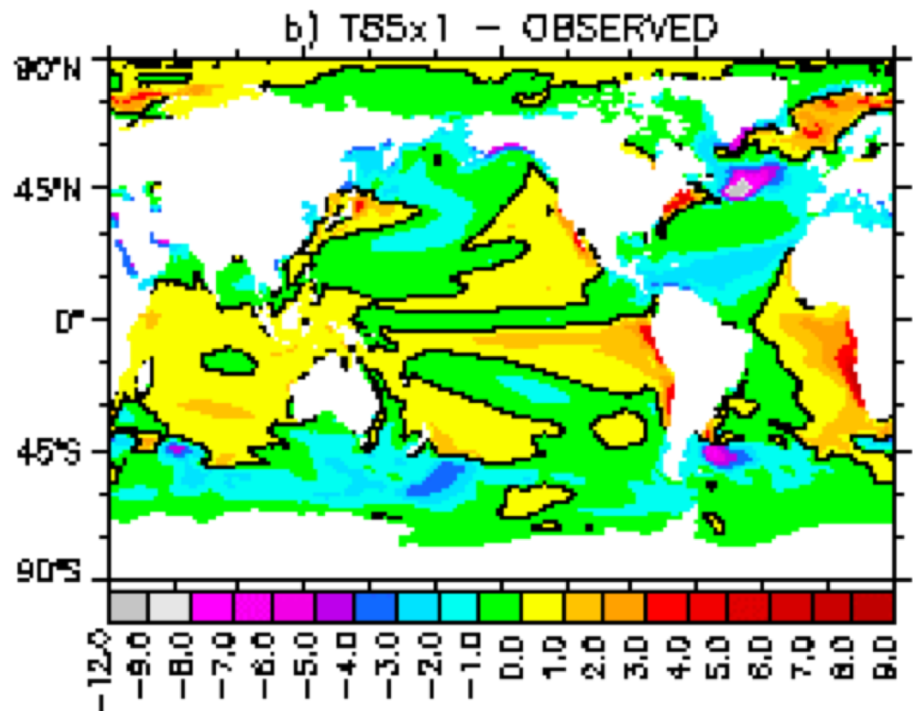


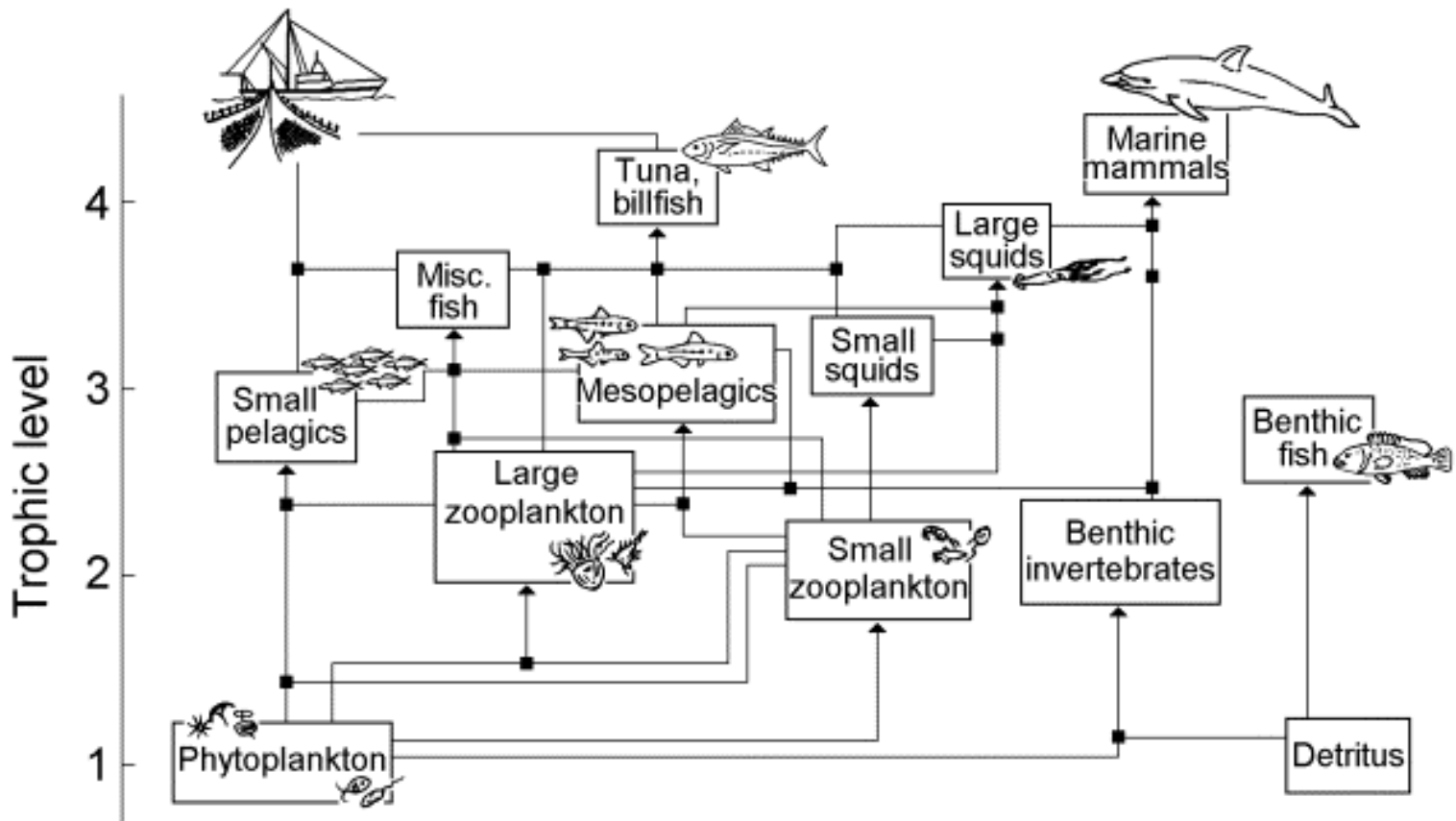
Combined effects of bottom-up and top-down drivers on North Atlantic marine ecosystems

Climate down/up-scaling

The weather and climate of Europe are affected by perturbations in the north Atlantic storm tracks. These are linked to the position of the Gulf stream (ocean dynamics) and orographic effects. (Wilson, *J. Clim*, 2009)

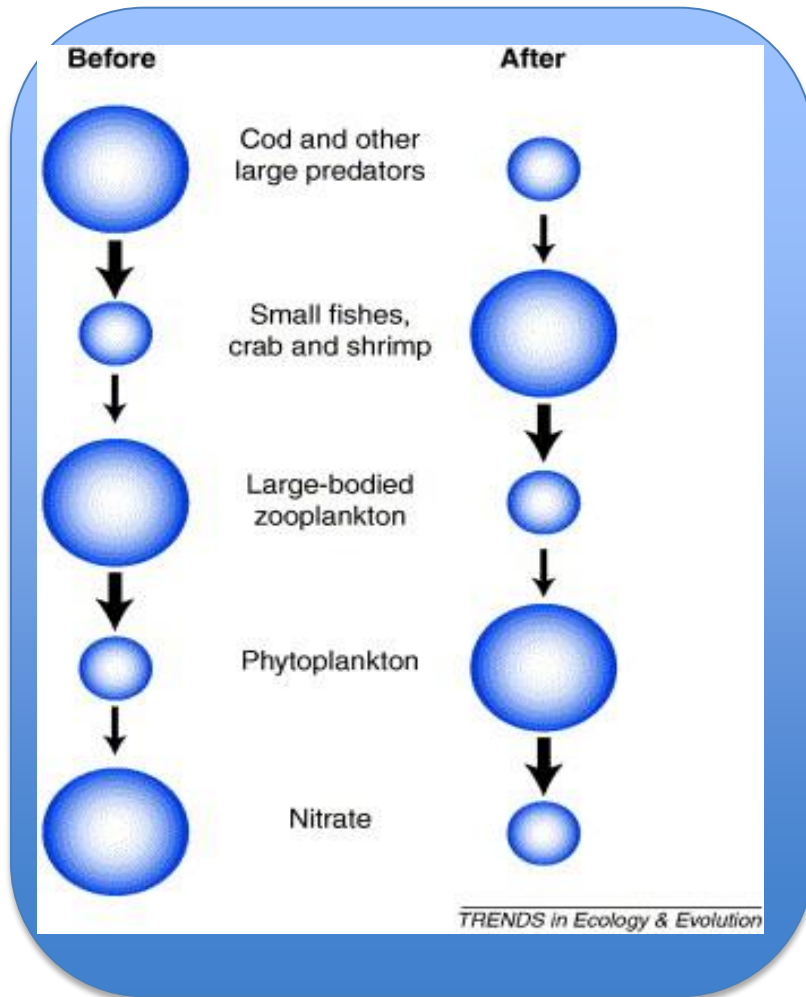


Schematic of ecosystem dynamics

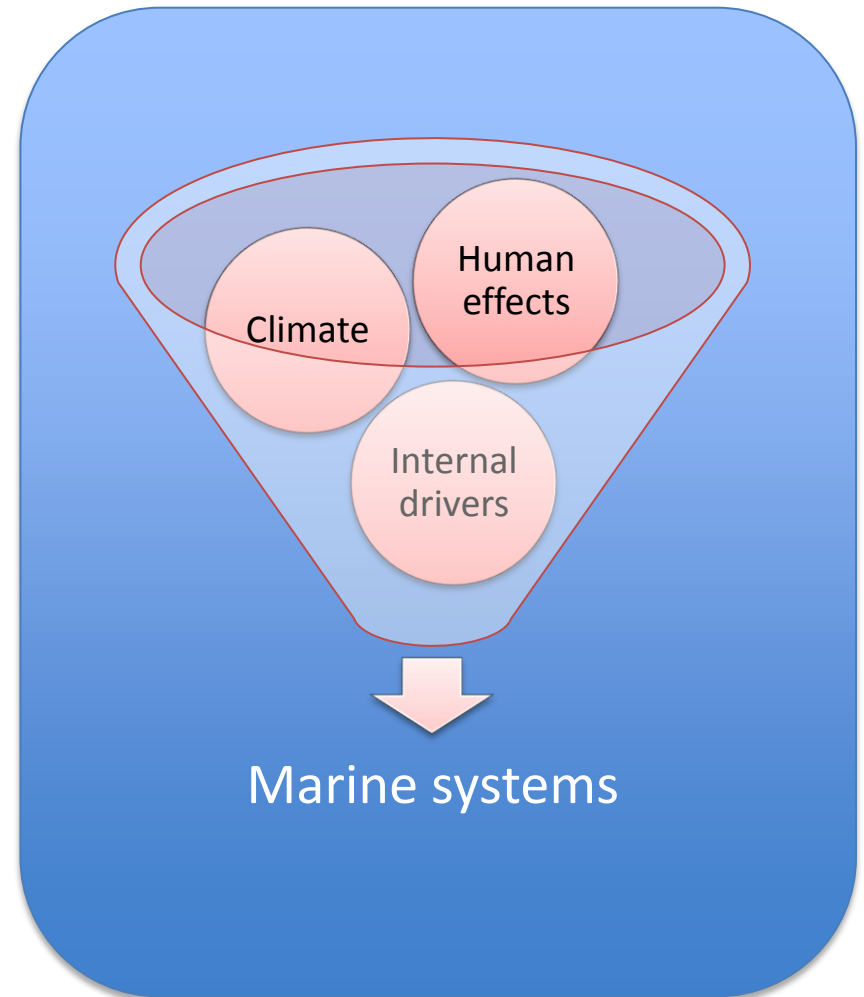


Pauly, 1998.

Towards combined effects...



Scheffer, 2005



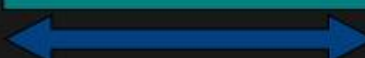
Planque and Bernal, 2009

Our modeling framework

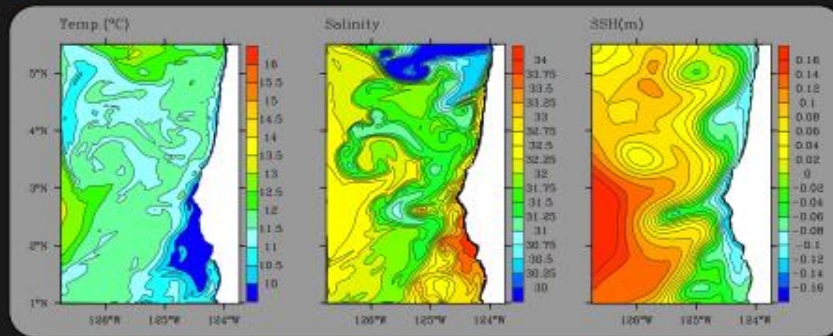
NCAR-CCSM Global Climate Model



Dynamical two-way downscaling

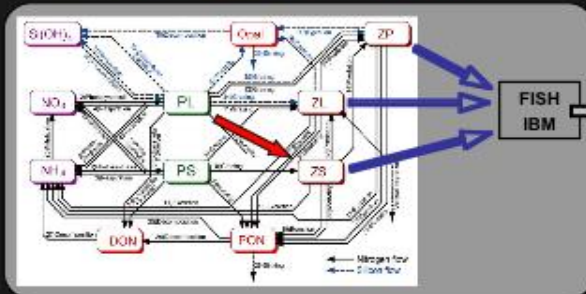


ROMS regional ocean model



Tightly coupled to lower and upper trophic level models

NEMURO NPZD and Individual Based Model



Growth
Reproduction
Mortality
Movement

FISH
IBM