

ON THE NEED FOR REFERENCE POINTS WHEN INVESTIGATING THE EXISTENCE OF ECOLOGICAL TRAPS

By Marianne Robert, Laurent Dagorn, Nathalie Bodin, Fabrice Pernet, Marie-Julie Arsenault-Pernet, Jean Louis Deneubourg

Robert et al. Under Review in *Fish and Fisheries*

▶ **Three main impacts of FADs fishing**

- Removal of important amount of juvenile YFT and BET
- Removal of non-target species and bycatch
- Recent and rapid habitat modification
 - => increasing density of floating objects

▶ **Three main impacts of FADs fishing**

- Removal of important amount of juvenile YFT and BET
- Removal of non-target species and bycatch
- Recent and rapid habitat modification
=> increasing density of floating objects

▶ **FADs can act as ecological trap**

Marsac et al 2000; Hallier and Gaertner 2008; Jacquemet et al 2011

by altering the natural movements (e.g. migrations) of tunas
and potentially impacting their biology (e.g. growth)

The ecological trap concept

- ▶ Potential mechanisms leading to traps

Robertson & Hutto 2006

decoupling the

Attractiveness

Suitability (adaptive value)

The ecological trap concept

▶ Potential mechanisms leading to traps

Robertson & Hutto 2006

decoupling the

Attractiveness

- Identify the underlying mechanisms and triggering factors of attractiveness

Study of the associative behavior

Suitability (adaptive value)

- Identify the role of floating objects in the ecology of the specie
- Compare suitability indices before and after the change

Study of the physiology

- ▶ Association with logs is an old and non-human influenced process that certainly provided some benefits to fish
 - ▶ If the differences in fish conditions observed under the current FAD deployment regime between individuals associated and those not associated with floating objects are interpreted as a demonstration of the ecological trap

Marsac et al 2000; Hallier and Gaertner 2008; Jacquemet et al 2011
 - ▶ theoretically, such differences should not have existed before the introduction of man-made FADs

The lack of this reference point represents a major information gap

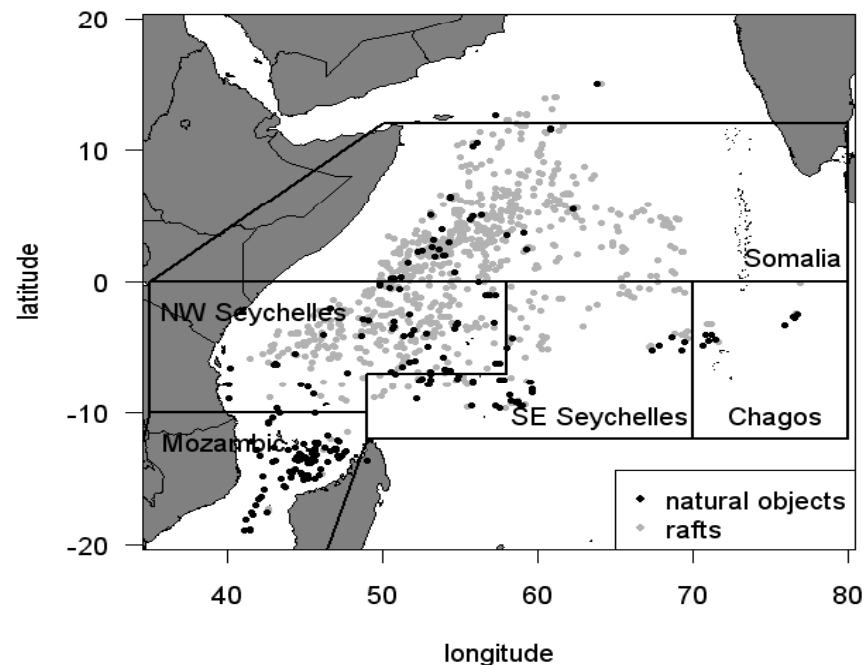
The objective of our study is trying to estimate such a reference point

► This study objective requires either

(1) the acquisition of historical data before the use of FADs (which was not possible)

(2) an area where logs are naturally abundant and which has only been slightly modified by FADs deployment

The Mozambique Channel typically matches this description



- ▶ In this study, we tested the underlying hypothesis that

within this area of natural occurring logs (and free of FADs) representing

natural behavior
evolutionary reason of the association

the health condition of tuna associated with logs is similar or superior to that of tuna in free swimming schools

Species : Skipjack tuna (*Katsuwonus pelamis*)

Sampling gear : Purse Seine fishing

Free swimming school : 6 sets (118 fish)

Logs : 21 sets (251 fish)

fish between 40-55 cm Fork Length

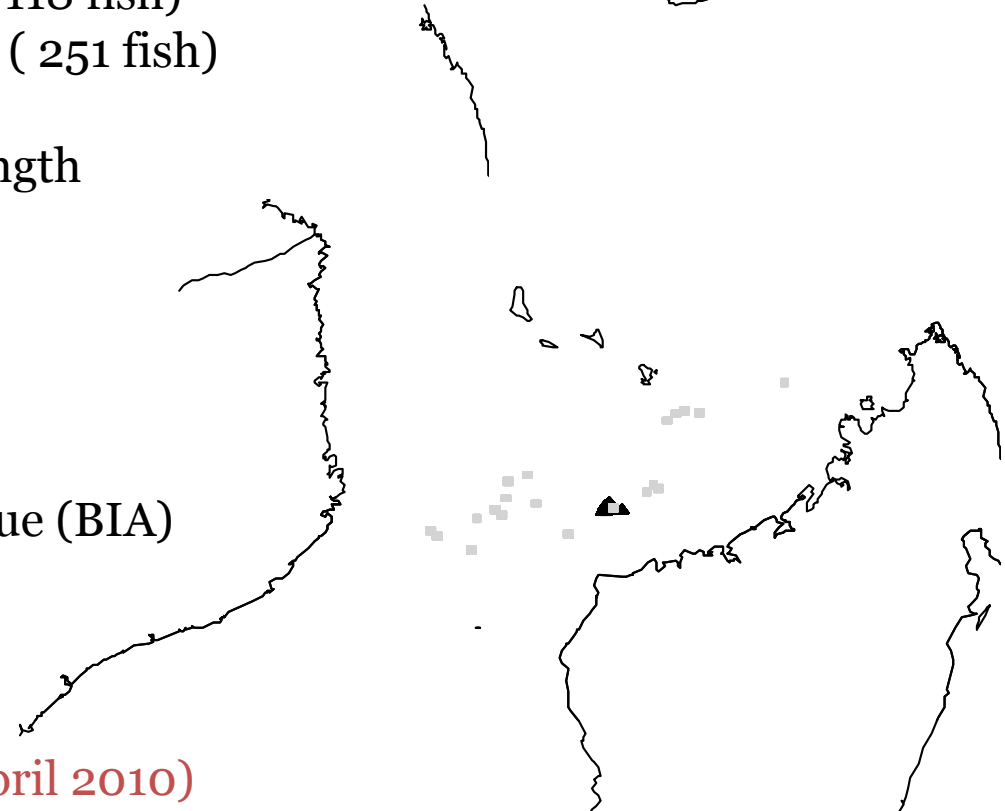
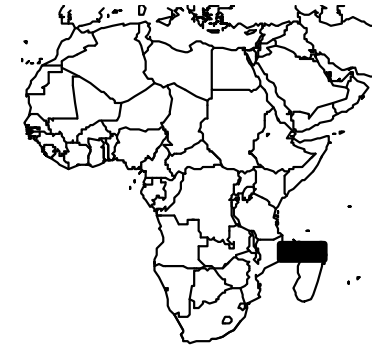
Conditions factors :

Plumpness (Thorax Girth)

Bioelectrical impedance of tissue (BIA)

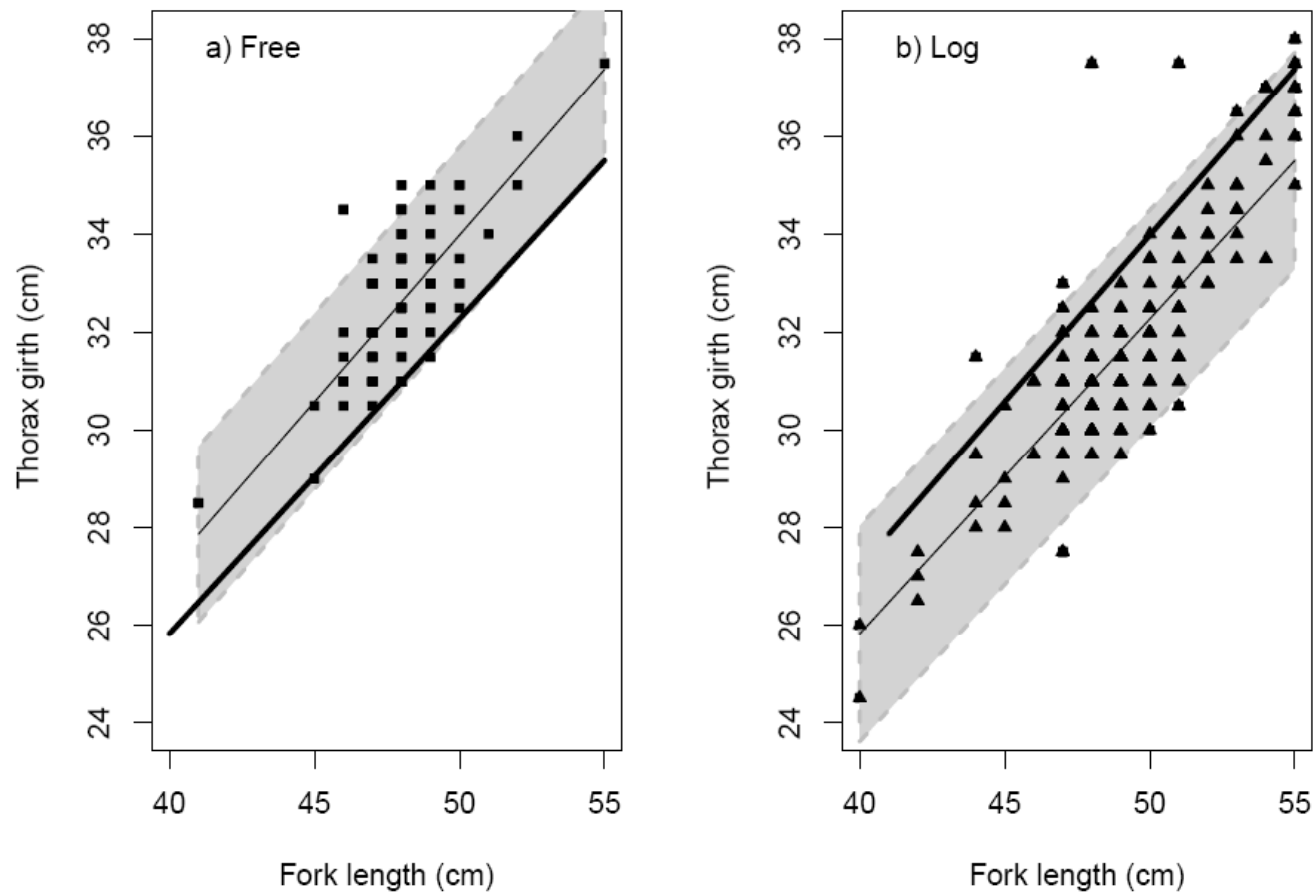
Phase angle

=> small spatio-temporal windows (April 2010)



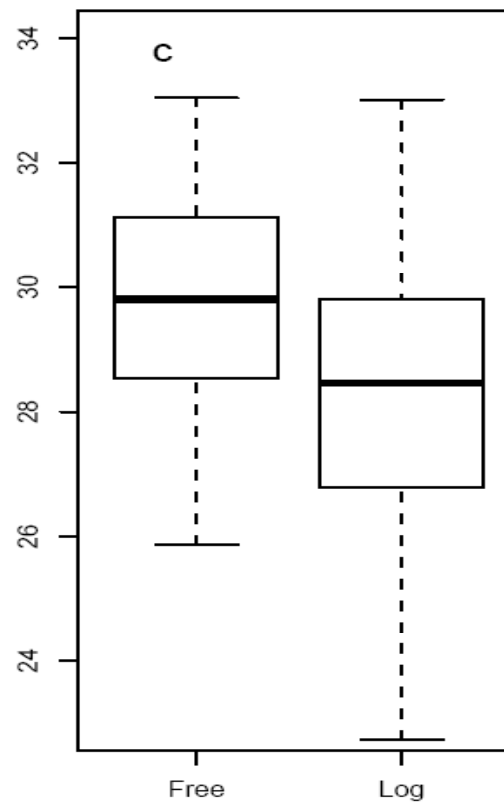
For a same fork length :

fish caught in FSS have a larger thorax girth than tuna caught under logs



The higher the Phase Angle (PA), the higher the condition :

Fish caught in FSS have a higher PA than tuna caught under logs



Rejection of the hypothesis tested :

In an area of natural occurring logs, and free of FADs

Tuna in FSS are “naturally” in better condition than those associated with logs for both morphometric and physiological condition indices

=>This result prevents from unequivocally interpreting poorer condition of tuna under FADs as evidence that FADs act as ecological trap

=>When attempting to understand impacts of human disturbance on ecosystem, evaluating a baseline ahead of changes is essential

Interpretation of difference in condition

▶ Time spent in both associated and unassociated phases

Acoustic tagging studies :

Tuna alternate between the two phases

Schaefer and Fuller (2010), Govinden *et al.* 2010)

On FADs and off-FAD period : Around a week

Ohta & kakuma (2005), Dagorn *et al.* (2007), Schaefer & Fuller (2010), Govinden *et al.* (2010)

▶ The speed at which condition indices vary under starving conditions

PA is supposed to vary quickly + High metabolic rate of tuna

(Willis and Hodbay 2008)

TG decreases rapidly under starved conditions:

3-4 days of starvation to reach differences observed in our samples

(captive experiment Holland Prs. Comm)

Why do tuna associate with logs ?

Trophic function : Log indicator hypothesis

Not supported by our results and other studies
at least at small spatial scale

Why do tuna associate with logs ?

Trophic function : Not supported by our results and other studies at least at small spatial scale

Social benefit : Meeting point hypothesis
The poorer condition of tuna under logs can be seen as :

Consequence of the association with logs:

reduced feeding activities under logs is a compromise to be more efficient in a medium term as a member of a larger school

Cause why they aggregate under logs :

Tuna associate with floating object when they are in poor condition in the open ocean, hoping to form larger schools more efficient in future foraging

Strong evidence of ecological trap are rare

rare in nature/scientist failed at proving them (Robertson and Hutto 2006)

Difficulties : Tuna-FADs association :

- The lack of clear understanding of
 - the mechanisms underlying this associative behavior (attractiveness)
 - the role of logs in the ecology of tuna (suitability)

Future works

- Collection of indices related to different cost and benefit
 - Number and the size of associated and free swinging schools
 - Monitor fish condition through time

- All the life cycle
 - male/female : primary results
 - juveniles / adults

- Contrasted situations
 - area “non” perturbed
 - area highly perturbed

BIA (Bioelectrical Impedance Analyser) :

Used in medicine for more than 20 years (Barbosa-Silva et al. 2005)

predictor of survival and recovery in human diseases

(ex : Anorexia Nervosa)

Malnutrition : changes in cell membrane integrity and fluid balance

detectable by Phase Angle (PA)

Recent application in ecology :

Advantage : low cost, non lethal and easy used

Mammal, reptile, fish (Ducan 2007, Willis and Hodbay 2008, Cox and Hatman 2009)

