Ecosystem impacts of applying single-species versus multiple-species MSY in the Patagonian sprat fishery (*Sprattus fuegensis*) in the inner sea ecosystem of southern Chile

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Background

- Management based traditionally on single-species and maximum sustainable yield (MSYss) as target (BRPt)...

- MSY as BRP limit (-> must be avoided)

- Because MSYss doesn’t consider
  - interactions between species
  - changes in the ecosystem structure/function
  - doesn’t maximize all species at once

Then...
Ecosystem Approach to Fisheries Management (EAFM – EAF)
- Try to balance different objectives
- Recognize species interactions
- MSY multispecies (could be) a better management target
- In Chile the “LGPA”...

Chilean Fisheries and Aquaculture Law (2013)

“Article 1°.- The objective of this Law is to reach conservation and sustainable use of hidrobiological resources, the aplication of precautionary approach, and the ecosystem approach in the fisheries and the safeguard of marine ecosystems that sustain them.”
Then to move to EAF
- We need to know the species interactions and others
- Demonstrate that multispecies MSY is a better management target

Especially to LTL species/forage species
- Southern sardine (*Sprattus fuegensis*) in the south part of Chile.
- The inner sea of the X and XI Regions
  - a complex ecosystem...
  - geography
  - oceanographic conditions
- Economically important...
- Ecological importance...

Southern hake

Chilean hoki

Niklitschek et al. (2014)
SUMAR 2016

Niklitschek et al. (2016)
- fisheries...

Kingklip

Kite skate
- fisheries...
Southern sardine...

- Have an important ecological role (as a LTL species - forage species)
- energy flow path: plankton -> high trophic level predators ($$$ importance)

- Considering...

- Southern sardine biomass

- Status of important stocks
  - over-exploited
We address the following questions

- Is the single-species MSY an BRP target or is it a limit?
- What are the effects of applying a multispecies MSY on southern sardine fishery?

General Objective

- Modeling the structure and functioning of the inner sea ecosystem of Regions X and XI, describe the role of the southern sardine (*Sprattus fuegensis*) and quantify the impact of its exploitation on the ecosystem.
Using ECOPATH we made a model of the food web of inner sea of Regions X and XI

**Methodology**

First

Using ECOPATH we made a model of the food web of inner sea of Regions X and XI

- 16 functional groups

| Otherpreds | Mammals (seals) |
| Zearchi | Kite skate |
| Genybla | Kingklip |
| MerlausAD | Zearaja chilensis |
| MerlausJUV | Genypterus blacodes |
| MacrmagAD | Southern hake |
| MacrmagJUV | Merluccius australis |
| Otherdemersals | Chilean hoki |
| Sprafue | Macrurus magellanicus |
| Otherpelags | Southern sardine |
| Munisub | Sprattus fuegensis |
| Benthos | Fiord prawn |
| Bigzoo | Munida subrugosa |
| Smallzoo | |
| Phytoplank | |
| Detritus | |

- 5 fleets

| Purseine | Sprafue |
| Artislongline | Otherpelags |
| Bottomline | Merlaus |
| Skates | Merlaus |
| ArtisPDA | Genybla |
| Zearchi | |
| Otherdemersal | Otherspelags |
| Otherspelags | Munisub |
Estimate a multispecies MSY to southern sardine and compare it with single-species MSY. Walters et al., 2005.

\[
\frac{dB_i}{dt} = f(B) - F_iB_i - \sum_{j=1}^{n} c_{ij}(B_i, B_j) - M_oB_i
\]

(Christensen & Pauly, 1992; Walters et al., 1997; Plagangy, 2008)
Assess capture scenarios, by simulation with Ecosim, based on MSYss and MSYms in long term (20 years).
RESULTS

ECOPATH model to 2003-2010 (average conditions)
MSY estimation

\[ F_{\text{msy}} = 1.113 - MSY_{\text{ss}} = 3.16 \]
\[ F_{\text{msy}} = 1.113 - MSY_{\text{ss}} = 3.16 \]

\[ F_{\text{msy}} = 1.387 - MSY_{\text{ms}} = 4.47 \]
The impacts of MSYss and MSYms
Our results indicate that MSYms is bigger than the MSYss, similar to results by Walters et al (2005).

MSYms, MSYss seems to be aggressive because the biomass of Sprattus decline in both scenarios.

Both scenarios results in direct and indirect effects in the biomass of others groups in the model.

Positive impacts: Chilean hoki (juveniles and adults) and others pelagic fishes.

Negative impacts: southern hake and kingklip.
Future work

Put values to the impacts...

How much it cost?
Thanks