BLACK SEA 4 FISH

PRESENTATION SERIES

Data poor stock assessment in the Black Sea

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22 December 2020

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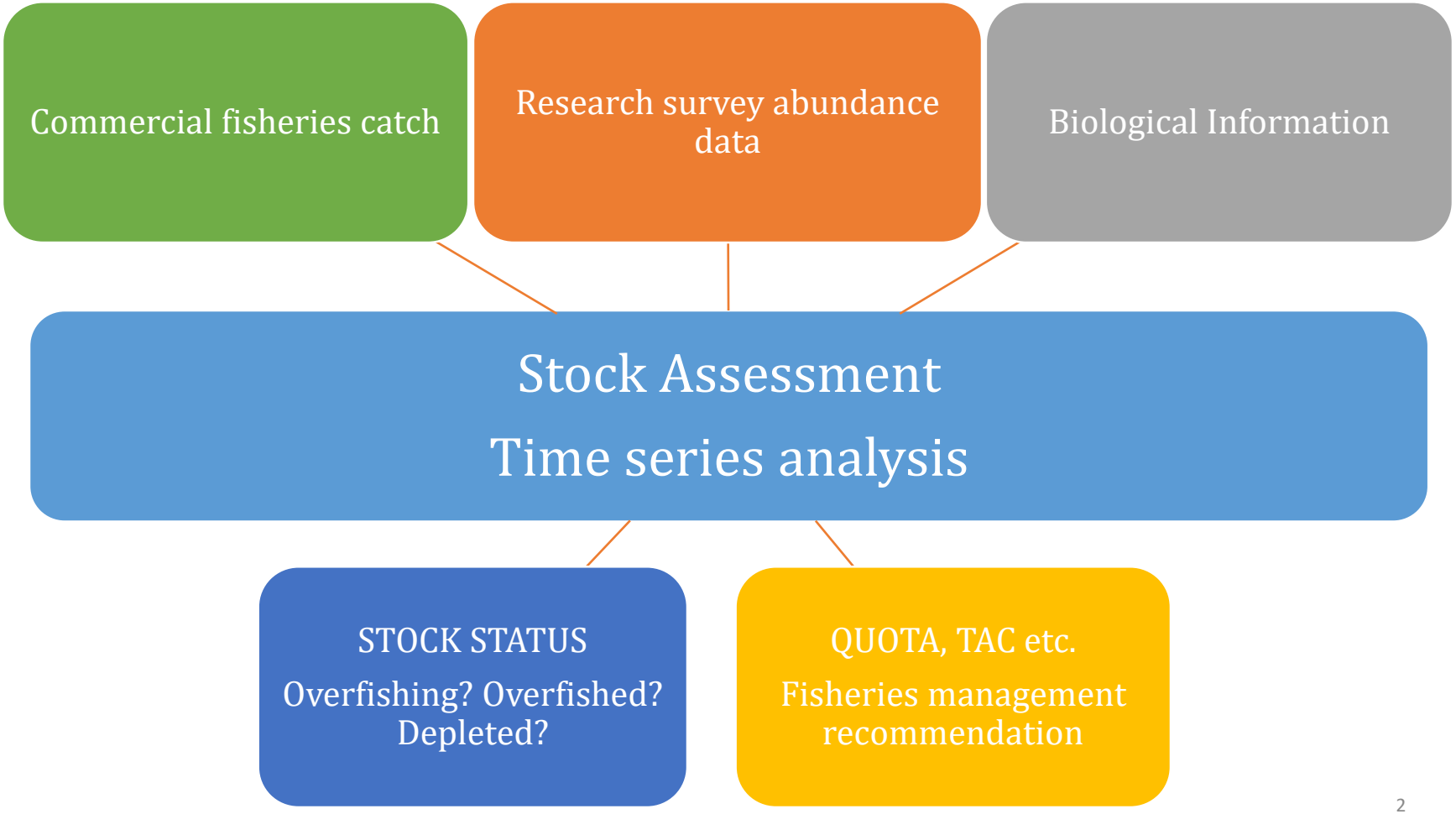
Stock assessment processes



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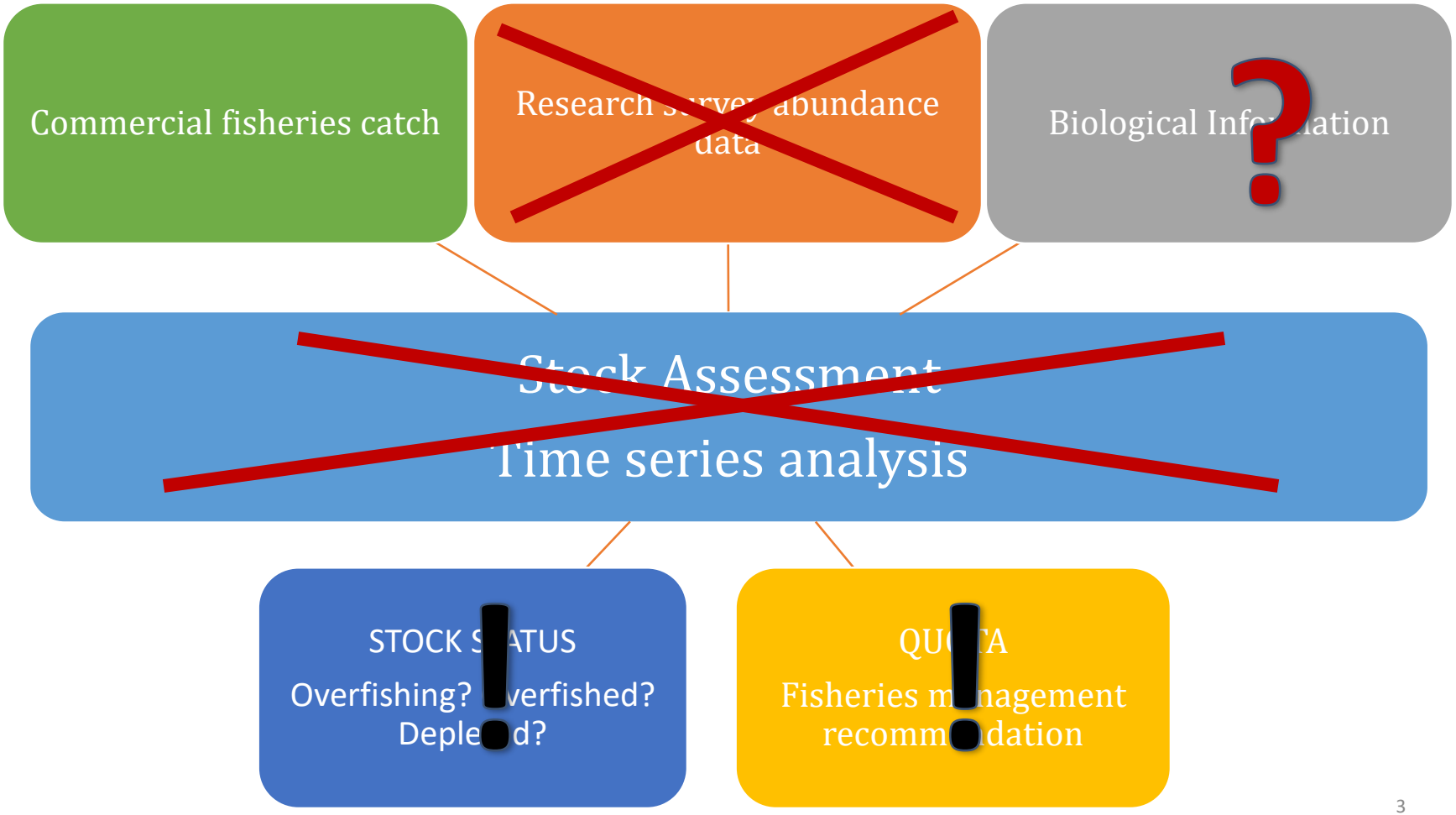
Stock assessment processes



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CMSY Method for data-poor stocks

Froese, R., Demirel, N., Coro, G., Kleisner K., Winker, H. (2016). Estimating fisheries reference points from catch and resilience. Fish and Fisheries, doi: 10.1111/faf.12190

FISH and FISHERIES

FISH and FISHERIES, 2017, **18**, 506–526

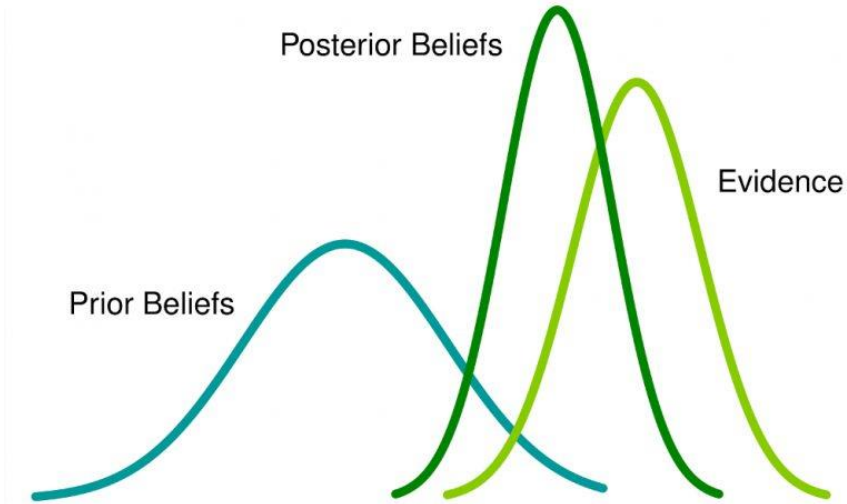
Estimating fisheries reference points from catch and resilience

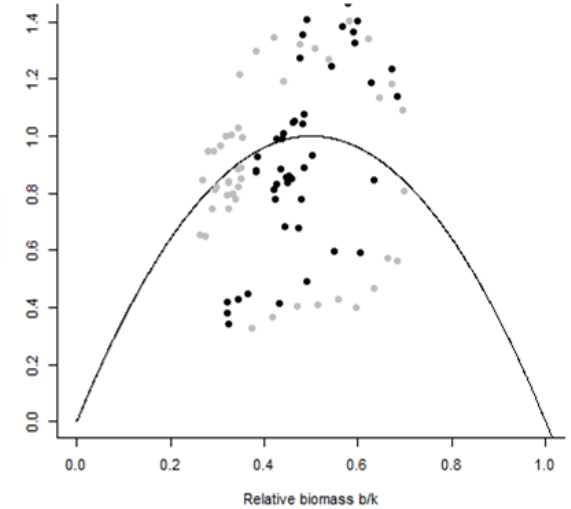
Rainer Froese[1], *Nazli Demirel*[2], *Gianpaolo Coro*[3], *Kristin M Kleisner*[4] & *Henning Winker*[5,6]

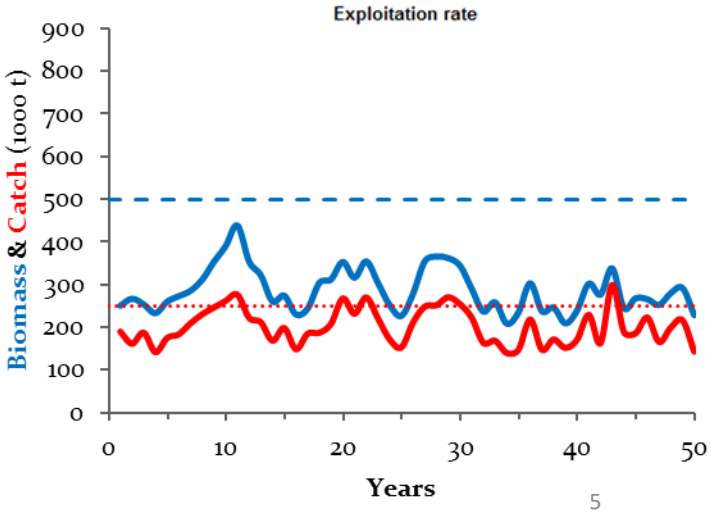
[1]GEOMAR Helmholtz Centre for Ocean Research Kiel, Düsternbrooker Weg 20, 24105 Kiel, Germany; [2]Institute of Marine Sciences and Management, Istanbul University, 34134 Istanbul, Turkey; [3]Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo", Consiglio Nazionale delle Ricerche (CNR), via Moruzzi 1, 56124 Pisa, Italy; [4]National Oceanographic and Atmospheric Administration, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543, USA; [5]South African National Biodiversity Institute, Kirstenbosch Research Centre, 7735 Claremont, South Africa; [6]Centre for Statistics in Ecology, Environment and Conservation (SEEC), Department of Statistical Sciences, University of Cape Town, Private Bag X3, 7700 Rondebosch, South Africa

CMSY Analysis – Brief

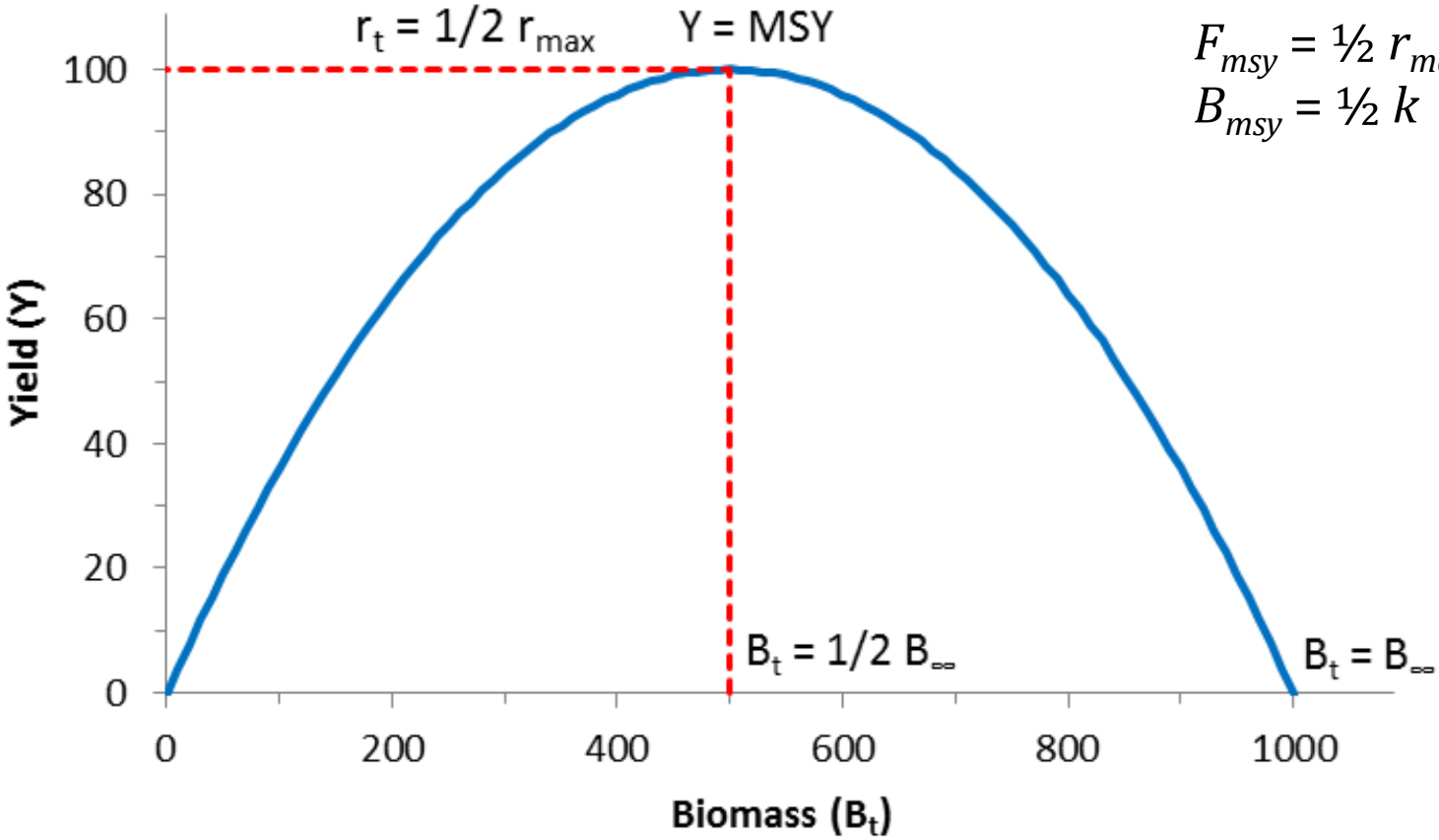
- Given a biomass trend compliant with the Schaefer function,
- Estimate the best pair of values for
  - ***intrinsic rate of increase*** (r)
  - **carrying capacity** (k)
- $b_{t+1} = b_t - c_t + \boldsymbol{r}\, b_t \left(1 - \frac{b_t}{\boldsymbol{k}}\right) v_s$
- Goal: estimate **r** and **k**.







CMSY Analysis – Brief



$F_{msy} = ½\ r_{max}$
$B_{msy} = ½\ k$

The Schaefer Model (1954)

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CMSY Analysis – Brief

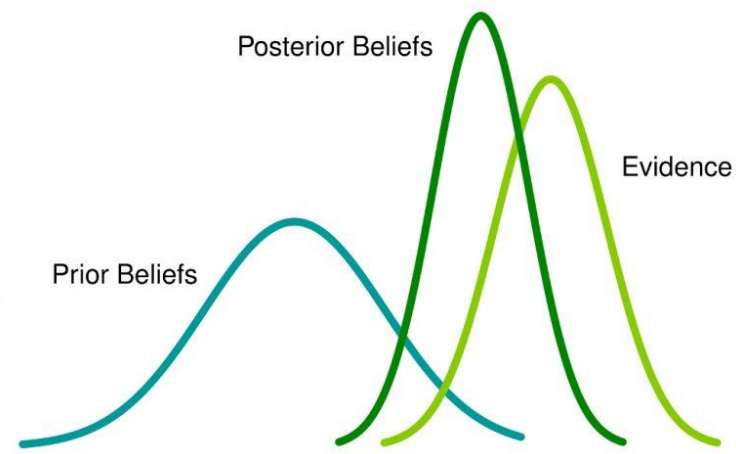
- Bayesian stock assessments, data rich and especially data-poor, need priors for intrinsic rate of population increase rmax
- FishBase and SealifeBase provide qualitative (= uniform) priors for resilience/productivity based on life history (tm, tmax, fecundity, K)
- FishBase and SealifeBase provide quantitative priors for rmax based on observed changes in abundance (= stock assessments)

Resilience	prior r range
High	0.6 – 1.5
Medium	0.2 – 0.8
Low	0.05 – 0.5
Very low	0.015 – 0.1

Prior biomass	B/k range
High	0.5 – 0.9
Medium	0.2 – 0.6
Low	0.01 – 0.4

Prior ranges for parameter *r*, based on classification of resilience (fishbase.org)

Parameter	High	Medium	Low	Very low
Threshold	0.99	0.95	0.85	0.70
rmaks (1/y)	> 0,5	0.16 – 0.50	0.05 – 0.15	< 0.05
K (1/yıl)	> 1	0.20 – 0.80	0.05 – 0.20	< 0.05
Fecundity (1/y)	> 50,000	100 – 10,000	10 – 100	< 10
tm (y)	< 1	2 – 4	5 – 10	> 10
tmax (y)	1 – 3	4 – 10	11 – 30	> 30



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CMSY Analysis – Brief

- rmax prior for European anchovy in FishBase

Engraulis encrasicolus (Linnaeus, 1758)
European anchovy

Estimates of some properties based on models

Preferred temperature (Ref. 115969): 7.1 - 18, mean 10.8 (based on 667 cells).

Phylogenetic diversity index (Ref. 82805): PD_{50} = 0.5020 [Uniqueness, from 0.5 = low to 2.0 = high].

Bayesian length-weight: a=0.00479 (0.00430 - 0.00532), b=3.09 (3.06 - 3.12), in cm Total Length, based on LWR estimates for this species (Ref. 93245).

Trophic Level (Ref. 69278): 3.1 ±0.36 se; Based on food items.

Resilience (Ref. 69278): Medium, minimum population doubling time 1.4 - 4.4 years (K=0.3-1.73; tmax=6; Fec =13,000-503,000).

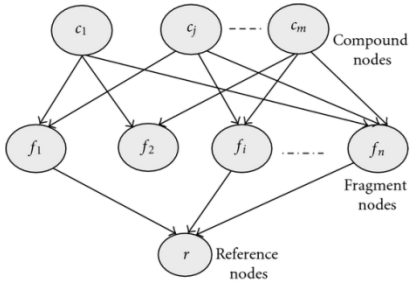
Prior r = 0.59, 95% CL = 0.39 - 0.91, Based on 21 stock assessments.

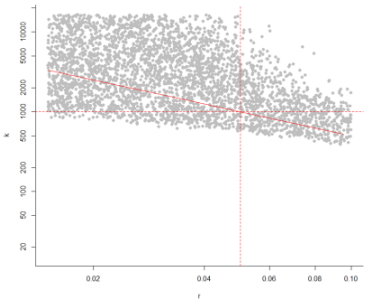
Vulnerability (Ref. 59153): Low vulnerability (25 of 100) .

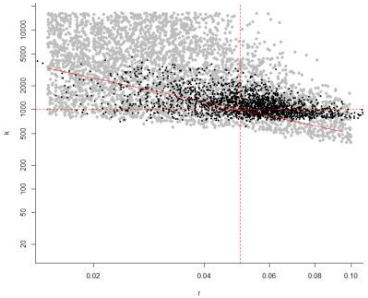
Price category (Ref. 80766): Medium.

CMSY Analysis – Brief

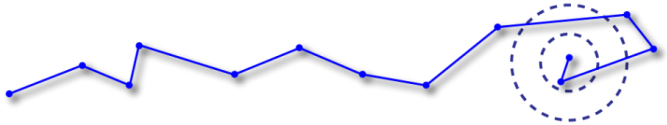
- Bayesian Method
  - Uninformative priors
  - Sample all possible r and k pairs compliant with the Schaefer function and the priors



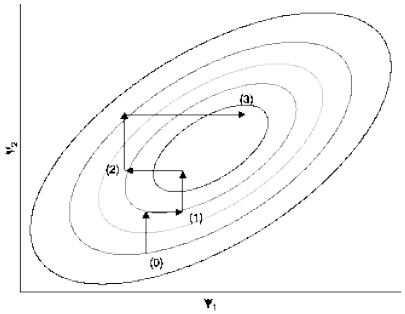


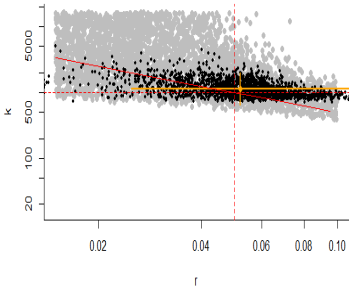


- Monte Karlo approach
  - Integration
  - Resulting best (r, k) pairs

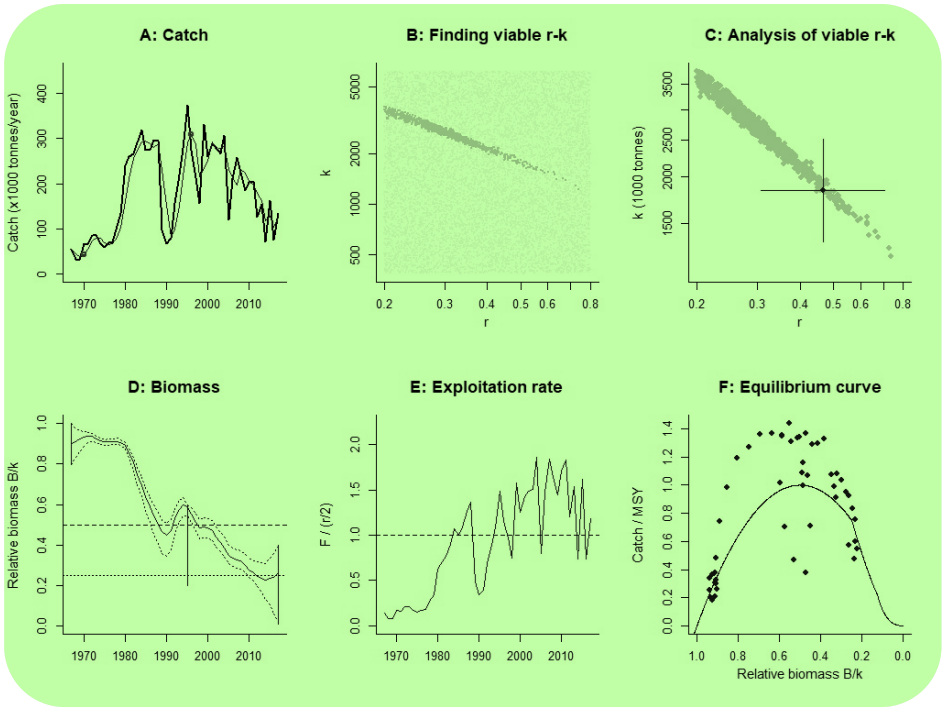


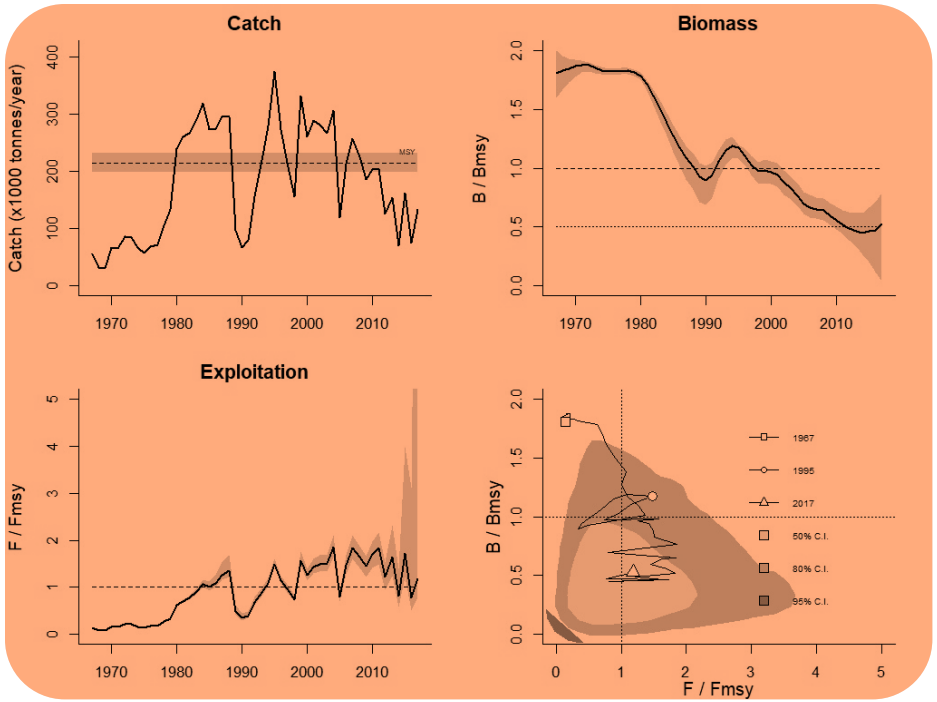
- Gibbs Sampling
  - Fixing the model
  - Converge to the best estimation





CMSY Analysis – Outputs





- Panel A: Time series of catches
- Panel B: *r-k* pairs by the CMSY model
- Panel C: Most probable *r-k* pair
- Panel D: Estimated biomass trajectory
- Panel E: Harvest rate
- Panel F: Schaefer equilibrium curve

Management graph

- Catch and MSY
- Relative total biomass (B/Bmsy)
- Relative exploitation (F/Fmsy)
- B/Bmsy and F/Fmsy

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CMSY Method for data-poor stocks

Demirel N, Zengin M and Ulman A (2020) First Large-Scale Eastern Mediterranean and Black Sea Stock Assessment Reveals a Dramatic Decline. Front. Mar. Sci. 7:103. doi: 10.3389/fmars.2020.00103

frontiers in Marine Science

ORIGINAL RESEARCH
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First Large-Scale Eastern Mediterranean and Black Sea Stock Assessment Reveals a Dramatic Decline

Nazli Demirel[1], Mustafa Zengin[2] and Aylin Ulman[3]*

[1] Department of Marine Biology, Institute of Marine Sciences and Management, Istanbul University, Istanbul, Turkey, [2] Central Fisheries Research Institute, Yomra, Turkey, [3] Mersea Marine Conservation Consulting, Fethiye, Turkey

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The Mediterranean Sea is classified as a "data-poor" region in fisheries due to its low number of assessed stocks given its biodiversity and number of exploited species. In this study, the CMSY method was applied to assess the status and exploitation levels

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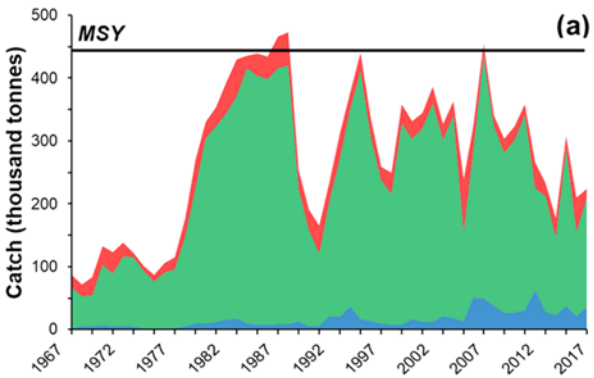
Stock status in Black Sea

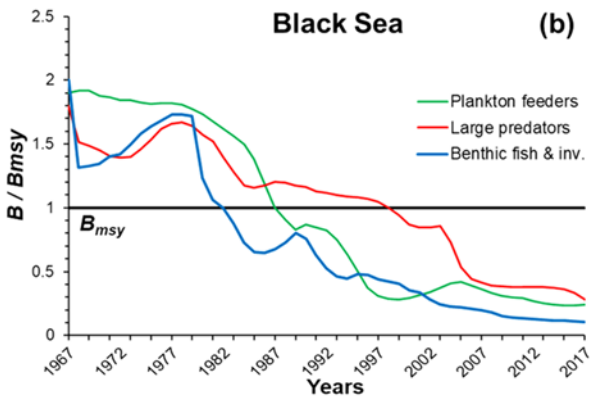
Group	Common name	Scientific name	Start year	End year	Biomass type	Max Catch	Last Catch
Plankton feeders	Anchovy	*Engraulis encrasicolus*	1967	2017	None	373,782	133,767
Plankton feeders	Horse mackerel	*Trachurus trachurus*	1968	2017	None	19,203	2,167
Plankton feeders	Sprat	*Sprattus sprattus*	1993	2017	None	86,676	33,944
Plankton feeders	Med. horse mackerel	*Trachurus mediterraneus*	1967	2017	None	160,943	4,257
Plankton feeders	Chub mackerel	*Scomber colias*	1967	2016	None	15,058	0.02
Plankton feeders	Shad	*Alosa immaculata*	1967	2017	None	3,787	0.62
Plankton feeders	Picarel	*Spicara* sp.	1967	2017	None	2,025	0.005
Large predators	Bonito	*Sarda sarda*	1967	2017	None	63,896	5,570
Large predators	Whiting	*Merlangius merlangus*	1967	2017	None	28,263	7,416
Large predators	Bluefish	*Pomatomus saltatrix*	1967	2017	None	23,507	0.997
Large predators	Garfish	*Belone belone*	1967	2017	None	3,737	0.099
Benthic fish & inv.	Striped venus	*Chamelea gallina*	1992	2017	None	64,225	34,941
Benthic fish & inv.	Turbot	*Scophthalmus maximus*	1967	2017	None	5,249	0.152
Benthic fish & inv.	Picked dogfish	*Squalus acanthias*	1967	2014	None	10,886	0.003
Benthic fish & inv.	Red mullet	*Mullus barbatus barbatus*	1967	2017	None	5,641	0.329
Benthic fish & inv.	Thornback ray	*Raja clavata*	1968	2017	None	3,389	0.012

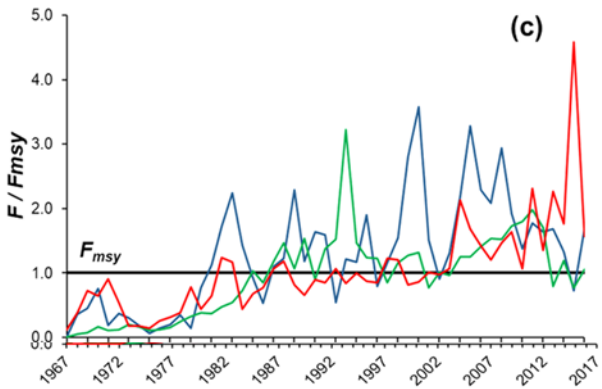
Totally 16 stocks:

7 plankton feeders, 4 large predators, and 5 benthic fish

Stock status in Black Sea







- Total catch < MSY since 2011
- Catch/MSY < 1 in 2017 for all groups

- 94% below Bmsy
- 86% below 0.5 Bmsy (critical point)
- Bad status since 1991

- 76% above Fmsy
- Bad status since 1987

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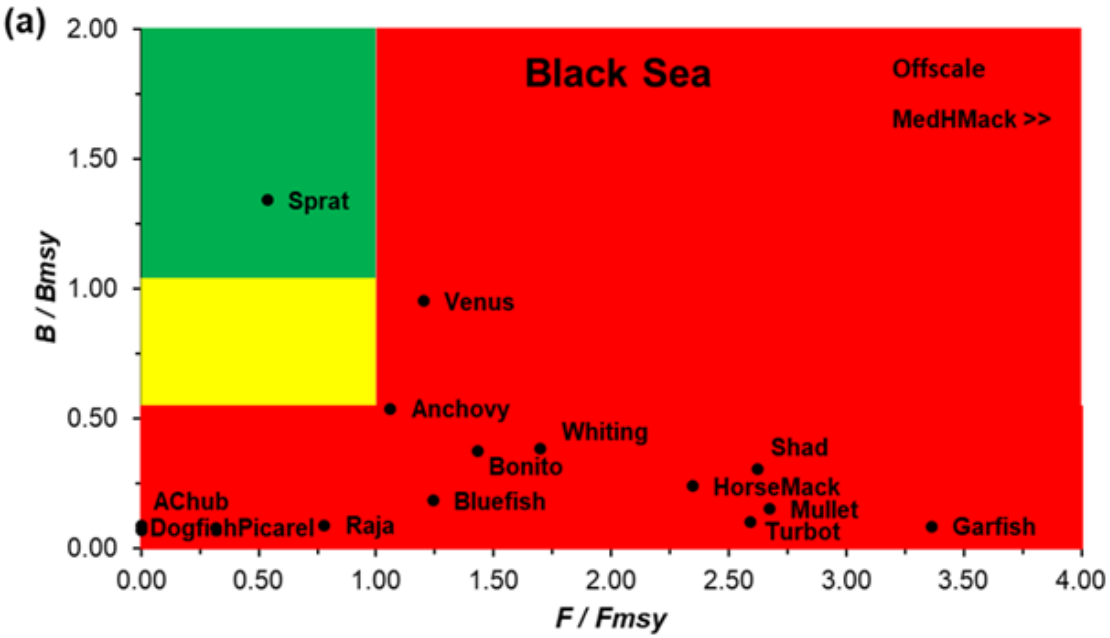
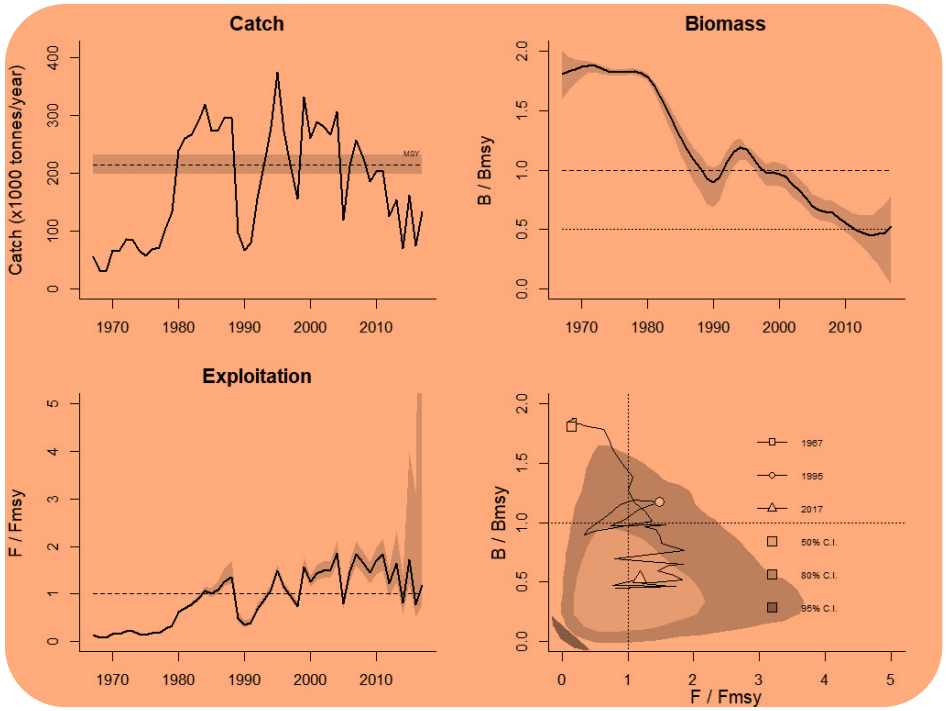
Stock Status vs. Good Environmental Status

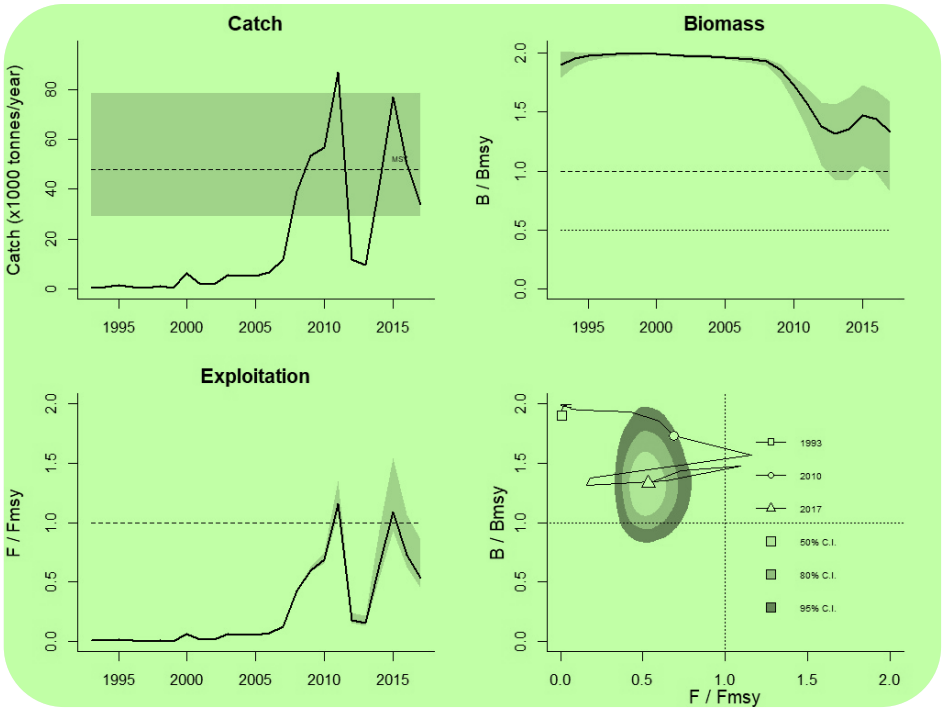


Stock	B/Bmsy	F/Fmsy
Anchovy	0.54	1.06
HorseMack	0.24	2.35
Sprat	1.34	0,54
MedHMack	0.09	4.15
Chub	0.07	0.01
Shad	0.31	2.62
Picarel	0.08	0.32
Bonito	0.38	1.43
Whiting	0.38	1.70
Bluefish	0.18	1.24
Garfish	0.09	3.36
Venus	0.95	1.20
Turbot	0.10	2.59
Dogfish	0.09	0.01
Mullet	0.15	2.67
Raja	0.09	0.78

- Only 1 stock is in good conditions and corresponds GEnS requirements
- The rest 15 stocks are outside of safe biological limits
- 2 stocks are recognized as «critical conditions»

Anchovy vs. Sprat





- Biomass 2017 is equal to 0.5 Bmsy
- Biomass is outside of safe biological limits
- Ongoing overexploitation (F/Fmsy>1 in 2017)
- Very good condition in 1967
- Good condition in 1995
- Bad condition in 2017

- Biomass 2017 is over Bmsy appx 1.5 fold
- Gradual decrease in biomass since 2007
- Exploitation provides MSY (F/Fmsy <1)
- Very good condition between 1967 and 2017
- Less catch but expected to increase
- Less valuable but expected to increase

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Rebuilding stocks

Froese, R., Winker, H., Coro, G., Demirel, N., Tsikliras, A., Dimarchopoulou, D., Scarcella, G., Quaas, M., Matz-Lück, N. (2018). Status and rebuilding European Fisheries. Marine Policy, 93: 159-170. doi: 10.1016/j.marpol.2018.04.018

Marine Policy 93 (2018) 159–170

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Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Status and rebuilding of European fisheries

Rainer Froese[a,*], Henning Winker[b,c], Gianpaolo Coro[d], Nazli Demirel[e], Athanassios C. Tsikliras[f,*], Donna Dimarchopoulou[f], Giuseppe Scarcella[g], Martin Quaas[h], Nele Matz-Lück[i]

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[b] DAFF - Department of Agriculture, Forestry and Fisheries, Private Bag X2, Rogge Bay 8012, South Africa
[c] Centre for Statistics in Ecology, Environment and Conservation, Department of Statistical Sciences, University of Cape Town, Rondebosch, Cape Town, South Africa
[d] Institute of Information Science and Technologies "A. Faedo" - National Research Council of Italy (ISTI-CNR), via Moruzzi 1, 56124 Pisa, Italy
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[h] Institute of Economics, Kiel University, Wilhem-Seelig-Platz 1, 24118 Kiel, Germany
[i] Walther Schücking Institute of International Law, Kiel University, Westring 400, 24118 Kiel, Germany

Feedback

Rebuilding stocks

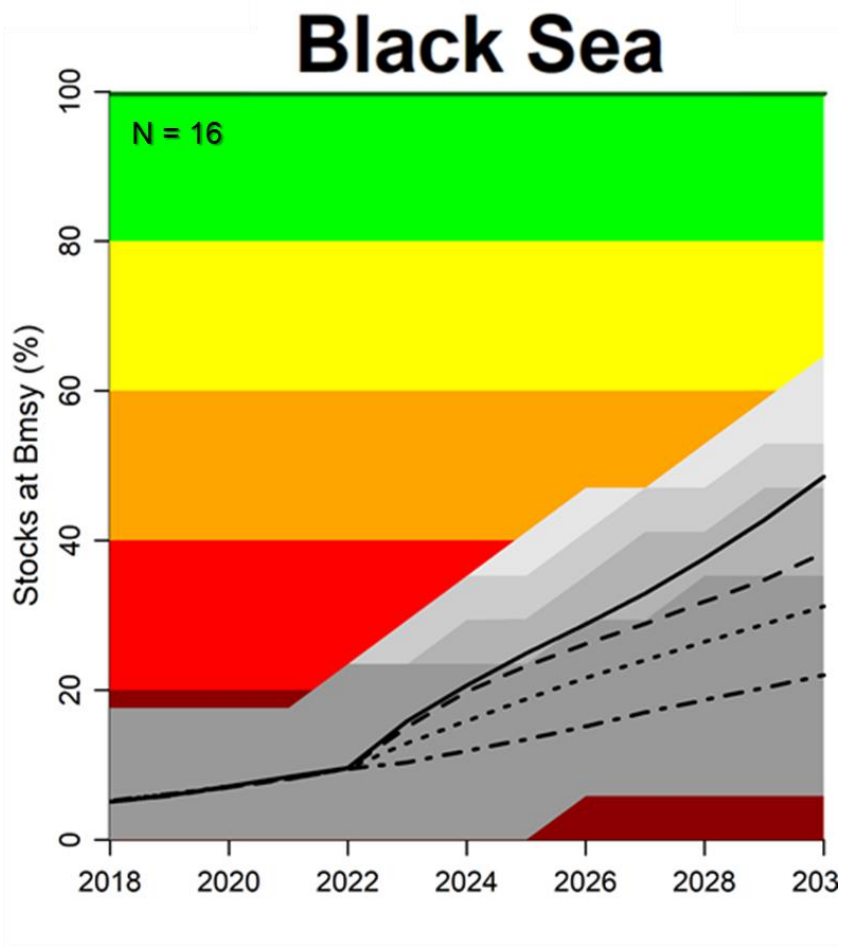
Predicted percentage of stocks capable of producing MSY

(a) The 0.5 scenario ($F = 0.5\ F_{msy}$)

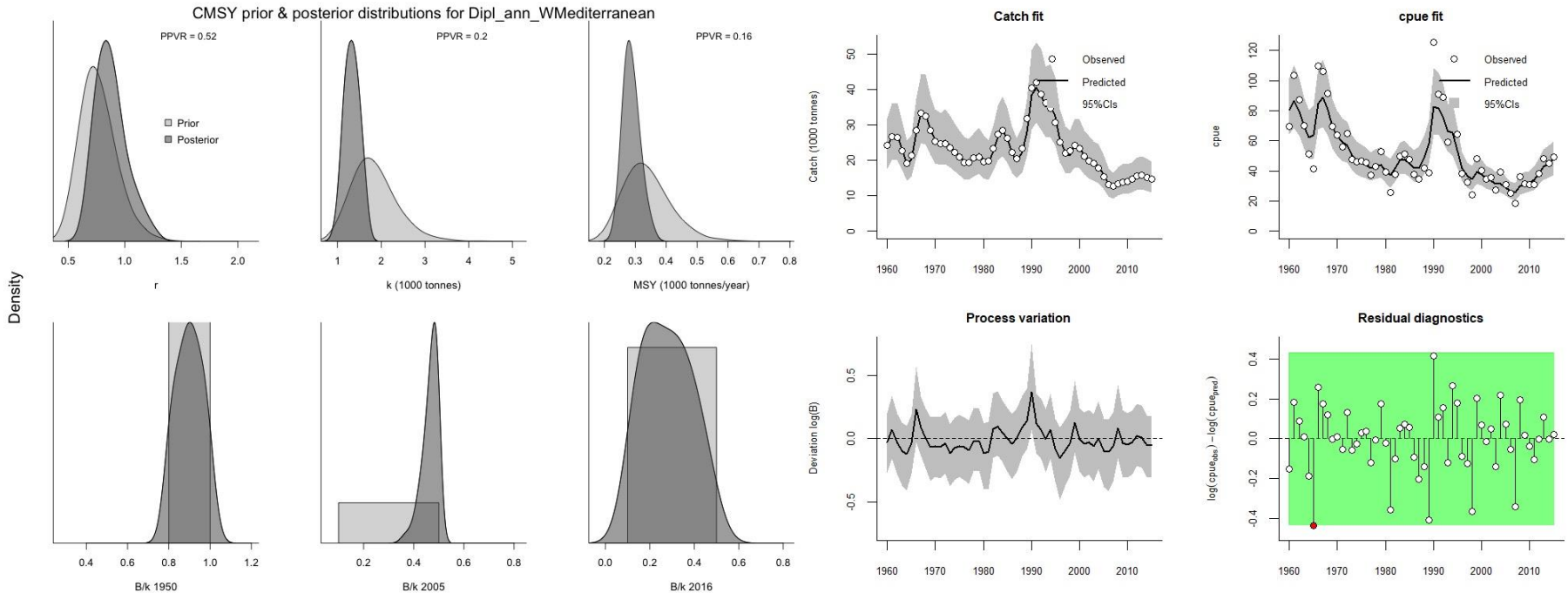
(b) The 0.6 scenario ($F = 0.6\ F_{msy}$)

(c) The 0.8 scenario ($F = 0.8\ F_{msy}$)

(d) The 0.95 scenario ($F = 0.95\ F_{msy}$)



CMSY+



✓Graph showing prior and posterior distributions for r, k, and last year B/B0

✓Graph showing retrospective analysis for predicted F/Fmsy and B/Bmsy trajectories

CMSY++ is on the way…

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Thanks for your attention!

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