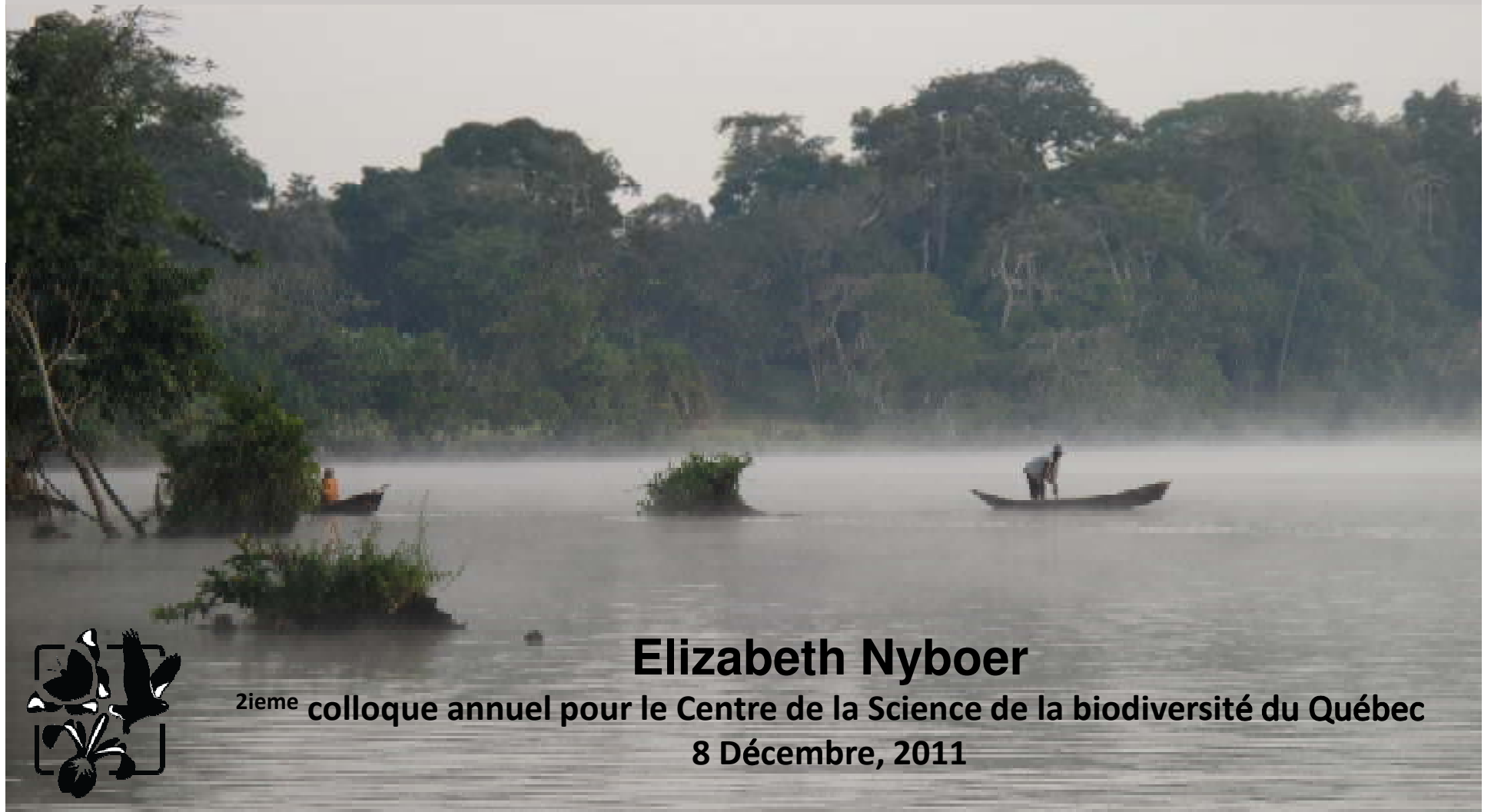


# Mouvement, domaine vital, et divergence écologique chez la perche du Nil (*Lates niloticus*) dans le lac Nabugabo, Ouganda

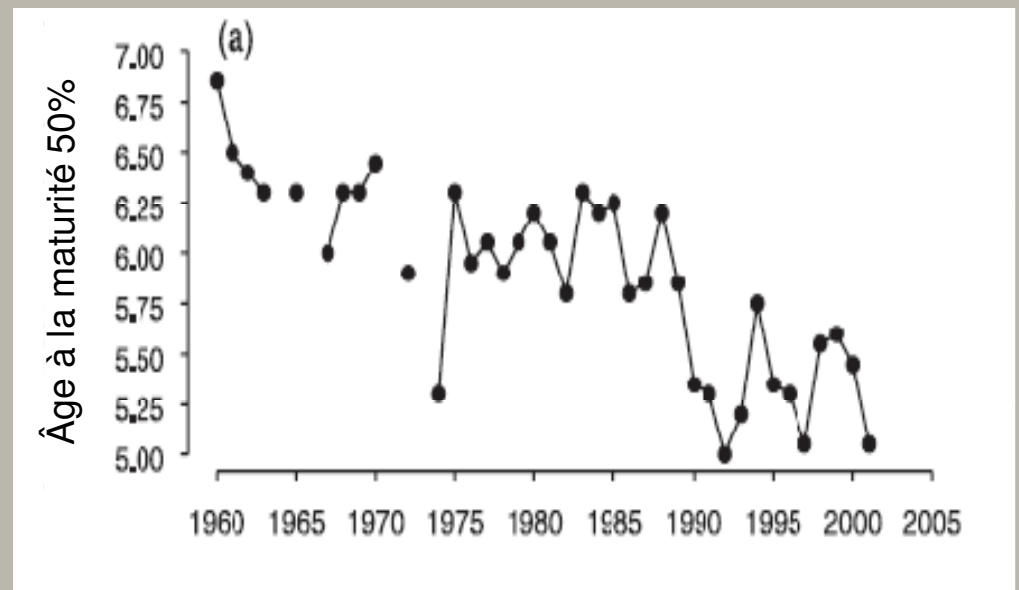


**Elizabeth Nyboer**  
2<sup>ieme</sup> colloque annuel pour le Centre de la Science de la biodiversité du Québec  
8 Décembre, 2011

# Divergence écologique causée par la pêche

- Le taux de mortalité sélective peut mener à des changements dans les traits d'histoire de vie.
- La sélection directionnelle favorise les poissons de petite taille, avec une espérance de vie plus courte.

Exemple: le stock de morue de l'Atlantique Nord



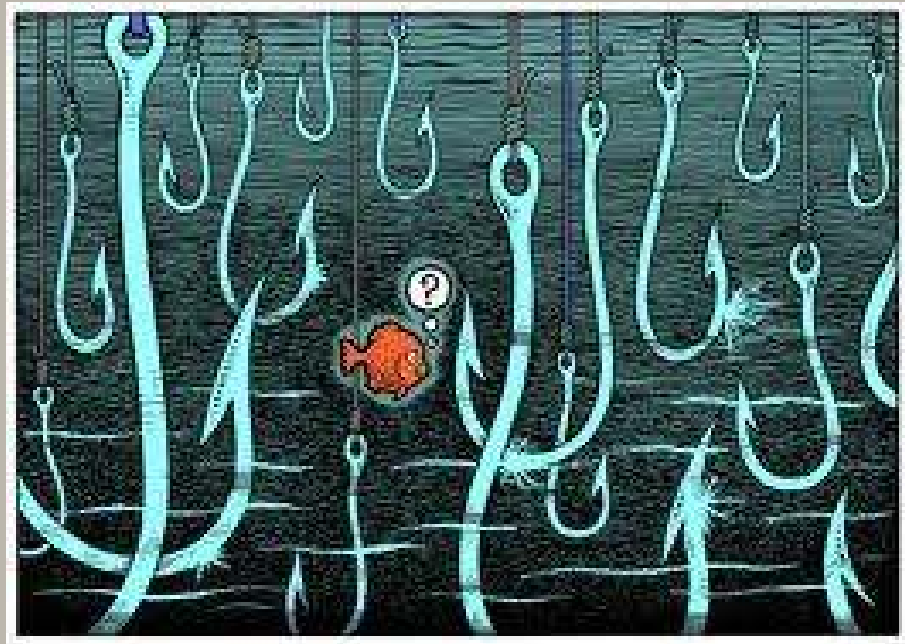
Hutchings et. al. 2005

# Divergence écologique causée par la pêche

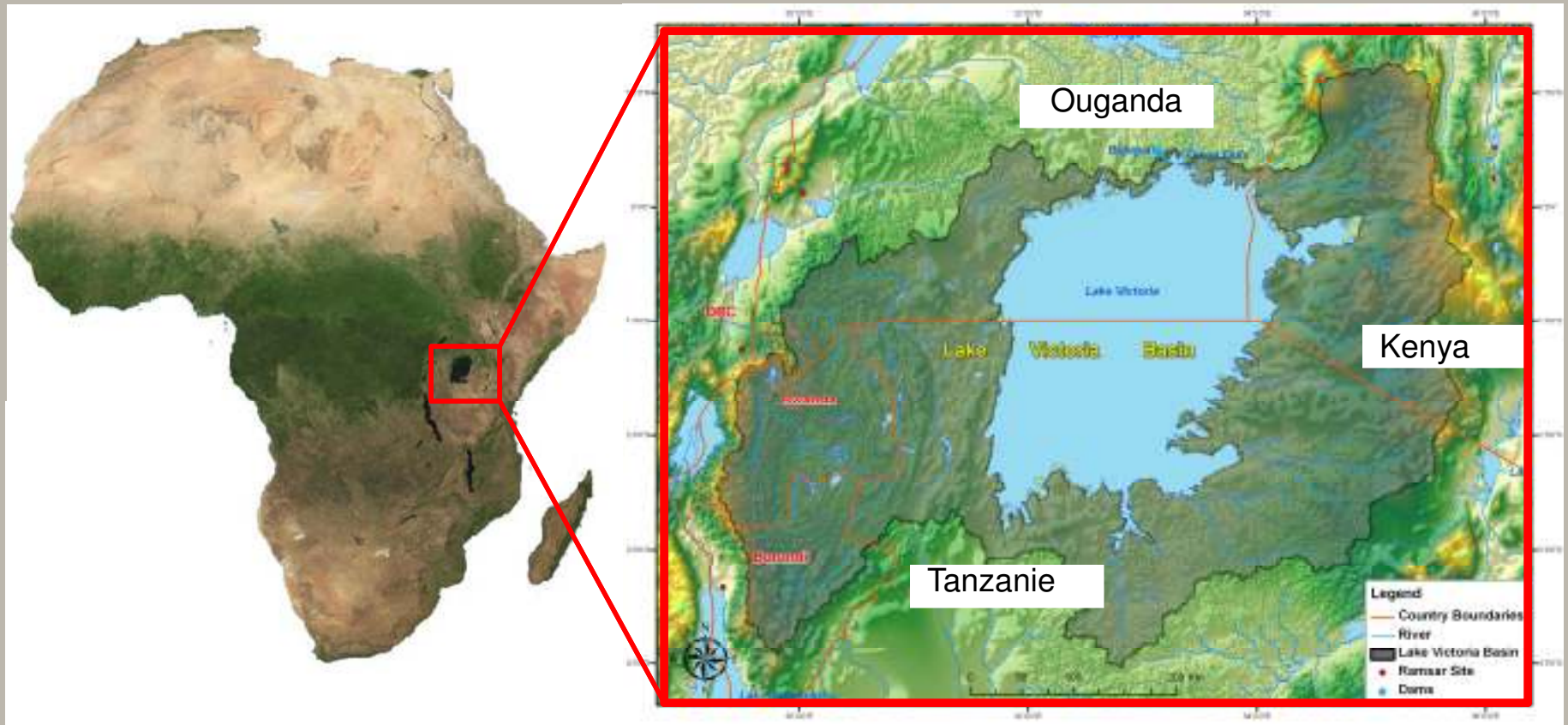
-Mortalité causée par la pêche peut affecter les interactions entre les poissons et leur environnement.

-mouvement

-utilisation de  
l'habitat



# Systeme de l'étude: Bassin du Lac Victoria, Afrique de l'Est



- La plus importante source de production des pêcheries à l'intérieur de l'Afrique

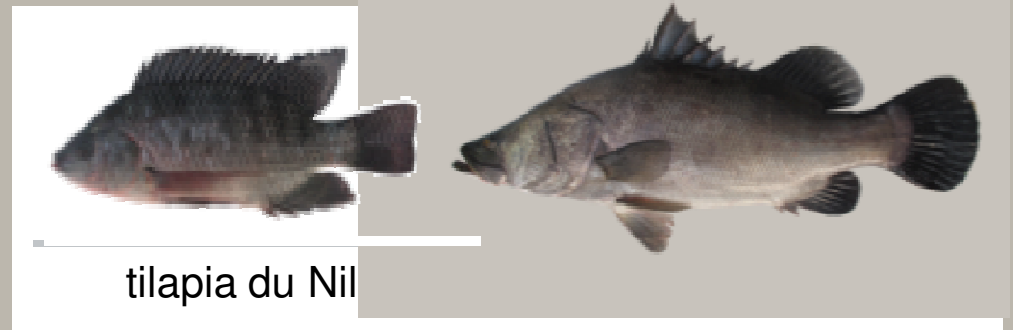
# Thématique de recherche

- **divergence écologique** dans le stock d'un poisson **exotique et prédateur** qui a connu une **pression intense de pêche sélective de taille.**



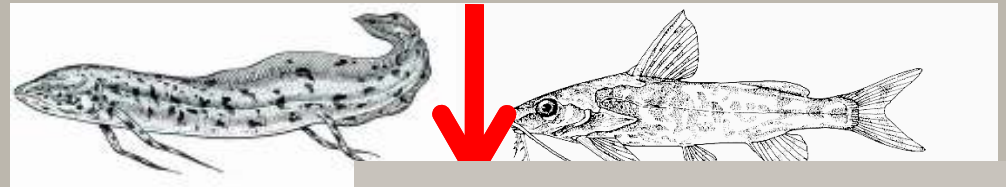
# Antécédents

- Épuisement des stocks de poissons indigènes
- Poissons comestibles introduits(1950s)
- Forte croissance de population de la PN (1980s)
- Pêcherie importante destinée à l'export (1990s)
- Baisse de la PN (aujourd'hui)



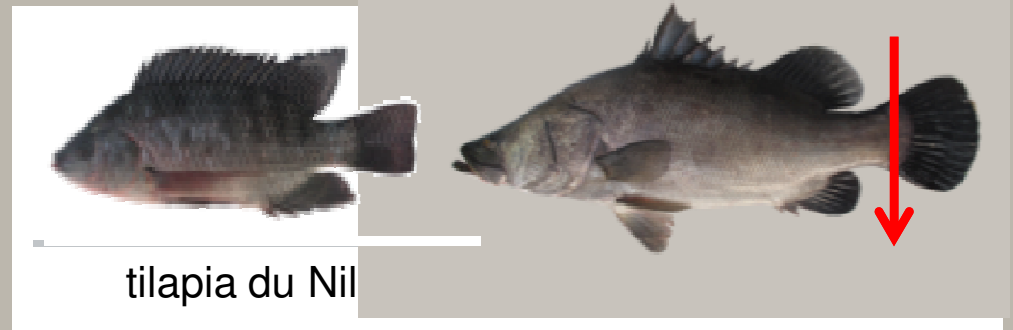
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# Antécédents

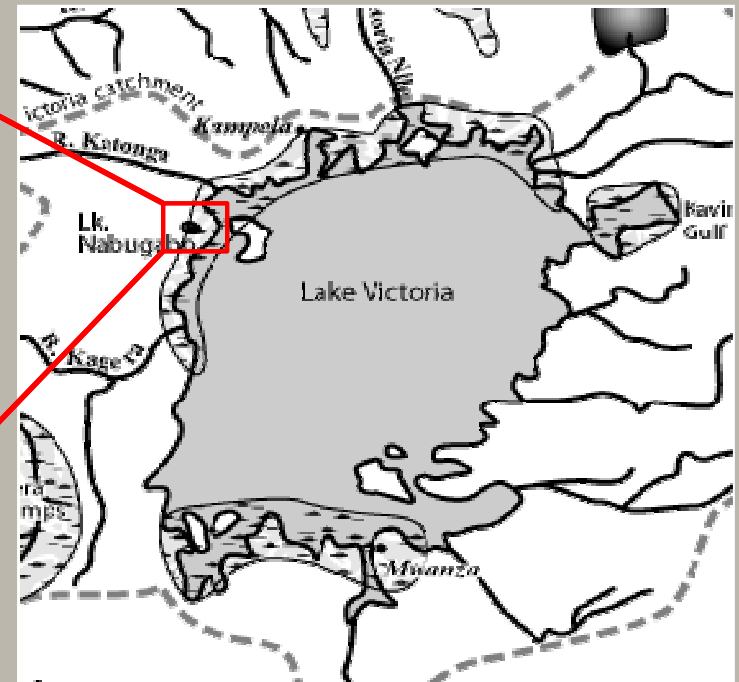
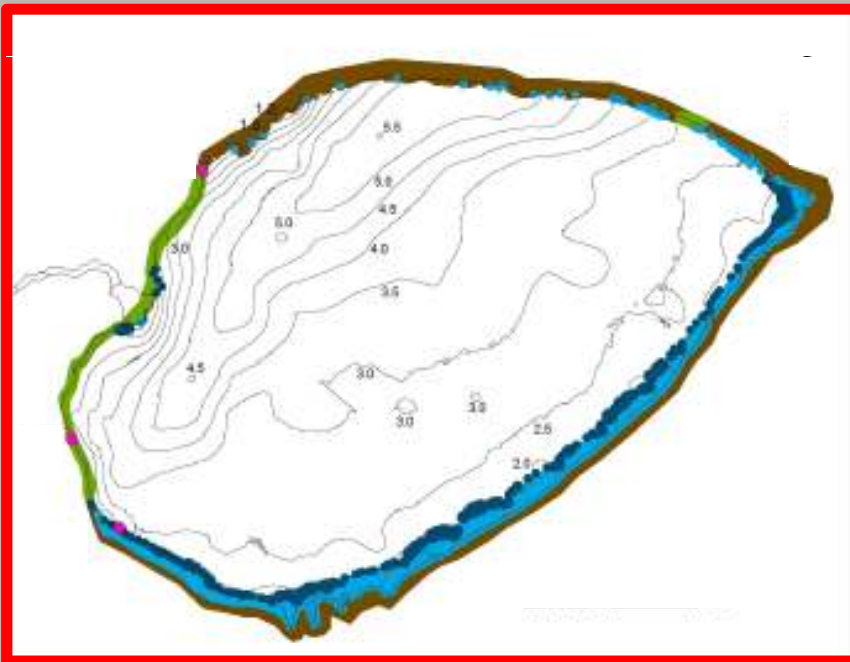
- Essentiel de développer des stratégies pour la gestion des pêcheries
- La pêche affecte les interactions écologiques de la perche du Nil
- Unités de gestion des plages/ Beach Management Units



# Lieu d'études: Lac Nabugabo, Ouganda

-Satellite du lac Victoria

- Tendances similaires dans la fluctuation des espèces et les changements écologiques



# Objectif de l'étude

Améliorer notre connaissance des interactions écologiques de la perche du Nil dans ses environnements.

- Taille du domaine vital
- Schémas de mouvement
- Utilisations de l'habitat



# Aperçu

- Divergence écologique dans la perche du Nil
- Facteurs affectant la divergence
  - domaine vital et mouvement
  - utilisation de l'habitat
- Implications pour la gestion
- Unités de gestion des plages / Beach Management Units



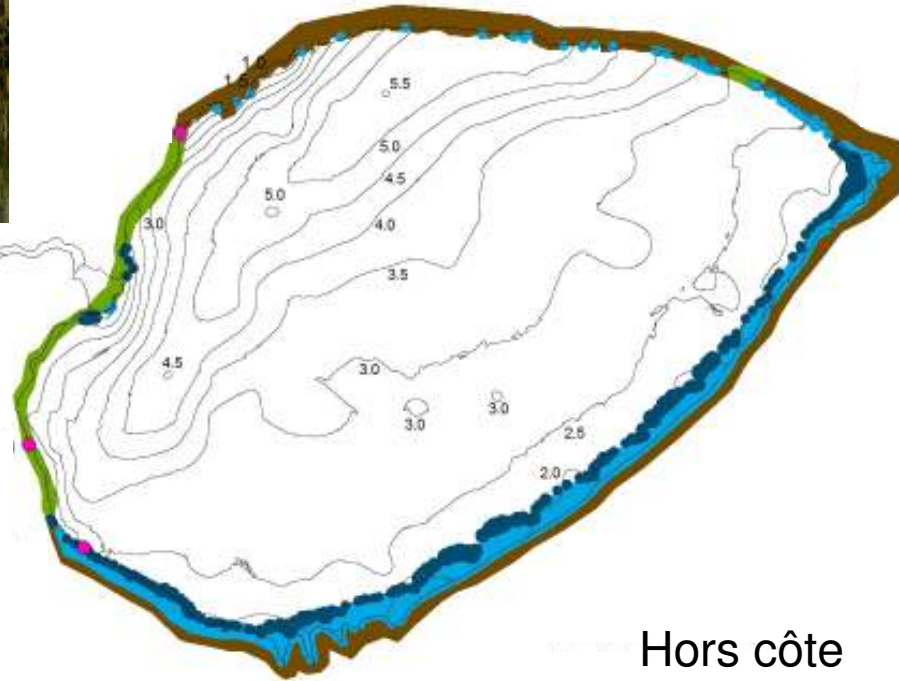
# Plan écologique



Miscanthidium



Herbe d'hippo



Bord de forêt



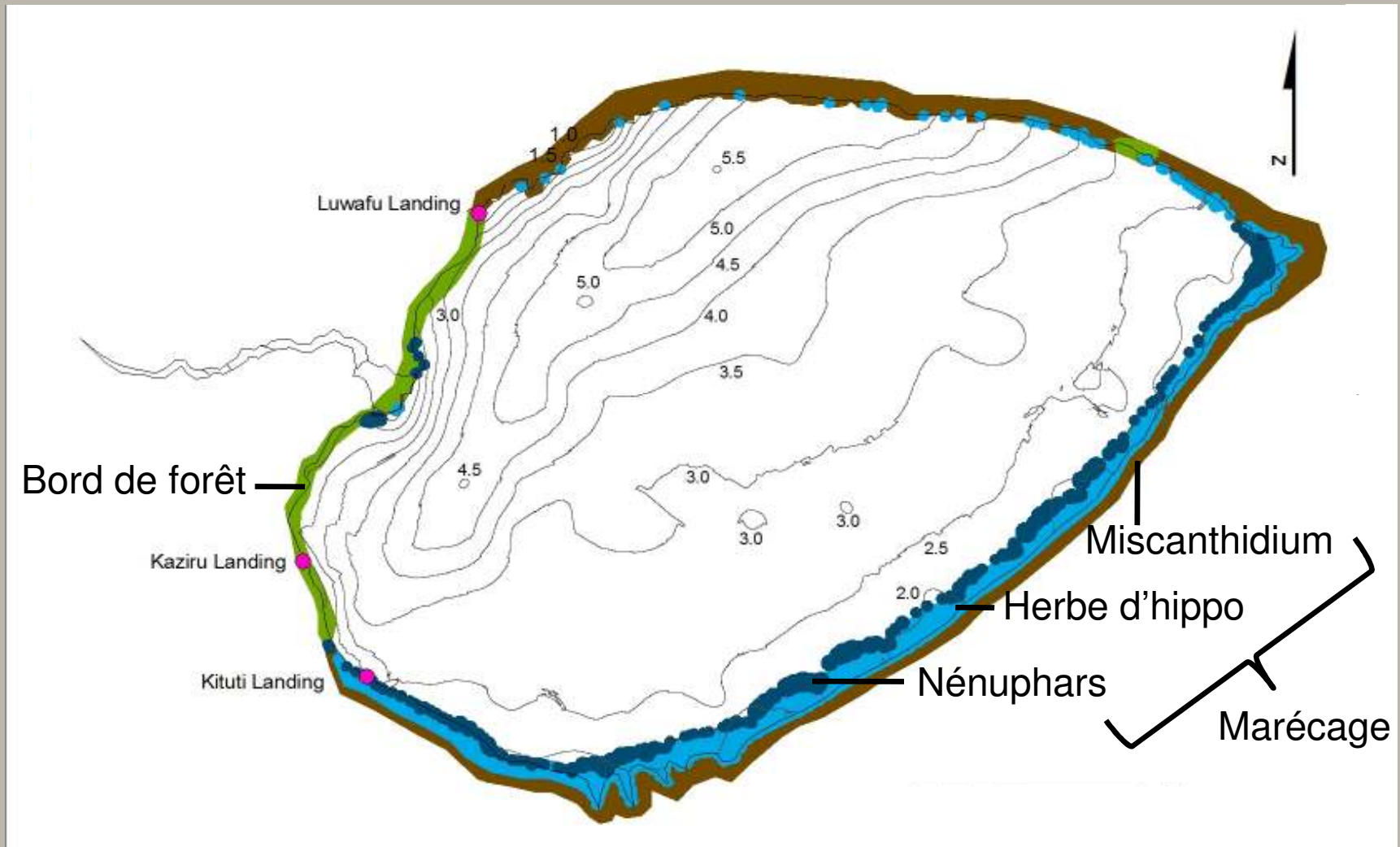
Hors côte



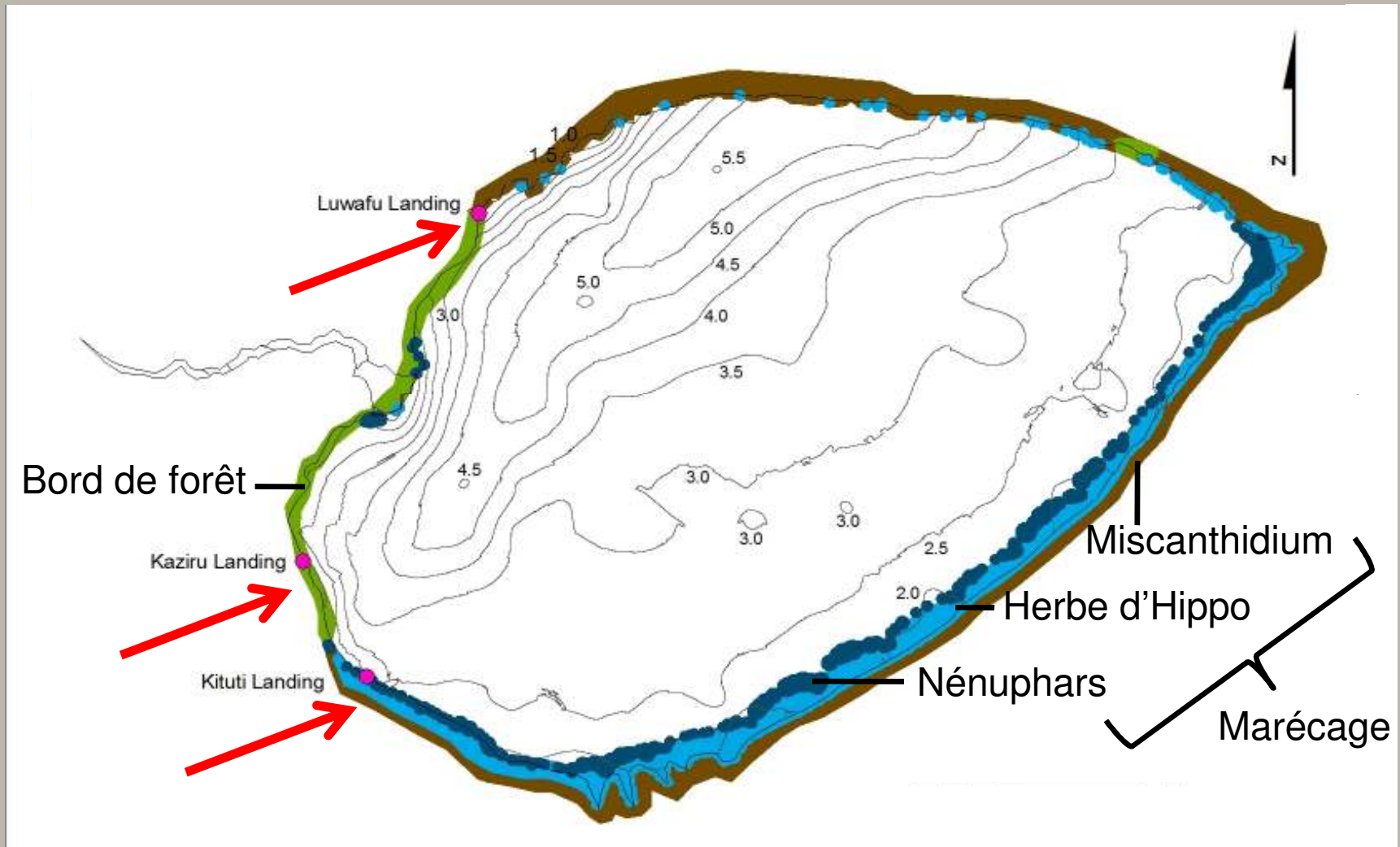
Nénuphars



# Plan écologique



# Plan écologique



# Divergence écologique: distribution, taille, morphologie, alimentation

## Distribution

- Proportionnellement plus de PN dans le marécage

Chapman et al. 2008

## Taille

- Baisse générale (surtout en bord de forêt)

Paterson and Chapman 2009

## Morphologie

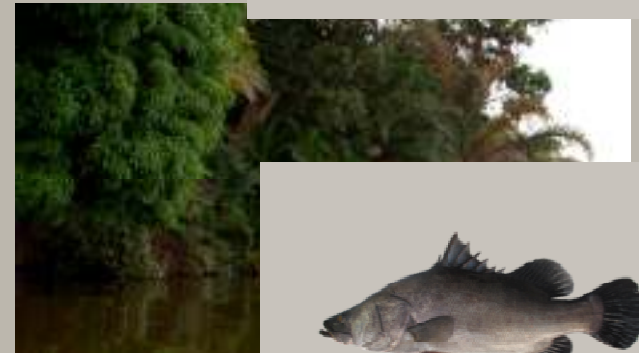
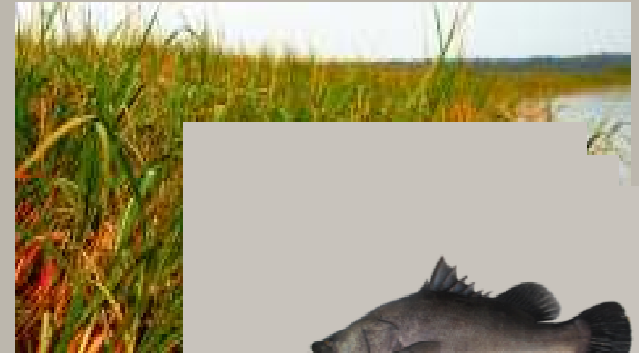
- Branchies plus larges dans le marécage

Paterson and Chapman 2010

## Alimentation

- Divergente selon les habitats

Chapman Lab long term monitoring



# Divergence écologique: distribution, taille, morphologie, alimentation

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- Proportionnellement plus de PN dans le marécage

Chapman et al. 2008

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- Baisse générale (surtout en bord de forêt)

Paterson and Chapman 2009

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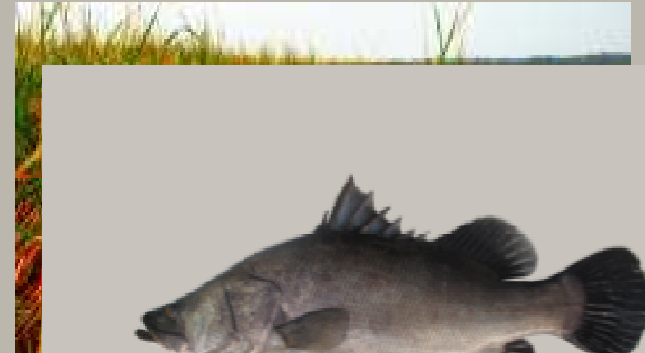
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Paterson and Chapman 2010

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- Divergente selon les habitats

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# Divergence écologique: **distribution, taille, morphologie, alimentation**

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Paterson and Chapman 2009



## Morphologie

- Branchies plus larges dans le marécage

Paterson and Chapman 2010

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Chapman et al. 2008

## Taille

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Paterson and Chapman 2009

## Morphologie

- Branchies plus larges dans le marécage

Paterson and Chapman 2010

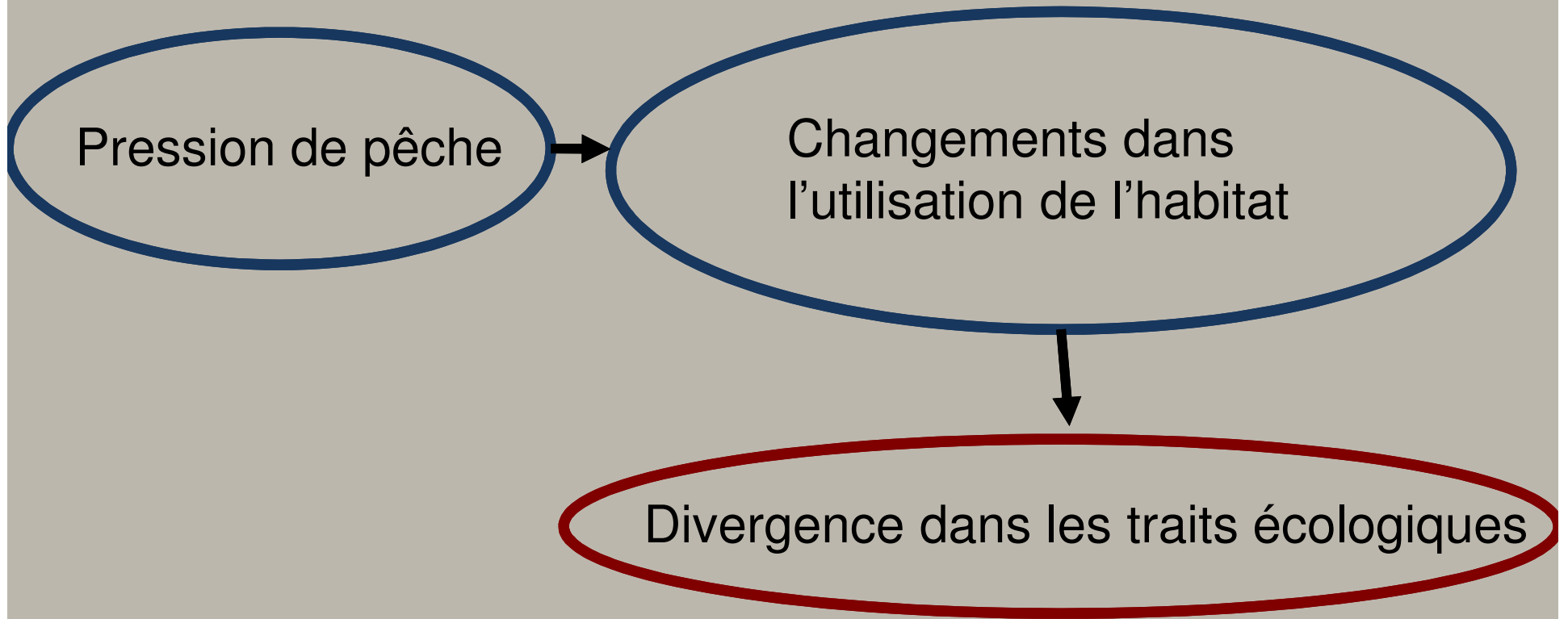
## Alimentation

- Divergente selon les habitats

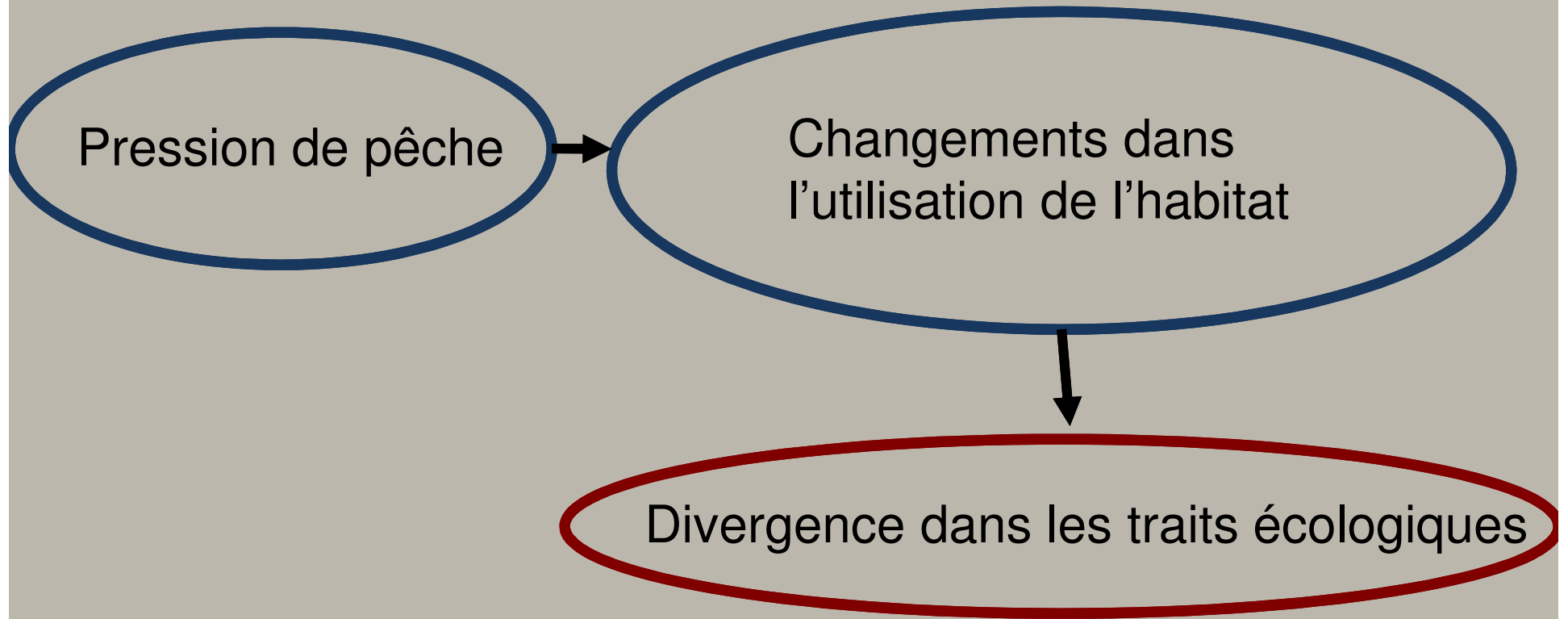
Chapman Lab long term monitoring



# Pêche et changements écologiques dans la perche du Nil



# Pêche et changements écologiques dans la perche du Nil

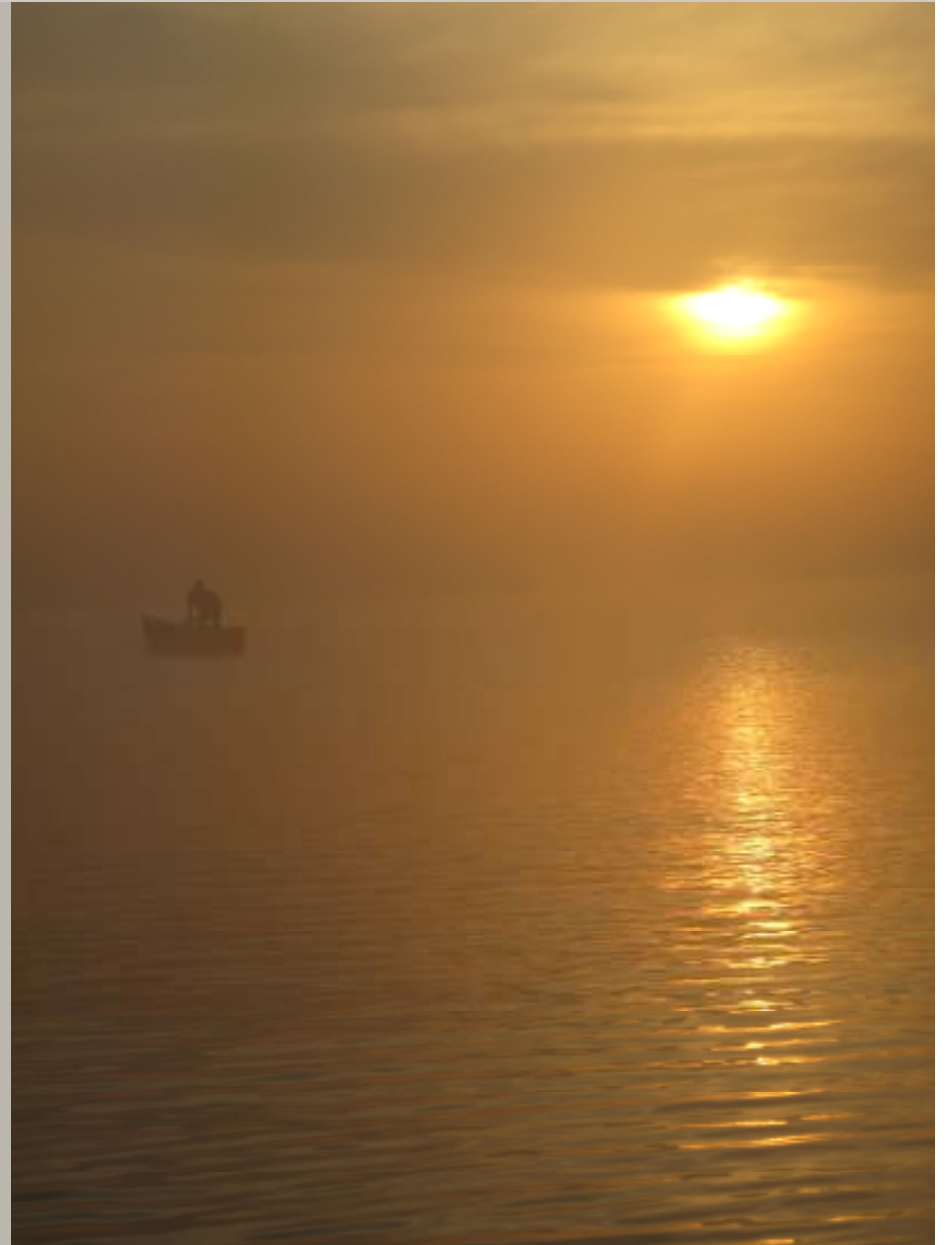


Est-ce que la variation est transitoire, ontogénétique ou représente-elle des phénotypes distincts au sein de la population?

# Facteurs affectant la divergence

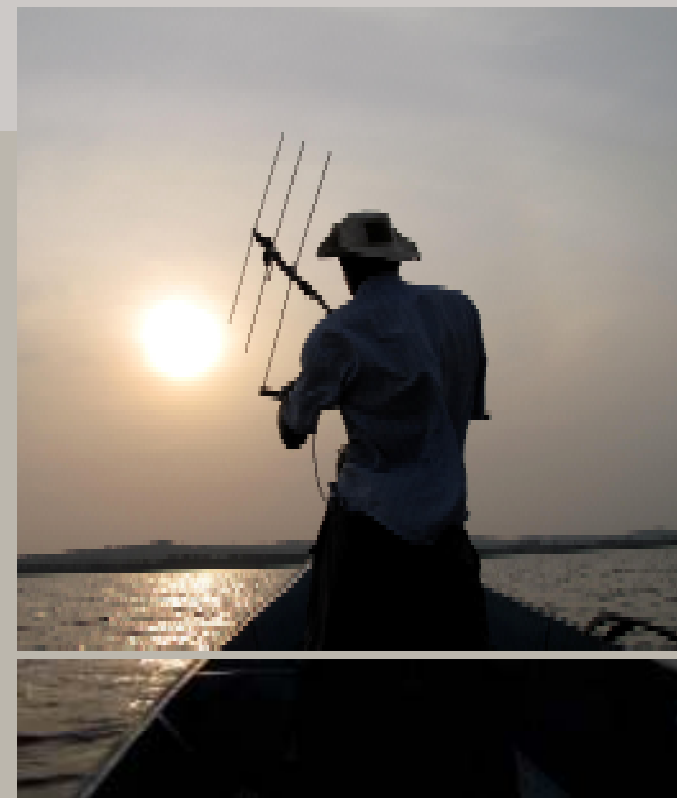
-domaine vital

-mouvement

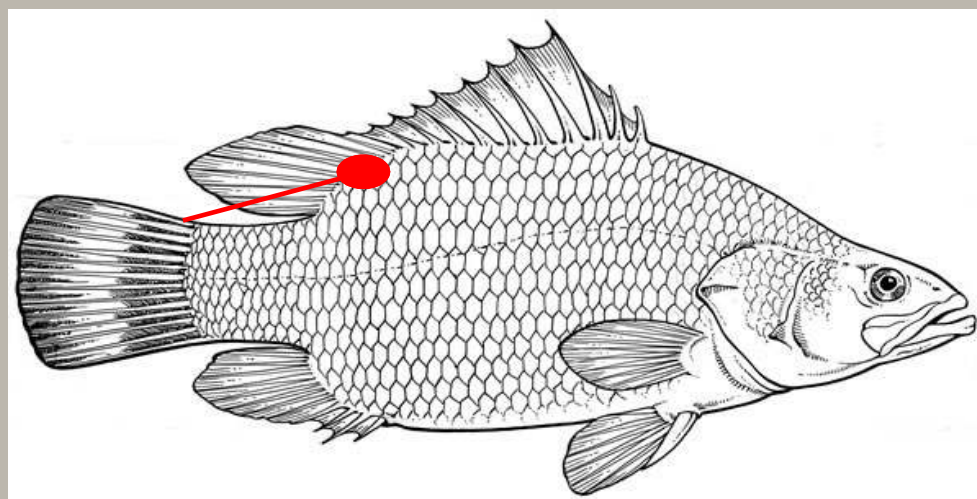
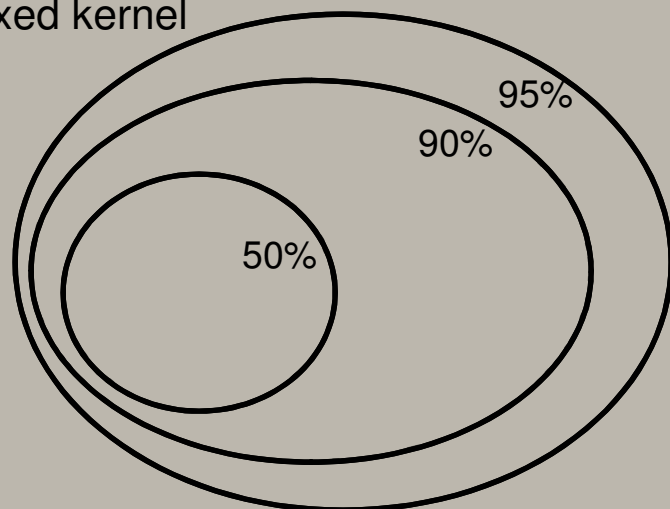


# Méthodes

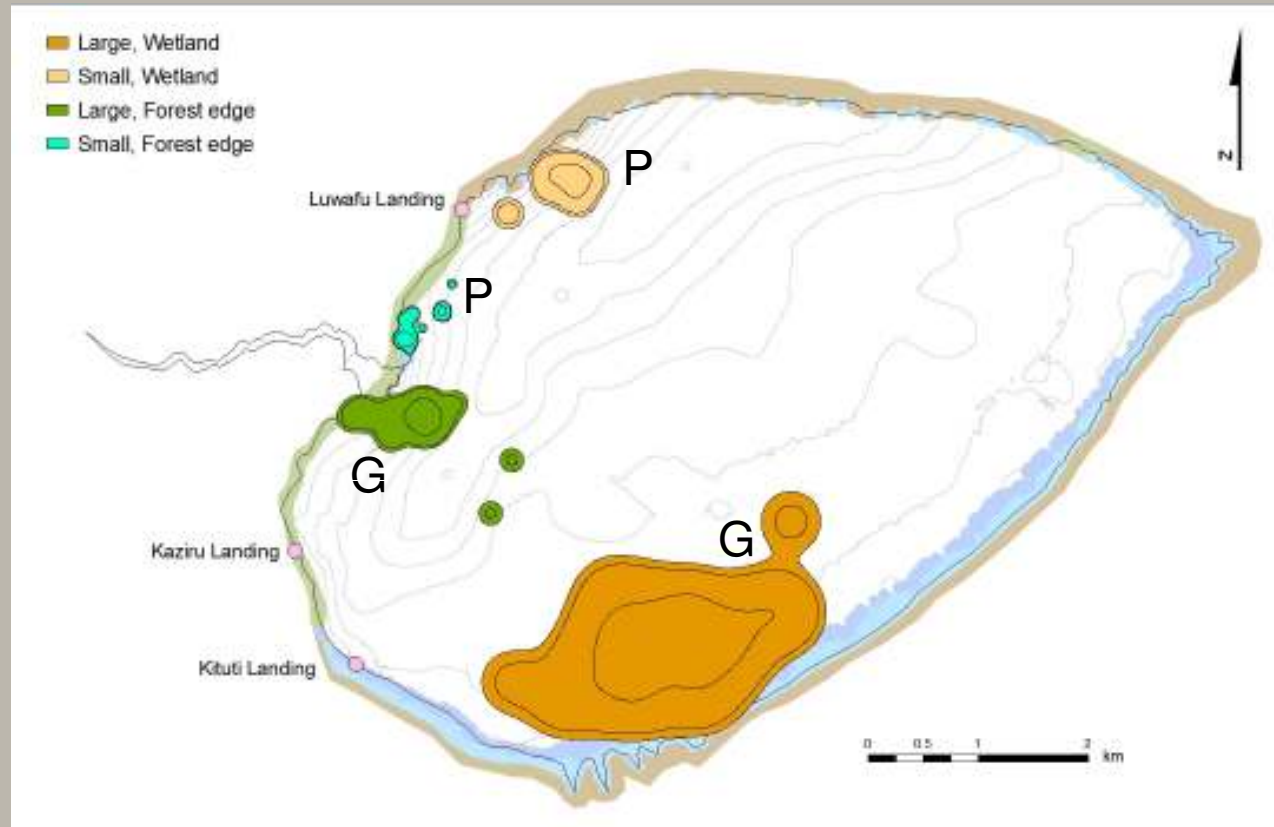
- Quantifier la taille du domaine vital et les mouvements de la perche du Nil
- radiotélémétrie (poursuite active)
- domaine vital estimé par le noyau fixe (ArcGIS)



fixed kernel



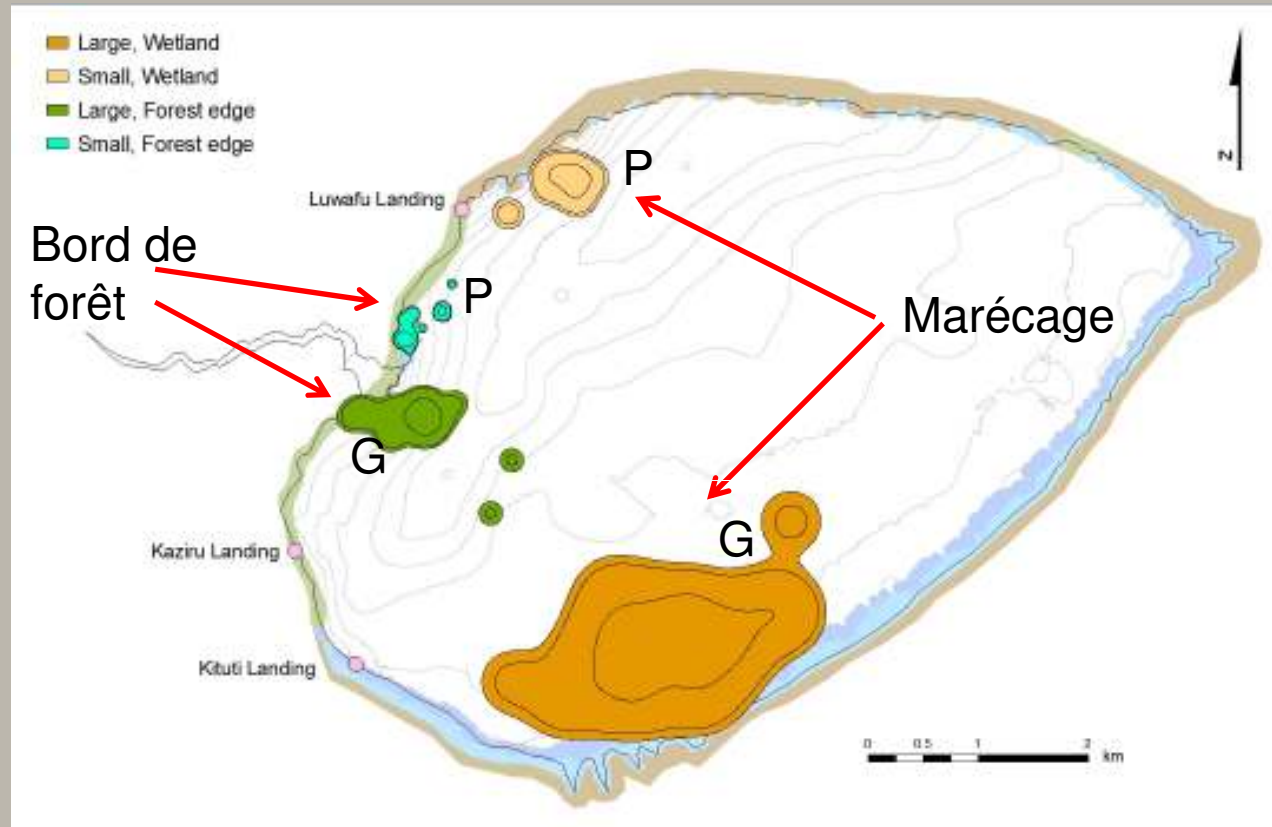
# Facteurs affectant la divergence: **Domaine vital**



Surface du DV en moyenne =  $1.48\text{km}^2$

Distance/h en moyenne =  $18\text{m/h}$  ( $400\text{m/jour}$ )

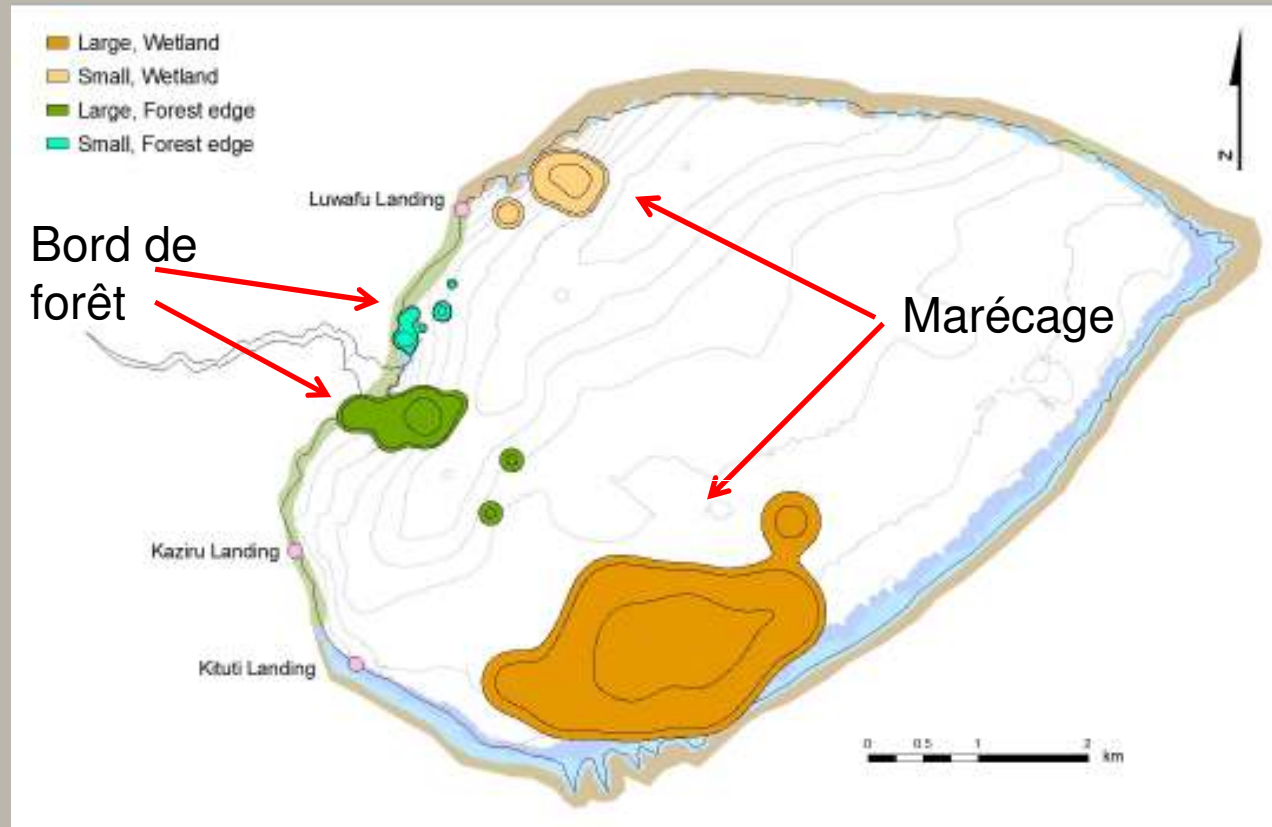
# Facteurs affectant la divergence: **Domaine vital**



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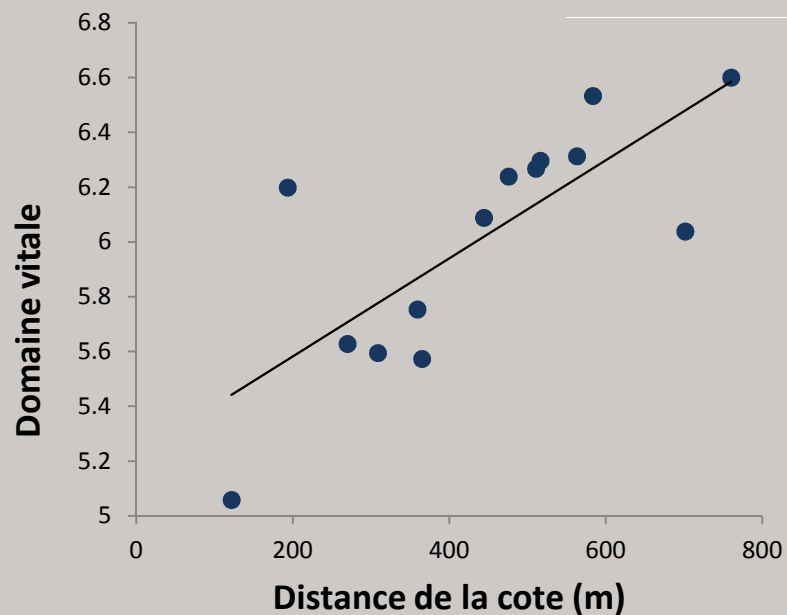
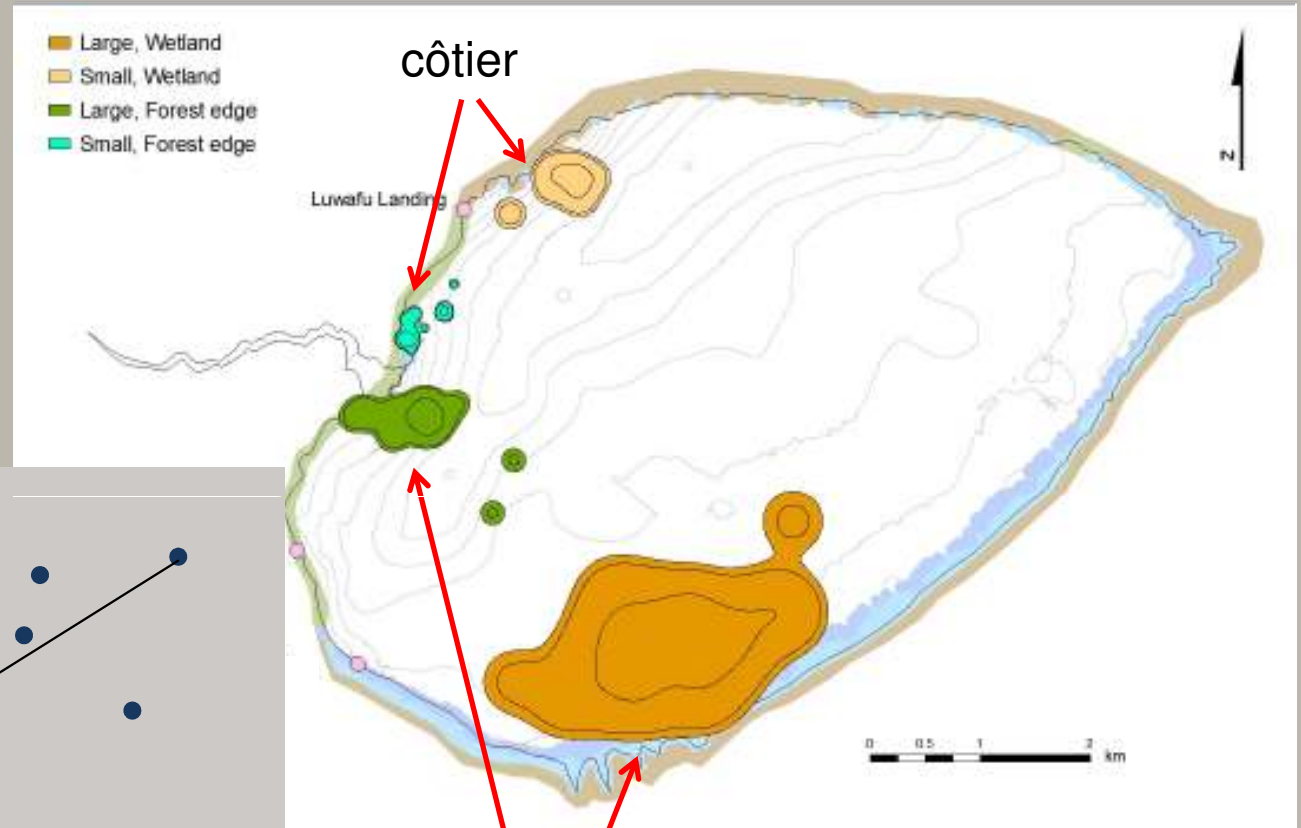
# Domaine vital: plus large dans le marécage



DV du marécage (2.04 km<sup>2</sup>) > DV en bord de forêt (.74km<sup>2</sup>)

(  $t_{(12)} = 2.61$ ,  $p = .02$  )

# Domaine vital: plus large hors côtes



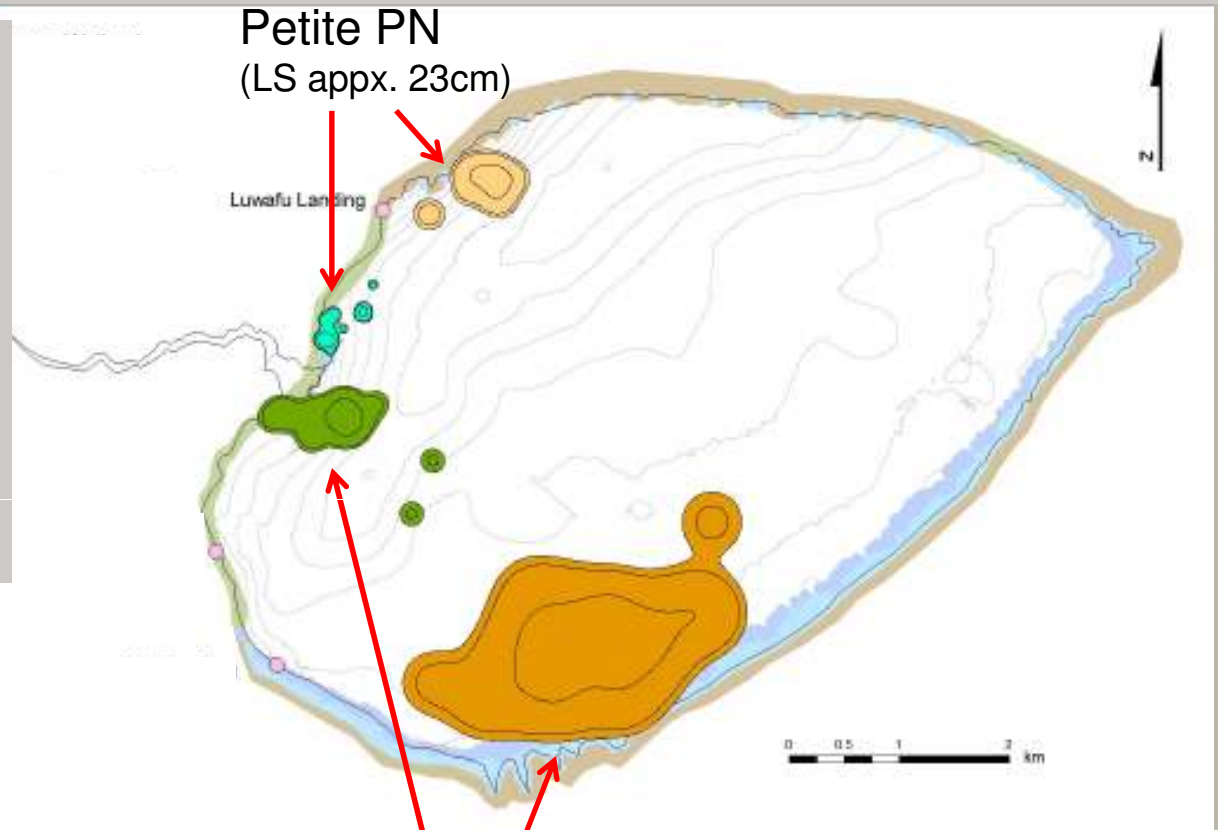
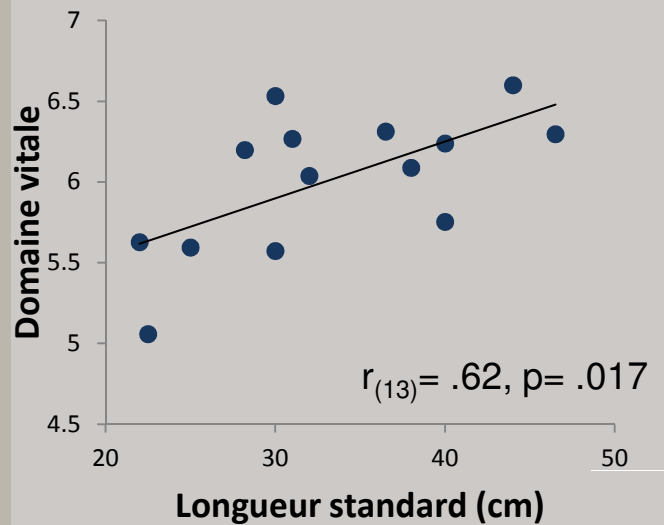
Hors côtes

DV hors côtes > DV côtier

$r_{(13)} = .78, p = .0016$

# Utilisation de l'habitat:

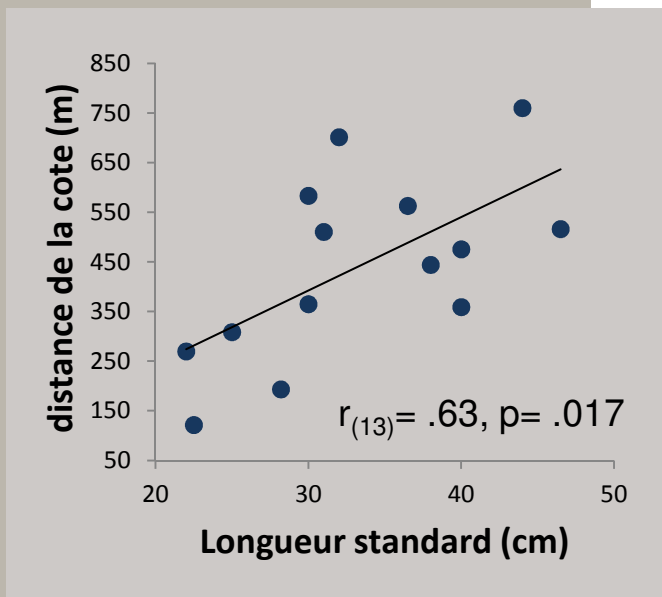
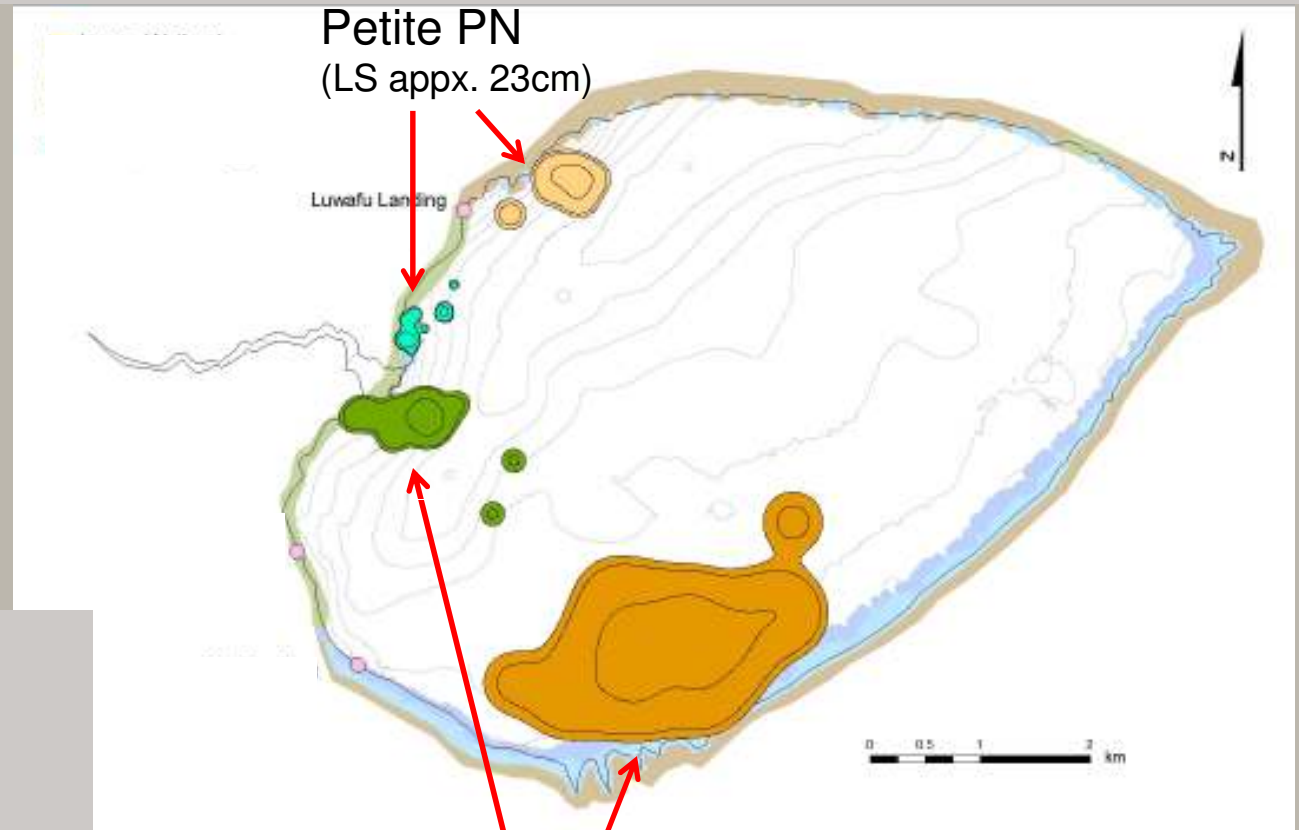
gros poissons ont des domaines vitaux plus grands



Grande PN  
(LS appx. 45cm)

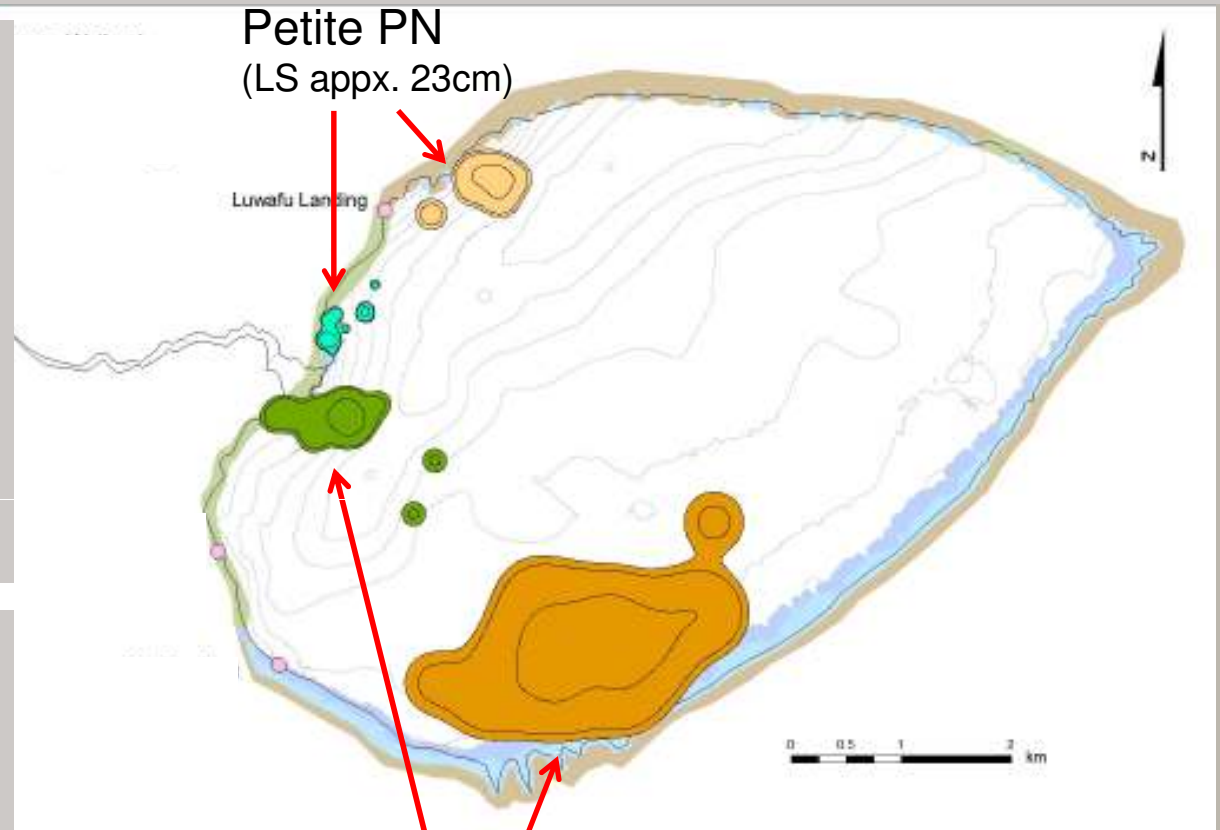
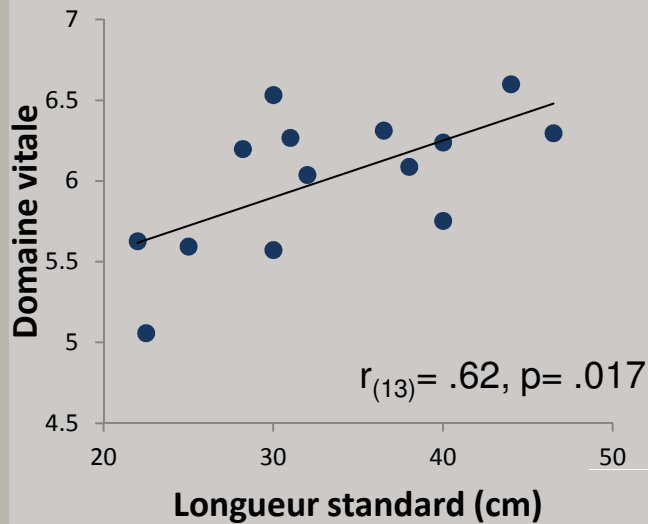
# Utilisation de l'habitat:

gros poissons ont des domaines vitaux hors côtes

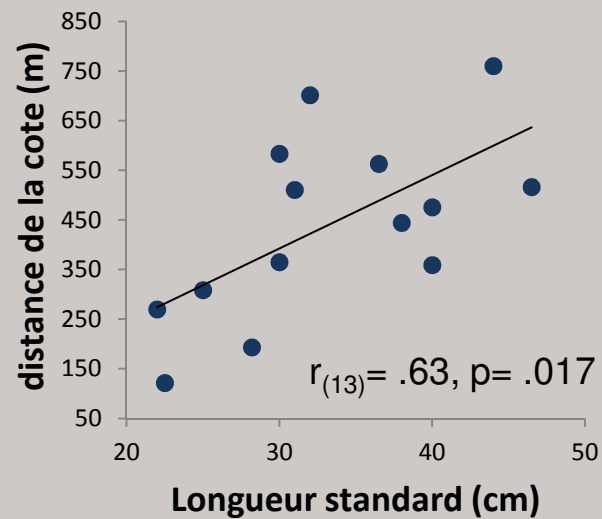


# Utilisation de l'habitat:

gros poissons ont de grands domaines vitaux hors côte



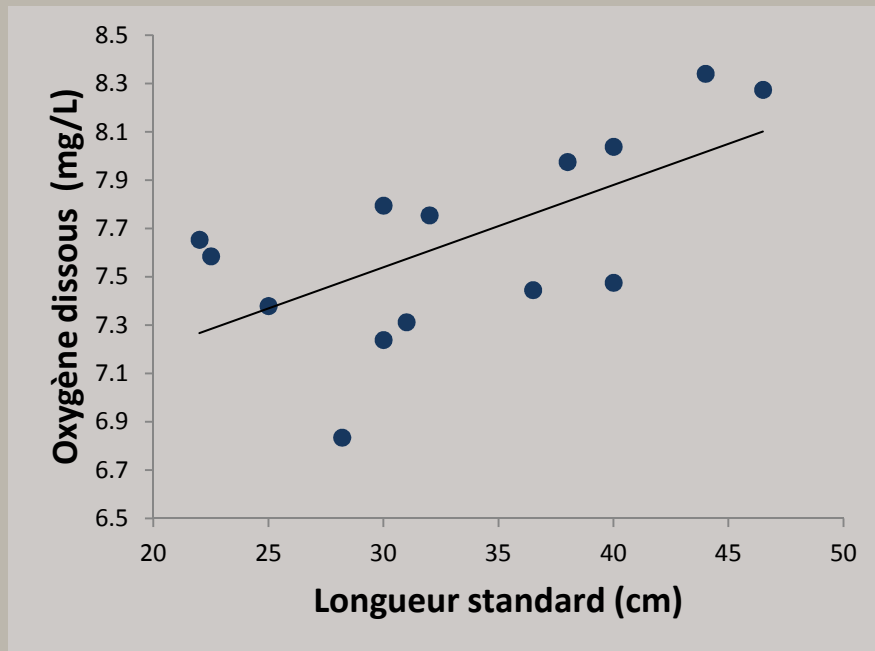
Grande PN  
(LS appx. 45cm)



# Utilisation de l'habitat:

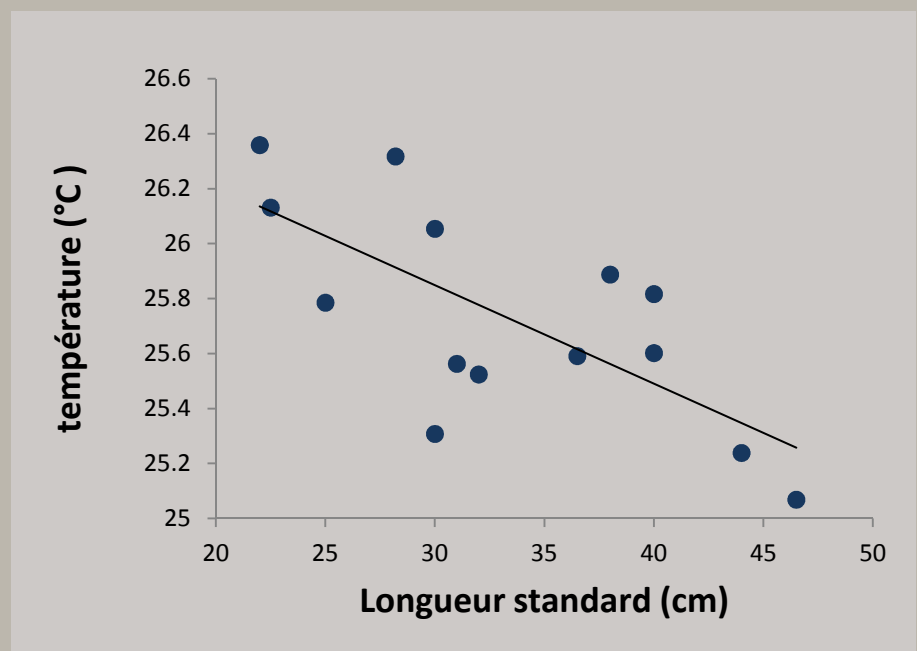
gros poissons sont trouvés dans des eaux plus froides avec O<sub>2</sub> plus élevé

## Oxygène dissous



$$r_{(13)} = .63, p = .015$$

## Température



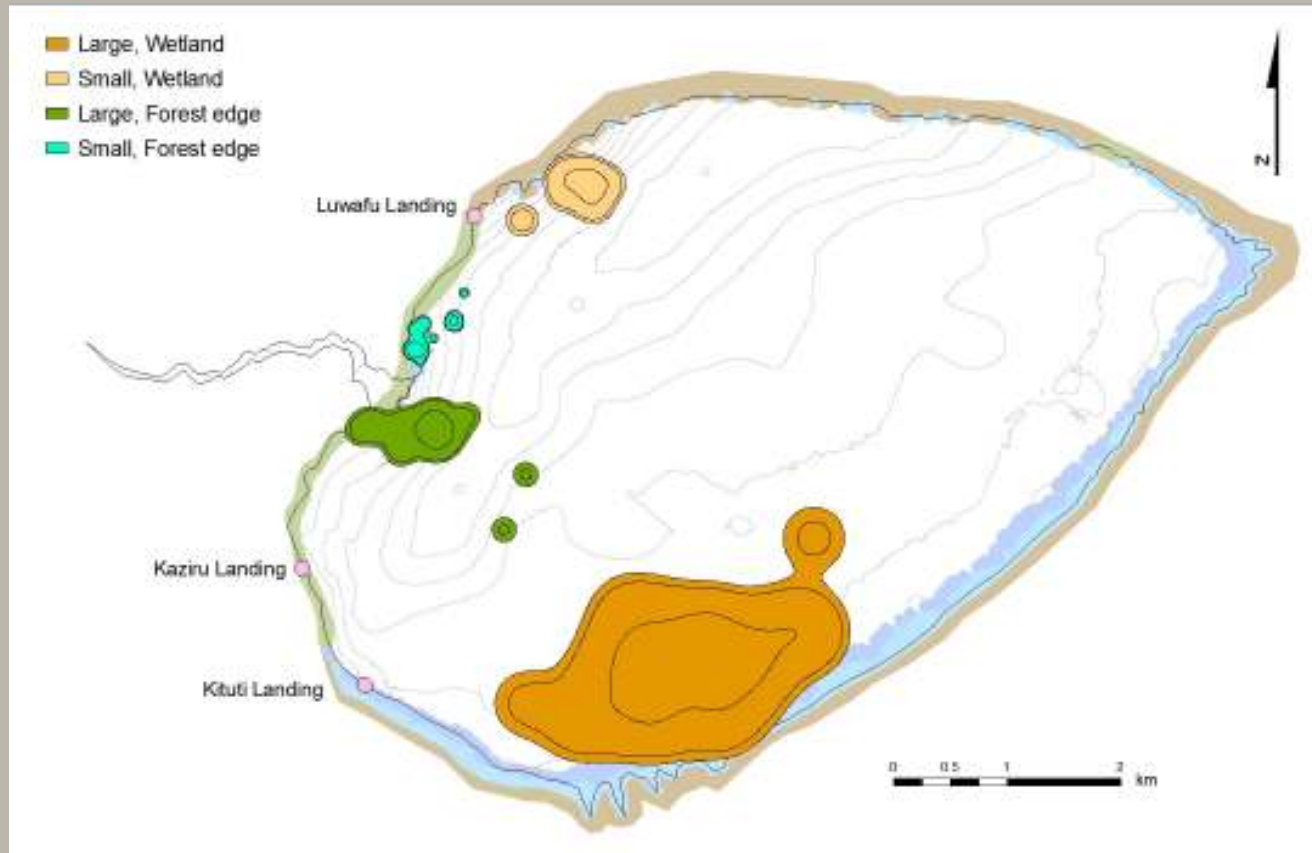
$$r_{(13)} = .71, p = .0048$$

# Utilisation de l'habitat: résumé



- exigences spatiales à travers les habitats et classes de taille

# Utilisation de l'habitat: résumé



-Le mouvement restreint promouvoit la divergence écologique

# Utilisation de l'habitat: résumé



- Le mouvement restreint promouvoit la divergence écologique

# Implications pour la gestion



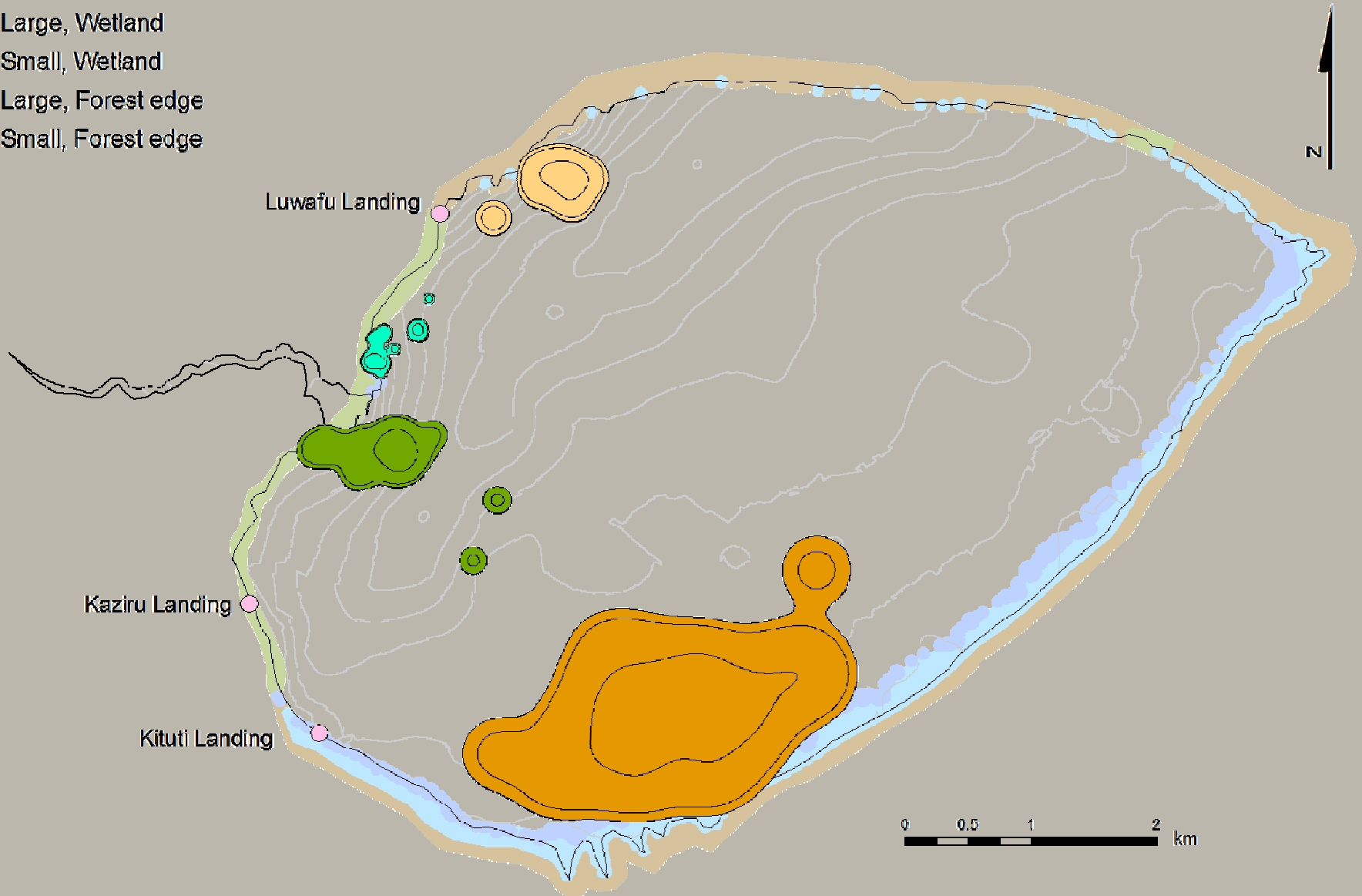
# Implications pour la gestion



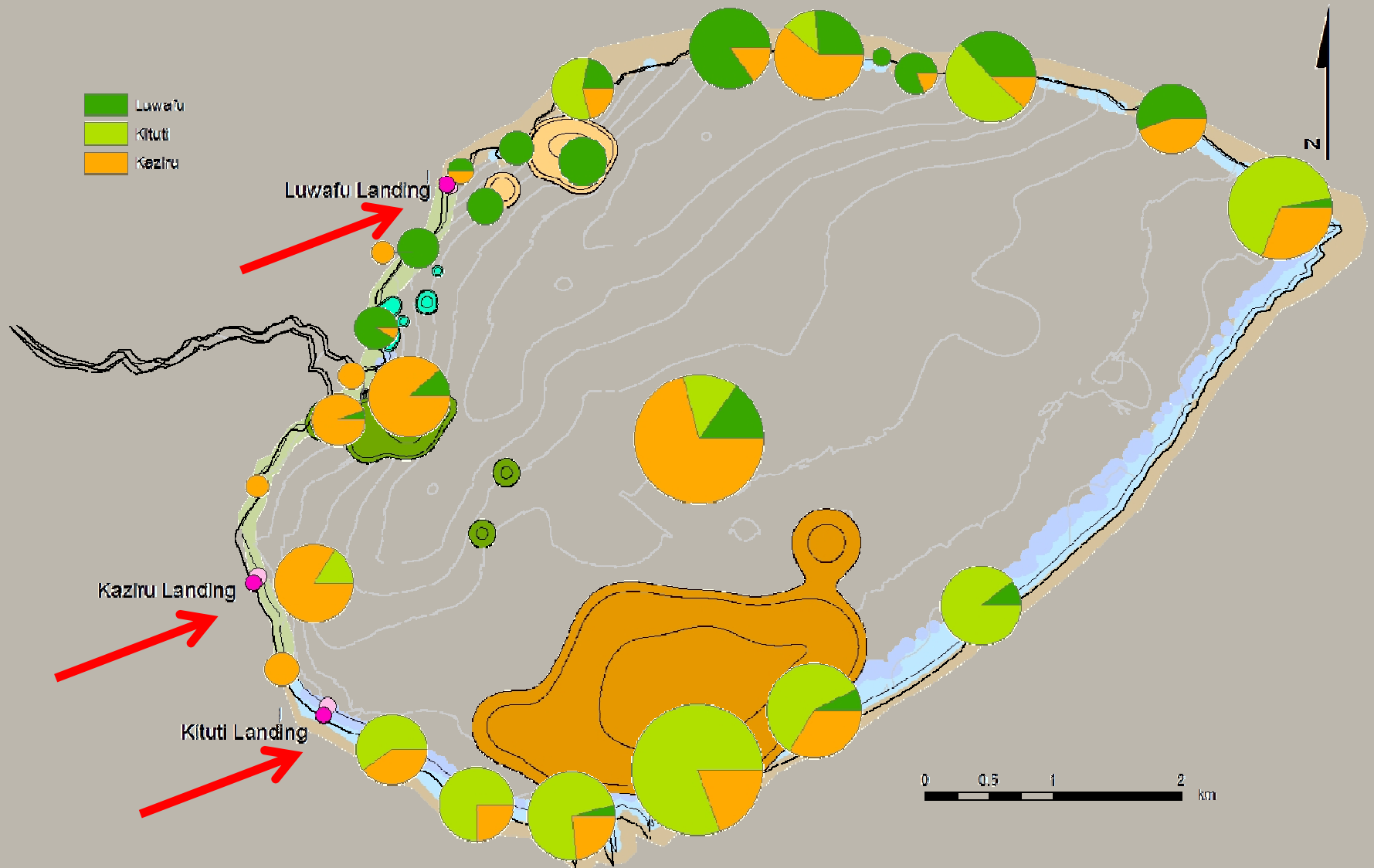
Unités de gestion des plages / Beach Management Units (BMU's)

# Implications pour la gestion

- Large, Wetland
- Small, Wetland
- Large, Forest edge
- Small, Forest edge



# Implications pour la gestion



# Remarques finales



# Remerciements

Superviseur

Dr. Lauren Chapman

Collègues et Assistants

Laboratoire Chapman

Équipe de recherche de Nabugabo

Les pêcheurs de Nabugabo

Conseil National de la Science et la  
Technologie d'Ouganda

Authorities ougandaises pour la protection  
de la faune et flore

Les agences de Financement



merci



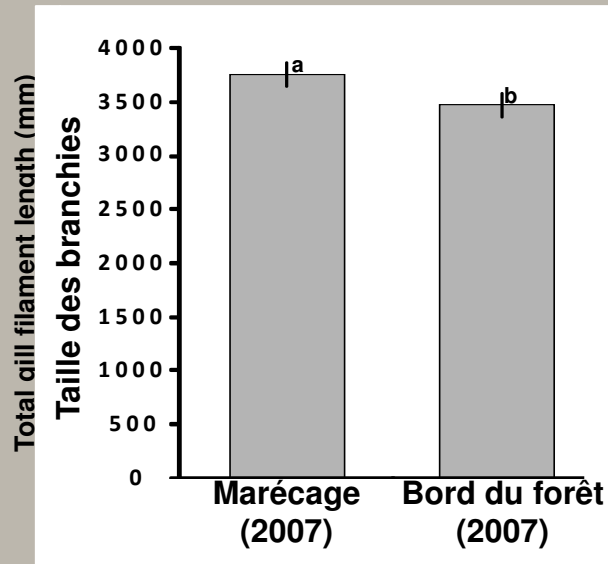
# Divergence écologique: la morphologie

1. Morphes distincts  
- couleurs, morphologie



Marécage  
17cm

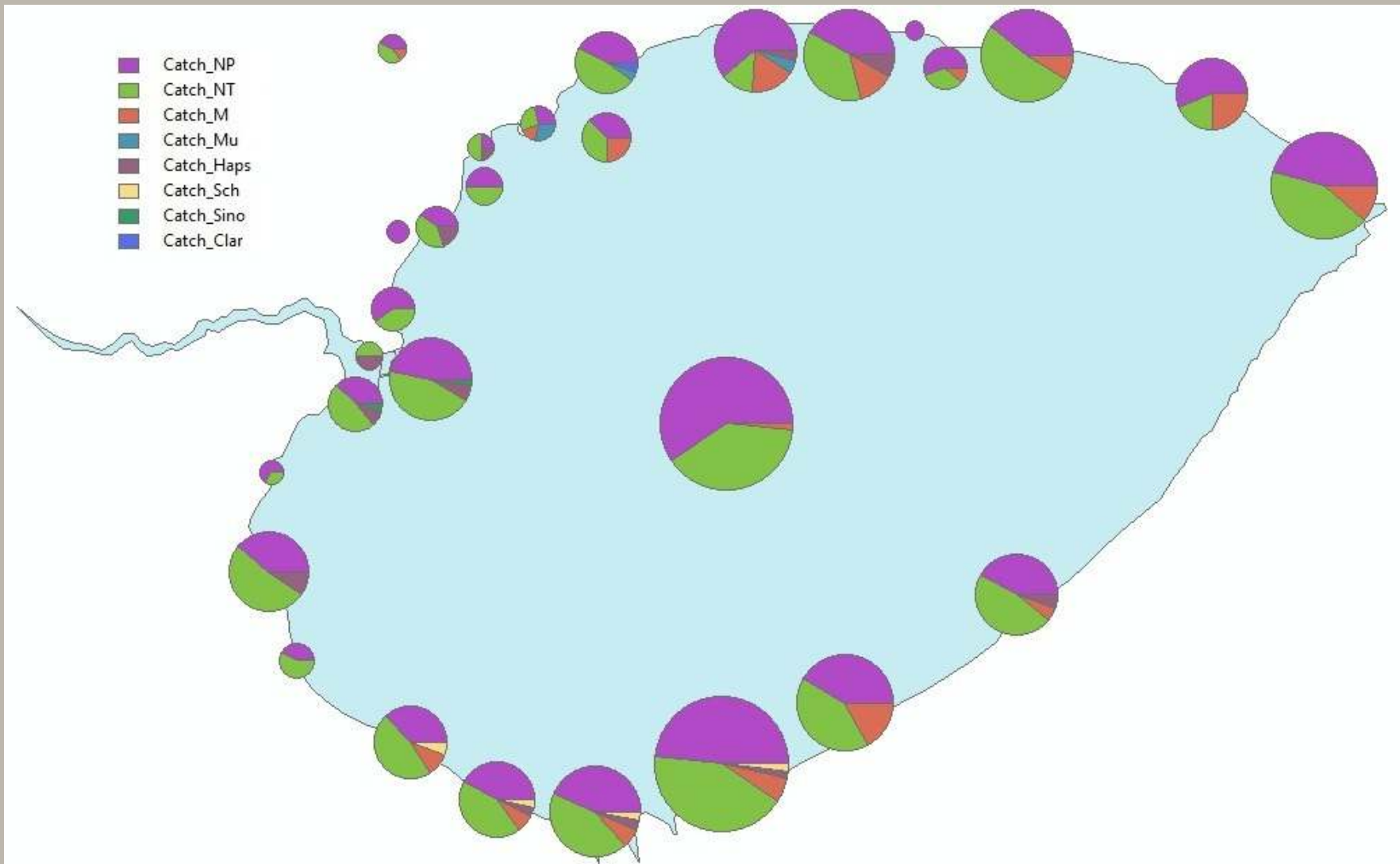
2. Divergences dans la  
taille des branchies



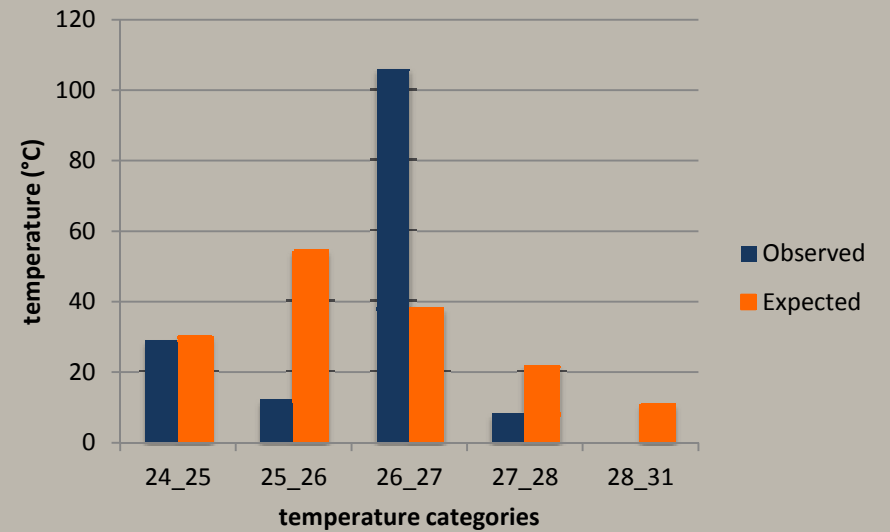
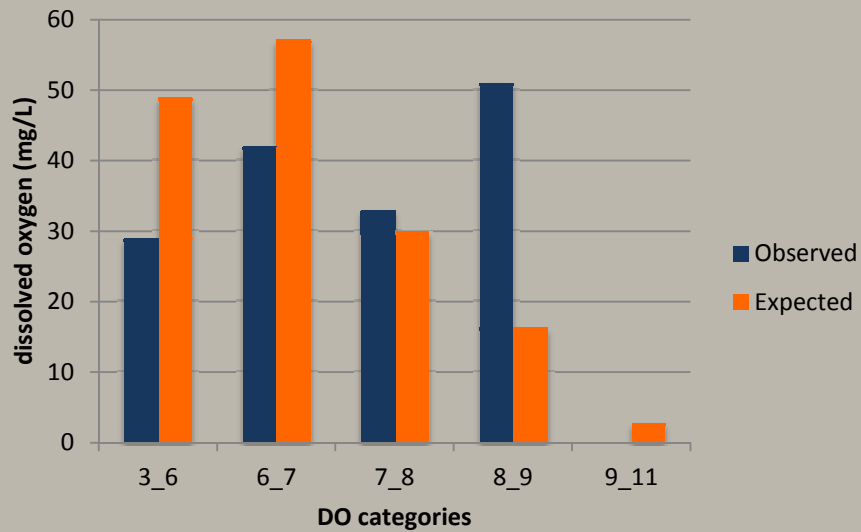
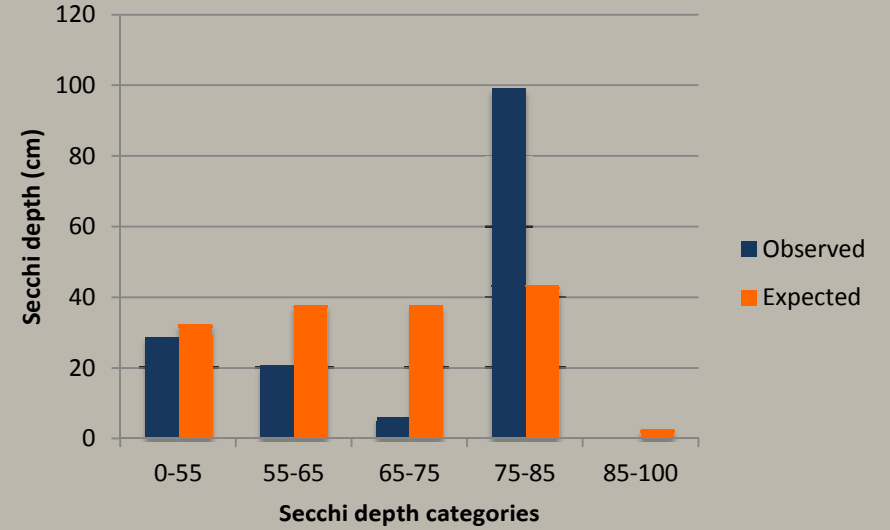
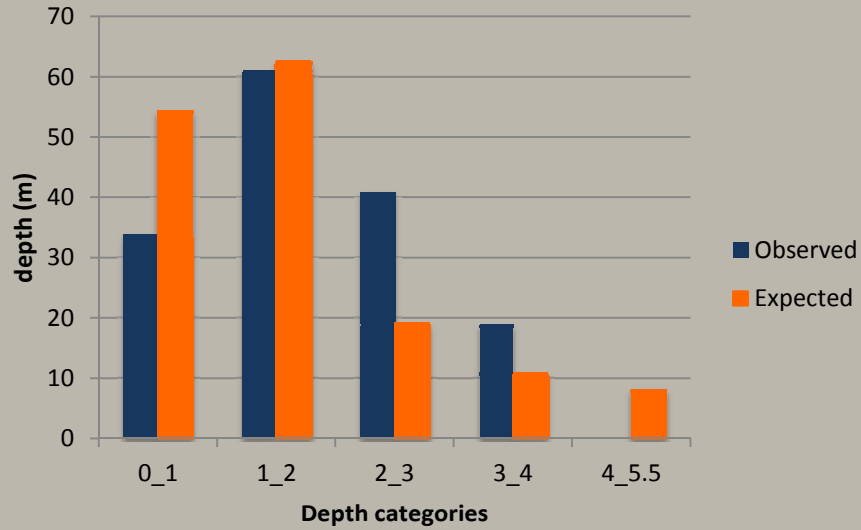
Bord du forêt  
18.5 cm

Paterson & Chapman, 2010

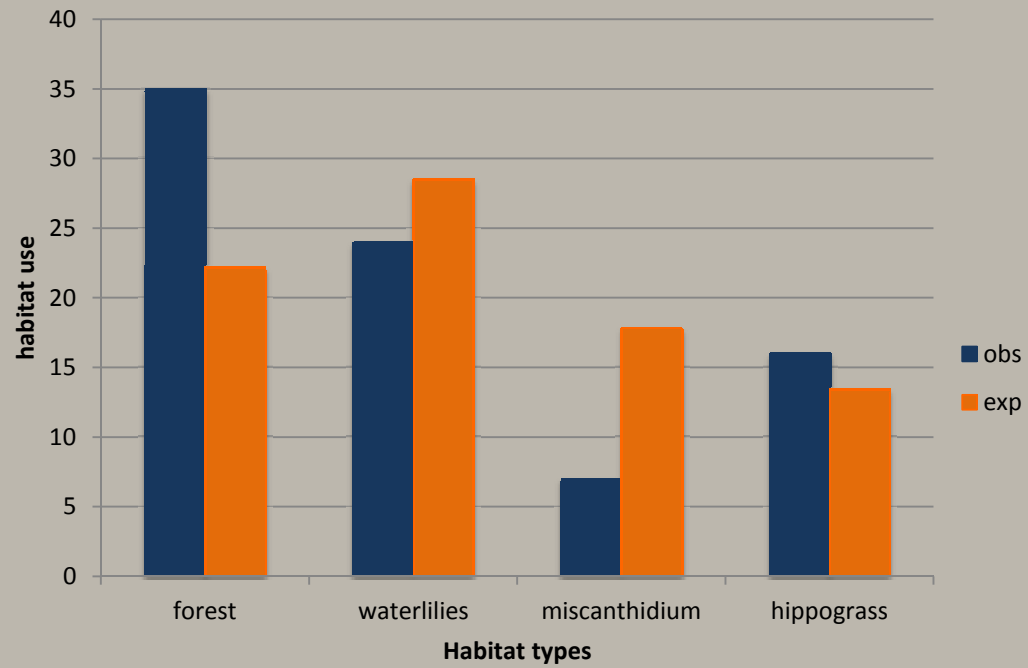
# Fishing effort and target species



# Habitat selection



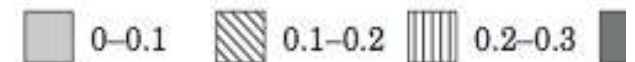
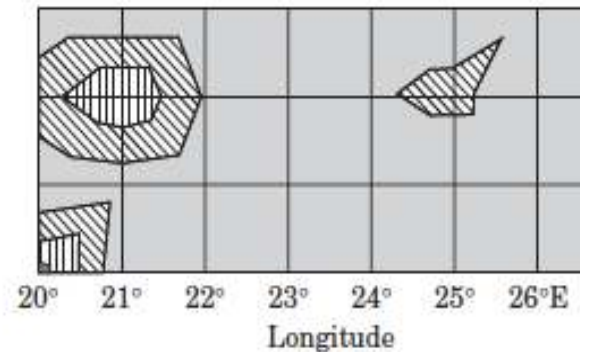
# Habitat selection



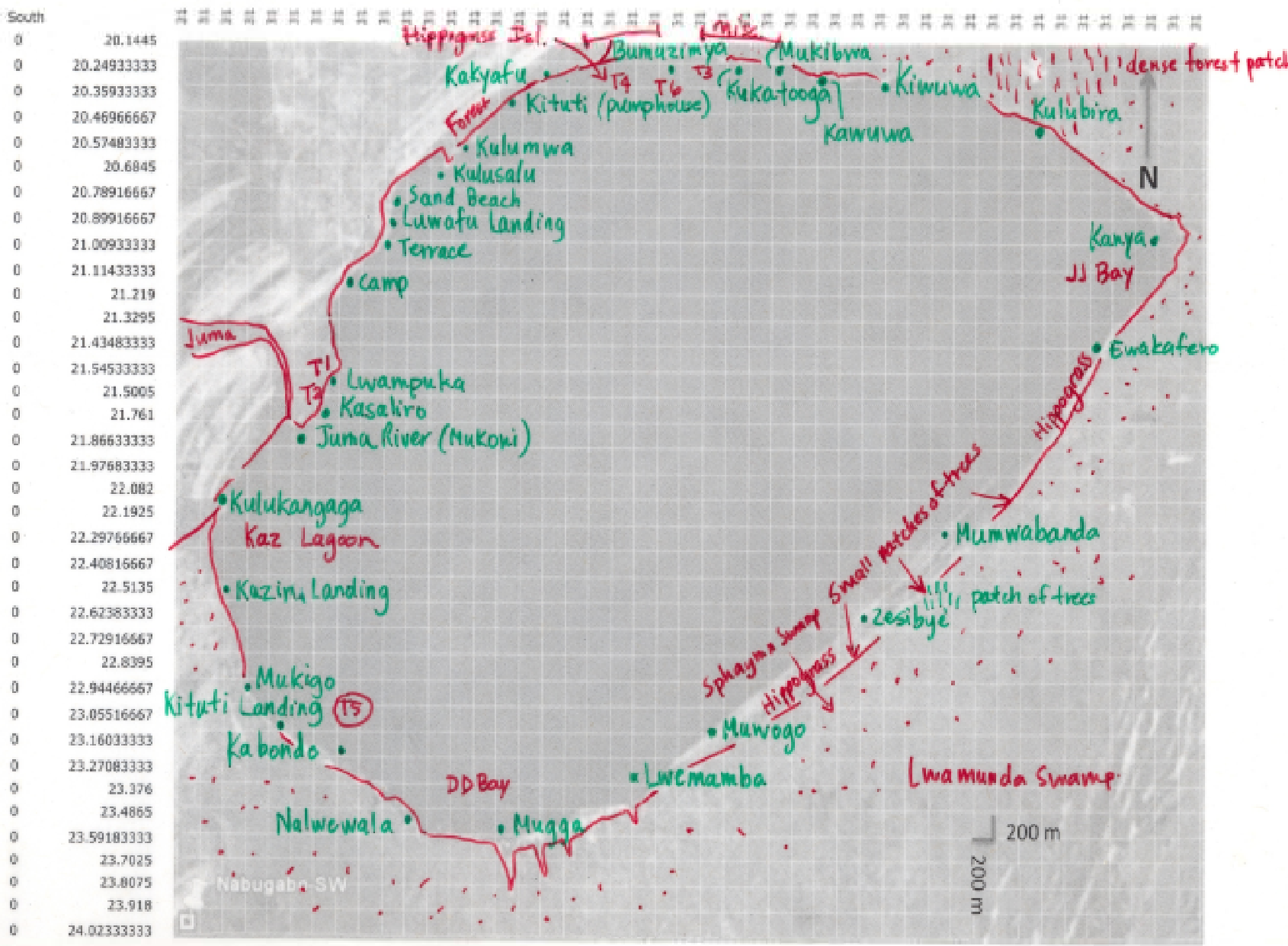
# Fishing induced ecological divergence

- tropical inland fisheries are understudied
- increasing human population growth rates
- 
- high levels of biodiversity

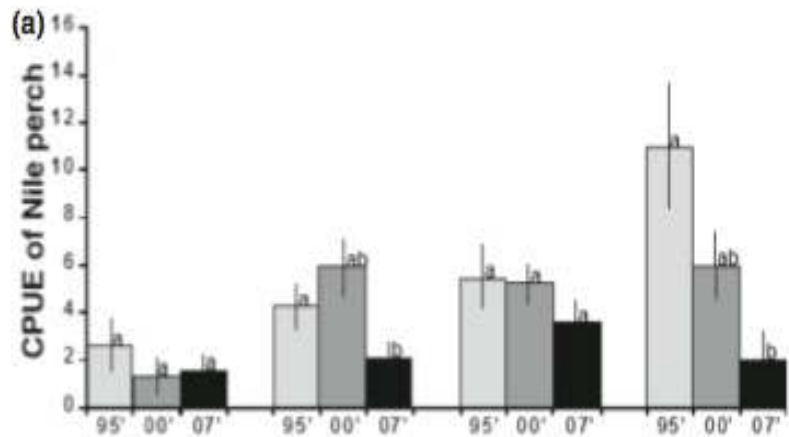
Fishing effort, Agulhas Bank, S



East	South
51.811	21.1445
51.9183333	20.24933333
52.0256667	20.35933333
52.1329	20.46966667
52.24116667	20.57483333
52.34533333	20.6845
52.455	20.78916667
52.5646667	20.89916667
52.6629	21.00933333
52.7796667	21.11433333
52.8814667	21.219
52.9945	21.3295
53.105	21.43483333
53.21016667	21.54533333
53.3155	21.5005
53.426	21.761
53.53116667	21.86633333
53.6416667	21.97683333
53.747	22.082
53.8575	22.1925
53.96266667	22.29766667
54.07316667	22.40816667
54.17833333	22.5135
54.28883333	22.62383333
54.39416667	22.72916667
54.5046667	22.8395
54.60983333	22.94466667
54.72033333	23.05516667
54.8255	23.16033333
54.936	23.27083333
55.04116667	23.376
55.15166667	23.4865
55.257	23.59183333
55.3675	23.7025
55.4725	23.8075
55.583	23.918
55.68833333	24.02333333
55.79883333	
55.90416667	
56.014	
56.11933333	
56.23	
56.33616667	
56.44566667	
56.55166667	
56.66183333	



Paterson and Chapman, 2009



Inshore  
wetland

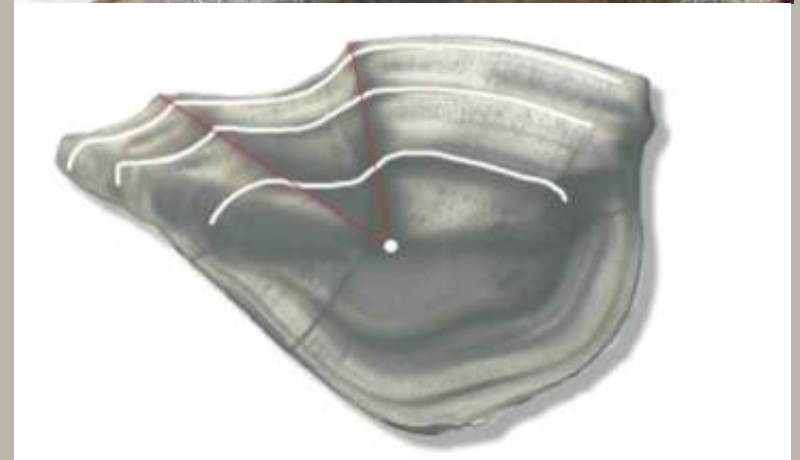
Offshore  
wetland

Inshore  
exposed

Offshore  
exposed

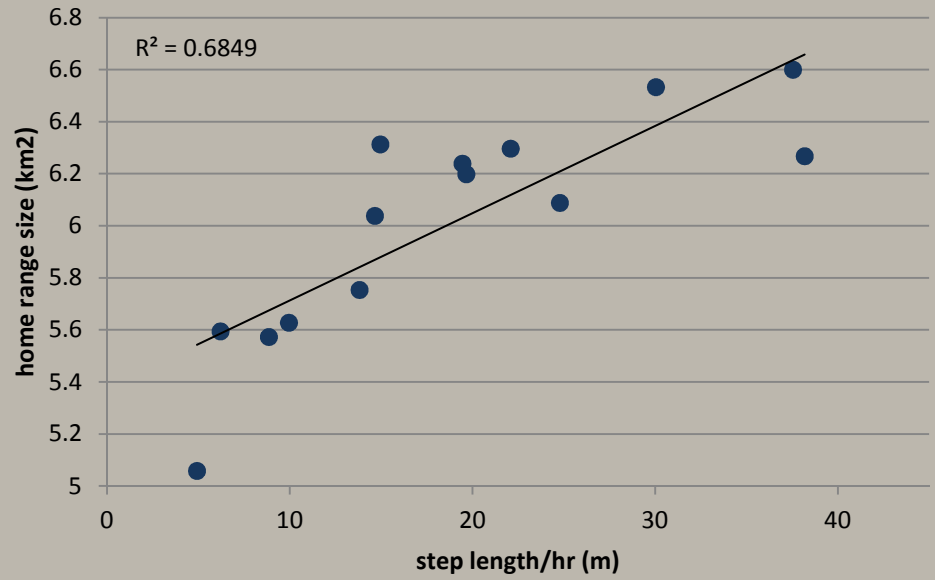
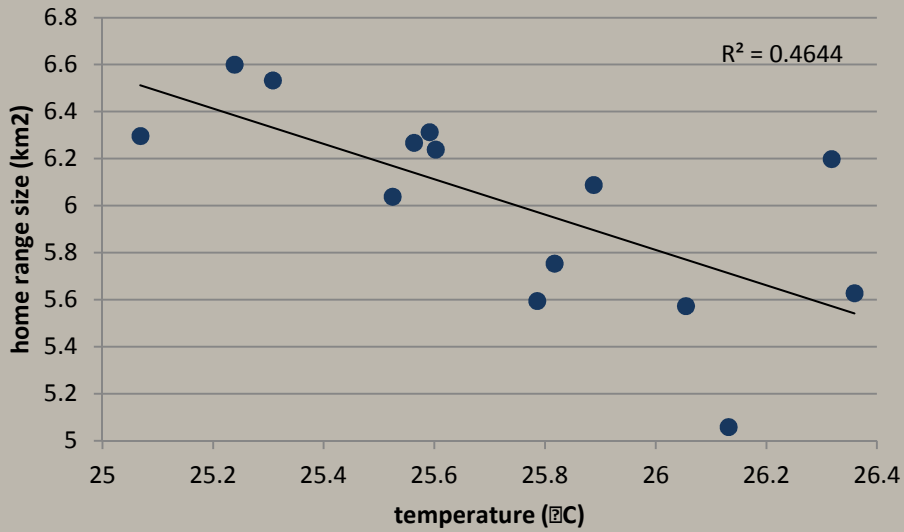
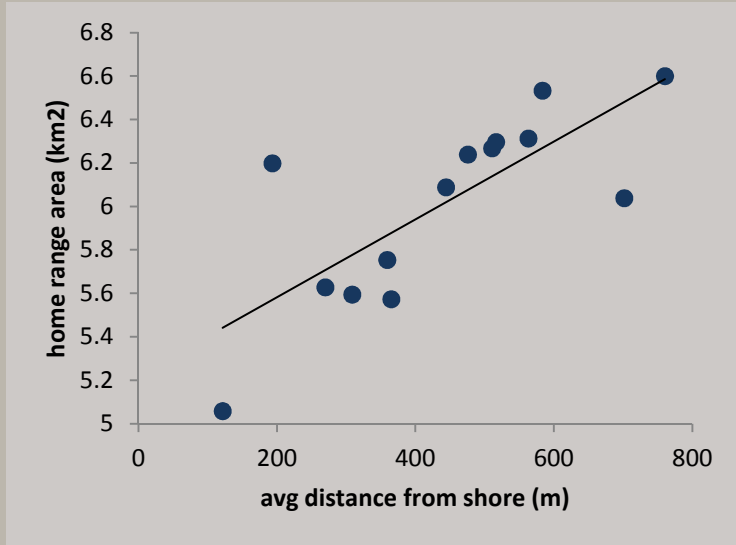


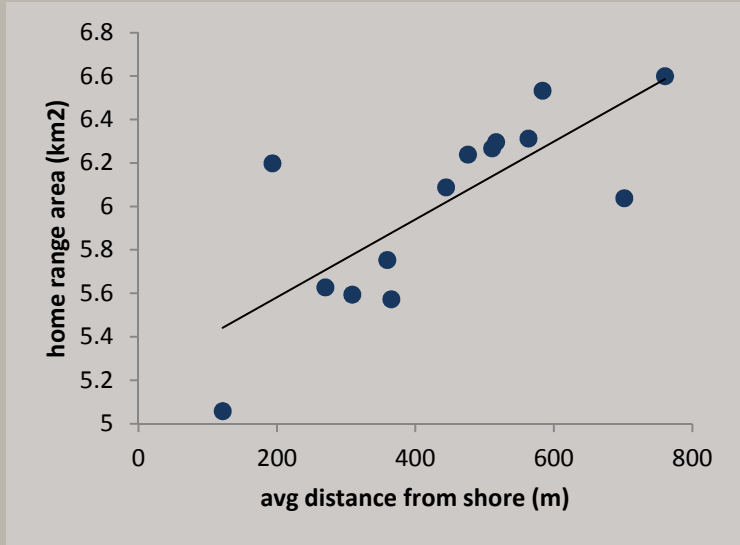
stomach contents  
(point source diet)



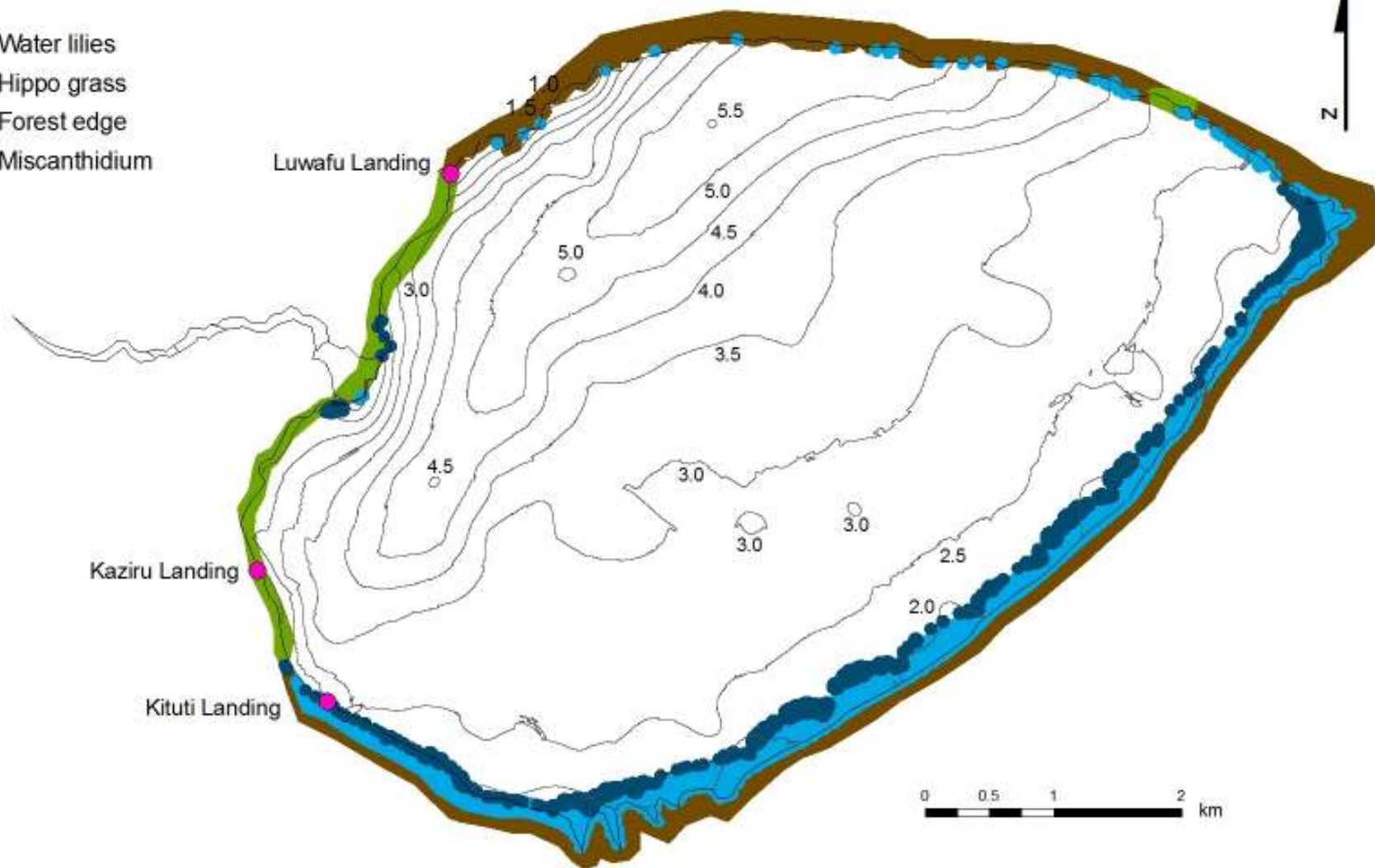
otoliths (age)

- is this variation transient, ontogenetic or representing distinct phenotypes within the population?
- transient variation – may occur if all NP move freely between habitats
- ontogenetic variation - may occur if juveniles are restricted in habitat but move as adults
- distinct phenotypes - may occur if NP remain in distinct habitats throughout their life.

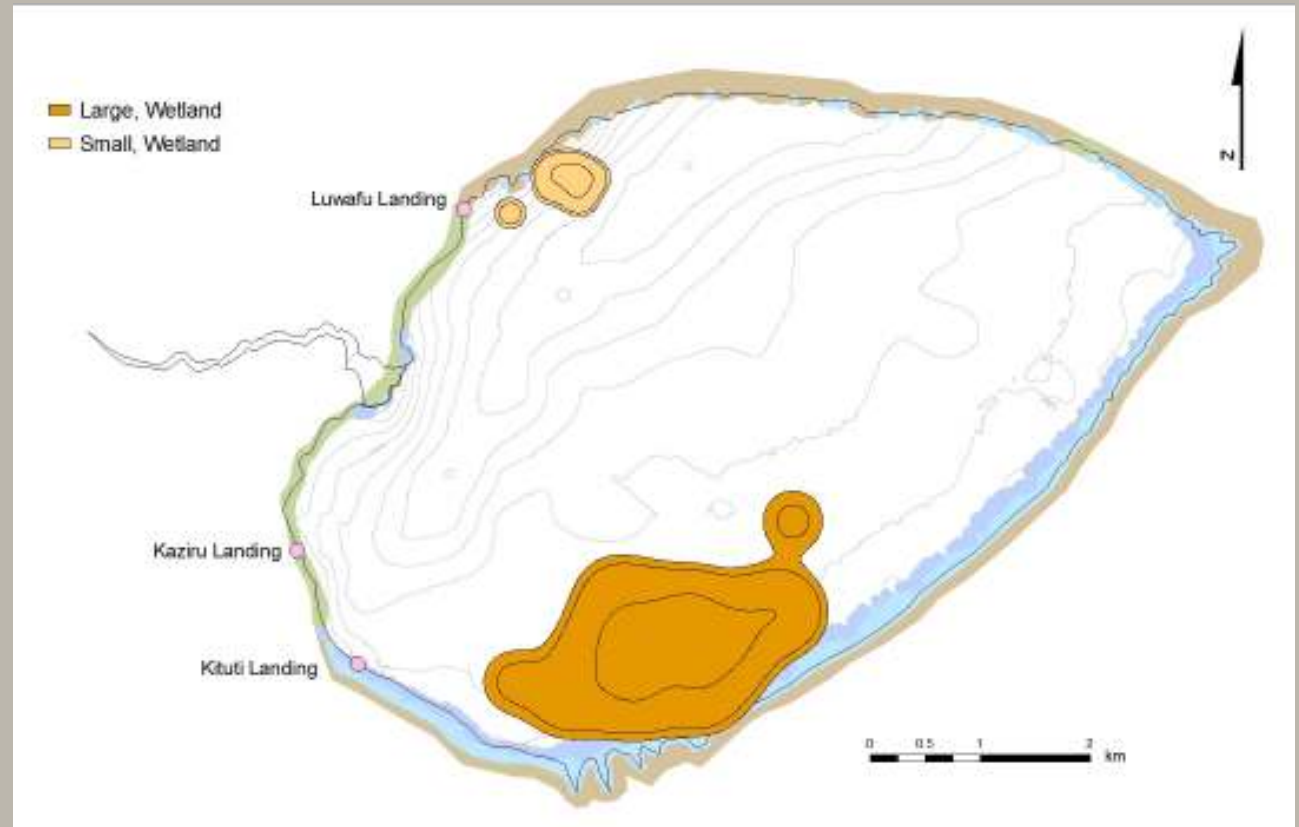




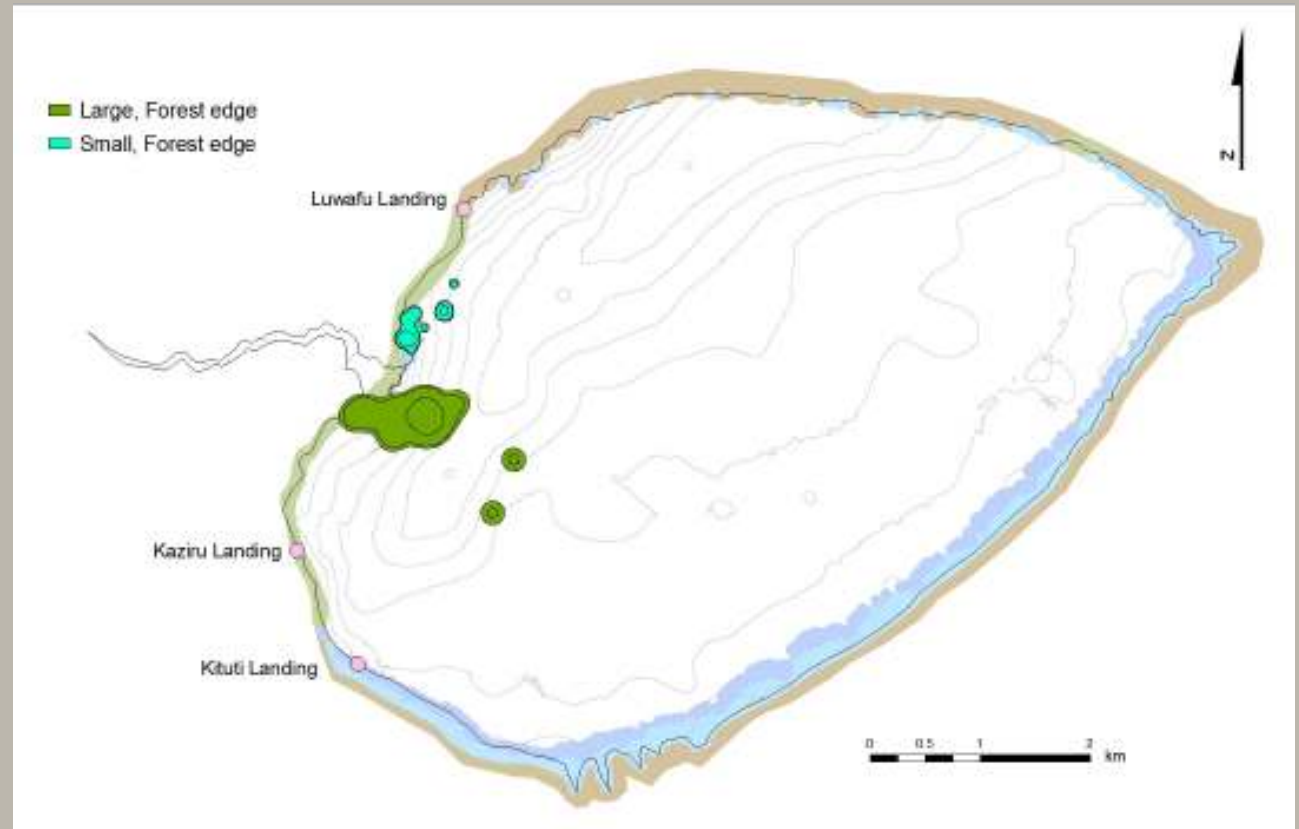
- Water lilies
- Hippo grass
- Forest edge
- Miscanthidium



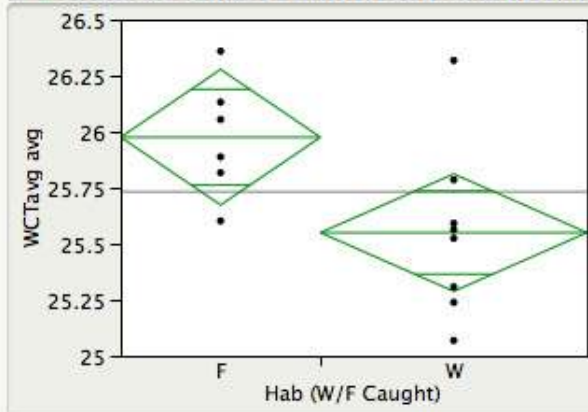
# Home ranges



# Home ranges



▼ **Oneway Analysis of WCTavg avg By Hab (W/F Caught)**



▼ **Oneway Anova**

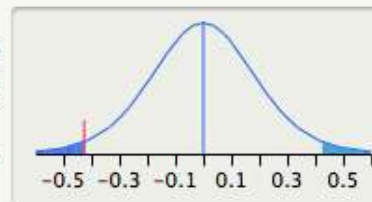
▼ **Summary of Fit**

Rsquare	0.30972
Adj Rsquare	0.252196
Root Mean Square Error	0.339699
Mean of Response	25.73209
Observations (or Sum Wgts)	14

▼ **t Test**

W-F  
Assuming equal variances

Difference	-0.42570	t Ratio	-2.3204
Std Err Dif	0.18346	DF	12
Upper CL Dif	-0.02597	Prob >  t	0.0387*
Lower CL Dif	-0.82542	Prob > t	0.9806
Confidence	0.95	Prob < t	0.0194*



▼ **Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Hab (W/F Caught)	1	0.6213153	0.621315	5.3842	0.0387*
Error	12	1.3847425	0.115395		
C. Total	13	2.0060578			

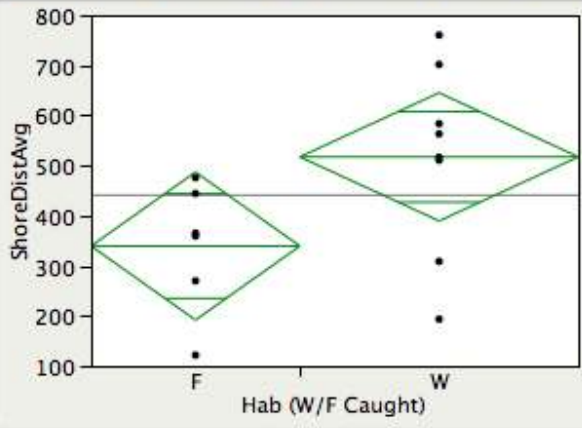
▼ **Means for Oneway Anova**

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
F	6	25.9753	0.13868	25.673	26.278
W	8	25.5496	0.12010	25.288	25.811

Std Error uses a pooled estimate of error variance

▶ **t Test**

**Oneway Analysis of ShoreDistAvg By Hab (W/F Caught)**



**Oneway Anova**

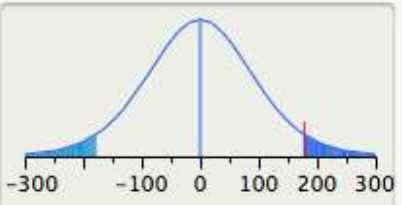
**Summary of Fit**

Rsquare	0.247025
Adj Rsquare	0.184278
Root Mean Square Error	166.0383
Mean of Response	440.8921
Observations (or Sum Wgts)	14

**t Test**

W-F  
Assuming equal variances

Difference	177.92	t Ratio	1.984135
Std Err Dif	89.67	DF	12
Upper CL Dif	373.30	Prob >  t	0.0706
Lower CL Dif	-17.46	Prob > t	0.0353*
Confidence	0.95	Prob < t	0.9647



**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Hab (W/F Caught)	1	108532.37	108532	3.9368	0.0706
Error	12	330824.73	27569		
C. Total	13	439357.10			

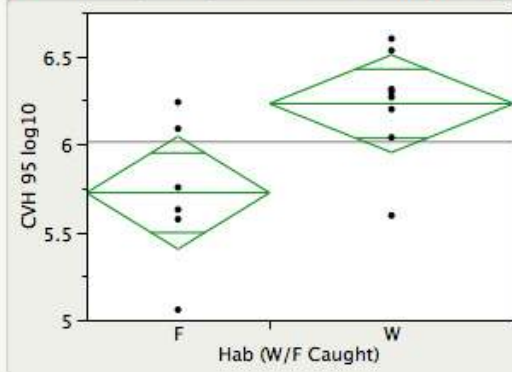
**Means for Oneway Anova**

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
F	6	339.224	67.785	191.53	486.91
W	8	517.143	58.703	389.24	645.05

Std Error uses a pooled estimate of error variance

**t Test**

▼ **Oneway Analysis of CVH 95 log10 By Hab (W/F Caught)**



▼ **Oneway Anova**

▼ **Summary of Fit**

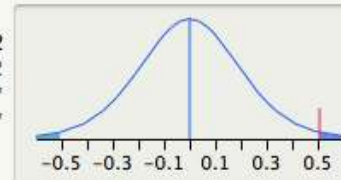
Rsquare	0.361323
Adj Rsquare	0.3081
Root Mean Square Error	0.360255
Mean of Response	6.013041
Observations (or Sum Wgts)	14

▼ **t Test**

W-F

Assuming equal variances

Difference	0.506934	t Ratio	2.605542
Std Err Dif	0.194560	DF	12
Upper CL Dif	0.930843	Prob >  t	0.0230*
Lower CL Dif	0.083024	Prob > t	0.0115*
Confidence	0.95	Prob < t	0.9885



▼ **Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Hab (W/F Caught)	1	0.8810803	0.881080	6.7888	0.0230*
Error	12	1.5574019	0.129783		
C. Total	13	2.4384822			

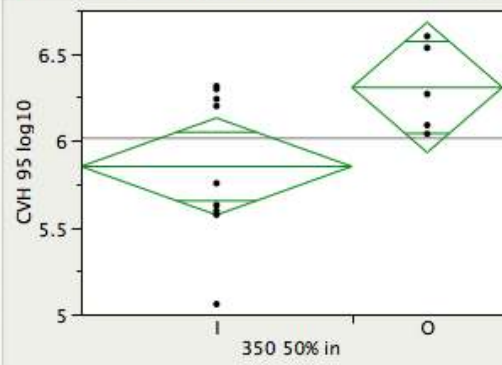
▼ **Means for Oneway Anova**

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
F	6	5.72336	0.14707	5.4029	6.0438
W	8	6.23030	0.12737	5.9528	6.5078

Std Error uses a pooled estimate of error variance

▶ **t Test**

▼ Oneway Analysis of CVH 95 log10 By 350 50% in



▼ Oneway Anova

▼ Summary of Fit

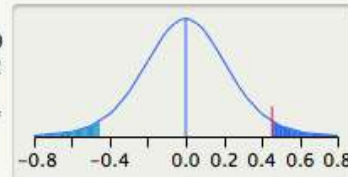
Rsquare	0.272905
Adj Rsquare	0.212313
Root Mean Square Error	0.384384
Mean of Response	6.013041
Observations (or Sum Wgts)	14

▼ t Test

O-I

Assuming equal variances

Difference	0.45501	t Ratio	2.122269
Std Err Dif	0.21440	DF	12
Upper CL Dif	0.92215	Prob >  t	0.0553
Lower CL Dif	-0.01212	Prob > t	0.0277*
Confidence	0.95	Prob < t	0.9723



▼ Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
350 50% in	1	0.6654734	0.665473	4.5040	0.0553
Error	12	1.7730088	0.147751		
C. Total	13	2.4384822			

▼ Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	9	5.85054	0.12813	5.5714	6.1297
O	5	6.30555	0.17190	5.9310	6.6801

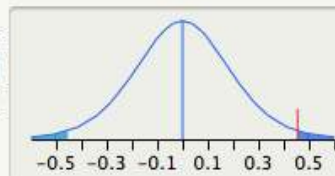
Std Error uses a pooled estimate of error variance

▼ t Test

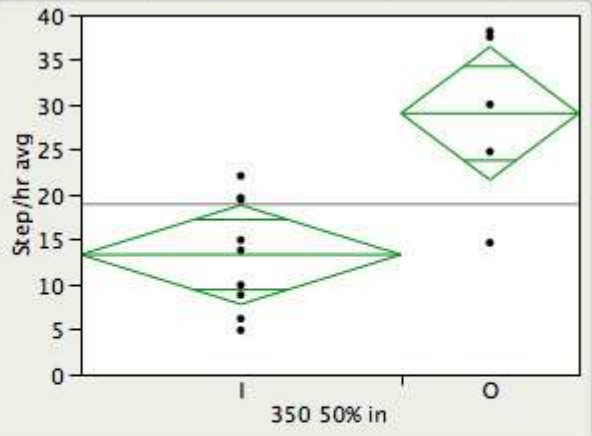
O-I

Assuming unequal variances

Difference	0.455012	t Ratio	2.468876
Std Err Dif	0.184299	DF	11.87963
Upper CL Dif	0.857018	Prob >  t	0.0297*
Lower CL Dif	0.053007	Prob > t	0.0149*
Confidence	0.95	Prob < t	0.9851



▼ Oneway Analysis of Step/hr avg By 350 50% in



▼ Oneway Anova

▼ Summary of Fit

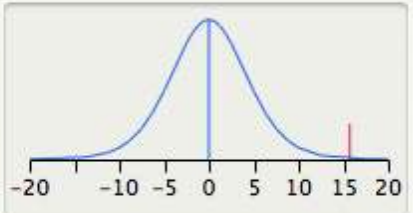
Rsquare	0.53437
Adj Rsquare	0.495567
Root Mean Square Error	7.594062
Mean of Response	18.93396
Observations (or Sum Wgts)	14

▼ t Test

O-I

Assuming equal variances

Difference	15.7189	t Ratio	3.711
Std Err Dif	4.2358	DF	12
Upper CL Dif	24.9479	Prob >  t	0.0030*
Lower CL Dif	6.4900	Prob > t	0.0015*
Confidence	0.95	Prob < t	0.9985



▼ Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
350 50% in	1	794.2007	794.201	13.7715	0.0030*
Error	12	692.0373	57.670		
C. Total	13	1486.2380			

▼ Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
I	9	13.3201	2.5314	7.805	18.835
O	5	29.0390	3.3962	21.639	36.439

Std Error uses a pooled estimate of error variance

Figures I could show:

## MAPS

~~Homeranges (fixed kernel vs MCP)~~

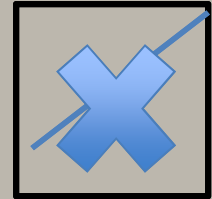
## GRAPHS

- ~~-Average distance moved/hour~~
- ~~-Average homerange size~~
- ~~-Homerange size vs fish size~~
- ~~-steplength/hour vs fish size~~
- ~~-Distance from shore vs fish size~~
- ~~-Water temperature and oxygen vs. fish size~~
- ~~-HR size by shore distance.~~
- ~~-HR size by habitat type (W/FE)~~

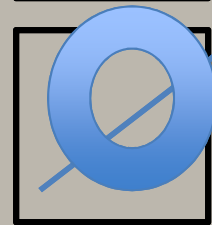
~~Do analyses on how these traits differ between habitat types (F,W,in,off) (Home-range size, fish size, temp, depth, secchi, oxygen) — nothing interesting came out of this...~~

~~Habitat boundaries (crossing) and habitat selection~~

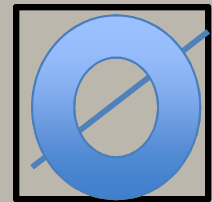
Distance moved/hr



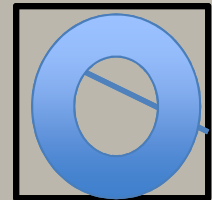
Distance from shore



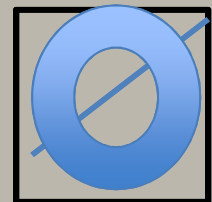
Home range size



Temp



DO



Fish Size

- **wetlands**: structural and low-oxygen refugia



cichlids

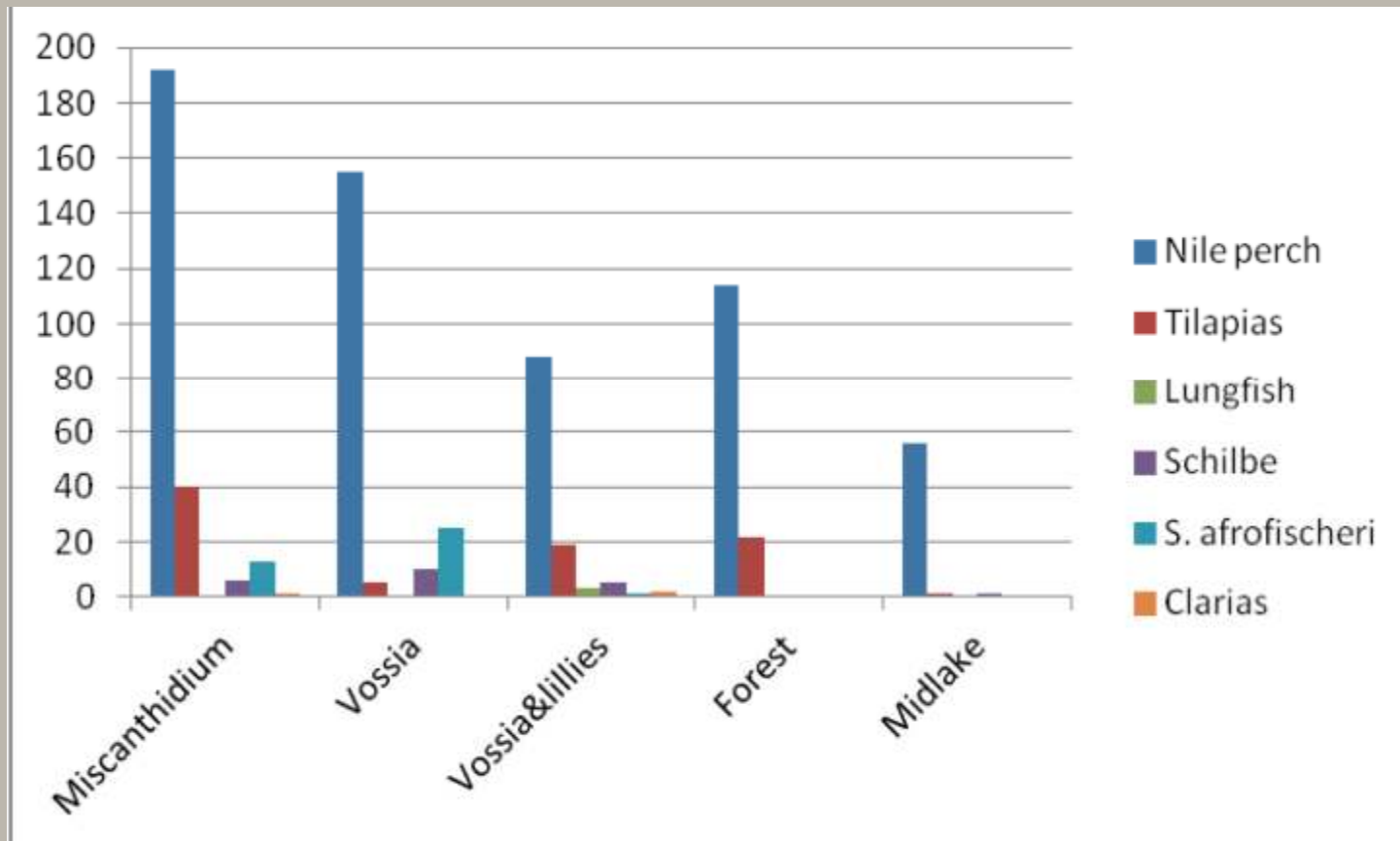


cyprinids



mormyrids

# CPUE in different habitat types



# Ecological divergence in morphology



ERROR: stackunderflow  
OFFENDING COMMAND: ~

STACK: