

RESILIENCE ANALYSIS OF THE BLACK SEA

Susa Niiranen

Stockholm University,
Stockholm Resilience Center

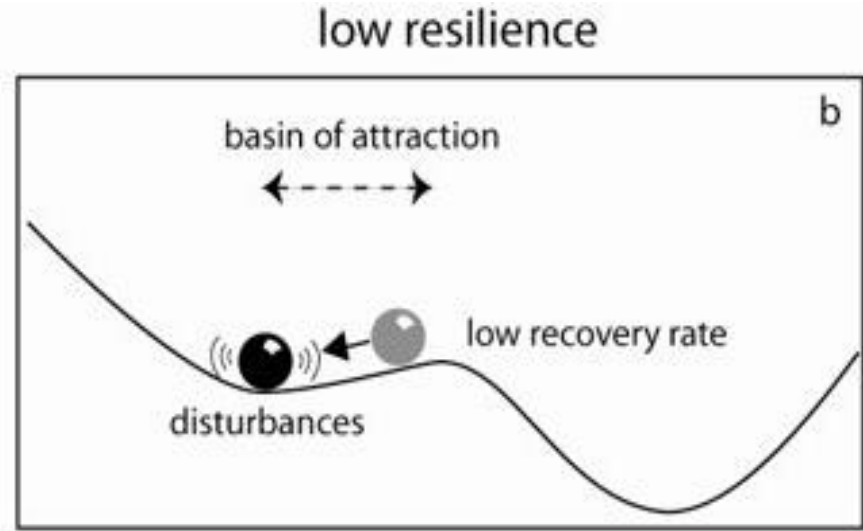
susa.niiranen@su.se



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No:101000240.

RESILIENCE IS THE ABILITY TO RETAIN ESSENTIAL FUNCTIONS, STRUCTURES AND FEEDBACKS

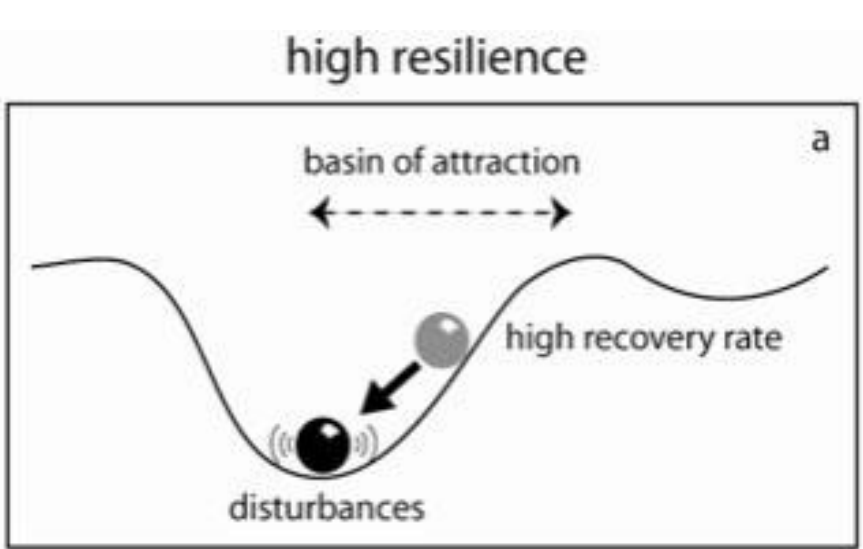
BLACK SEA PRE-1990



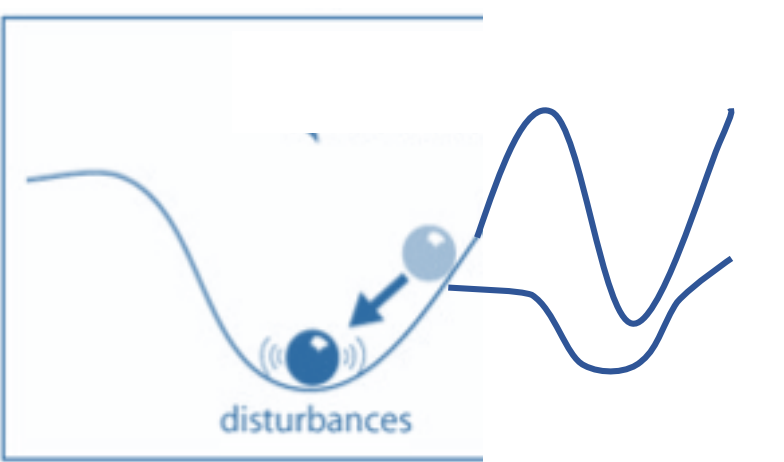
BLACK SEA 2050



BLACK SEA AFTER 1990



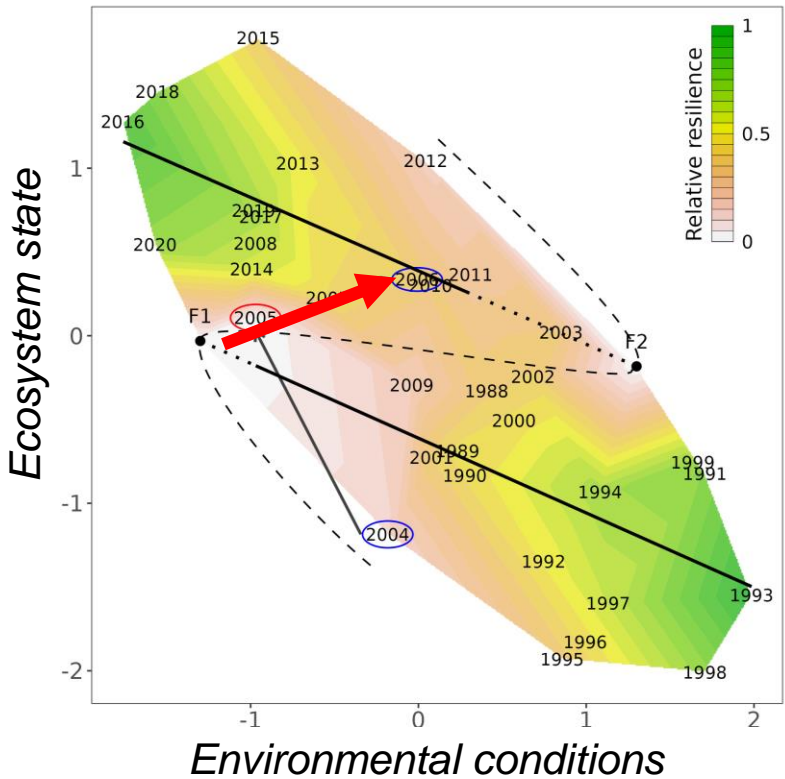
FUTURE RESILIENCE?



(Van Nes & Scheffer, American Naturalist 2007)

PAST AND FUTURE ECOSYSTEM RESILIENCE AT BLACK SEA BASIN-SCALE

**PAST
(ECOSYSTEM DATA)**

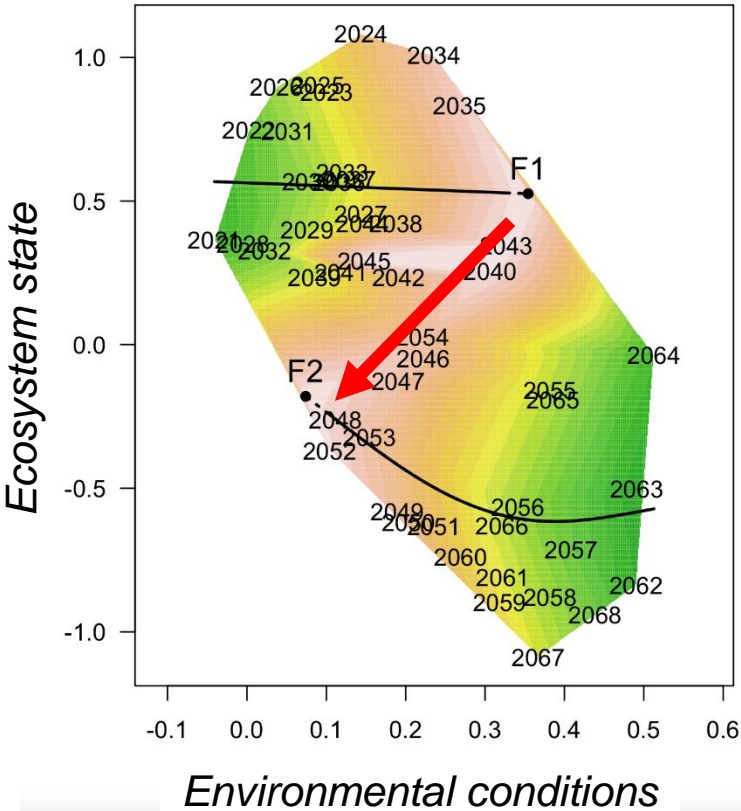


- Recovery towards pre-jellyfish state identified in 2005
- Driven by environmental drivers via trophic cascades (Daskalov *et al.* in prep)

**FUTURE SSP1
(2021-2070, MODELLED)**

**NO REGIME SHIFT
IN SSP1**

**FUTURE SSP5
(2021-2070, MODELLED)**

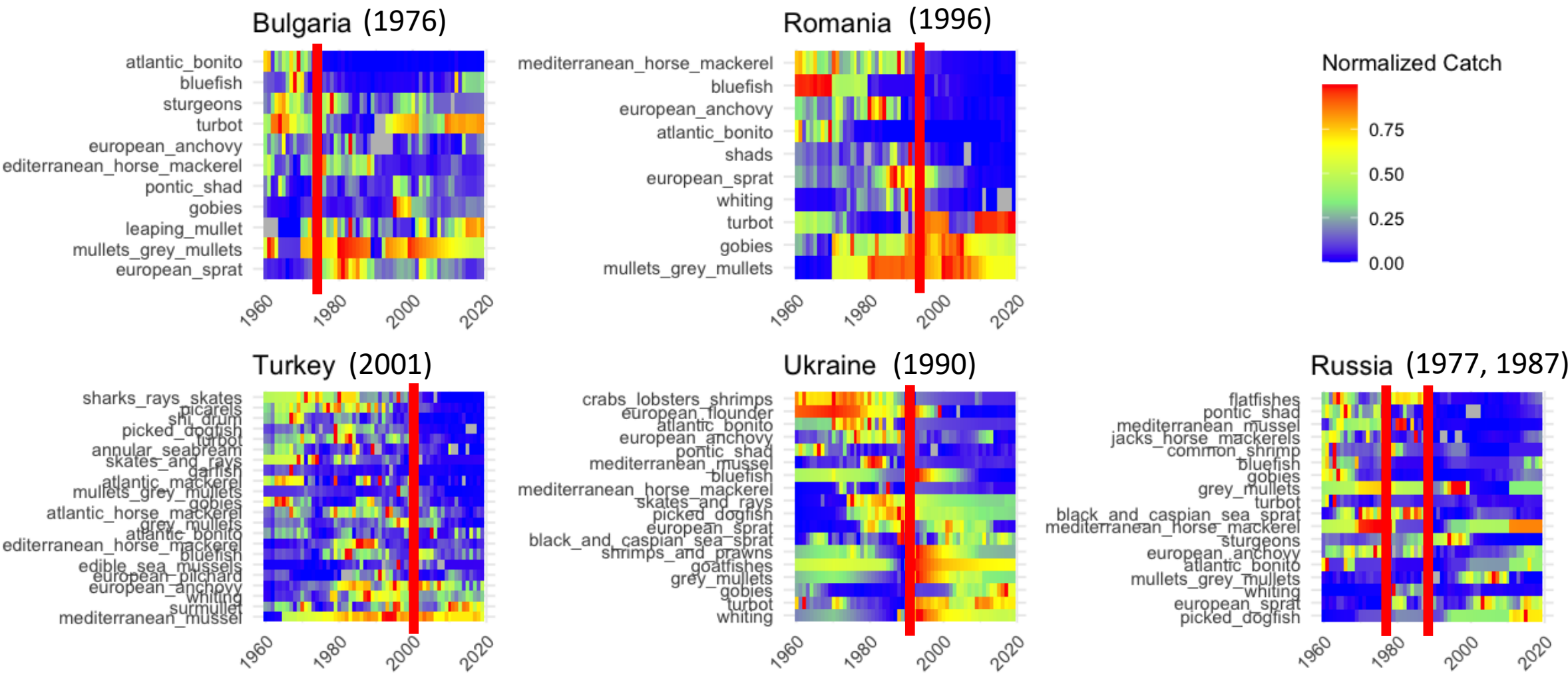


- Regime shift observed at around 2045; resilience starts to erode before

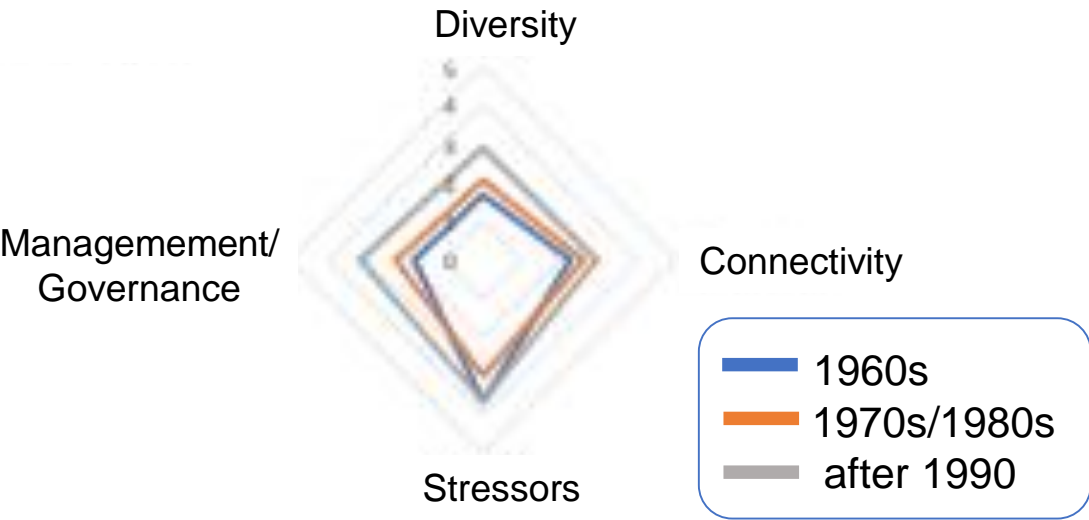
Changes in fish landings composition and volume across the different EEZs (1960-2010)



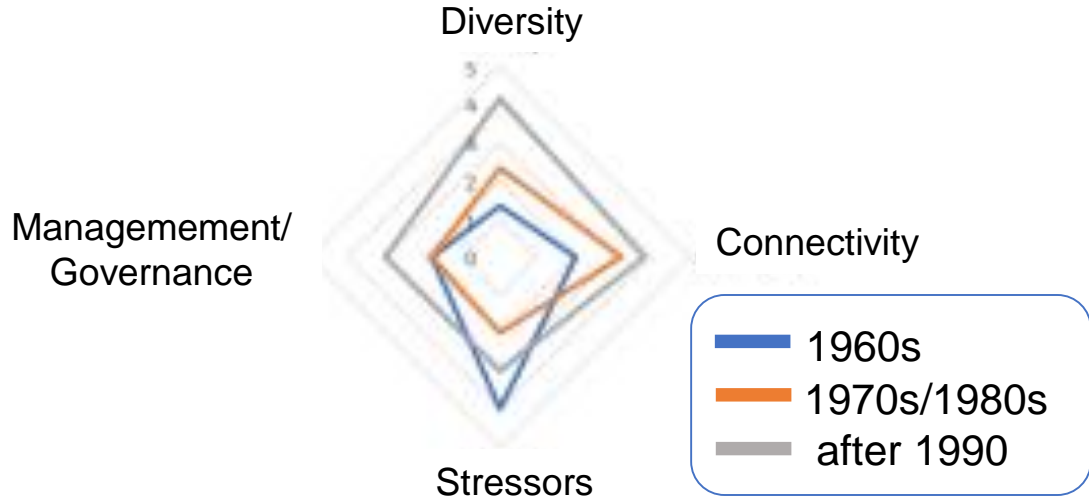
Regime shifts detected at different times



Cultural ES - PS1 (Istanbul)



Cultural ES - PS2 (Bulgaria)



7 Ecosystem Service resilience principles (Biggs et al. 2012)

SES PROPERTIES TO MANAGE (1-3):

- 1 DIVERSITY AND REDUNDANCY ↑
- 2 CONNECTIVITY ↑
- 3 SLOW VARIABLE AND FEEDBACKS ↓

KEY GOVERNANCE ATTRIBUTES (4-7):

- 4 UNDERSTANDING COMPLEX ADAPTIVE SYSTEMS
- 5 LEARNING AND EXPERIMENTATION
- 6 PARTICIPATION ↑
- 7 POLYCENTRICITY ↑