Effects of green tides on flatfish sandy beach nurseries: a multi-metric approach

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Coastal zones provide many goods and services…

Beck et al., 2001; Costanza et al., 1997

...but are subject to anthropogenic impacts...

Defeo et al., 2009

...such as eutrophication and green tides...

Charlier et al., 2008; Defeo et al., 2009; Quillien et al., 2015; UE Water Framework Directive; Ye et al., 2011

… that could alter their function and quality…

- Contribution to the adult fish stocks (Beck et al., 2001; Dahlgren,2006)
- Similar to habitat quality "high quality habitats are assumed to be those where growth, survival and future reproductive potential are optimized" (Gibson, 1994)
- Assessment using juvenile density, growth and / or condition (*e.g.* Gilliers et al., 2006; Wennhage et al., 2007; Le Pape 2003; Amara et al., 2007; Freitas et al., 2010)

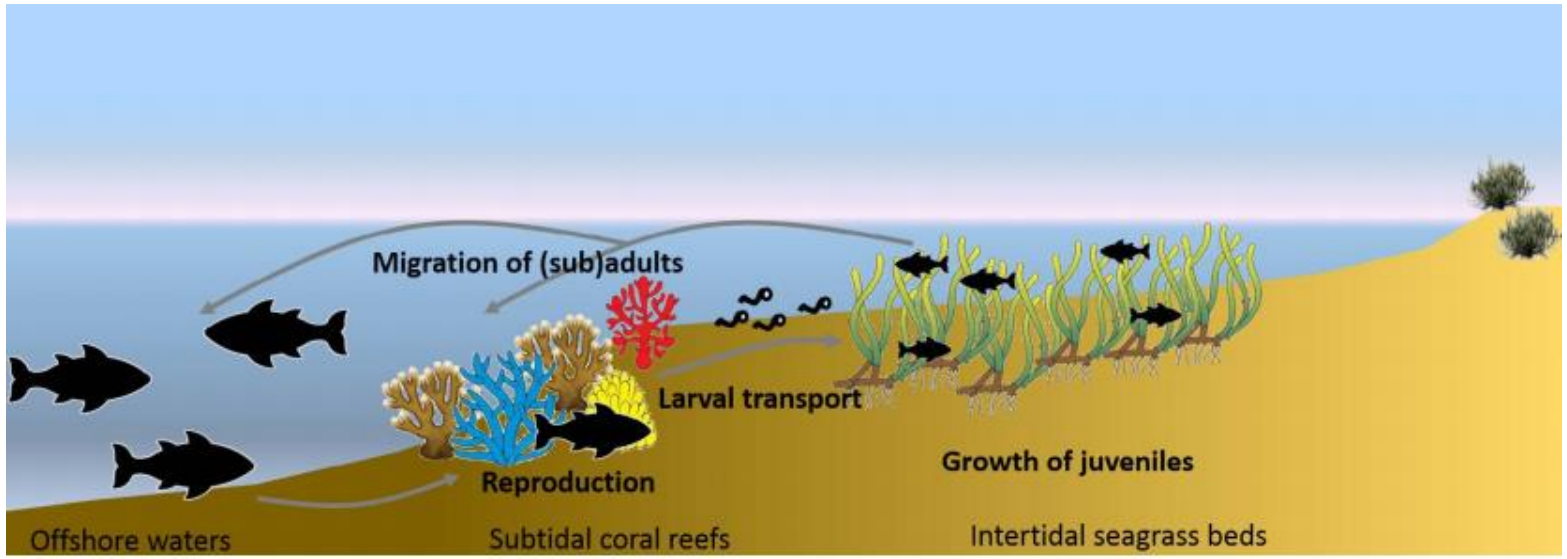

Figure from van der Veer & Camphuysen (2018)

...focusing on juvenile flatfish and their prey

- Potential prey = benthic invertebrates → modification of richness, abundance, biomass, composition, functional groups (Quillien et al., 2015a, 2015b, 2018; Pihl et al., 1995; Carriço et al., 2013; Grall and Chauvaud, 2002)

- Predators = juvenile flatfish → drastic abundance decrease in impacted estuaries (Paumier et al., 2018) and highly impacted sandy bays (Le Luherne et al., 2016)

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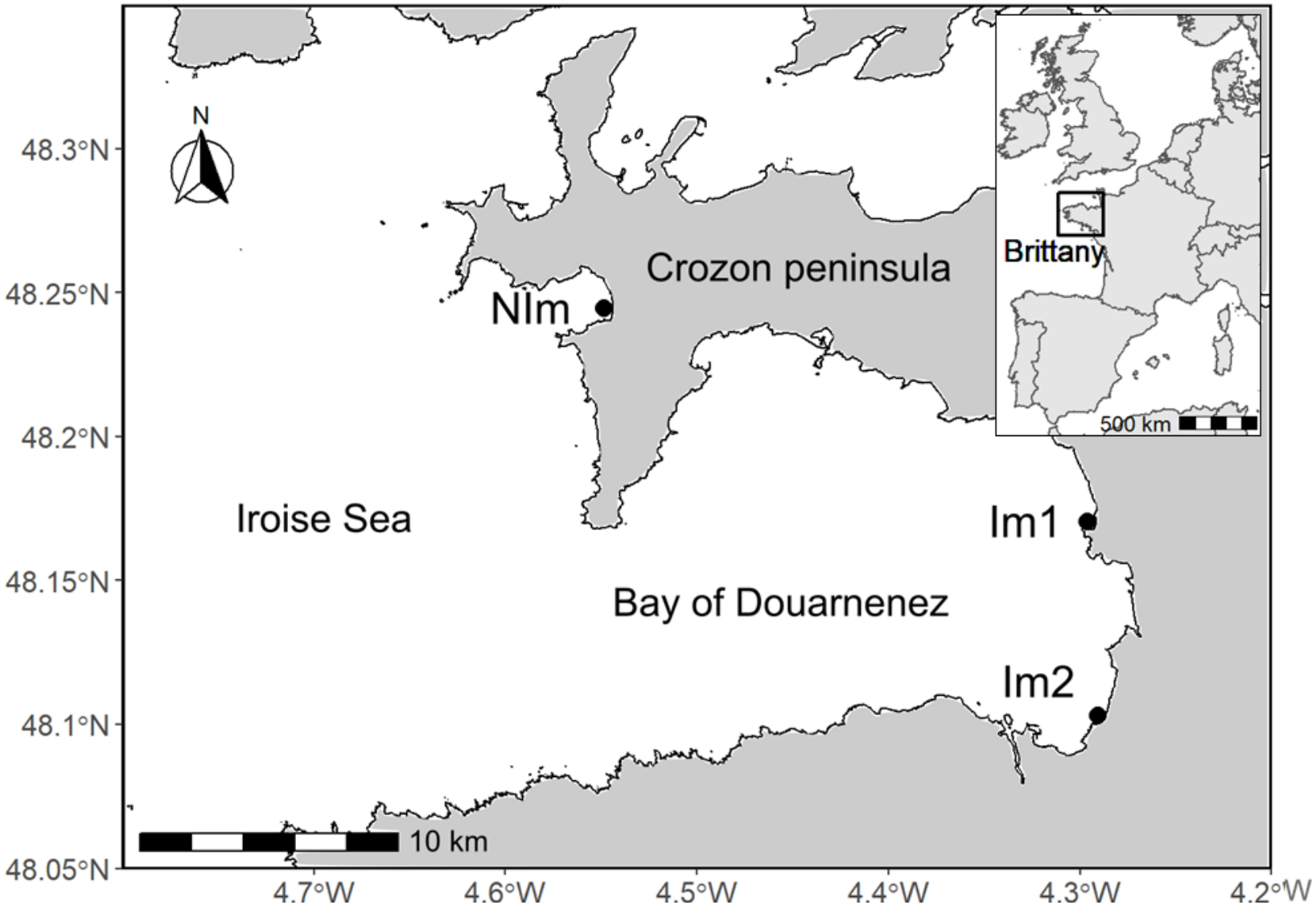
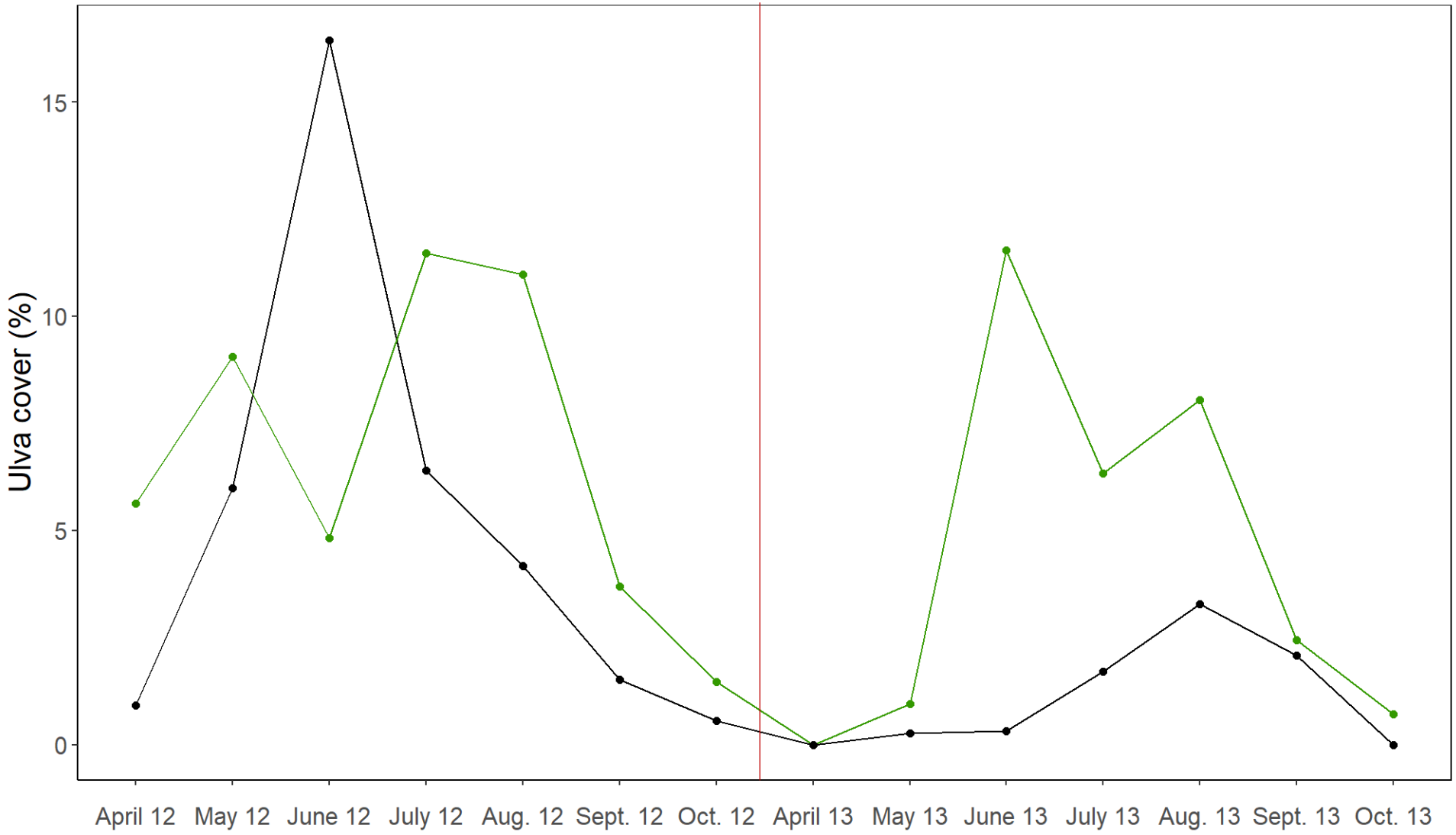
1) Food production and accessibilty
2) Flatfish density
3) Flatfish condition

Study sites


N
48.3°N
48.25°N
48.2°N
48.15°N
48.1°N
48.05°N
4.7°W
4.6°W
4.5°W
4.4°W
4.3°W
4.2°W
Crozon peninsula
NIm
Iroise Sea
Im1
Bay of Douarnenez
Im2
10 km
Brittany
500 km

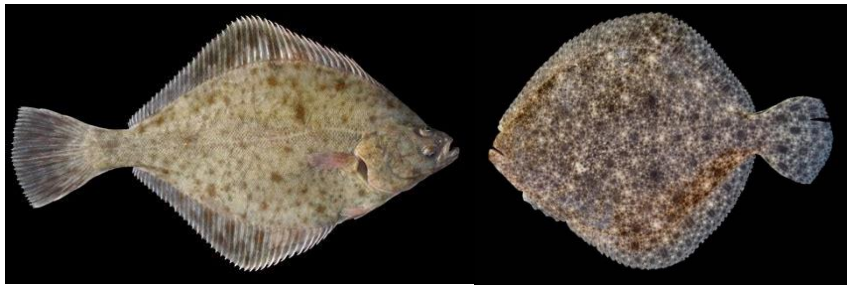
Green tides over time at the two impacted sites (2012 and 2013)



Data from the CEVA and Quillien et al.

Sampling

Three or five cores (each 0.01 m^2) at each study site
2012: april and september
2013: february and september
1mm sieve
Abundance + AFDW / species



Diurnal sampling, rising tide
Beach trawl (5m wide, 0.3 m high, 8mm stretched mesh net)
PNMI + Quillien et al sampling
Different number of traits each month and year (2012 and 2013)
Individual size, sometimes weight
Standardized as ind/ha

→ **Focus on *Pegusa lascaris*, *Pleuronectes platessa*, *Scophthalmus maximus* et *S. rhombus***

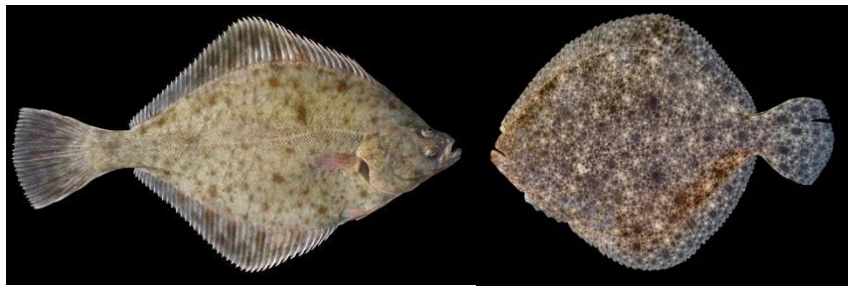
Potential prey production

simplified version of the ABEC = Available Benthic Energy Coefficient (Tableau et al., 2015)

$$FP = \sum_{i \in 1:I \text{ species}} \overline{B}_i . B{:}\, P \,.\, E_i \quad (\text{in kJ.m}^{-2}\text{.year}^{-1})$$

- $\overline{B}_i$ = mean annual biomass of the species (in g.m^2) calculated using April and September data (2012) and February and September data (2013) (spring and autumn data cf. Saulnier et al., 2019)
- P:B = production to biomass ratio (in year^{-1}) estimated using Brey models (biological trait matrix, depth (1m), mean annual temperature (Previmer)
- E_i = energy density (in kJ.g^{-1}) retrieved from Brey et al. (2010)

Prey accessibility



Trait based approach rather than based on gut contents (Jones et al., 2020)

Prey accessibility

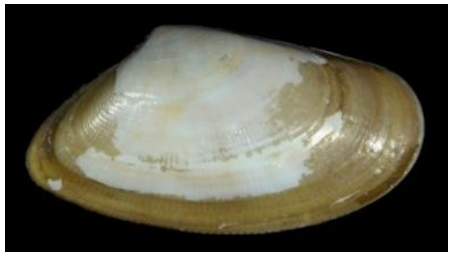
Biological trait	Trait modalities	Modality code
Position	above the sediment	1
	exclusively on the sediment surface	2
	on the sediment surface and in the sediment	3
	in the sediment	4
Living habit	swimmer	1
	crawler	2
	burrower	3
	tube dweller	4
	attached	5
Protection	no protection	1
	carapace	2
	exoskeleton	3
	exoskeleton + spines or shell	4
Mean body size	< 5 mm	1
	5-10 mm	2
	10-20 mm	3
	> 20 mm	4

Prey accessibility

- Hierarchical classification on the trait matrix
- 3 groups defined
- Mean parameter value for each class

Accessibility coef = 1

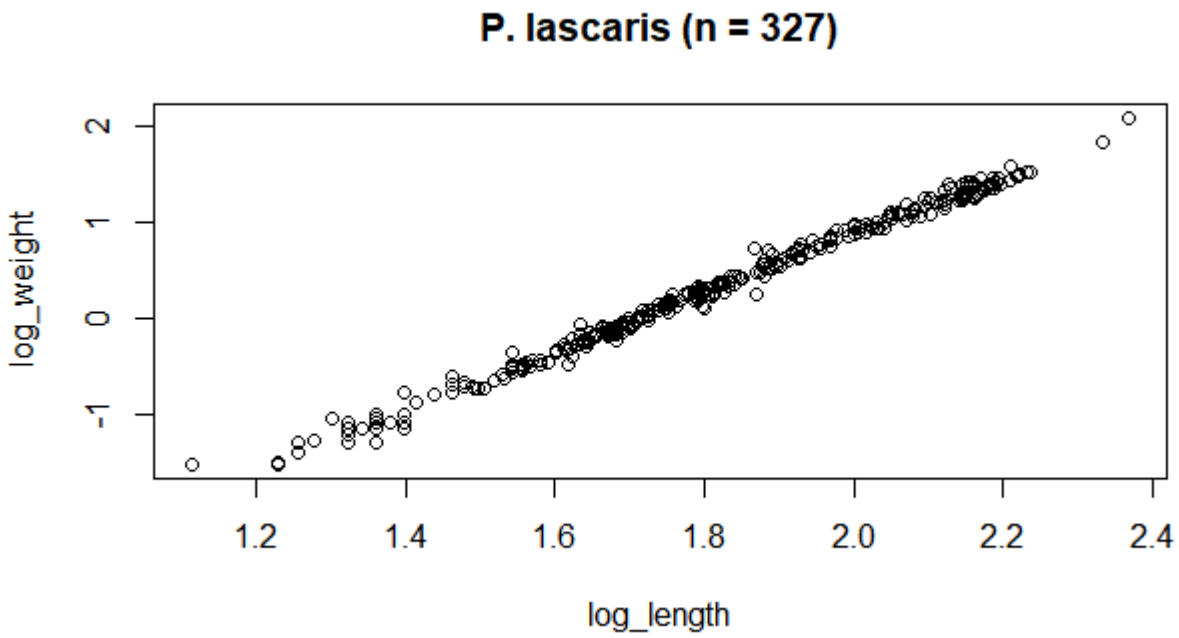
Accessibility coef = 0.7

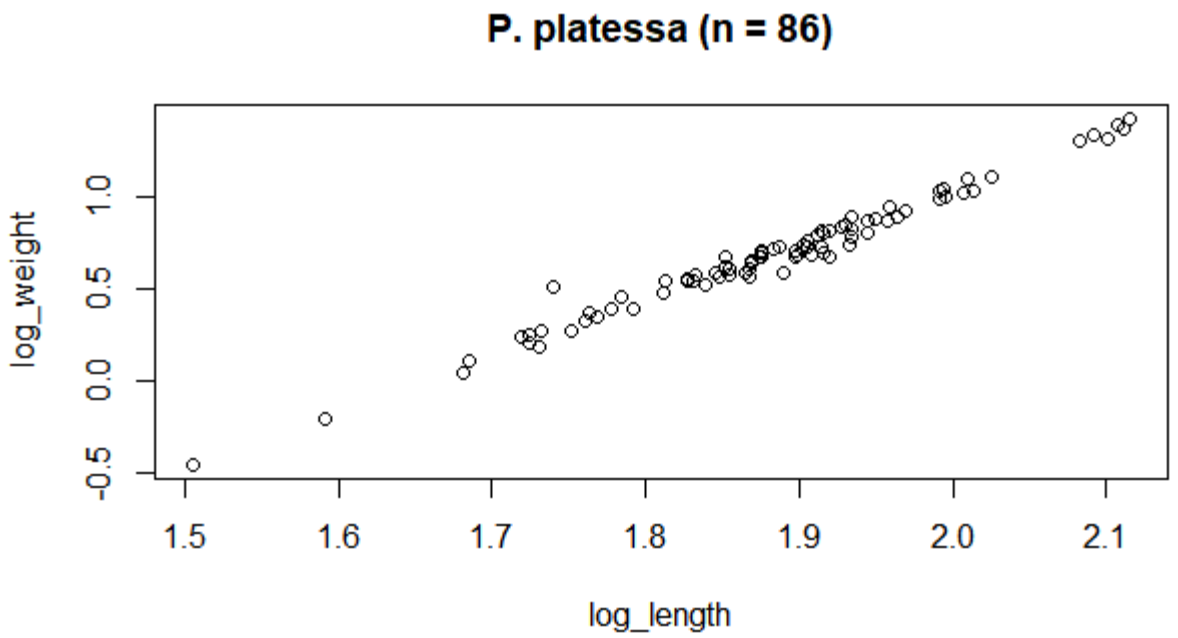


Accessibility coef = 0.55

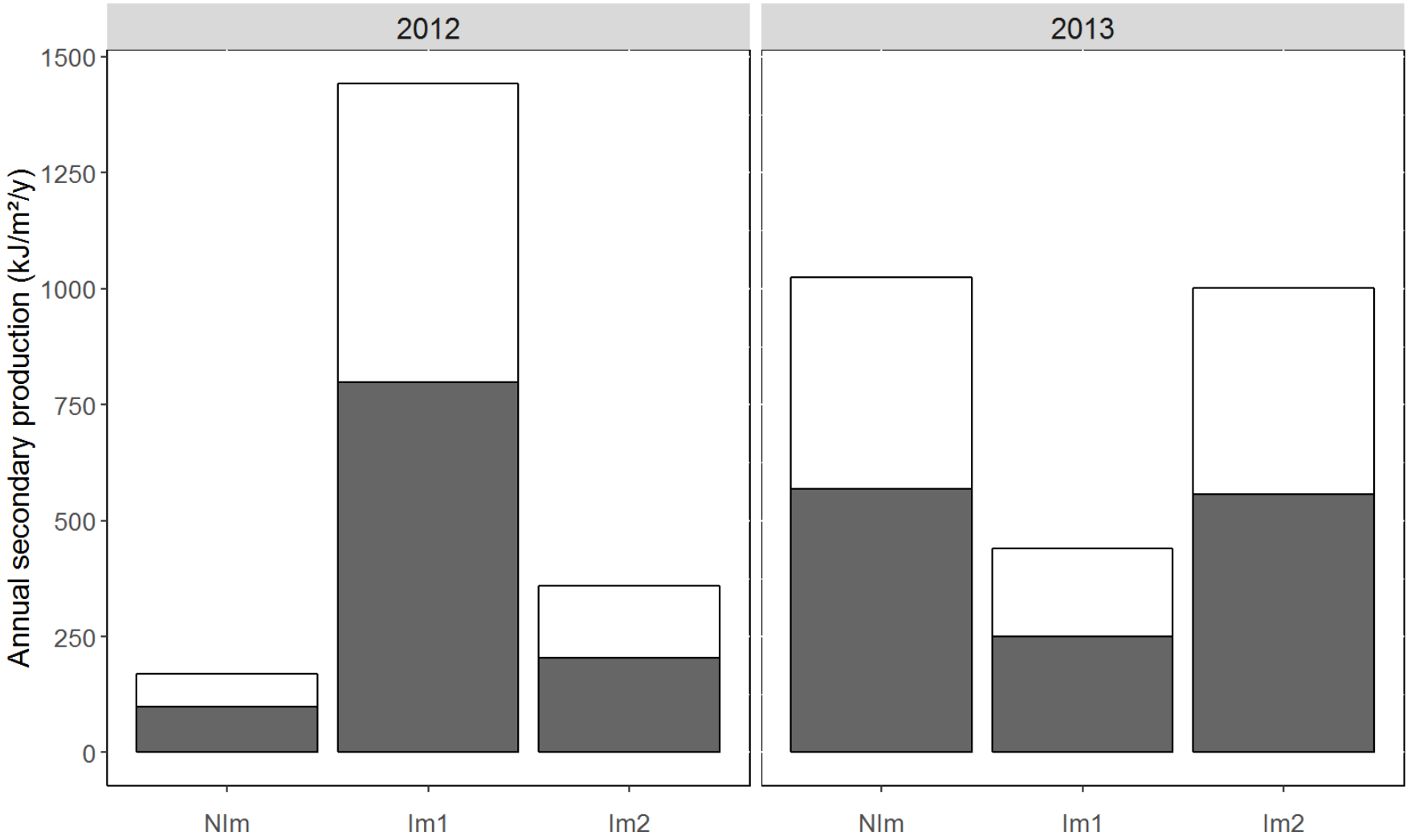
Predator body condition

- Relative condition index Kn computed for each species
- Based on length – weight relations computed using all the values (all months, 2012 and 2013)
- Difference between individual weight and fitted weight (lm)





Macrobenthic total and accessible secondary production



Large inter-site and inter-annual variability

No trend seems linked to the green tides

Do better with the accessibility coefficient (soon to come)

Would need data over a longer time period

Inter-annual and inter-site variability linked to the *Donax* spp. And mainly *Donax vittatus*

GT could favor the recruitment of *Donax vittatus*

Add age class for some species (accessibility coef)

Need to add « incertitudes » in these calculations

Sand sole

Plaice

Turbot

Brill

Sand sole

Plaice

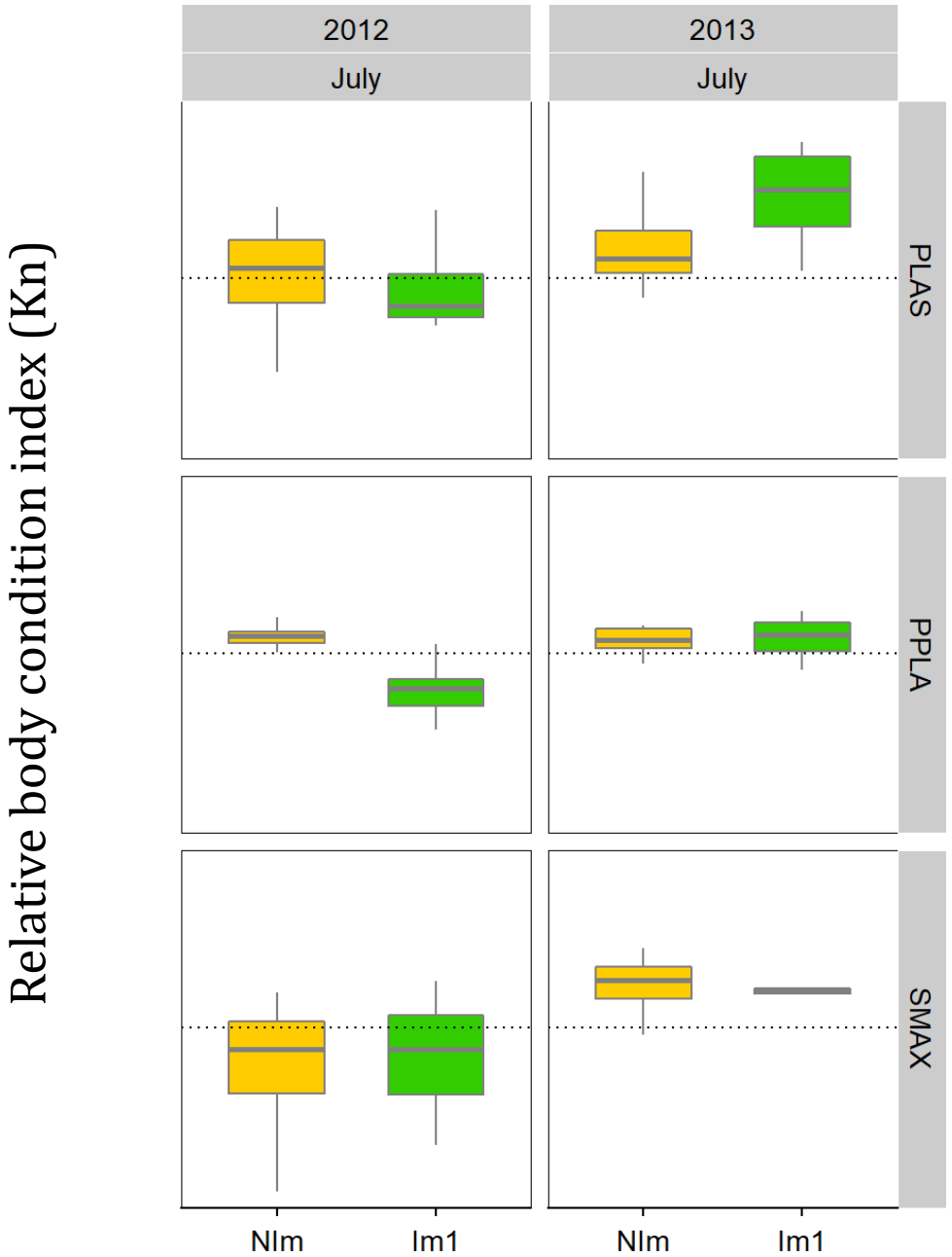
Turbot

Brill

In 2012, n = 3
In 2013, n = 3 (NIm) and n=6 (Im)

Wilcoxon test between each site in 2012 and 2013

Only one significant difference between the two sites for plaice in 2012



Sand sole
2012 = 35/12
2013 = 11/6

Plaice
2012 = 14/15
2013 = 7/7

Turbot
2012 = 22/27
2013 = 4/5

Wilcoxon test between each site in 2012 and 2013

Significant difference for

P. lascaris in 2012 and 2013

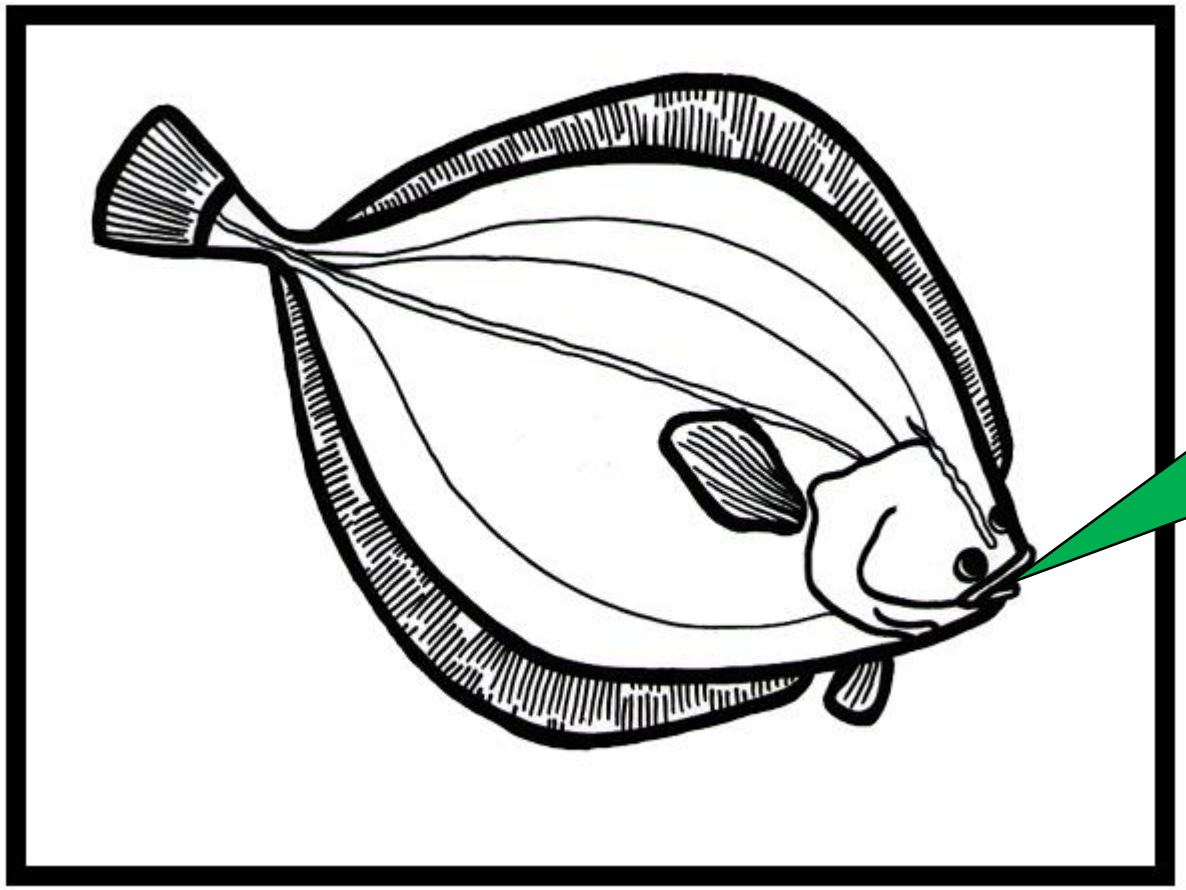
P. platessa in 2012

Conclusion, perspectives

- No clear GT signal in prey production
- Mainly linked to one species *Donax vittatus*
- New tests regarding accessibility coefficients (fuzzy coded ACP + functional group definition, how many to define ?)
- Seems to be an effect of GT on plaice abundance (higher in impacted sites) and condition (lower in impacted sites)
- Very important inter-year variability why ?

→ Linked to the GT intensity ?

→ Linked to recruitment strength ? Food limitation ? Predation ?



Thanks for your attention !

Questions ?

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