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Role of social interactions on dynamics of fish aggregations in a multi-site system of fish aggregating devices (FADs)

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Postcard from Brussels

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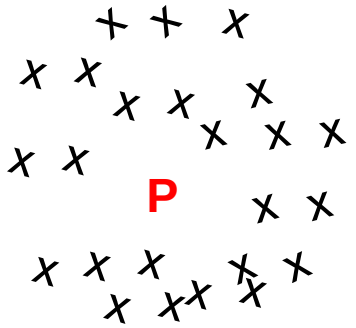
A theoretical approach

The Ocean



Tuna around a FOB

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The models are TOOLS

➢To analyze the **relation** between individual behavior, population parameters (density) and environmental characteristics

In the case of the **spatio-temporal organization** of the population around FADs → to integrate different types of data

➢To make predictions, to test strategies

State of the art

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- 300 pelagic fish species naturally aggregate around floating objects (FOBs)

- more than 50% of the world catch of tropical tuna comes from the industrial tuna fisheries based around drifting FOBs

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- 300 pelagic fish species naturally aggregate around floating objects (FOBs)
- more than 50% of the world catch of tropical tuna comes from the industrial tuna fisheries based around drifting FOBs
- The release of thousands of FADs into the ocean by purse seine vessels drastically increases the number of floating objects (Dagorn et al., in press)
- Prediction on the impact of the number of FADs on
  - the catchability
  - the biodiversity

Why tuna are associated with FOBs

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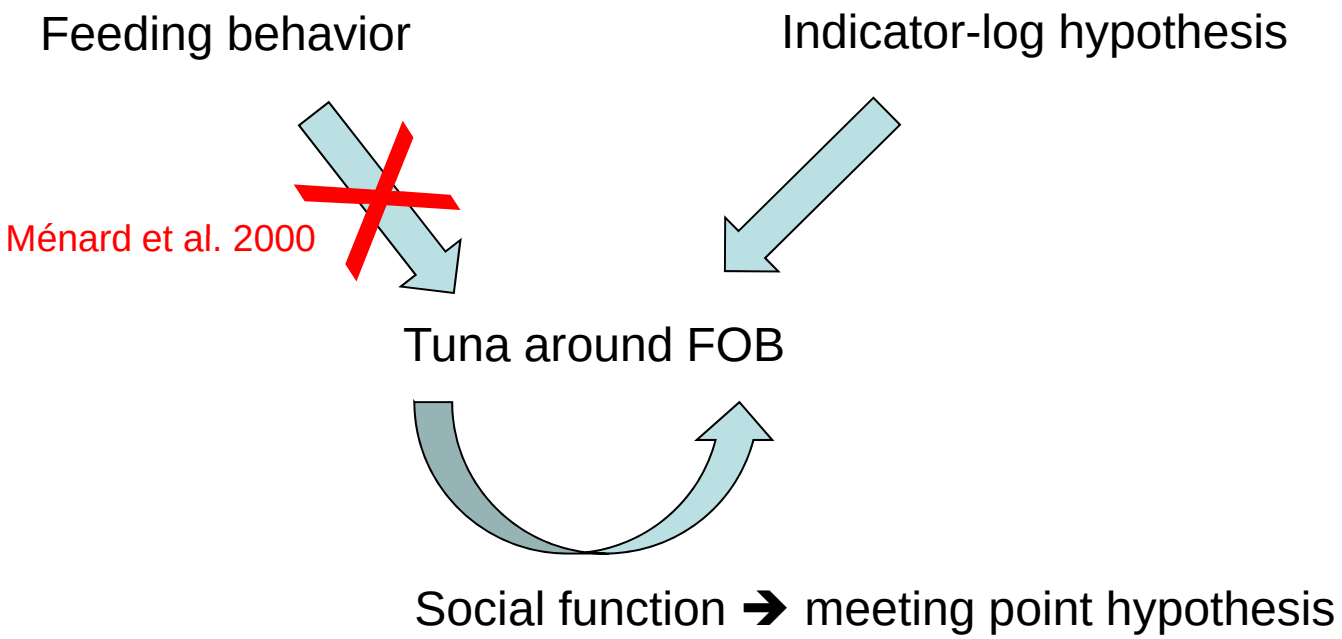

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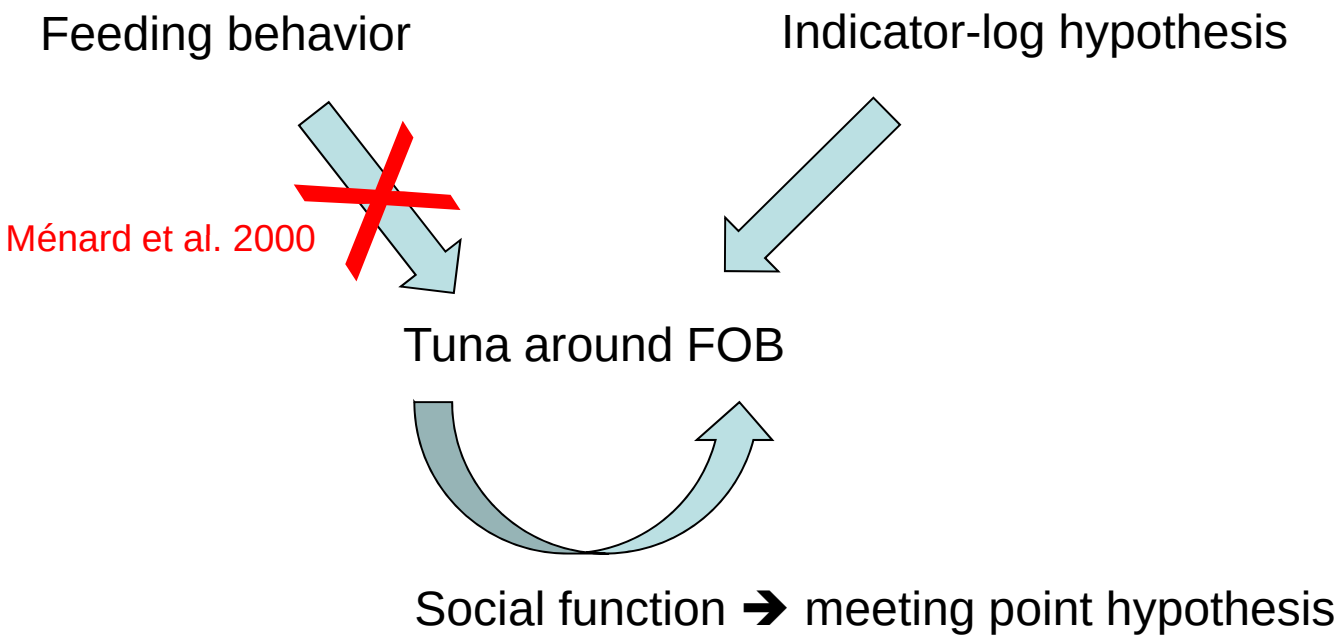
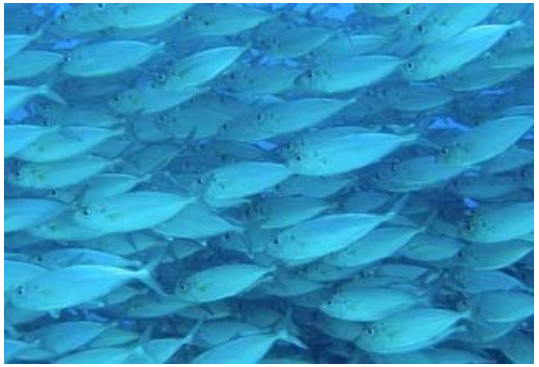


Mechanisms??

Aggregation behavior

➔without social interactions (e.g. Clark & mangel 1979, Hilborn & Medley 1989, Dagorn et al. 2000)

➔**with** social interactions (e.g. Soria et al. 2009, Capello et al. 2011)



Selar crumenophthalmus

➔The influence of the social behavior of tunas on their aggregations dynamics around FOBs is still poorly understood (Robert et al., in press)

Aim

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Understand the **complex decision-making processes** leading to this aggregation pattern and the impact of the massive release of artificial FOBs by fishermen on the spatial distribution and management of tuna.

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Understand the **complex decision-making processes** leading to this aggregation pattern and the impact of the massive release of artificial FOBs by fishermen on the spatial distribution and management of tuna.

- How the interactions between **social** (relationships between individuals) and **non-social** (responses to the environment) behaviours affect the spatial distribution of a population in a multi-FOB environment.

- How the increase of the FOBs number affects the fish aggregation dynamics and the distribution of the population among patches
  - the population size
  - the level of sociality
  - the natural retention/attraction forces of FOBs on individual tuna.

- Using differential equations and stochastic simulations,

General framework

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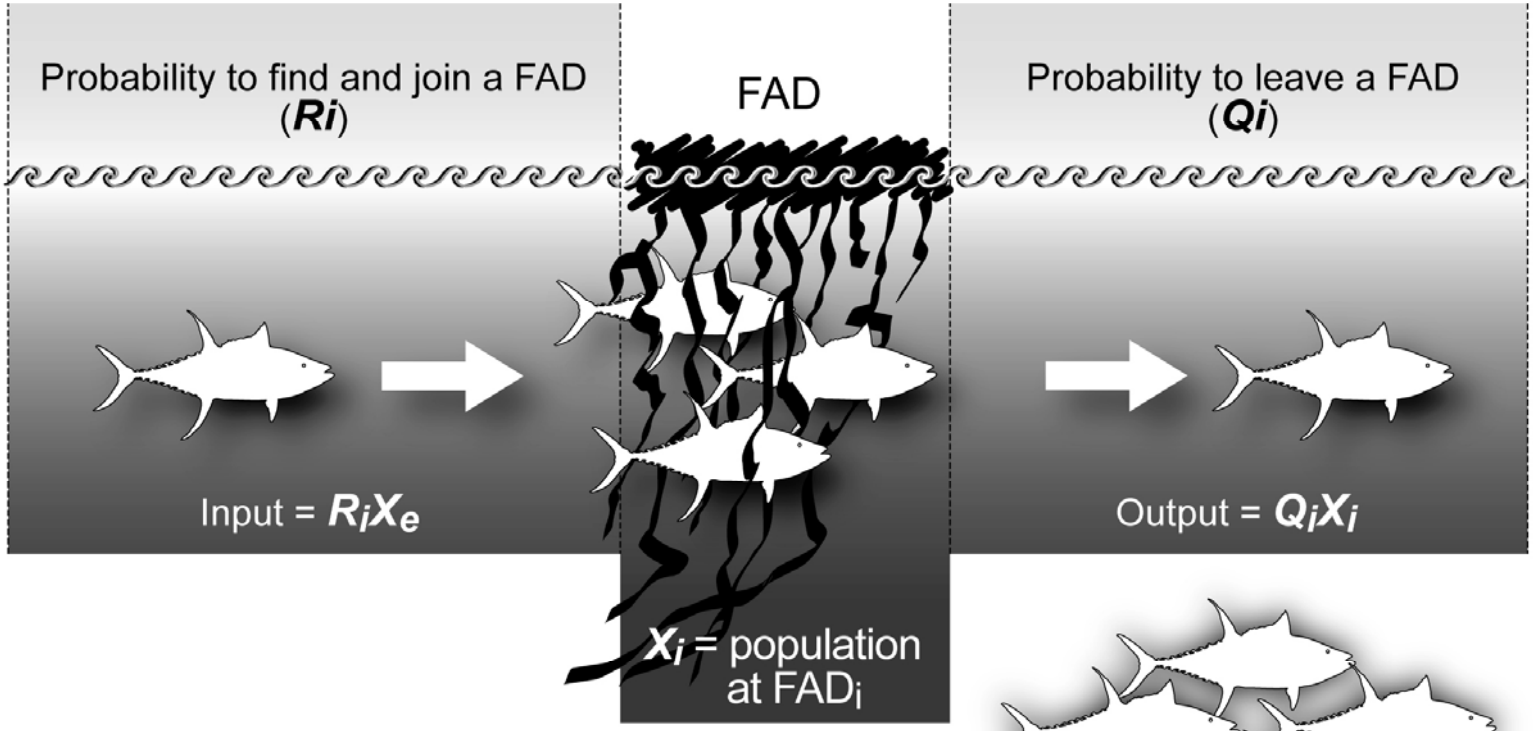
Model of aggregation processes



$$\frac{dX_i}{dt} = R_i X_e - Q_i X_i$$

$$N = X_e + \sum_{i=1}^{p} X_i$$

Model

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joining leaving

$$\frac{dx_i}{d\tau} = \left(1+bx_i\right)x_e - \frac{gx_i}{1+bx_i} \quad (4,a)$$

$$1 = x_e + \sum_{i=1}^{p} x_i \quad (4,b)$$

$b = \square N$ Interattractions * population size

$g = \frac{\square}{\square}$ FOB retention capability

the model properties and behaviours are unchanged if we increase the **grain** by considering small **schools of fish** as the basic units instead of individual fish

Model : 2 identical FOBs

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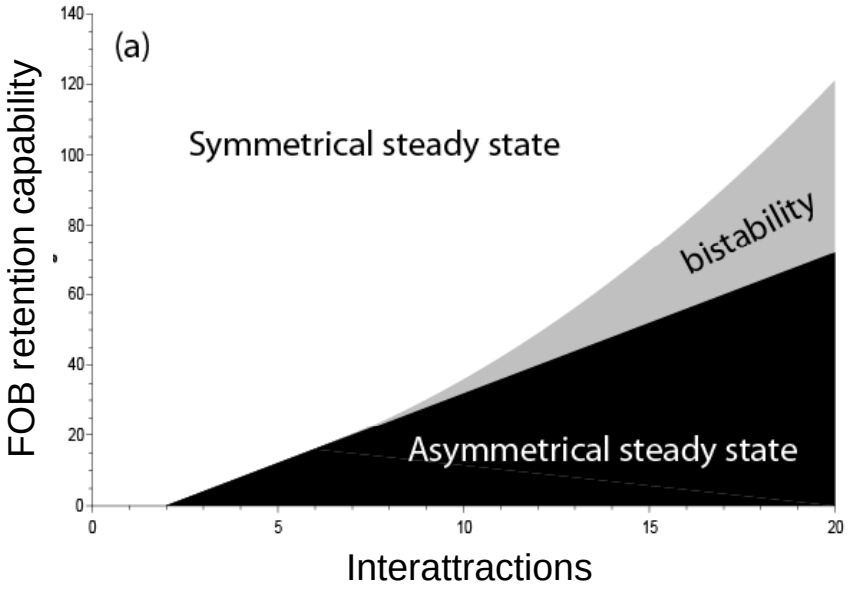
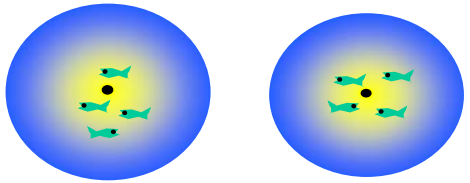


Symmetrical



Symmetrical solution: -small interattraction
-low quality FOB

Model : 2 identical FOBs

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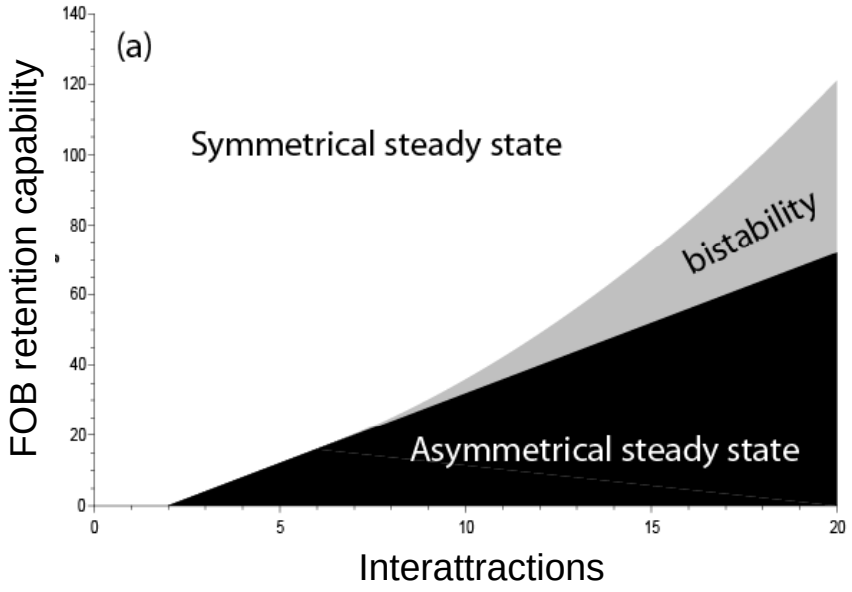

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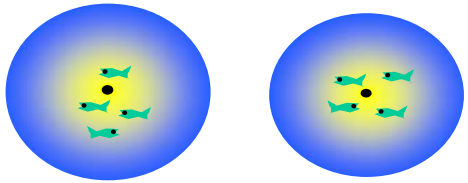

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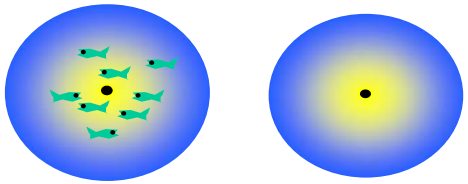

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Asymetrical solution: -high interattraction
-high quality FOB

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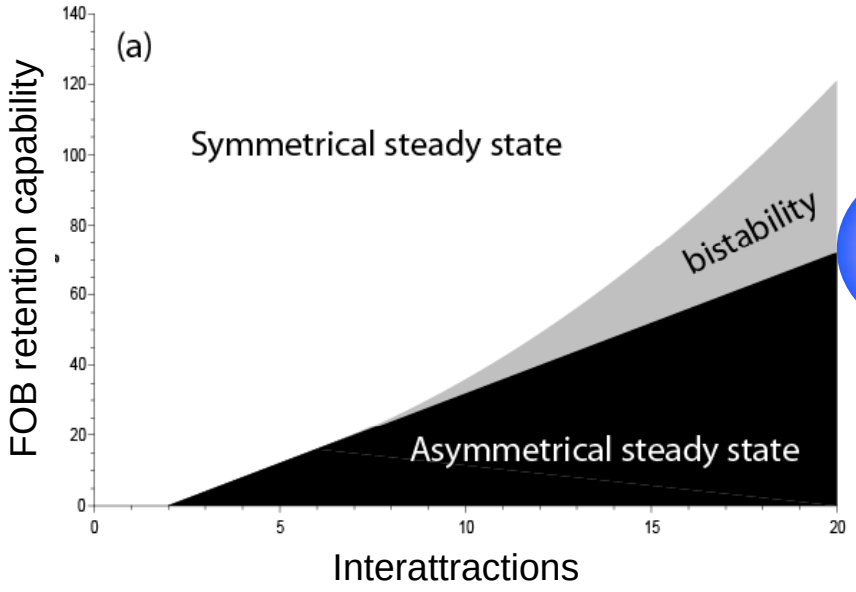

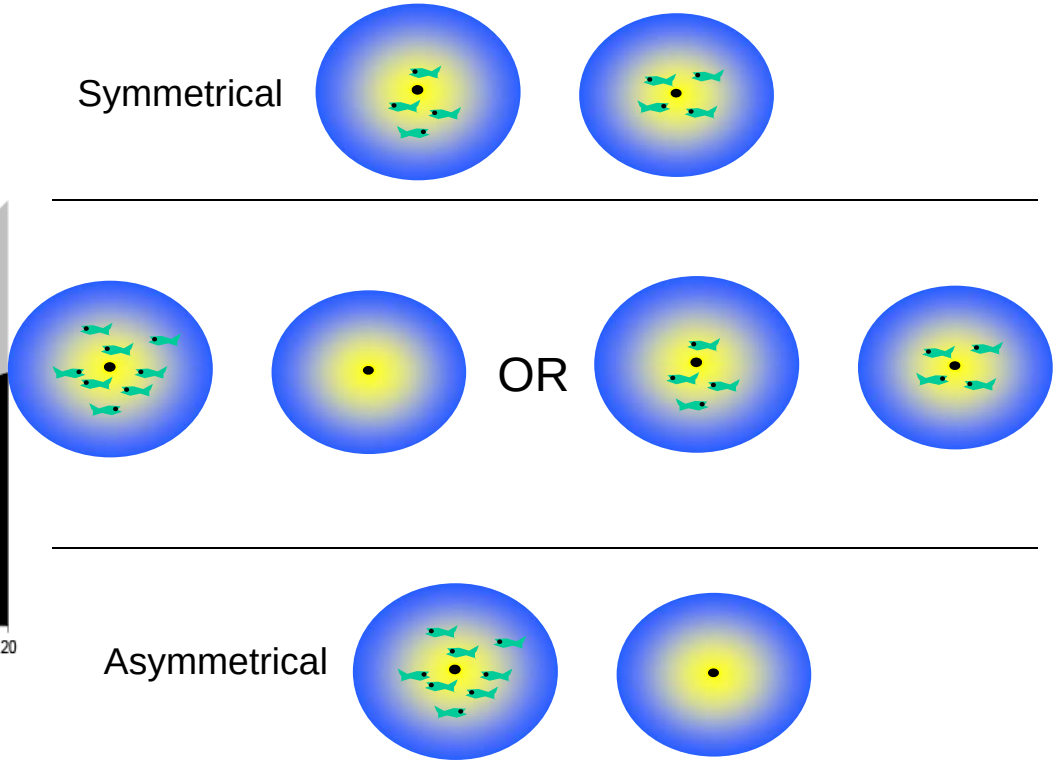

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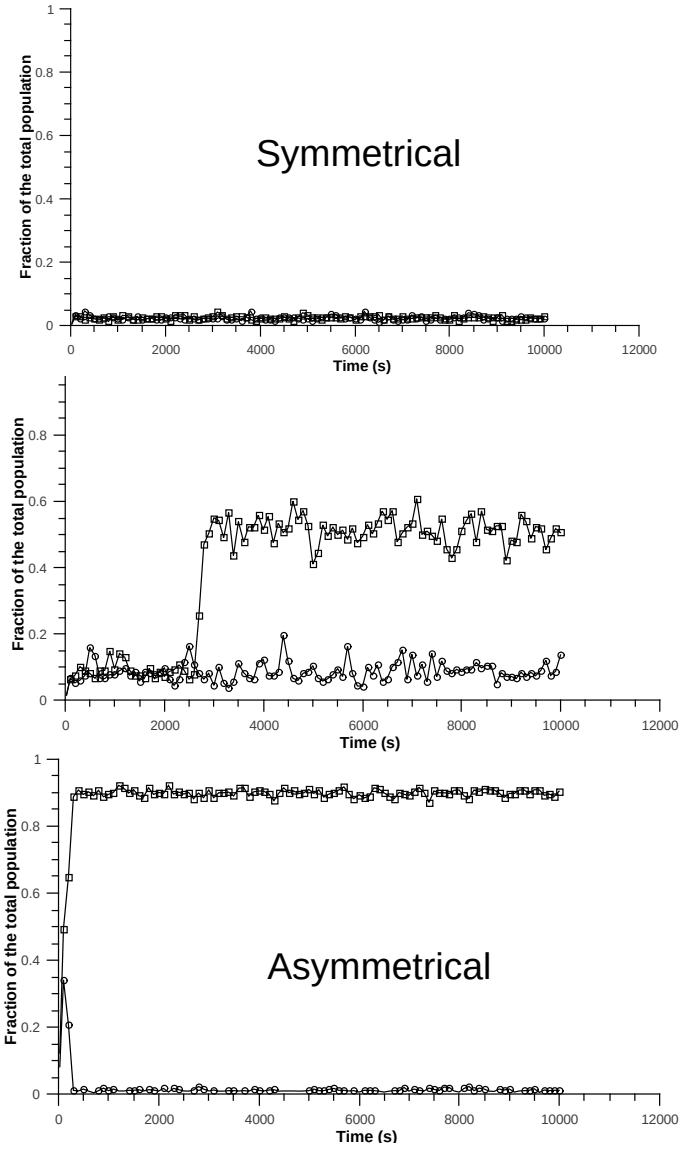

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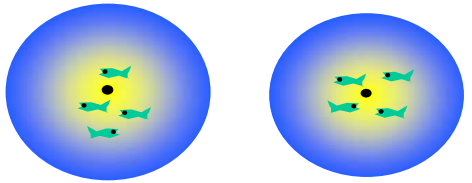

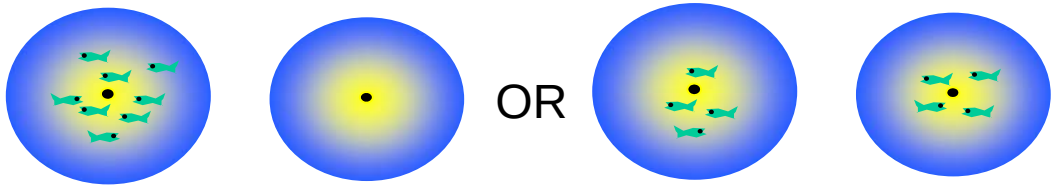

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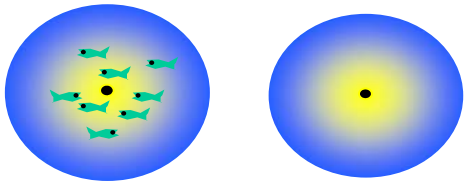

Model : *p* identical FOBs

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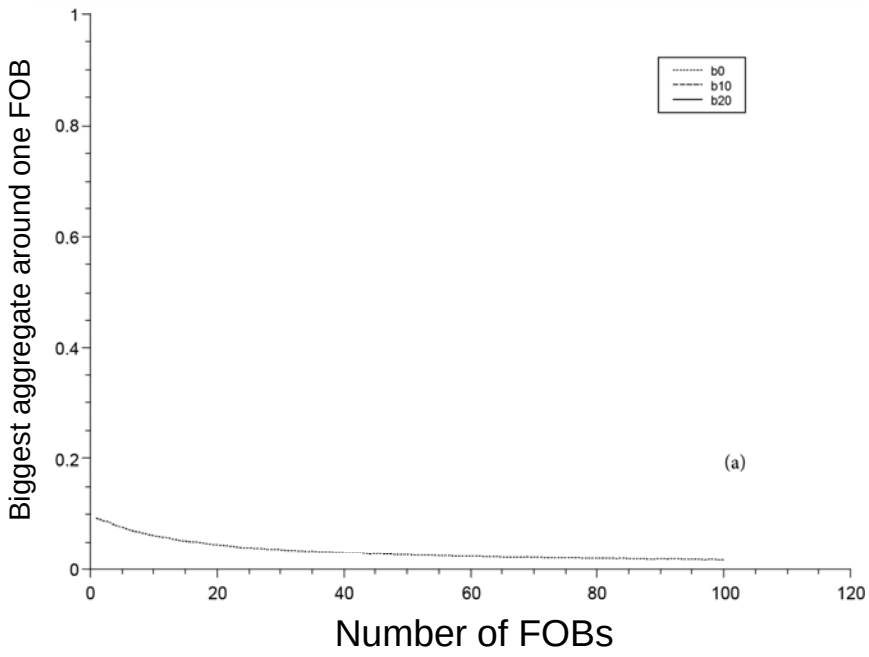

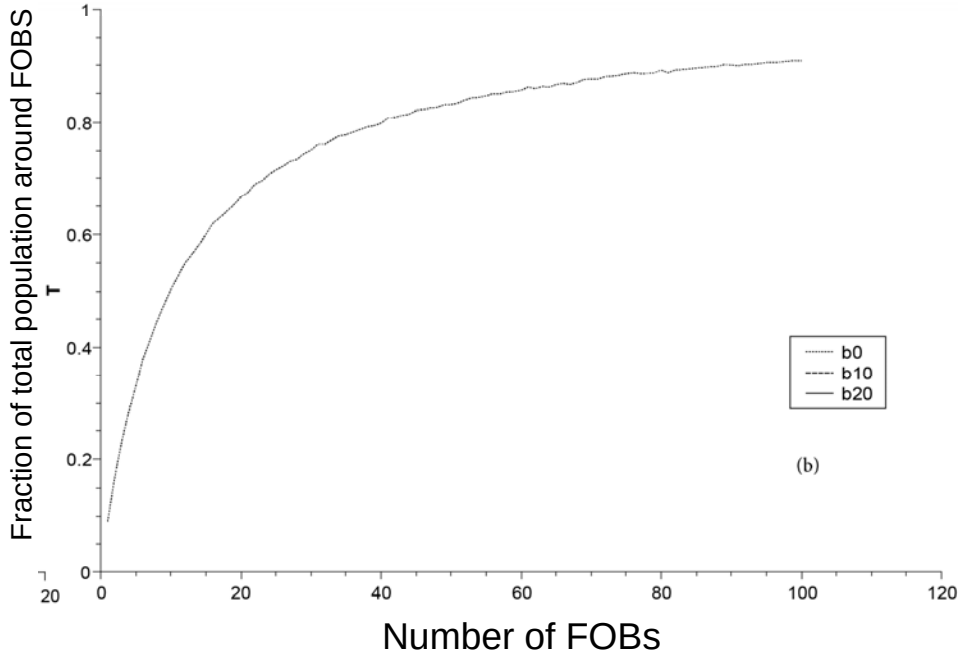

b=0 : no interattraction, asocial fish

Model : *p* identical FOBs

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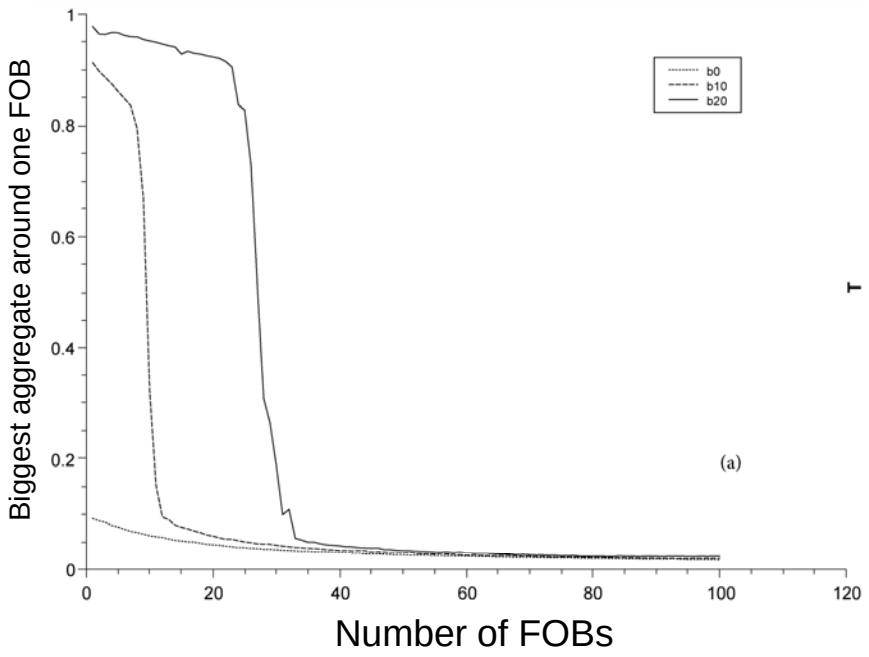

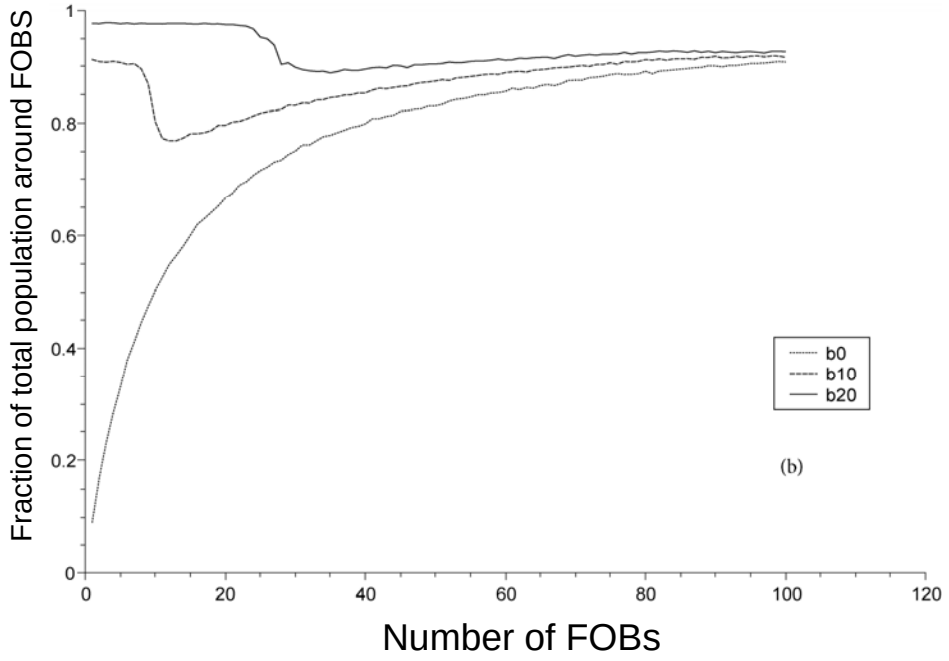

b>0 and increasing number of FOBs

asymmetric ➔ symmetric distribution

Take-home message

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1. Depending on the species' level of sociality and on the number of FOBs deployed in a homogeneous oceanic region, fish will be:

   -scattered among FOBs

   -aggregated around a single FOB based.

Take-home message

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2. Even for social species, we demonstrated that there is a number of FOBs that **minimizes** the total population of fish associated with one FOB and another number of FOBs that **maximizes** the total population of associated fish.

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3. **Management:**
   - **-more FOBs decrease the catch uncertainty but increase the fishing effort**
   - **-more fishing sets increase the amount of bycatch**

➔ Deploy more and more FADs will not be helpful for fishermen and will have negative impact on biodiversity

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General request: we need data to parameterize our model
(e.g. CRT, 2 identical FADs)