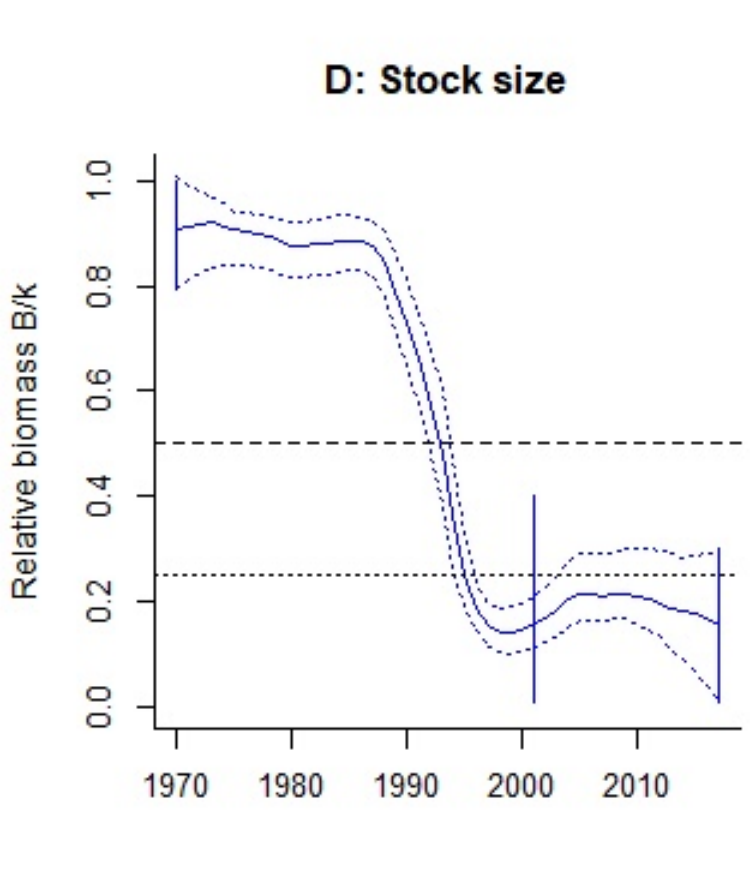


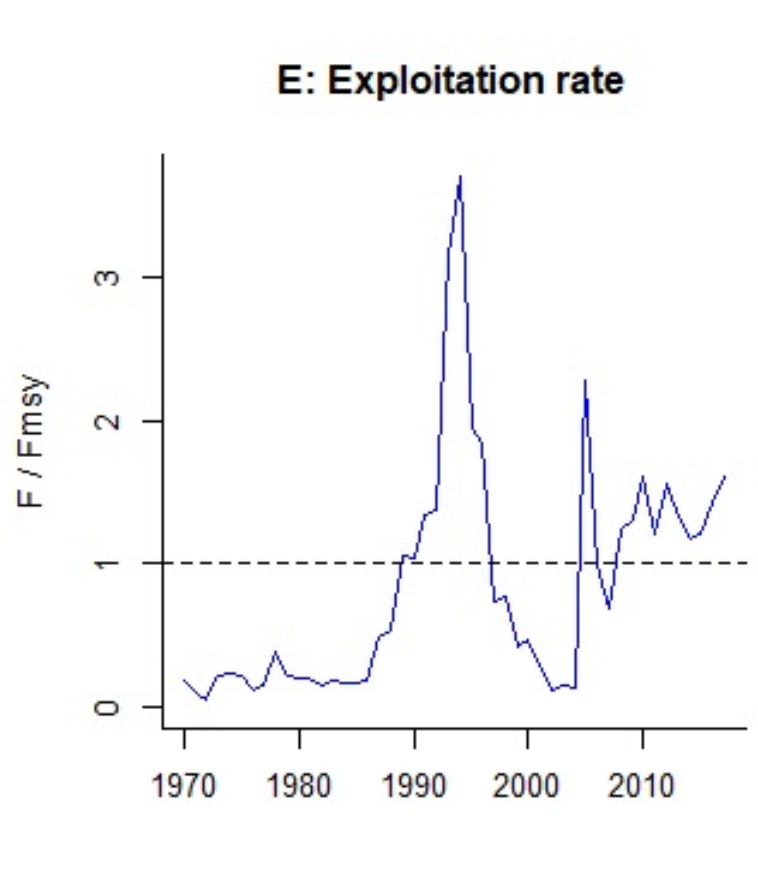


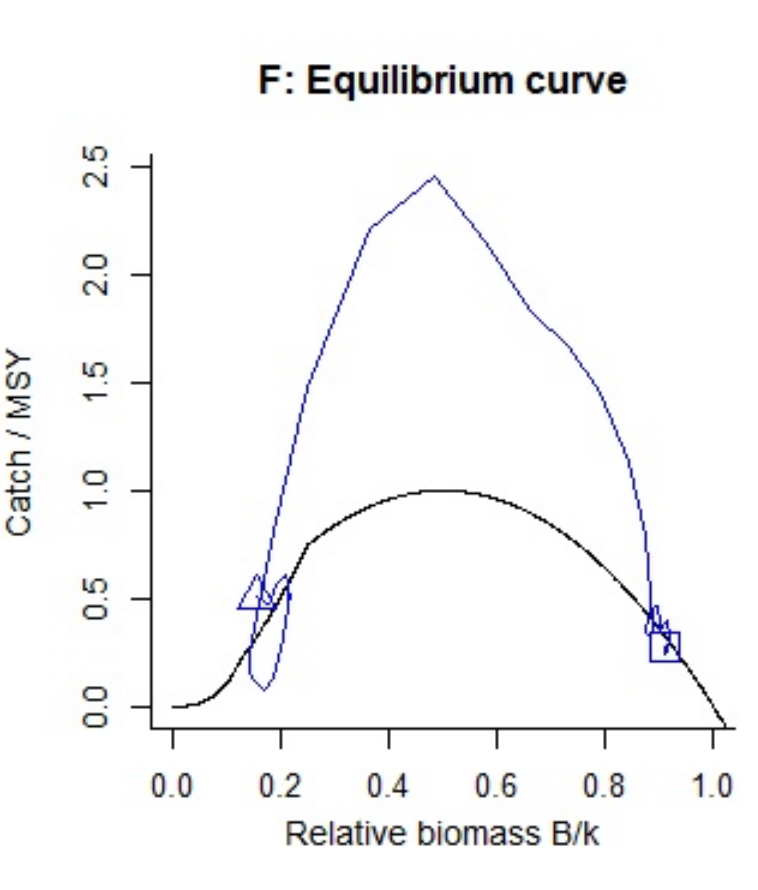

A: Catch Shad_BS
Catch (1000 tonnes/year)
0
1
2
3
4
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
0.2
0.5
1.0
r

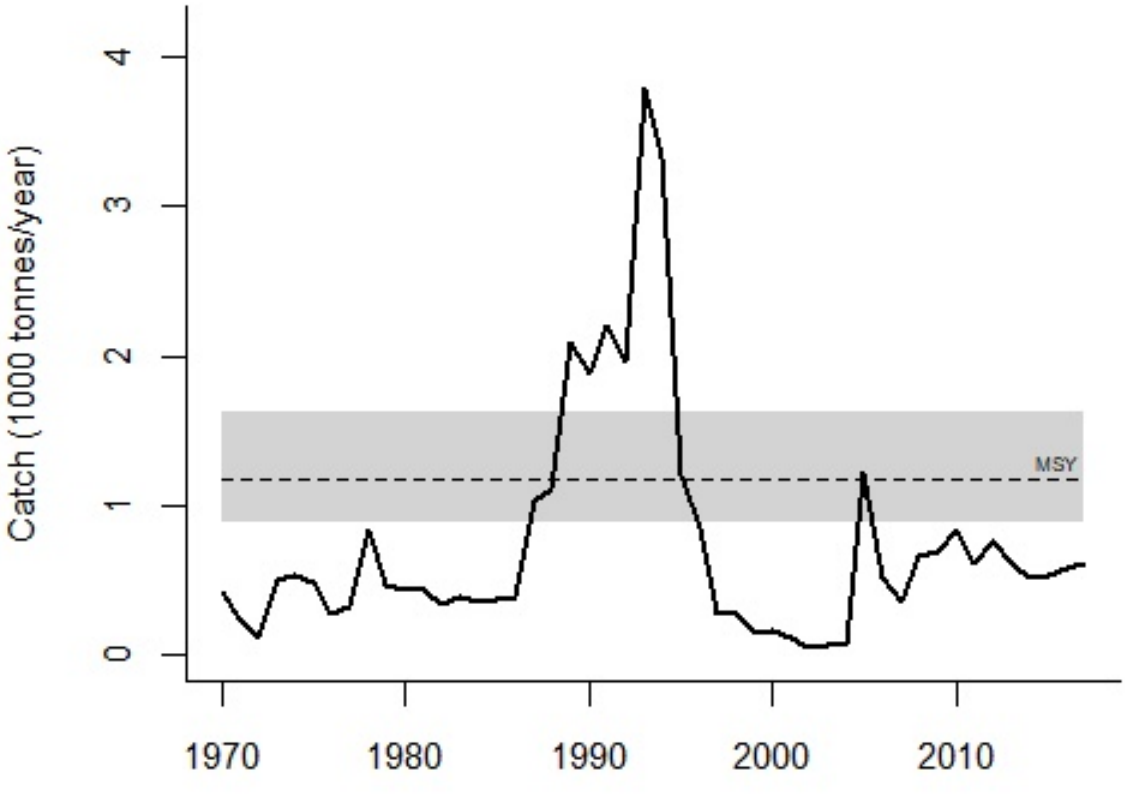

C: Analysis of viable r-k
k (1000 tonnes)
10
15
20
25
30
0.20
0.25
0.30
0.40
0.50
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

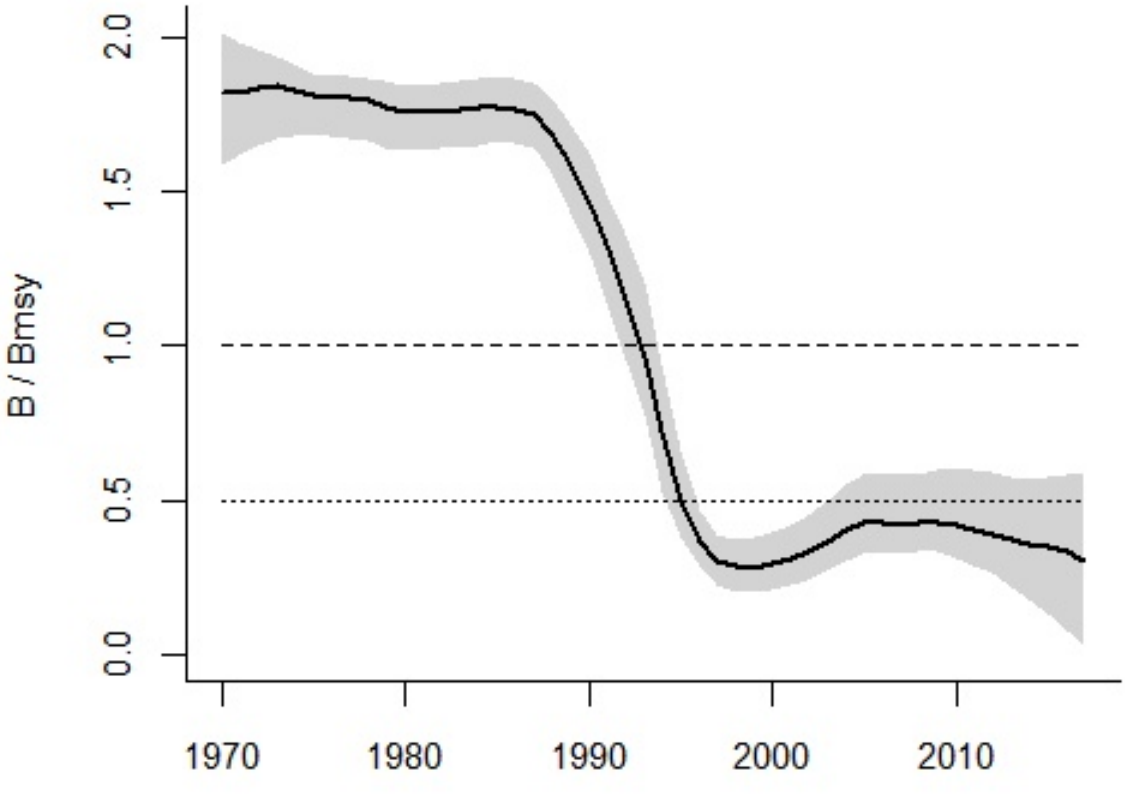

E: Exploitation rate
F / Fmsy
0
1
2
3
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
2.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

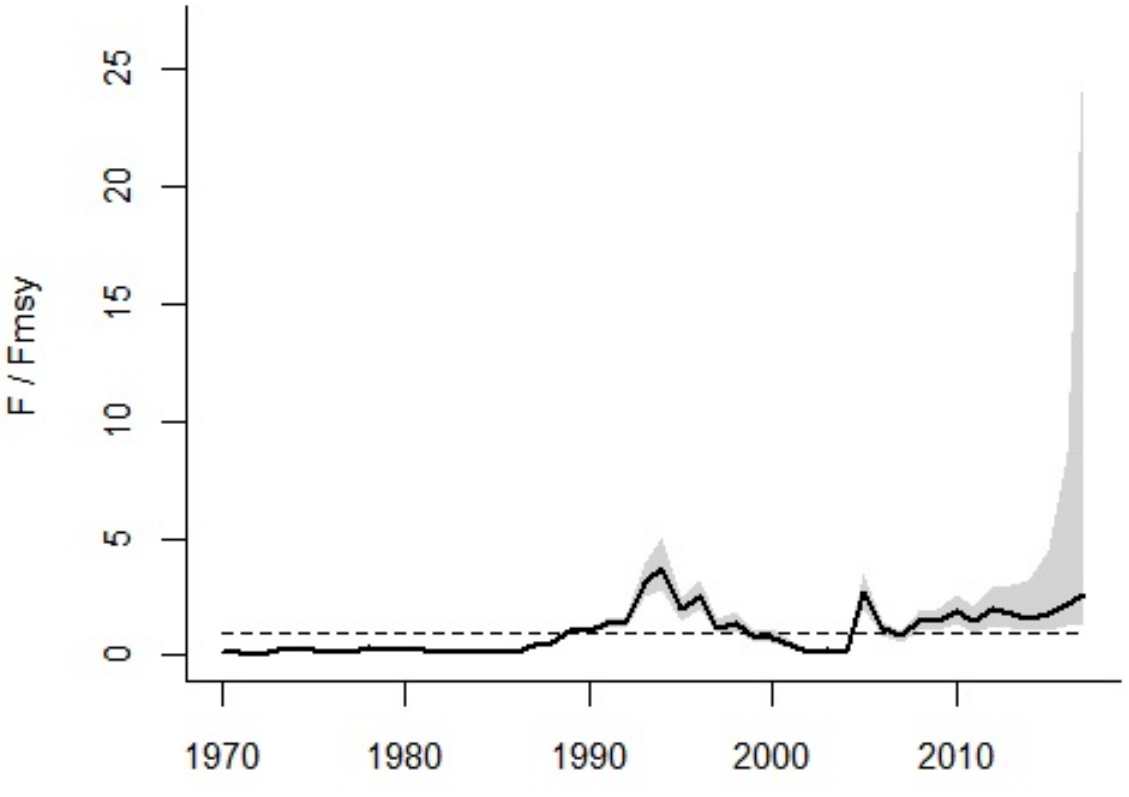
Catch

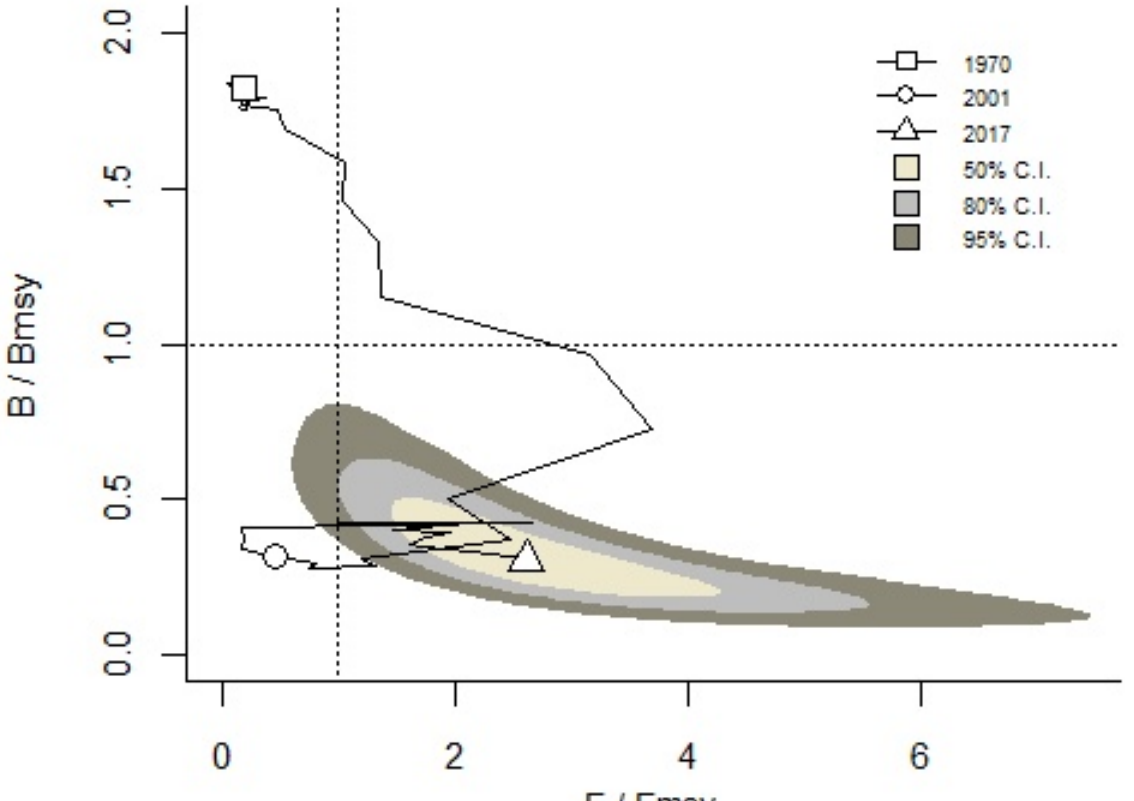


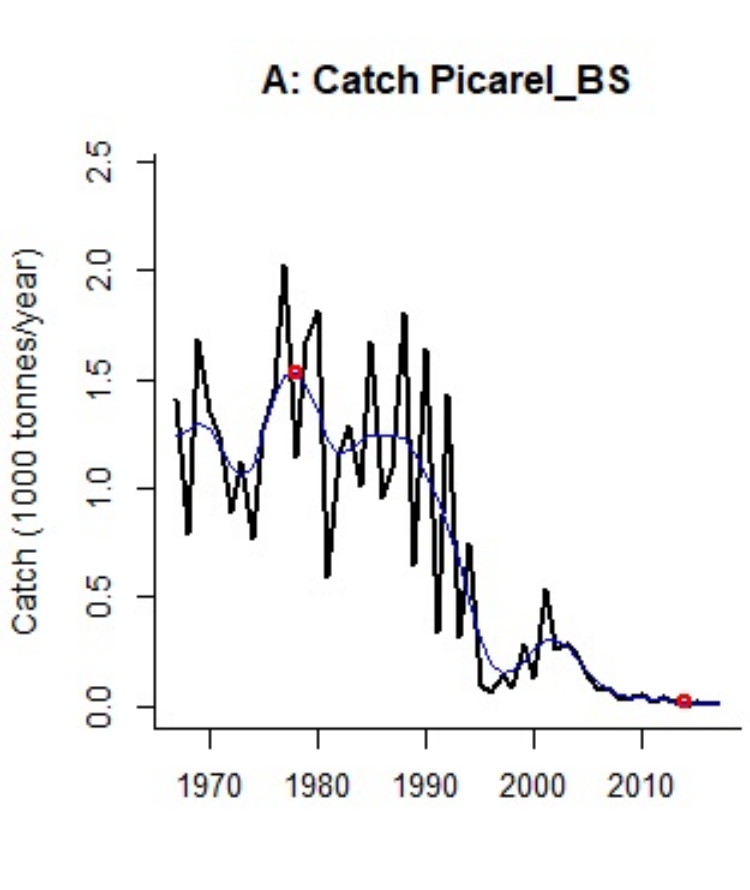
Stock size

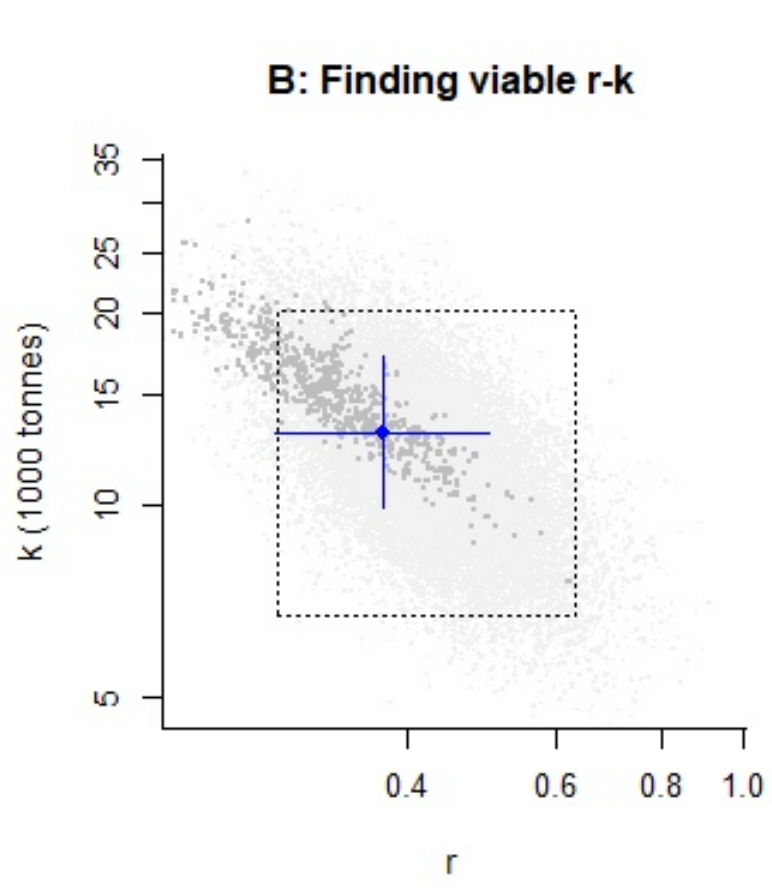


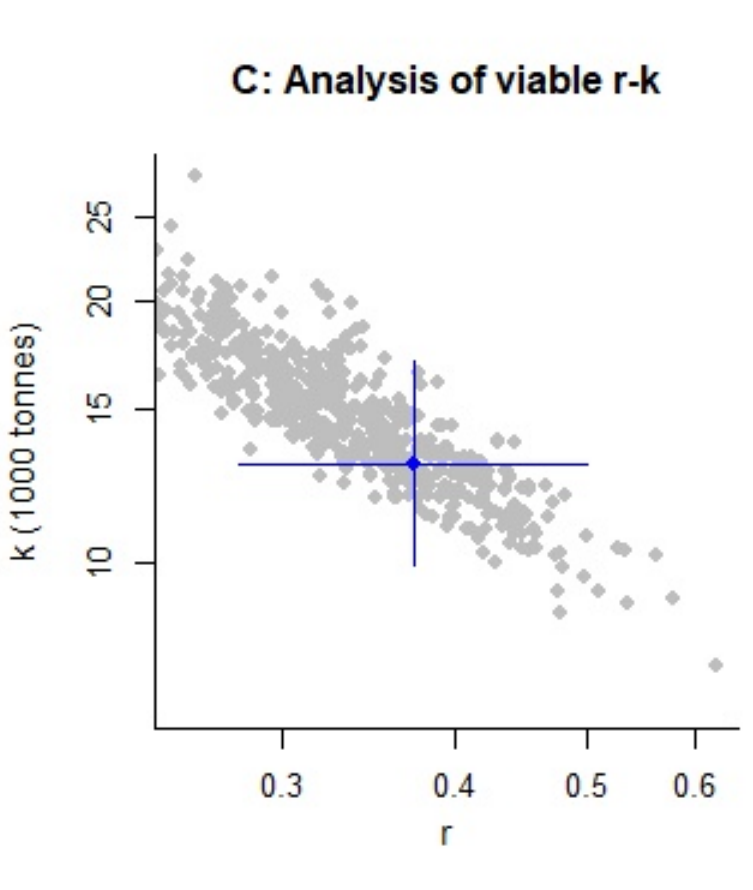
Exploitation

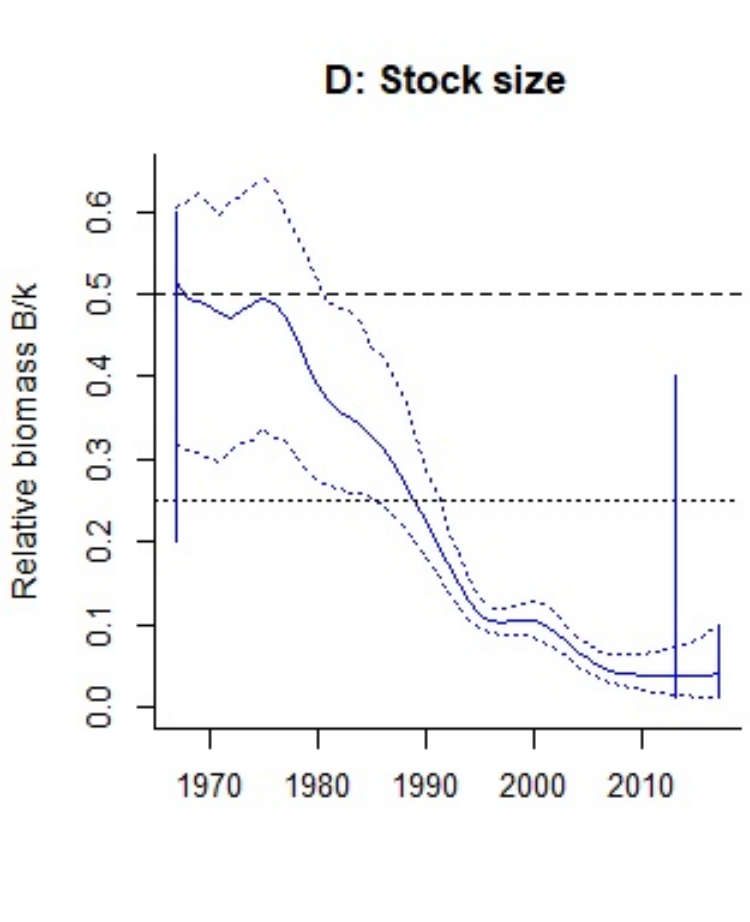


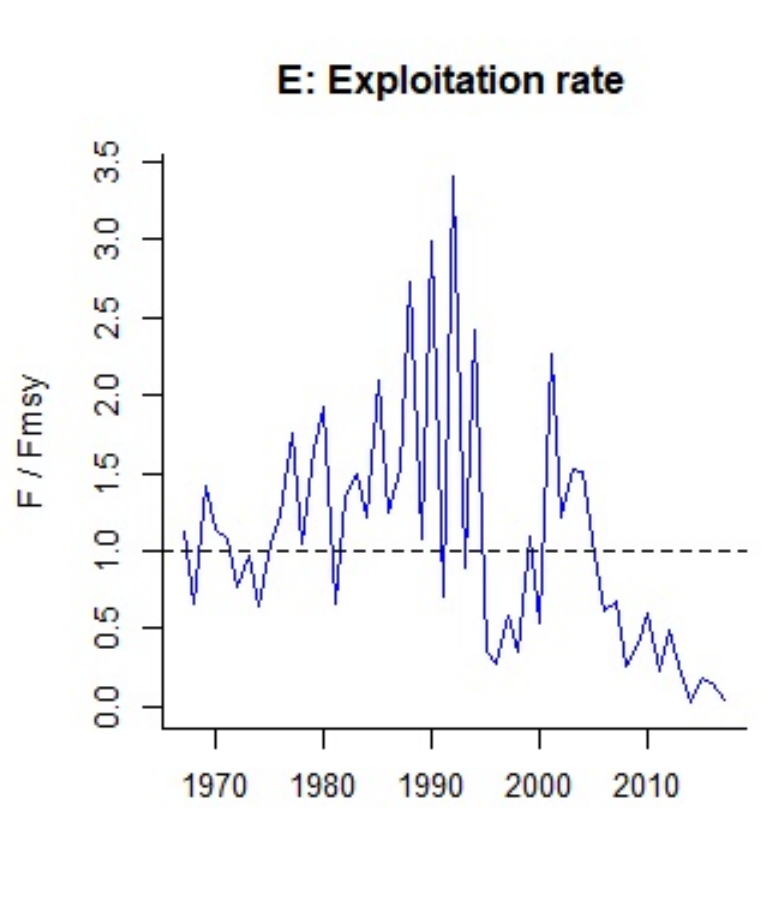


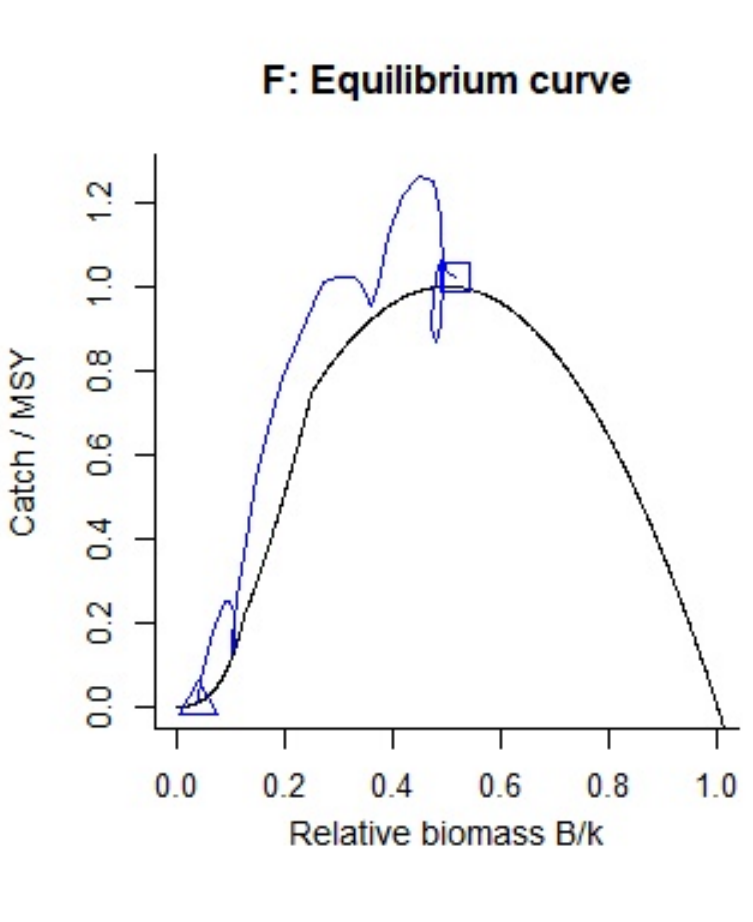

A: Catch Picarel_BS
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
25
35
0.4
0.6
0.8
1.0
r

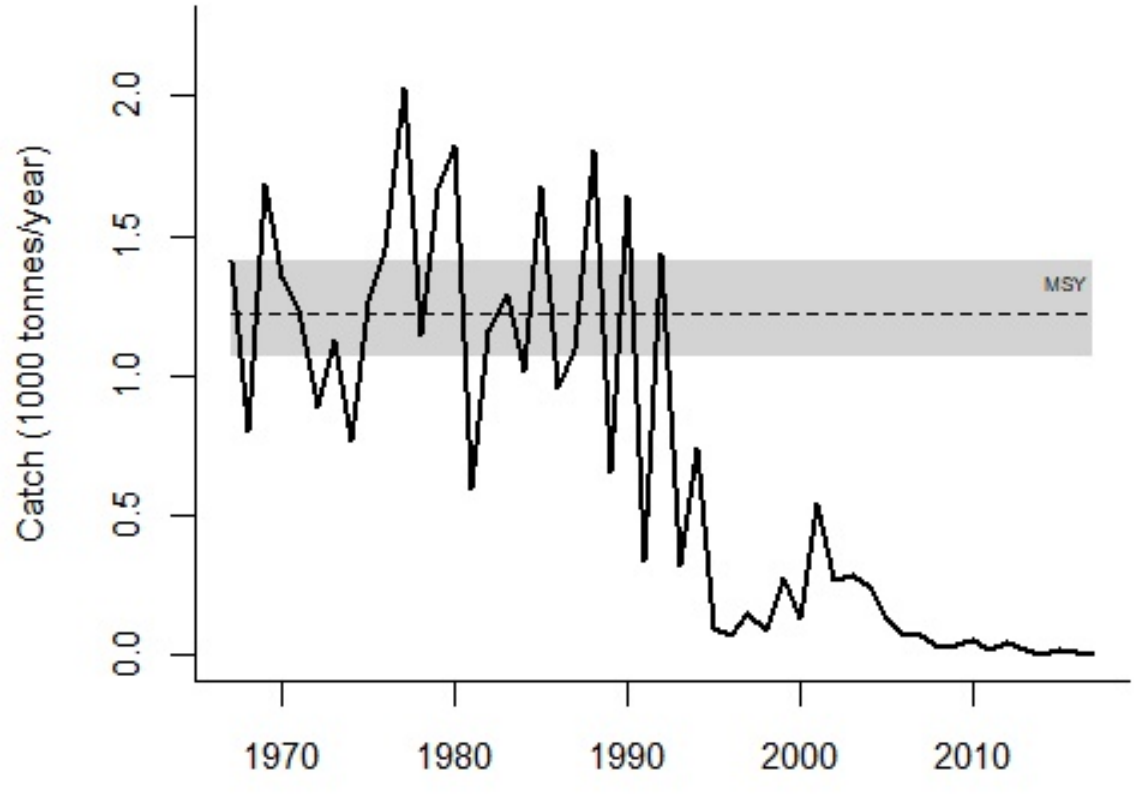

C: Analysis of viable r-k
k (1000 tonnes)
10
15
20
25
0.3
0.4
0.5
0.6
r


D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

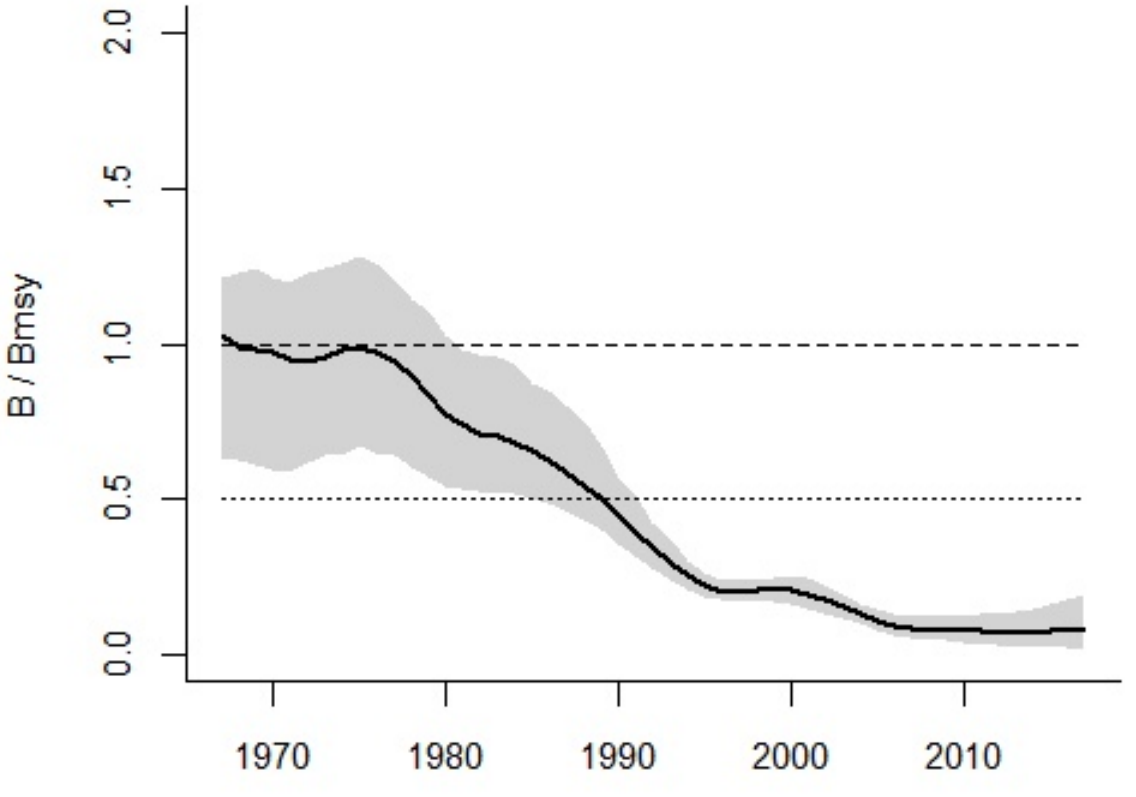

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

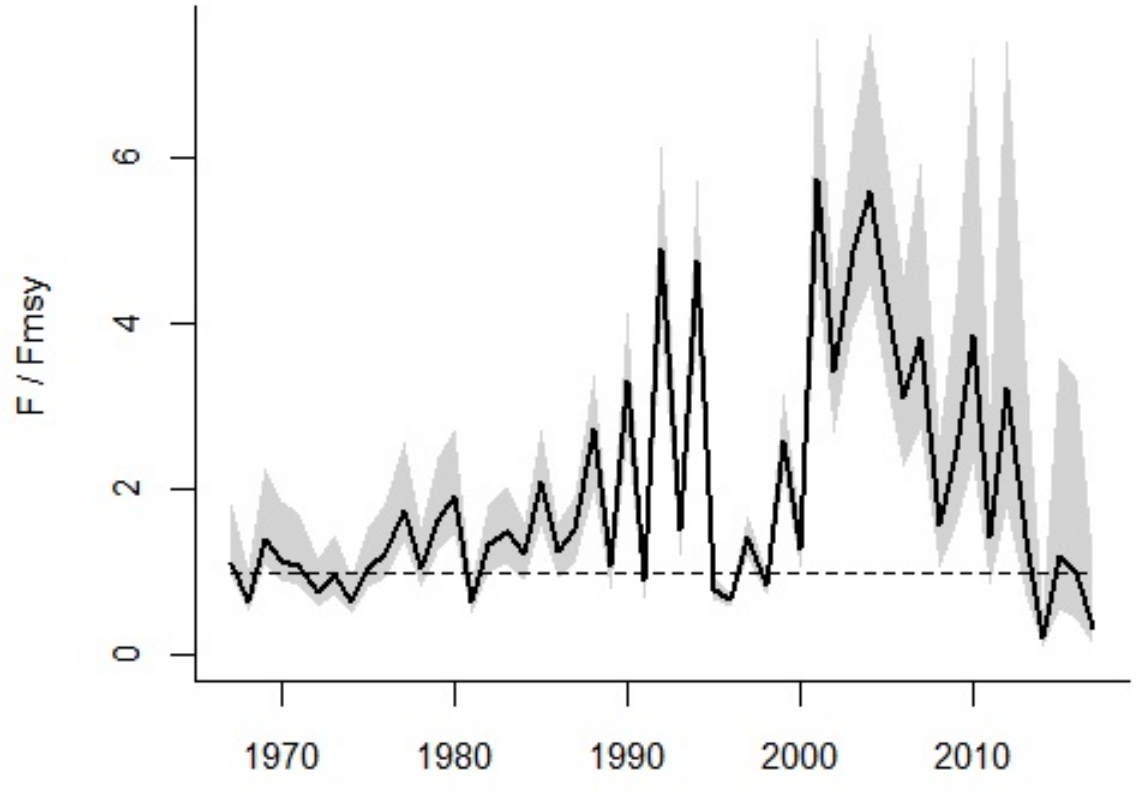
Catch

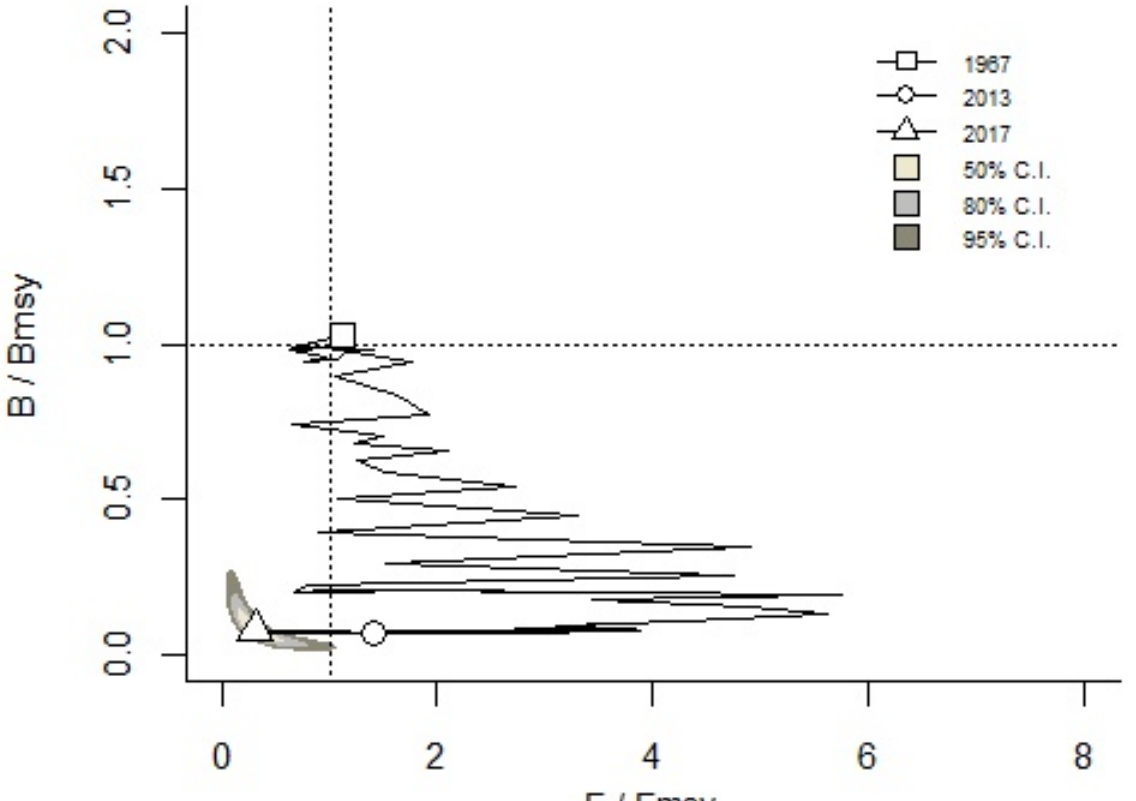


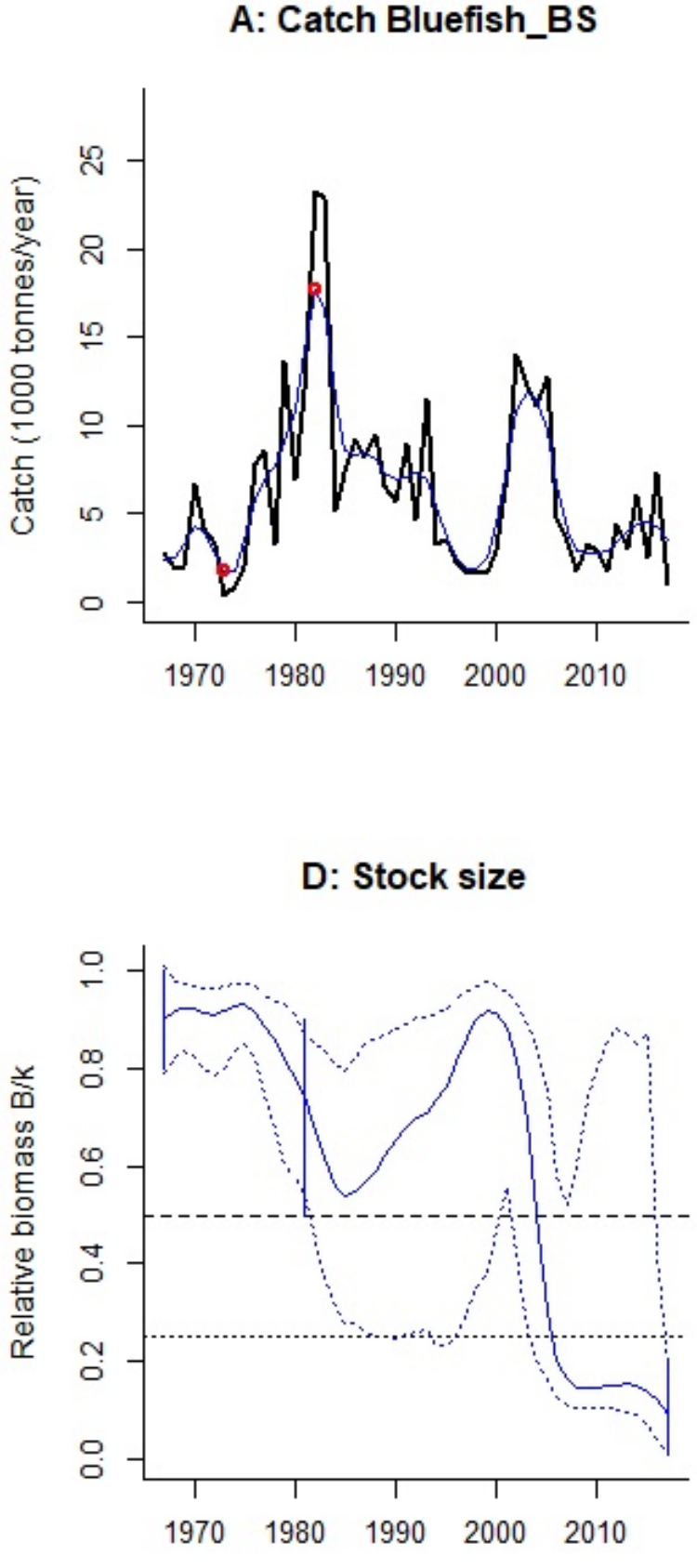
Stock size

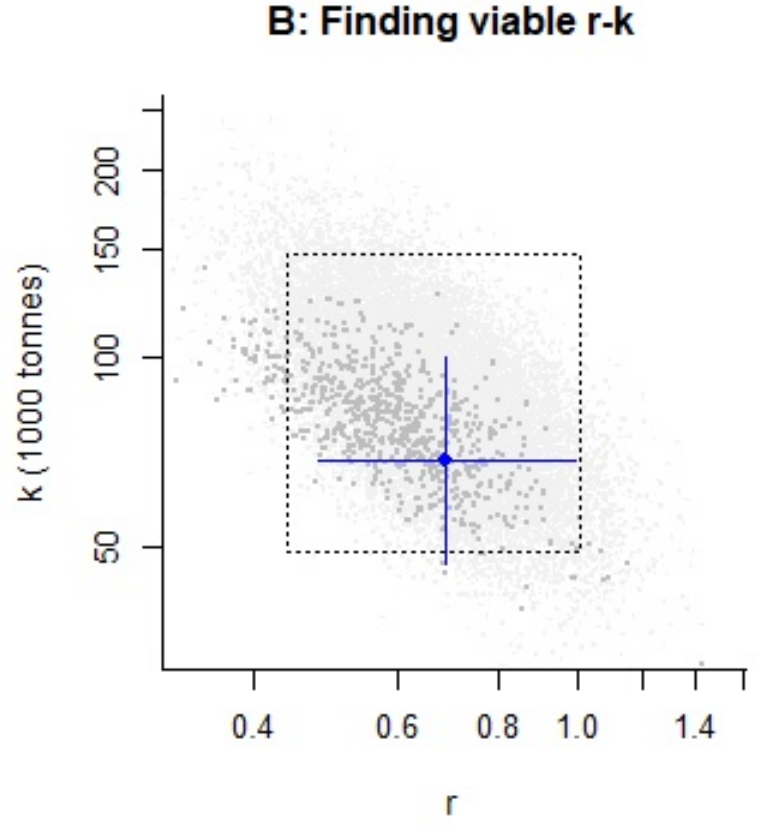


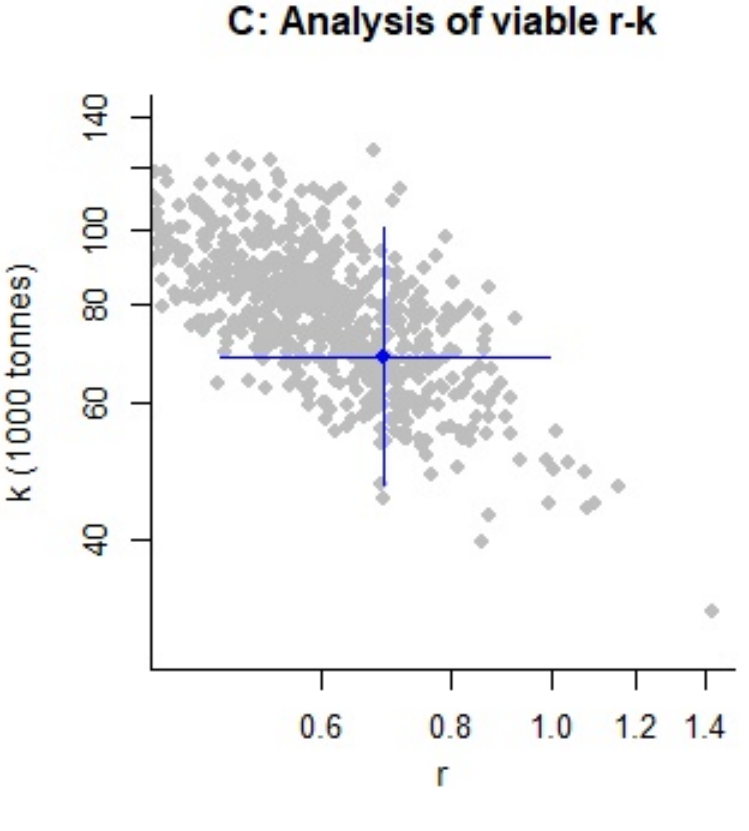
Exploitation



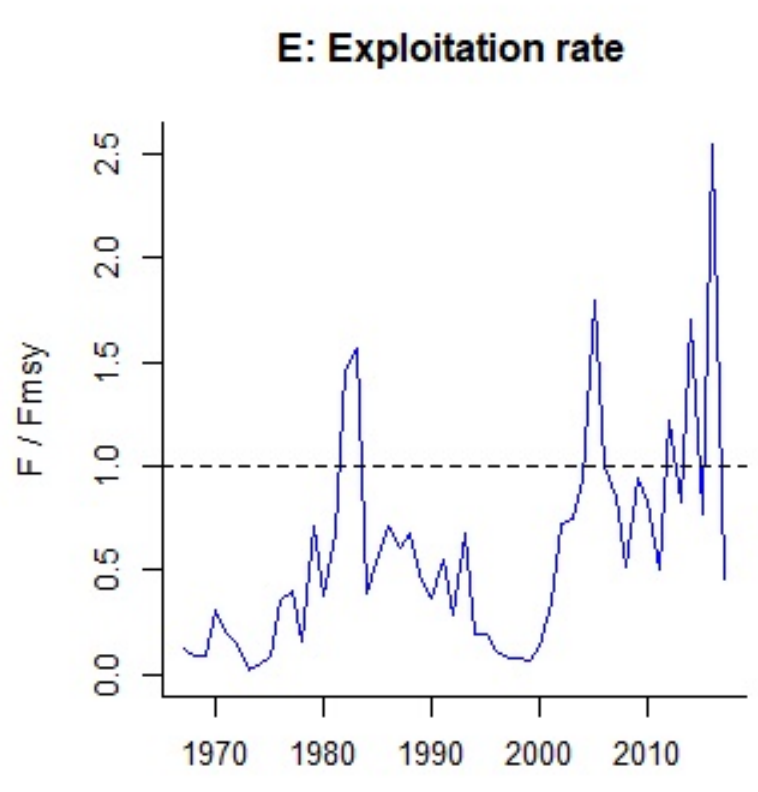


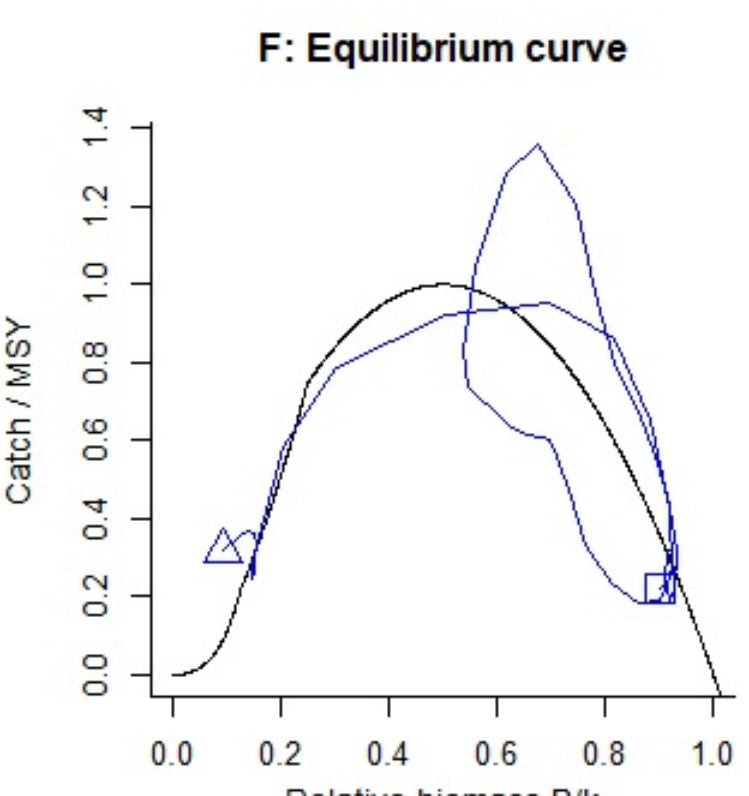

A: Catch Bluefish_BS
Catch (1000 tonnes/year)
0
5
10
15
20
25
1970
1980
1990
2000
2010

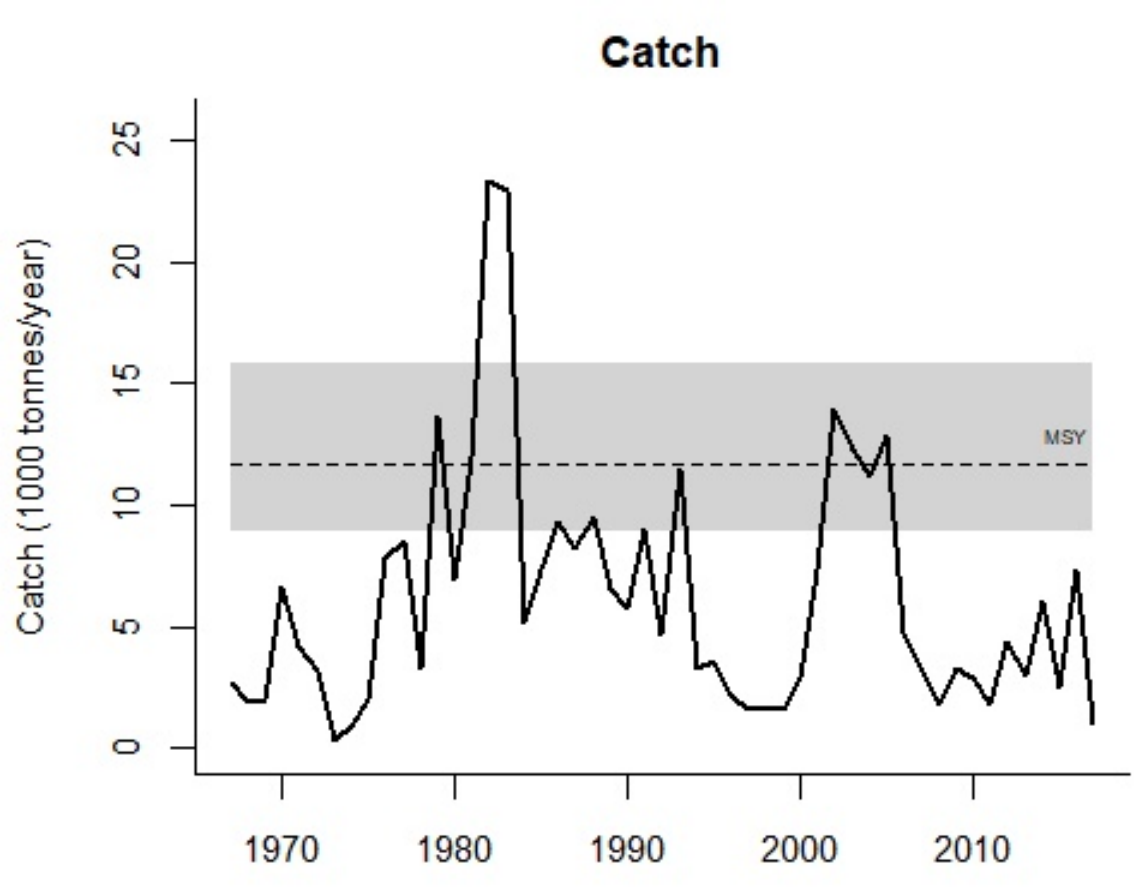

B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
0.4
0.6
0.8
1.0
1.4
r

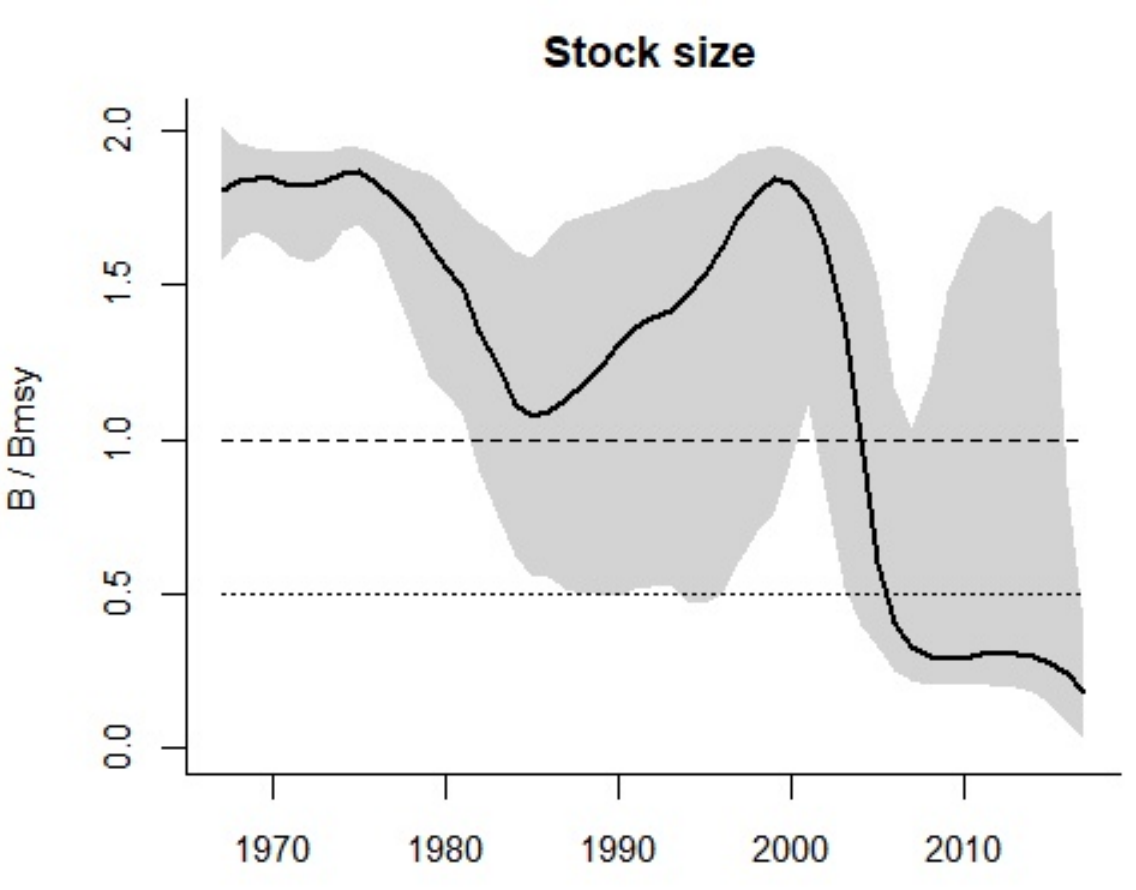

C: Analysis of viable r-k
k (1000 tonnes)
40
60
80
100
140
0.6
0.8
1.0
1.2
1.4
r

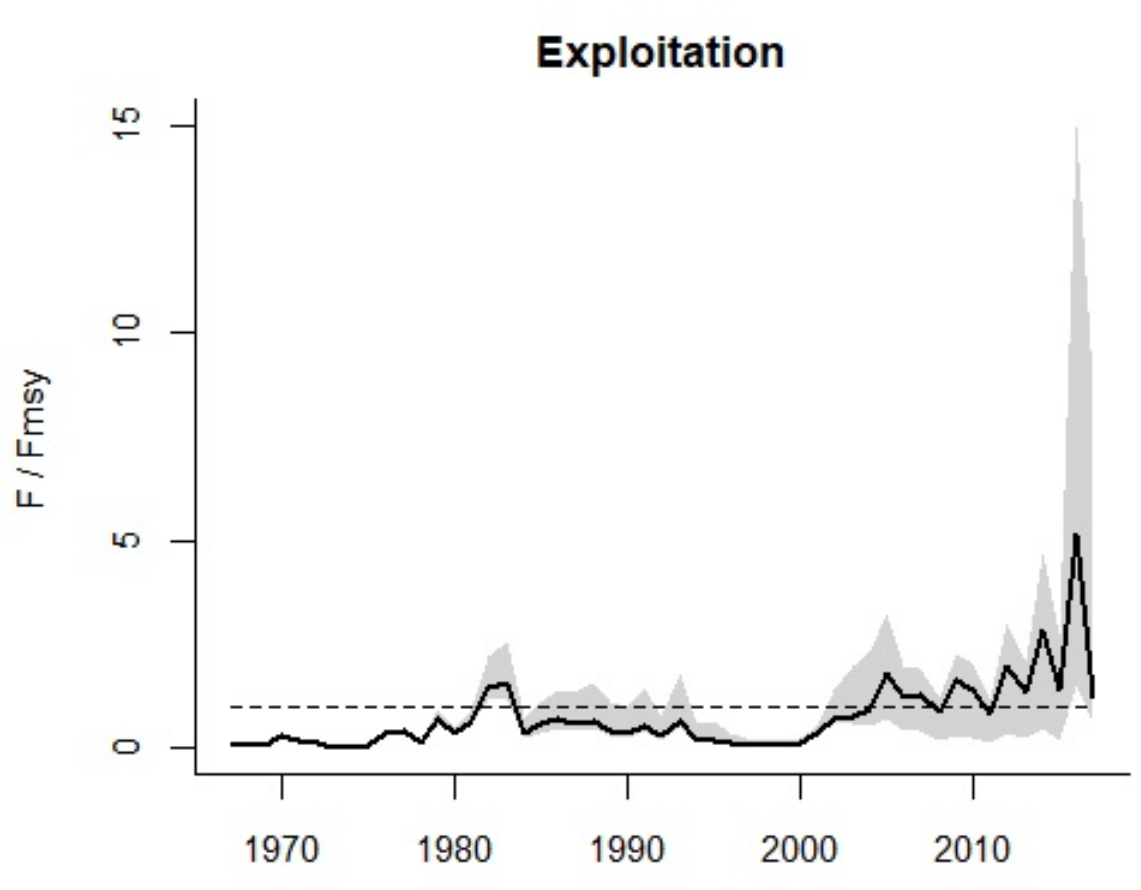
D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

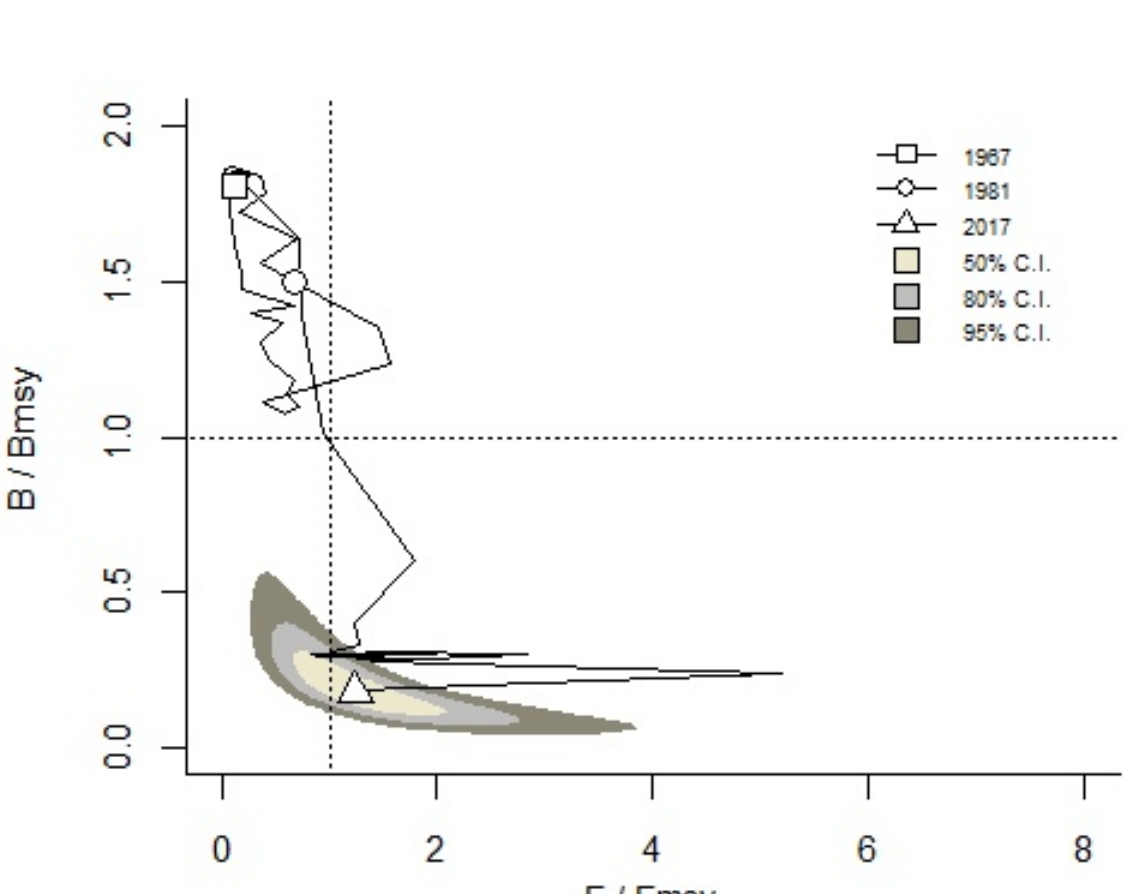

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

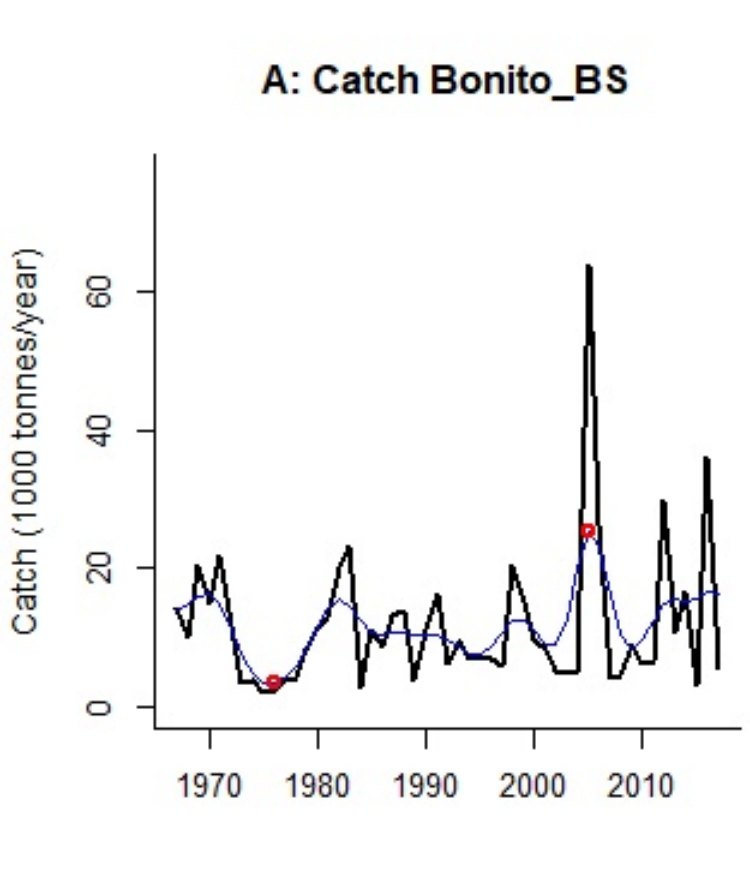

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

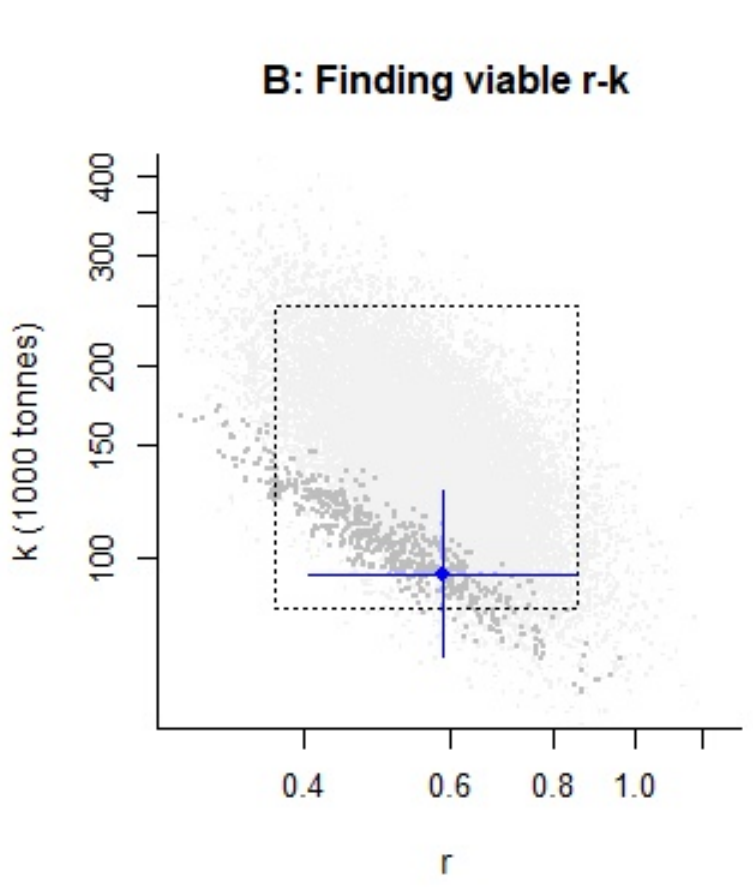

Catch
Catch (1000 tonnes/year)
0
5
10
15
20
25
MSY
1970
1980
1990
2000
2010

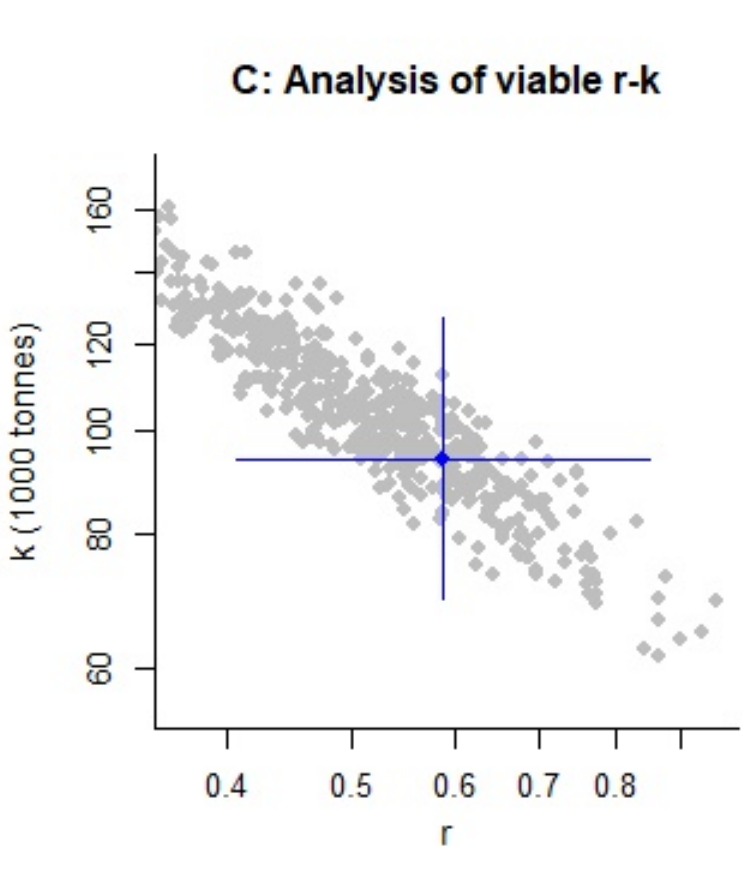

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

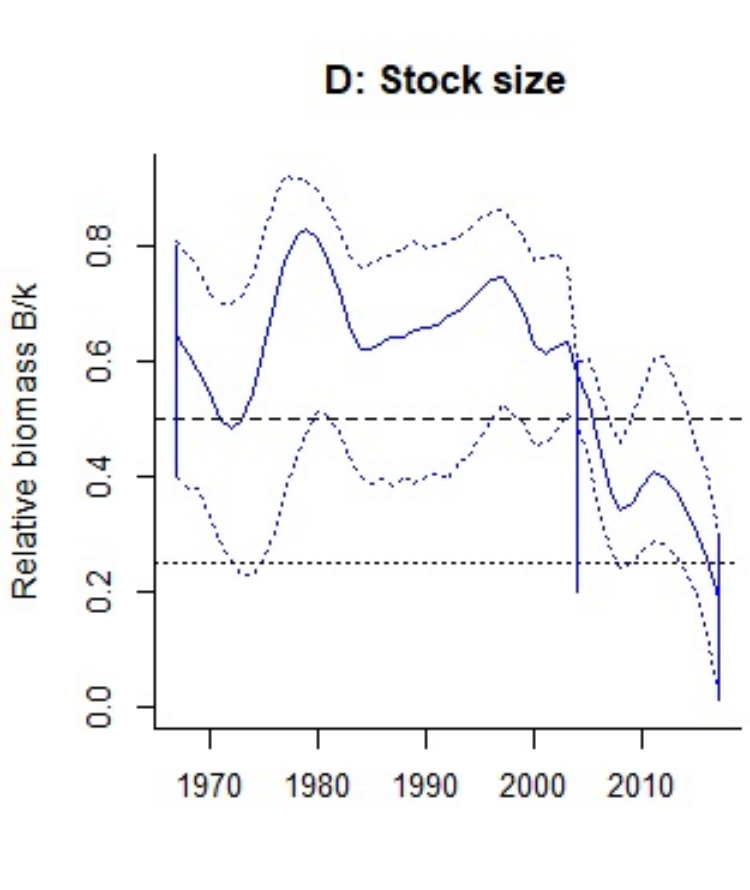

Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

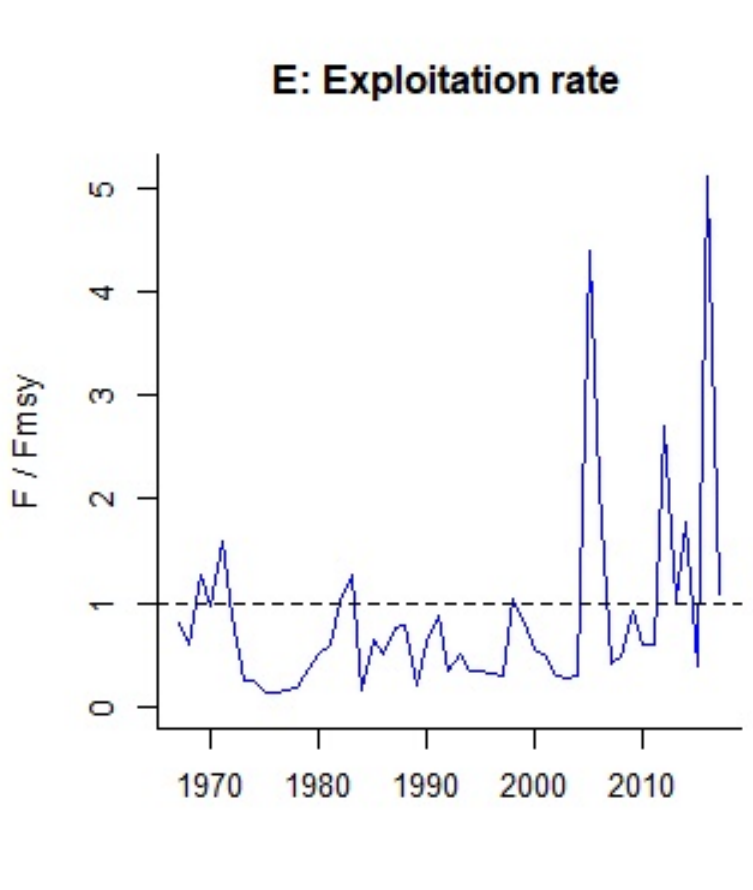

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1981
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

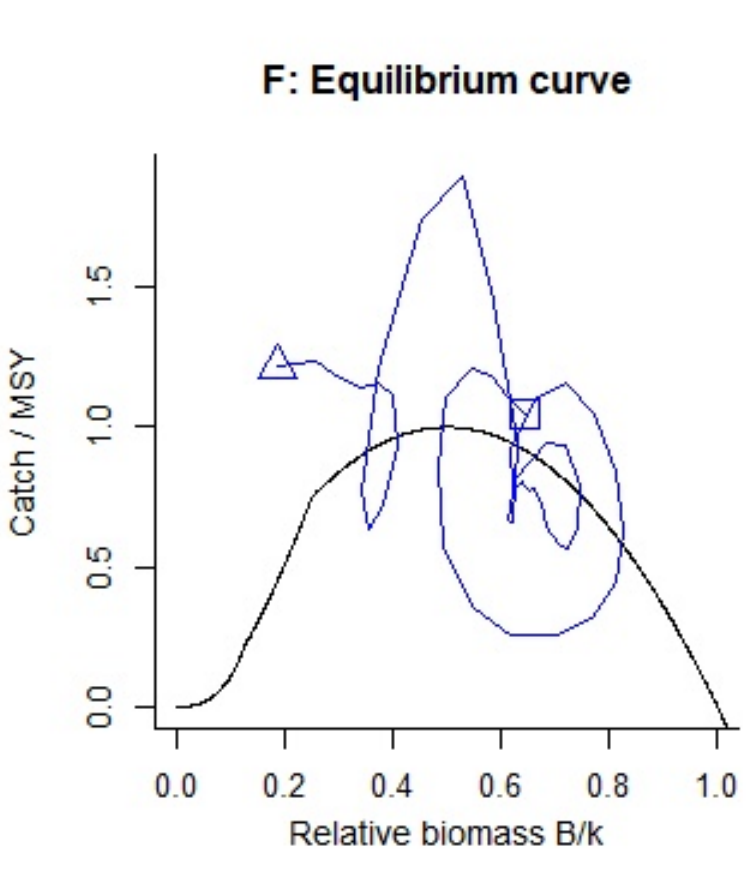

A: Catch Bonito_BS
Catch (1000 tonnes/year)
0
20
40
60
1970
1980
1990
2000
2010

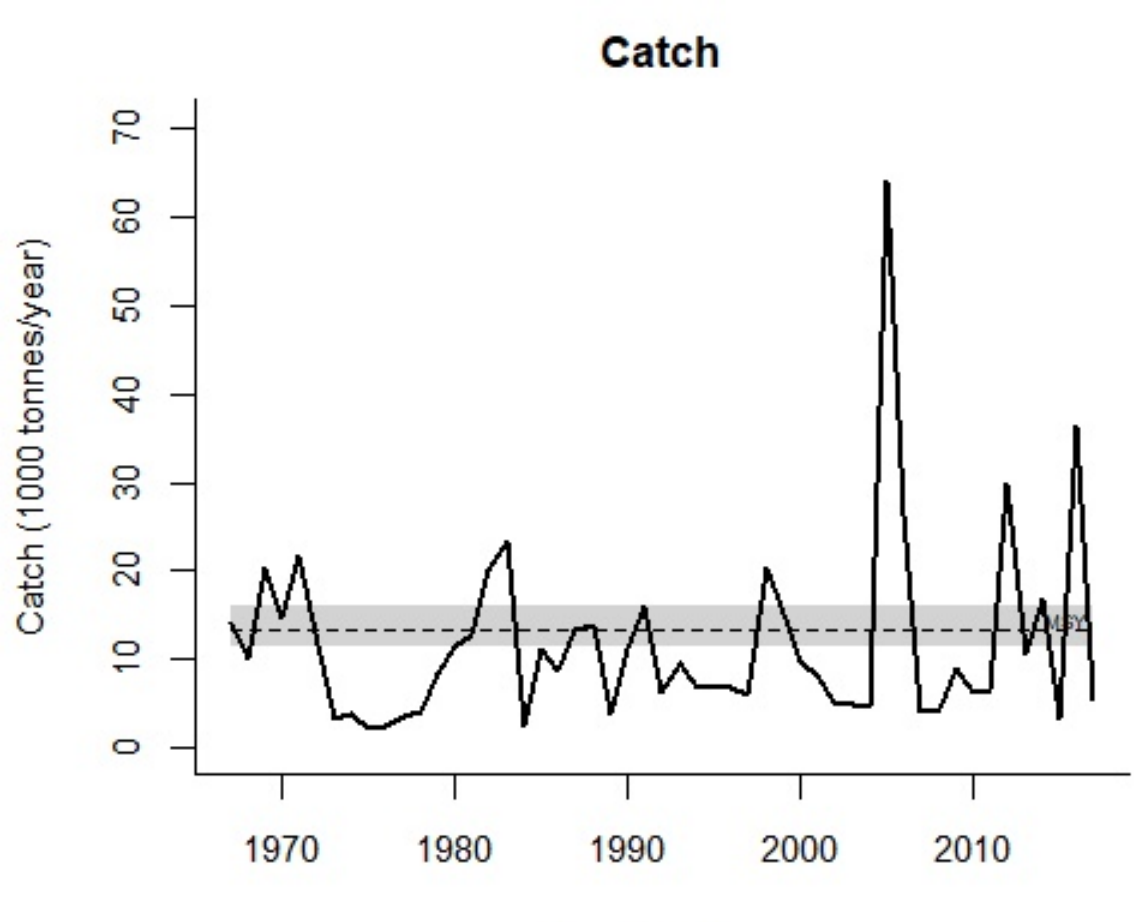

B: Finding viable r-k
k (1000 tonnes)
100
150
200
300
400
0.4
0.6
0.8
1.0
r

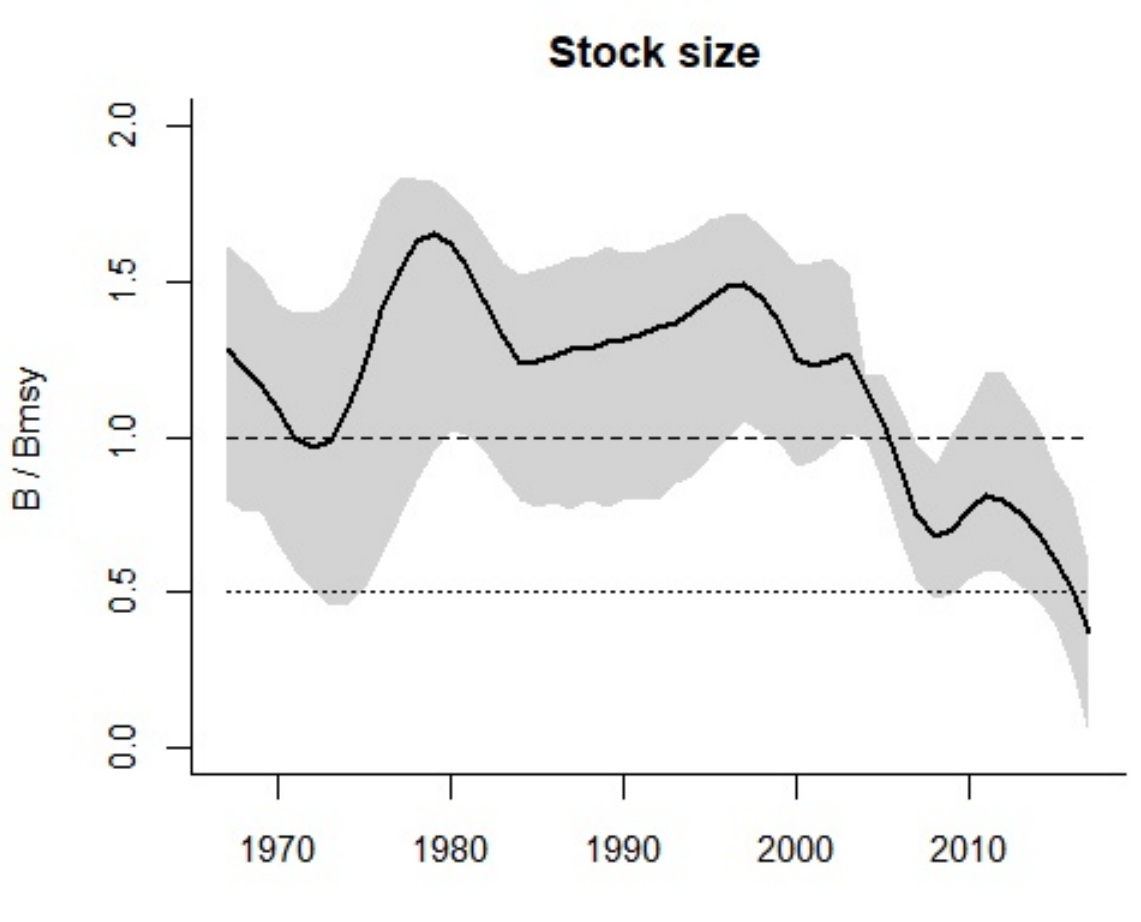

C: Analysis of viable r-k
k (1000 tonnes)
60
80
100
120
160
0.4
0.5
0.6
0.7
0.8
r

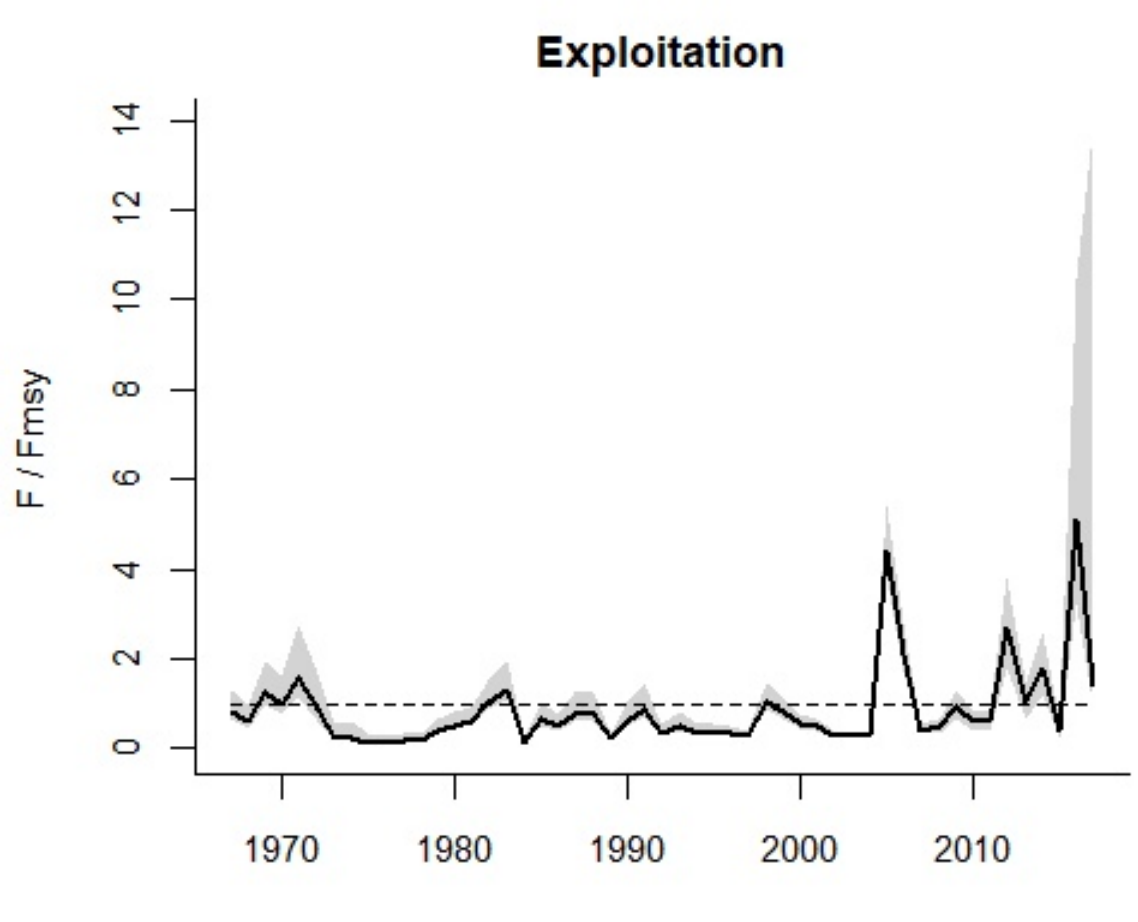

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

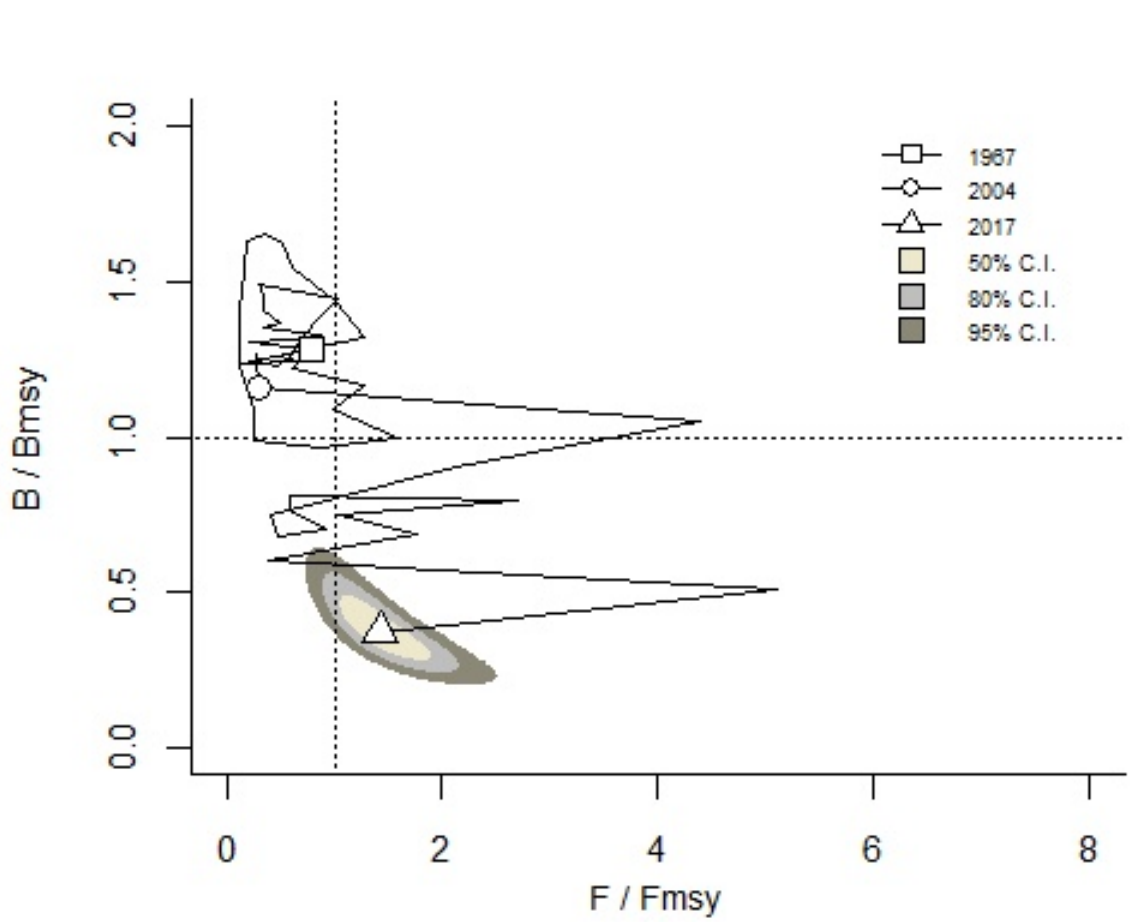

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010

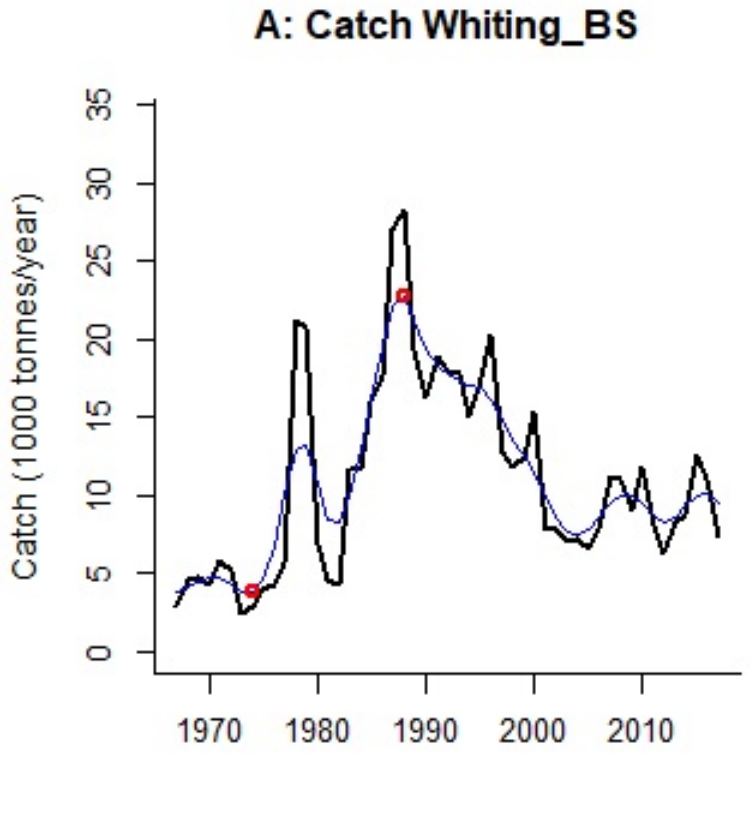

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

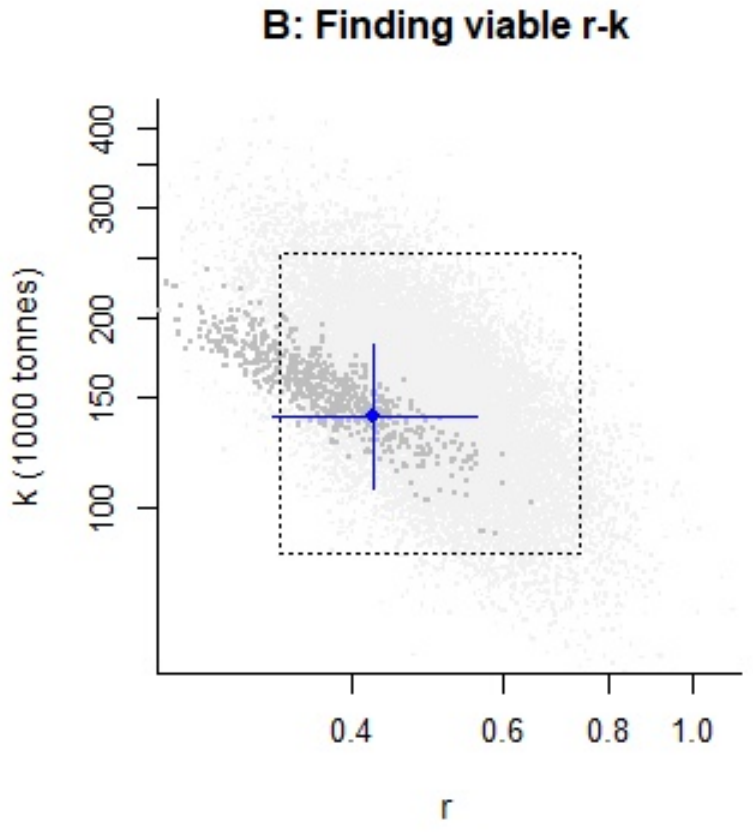

Catch
Catch (1000 tonnes/year)
0
10
20
30
40
50
60
70
MSY
1970
1980
1990
2000
2010

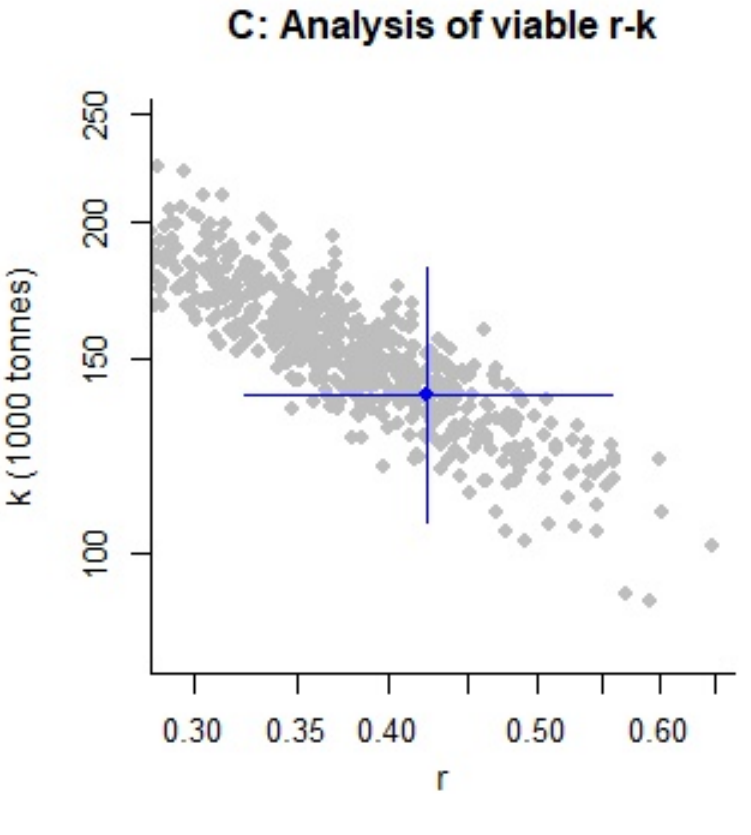

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

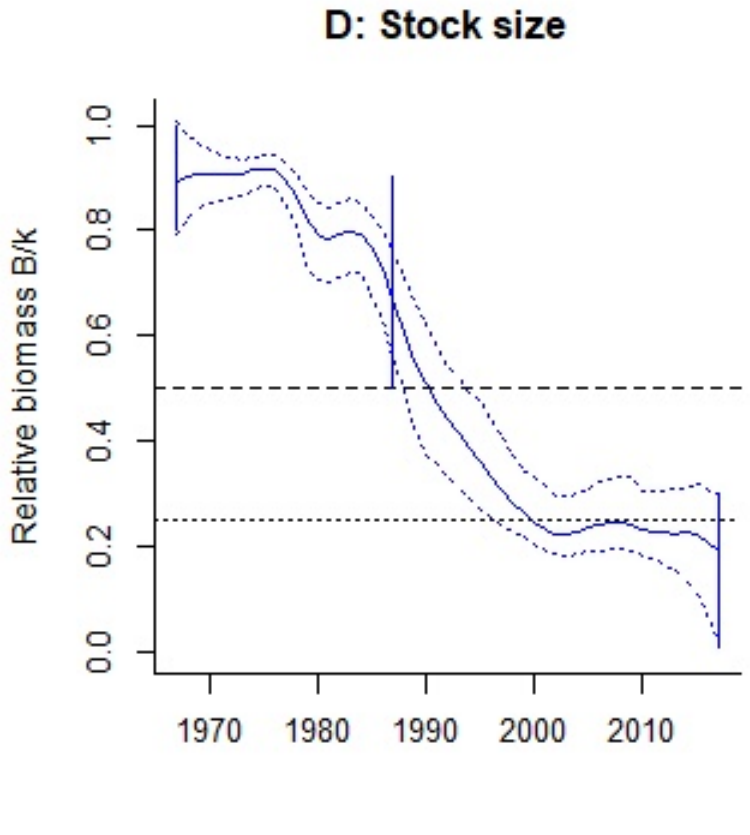

Exploitation
F / Fmsy
0
2
4
6
8
10
12
14
1970
1980
1990
2000
2010

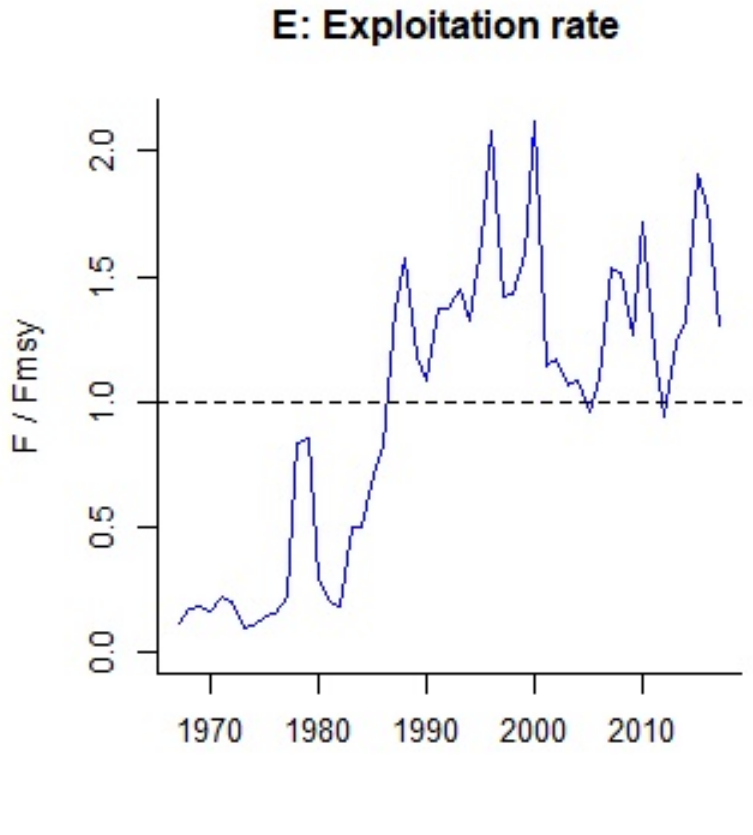

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2004
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

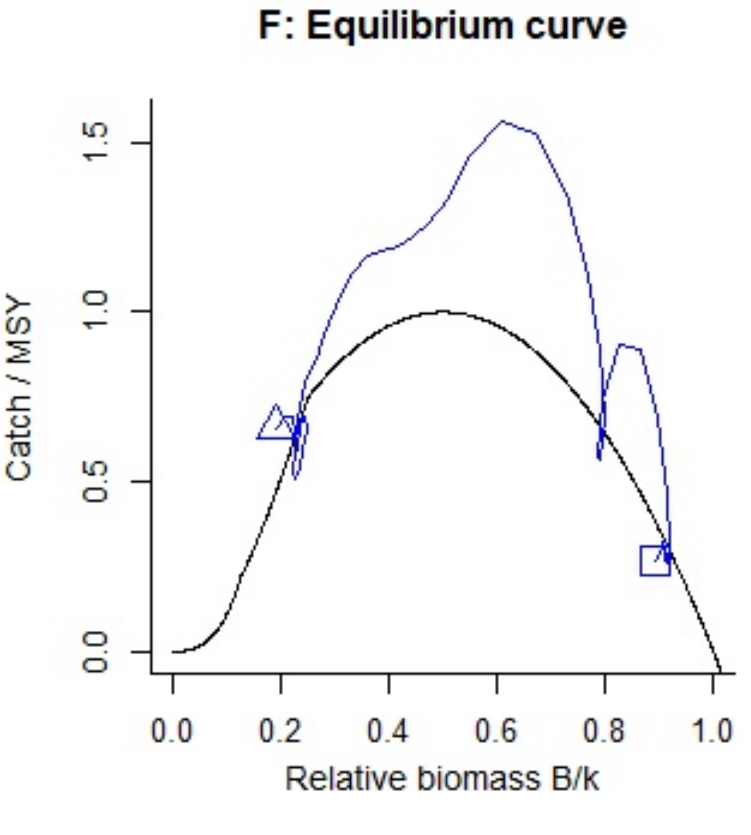

A: Catch Whiting_BS
Catch (1000 tonnes/year)
0
5
10
15
20
25
30
35
1970
1980
1990
2000
2010

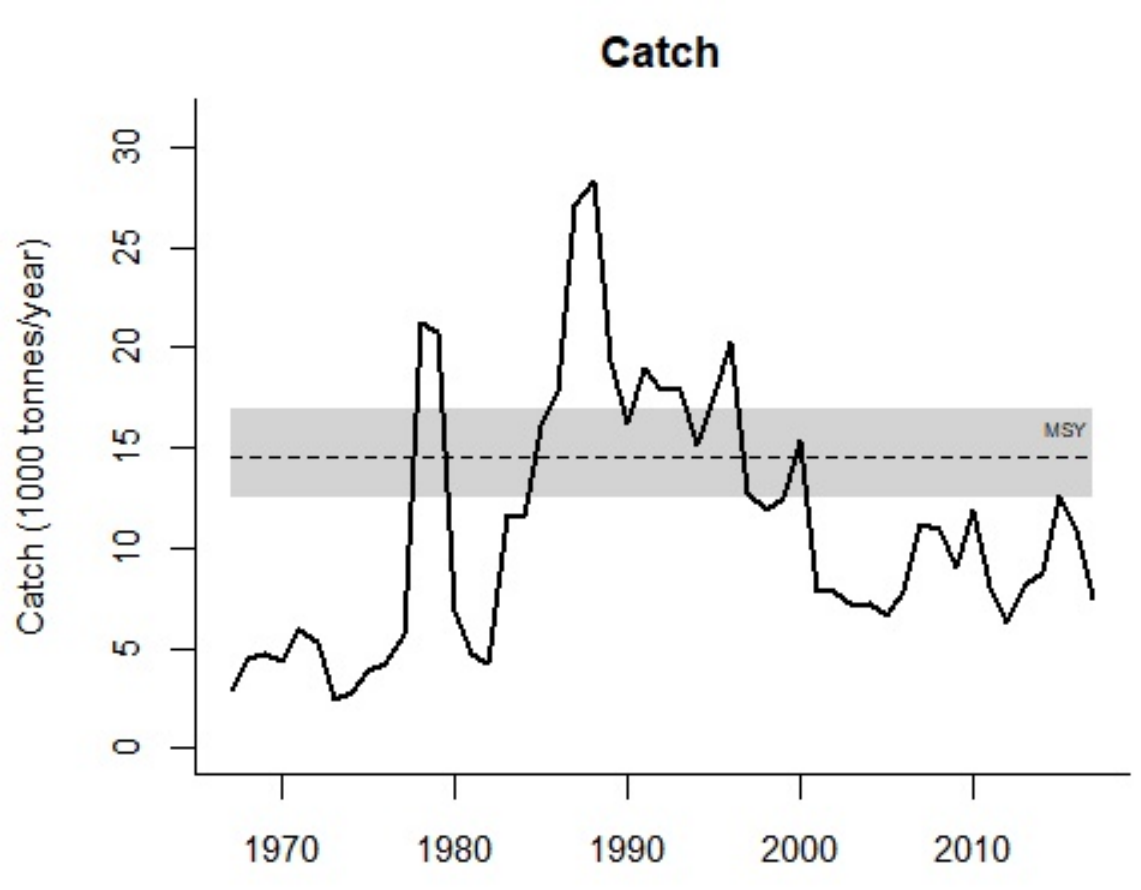

B: Finding viable r-k
k (1000 tonnes)
100
150
200
300
400
0.4
0.6
0.8
1.0
r

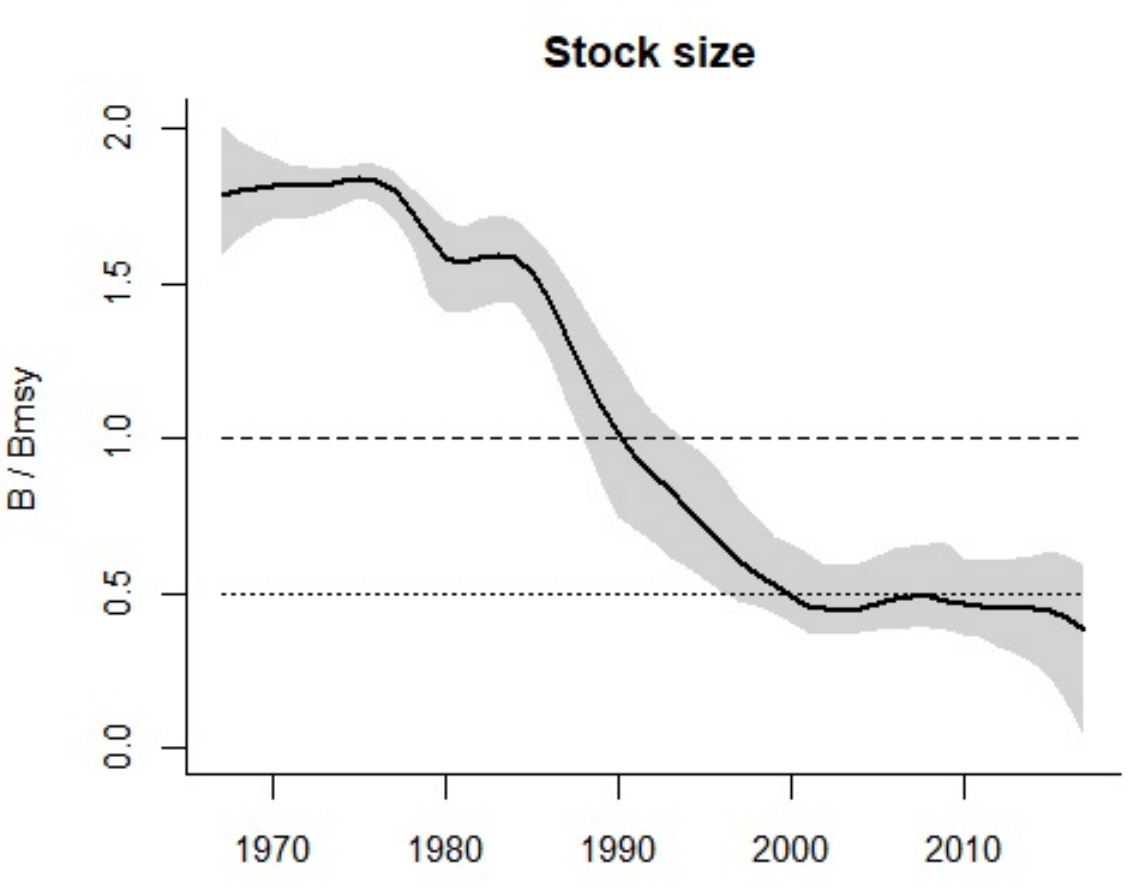

C: Analysis of viable r-k
k (1000 tonnes)
100
150
200
250
0.30
0.35
0.40
0.50
0.60
r

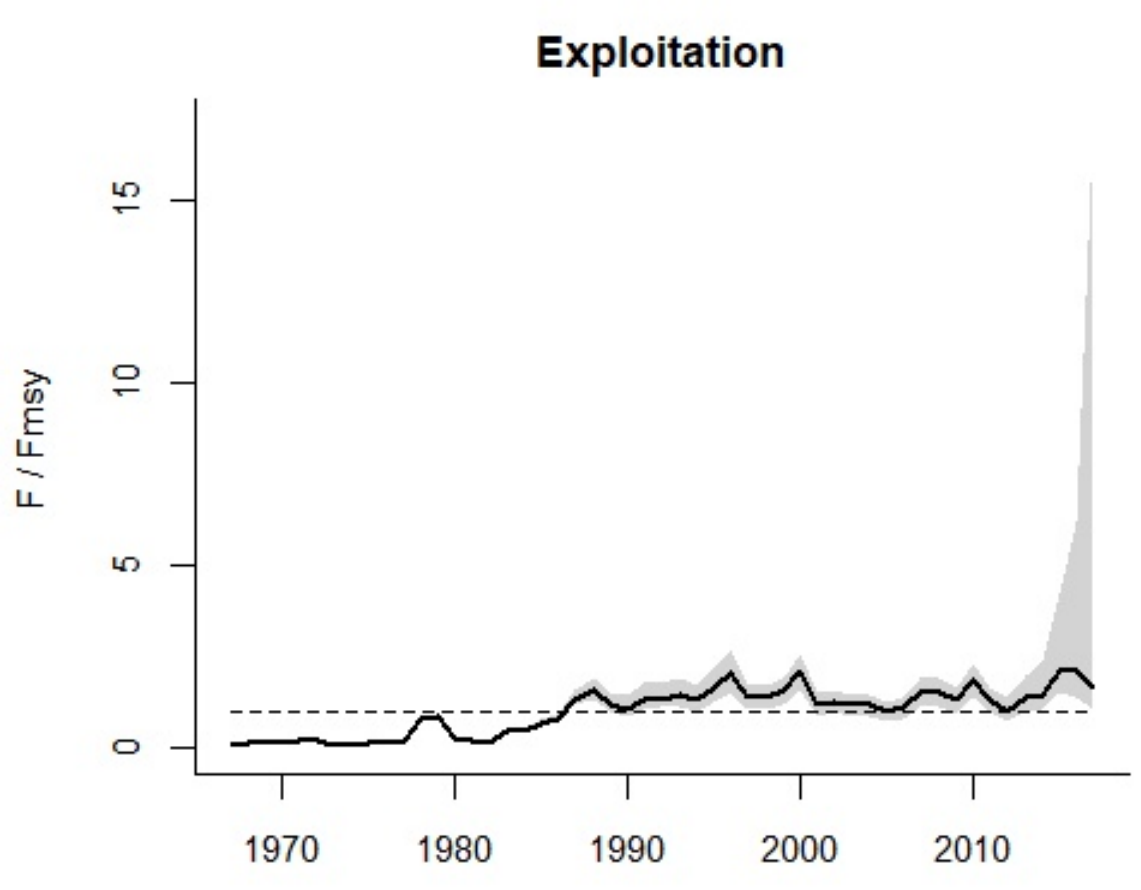

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

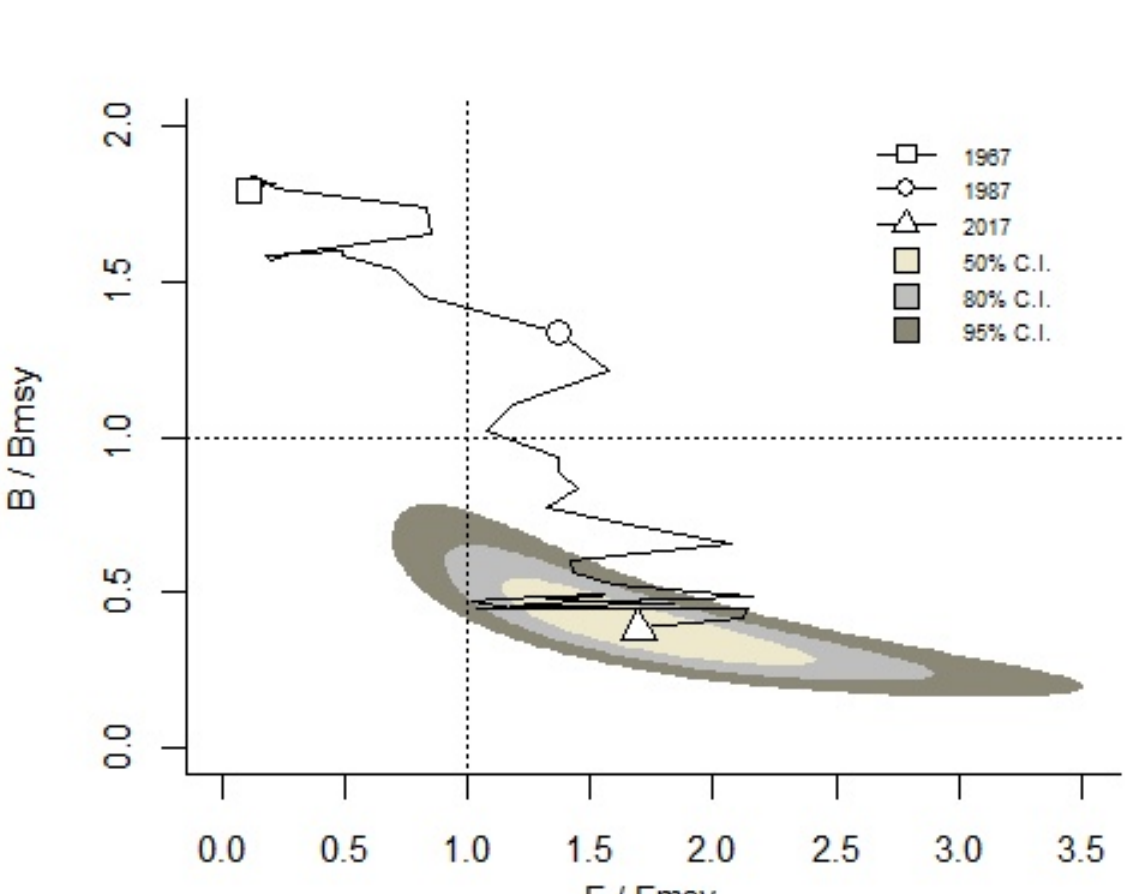

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

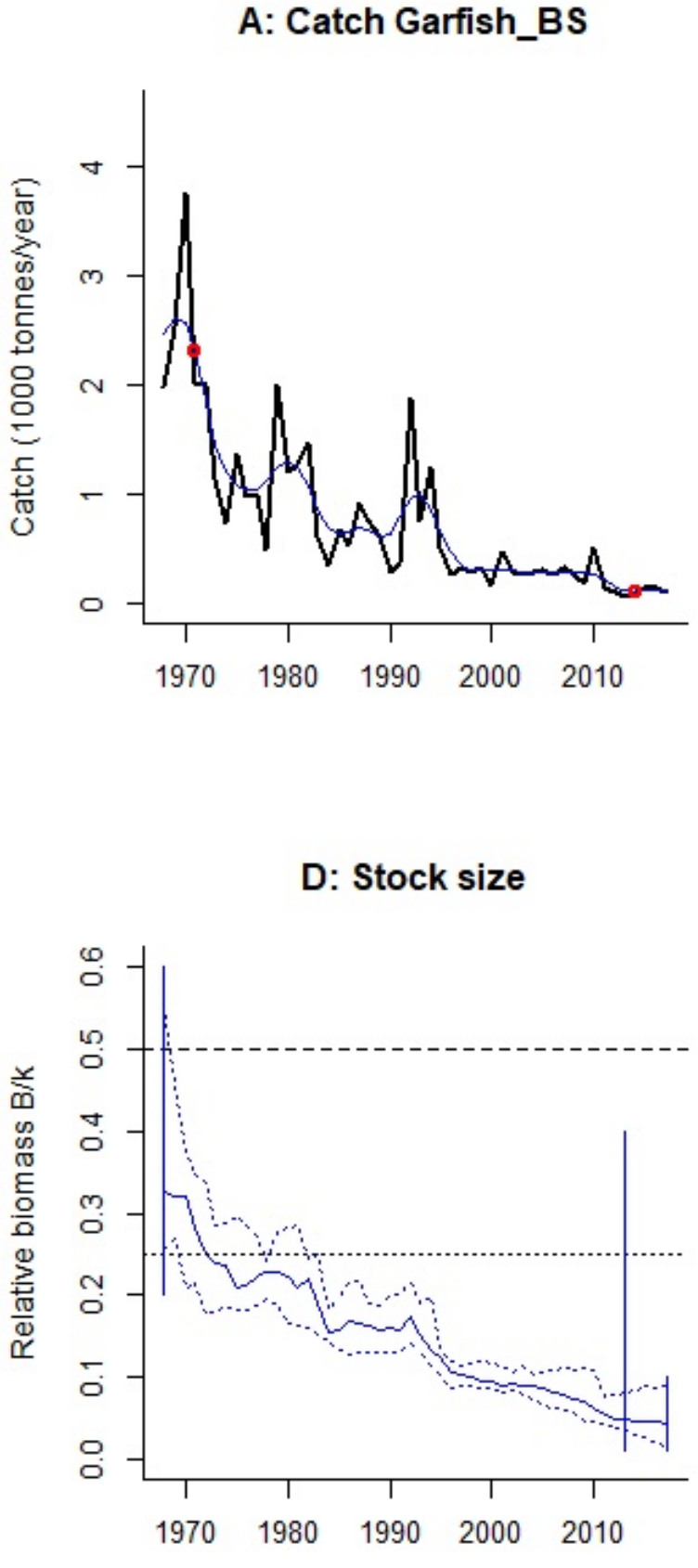

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

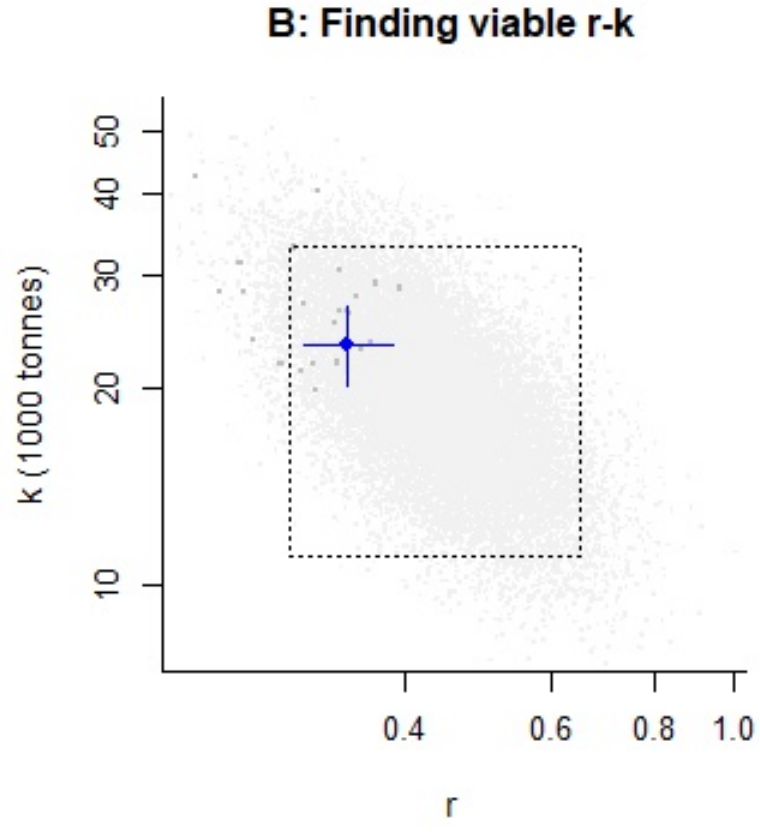

Catch
Catch (1000 tonnes/year)
0
5
10
15
20
25
30
MSY
1970
1980
1990
2000
2010

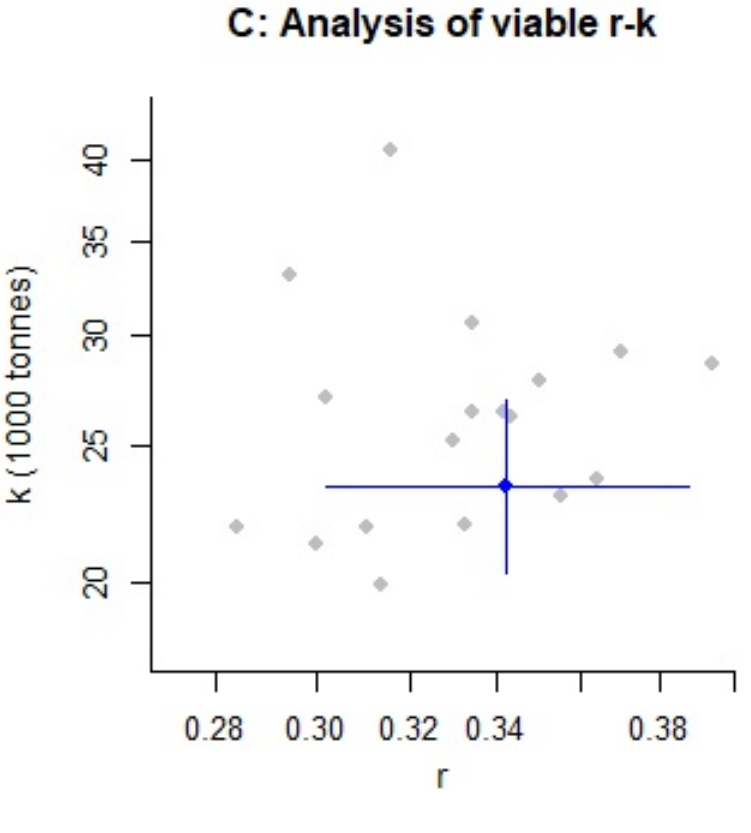

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

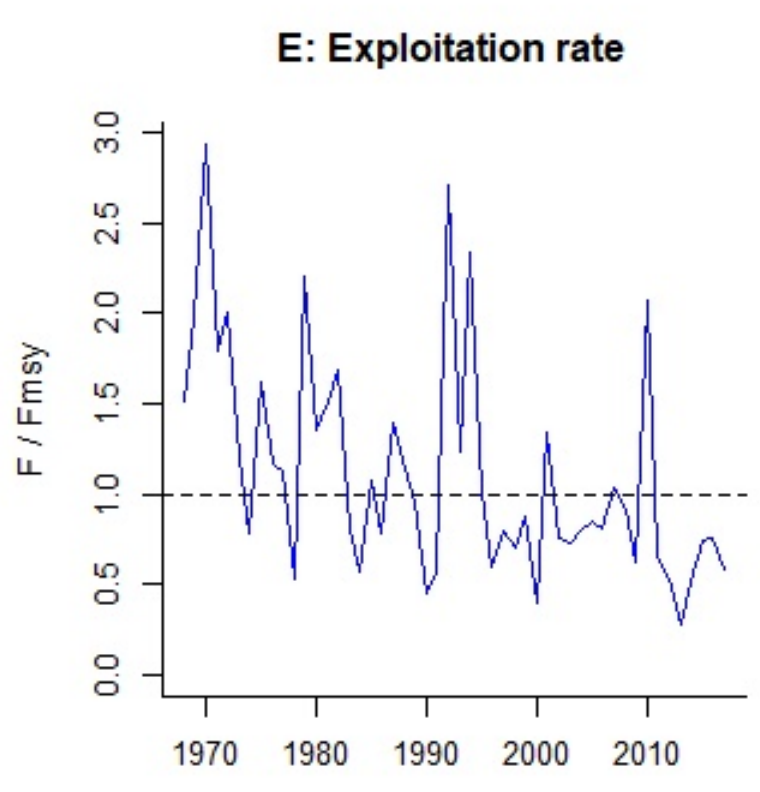

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1987
2017
50% C.I.
80% C.I.
95% C.I.
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
F / Fmsy

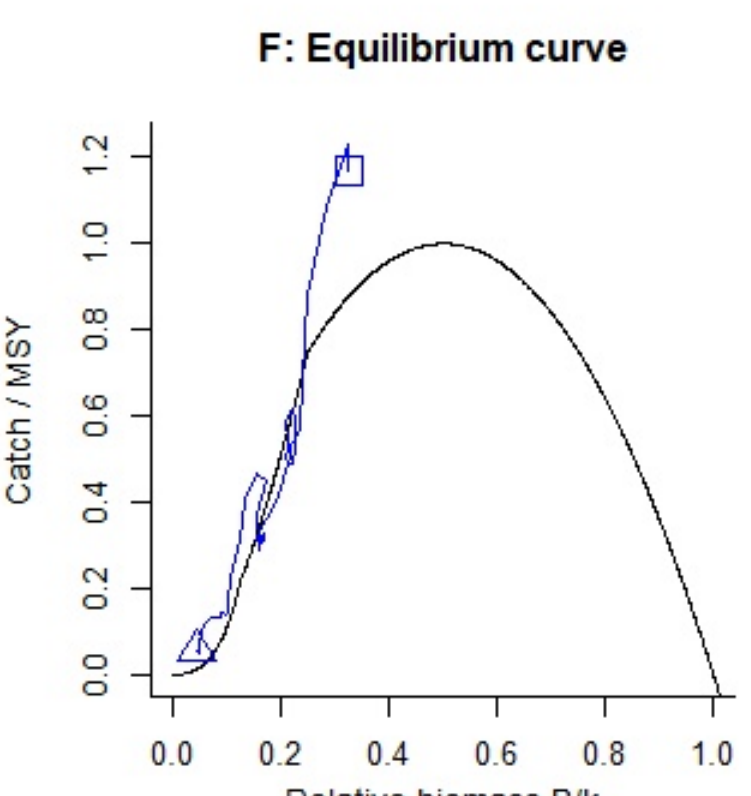

A: Catch Garfish_BS
Catch (1000 tonnes/year)
0
1
2
3
4
1970
1980
1990
2000
2010

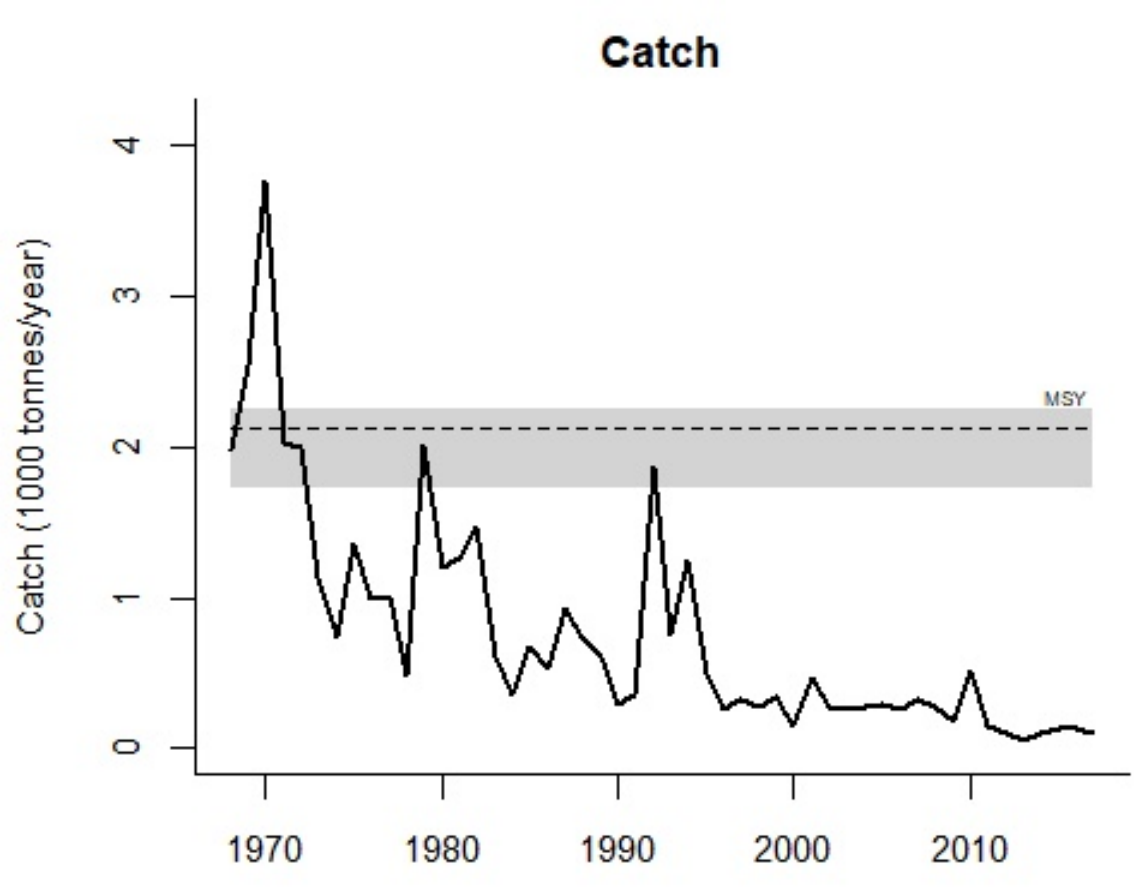

B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
0.4
0.6
0.8
1.0
r

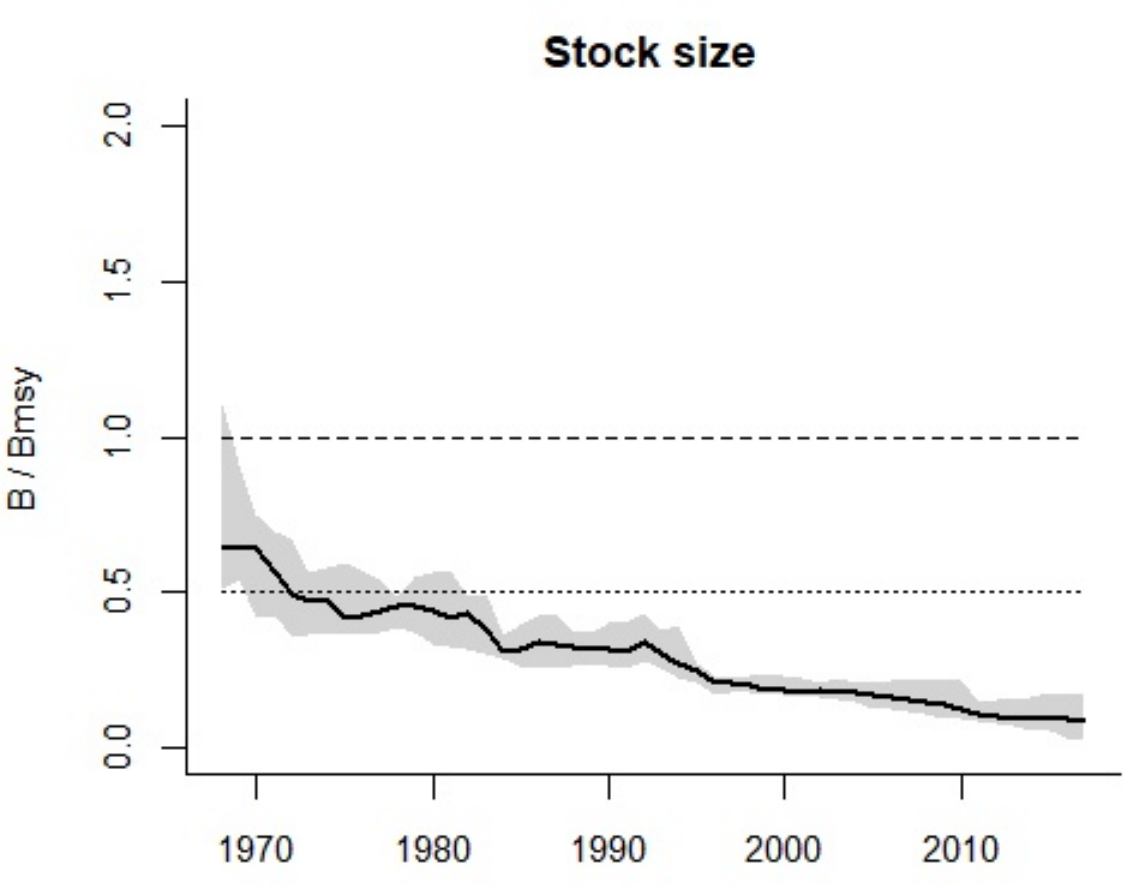

C: Analysis of viable r-k
k (1000 tonnes)
20
25
30
35
40
0.28
0.30
0.32
0.34
0.38
r

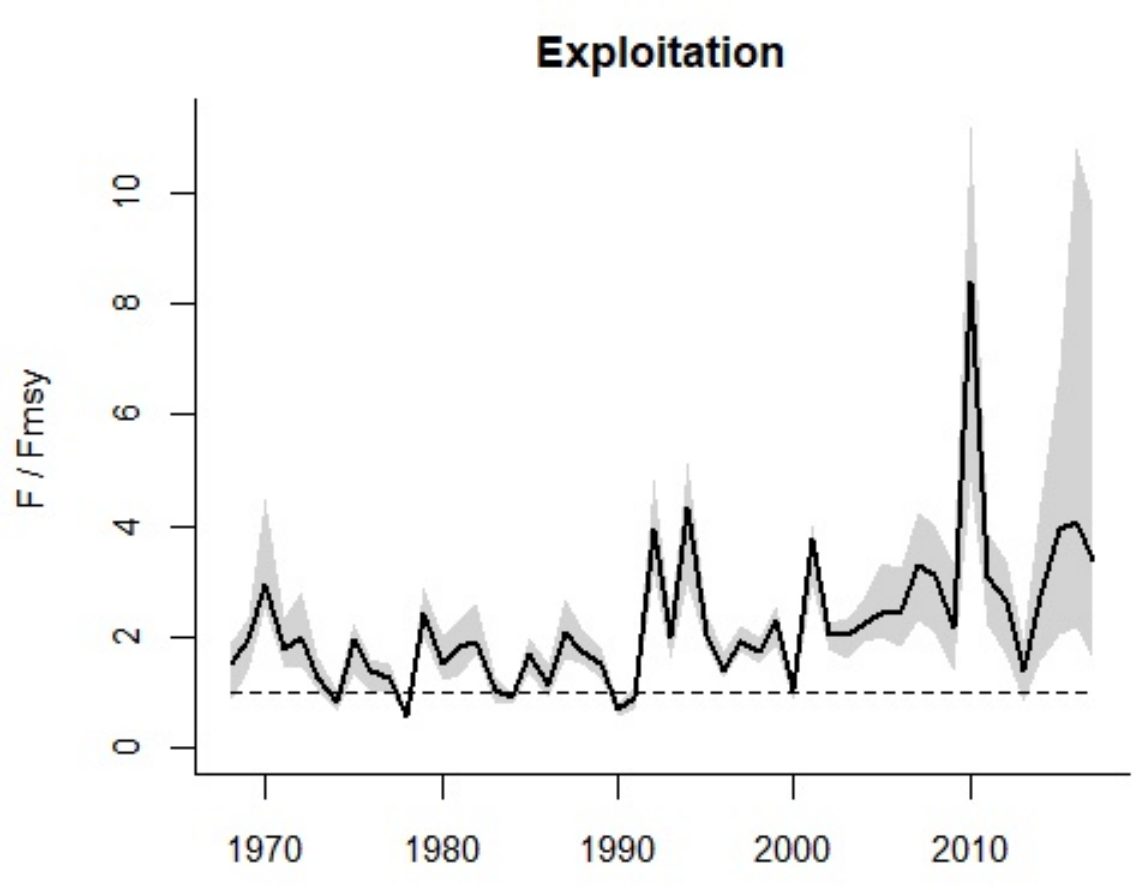
D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

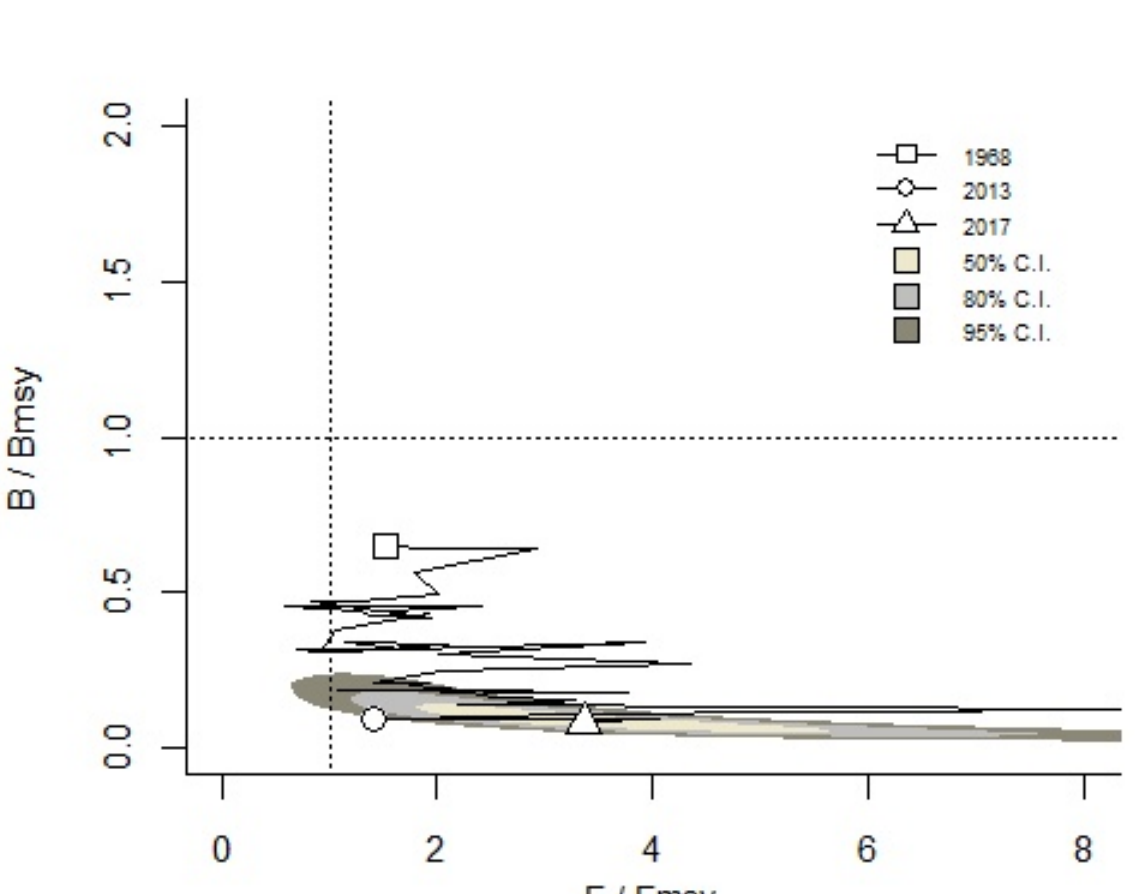

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010

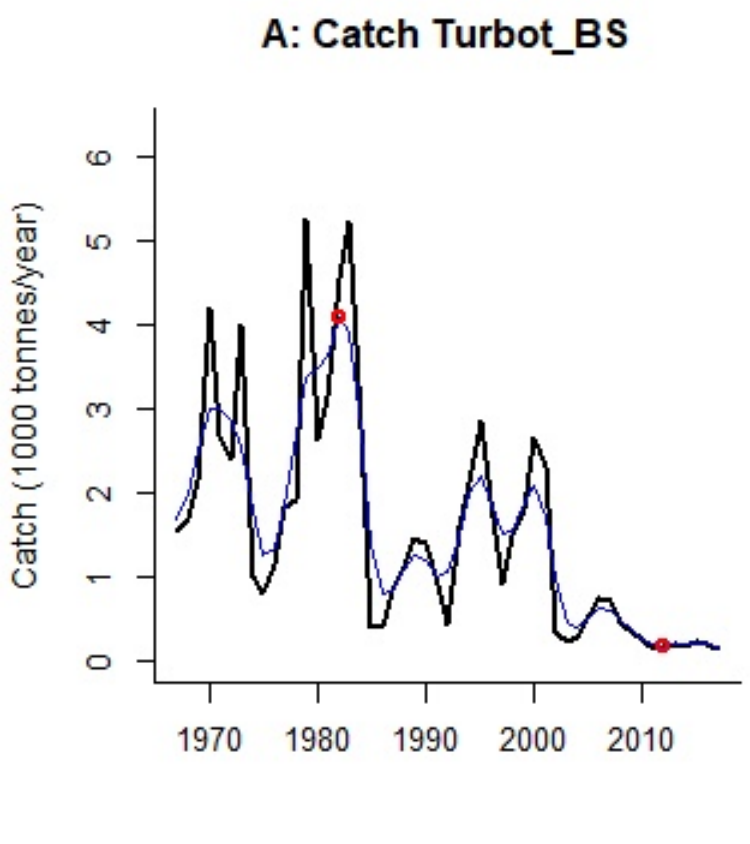

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

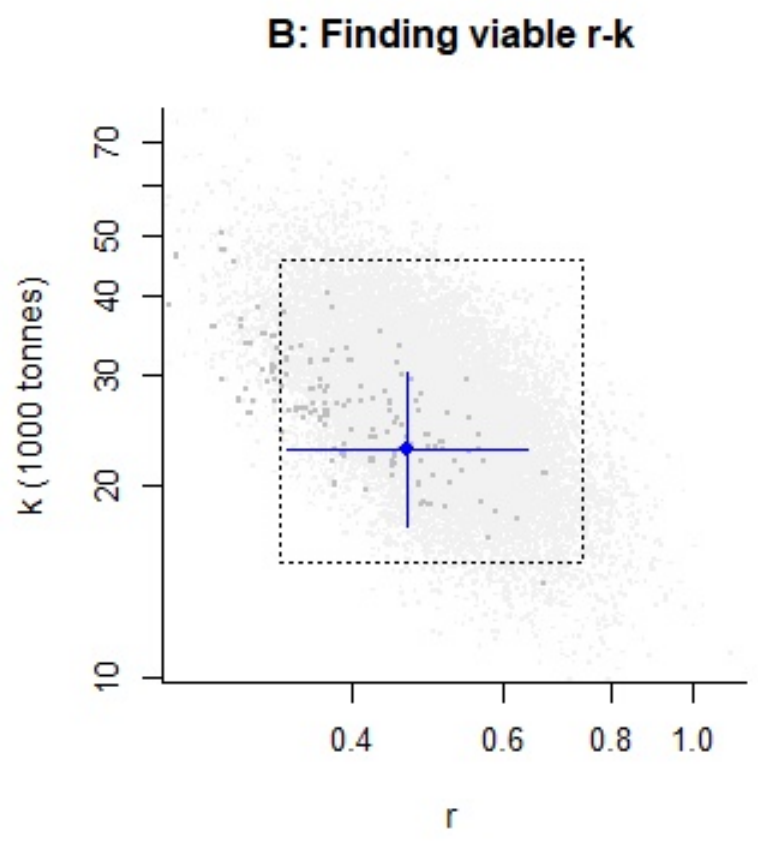

Catch
Catch (1000 tonnes/year)
0
1
2
3
4
MSY
1970
1980
1990
2000
2010

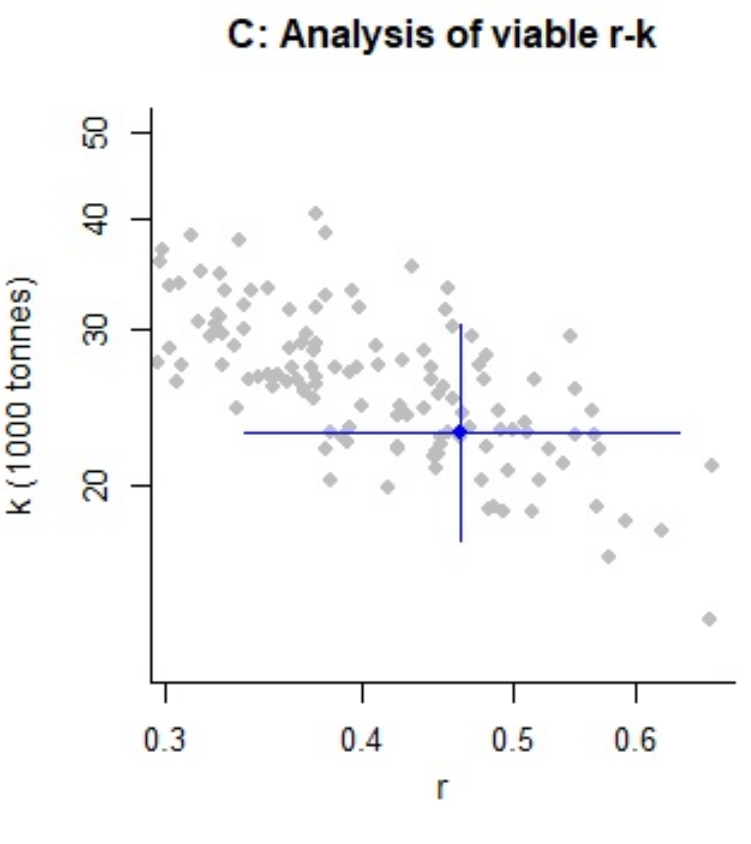

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

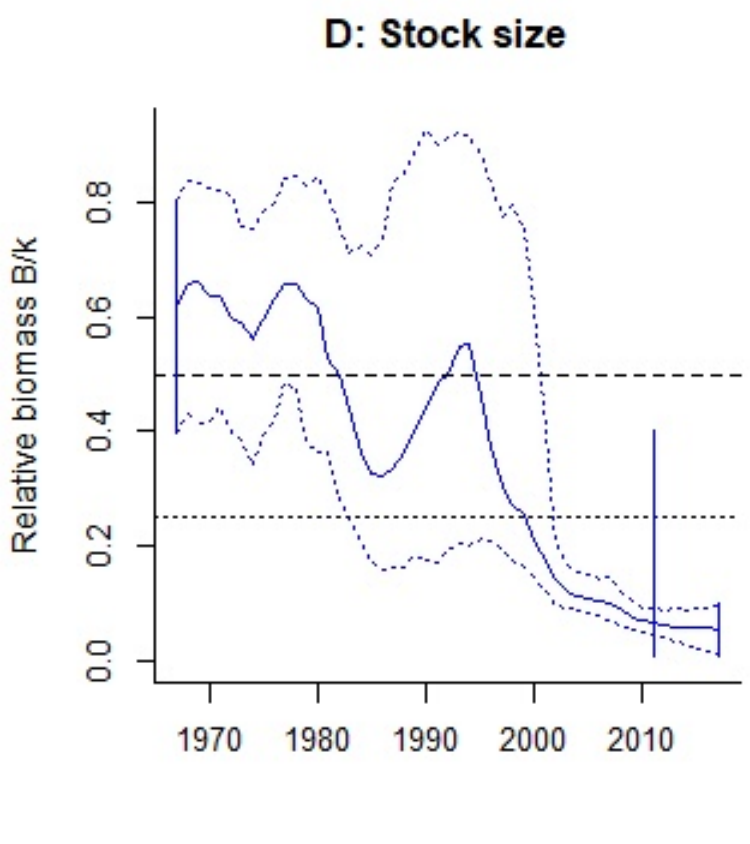

Exploitation
F / Fmsy
0
2
4
6
8
10
1970
1980
1990
2000
2010

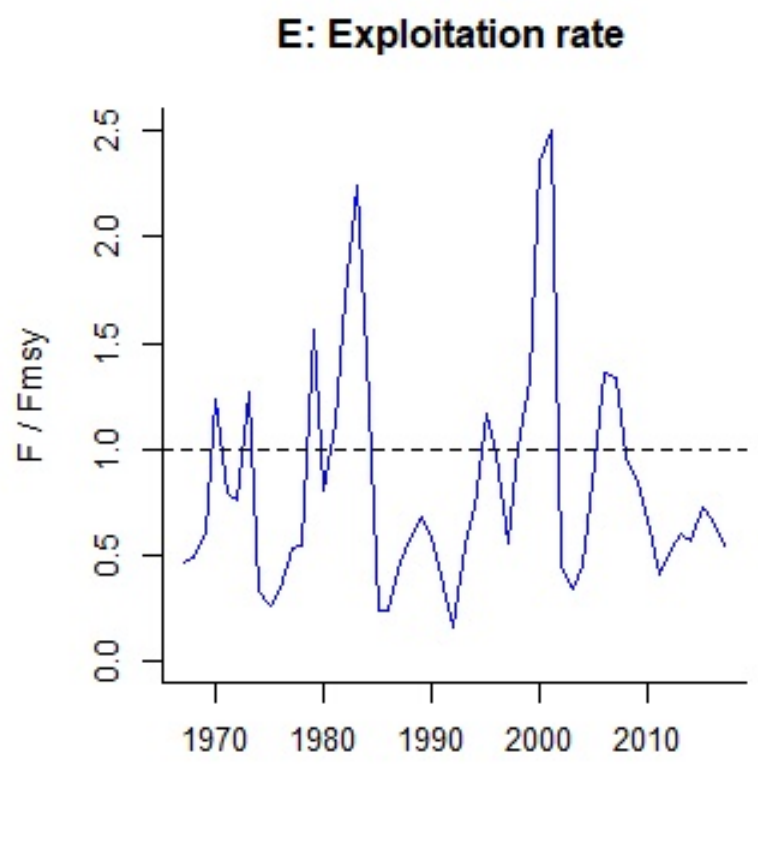

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1968
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

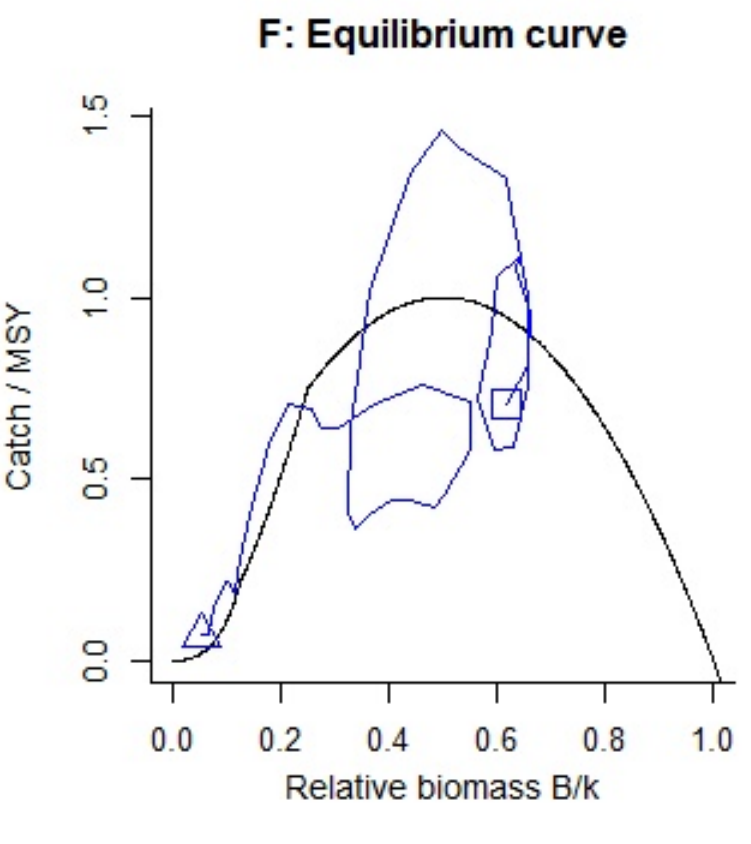

A: Catch Turbot_BS
Catch (1000 tonnes/year)
0
1
2
3
4
5
6
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
70
0.4
0.6
0.8
1.0
r

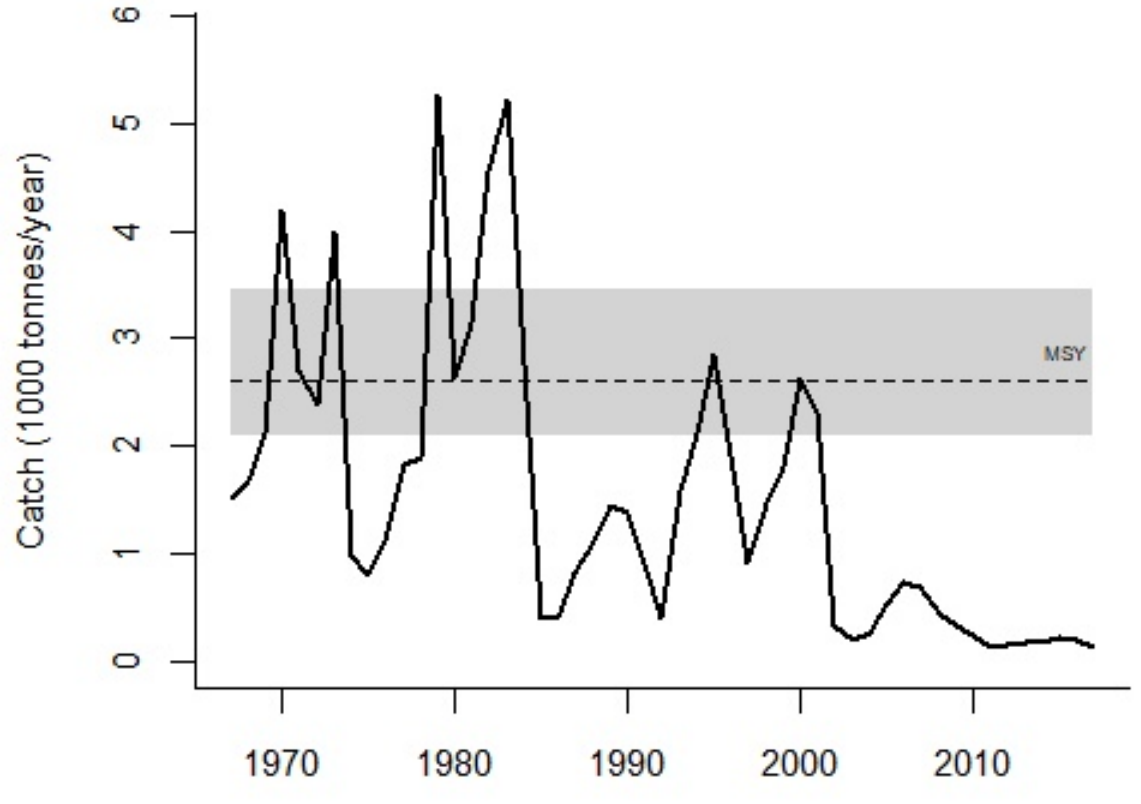

C: Analysis of viable r-k
k (1000 tonnes)
20
30
40
50
0.3
0.4
0.5
0.6
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

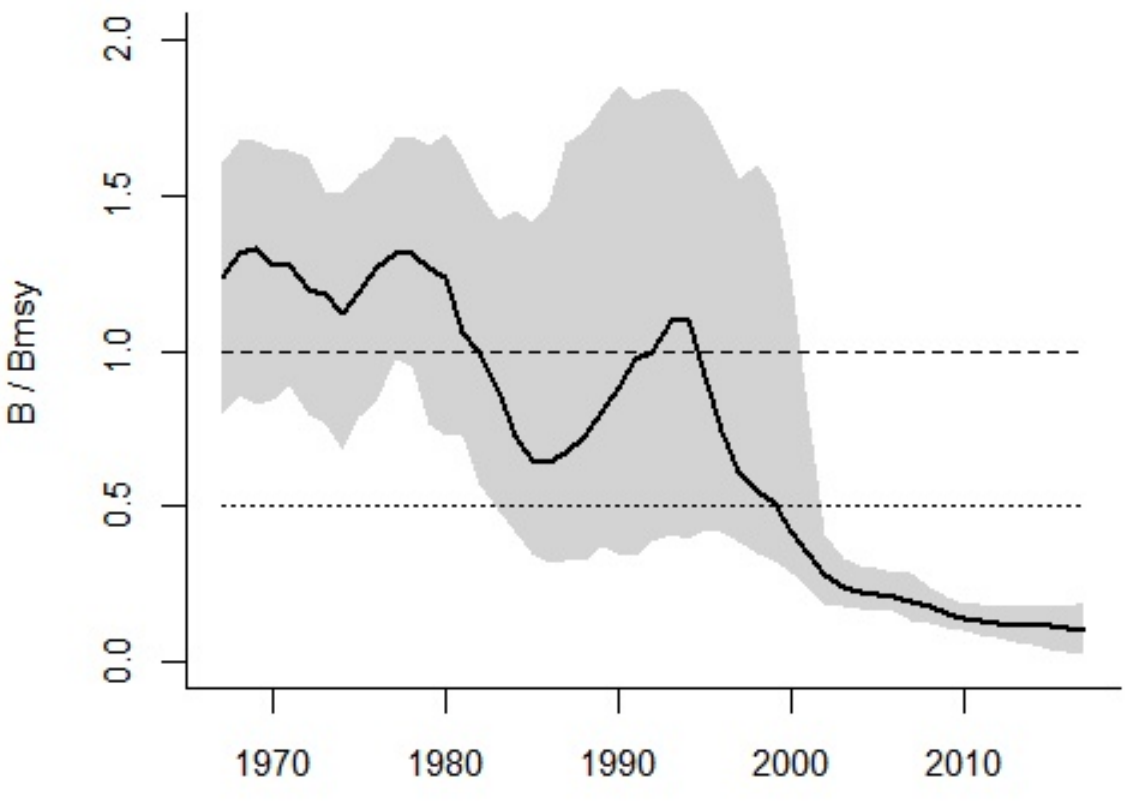

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

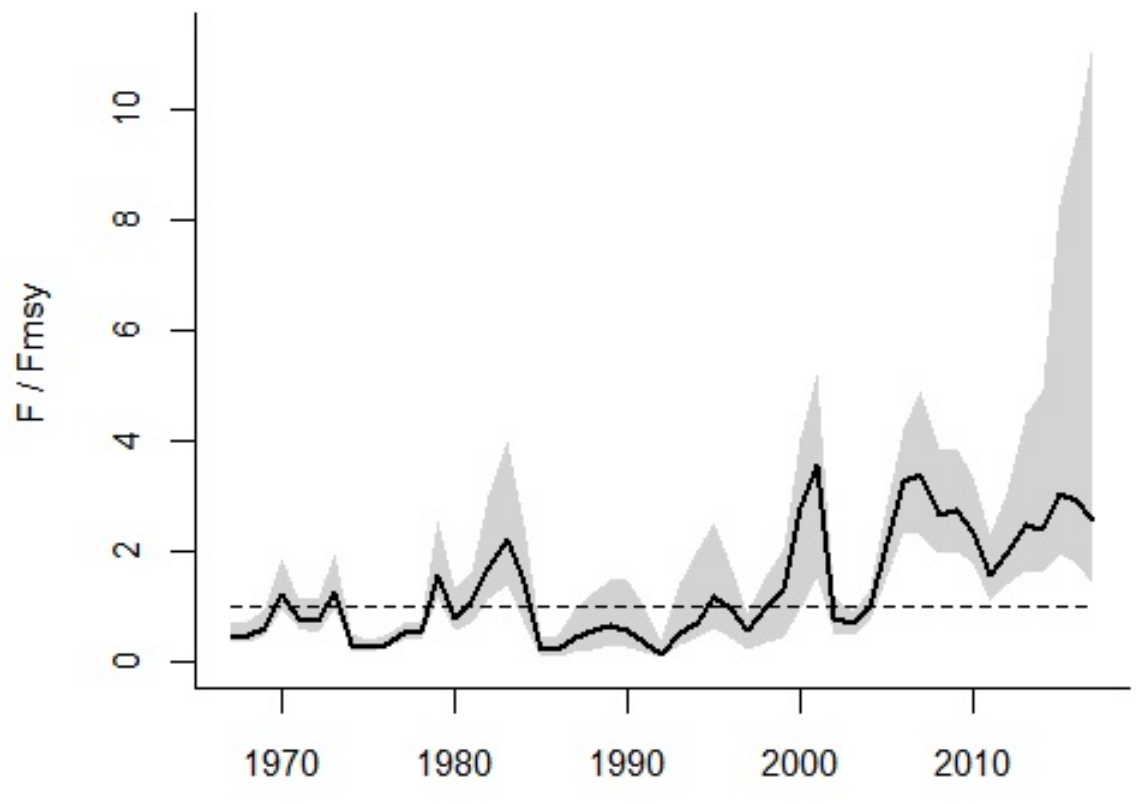
Catch

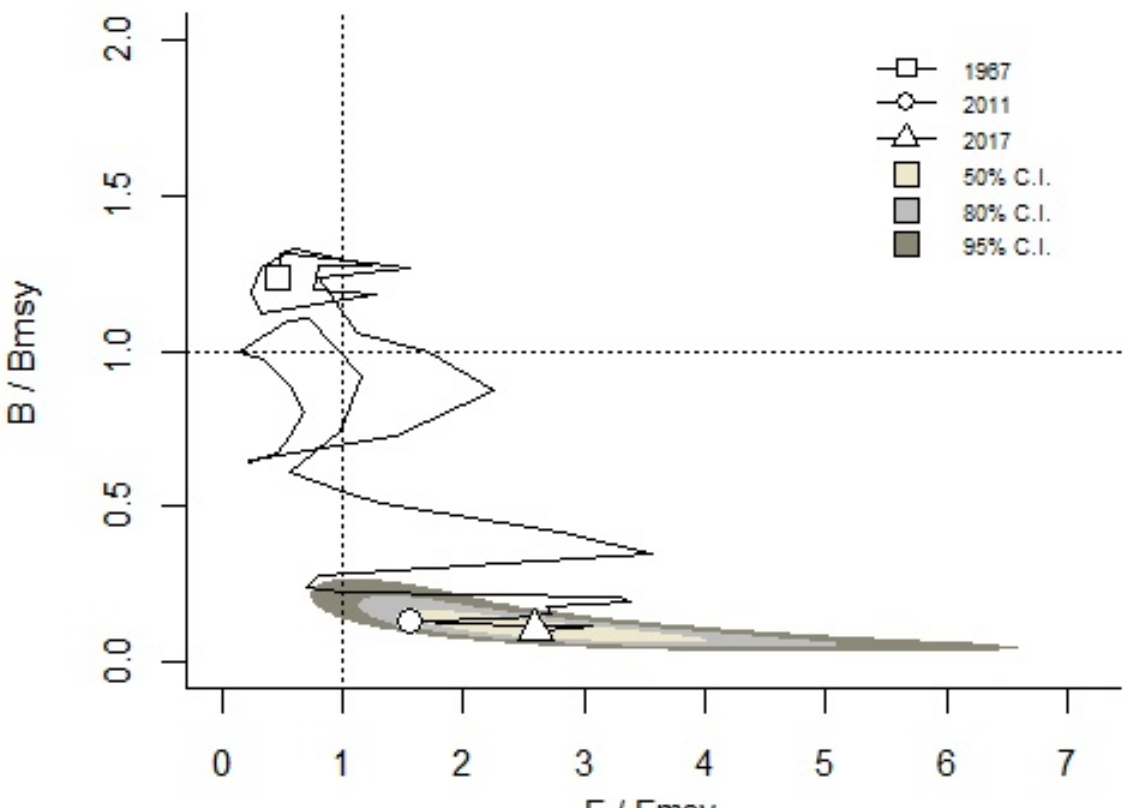


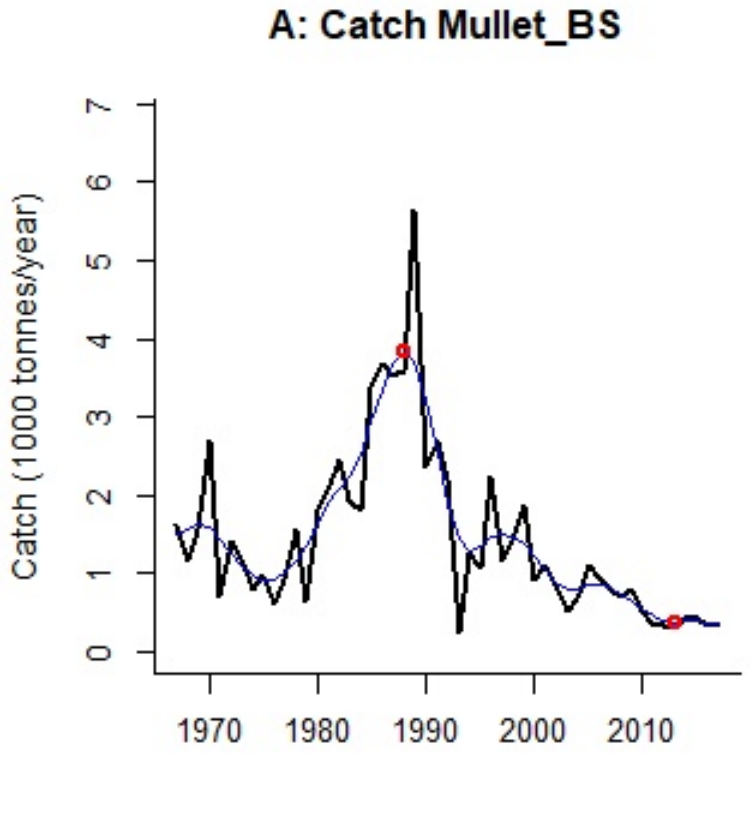
Stock size

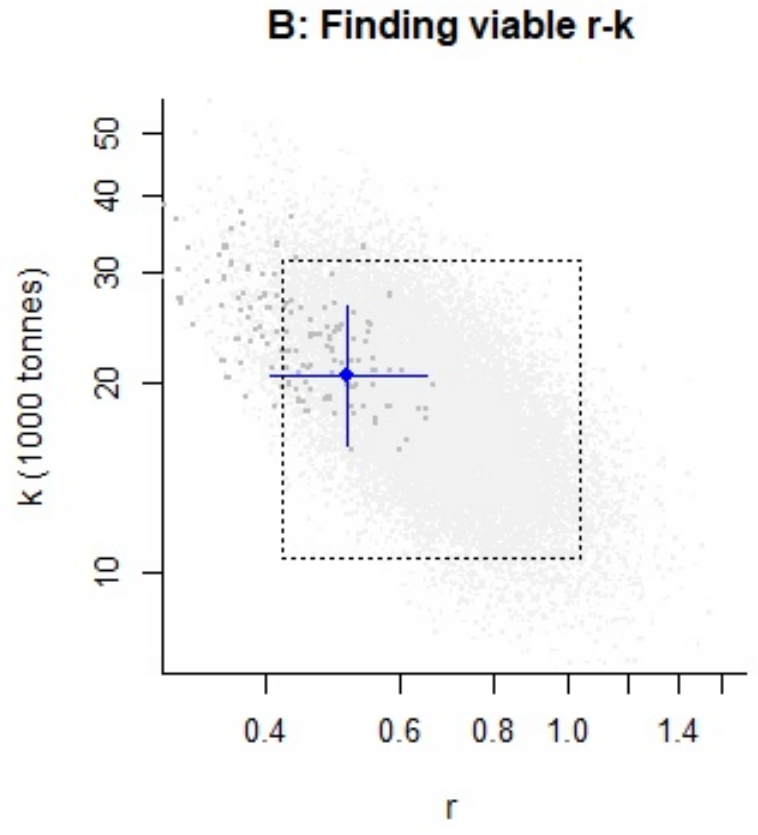


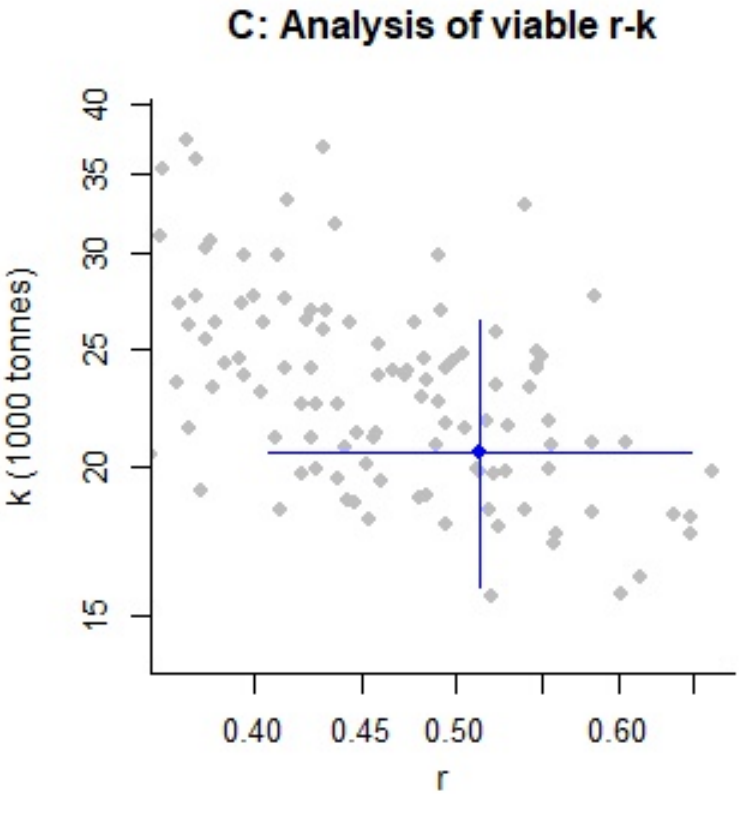
Exploitation

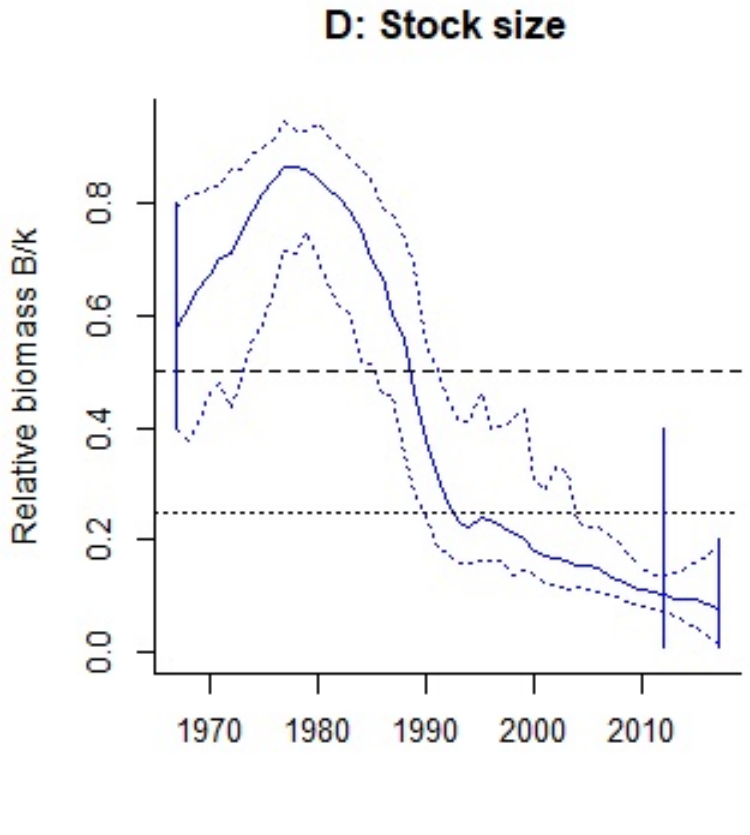


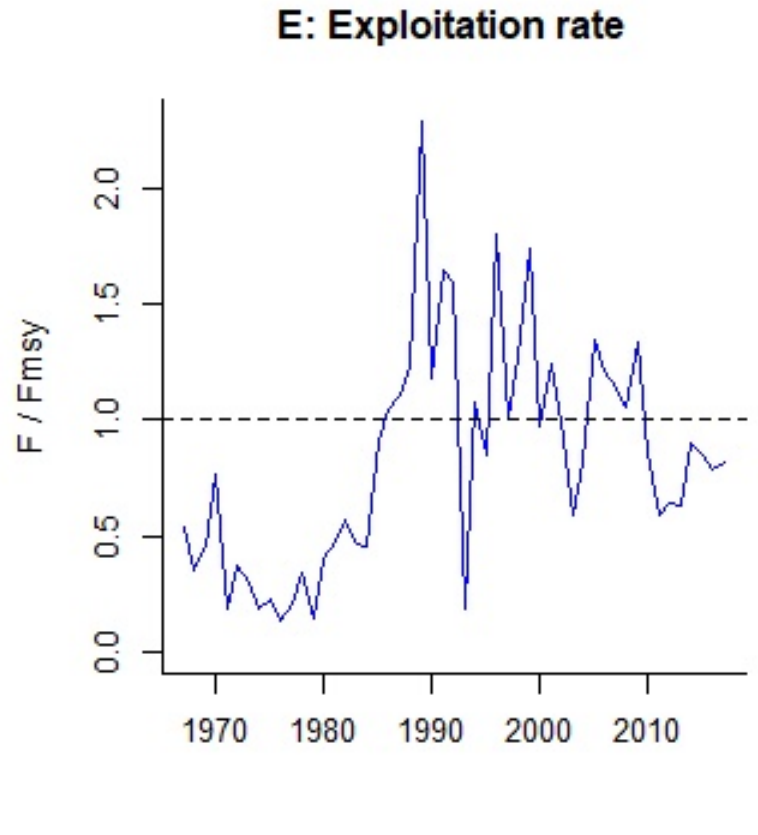


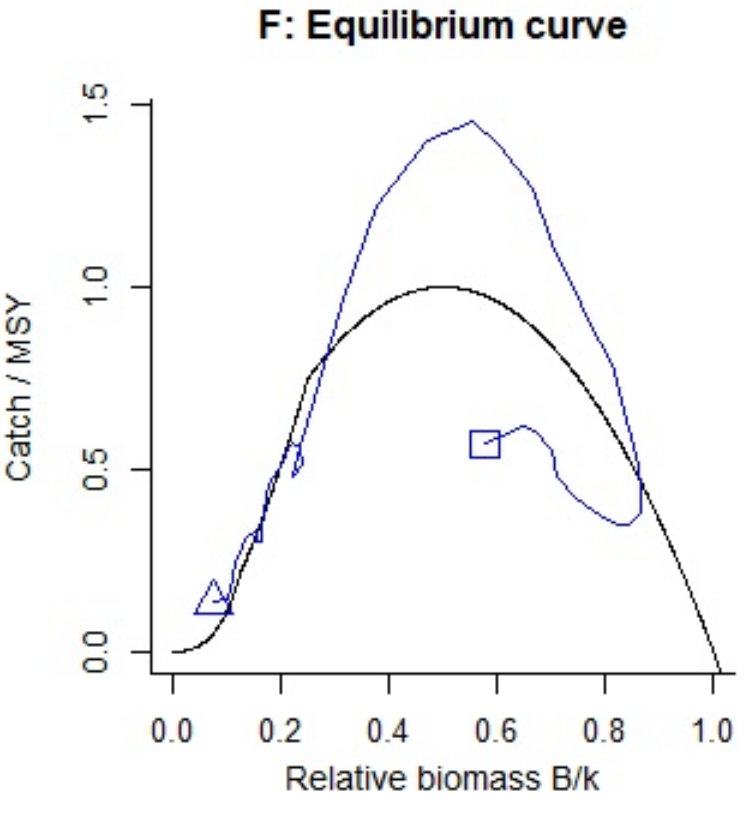

A: Catch Mullet_BS
Catch (1000 tonnes/year)
0
1
2
3
4
5
6
7
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
0.4
0.6
0.8
1.0
1.4
r

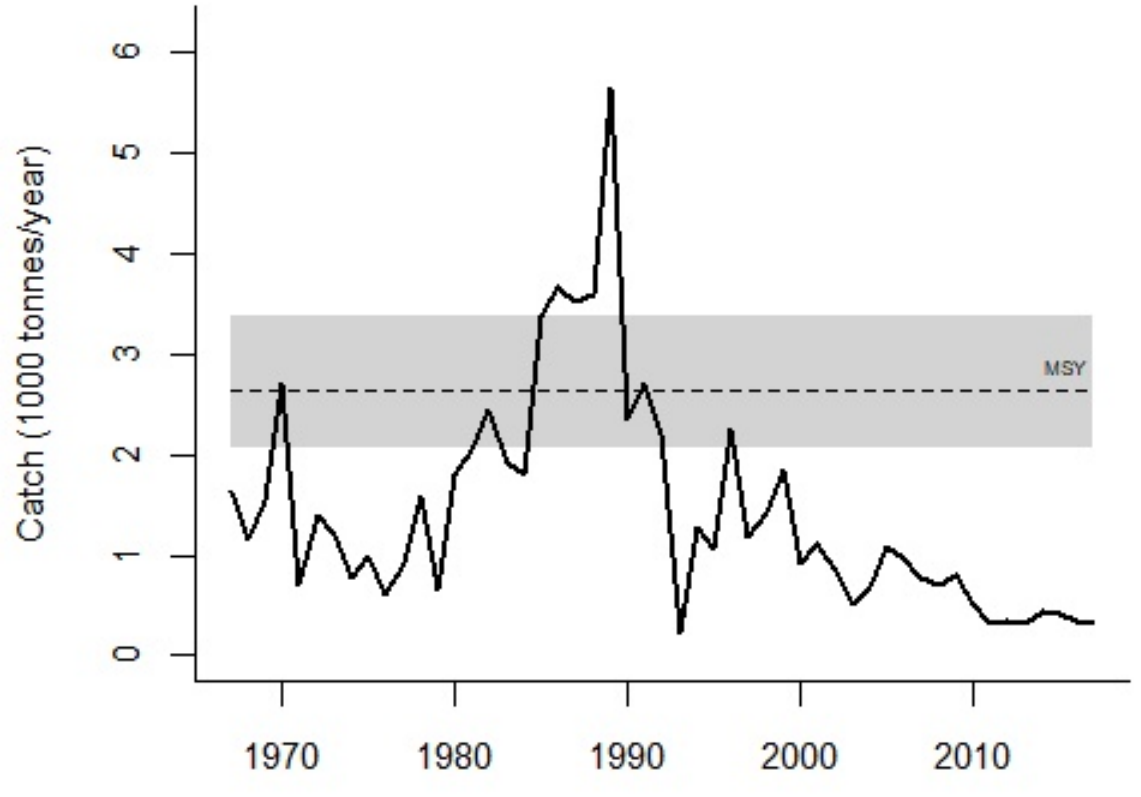

C: Analysis of viable r-k
k (1000 tonnes)
15
20
25
30
35
40
0.40
0.45
0.50
0.60
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

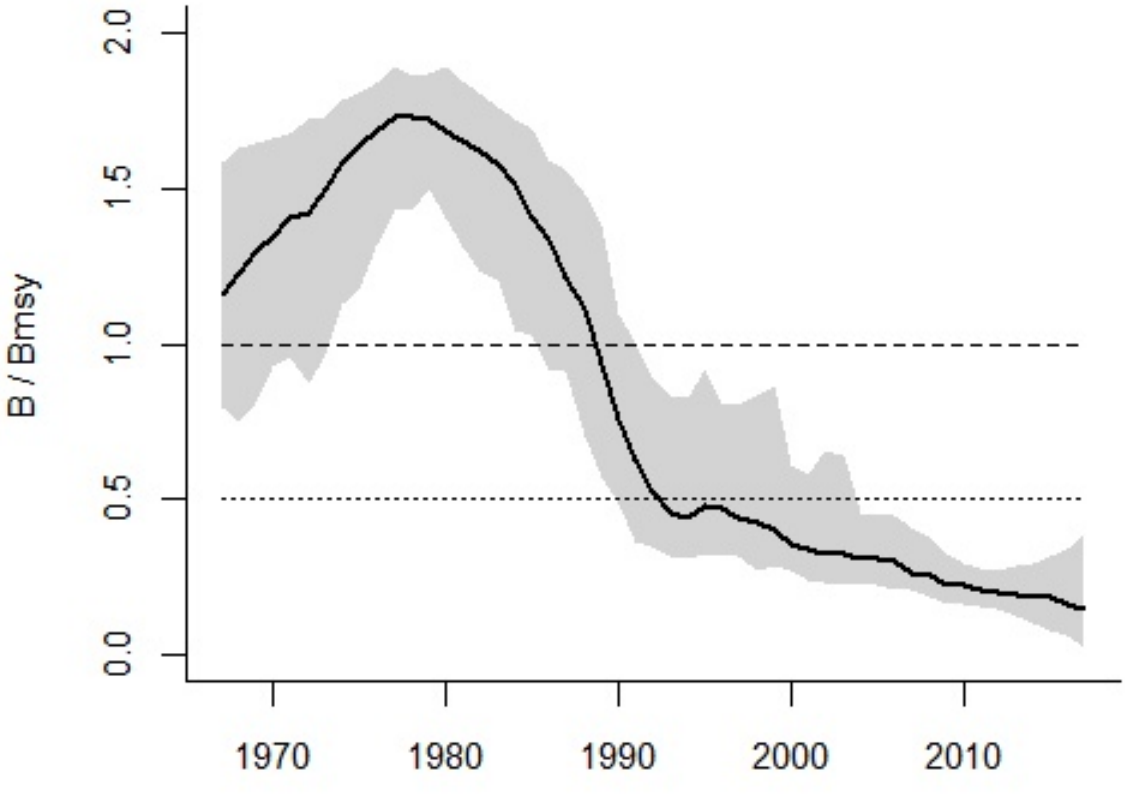

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

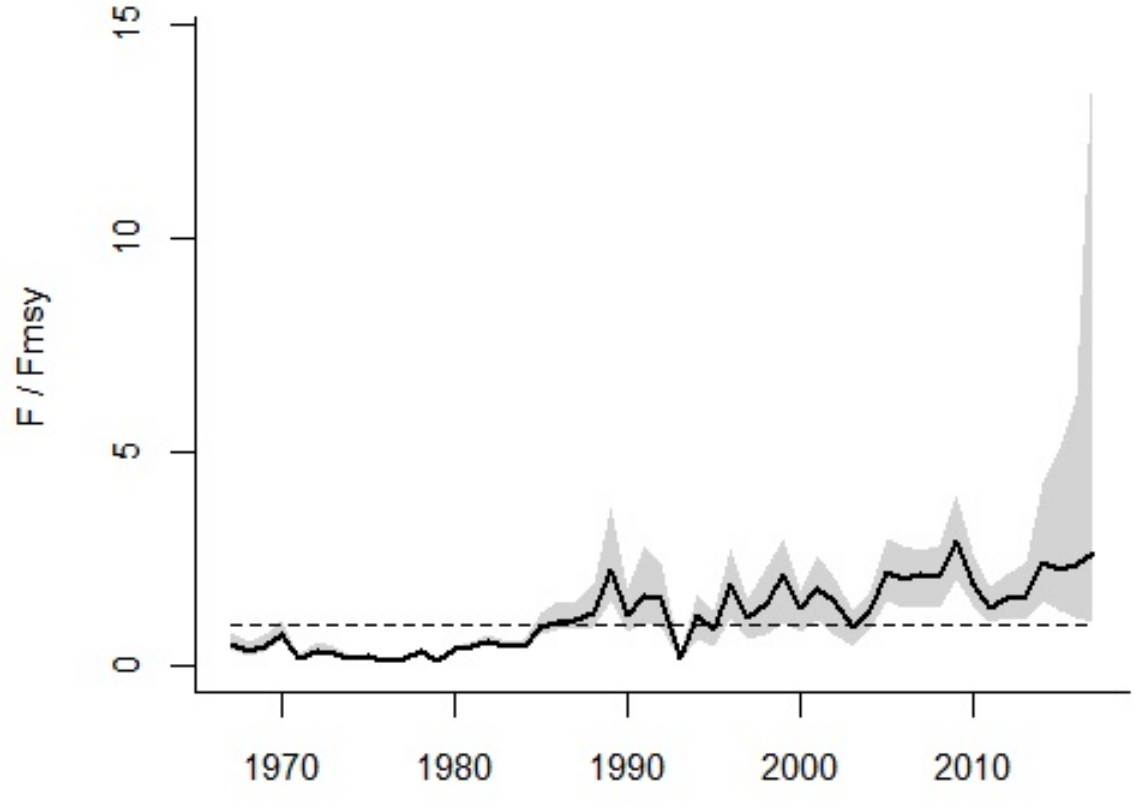
Catch

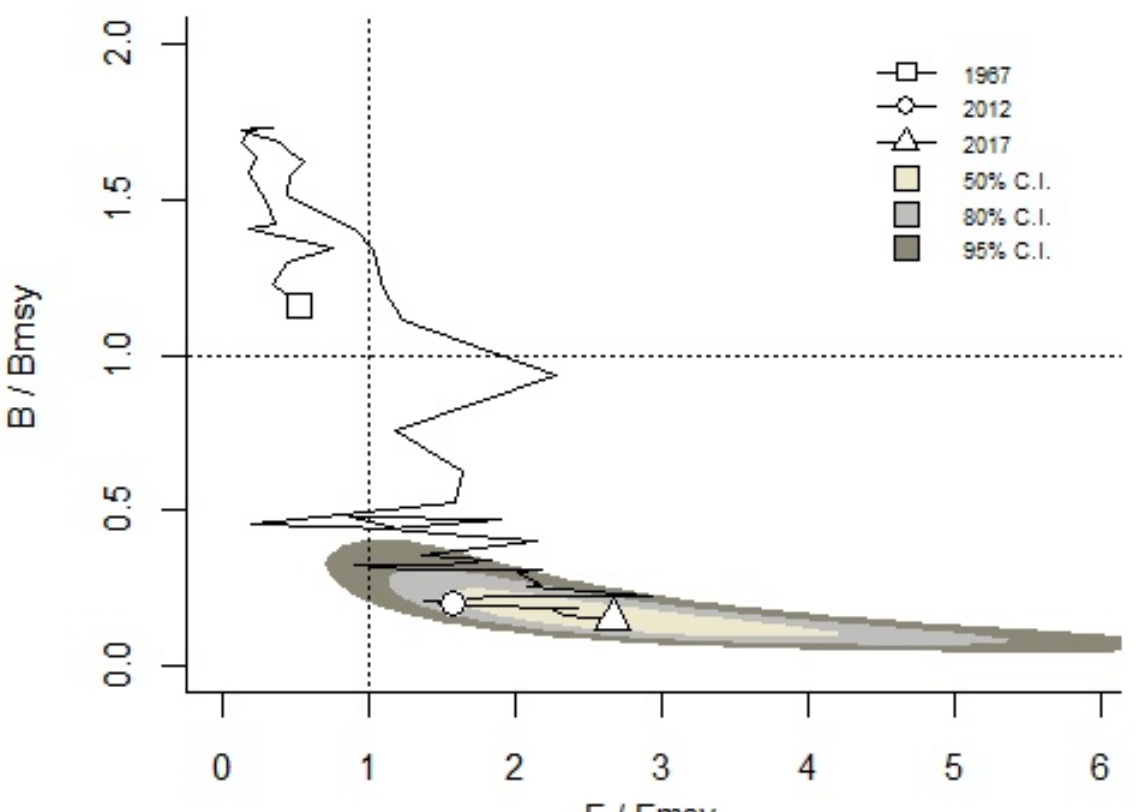


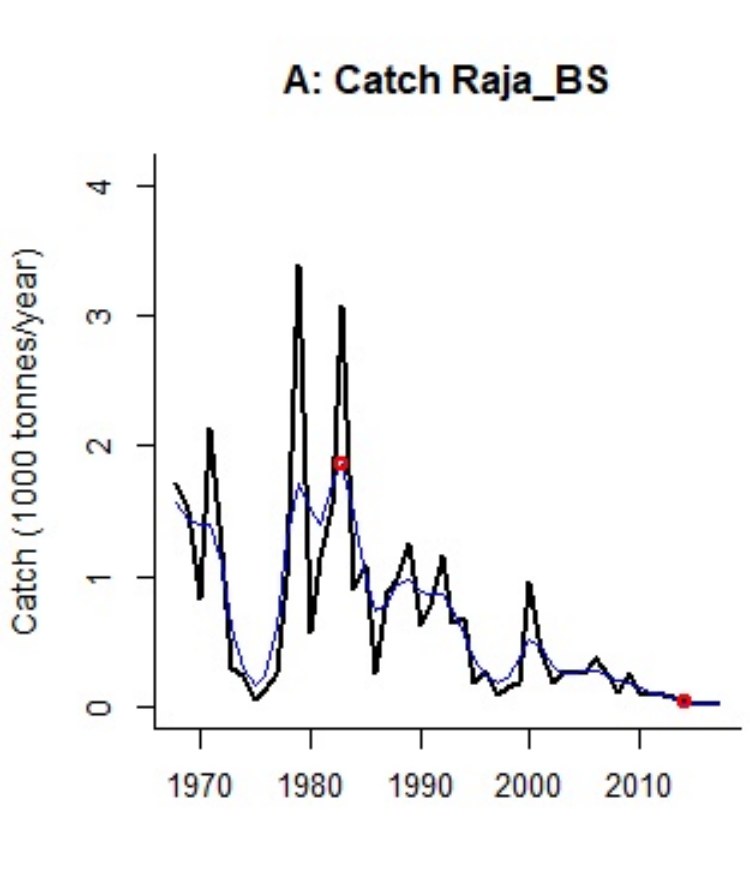
Stock size

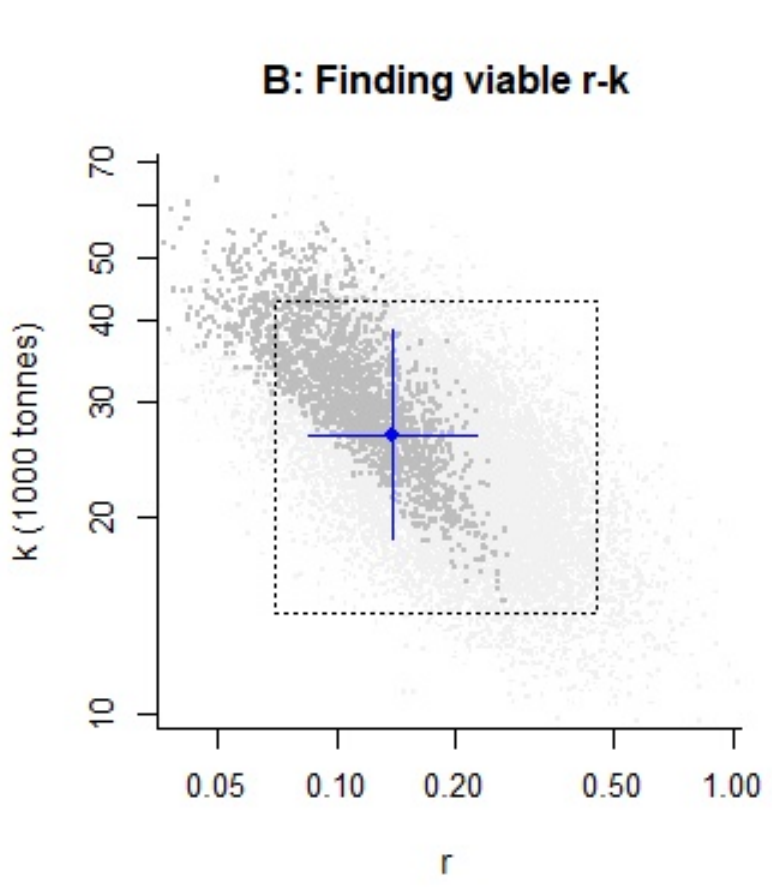


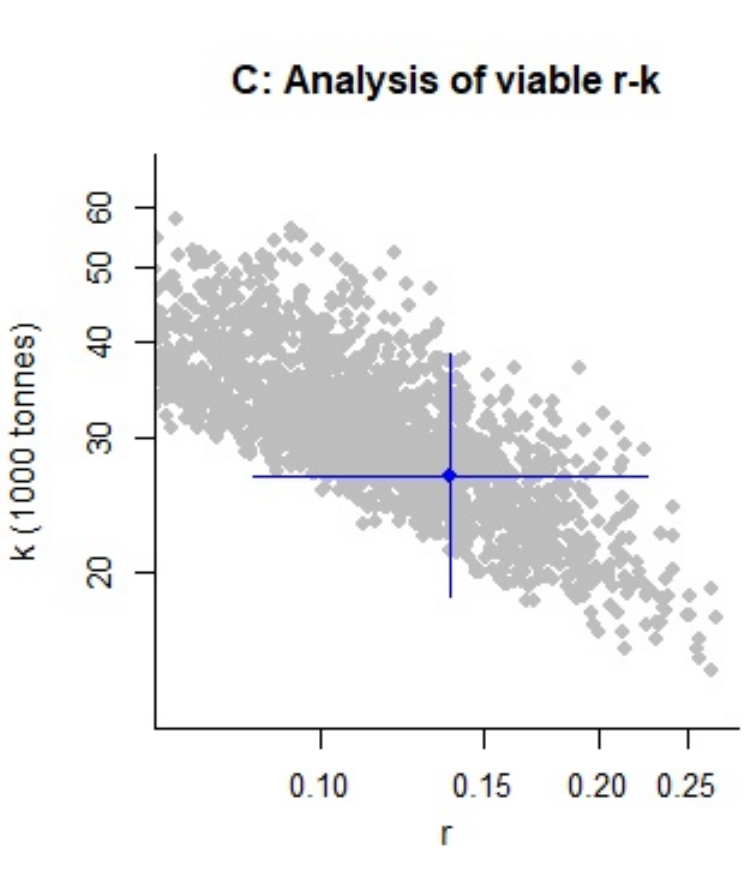
Exploitation

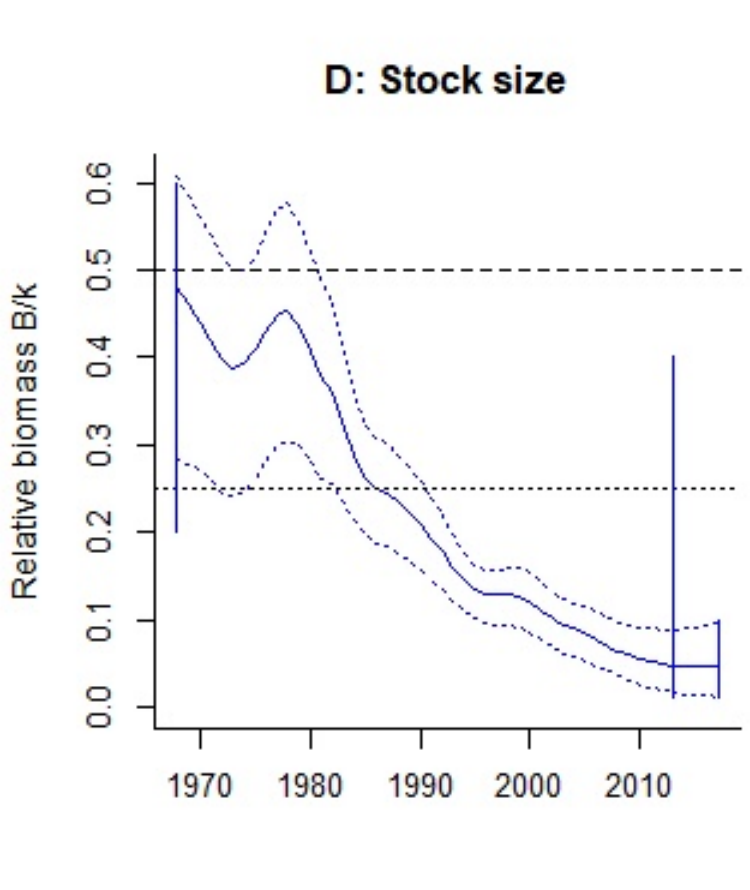


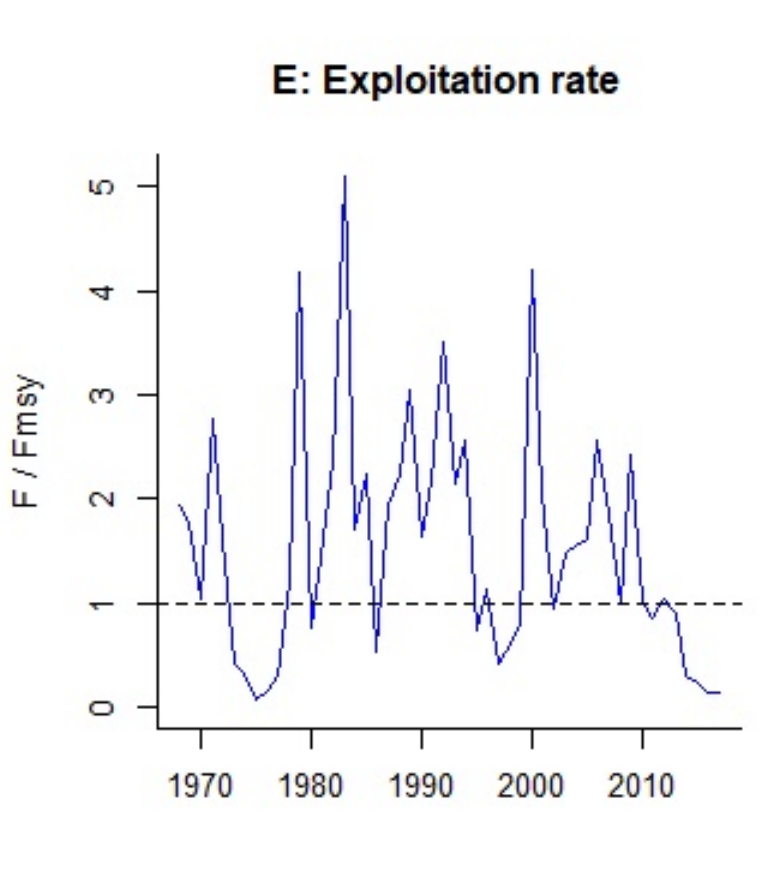


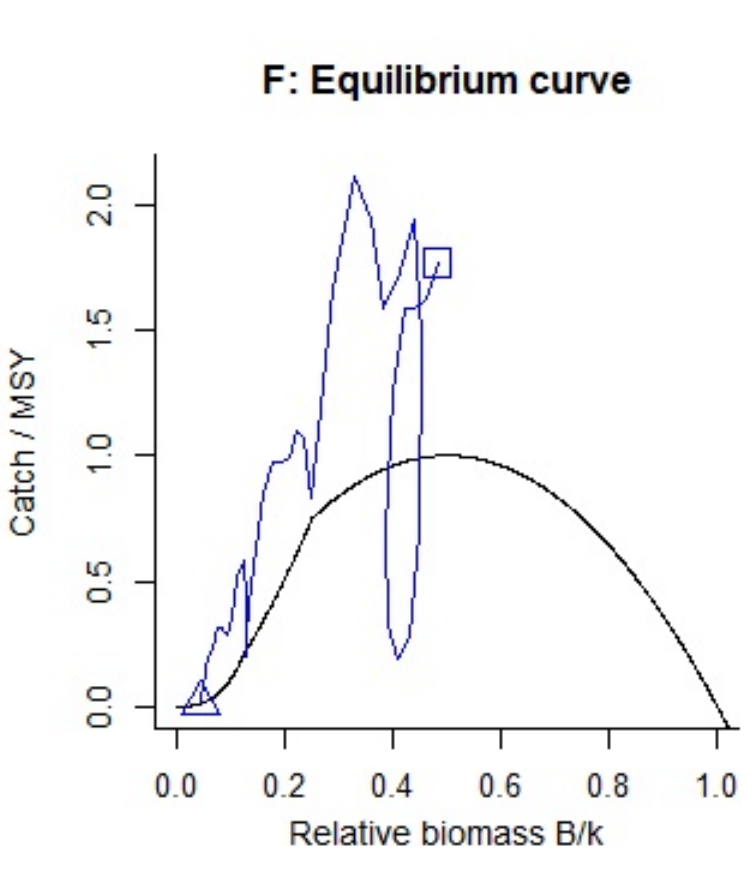

A: Catch Raja_BS
Catch (1000 tonnes/year)
0
1
2
3
4
1970
1980
1990
2000
2010

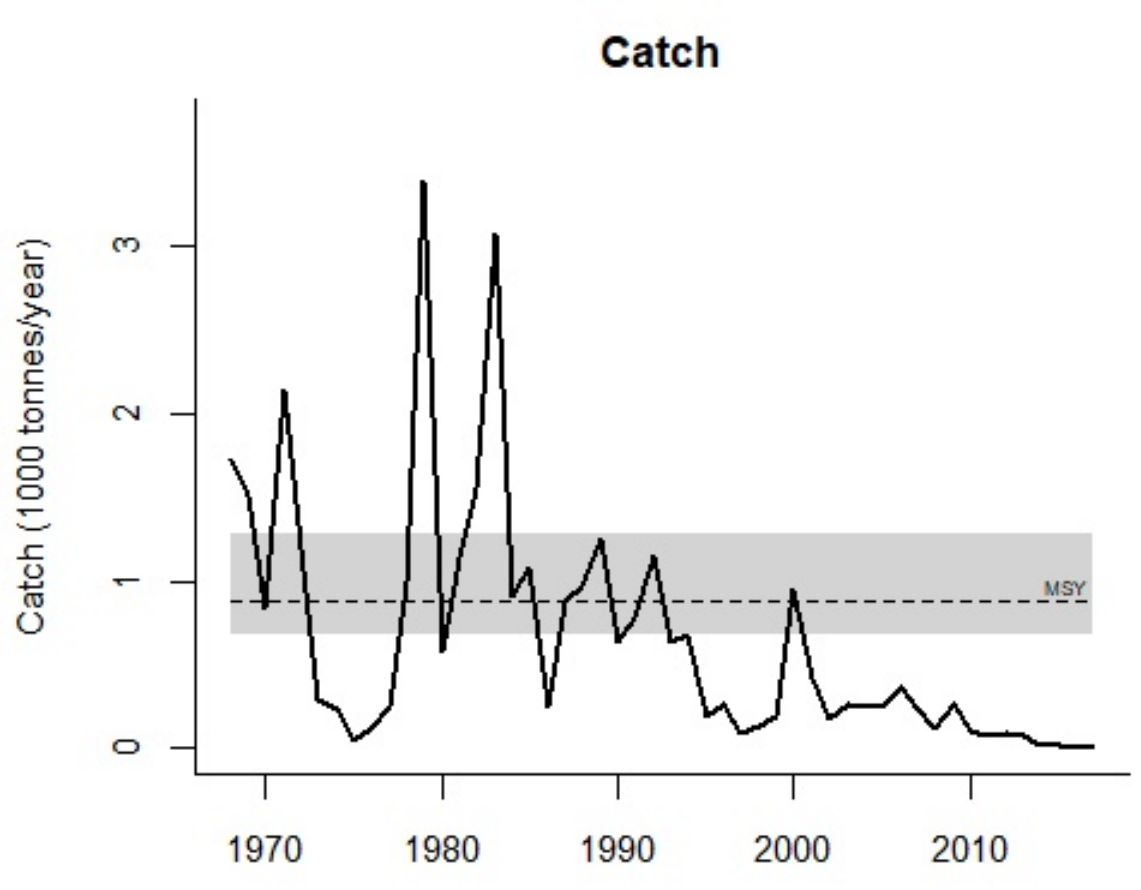

B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
70
0.05
0.10
0.20
0.50
1.00
r

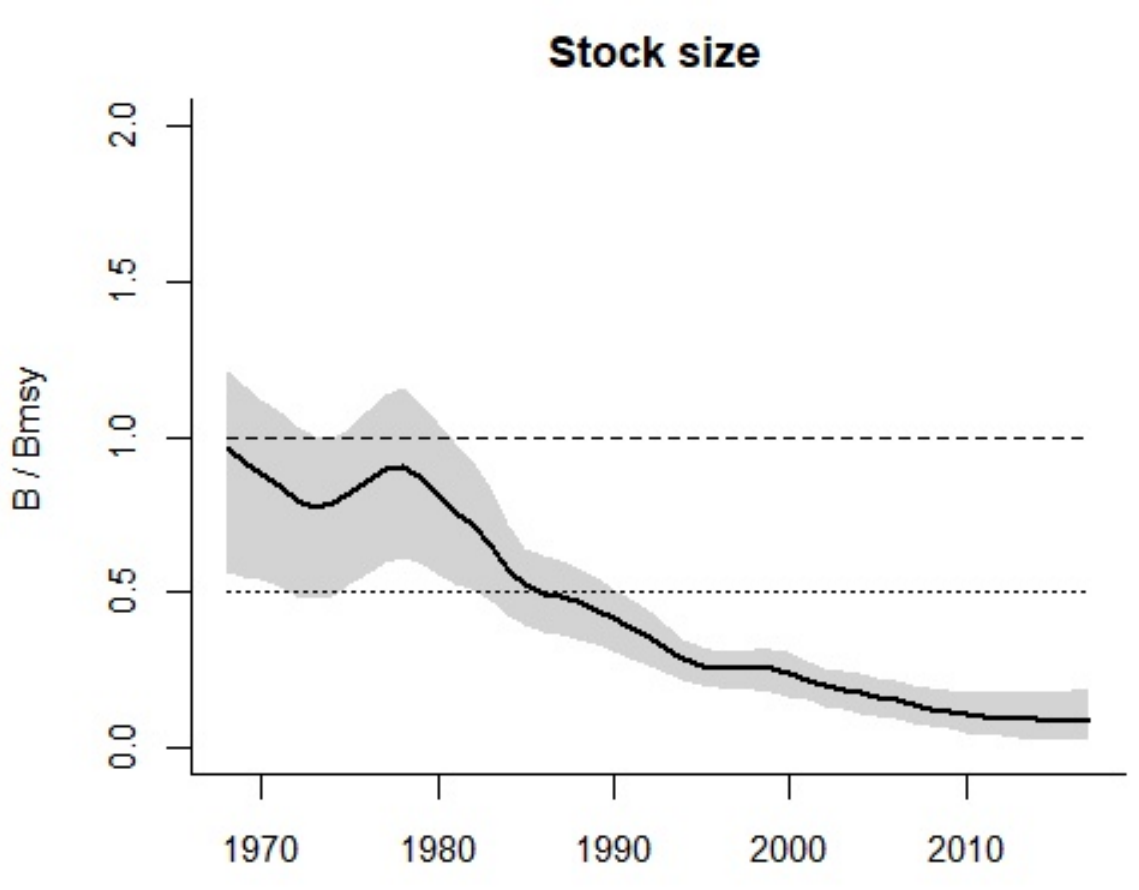

C: Analysis of viable r-k
k (1000 tonnes)
20
30
40
50
60
0.10
0.15
0.20
0.25
r

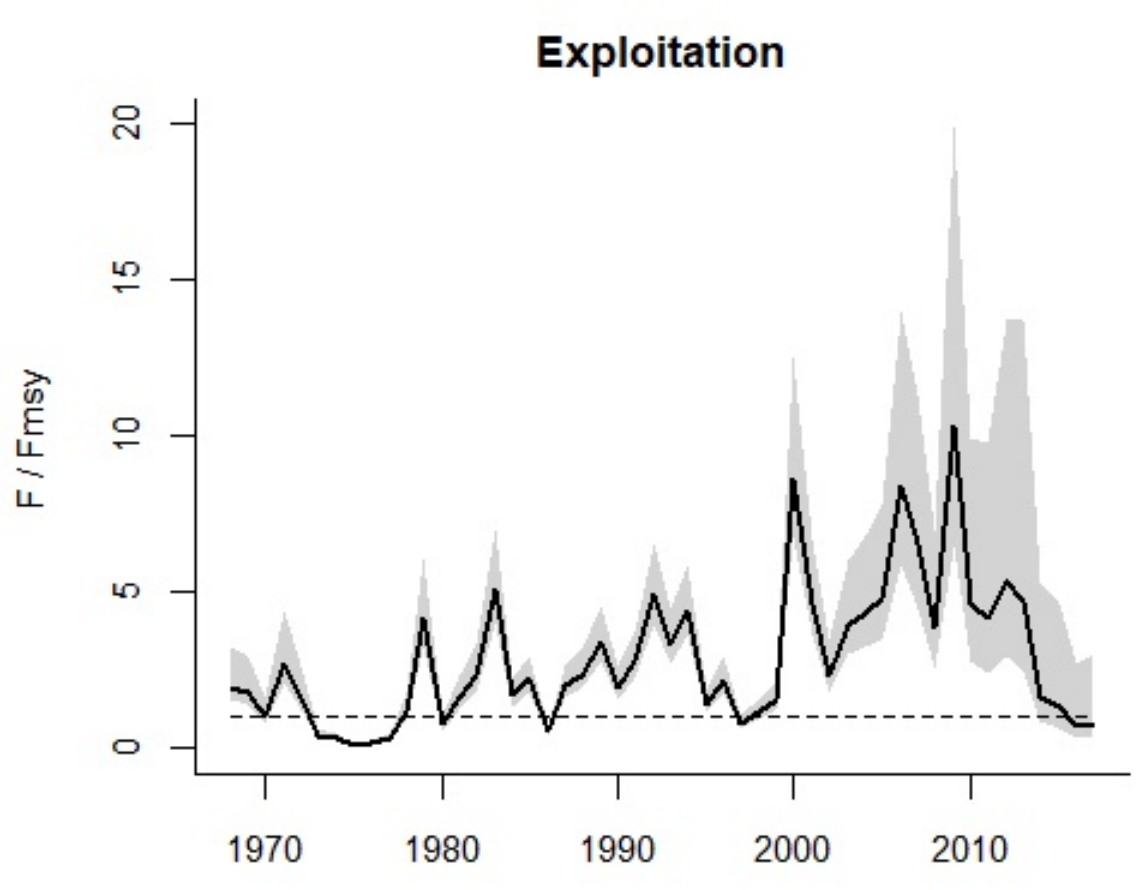

D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

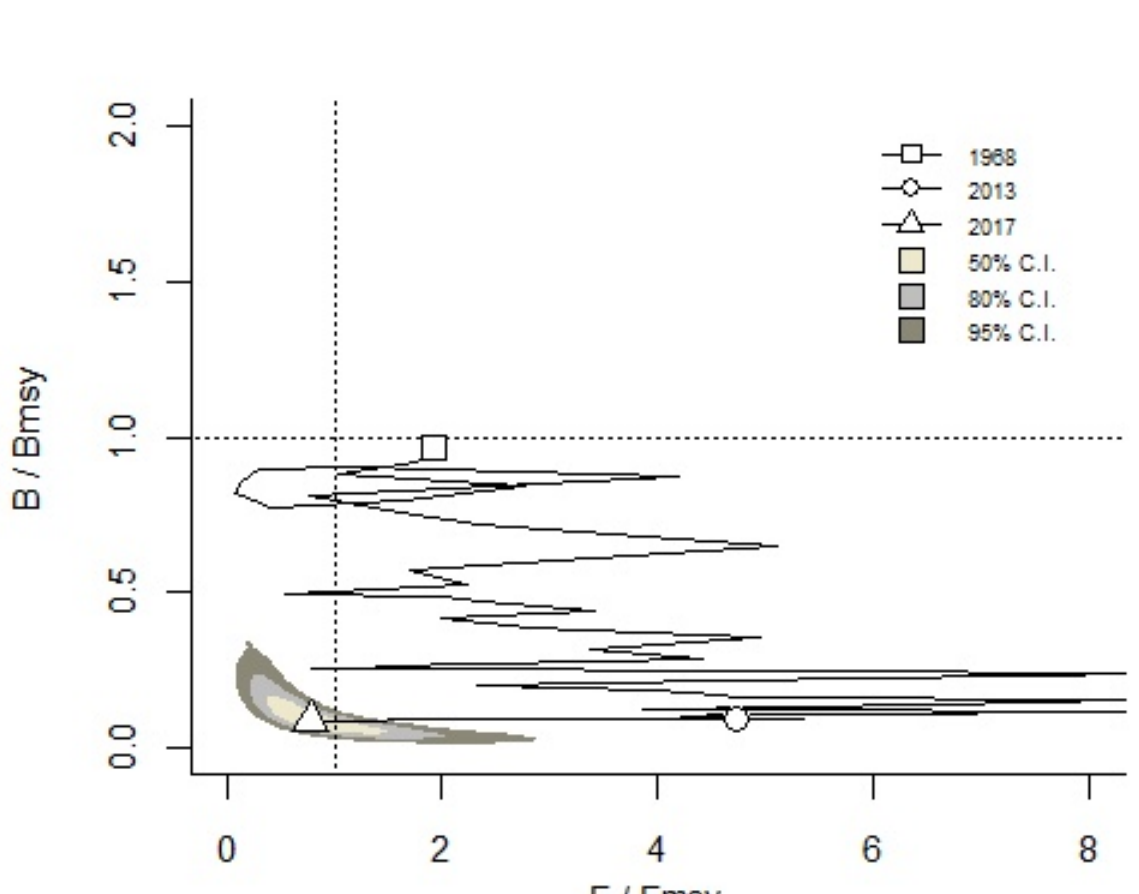

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010

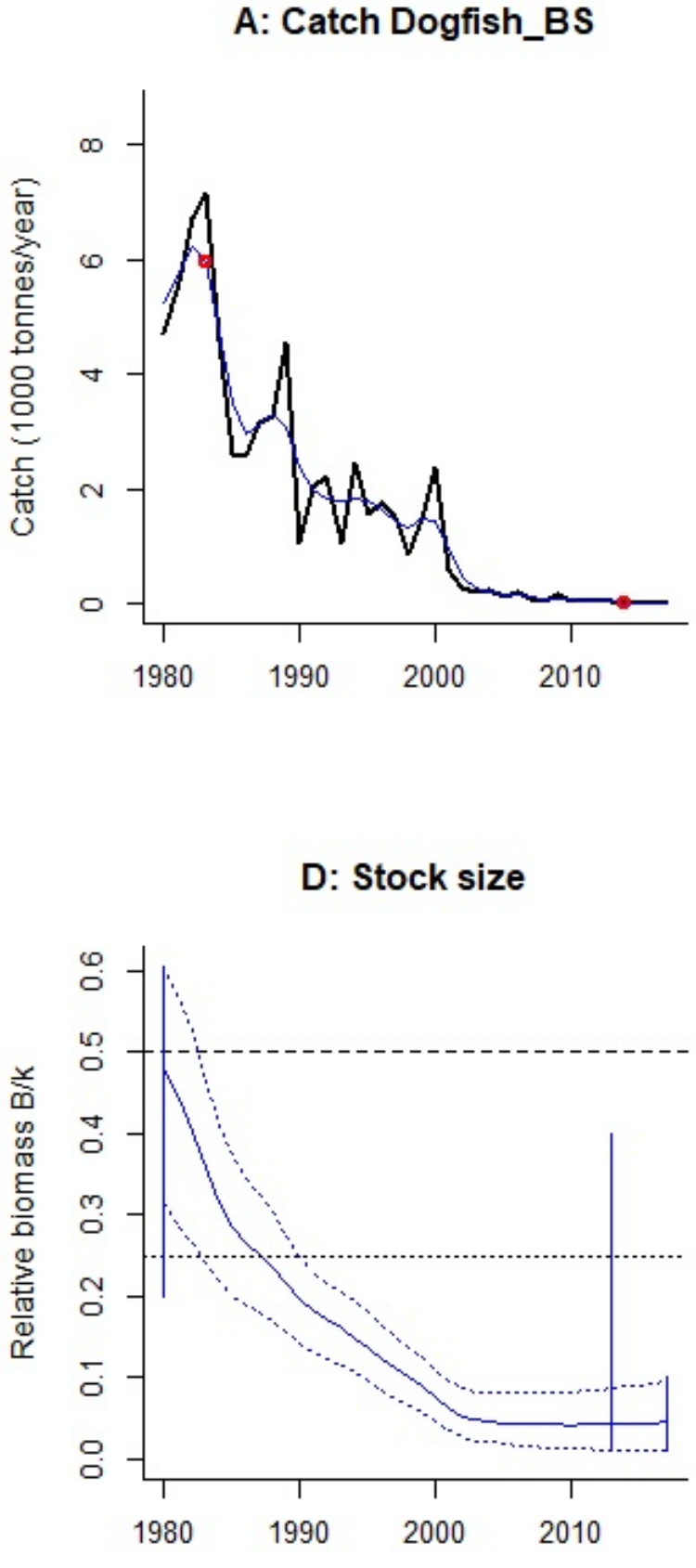

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

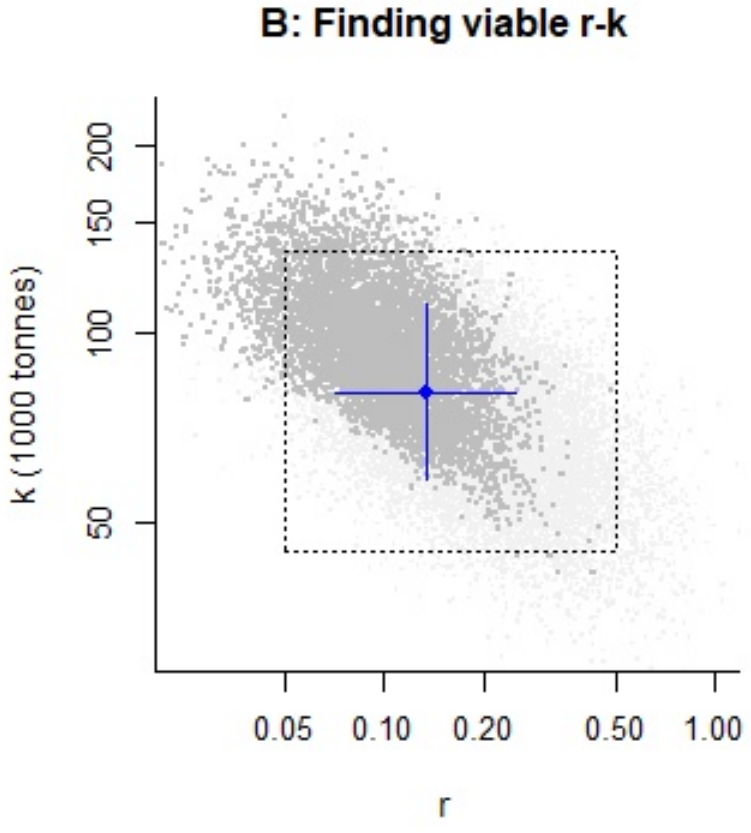

Catch
Catch (1000 tonnes/year)
0
1
2
3
MSY
1970
1980
1990
2000
2010

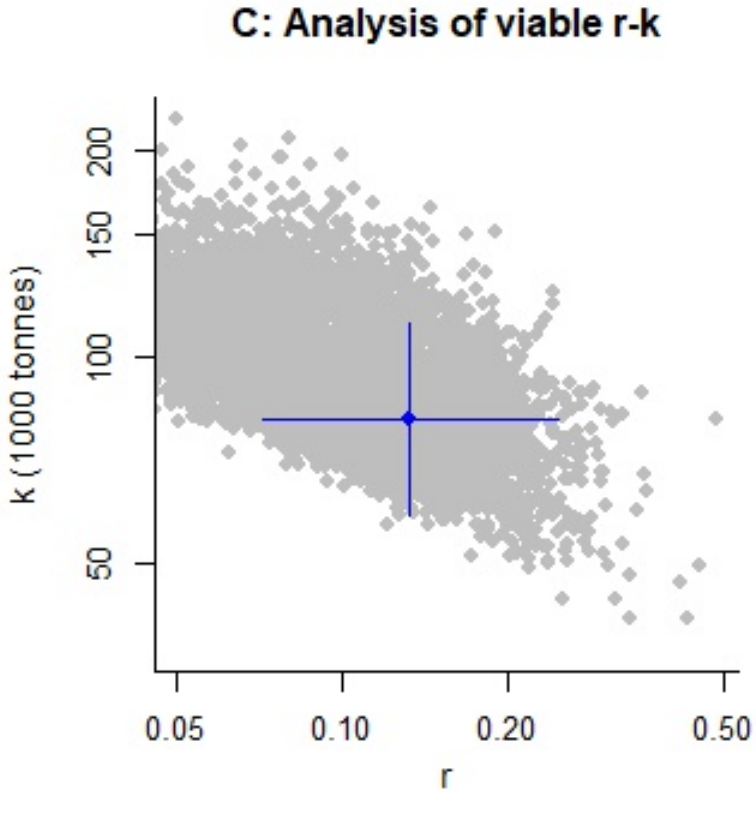

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
5
10
15
20
1970
1980
1990
2000
2010

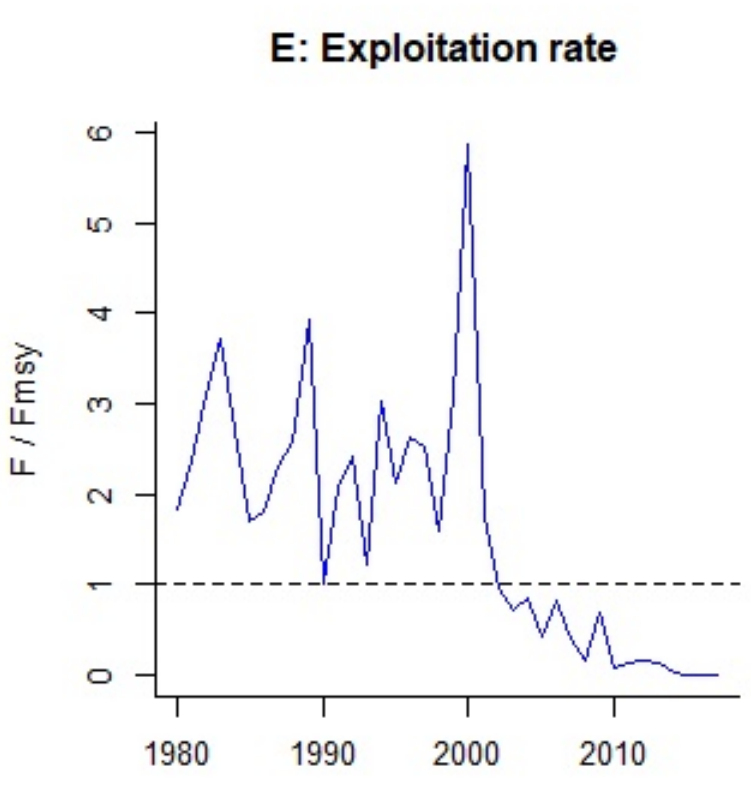

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1968
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

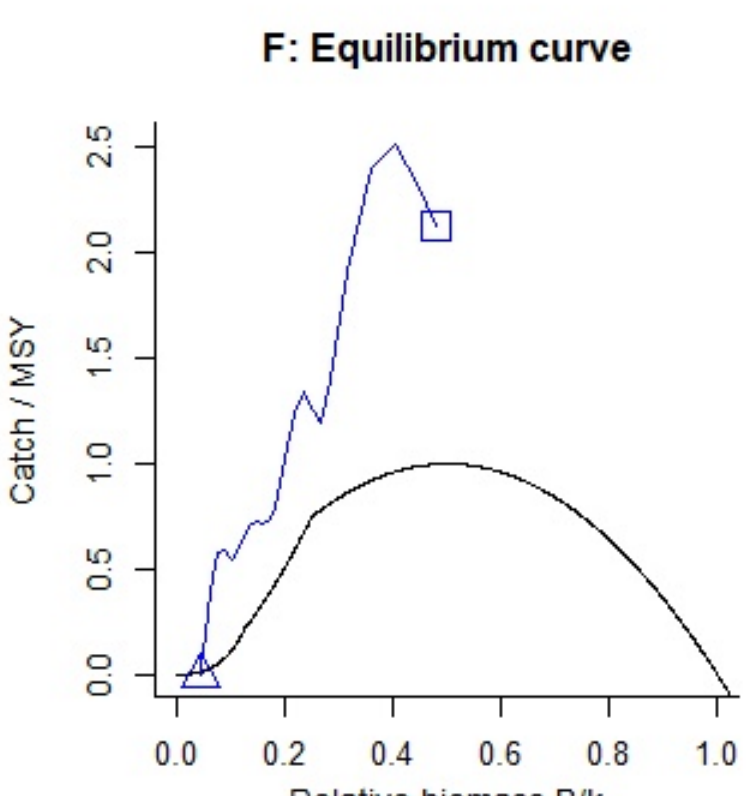

A: Catch Dogfish_BS
Catch (1000 tonnes/year)
0
2
4
6
8
1980
1990
2000
2010

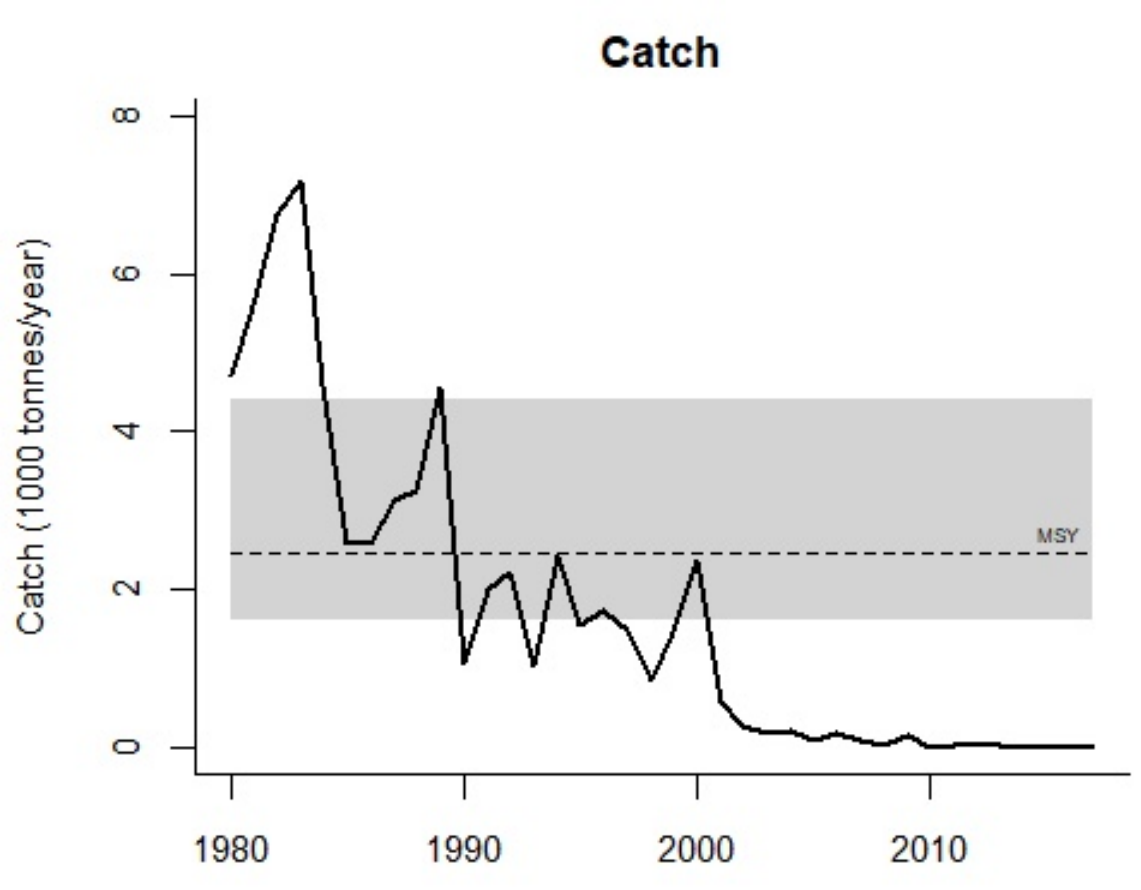

B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
0.05
0.10
0.20
0.50
1.00
r

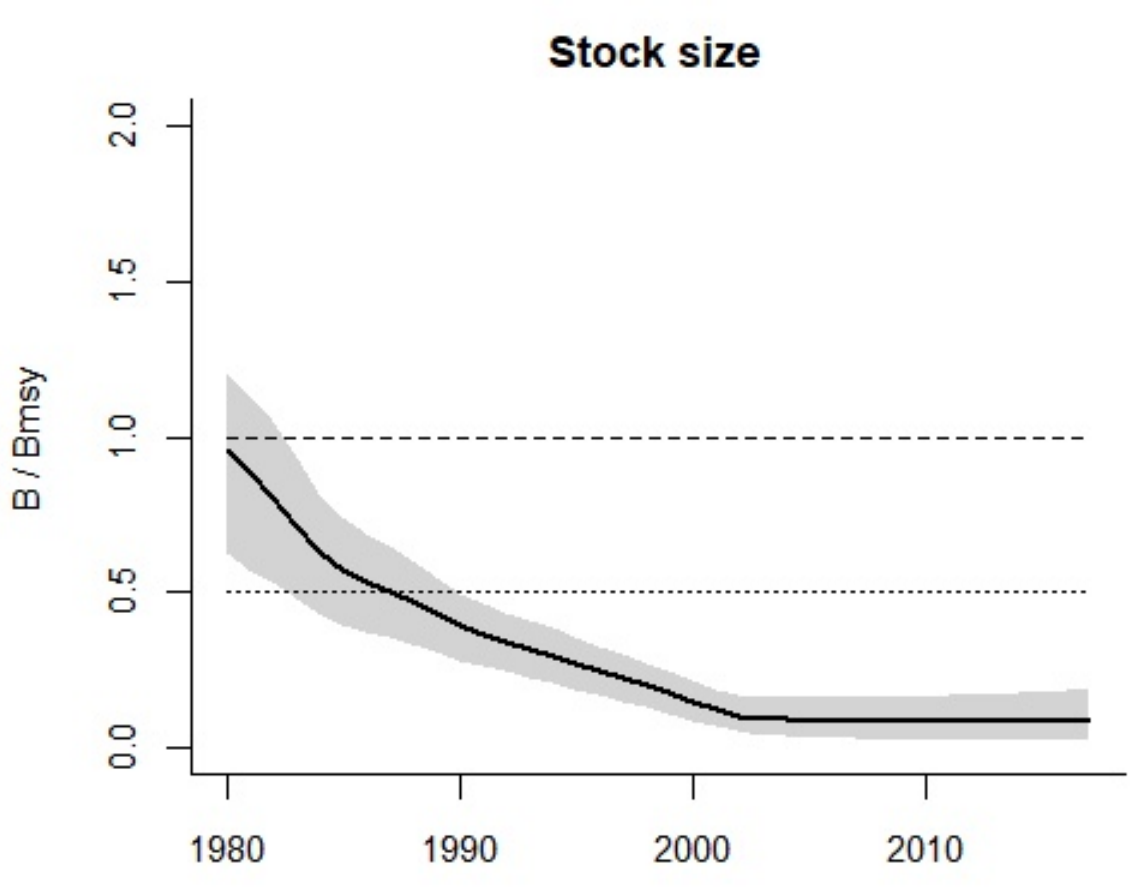

C: Analysis of viable r-k
k (1000 tonnes)
50
100
150
200
0.05
0.10
0.20
0.50
r

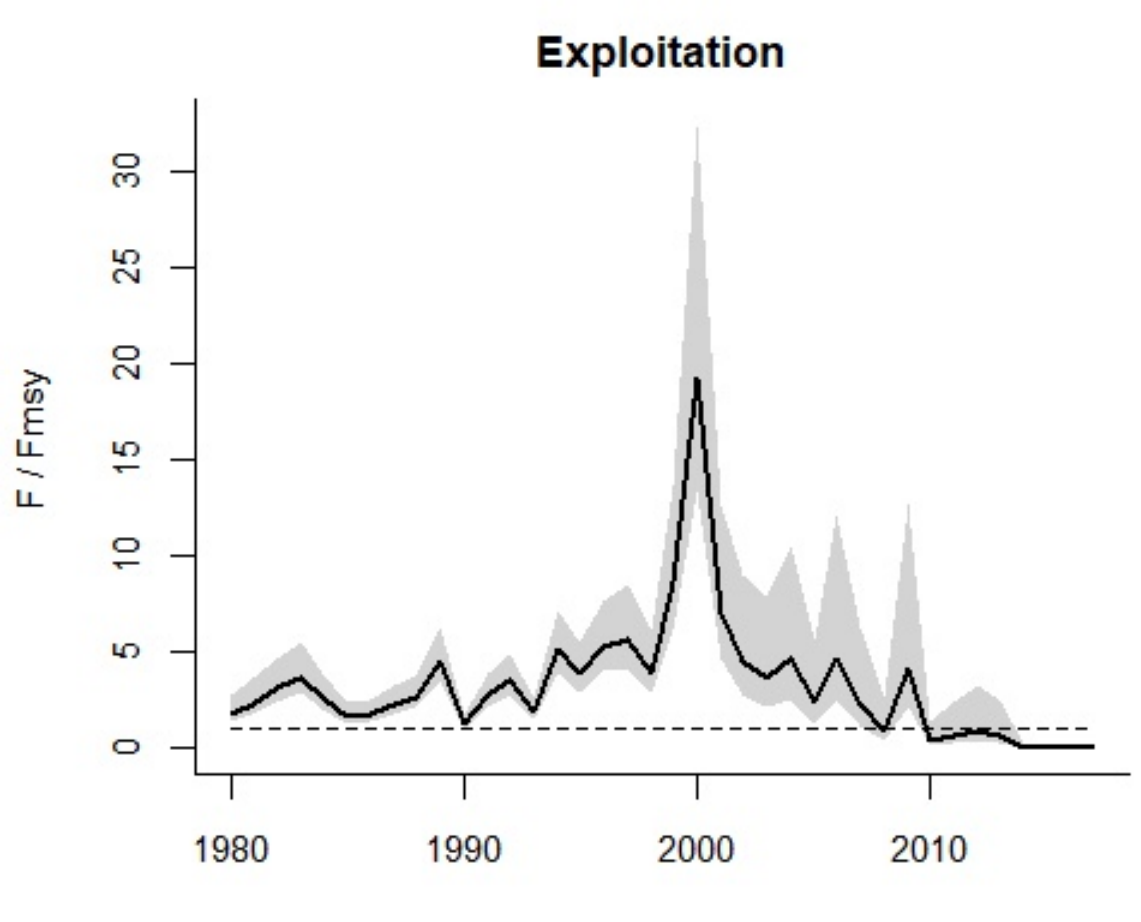
D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1980
1990
2000
2010

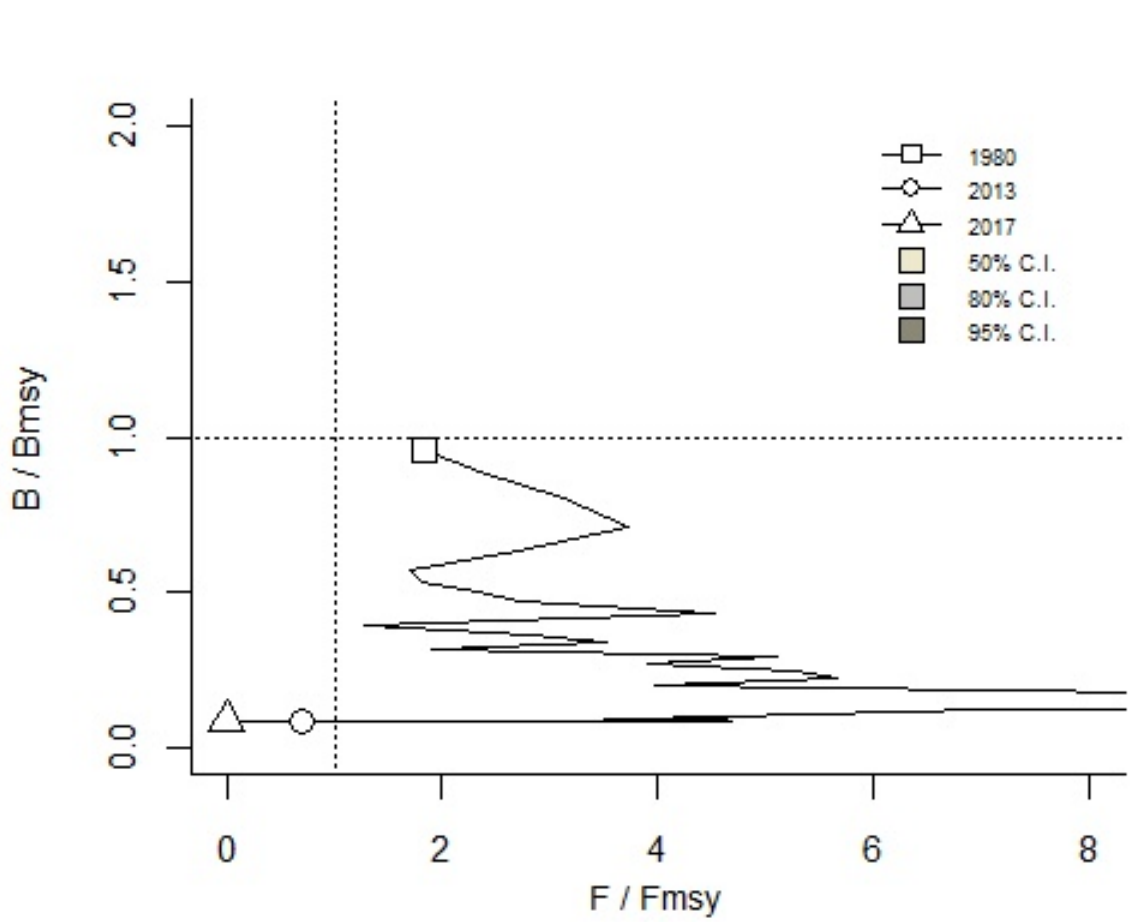

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
6
1980
1990
2000
2010

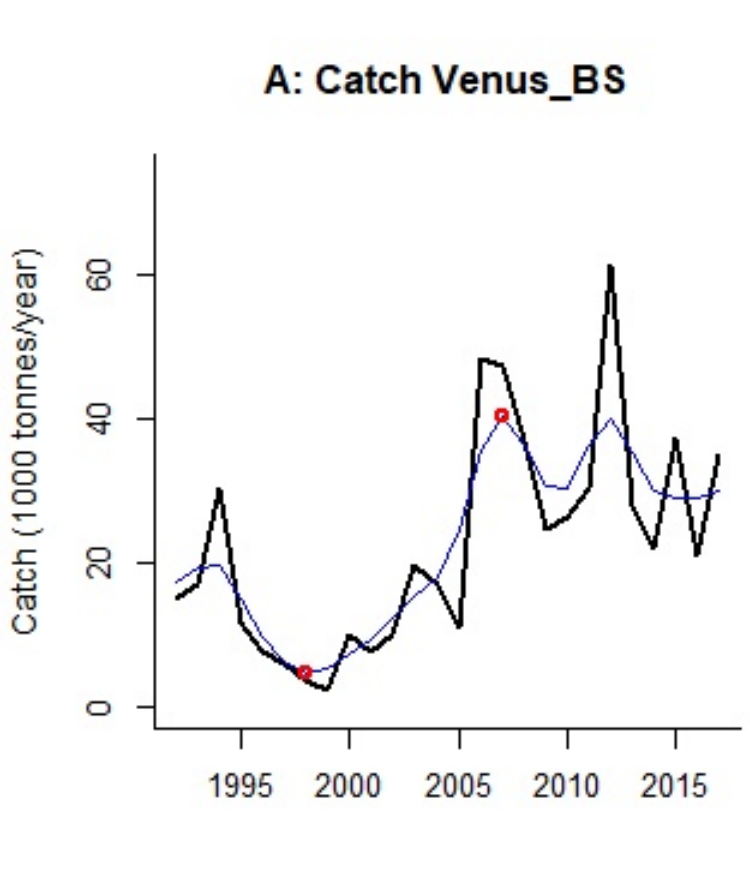

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
2.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

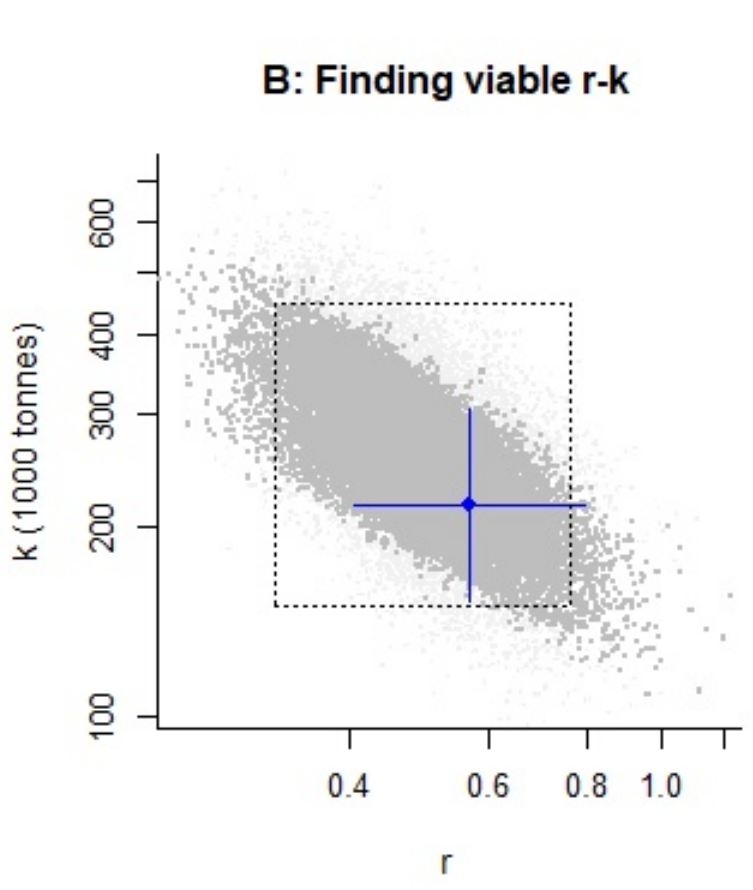

Catch
Catch (1000 tonnes/year)
0
2
4
6
8
MSY
1980
1990
2000
2010

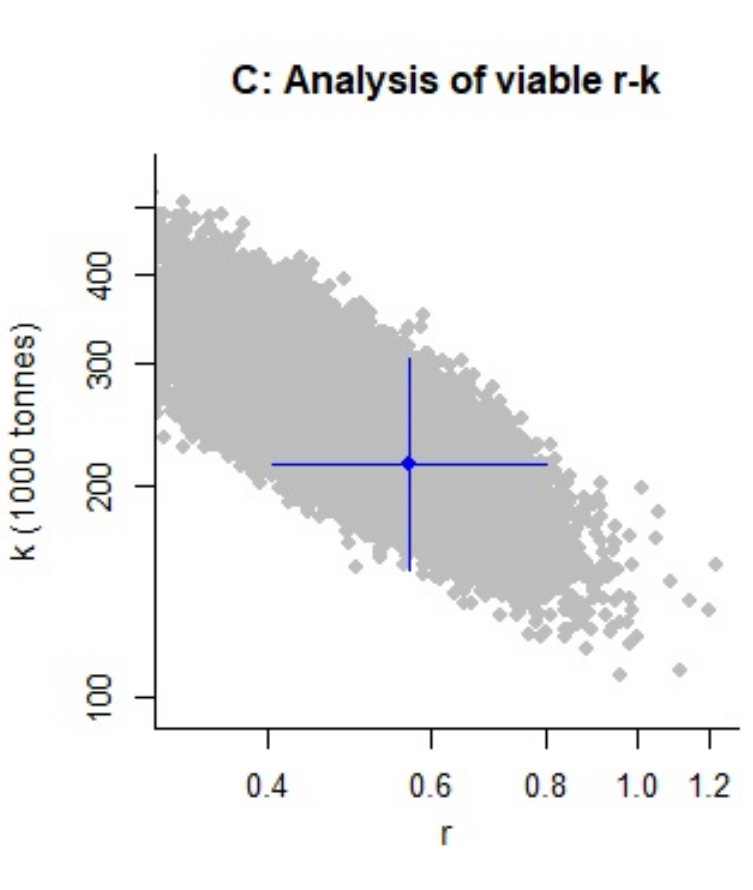

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010

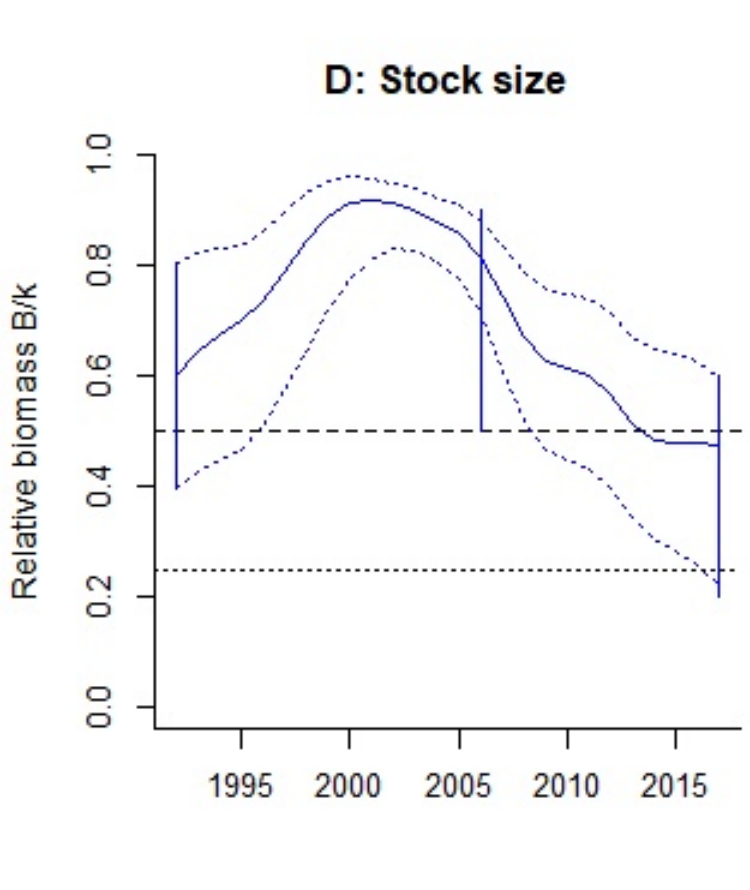

Exploitation
F / Fmsy
0
5
10
15
20
25
30
1980
1990
2000
2010

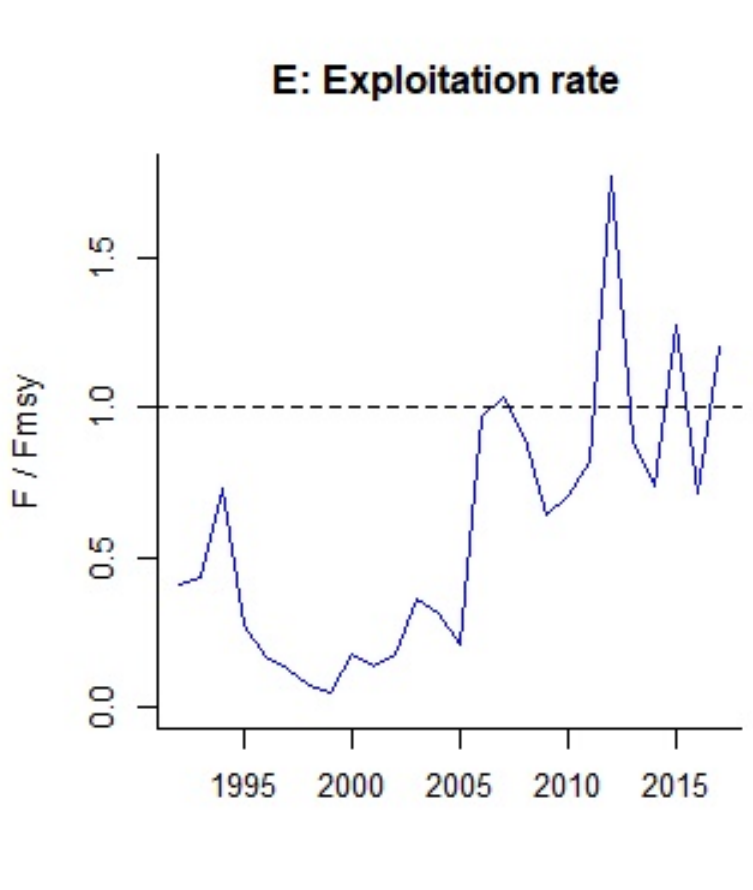

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1980
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

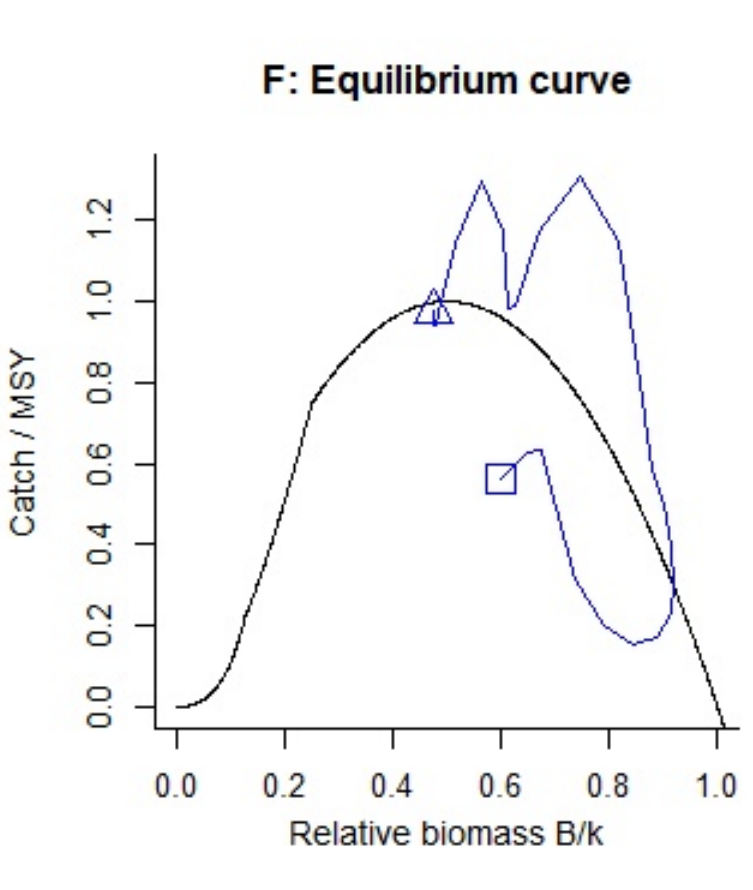

A: Catch Venus_BS
Catch (1000 tonnes/year)
0
20
40
60
1995
2000
2005
2010
2015

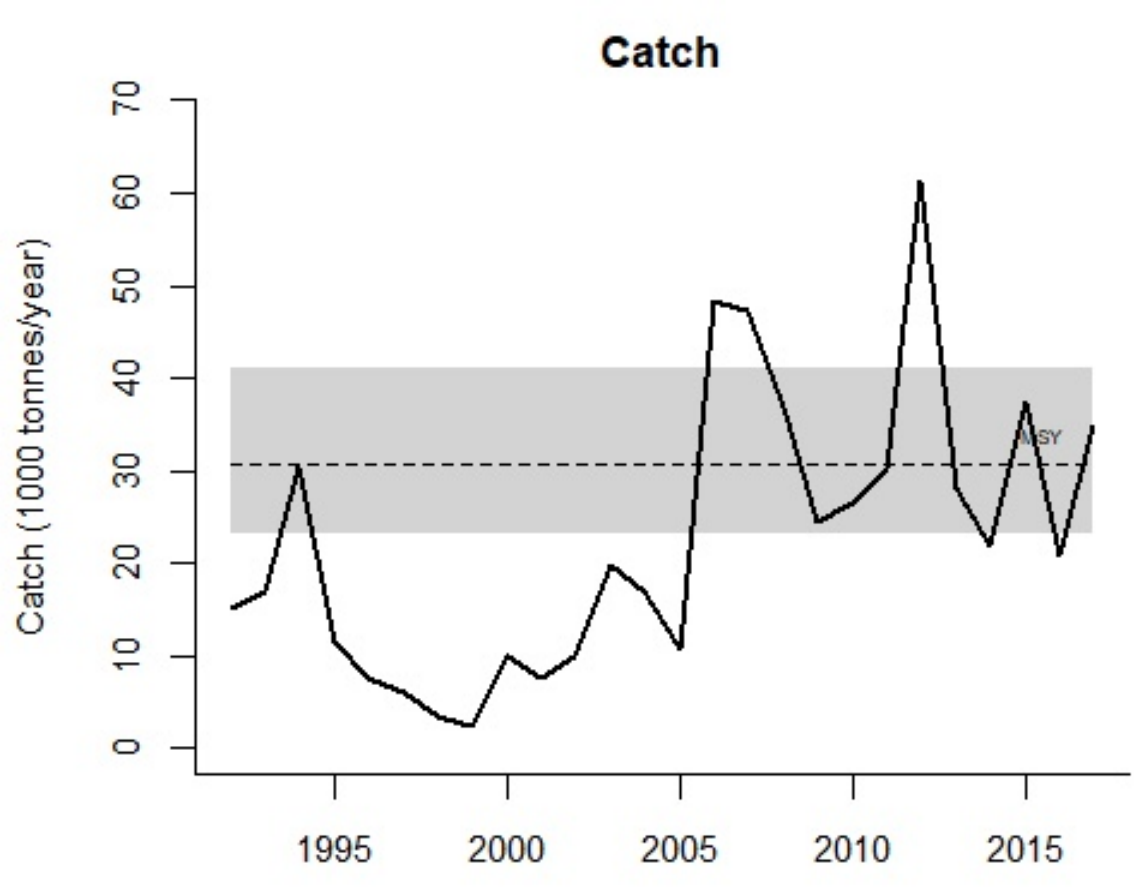

B: Finding viable r-k
k (1000 tonnes)
100
200
300
400
600
0.4
0.6
0.8
1.0
r

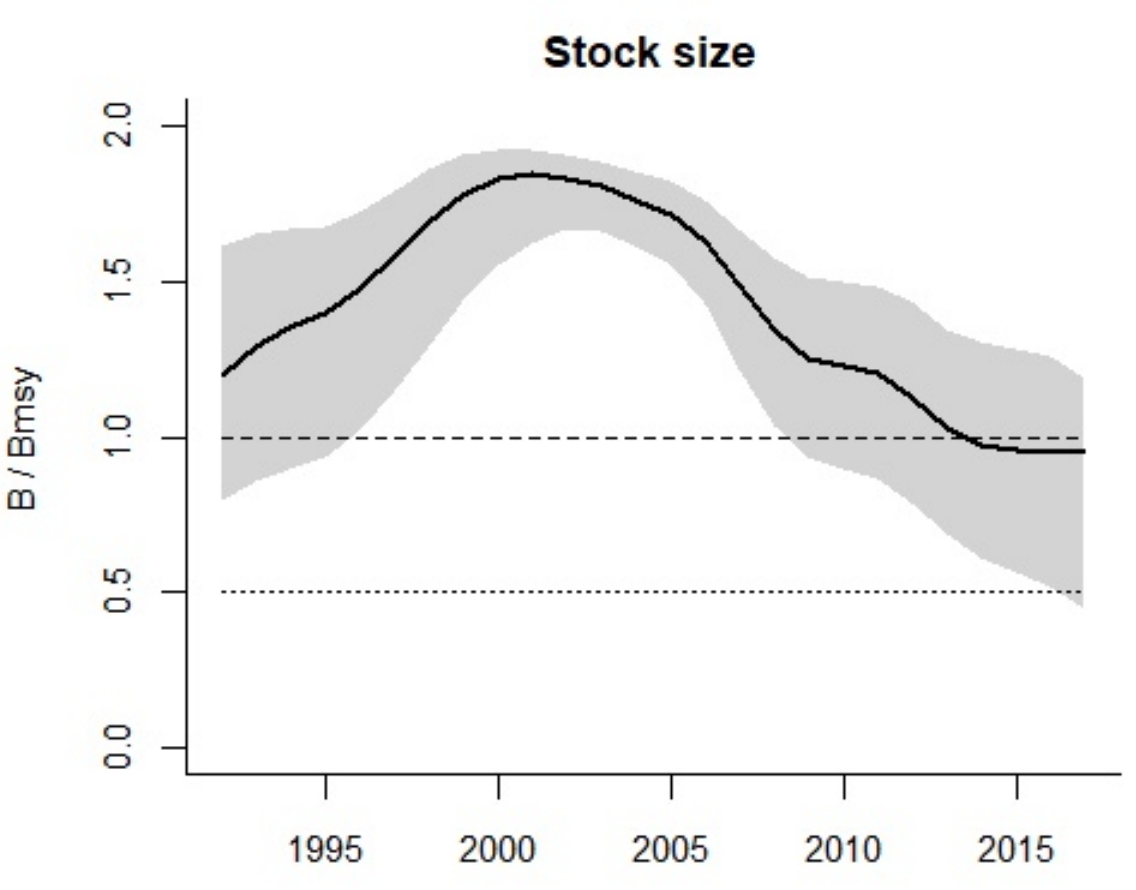

C: Analysis of viable r-k
k (1000 tonnes)
100
200
300
400
0.4
0.6
0.8
1.0
1.2
r

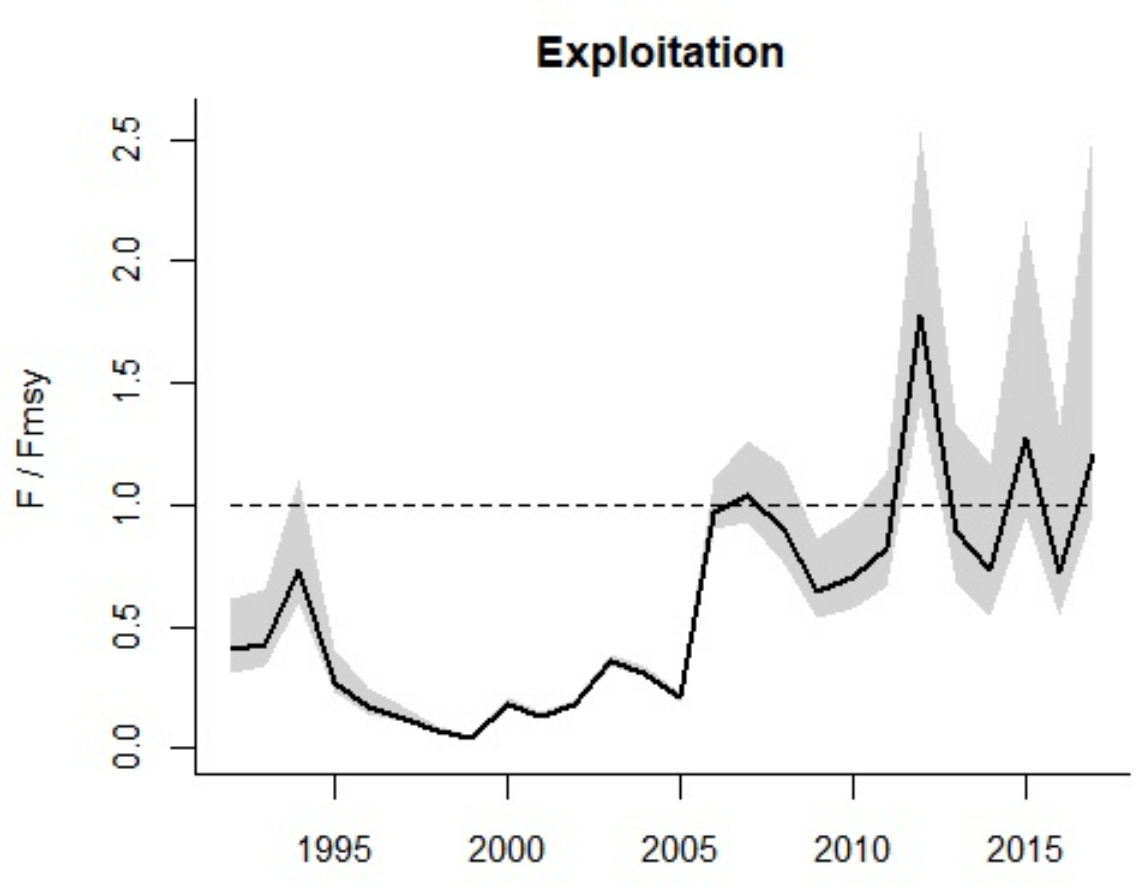

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1995
2000
2005
2010
2015

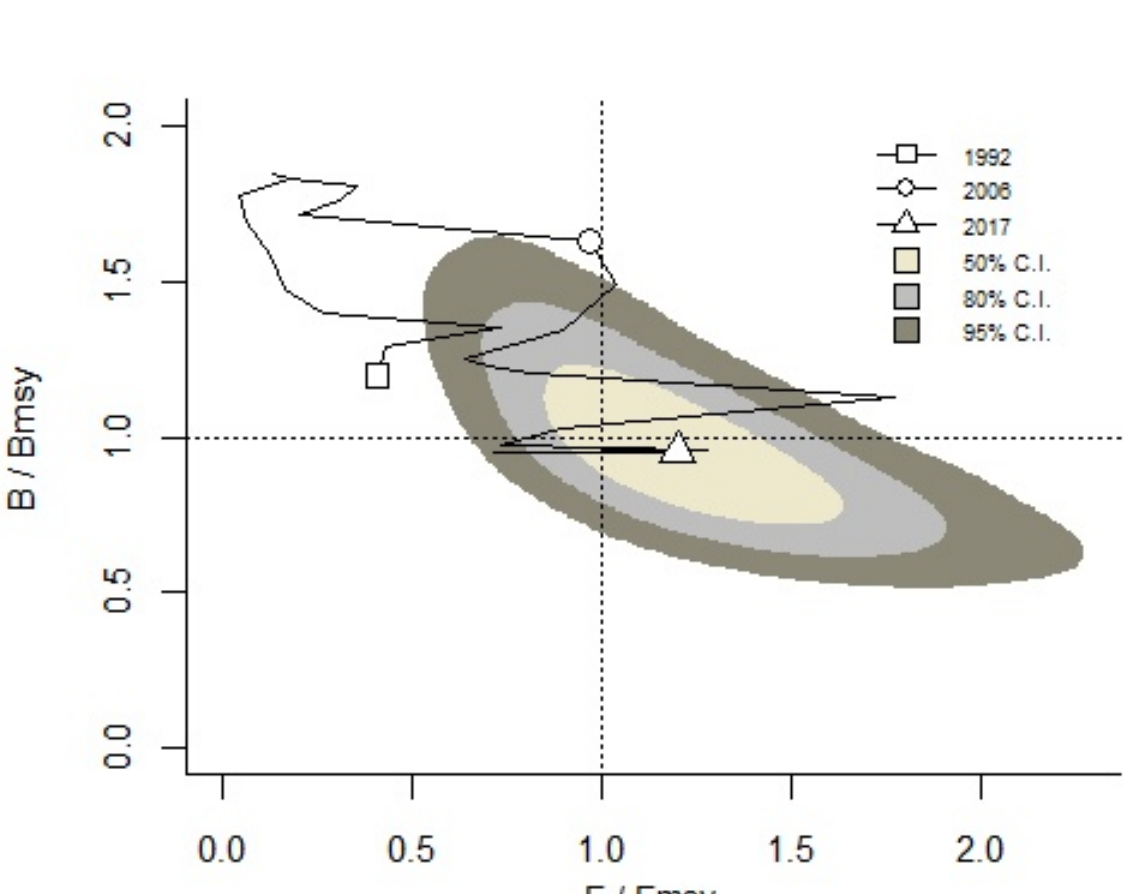

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
1995
2000
2005
2010
2015

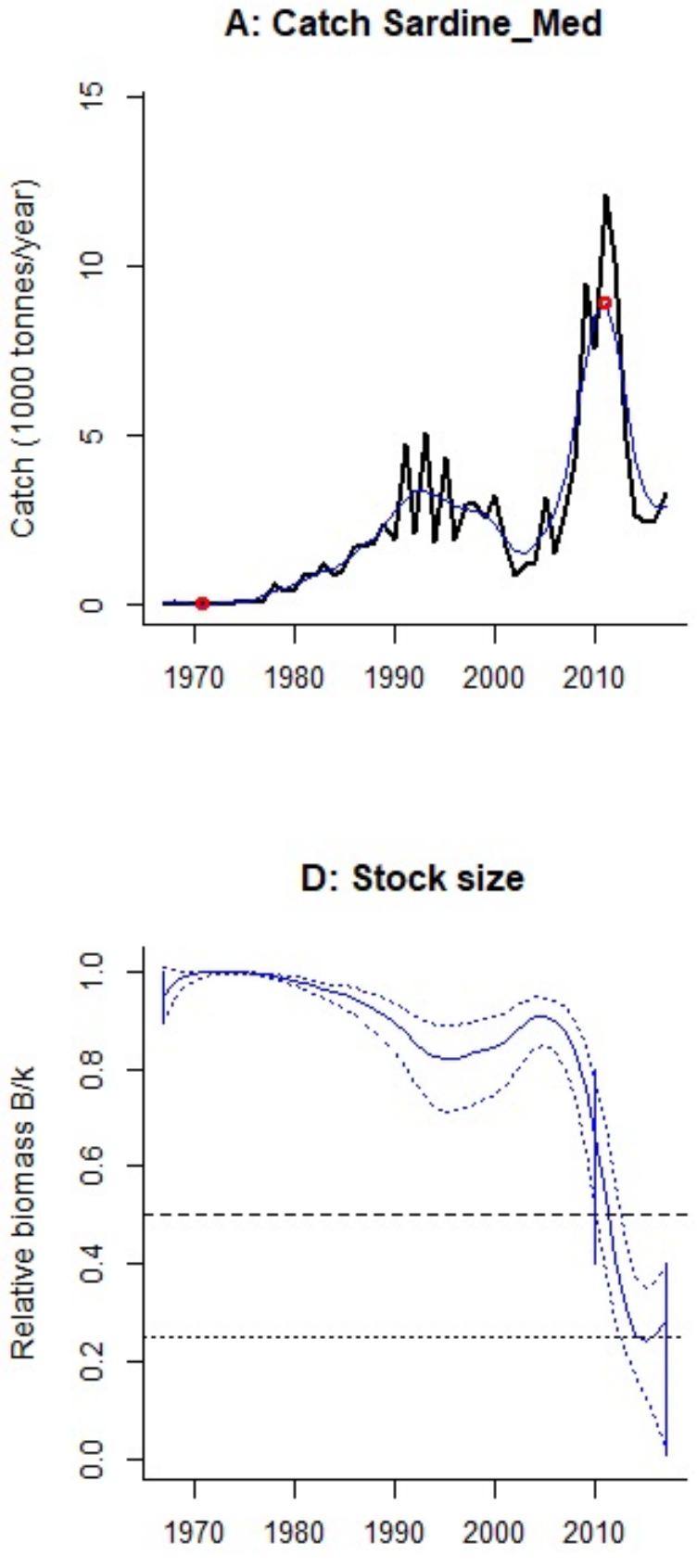

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

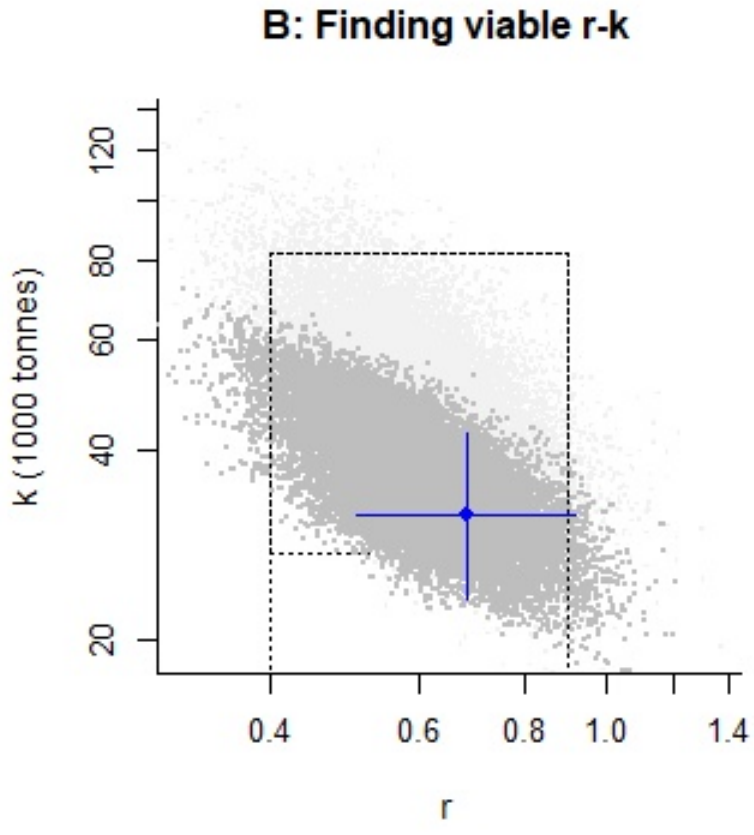

Catch
Catch (1000 tonnes/year)
0
10
20
30
40
50
60
70
MSY
1995
2000
2005
2010
2015

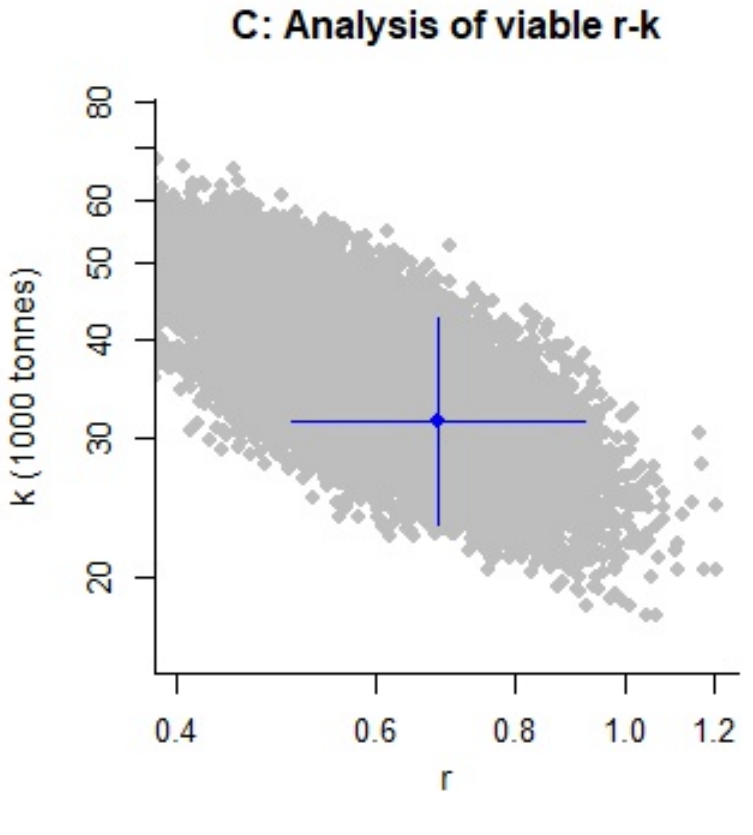

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1995
2000
2005
2010
2015


Exploitation
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1995
2000
2005
2010
2015

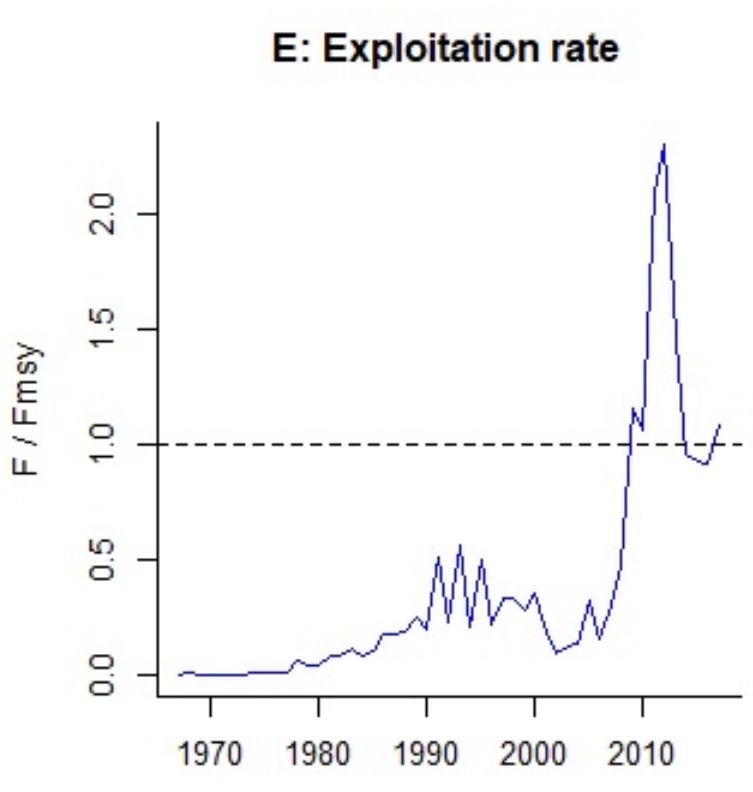

B / Bmsy
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1992
2006
2017
50% C.I.
80% C.I.
95% C.I.

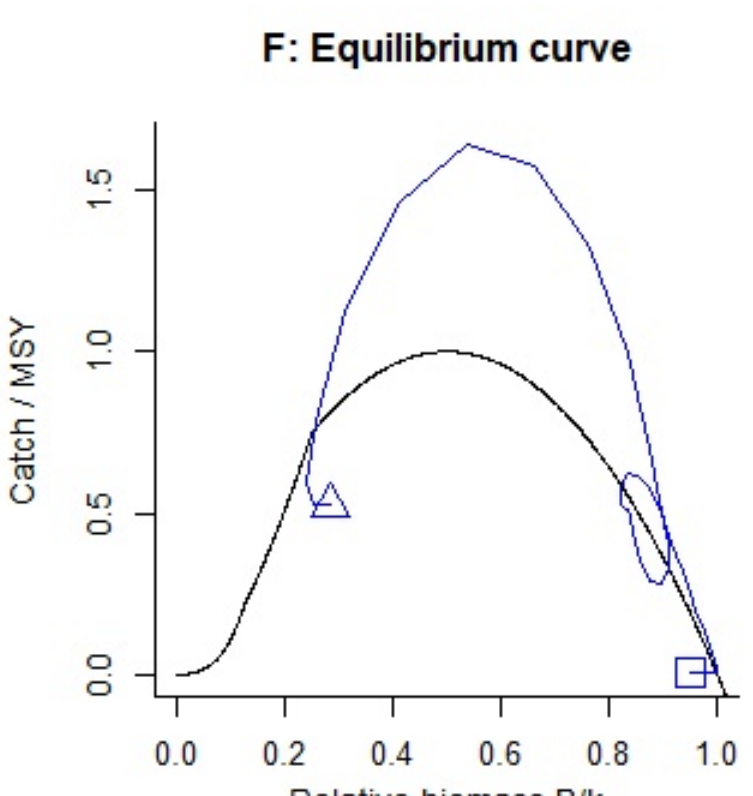

A: Catch Sardine_Med
Catch (1000 tonnes/year)
0
5
10
15
1970
1980
1990
2000
2010

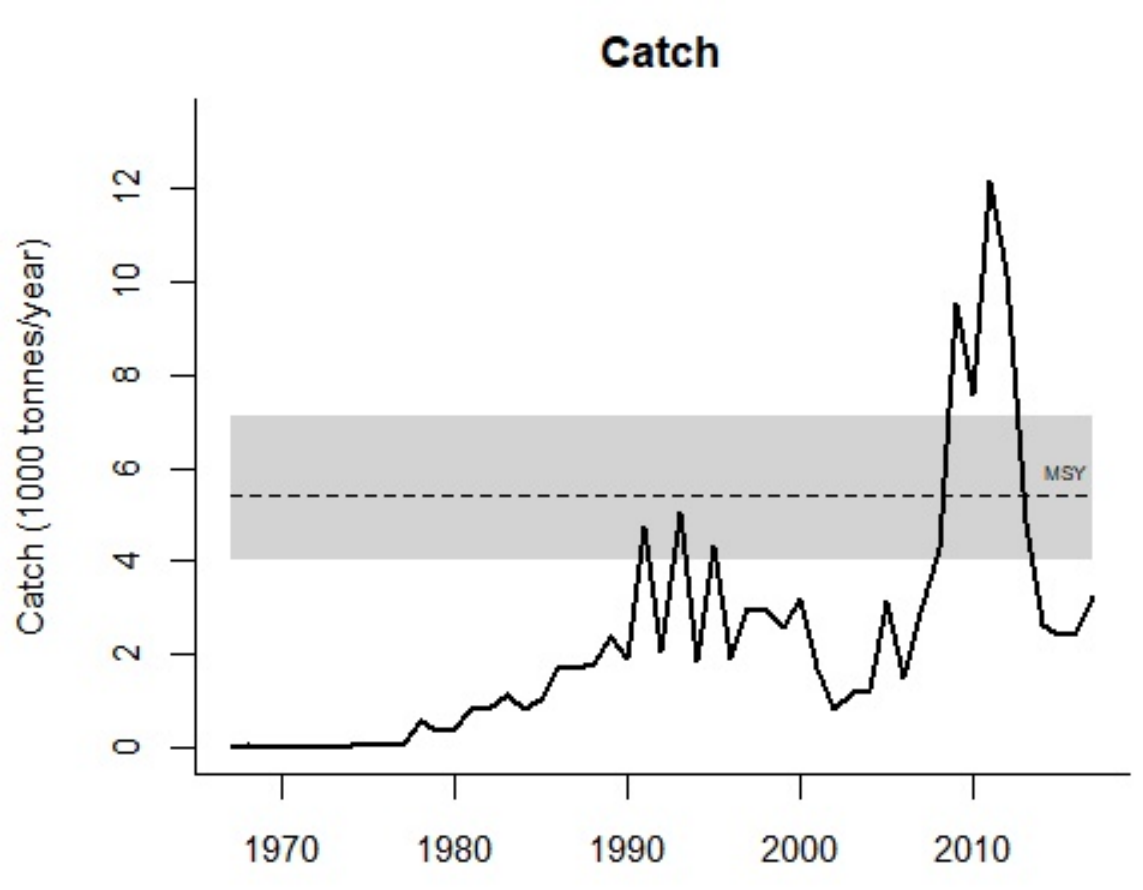

B: Finding viable r-k
k (1000 tonnes)
20
40
60
80
120
0.4
0.6
0.8
1.0
1.4
r

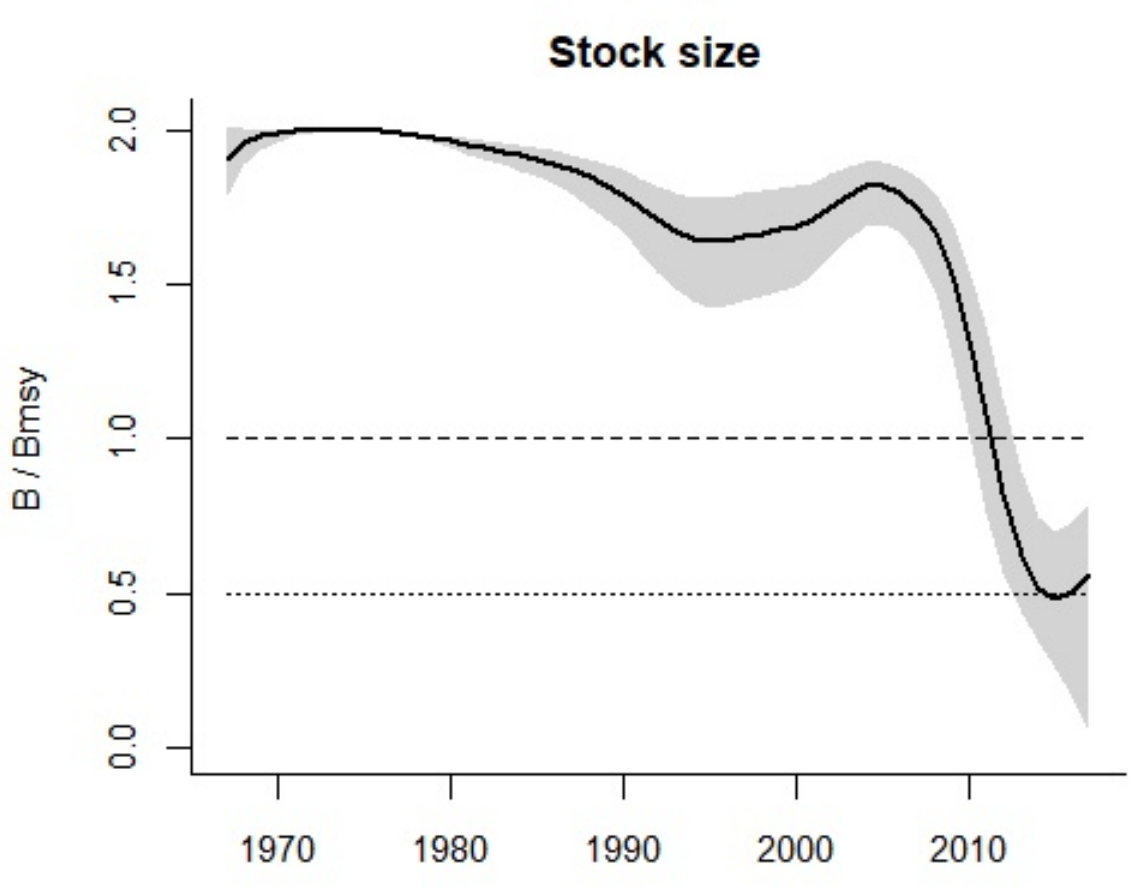

C: Analysis of viable r-k
k (1000 tonnes)
20
30
40
50
60
80
0.4
0.6
0.8
1.0
1.2
r

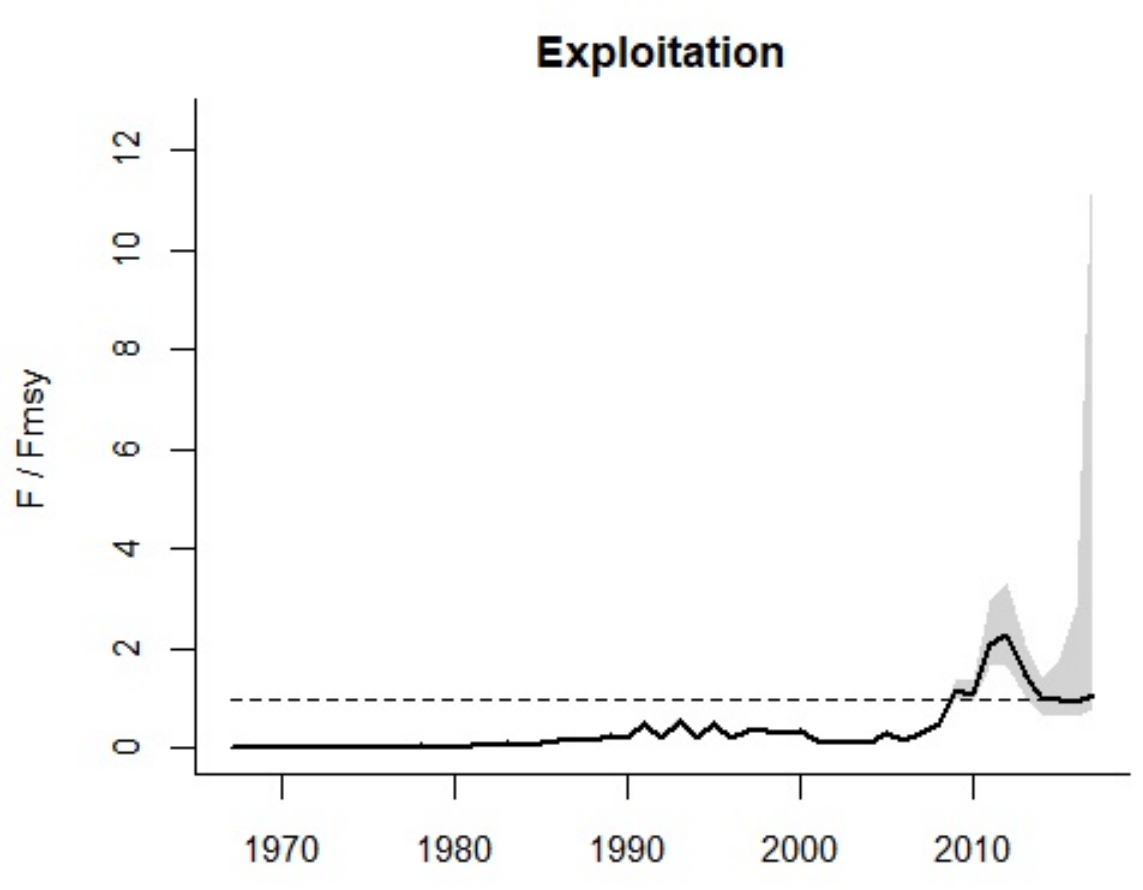
D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

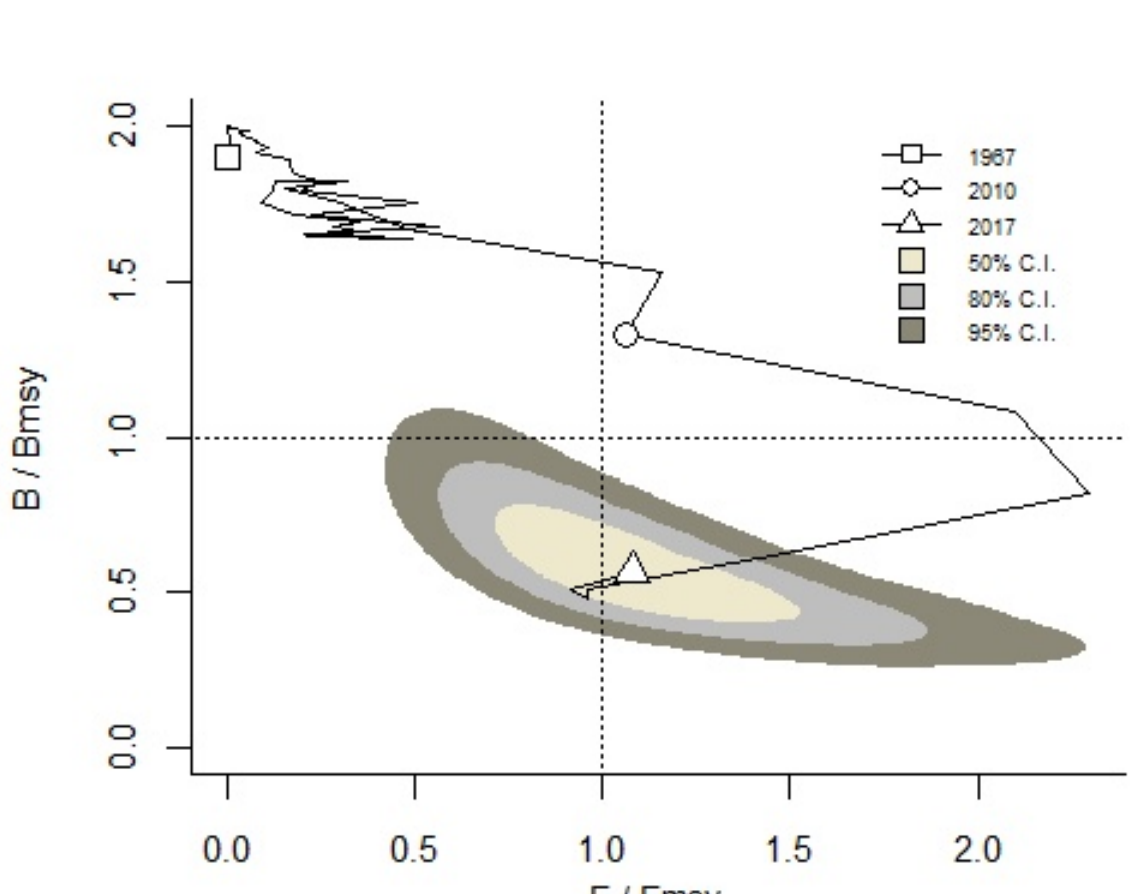

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

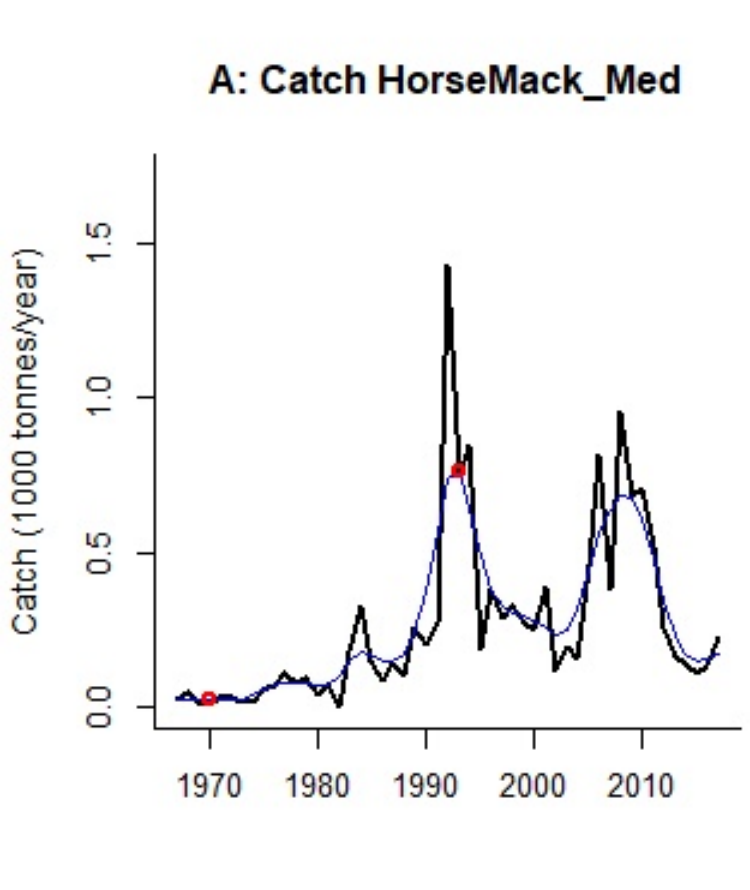

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

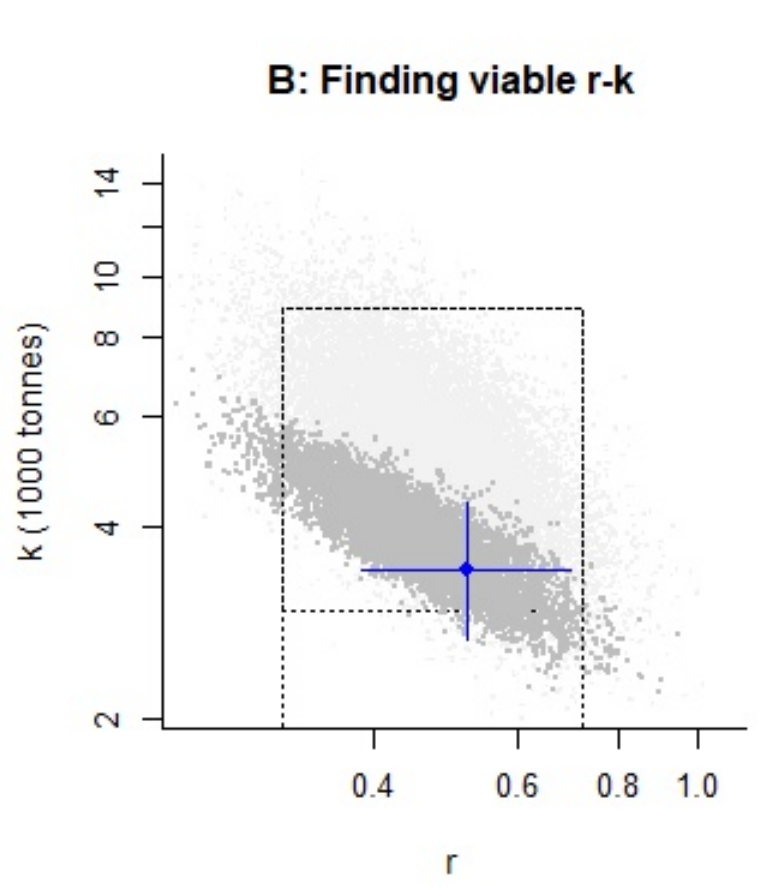

Catch
Catch (1000 tonnes/year)
0
2
4
6
8
10
12
MSY
1970
1980
1990
2000
2010

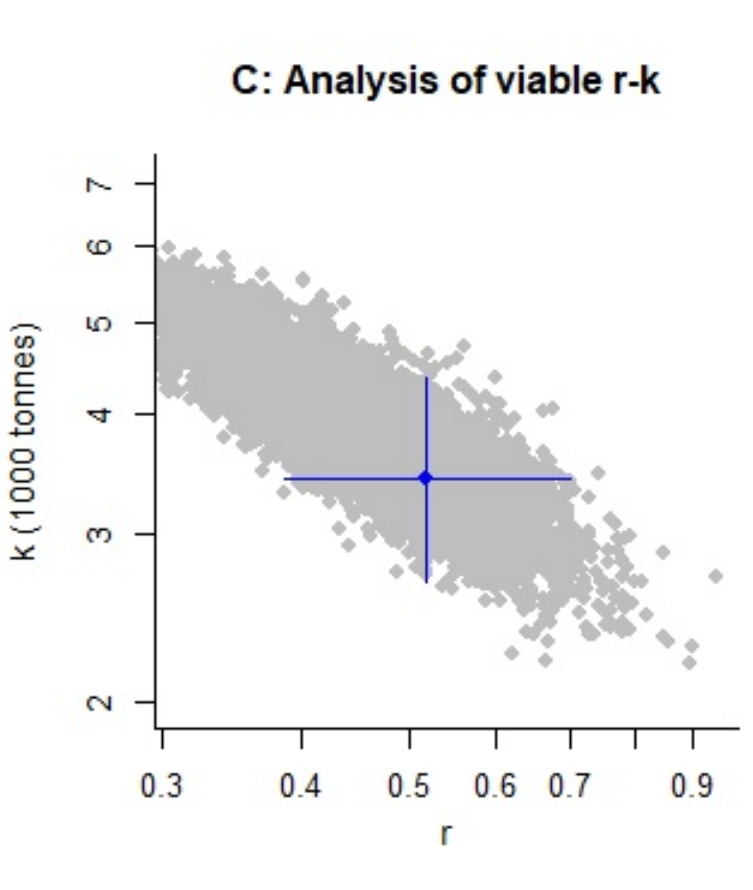

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

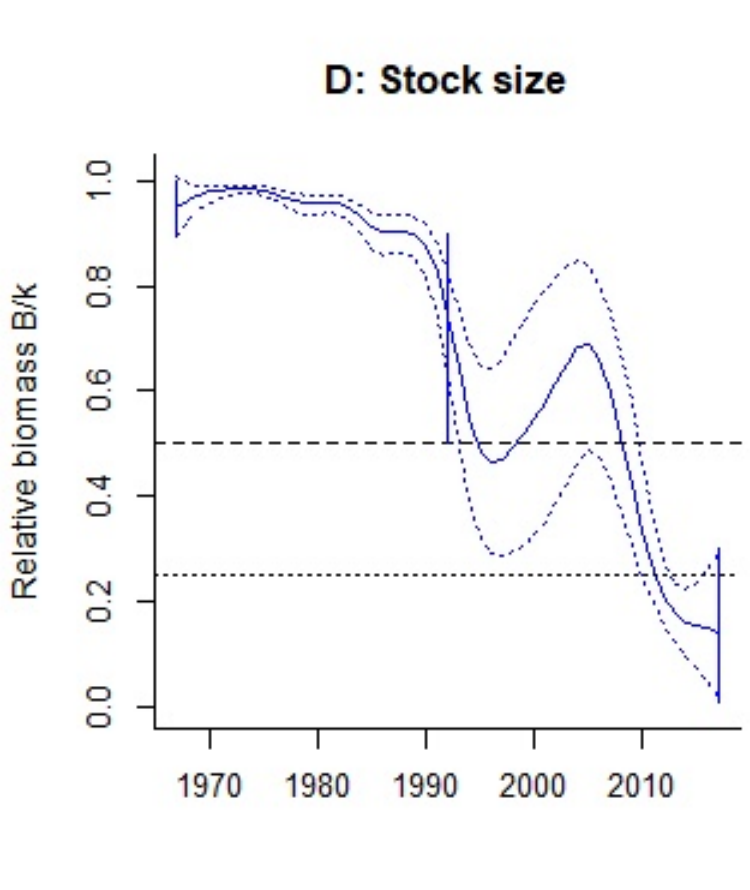

Exploitation
F / Fmsy
0
2
4
6
8
10
12
1970
1980
1990
2000
2010

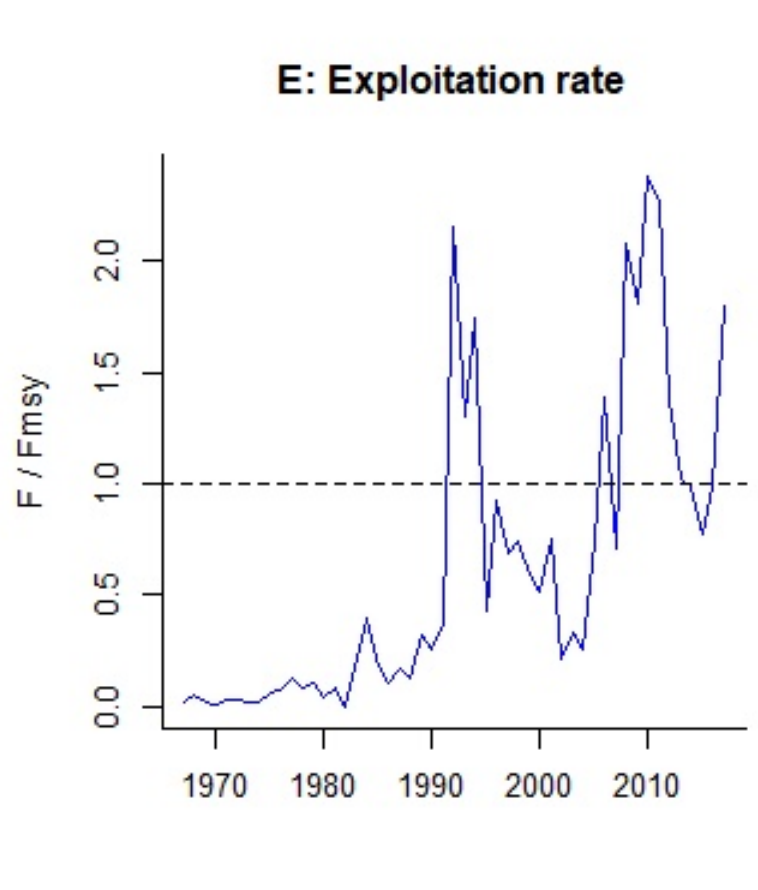

B / Bmsy
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1967
2010
2017
50% C.I.
80% C.I.
95% C.I.

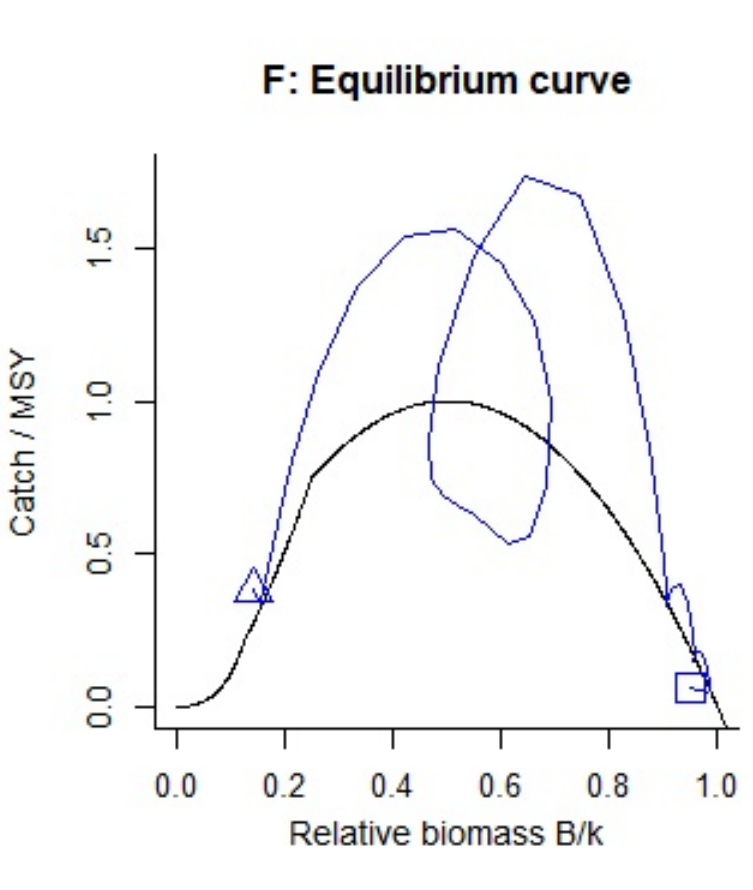

A: Catch HorseMack_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
14
0.4
0.6
0.8
1.0
r

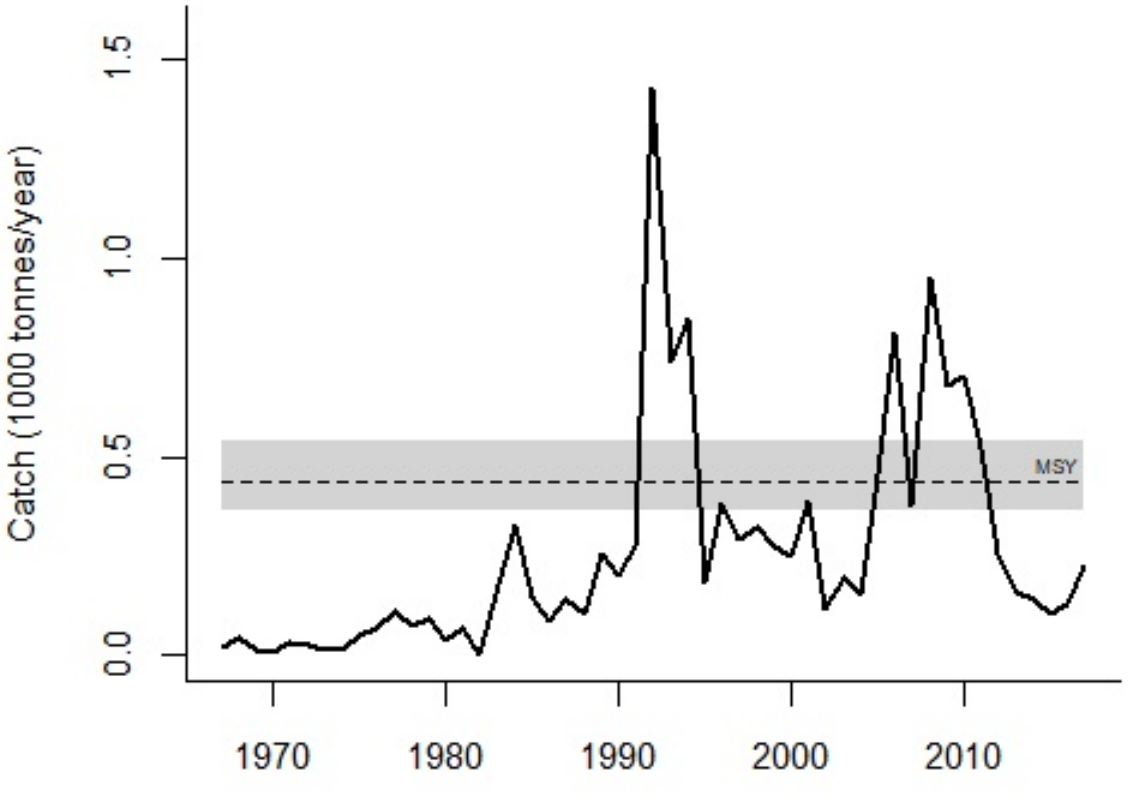

C: Analysis of viable r-k
k (1000 tonnes)
2
3
4
5
6
7
0.3
0.4
0.5
0.6
0.7
0.9
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

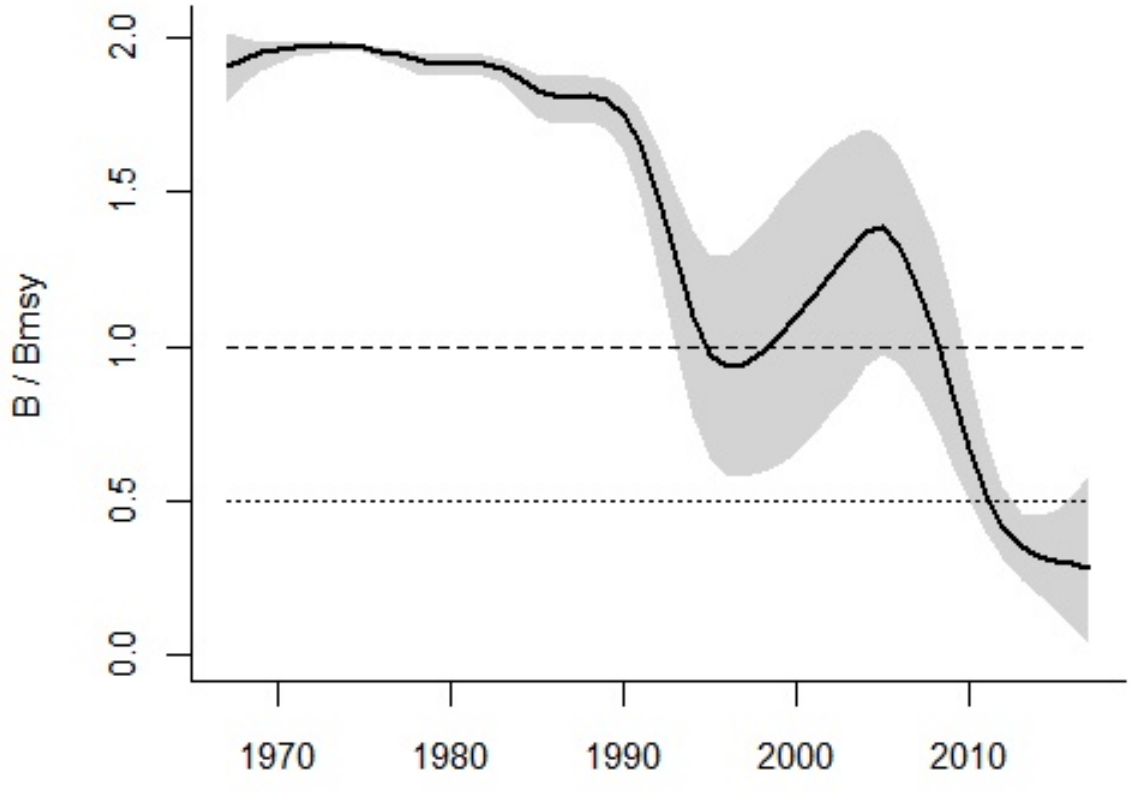

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

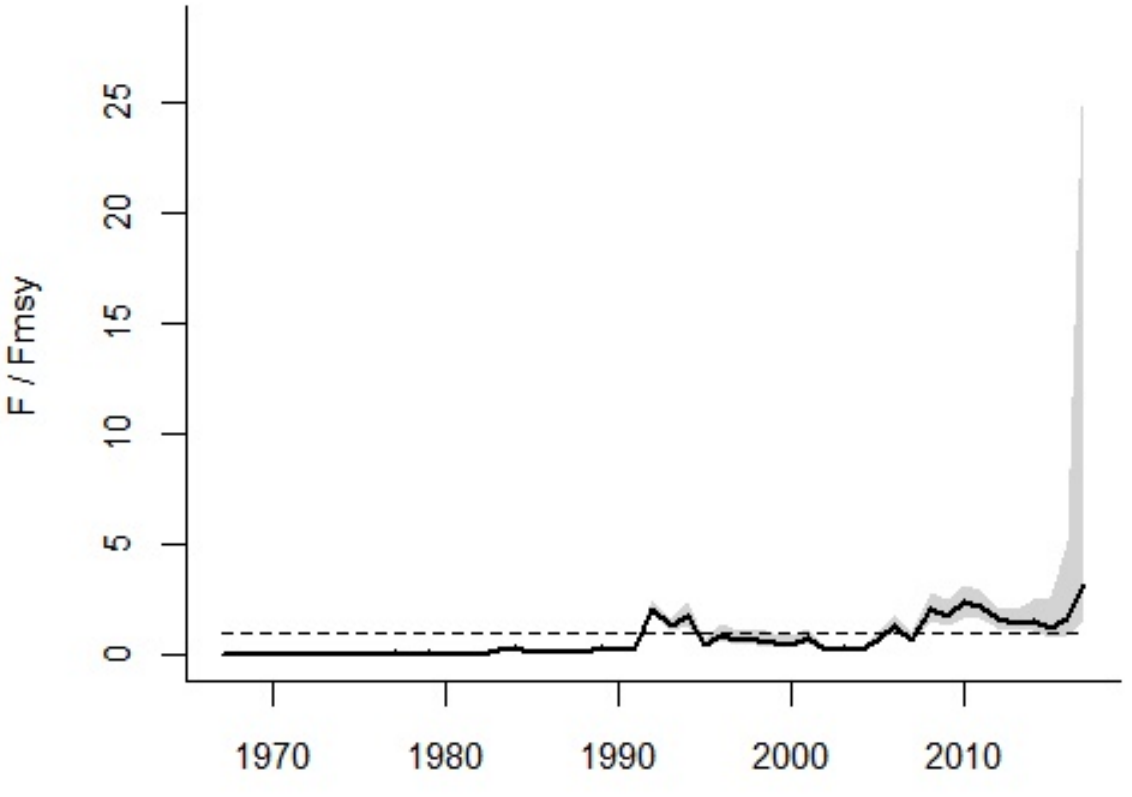
Catch

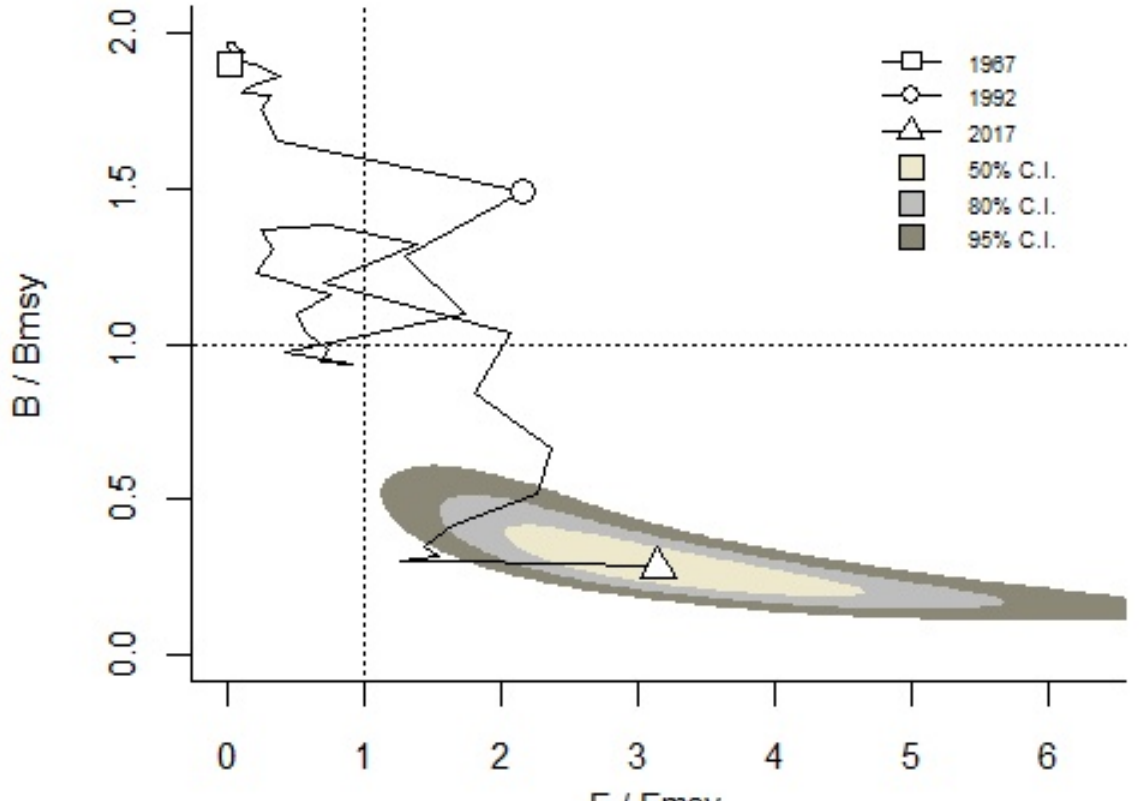


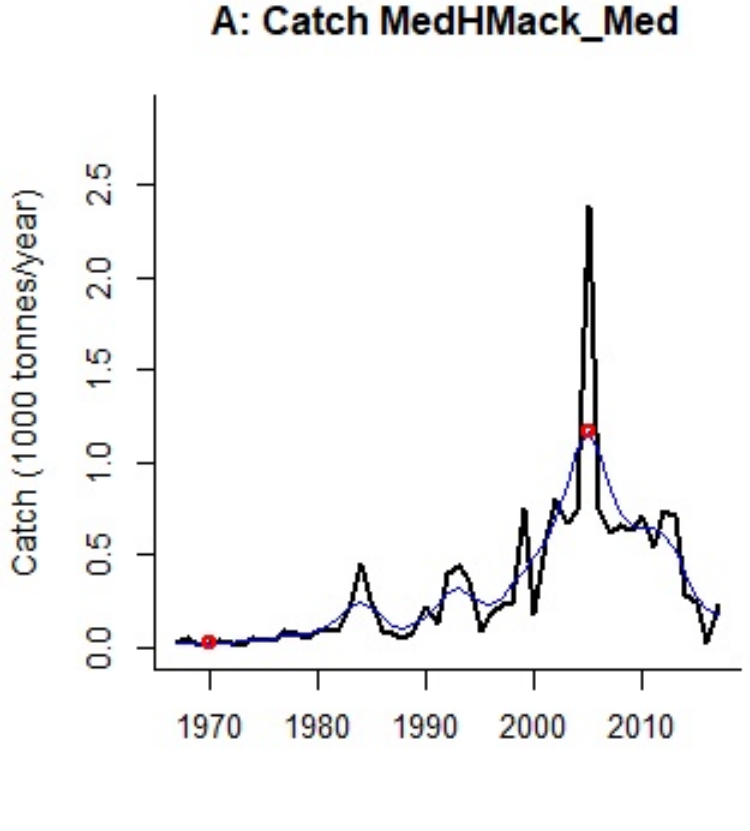
Stock size

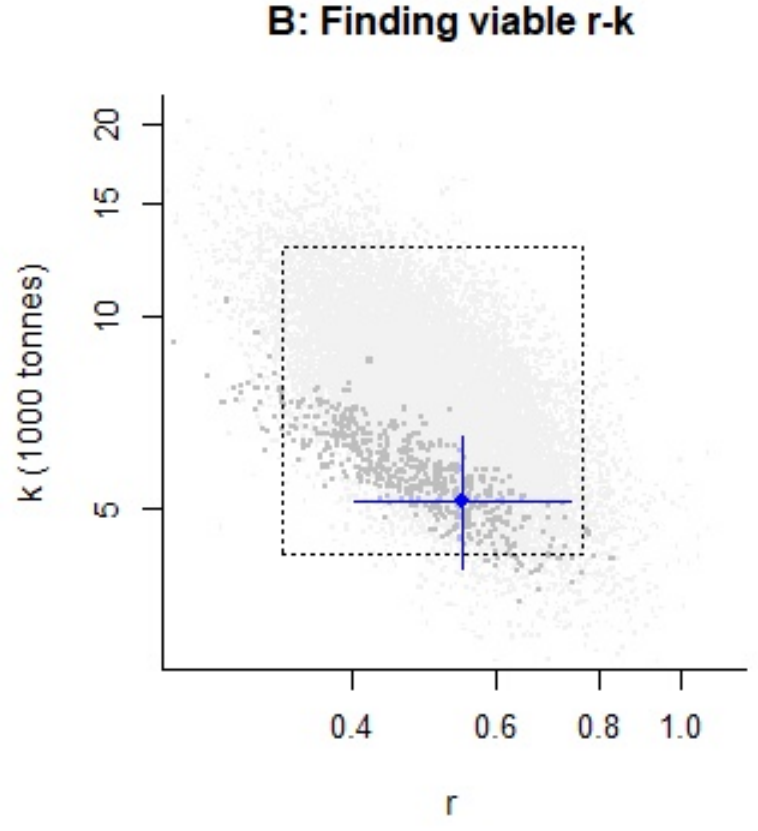


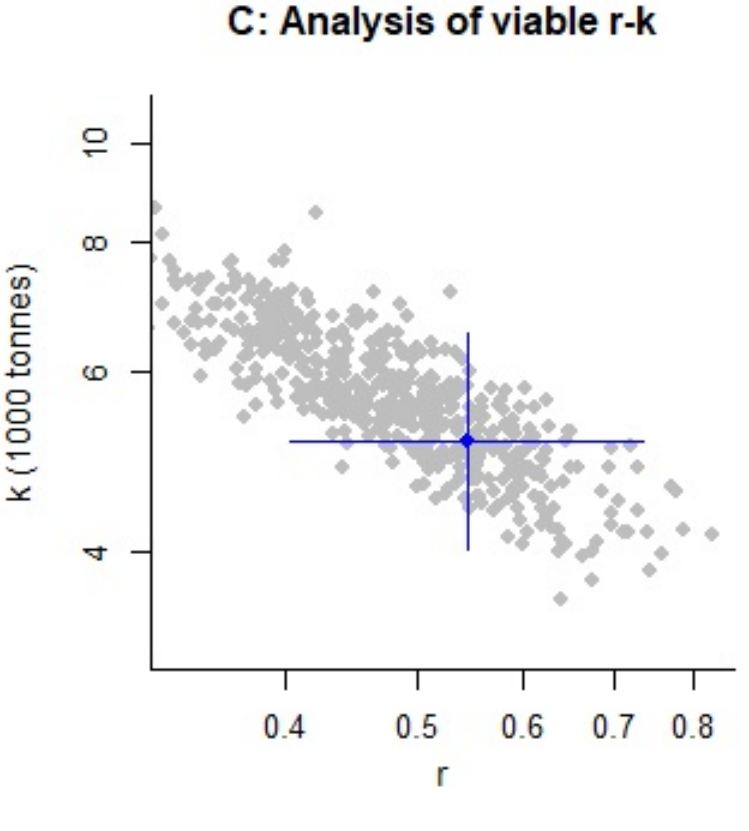
Exploitation

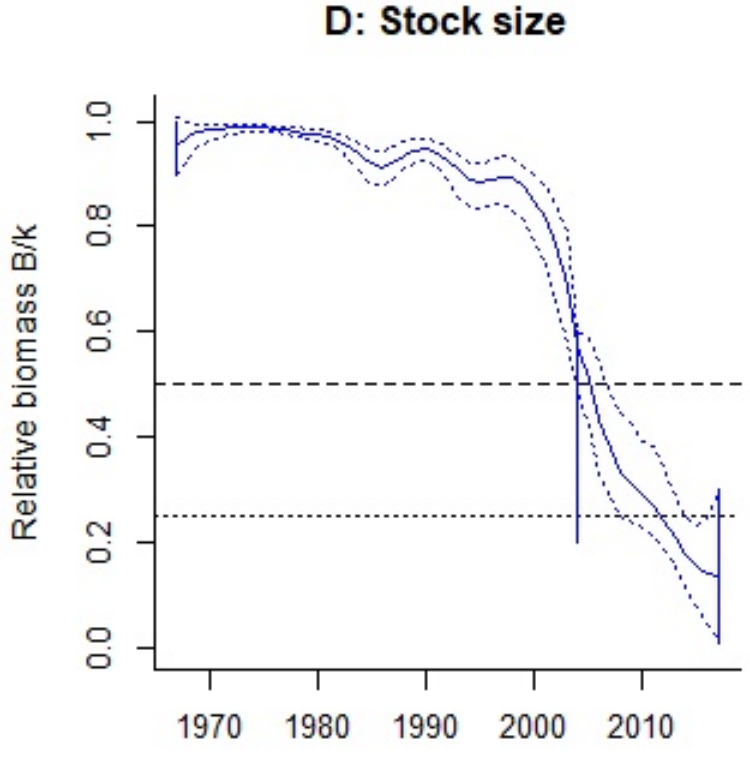


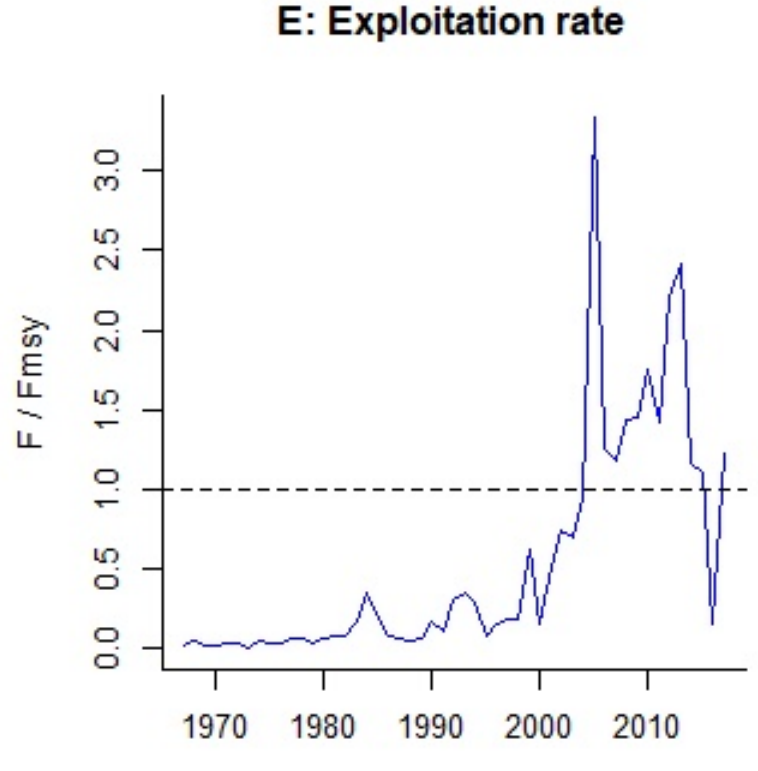


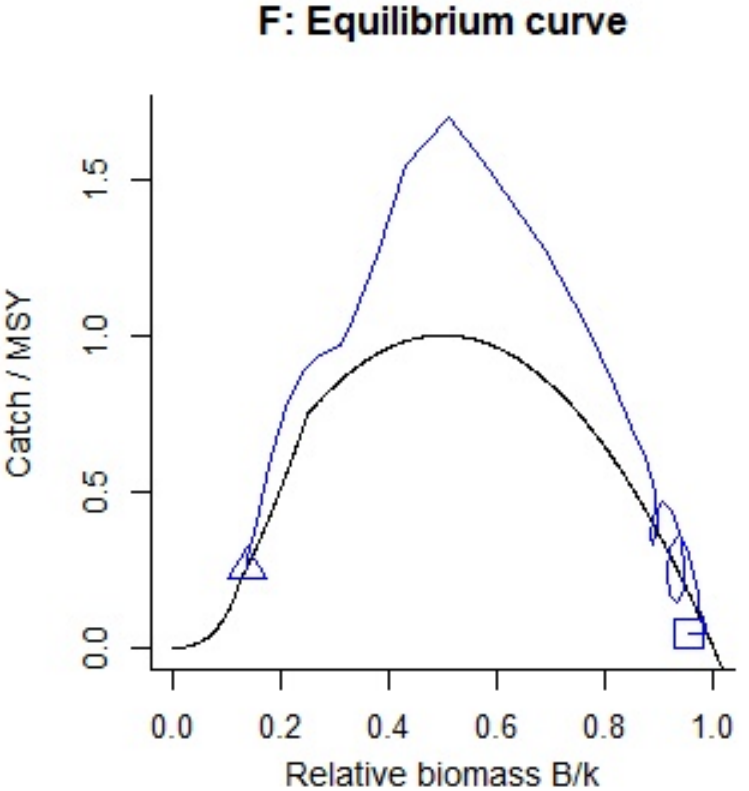

A: Catch MedHMack_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

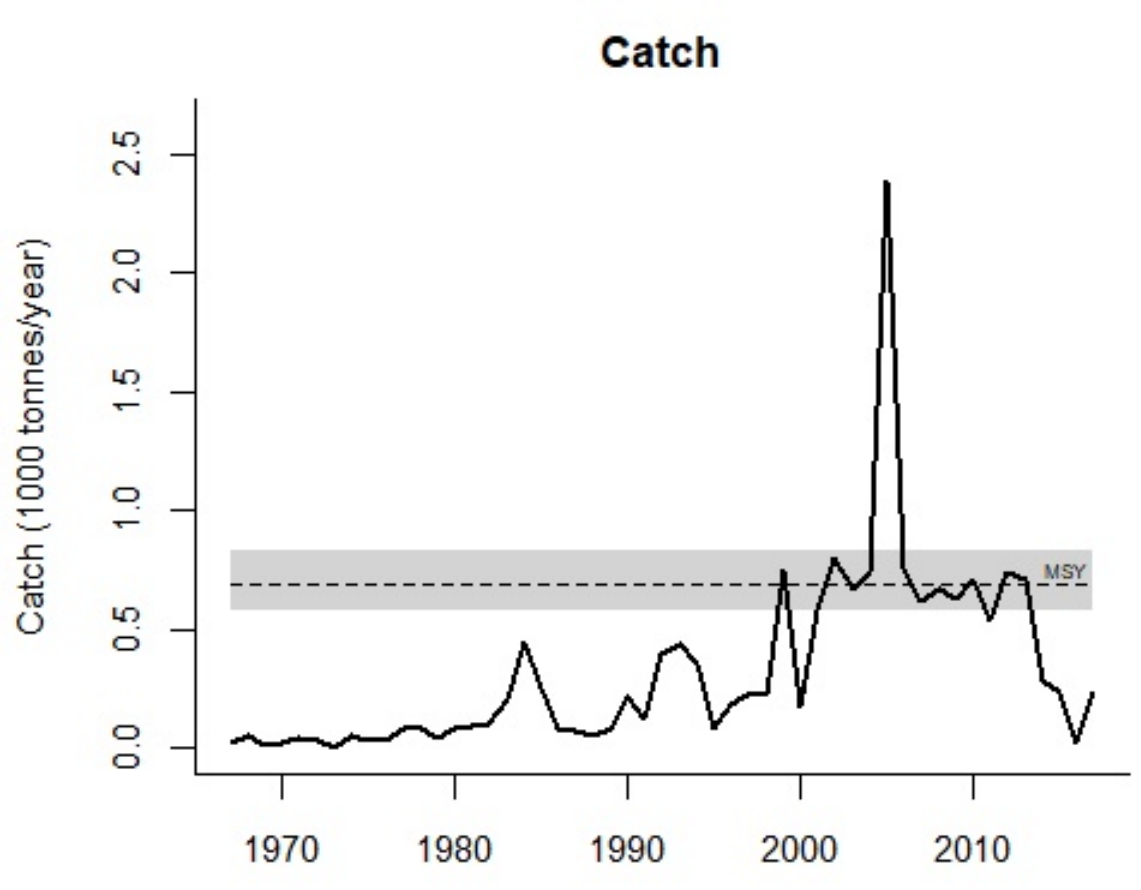

B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
0.4
0.6
0.8
1.0
r

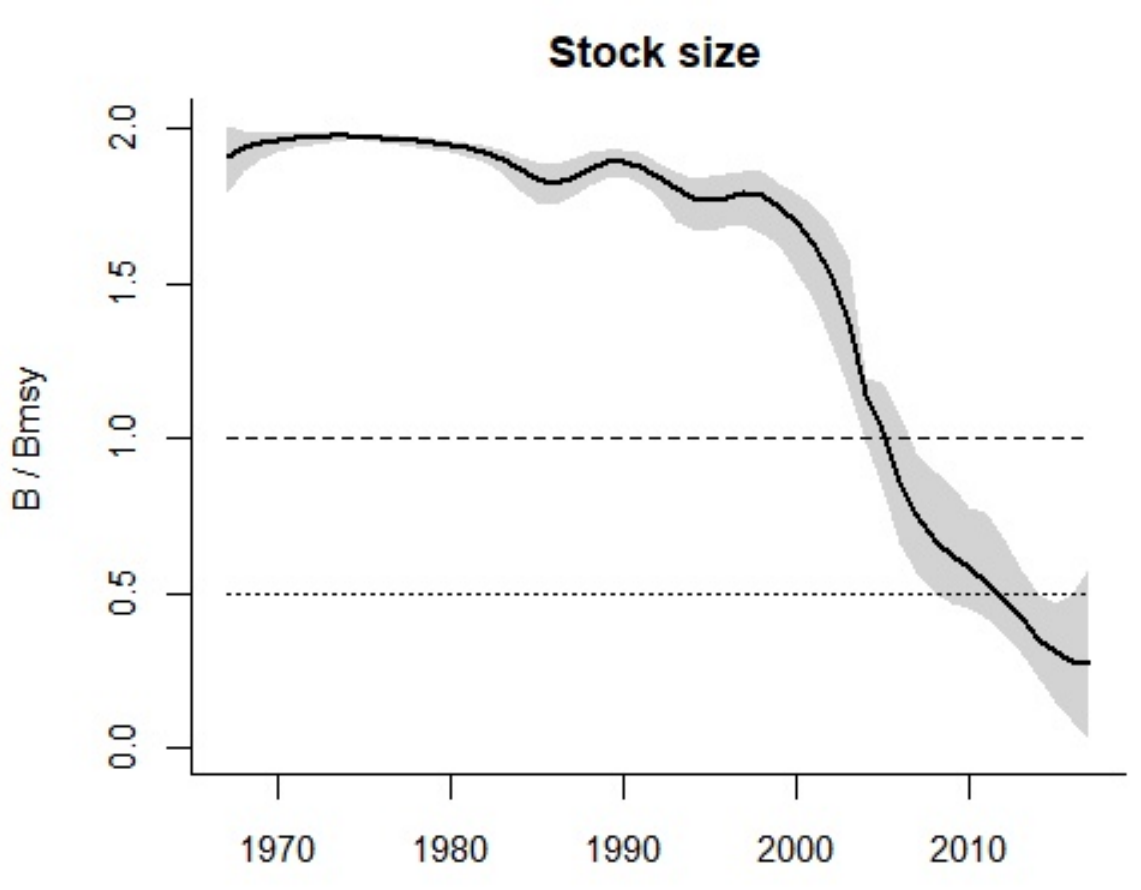

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
0.4
0.5
0.6
0.7
0.8
r

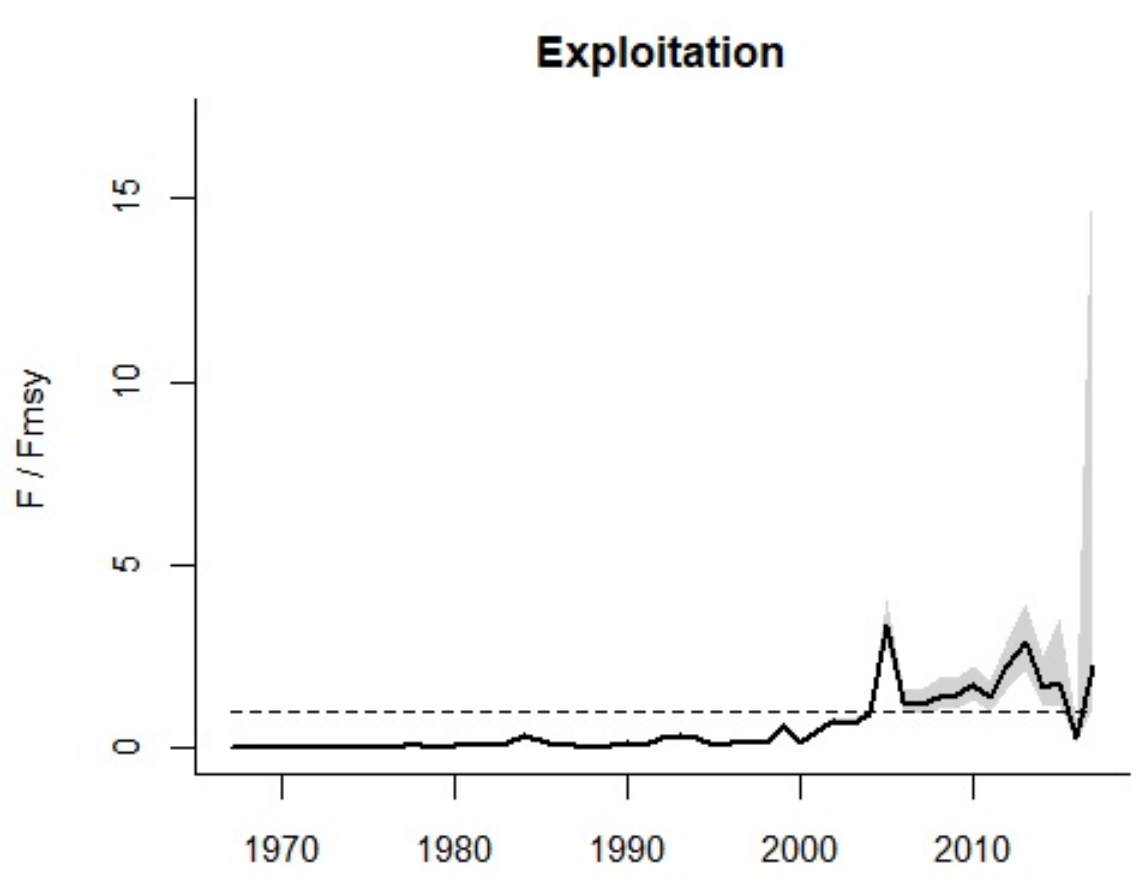

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

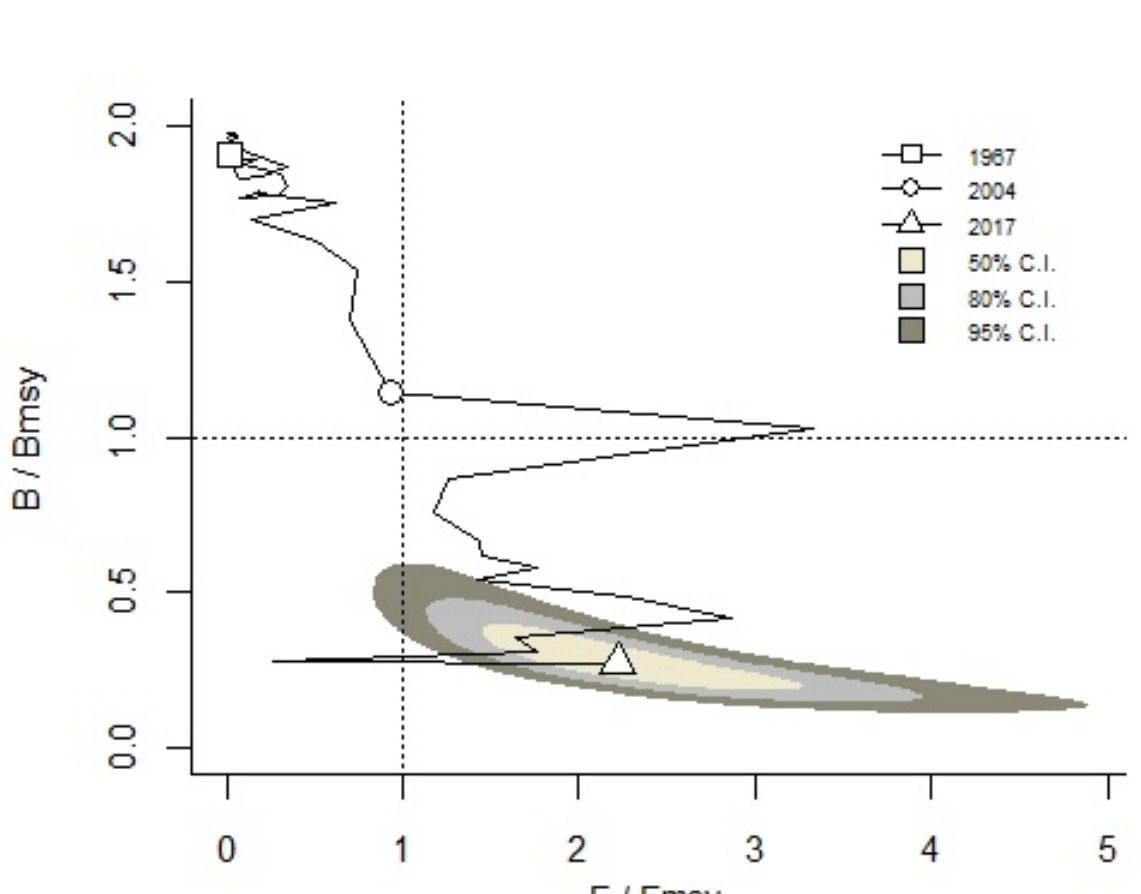

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010

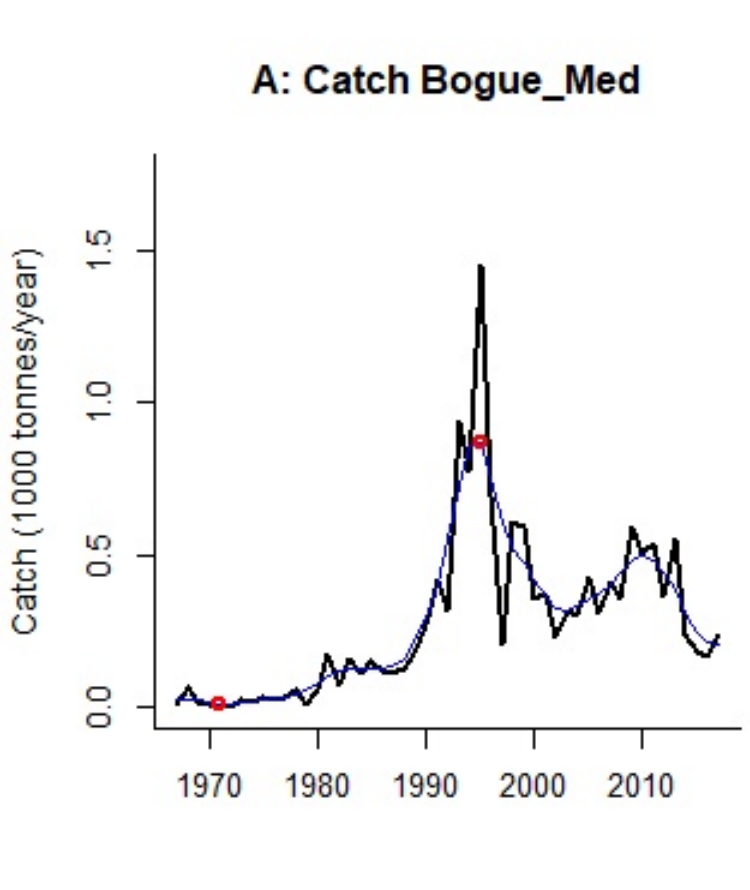

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

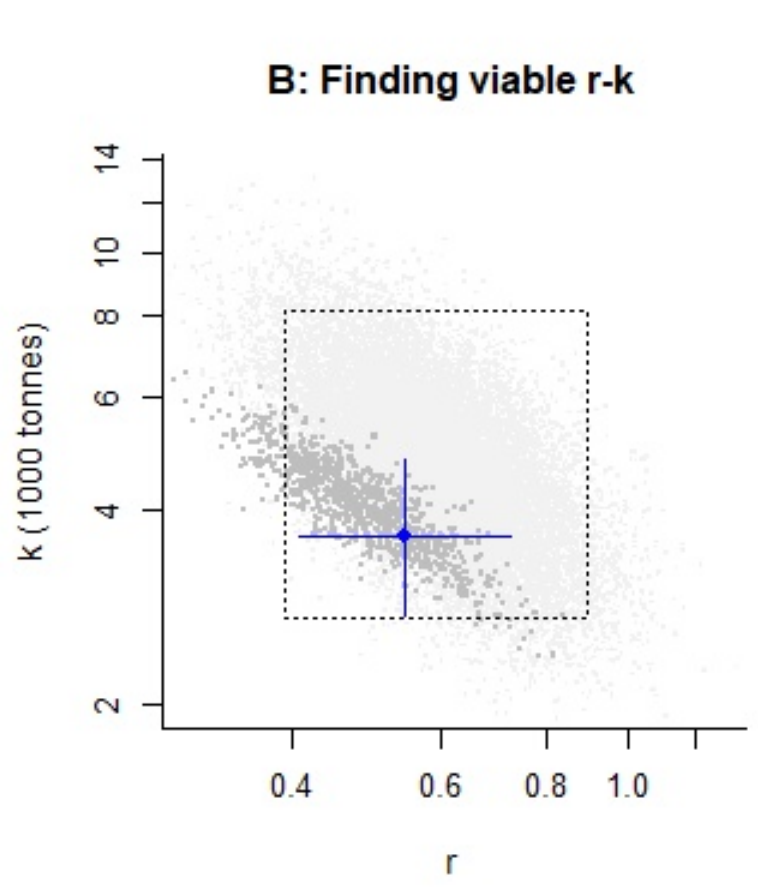

Catch
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
2.5
MSY
1970
1980
1990
2000
2010

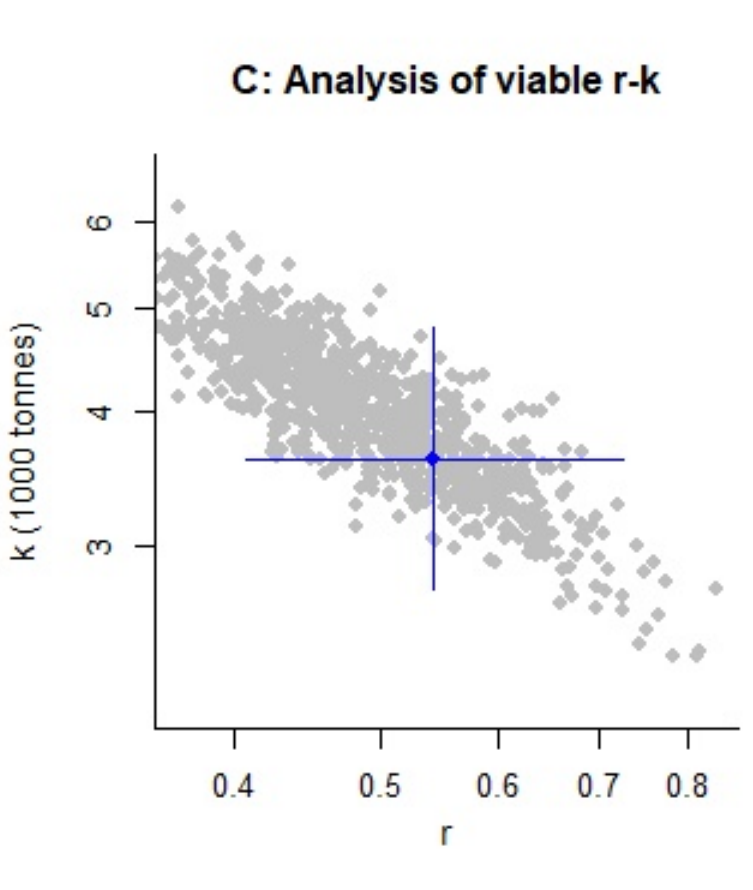

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

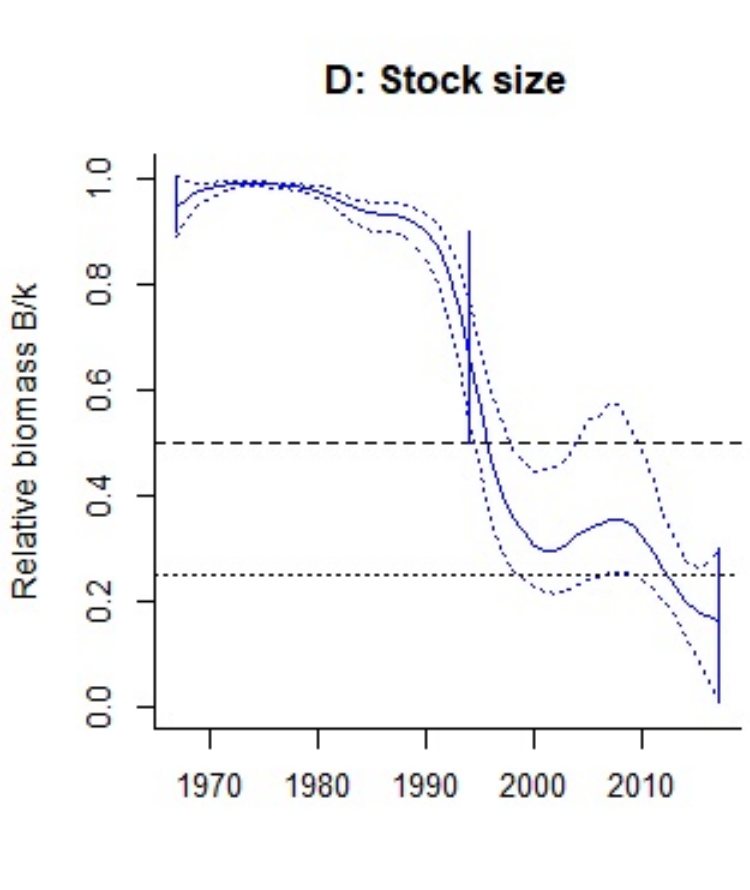

Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

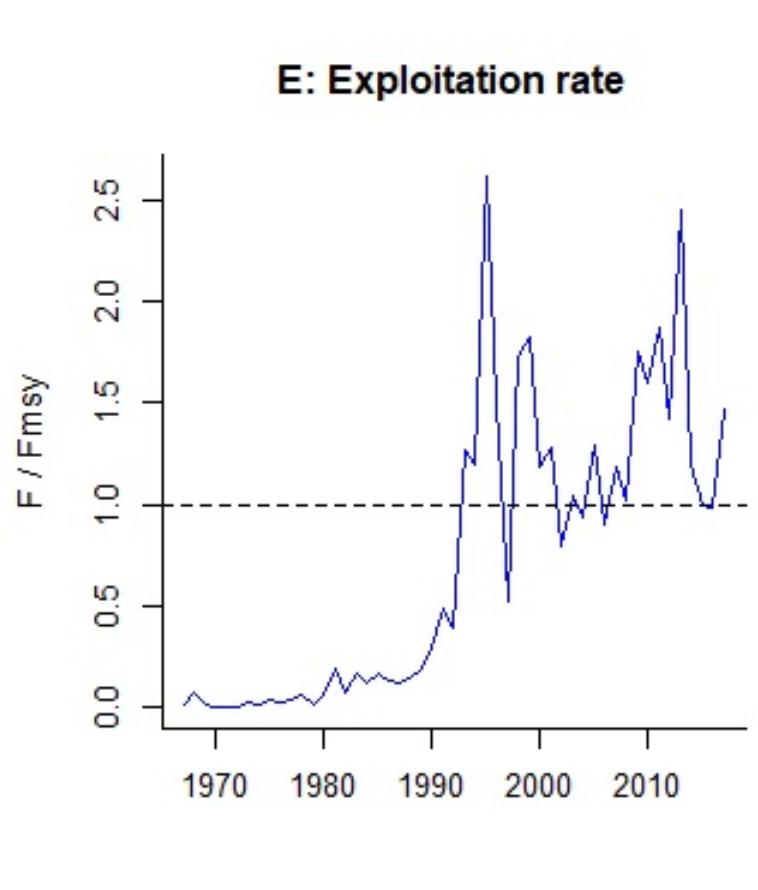

B / Bmsy
F / Fmsy
0.0
0.5
1.0
1.5
2.0
0
1
2
3
4
5
1967
2004
2017
50% C.I.
80% C.I.
95% C.I.

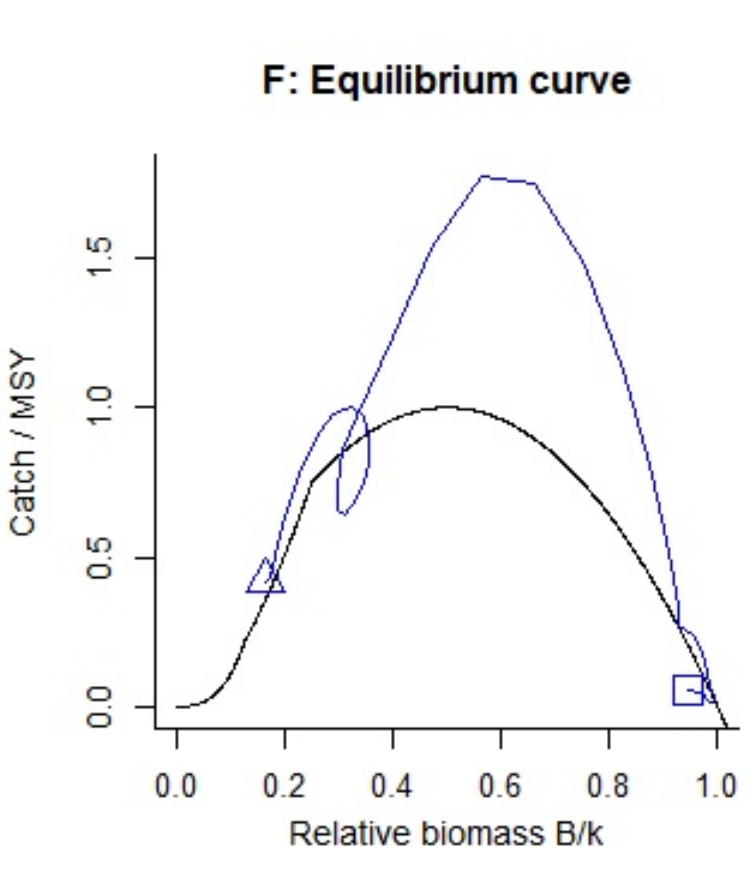

A: Catch Bogue_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
14
0.4
0.6
0.8
1.0
r

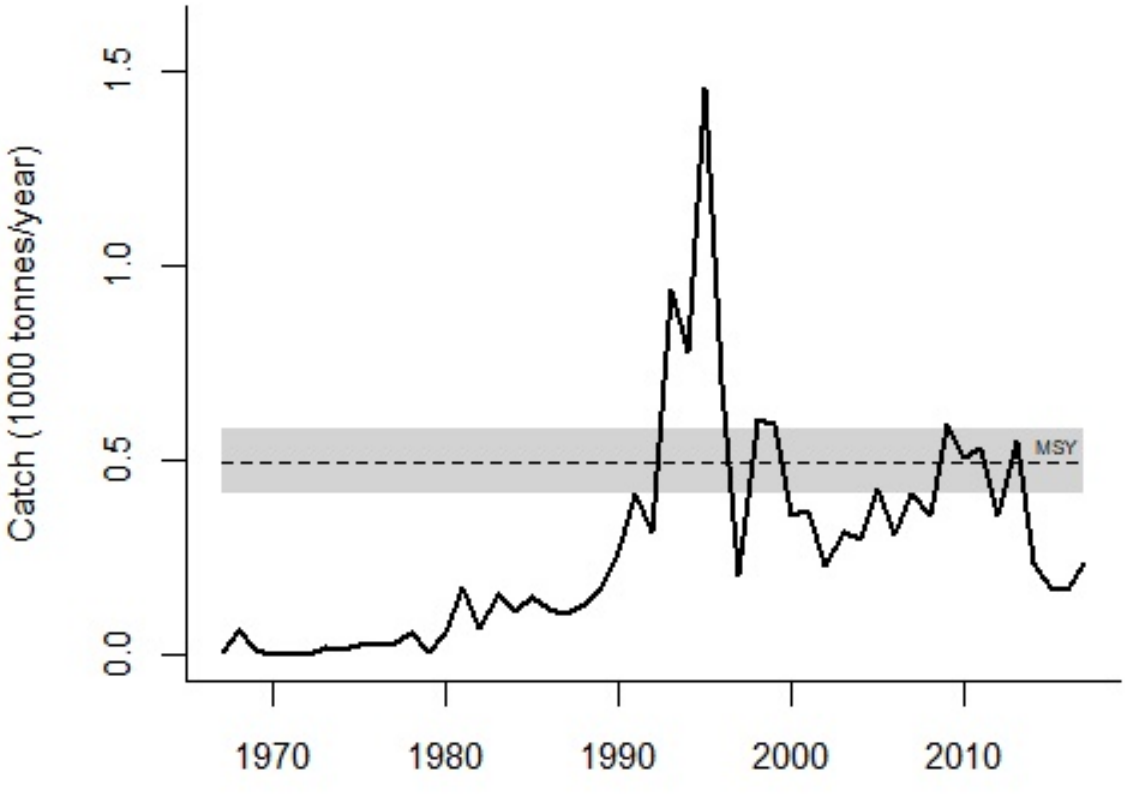

C: Analysis of viable r-k
k (1000 tonnes)
3
4
5
6
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

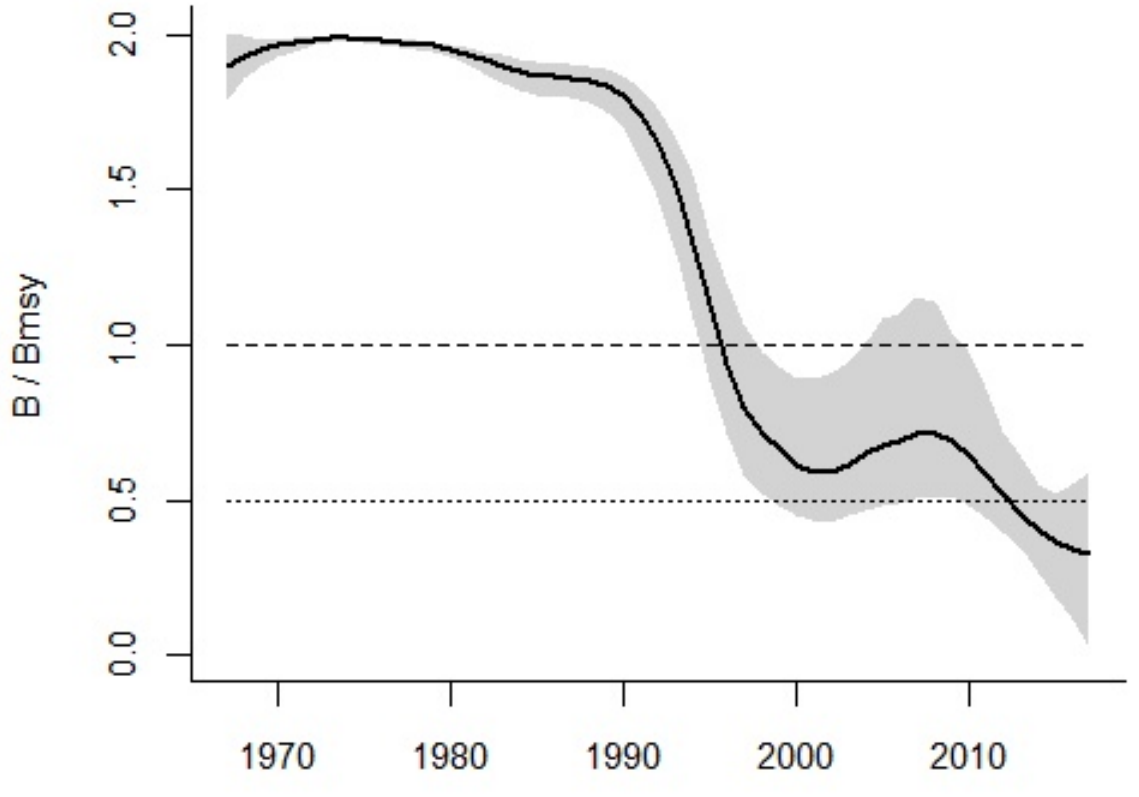

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

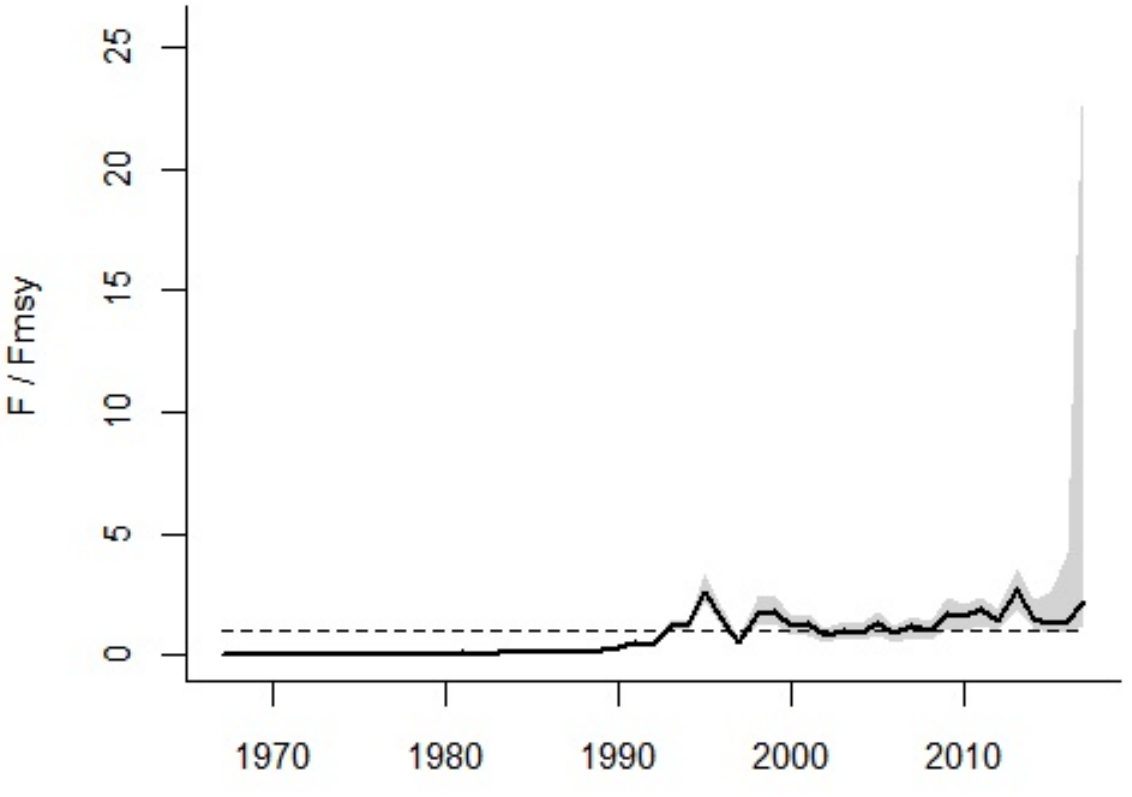
Catch

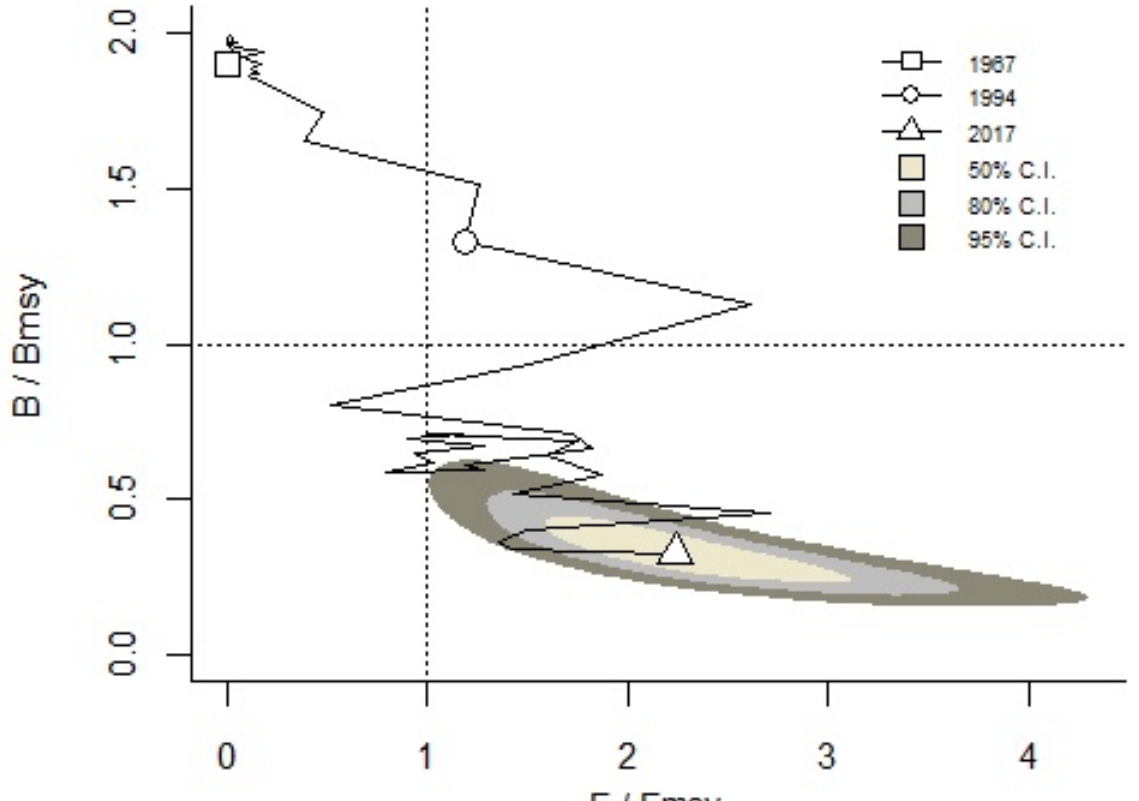


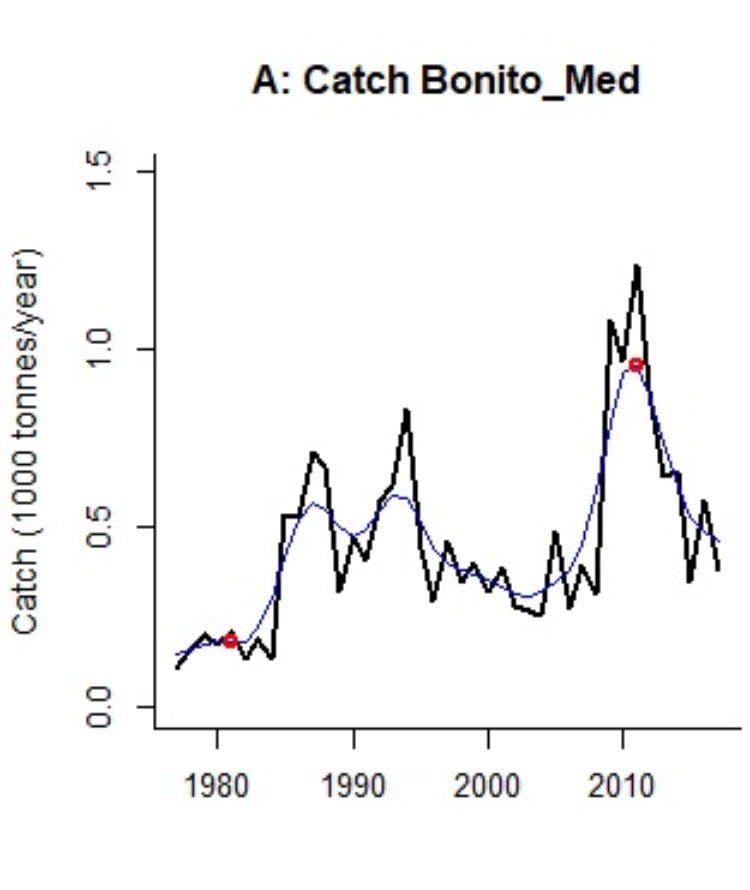
Stock size

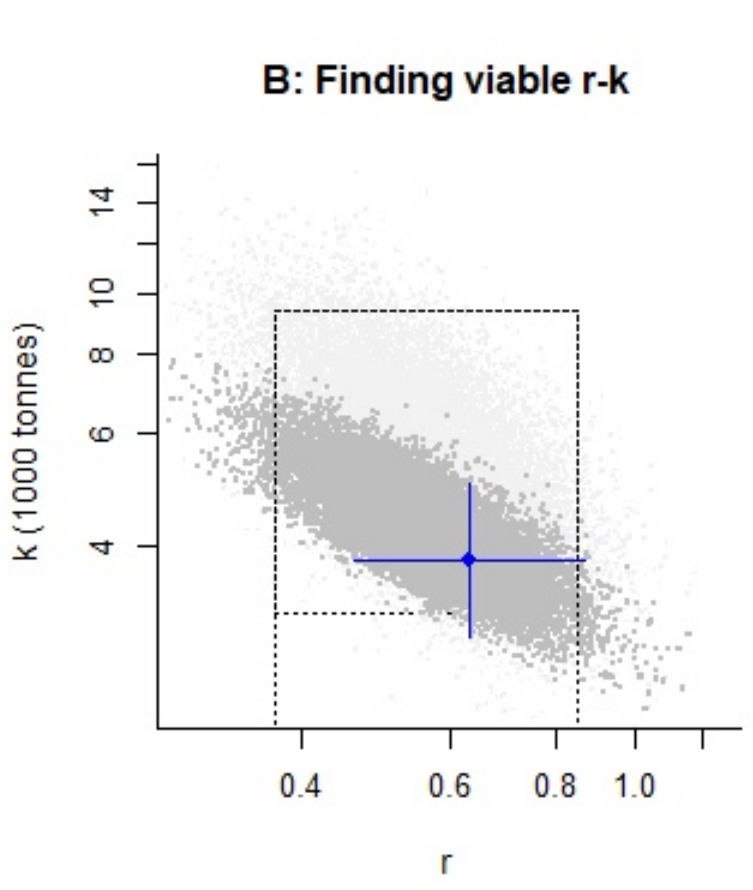


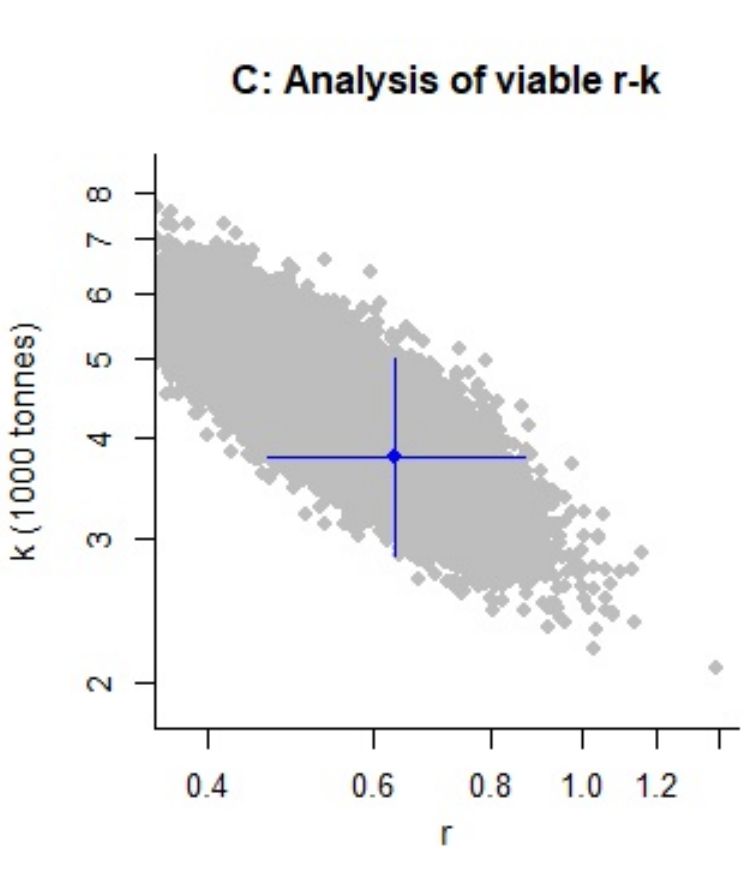
Exploitation

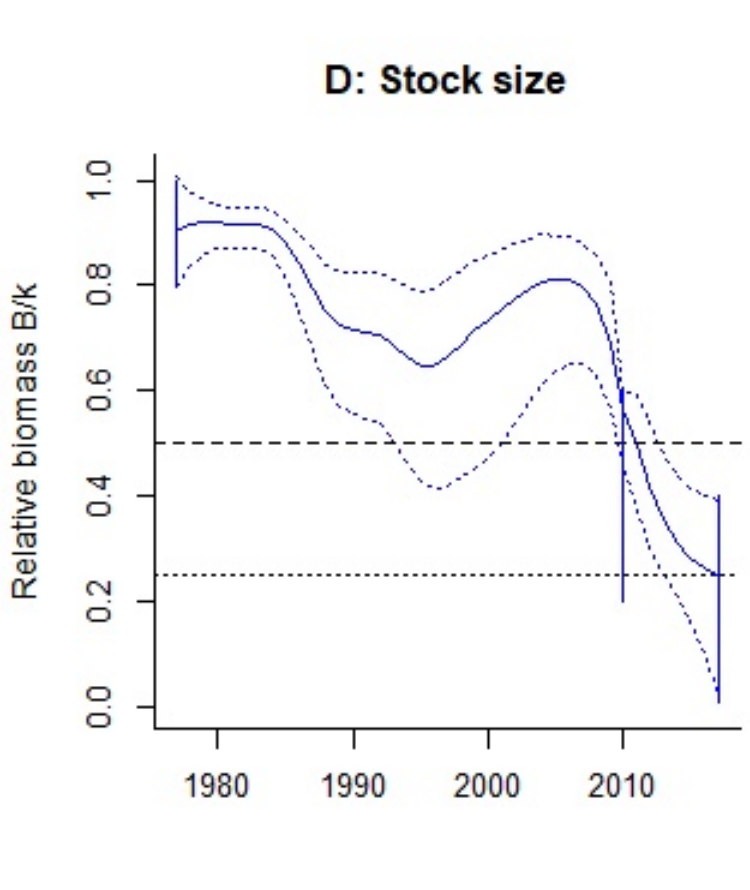


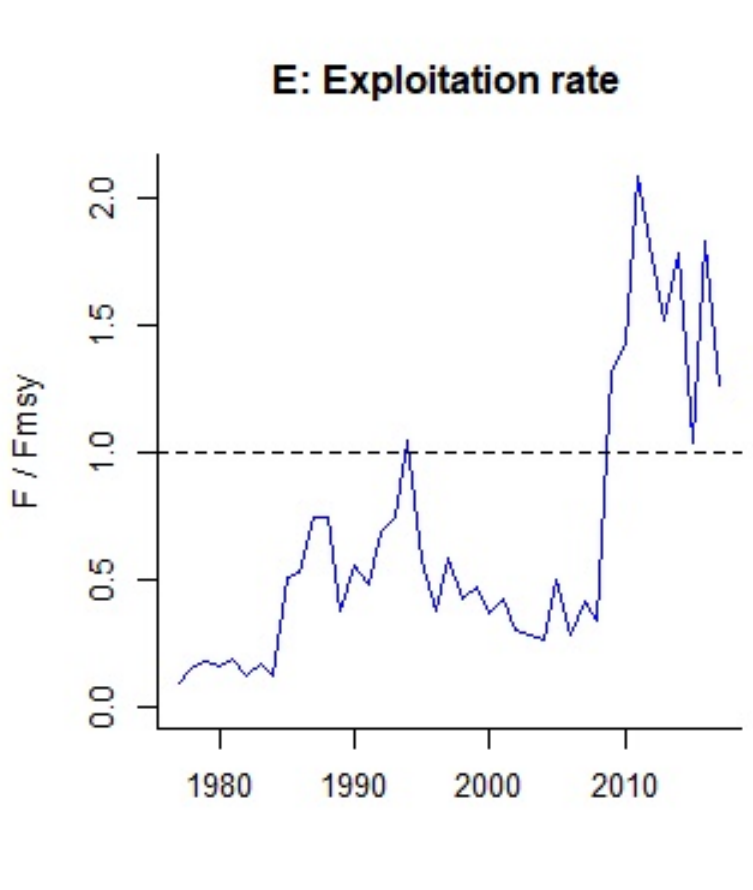


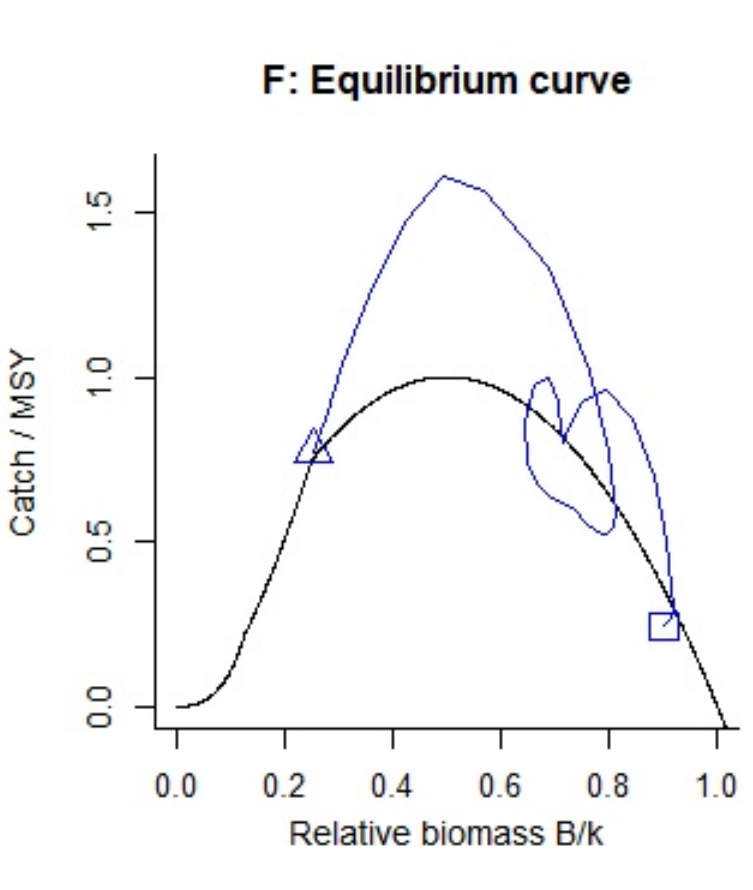

A: Catch Bonito_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
1980
1990
2000
2010

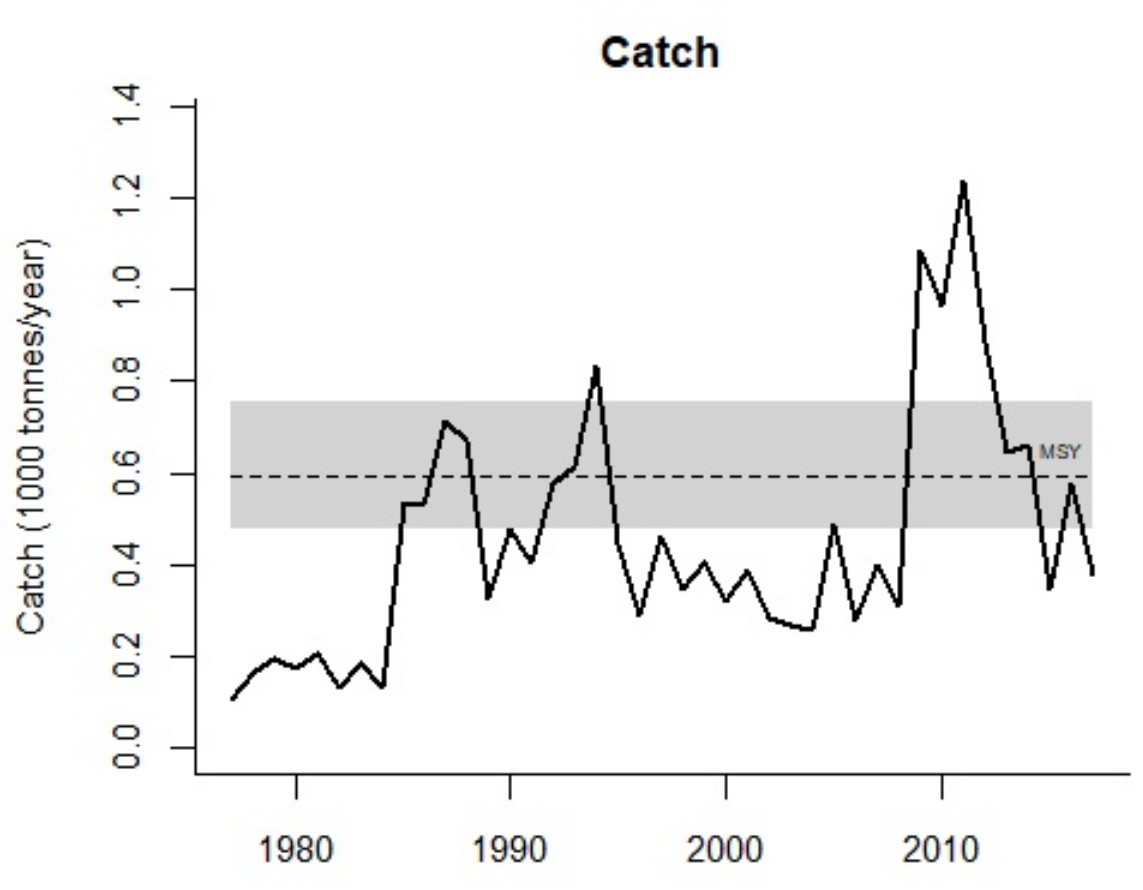

B: Finding viable r-k
k (1000 tonnes)
4
6
8
10
14
0.4
0.6
0.8
1.0
r

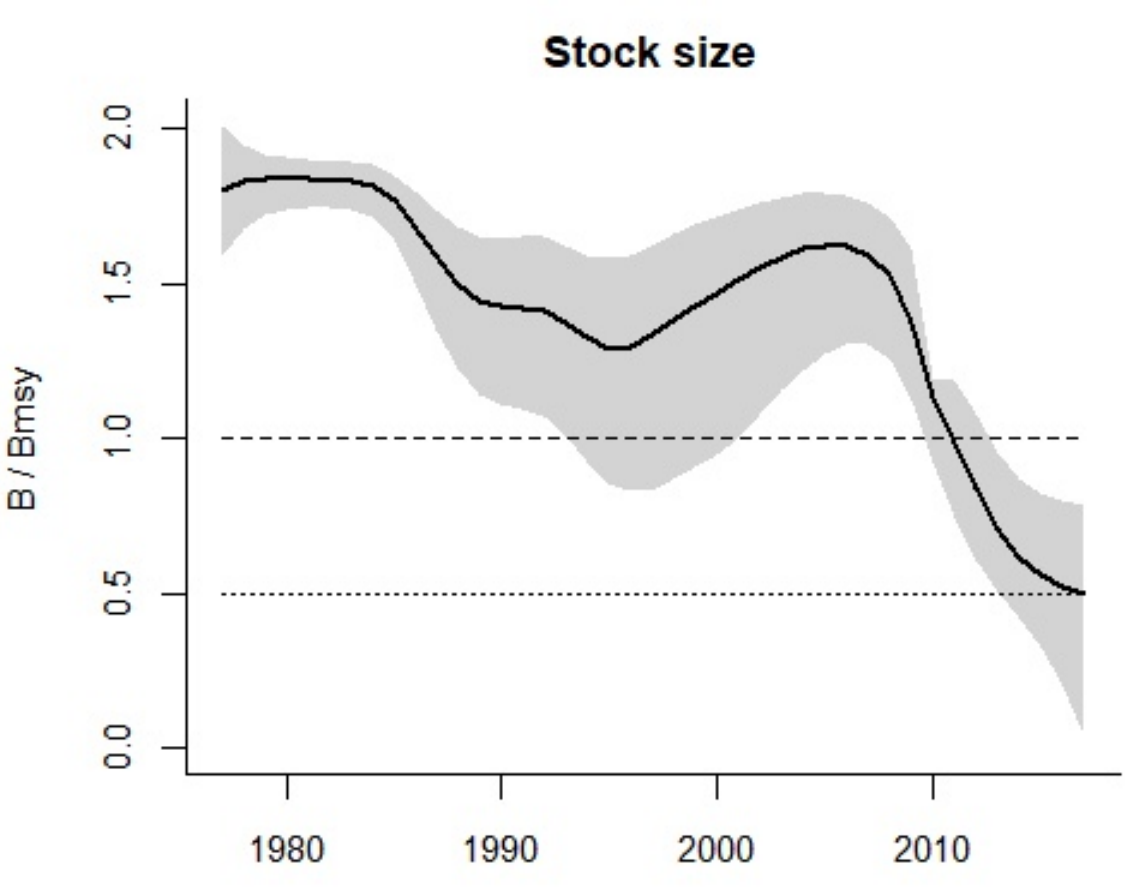

C: Analysis of viable r-k
k (1000 tonnes)
2
3
4
5
6
7
8
0.4
0.6
0.8
1.0
1.2
r

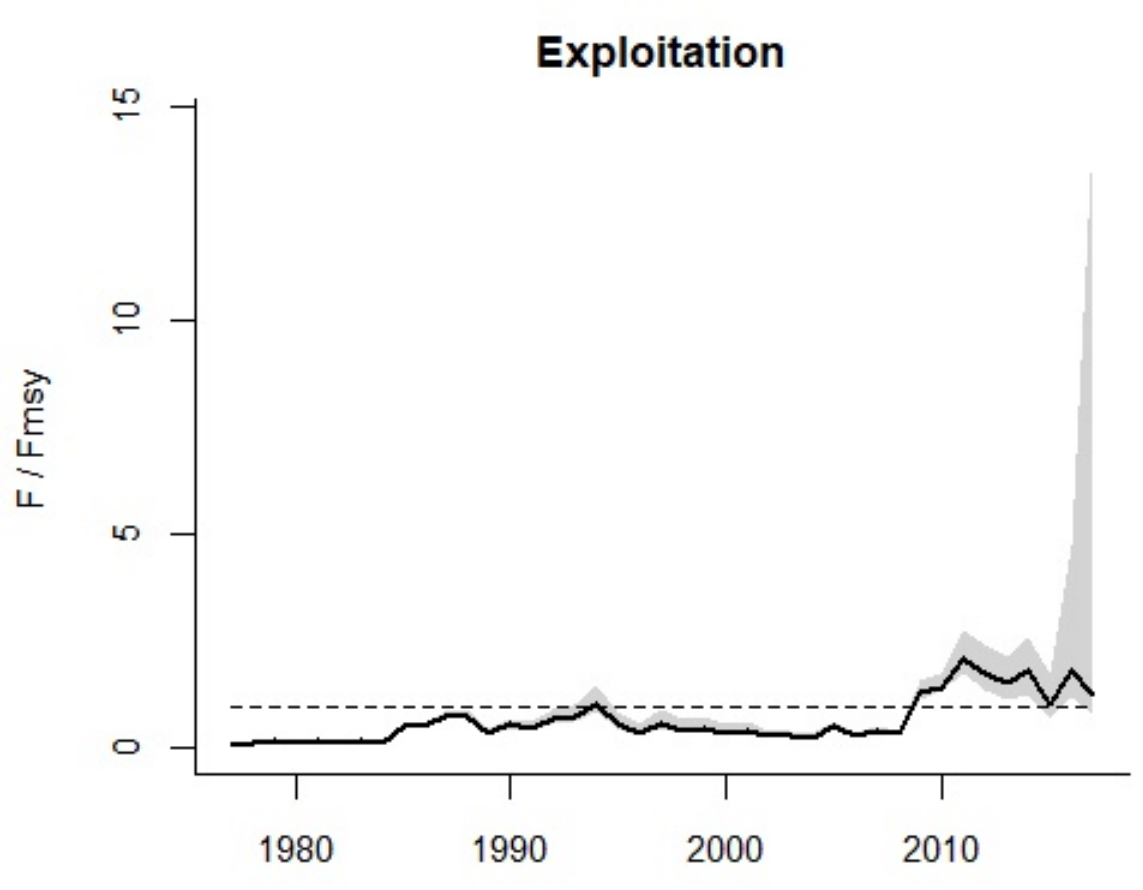

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

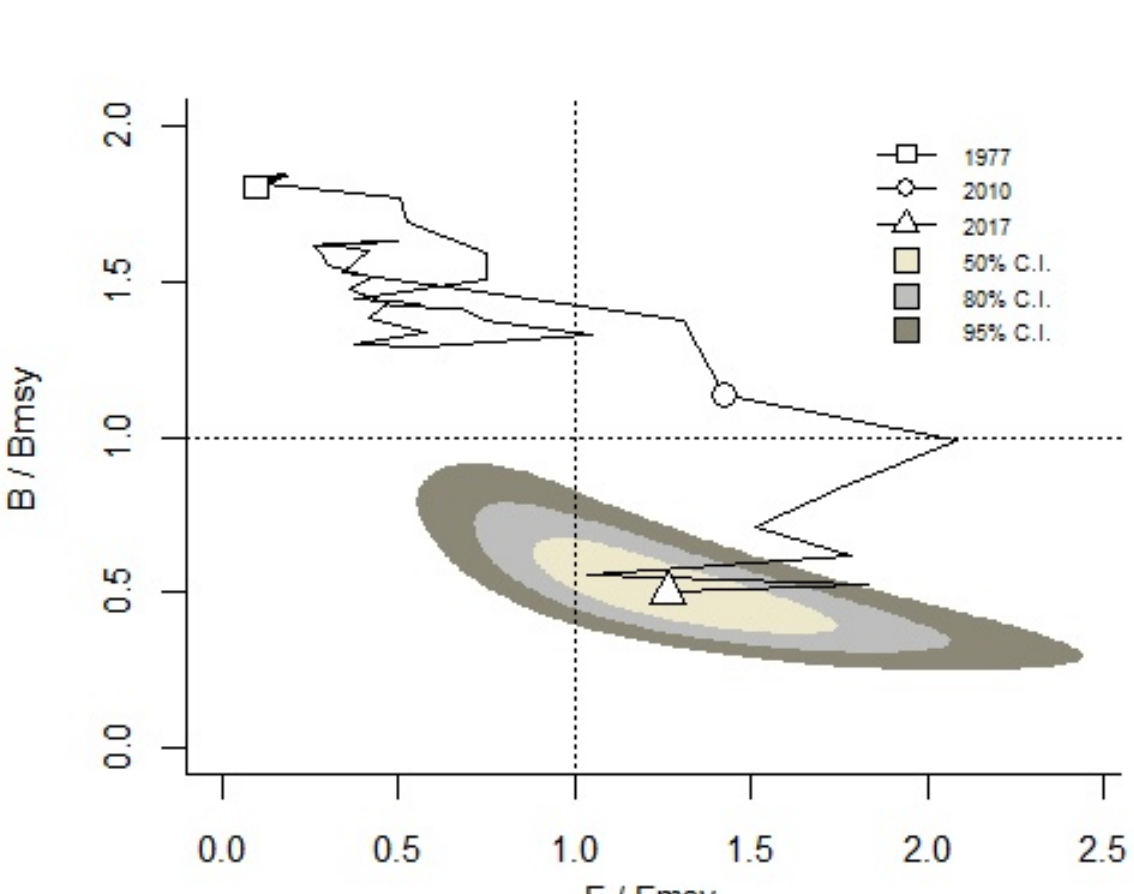

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010

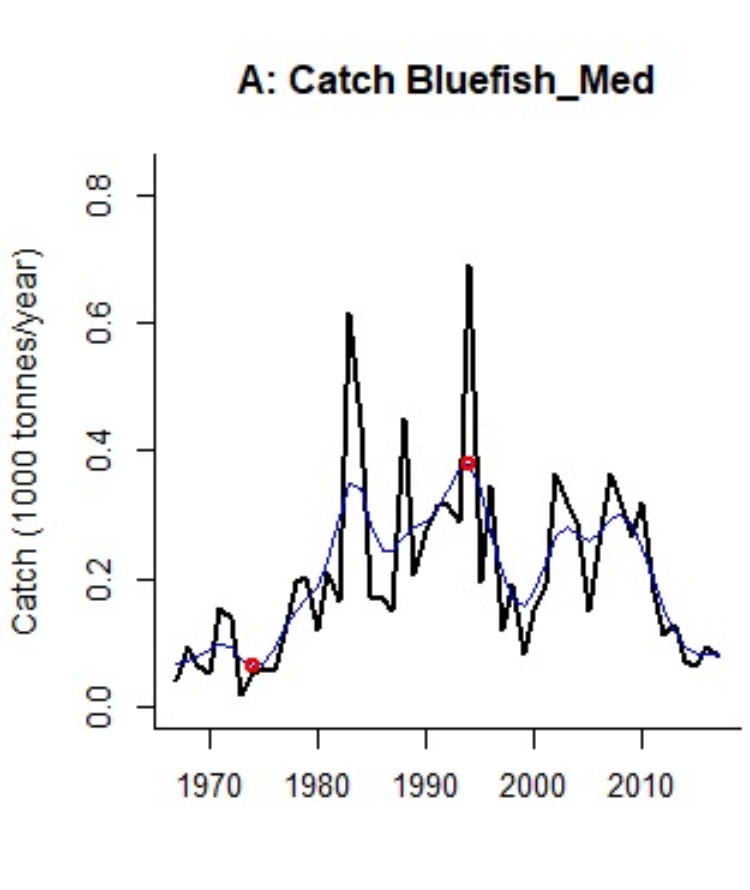

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

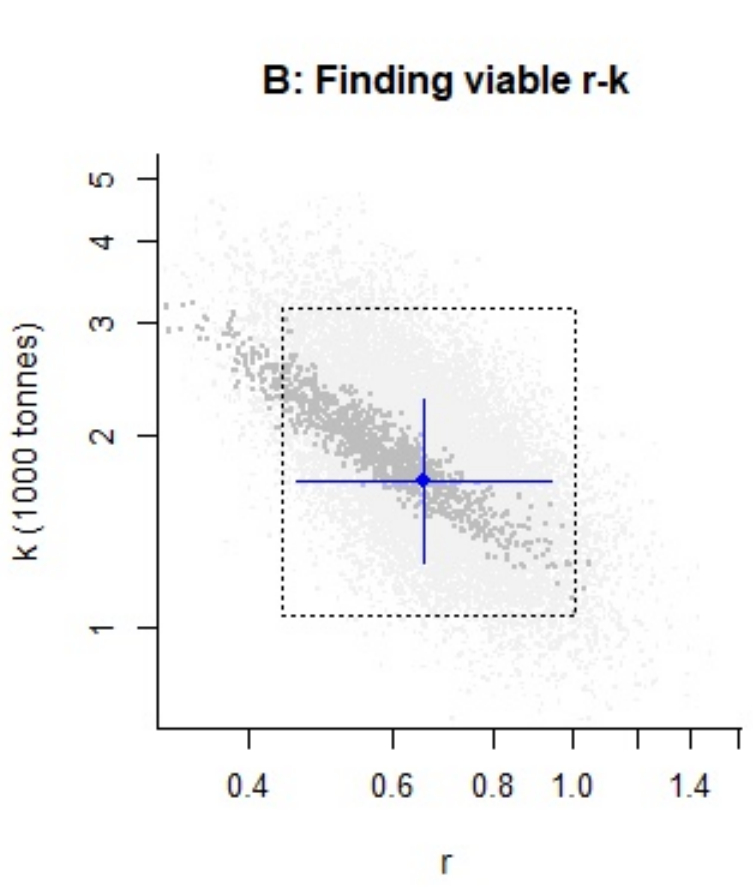

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MSY
1980
1990
2000
2010

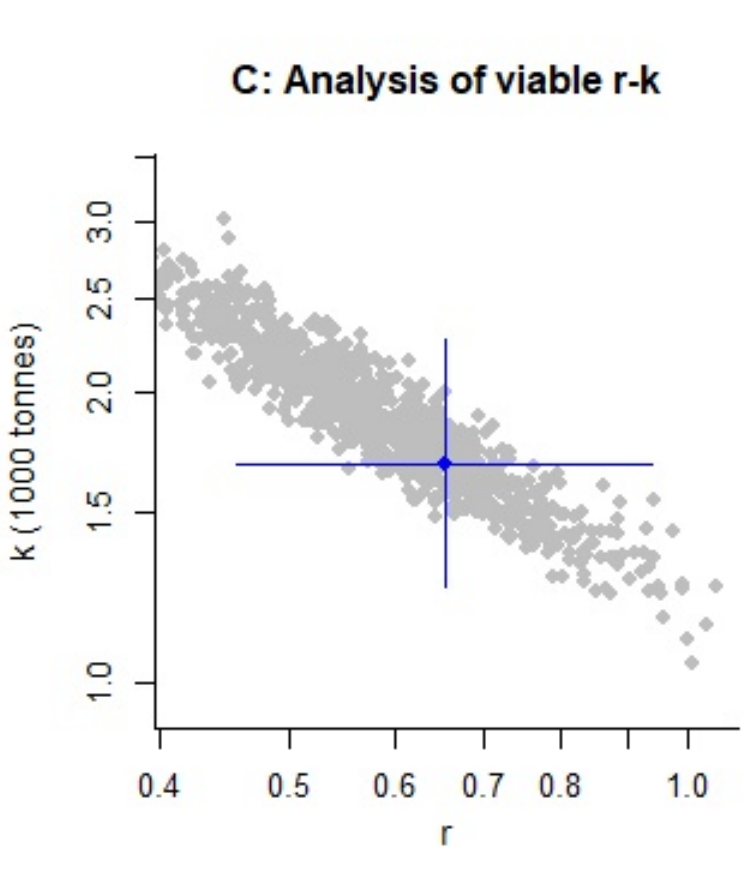

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010

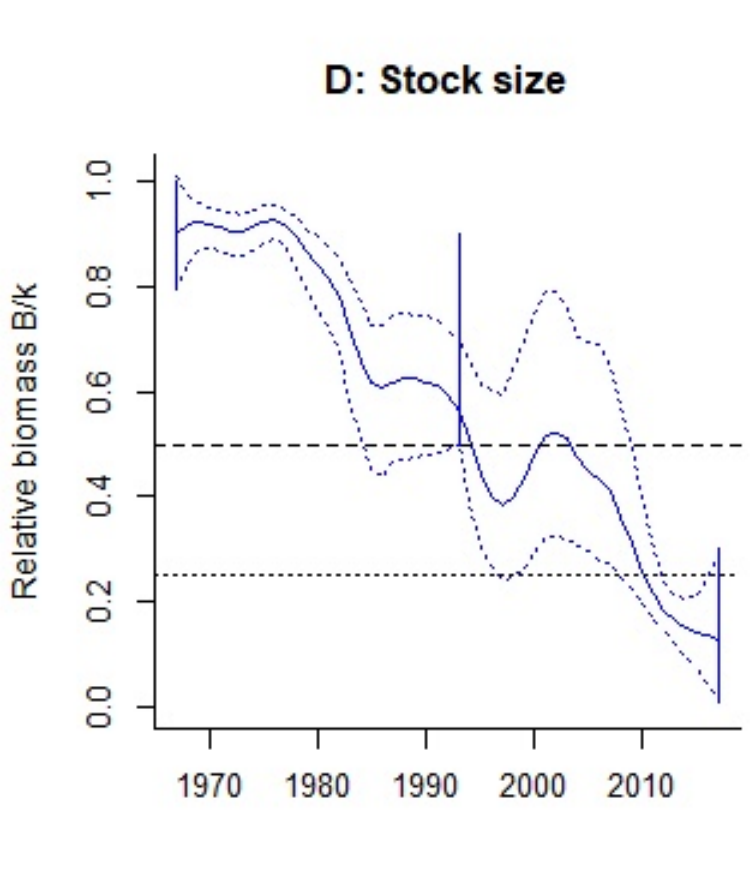

Exploitation
F / Fmsy
0
5
10
15
1980
1990
2000
2010

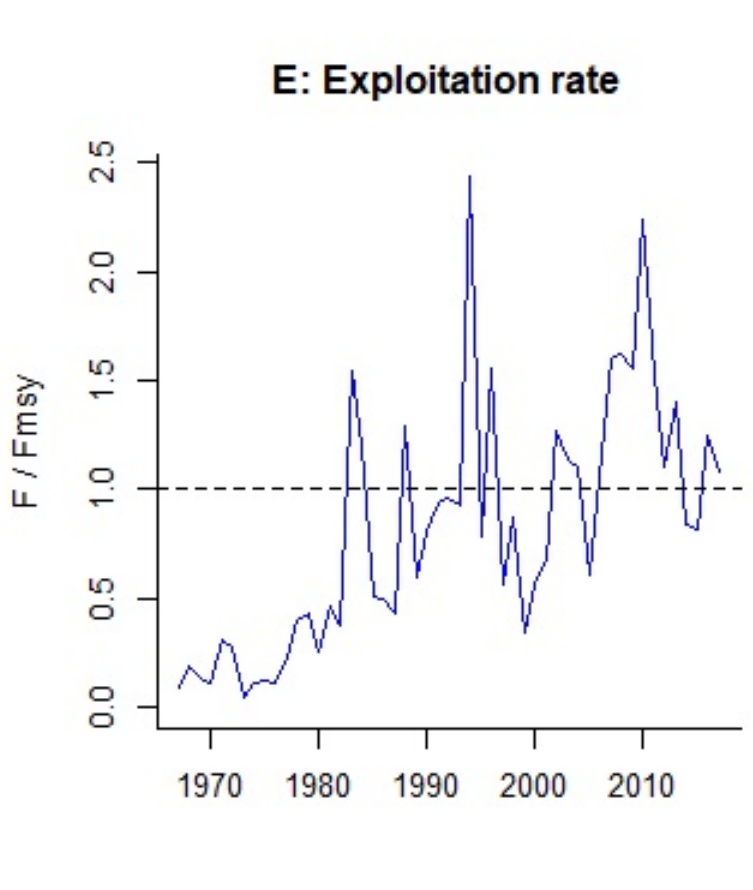

B / Bmsy
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1977
2010
2017
50% C.I.
80% C.I.
95% C.I.

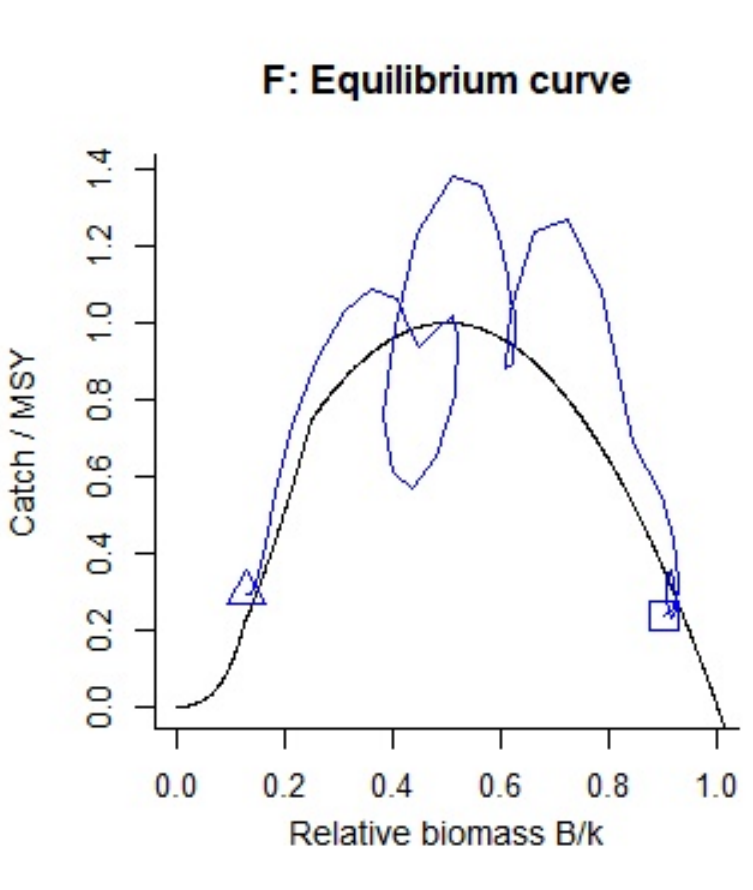

A: Catch Bluefish_Med
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

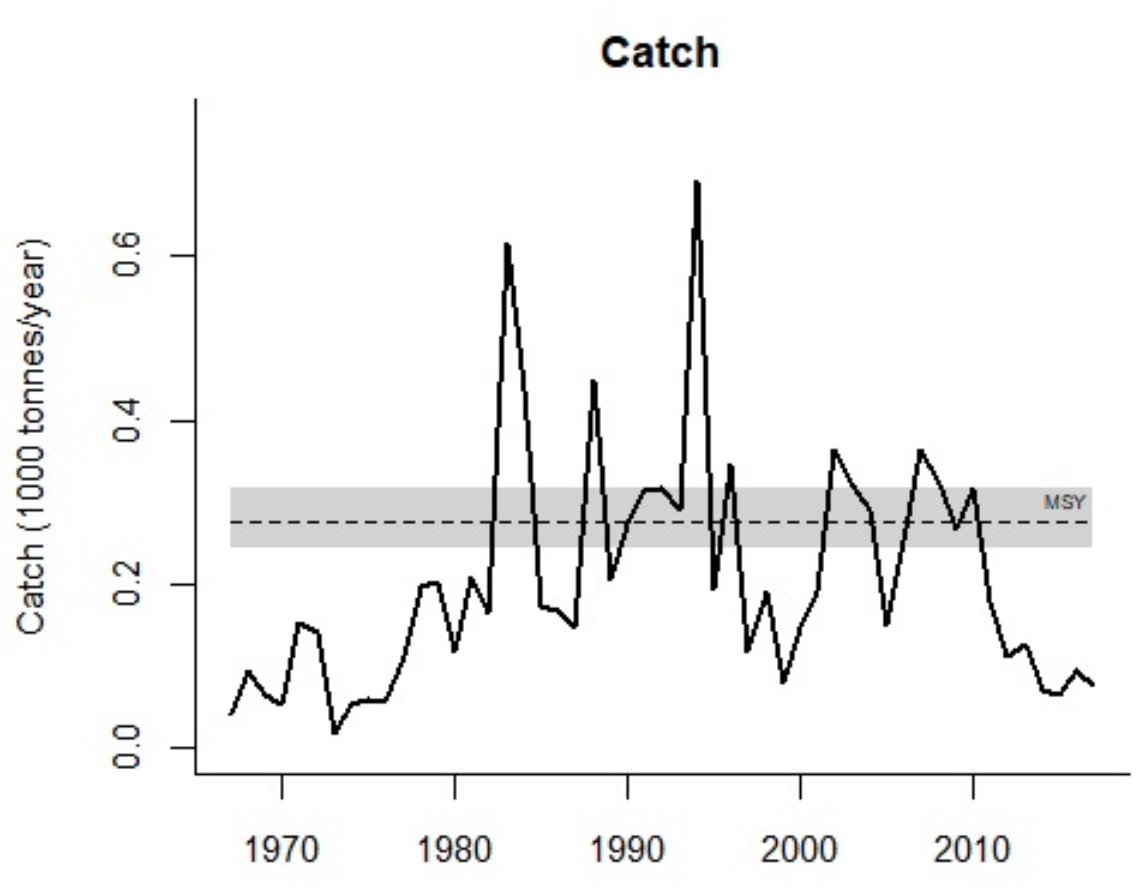

B: Finding viable r-k
k (1000 tonnes)
1
2
3
4
5
0.4
0.6
0.8
1.0
1.4
r

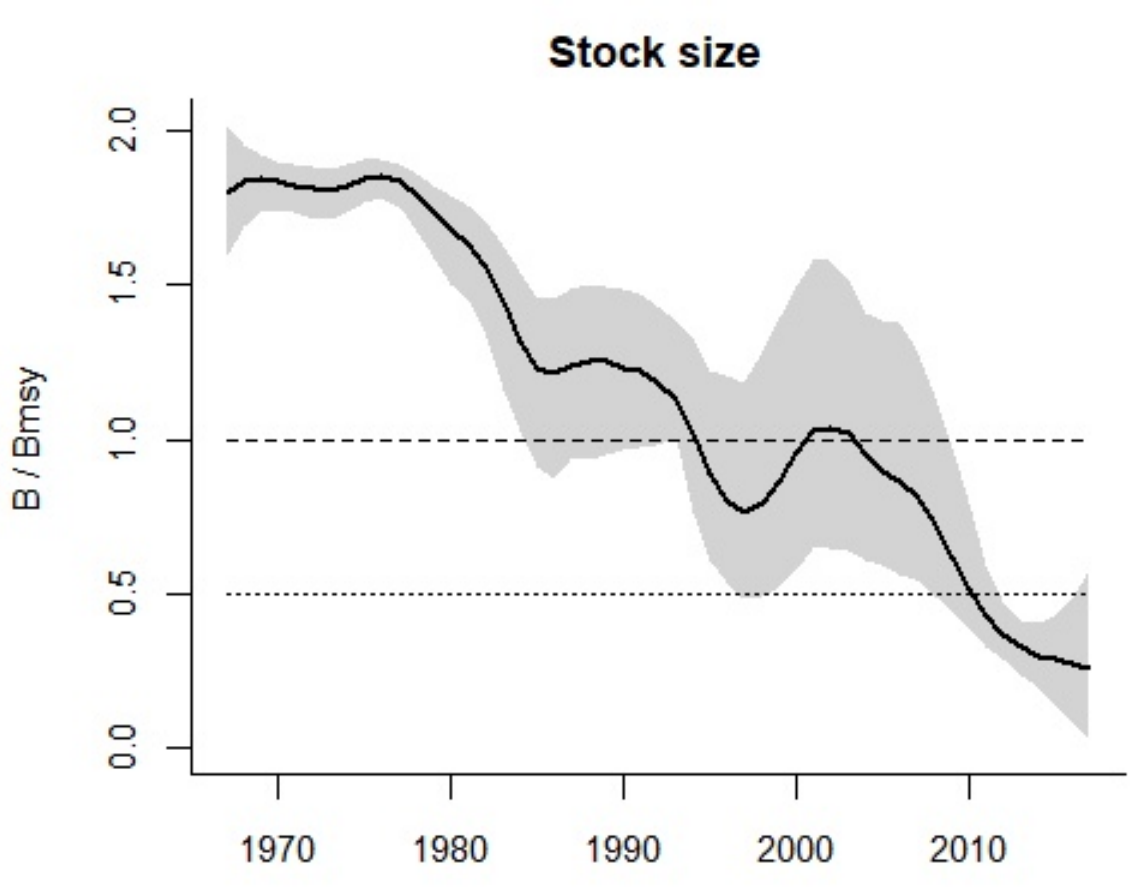

C: Analysis of viable r-k
k (1000 tonnes)
1.0
1.5
2.0
2.5
3.0
0.4
0.5
0.6
0.7
0.8
1.0
r

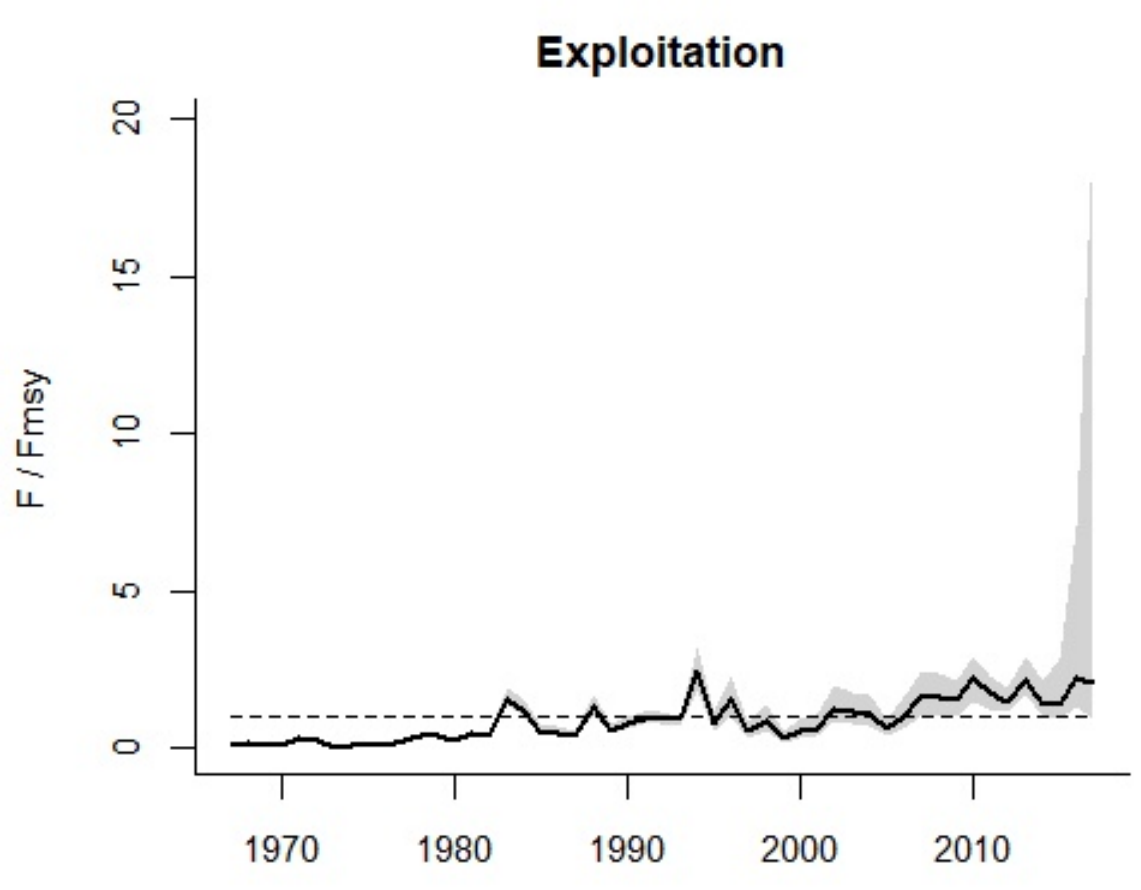

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

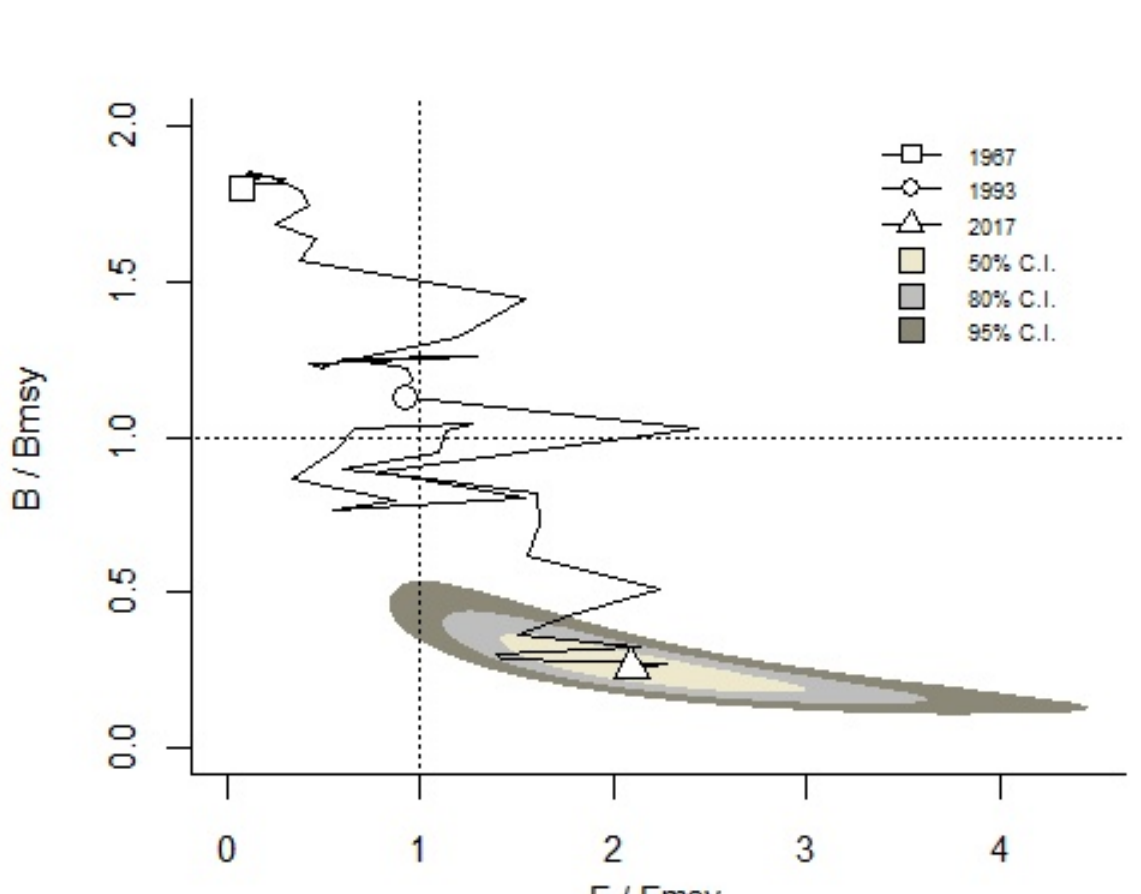

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

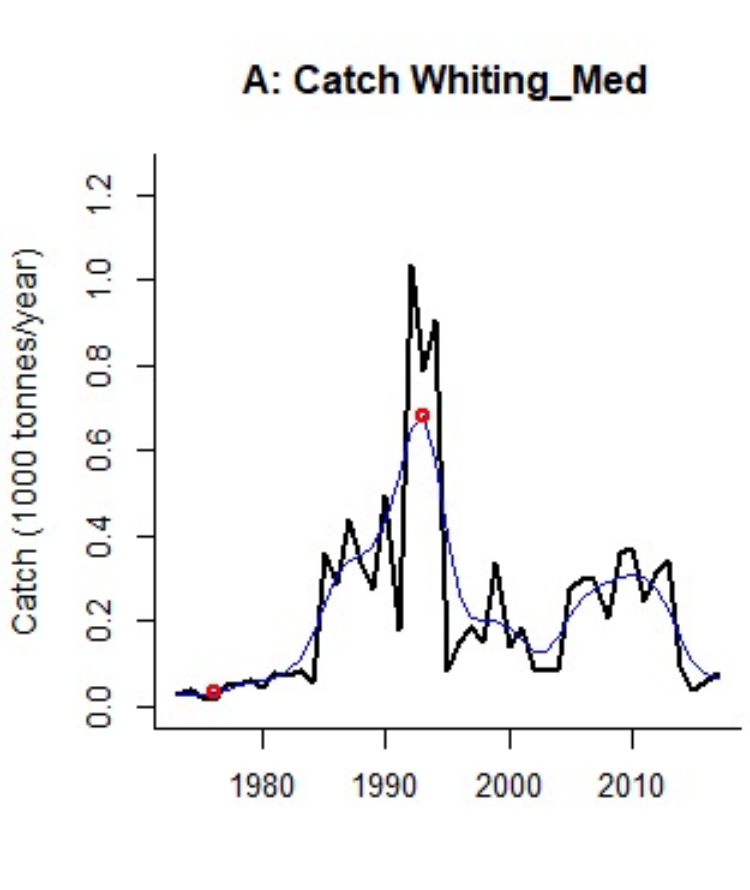

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

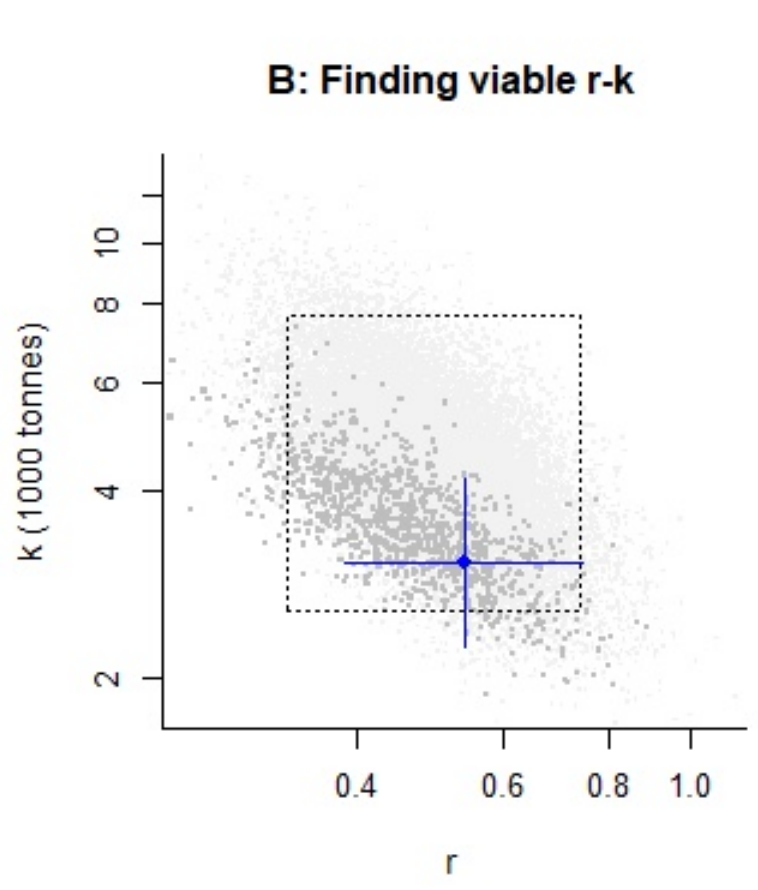

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
MSY
1970
1980
1990
2000
2010

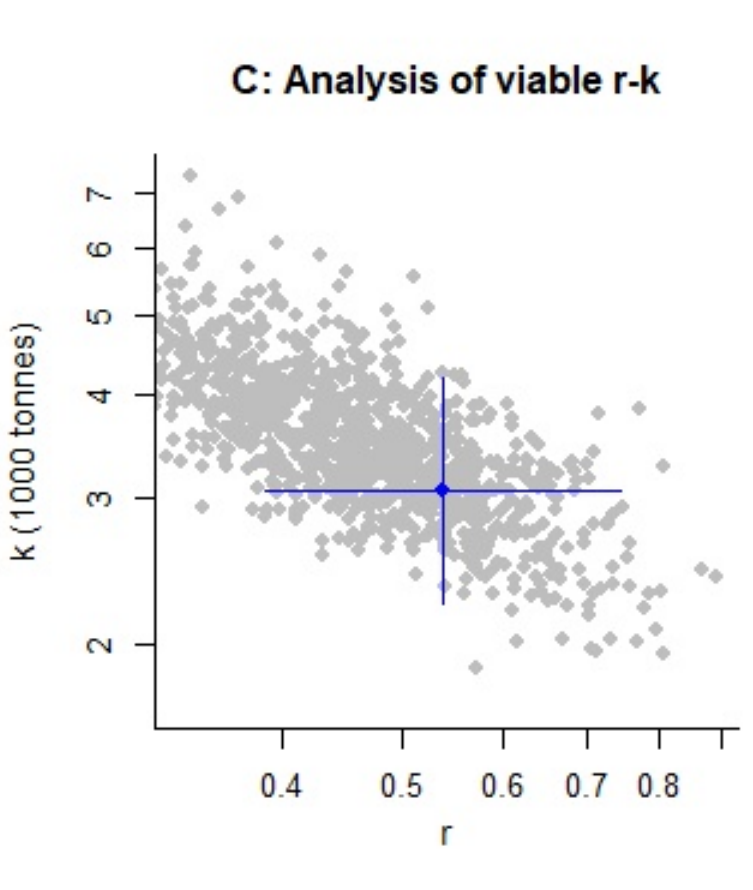

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

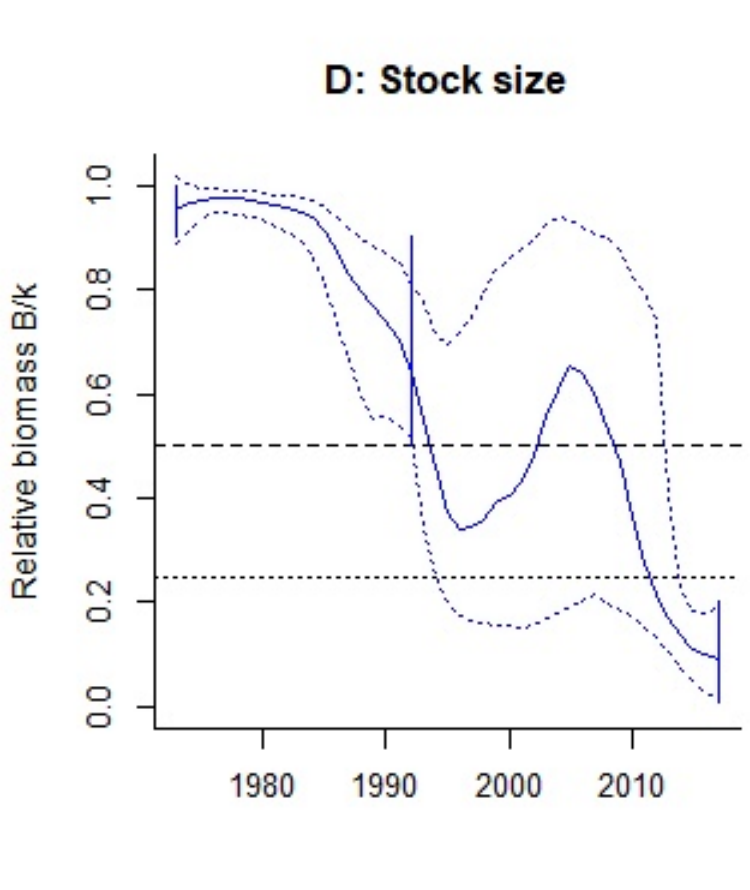

Exploitation
F / Fmsy
0
5
10
15
20
1970
1980
1990
2000
2010

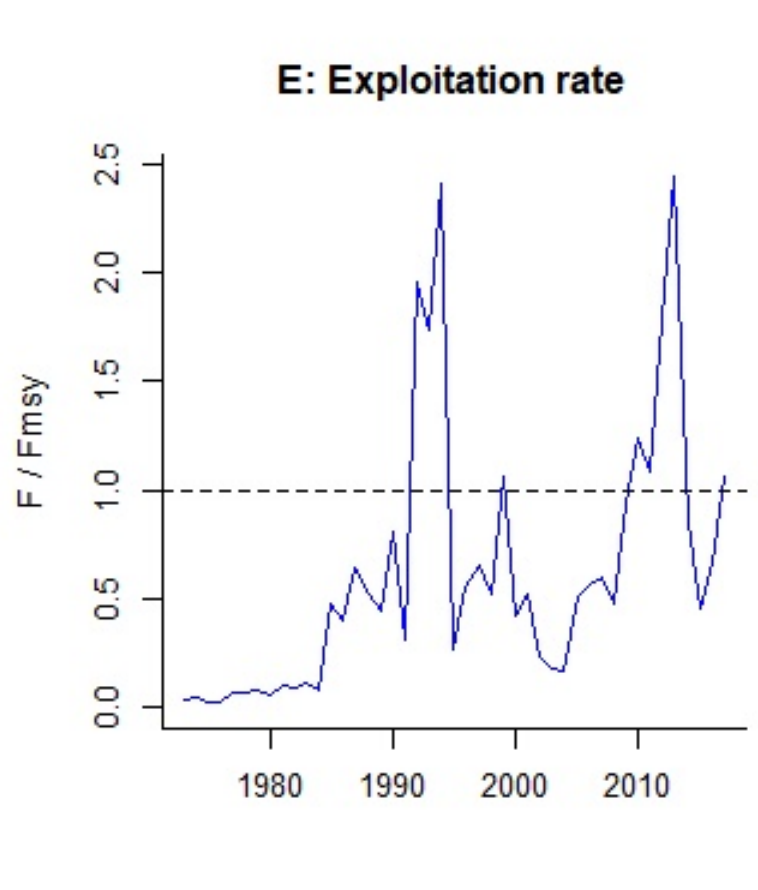

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1993
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
F / Fmsy

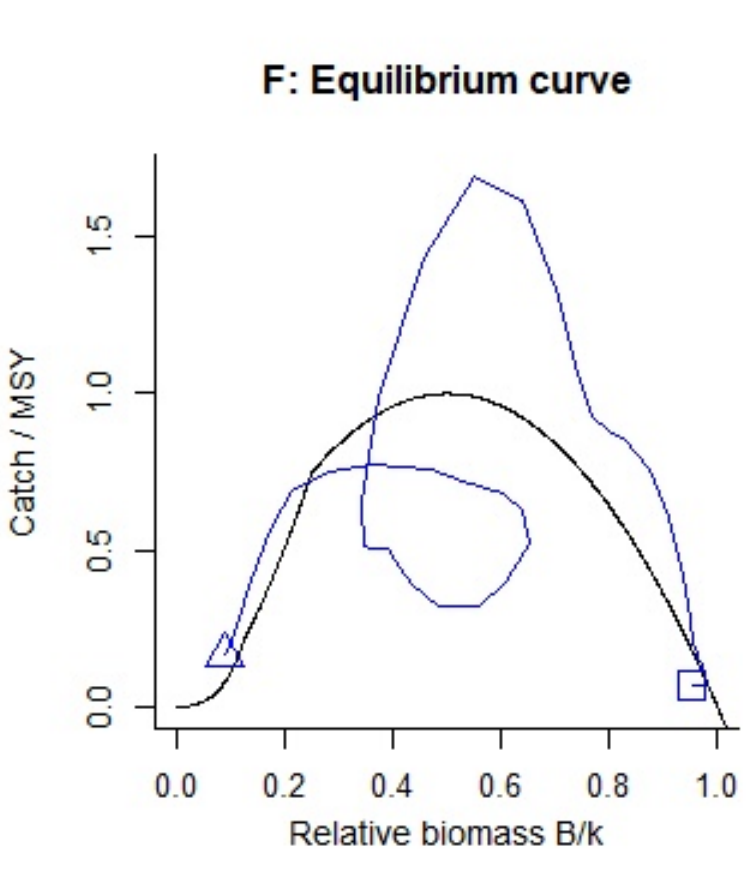

A: Catch Whiting_Med
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
0.4
0.6
0.8
1.0
r

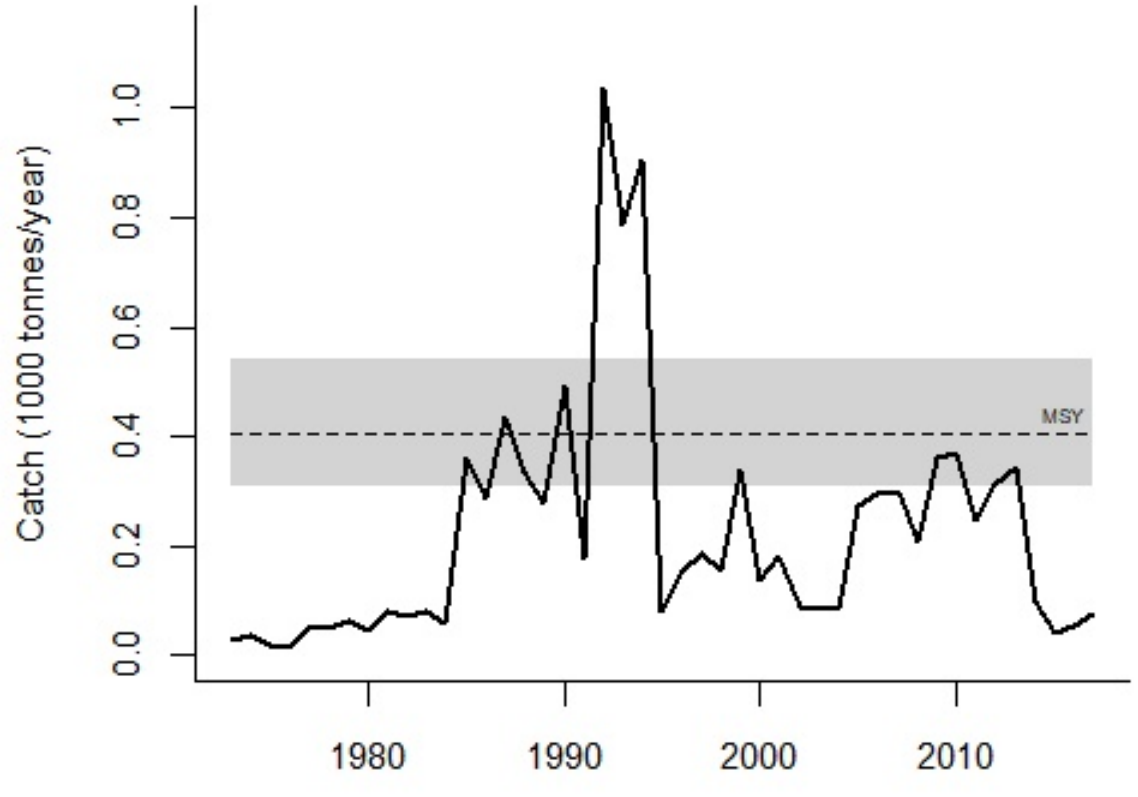

C: Analysis of viable r-k
k (1000 tonnes)
2
3
4
5
6
7
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

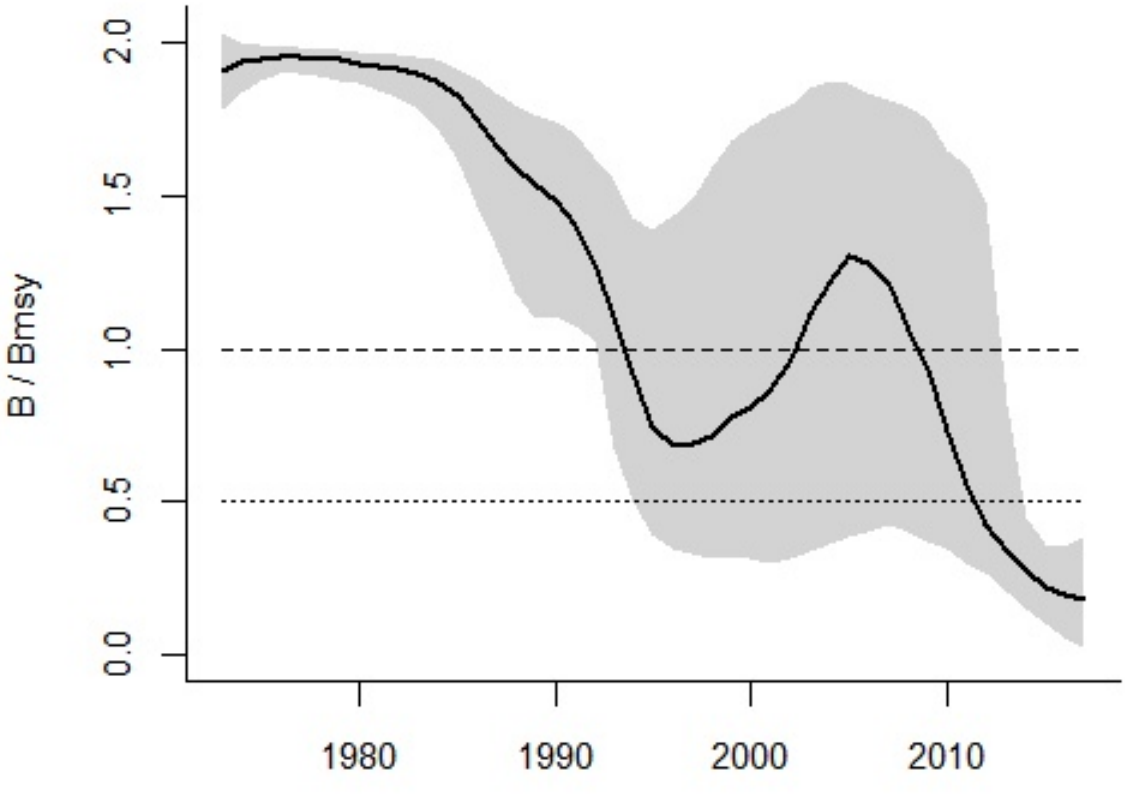

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

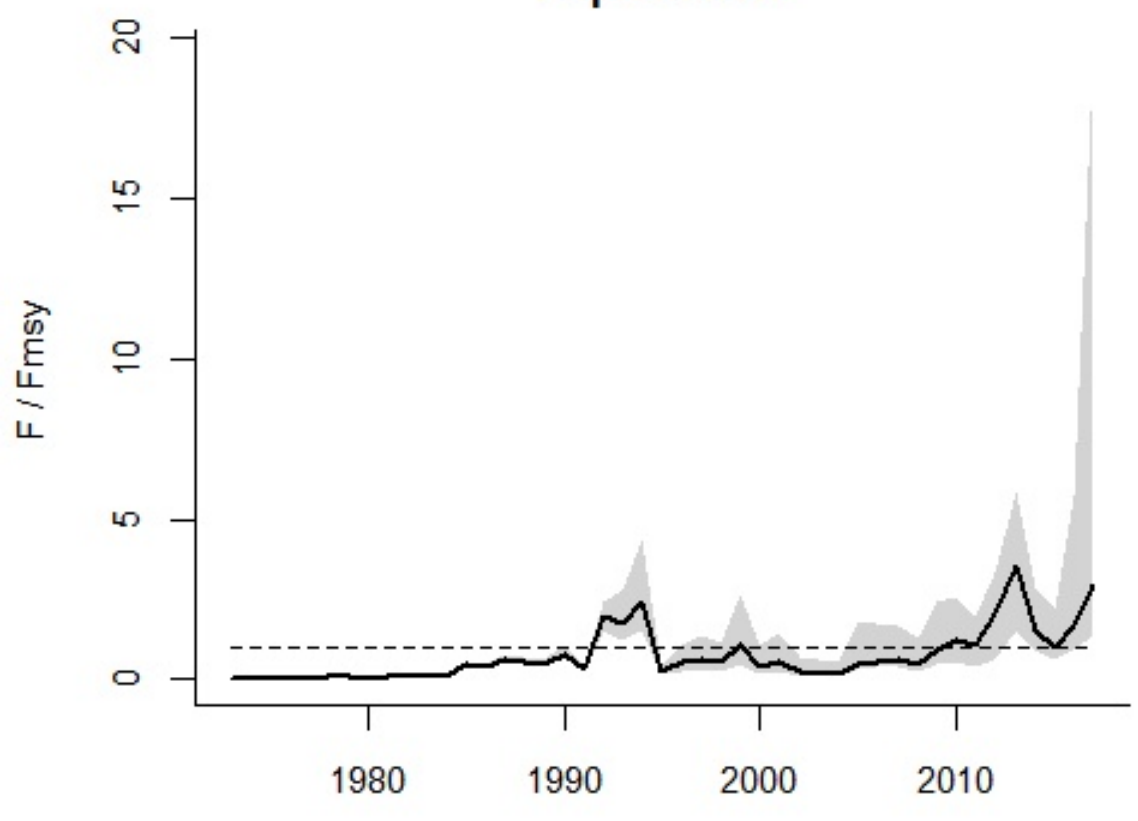
Catch

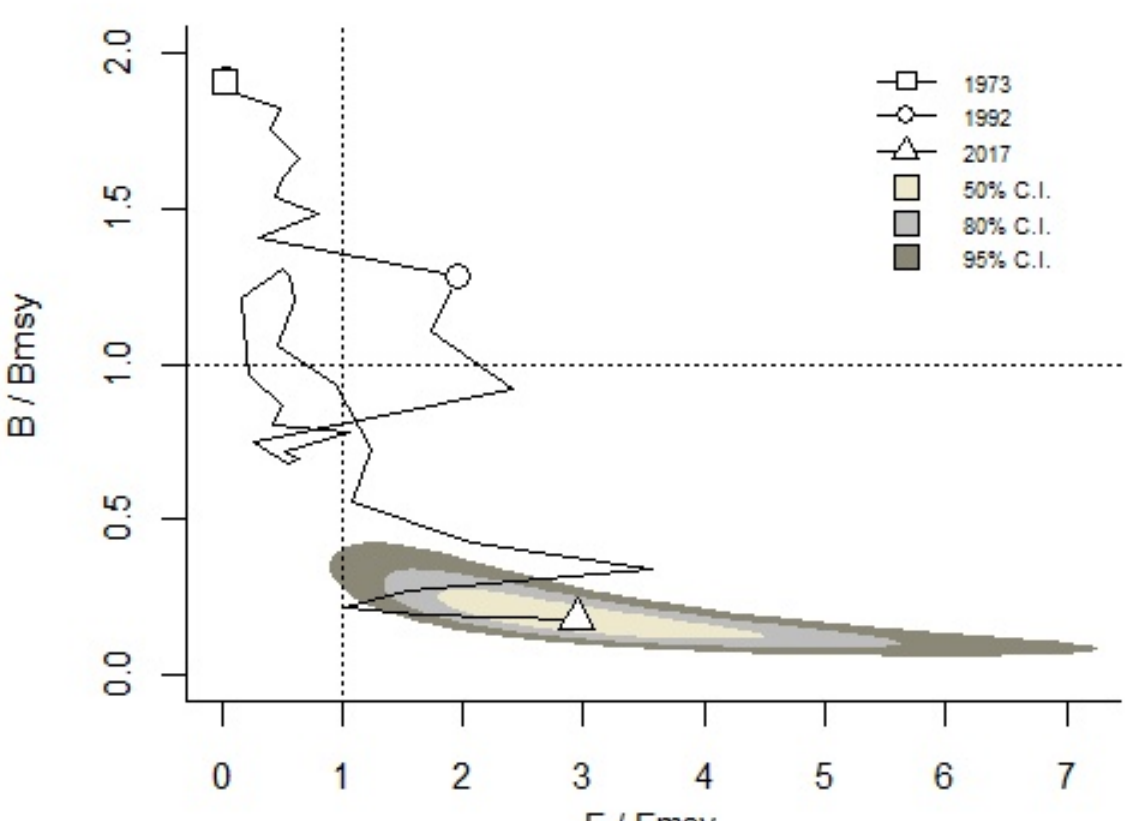


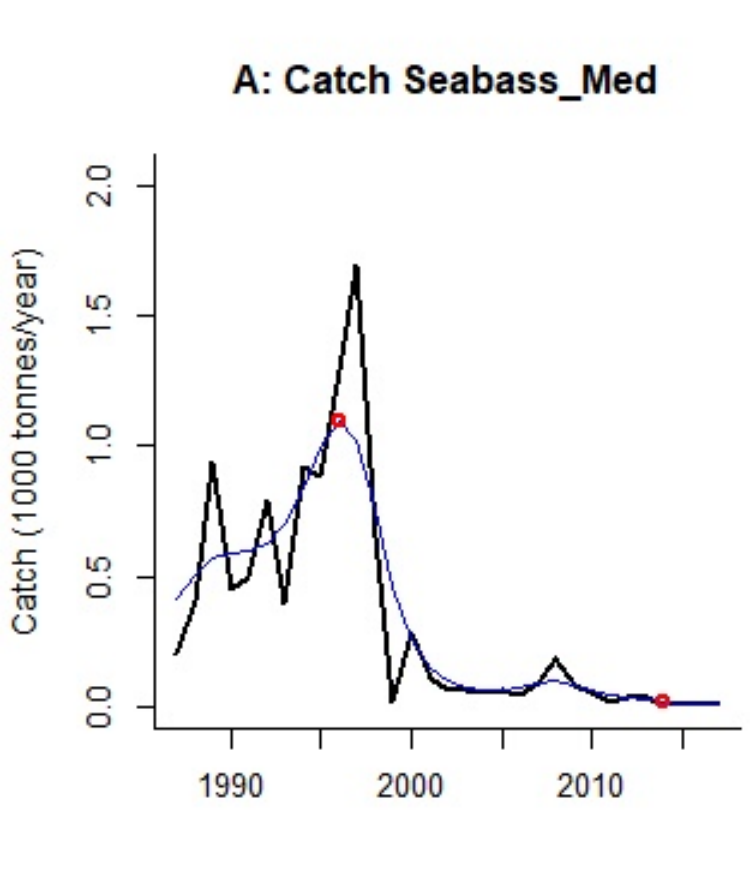
Stock size

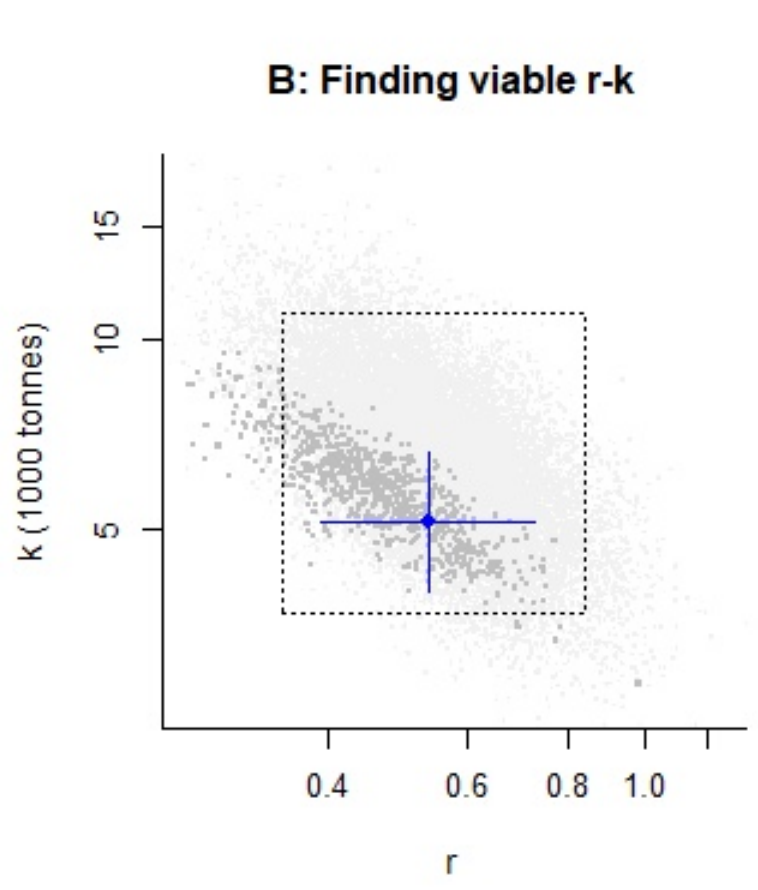


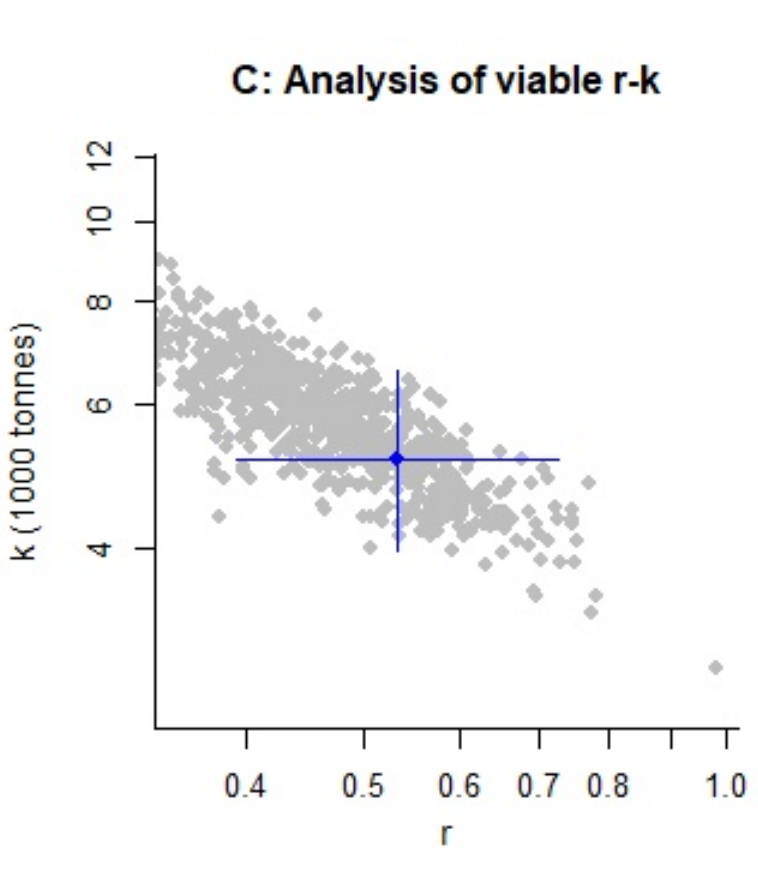
Exploitation

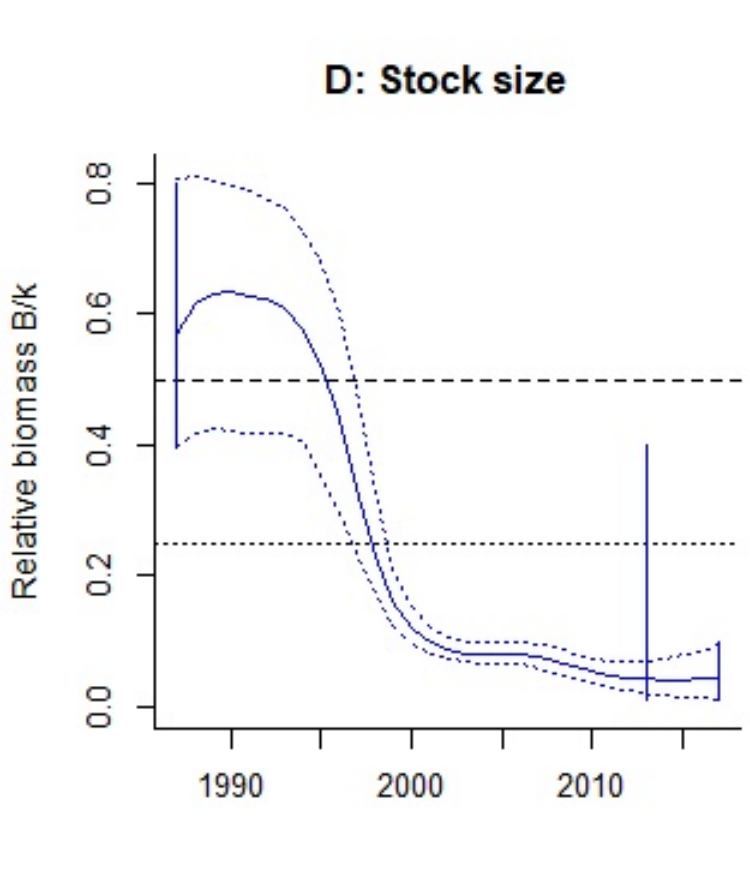


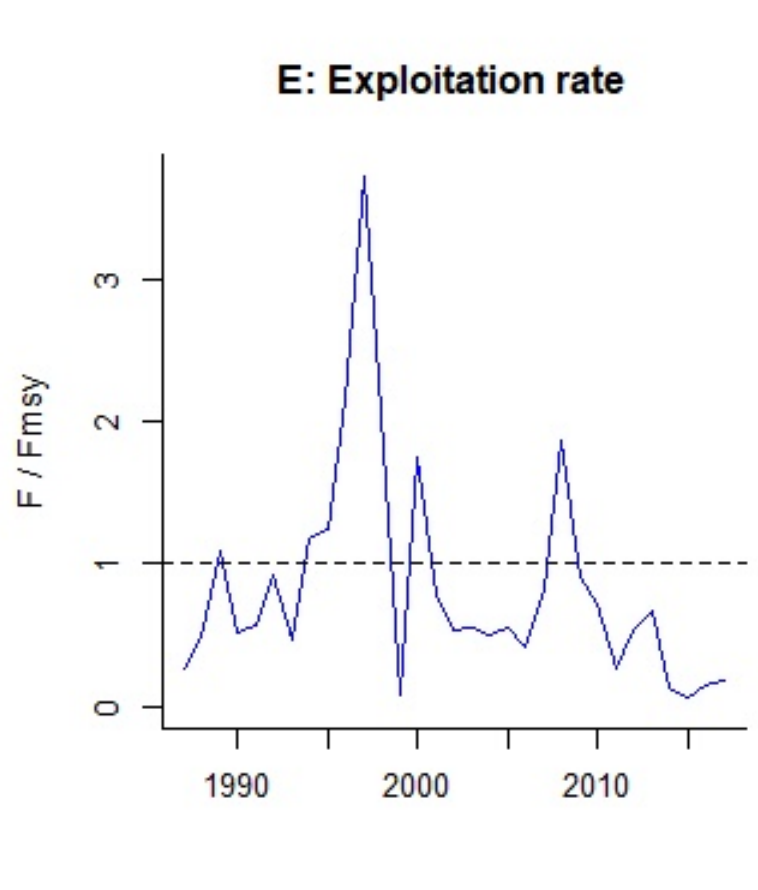


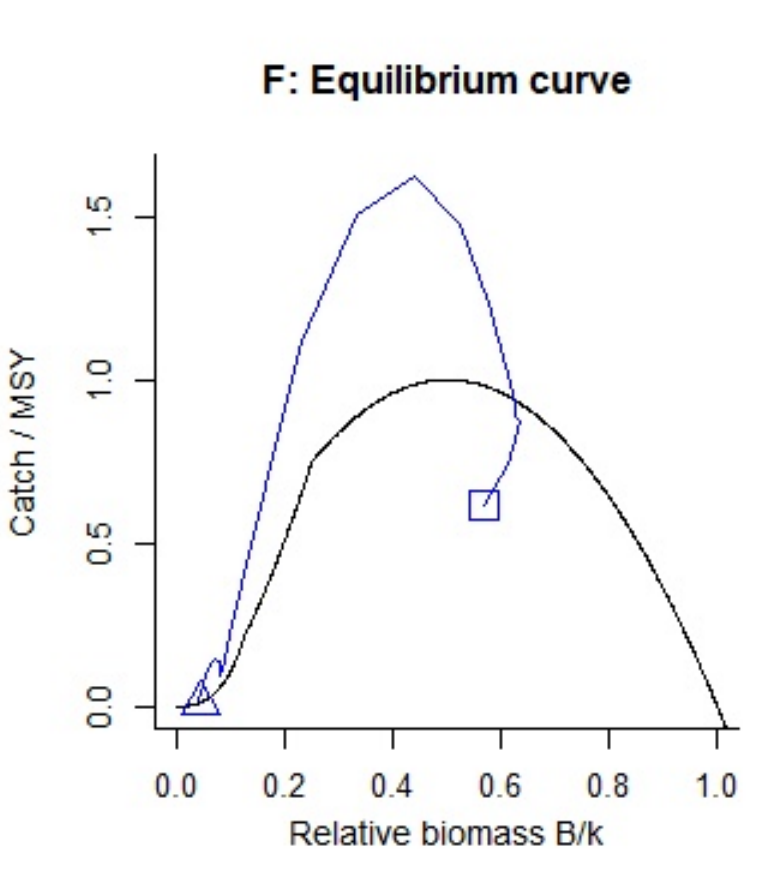

A: Catch Seabass_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
1990
2000
2010

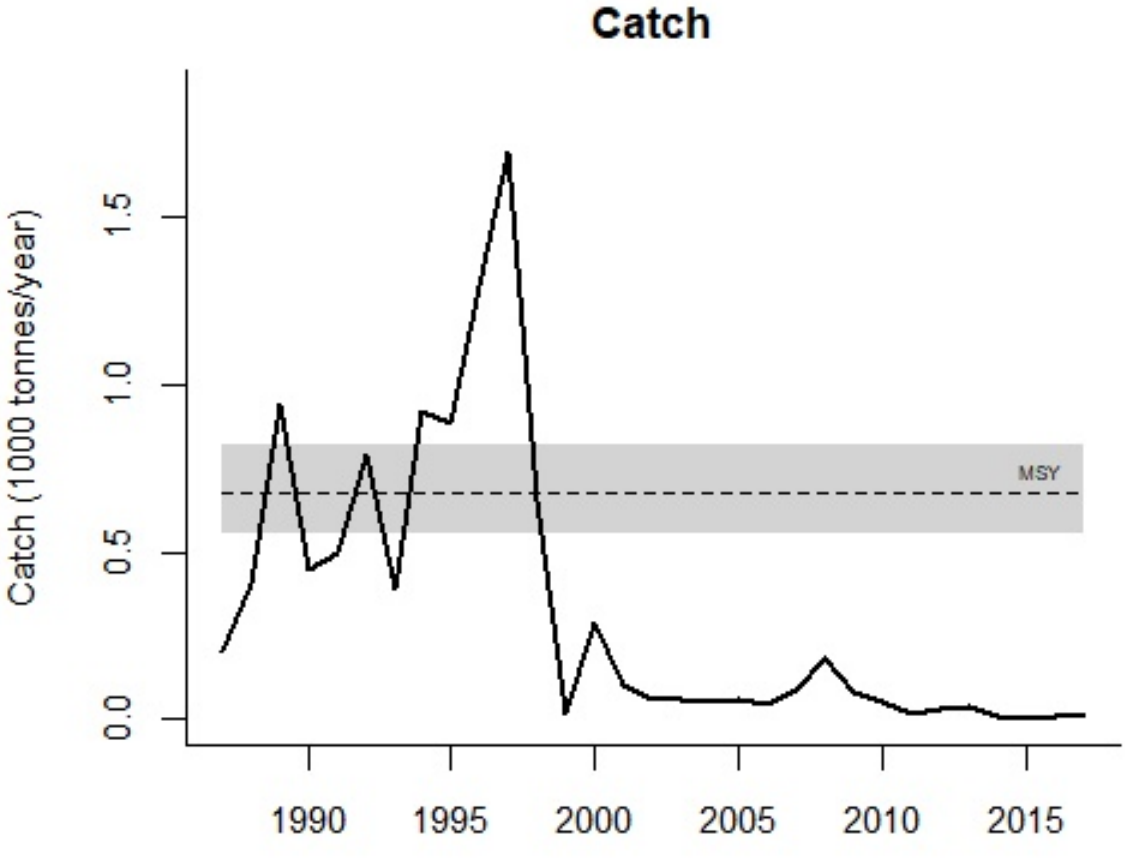

B: Finding viable r-k
k (1000 tonnes)
5
10
15
0.4
0.6
0.8
1.0
r

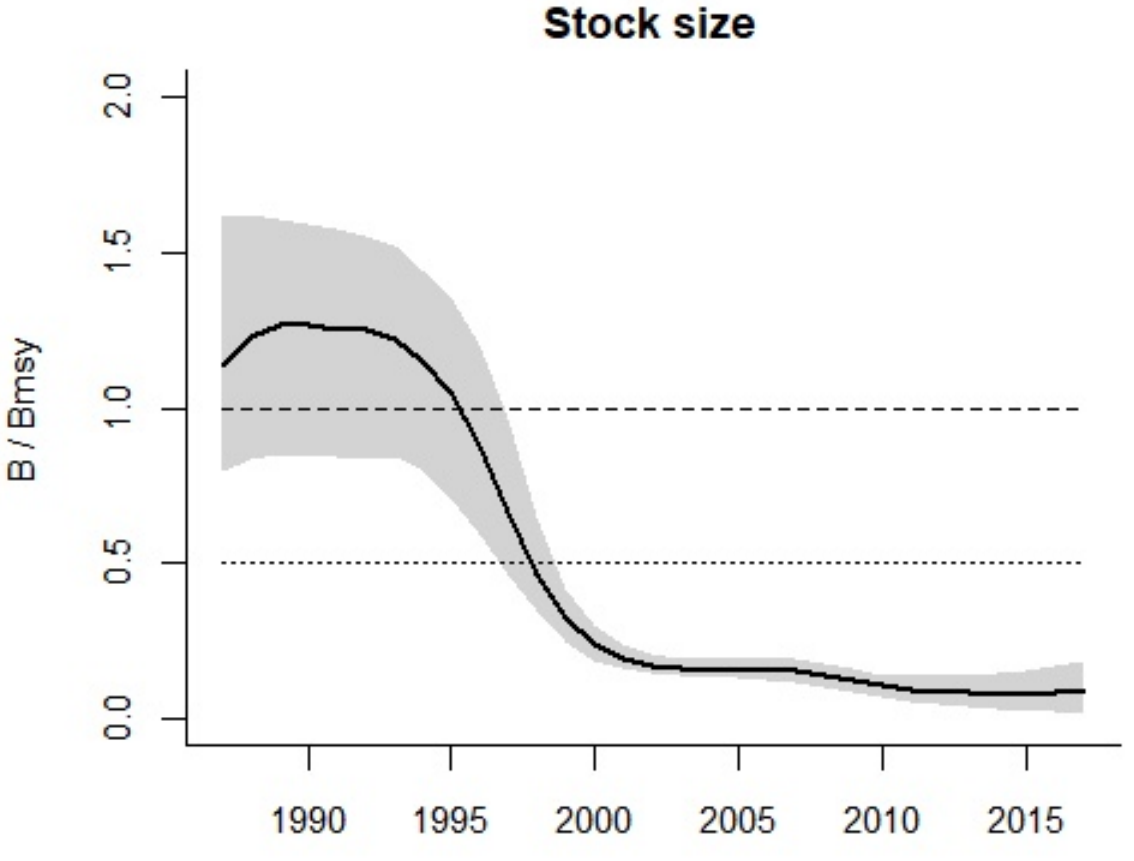

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
12
0.4
0.5
0.6
0.7
0.8
1.0
r

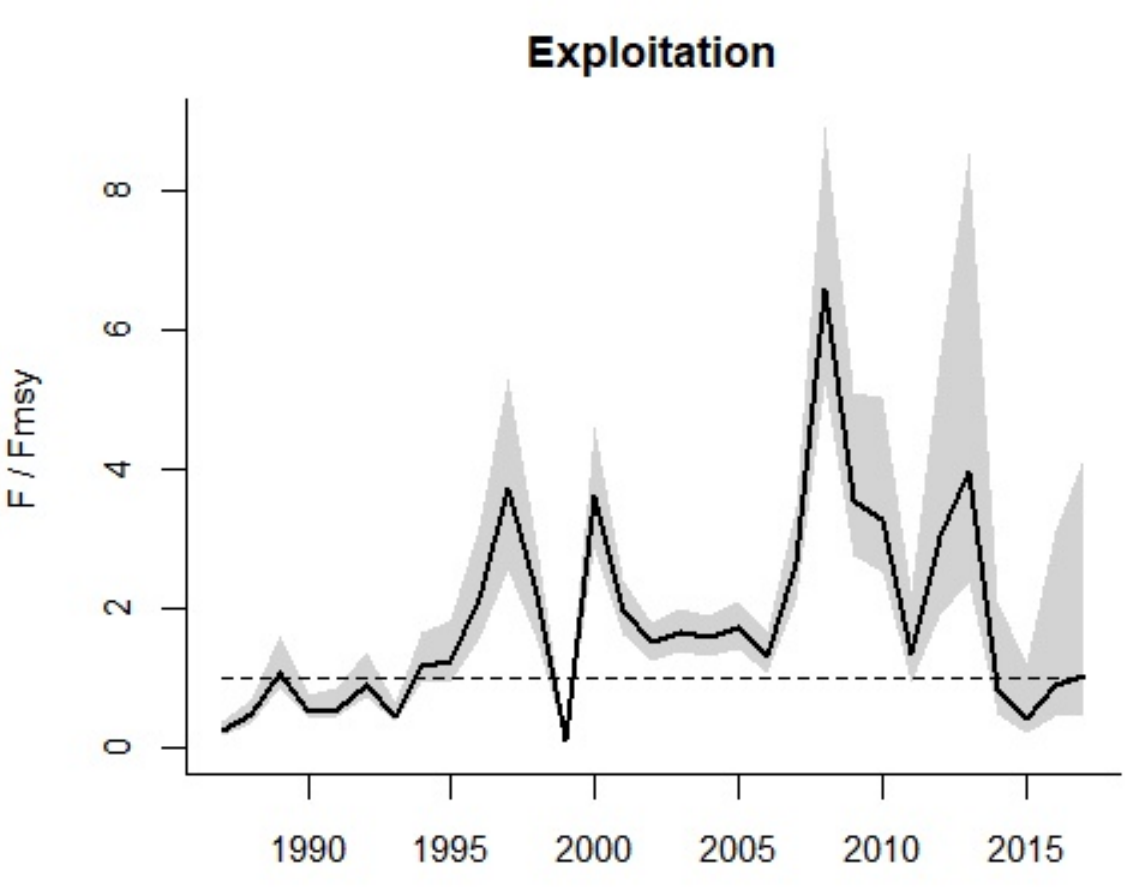

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1990
2000
2010

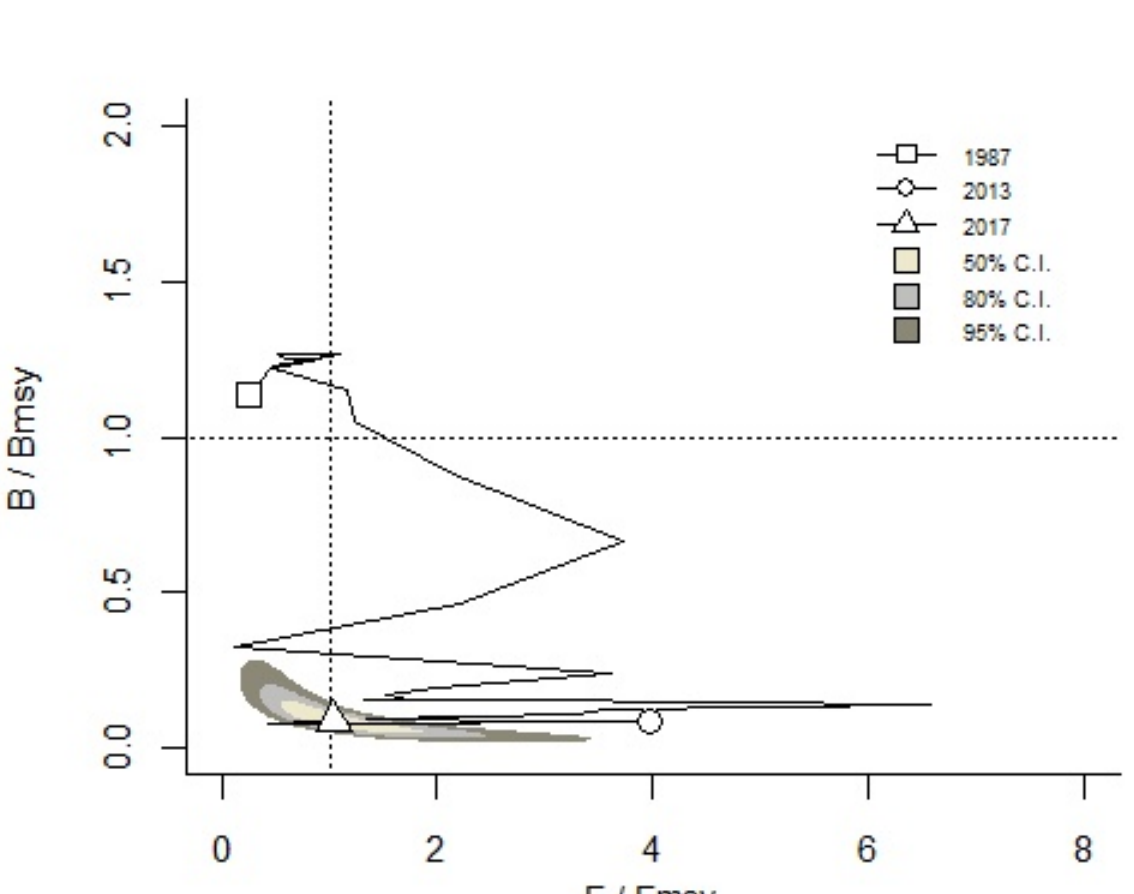

E: Exploitation rate
F / Fmsy
0
1
2
3
1990
2000
2010

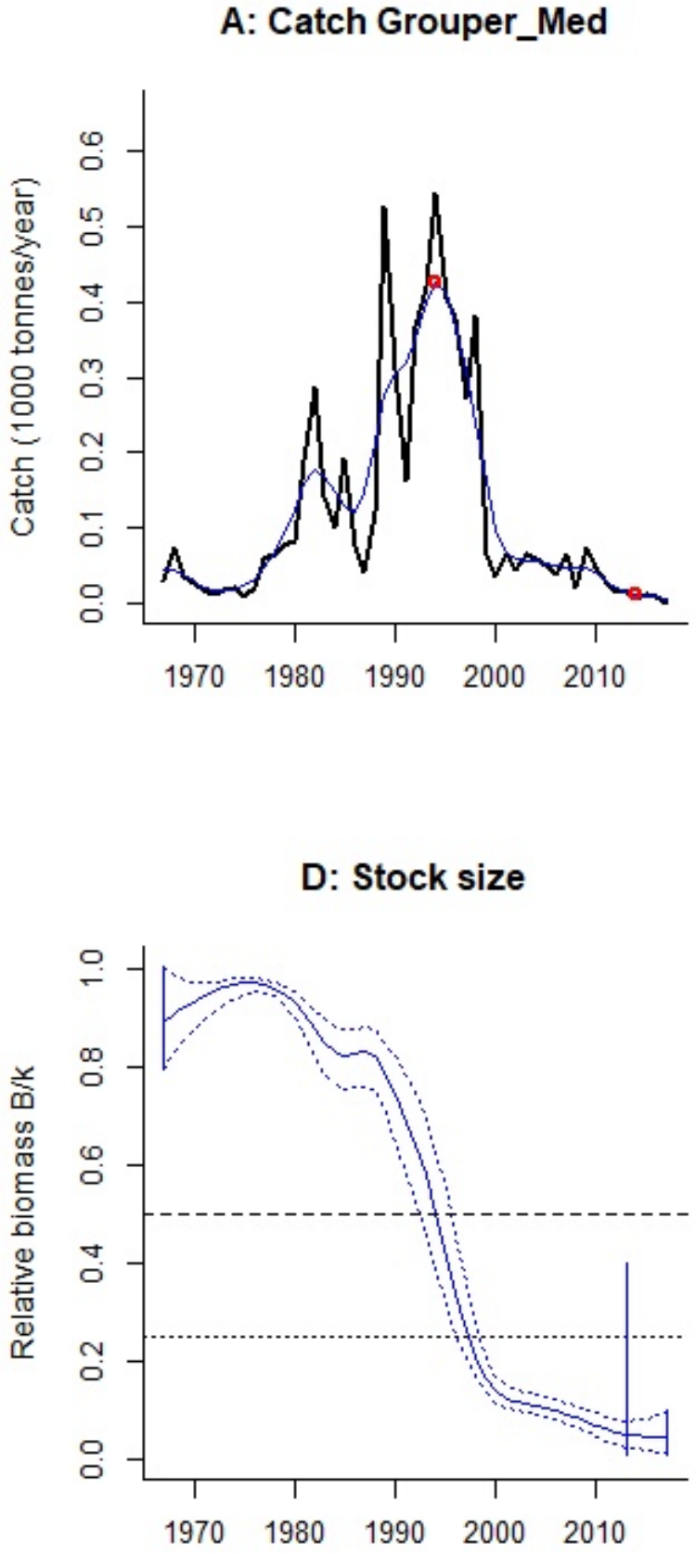

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

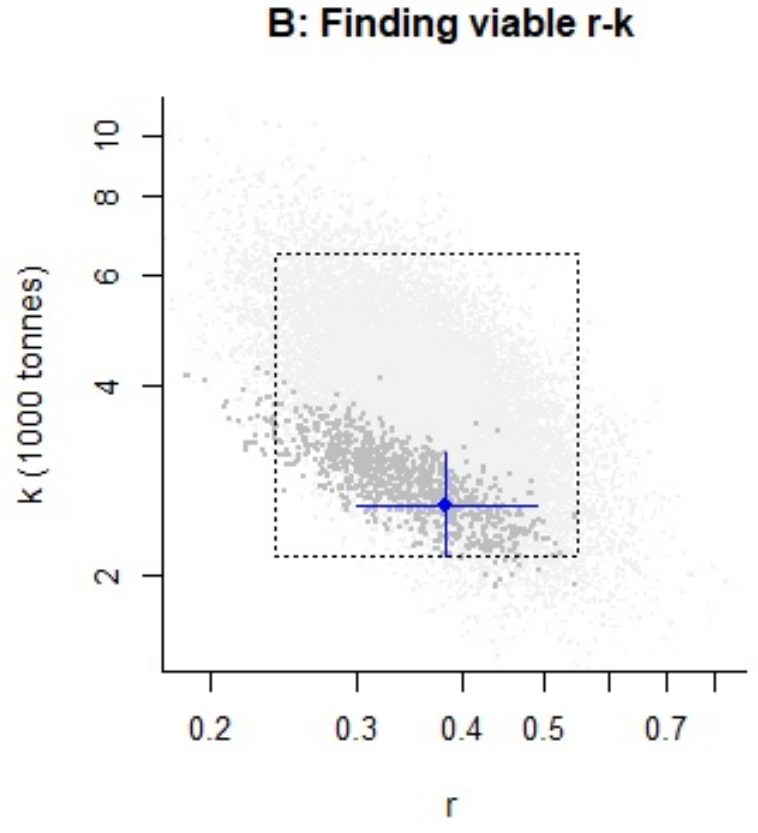

Catch
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
MSY
1990
1995
2000
2005
2010
2015

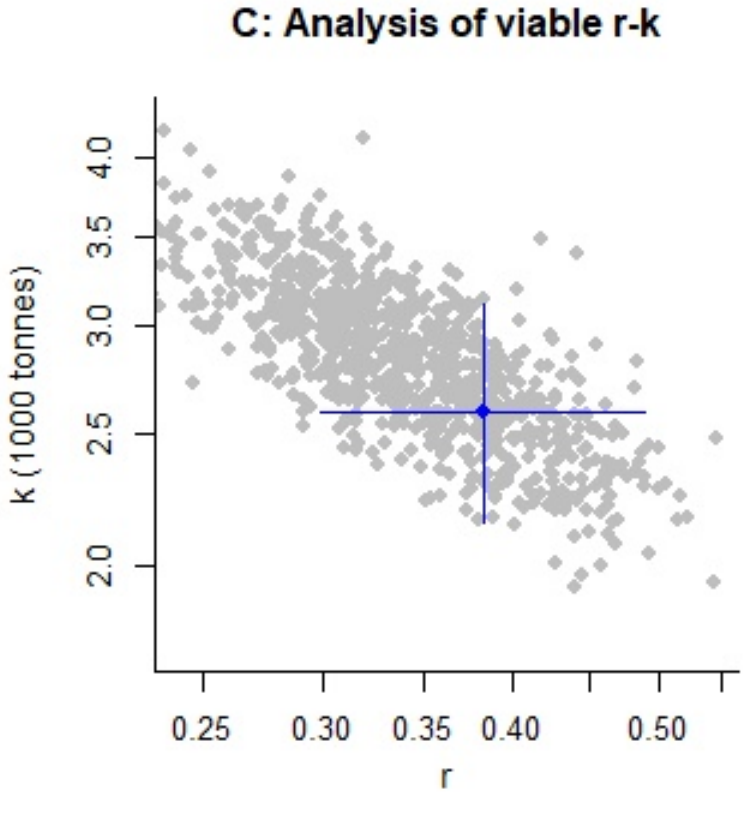

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1990
1995
2000
2005
2010
2015


Exploitation
F / Fmsy
0
2
4
6
8
1990
1995
2000
2005
2010
2015

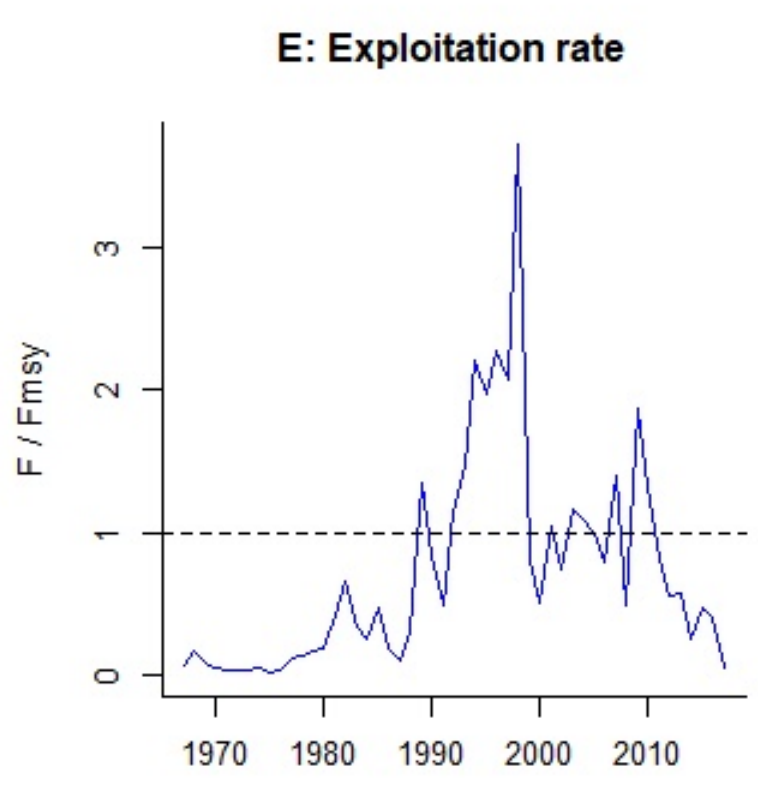

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1987
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

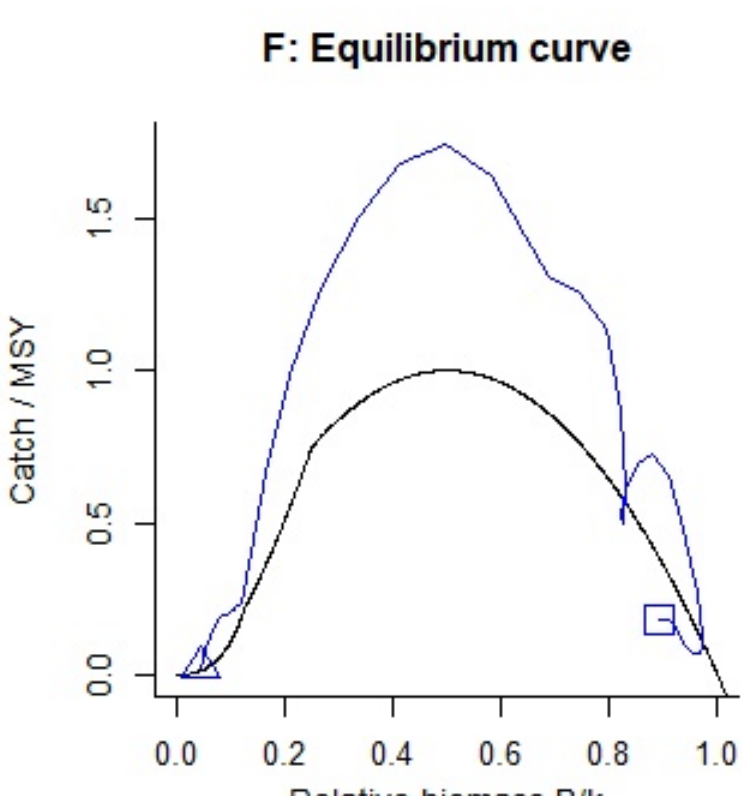

A: Catch Grouper_Med
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

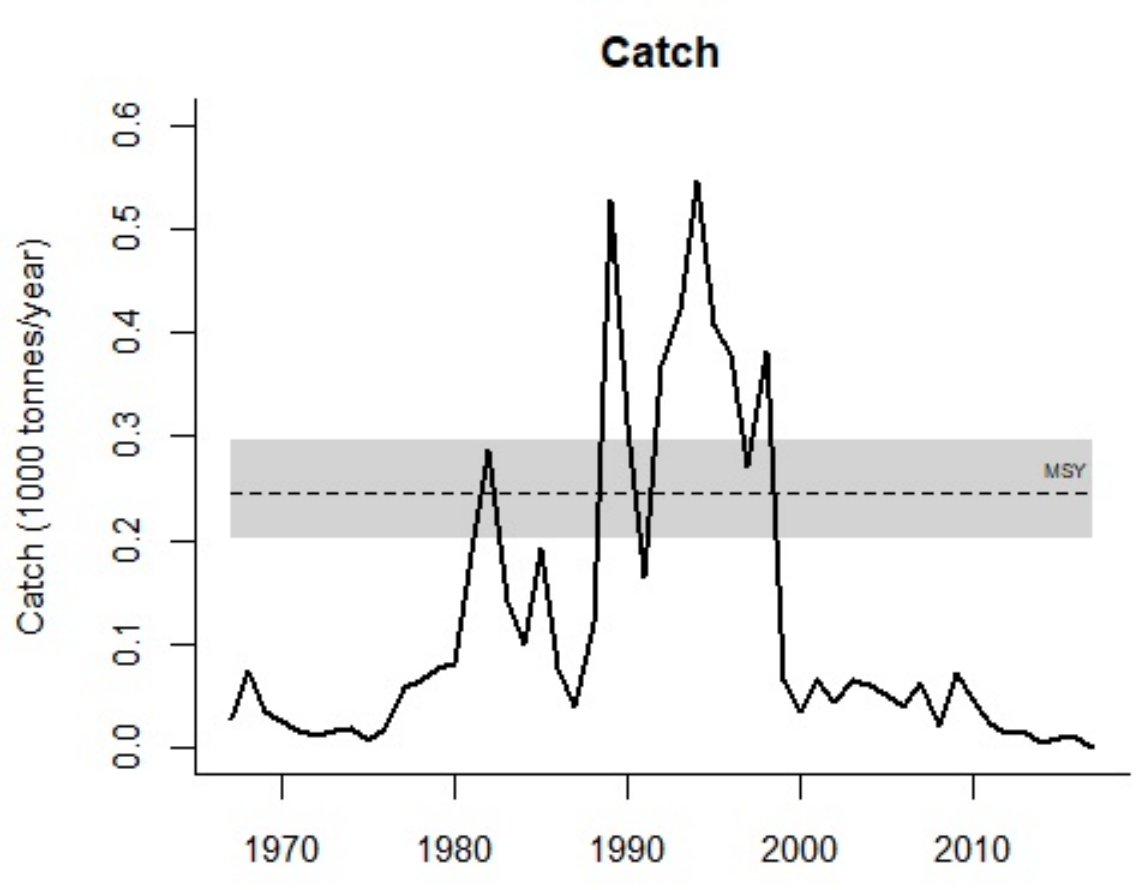

B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
0.2
0.3
0.4
0.5
0.7
r

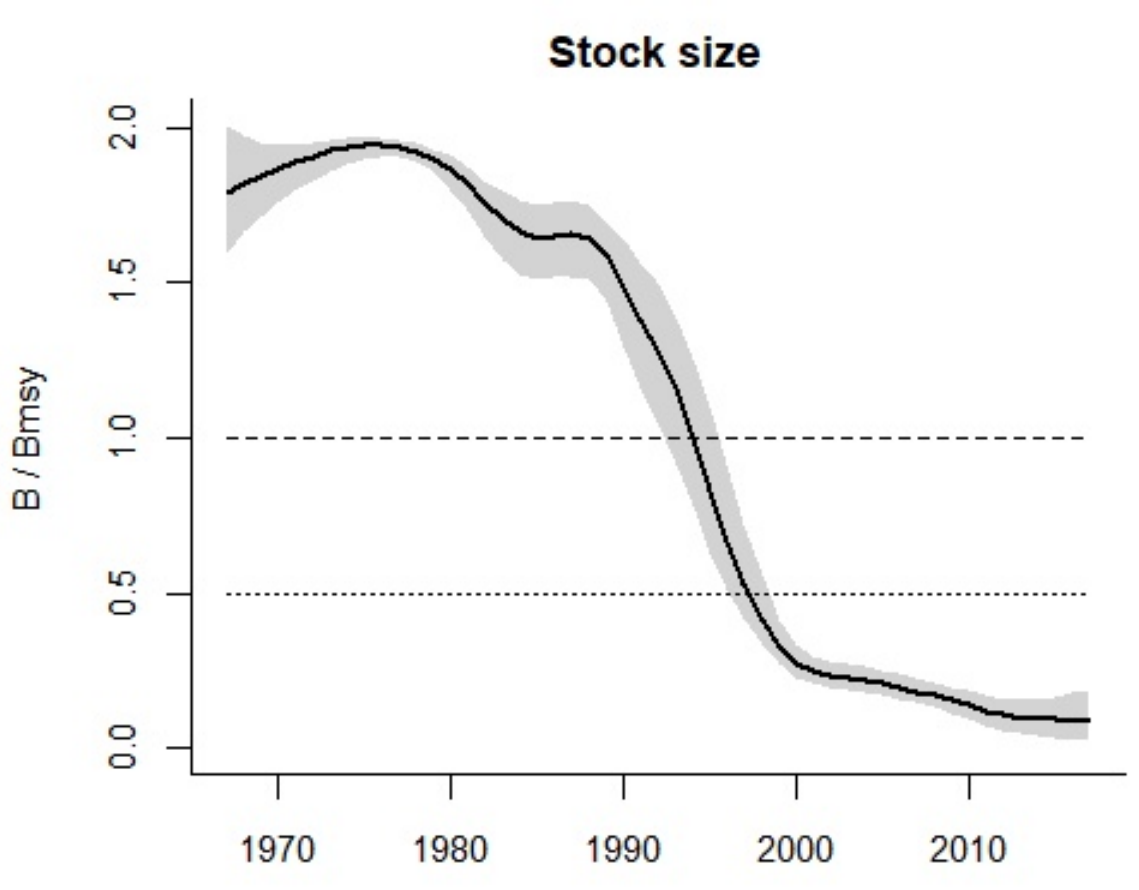

C: Analysis of viable r-k
k (1000 tonnes)
2.0
2.5
3.0
3.5
4.0
0.25
0.30
0.35
0.40
0.50
r

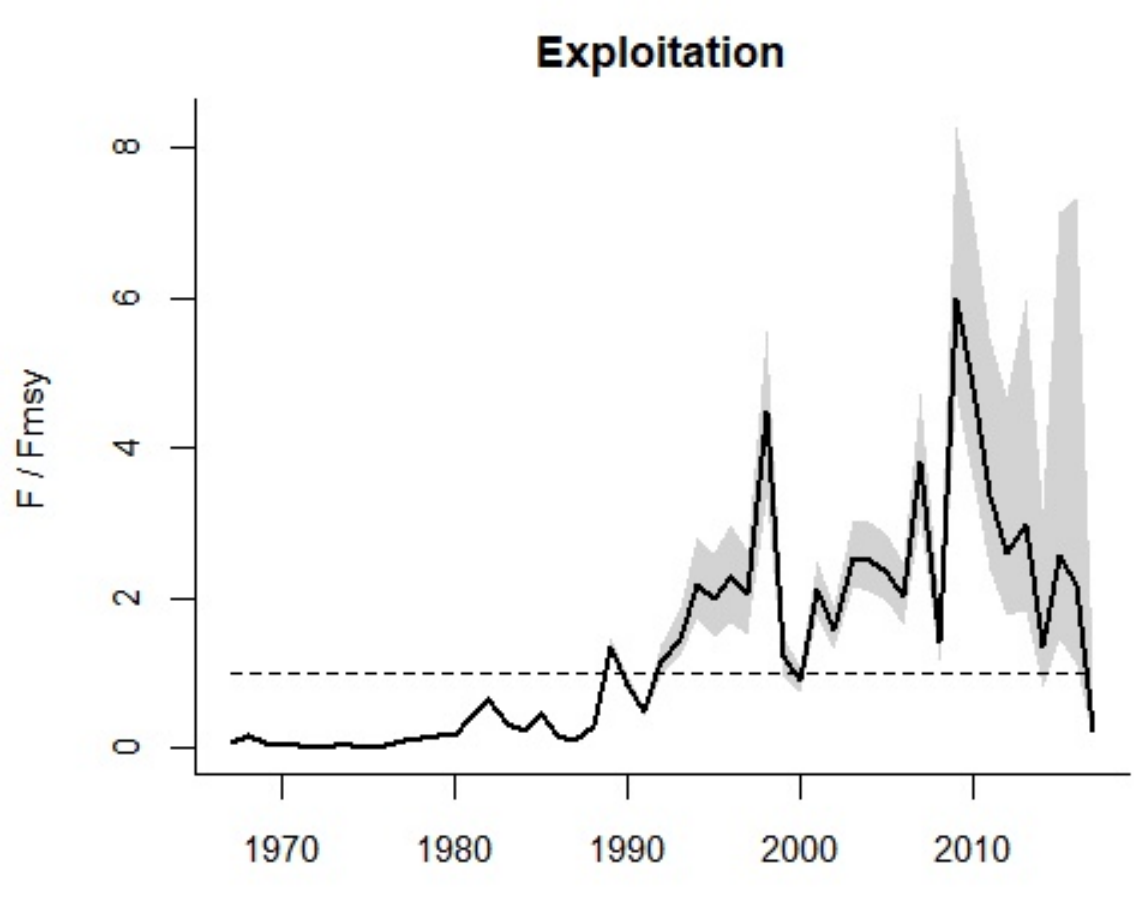
D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

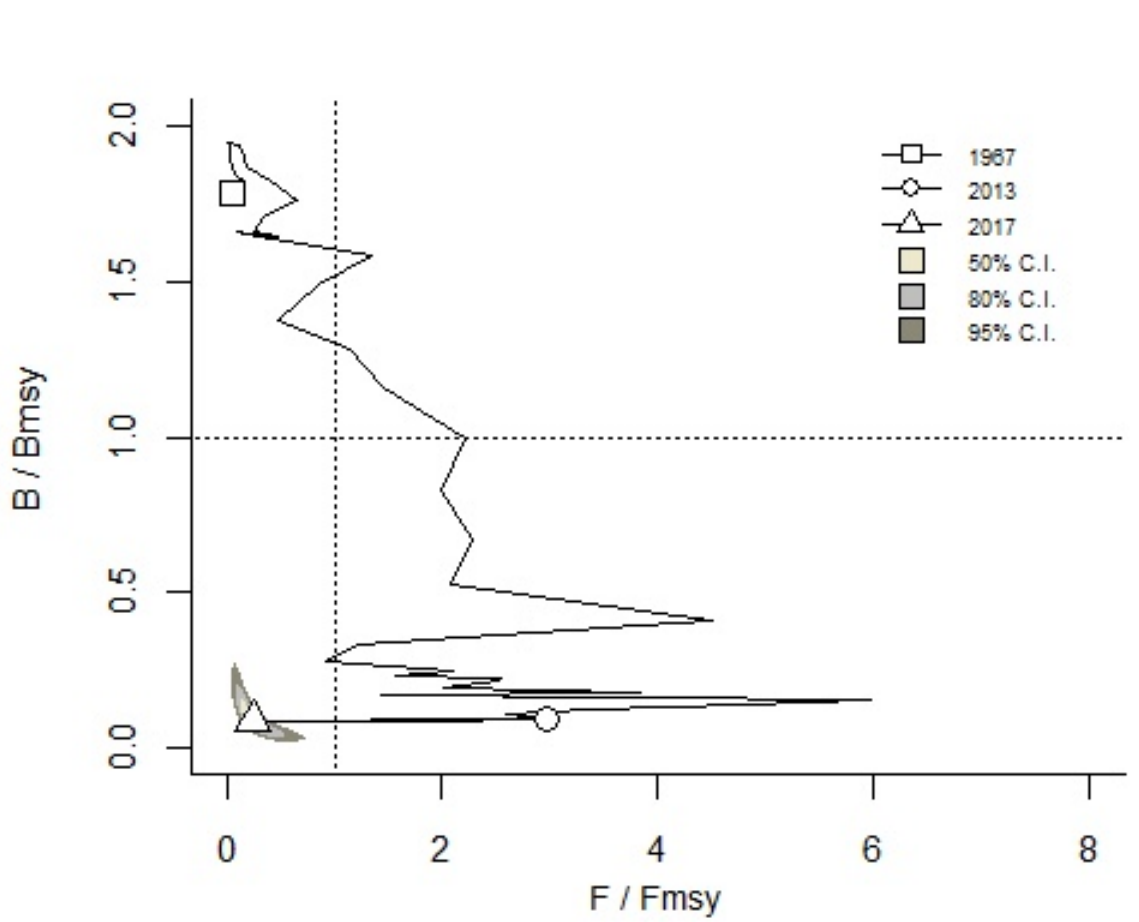

E: Exploitation rate
F / Fmsy
0
1
2
3
1970
1980
1990
2000
2010

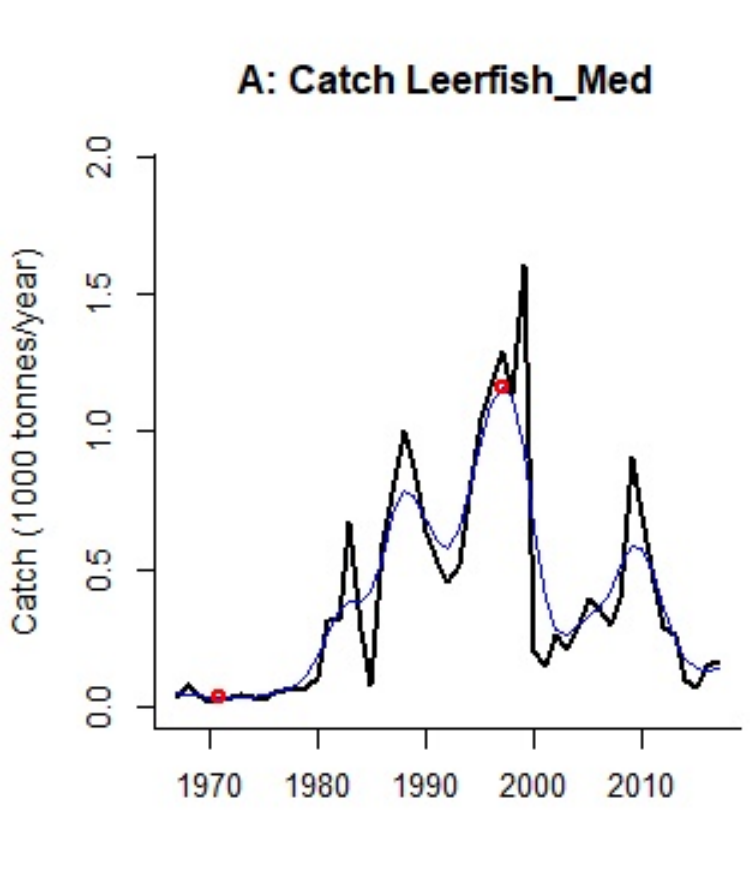

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

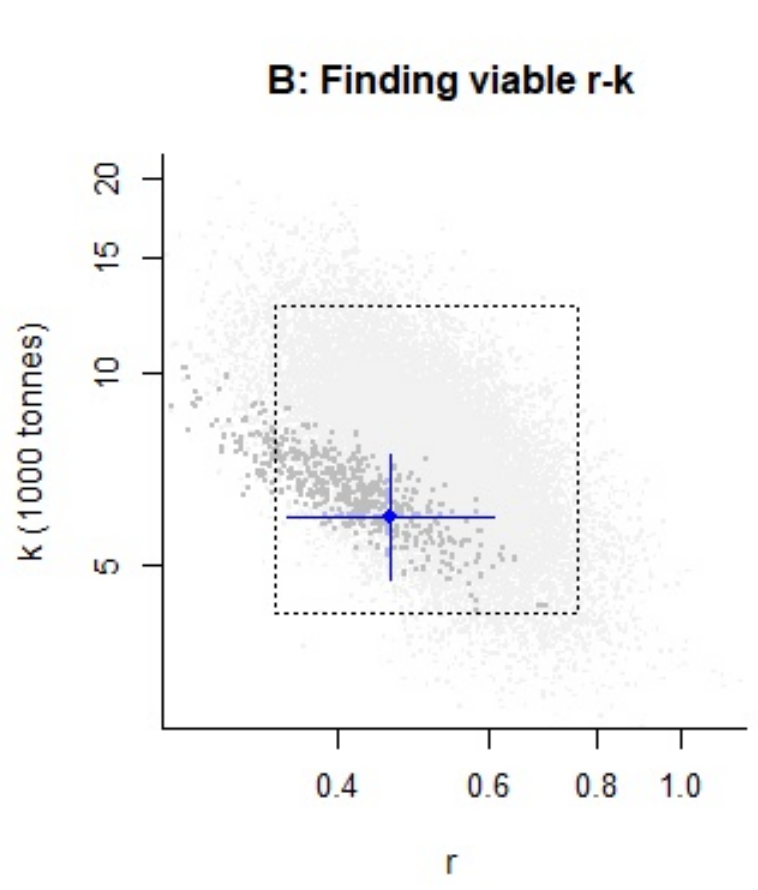

Catch
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
MSY
1970
1980
1990
2000
2010

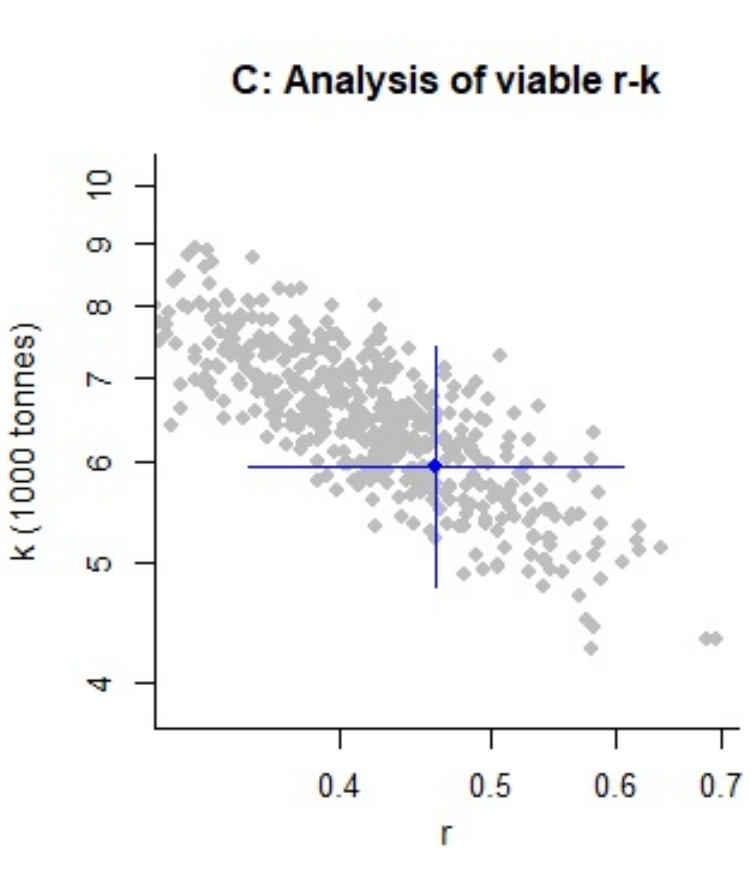

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

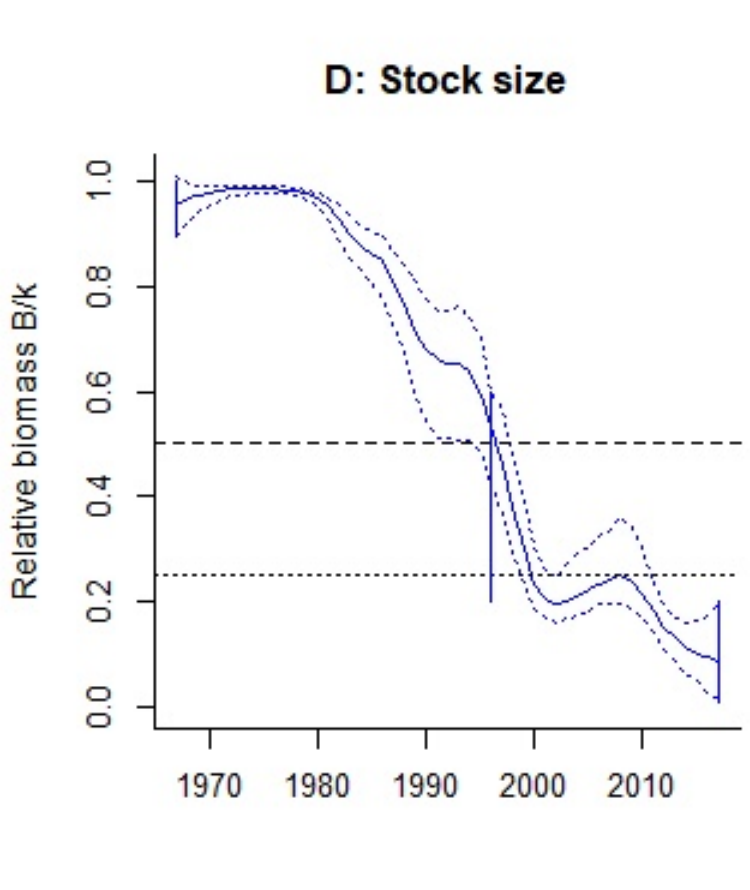

Exploitation
F / Fmsy
0
2
4
6
8
1970
1980
1990
2000
2010

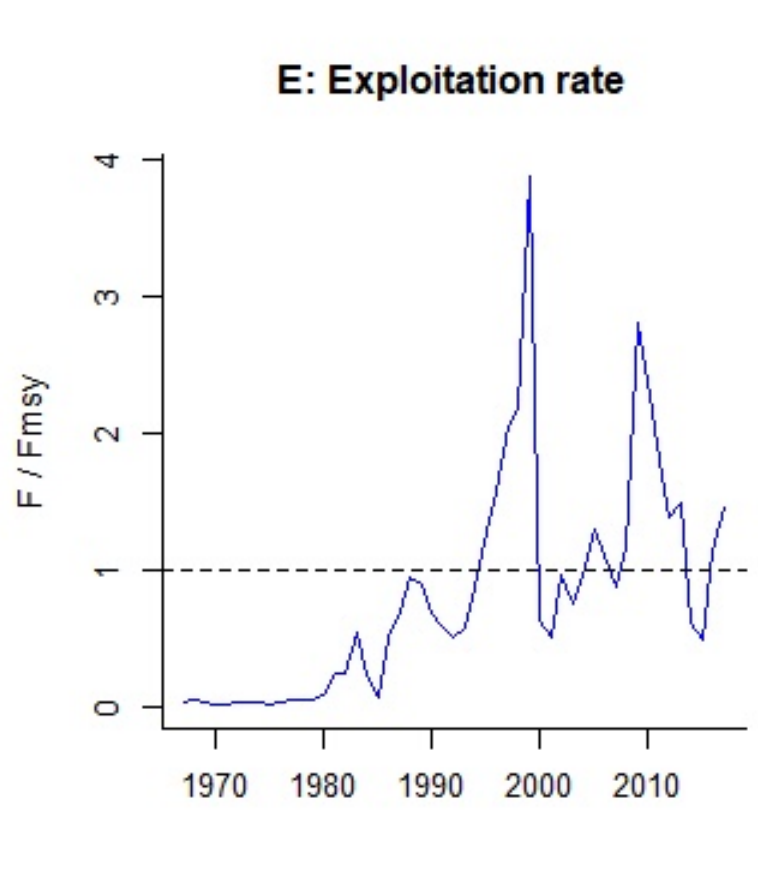

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

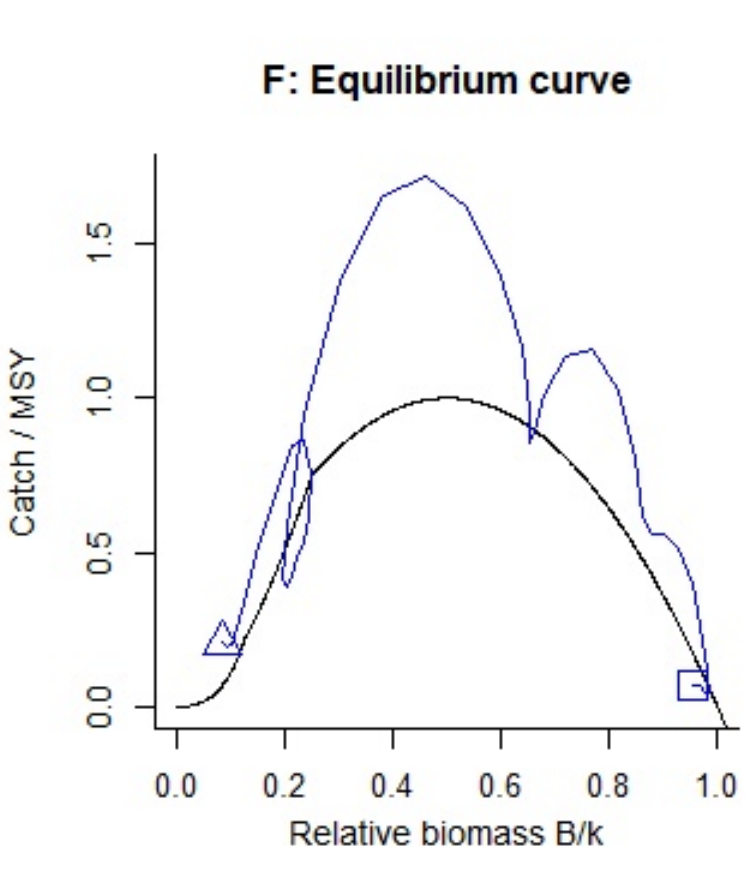

A: Catch Leerfish_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

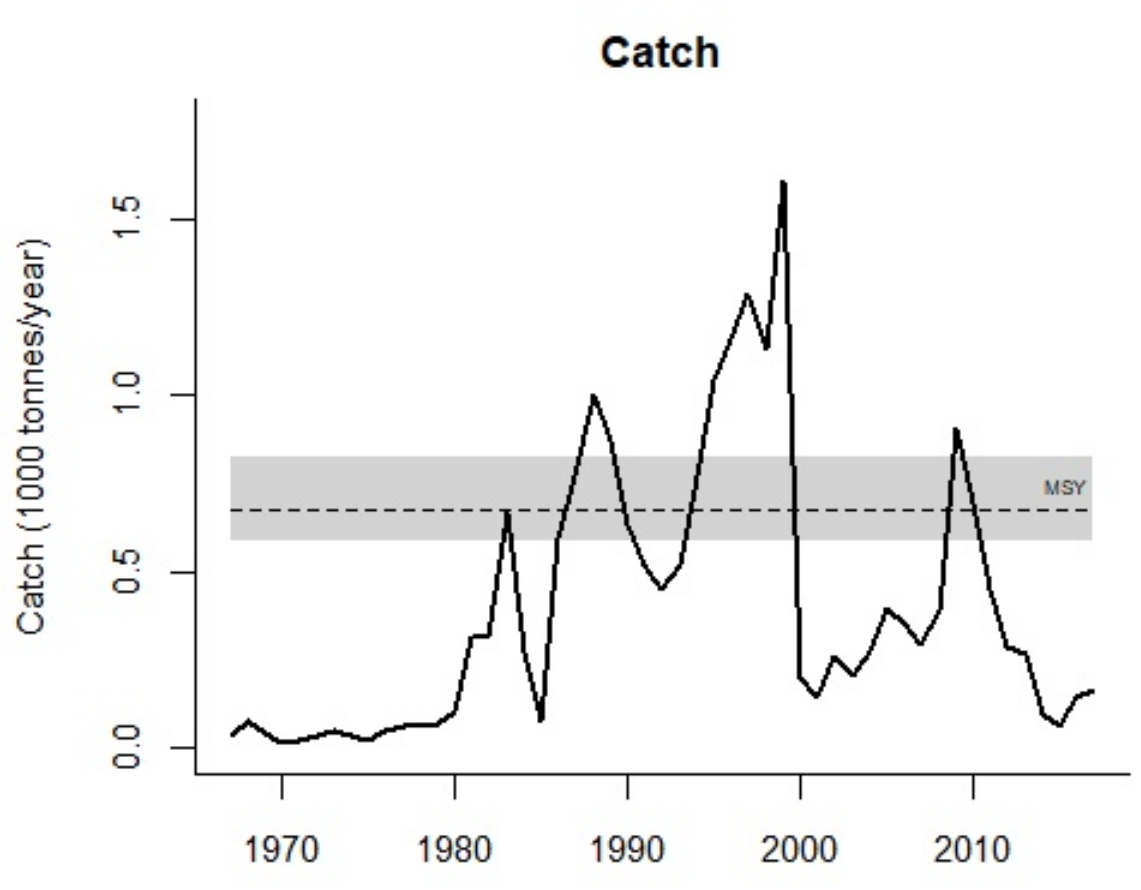

B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
0.4
0.6
0.8
1.0
r

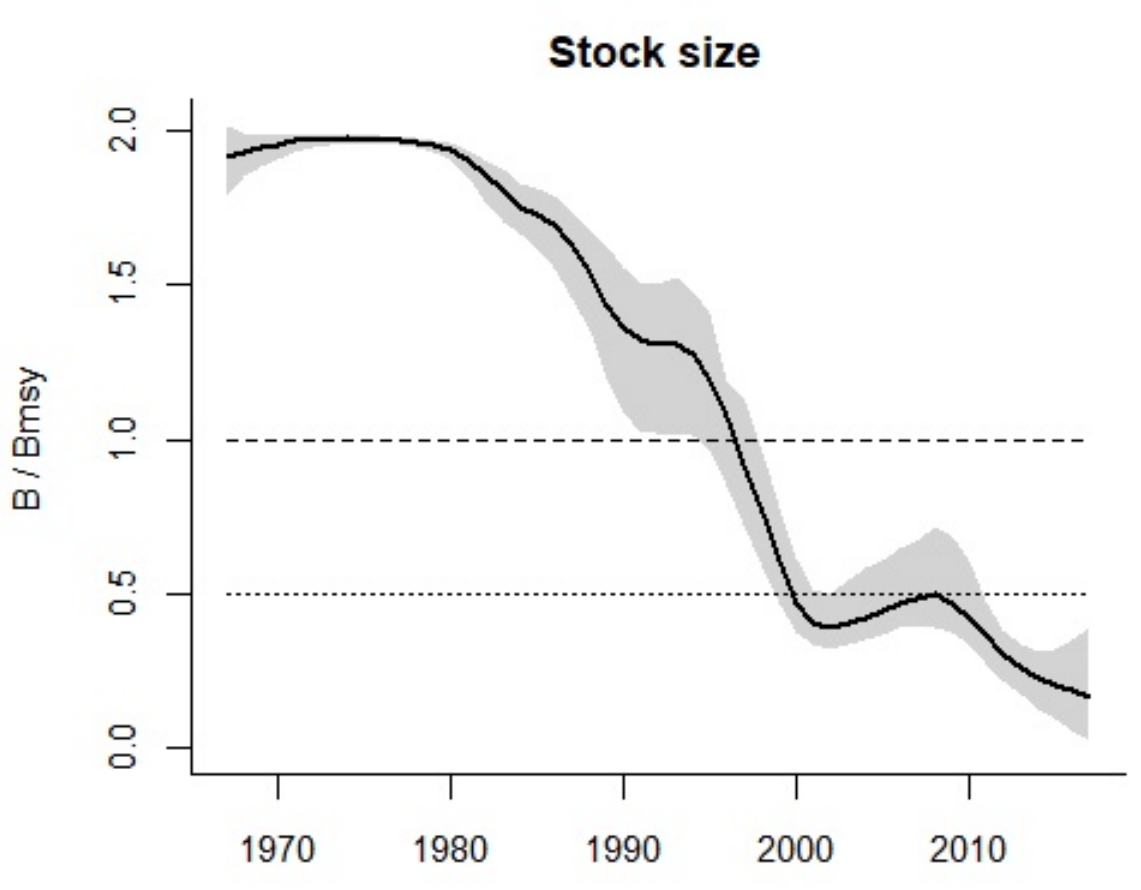

C: Analysis of viable r-k
k (1000 tonnes)
4
5
6
7
8
9
10
0.4
0.5
0.6
0.7
r

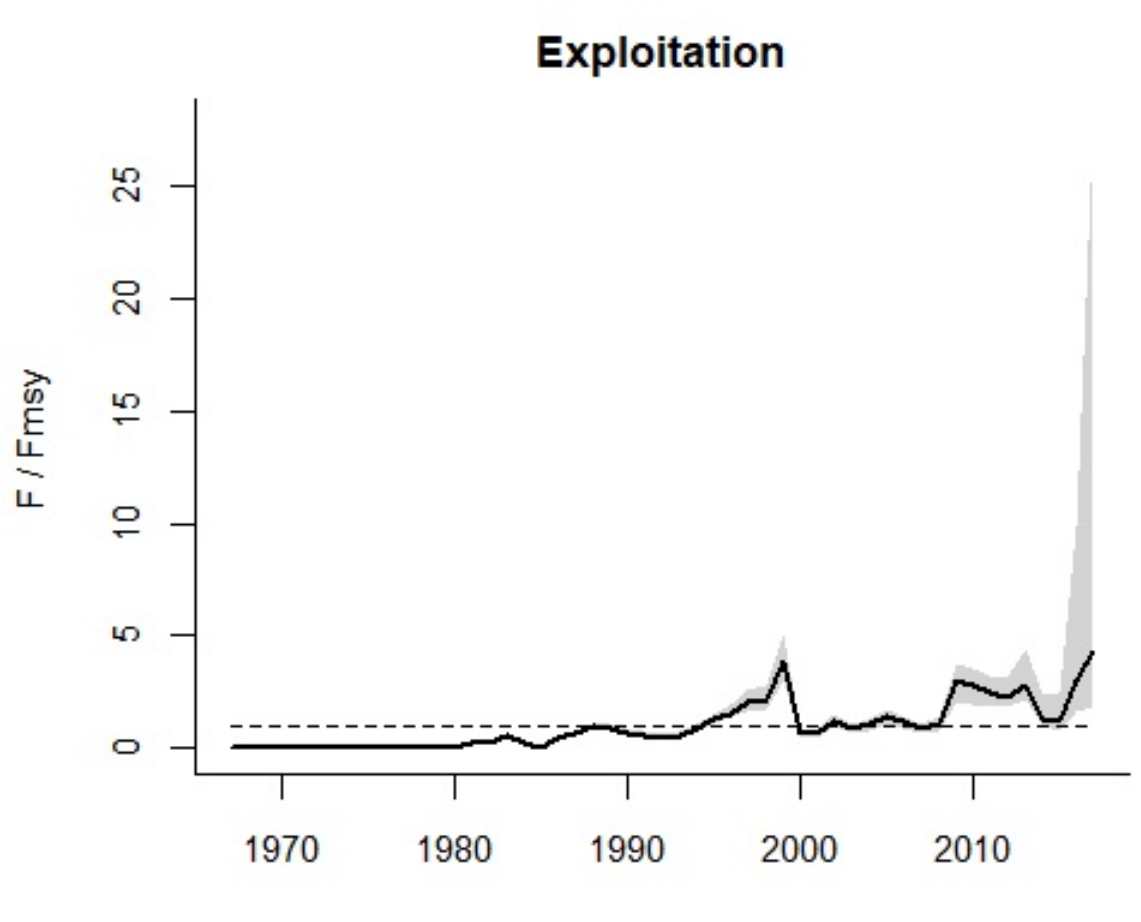

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

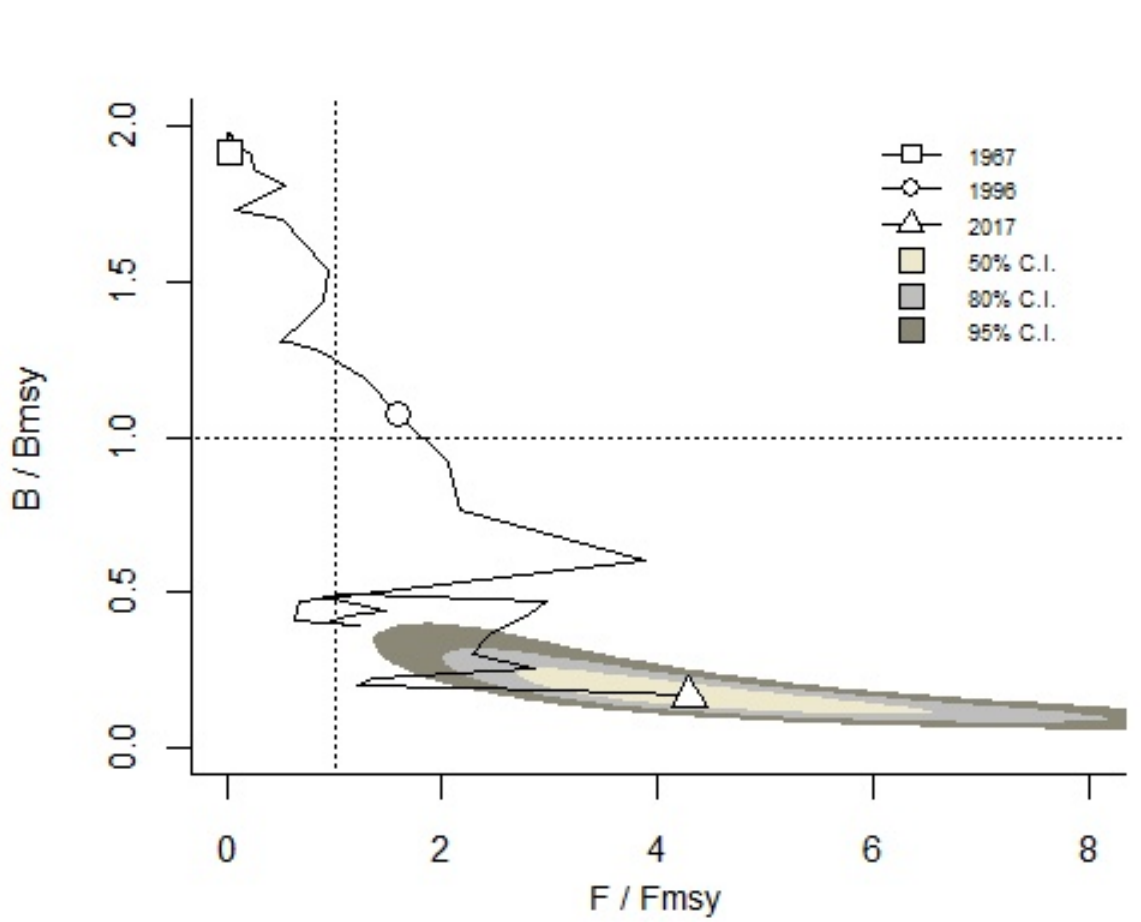

E: Exploitation rate
F / Fmsy
0
1
2
3
4
1970
1980
1990
2000
2010

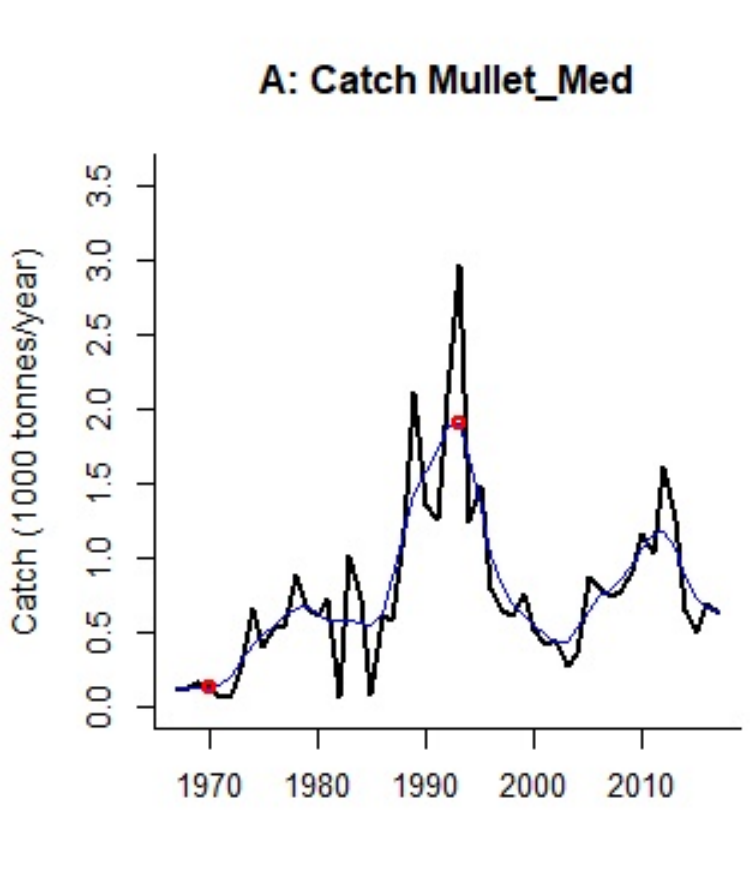

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

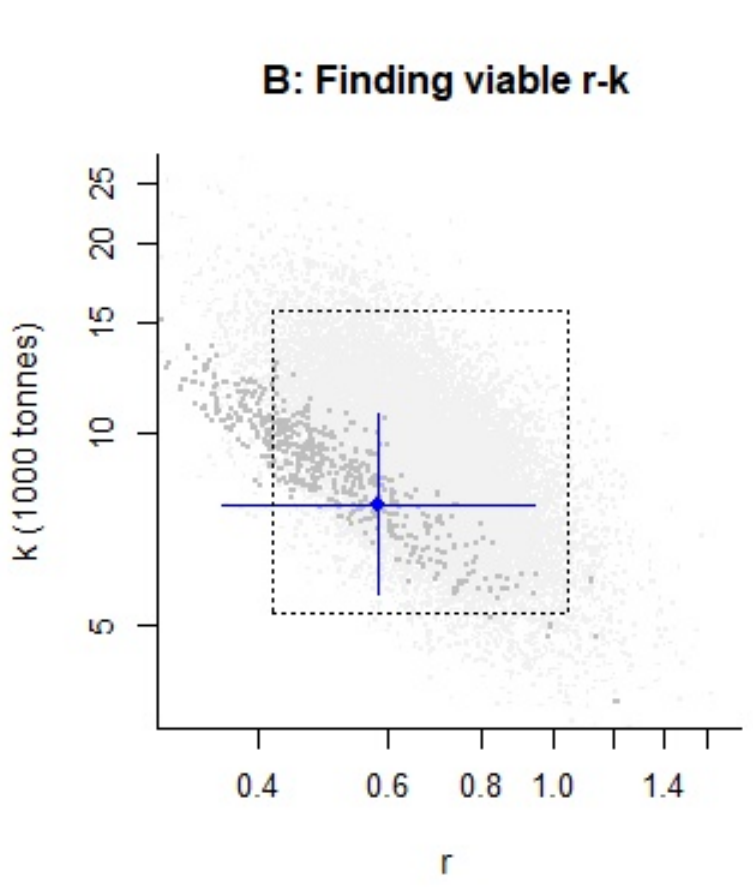

Catch
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
MSY
1970
1980
1990
2000
2010

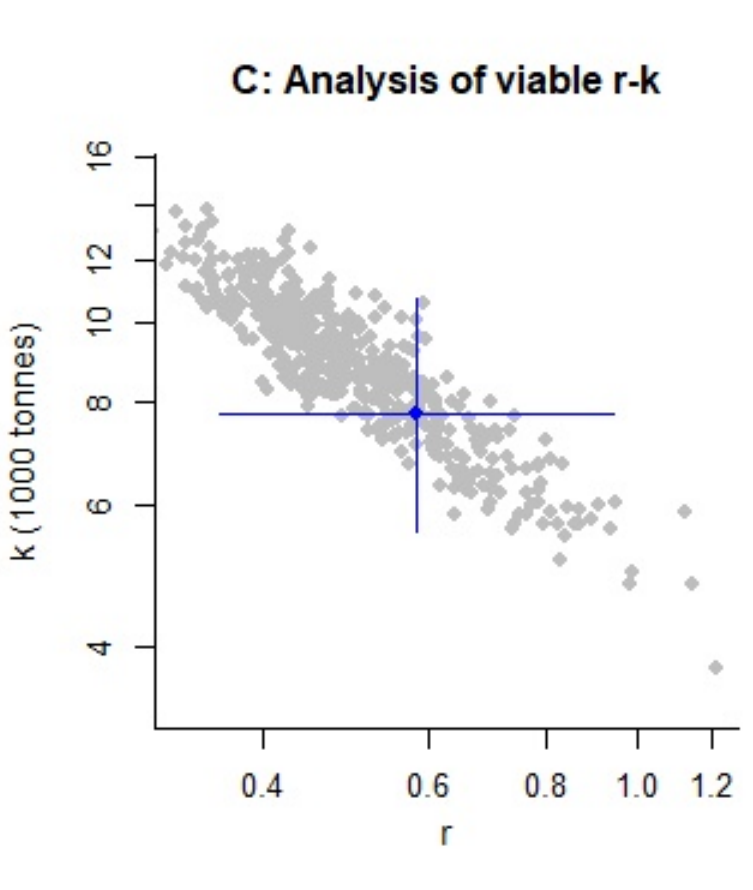

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

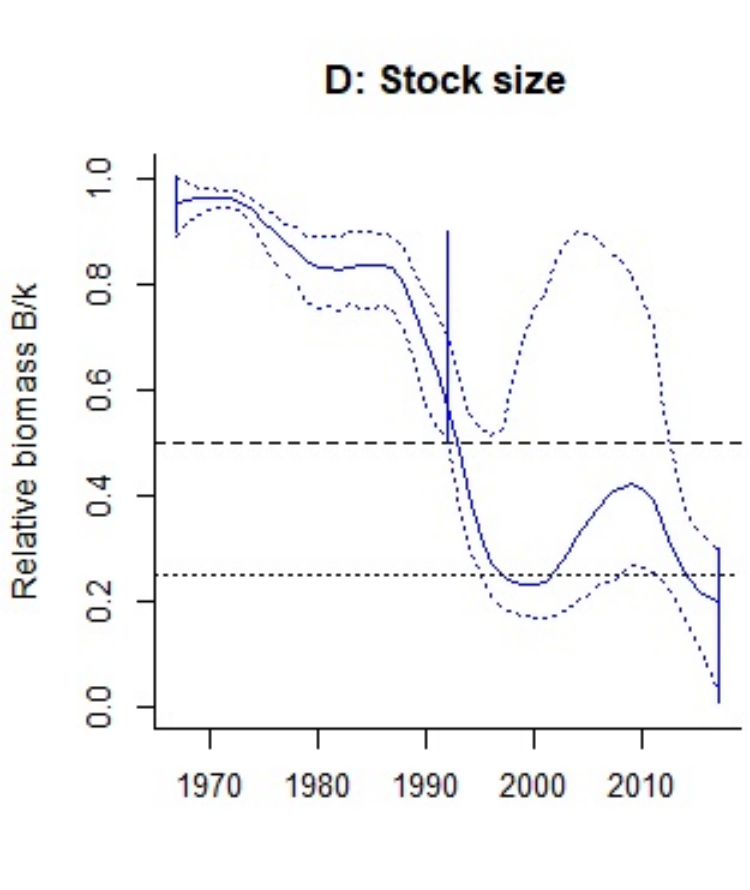

Exploitation
F / Fmsy
0
5
10
15
20
25
1970
1980
1990
2000
2010

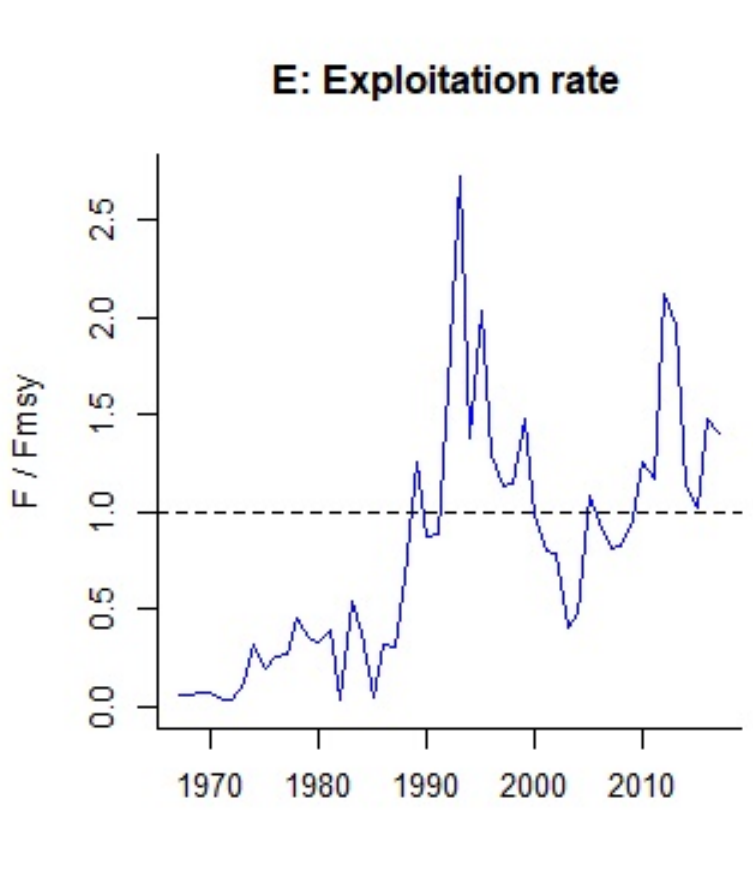

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1996
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

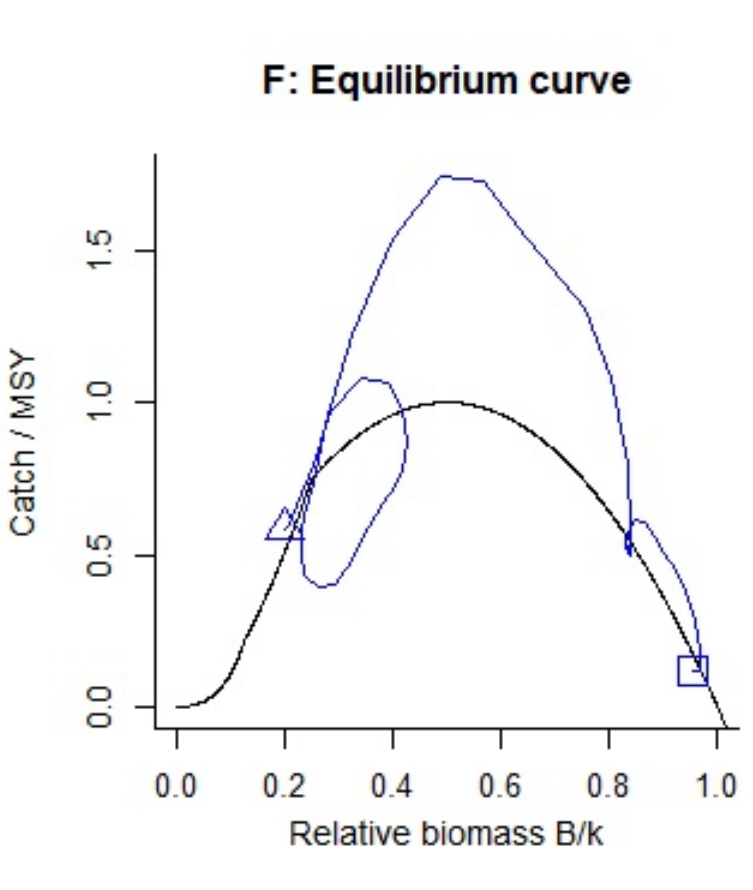

A: Catch Mullet_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1970
1980
1990
2000
2010

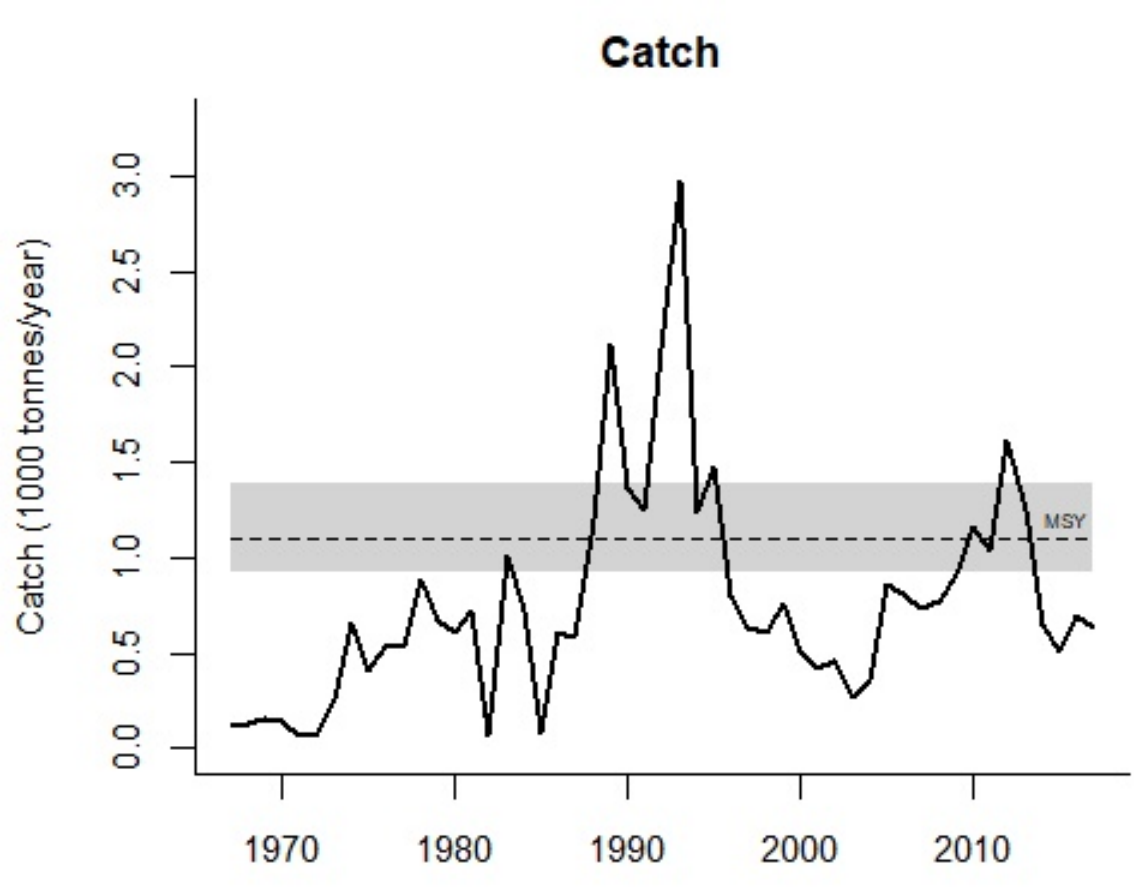

B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
25
0.4
0.6
0.8
1.0
1.4
r

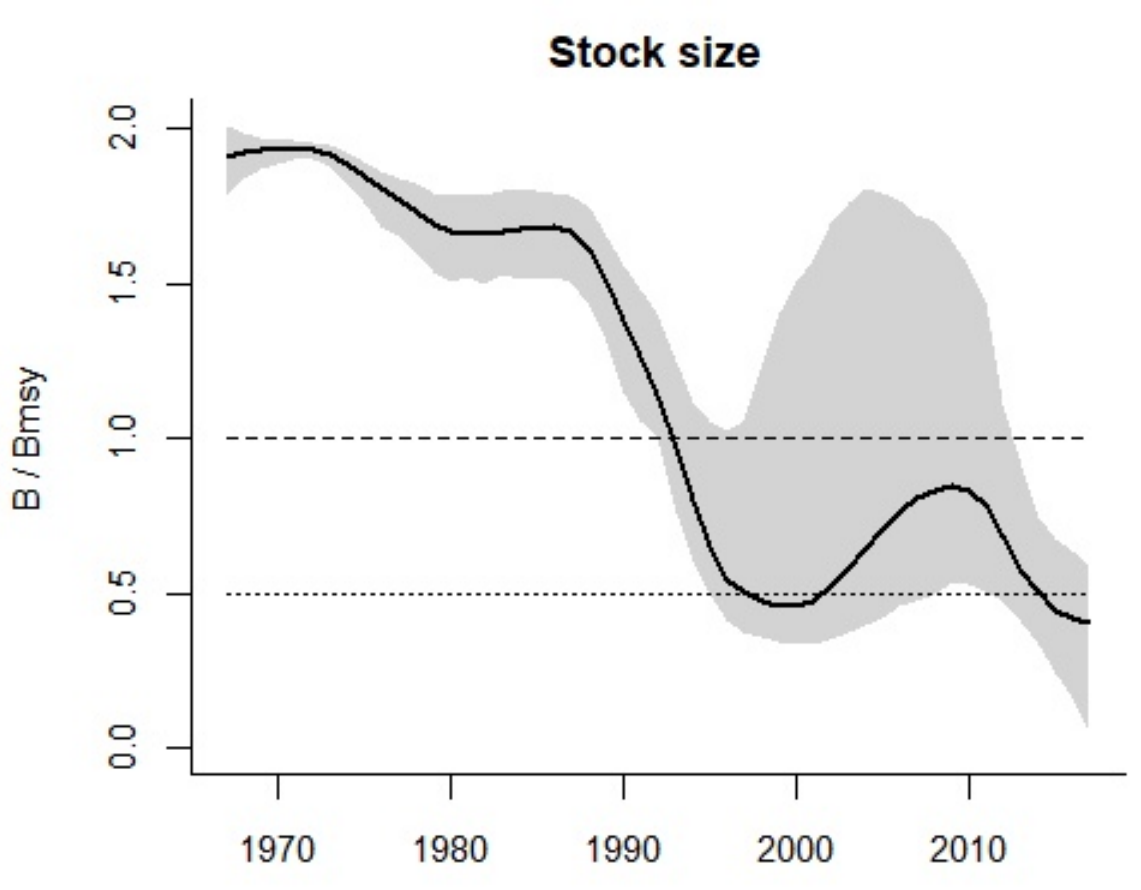

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
12
16
0.4
0.6
0.8
1.0
1.2
r

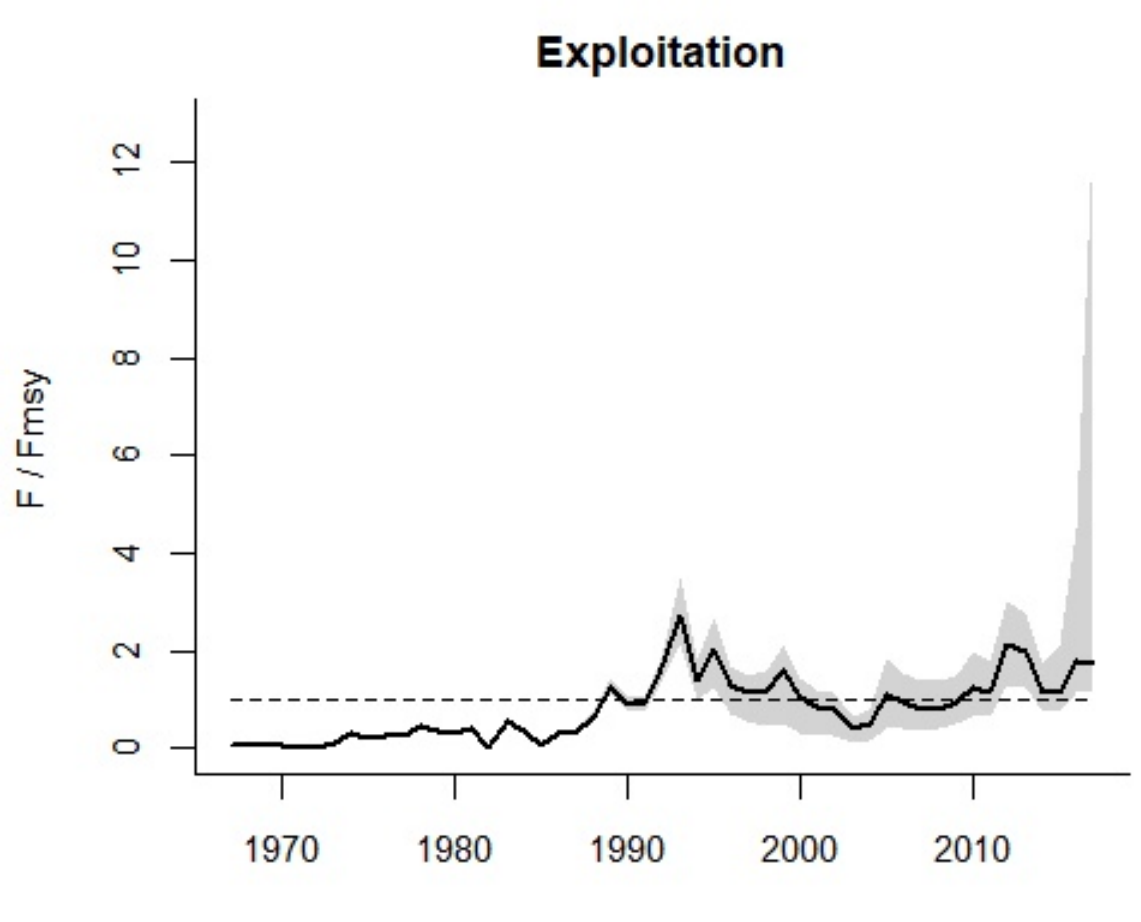

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

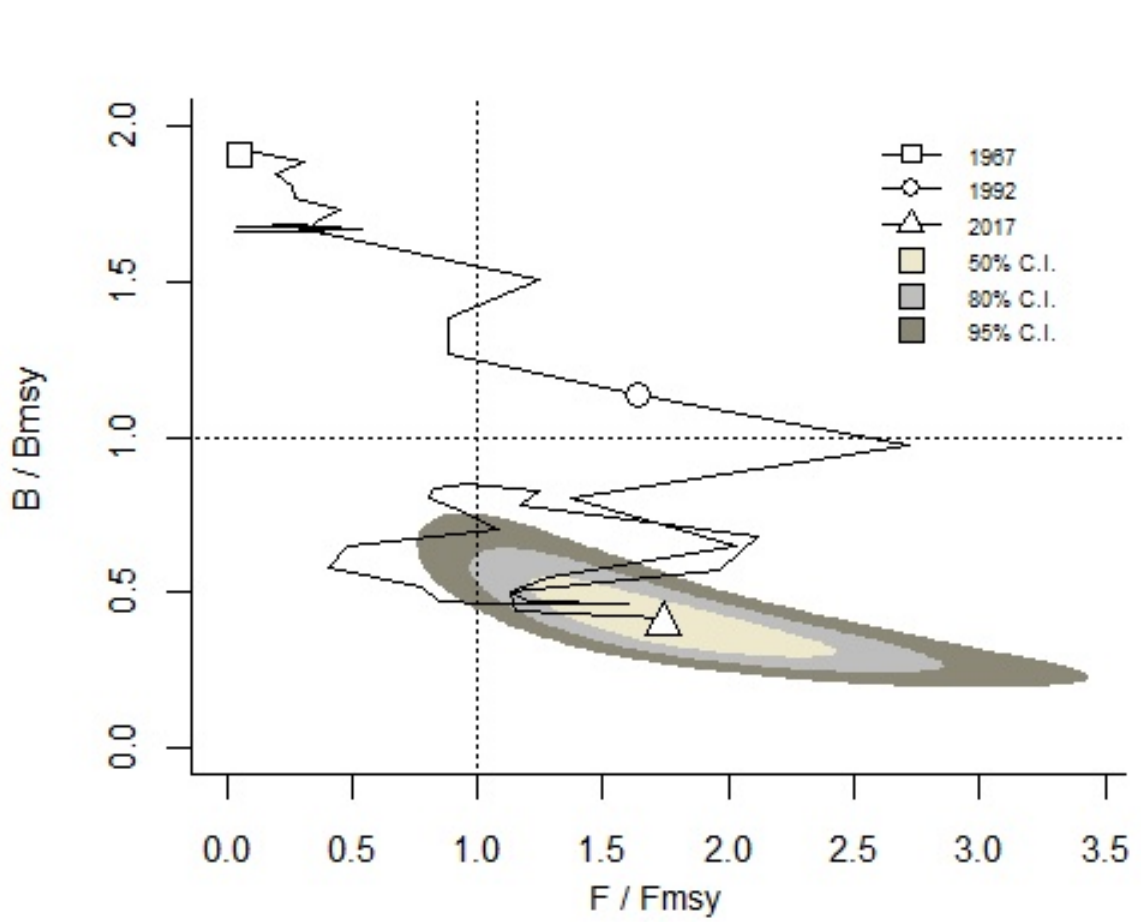

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

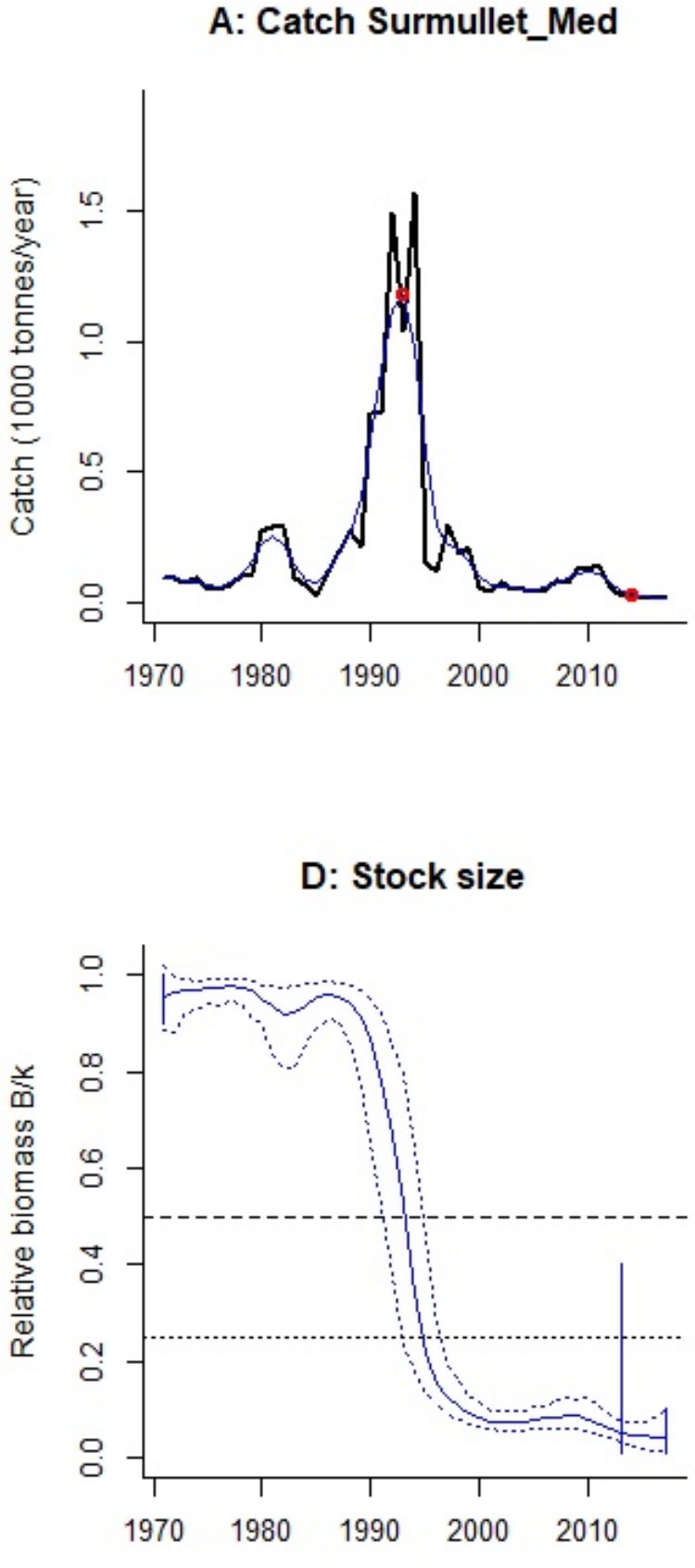

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

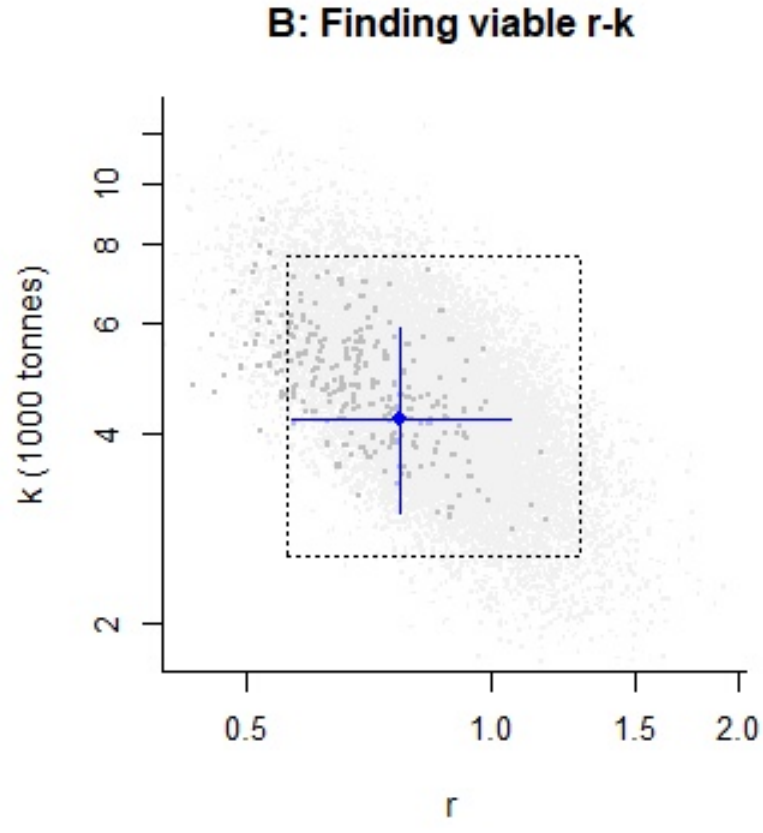

Catch
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
MSY
1970
1980
1990
2000
2010

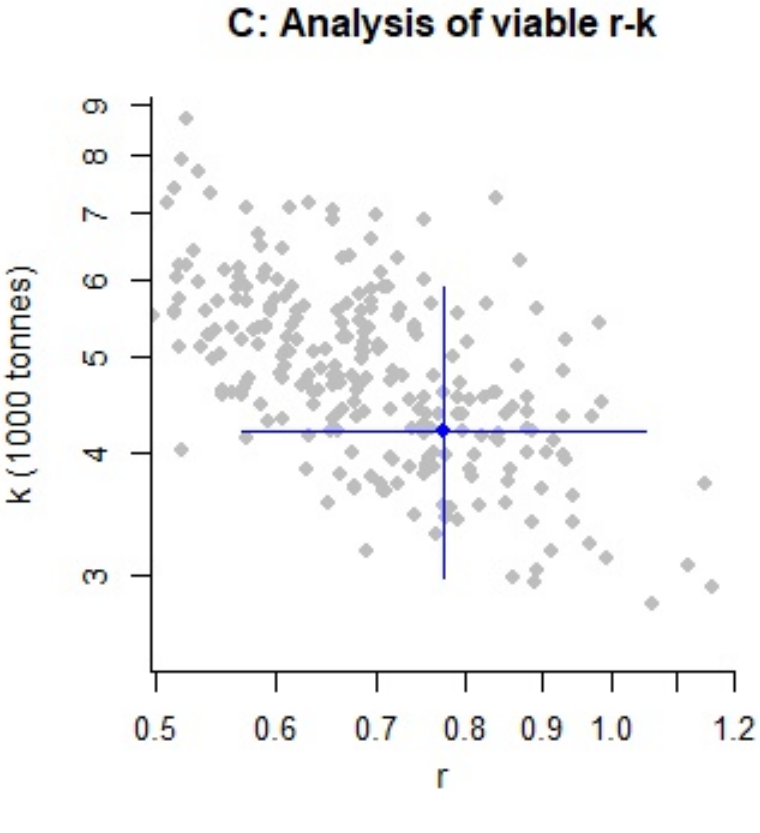

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
2
4
6
8
10
12
1970
1980
1990
2000
2010

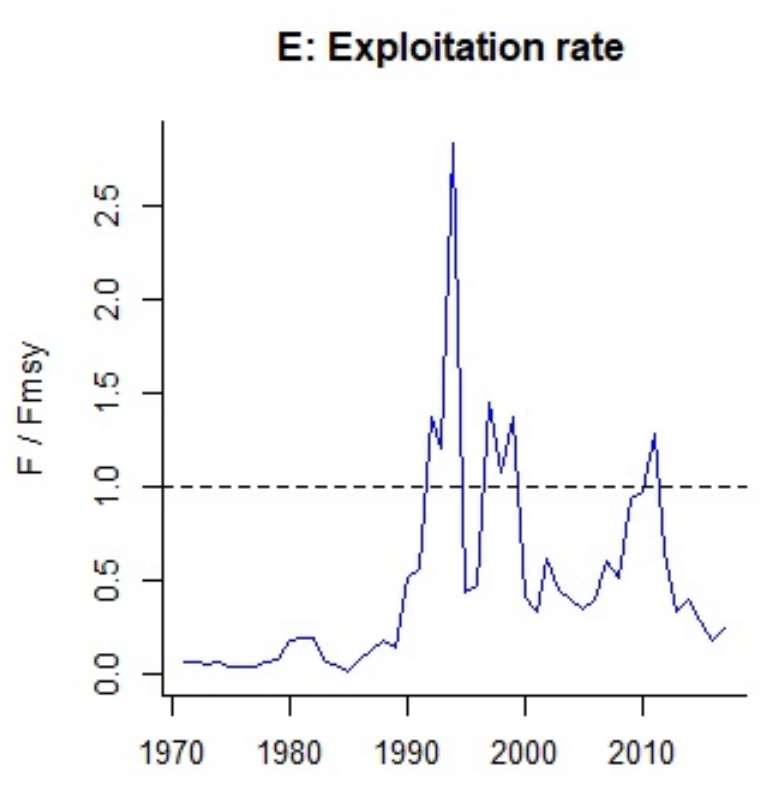

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1992
2017
50% C.I.
80% C.I.
95% C.I.
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
F / Fmsy

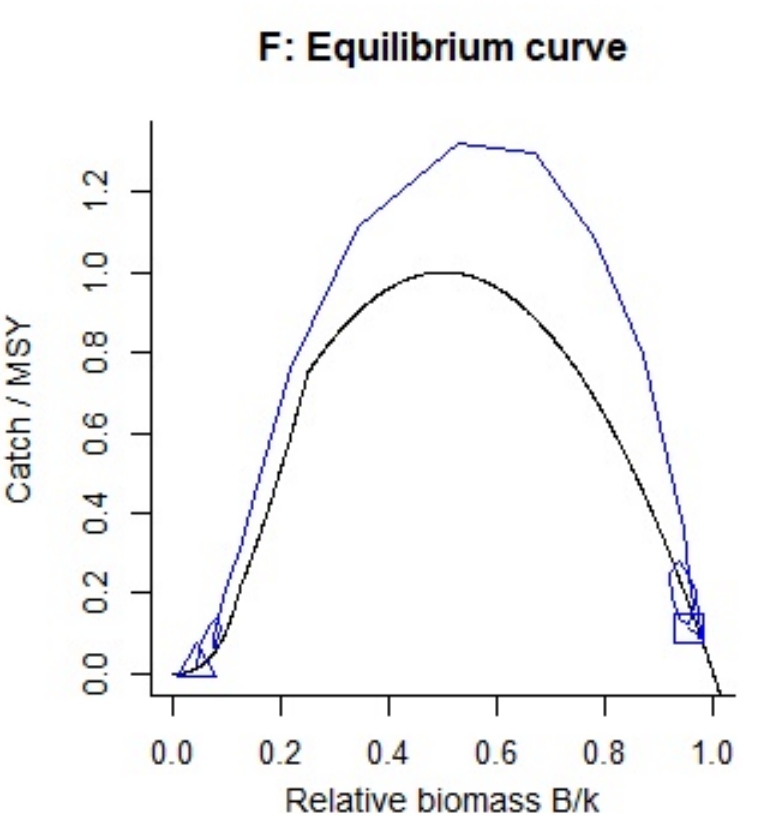

A: Catch Surmullet_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
0.5
1.0
1.5
2.0
r

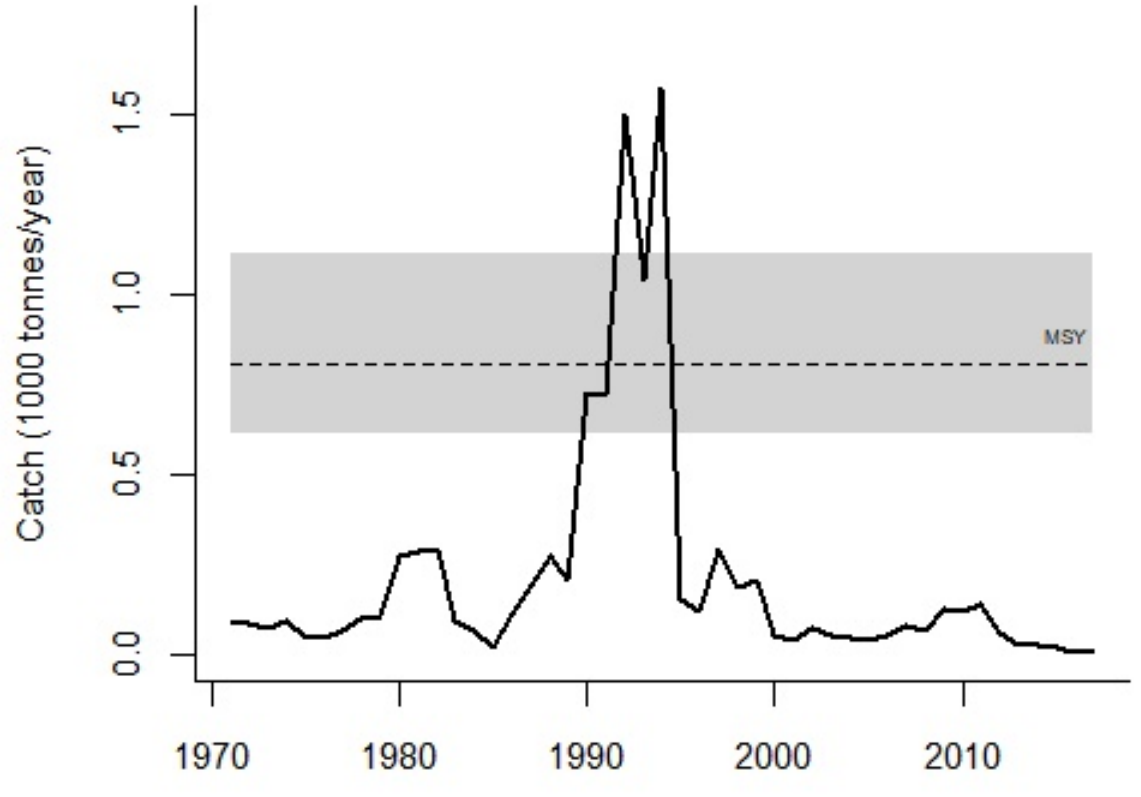

C: Analysis of viable r-k
k (1000 tonnes)
3
4
5
6
7
8
9
0.5
0.6
0.7
0.8
0.9
1.0
1.2
r

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

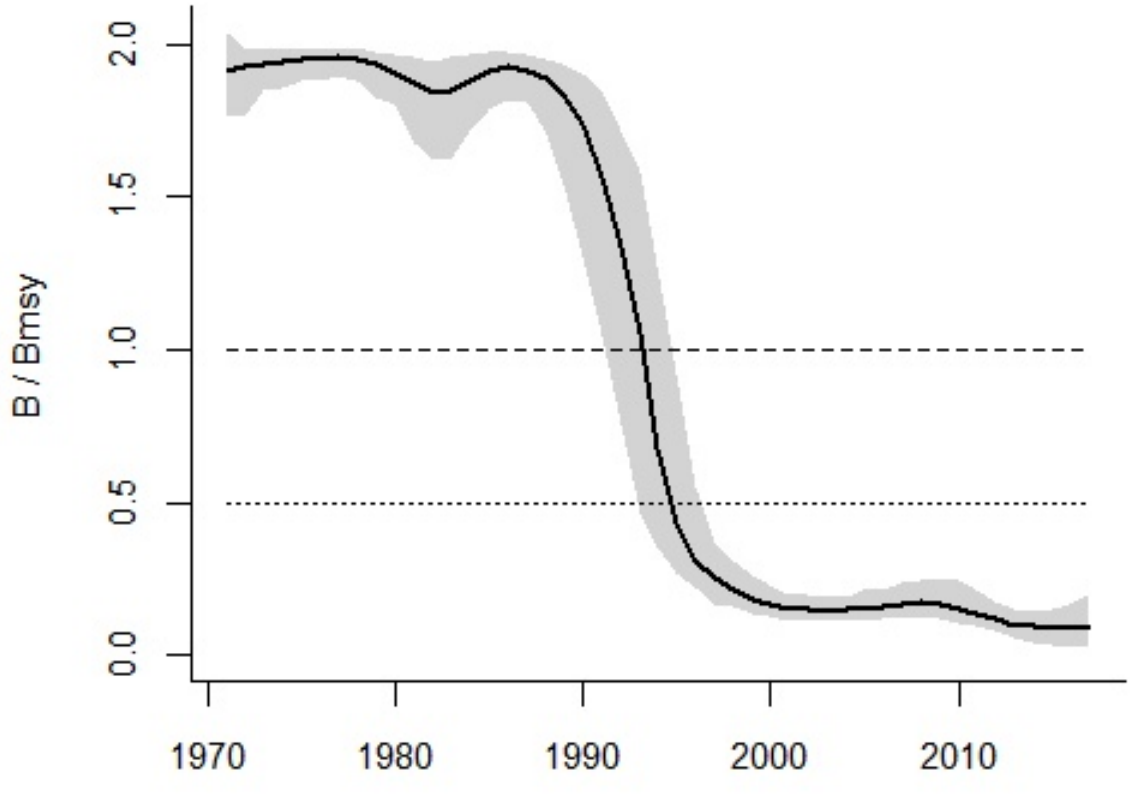

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

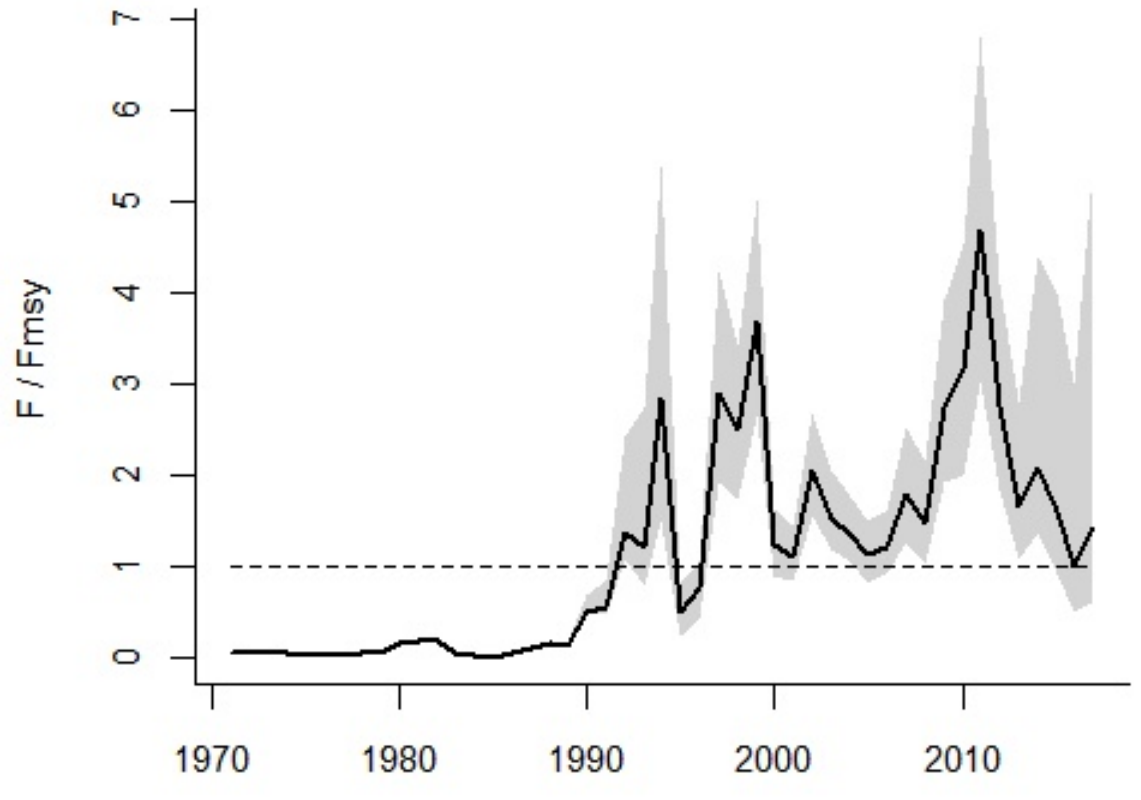
Catch

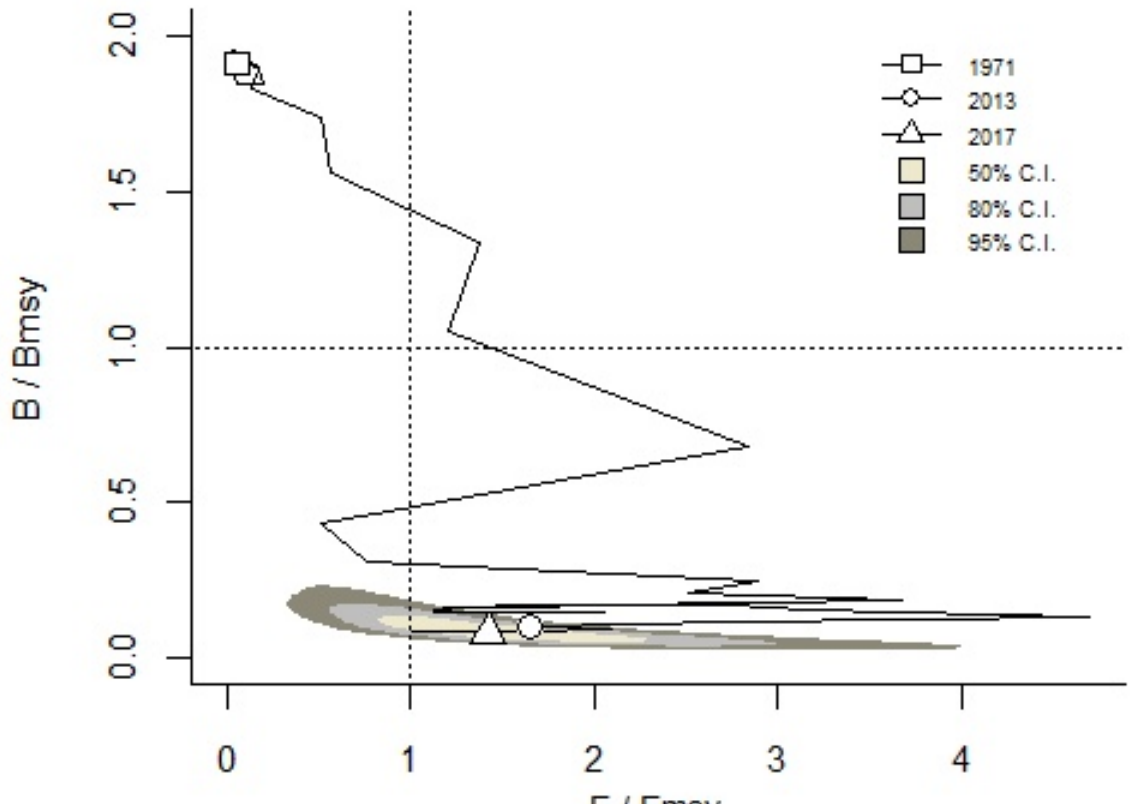


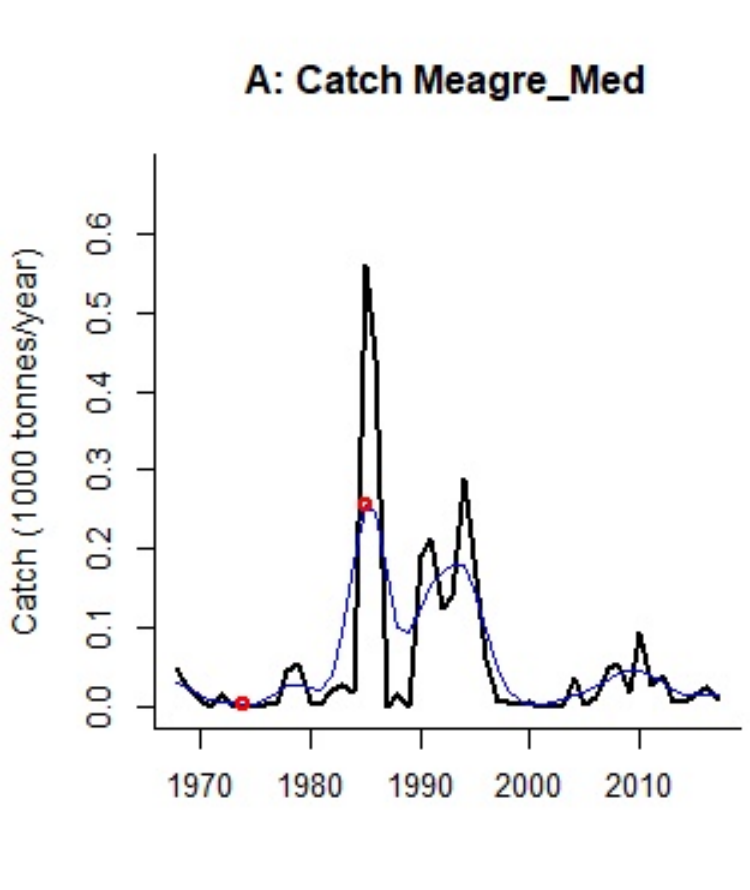
Stock size

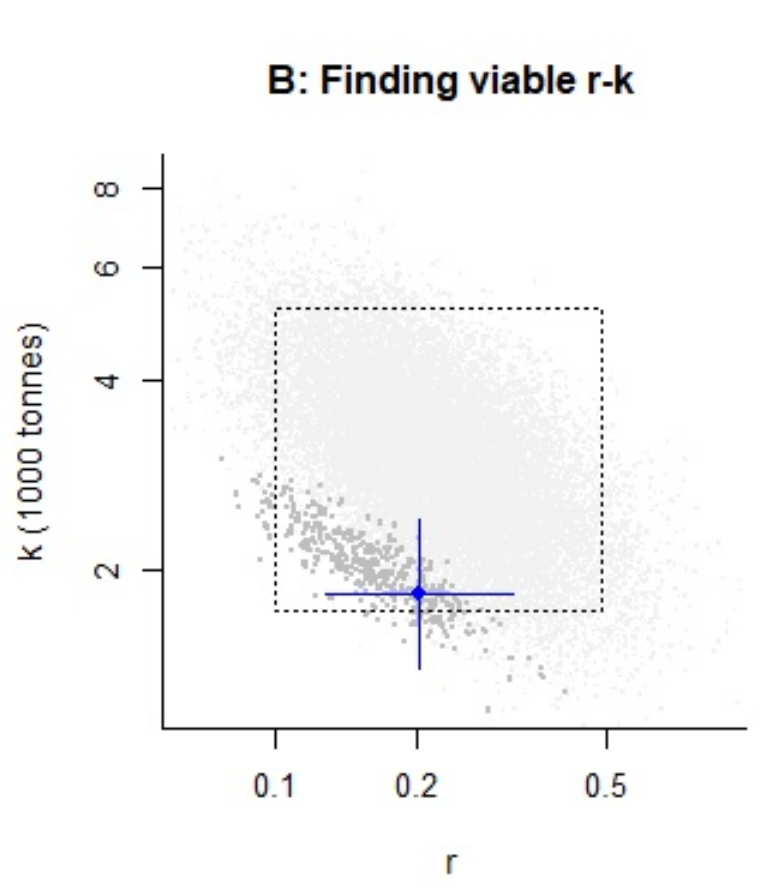


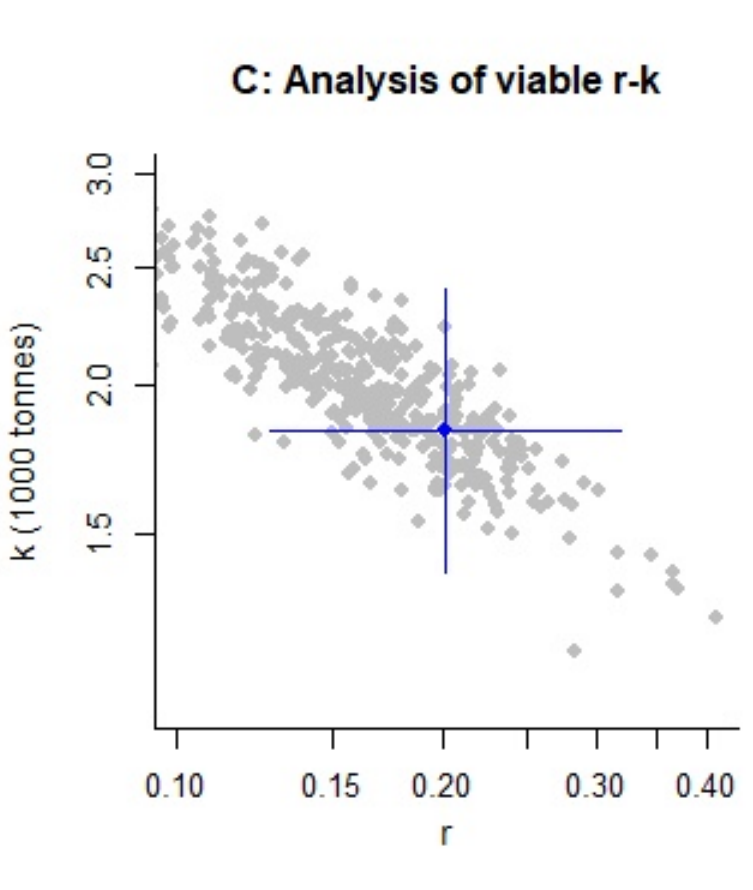
Exploitation

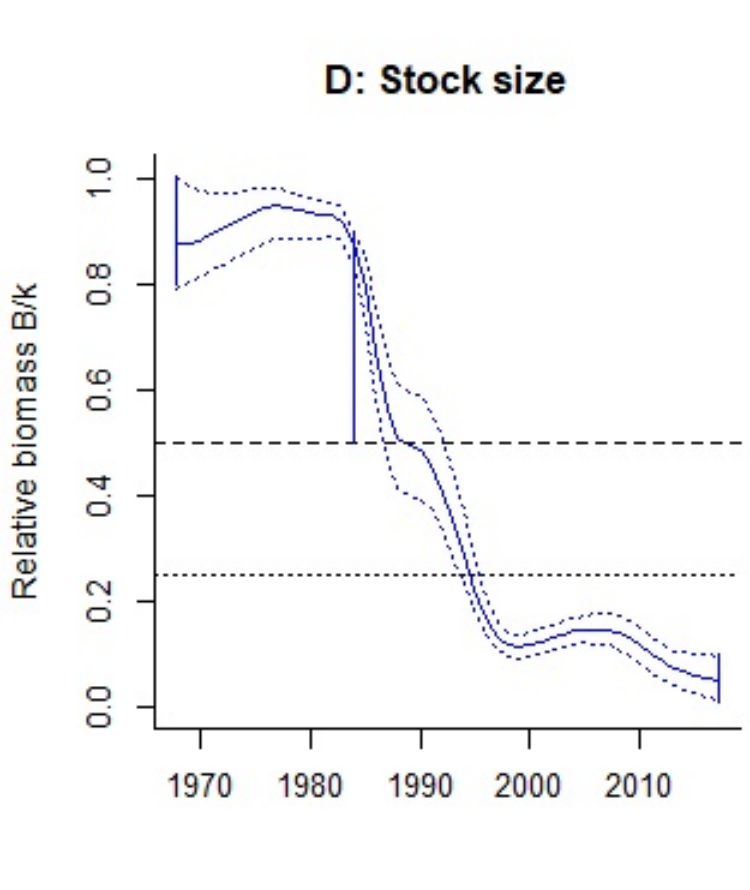


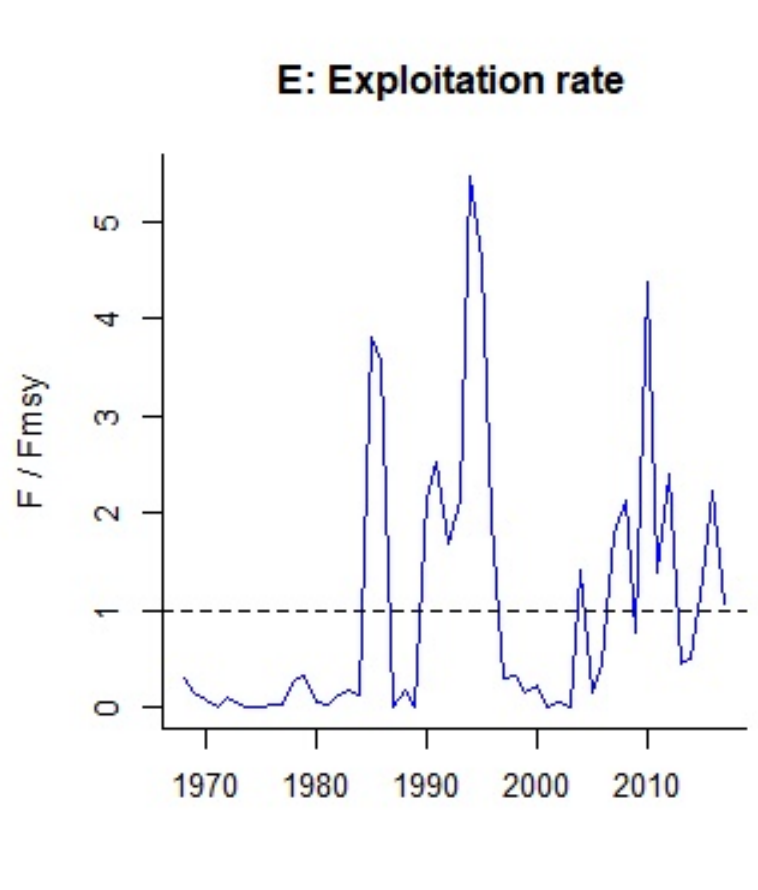


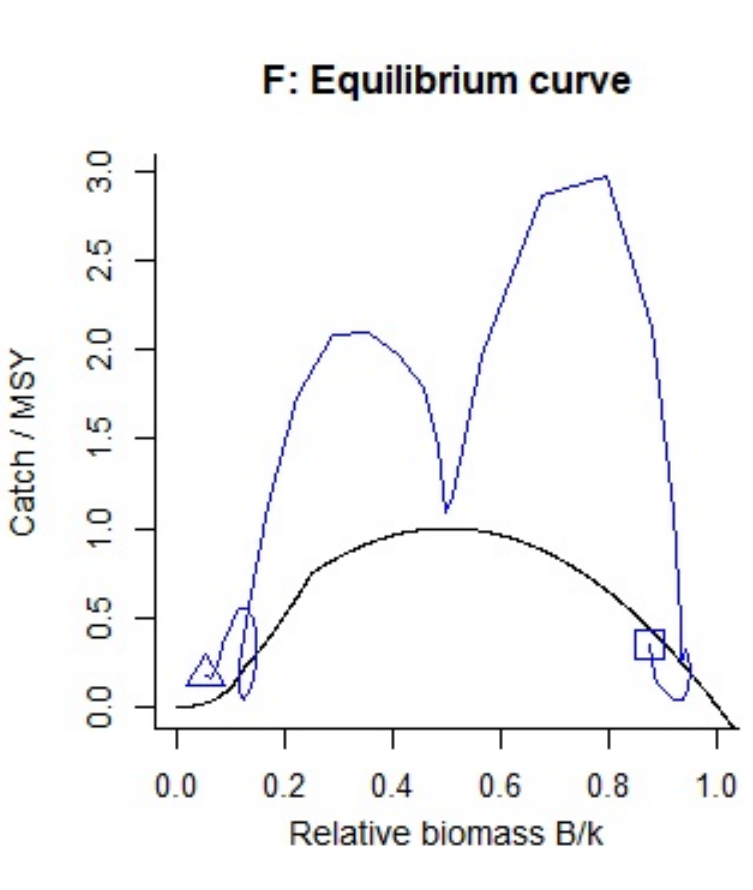

A: Catch Meagre_Med
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

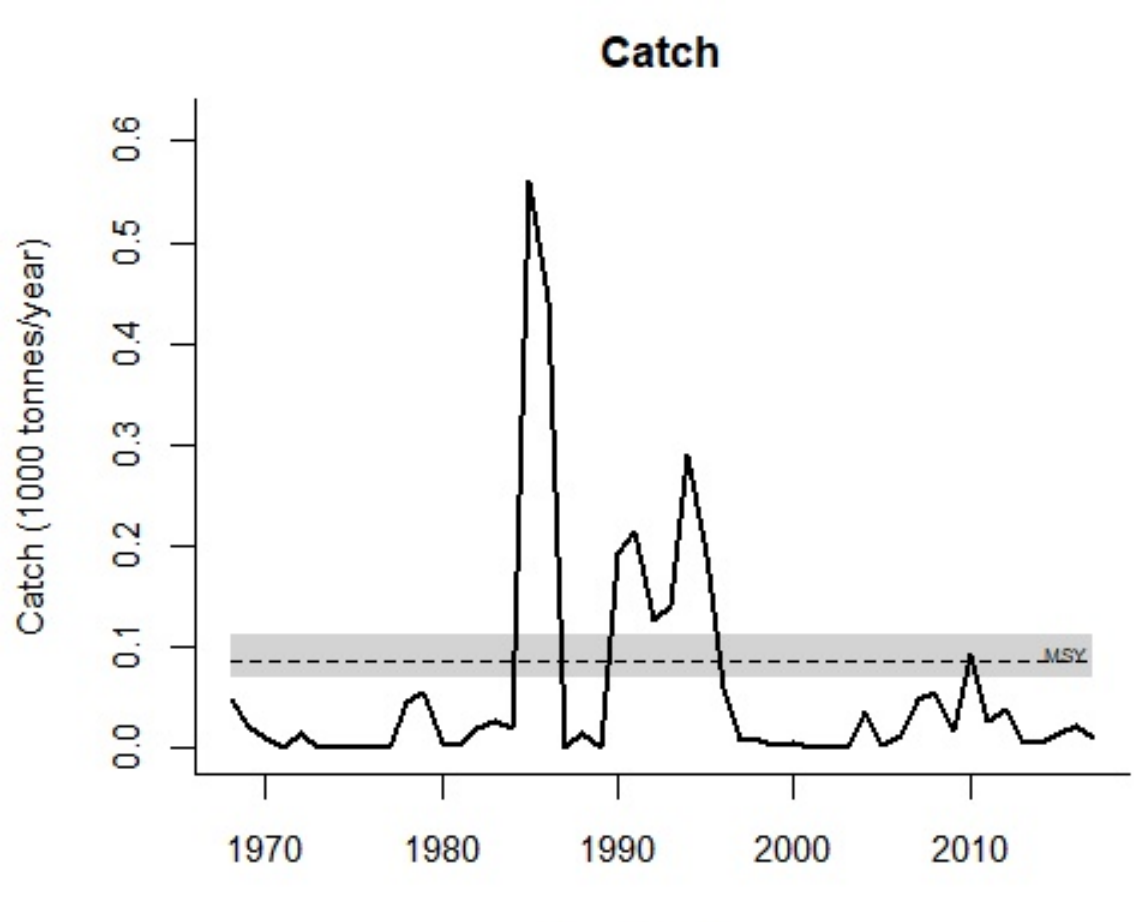

B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
0.1
0.2
0.5
r

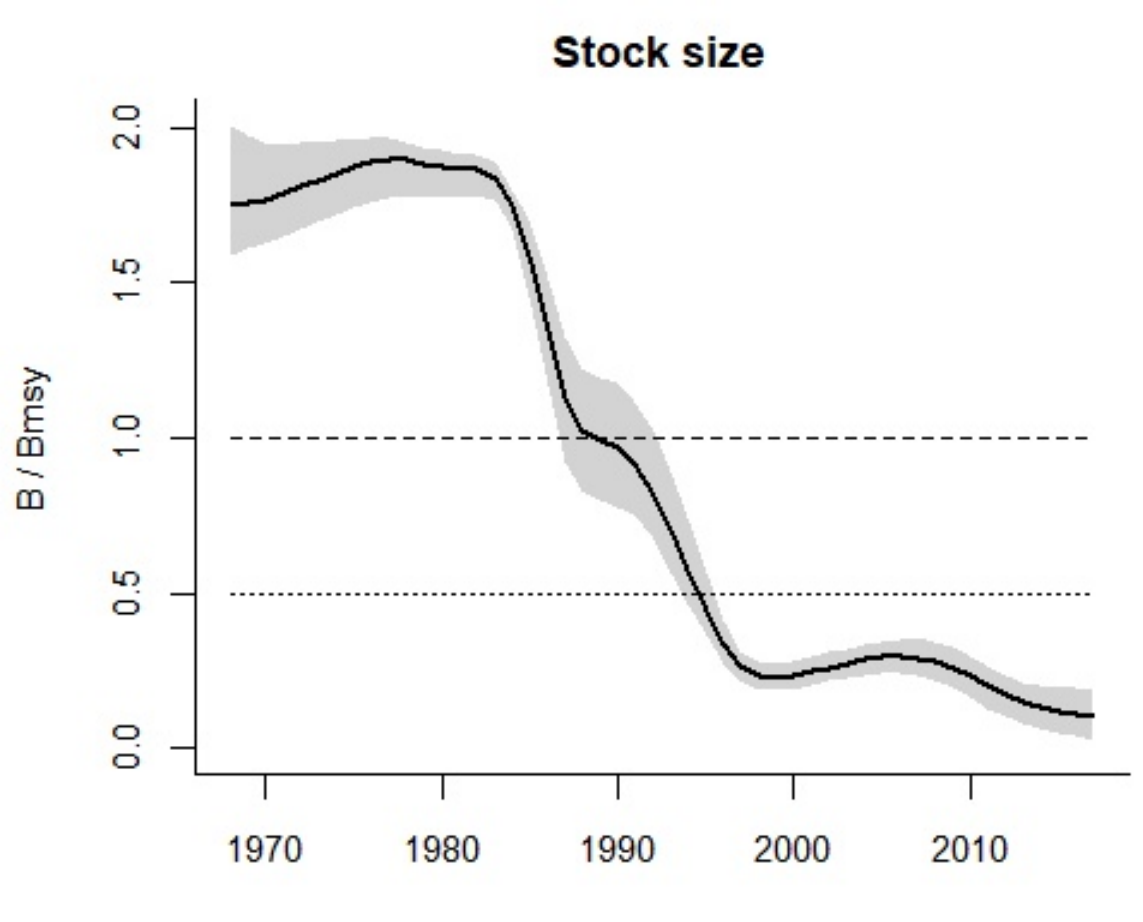

C: Analysis of viable r-k
k (1000 tonnes)
1.5
2.0
2.5
3.0
0.10
0.15
0.20
0.30
0.40
r

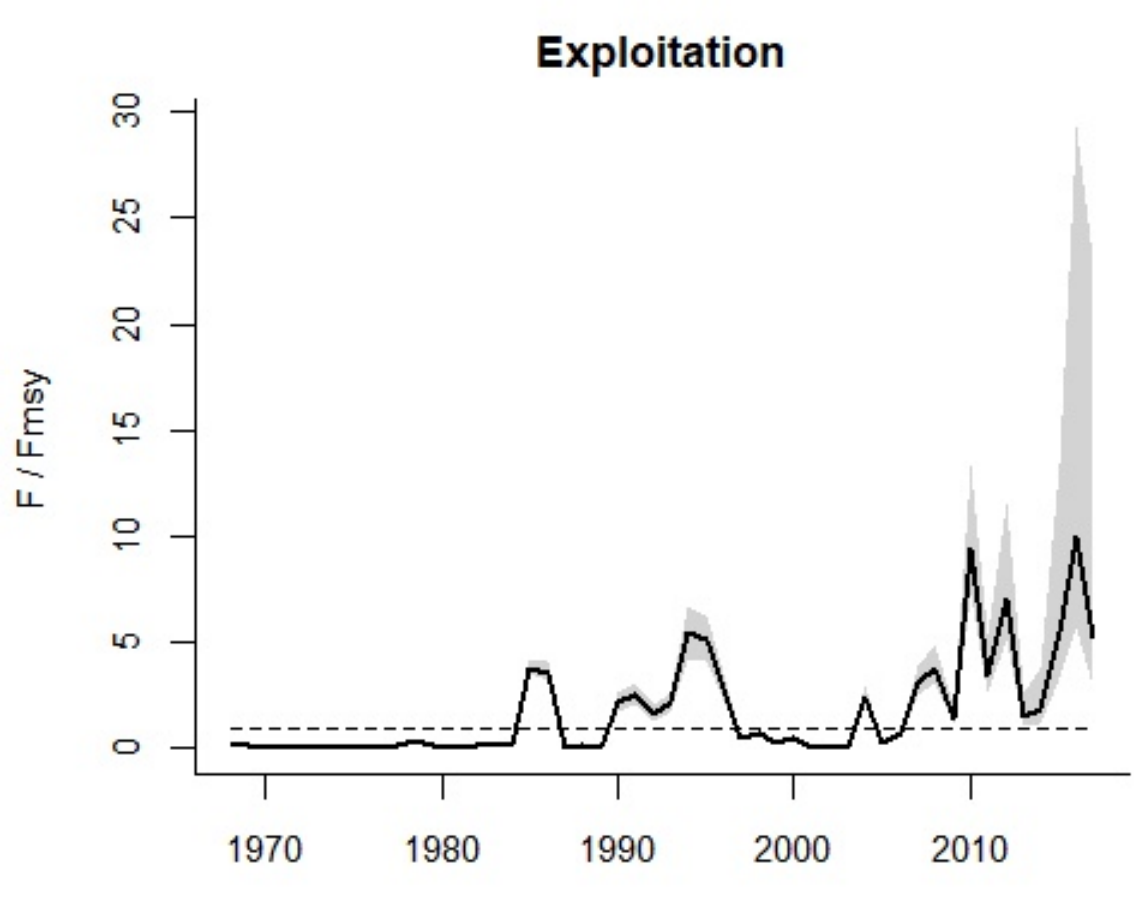

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

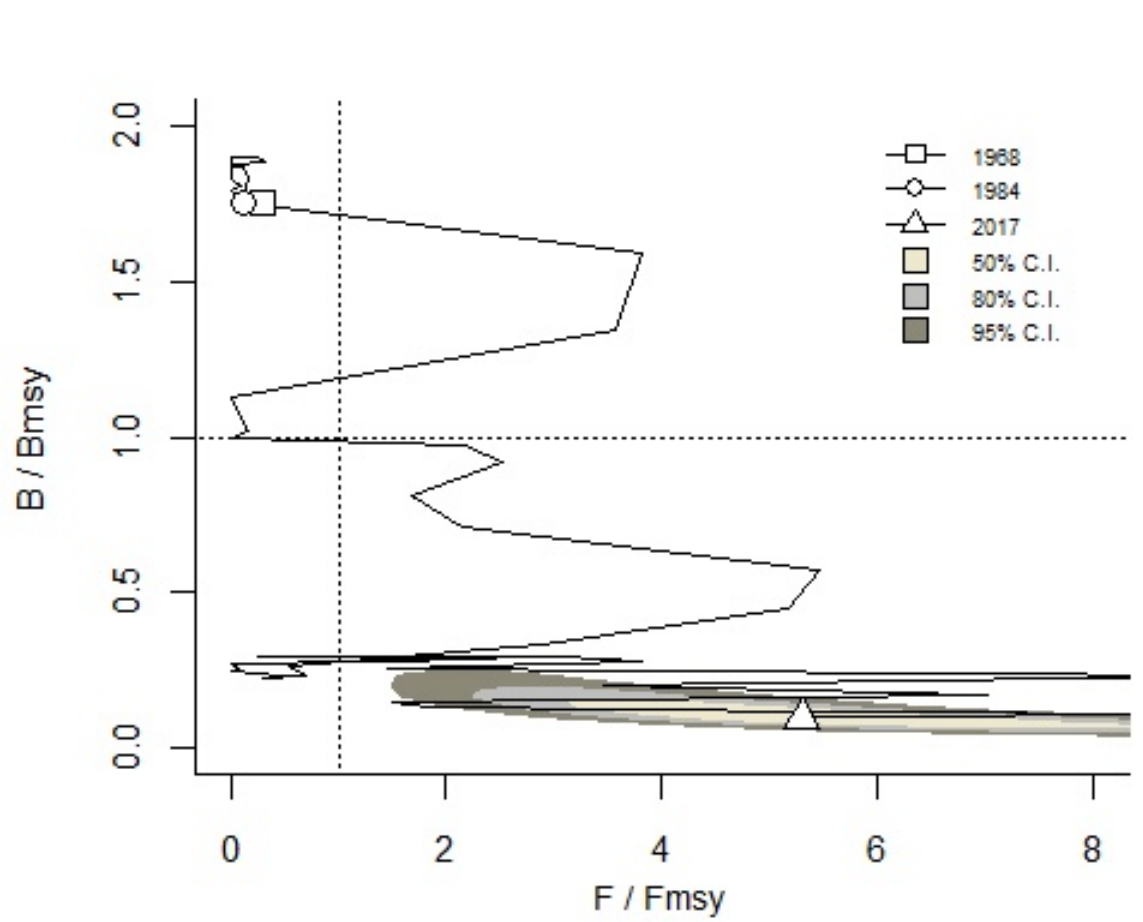

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010

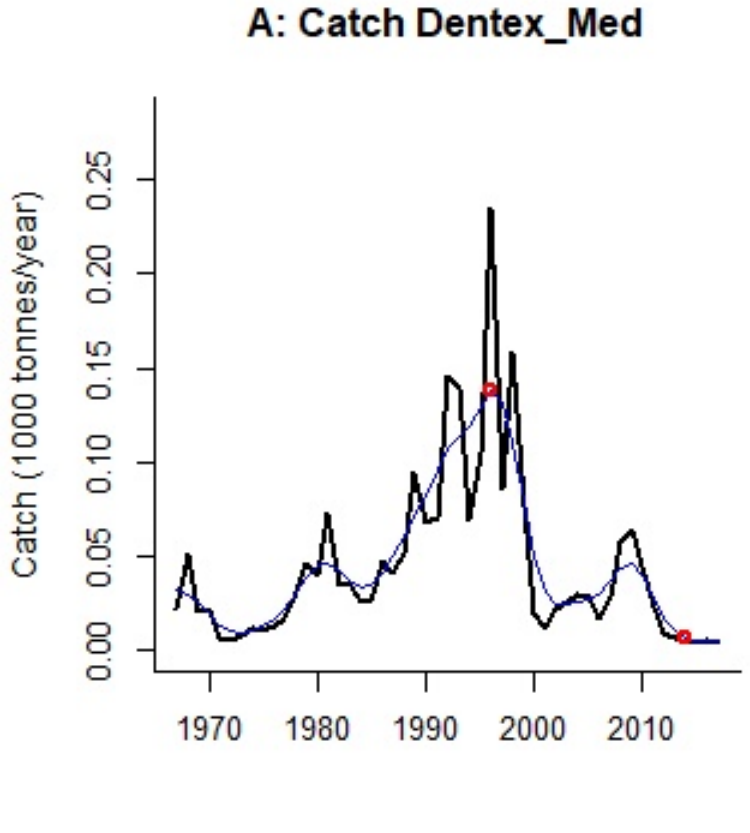

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

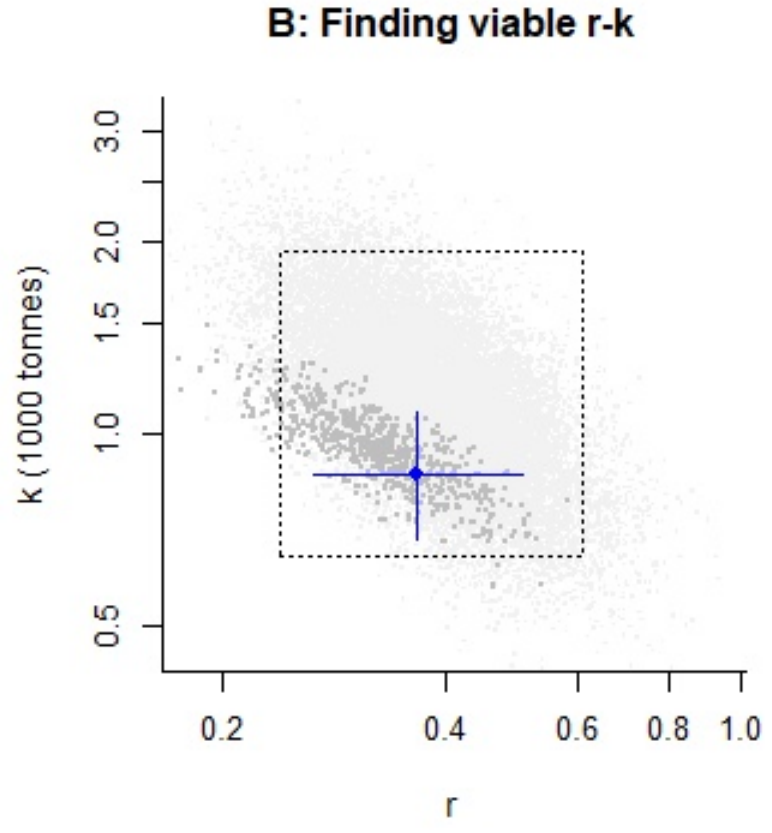

Catch
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
MSY
1970
1980
1990
2000
2010

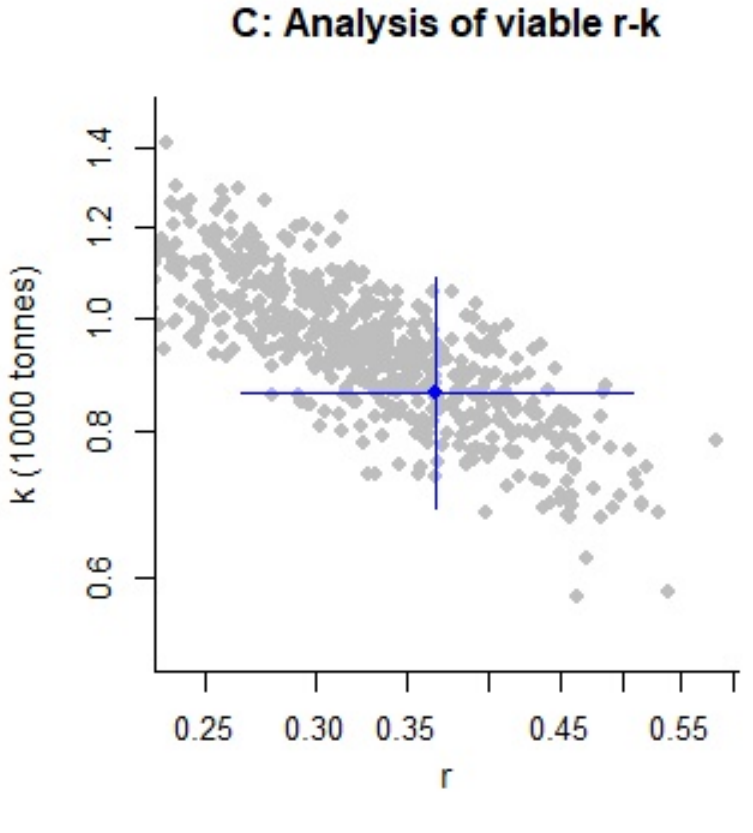

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

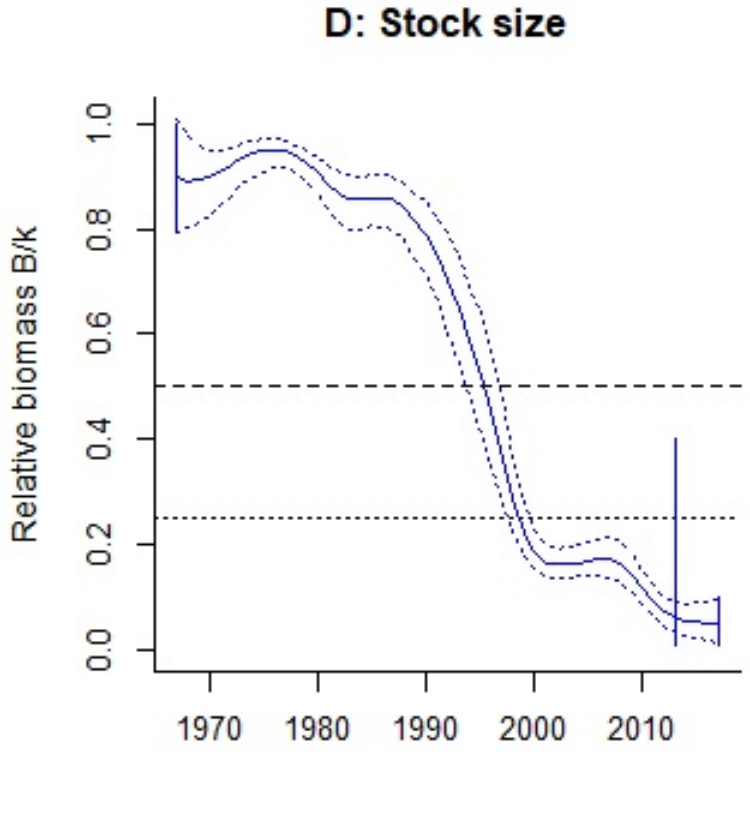

Exploitation
F / Fmsy
0
5
10
15
20
25
30
1970
1980
1990
2000
2010

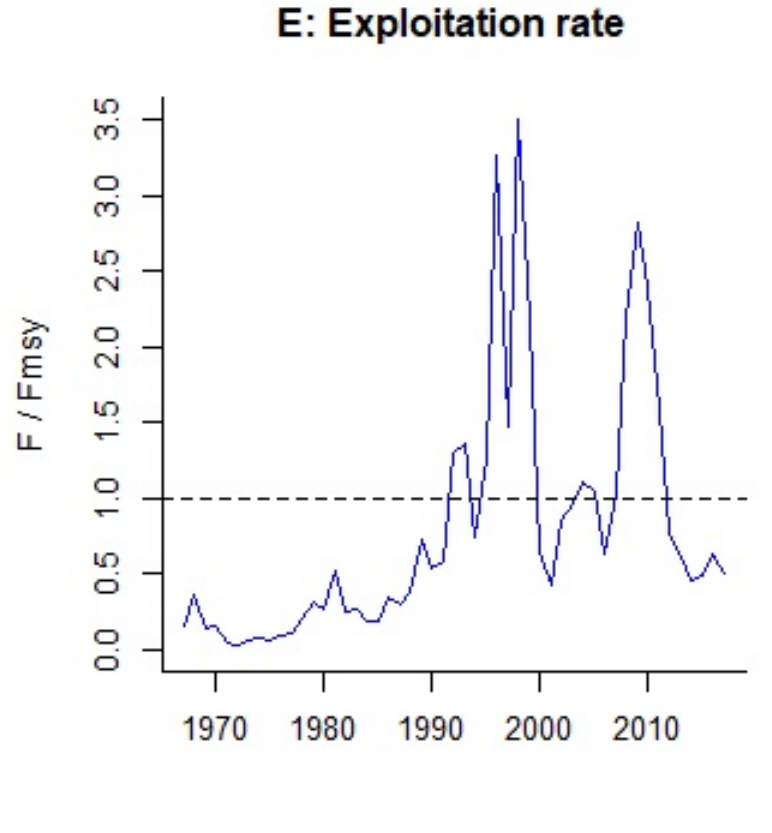

B / Bmsy
F / Fmsy
1968
1984
2017
50% C.I.
80% C.I.
95% C.I.
0.0
0.5
1.0
1.5
2.0
0
2
4
6
8

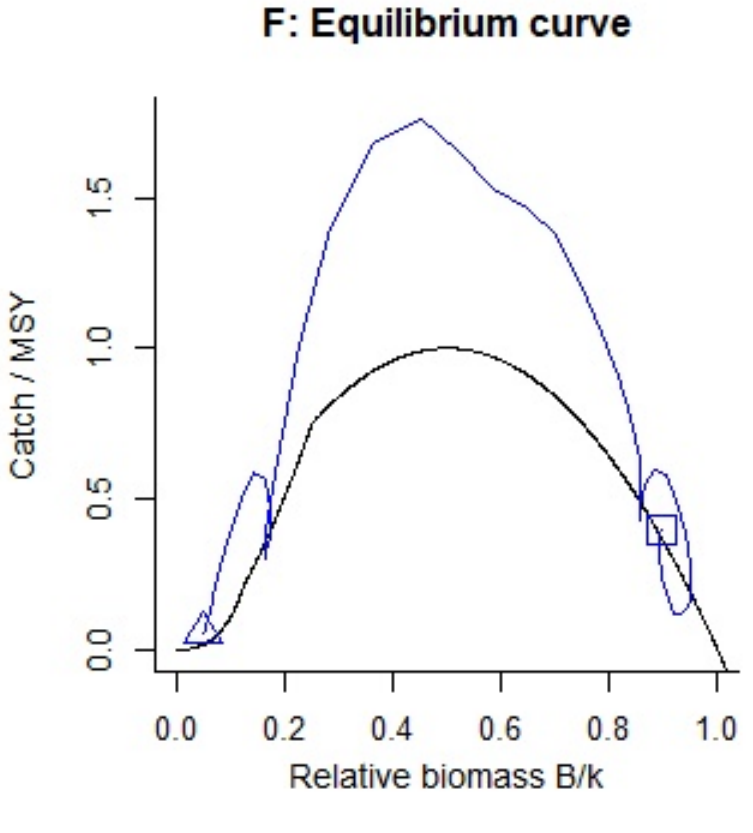

A: Catch Dentex_Med
Catch (1000 tonnes/year)
0.00
0.05
0.10
0.15
0.20
0.25
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
0.5
1.0
1.5
2.0
3.0
0.2
0.4
0.6
0.8
1.0
r

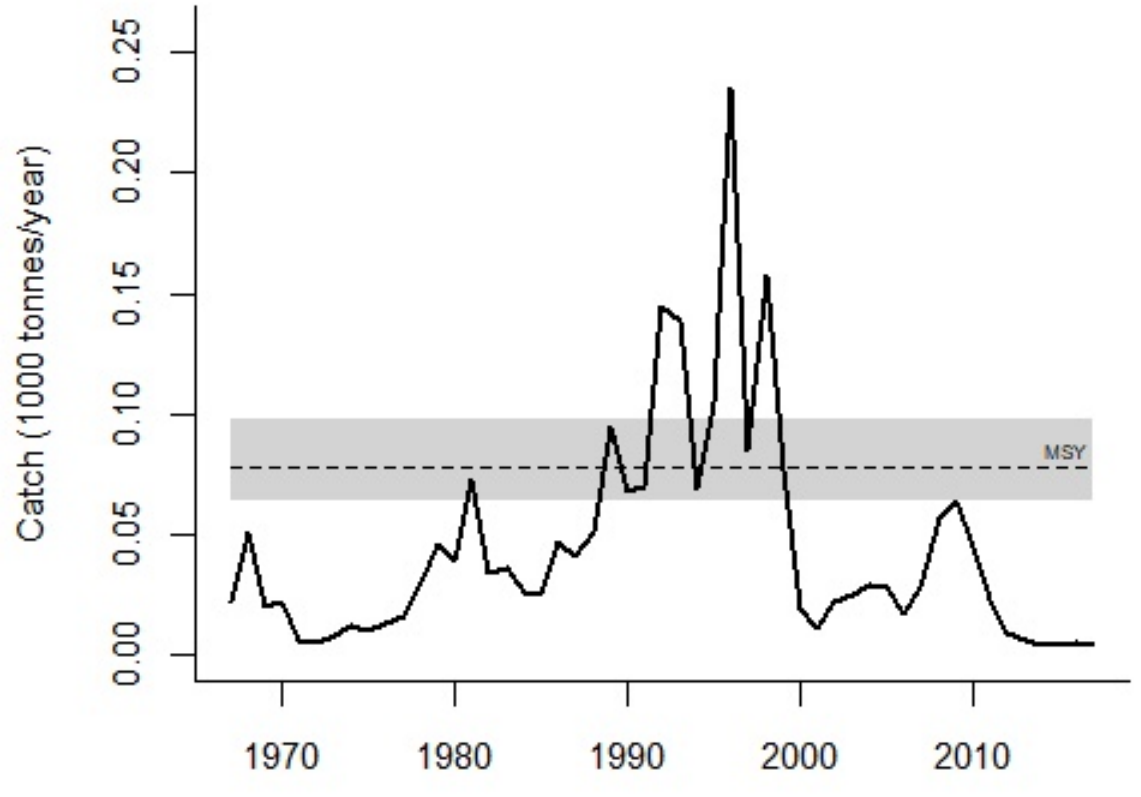

C: Analysis of viable r-k
k (1000 tonnes)
0.6
0.8
1.0
1.2
1.4
0.25
0.30
0.35
0.45
0.55
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

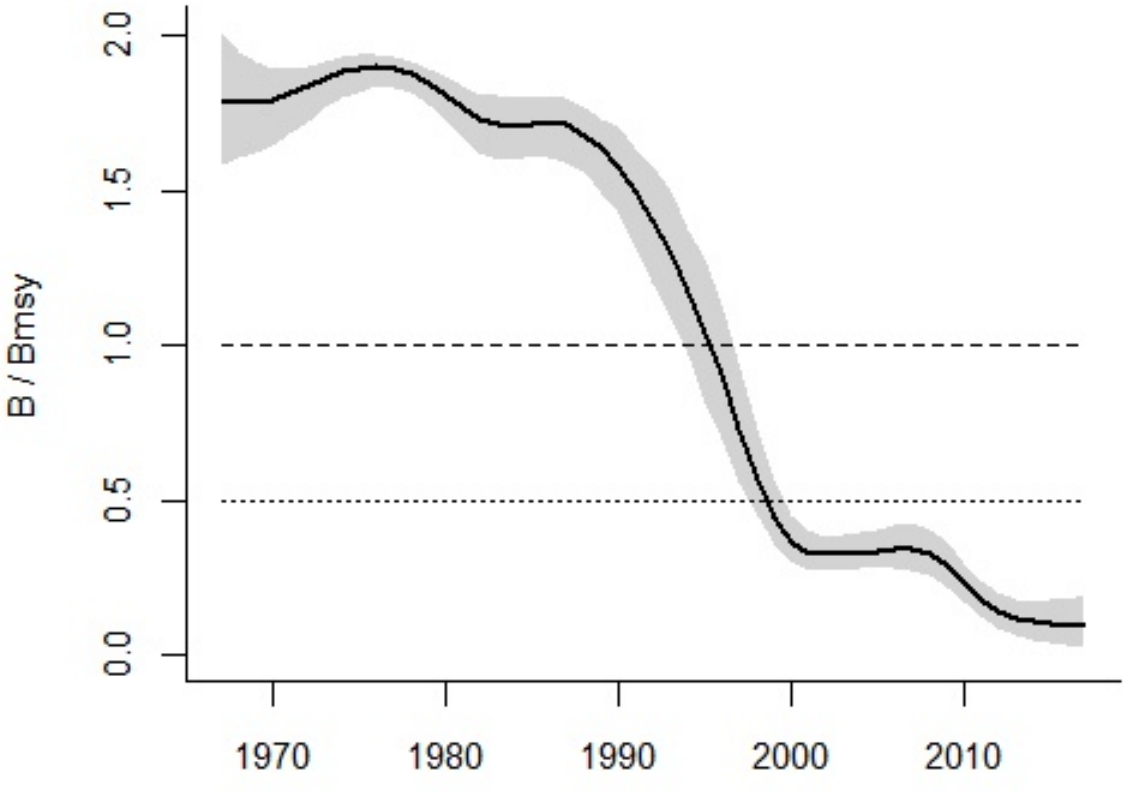

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

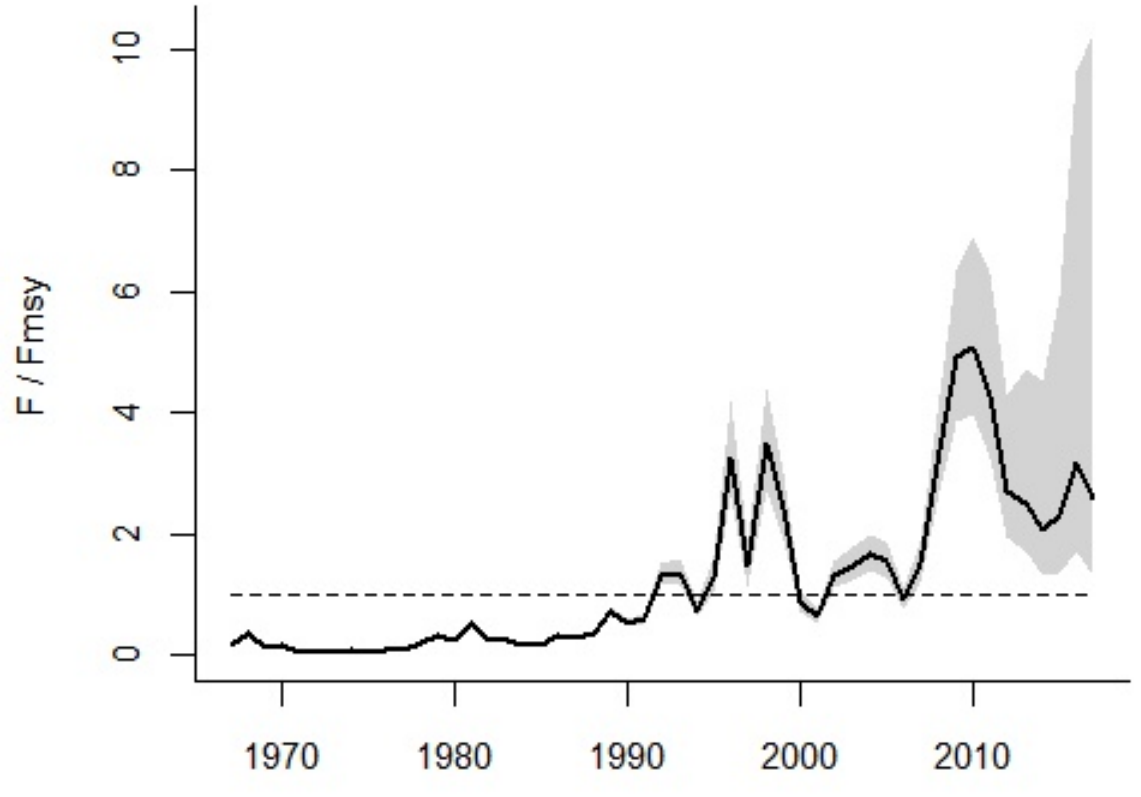
Catch

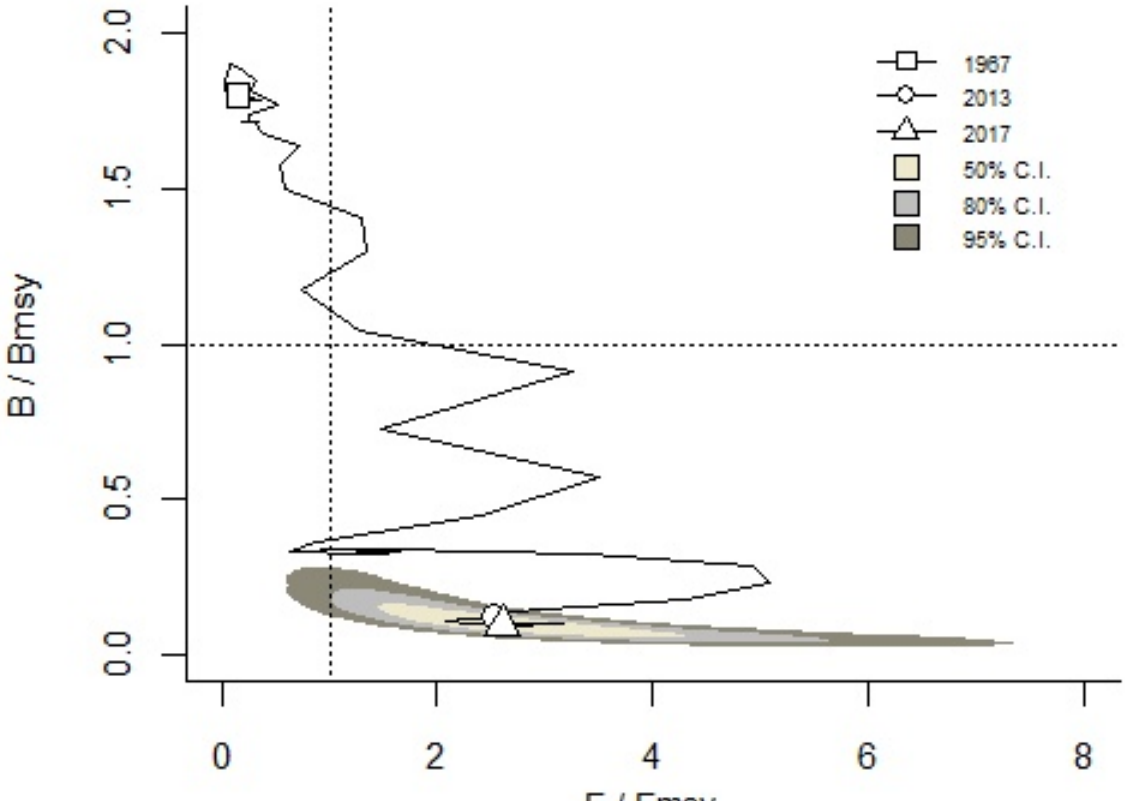


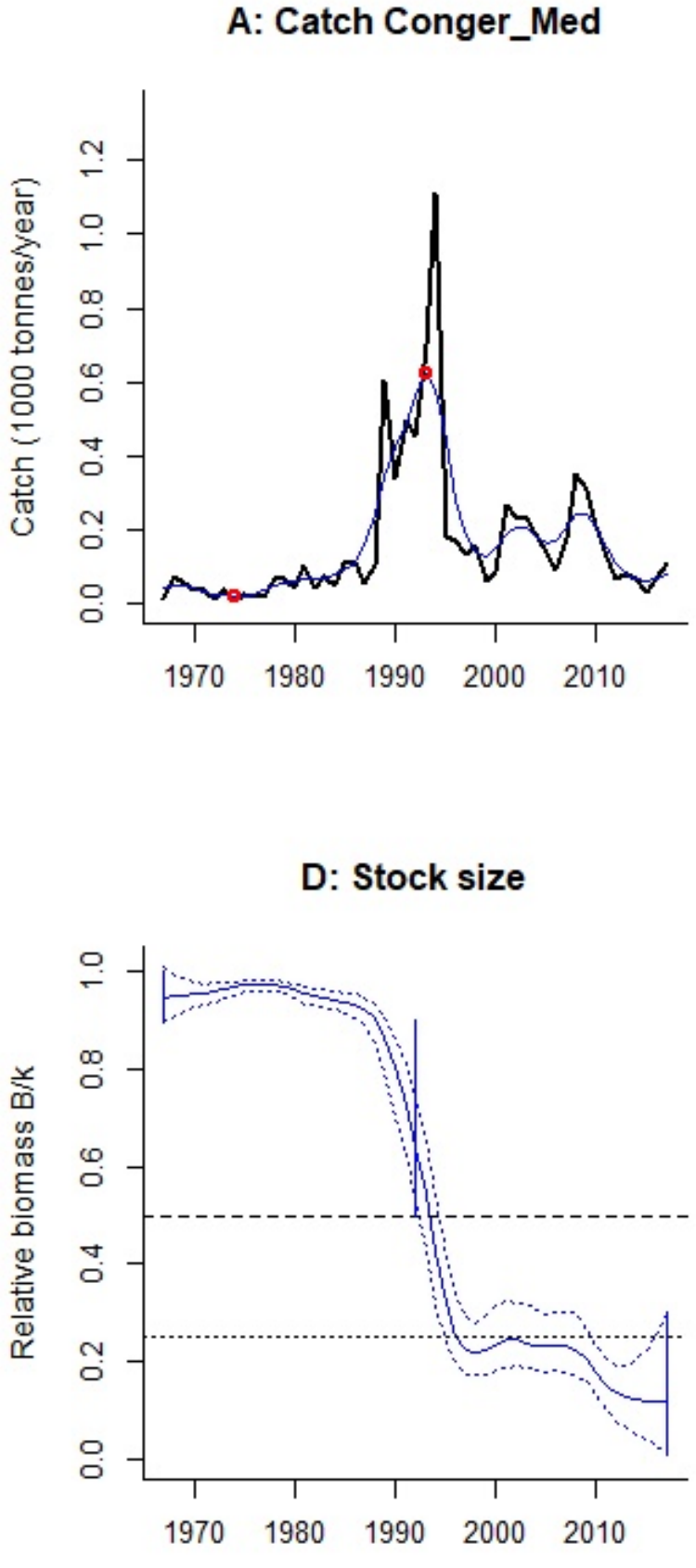
Stock size

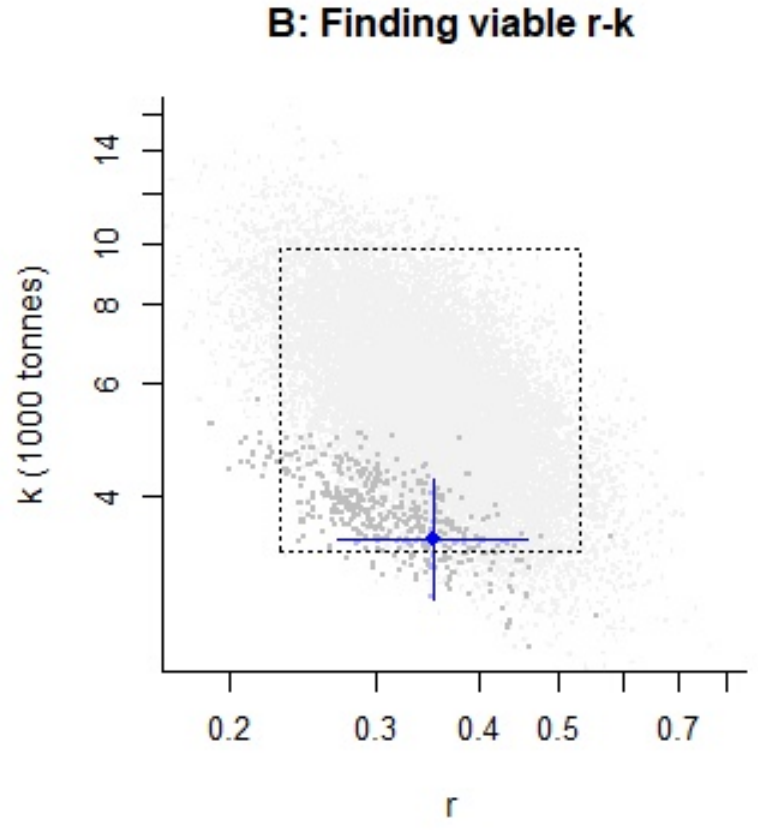


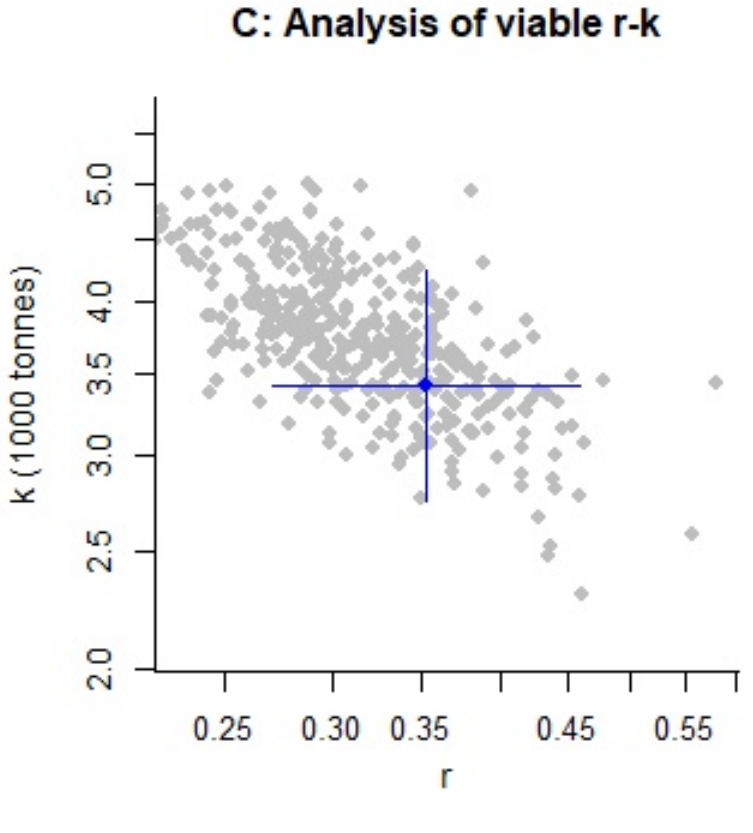
Exploitation



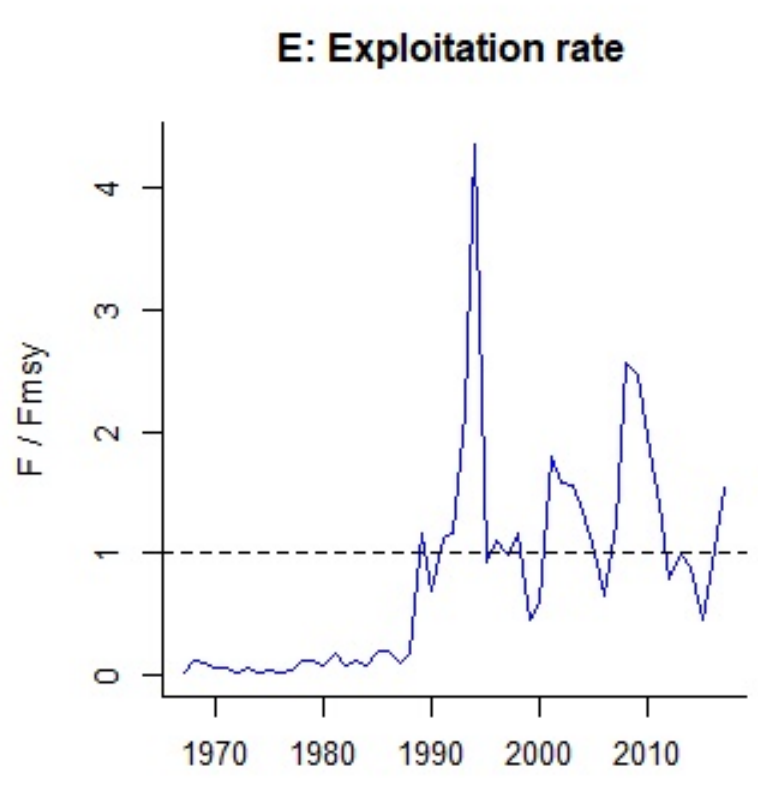


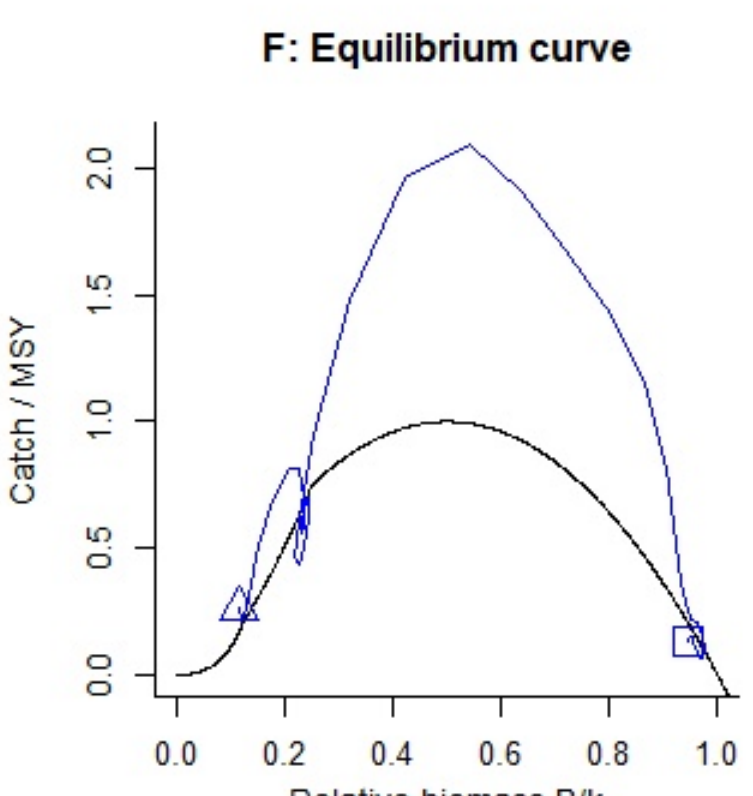

A: Catch Conger_Med
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1970
1980
1990
2000
2010

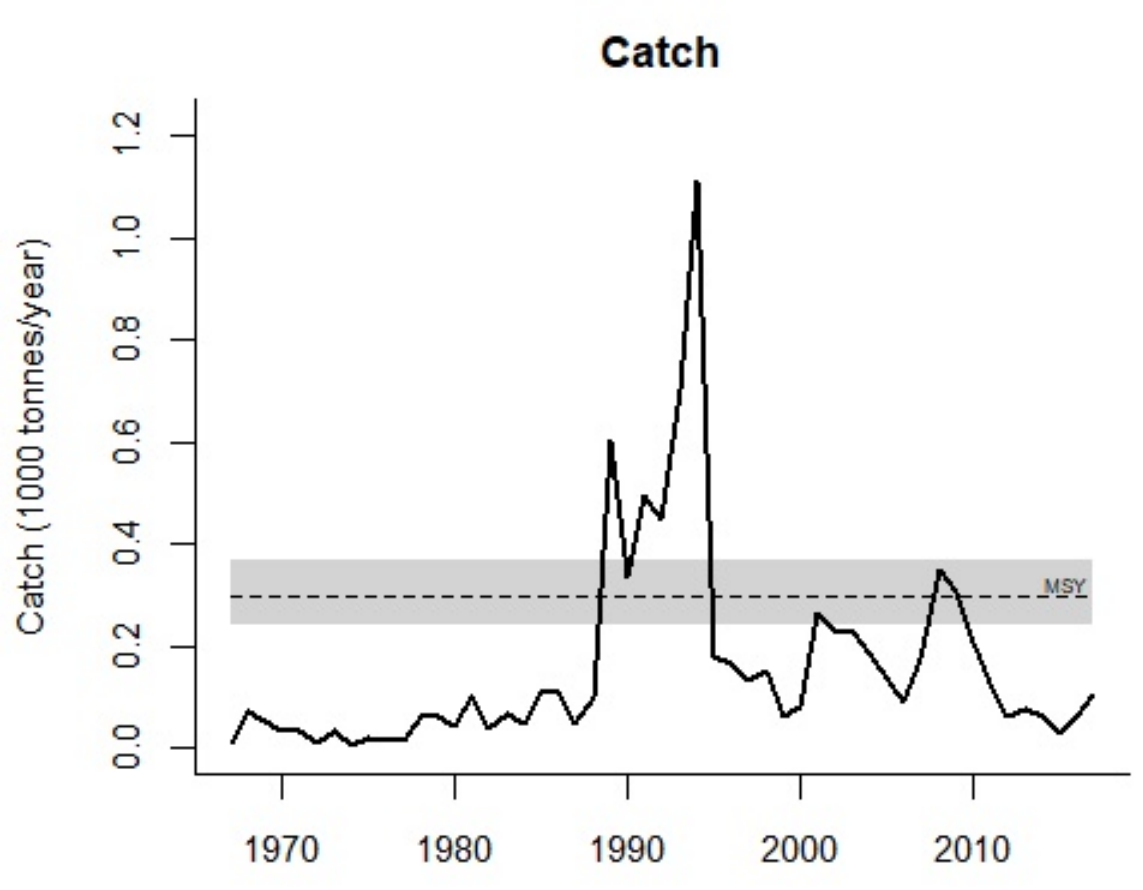

B: Finding viable r-k
k (1000 tonnes)
4
6
8
10
14
0.2
0.3
0.4
0.5
0.7
r

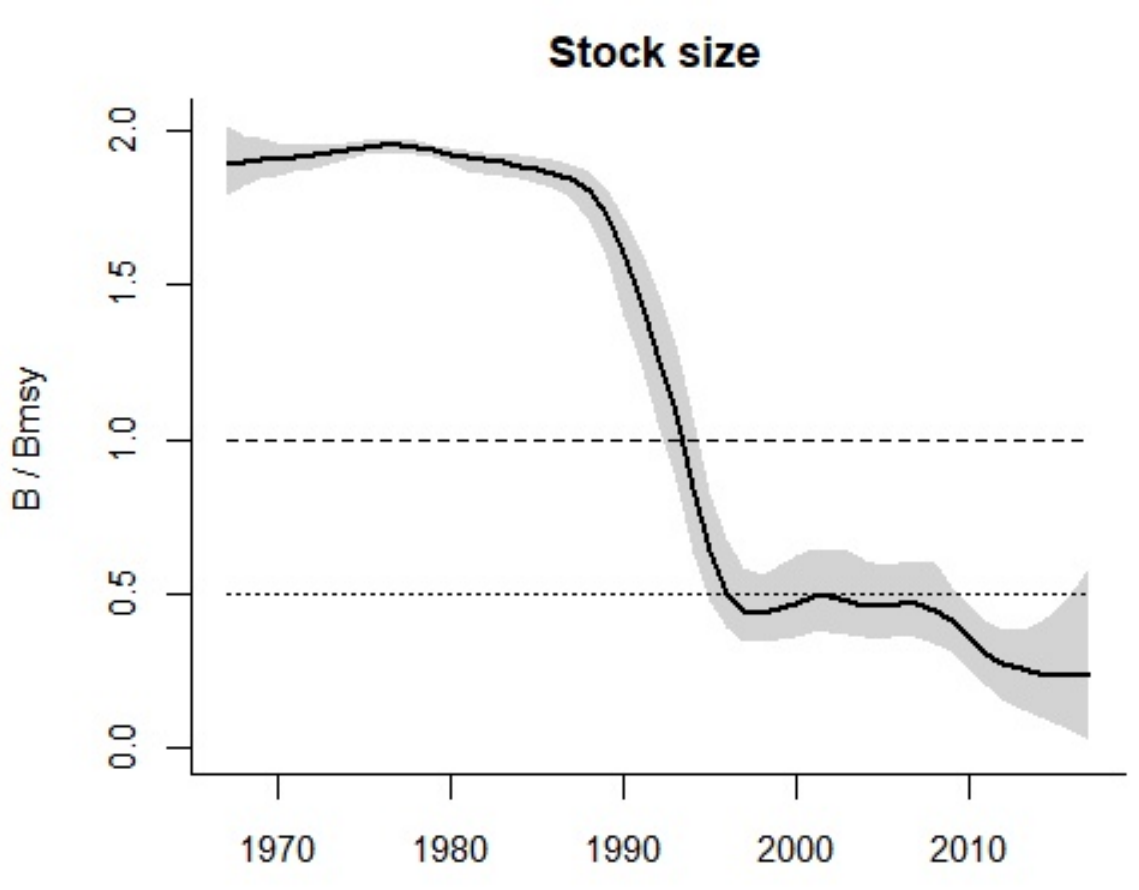

C: Analysis of viable r-k
k (1000 tonnes)
2.0
2.5
3.0
3.5
4.0
5.0
0.25
0.30
0.35
0.45
0.55
r

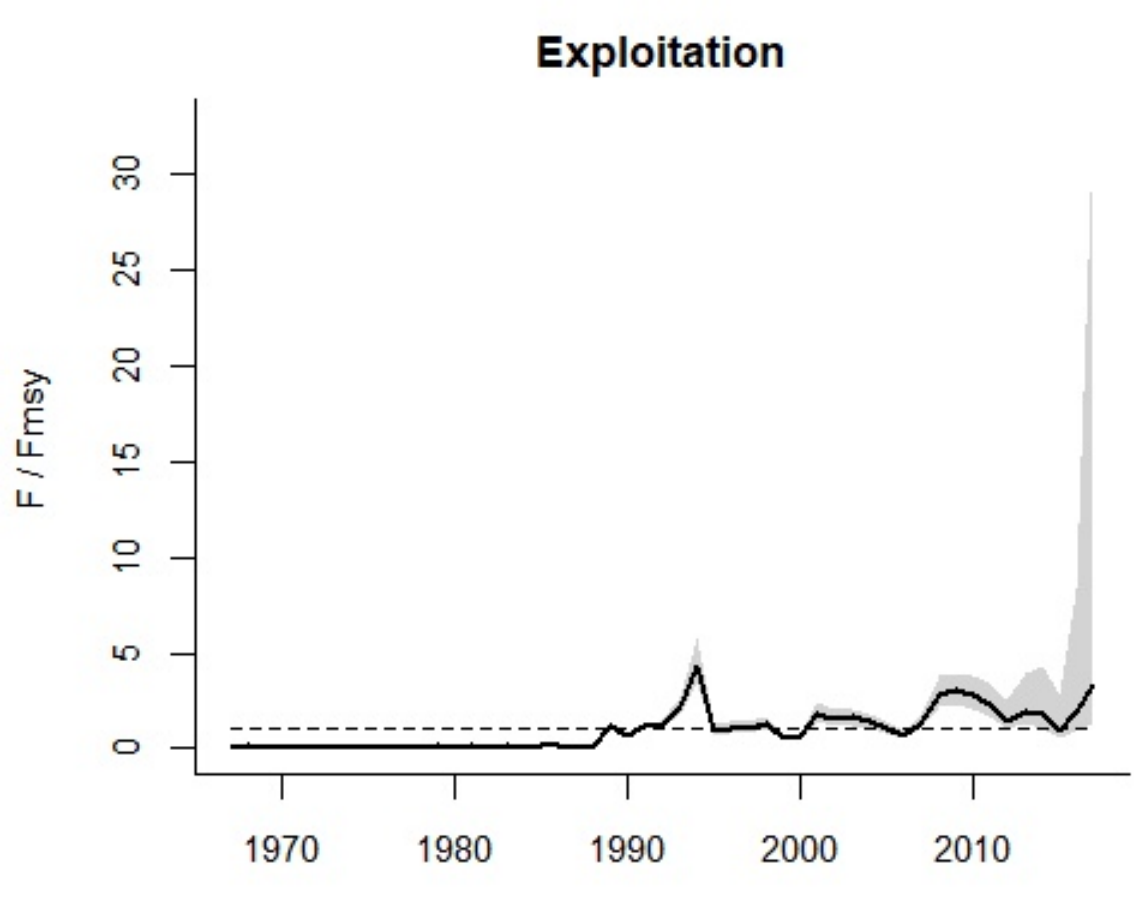
D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

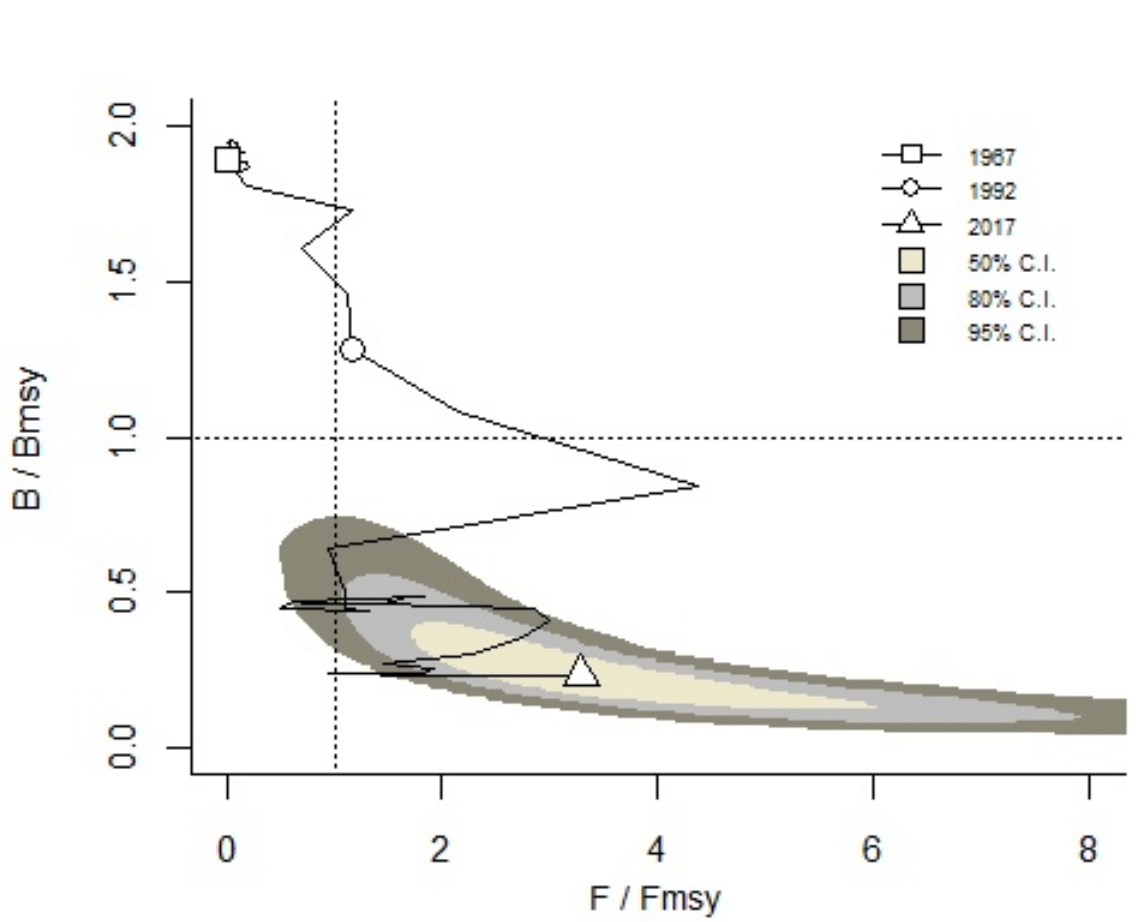

E: Exploitation rate
F / Fmsy
0
1
2
3
4
1970
1980
1990
2000
2010

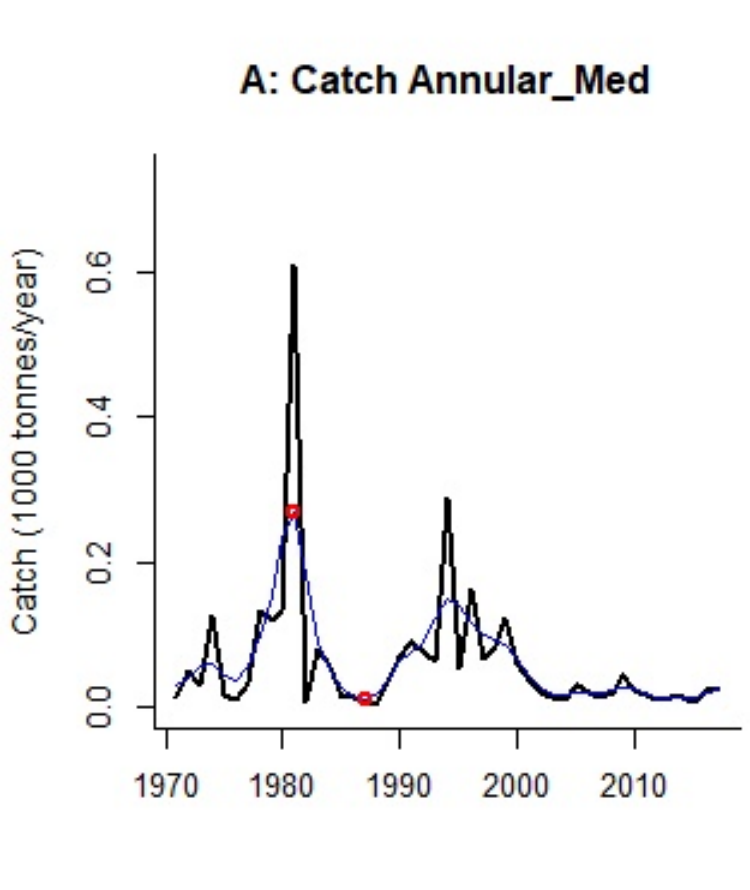

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

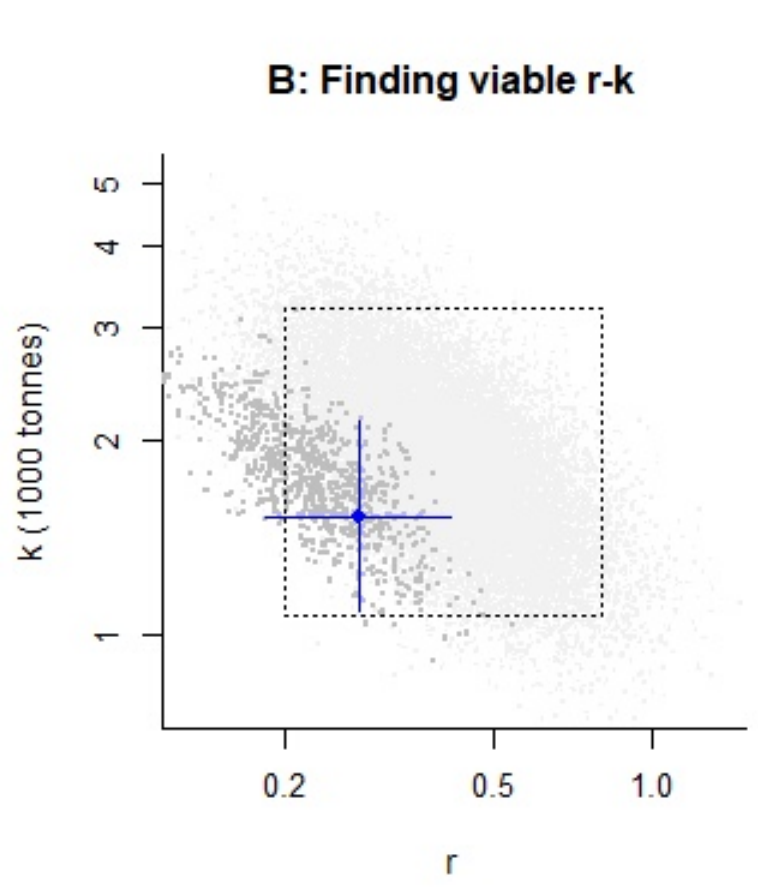

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
MSY
1970
1980
1990
2000
2010

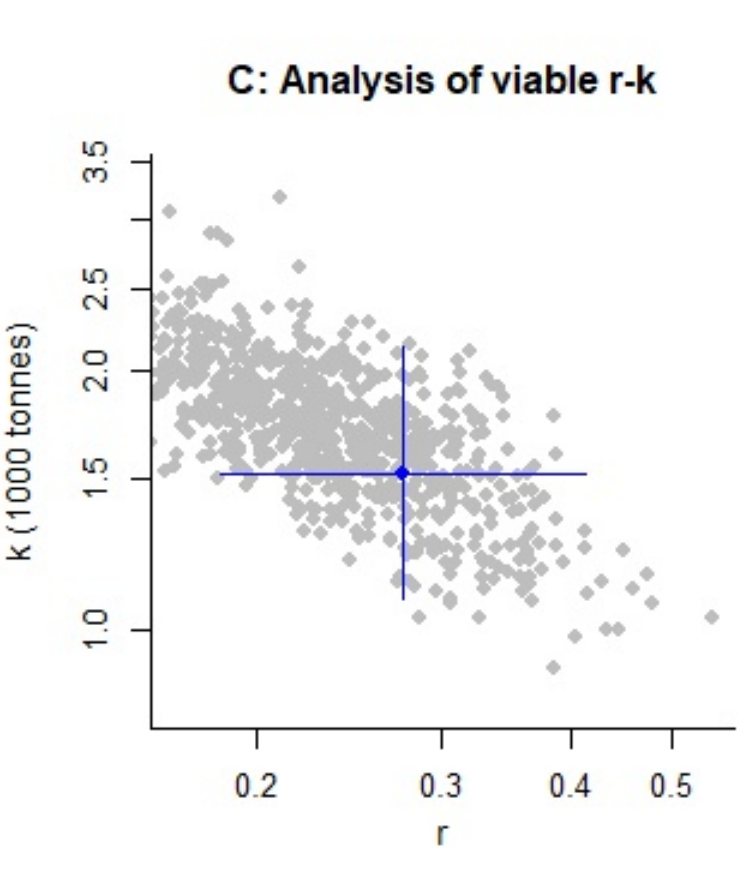

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

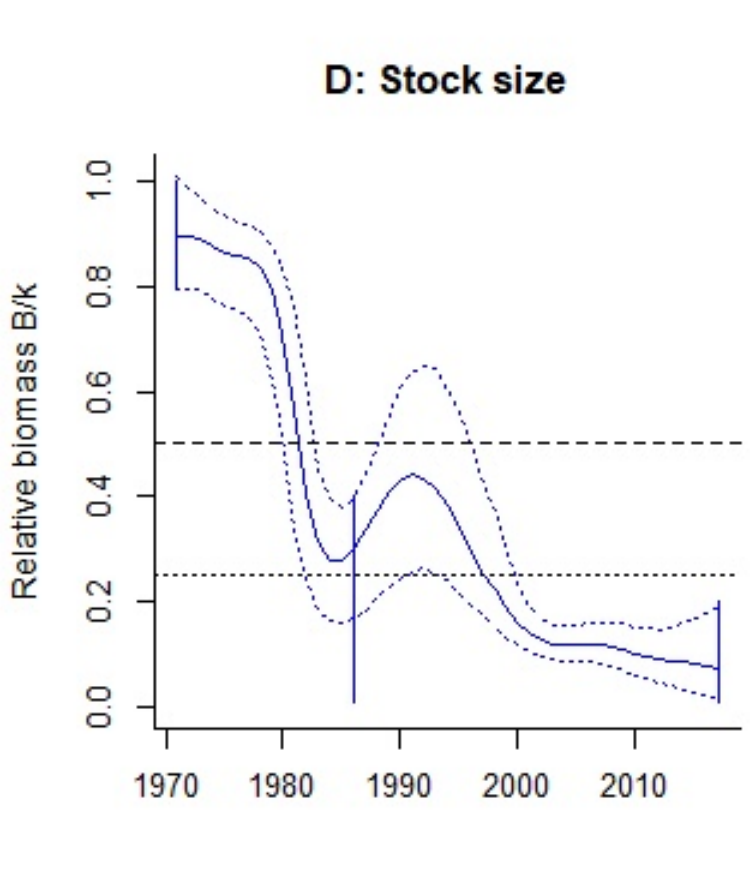

Exploitation
F / Fmsy
0
5
10
15
20
25
30
1970
1980
1990
2000
2010

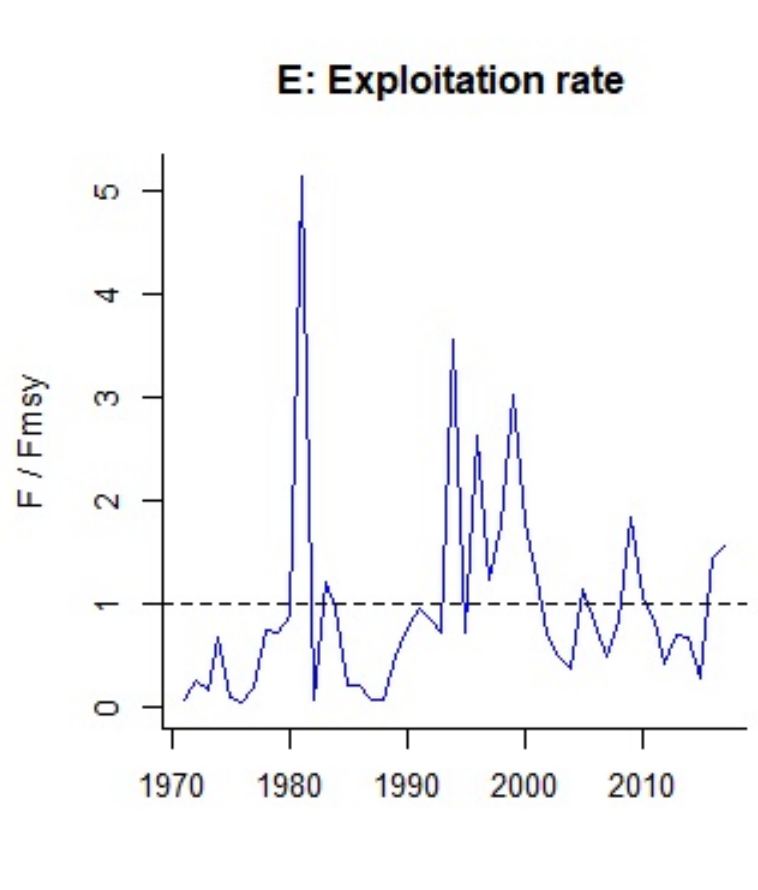

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1992
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

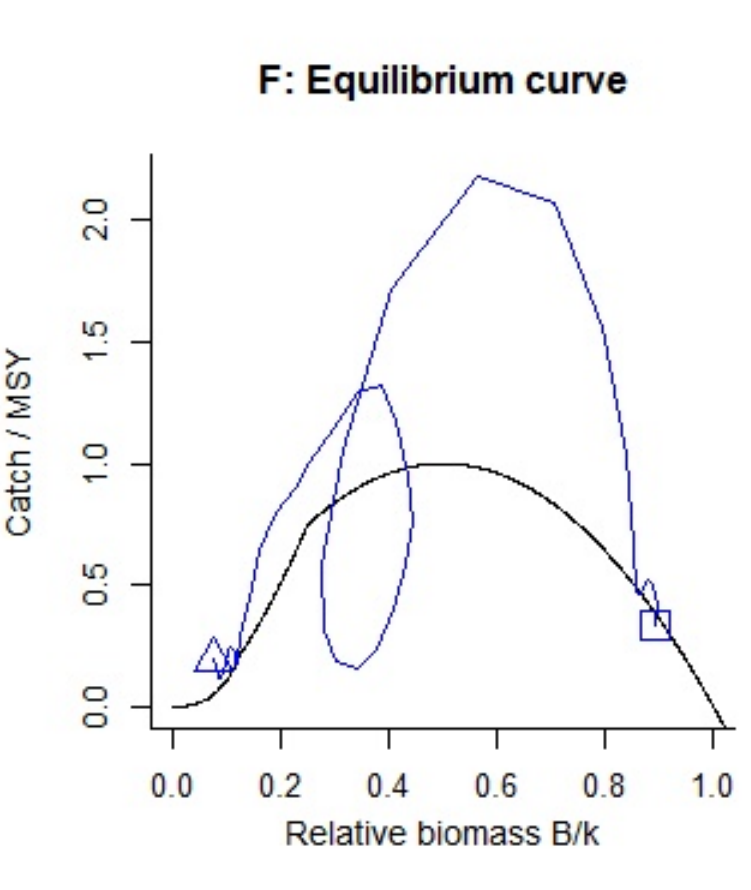

A: Catch Annular_Med
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
1
2
3
4
5
0.2
0.5
1.0
r

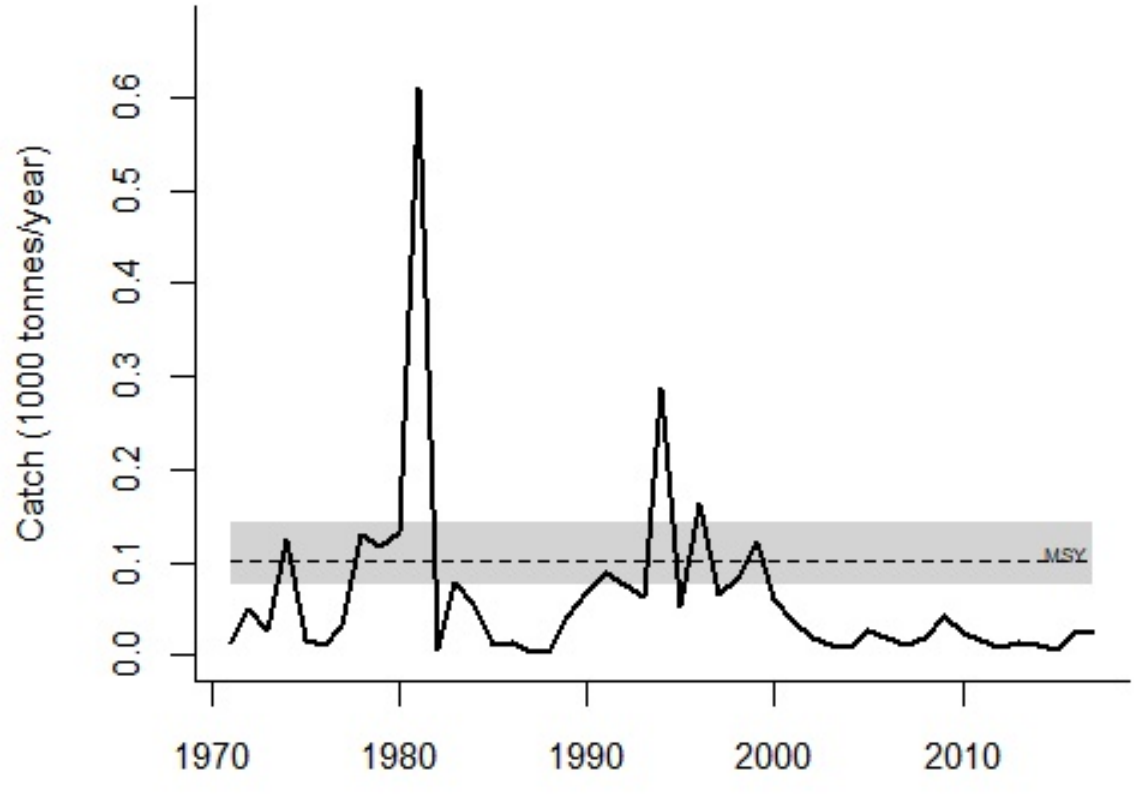

C: Analysis of viable r-k
k (1000 tonnes)
1.0
1.5
2.0
2.5
3.5
0.2
0.3
0.4
0.5
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

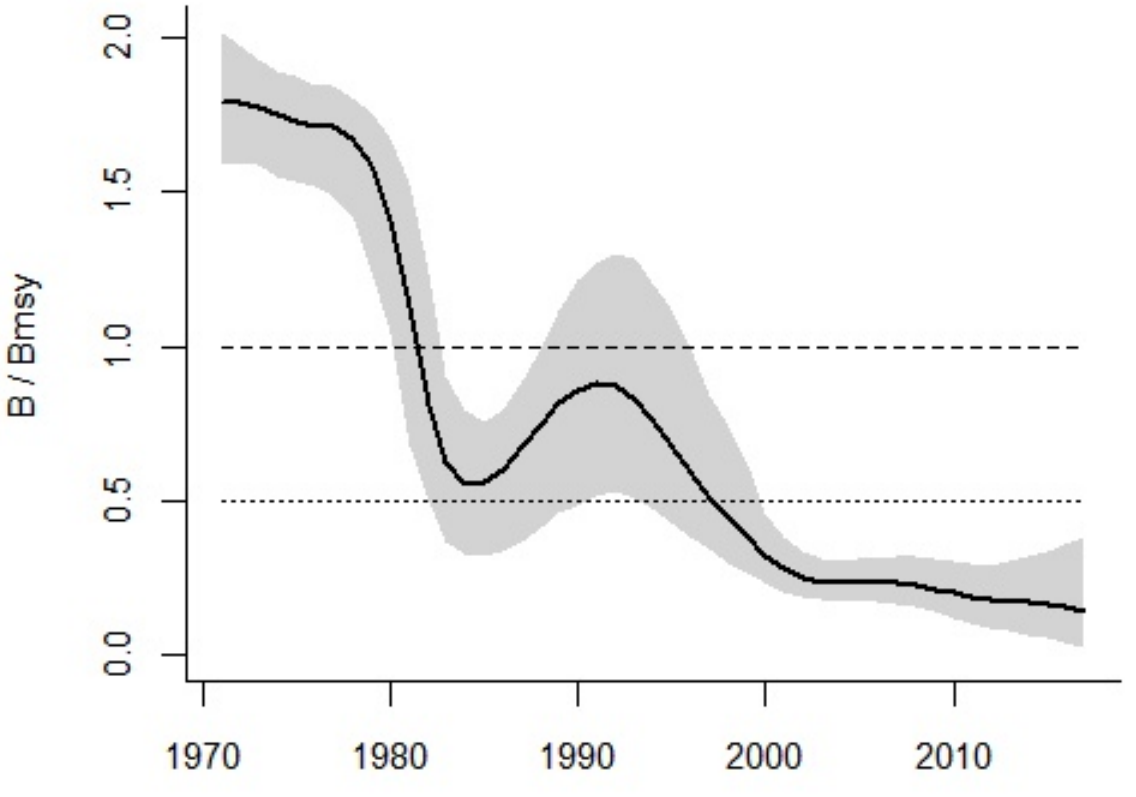

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

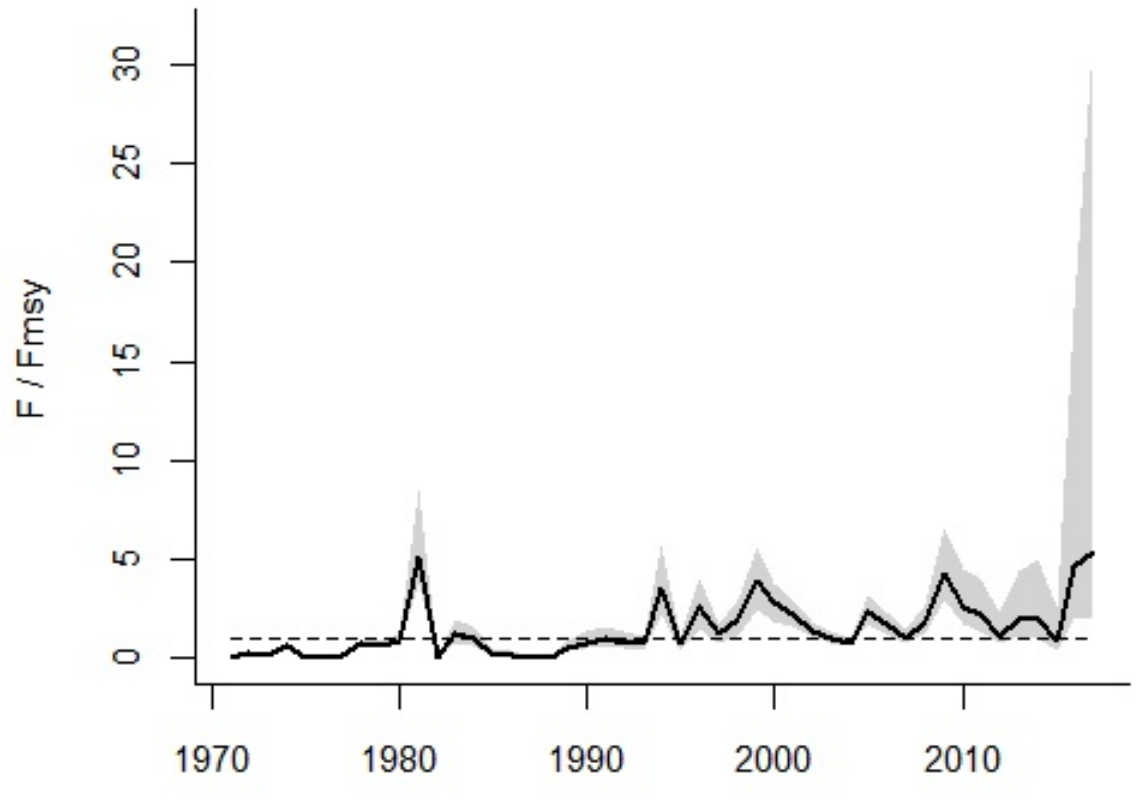
Catch

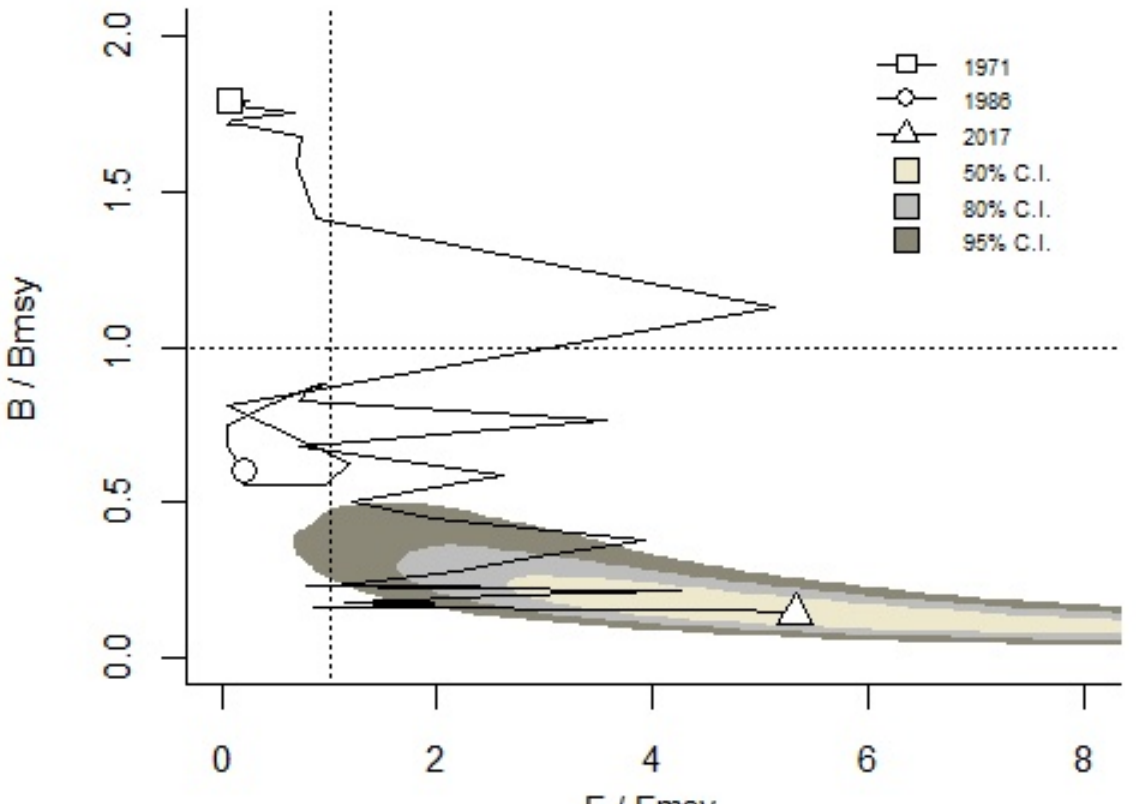


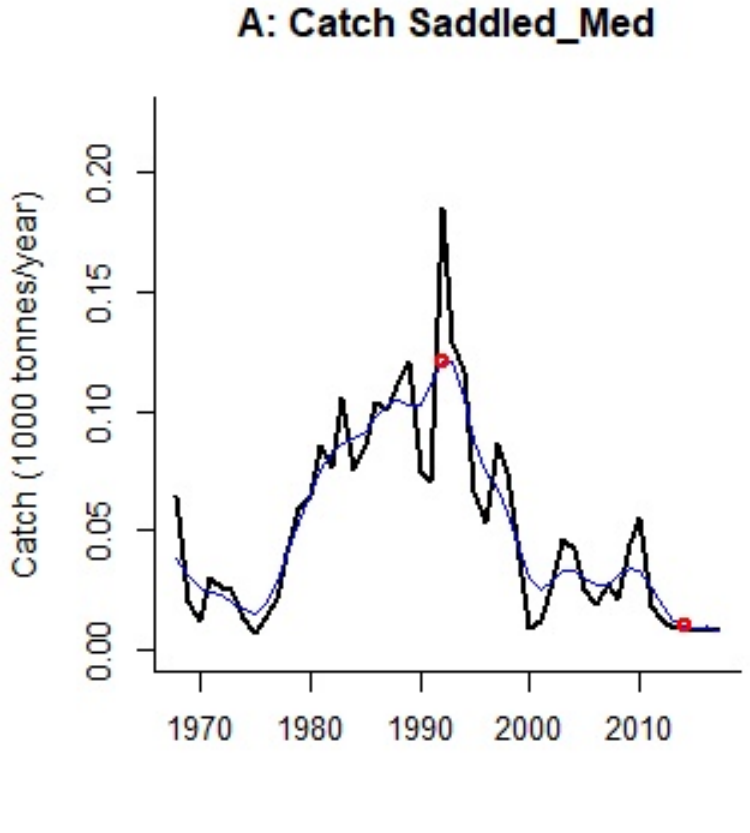
Stock size

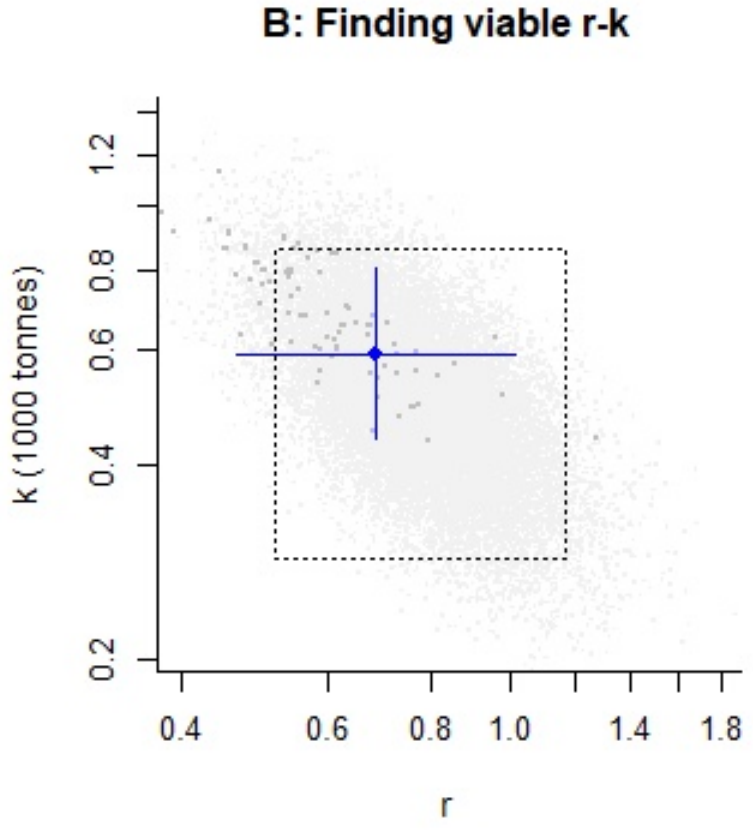


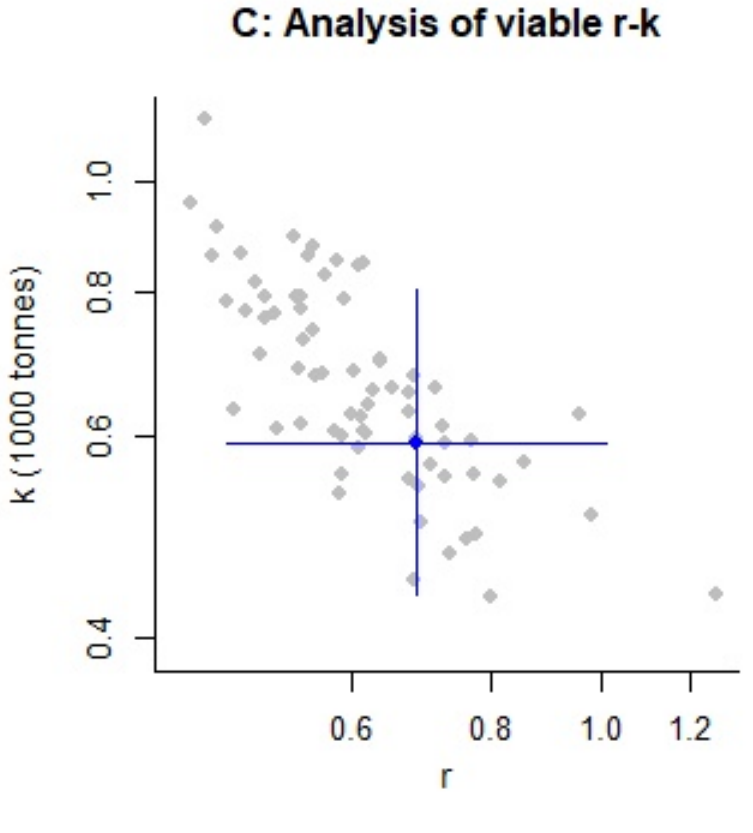
Exploitation

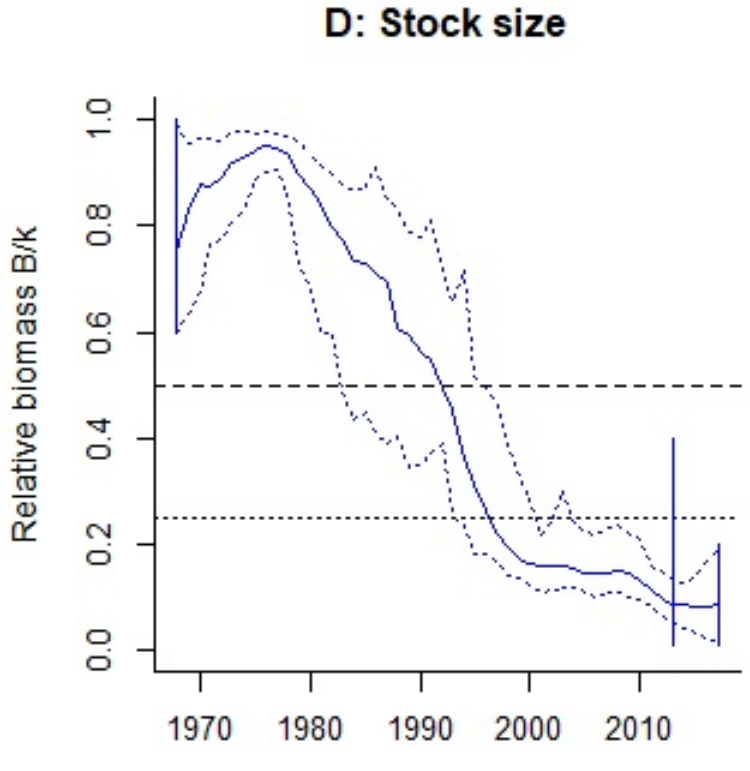


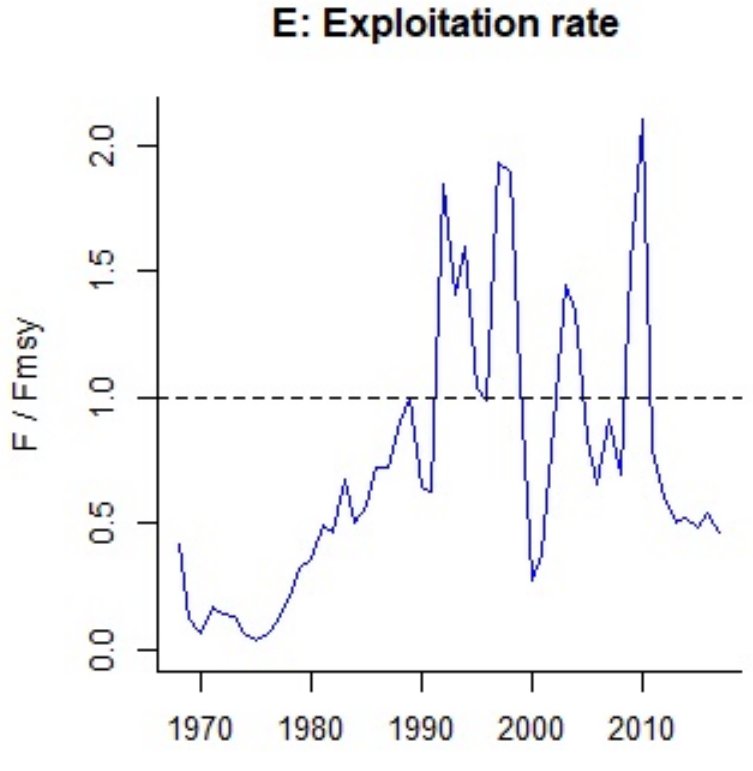


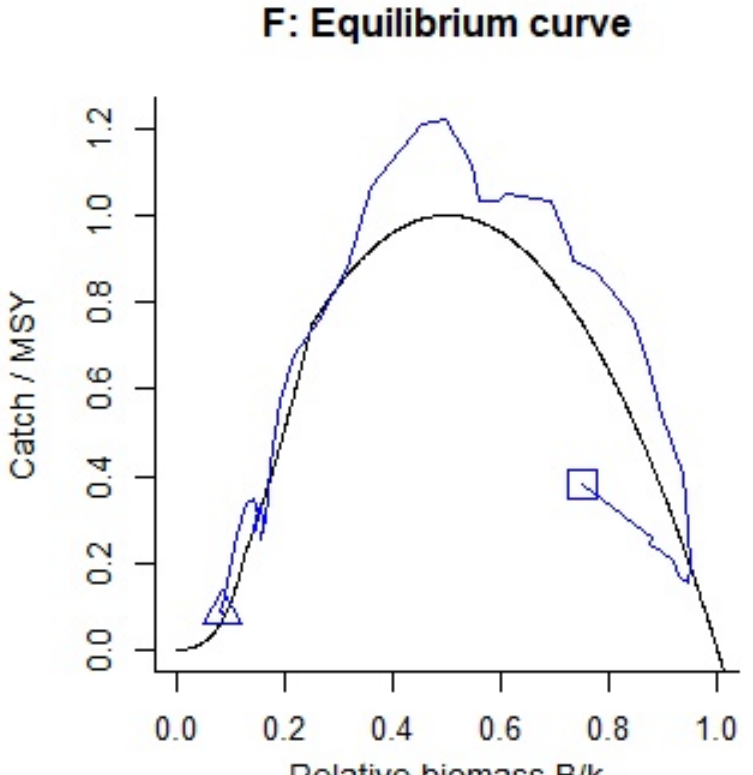

A: Catch Saddled_Med
Catch (1000 tonnes/year)
0.00
0.05
0.10
0.15
0.20
1970
1980
1990
2000
2010

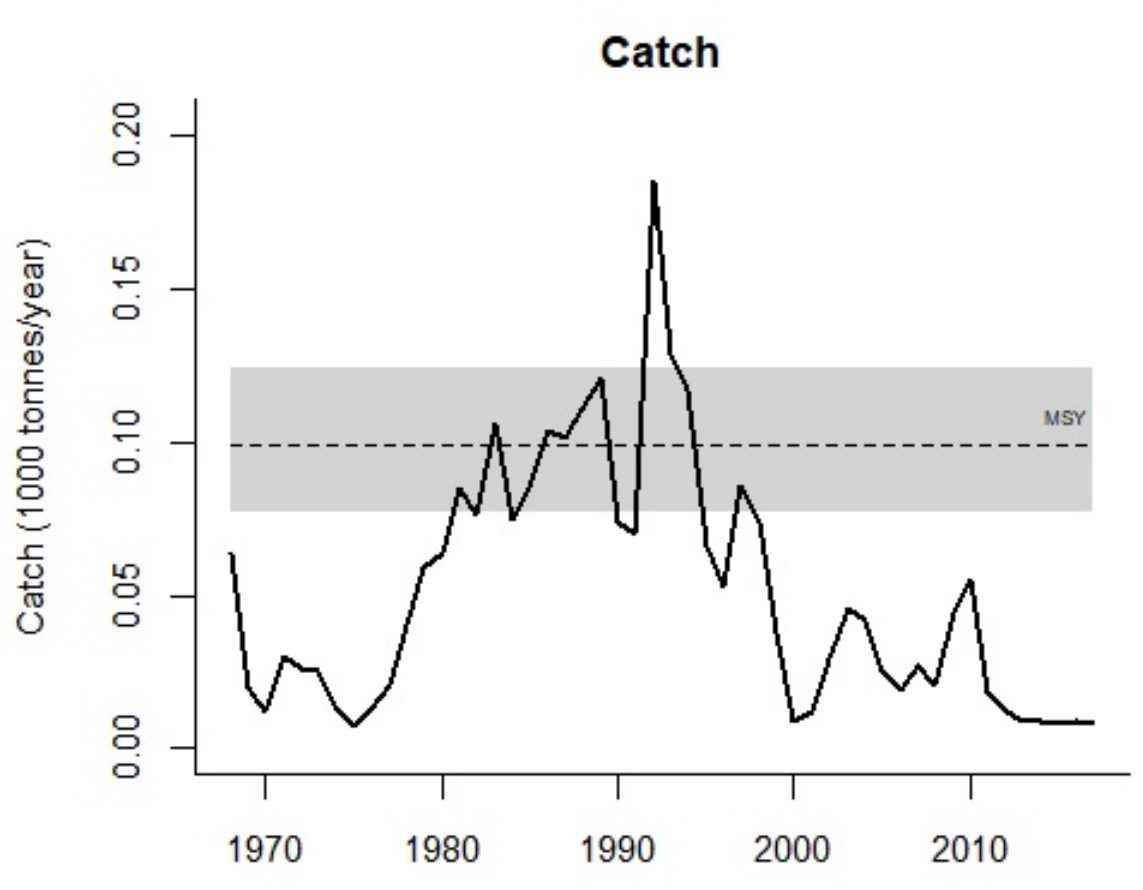

B: Finding viable r-k
k (1000 tonnes)
0.2
0.4
0.6
0.8
1.2
0.4
0.6
0.8
1.0
1.4
1.8
r

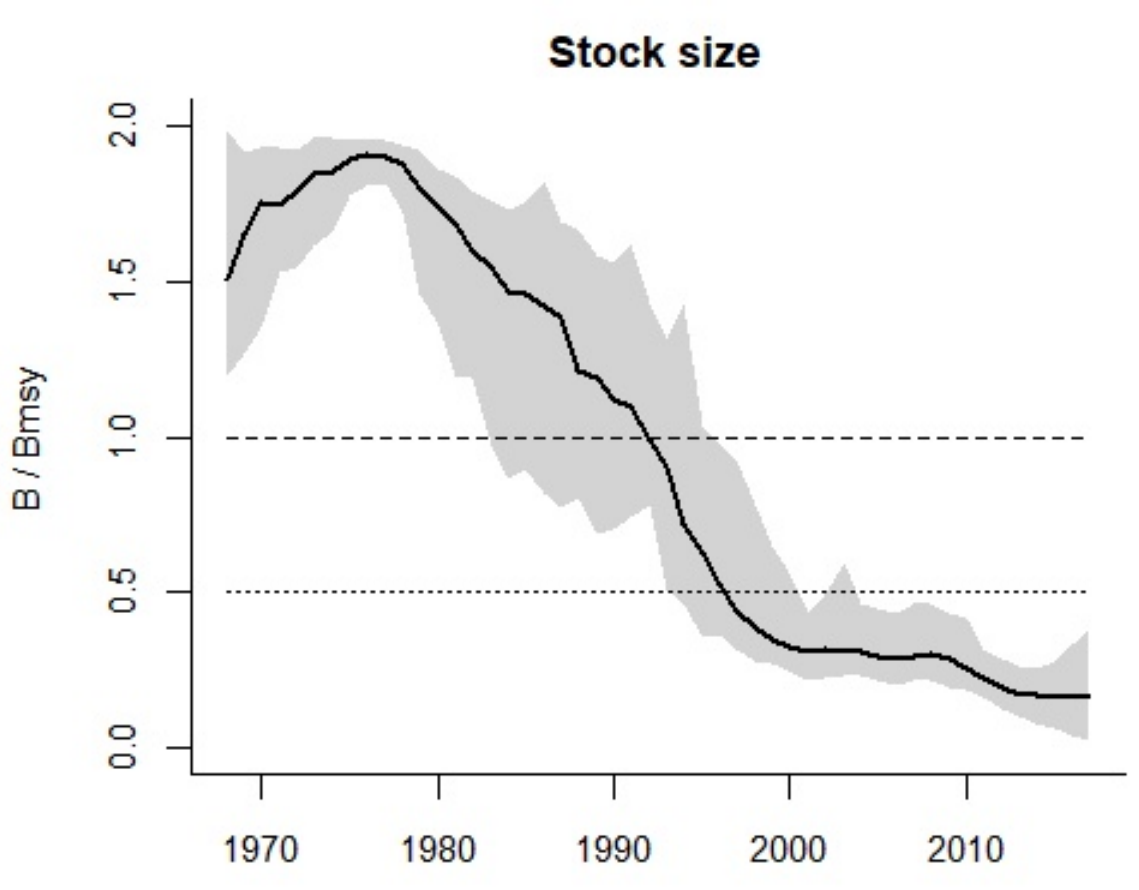

C: Analysis of viable r-k
k (1000 tonnes)
0.4
0.6
0.8
1.0
0.6
0.8
1.0
1.2
r

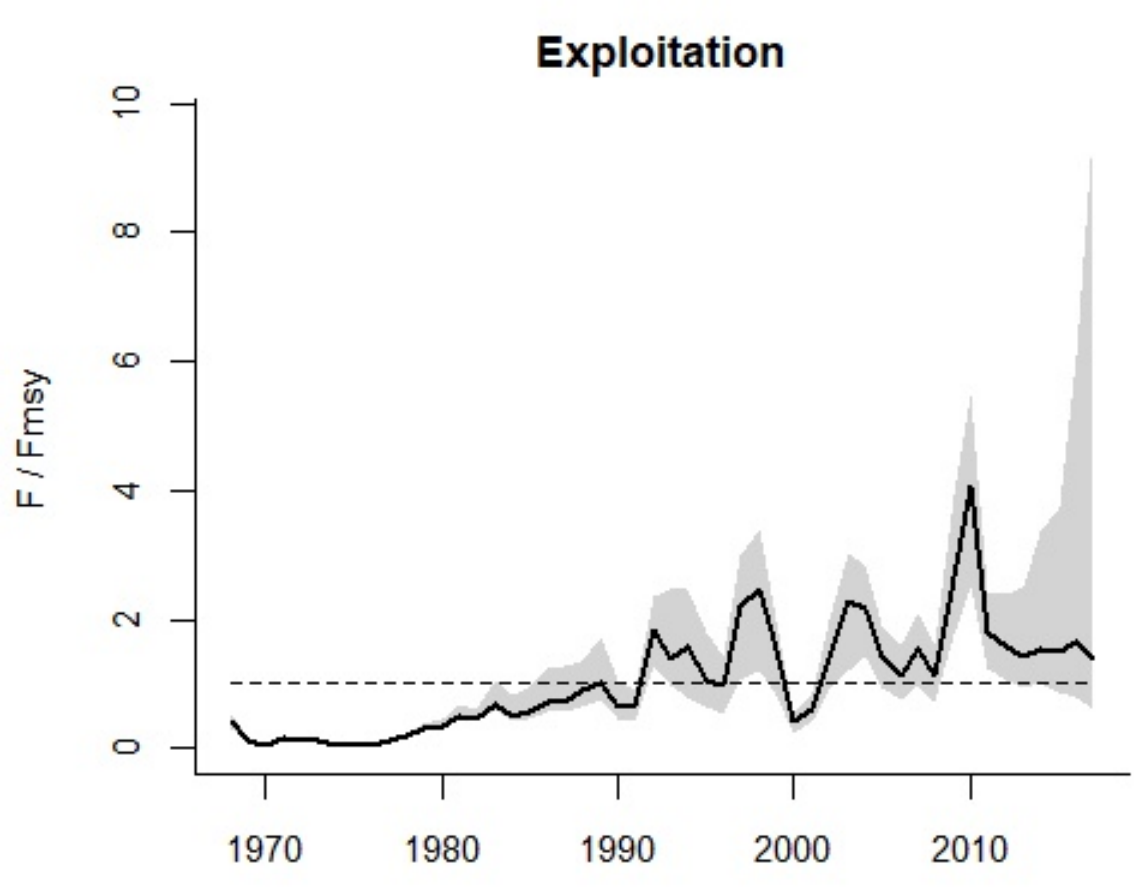

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

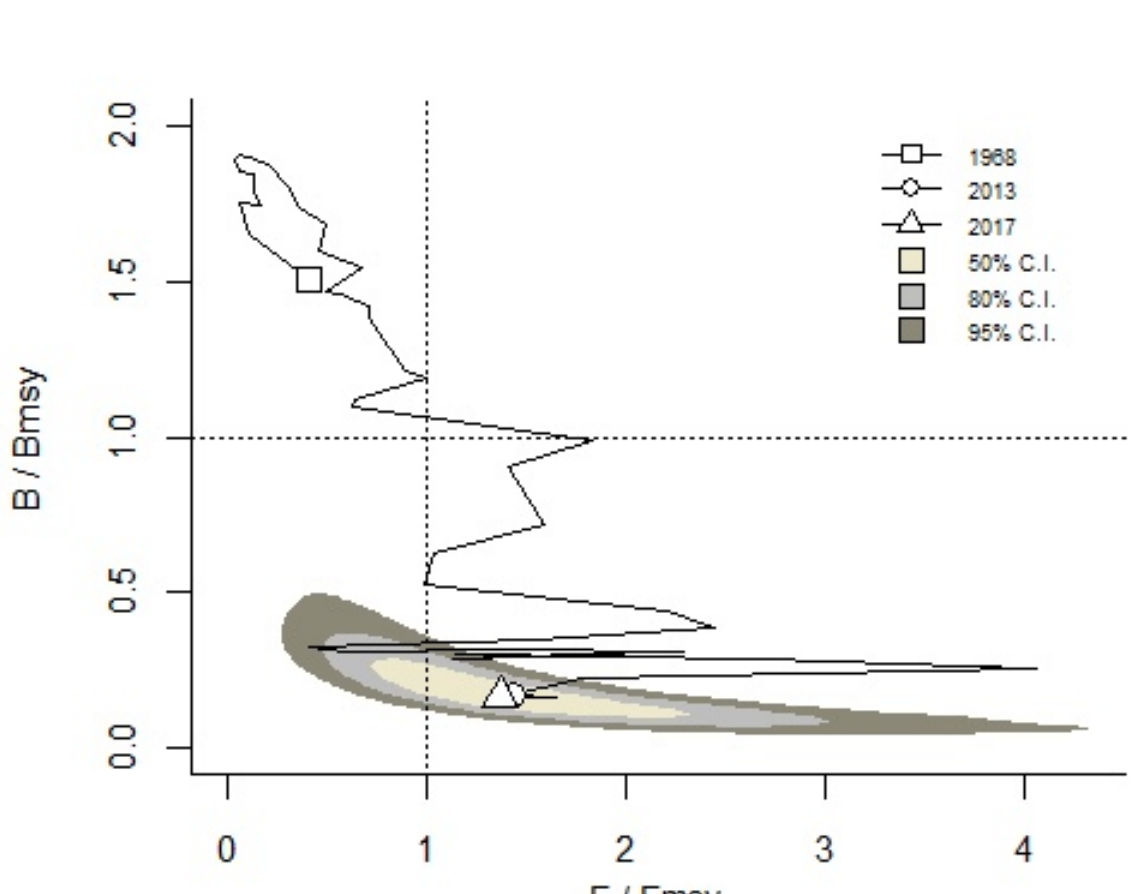

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

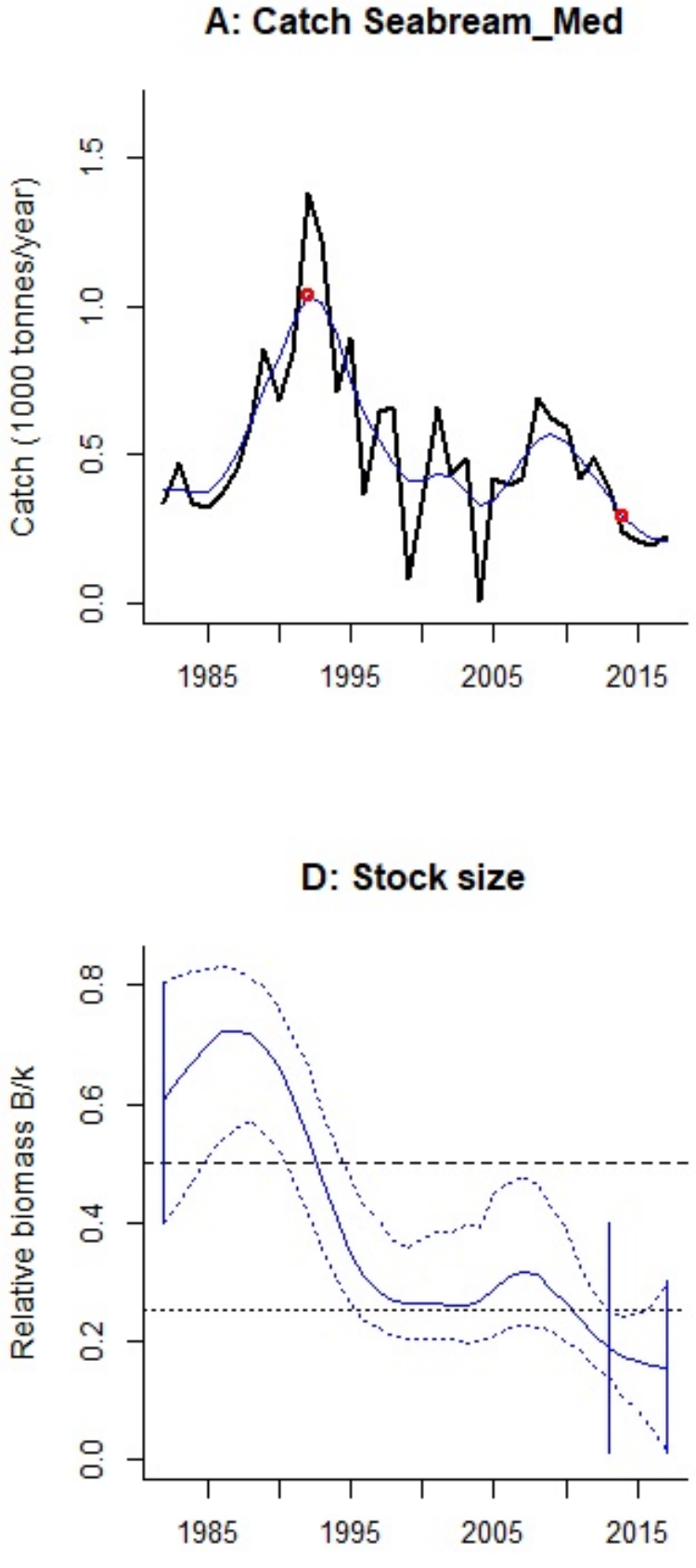

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

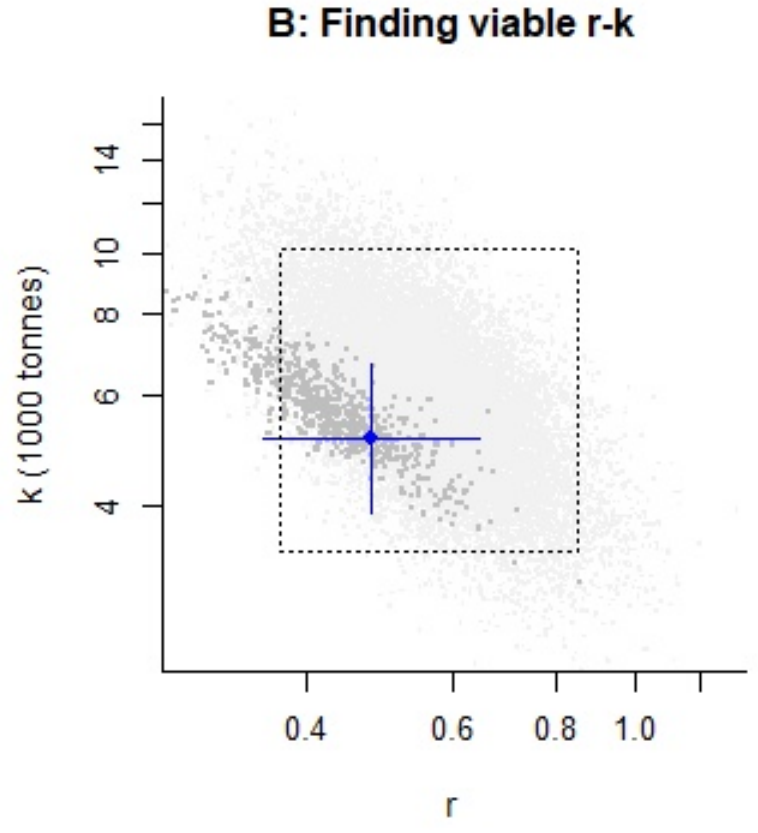

Catch
Catch (1000 tonnes/year)
0.00
0.05
0.10
0.15
0.20
MSY
1970
1980
1990
2000
2010

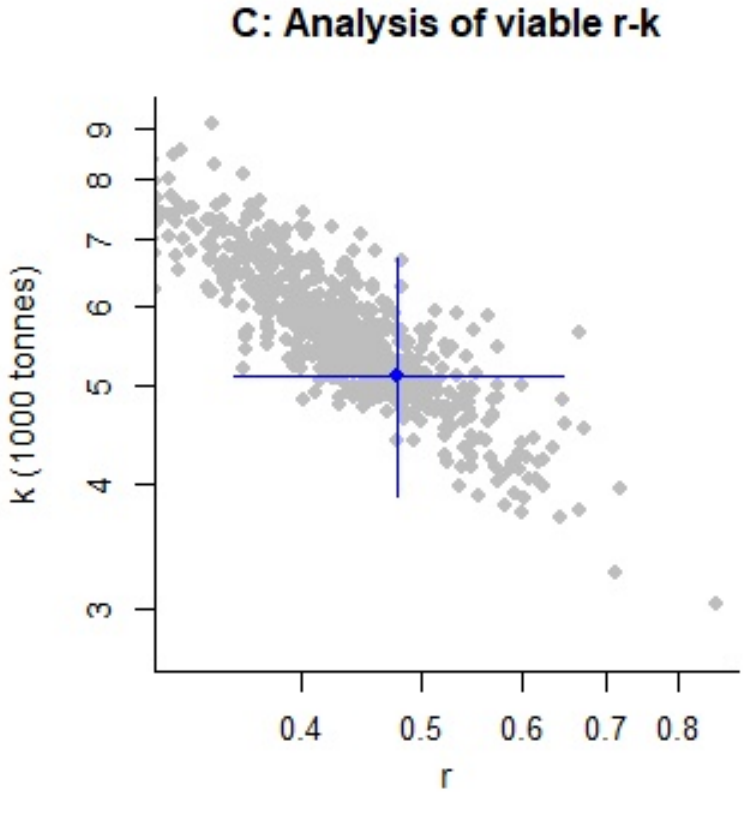

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
2
4
6
8
10
1970
1980
1990
2000
2010

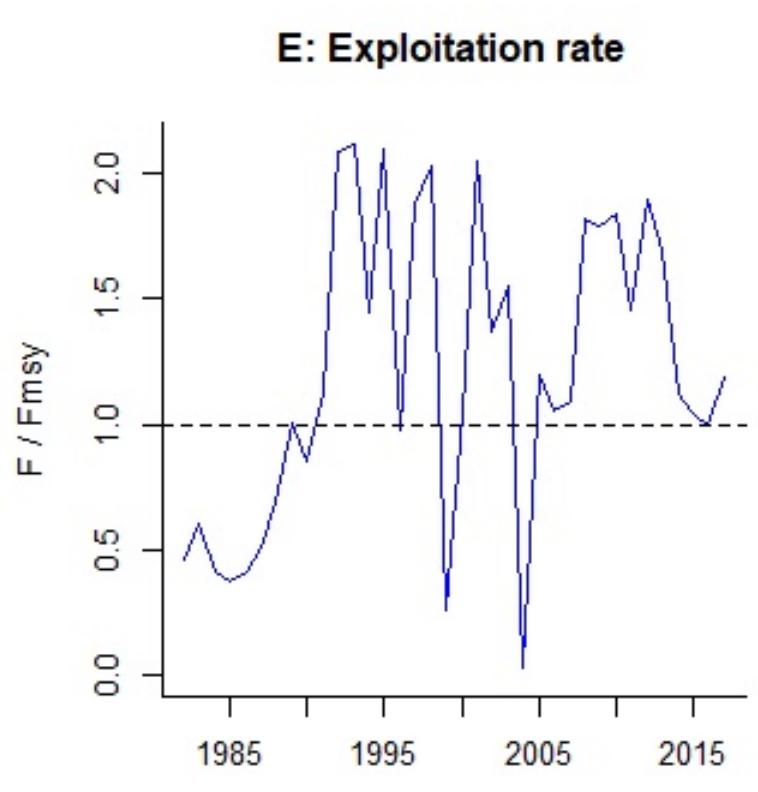

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1968
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
F / Fmsy

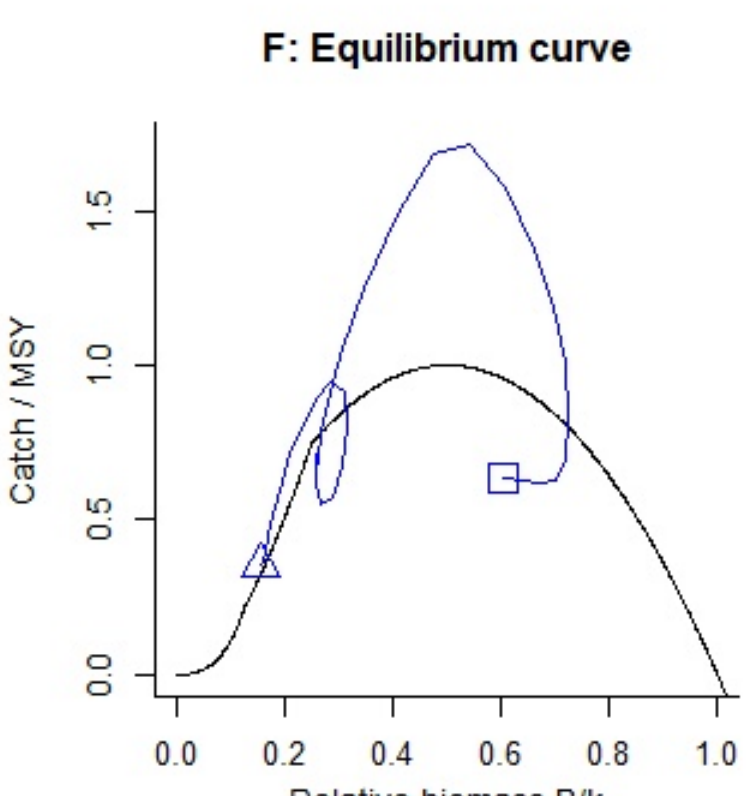

A: Catch Seabream_Med
Catch (1000 tonnes/year)
0.0
0.5
1.0
1.5
1985
1995
2005
2015


B: Finding viable r-k
k (1000 tonnes)
4
6
8
10
14
0.4
0.6
0.8
1.0
r

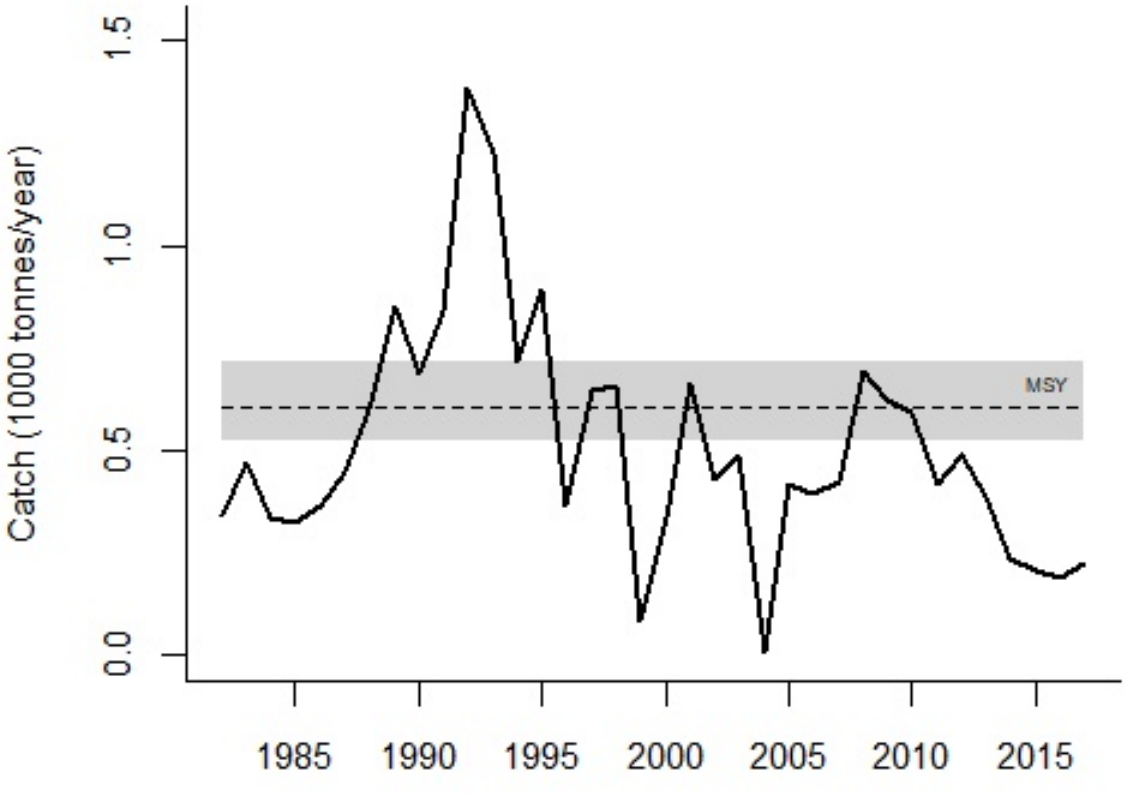

C: Analysis of viable r-k
k (1000 tonnes)
3
4
5
6
7
8
9
0.4
0.5
0.6
0.7
0.8
r

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1985
1995
2005
2015

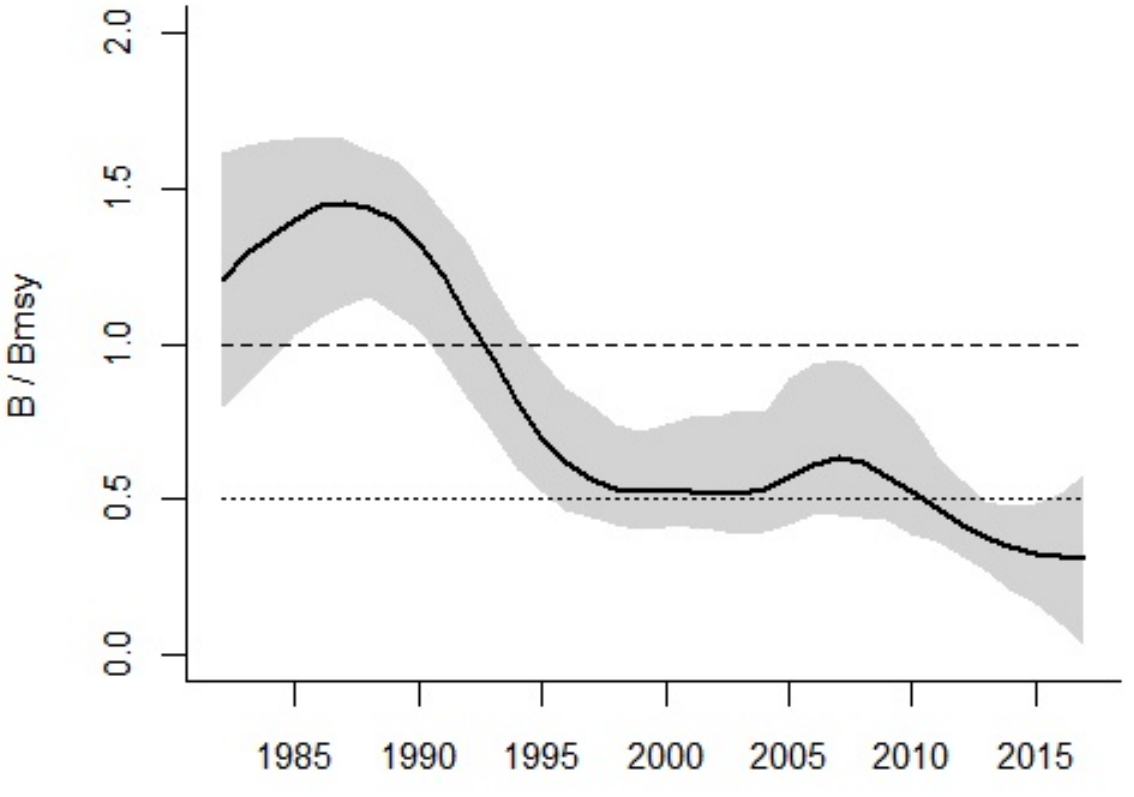

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1985
1995
2005
2015


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

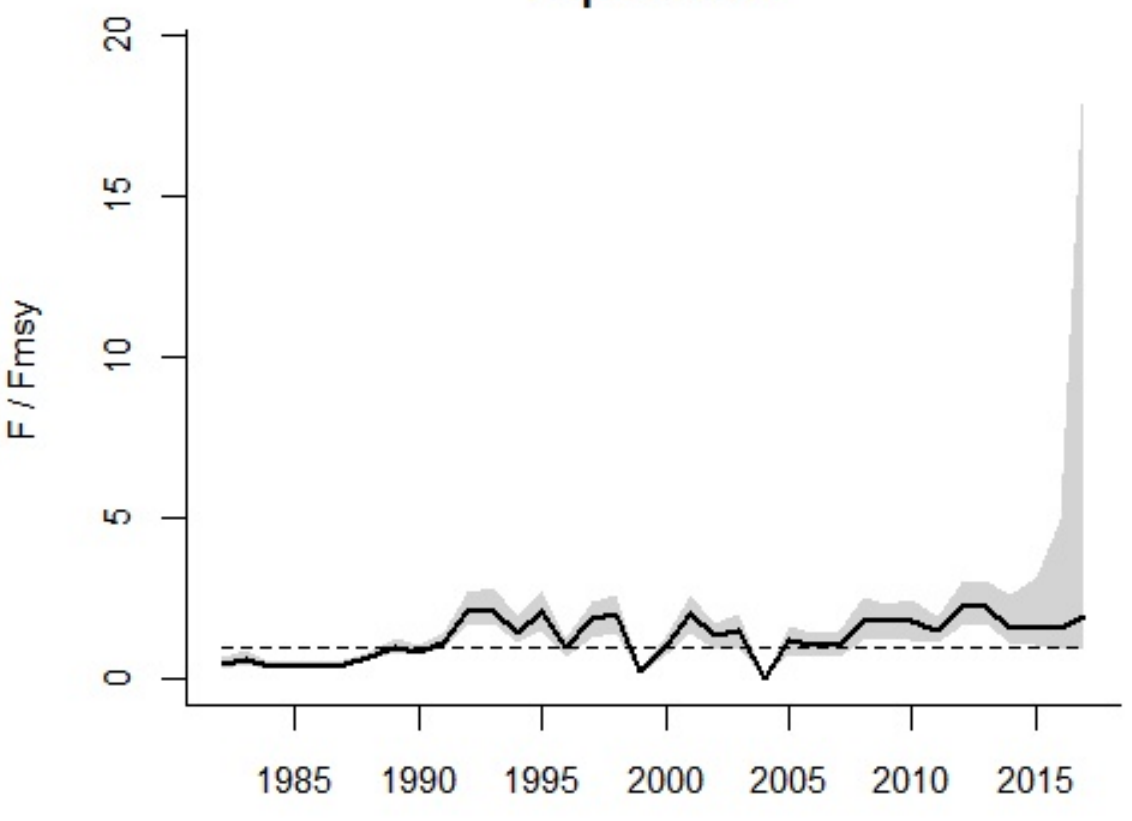
Catch

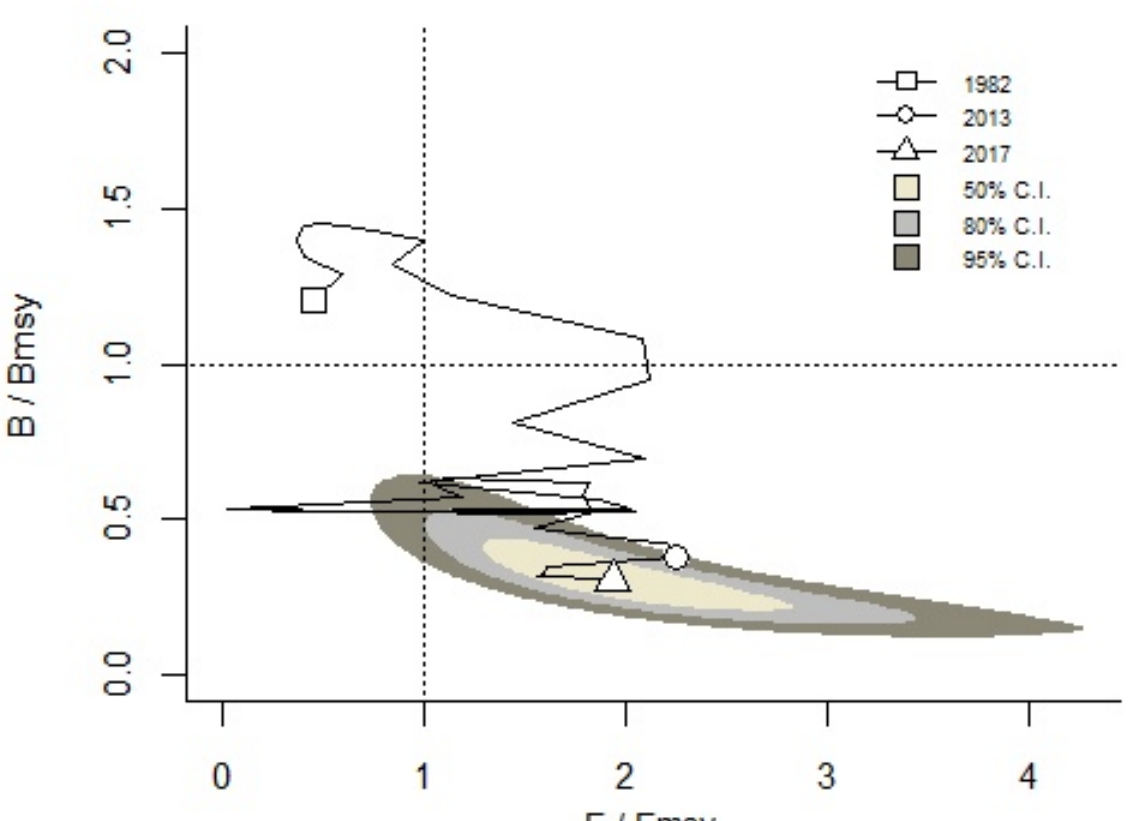


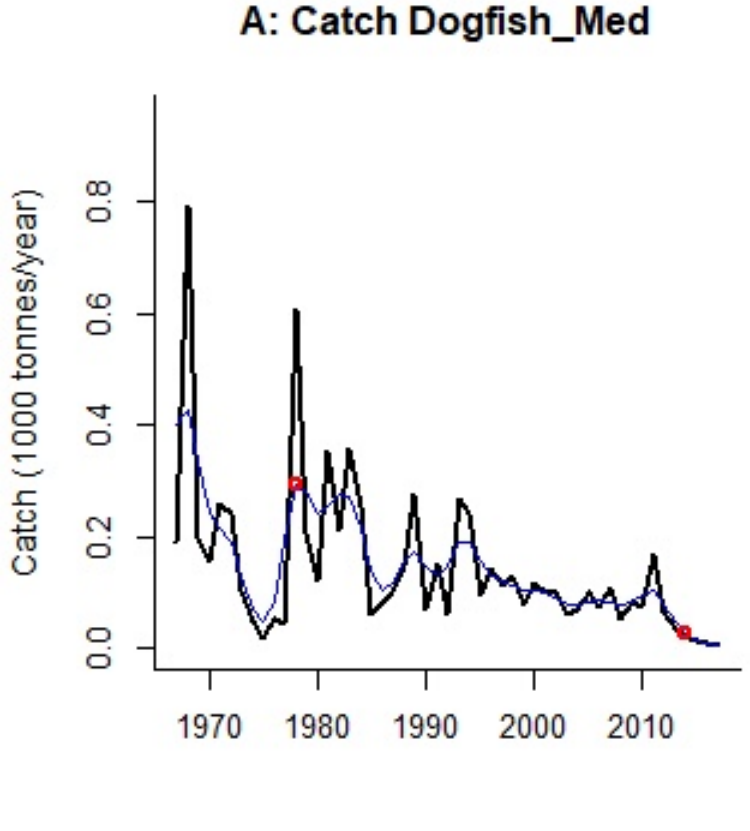
Stock size

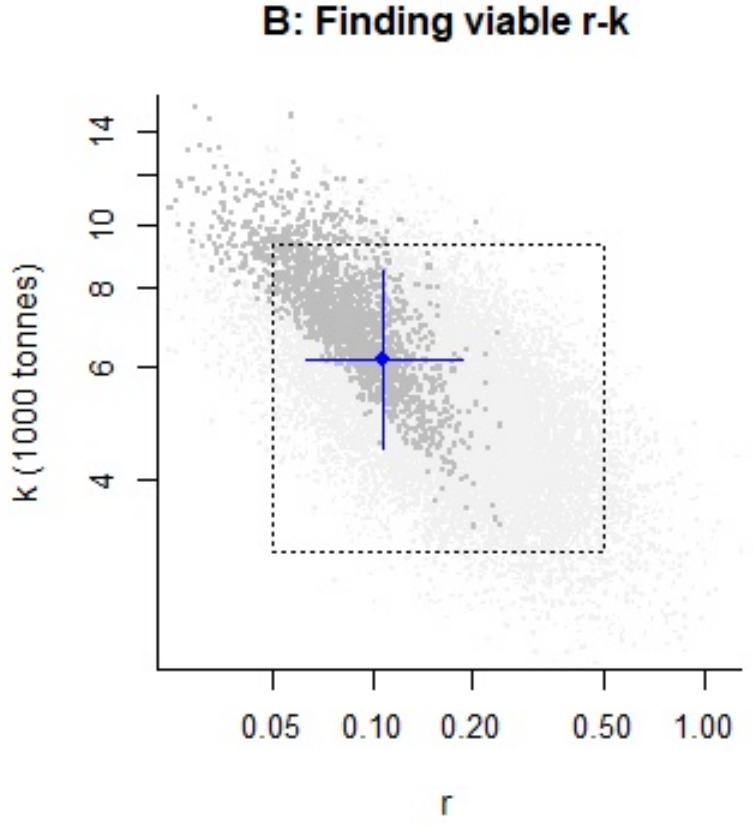


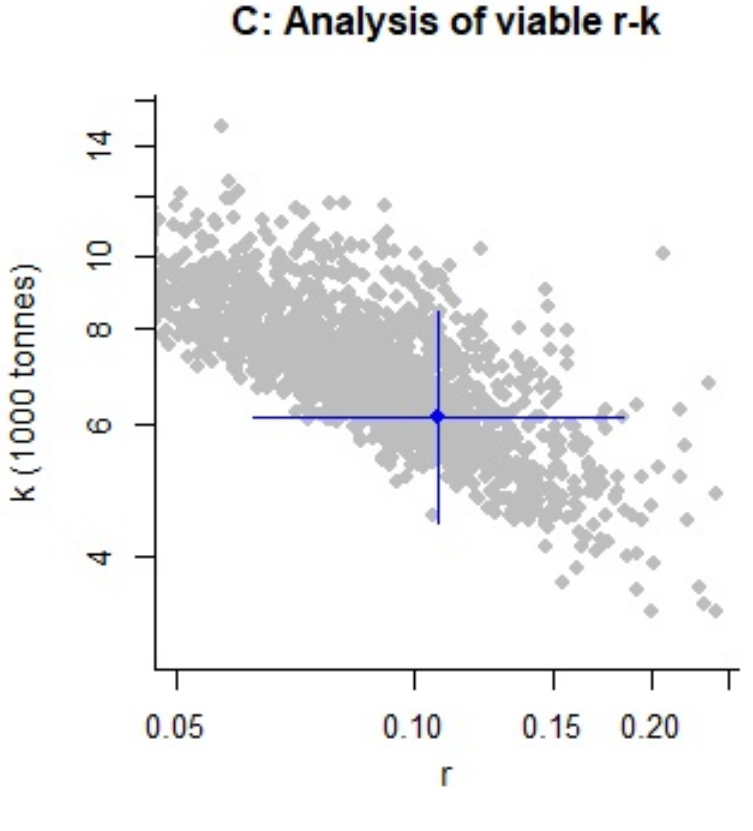
Exploitation

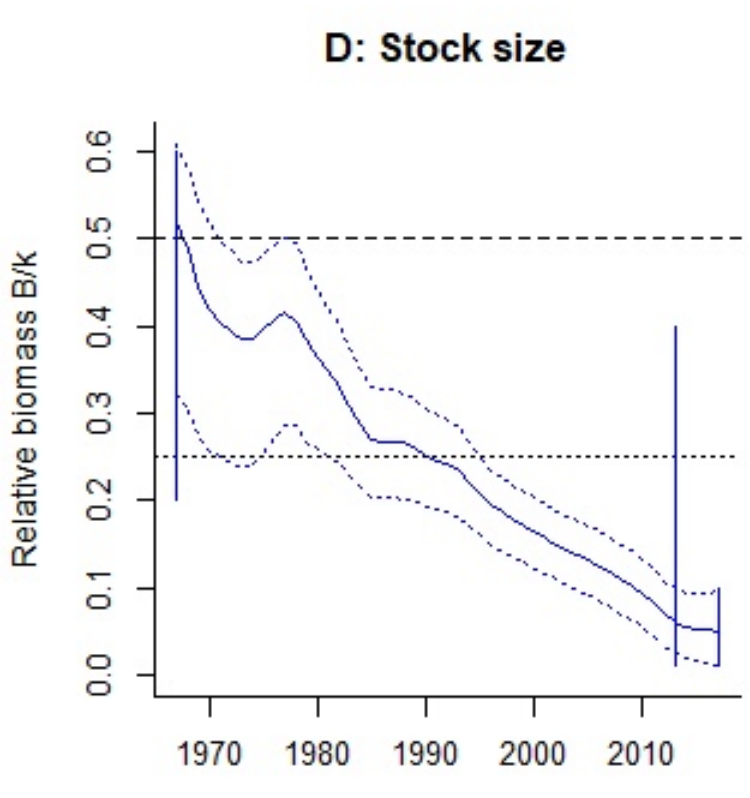


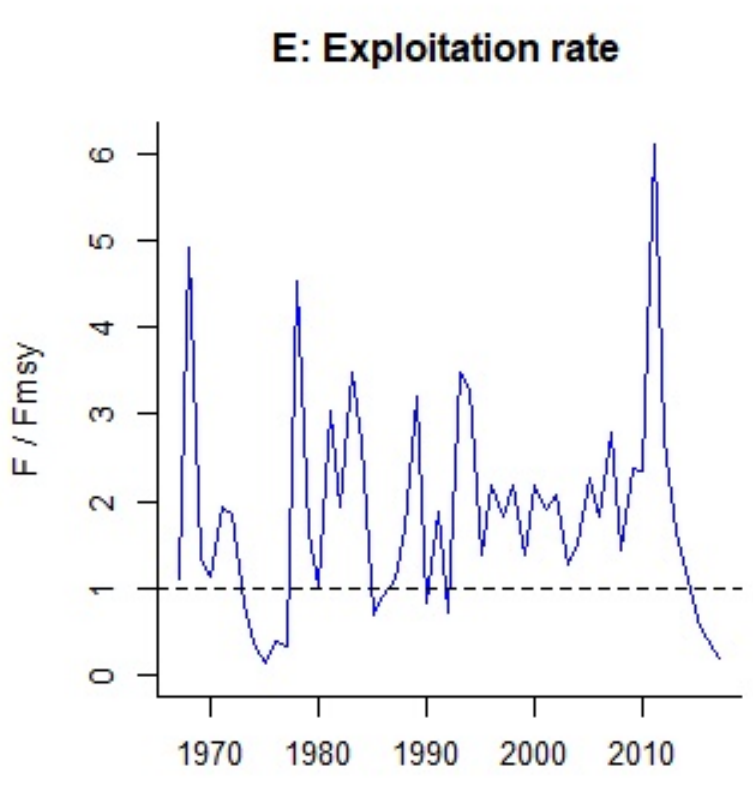


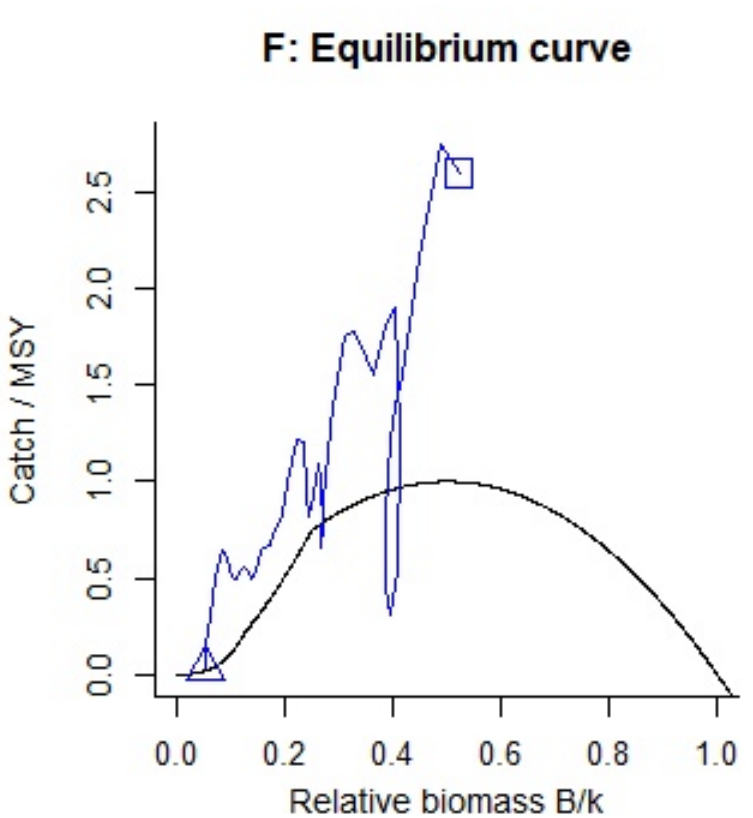

A: Catch Dogfish_Med
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
4
6
8
10
14
0.05
0.10
0.20
0.50
1.00
r

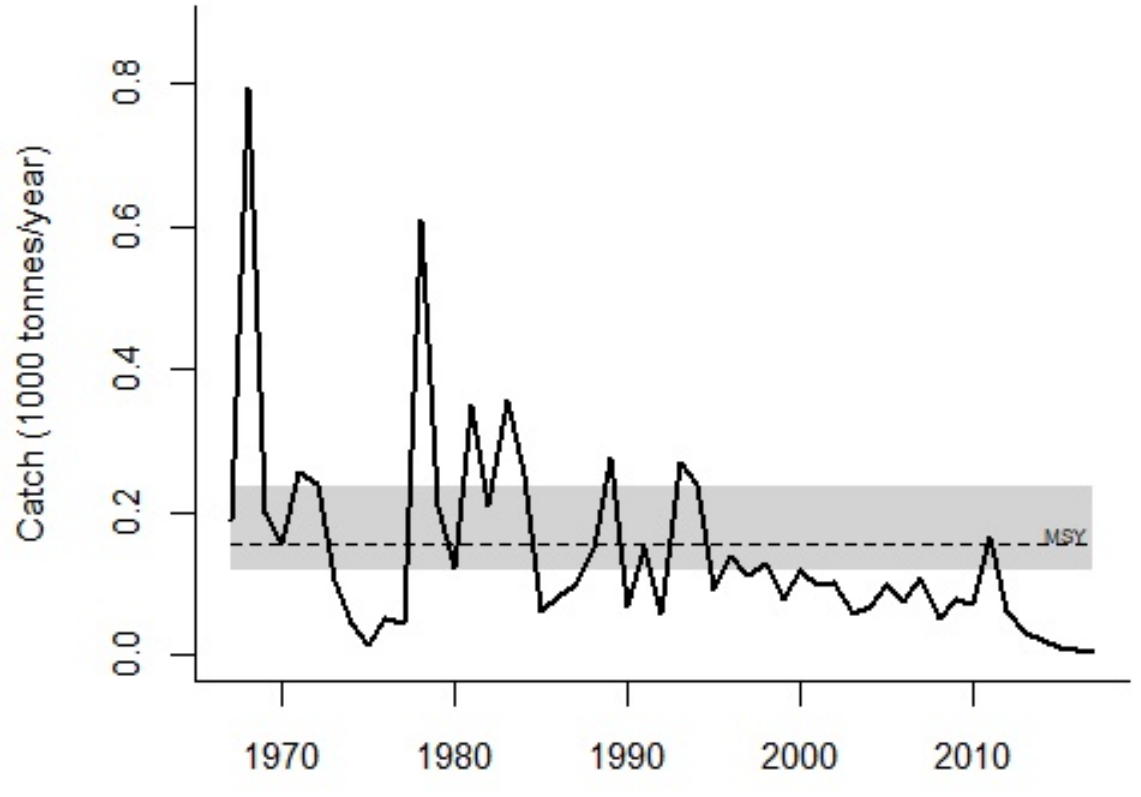

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
14
0.05
0.10
0.15
0.20
r


D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

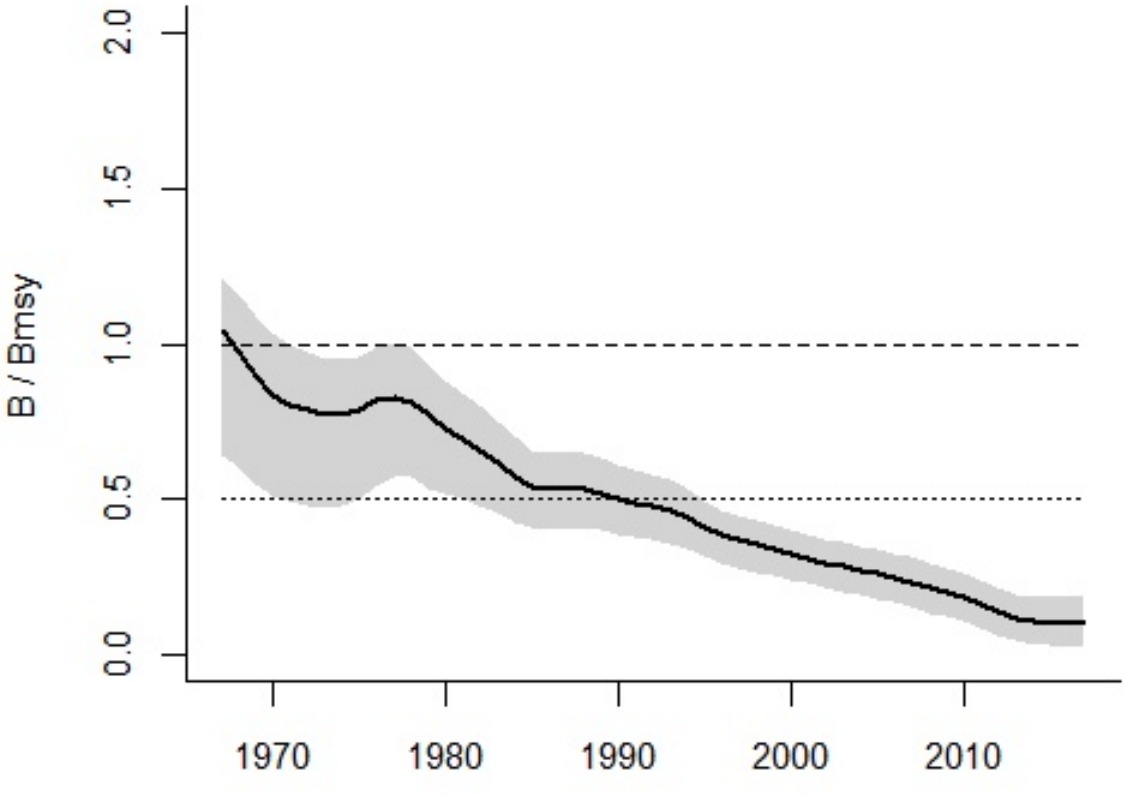

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
6
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
2.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

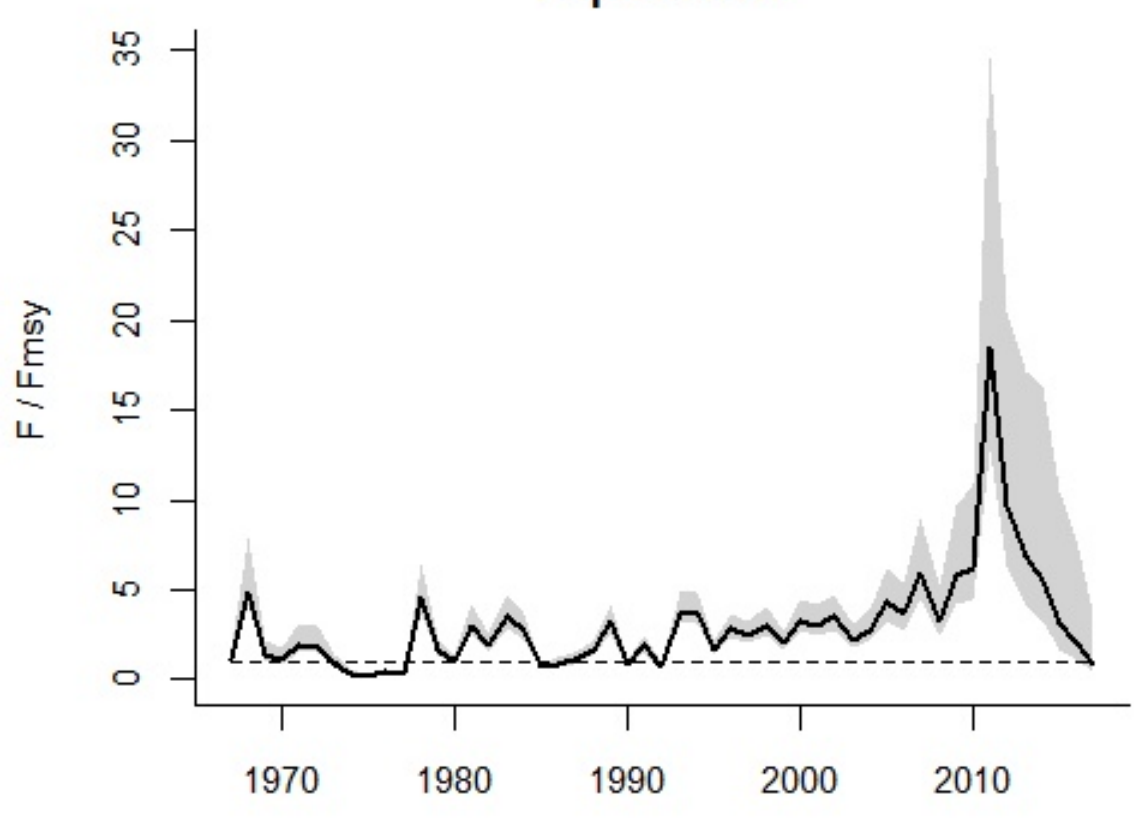
Catch

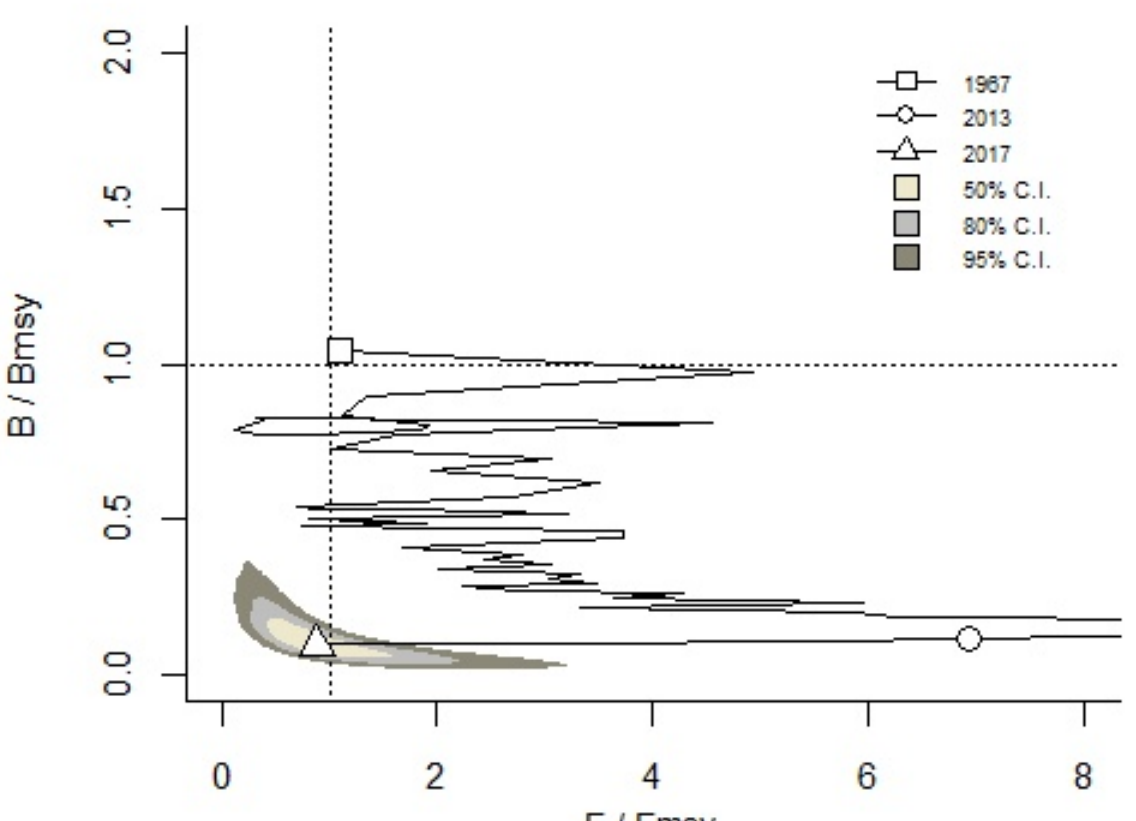


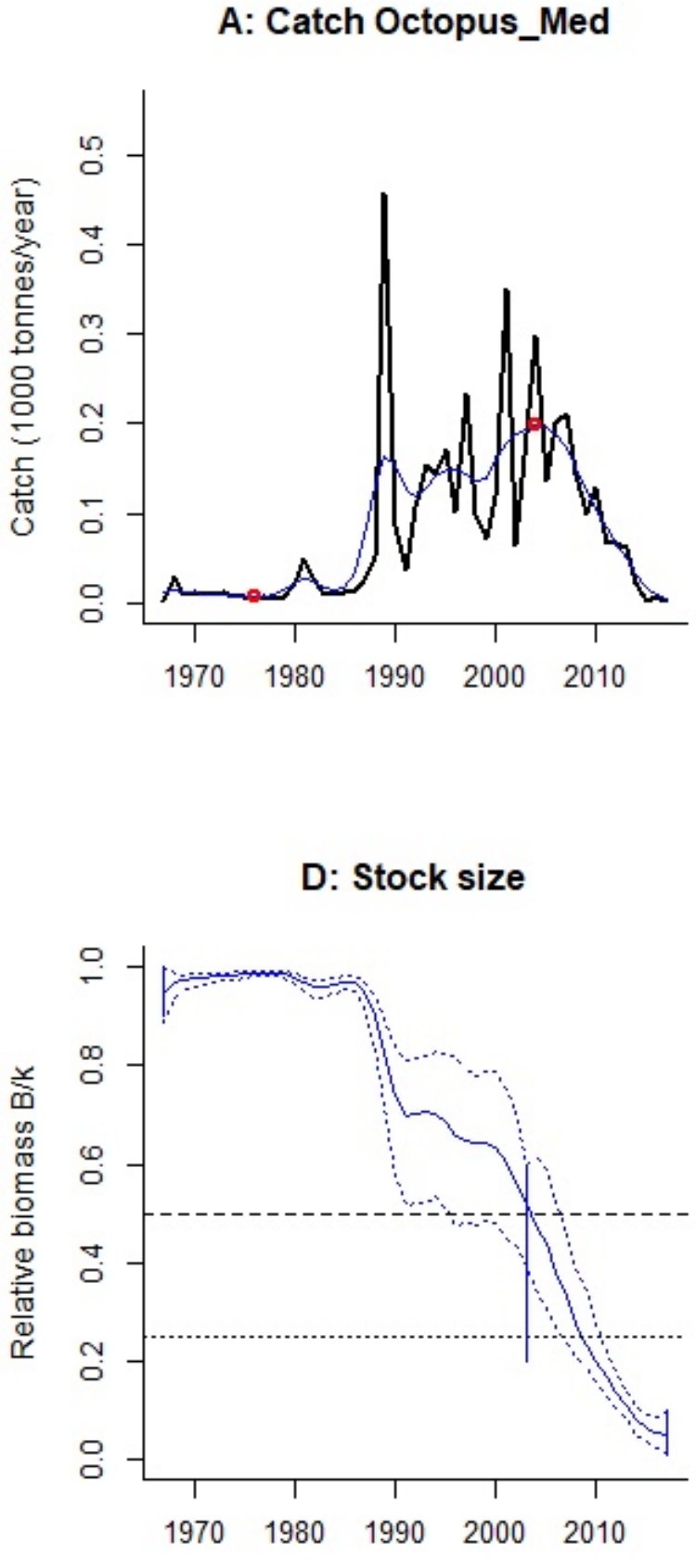
Stock size

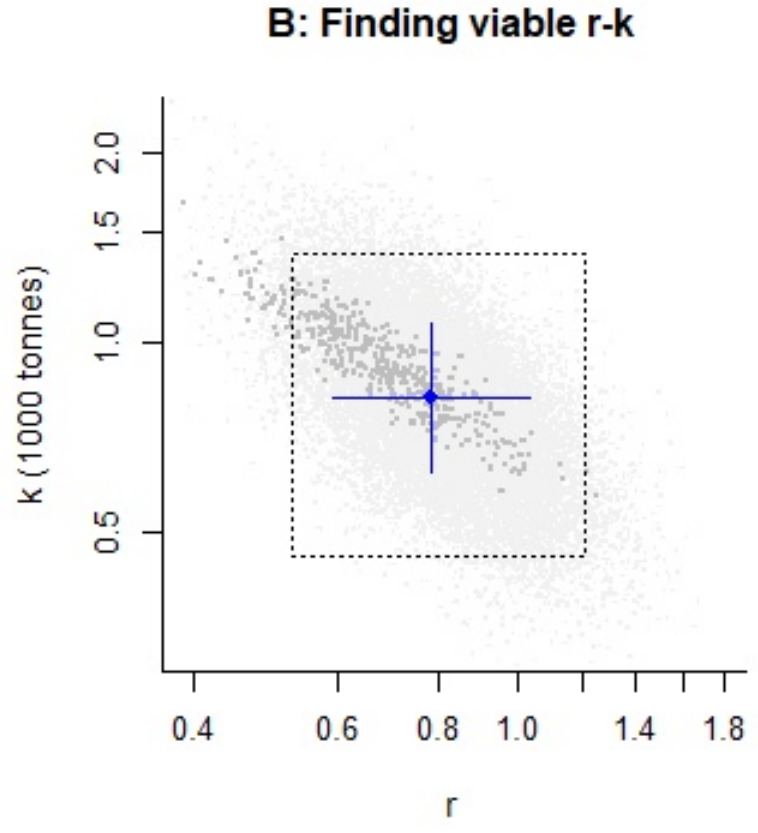


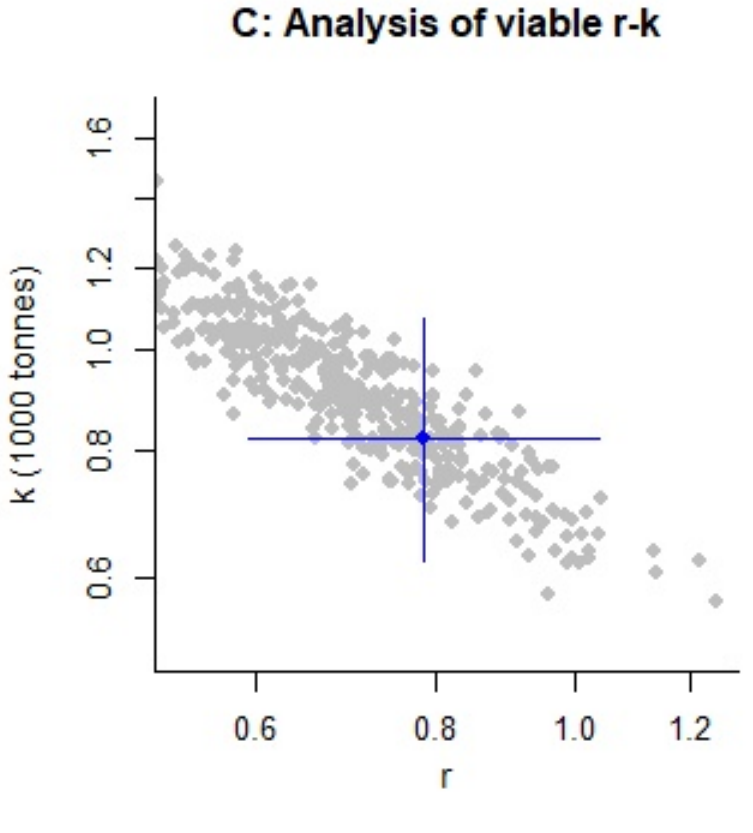
Exploitation



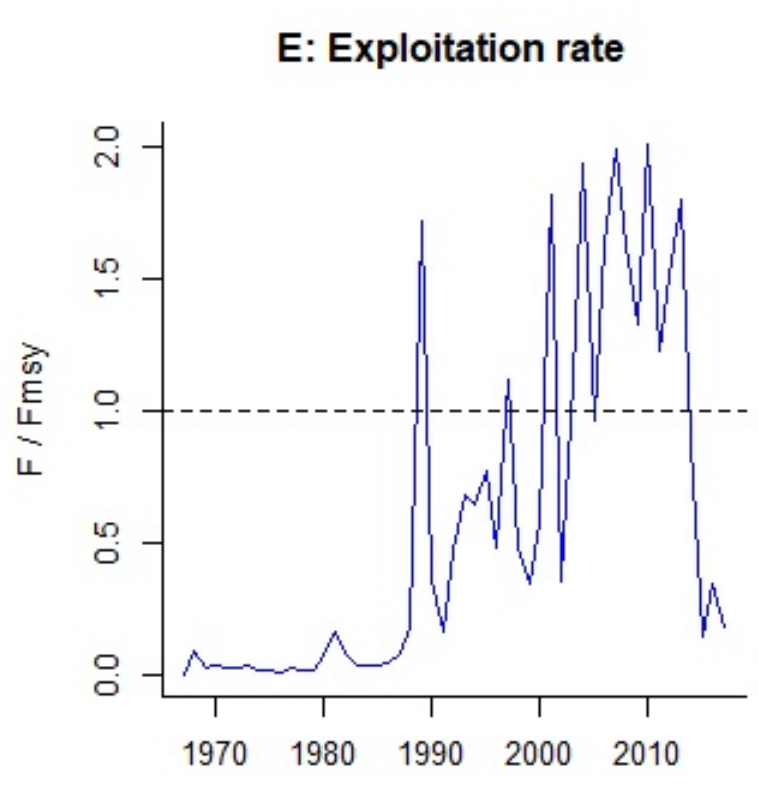


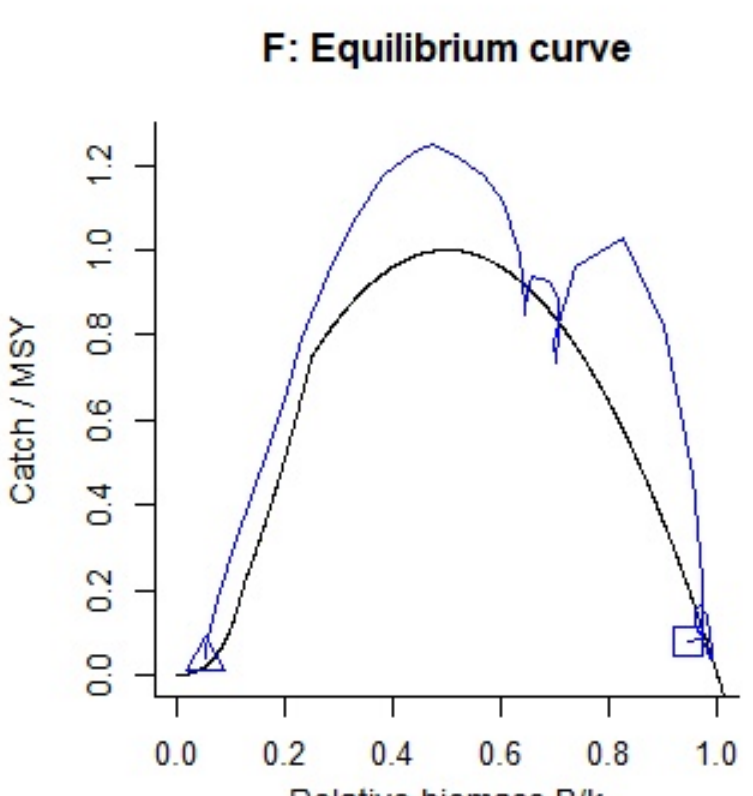

A: Catch Octopus_Med
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
1970
1980
1990
2000
2010

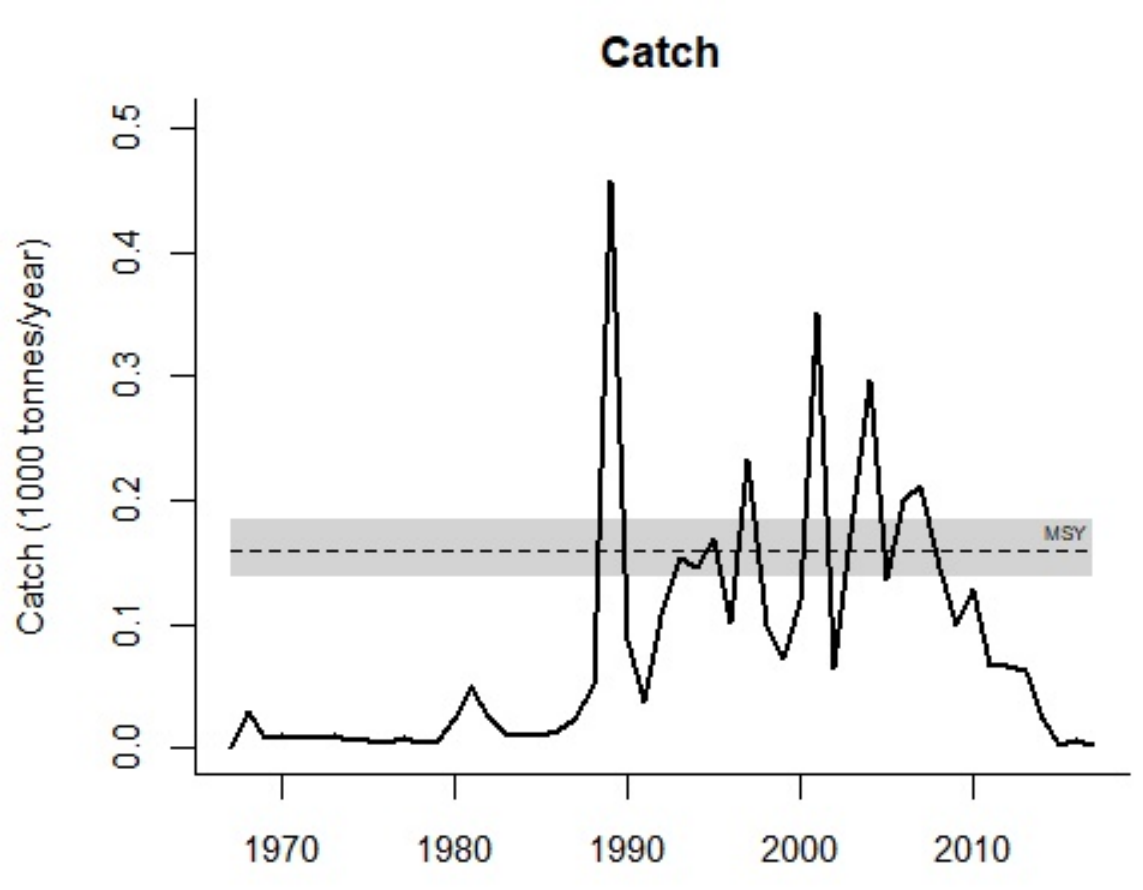

B: Finding viable r-k
k (1000 tonnes)
0.5
1.0
1.5
2.0
0.4
0.6
0.8
1.0
1.4
1.8
r

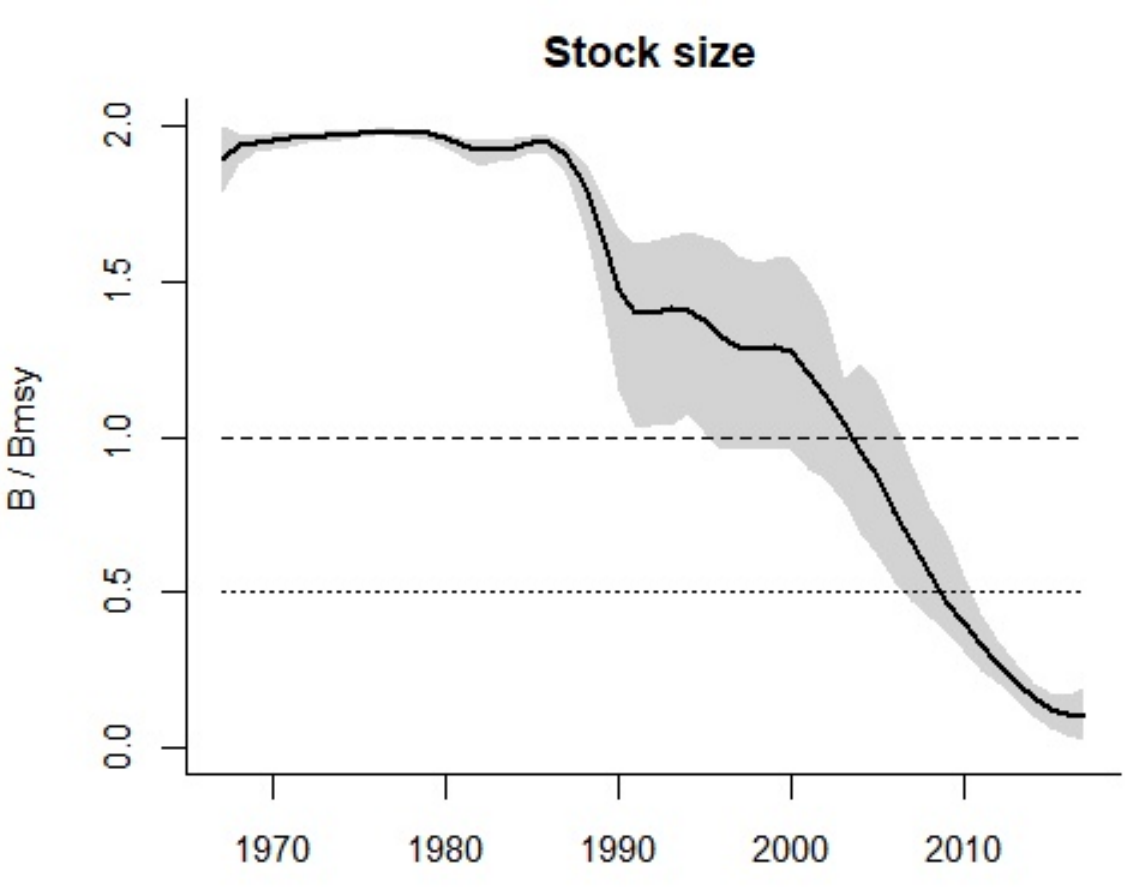

C: Analysis of viable r-k
k (1000 tonnes)
0.6
0.8
1.0
1.2
1.6
0.6
0.8
1.0
1.2
r

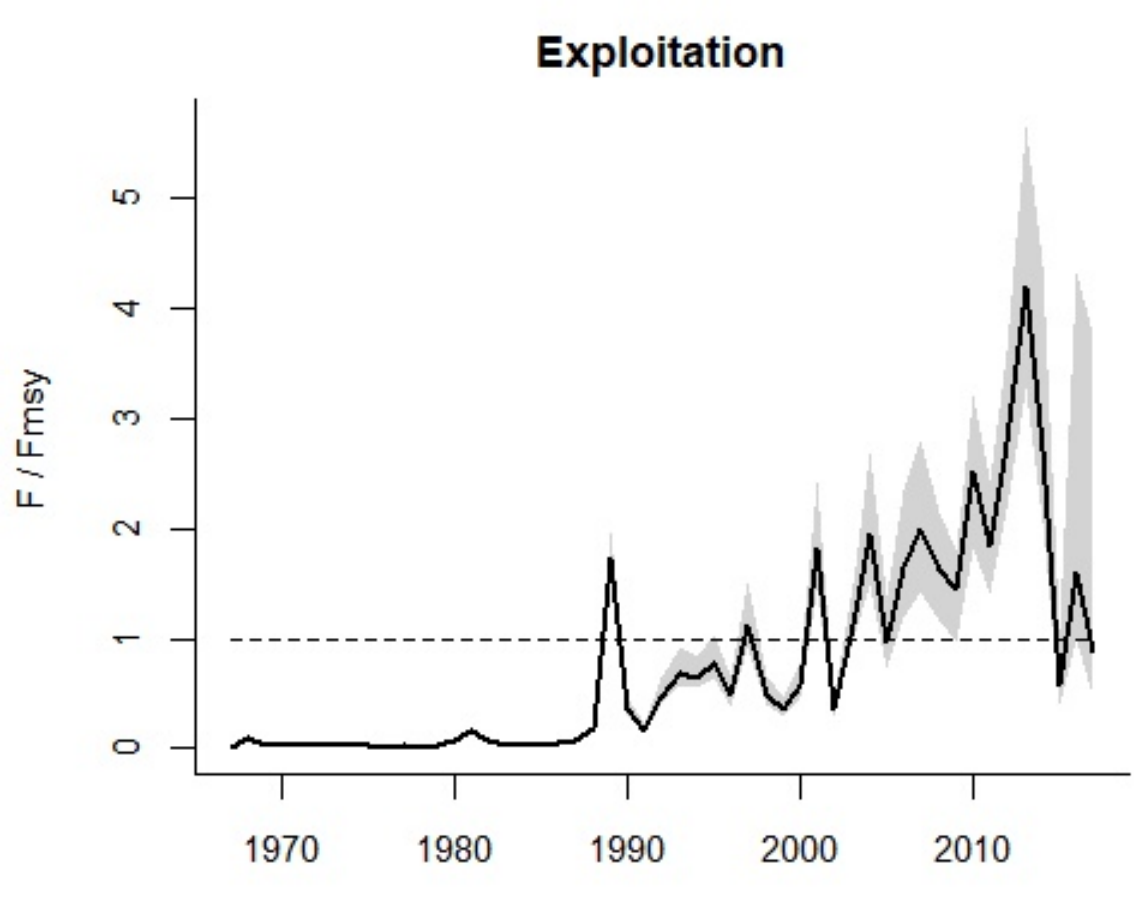
D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

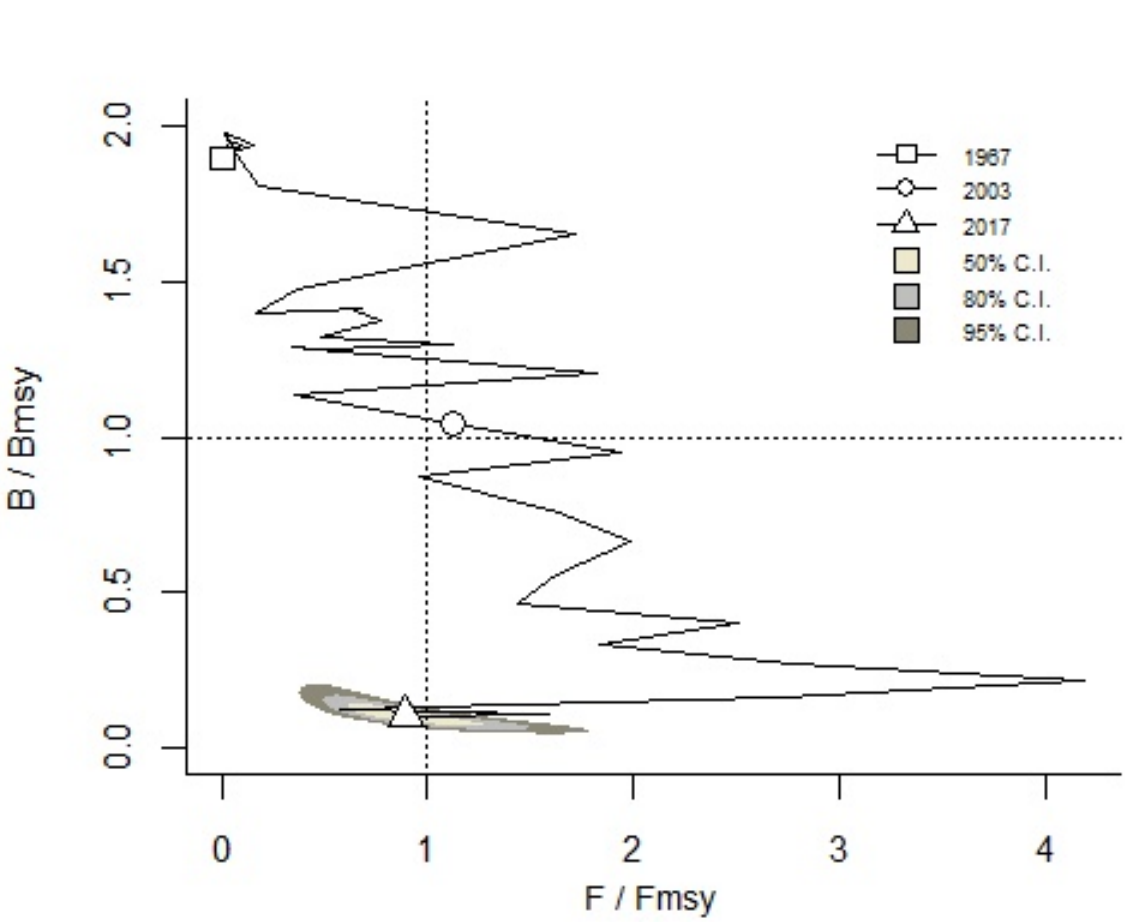

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

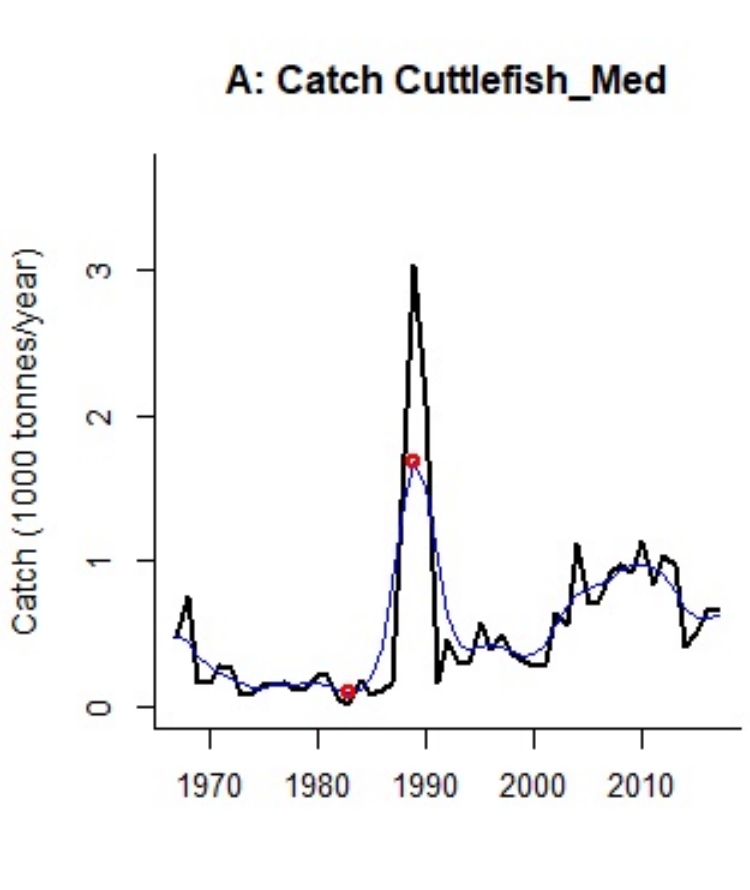

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

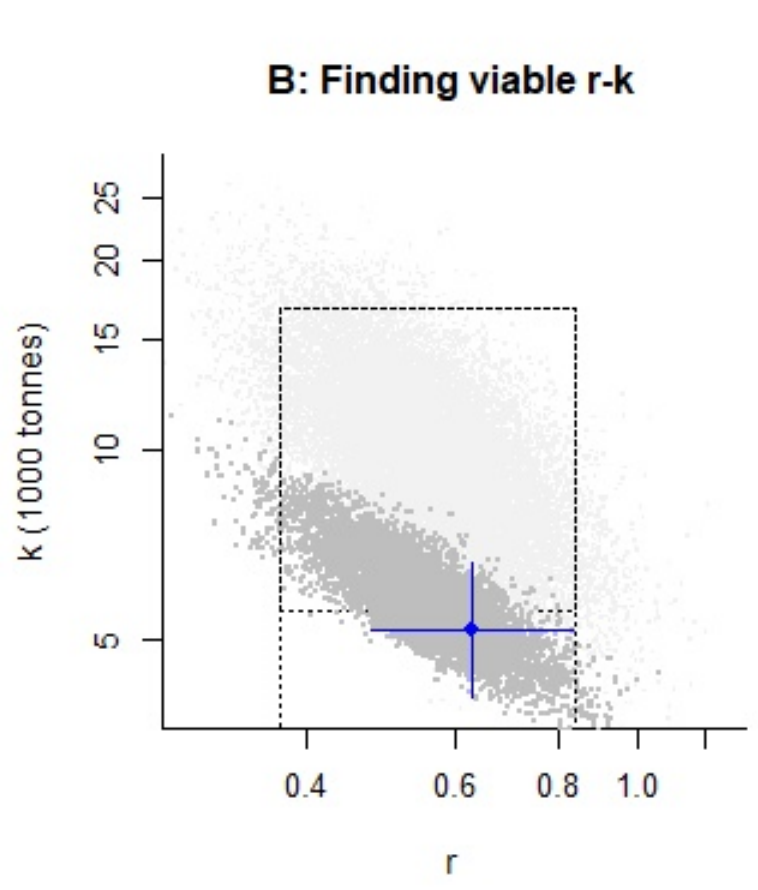

Catch
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
MSY
1970
1980
1990
2000
2010

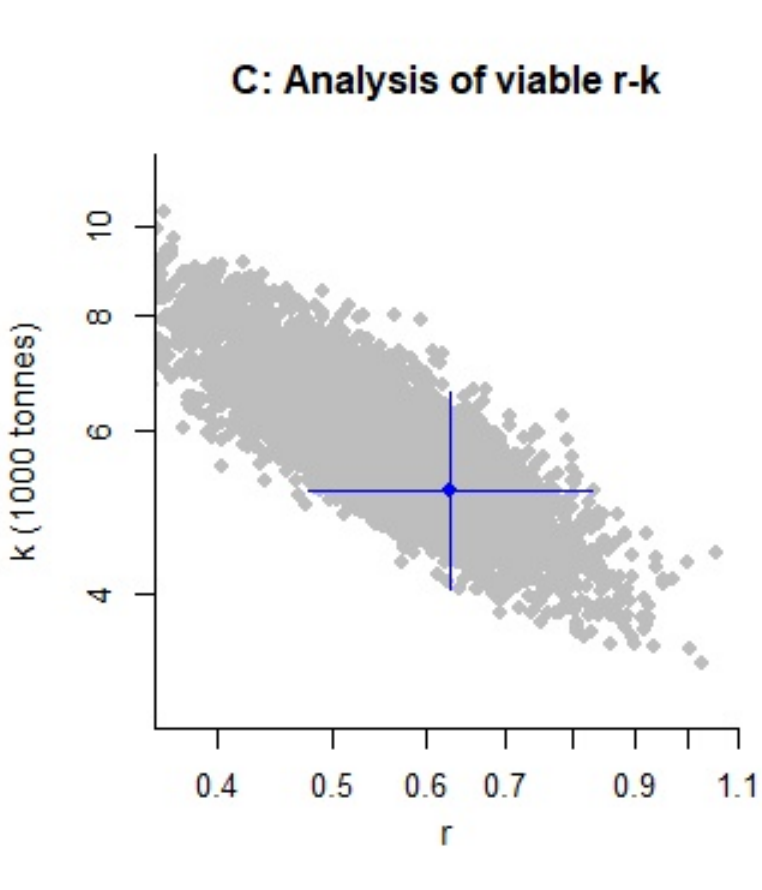

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

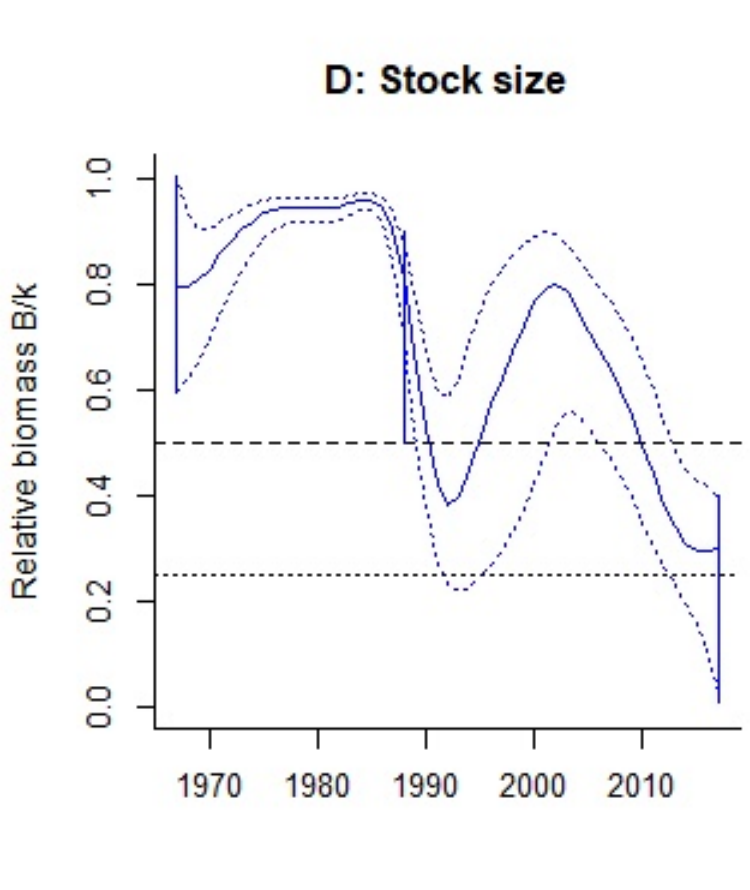

Exploitation
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010

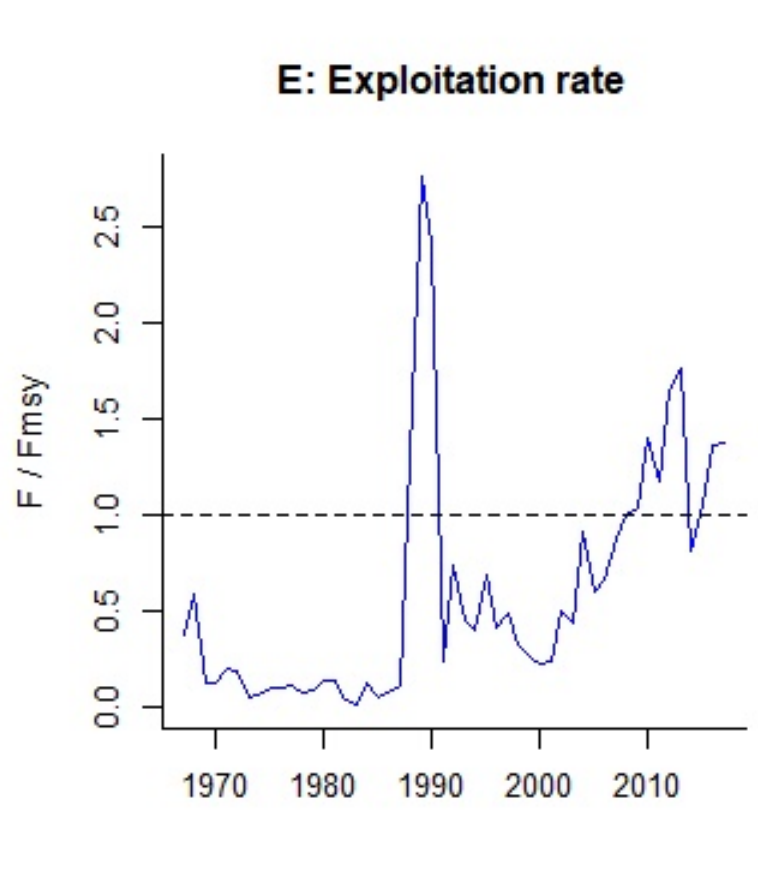

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2003
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
F / Fmsy

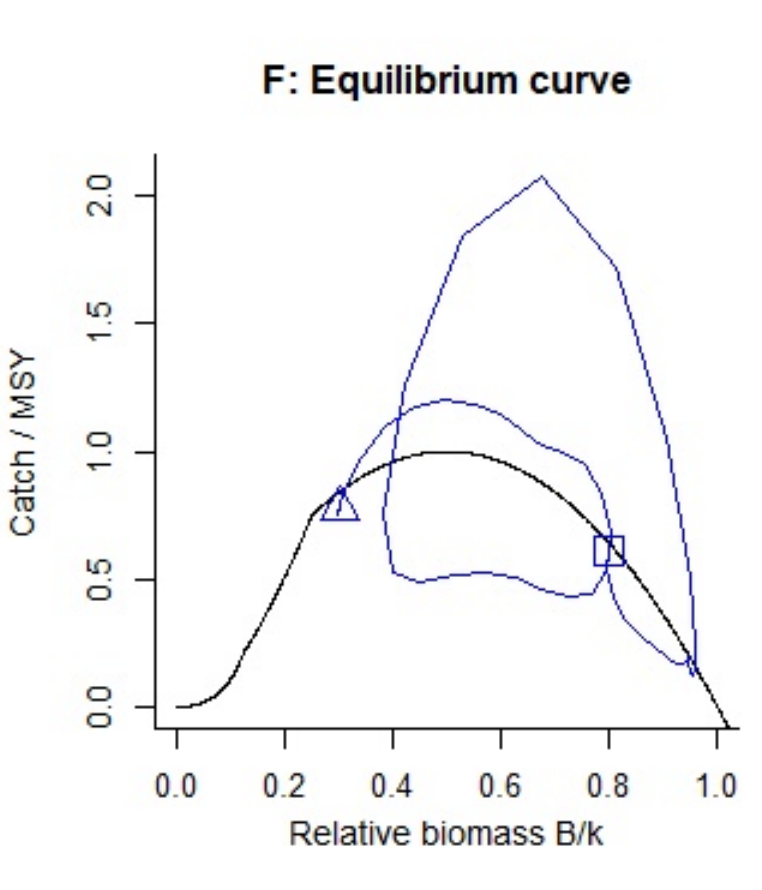

A: Catch Cuttlefish_Med
Catch (1000 tonnes/year)
0
1
2
3
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
25
0.4
0.6
0.8
1.0
r

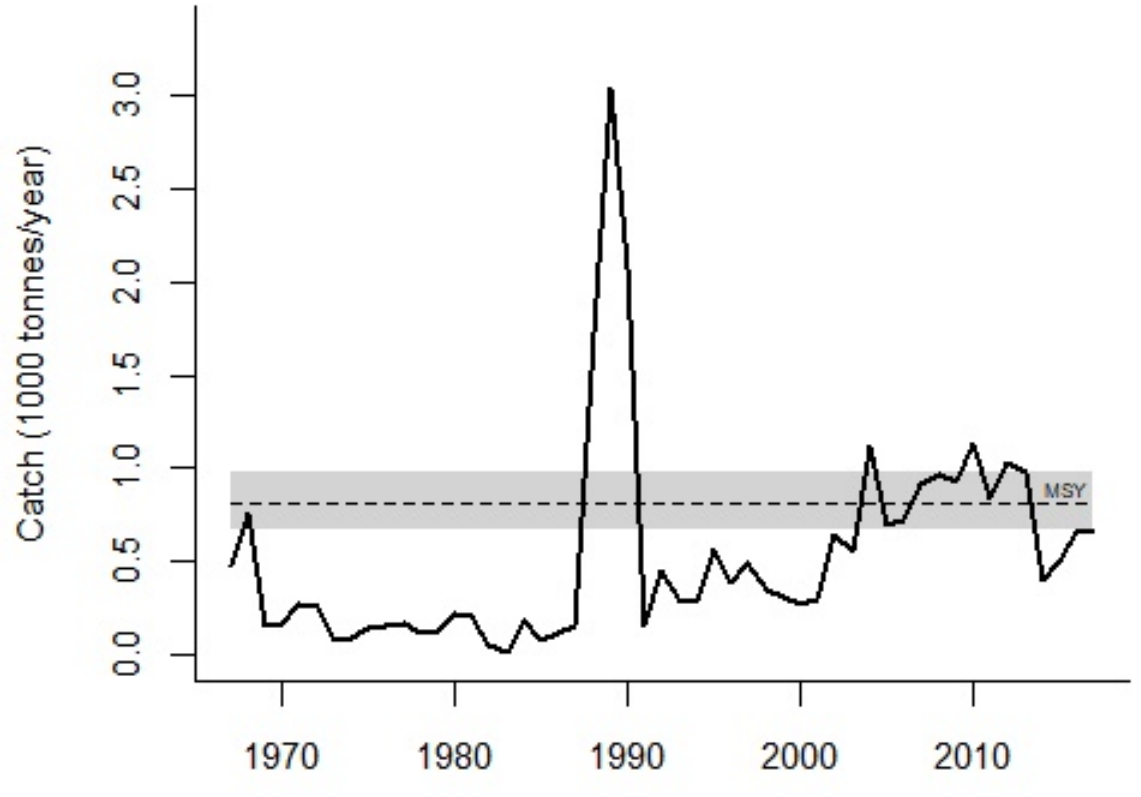

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
0.4
0.5
0.6
0.7
0.9
1.1
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

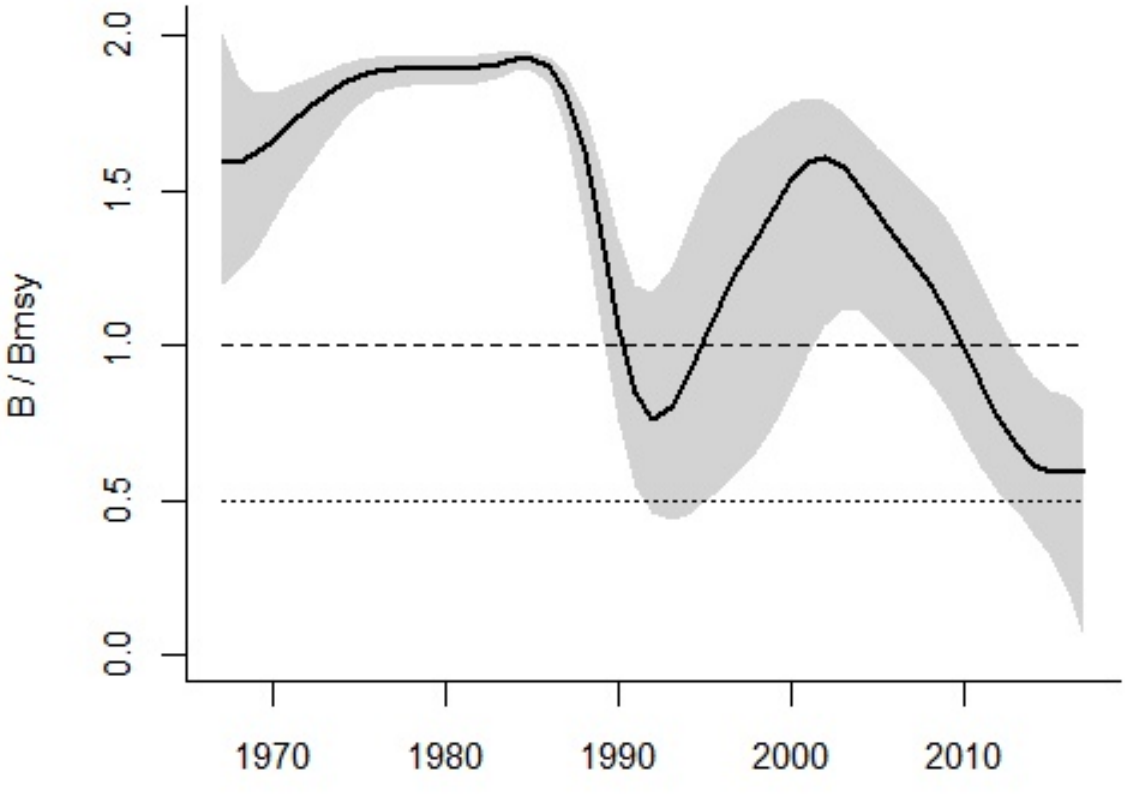

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

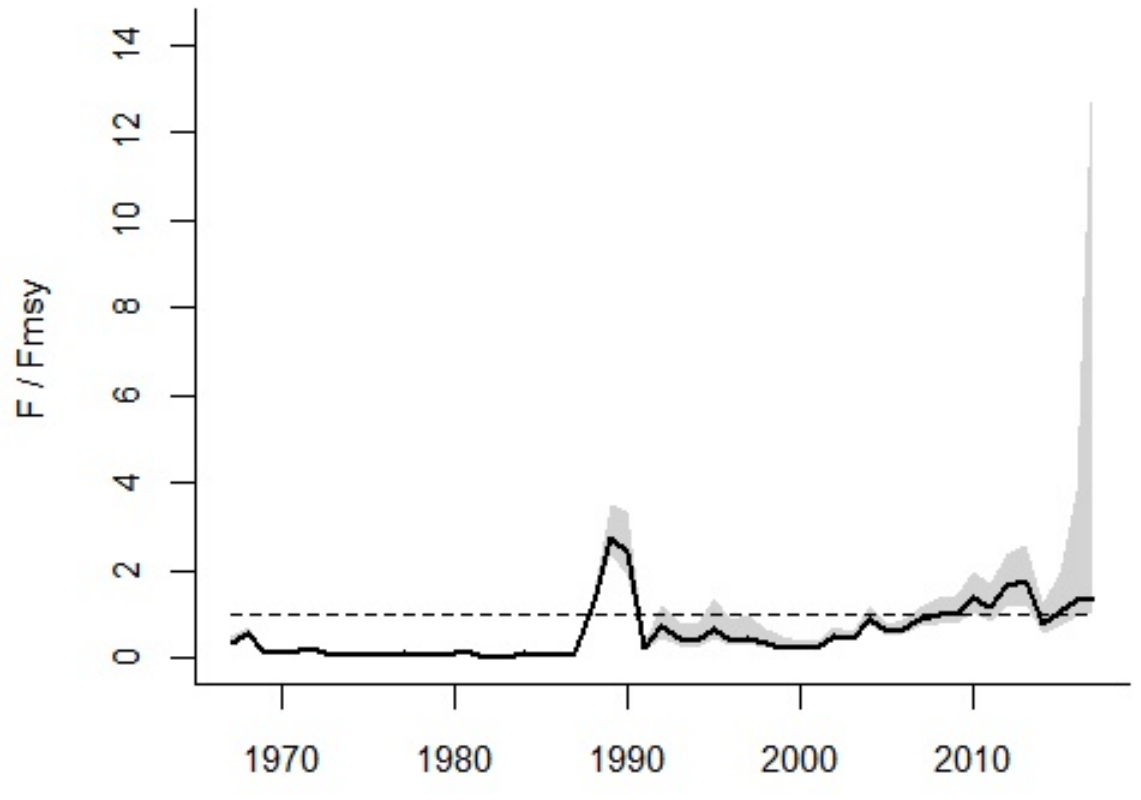
Catch

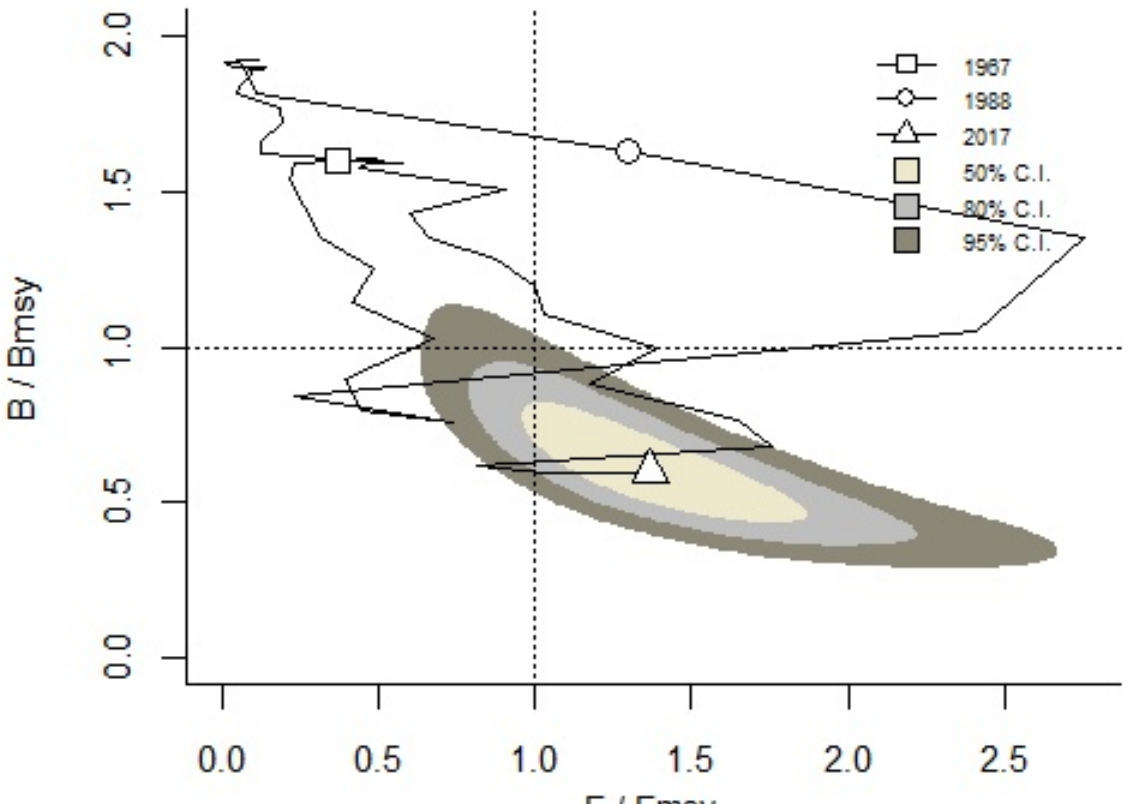


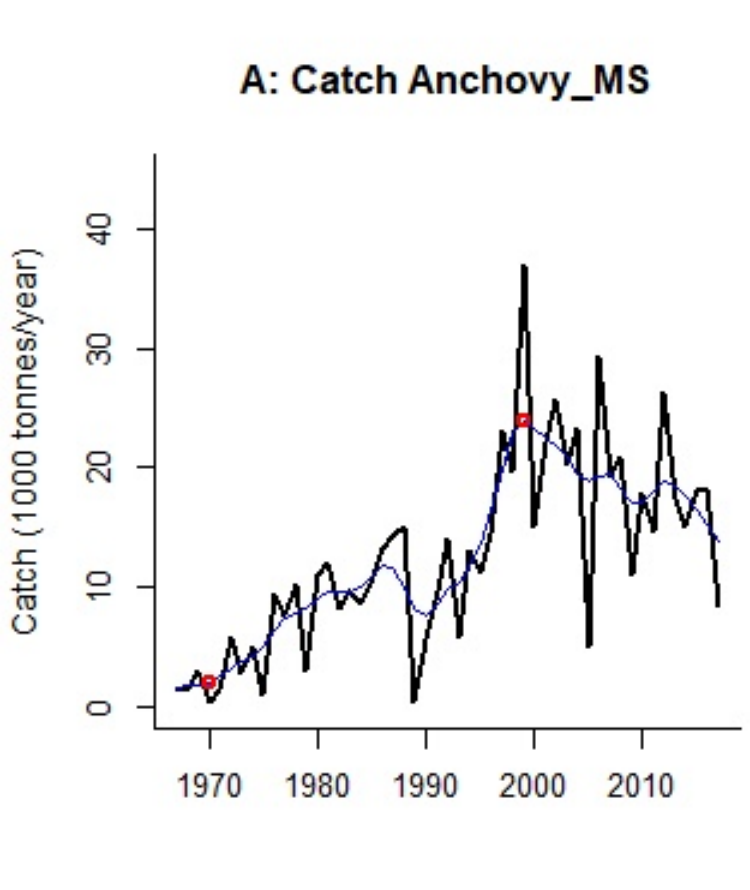
Stock size

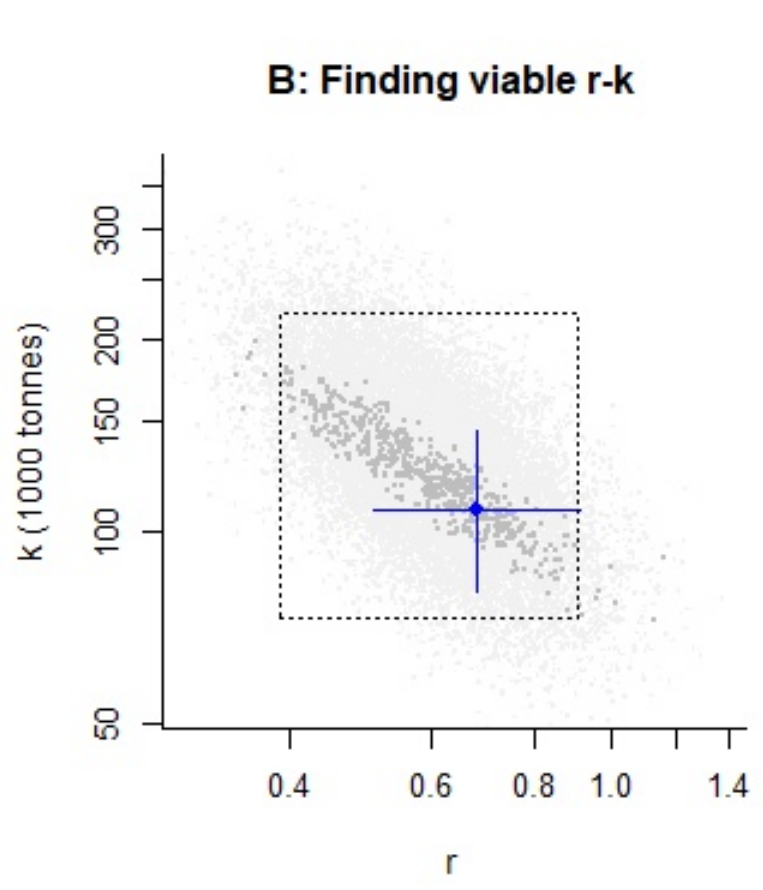


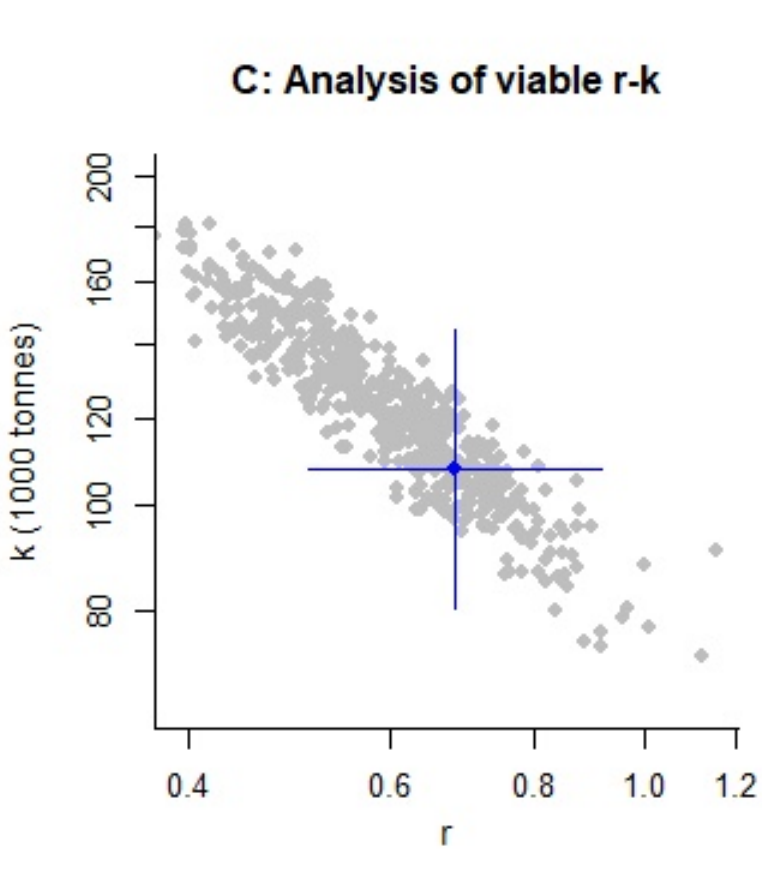
Exploitation

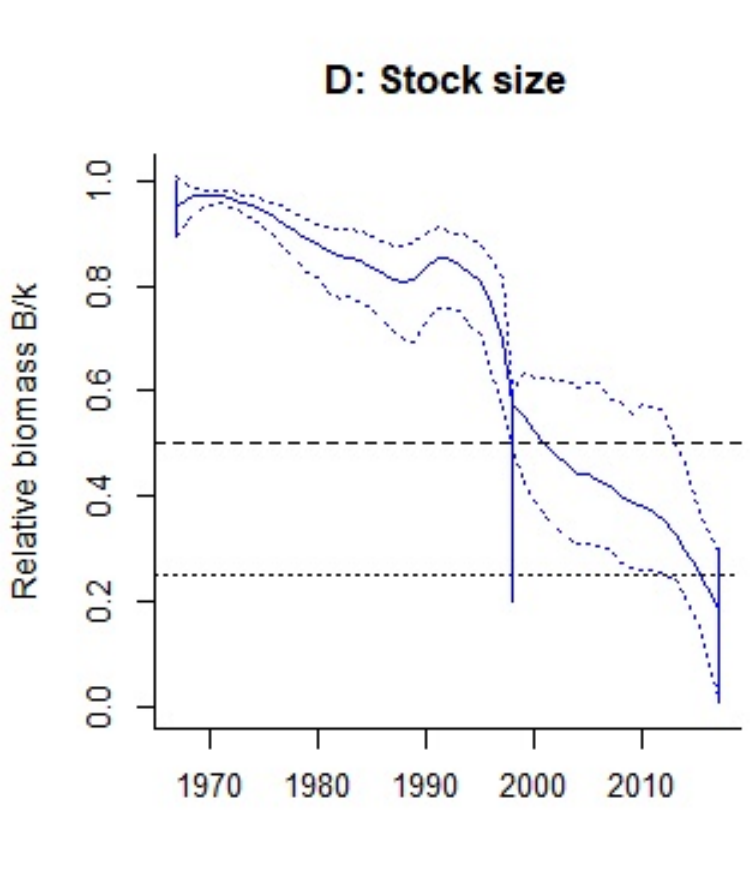


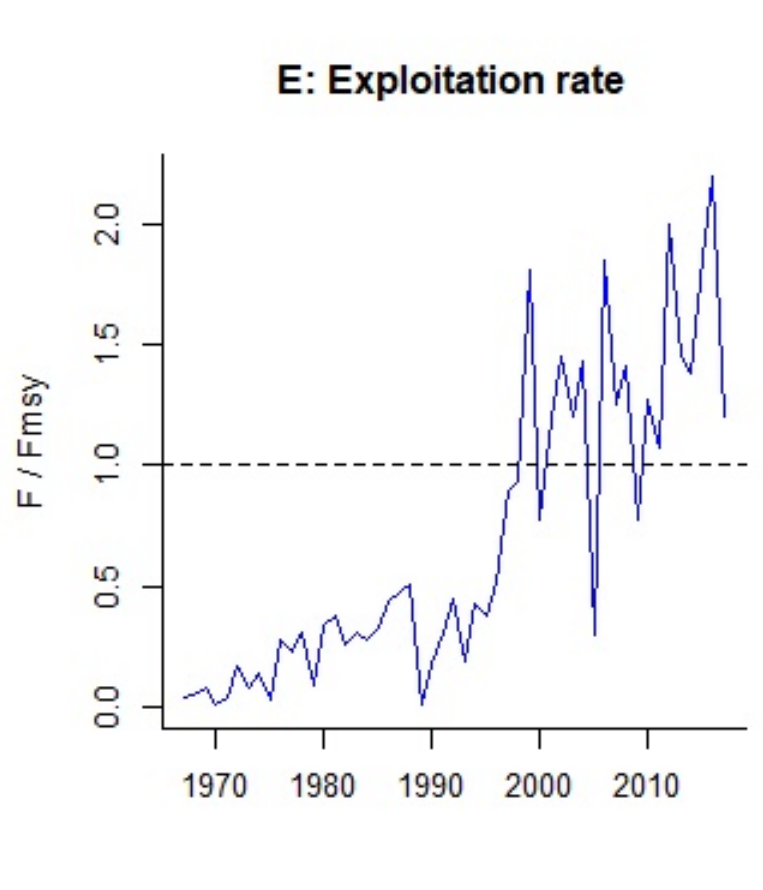


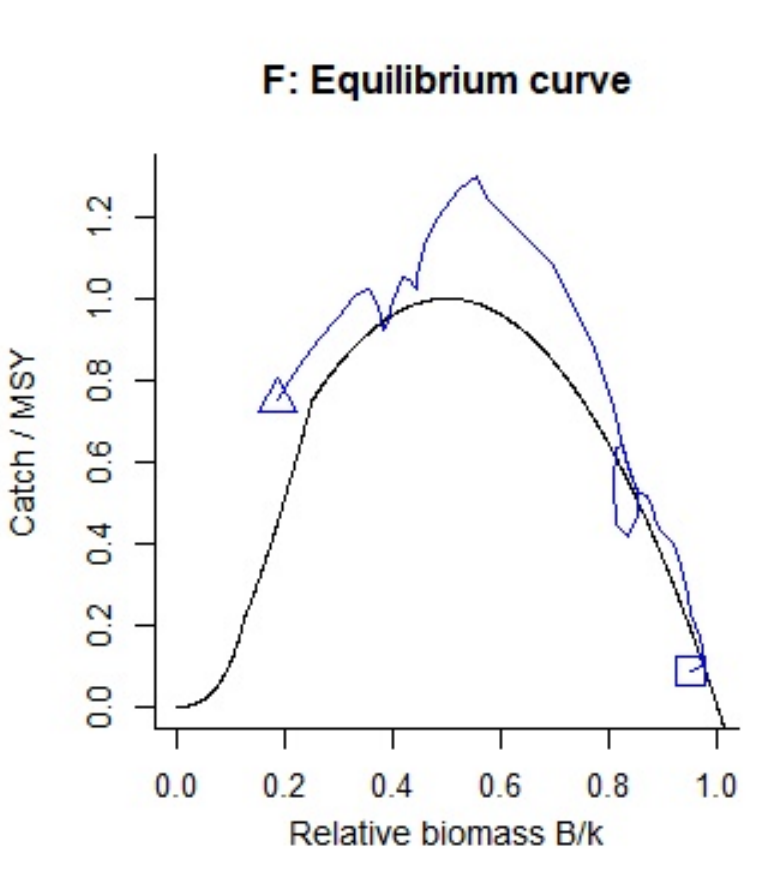

A: Catch Anchovy_MS
Catch (1000 tonnes/year)
0
10
20
30
40
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
300
0.4
0.6
0.8
1.0
1.4
r

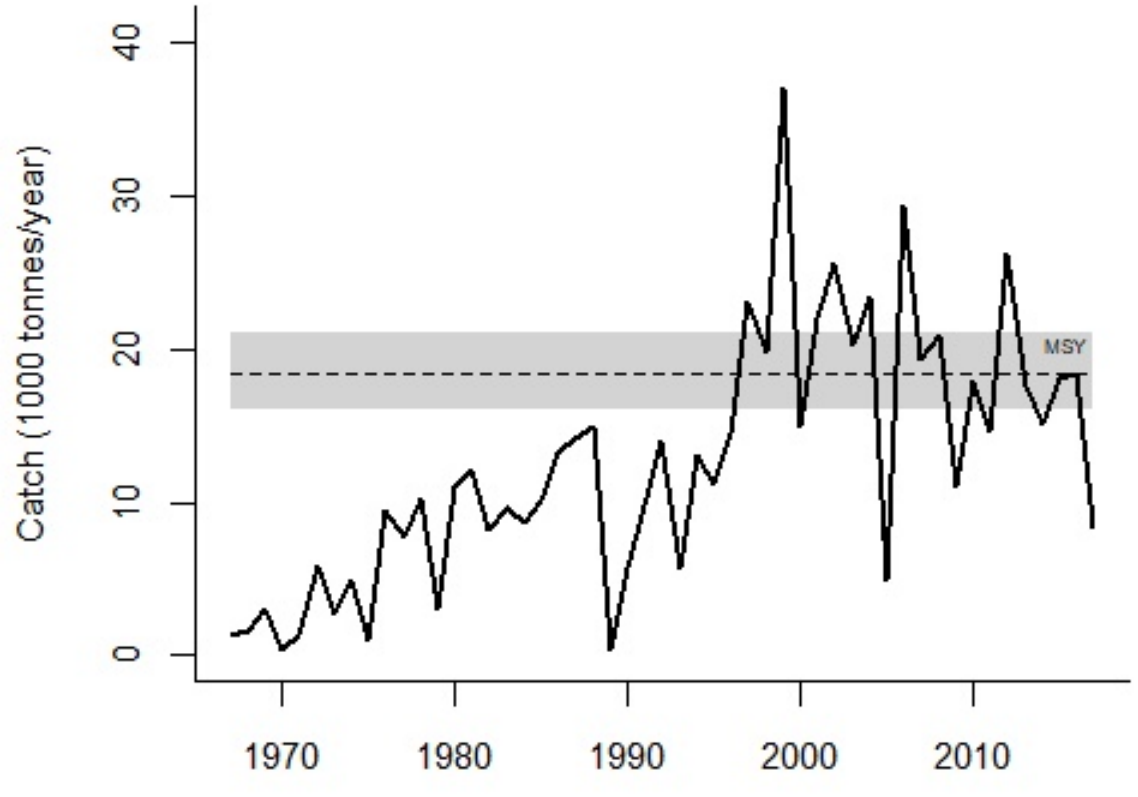

C: Analysis of viable r-k
k (1000 tonnes)
80
100
120
160
200
0.4
0.6
0.8
1.0
1.2
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

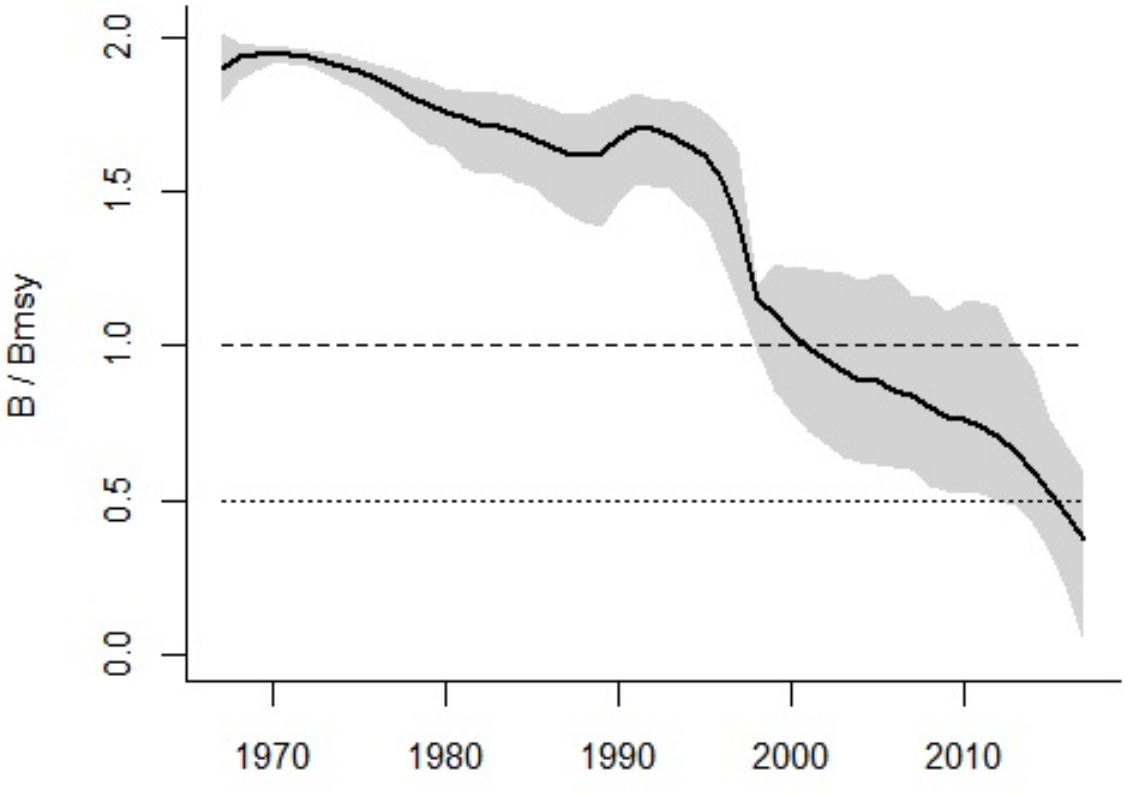

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

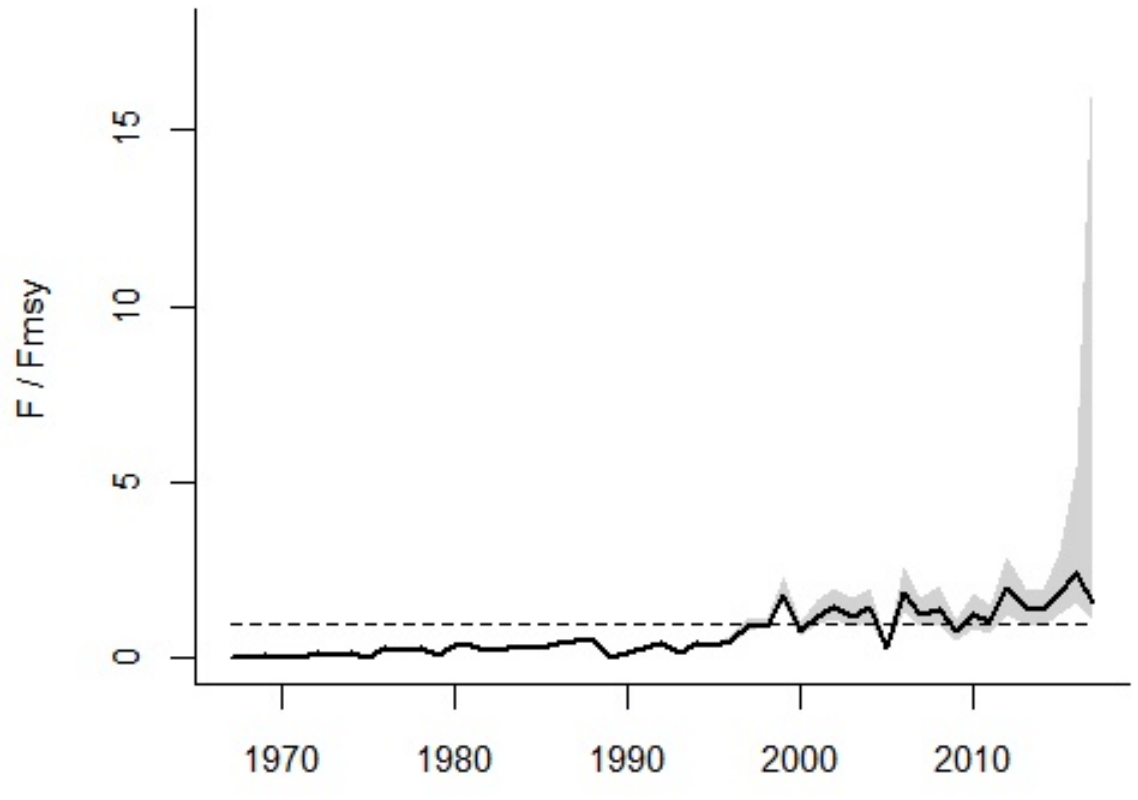
Catch

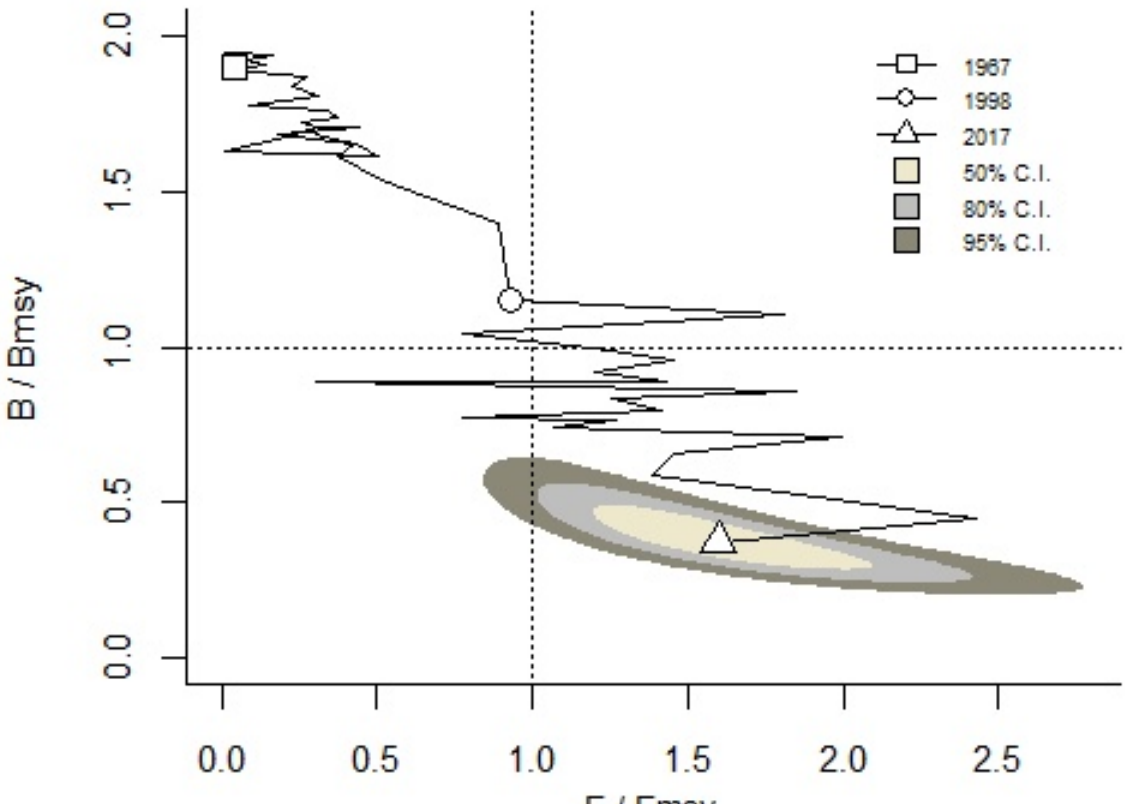


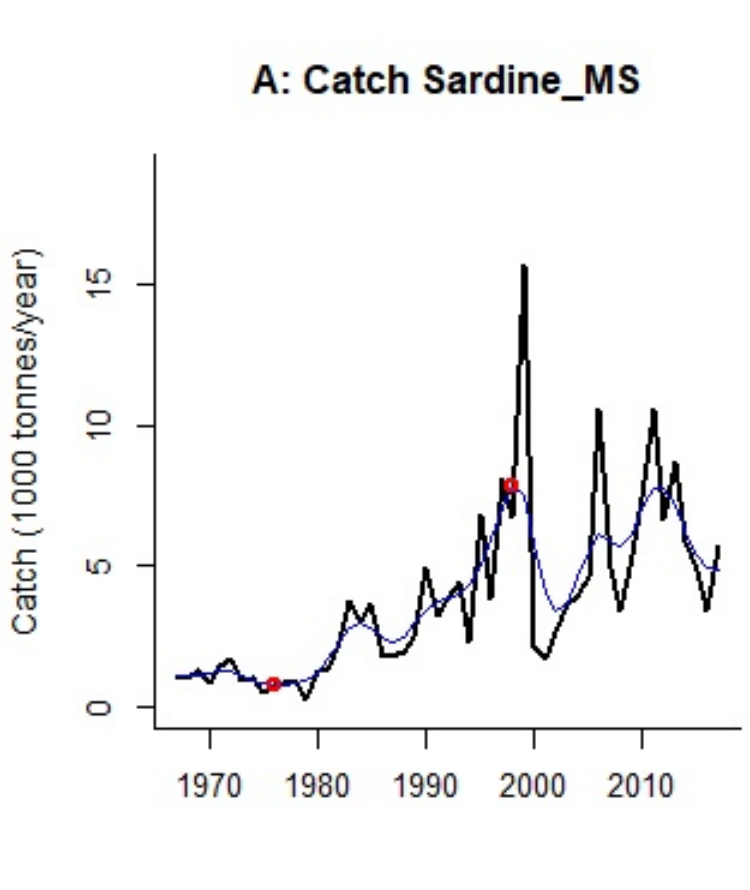
Stock size

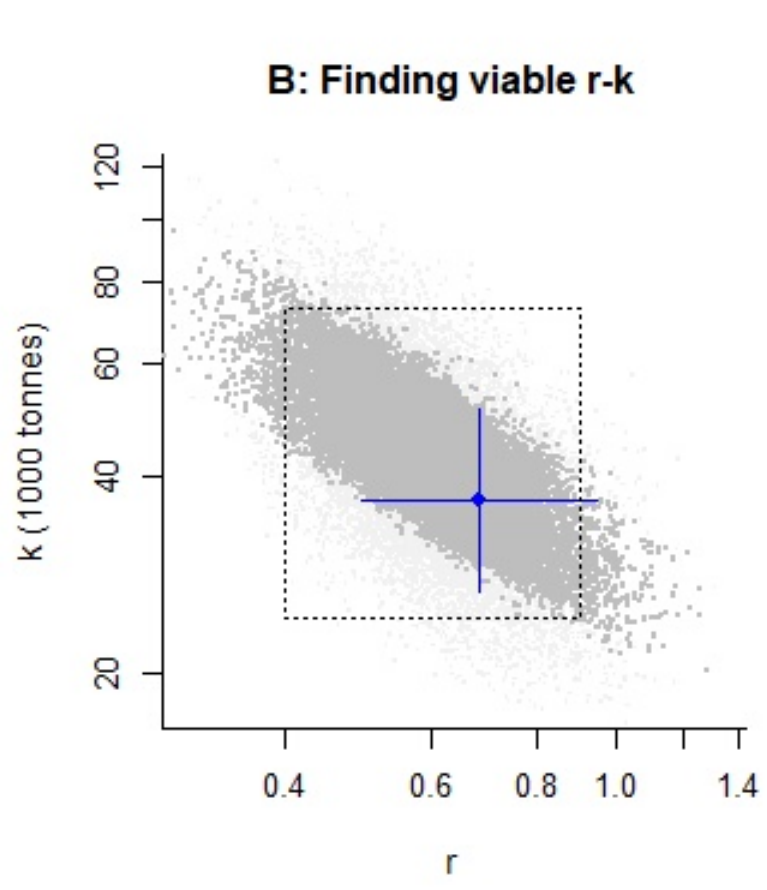


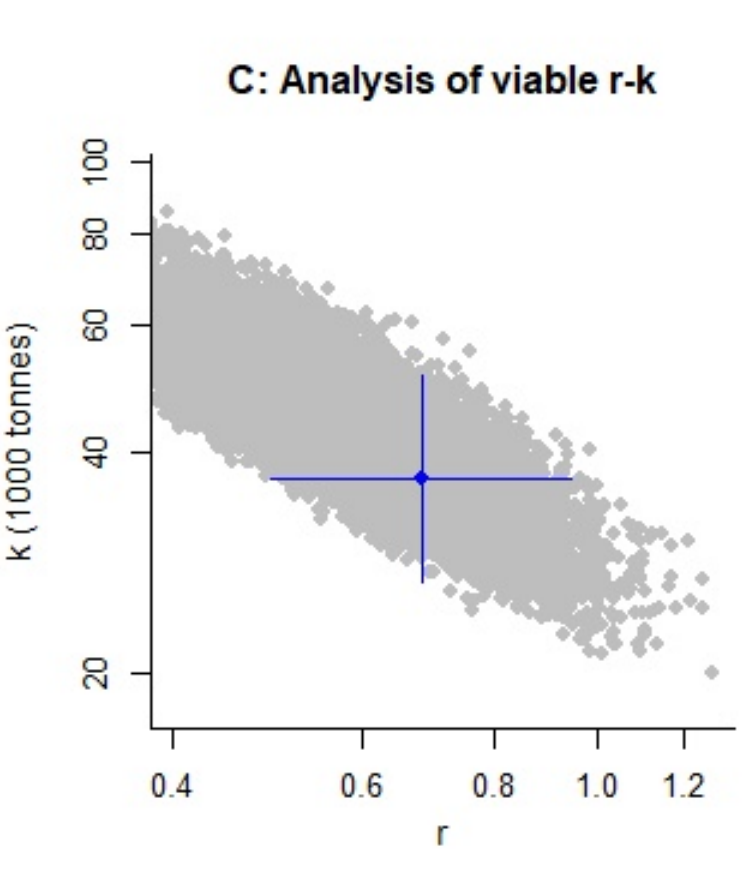
Exploitation

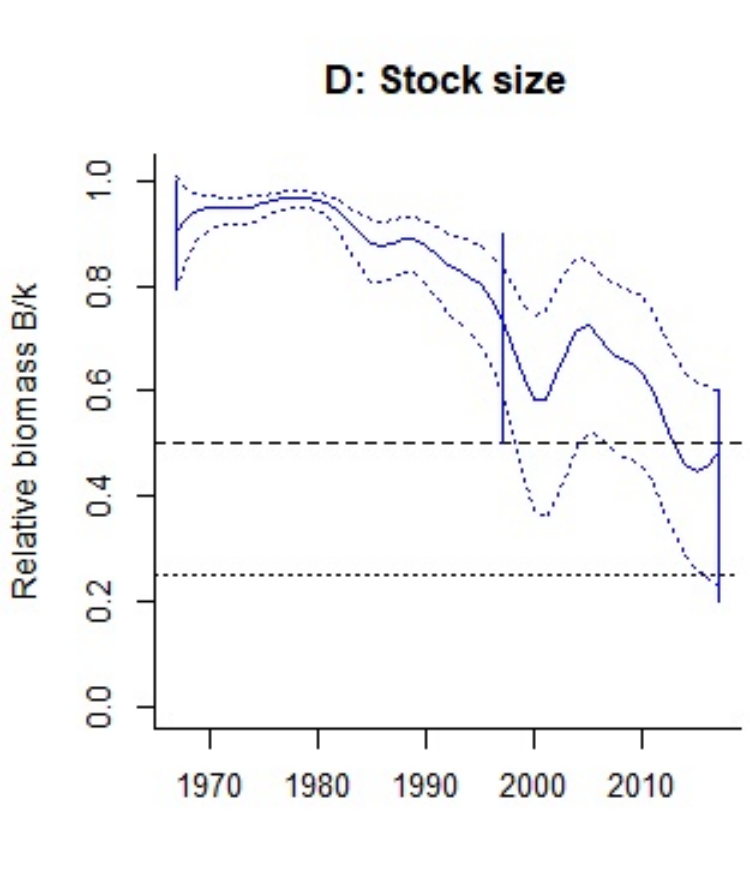


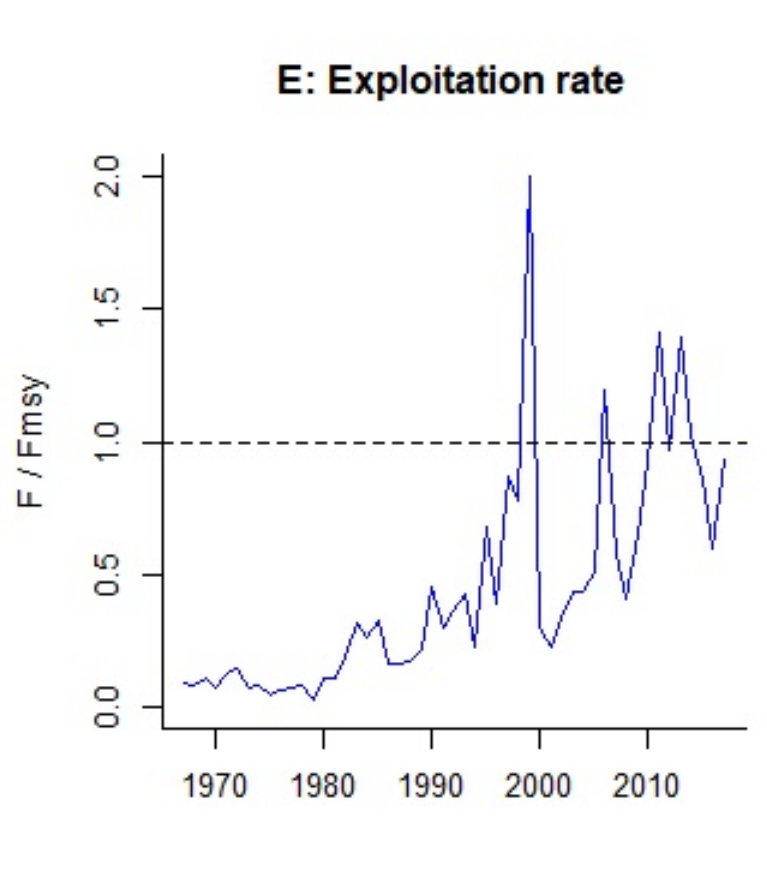


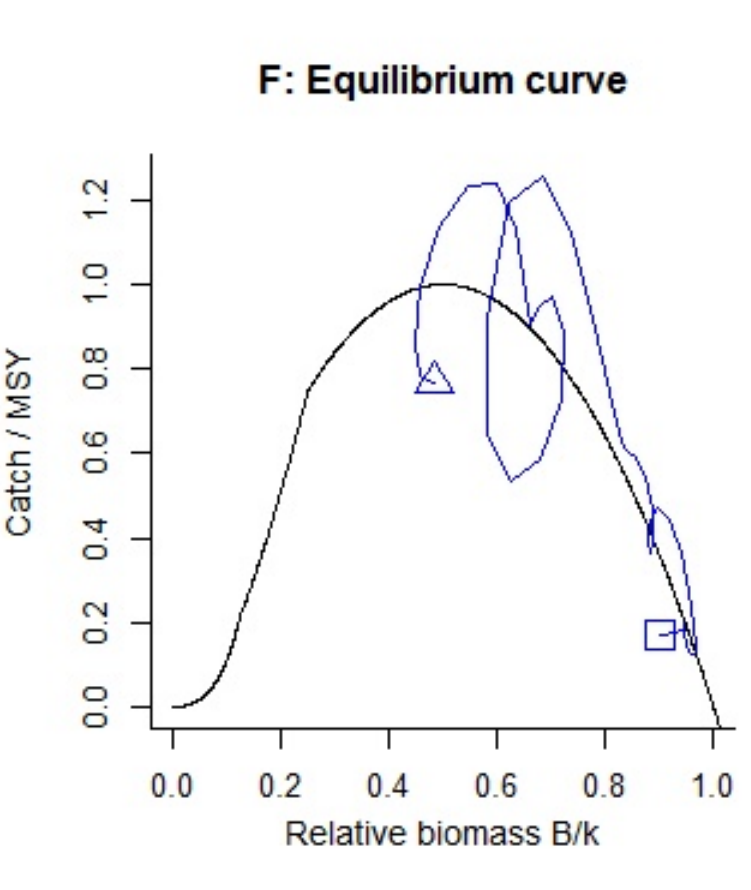

A: Catch Sardine_MS
Catch (1000 tonnes/year)
0
5
10
15
1970
1980
1990
2000
2010

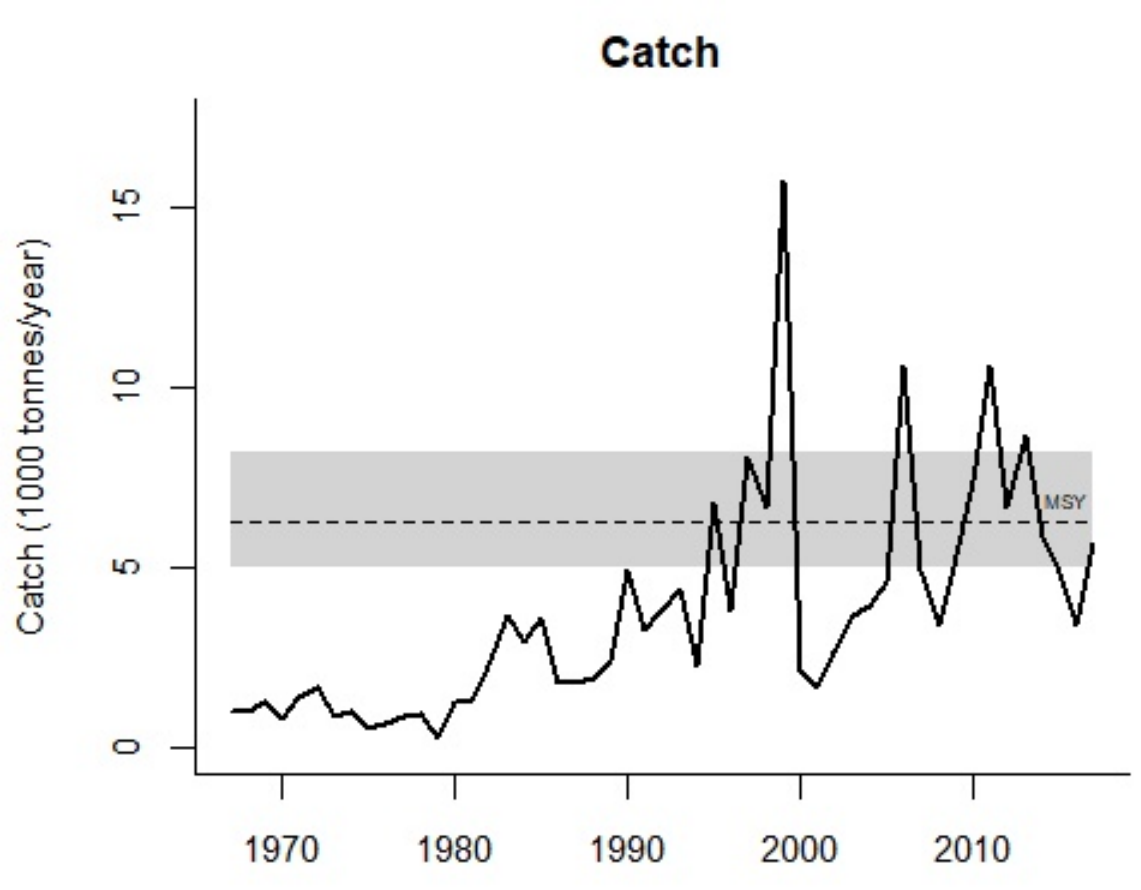

B: Finding viable r-k
k (1000 tonnes)
20
40
60
80
120
0.4
0.6
0.8
1.0
1.4
r

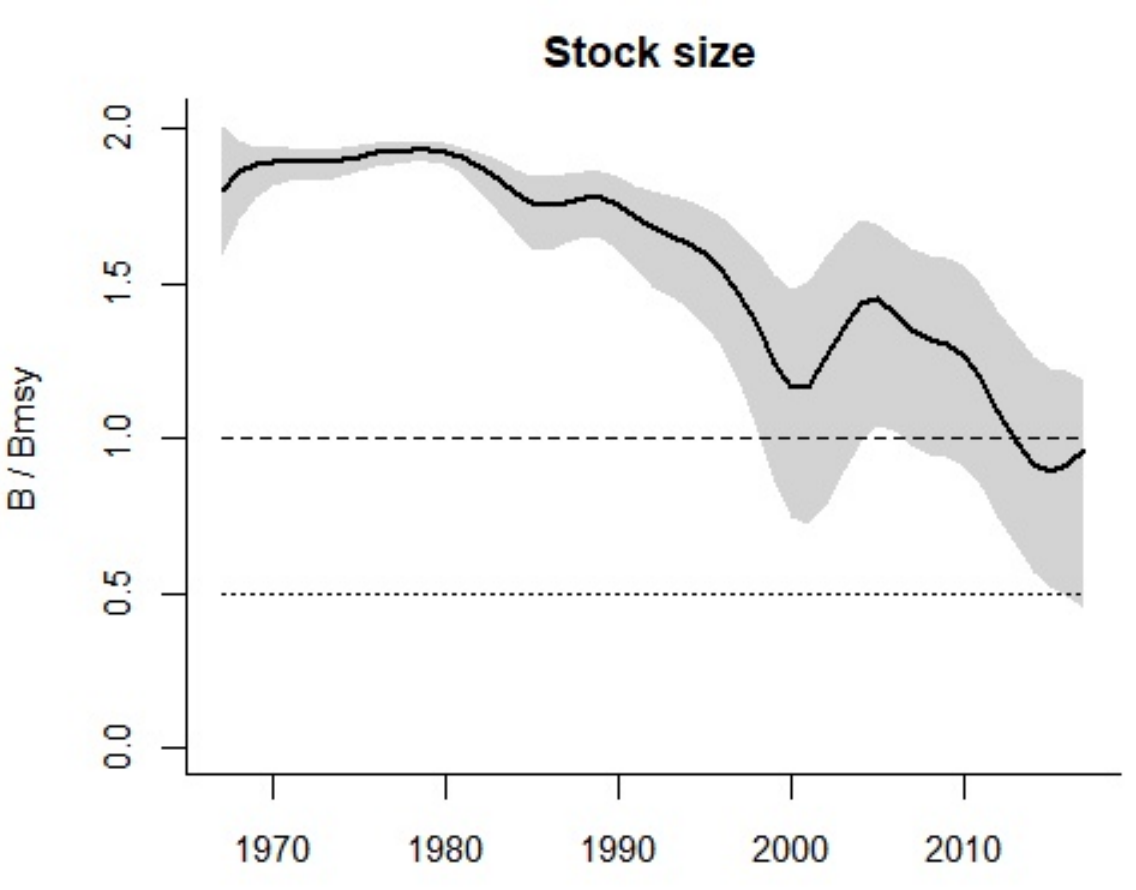

C: Analysis of viable r-k
k (1000 tonnes)
20
40
60
80
100
0.4
0.6
0.8
1.0
1.2
r

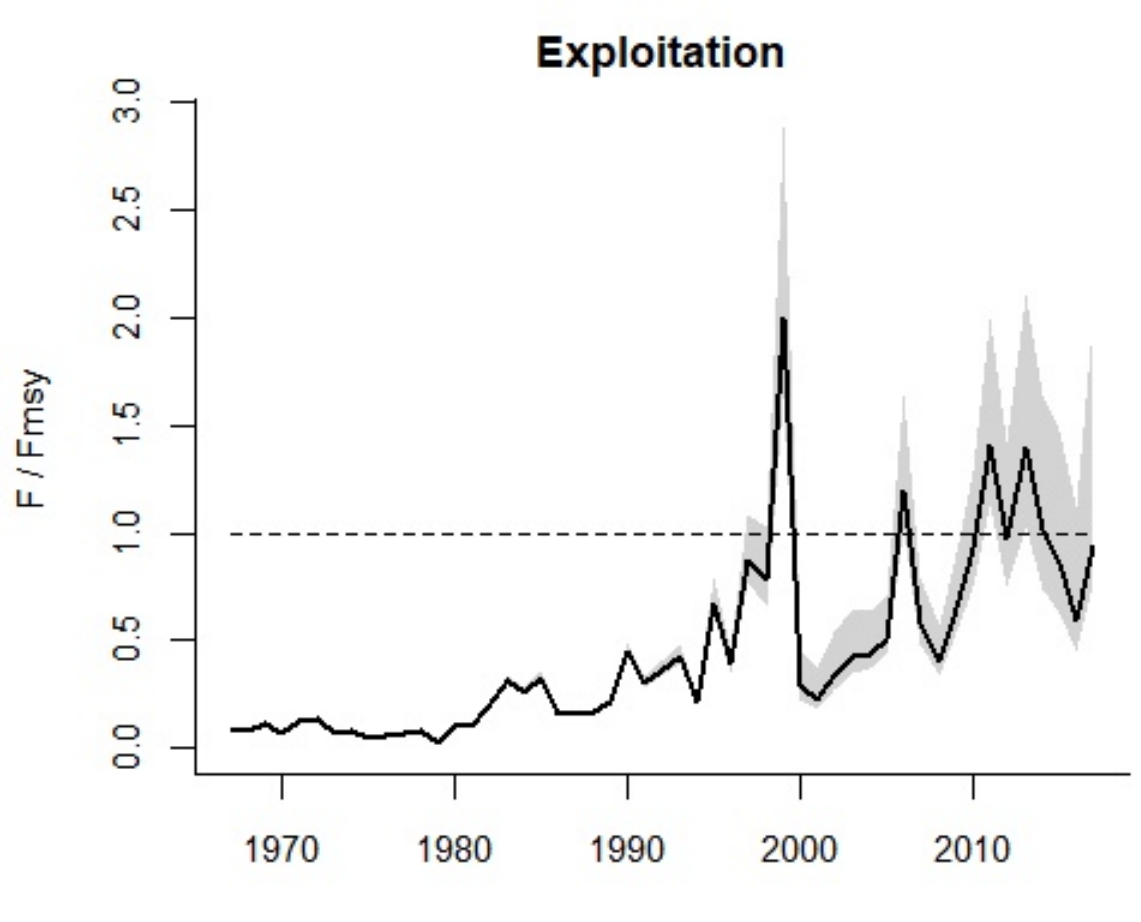

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

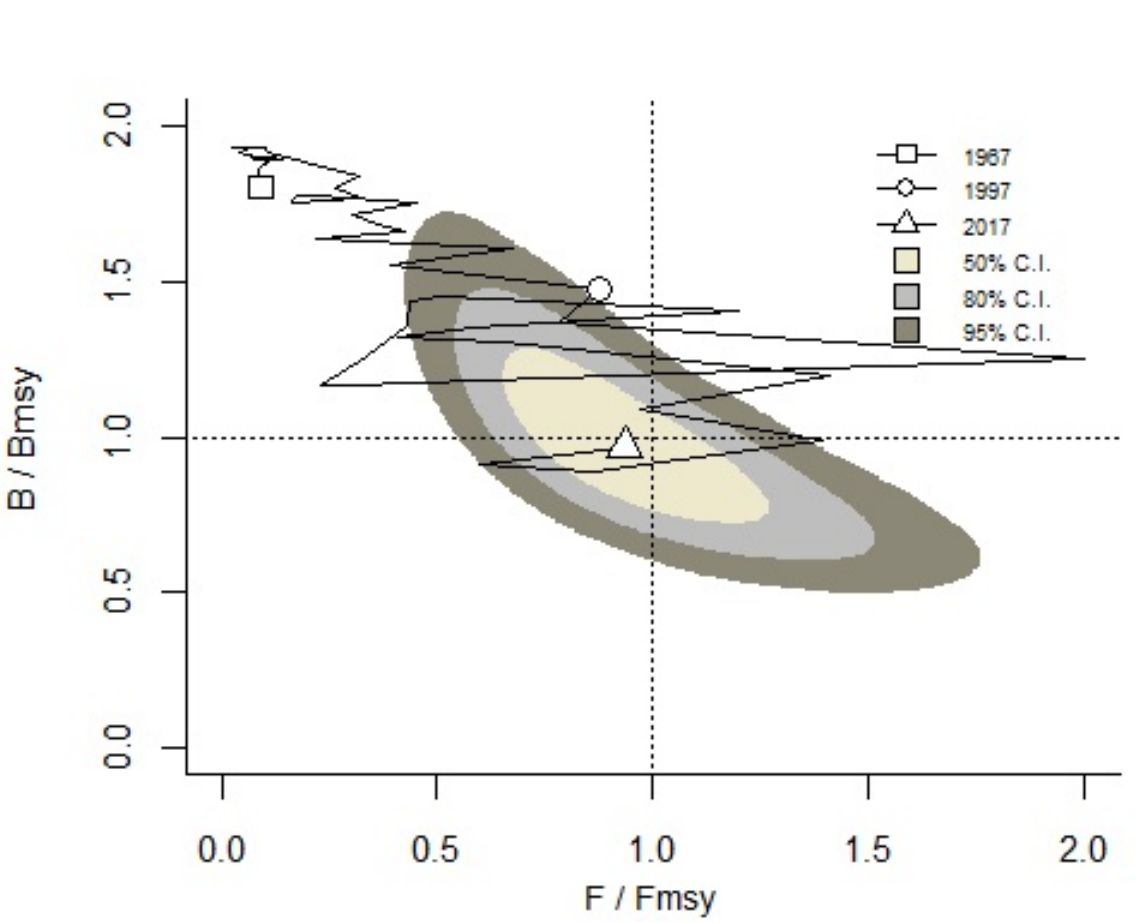

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

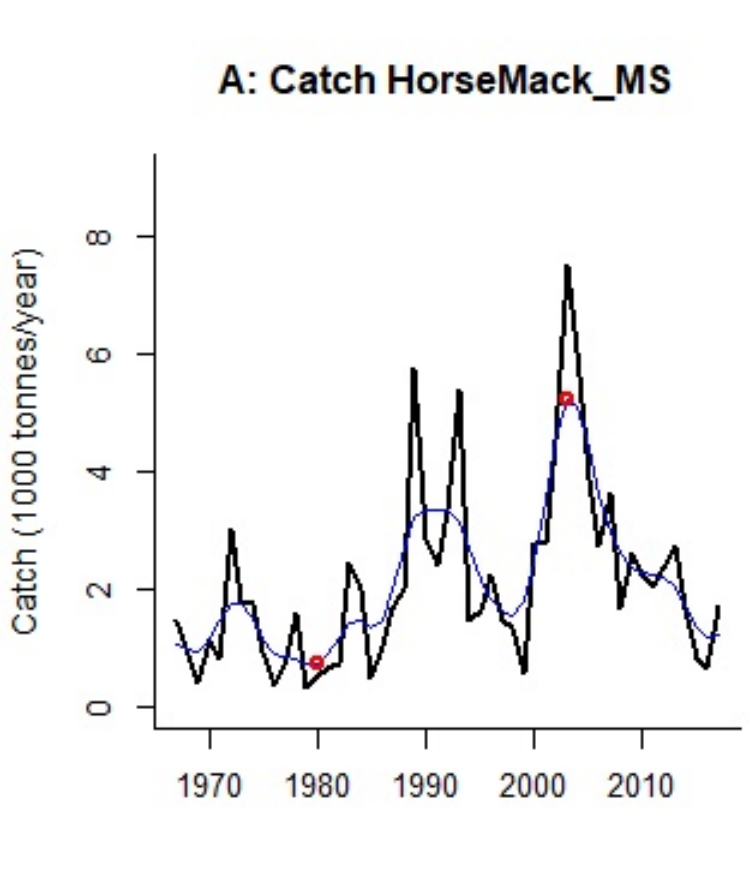

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

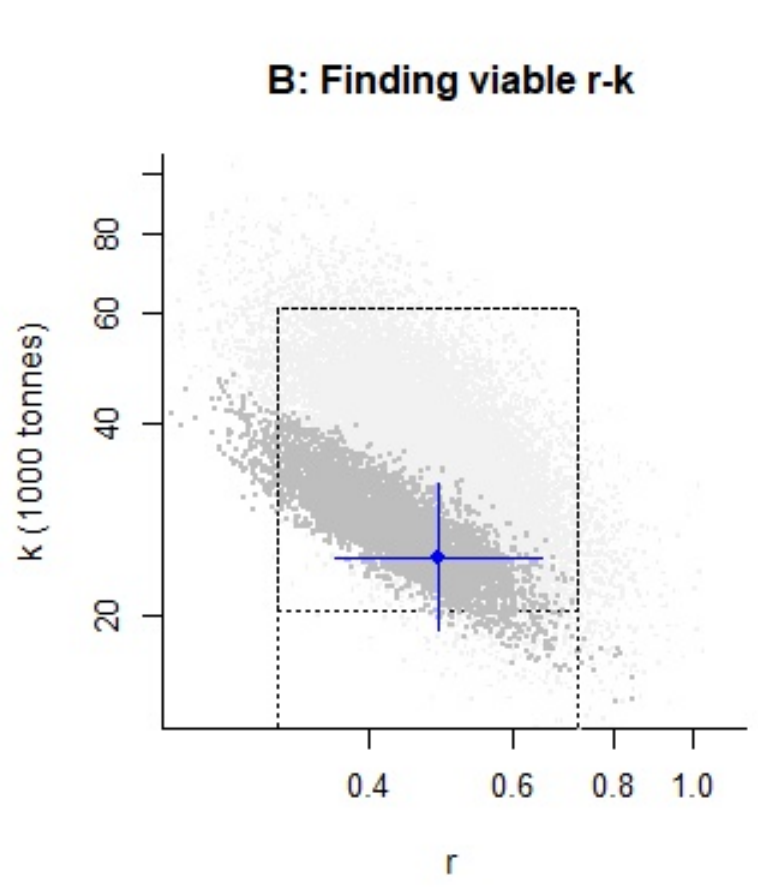

Catch
Catch (1000 tonnes/year)
0
5
10
15
MSY
1970
1980
1990
2000
2010

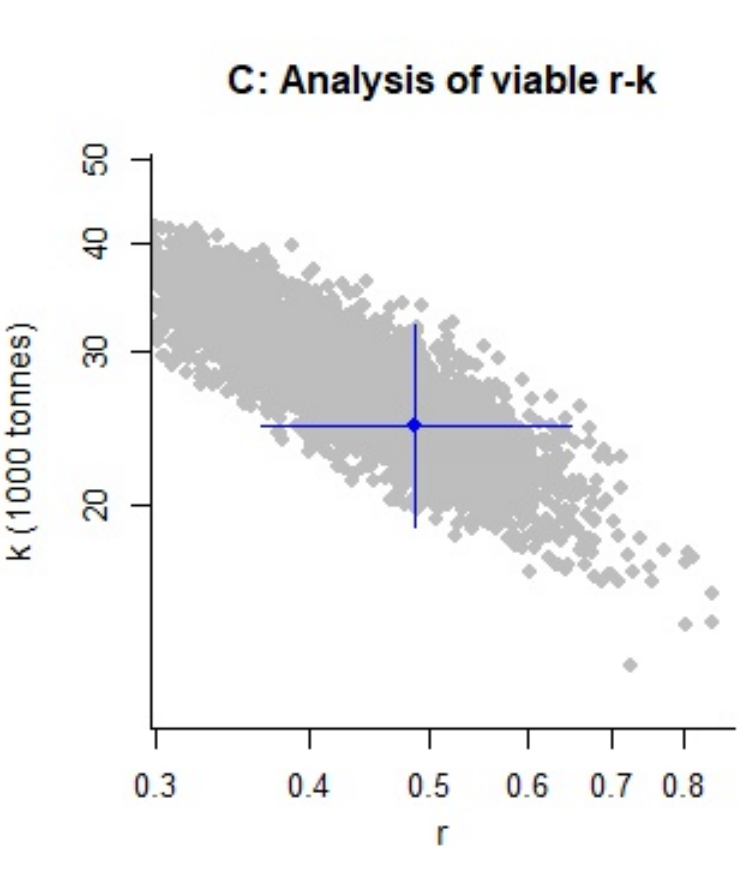

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

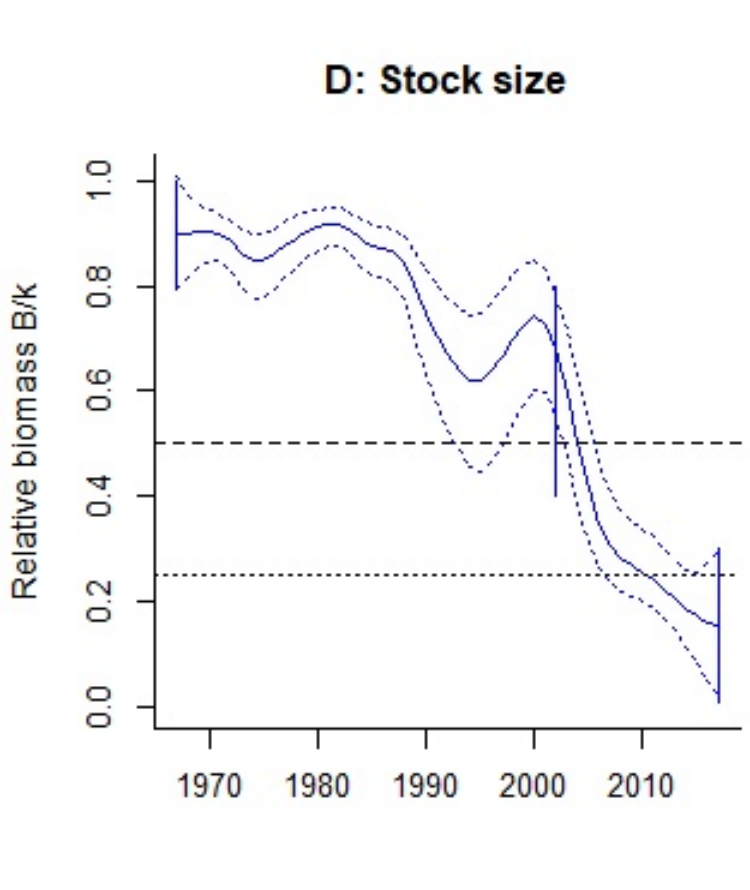

Exploitation
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010

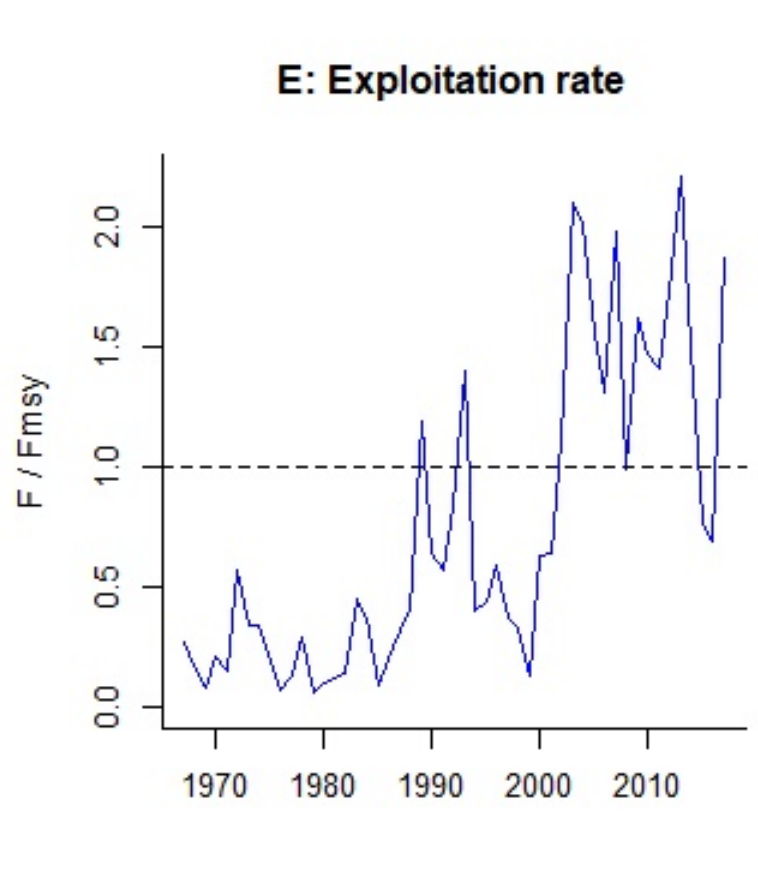

B / Bmsy
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1967
1997
2017
50% C.I.
80% C.I.
95% C.I.

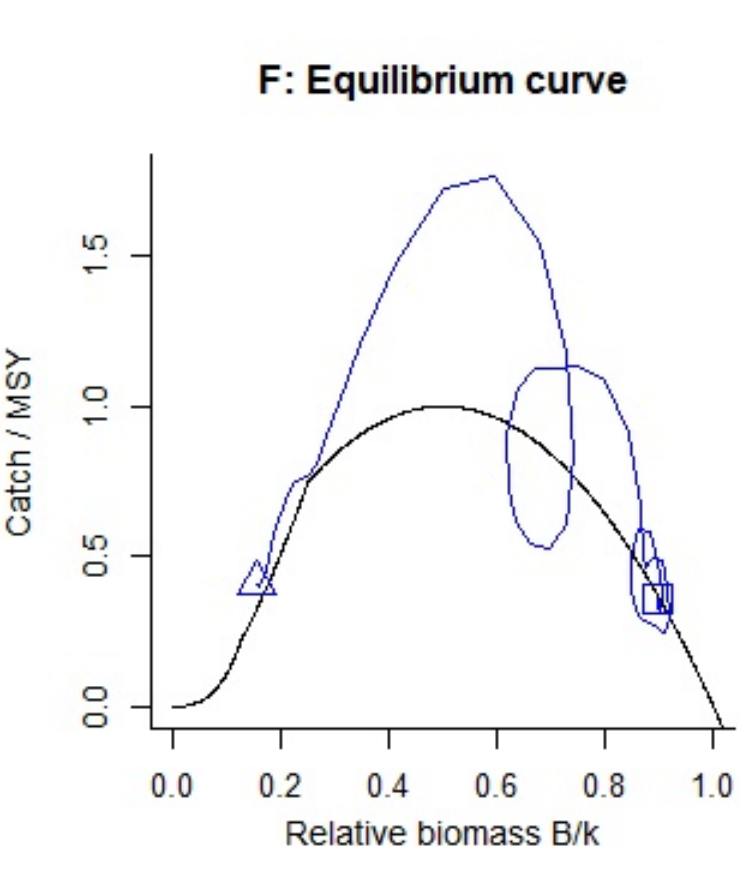

A: Catch HorseMack_MS
Catch (1000 tonnes/year)
0
2
4
6
8
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
20
40
60
80
0.4
0.6
0.8
1.0
r

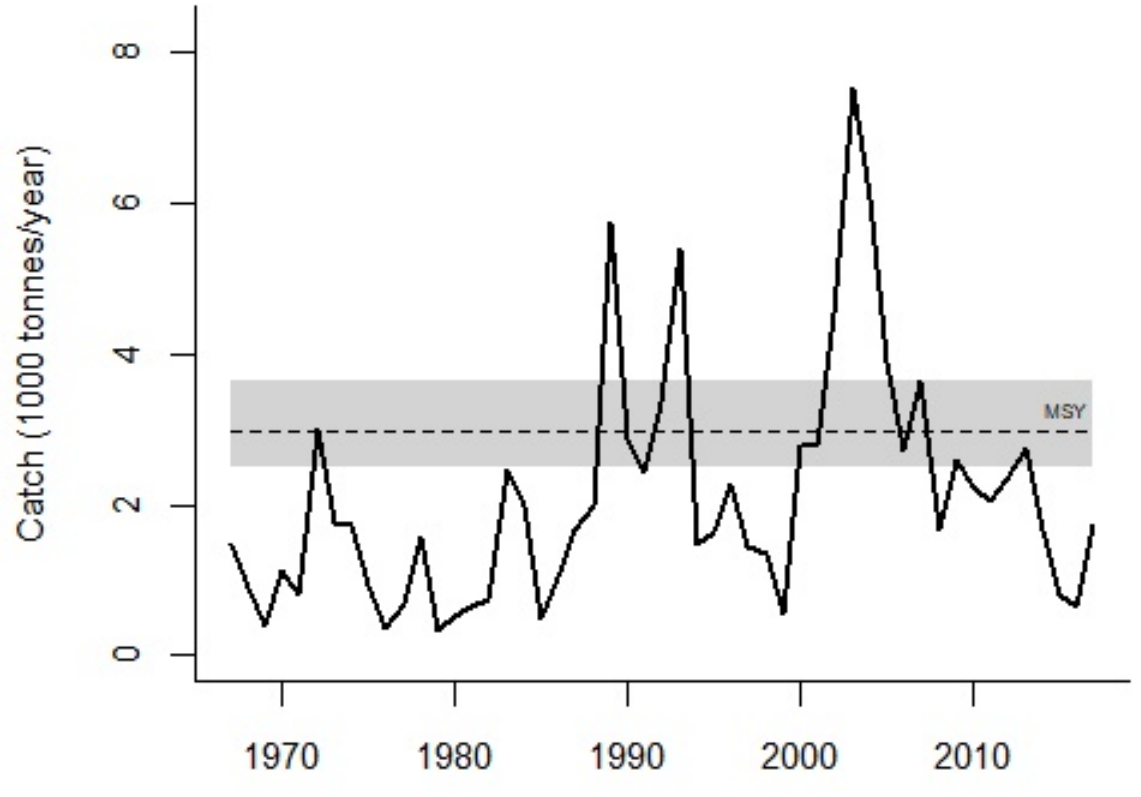

C: Analysis of viable r-k
k (1000 tonnes)
20
30
40
50
0.3
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

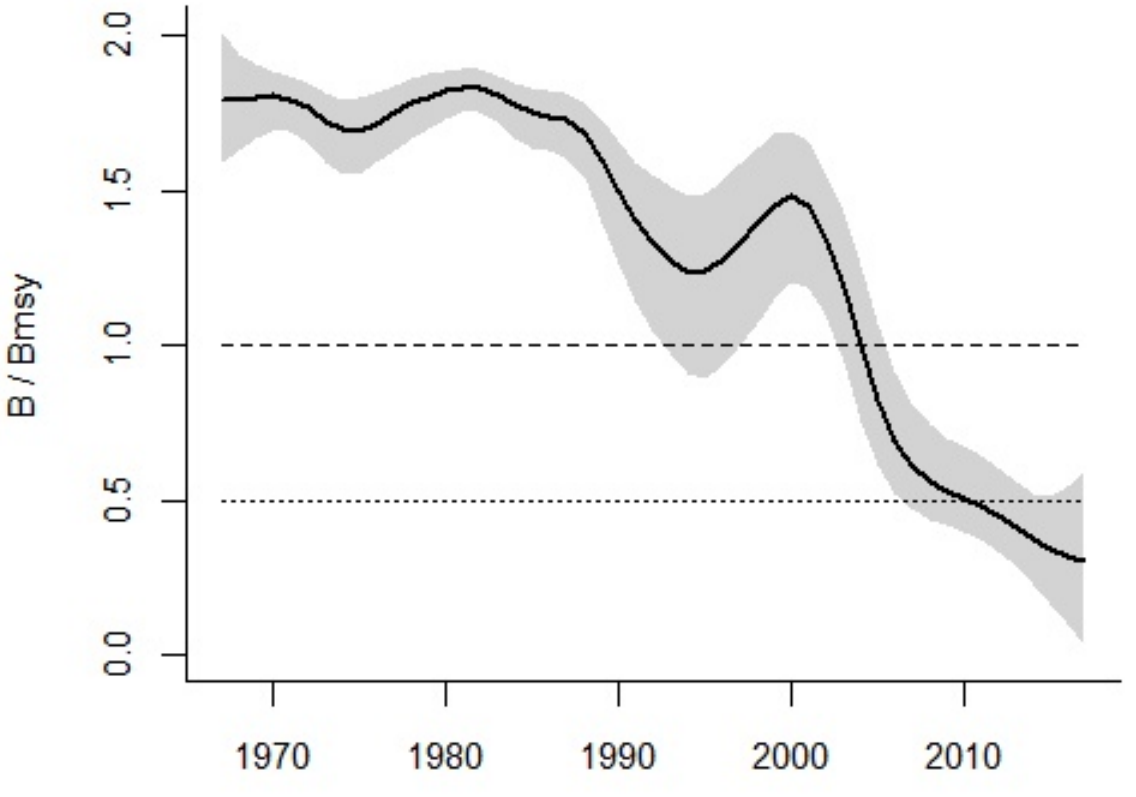

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

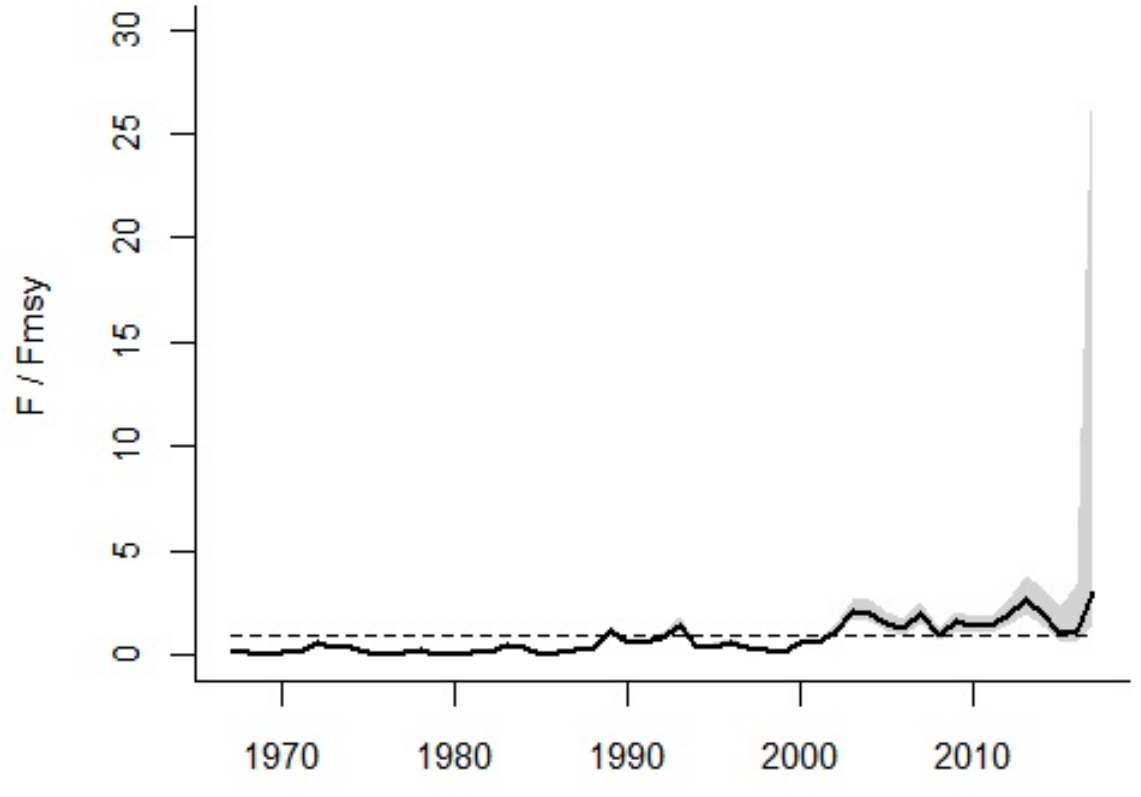
Catch

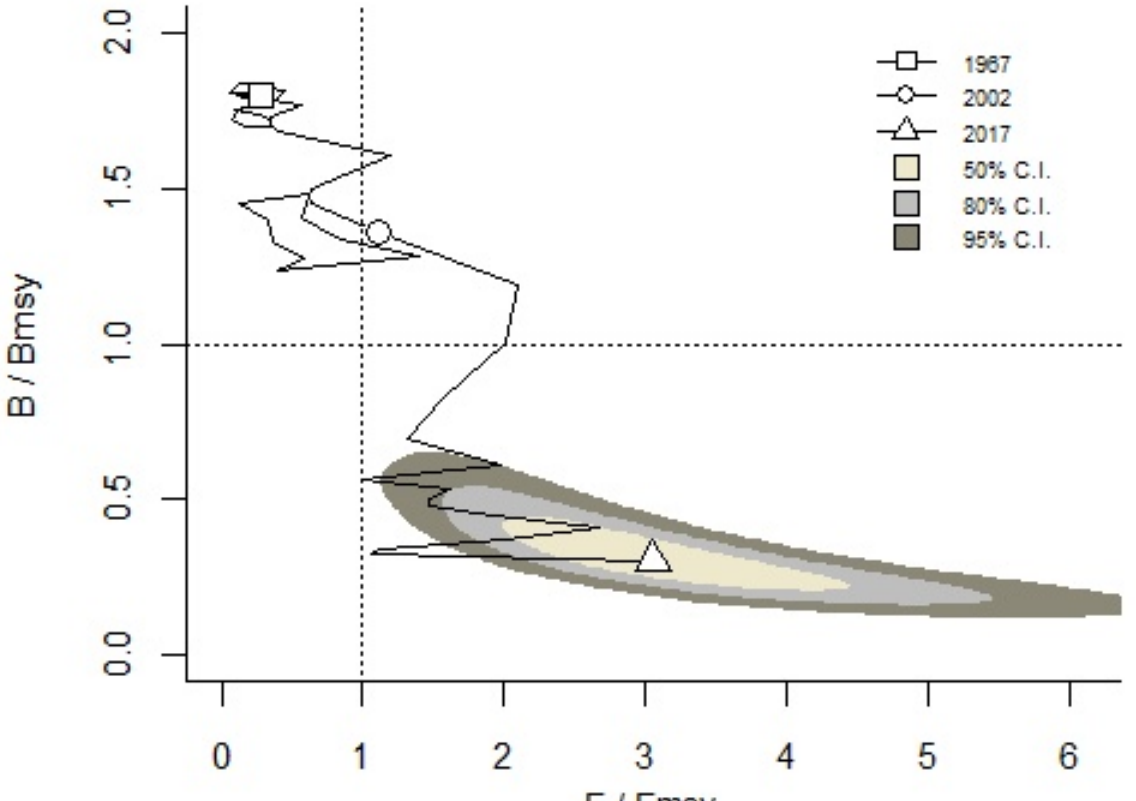


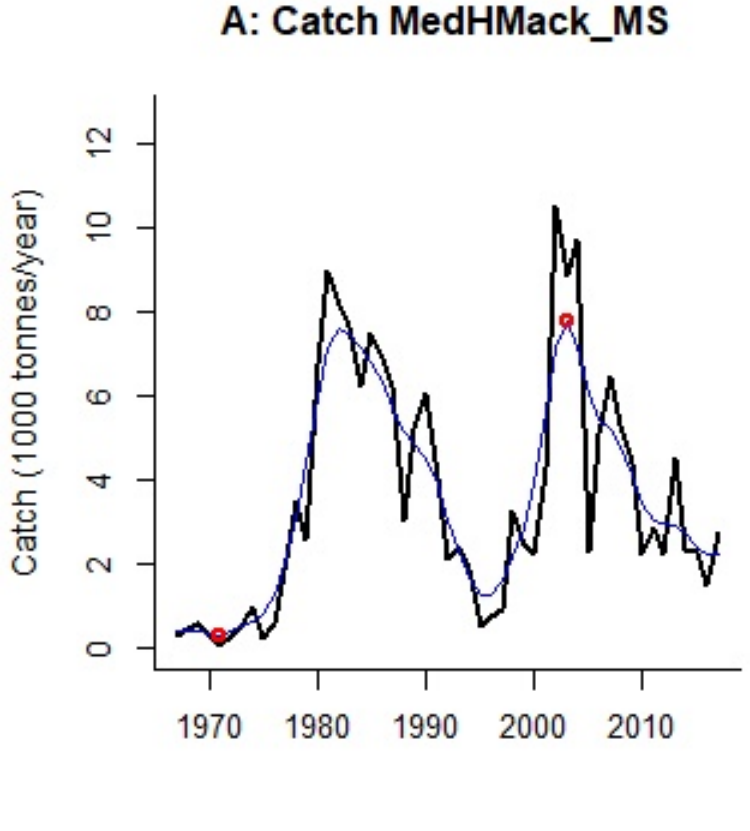
Stock size

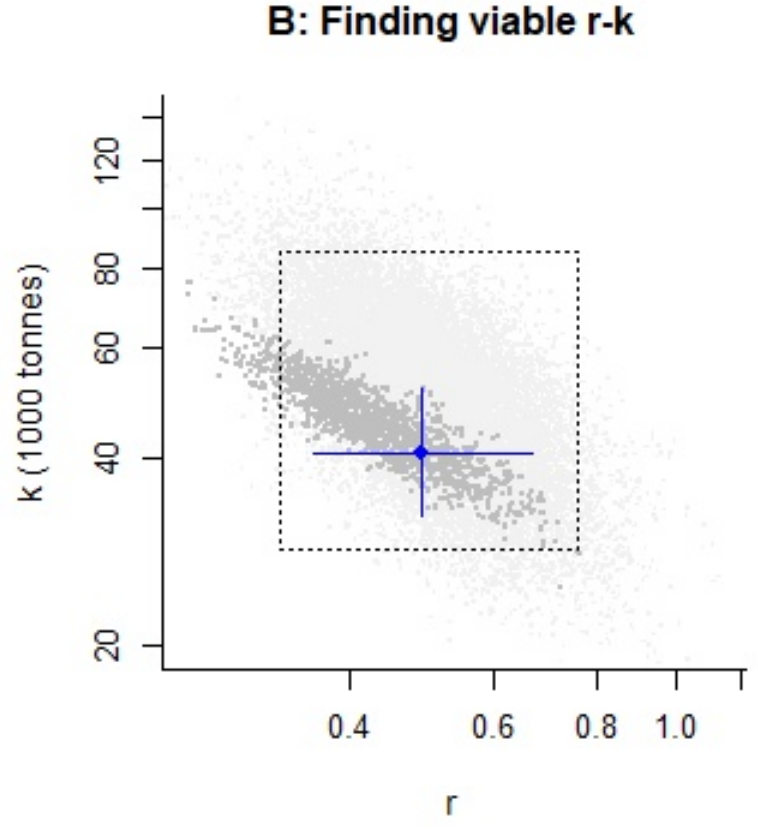


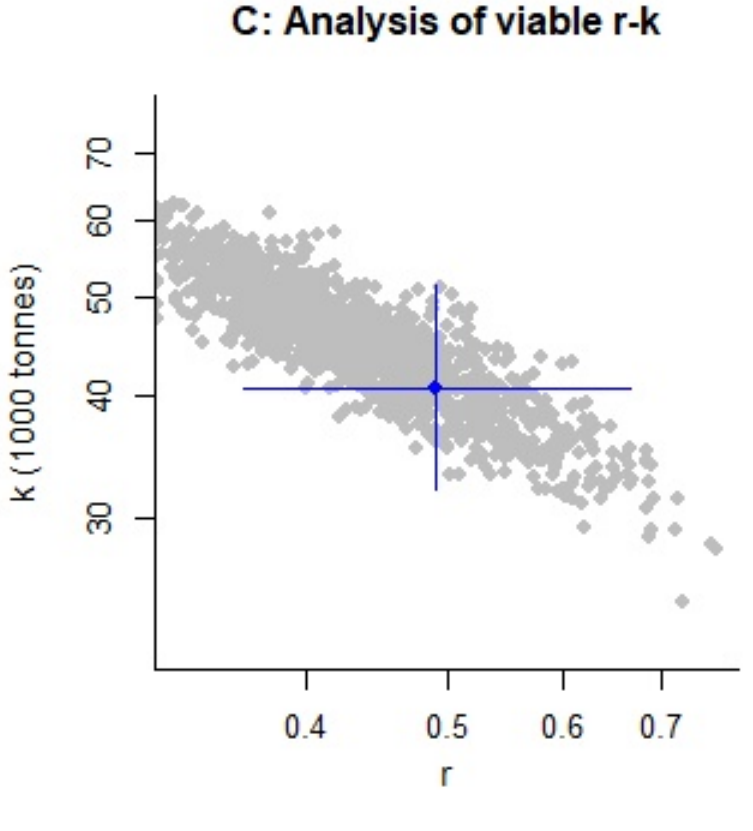
Exploitation

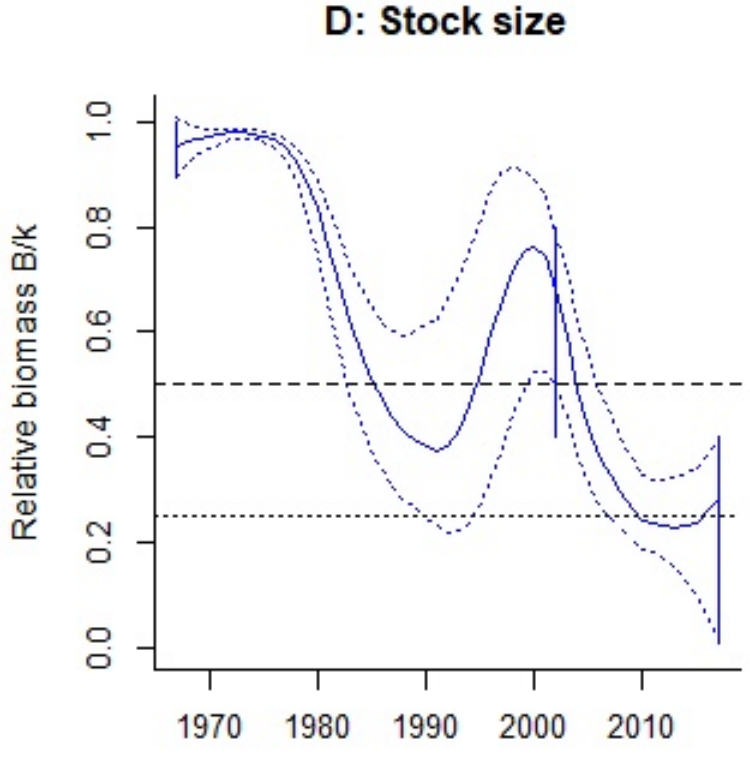


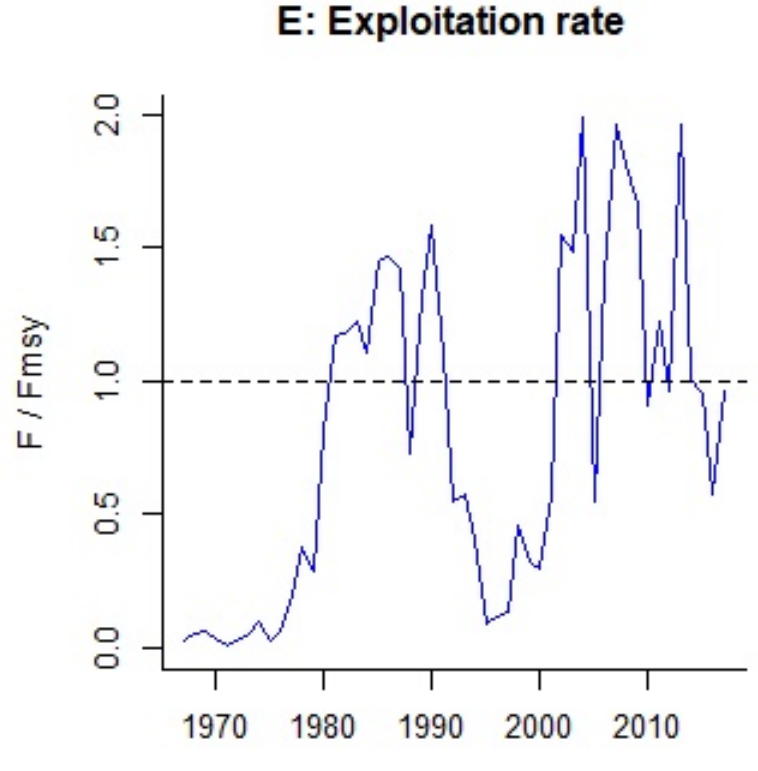


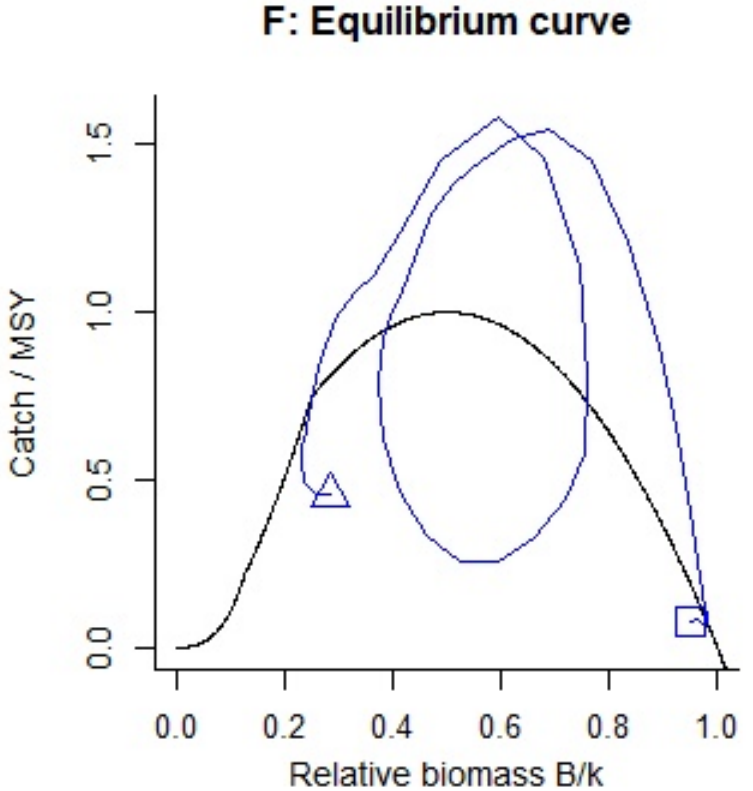

A: Catch MedHMack_MS
Catch (1000 tonnes/year)
0
2
4
6
8
10
12
1970
1980
1990
2000
2010

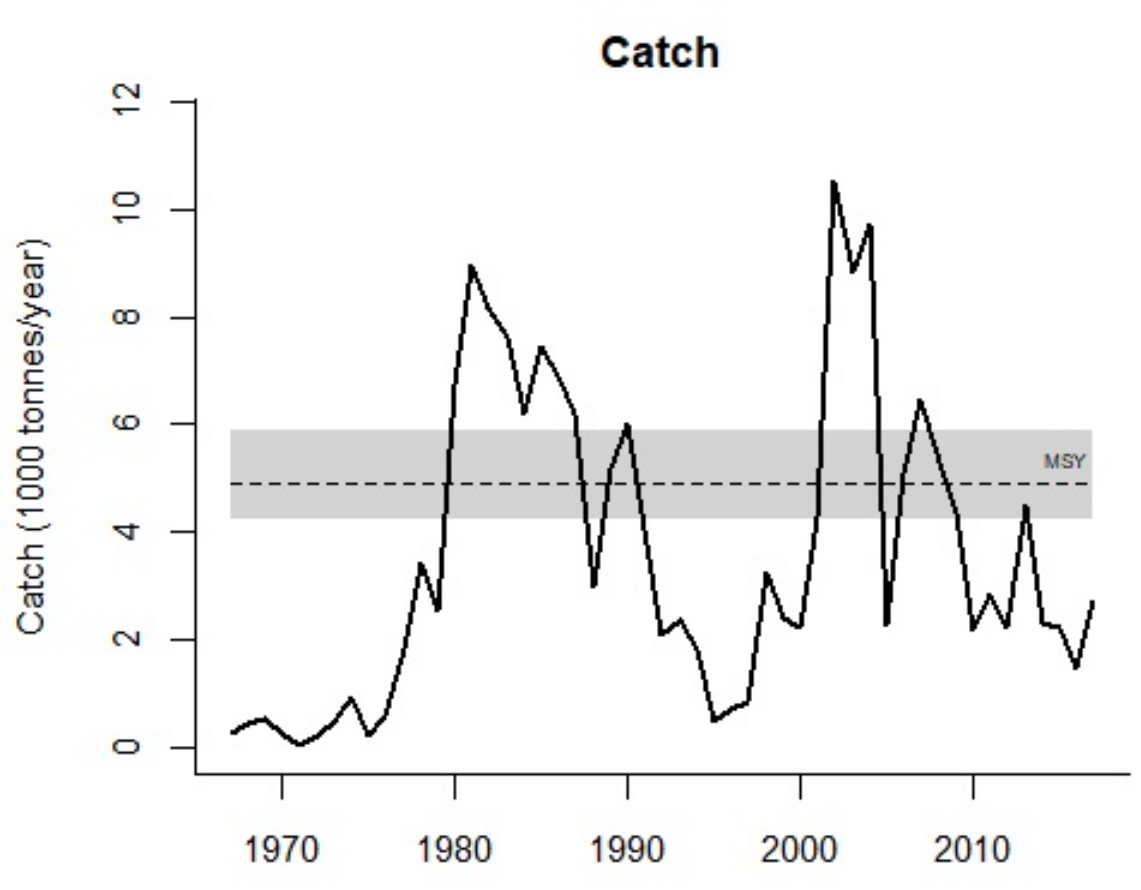

B: Finding viable r-k
k (1000 tonnes)
20
40
60
80
120
0.4
0.6
0.8
1.0
r

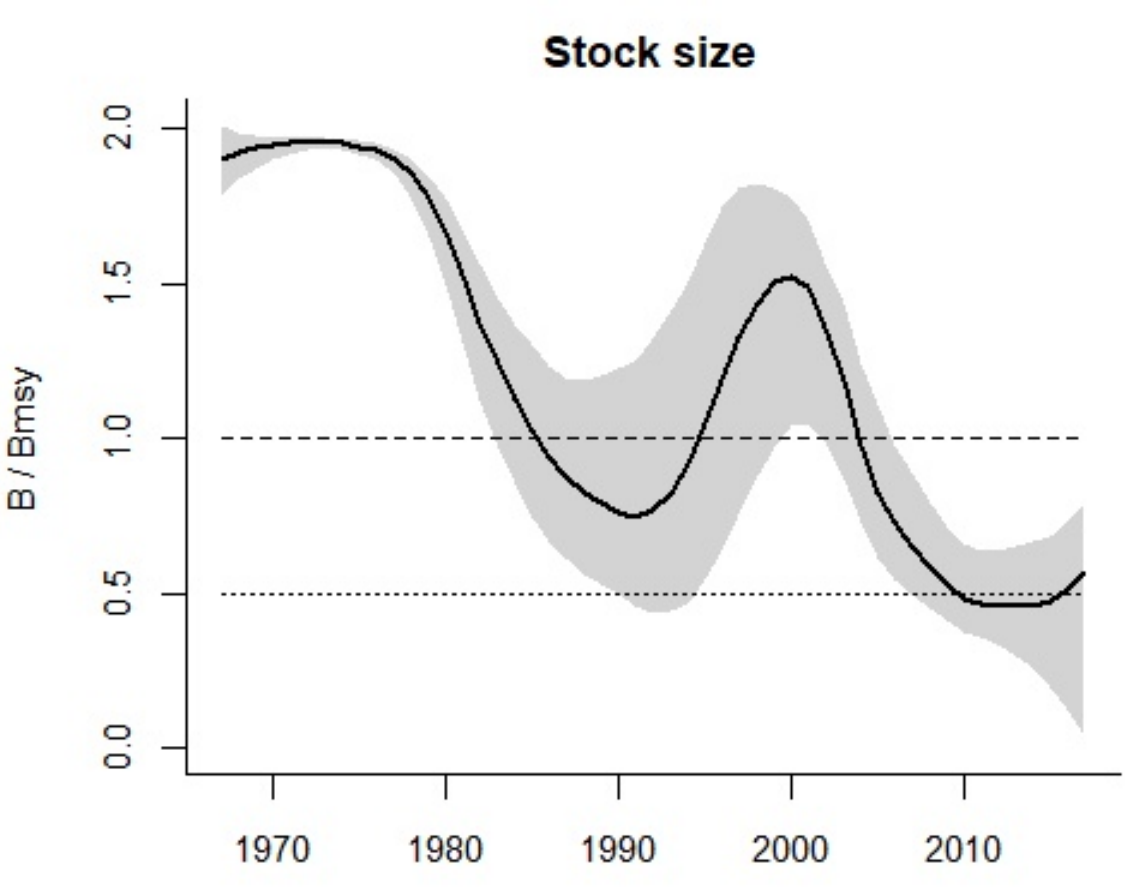

C: Analysis of viable r-k
k (1000 tonnes)
30
40
50
60
70
0.4
0.5
0.6
0.7
r

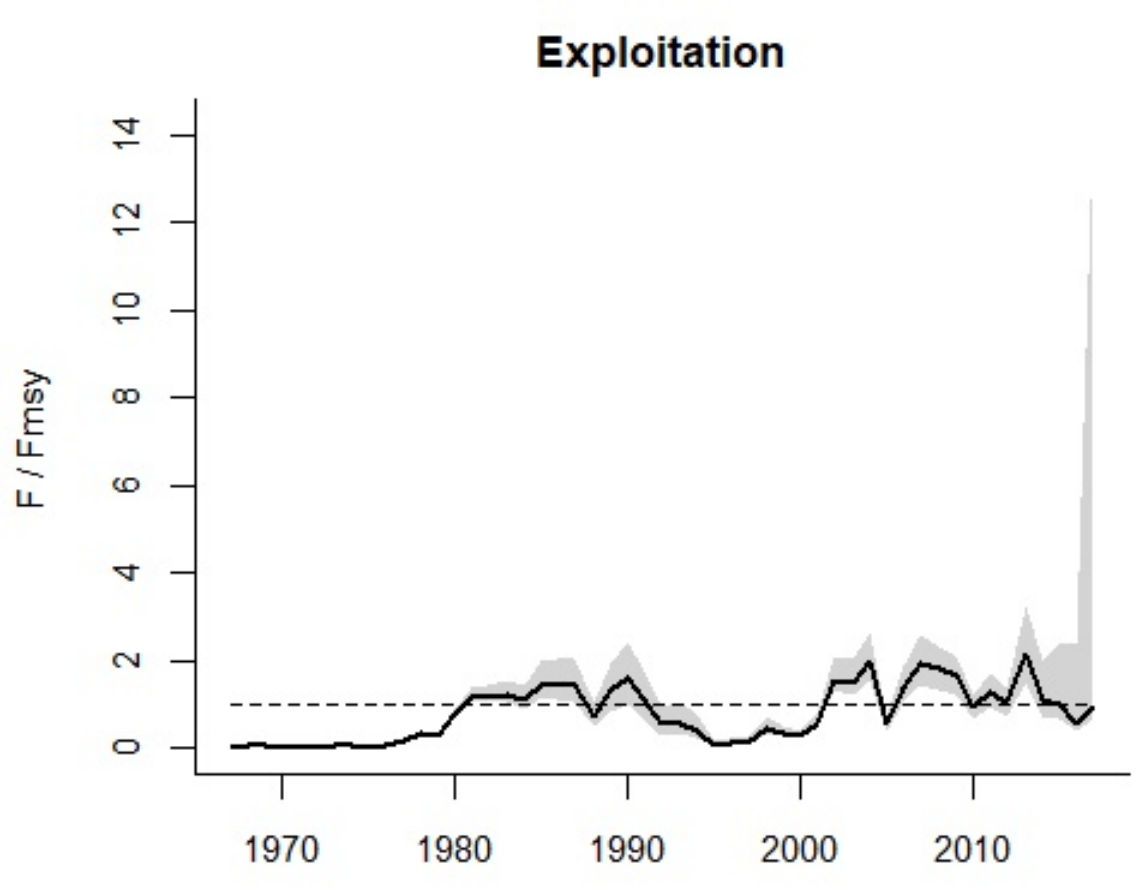

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

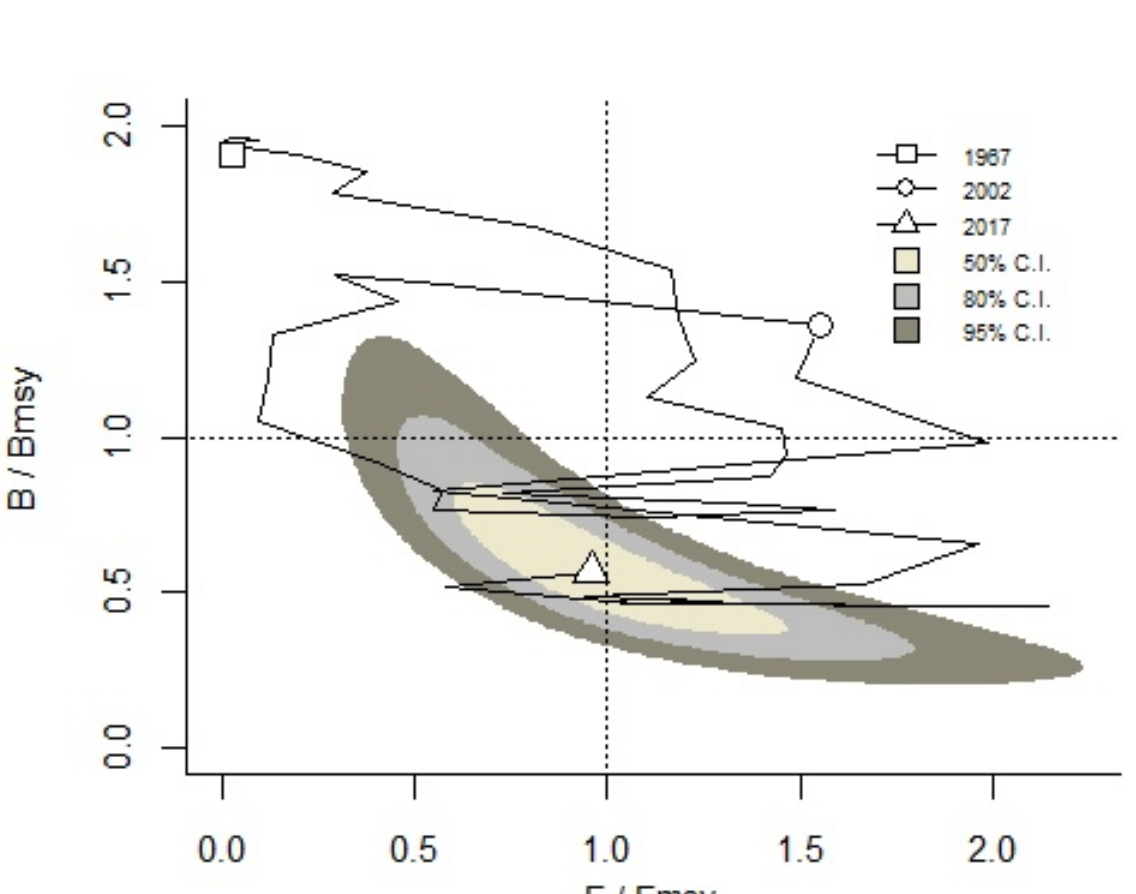

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

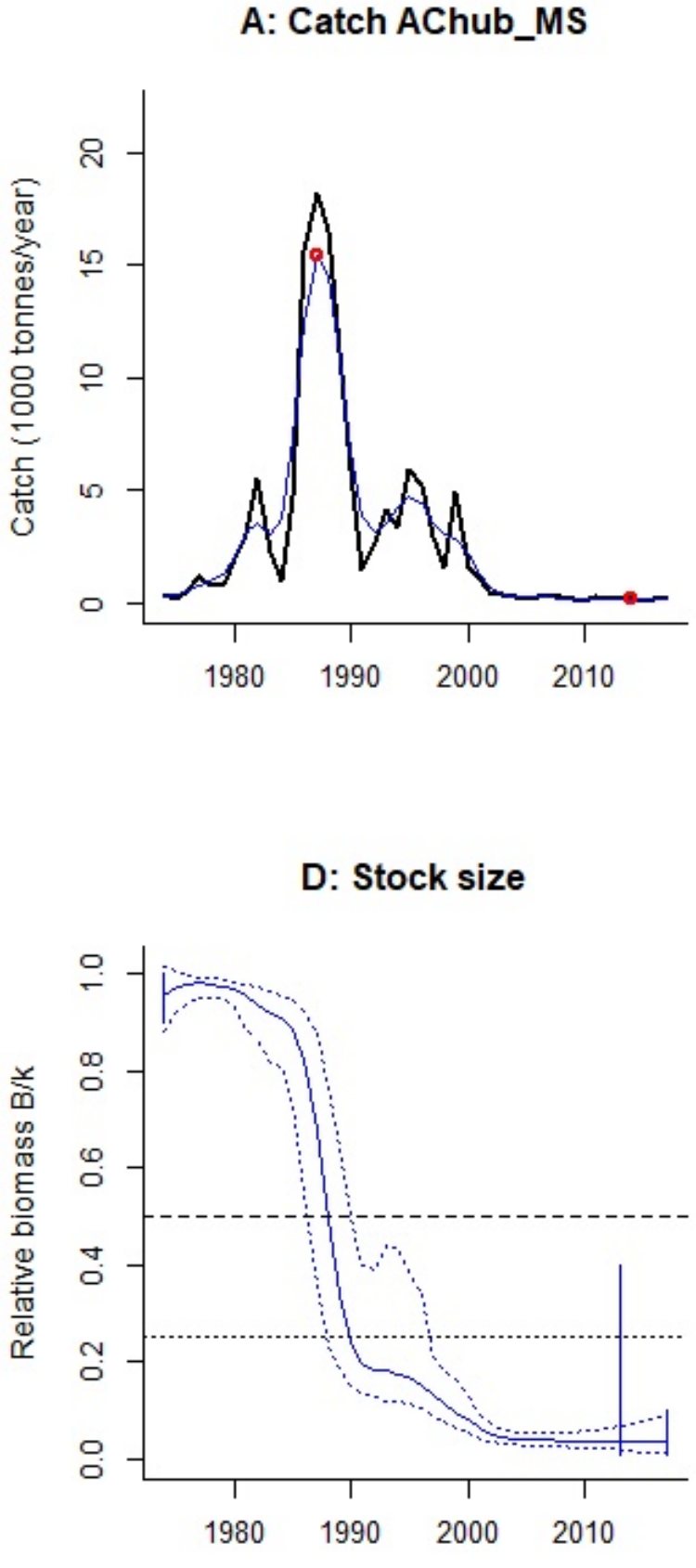

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

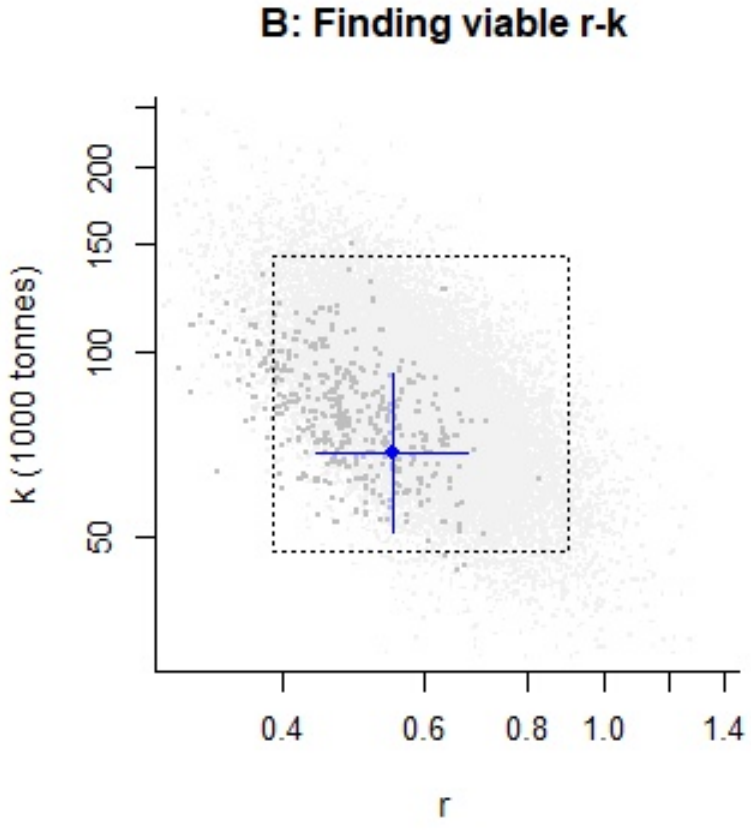

Catch
Catch (1000 tonnes/year)
0
2
4
6
8
10
12
MSY
1970
1980
1990
2000
2010

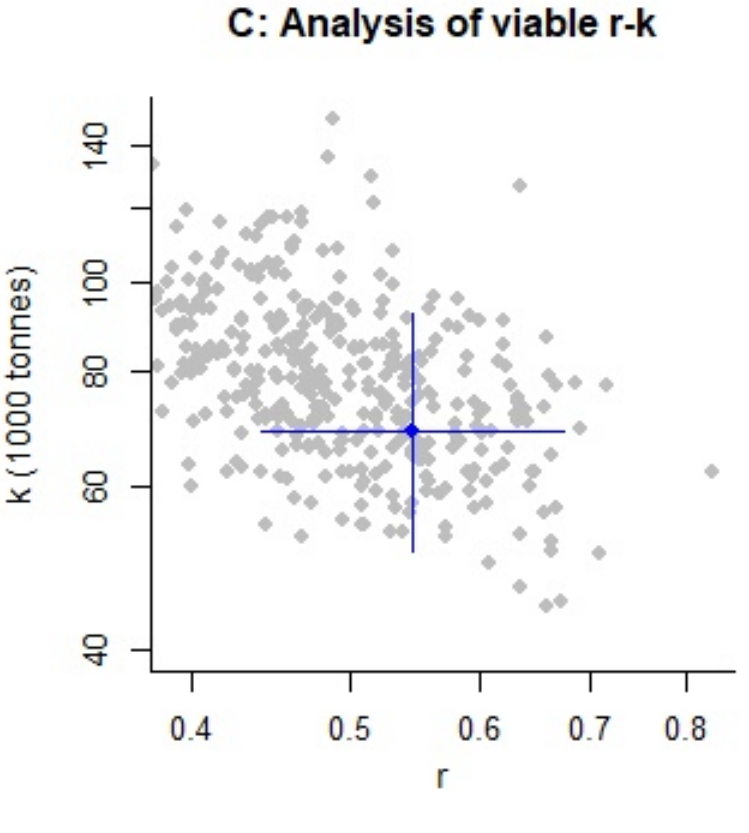

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
2
4
6
8
10
12
14
1970
1980
1990
2000
2010

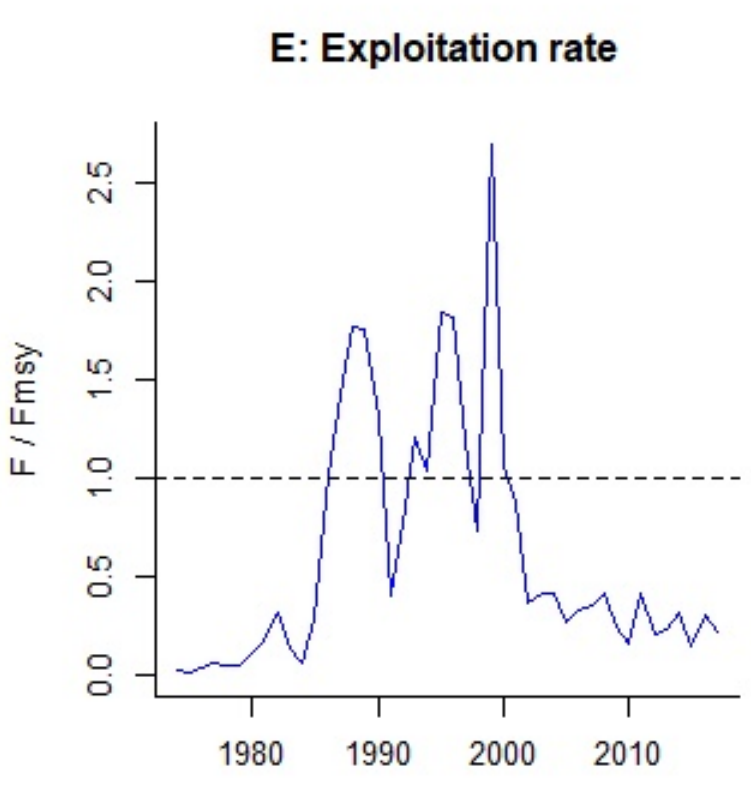

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2002
2017
50% C.I.
80% C.I.
95% C.I.
0.0
0.5
1.0
1.5
2.0
F / Fmsy

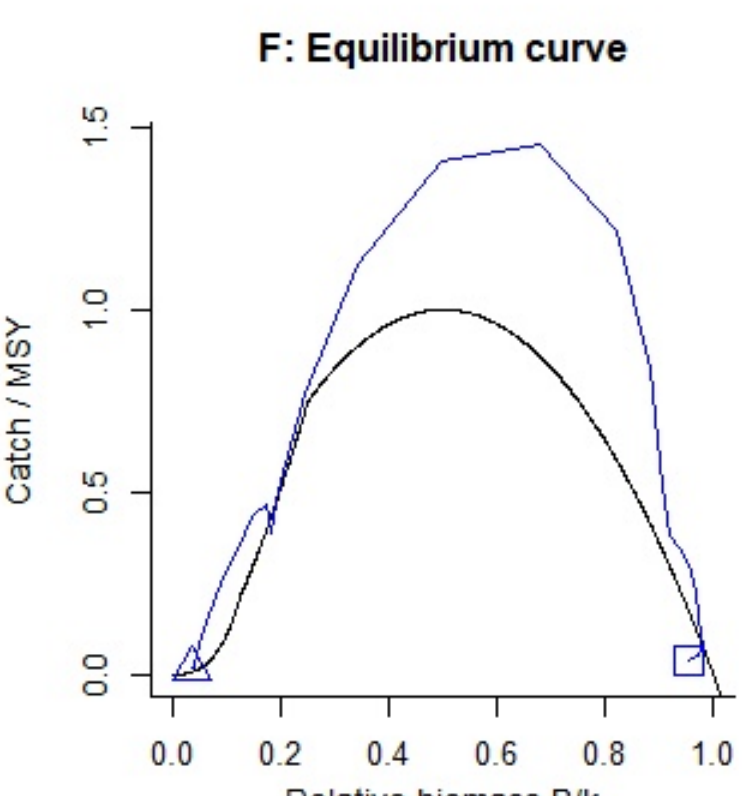

A: Catch AChub_MS
Catch (1000 tonnes/year)
0
5
10
15
20
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
0.4
0.6
0.8
1.0
1.4
r

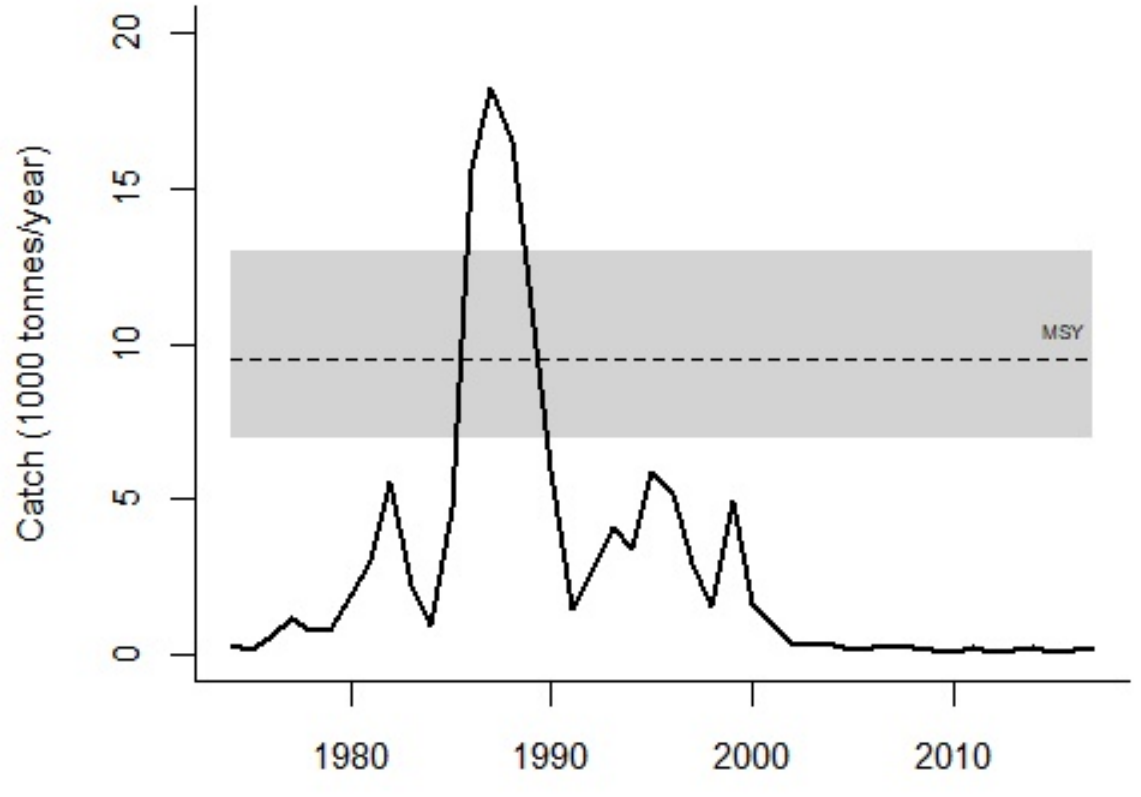

C: Analysis of viable r-k
k (1000 tonnes)
40
60
80
100
140
0.4
0.5
0.6
0.7
0.8
r

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

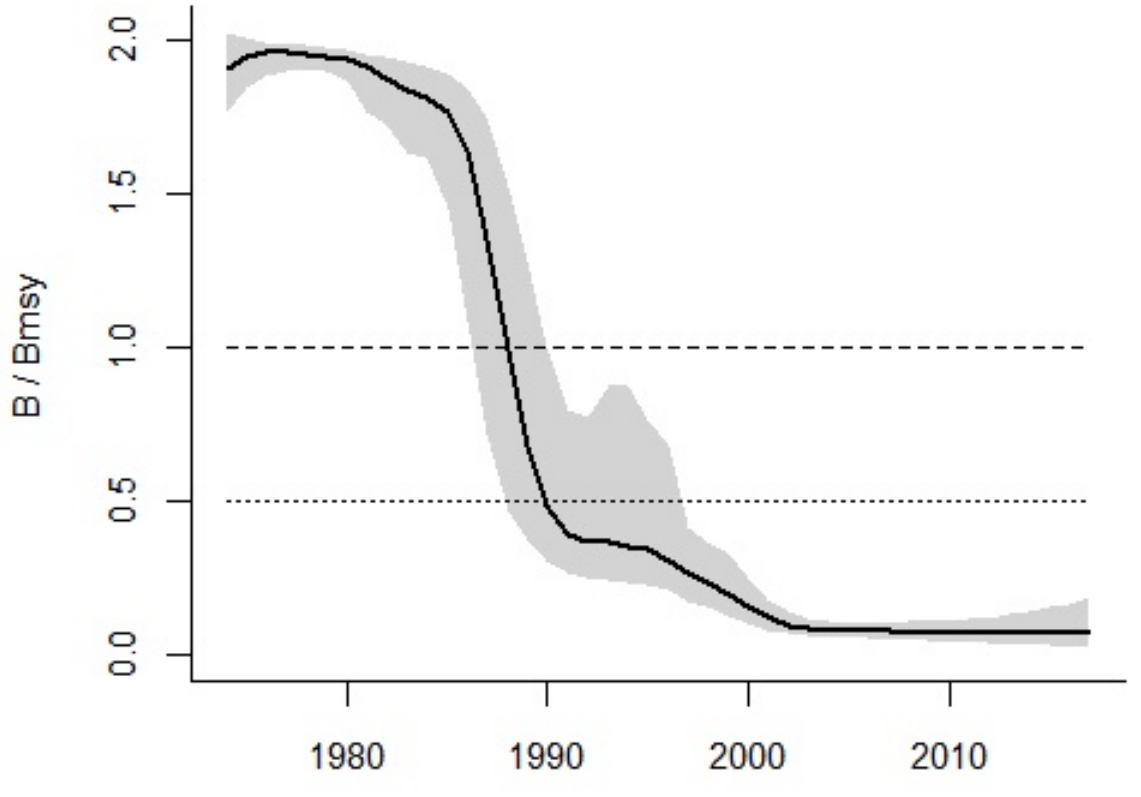

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

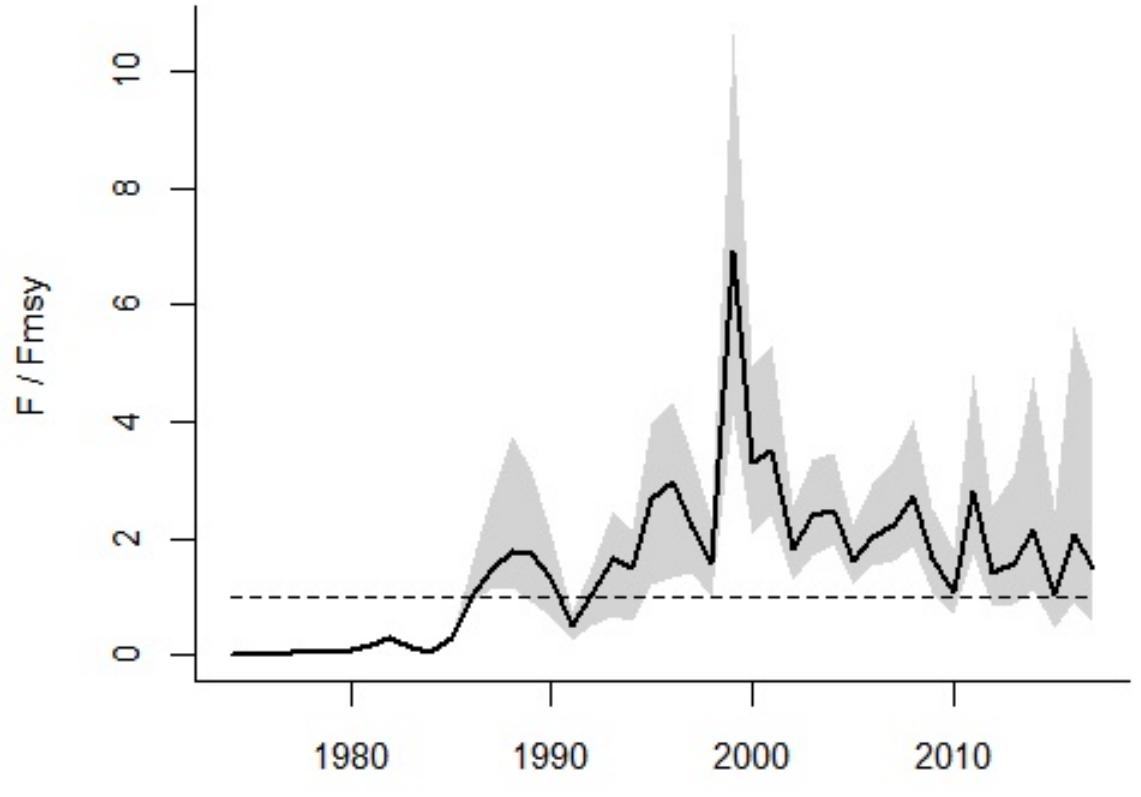
Catch

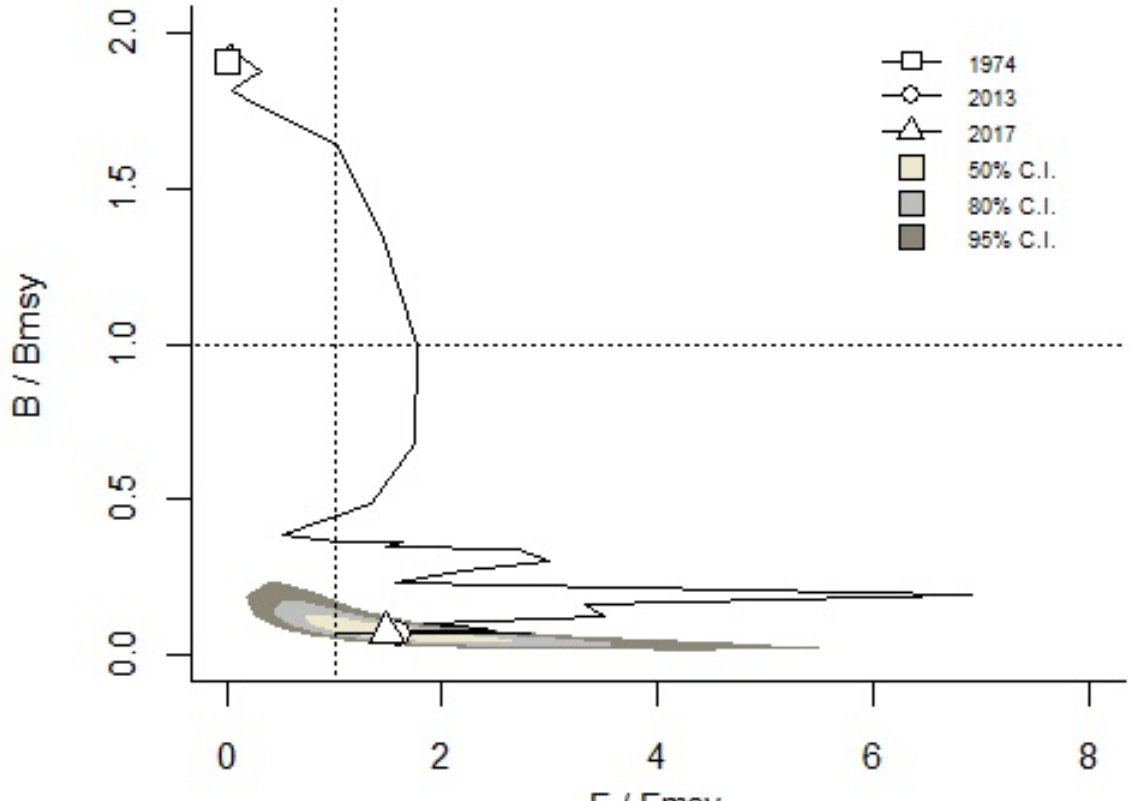


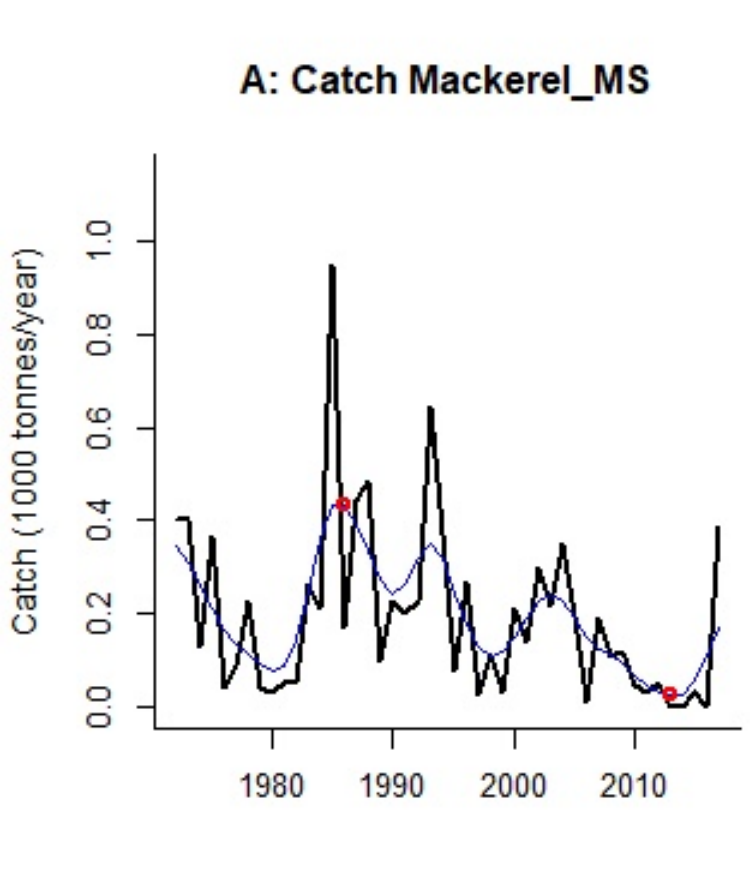
Stock size

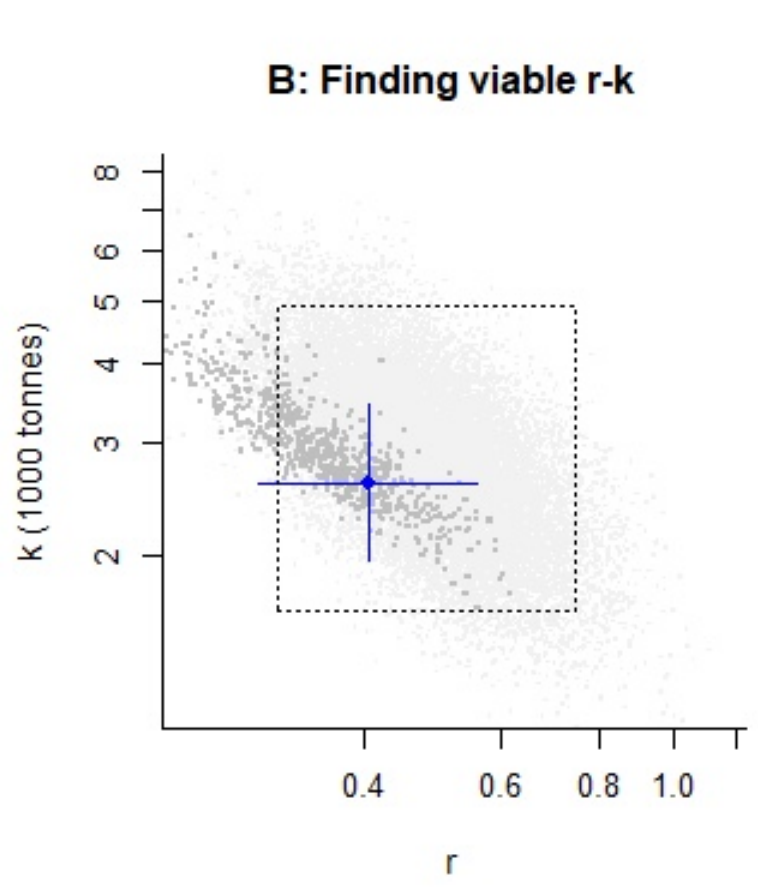


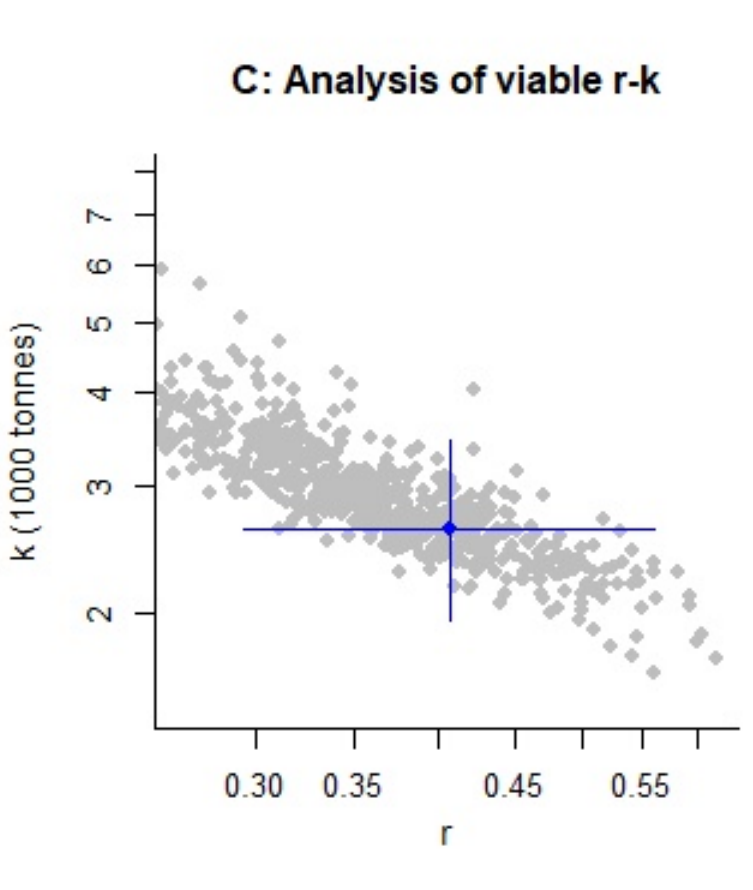
Exploitation

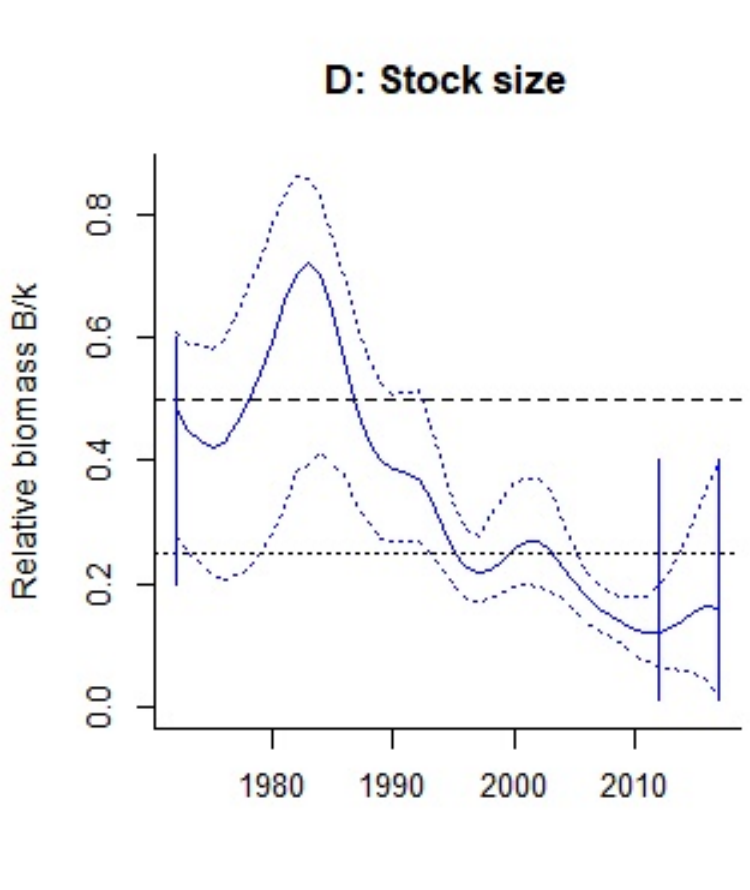


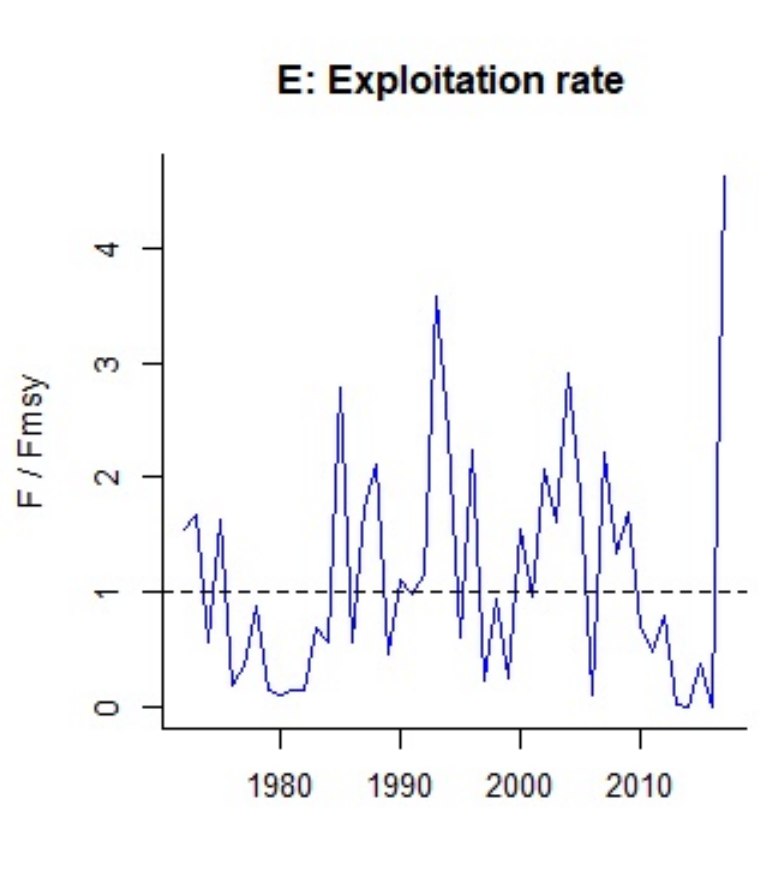


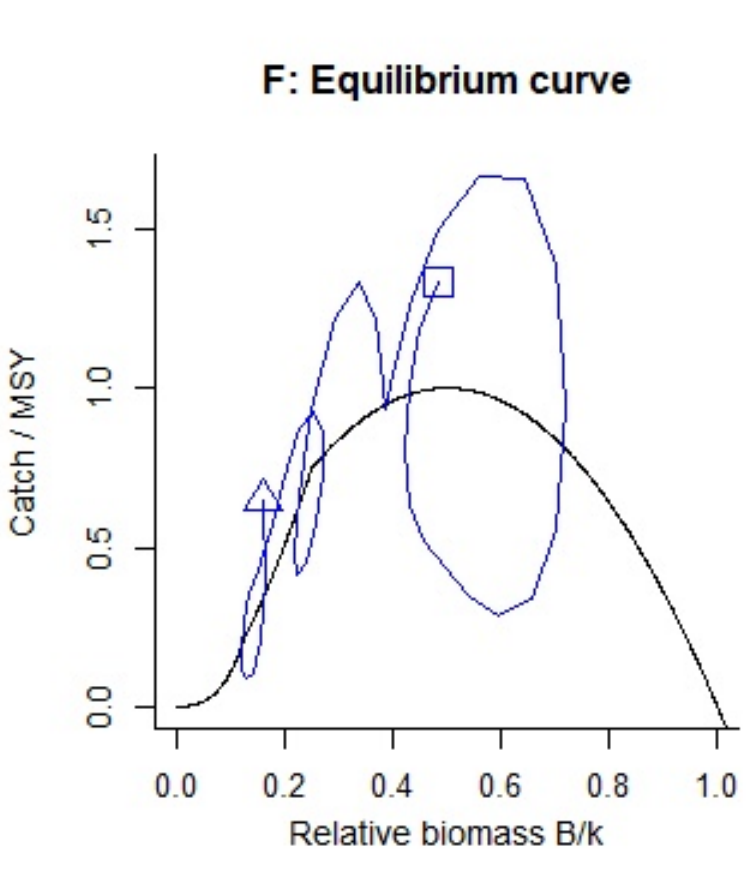

A: Catch Mackerel_MS
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1980
1990
2000
2010

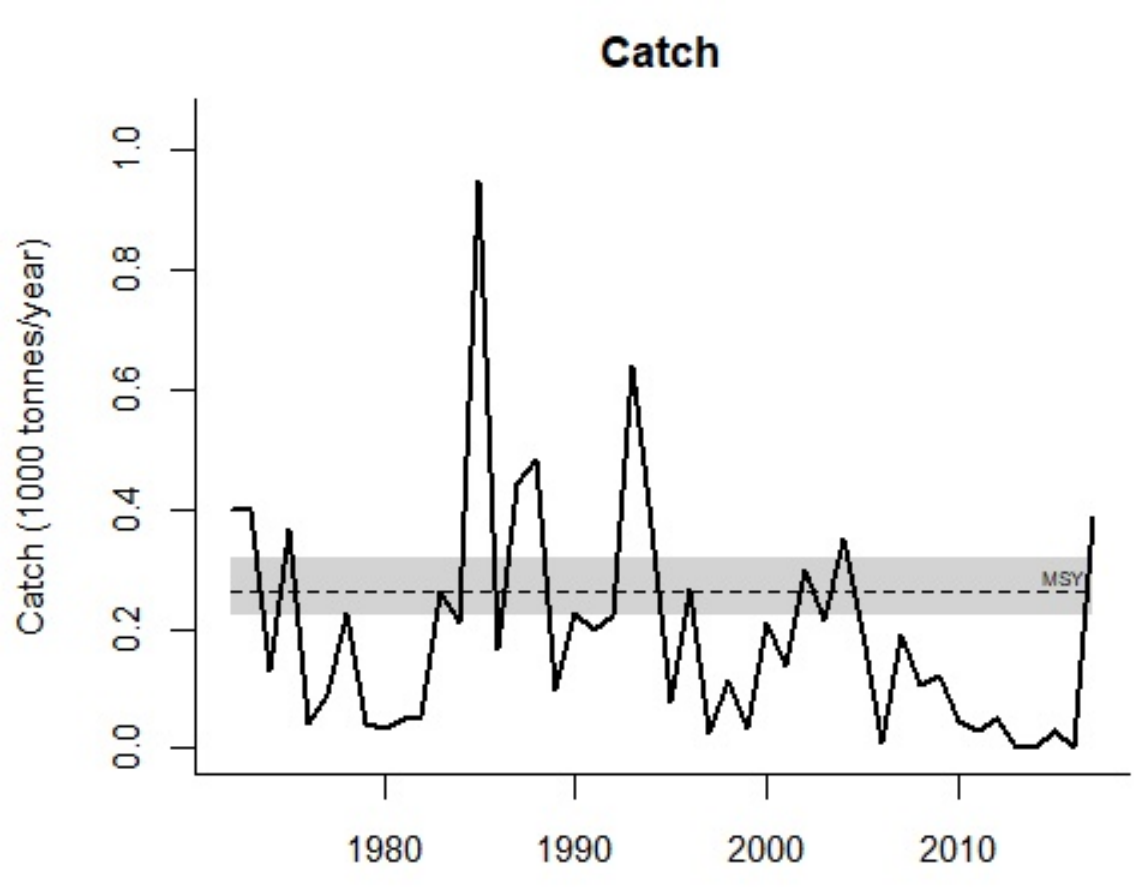

B: Finding viable r-k
k (1000 tonnes)
2
3
4
5
6
7
8
0.4
0.6
0.8
1.0
r

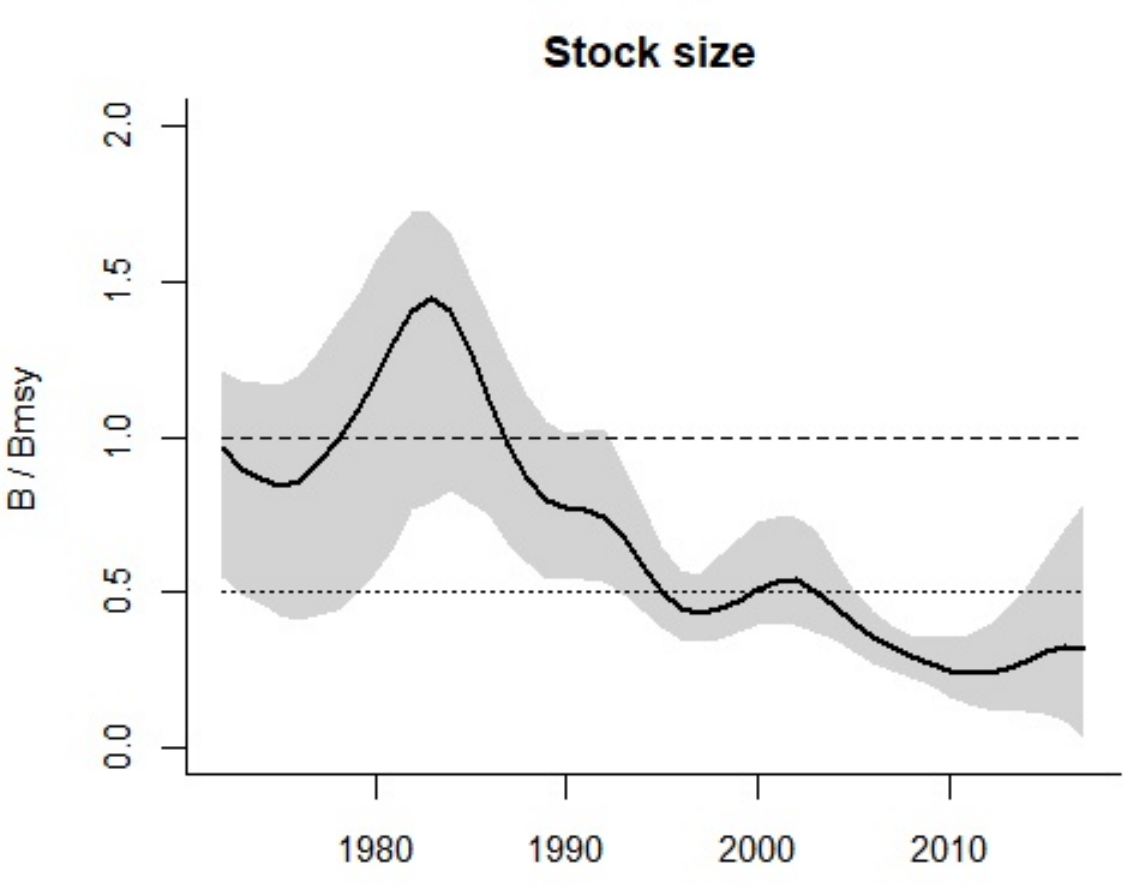

C: Analysis of viable r-k
k (1000 tonnes)
2
3
4
5
6
7
0.30
0.35
0.45
0.55
r

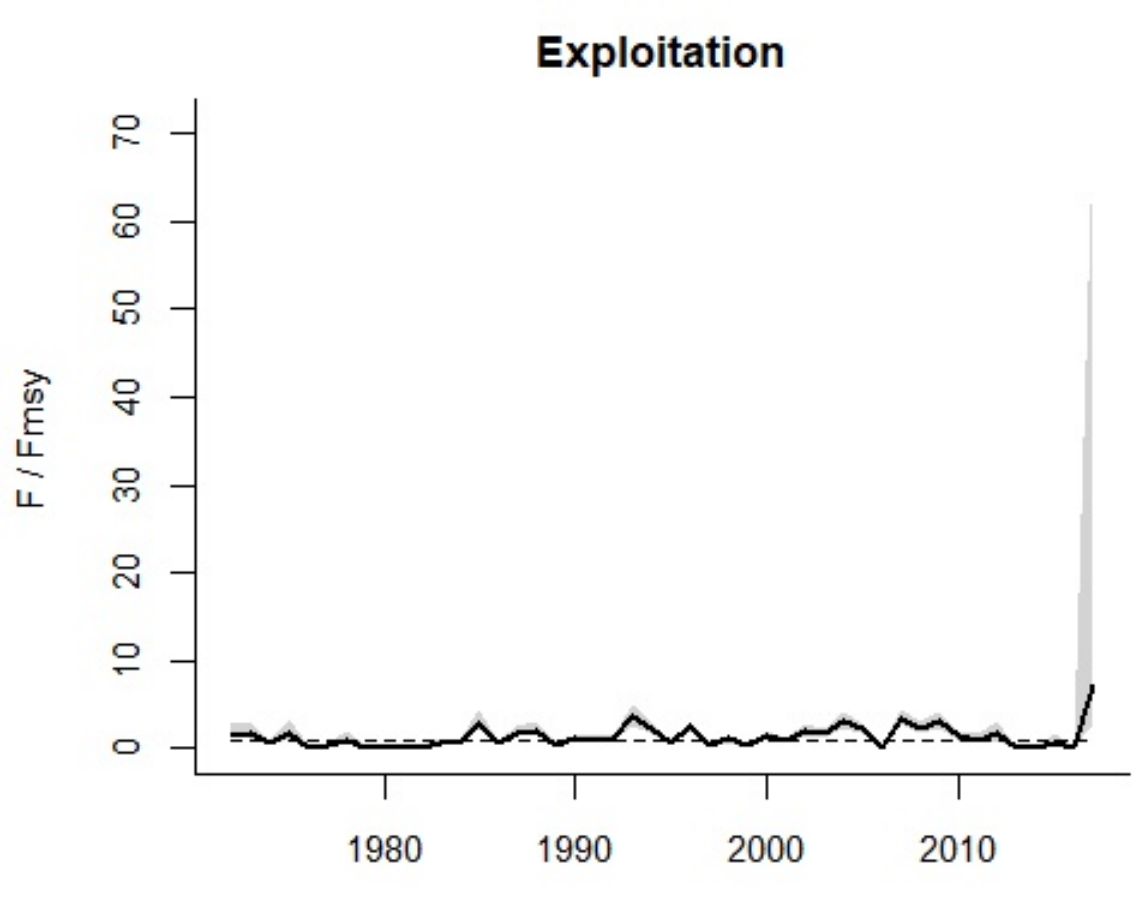

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1980
1990
2000
2010

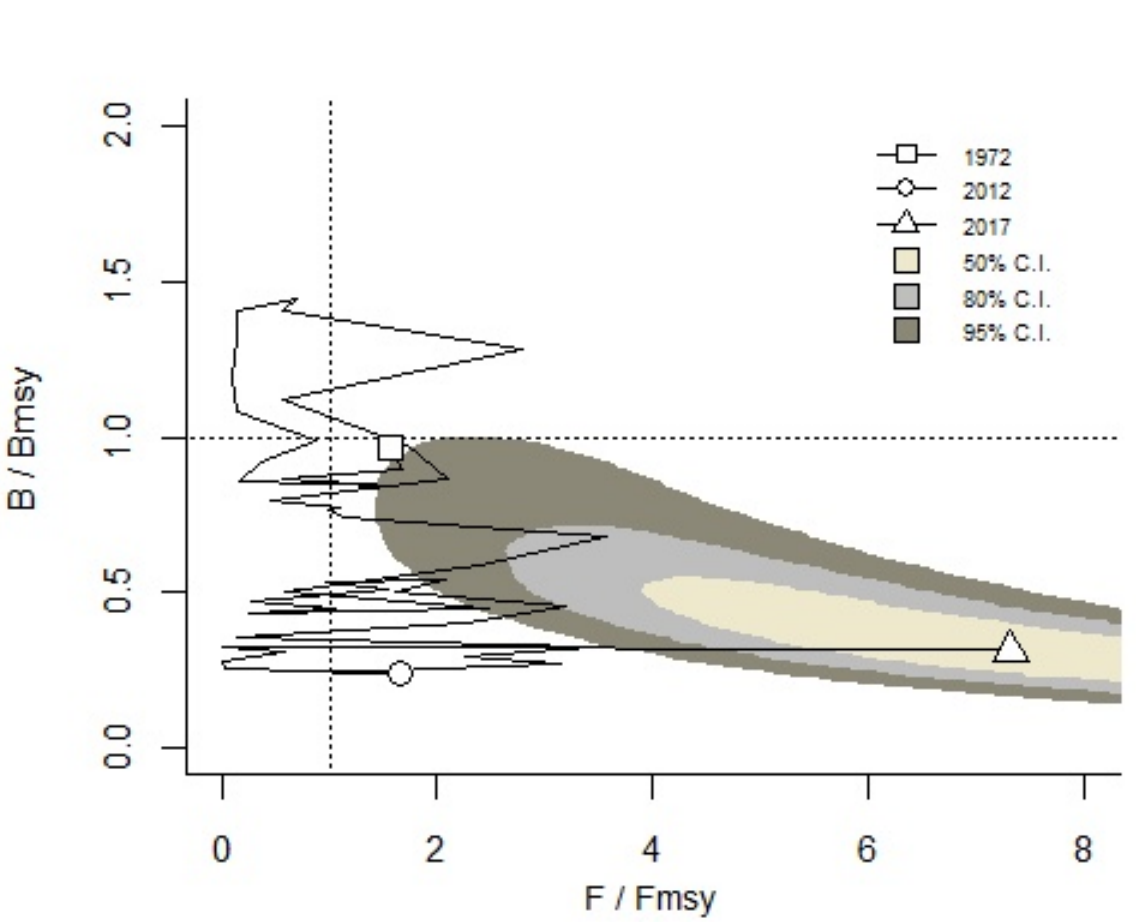

E: Exploitation rate
F / Fmsy
0
1
2
3
4
1980
1990
2000
2010

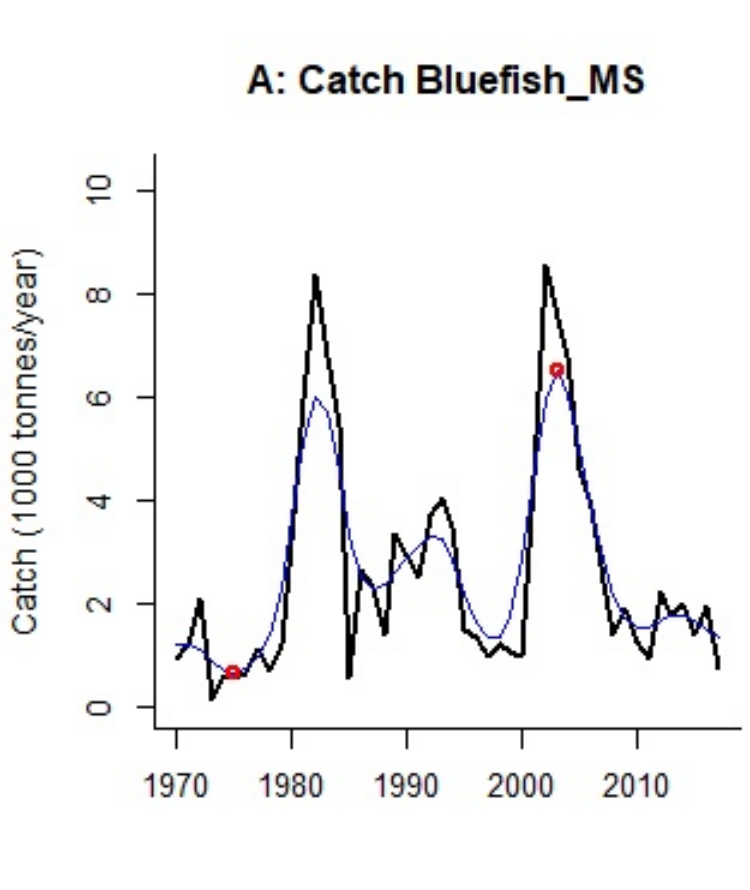

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

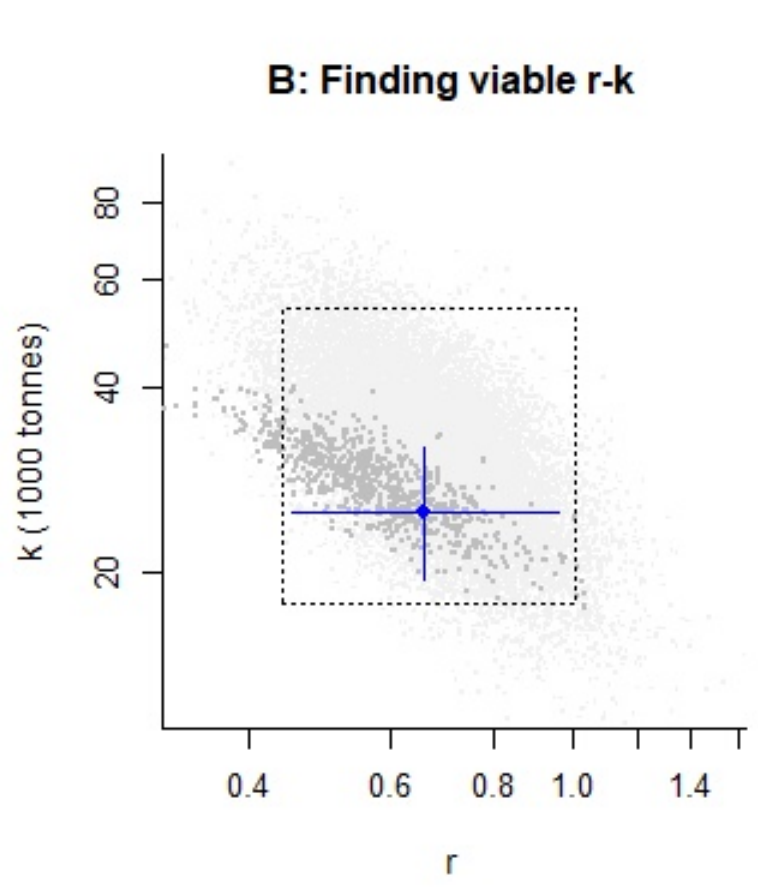

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
MSY
1980
1990
2000
2010

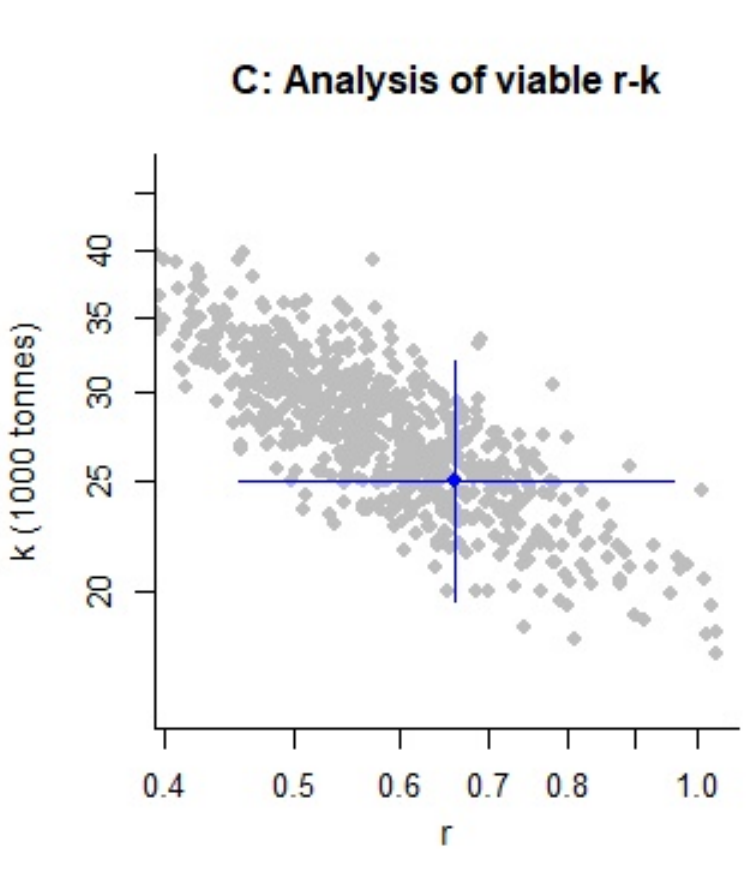

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1980
1990
2000
2010

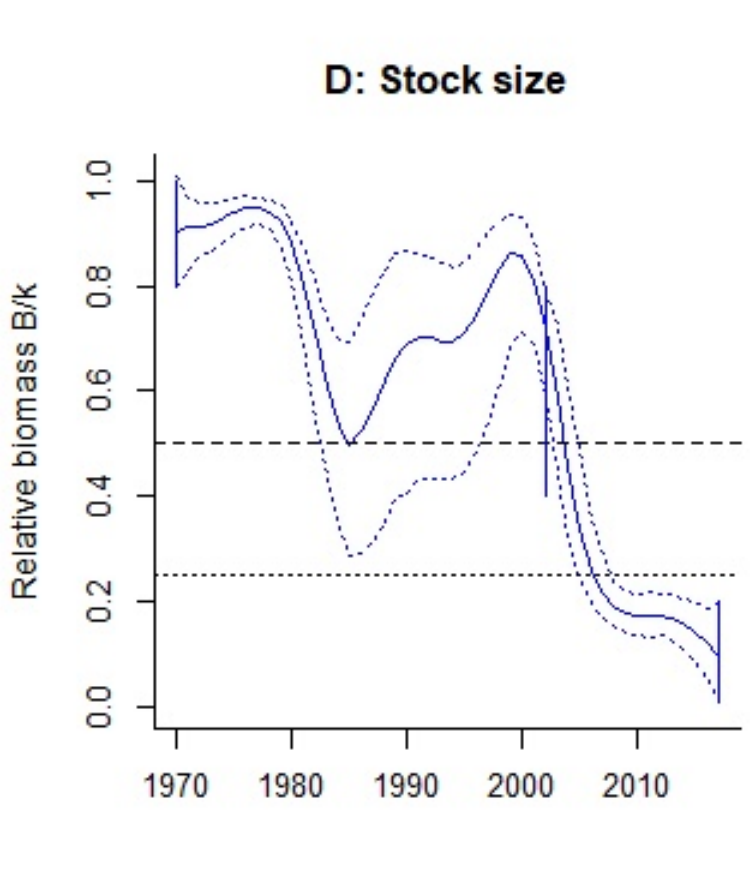

Exploitation
F / Fmsy
0
10
20
30
40
50
60
70
1980
1990
2000
2010

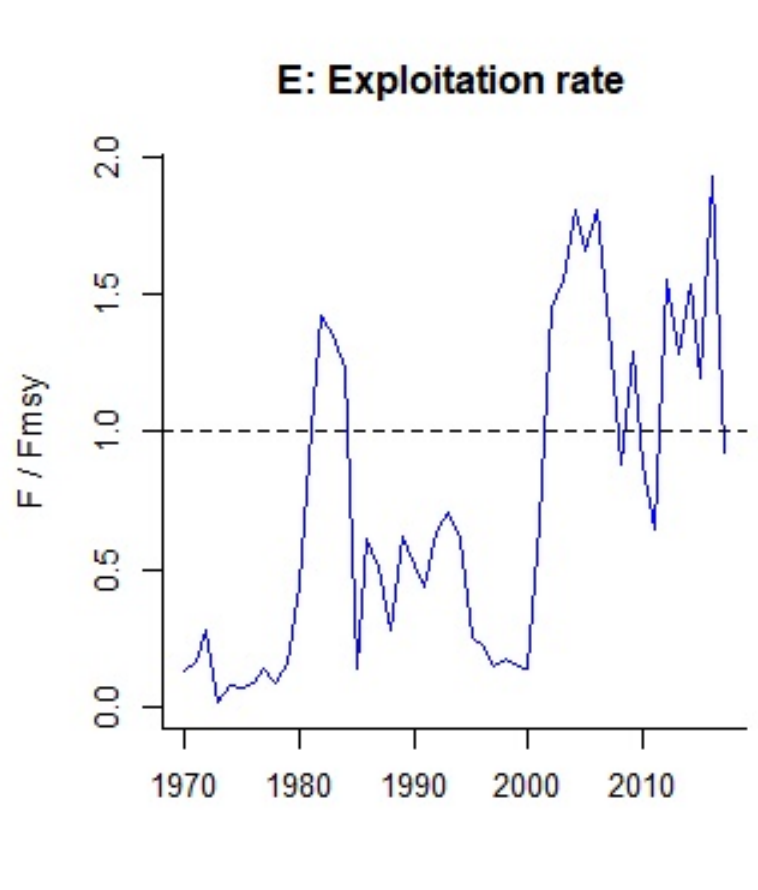

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1972
2012
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

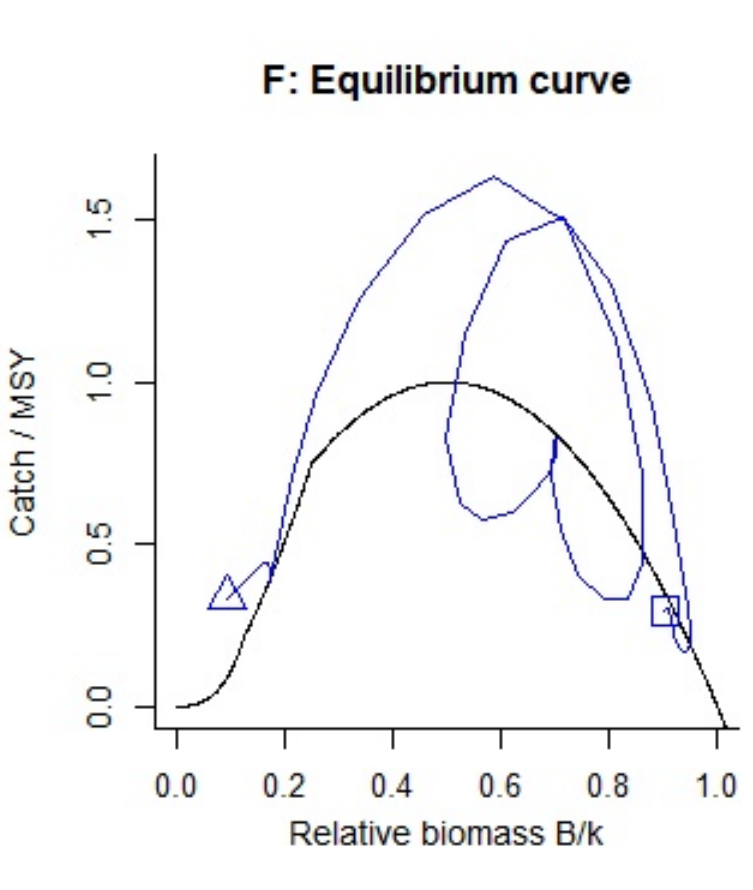

A: Catch Bluefish_MS
Catch (1000 tonnes/year)
0
2
4
6
8
10
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
20
40
60
80
0.4
0.6
0.8
1.0
1.4
r

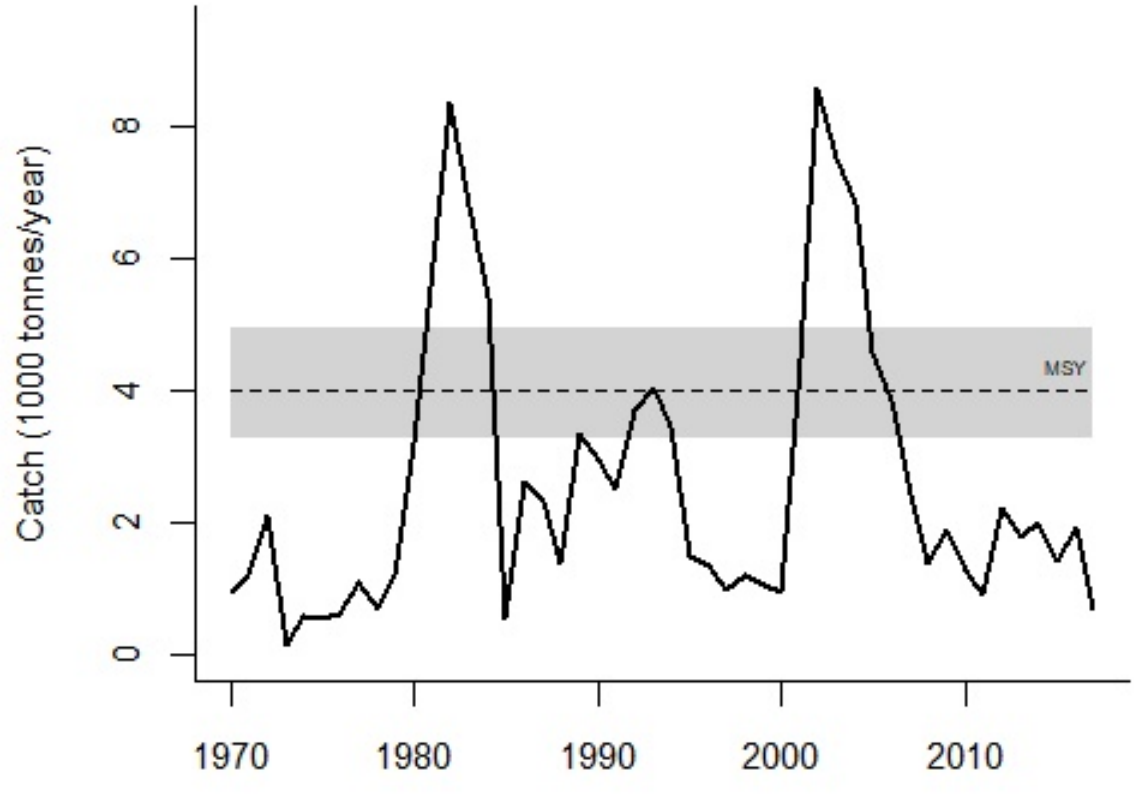

C: Analysis of viable r-k
k (1000 tonnes)
20
25
30
35
40
0.4
0.5
0.6
0.7
0.8
1.0
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

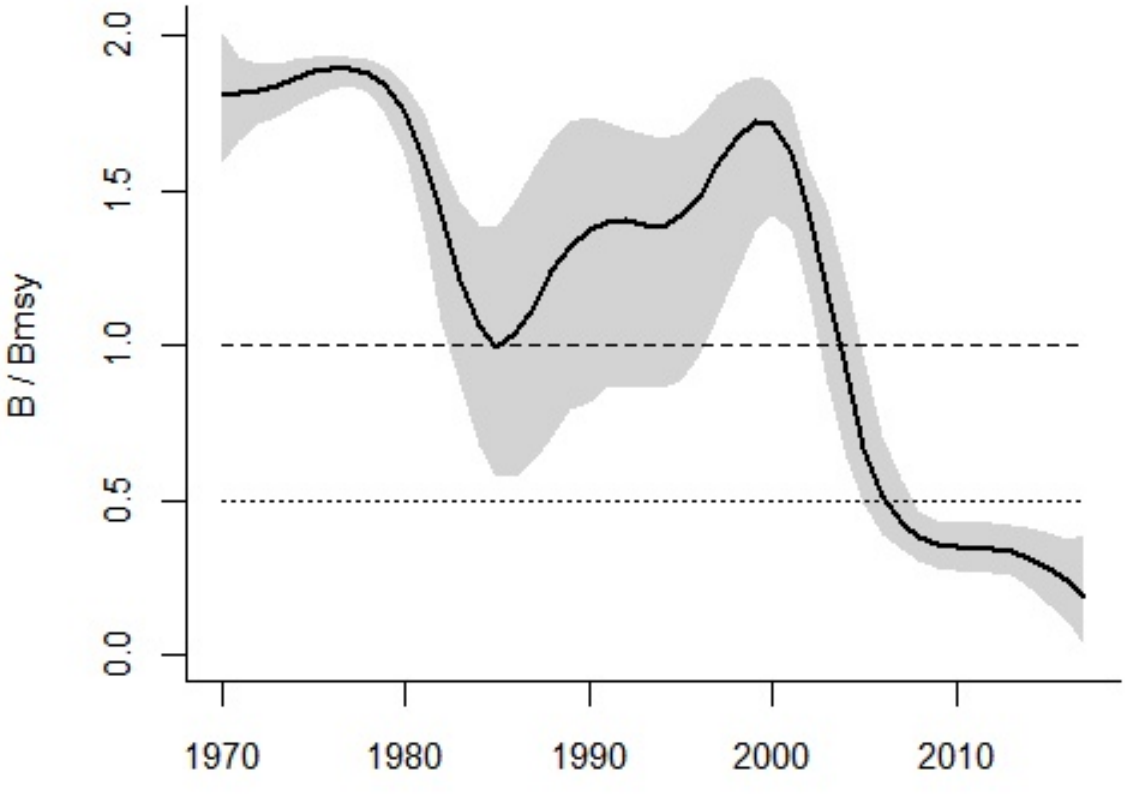

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

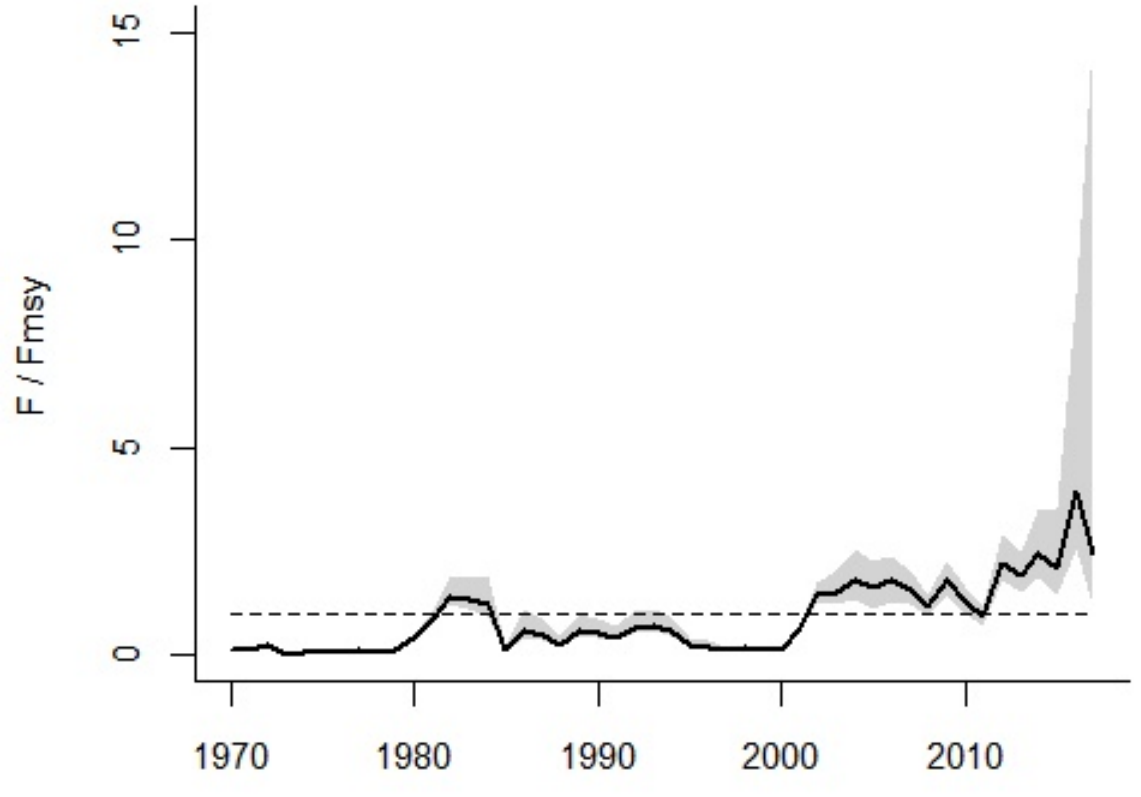
Catch

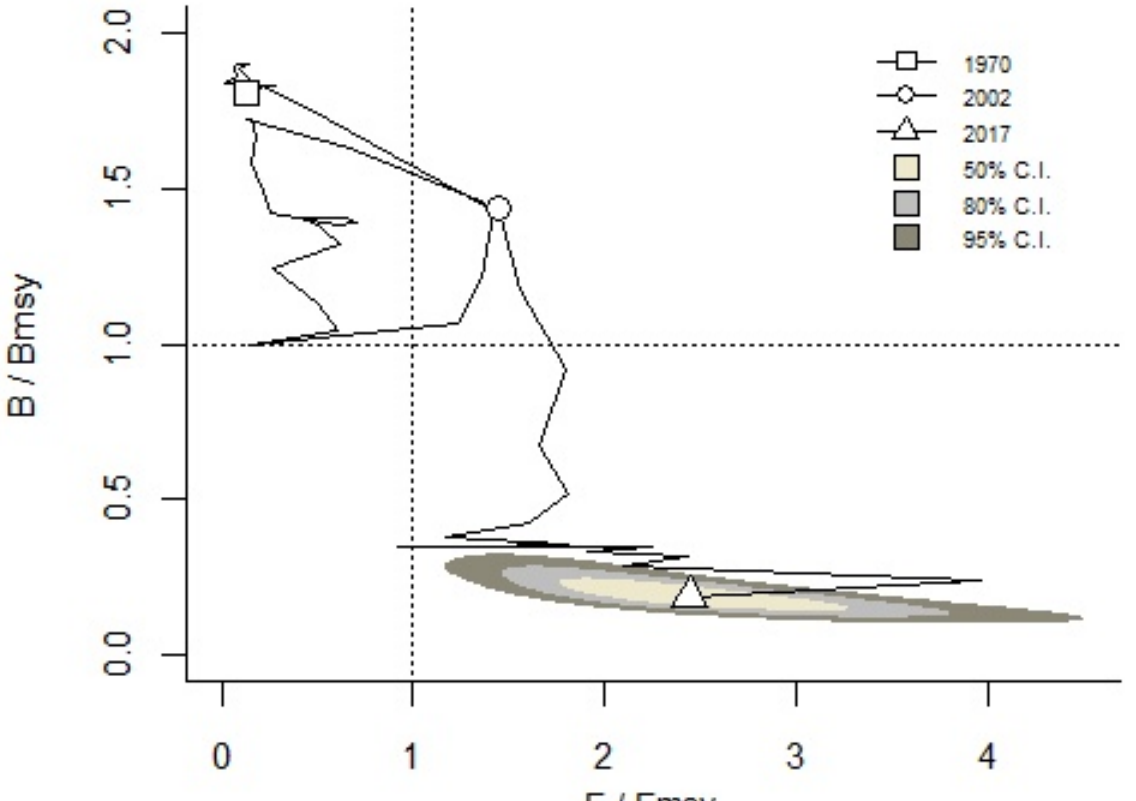


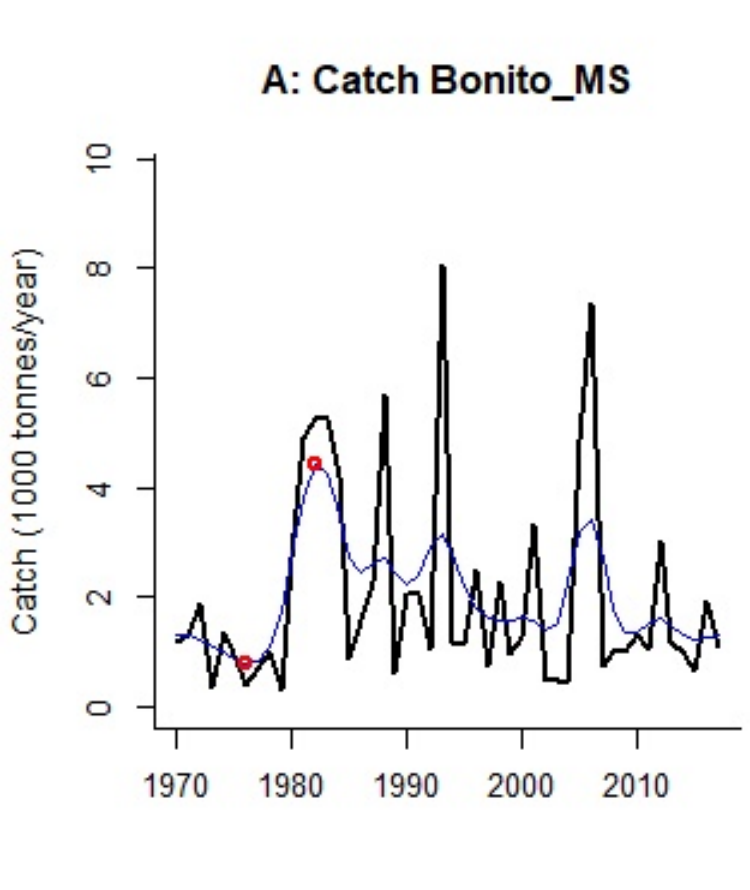
Stock size

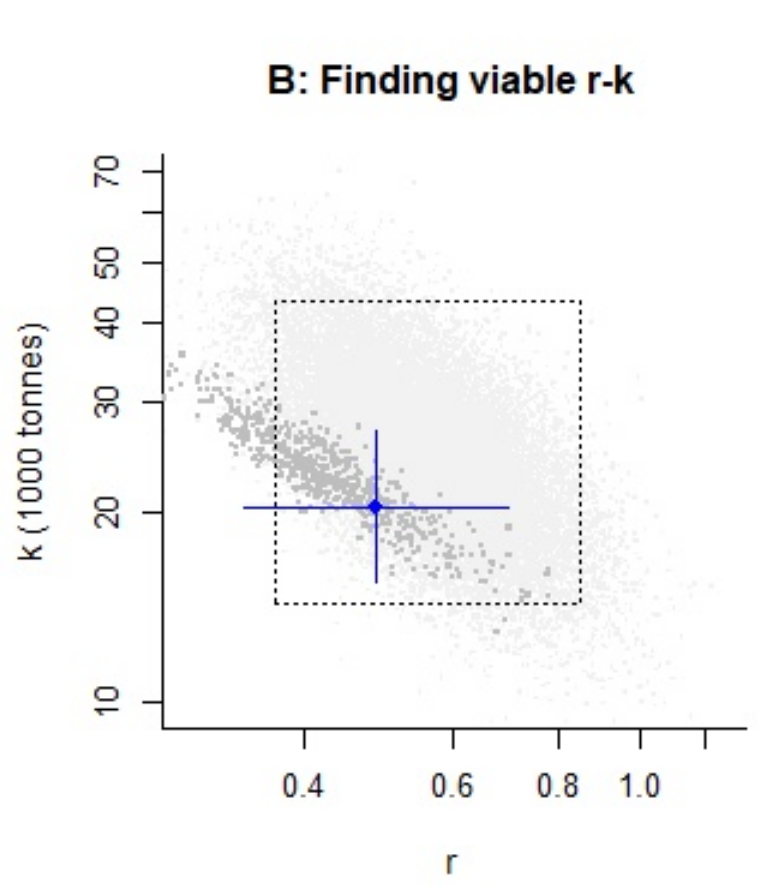


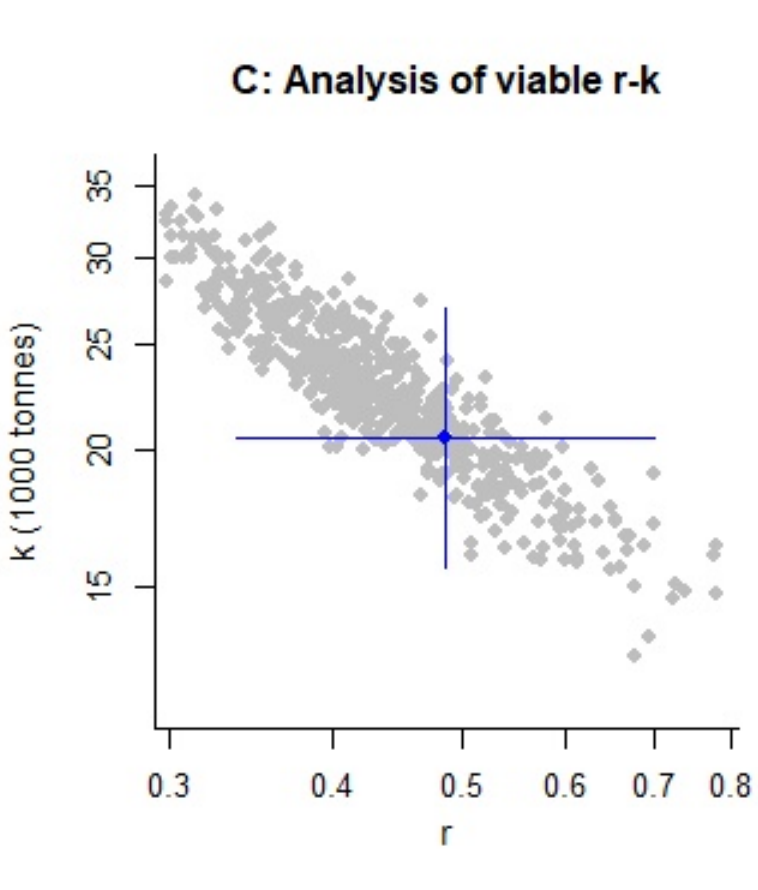
Exploitation

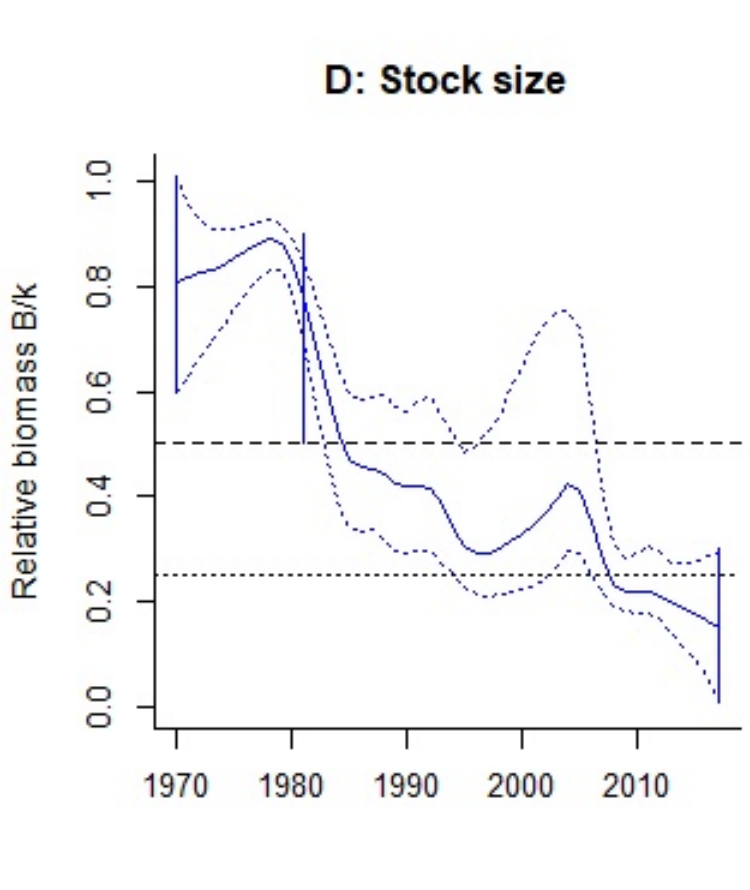


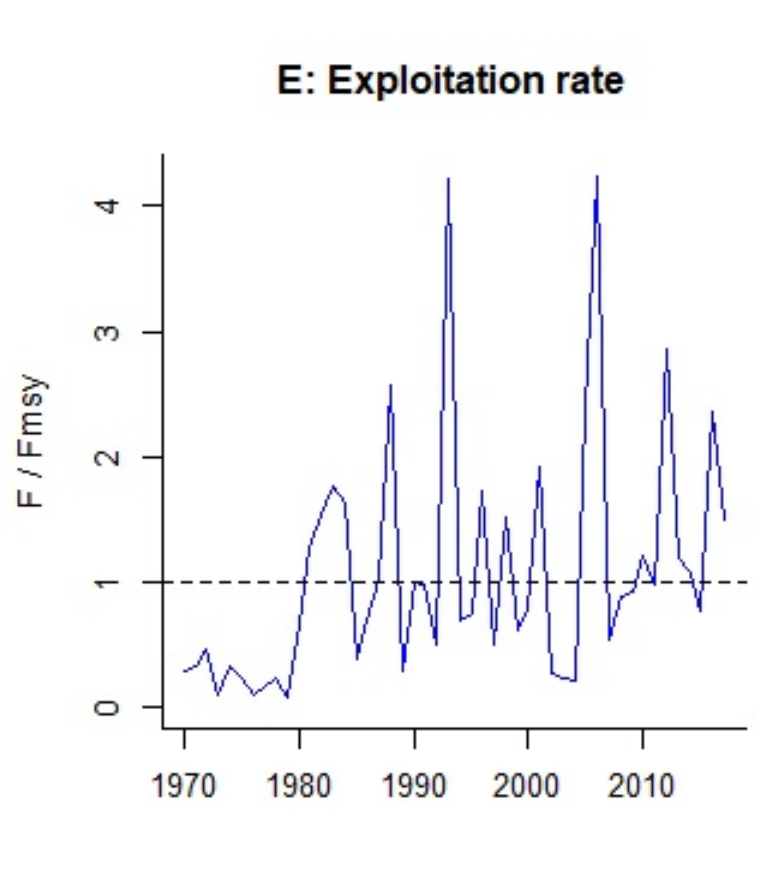


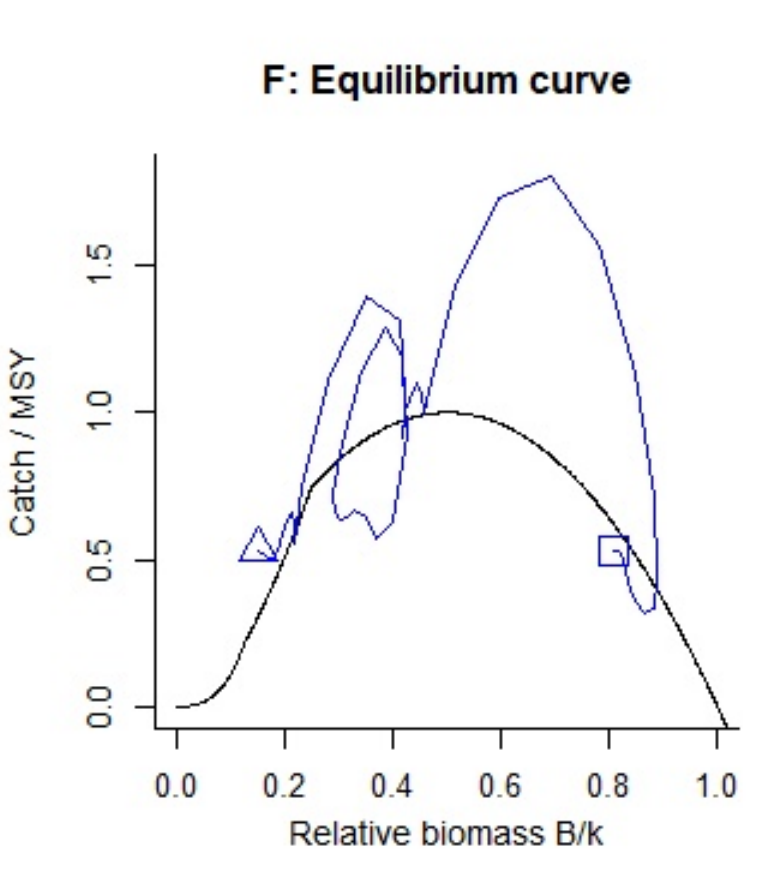

A: Catch Bonito_MS
Catch (1000 tonnes/year)
0
2
4
6
8
10
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
10
20
30
40
50
70
0.4
0.6
0.8
1.0
r

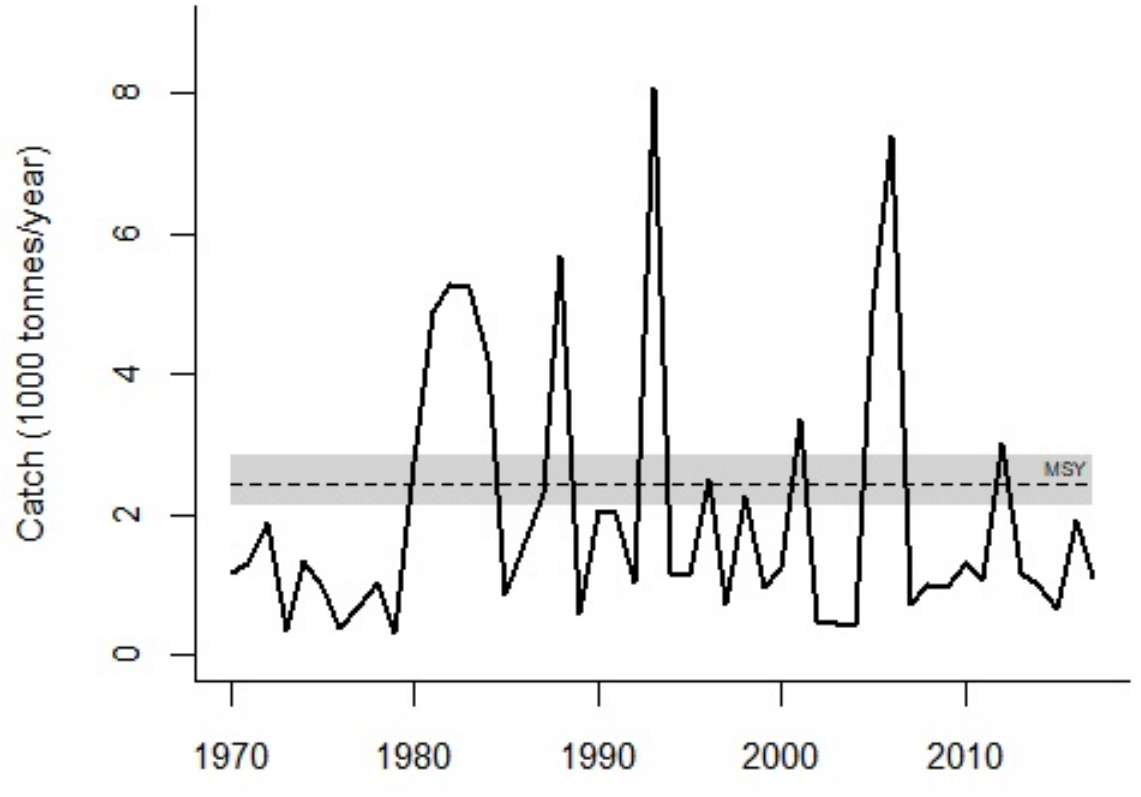

C: Analysis of viable r-k
k (1000 tonnes)
15
20
25
30
35
0.3
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

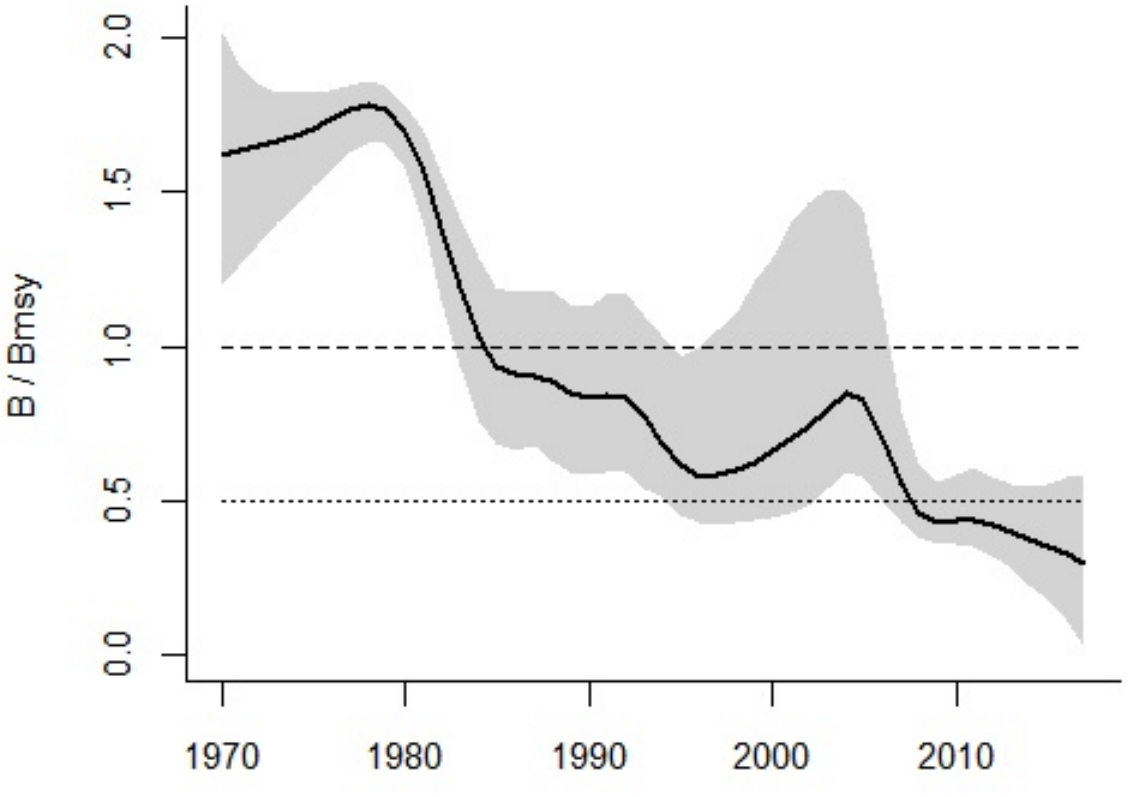

E: Exploitation rate
F / Fmsy
0
1
2
3
4
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

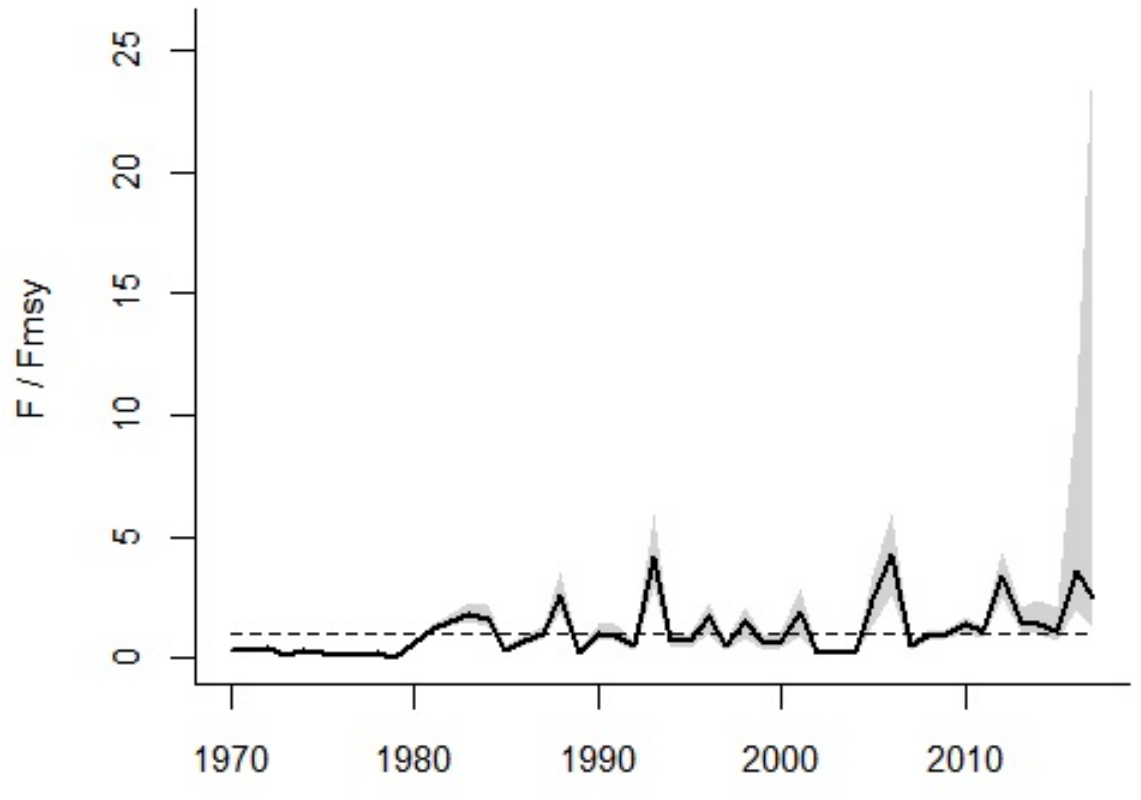
Catch

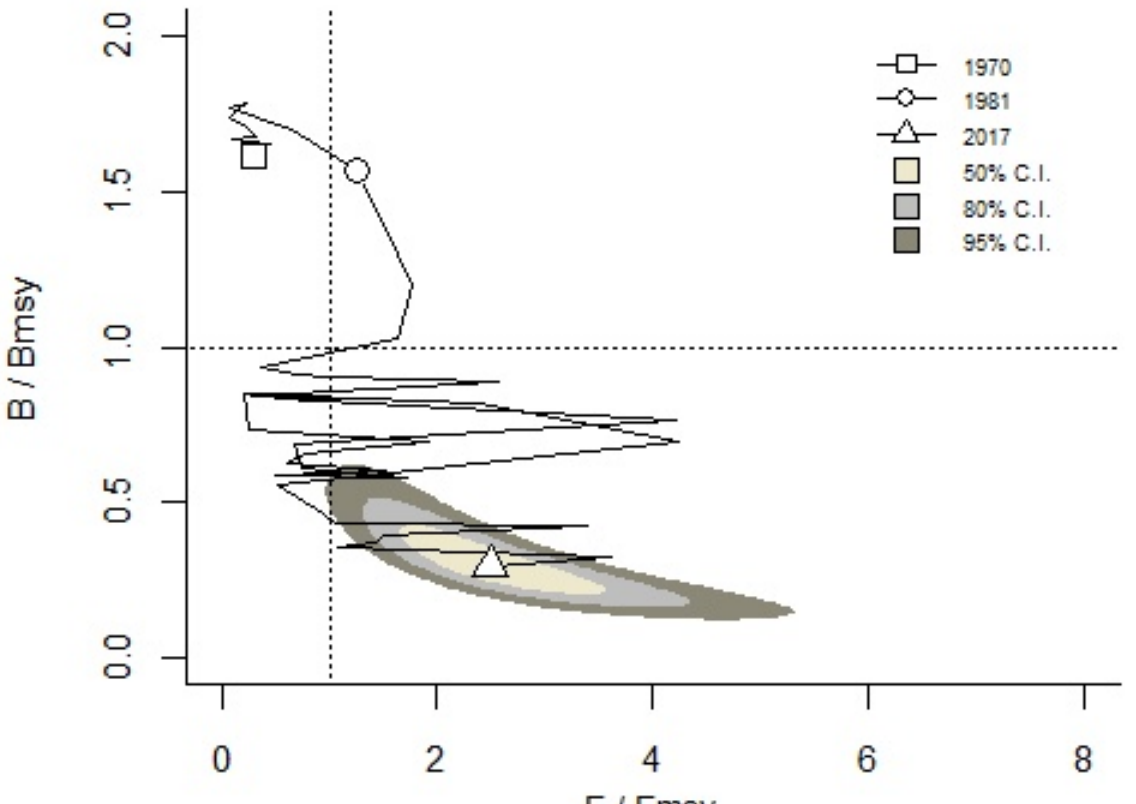


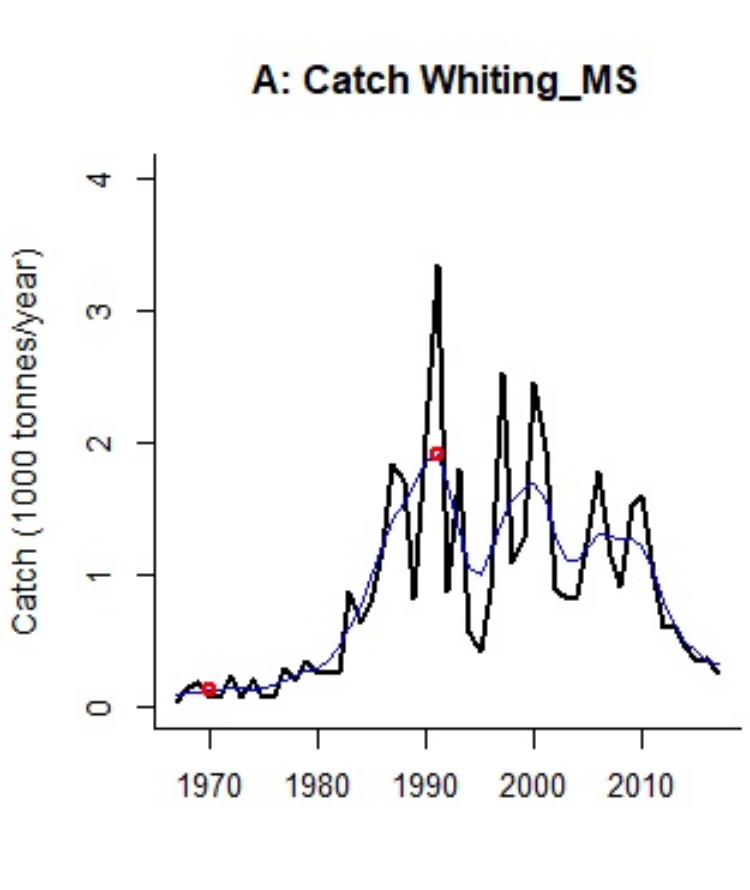
Stock size

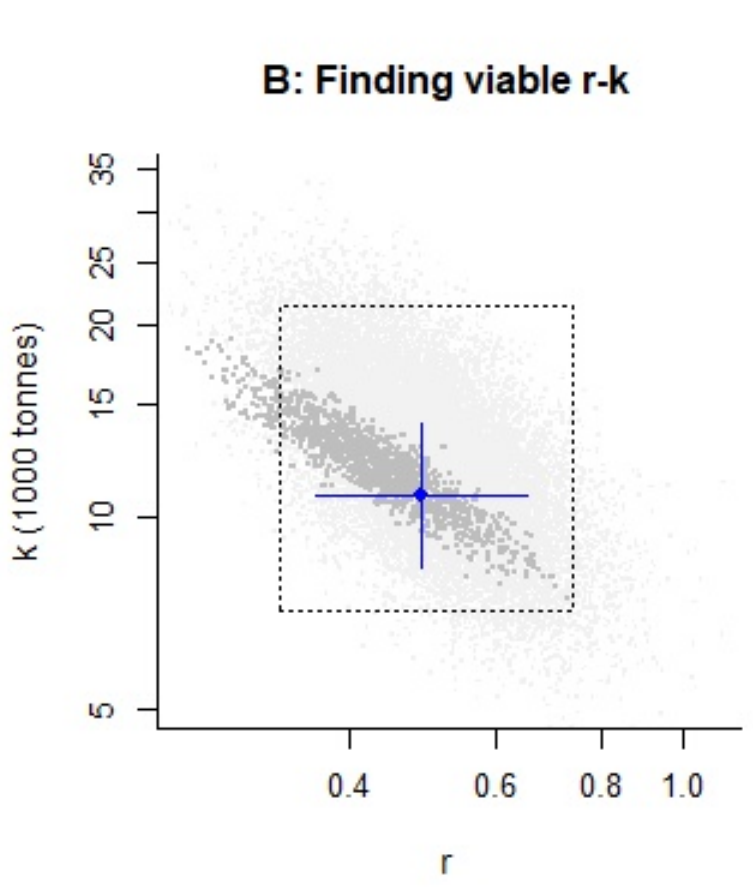


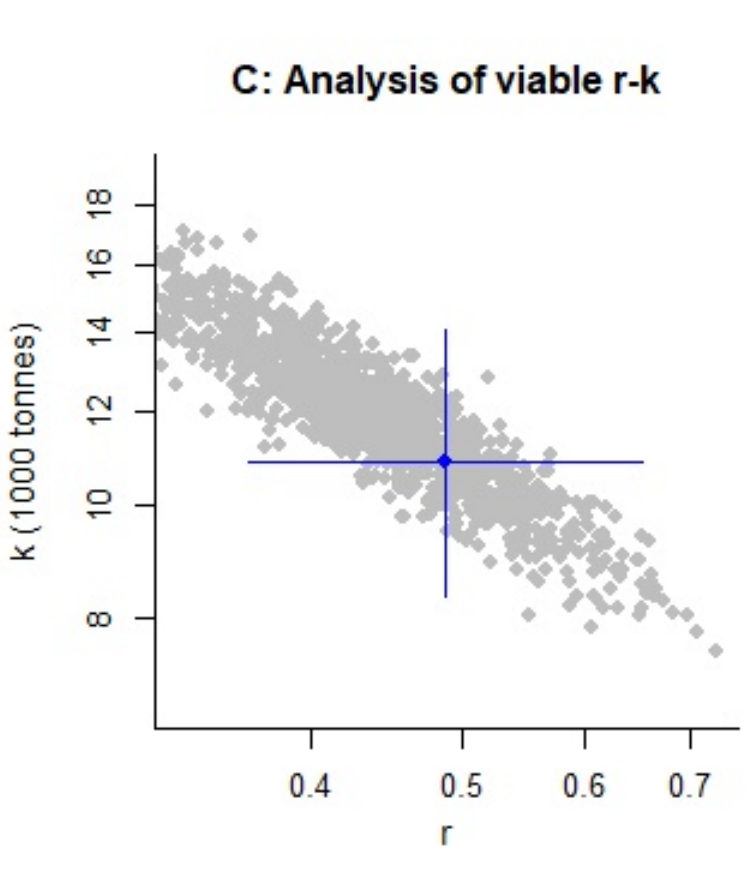
Exploitation

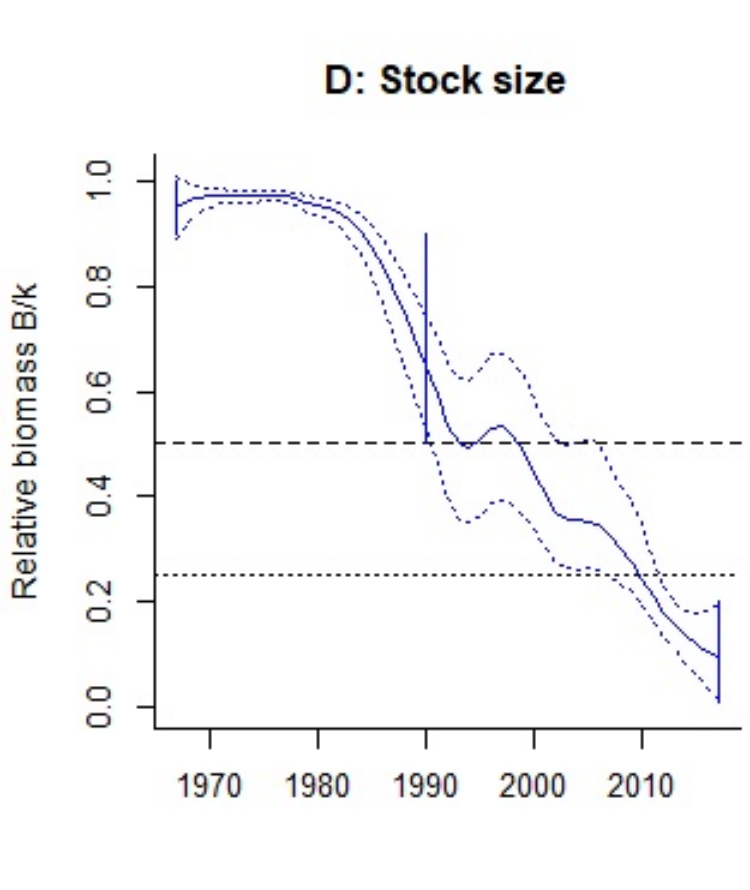


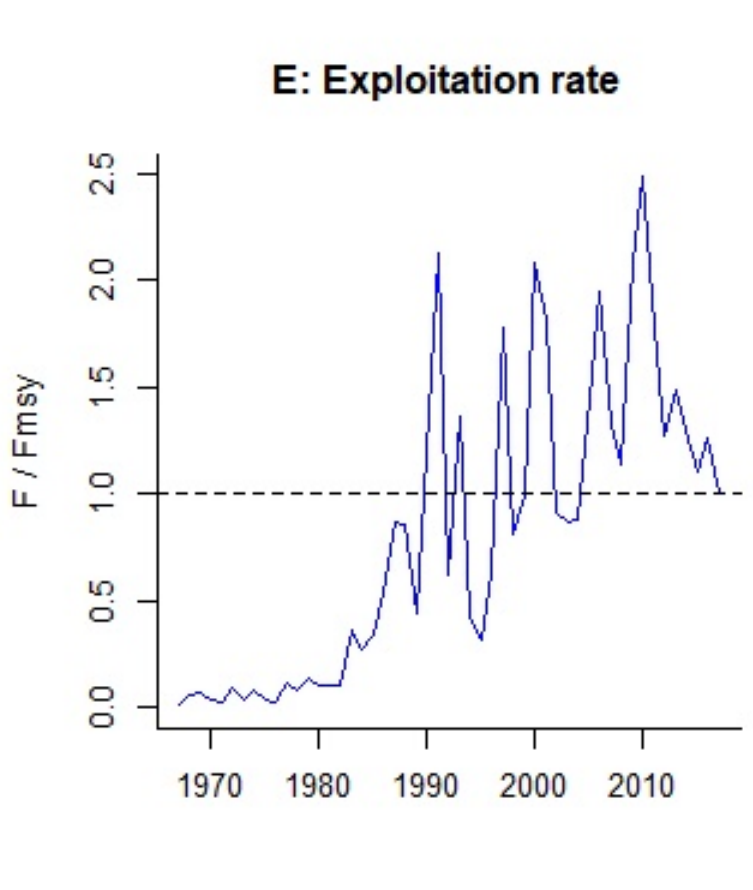


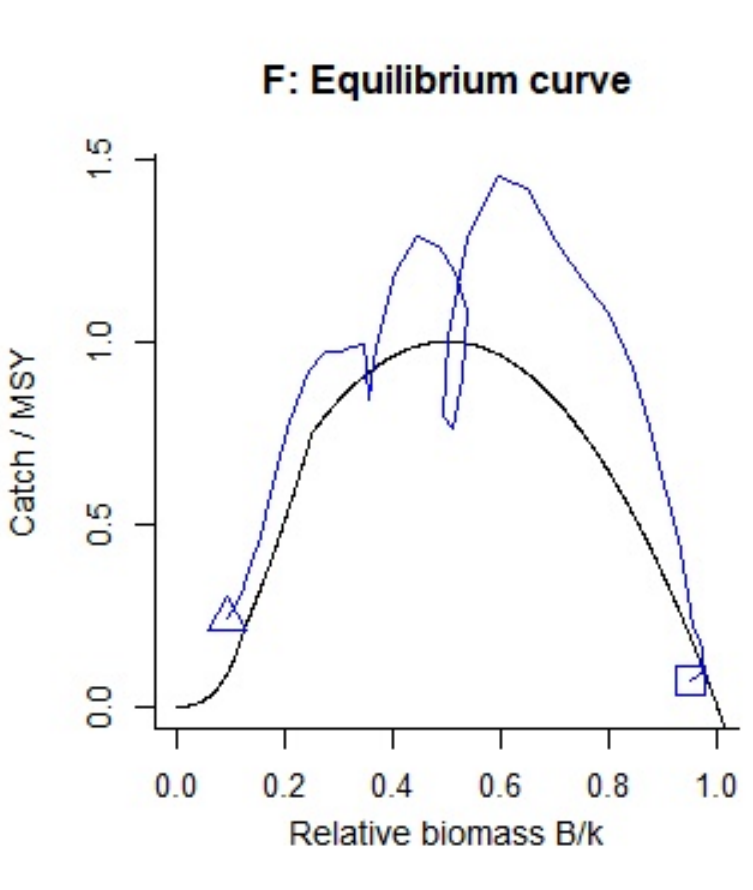

A: Catch Whiting_MS
Catch (1000 tonnes/year)
0
1
2
3
4
1970
1980
1990
2000
2010

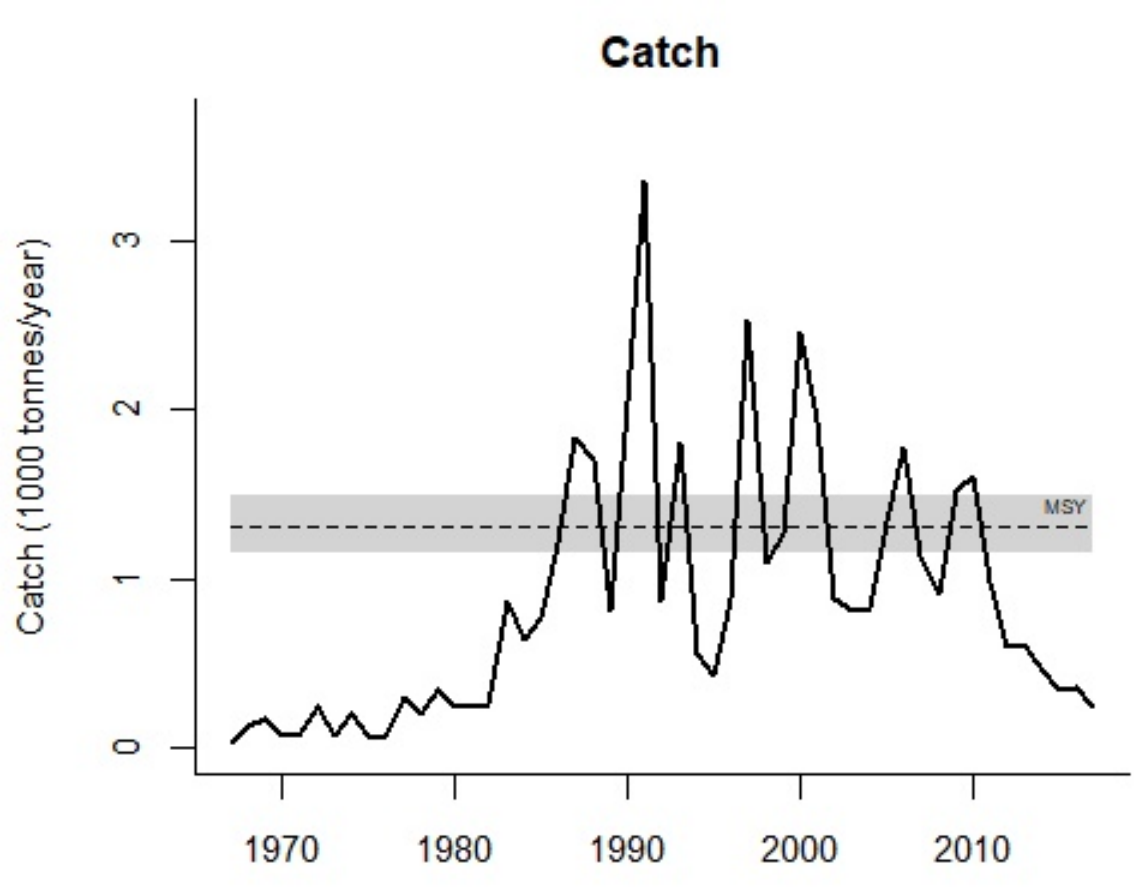

B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
25
35
0.4
0.6
0.8
1.0
r

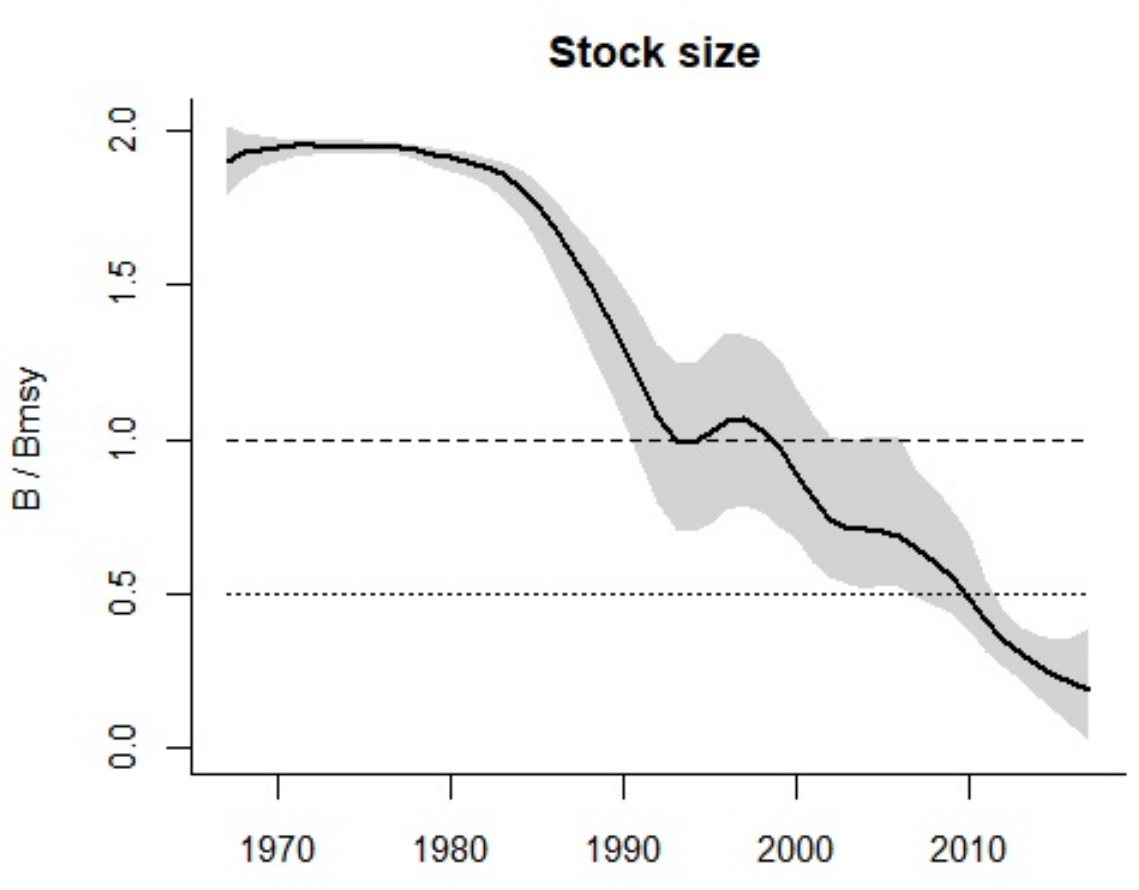

C: Analysis of viable r-k
k (1000 tonnes)
8
10
12
14
16
18
0.4
0.5
0.6
0.7
r

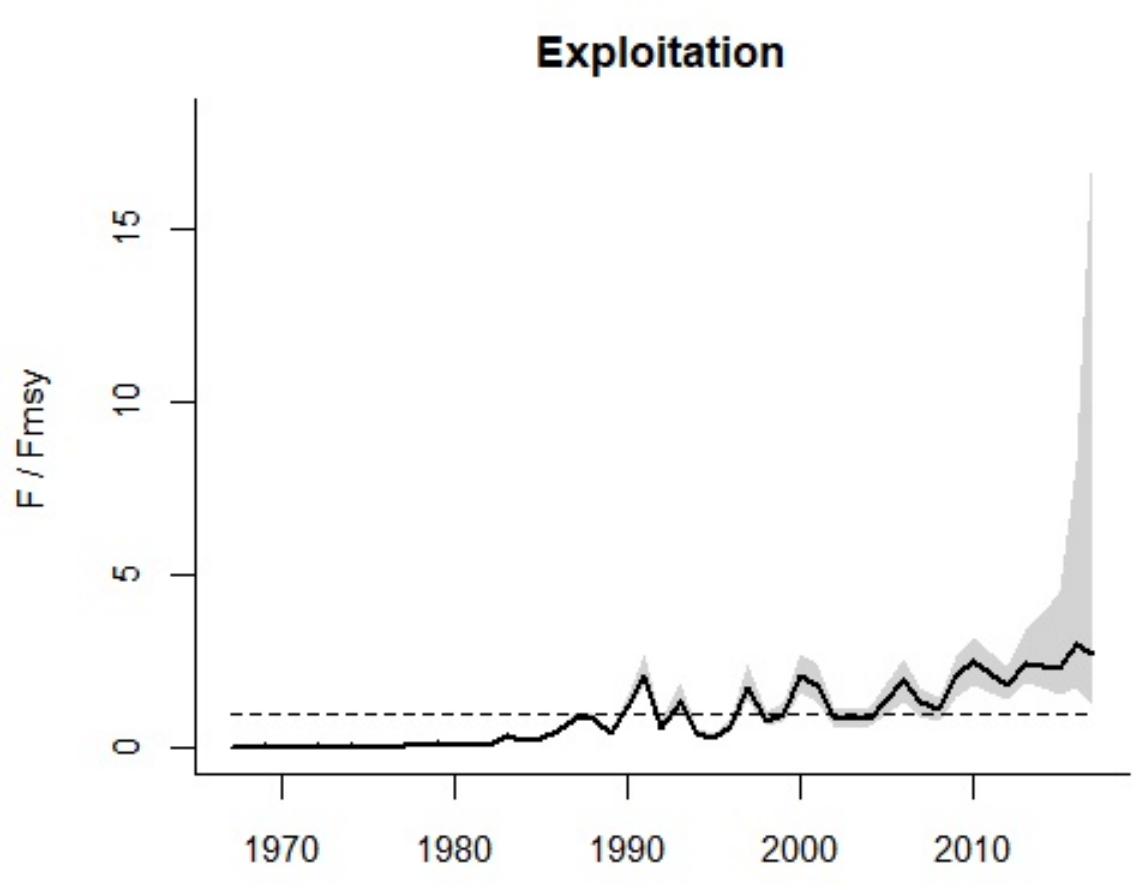

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

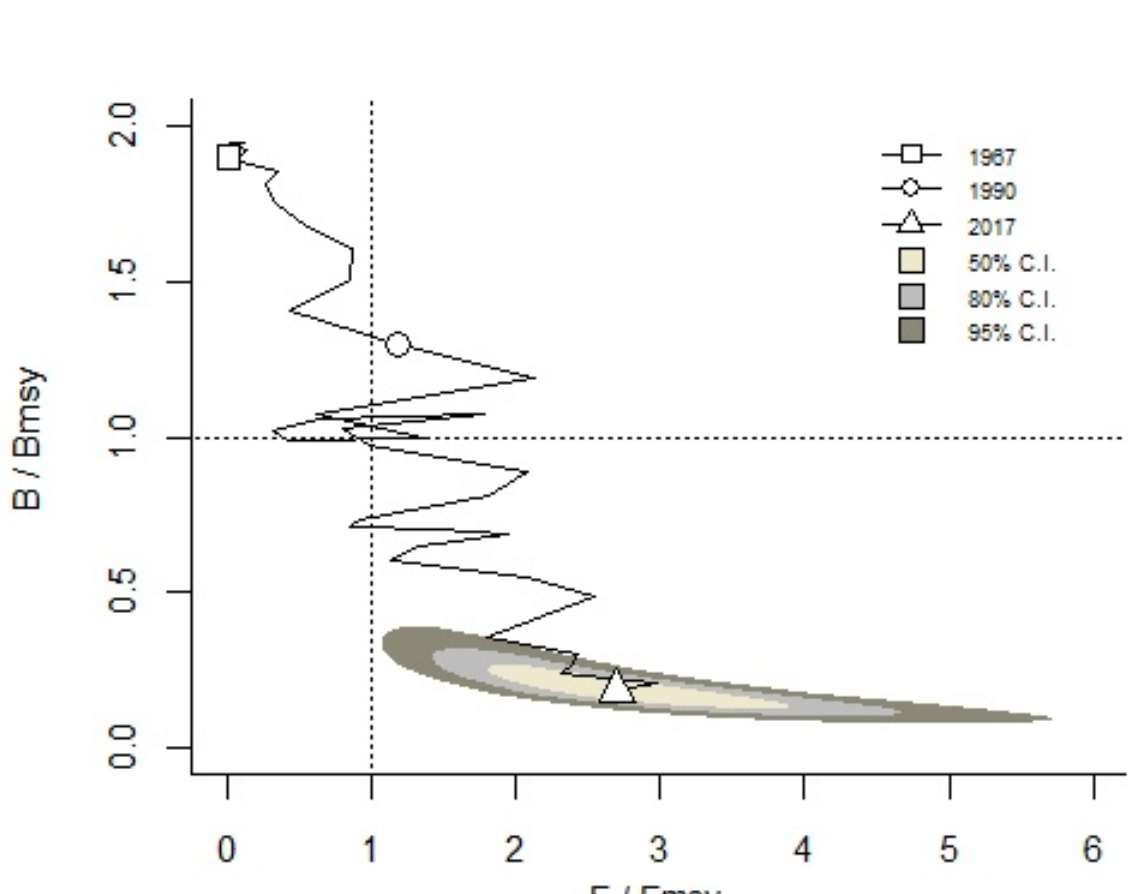

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

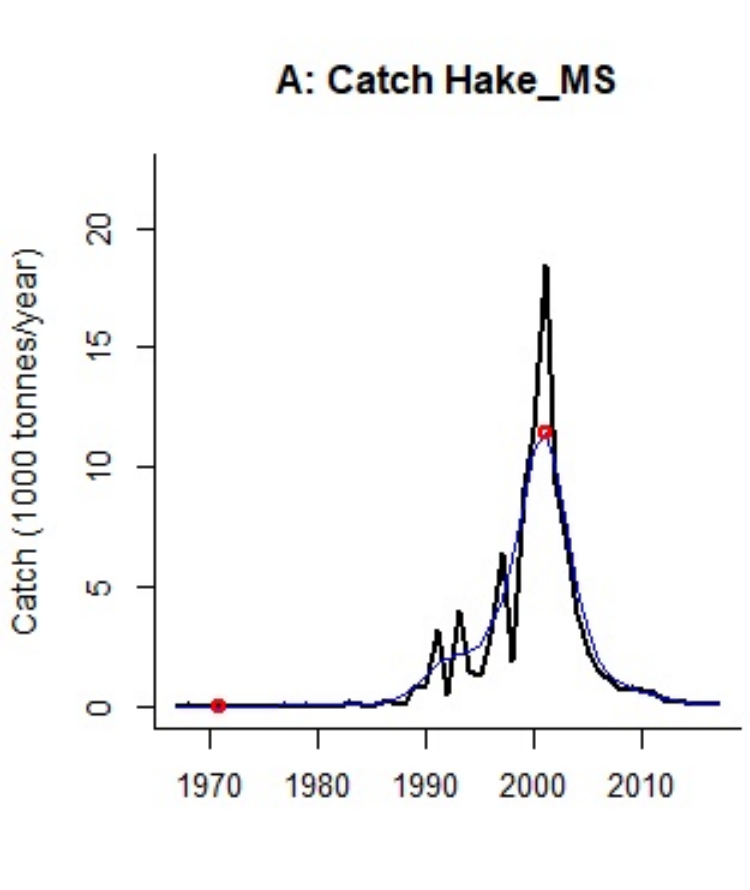

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

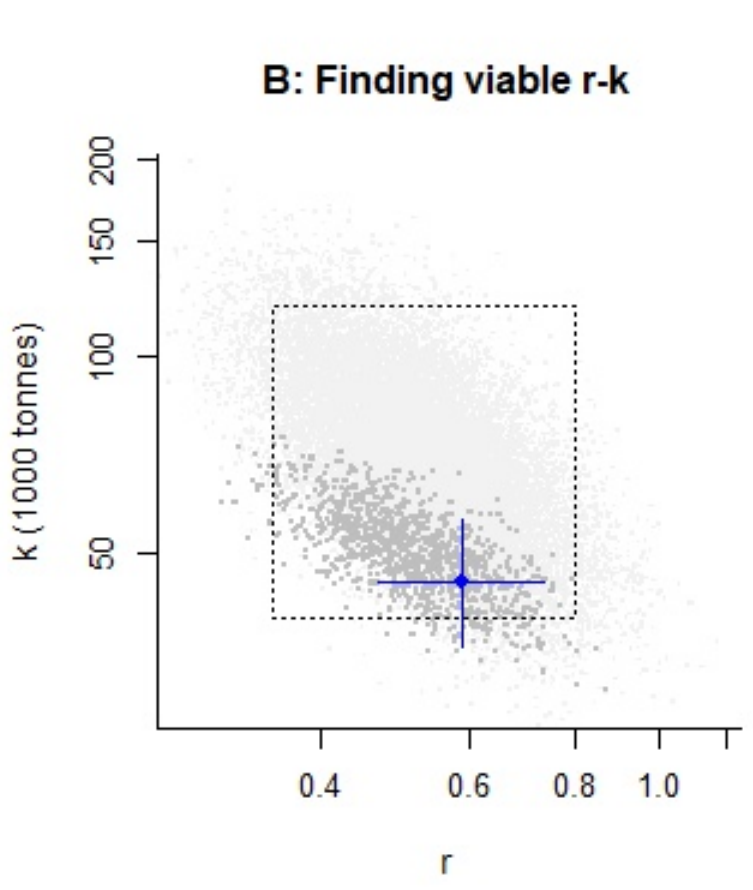

Catch
Catch (1000 tonnes/year)
0
1
2
3
MSY
1970
1980
1990
2000
2010

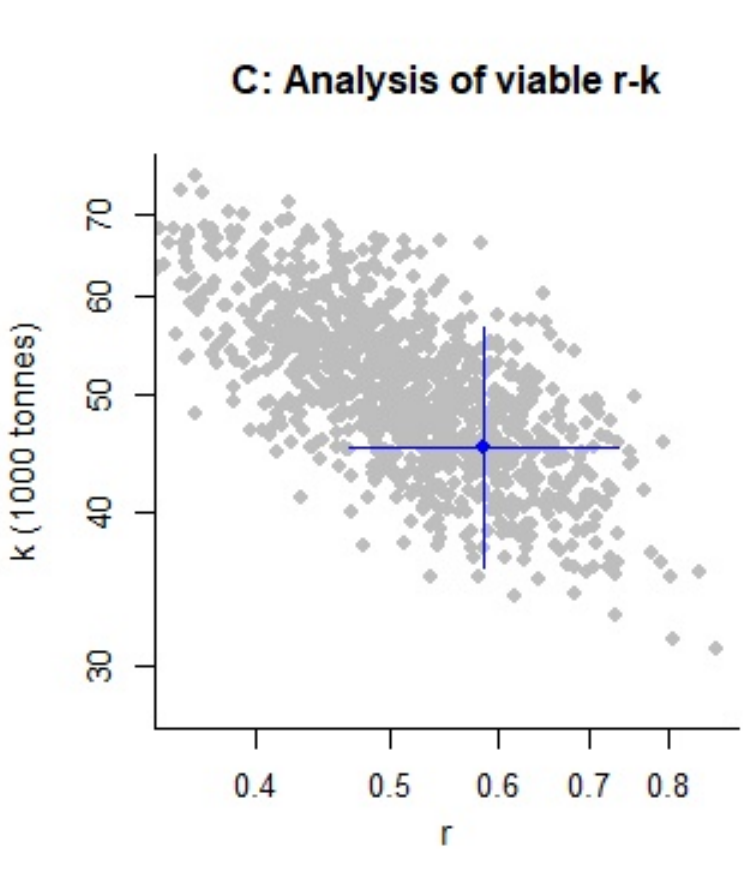

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

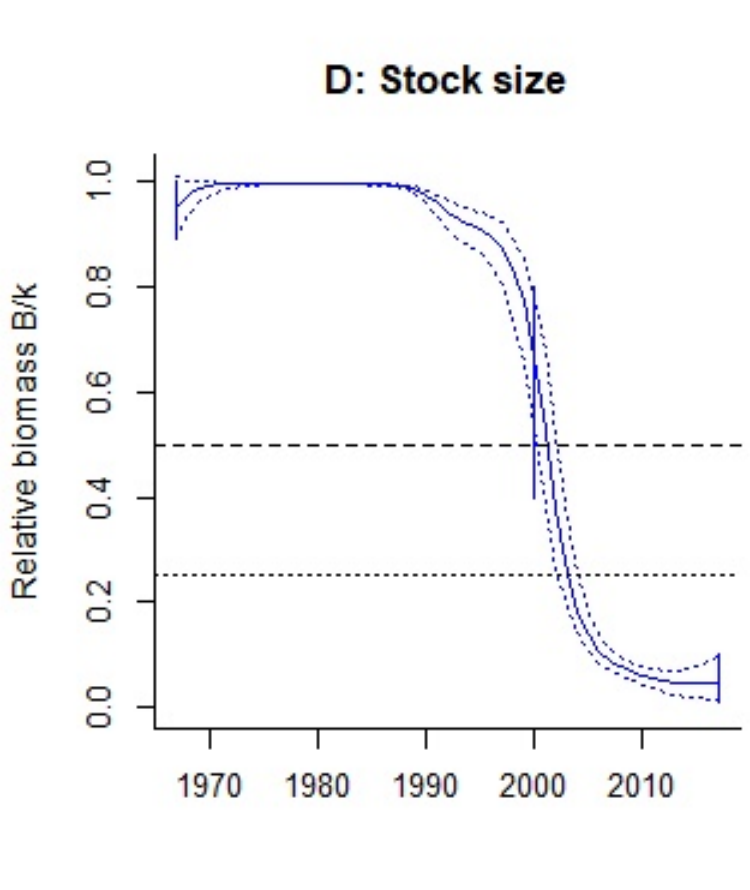

Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

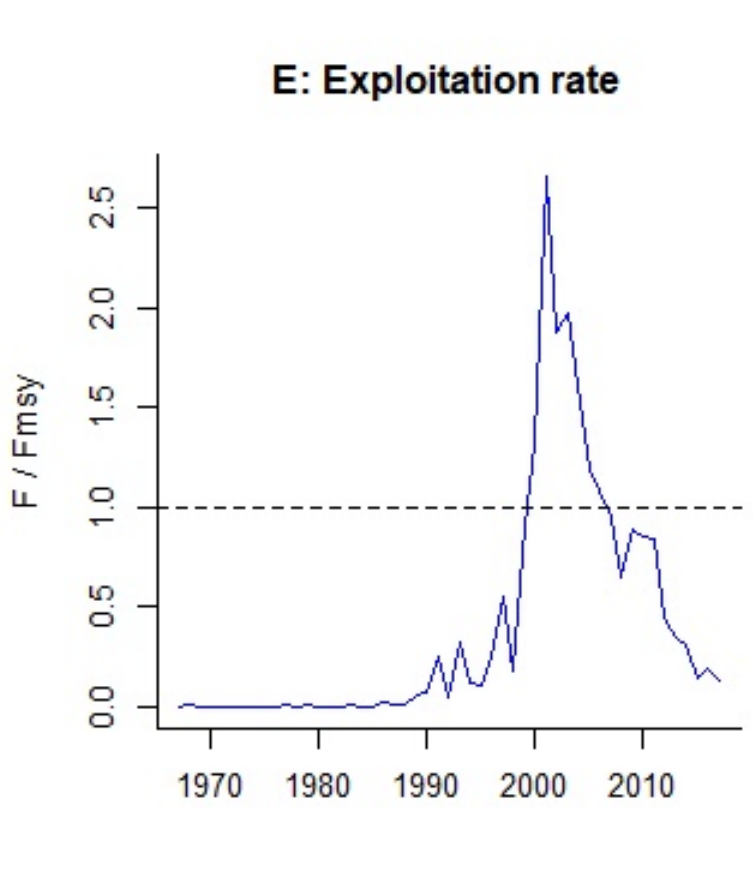

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
1990
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
5
6
F / Fmsy

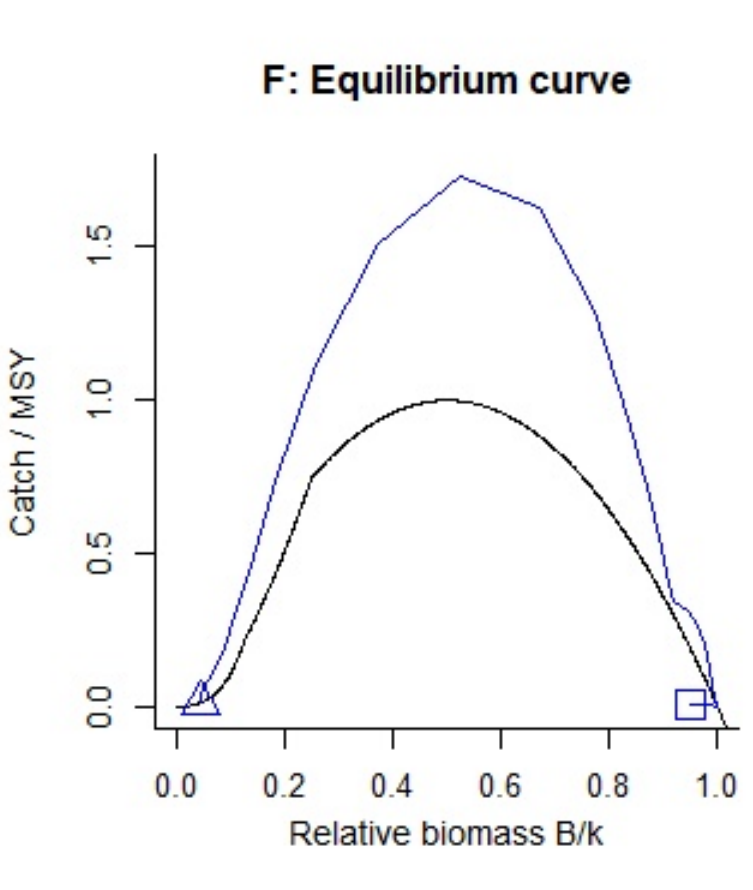

A: Catch Hake_MS
Catch (1000 tonnes/year)
0
5
10
15
20
1970
1980
1990
2000
2010

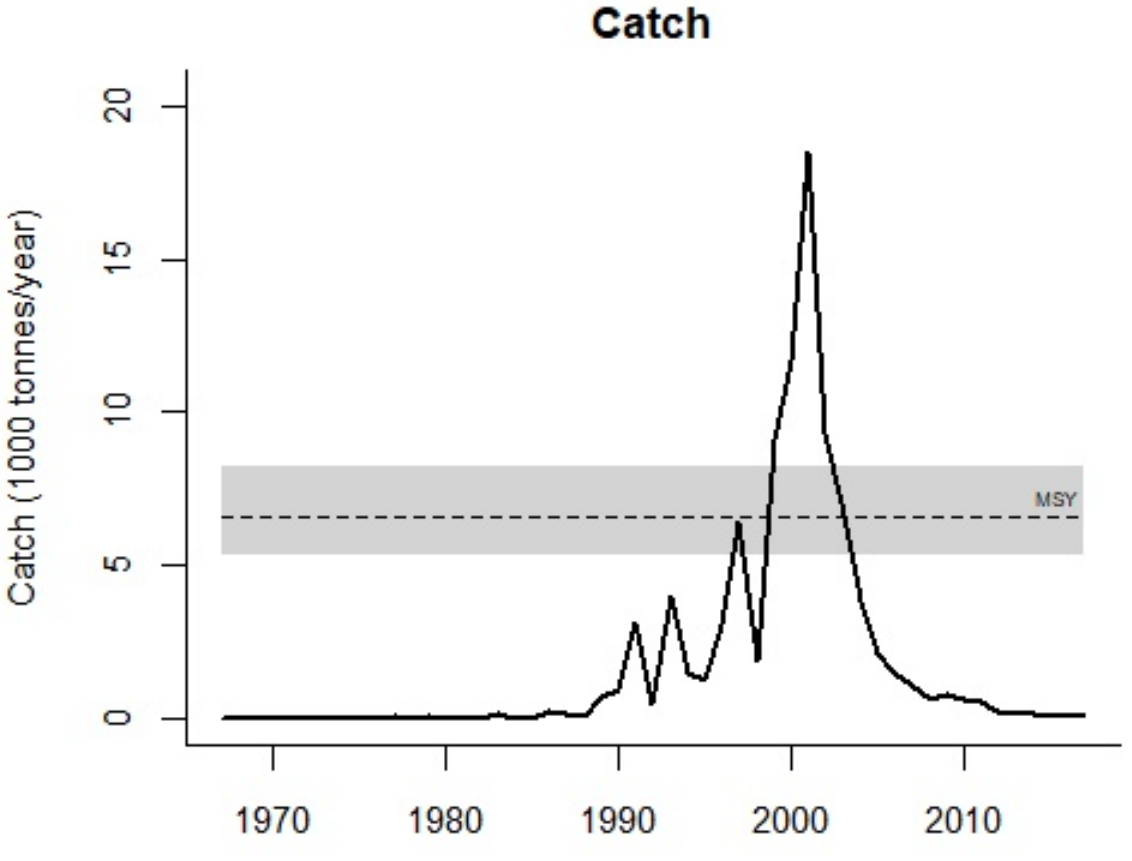

B: Finding viable r-k
k (1000 tonnes)
50
100
150
200
0.4
0.6
0.8
1.0
r

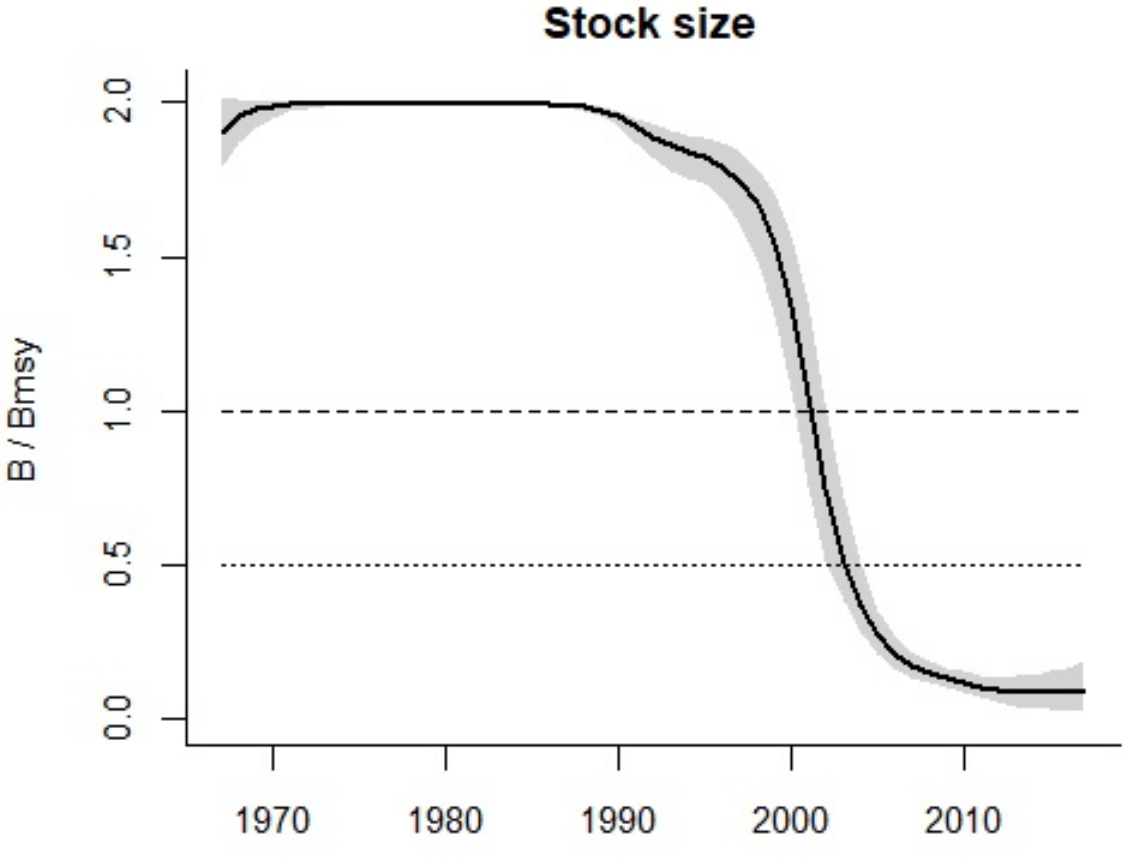

C: Analysis of viable r-k
k (1000 tonnes)
30
40
50
60
70
0.4
0.5
0.6
0.7
0.8
r

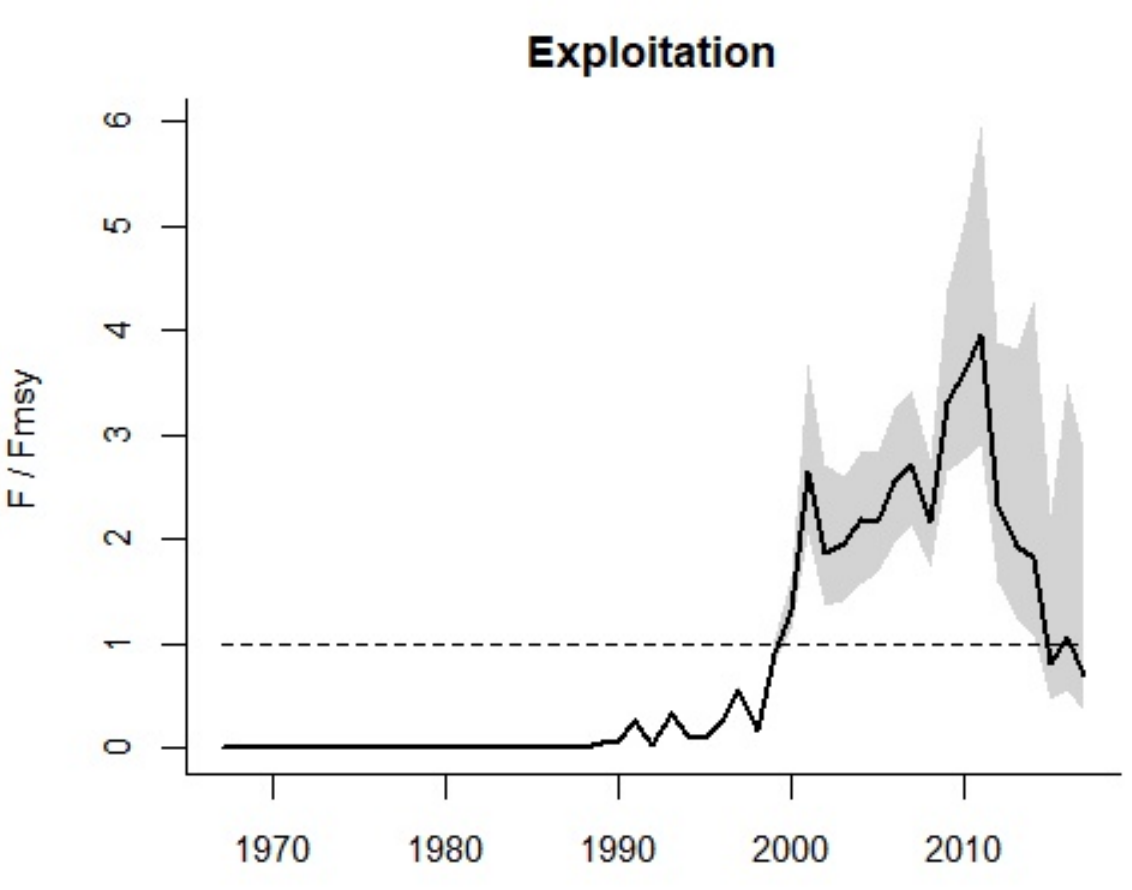

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

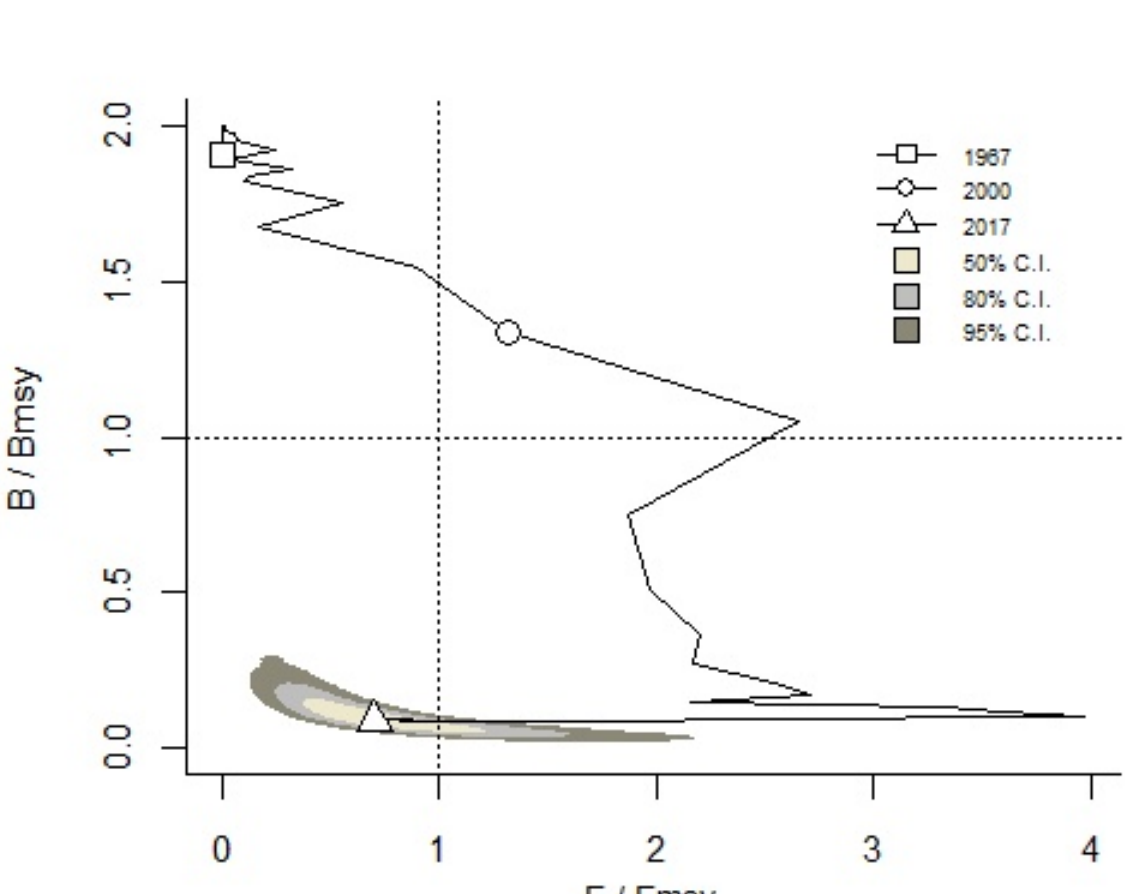

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

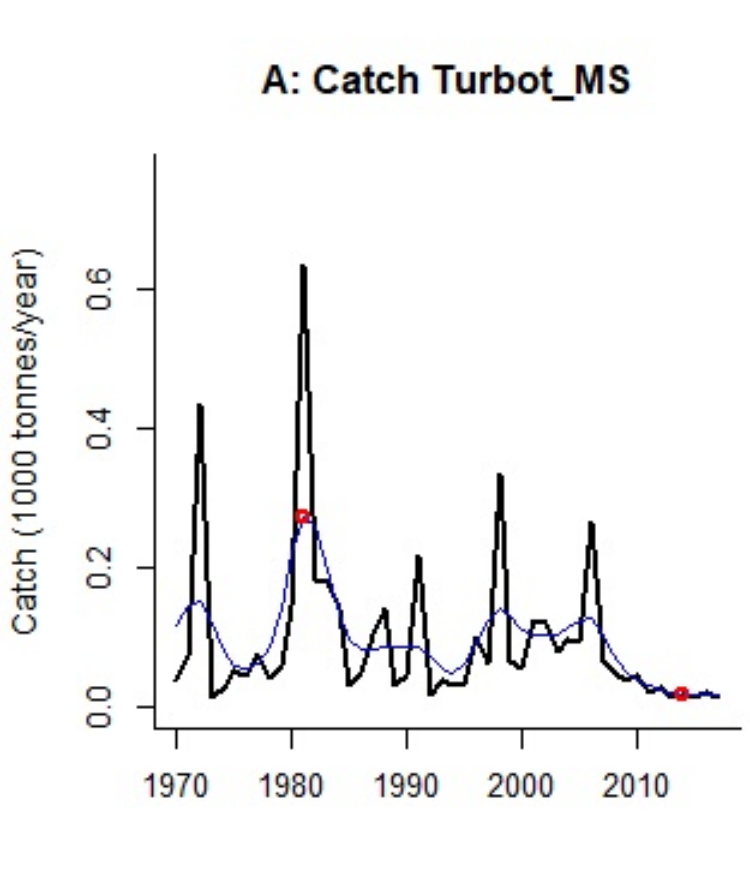

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

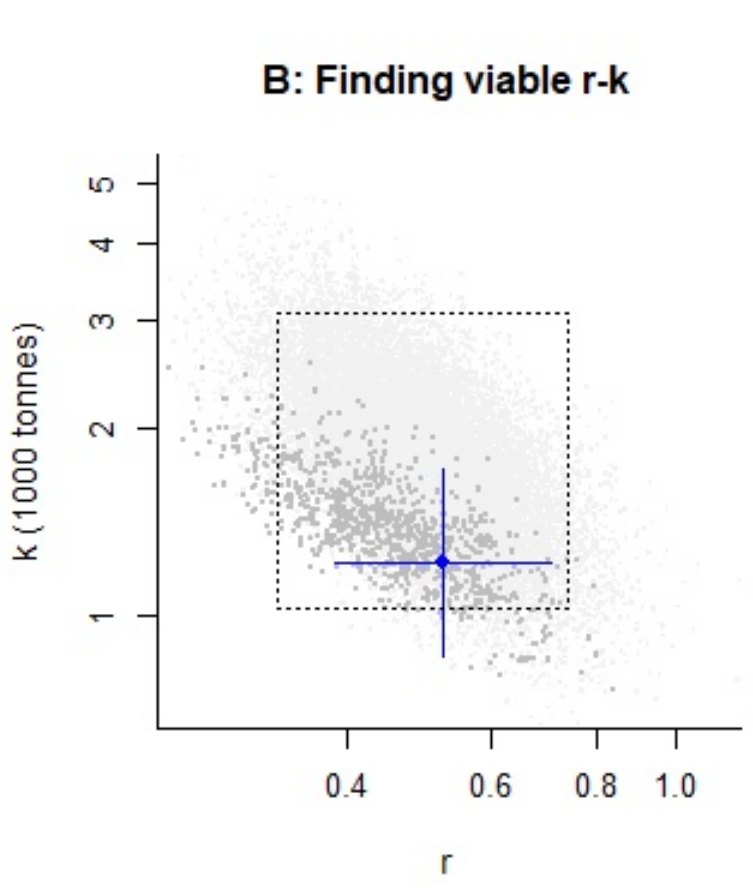

Catch
Catch (1000 tonnes/year)
0
5
10
15
20
MSY
1970
1980
1990
2000
2010

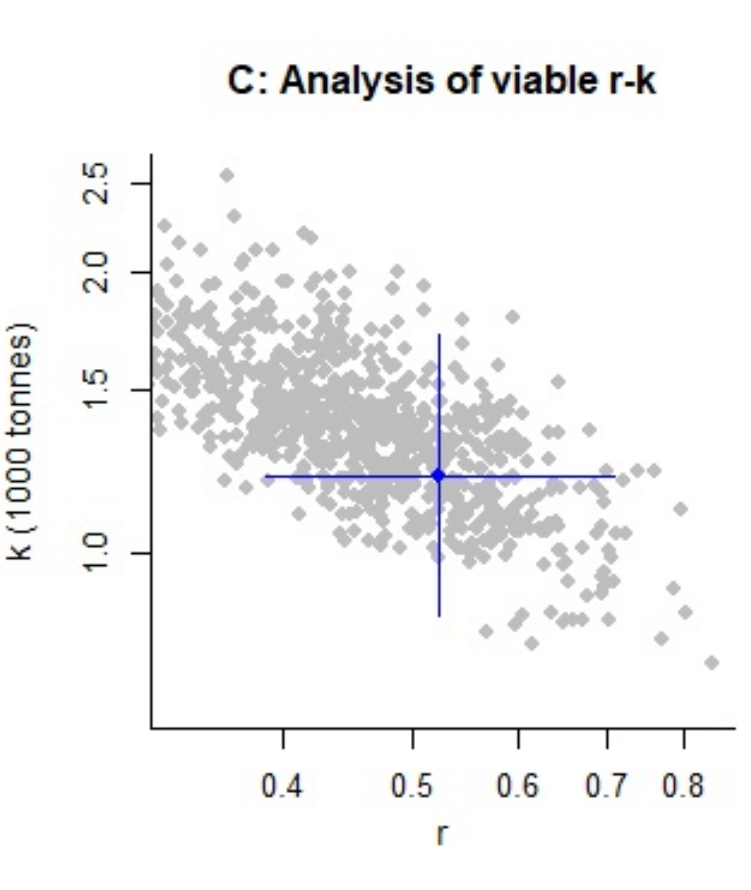

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

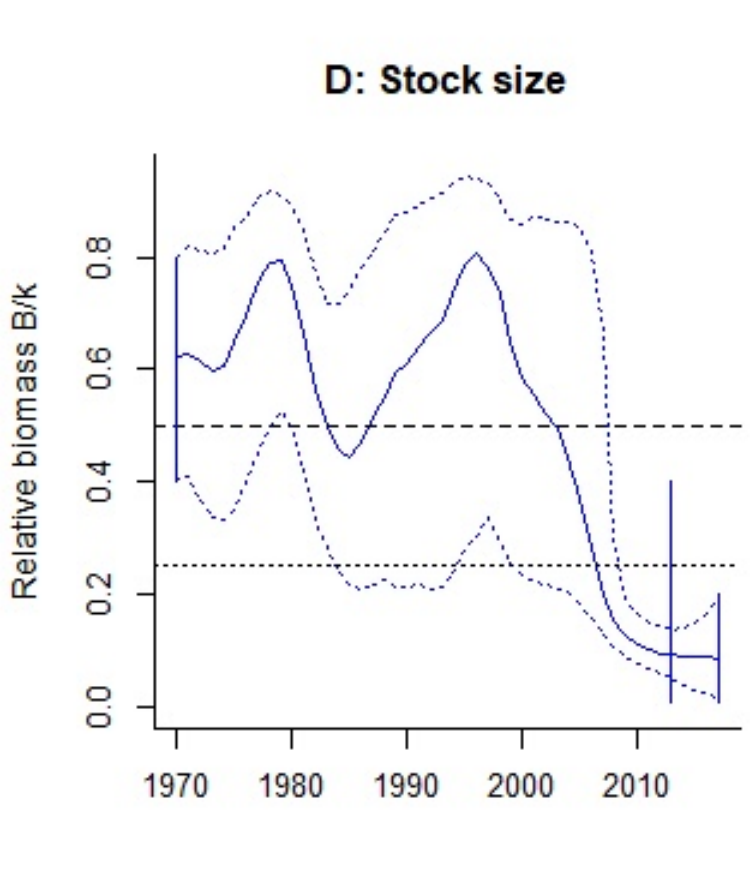

Exploitation
F / Fmsy
0
1
2
3
4
5
6
1970
1980
1990
2000
2010

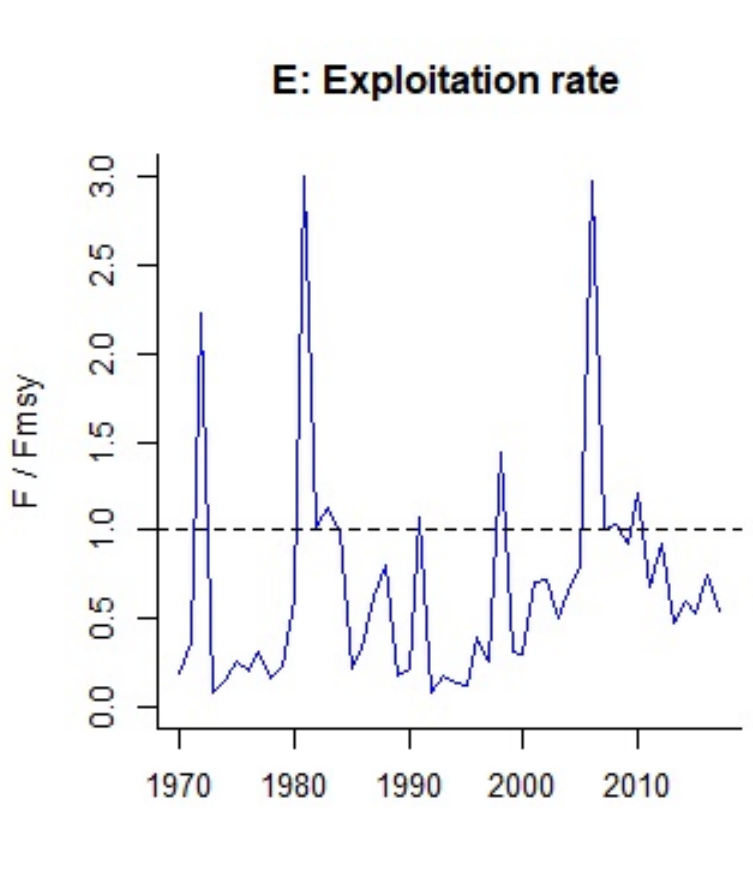

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2000
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
F / Fmsy

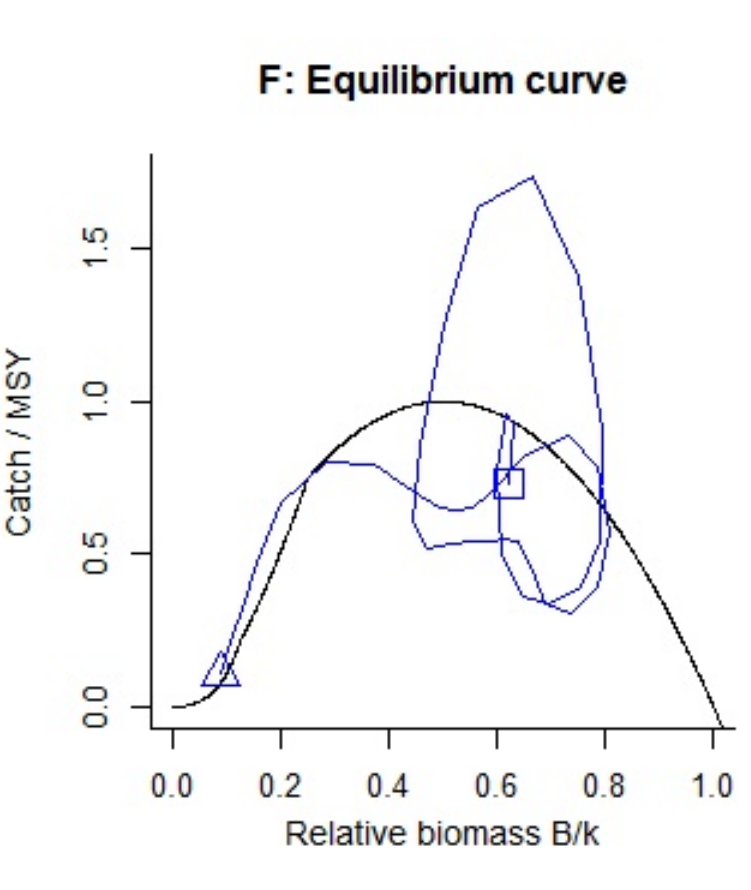

A: Catch Turbot_MS
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
1
2
3
4
5
0.4
0.6
0.8
1.0
r

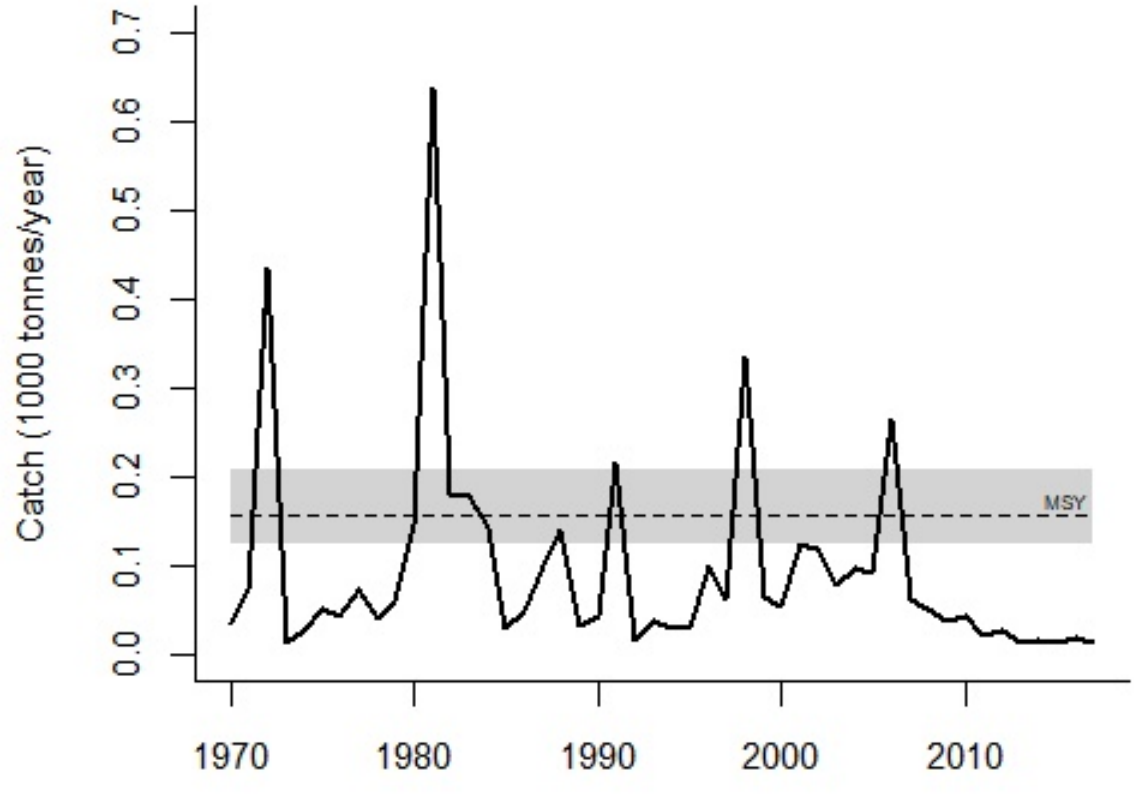

C: Analysis of viable r-k
k (1000 tonnes)
1.0
1.5
2.0
2.5
0.4
0.5
0.6
0.7
0.8
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

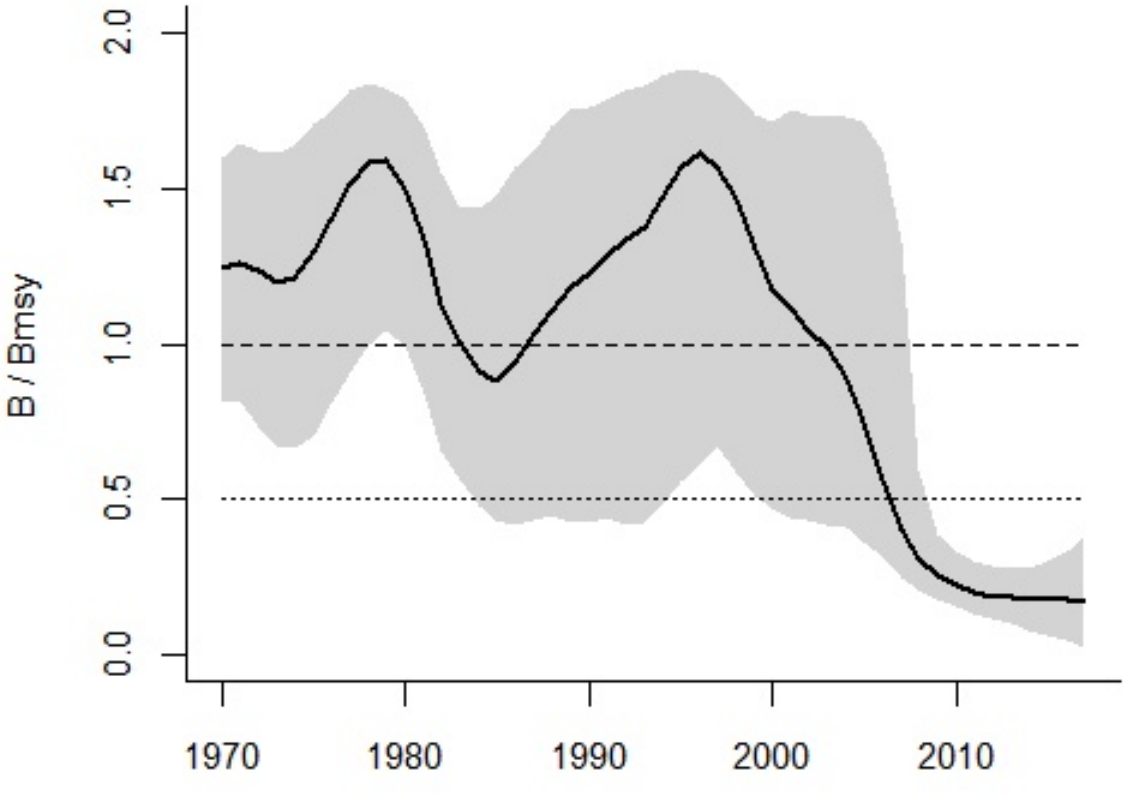

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

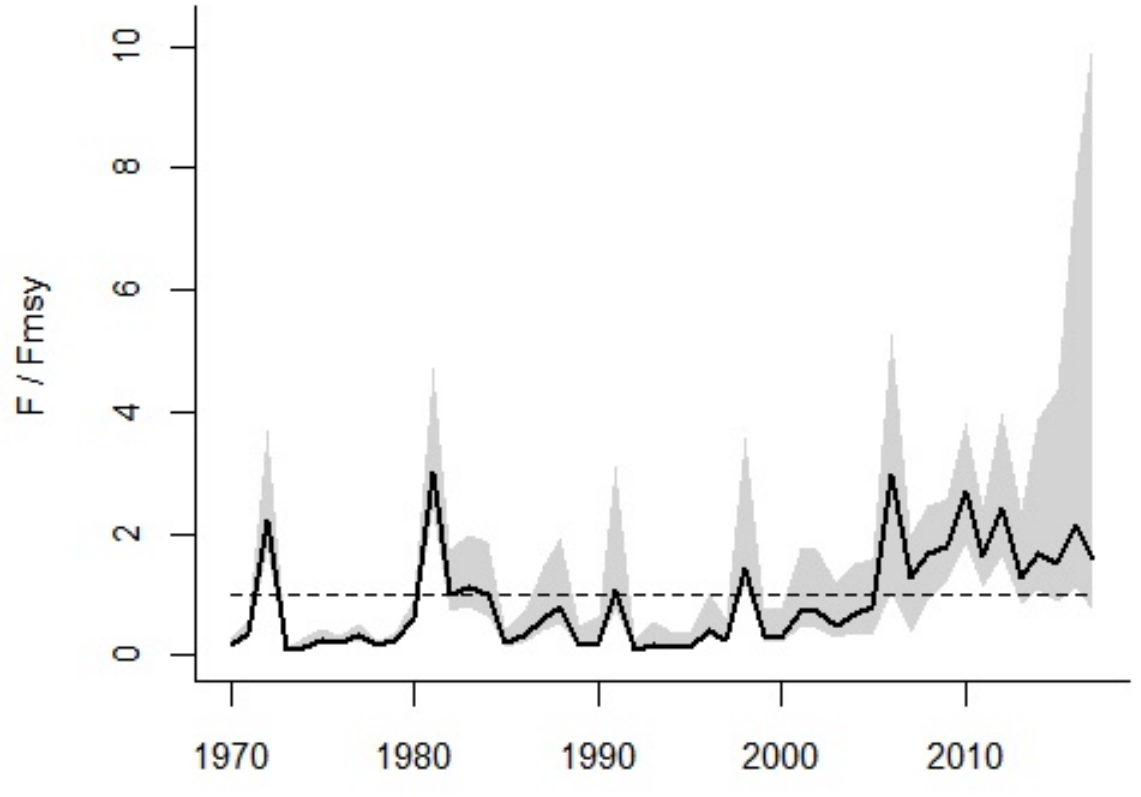
Catch

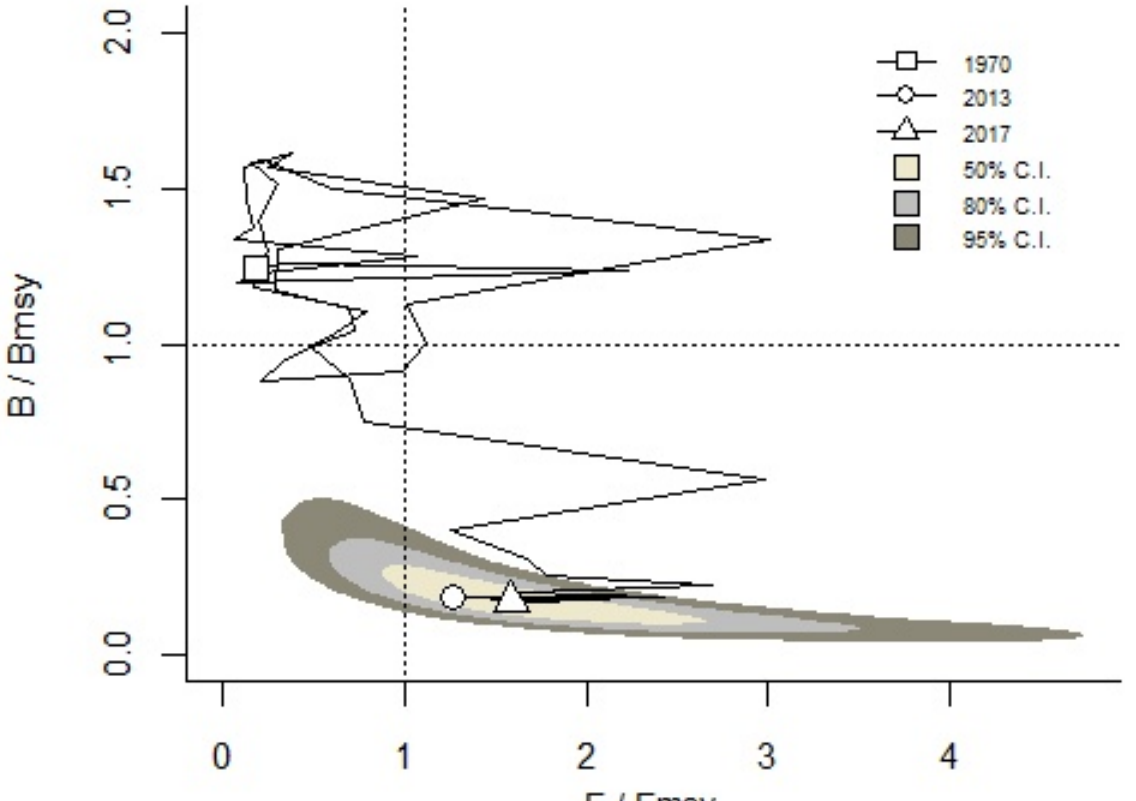


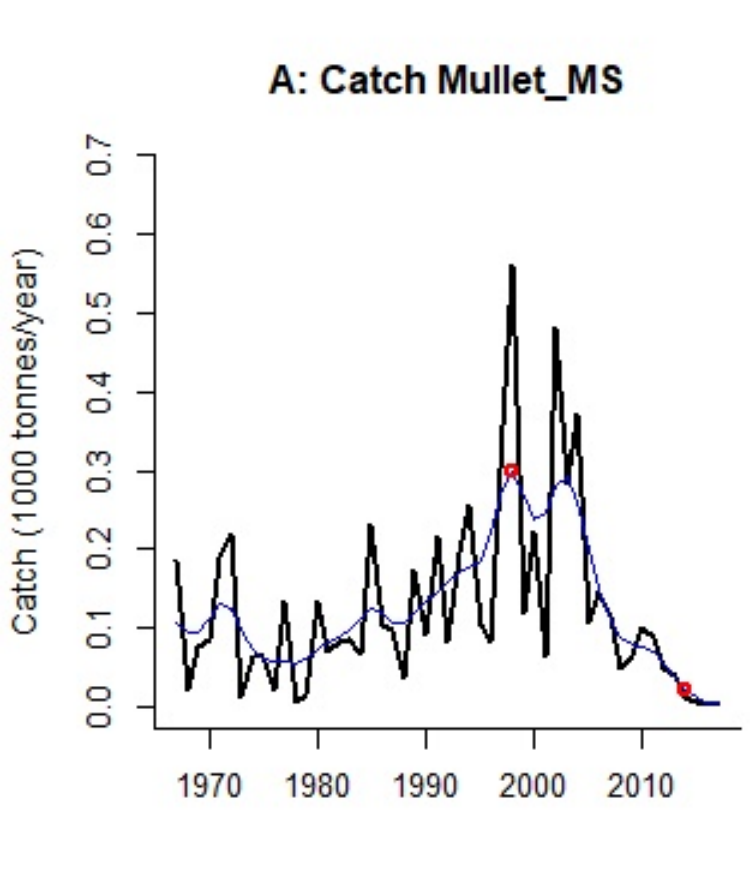
Stock size

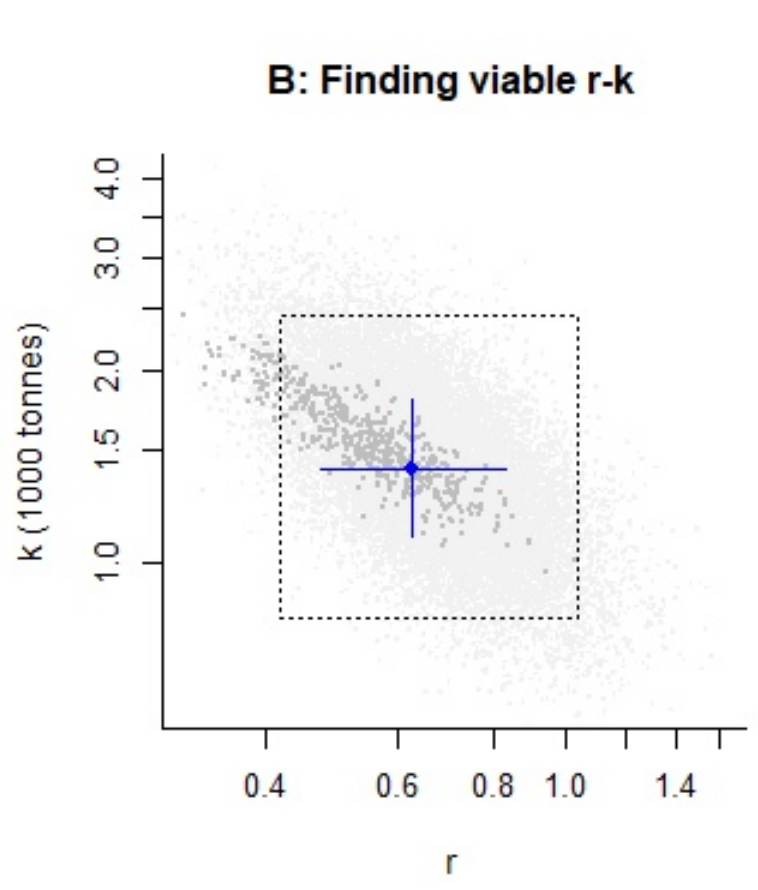


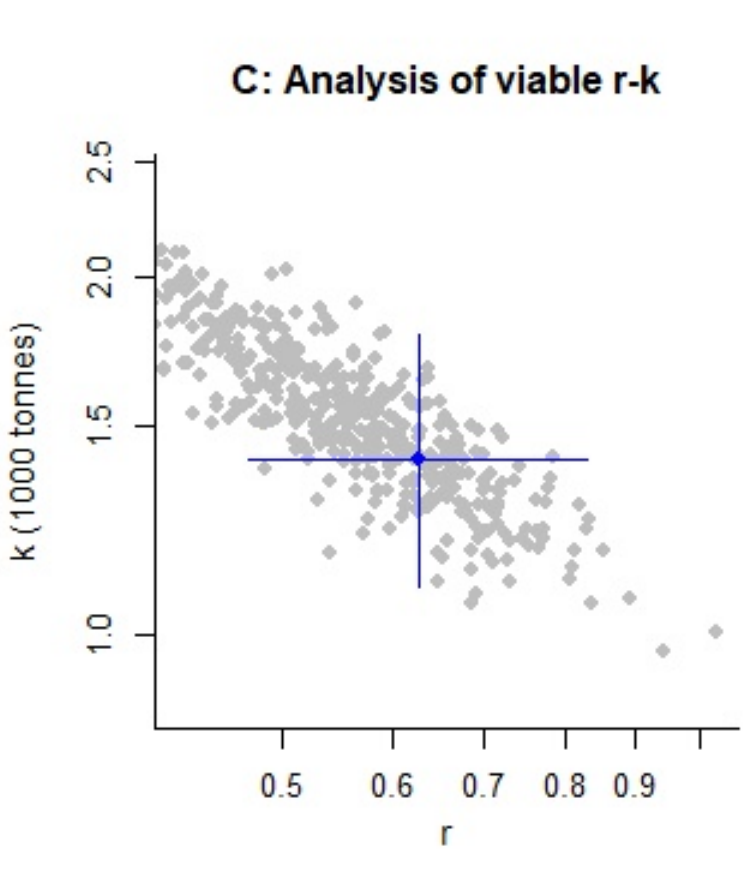
Exploitation

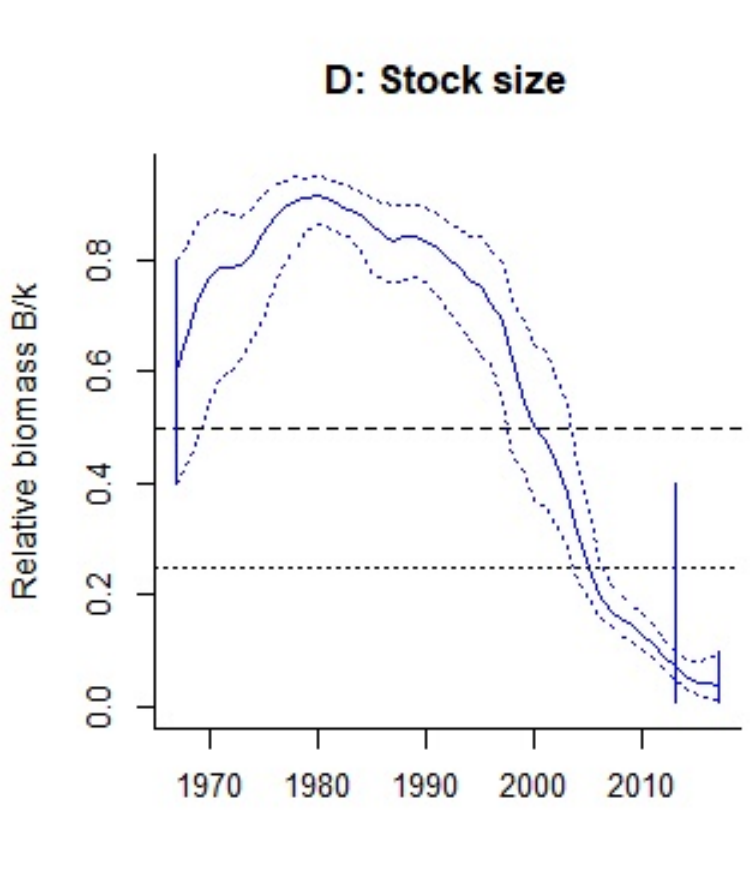


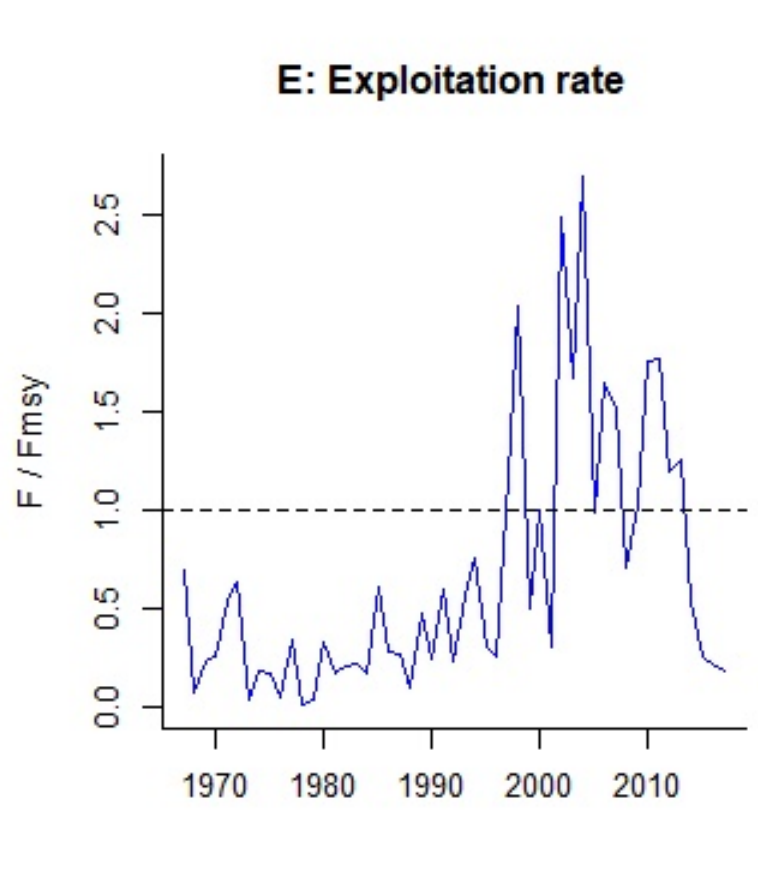


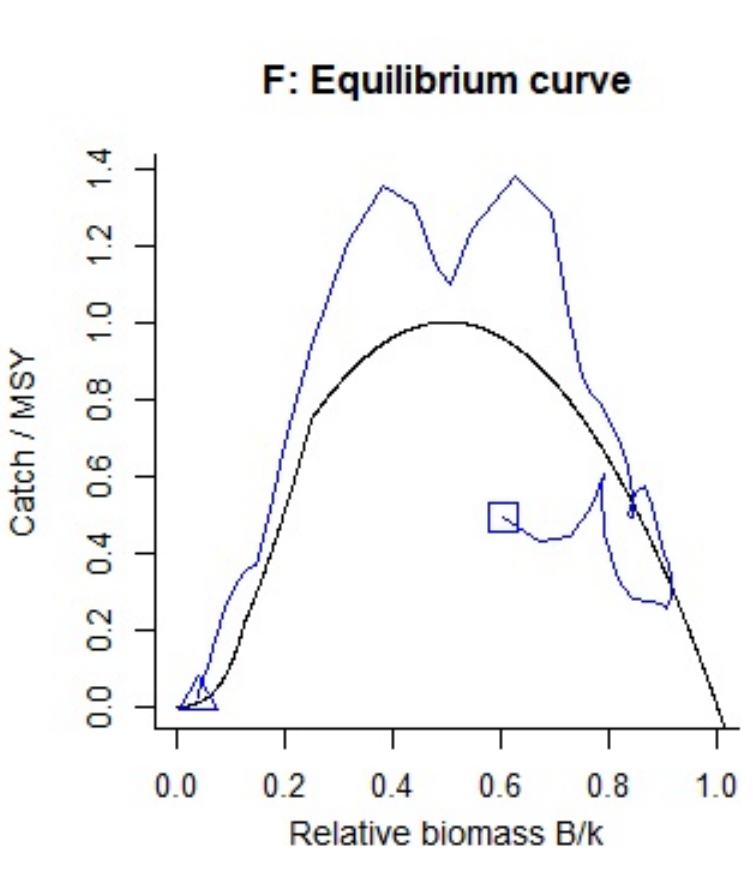

A: Catch Mullet_MS
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1970
1980
1990
2000
2010

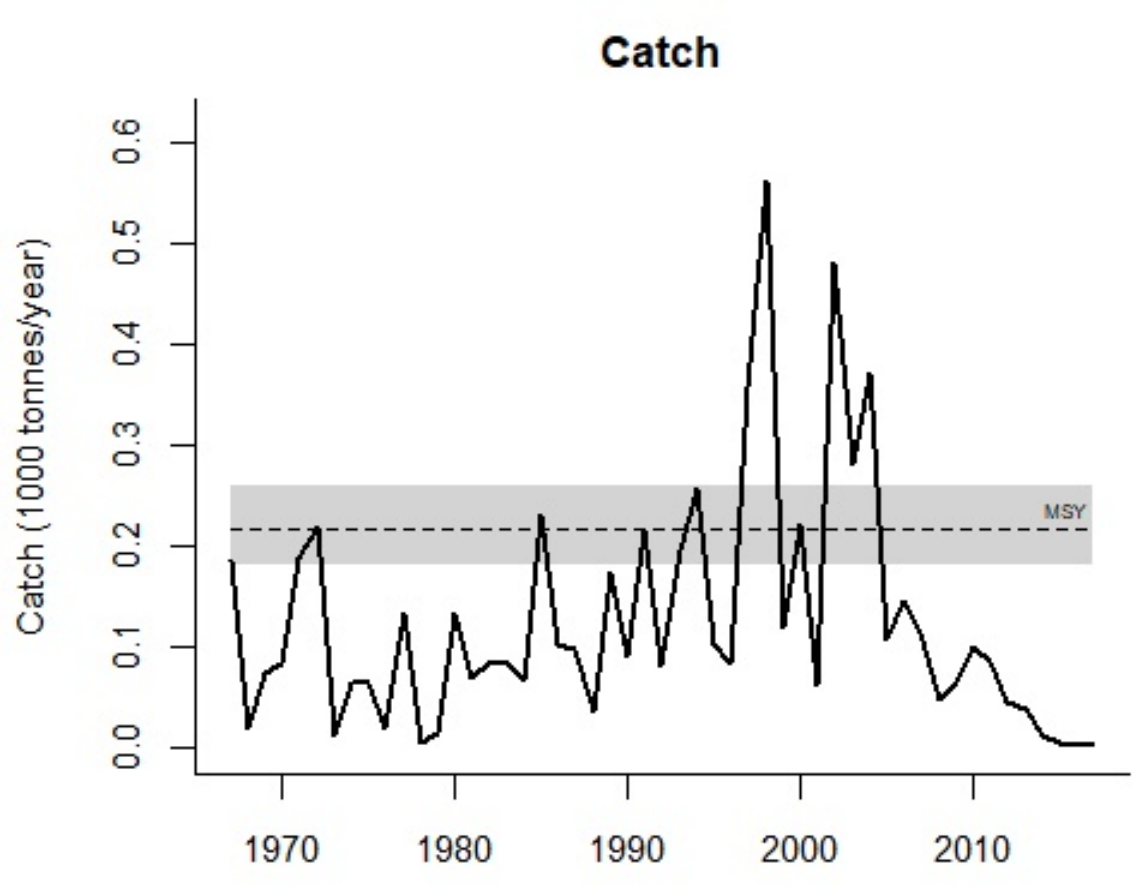

B: Finding viable r-k
k (1000 tonnes)
1.0
1.5
2.0
3.0
4.0
0.4
0.6
0.8
1.0
1.4
r

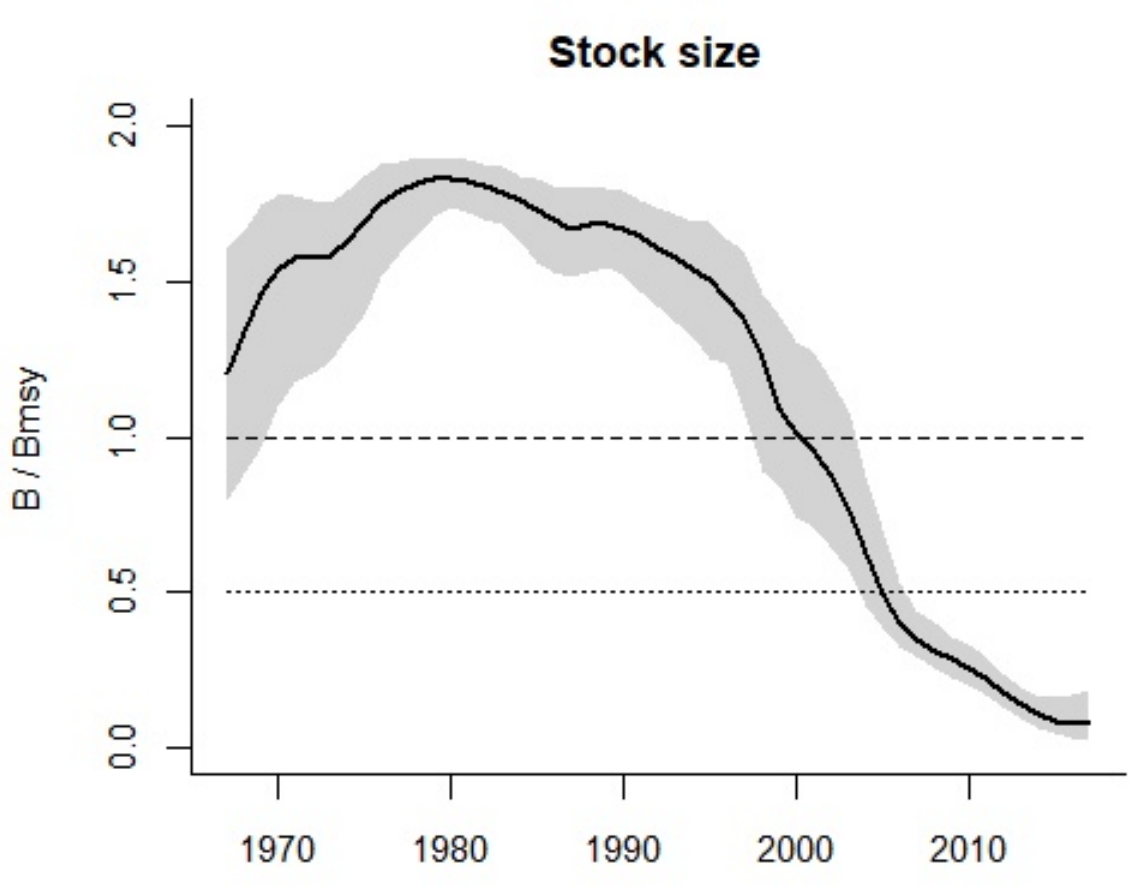

C: Analysis of viable r-k
k (1000 tonnes)
1.0
1.5
2.0
2.5
0.5
0.6
0.7
0.8
0.9
r

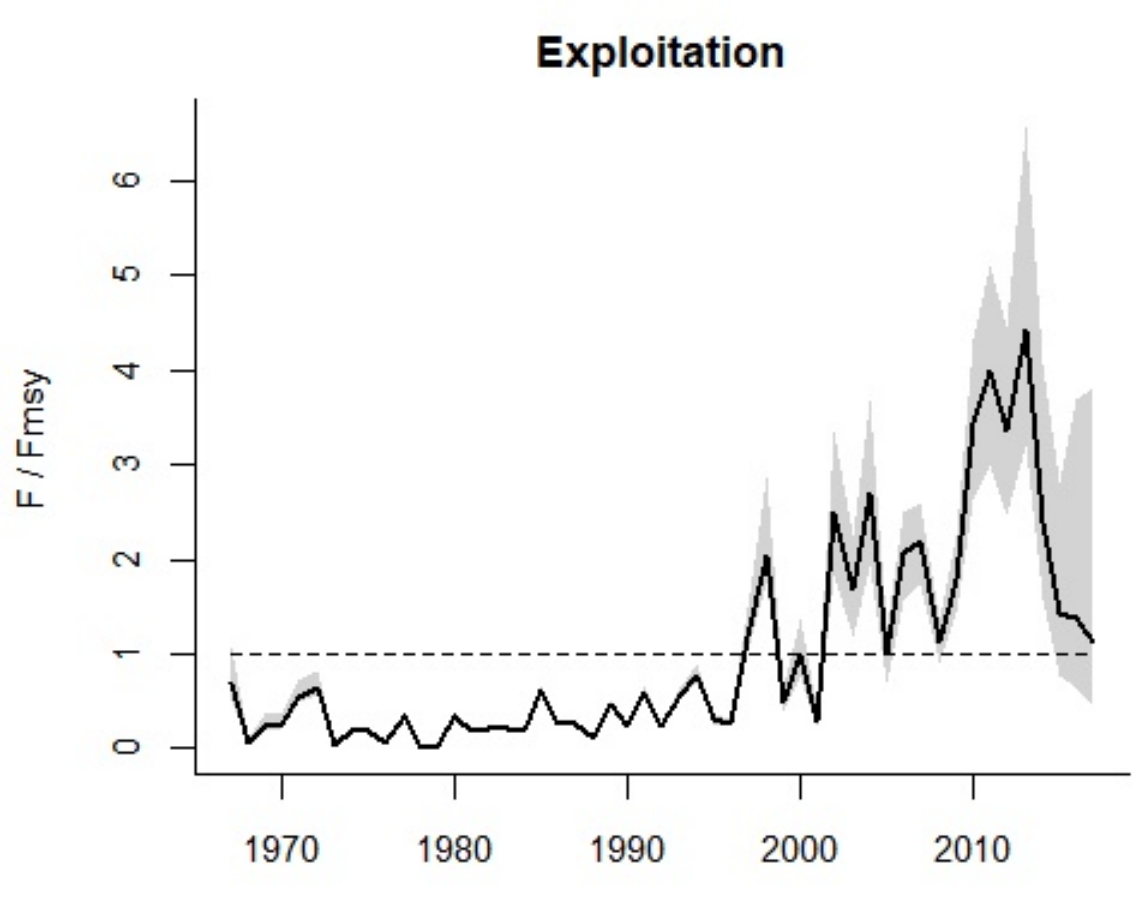

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

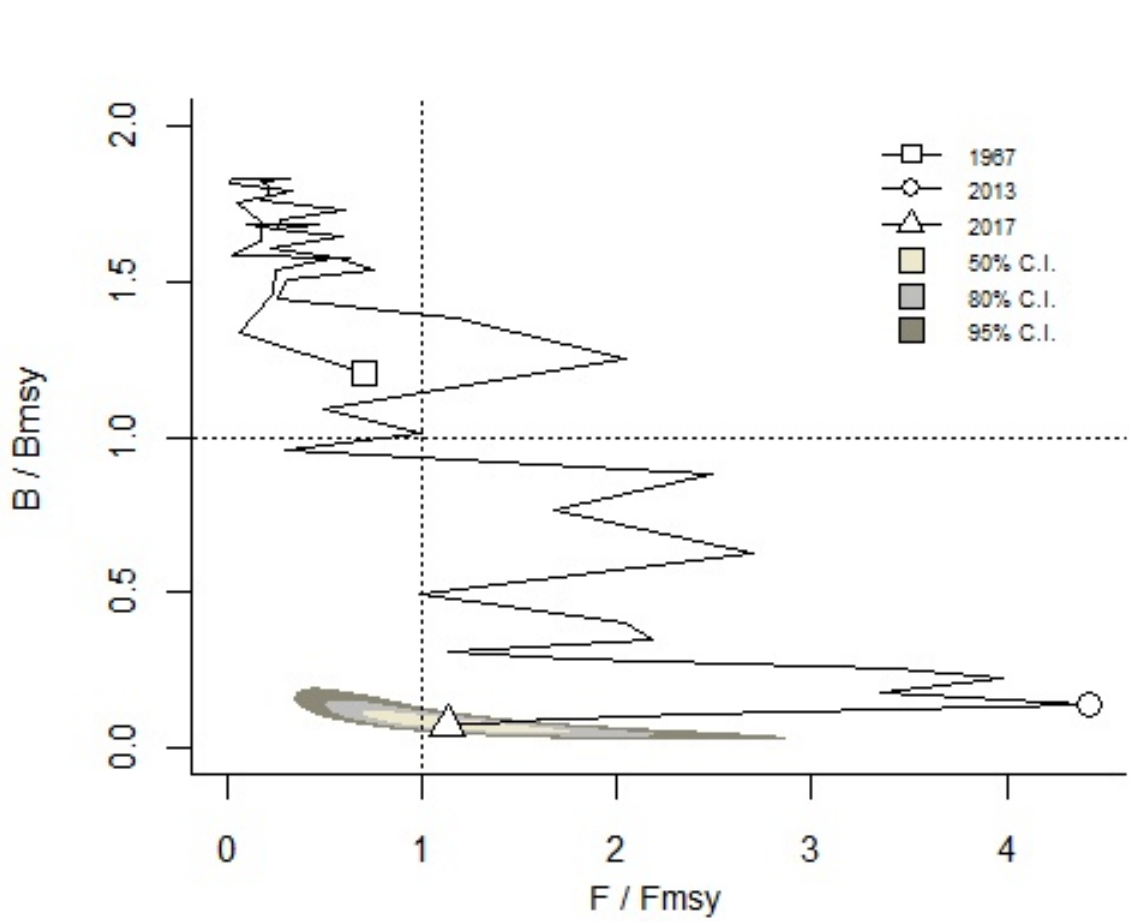

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

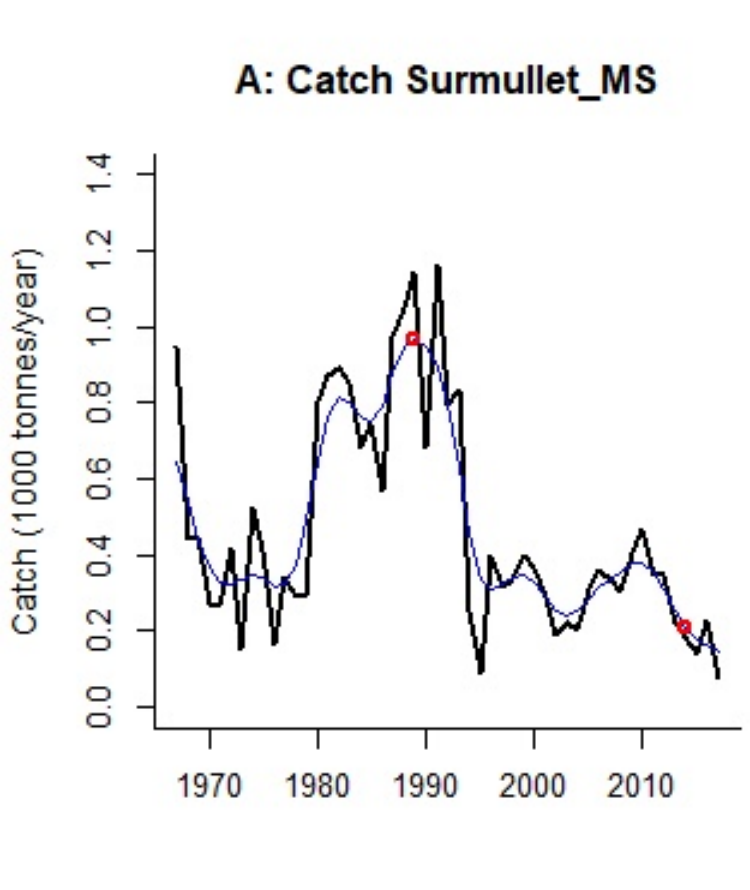

F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

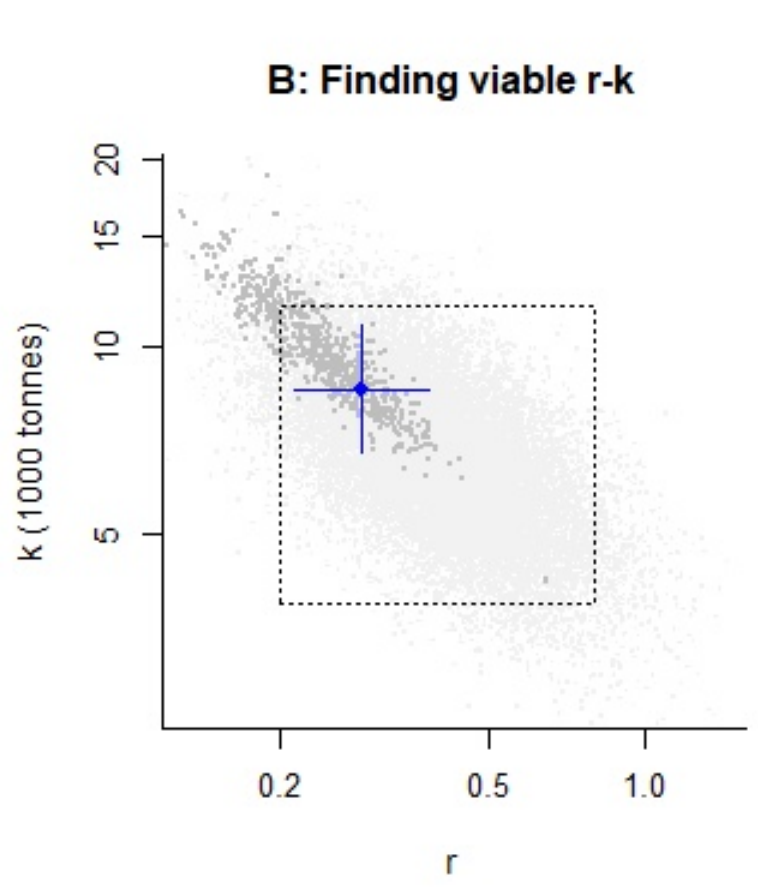

Catch
Catch (1000 tonnes/year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
MSY
1970
1980
1990
2000
2010

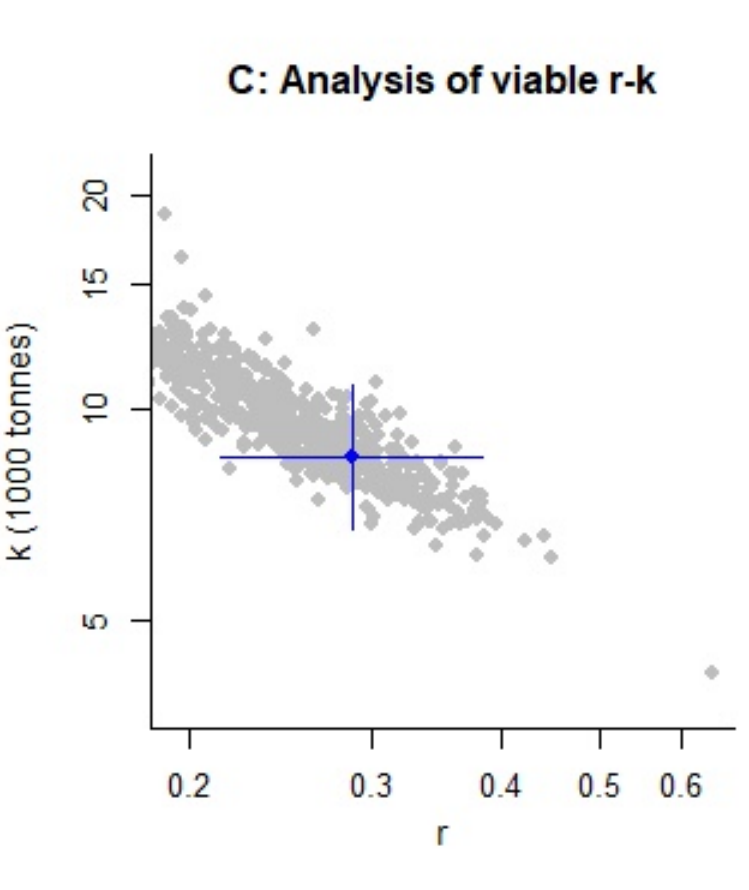

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

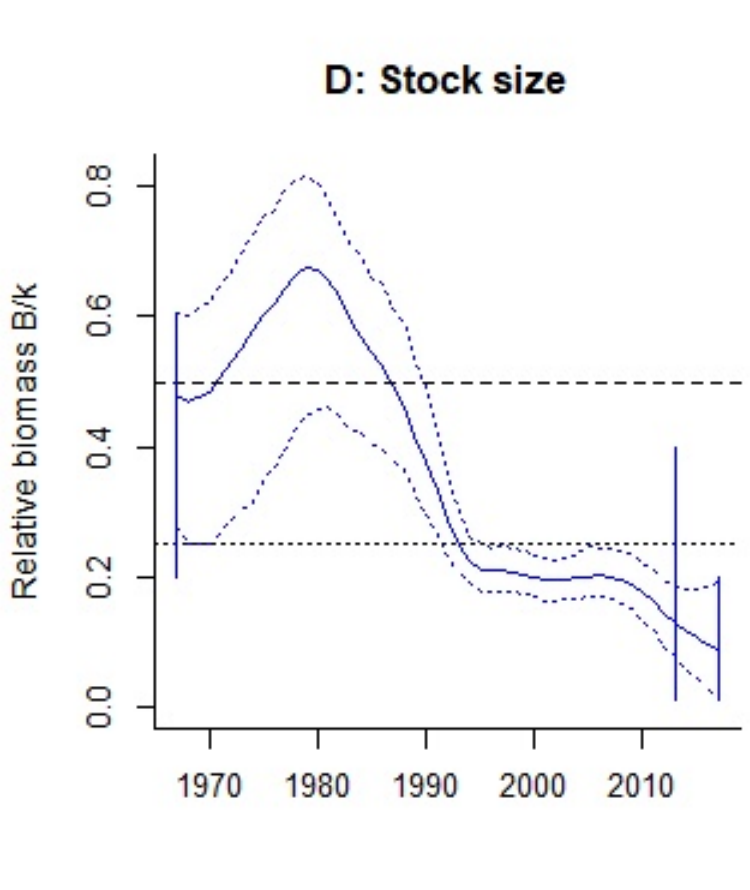

Exploitation
F / Fmsy
0
1
2
3
4
5
6
1970
1980
1990
2000
2010

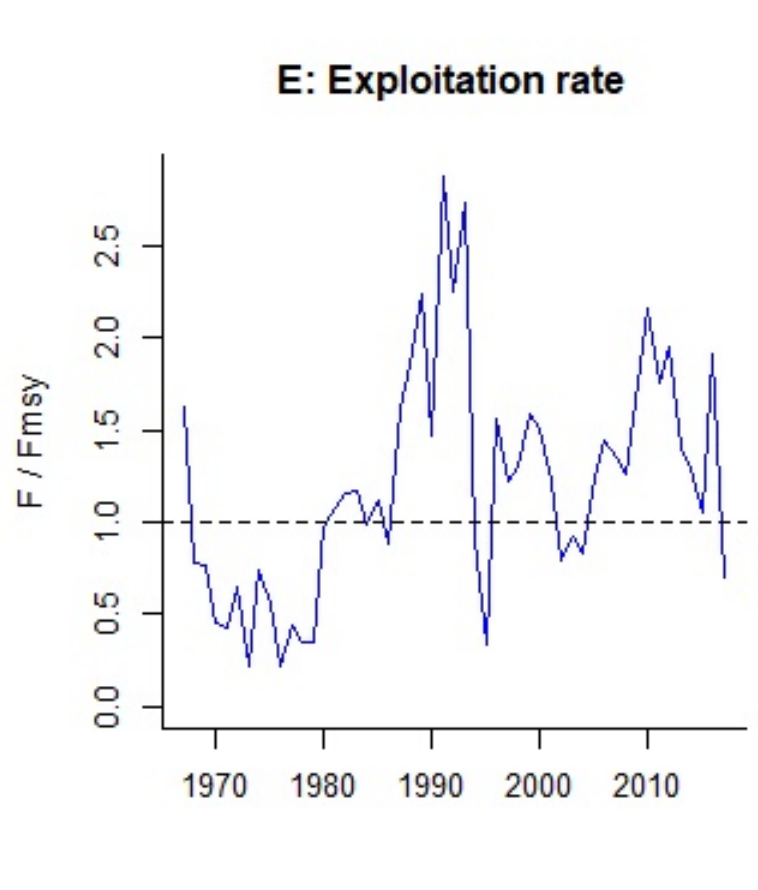

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
1
2
3
4
F / Fmsy

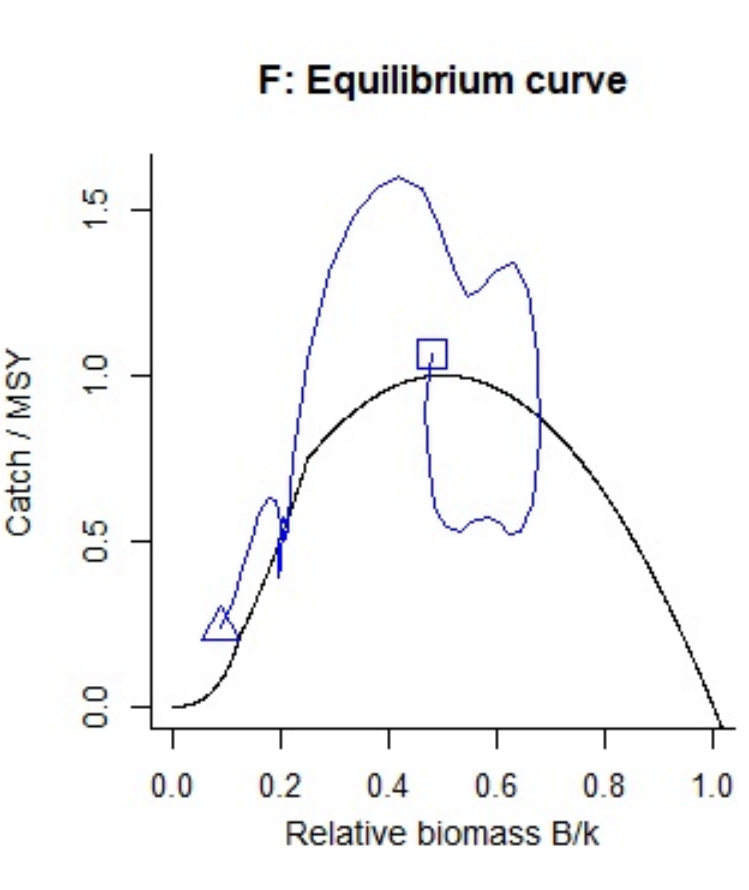

A: Catch Surmullet_MS
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1970
1980
1990
2000
2010

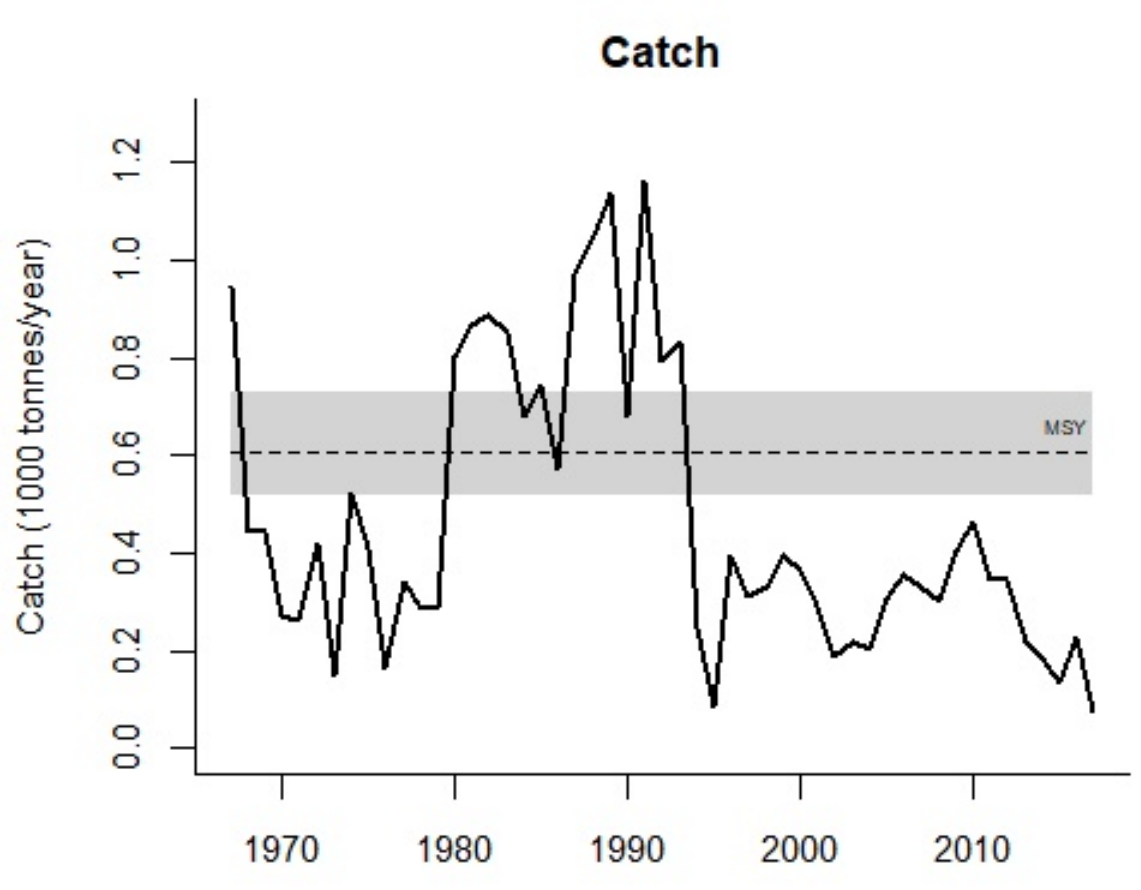

B: Finding viable r-k
k (1000 tonnes)
5
10
15
20
0.2
0.5
1.0
r

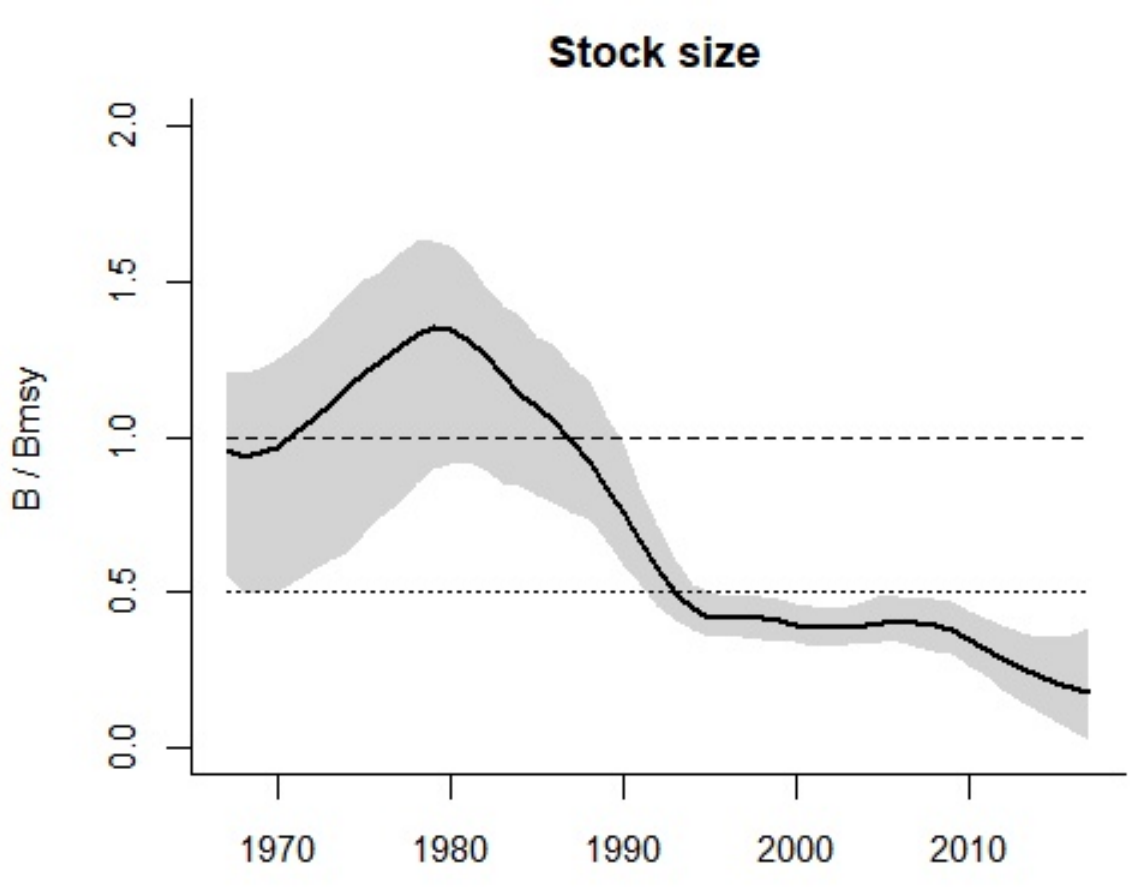

C: Analysis of viable r-k
k (1000 tonnes)
5
10
15
20
0.2
0.3
0.4
0.5
0.6
r

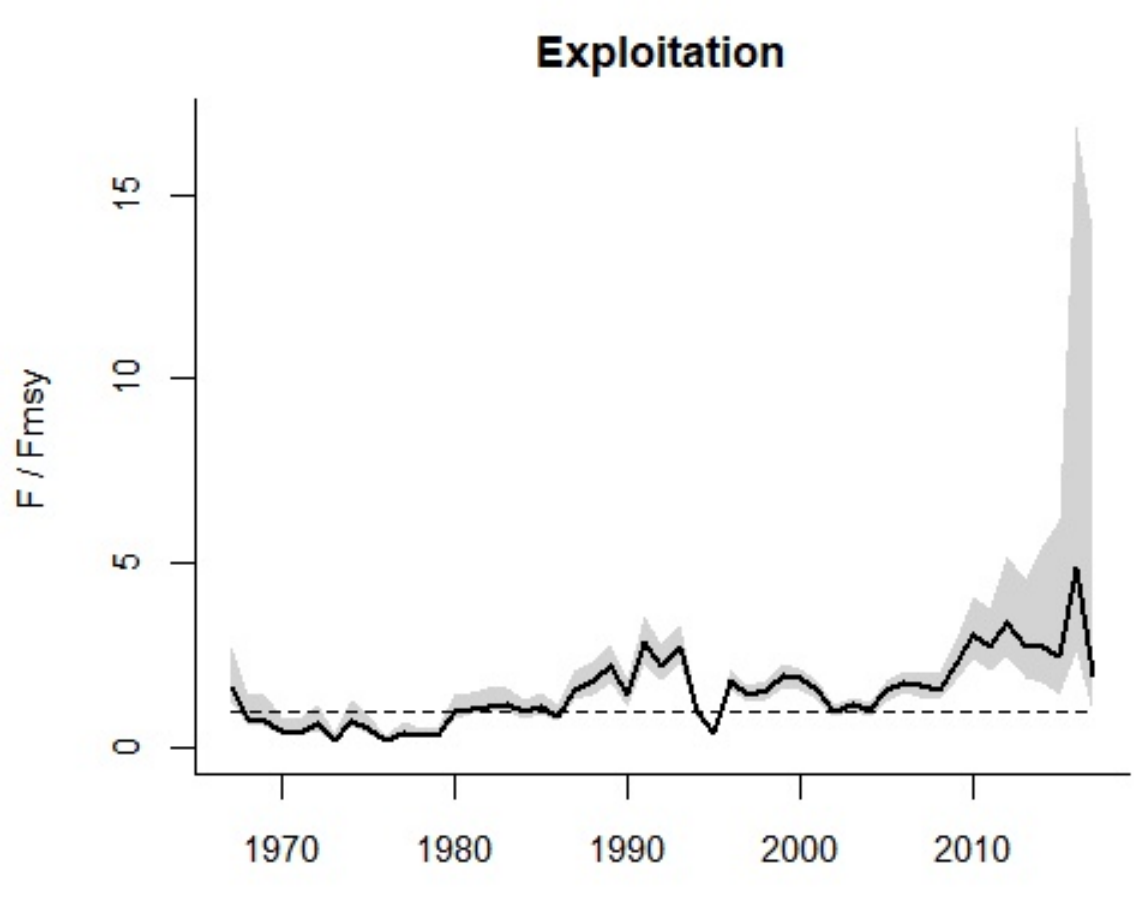

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

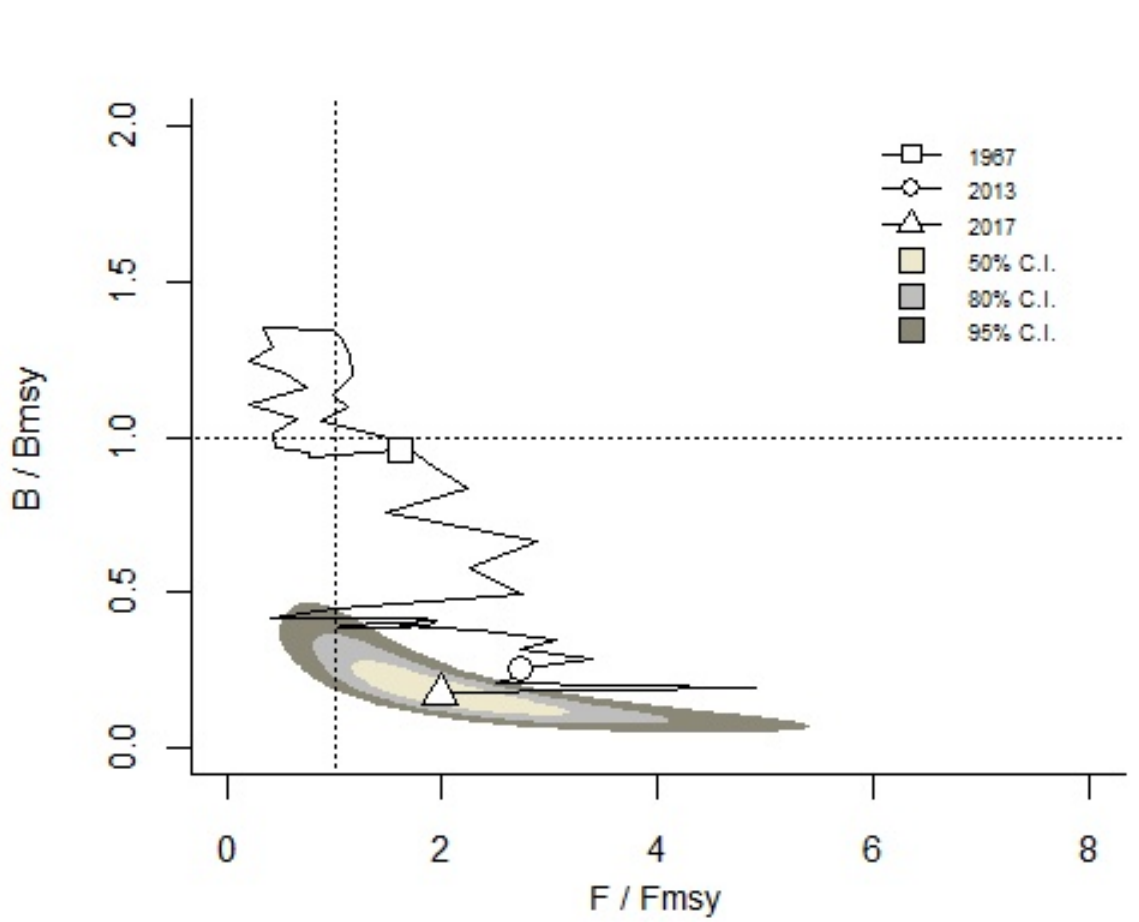

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

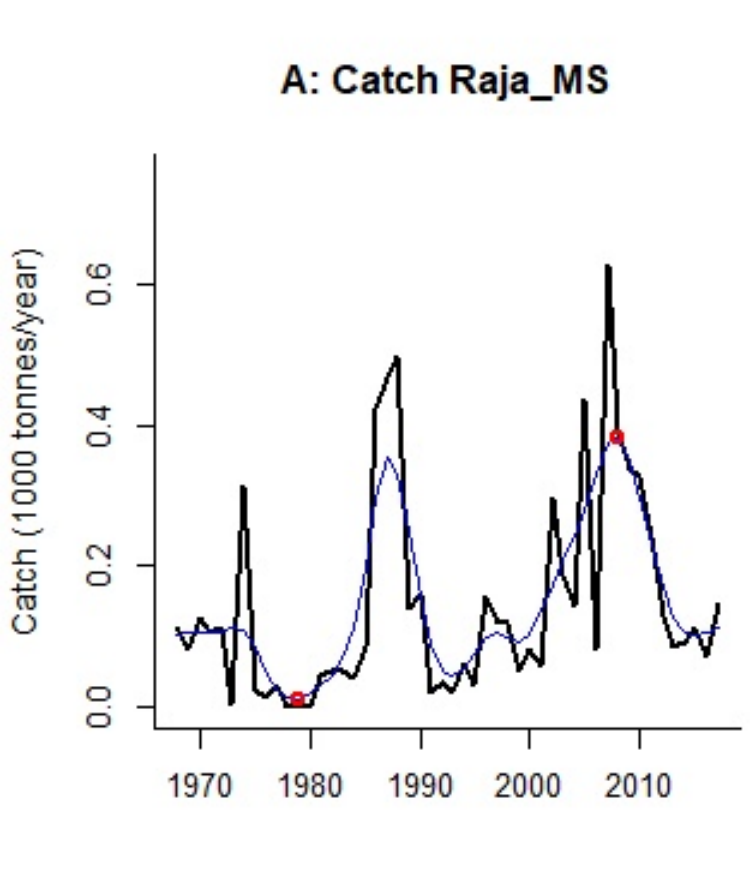

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

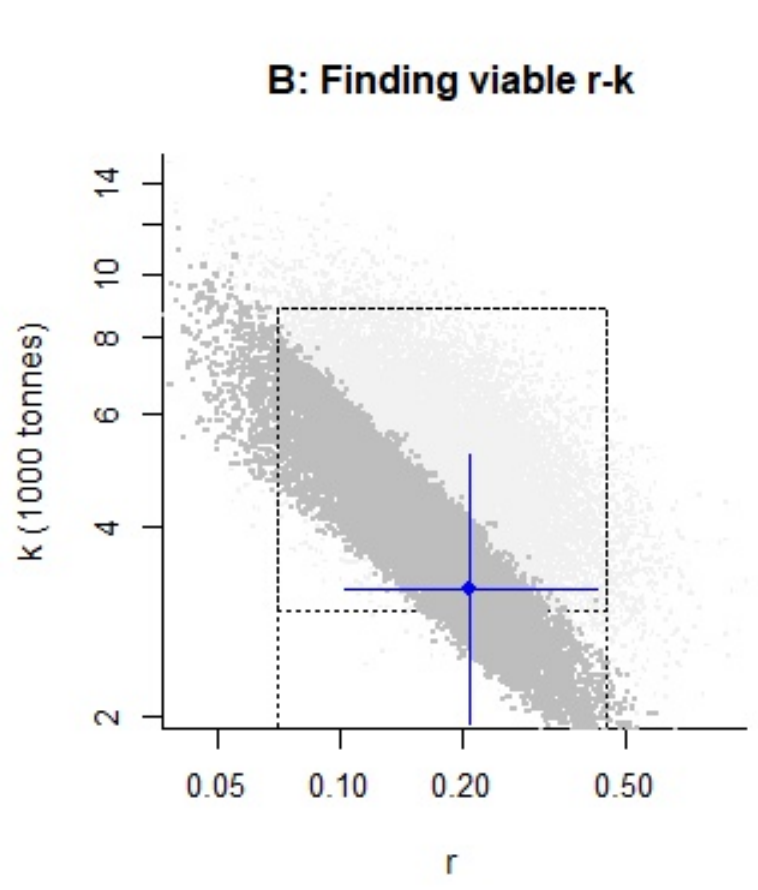

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
MSY
1970
1980
1990
2000
2010

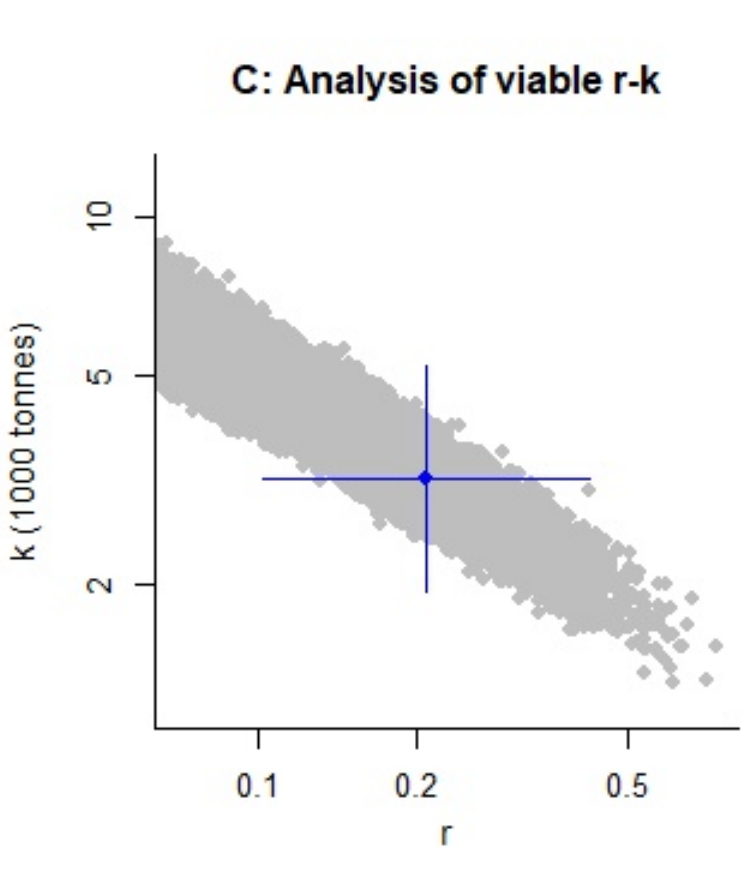

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

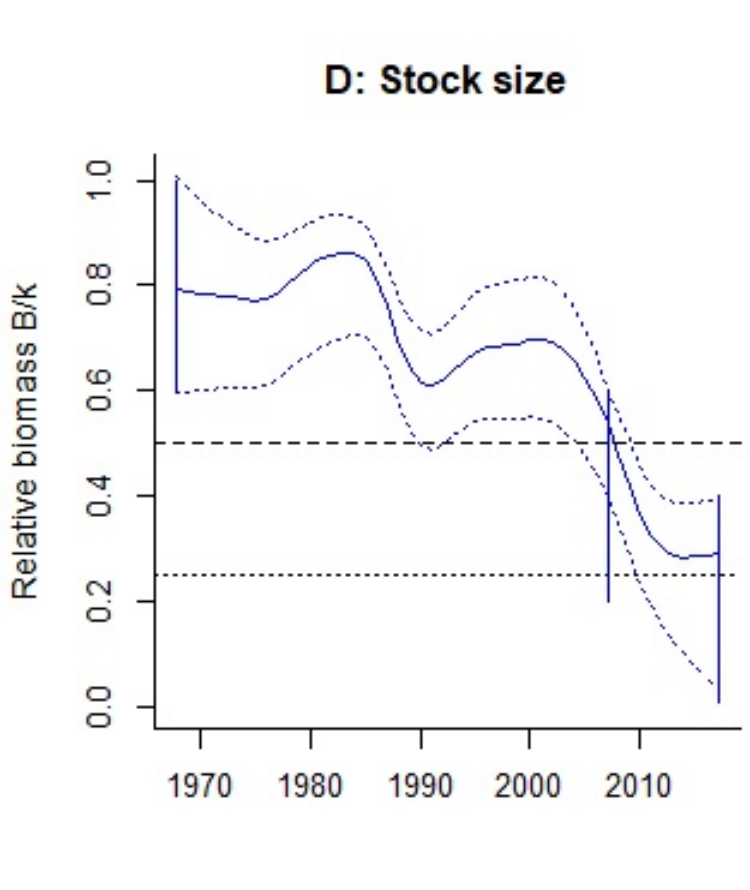

Exploitation
F / Fmsy
0
5
10
15
1970
1980
1990
2000
2010

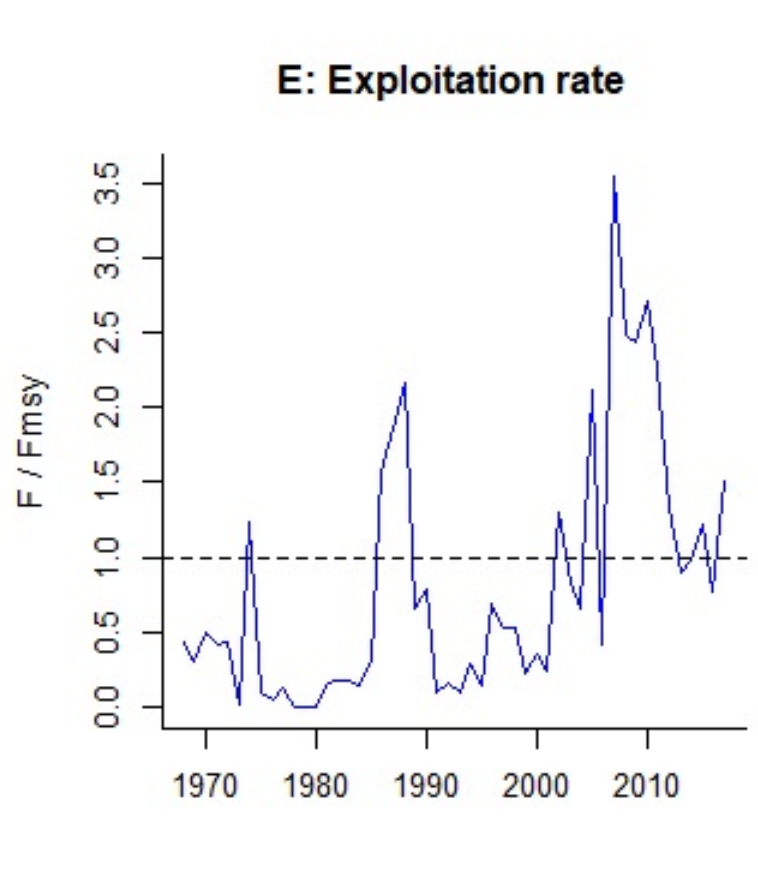

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

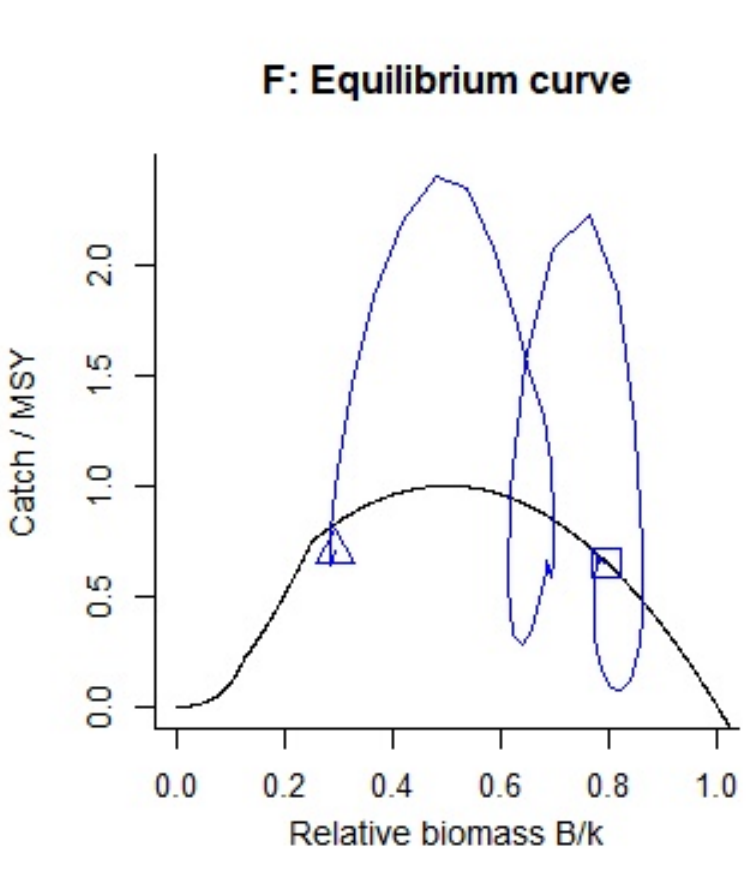

A: Catch Raja_MS
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
2
4
6
8
10
14
0.05
0.10
0.20
0.50
r

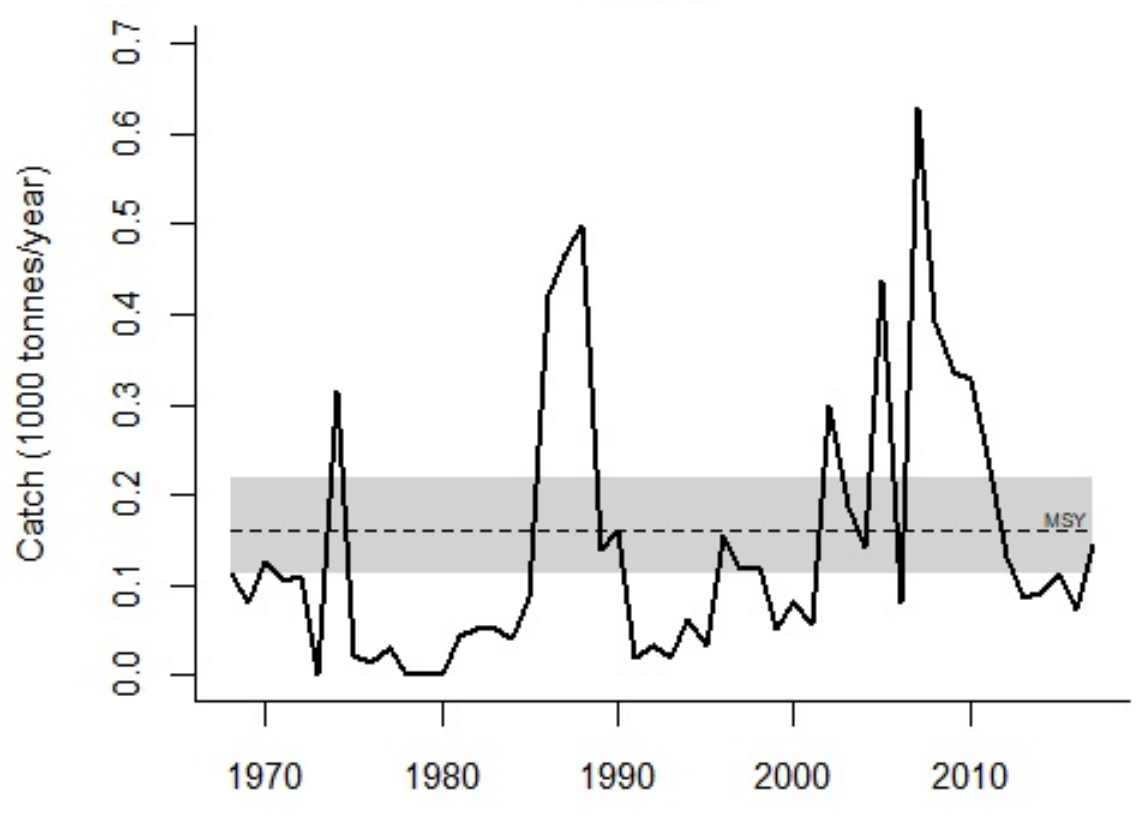

C: Analysis of viable r-k
k (1000 tonnes)
2
5
10
0.1
0.2
0.5
r


D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

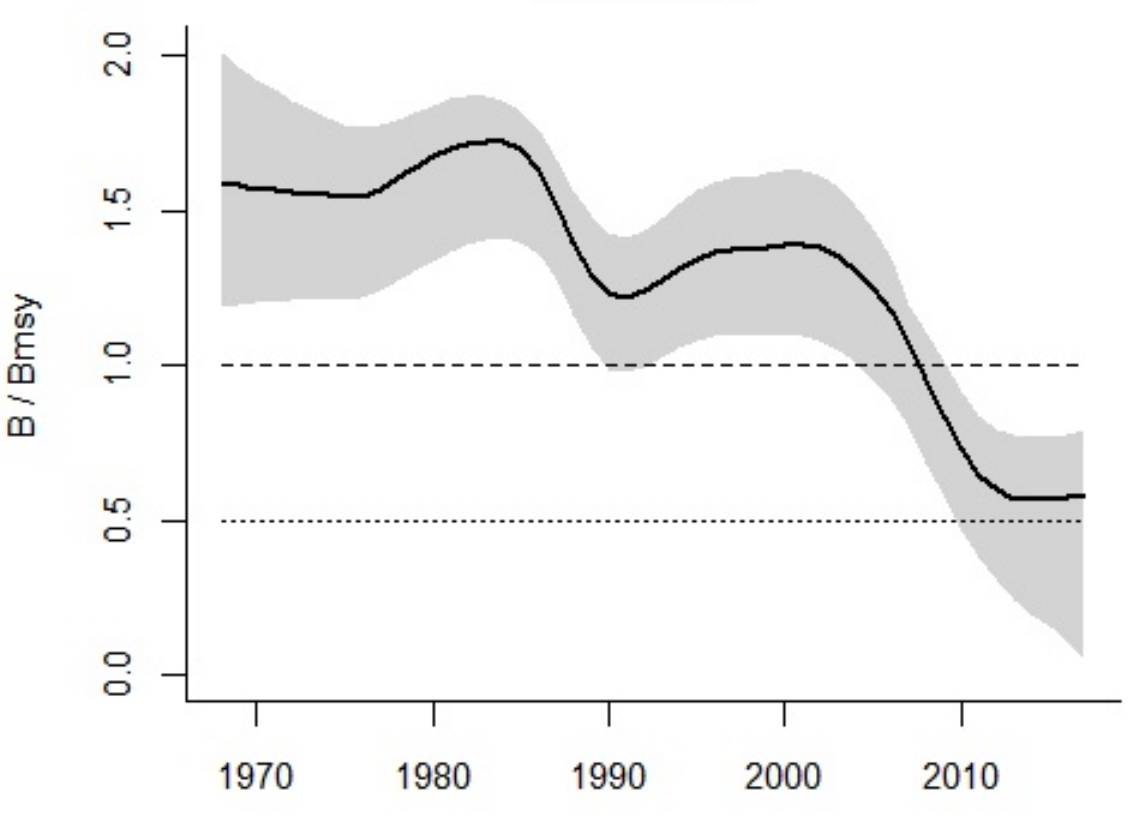

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

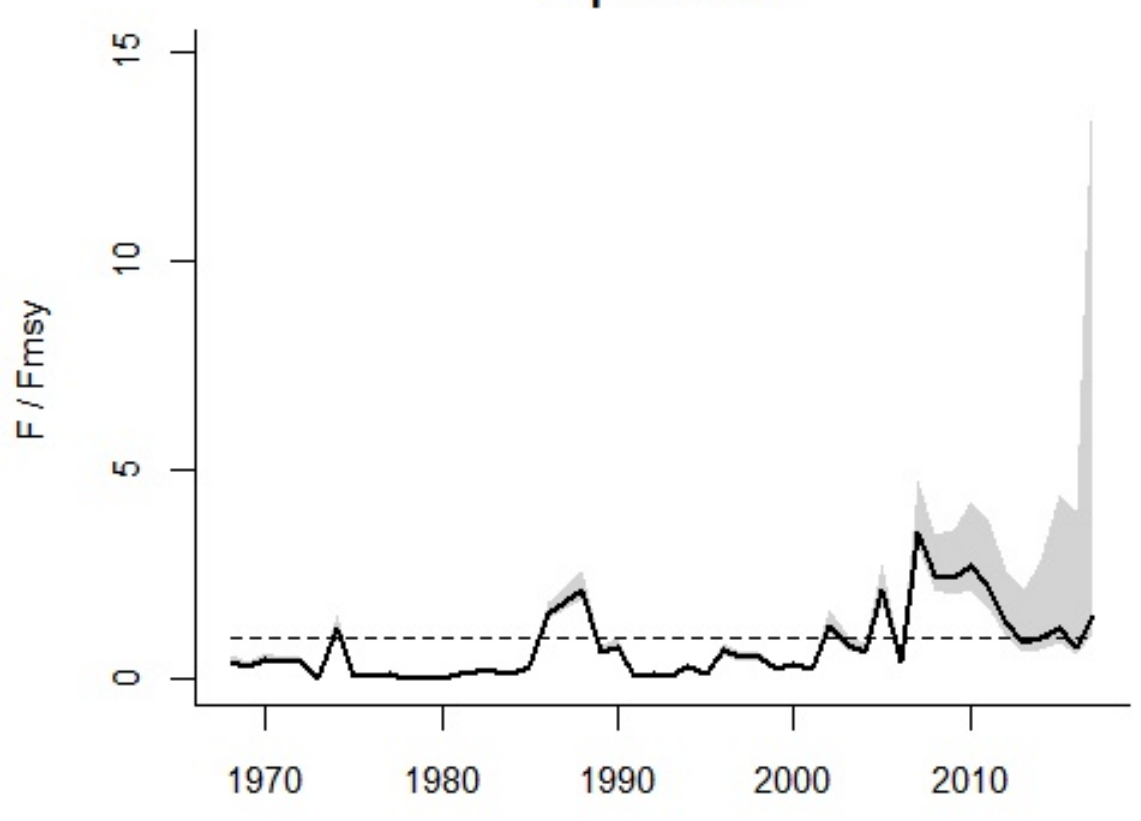
Catch

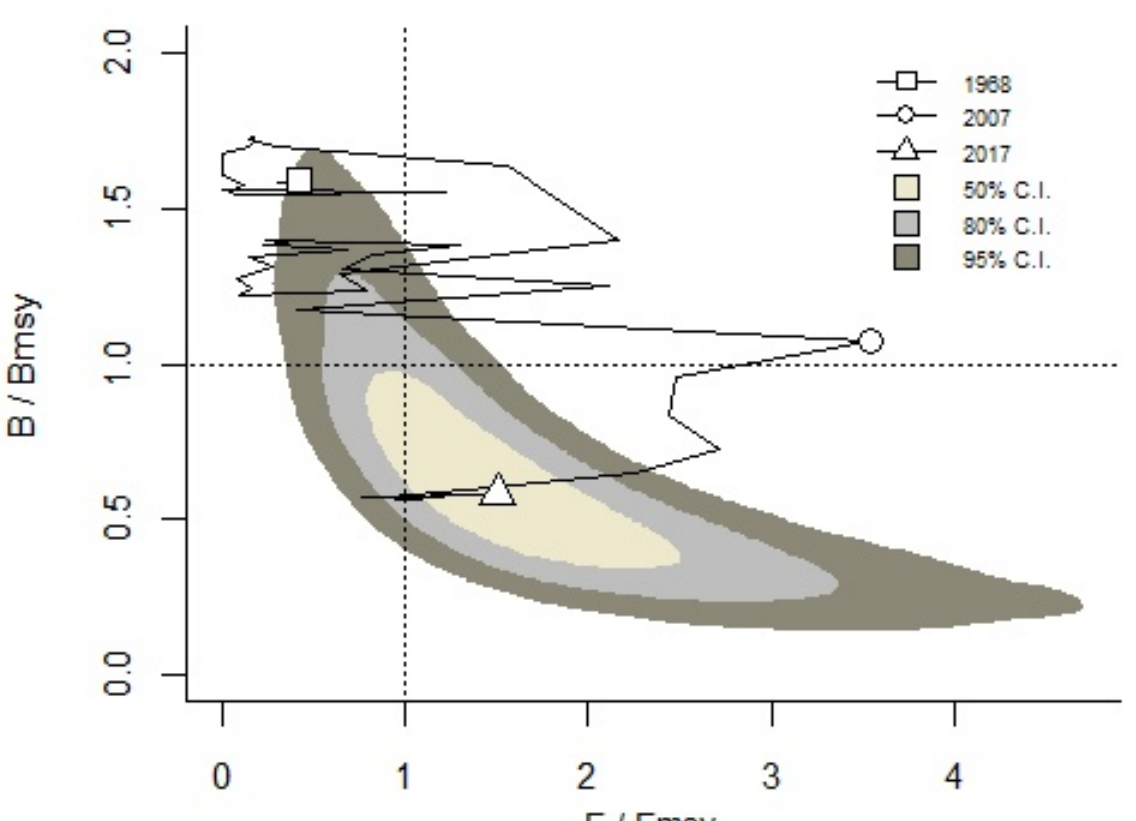


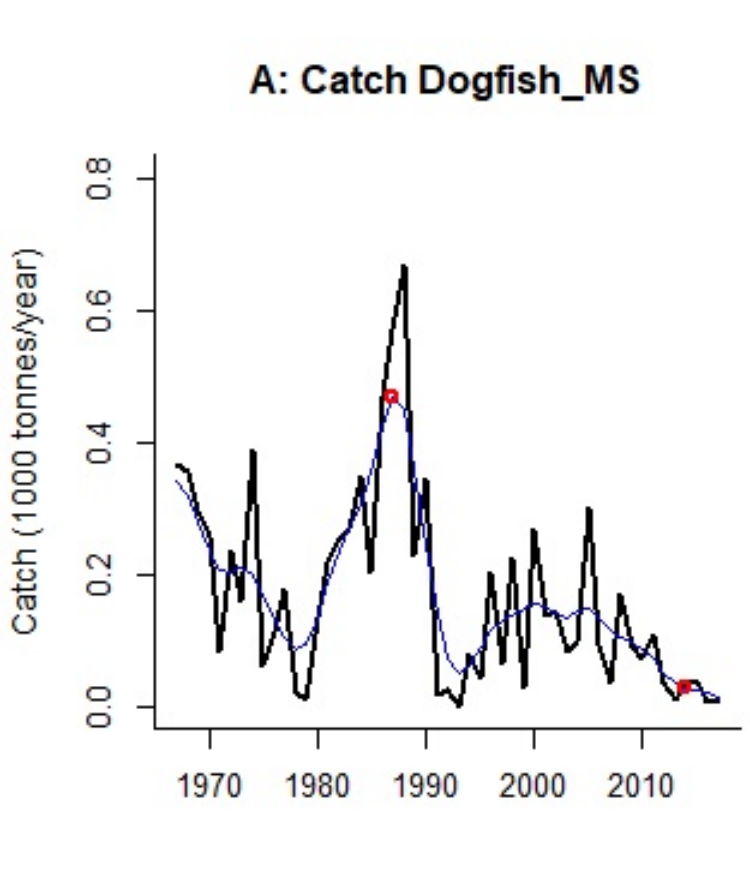
Stock size

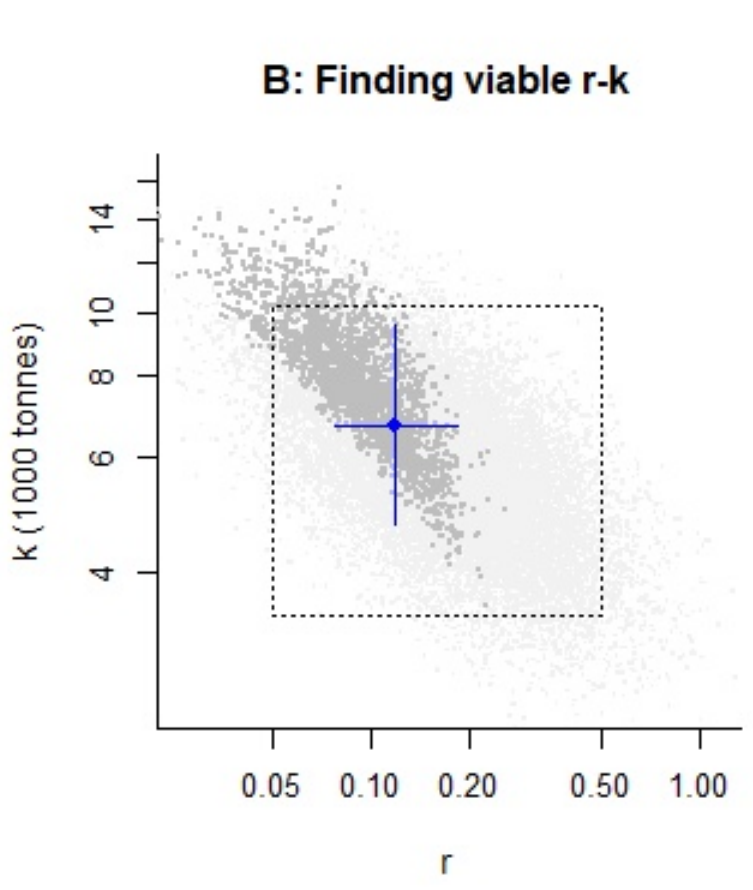


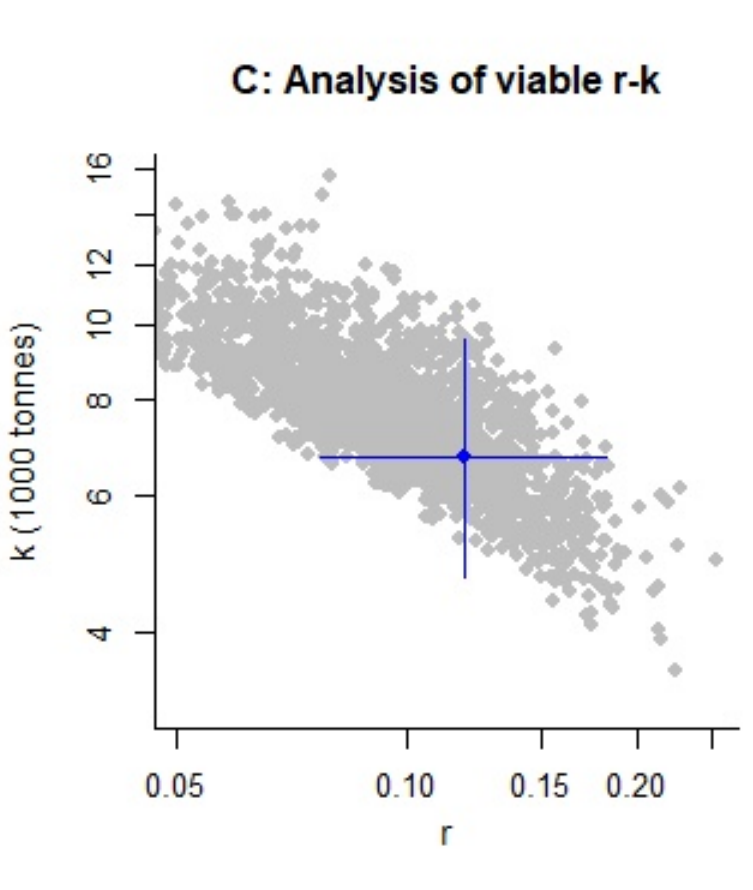
Exploitation

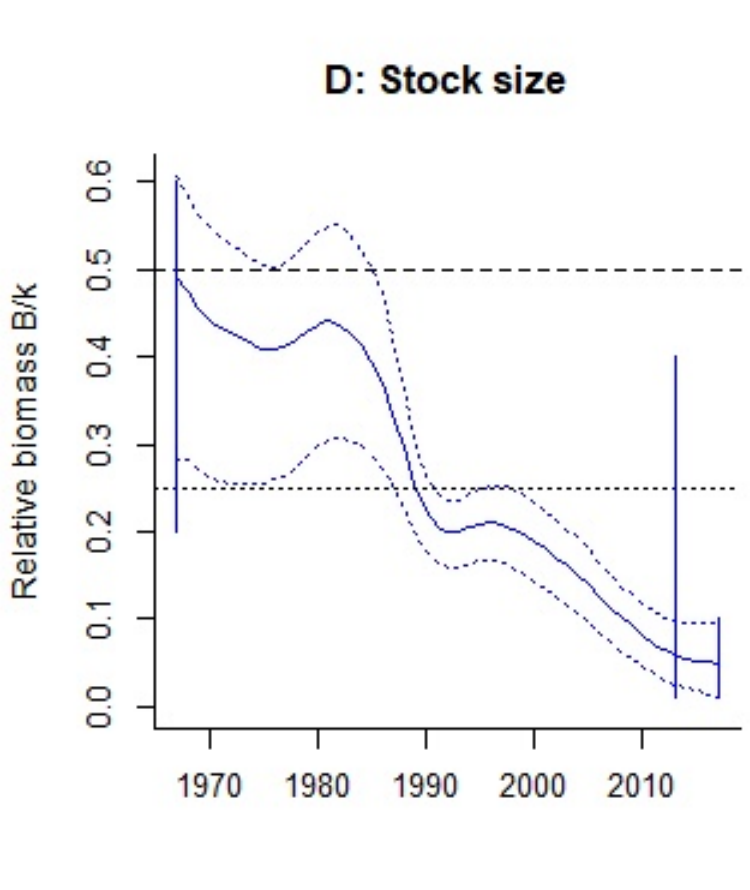


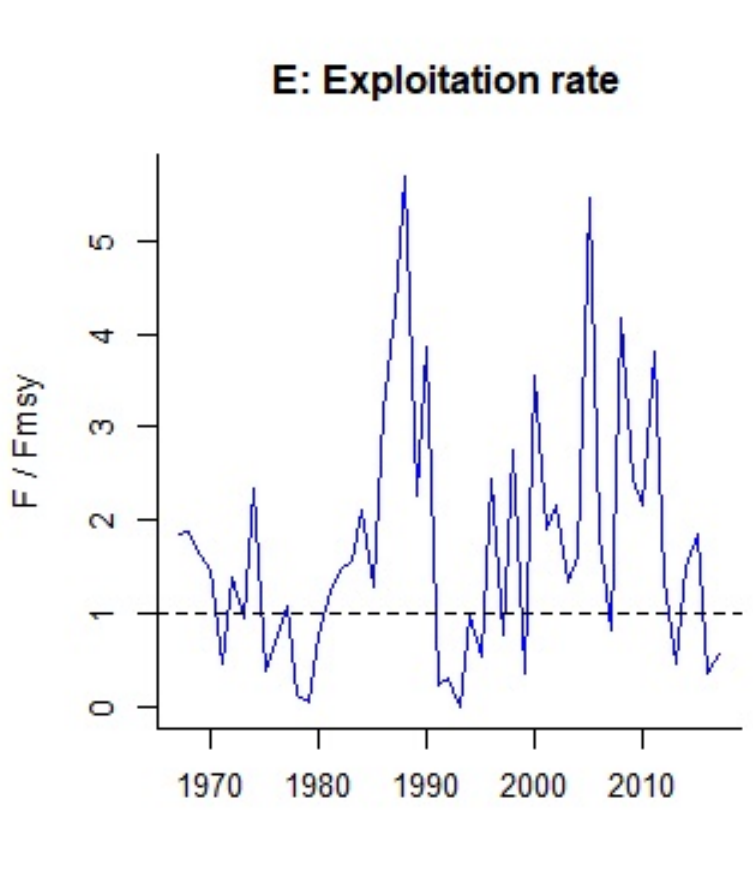


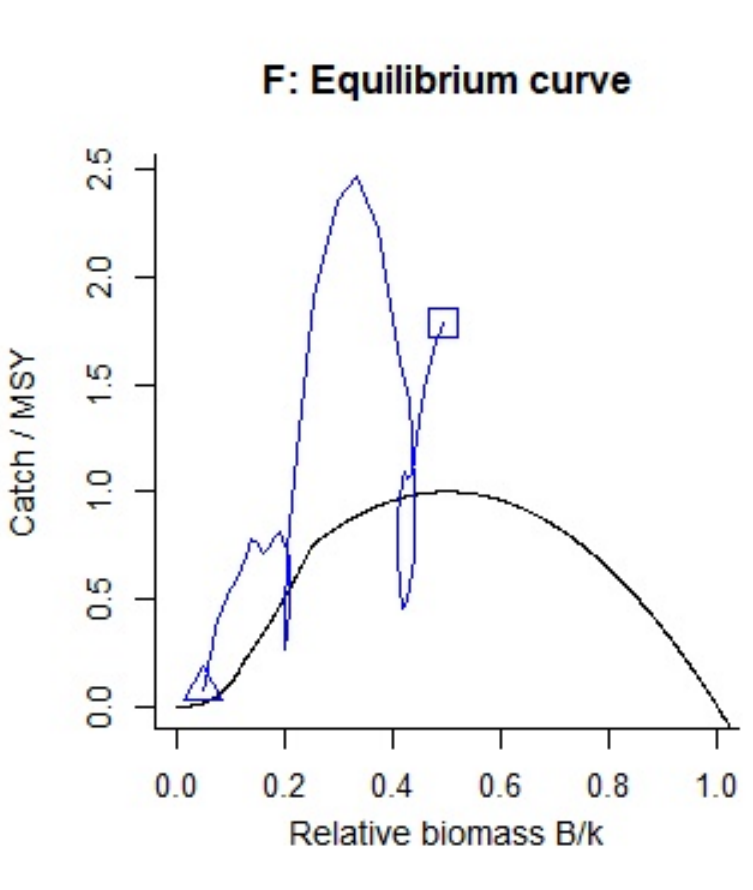

A: Catch Dogfish_MS
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
0.8
1970
1980
1990
2000
2010

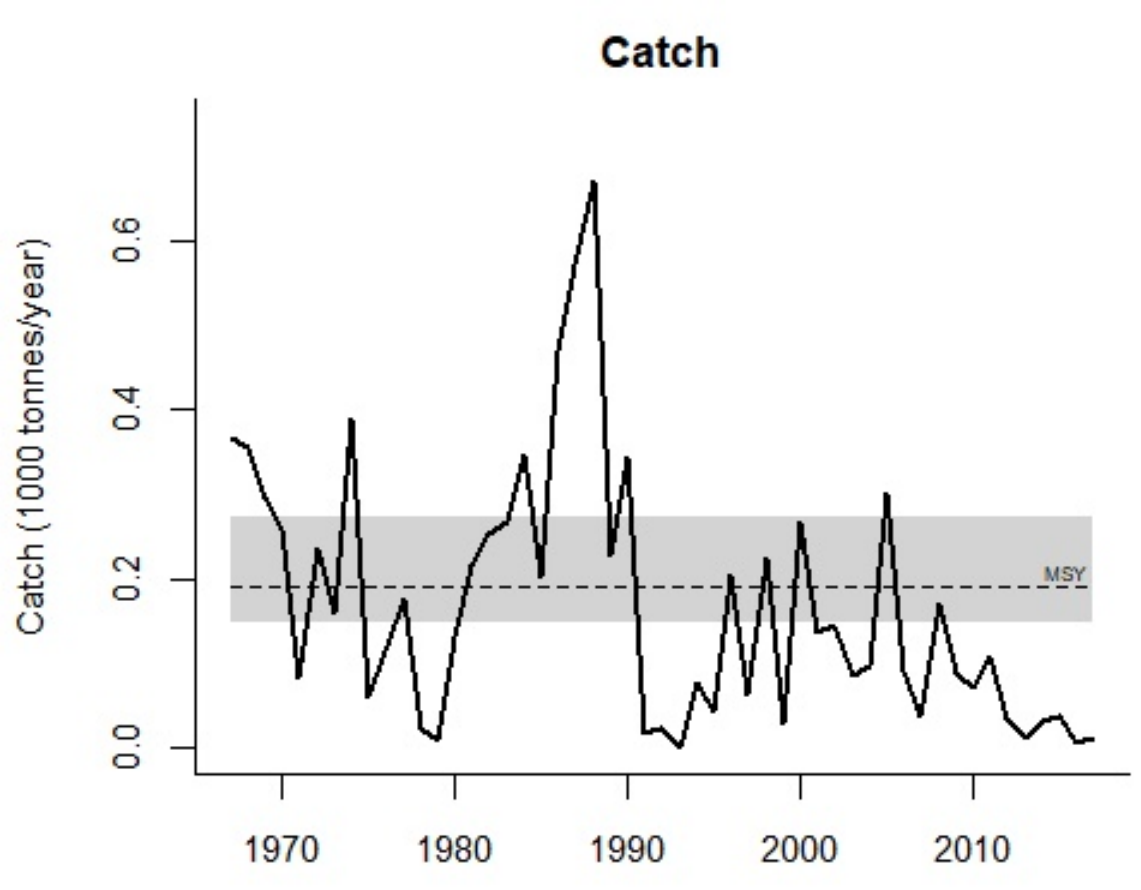

B: Finding viable r-k
k (1000 tonnes)
4
6
8
10
14
0.05
0.10
0.20
0.50
1.00
r

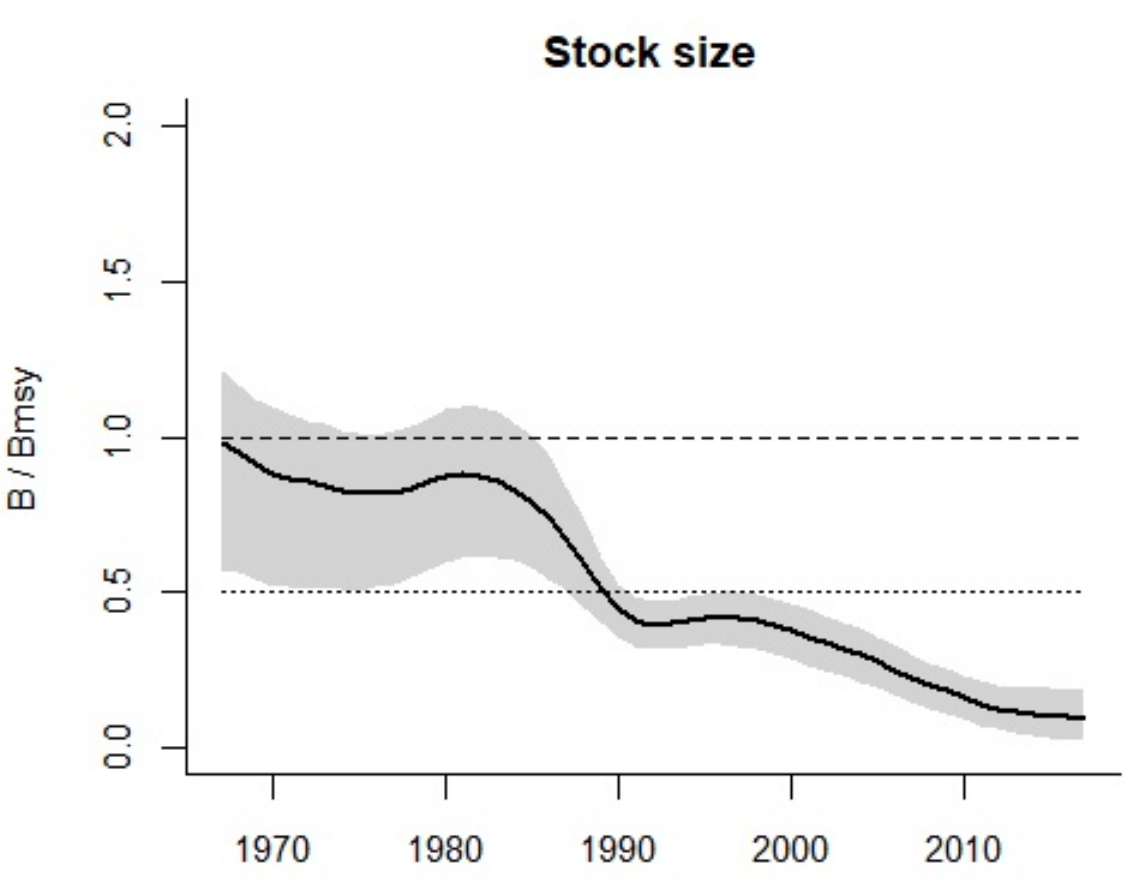

C: Analysis of viable r-k
k (1000 tonnes)
4
6
8
10
12
16
0.05
0.10
0.15
0.20
r

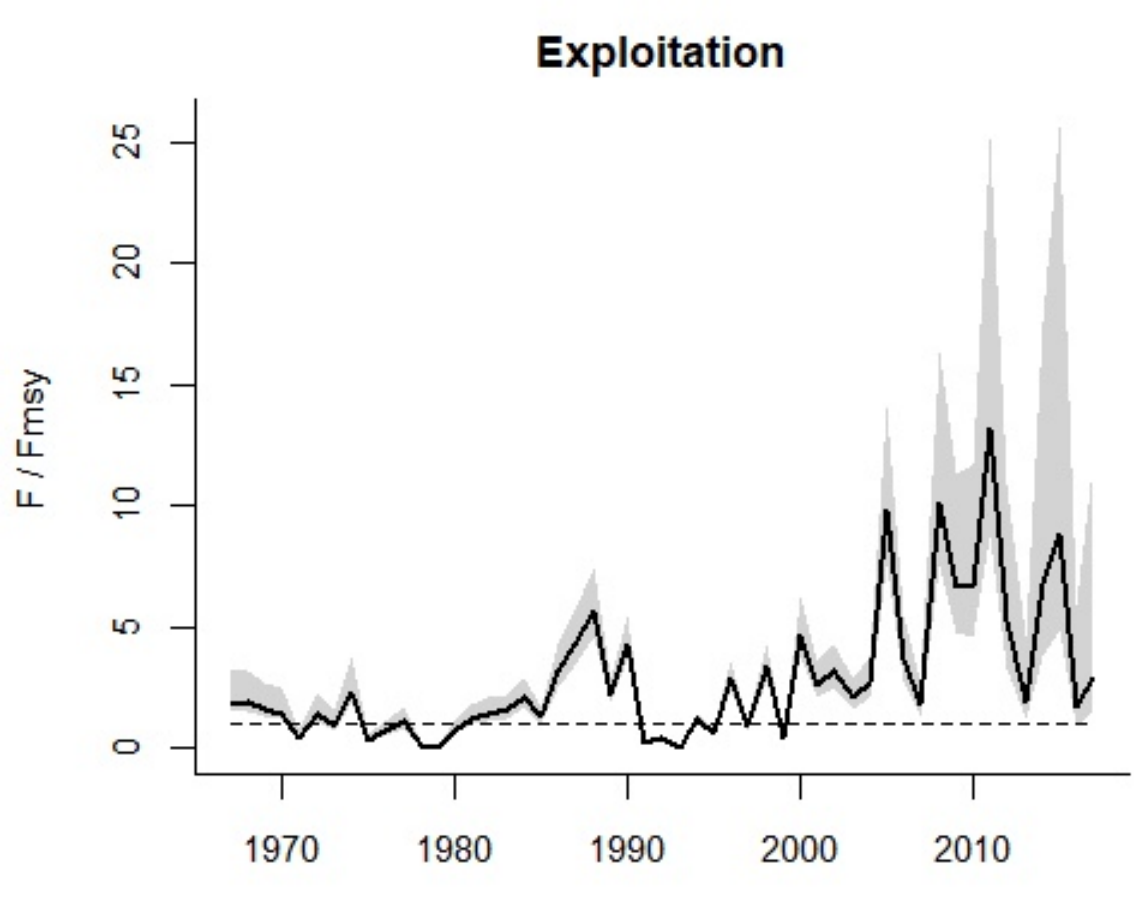

D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

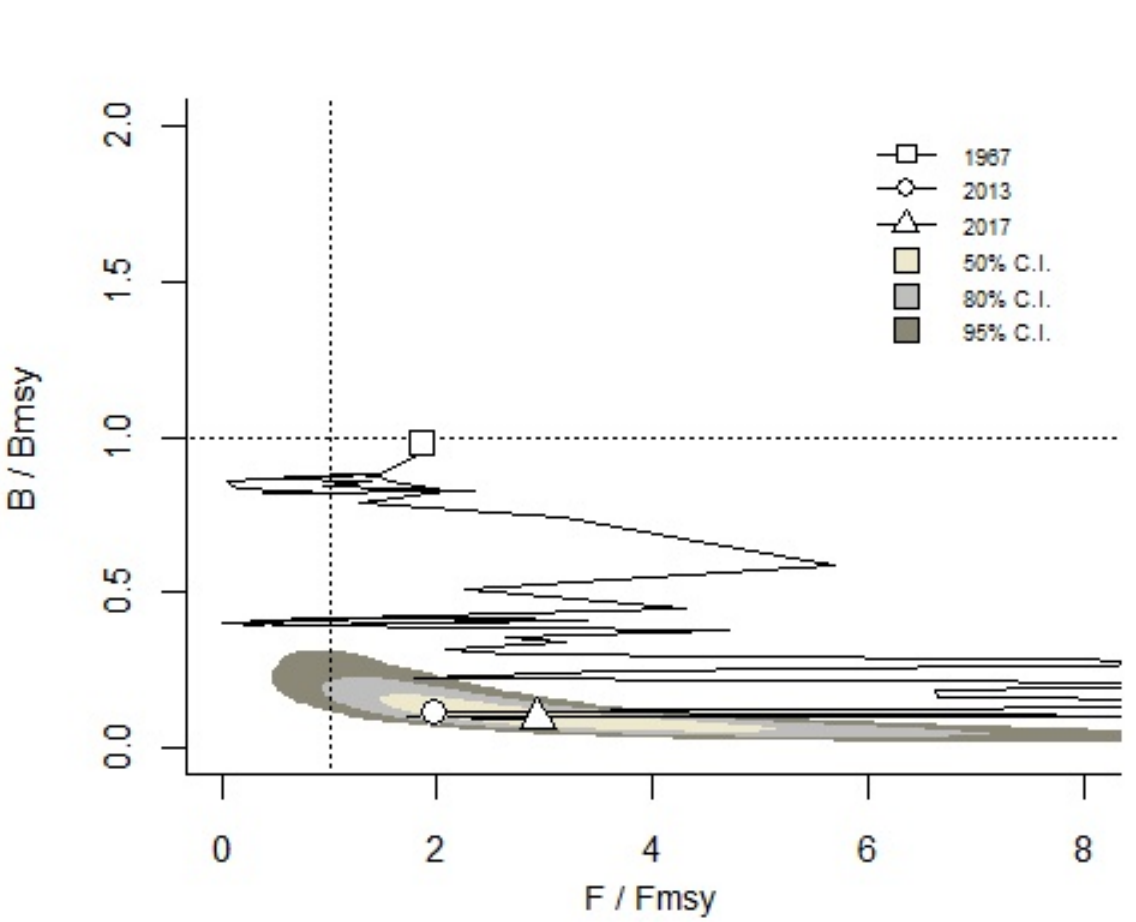

E: Exploitation rate
F / Fmsy
0
1
2
3
4
5
1970
1980
1990
2000
2010

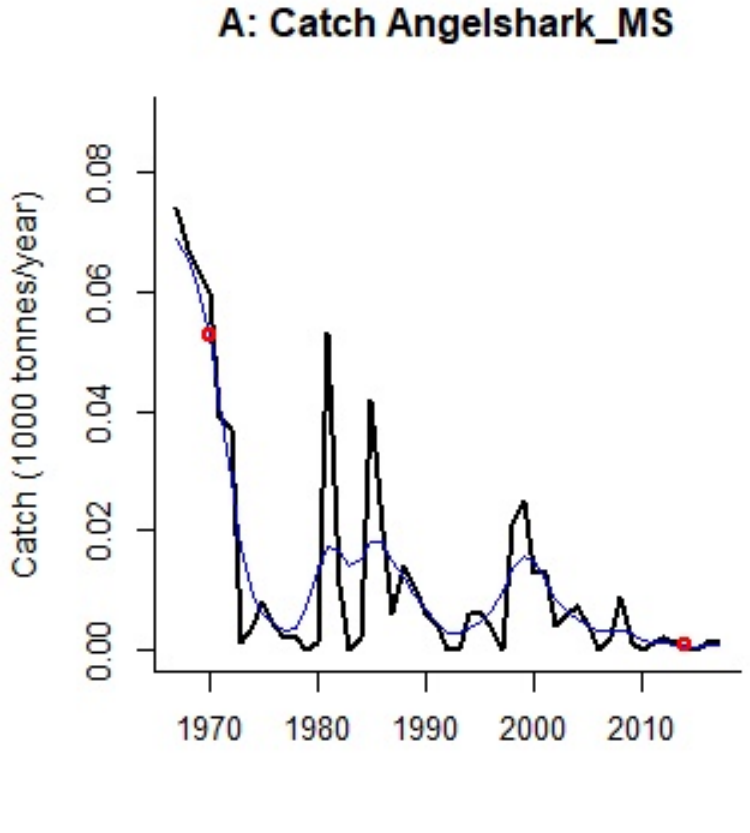

F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
2.0
2.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

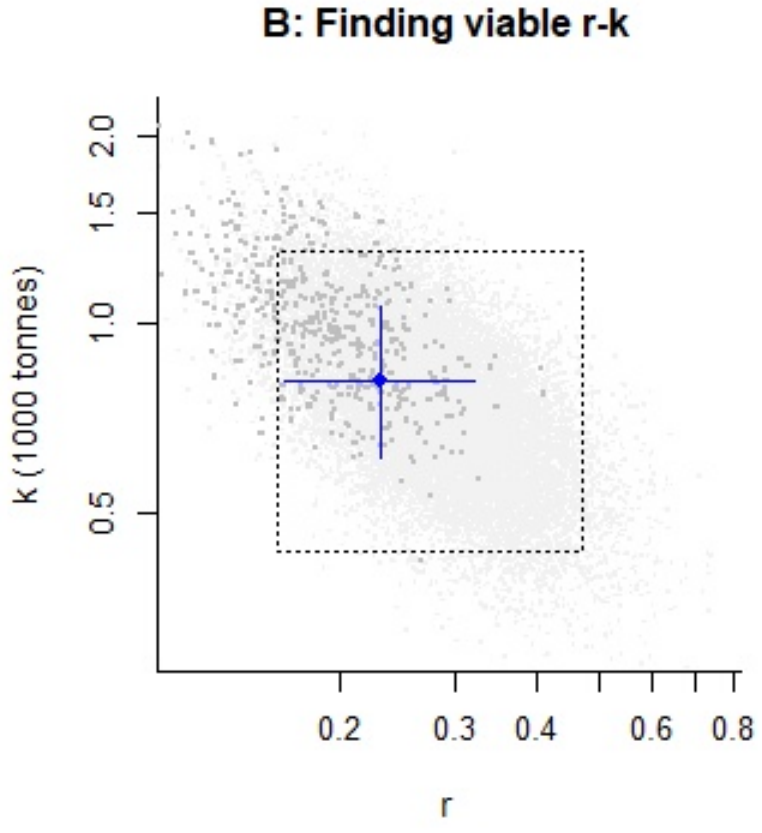

Catch
Catch (1000 tonnes/year)
0.0
0.2
0.4
0.6
MSY
1970
1980
1990
2000
2010

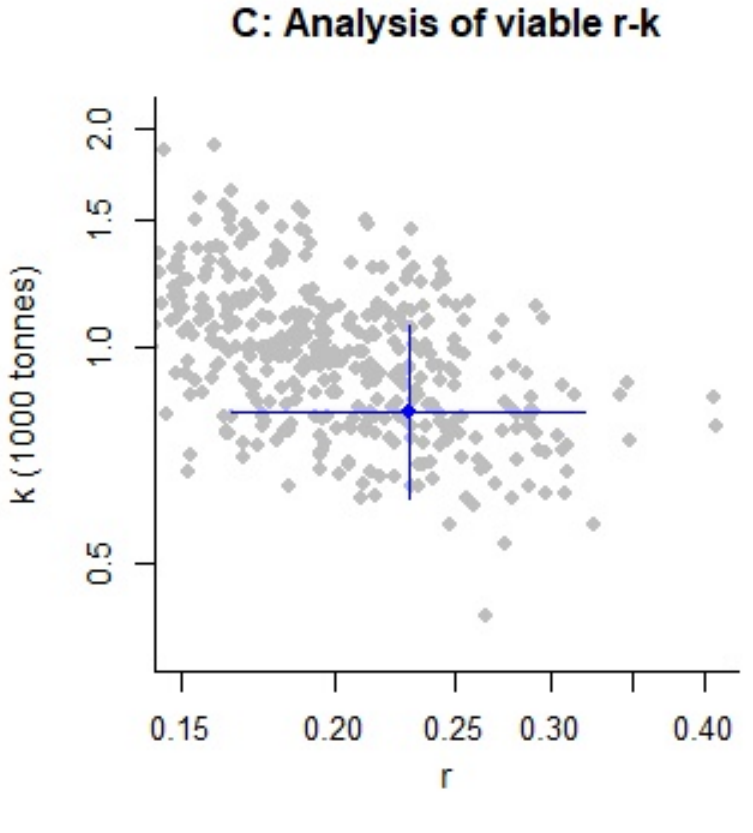

Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010

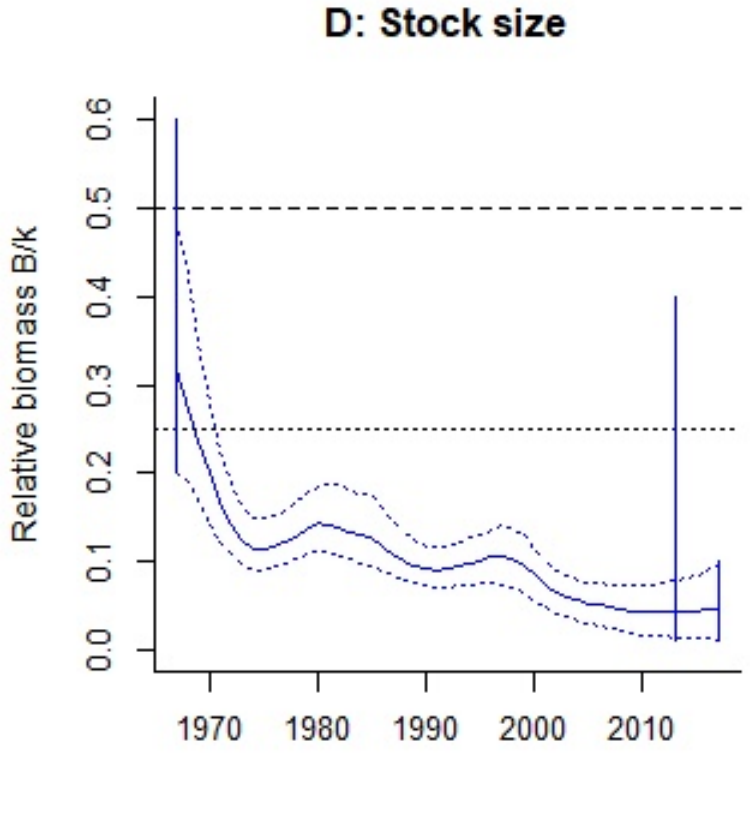

Exploitation
F / Fmsy
0
5
10
15
20
25
1970
1980
1990
2000
2010

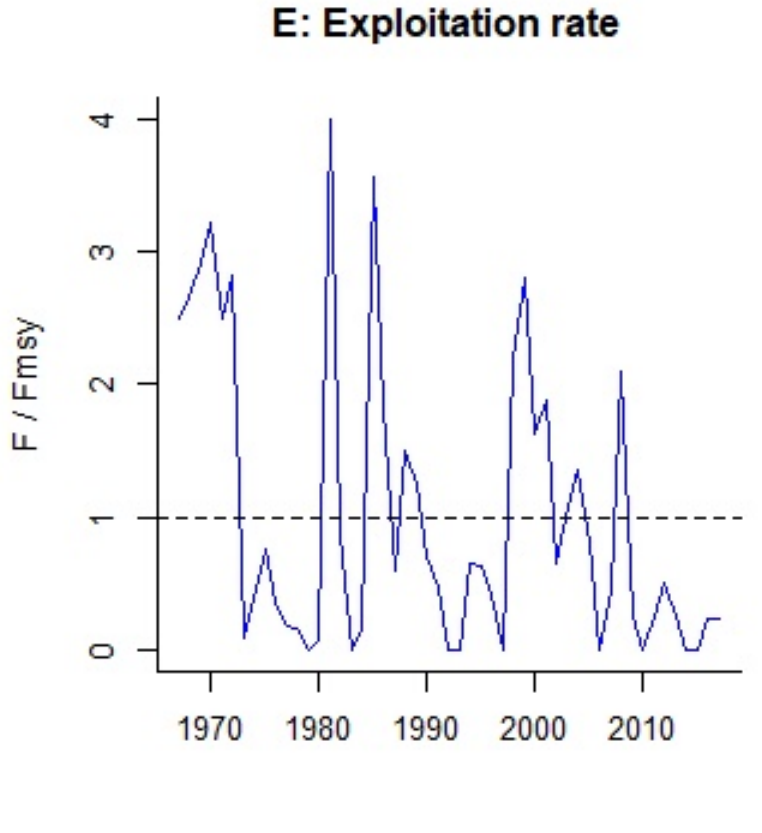

B / Bmsy
0.0
0.5
1.0
1.5
2.0
1967
2013
2017
50% C.I.
80% C.I.
95% C.I.
0
2
4
6
8
F / Fmsy

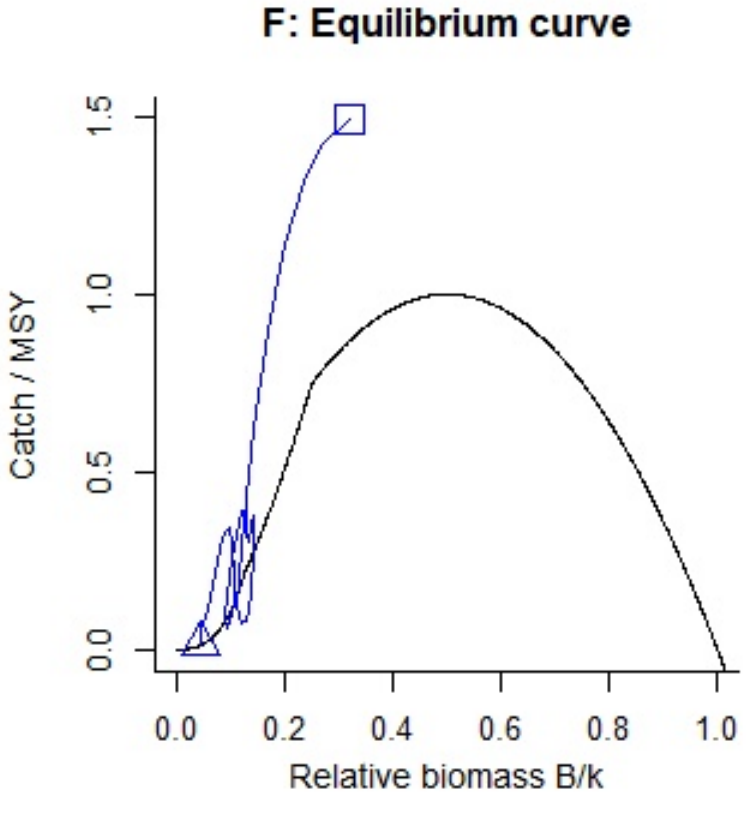

A: Catch Angelshark_MS
Catch (1000 tonnes/year)
0.00
0.02
0.04
0.06
0.08
1970
1980
1990
2000
2010


B: Finding viable r-k
k (1000 tonnes)
0.5
1.0
1.5
2.0
0.2
0.3
0.4
0.6
0.8
r

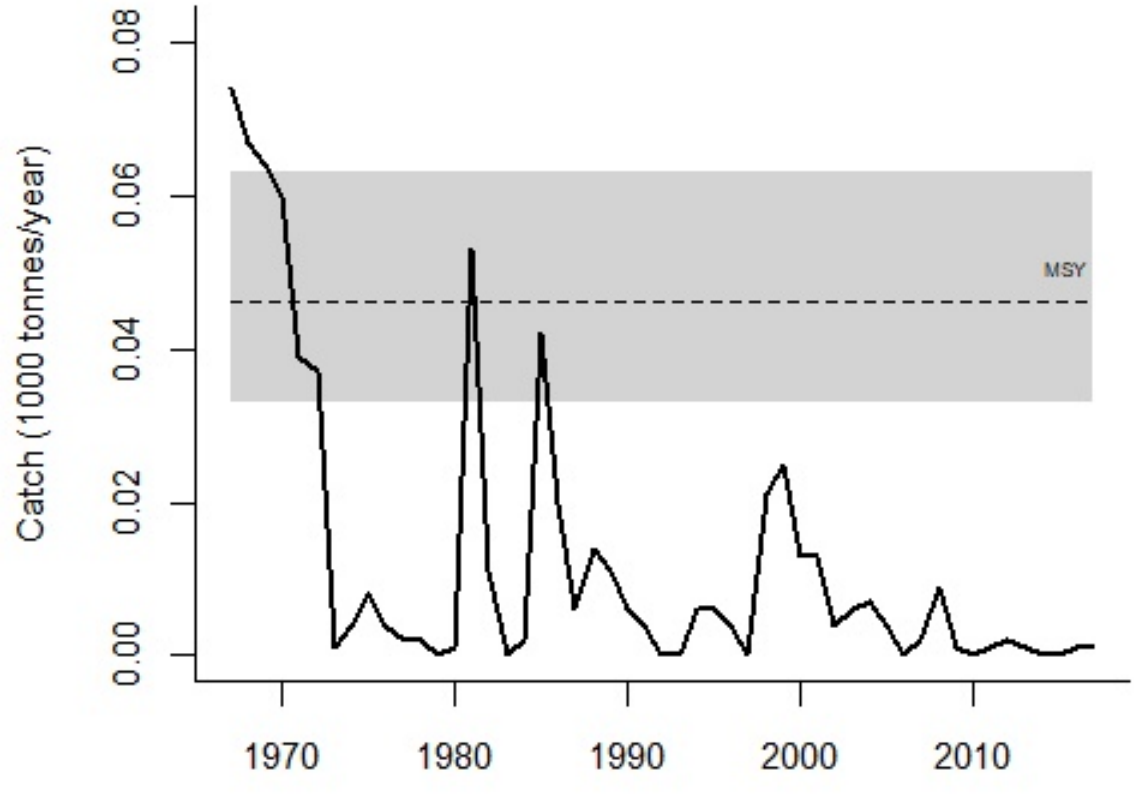

C: Analysis of viable r-k
k (1000 tonnes)
0.5
1.0
1.5
2.0
0.15
0.20
0.25
0.30
0.40
r


D: Stock size
Relative biomass B/k
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1970
1980
1990
2000
2010

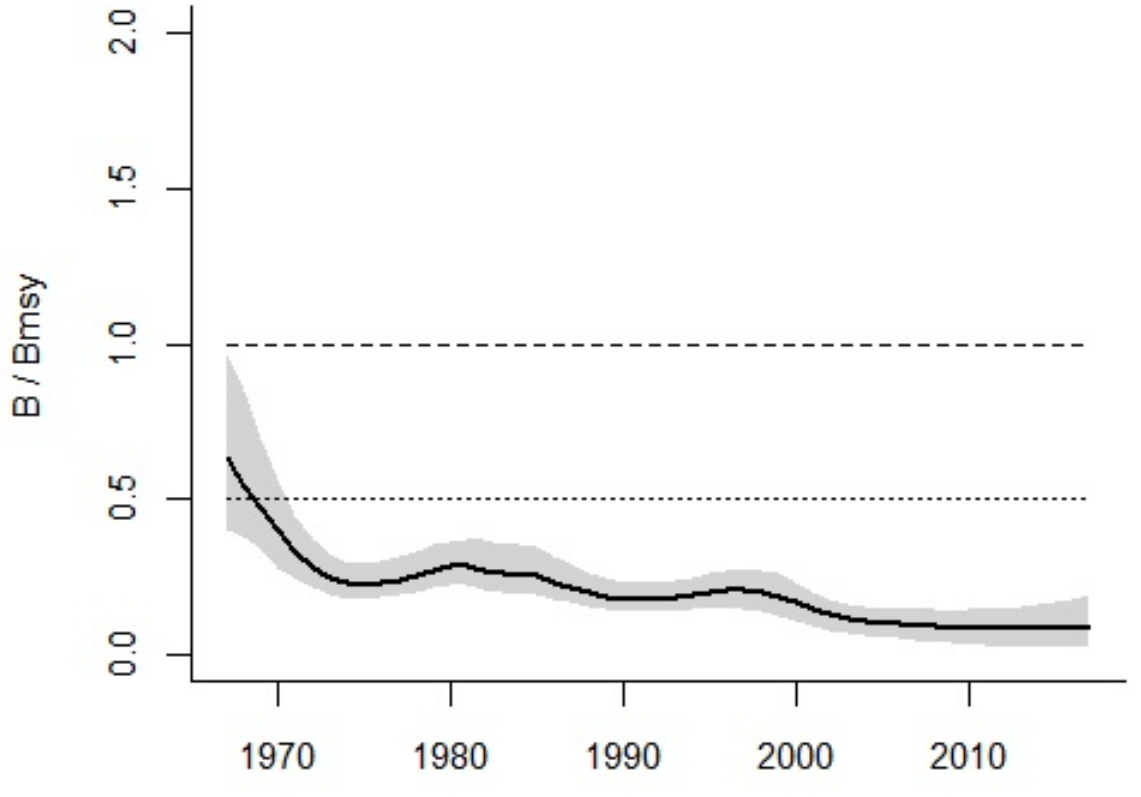

E: Exploitation rate
F / Fmsy
0
1
2
3
4
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.5
1.0
1.5
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k

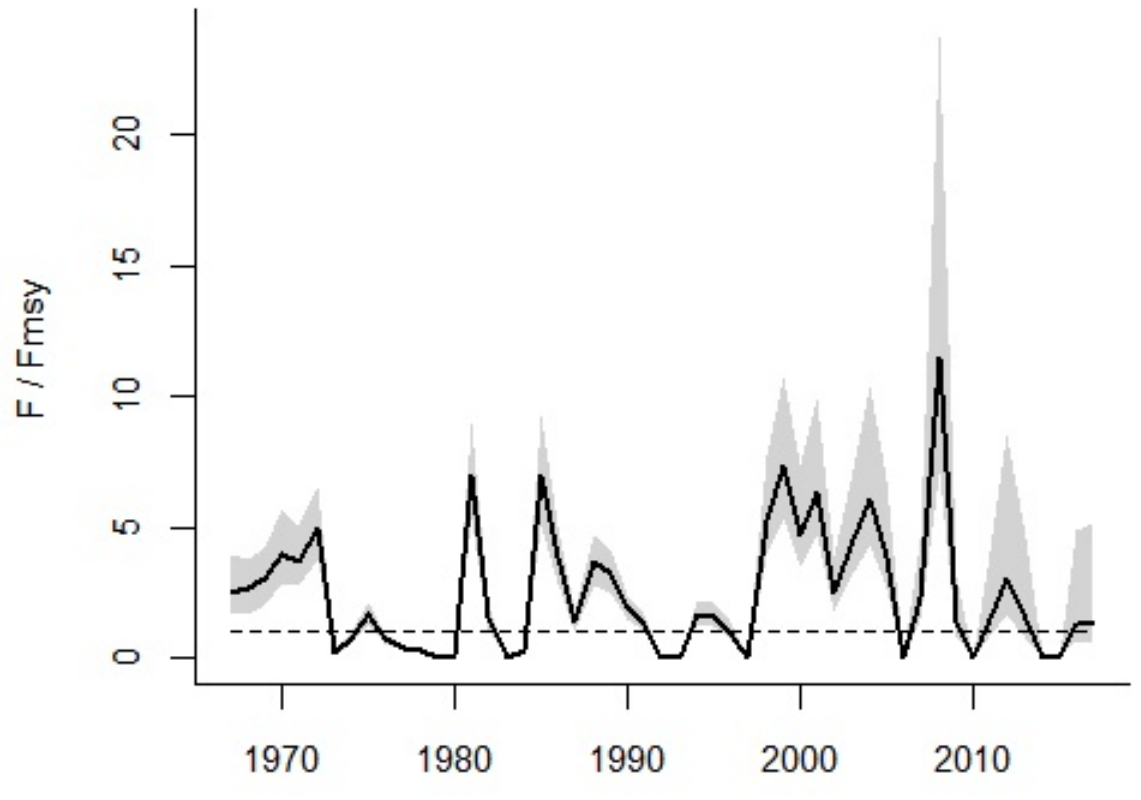
Catch

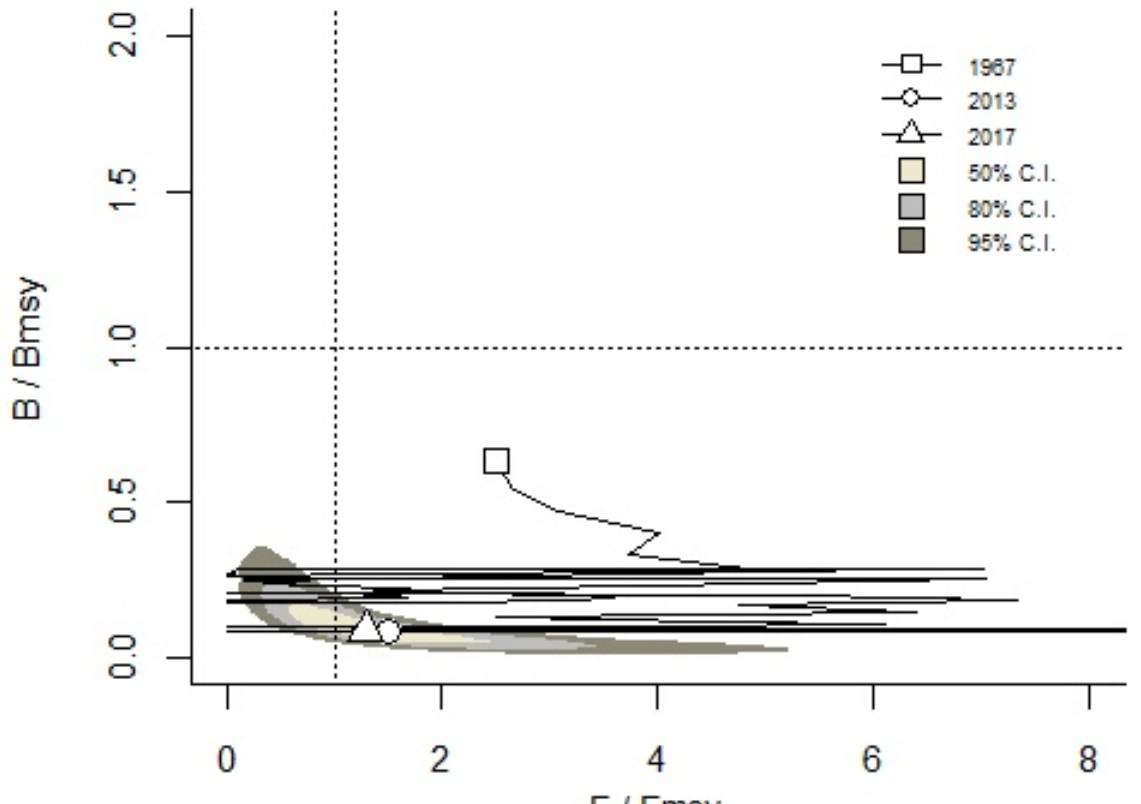


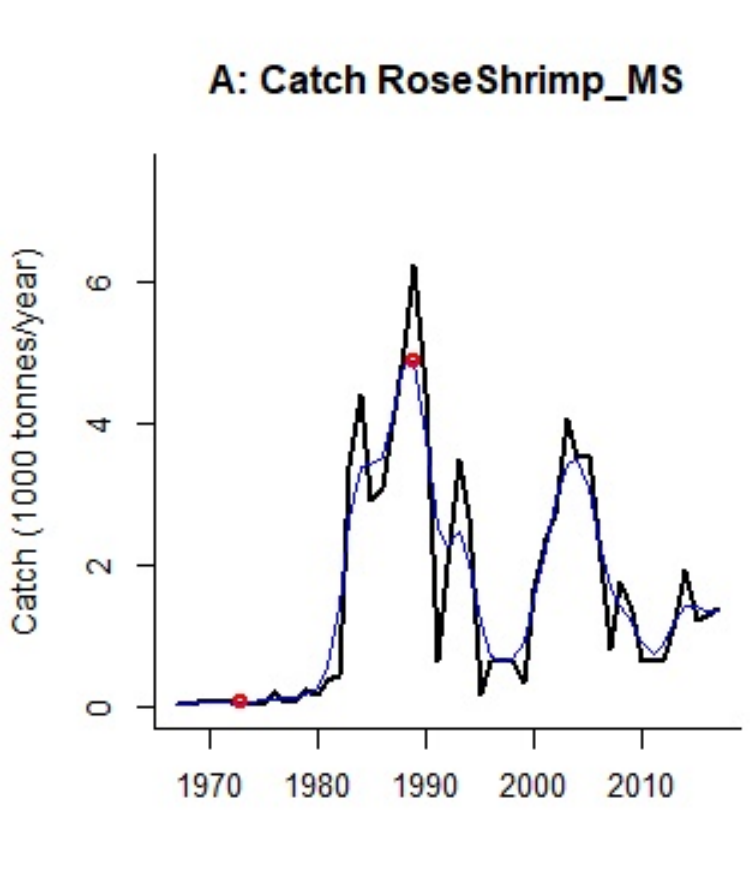
Stock size

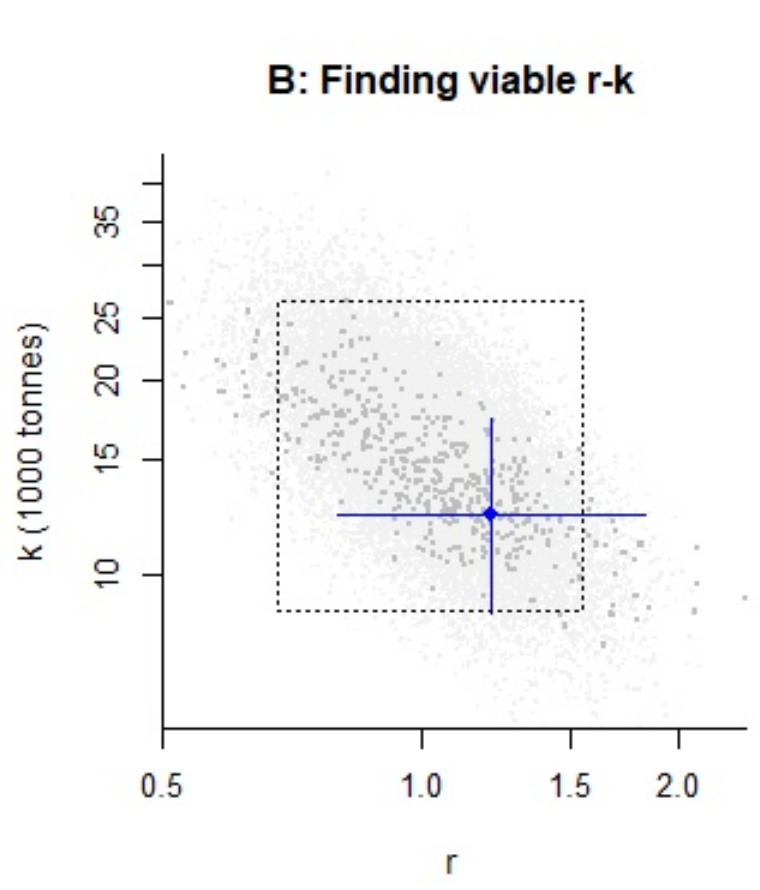


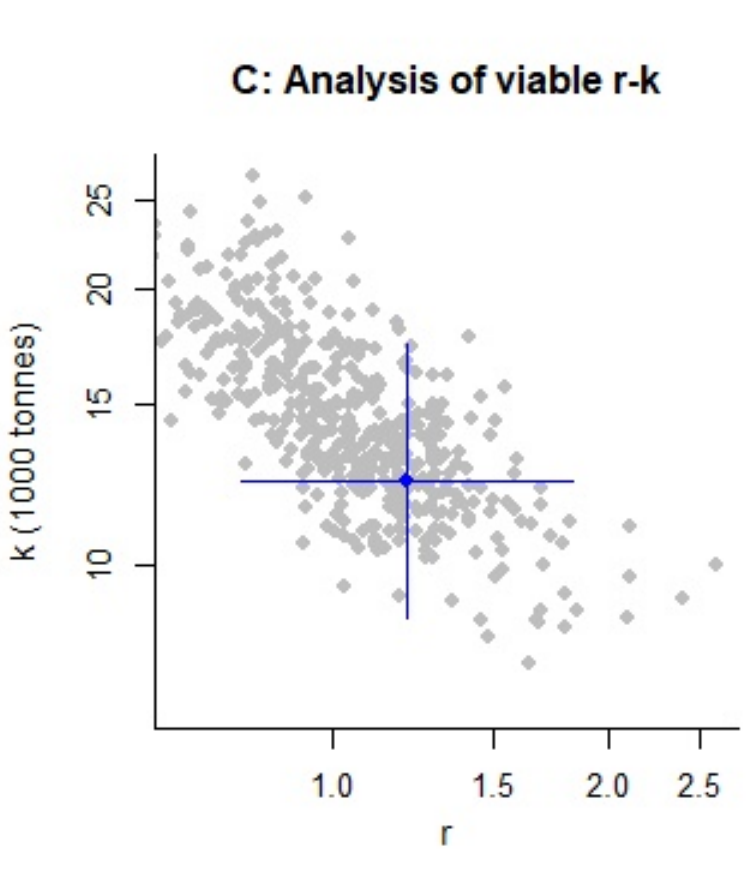
Exploitation

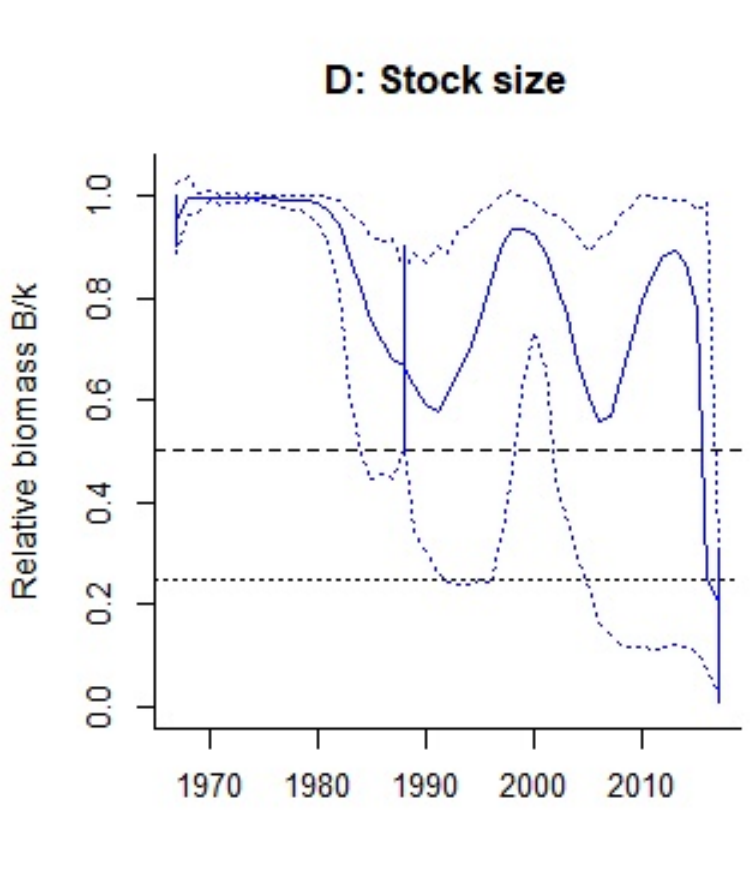


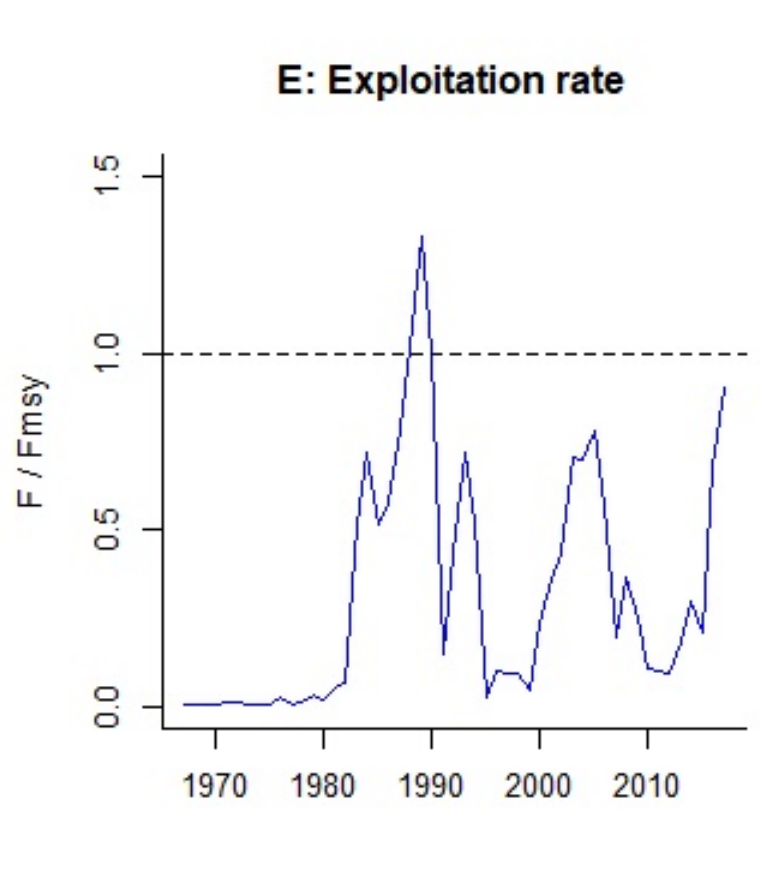


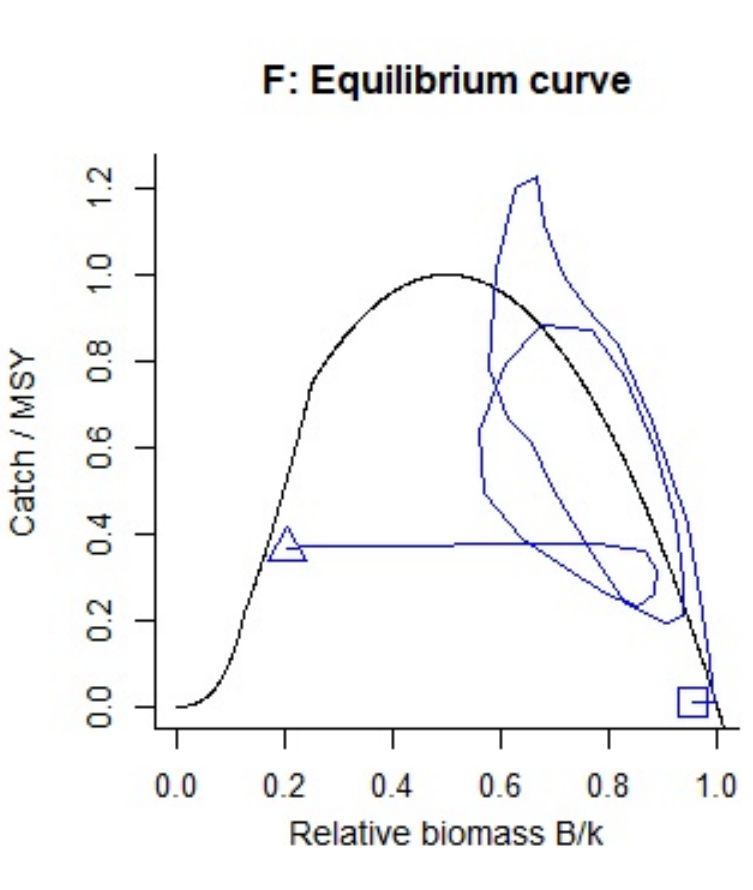

A: Catch RoseShrimp_MS
Catch (1000 tonnes/year)
0
2
4
6
1970
1980
1990
2000
2010

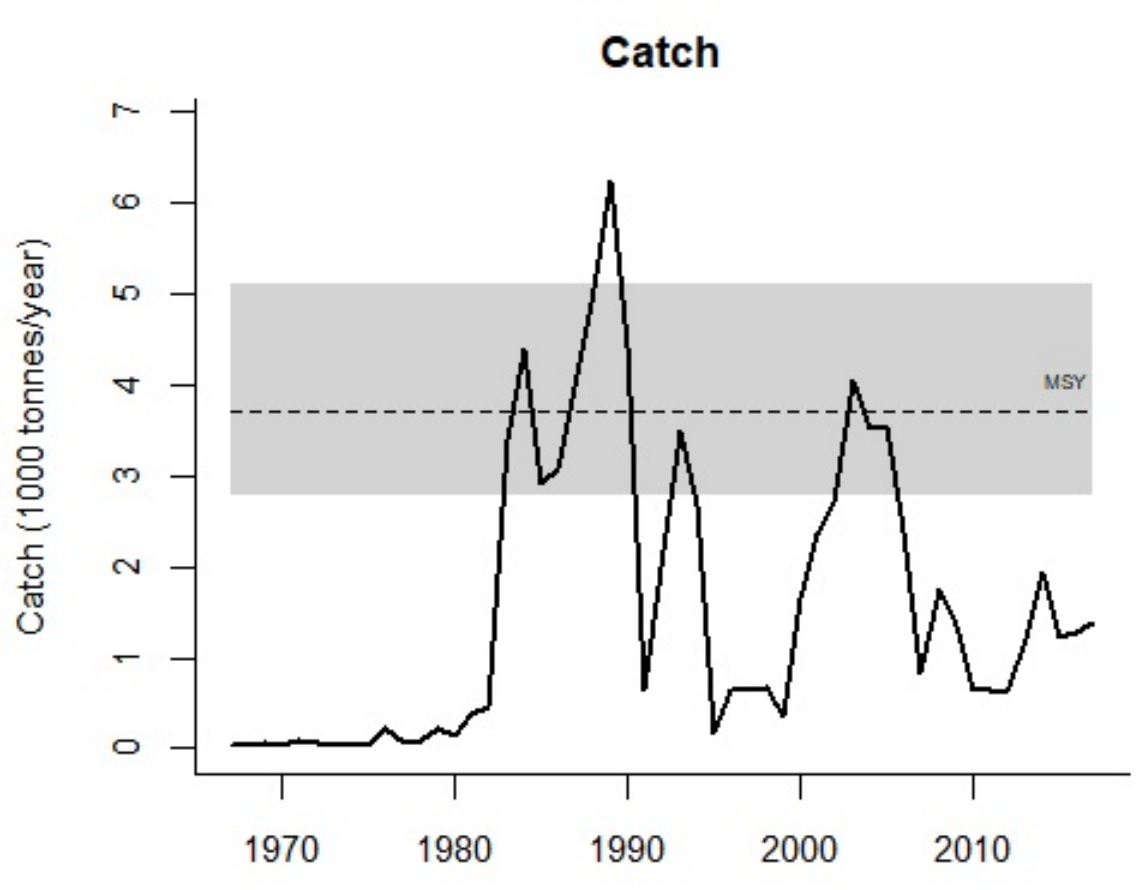

B: Finding viable r-k
k (1000 tonnes)
10
15
20
25
35
0.5
1.0
1.5
2.0
r

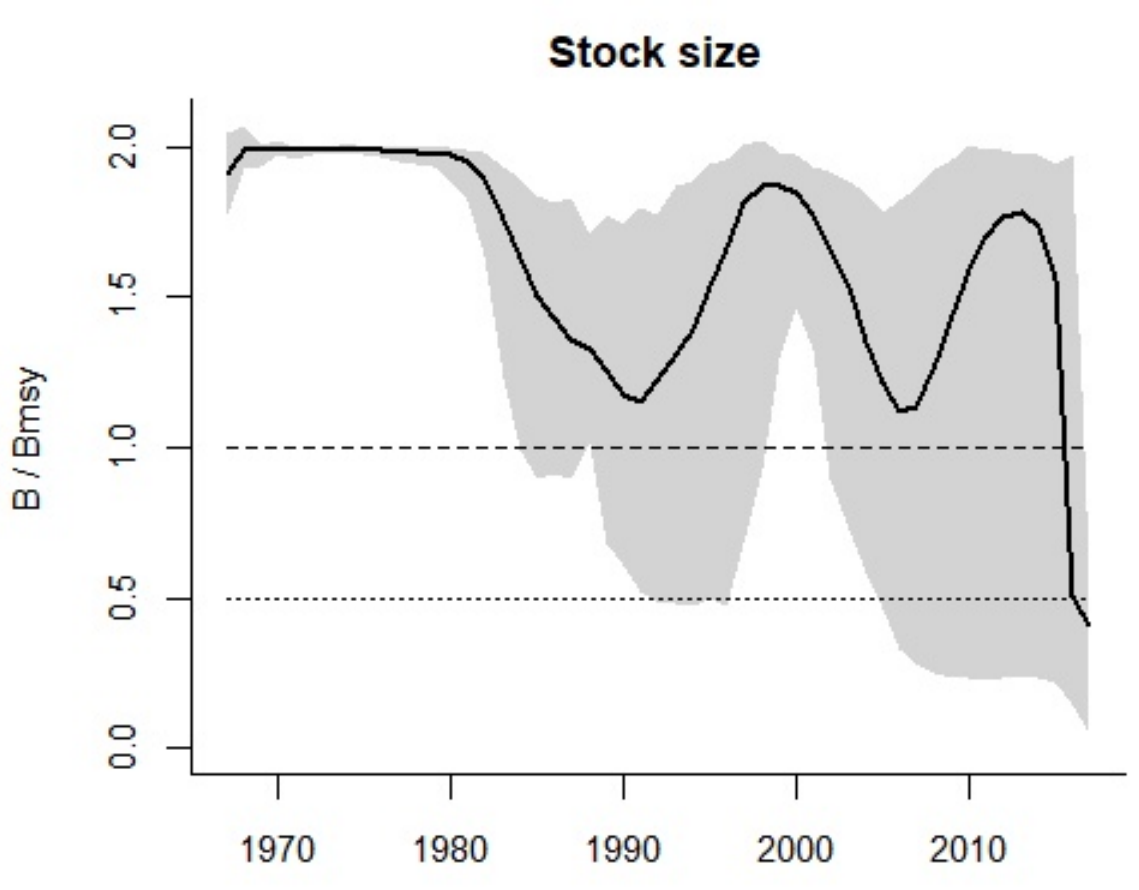

C: Analysis of viable r-k
k (1000 tonnes)
10
15
20
25
1.0
1.5
2.0
2.5
r

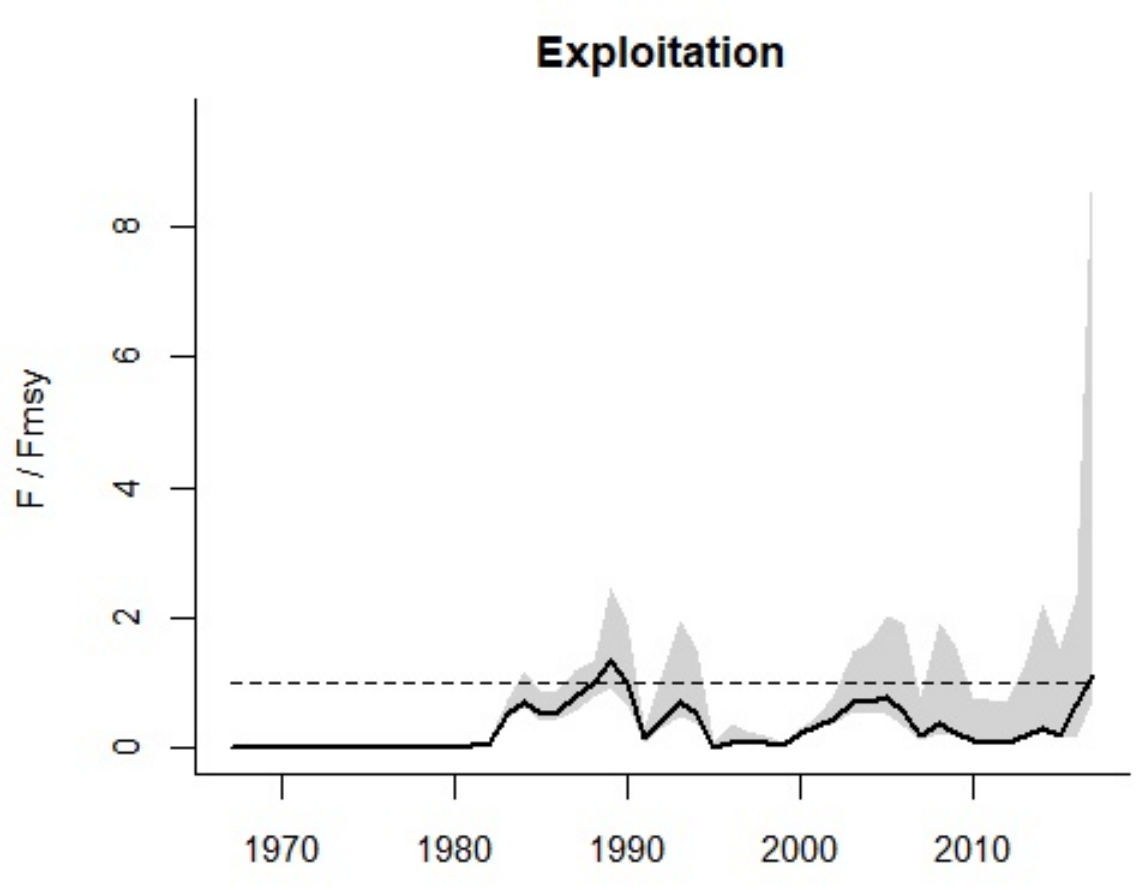

D: Stock size
Relative biomass B/k
0.0
0.2
0.4
0.6
0.8
1.0
1970
1980
1990
2000
2010

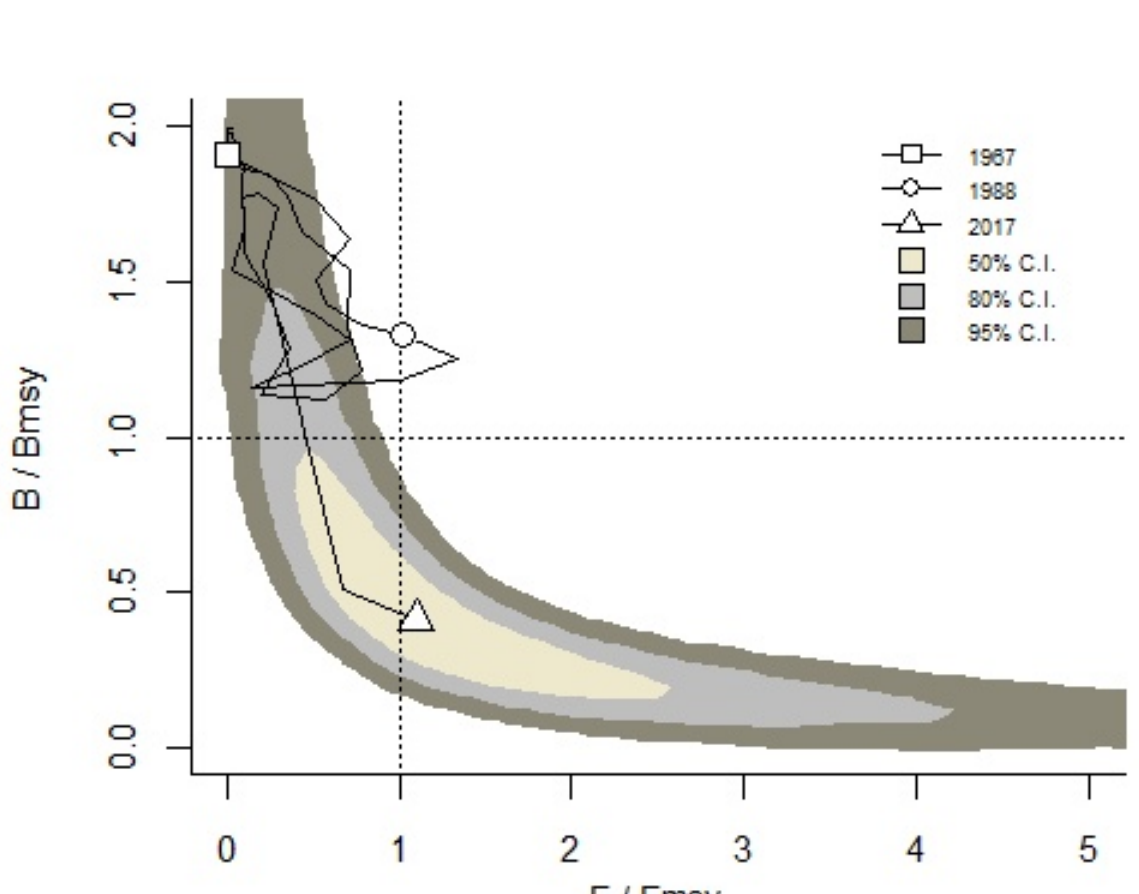

E: Exploitation rate
F / Fmsy
0.0
0.5
1.0
1.5
1970
1980
1990
2000
2010


F: Equilibrium curve
Catch / MSY
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0.0
0.2
0.4
0.6
0.8
1.0
Relative biomass B/k


Catch
Catch (1000 tonnes/year)
0
1
2
3
4
5
6
7
MSY
1970
1980
1990
2000
2010


Stock size
B / Bmsy
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010


Exploitation
F / Fmsy
0
2
4
6
8
1970
1980
1990
2000
2010


B / Bmsy
0.0
0.5
1.0
1.5
2.0
0
1
2
3
4
5
F / Fmsy
1967
1988
2017
50% C.I.
80% C.I.
95% C.I.