Oiseaux marins et stratégies de recherches de proies dans l'océan: comportement et cognition

RESOM 12 dec 2019

Julien Collet, supervision Henri Weimerskirch

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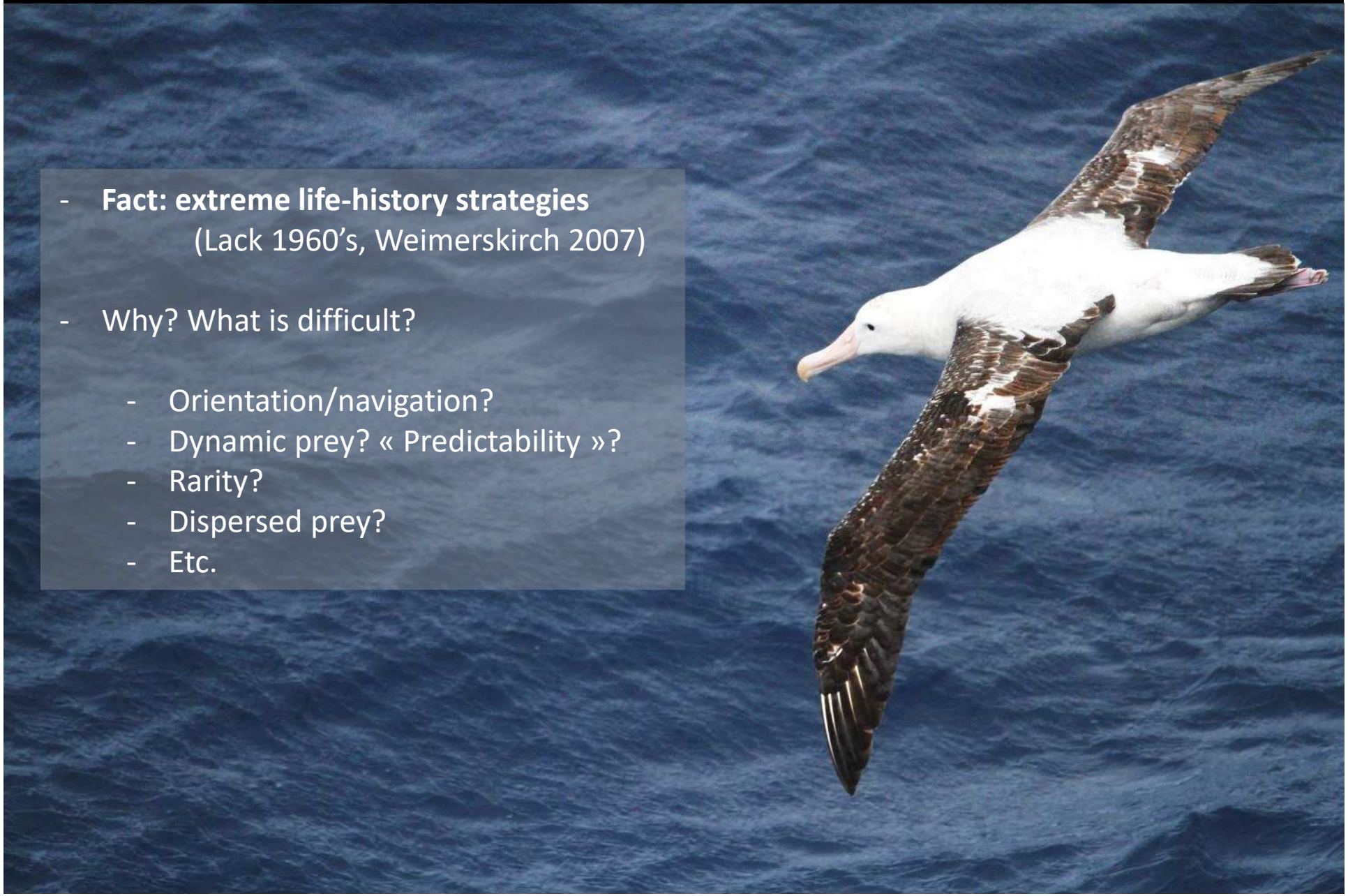
UNIVERSITÉ La Rochelle

Centre d'Études Biologiques de Chizé

Finding prey in the ocean: challenges

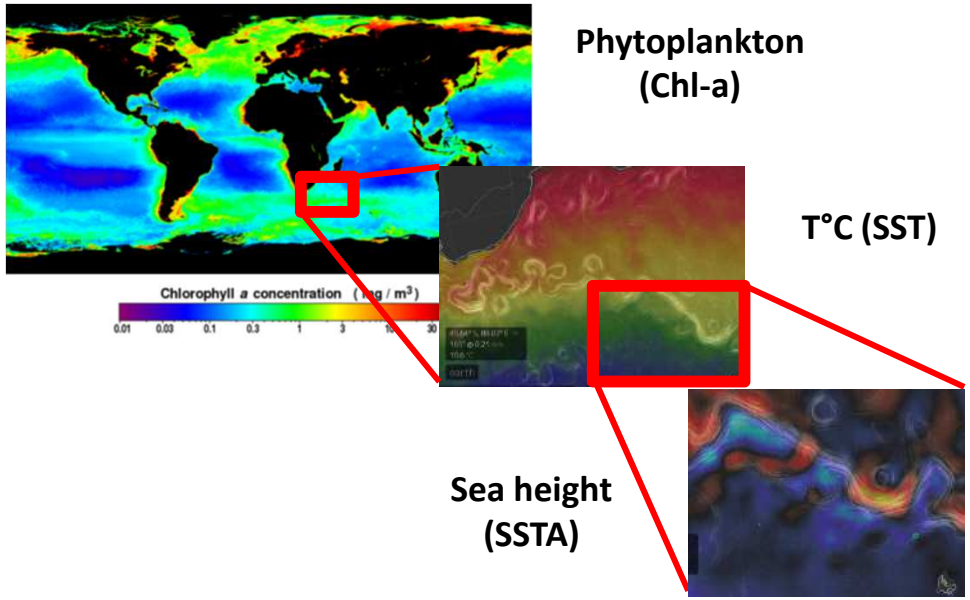


- **Fact: extreme life-history strategies**
  (Lack 1960's, Weimerskirch 2007)

- Why? What is difficult?

  - Orientation/navigation?
  - Dynamic prey? « Predictability »?
  - Rarity?
  - Dispersed prey?
  - Etc.

Seabird foraging: habitat selection



Scale dependent associations with habitats

(e.g. Weimerskirch 2007, Wakefield et al 2009)

Anticipation of the location of profitable habitats?

Seabird foraging: limited by encounter chance?

Foraging: **first** encounter resource, **then** exploit (or not)
(Schoener 1971)

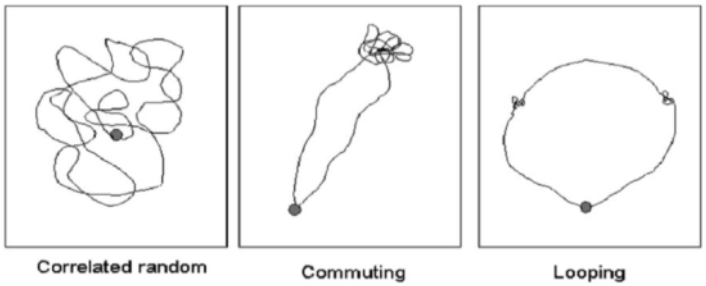
Anticipation of the location of profitable habitats?

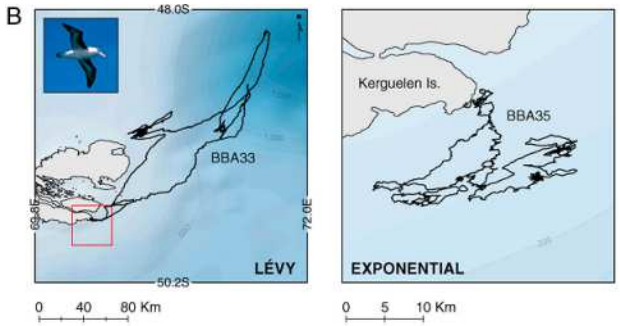
No
=> Should exploit any opportunity

Yes
=> Possible prey selection?

Plan de thèse

1. (Comment) peut-on inférer de façon fiable que les oiseaux anticipent ou non?

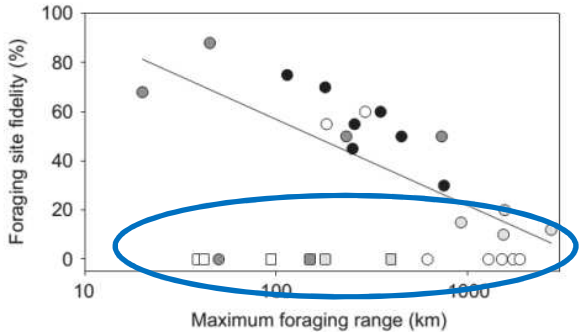




Site-Fidelity

2. Importance de la mémoire chez divers oiseaux marins (tropicaux)?

Fidelity



Weimerskirch 2007

3. Réponse des albatros aux bateaux de pêche: opportunistes ou sélectifs?

GPS data on boats and two species of albatrosses

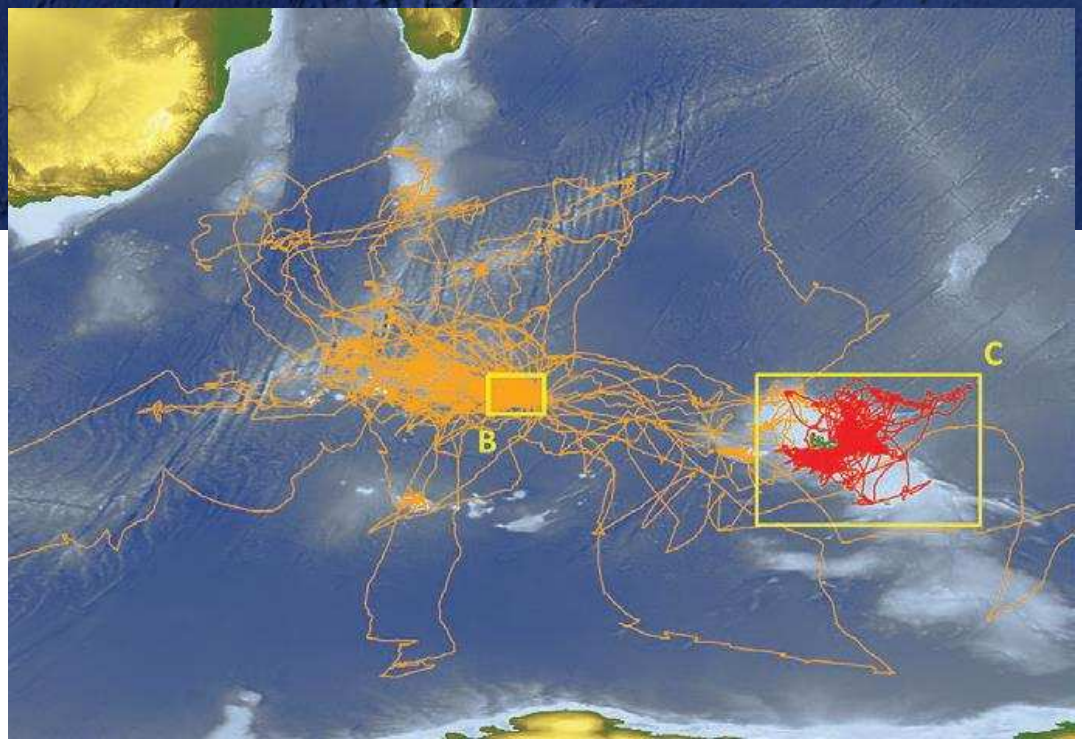
South Africa

Wandering albatrosses (WA)

Black-browed albatrosses (BBA)

7 legal boats / year

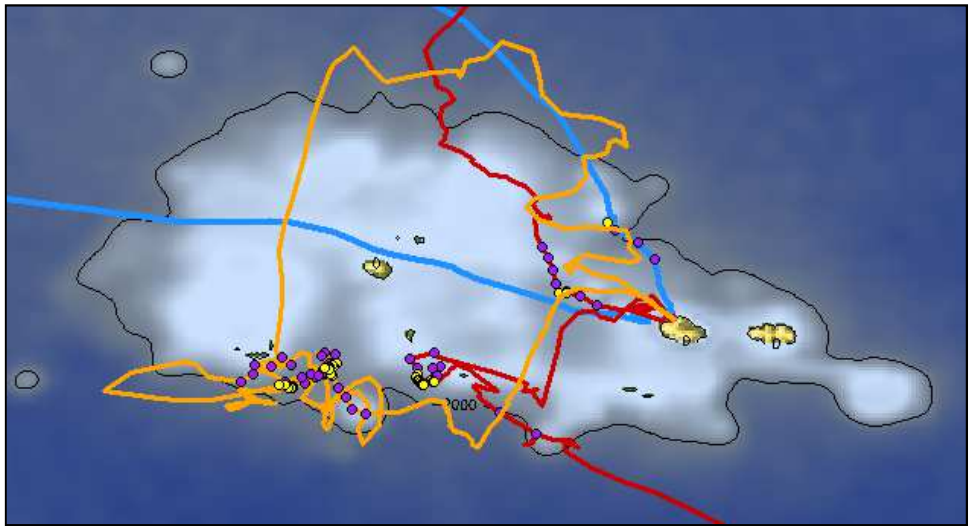
Port-aux-Français



WA: data on incubating birds (n=175)

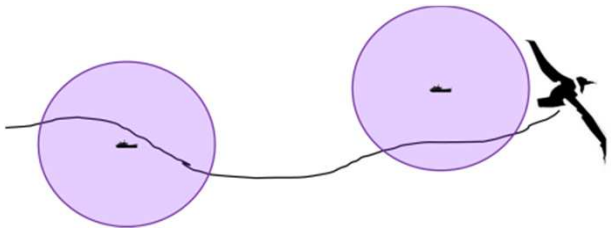
BBA: incubating (n=16) & chick-rearing (n=61)

Behavioural model: encounter/exploitation



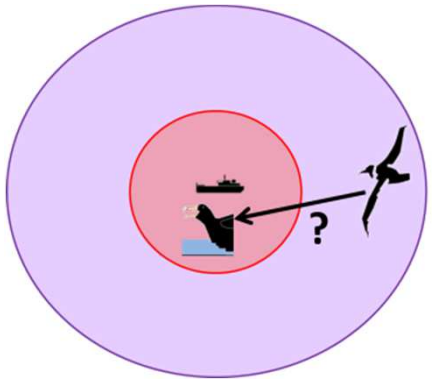
Three trips from wandering albatrosses around Crozet

How many times do they **find boats**?
Do they **stop to all**?

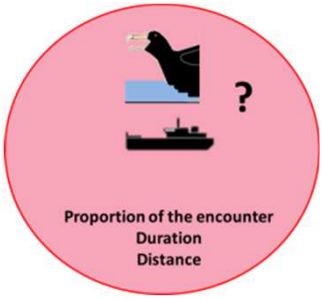


1. Encounter rate?

Detection capacities?



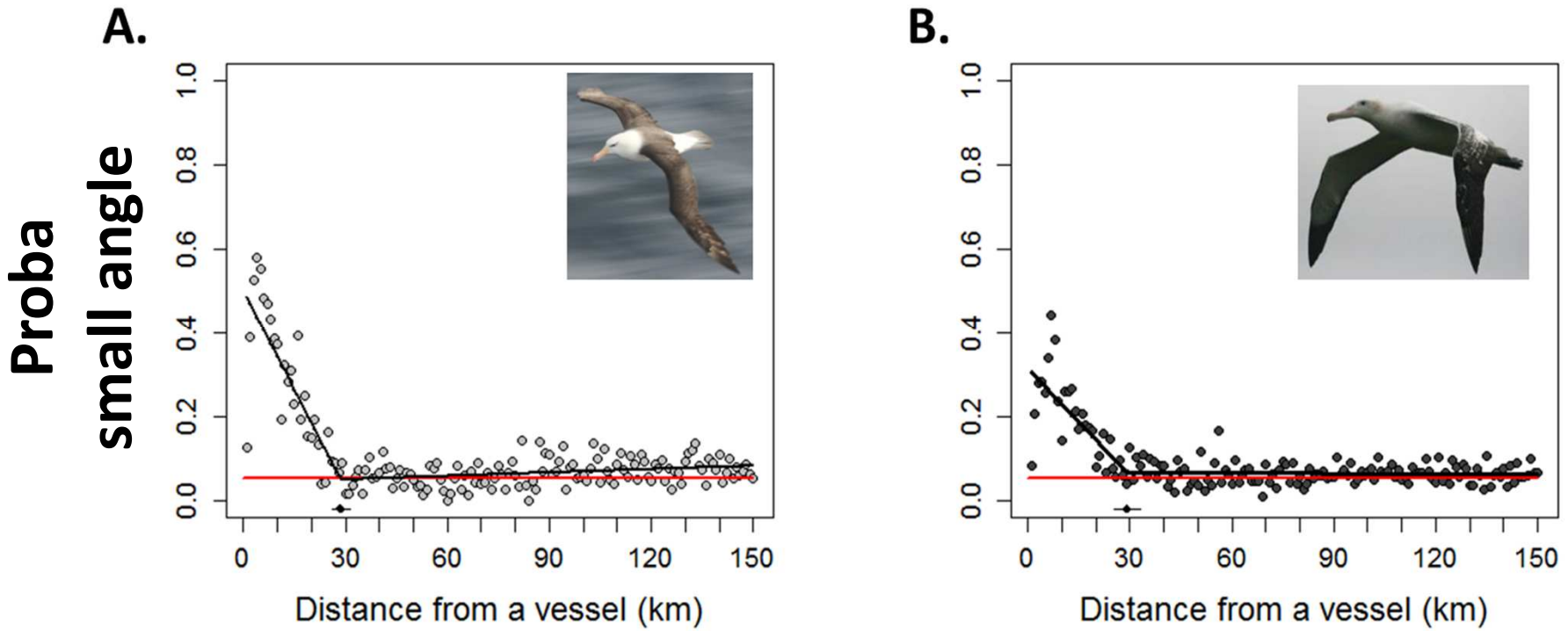
2. Proportion of encounters actually exploited?



3. Exploitation behaviour itself

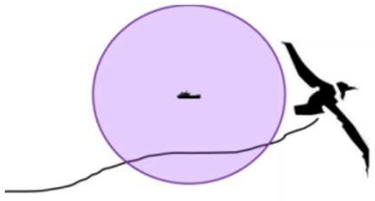
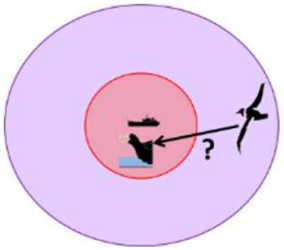
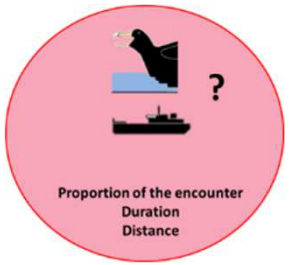
Detection capacities?

Estimated from the data, for each species



=> Up to ~ 30km for both

Factors influencing reactions to boats

	Species	Age, sex, Breeding Stage	Contextual variables
	Collet et al 2017 Behav Ecol	*Collet et al 2017 Ecol Evol*	*Collet et al 2017 Ecol Evol, Collet et al 2018 MEPS*
 **1. Encounter rate**	**WA (60% trips) > BBA (32% trips)**		
 **2. Probability to attend**	**BBA (80%) > WA (56%)**		
 **3. Attendance behaviour**	**BBA > WA**	**Chick > incub (BBA)**	

Longer-term, larger-scale influence of boats on BBA?

Strong attraction after detection of boats (80%)

Long term individual site-fidelity
(Patrick & Weimerskirch 2014, 2015, 2017)

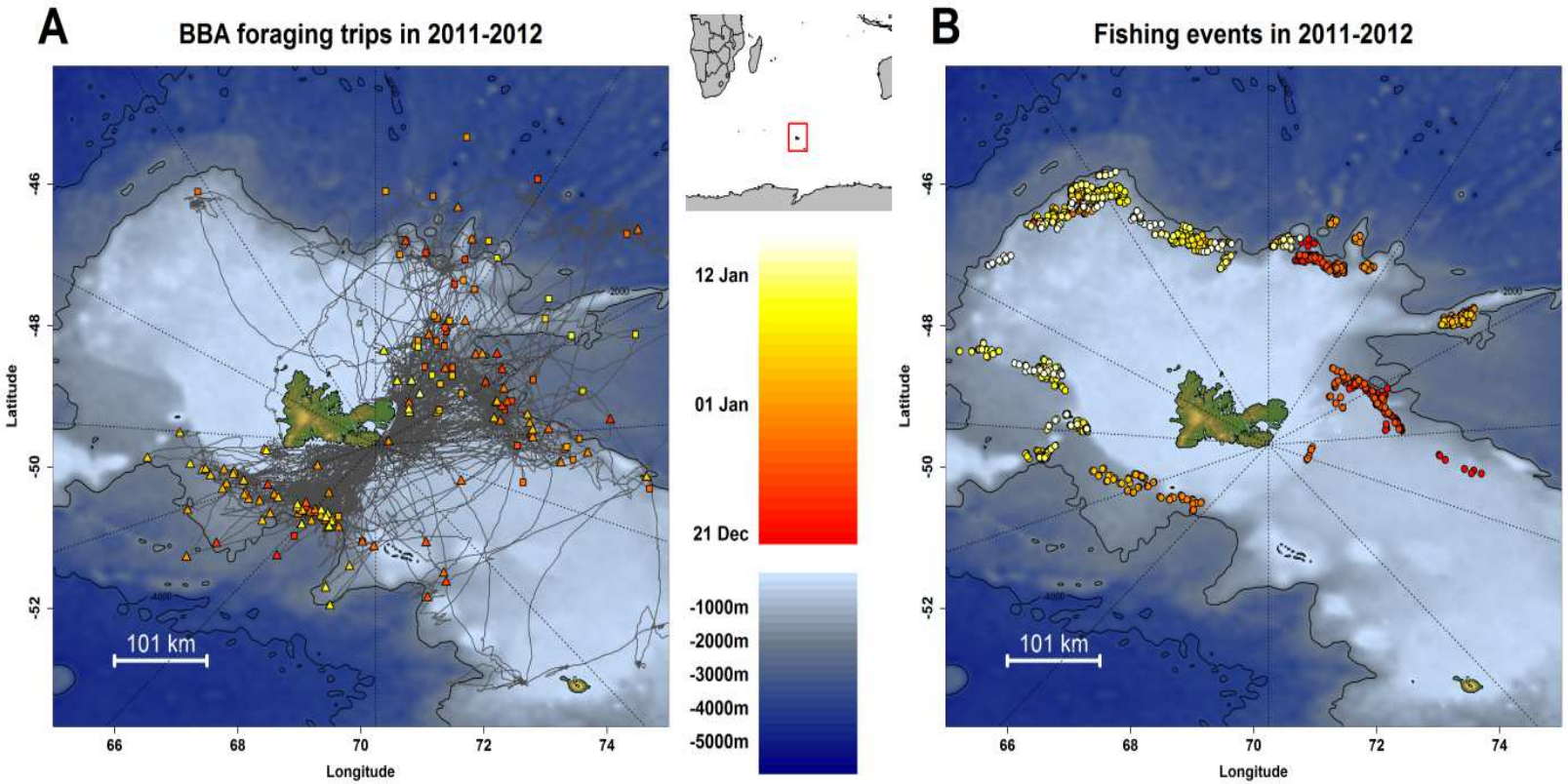
Are BBA returning where they previously interacted with boats?

- Would it be « useful »: are boats predictable?

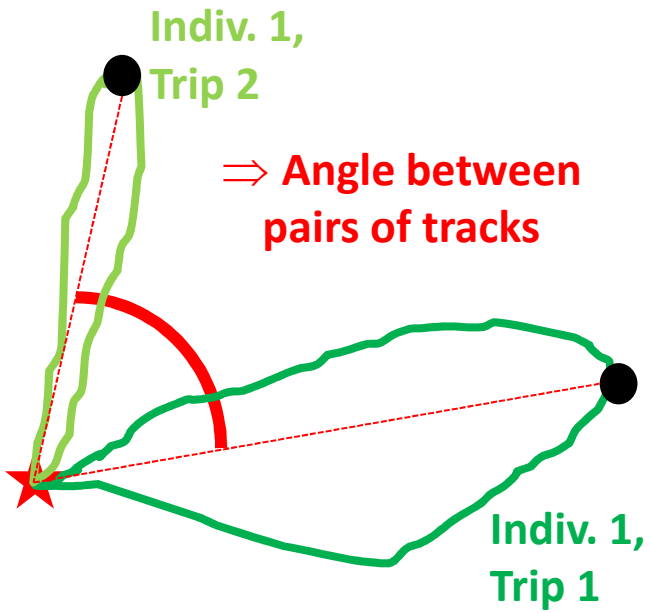
- Do BBA have required memory capacities to do so?

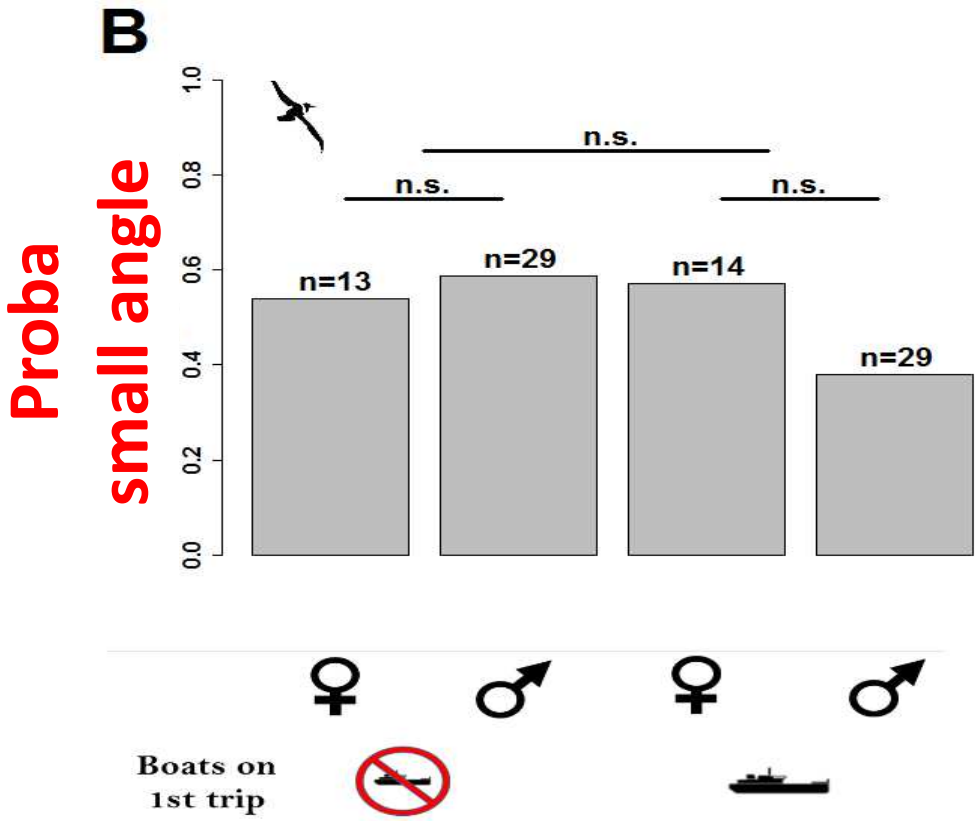
- Don’t they prefer more « natural » resources?
(resource selection?)

Overview of space use dynamics

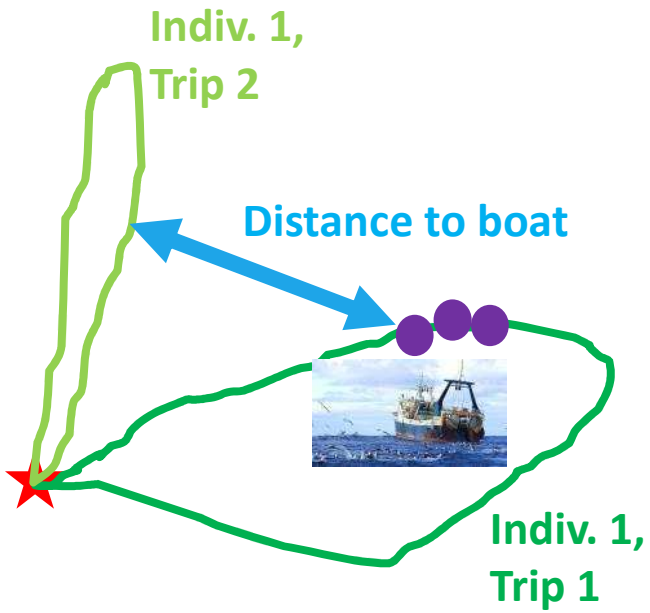


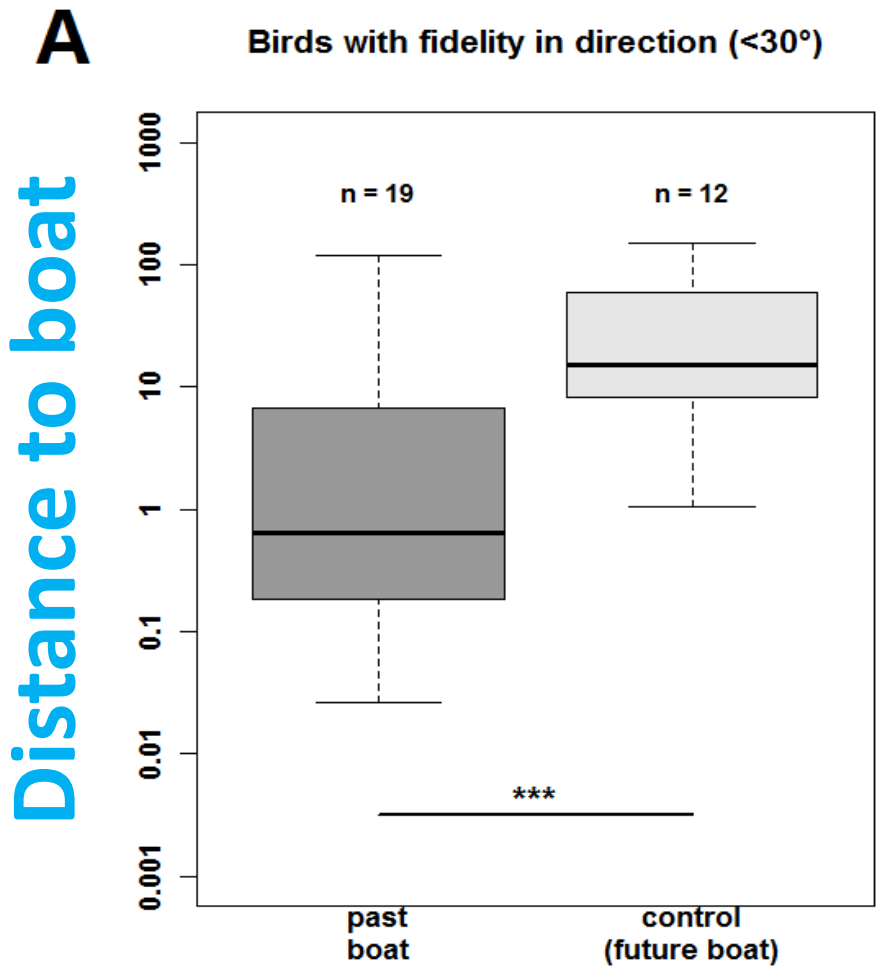
Large-scale site fidelity is independent of recent boat encounters





Spatial memory capacities?





BBA are able to memorize locations of recent boat encounters

Reponses aux bateaux: conclusions

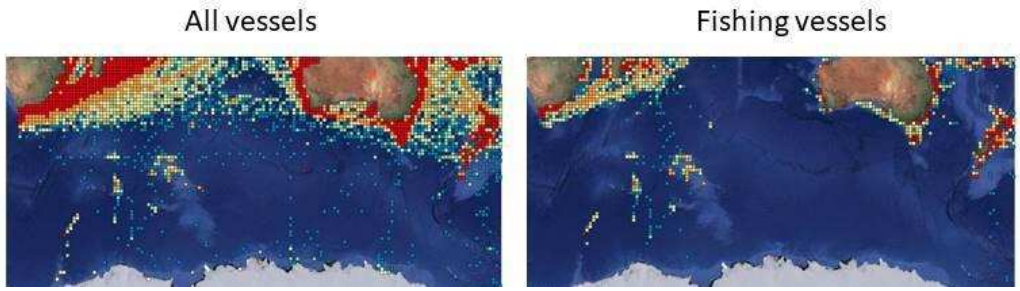
1. Ils s'arrêtent à beaucoup de bateaux, et y passent un temps non négligeable
=> Risques immédiats

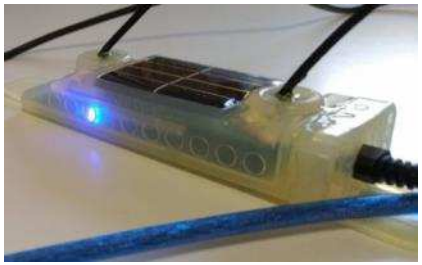
2. Ils ne s'arrêtent pas à TOUS les bateaux rencontrés
=> potentiels leviers pour diminuer l'attractivité?

3. Comprendre ces variations: déjà beaucoup de données dispo.
Limites: « politique » d'accès, finances et main d'œuvre pour les analyses

Bateaux hors des ZEE: données dispo

Données AIS





Loggers Centurion:

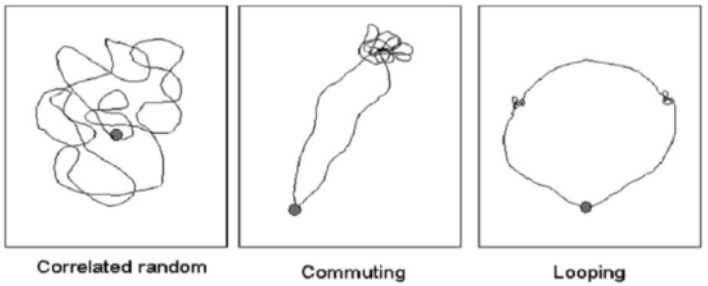
GPS + détecteur d'émissions radars (+ antennes Argos)

Weimerskirch et al 2018, Weimerskirch et al in rev.

Conclusions des autres chapitres de thèse

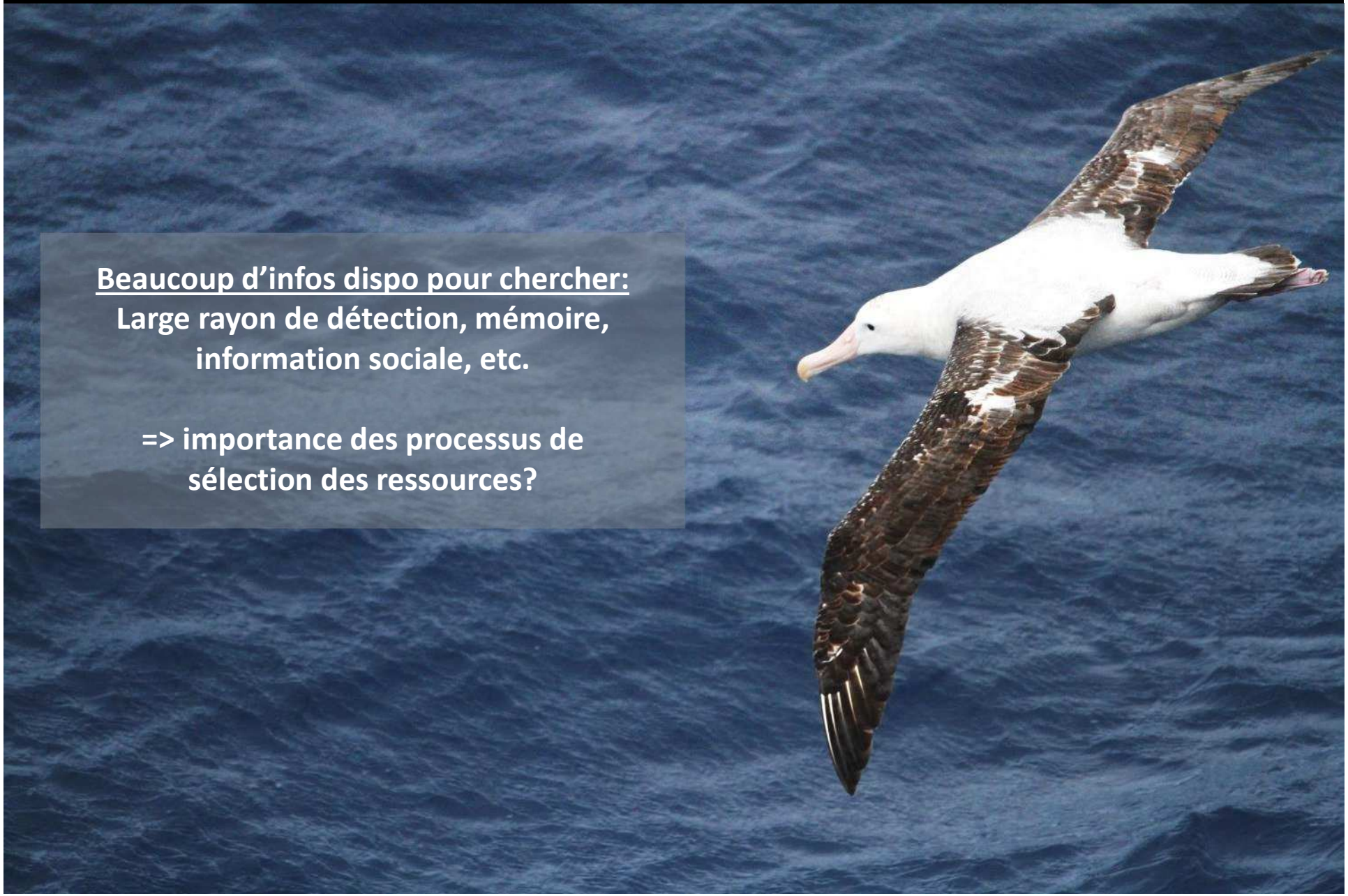
Méthodes: biais directionnels
persistance de la fidélité spatiale

~~Pas ligne droite~~, ~~pas Levy Walk~~



Stratégies de mémoire
même chez oiseaux marins tropicaux
Variations sur la persistance

Conclusions générales:
Quelles limites sur l'acquisition de ressources?



<u>Beaucoup d'infos dispo pour chercher:</u>
Large rayon de détection, mémoire, information sociale, etc.

=> importance des processus de sélection des ressources?

Acknowledgments

Centre d'Études Biologiques de Chizé

La Rochelle Université

ENS DE LYON

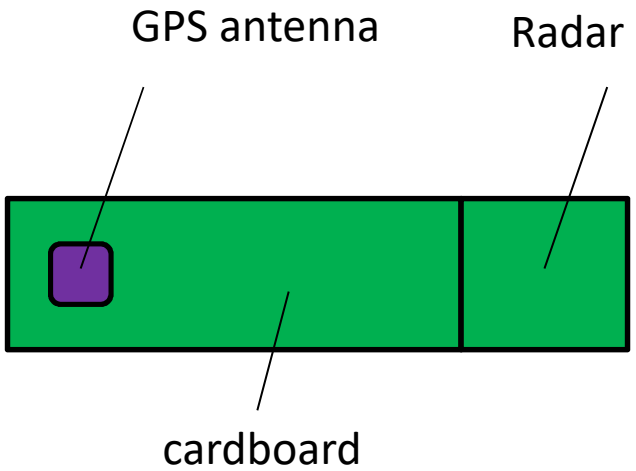
Thank you for your attention

Thèse (en français) disponible en ligne:
theses.fr (https://www.theses.fr/2018LAROS025) Ou sur ResearchGate

Radar detector loggers

XGPS (recording only)

Weimerskirch et al 2018 Cons. Biol., Gremillet et al 2019 Plos One, Corbeau et al 2019 PlosOne



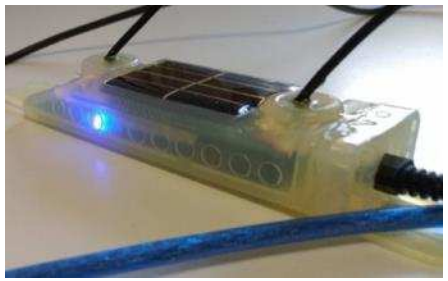
77×23×4 mm main board (~10g without battery)

independent 3.7V LiPo battery that is scalable to the species (2000mAh for WA, ~15d at 5min GPS freq)

To be encased for waterproofing

Centurion/Xargos (recording and/or transmitting)

Weimerskirch et al in rev.., Corbeau et al submitted

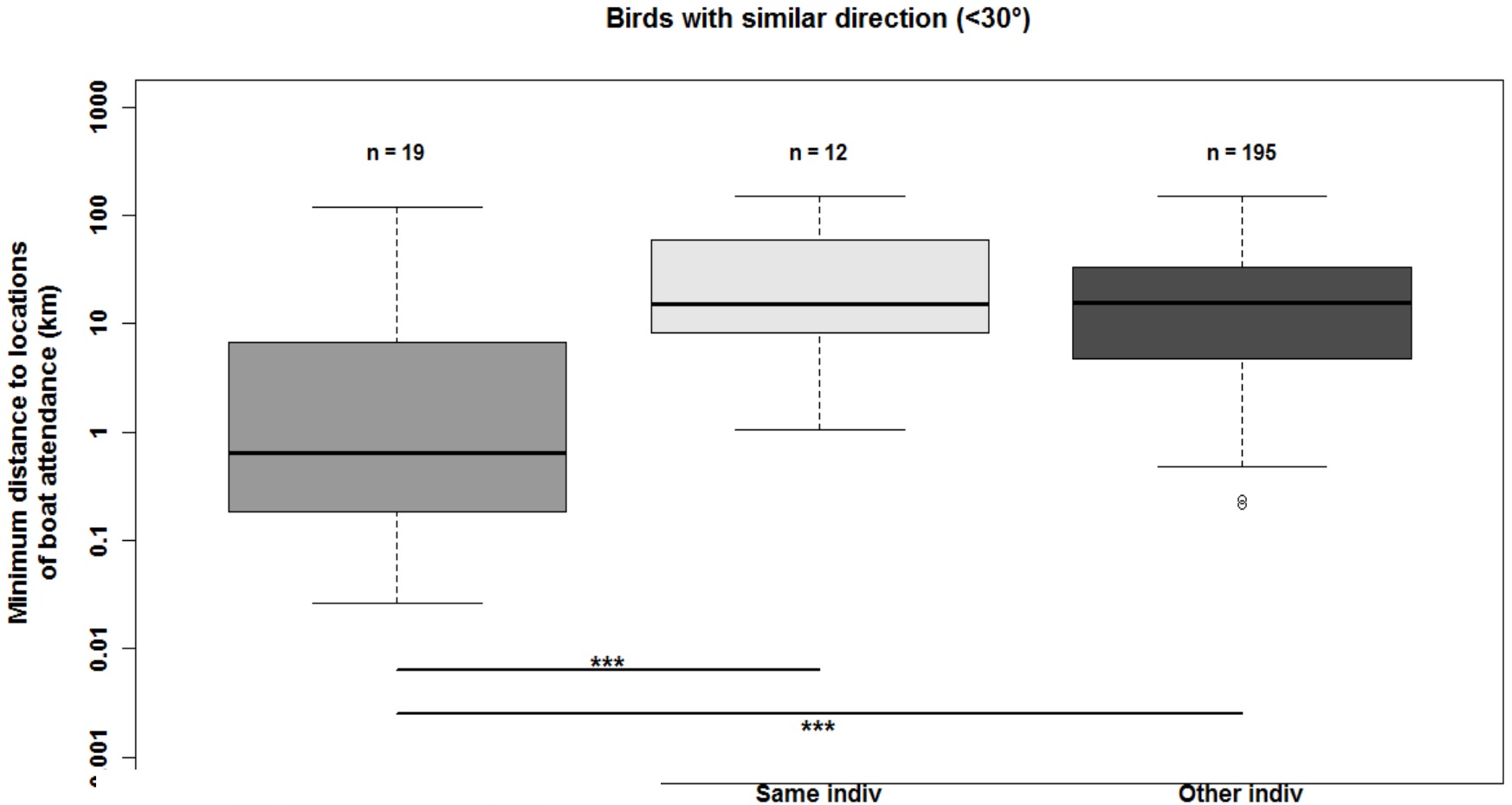


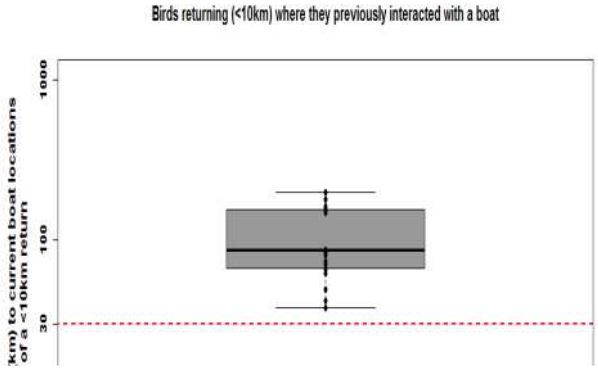
65 g, 109 X 30 X 22 mm

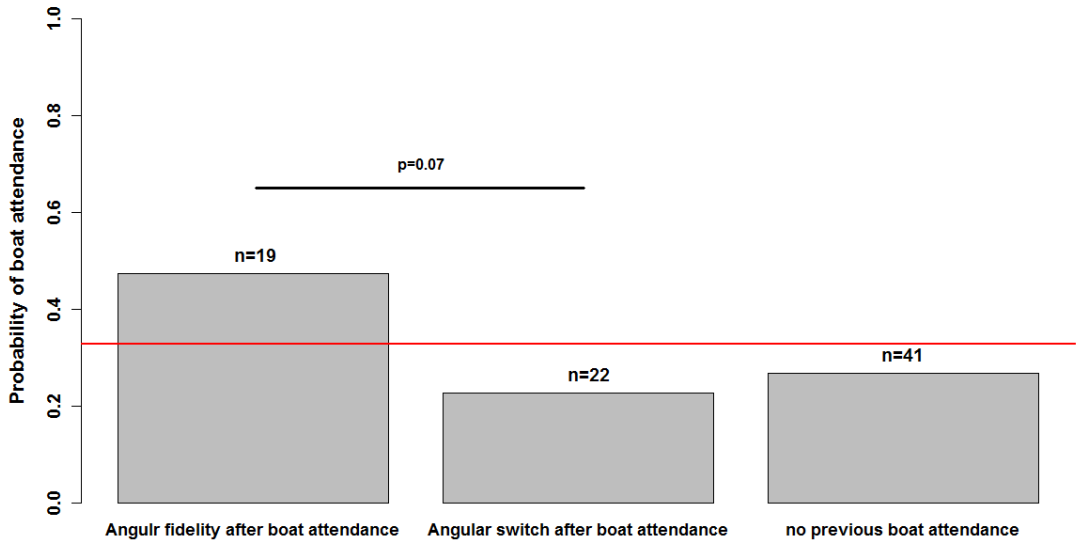
Already encased

2 external wired antennas (GPS, Argos)

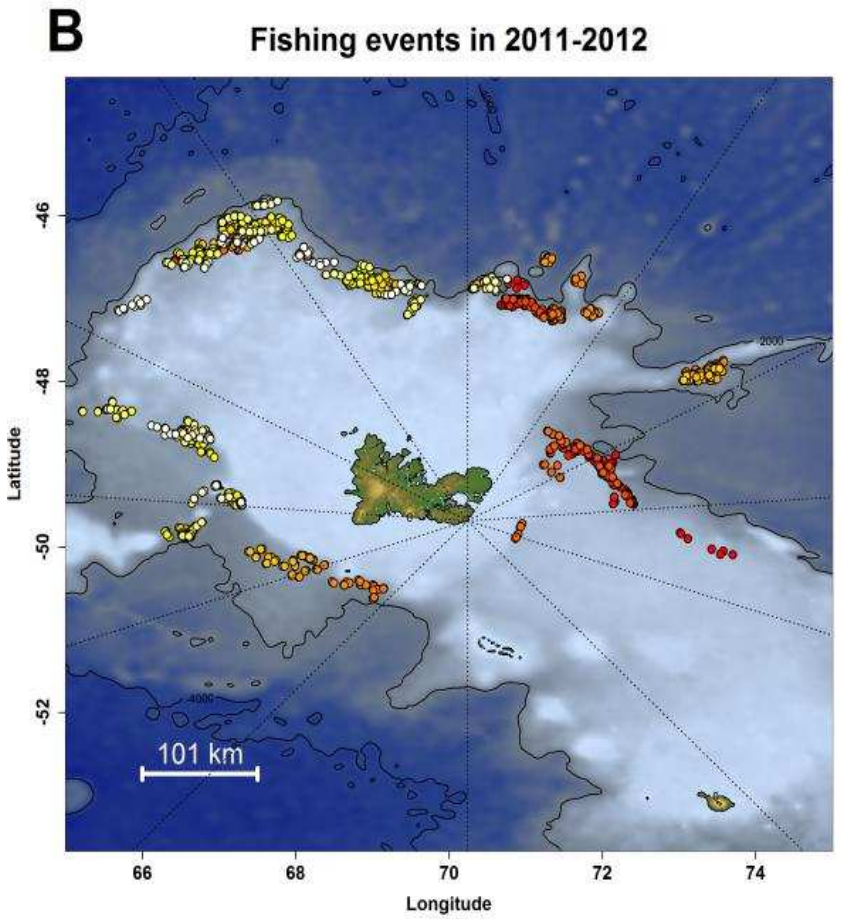
Is it really memory?

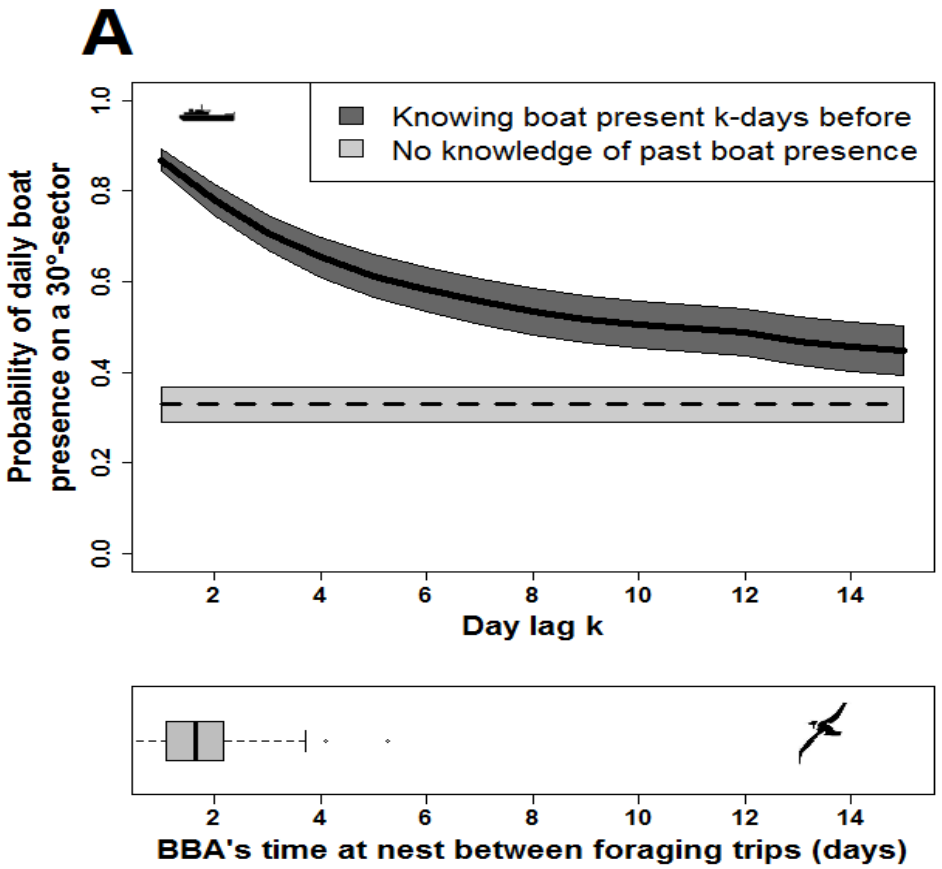





Probability of boat attendance
0.0
0.2
0.4
0.6
0.8
1.0
p=0.07
n=19
n=22
n=41
Angulr fidelity after boat attendance
Angular switch after boat attendance
no previous boat attendance

Boats are highly predictable over short time scales



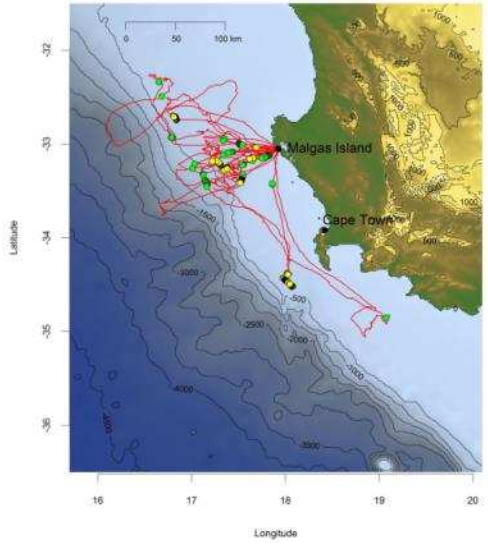


Les bateaux, un 2nd choix par défaut?

RESEARCH ARTICLE

Radar detectors carried by Cape gannets reveal surprisingly few fishing vessel encounters

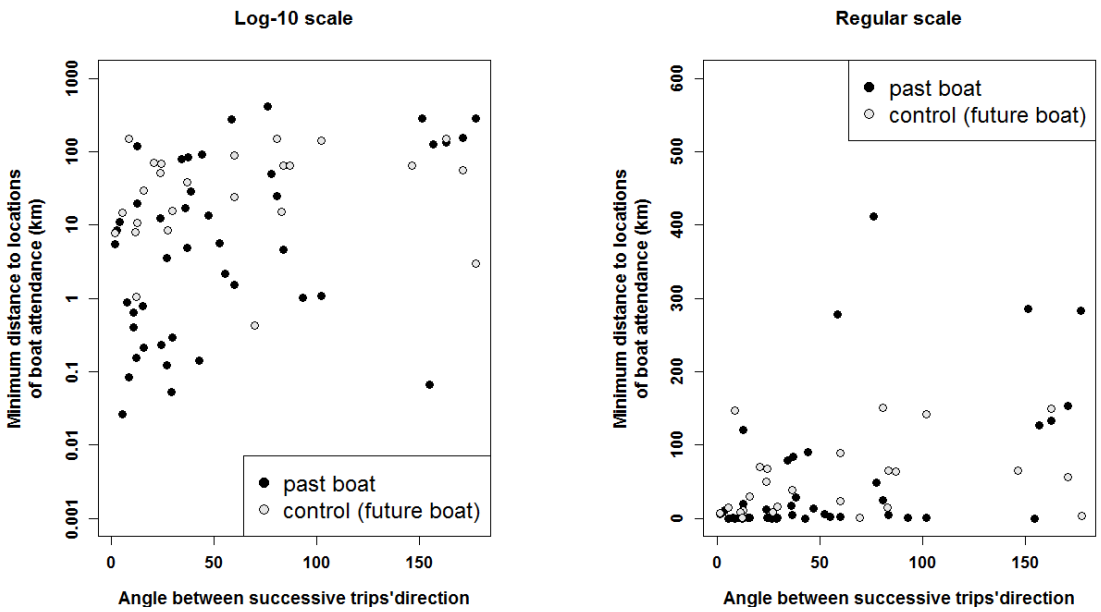
David Grémillet[1,2]*, Julien Collet[3], Henri Weimerskirch[3], Nicolas Courbin[1], Peter G. Ryan[2], Lorien Pichegru[4]



Fishery discards do not compensate natural prey shortage in Northern gannets from the English Channel

Tangi Le Bot[a,*], Amélie Lescroël[b], Jérôme Fort[c], Clara Péron[d], Olivier Gimenez[a], Pascal Provost[e], David Grémillet[a,f]

Vultures:
Montsarrat et al 2013, Fluhr et al 2017


Log-10 scale
Minimum distance to locations of boat attendance (km)
0.001
0.01
0.1
1
10
100
1000
0
50
100
150
Angle between successive trips'direction
past boat
control (future boat)

Regular scale
Minimum distance to locations of boat attendance (km)
0
100
200
300
400
500
600
0
50
100
150
Angle between successive trips'direction
past boat
control (future boat)

Vision très influencée par notre longue méconnaissance de l'océan

Evolution de la pêche (déclarée) dans le monde

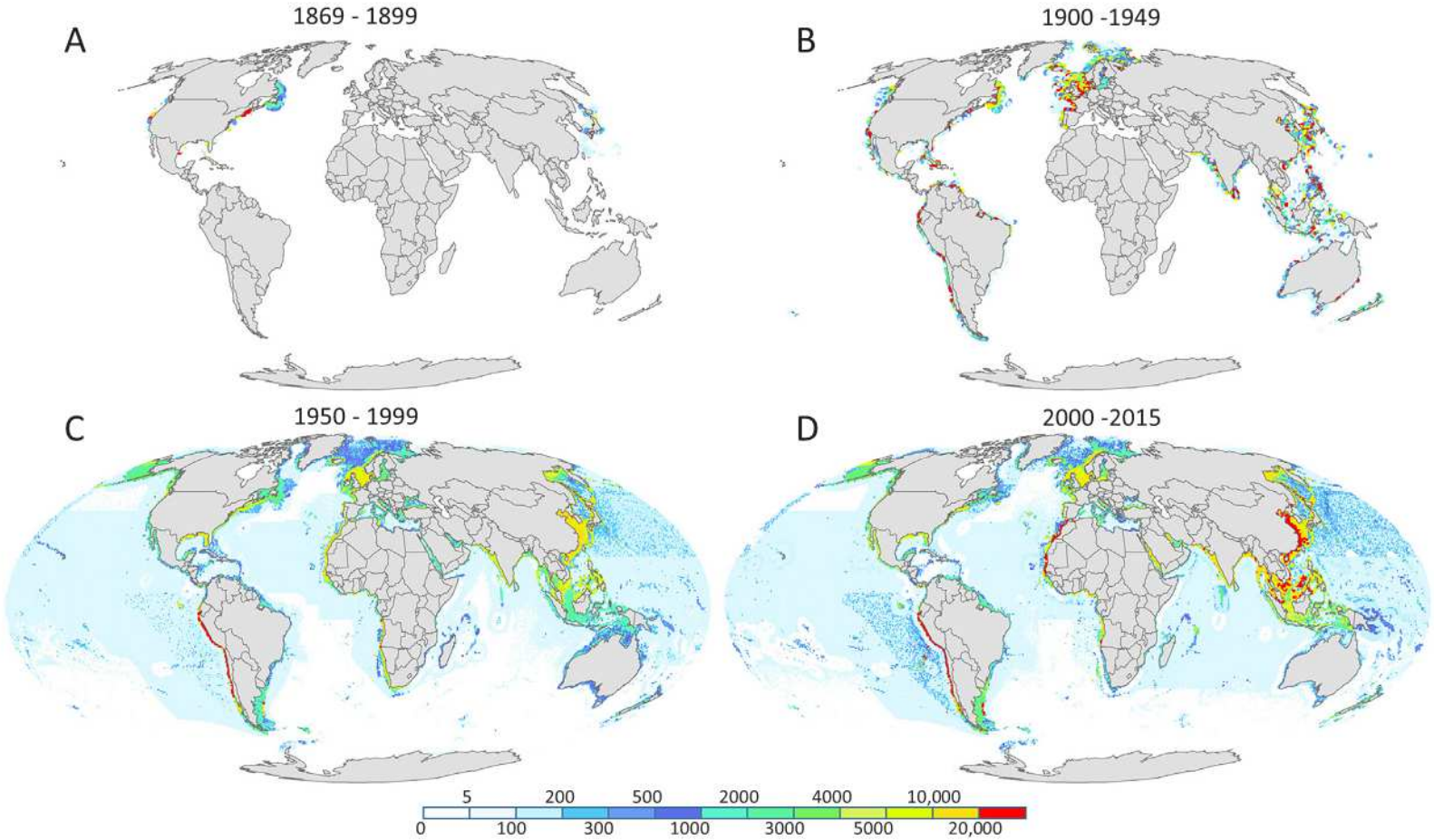
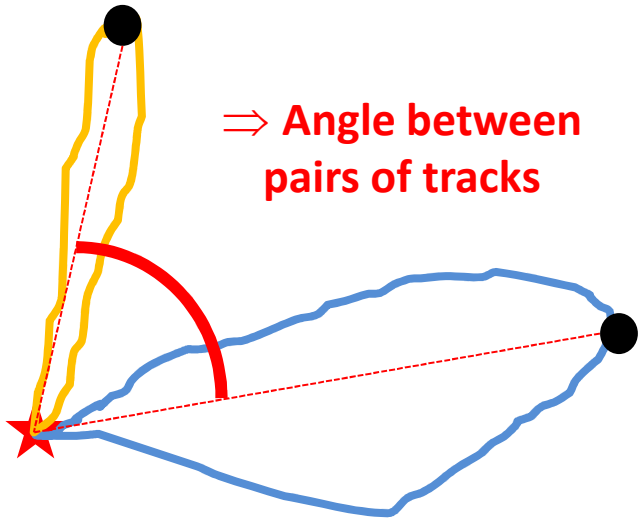


Fig. 2. Map of average annual reported landings for A 1869–1899, B 1900–1949, C 1950–1999 and D 2000–2015. Units for A and B are kg but for C and D are tonnes per year.

Watson & Tidd 2018, *Marine Policy*

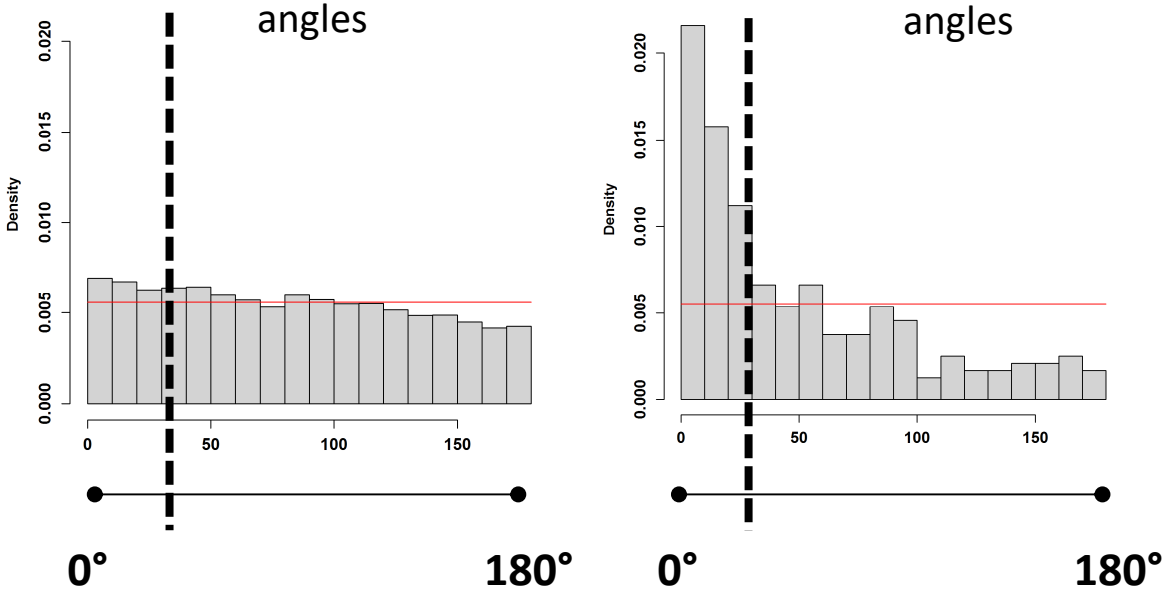
Methods: directional bias



⇒ **Angle between pairs of tracks**

Random directions:
Uniform probability of angles

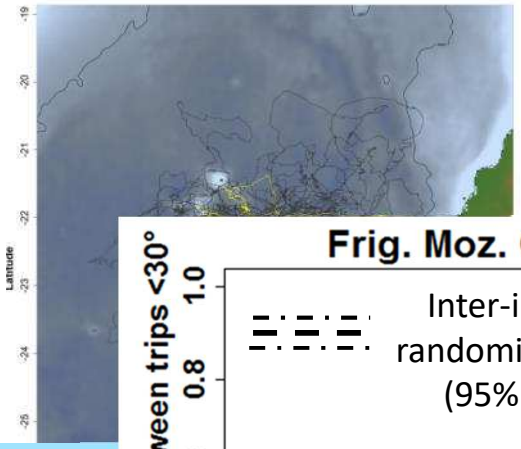
Informed directions:
0-biased probability of angles

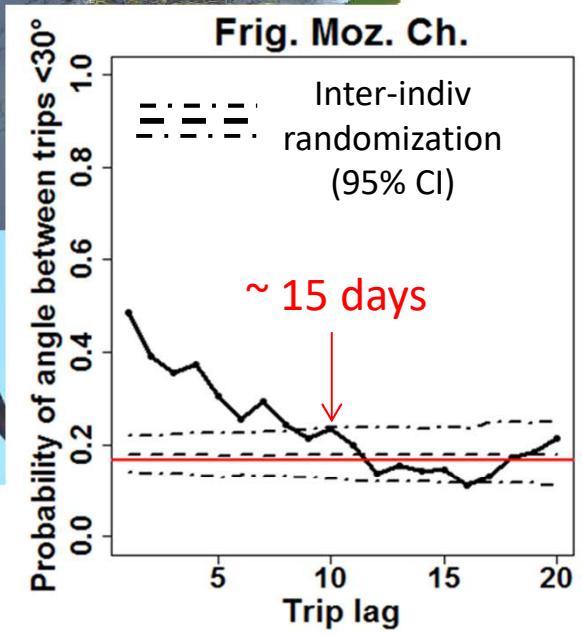


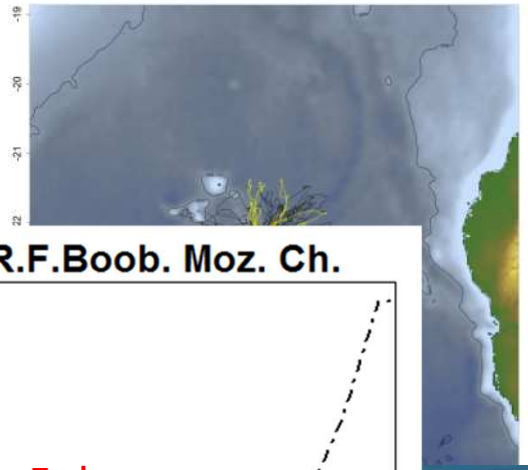
Random:
Threshold/180
(e.g. 30° => 17%
90° => 50%, etc.)

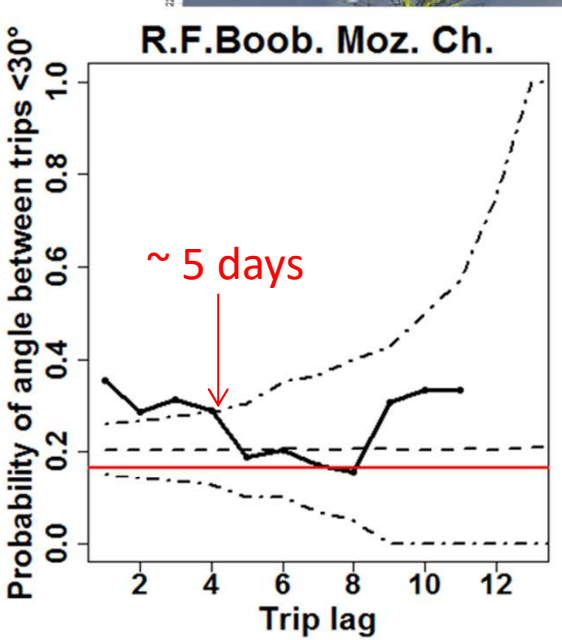
Proportion (angle < threshold°)?

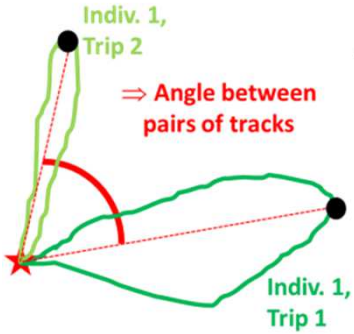
Adult fidelity across successive trips?



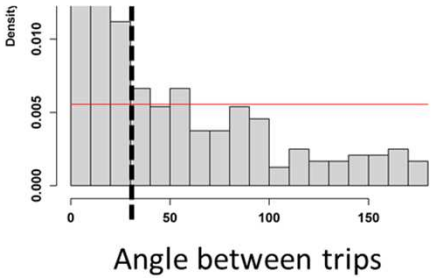


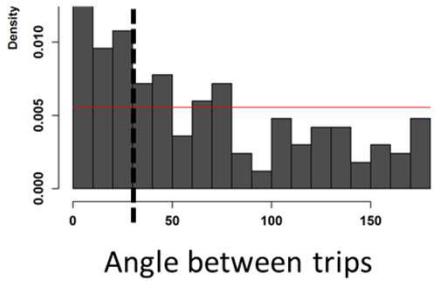






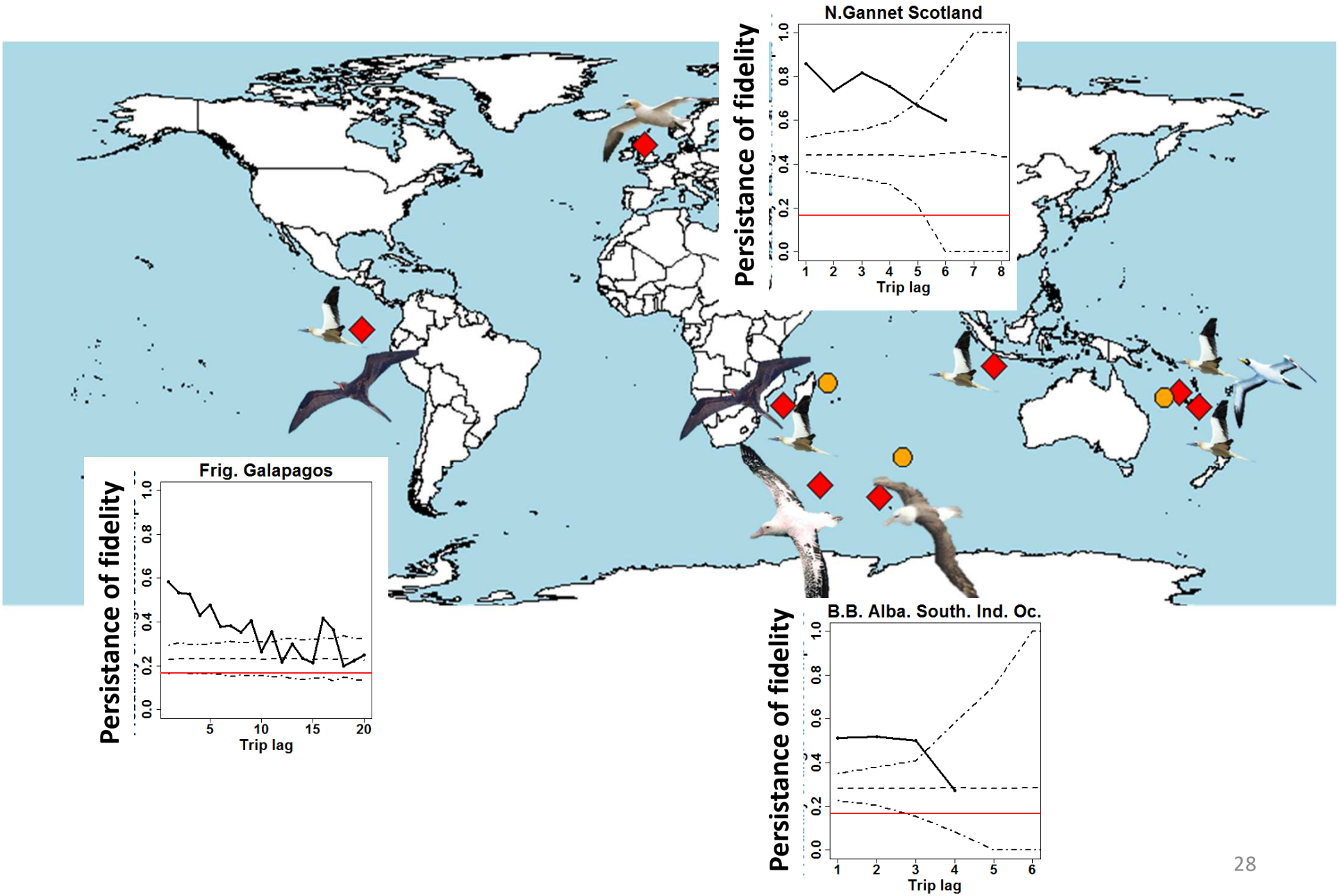
Within individual successive trips





Collet et al submitted (Am. Nat.)

Fidelity in other populations/species (adults)



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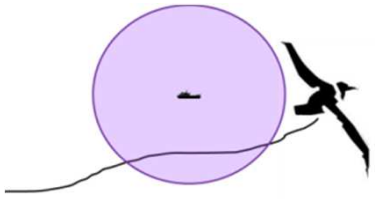
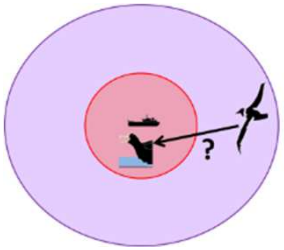
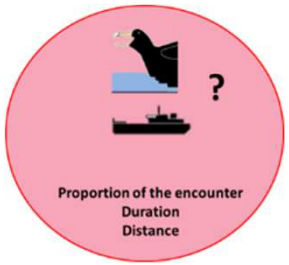
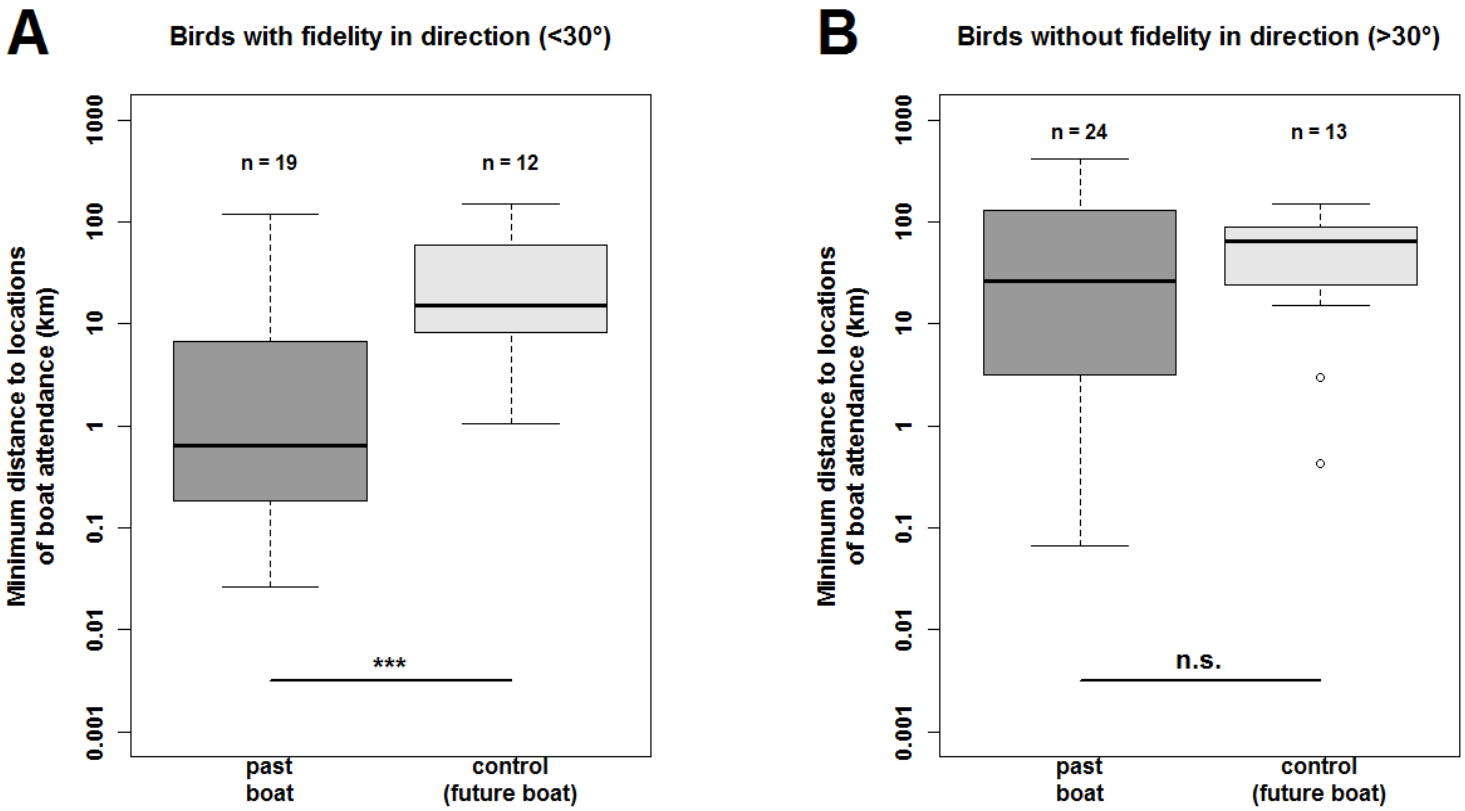
	Collet et al 2017 Behav Ecol	*Collet et al 2017 Ecol Evol*	*Collet et al 2017 Ecol Evol, Collet et al 2018 MEPS*
 **1. Encounter rate**	**WA (60% trips) > BBA (32% trips)**	**incub > chick (BBA)**	**Nb Boats**
 **2. Probability to attend**	**BBA (80%) > WA (56%)**	**none**	**Activity of boat**
 **3. Attendance behaviour**	**WA < BBA**	**incub < chick (BBA)**	**Activity of boat** **Presence of depredating cetaceans**

BBA are able to memorize locations of recent boat encounters



Chapitre 1: résumé

Ligne droite: Pas informatif

LW: pas informatif

Fidélité spatiale: très suggestif

Biais directionnel: pourquoi telle direction et pas une autre?

Chapitre 2: résumé

Direction au bout du trajet

Souvent la même d’un trajet au suivant, même en tropical

Ce qui varie: pendant combien de trajet successif c’est maintenu.

Milieu tropical => surprenant => probablement extrêmement répandu

Chapitre 3: albatros et bateaux

WA BBA et bateaux: données

Distance de detection?

Decisions d’exploitations: WA & BBA

Décisions d'exploitation: facteurs de variation

Attraction:

en pêche ou non

Pas d'effet du sexe,
de la présence d'orques/cachalots ou non,
du temps déjà passé avec les bateaux précédemment,
aller ou retour du trajet, personnalité, etc.

Probablement effet de la météo (non testé) mais pas de la direction du vent.

Durée d'exploitation

BBA incub < BBA chick-rearing
>Si présence orques/cachalots
>Quand bateaux en pêche

Pas d'effet du sexe

Forte attraction des BBA: impact à plus long terme/large échelle?
Mémoire des zones de bateaux?

1. Bateaux sont prévisibles

2. BBA s’en foutent

3. Pourtant ils s’en rappellent

En guise de conclusions

Ligne droite et LW => on oublie
Biais dans les directions renseigne sur l'utilisation d'info

Biais dans les directions des trajets successifs montrent mémoire
chez beaucoup d'oiseaux notamment tropicaux

$\Rightarrow$ Les oiseaux ont des infos préalables sur où chercher préferentiellement

$\Rightarrow$ Réponses aux bateaux nuancées