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Programa de Doctorado en Ciencias Mención
Manejo de Recursos Acuáticos Renovables

Doctorado MaReA

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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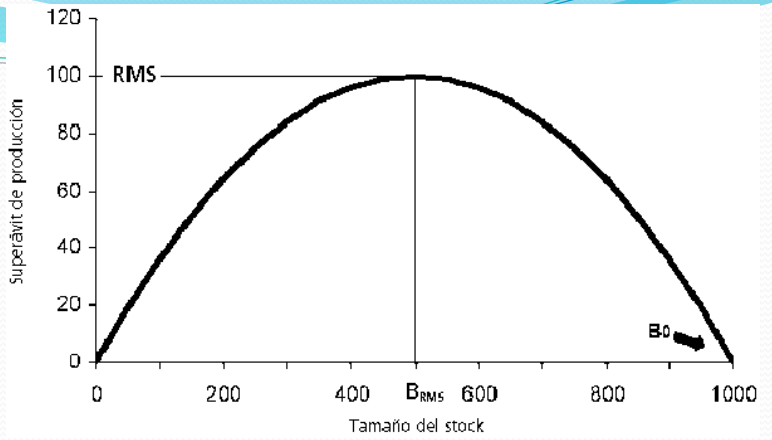
Background

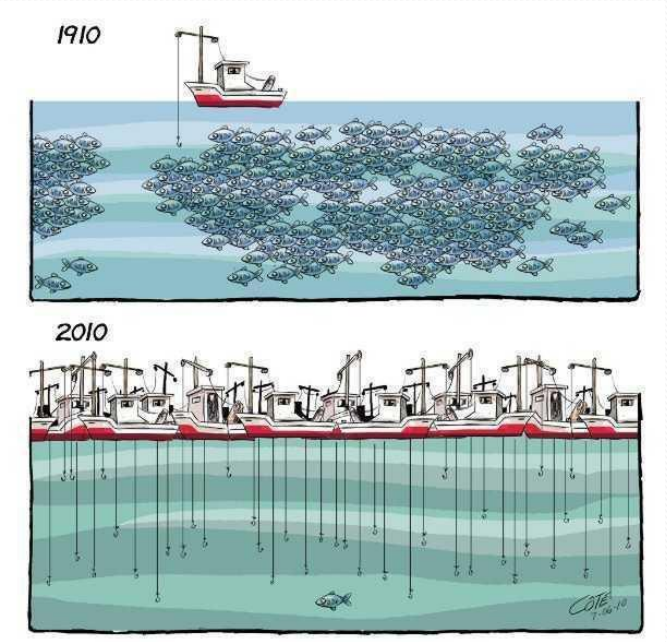
- Management based traditionally on single-species and maximum sustainable yield (MSYss) as target (BRPt)…

- 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 preacutionary approach, and the ecosystem approach in the fisheries and the safeguard of marine ecosystems that sustain them."

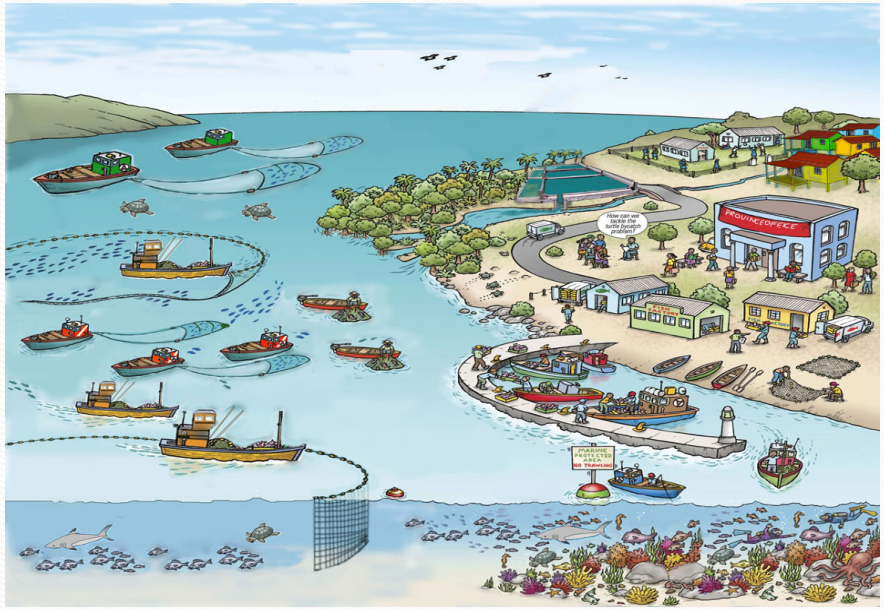
Then to move to EAF

- We need to know the species interactions and others
- Demonstrate that multispecies MSY is a better management target

Especially to LTL species/forage species

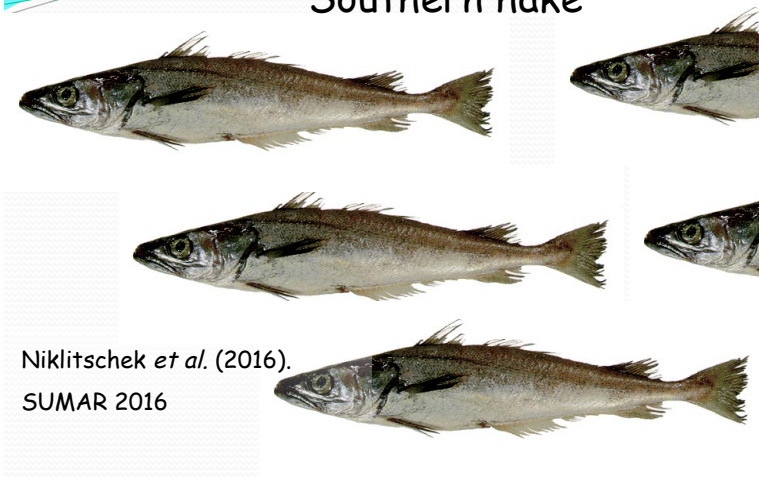
- Southern sardine (*Sprattus fuegensis*) in the south part of Chile.

- The inner sea of the X and XI Regions
  - a complex ecosystem…
    - geography
    - oceanographic conditions
- Economically important…



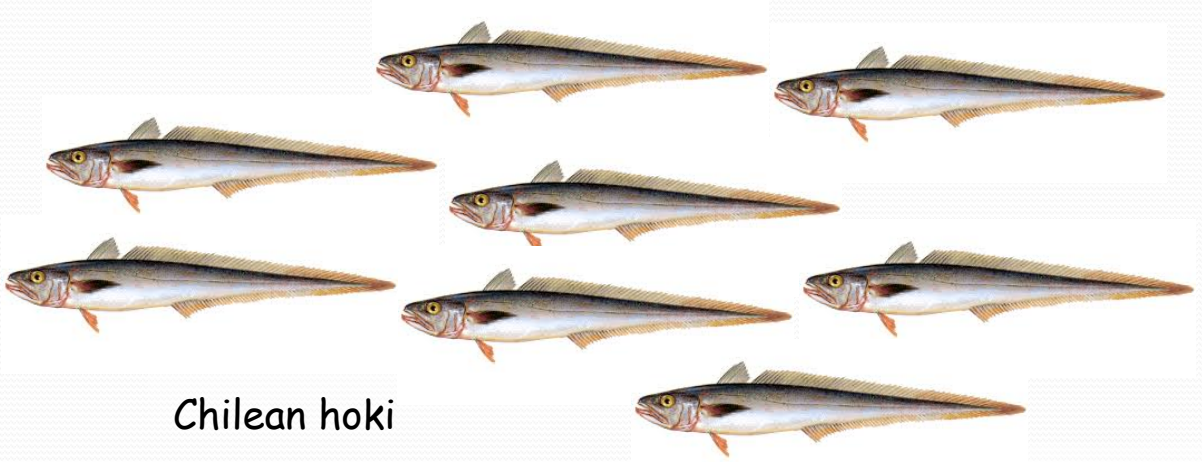
- Ecological importance…

Southern hake



Niklitschek *et al.* (2016).
SUMAR 2016

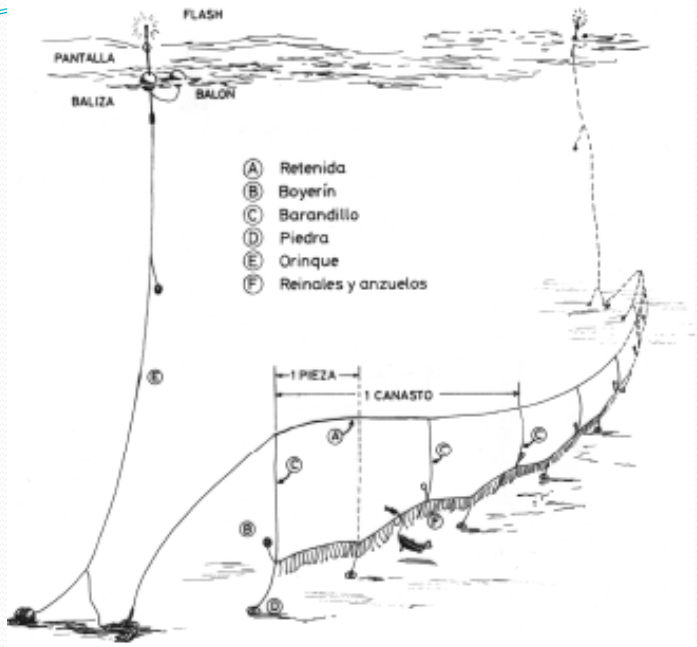
NURSERY AREA

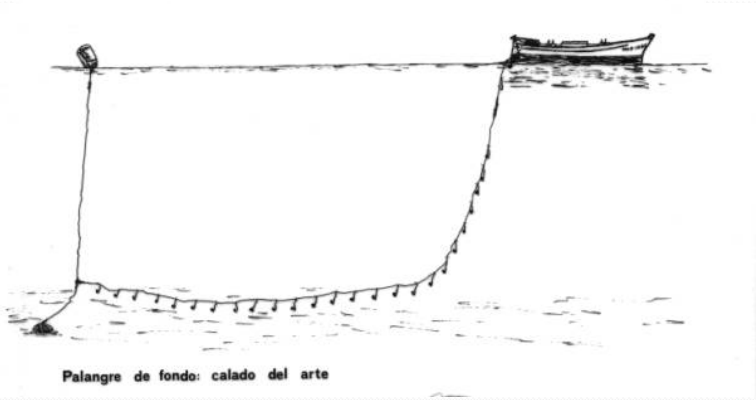


Chilean hoki

Niklitschek *et al.* (2014)

- fisheries…

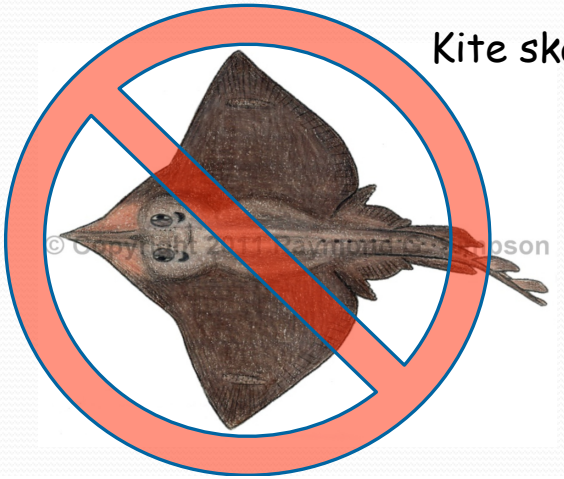




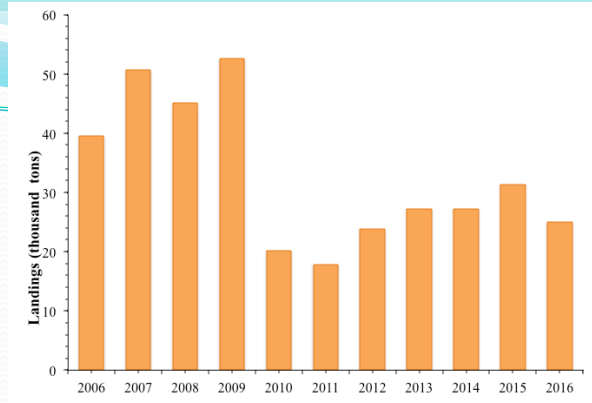
Palangre de fondo: calado del arte

Kingklip

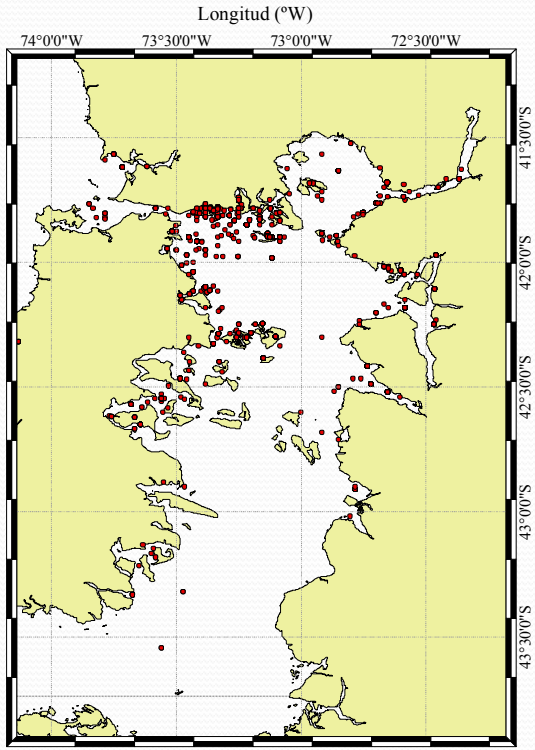
Kite skate



- fisheries…


Landings (thousand tons)
0
10
20
30
40
50
60
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016


MIGUEL


Longitud (°W)
74°0'0"W
73°30'0"W
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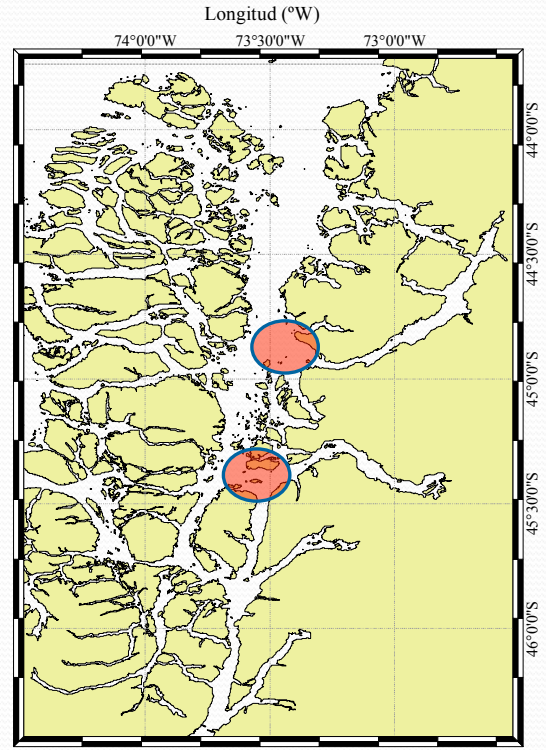
Longitud (°W)
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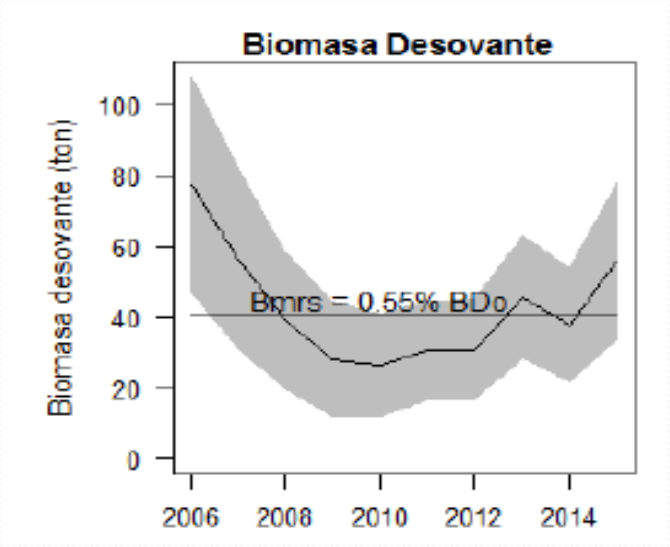
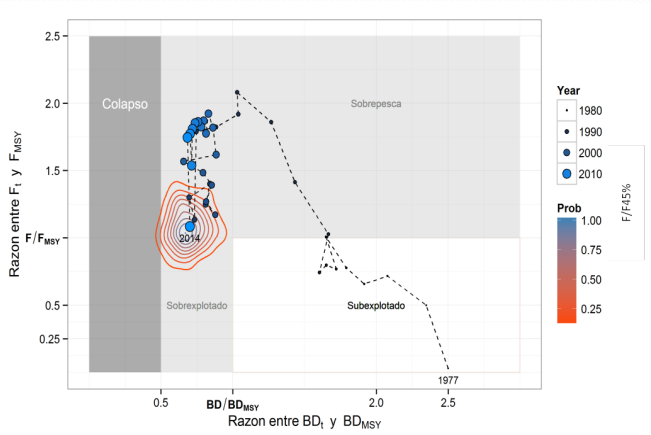
73°0'0"W
Latitud (°S)
44°0'0"S
44°30'0"S
45°0'0"S
45°30'0"S
46°0'0"S

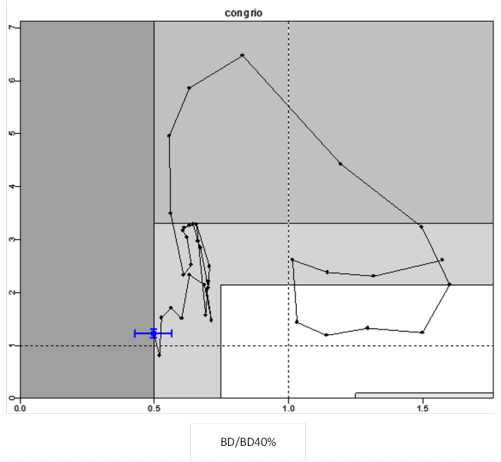
Southern sardine…

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

- Considering…







- Southern sardine biomass
  BT~ 250 mil t (2006) a ~45 mil t (2015)

- 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.

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	*Zearaja chilensis*
Genybla	Kingklip	*Genypterus blacodes*
MerlausAD MerlausJUV	Southern hake	*Merluccius australis*
MacrmagAD MacrmagJUV	Chilean hoki	*Macruronus magellanicus*
Otherdemersals		
Sprafue	Southern sardine	*Sprattus fuegensis*
Otherpelags		
Munisub	Fiord prawn	*Munida subrugosa*
Benthos		
Bigzoo		
Smallzoo		
Phytoplank		
Detritus		

- 5 fleets

Purseine	Sprafue	Otherpelags	
Artislongline	Merlaus		
Bottomline	Merlaus	Genybla	
Skates	Zearchi		
ArtisPDA	Otherdemersal	Otherspelags	Munisub

Second

Estimate a multispecies MSY to southern sardine and compare it with single-species MSY. Walters *et al.*, 2005.

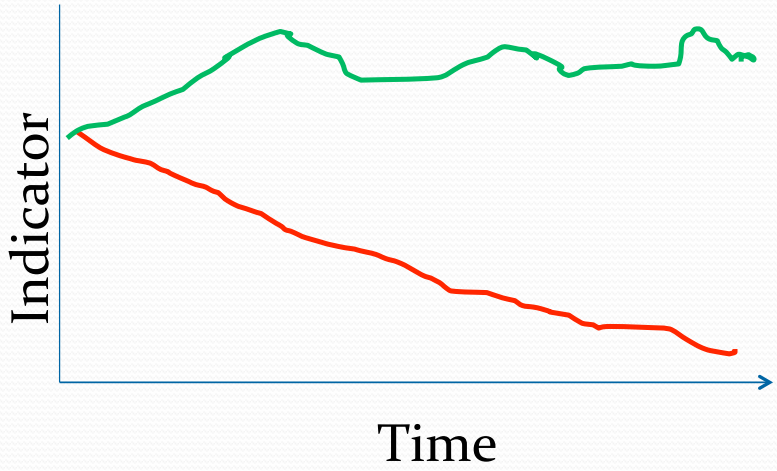
$$Ba = B_i \bullet \left(\frac{P}{B}\right)_i - Y_i - \sum_{j=1}^{n} B_j \bullet \left(\frac{Q}{B}\right)_j \bullet DC_{ji} - B_i \bullet \left(\frac{P}{B}\right)_i \bullet (1 - EE_i)$$

$$\frac{dB_i}{dt} = f(B) - F_i B_i - \sum_{j=1}^{n} c_{ij}(B_i, B_j) - M_o B_i$$

(Christensen & Pauly, 1992; Walters et al., 1997; Plagangy, 2008)

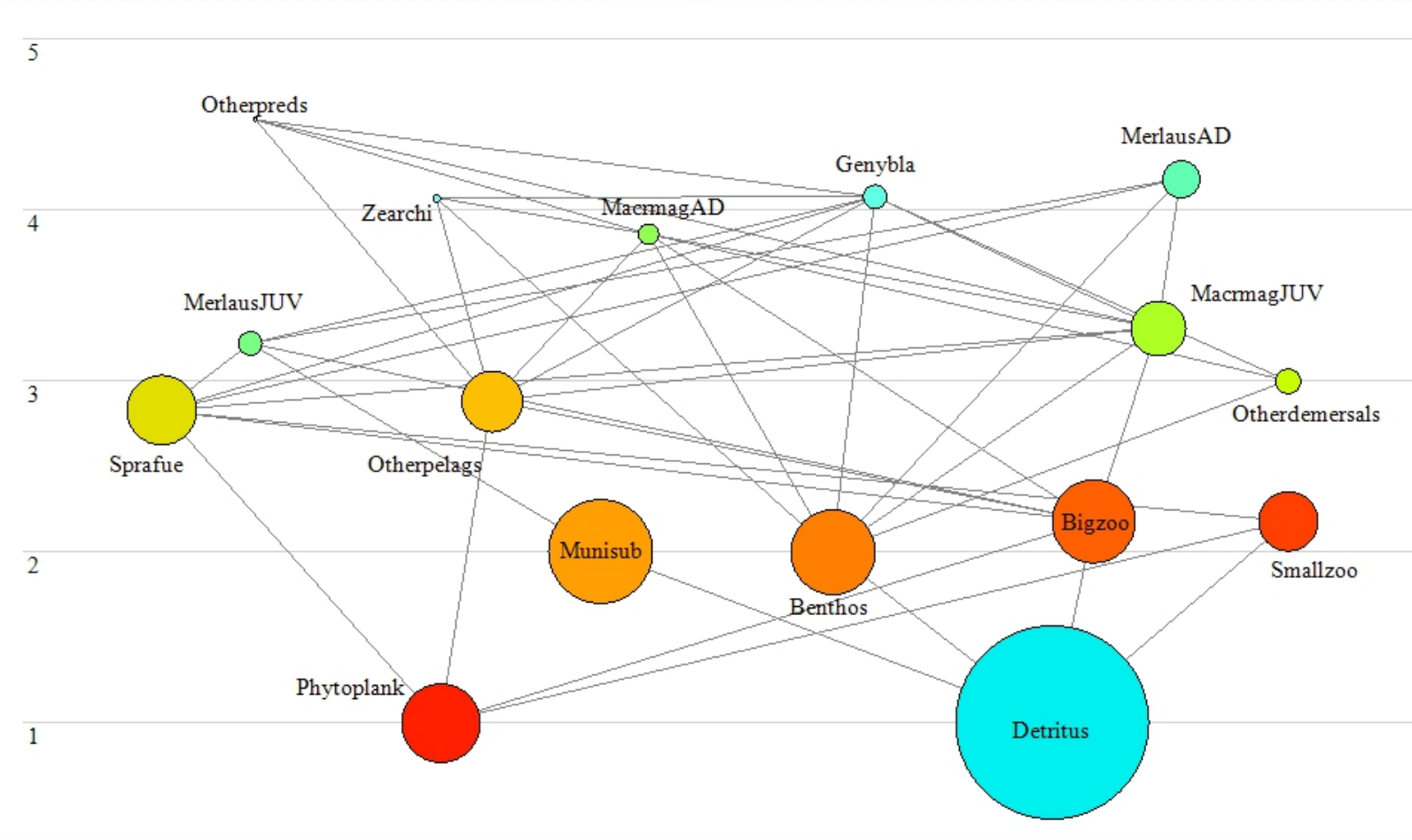
Third

Assess capture scenarios, by simulation with **Ecosim**, based on MSYss and MSYms in long term (20 years).

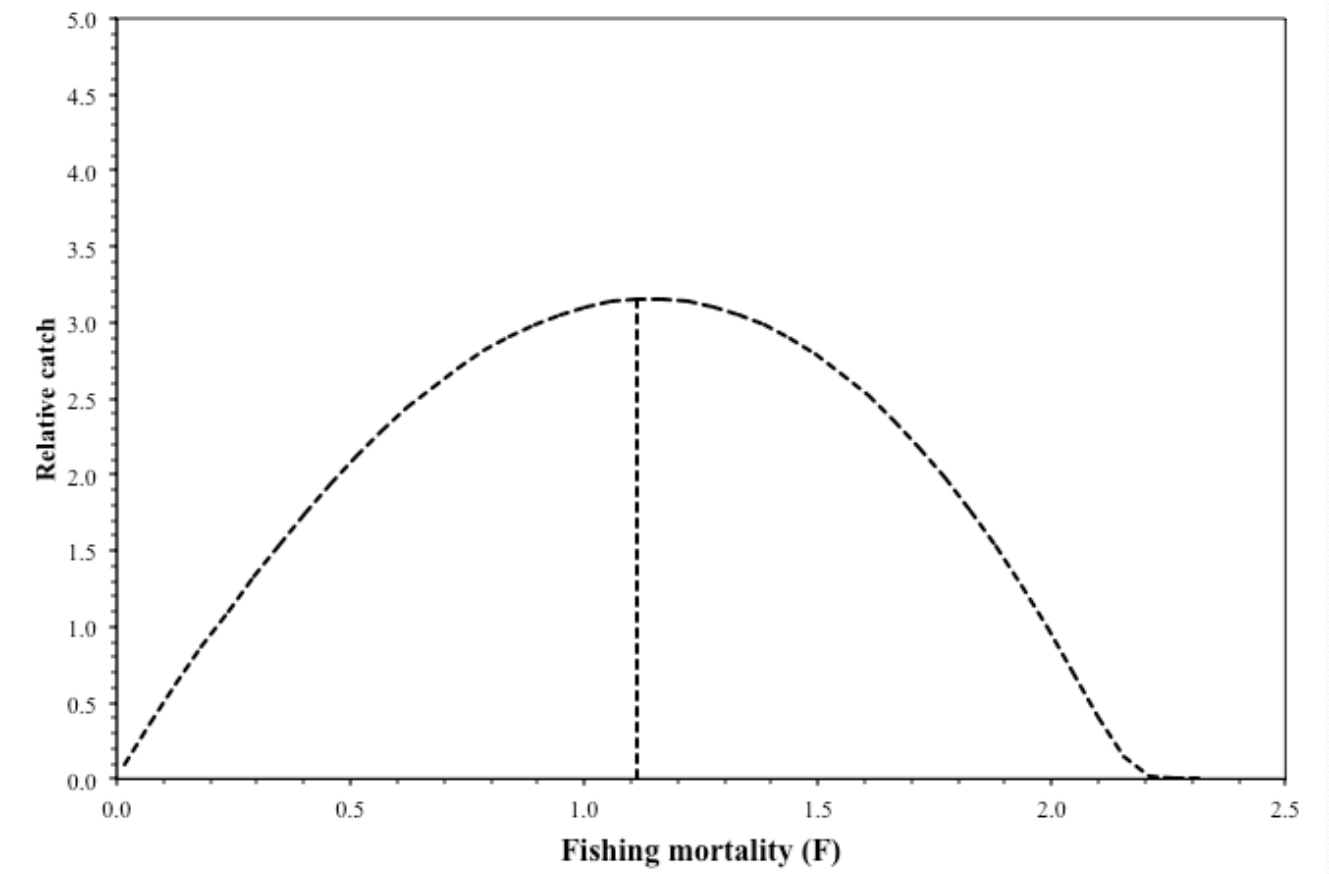


RESULTS

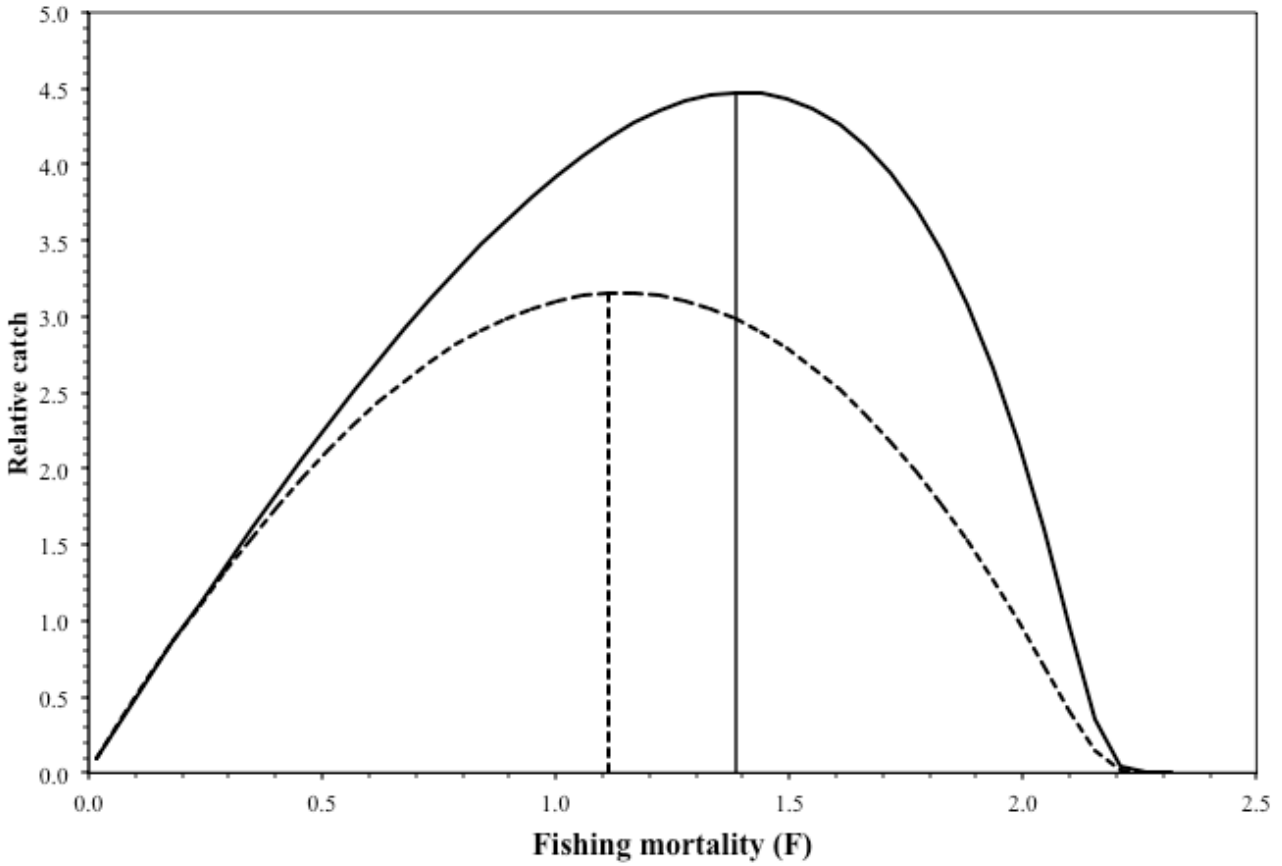
- ECOPATH model to 2003-2010 (average conditions)



➢ MSY estimation



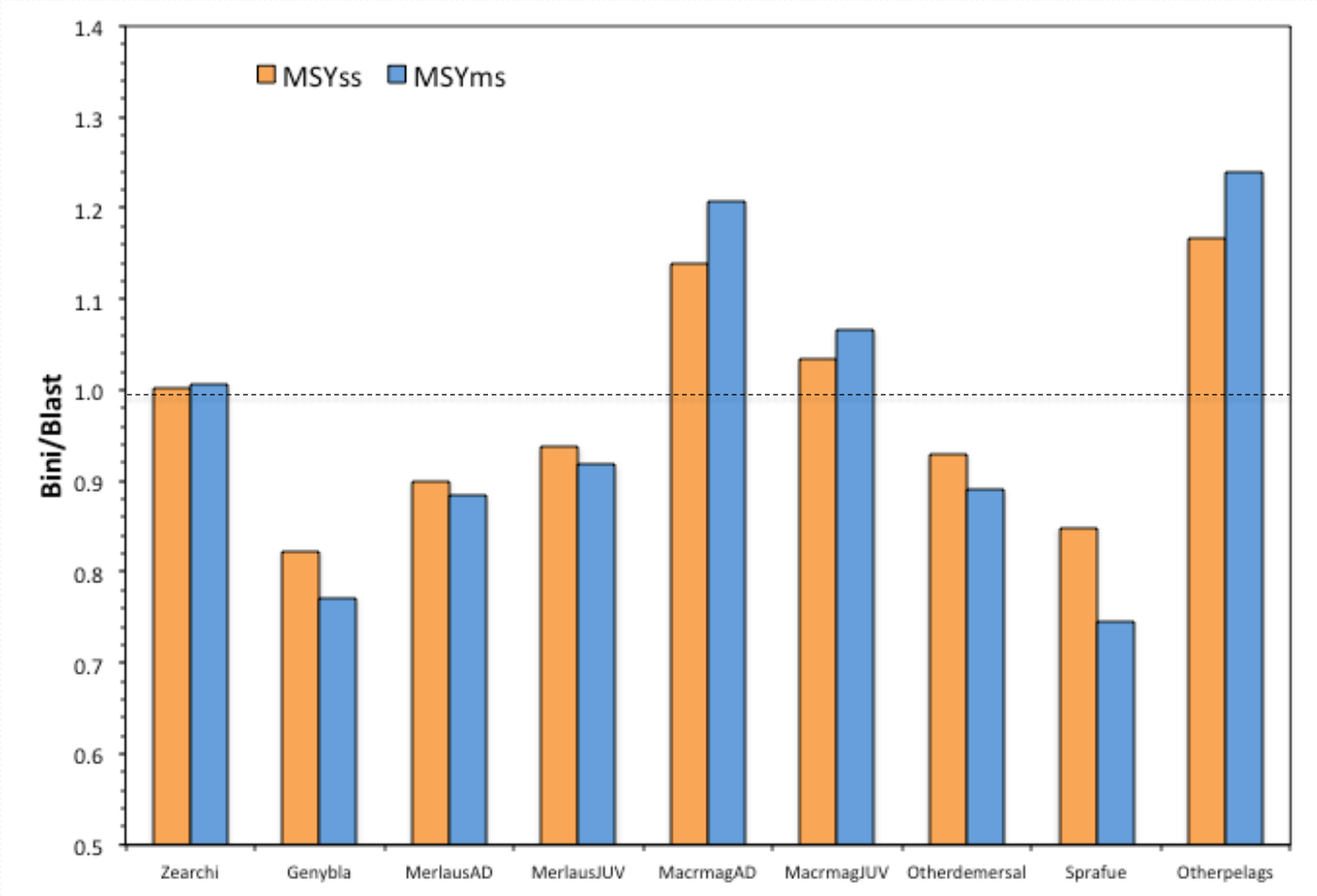
Fmsy = 1.113 – MSYss = 3.16



Fmsy = 1.113 – MSYss = 3.16

Fmsy = 1.387 – MSYms = 4.47

- The impacts of MSYss and MSYms



Summary

- Our results indicate that MSYms is bigger that 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...


Thanks