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EcoTroph, a son of Ecopath to project global impact of climate change and fishing strategies

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EcoTroph is a powerful trophic-level based model,

- to project climate change impacts on the global ocean
- or to assess fishing strategies such as the balance harvest

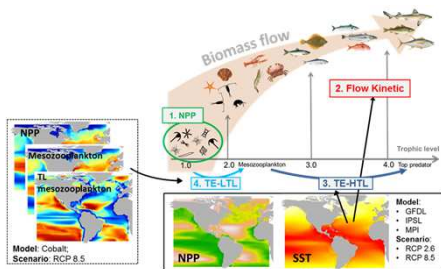
EcoTroph, a son of Ecopath to project global impact of climate change and fishing strategies

Didier GASCUEL, Hubert DU PONTAVICE, Ilan PEREZ, Jennifer REHREN

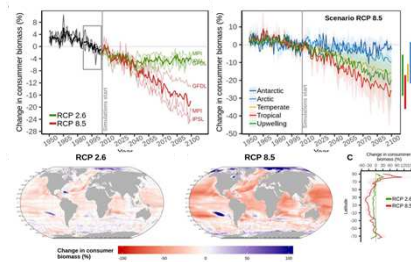
EcoTroph (ET) is an oversimplified trophic-level-based model, based on two ideas:

- Ecosystem structure can be summarized using trophic spectra, i.e. the continuous distribution of the biomass, production, catch, fishing mortality, etc. across trophic levels
- Ecosystem functioning modeled as a flow of biomass surging up the food web, from primary producers to top-predators

Application 1: projection of climate change impact on the biomass of the global Ocean

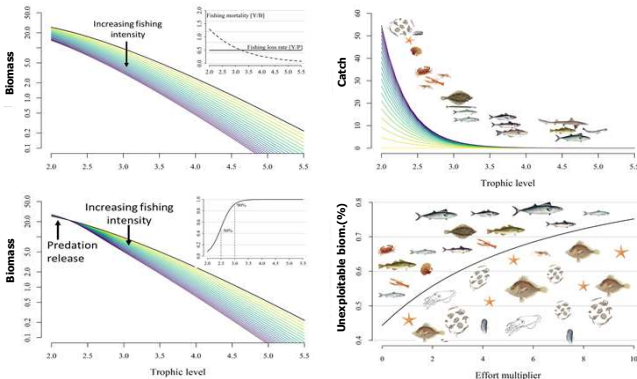


METHOD: one EcoTroph model in each 1°x1° cell each year, forced by 3 earth system models (NPP & SST). Trophic transfer efficiency and residence time depend on SST



RESULTS: a global decrease in the total biomass by 2100 (-4% in RCP2.6 to -20% in RCP8.5) More impact for predators and in tropical ecosystems

Application 2: assessment of a Balanced Harvest management scenario in a virtual ecosystem



Balanced harvest (i.e. exploitation rates Y/P proportional to productivity P/B) induces:

- unbalanced trophic structure due to the cumulative effect of fishing
- very large catches of low TLs but no predators anymore

Realistically assuming a fraction of not-exploitable at low TLs, balanced harvest implies:

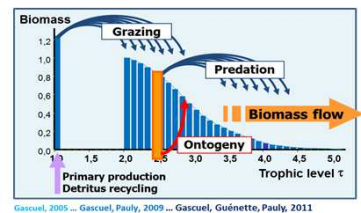
- The sea is filling up with not fishable species

- References:
- H. du Pontavice, D. Gascuel, G. Reygondeau, A. Maureaud, W.W. L. Cheung, (in press) Climate change undermines the global functioning of marine food webs, Global Change Biology
 - H. du Pontavice, W.W.L. Cheung, G. Reygondeau, C. Stock, D. Pauly, D. Gascuel, (Subm.) Toward a global decrease in biomass flow in marine food webs over the 21st century
 - J. Rehren, D. Gascuel (in prep.)

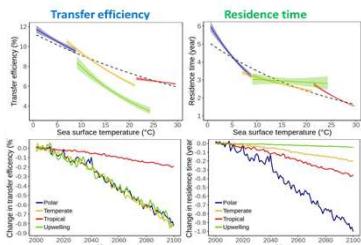
Extra tables and figures

EcoTroph Basis

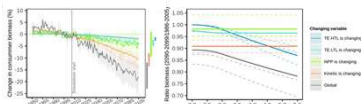
- A non conservative flow of biomass (Φ) due to predation and ontogeny
- ...characterized by the flow kinetic (K) which depends on the life expectancy
- For each trophic class: $Biomass = \Phi/K$



Gascuel, 2005 – Gascuel, Pauly, 2009 – Gascuel, Guénette, Pauly, 2011

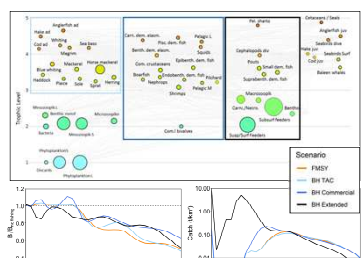


- SST impacts transfer efficiency and biomass residence time 1/K (Top) (from GLM applied to xxx ocean cells)
- Projections under scenario RCP8.5 in each ecosystem type (bottom)



- Consumer biomass decrease is mainly due to faster trophic transfers
- Decrease in trophic transfer efficiency leads to a change in the trophic structure, predators being the most impacted
- Decrease in NPP is key in tropical ecosystems

	NPP	kinetic	TE HTL	TE LTL	Cumulated
Arctic	8.7	-20.5	-2.8	5.1	-7.8
Temperate	2.5	-3.0	-0.8	0.0	-1.2
Tropical	-9.1	-9.3	-2.9	-2.2	-15.3
Worldwide	-5.3	-10.9	-2.9	-2.2	-25.2
GLOBAL	-4.0	-9.7	-2.8	-2.8	-28.5



- Using the Celtic sea EwE model, to simulate 4 scenarios of fisheries management (from MSY to Balance Harvest BH)
- Managing commercial stocks according to BH (F~P/B) provides more catch with less impacts
- ... while extended BH induces cumulative impacts on predators (even with low F)



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EcoTroph website



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