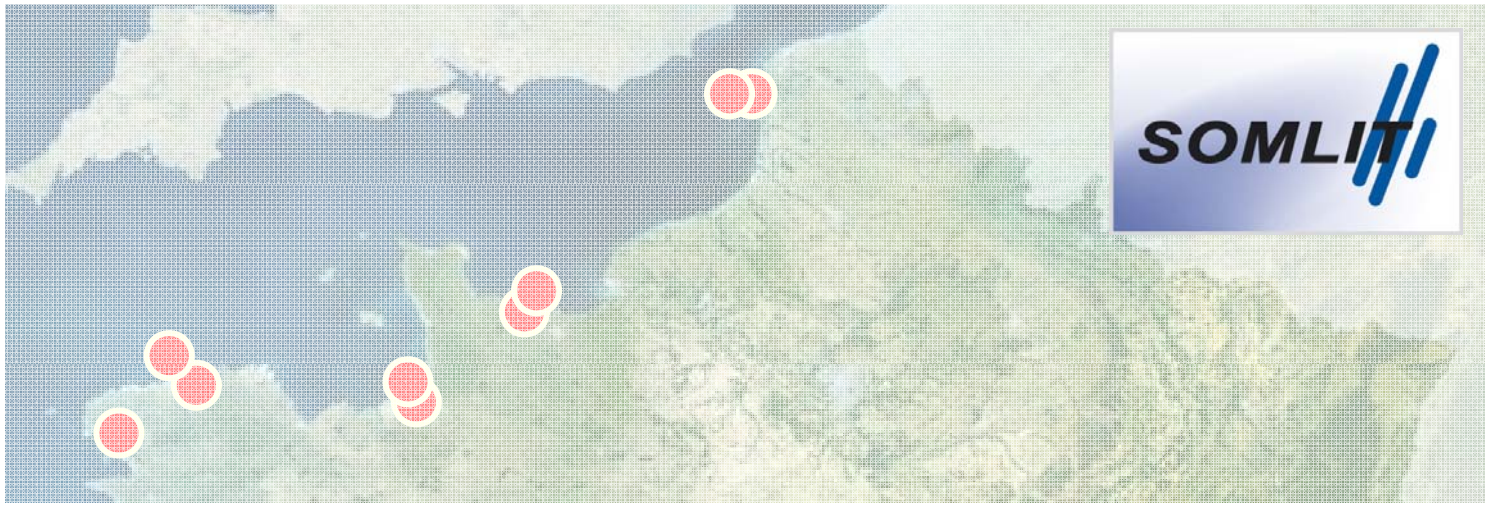
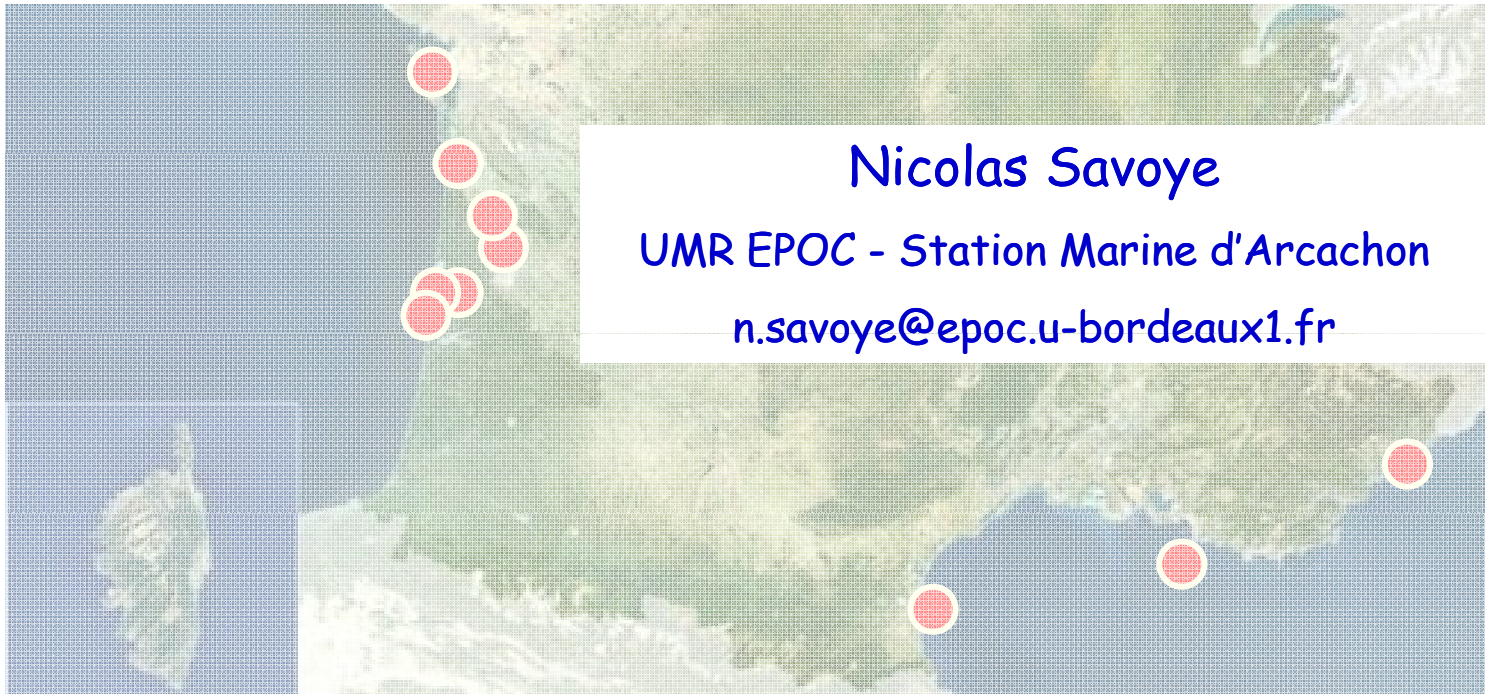



# Le potentiel des données Somlit pour la mise en place d'indicateurs 'réseau trophique' dans le cadre de la DCSMM



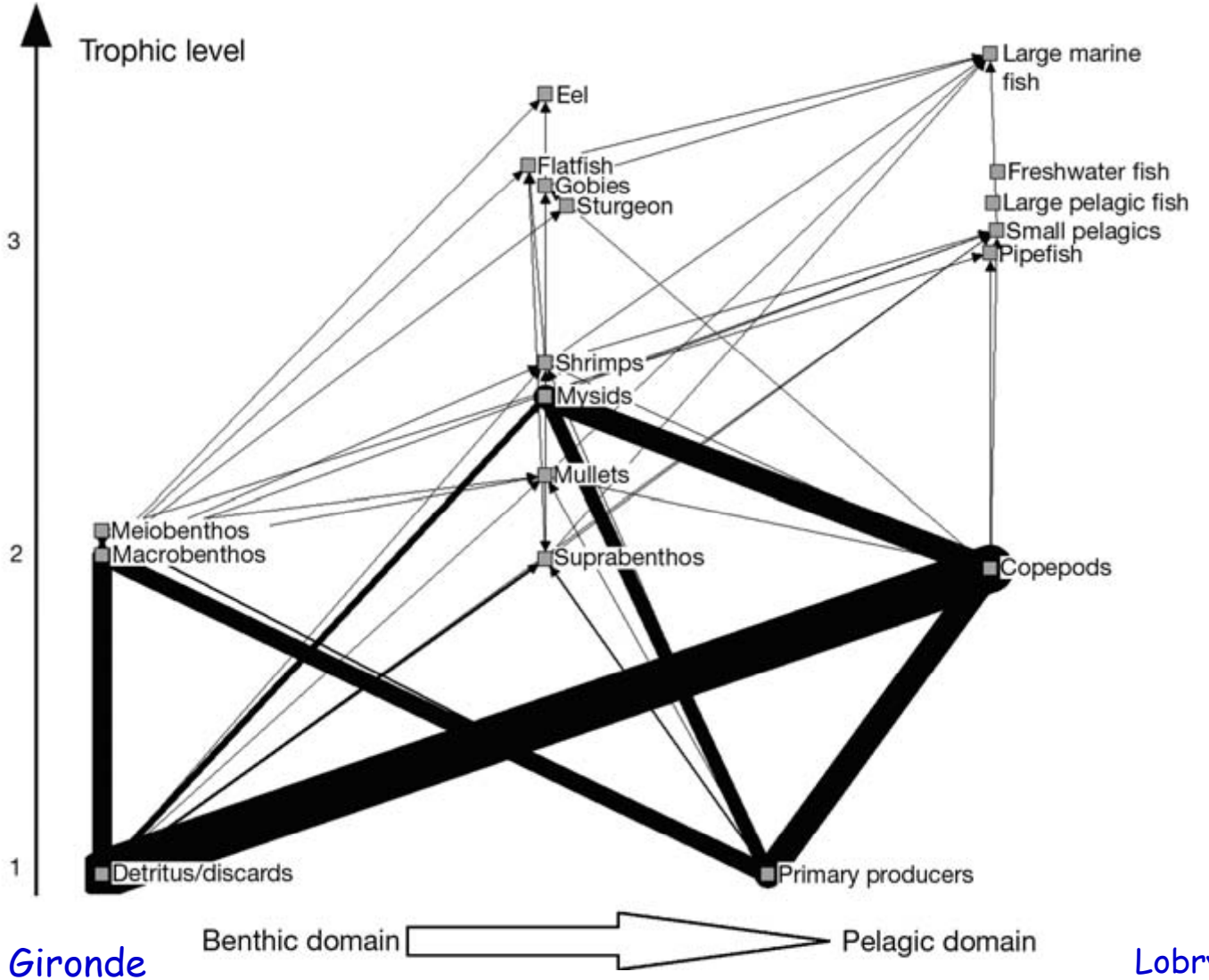
Nicolas Savoye

UMR EPOC - Station Marine d'Arcachon

n.savoye@epoc.u-bordeaux1.fr

# Réseau trophique

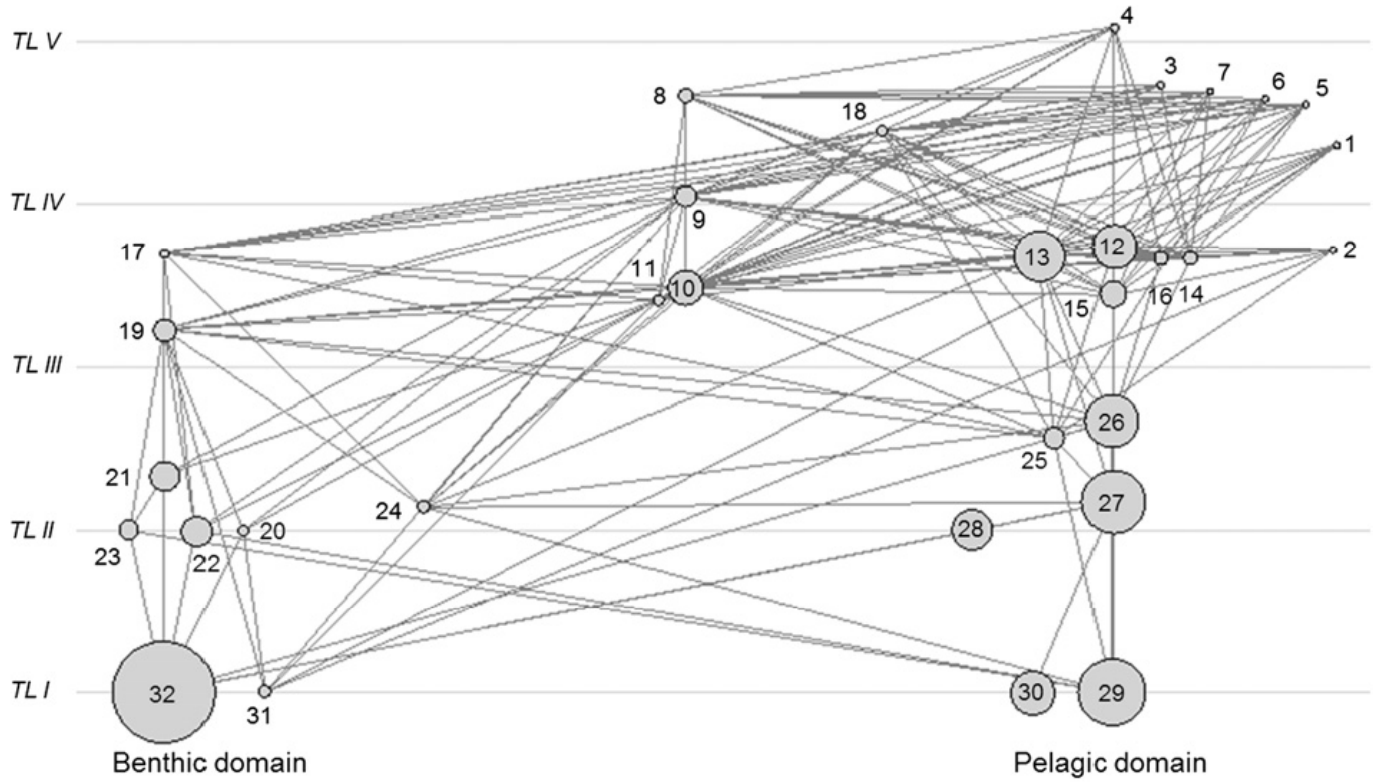
Schématiquement : une organisation de 'boîtes' (compartiments biologiques) et de 'flèches' (flux de matière et d'énergie).




Estuaire de la Gironde

Lobry et al. (2008)

# Réseau trophique




1. Plunge and pursuit diver seabirds; 2. Surface feeder seabirds; 3. Striped dolphin *Stenella coeruleoalba*; 4. Bottlenose dolphin *Tursiops truncatus*; 5. Common dolphin *Delphinus delphis*; 6. Long-finned pilot whale *Globicephala melas*; 7. Harbour porpoise *Phocoena phocoena*; 8. Piscivorous demersal fish; 9. Piscivorous and benthivorous demersal fish; 10. Suprabenthivorous demersal fish; 11. Benthivorous demersal fish; 12. Mackerel *Scomber scombrus*; 13. Horse mackerel *Trachurus trachurus*; 14. Anchovy *Engraulis encrasicolus*; 15. Sardine *Sardina pilchardus*; 16. Sprat *Sprattus sprattus*; 17. Benthic cephalopods; 18. Pelagic cephalopods; 19. Carnivorous benthic invertebrates; 20. Necrophagous benthic invertebrates; 21. Sub-surface deposit feeder invertebrates; 22. Surface suspension and deposit feeder invertebrates; 23. Benthic meiofauna; 24. Suprabenthic invertebrates; 25. Macrozooplankton (≥ 2 mm); 26. Mesozooplankton (0.2-2 mm); 27. Microzooplankton (≤ 0.2 mm); 28. Bacteria; 29. Large phytoplankton (≥ 3 µm); 30. Small phytoplankton (< 3 µm); 31. Fishery discards; 32. Pelagic detritus

Golfe de Gascogne

Lassale et al. (2011)

# Construire un réseau trophique

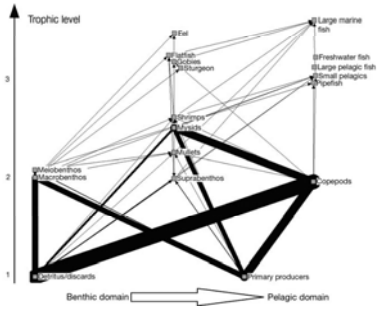
Identifier les compartiments

Quantifier les compartiments

Identifier les liens entre compartiments

Quantifier les flux entre compartiments

Réseau trophique




Description du fonctionnement d'un écosystème

Définition/construction d'indicateurs de bon/mauvais fonctionnement

# Construire un réseau trophique

Identifier les compartiments

Quantifier les compartiments ⟶ Mesure/estimation de la biomasse

# Construire un réseau trophique

Identifier les compartiments

Quantifier les compartiments ⟶ Mesure/estimation de la biomasse

Identifier les liens entre compartiments

Contenus stomacaux

Mesures (bio)chimiques : acides gras

Certains acides gras ne sont pas synthétisés par les organismes mais proviennent de leur alimentation ; ils peuvent être utilisés comme biomarqueurs des ressources trophiques.

# Construire un réseau trophique

Identifier les compartiments

Quantifier les compartiments ⟶ Mesure/estimation de la biomasse

Identifier les liens entre compartiments

Contenus stomacaux

Mesures (bio)chimiques : acides gras

isotopes stables ($\delta^{13}C$, $\delta^{15}N$, etc.)

Les rapports isotopiques des consommateurs sont le reflet des rapports isotopiques de leurs proies.

# Construire un réseau trophique

Identifier les compartiments

Quantifier les compartiments ⟶ Mesure/estimation de la biomasse

Identifier les liens entre compartiments

Contenus stomacaux

Mesures (bio)chimiques : acides gras

isotopes stables ($\delta^{13}C$, $\delta^{15}N$, etc.)

Quantifier les flux entre compartiments

Expériences en mésocosmes

# Construire un réseau trophique

Identifier les compartiments

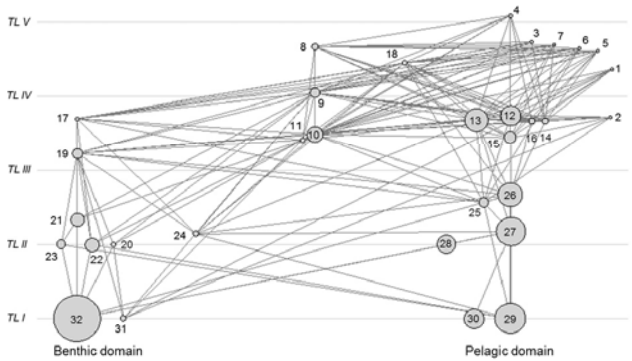
Quantifier les compartiments

Identifier les liens entre compartiments

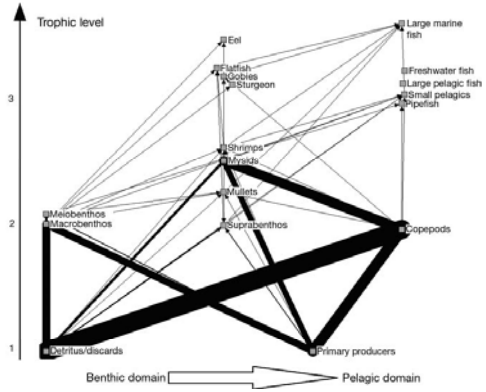
Quantifier les flux entre compartiments

Impossible de quantifier tous les flux entre tous les compartiments

Modélisation

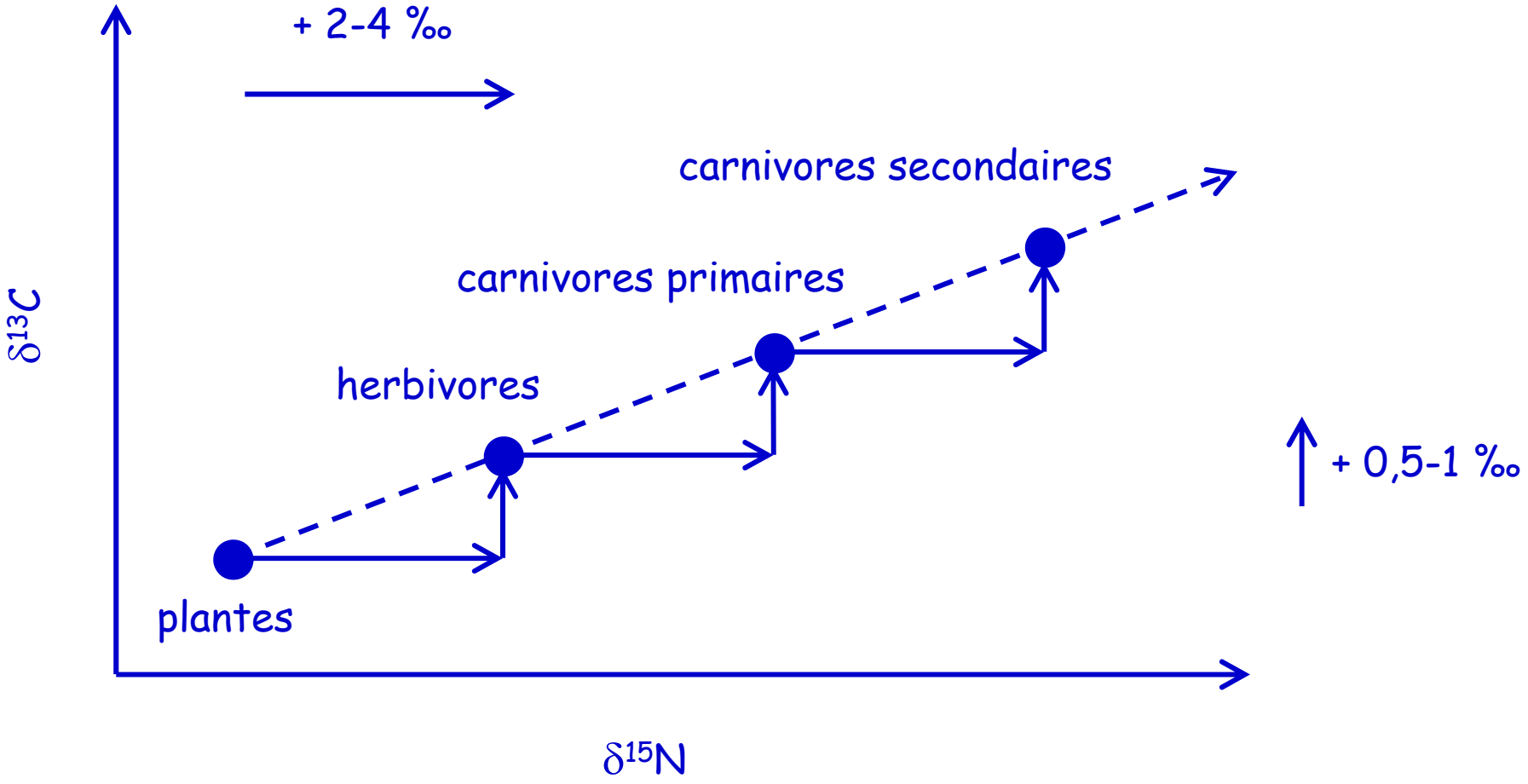



Lassale et al. (2011)




Lobry et al. (2008)

# Outil isotopique et réseau trophique




**« We are what we eat… plus few permil »**

# Reconstruction de la paléo-nourriture

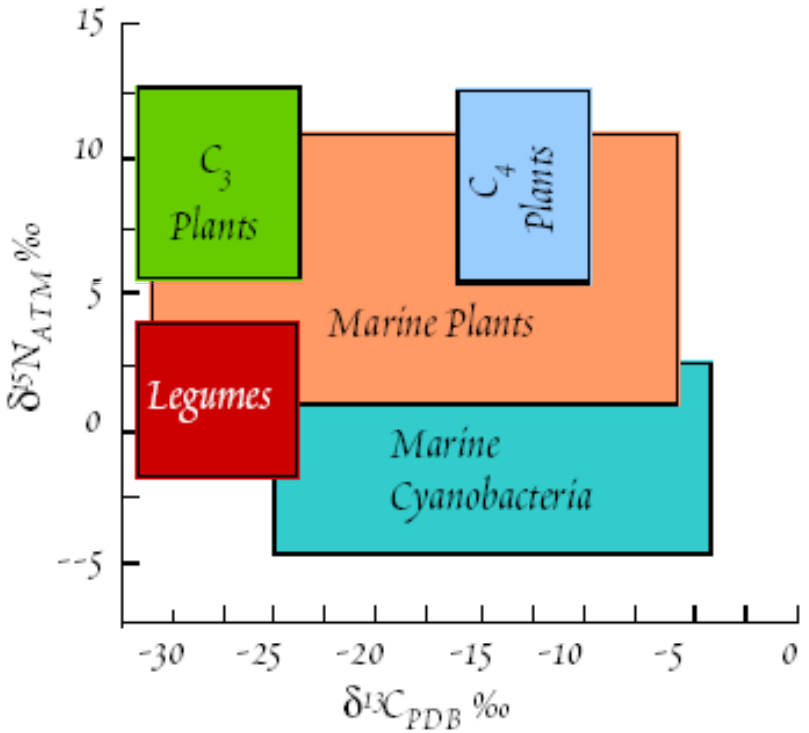



Figure 33.1. Relationship between $\delta^{13}C$ and $\delta^{15}N$ among the principal classes of autotrophs.

White, 1998.
http://www.geo.cornell.edu/geology/classes/Geo656/656notes98.html

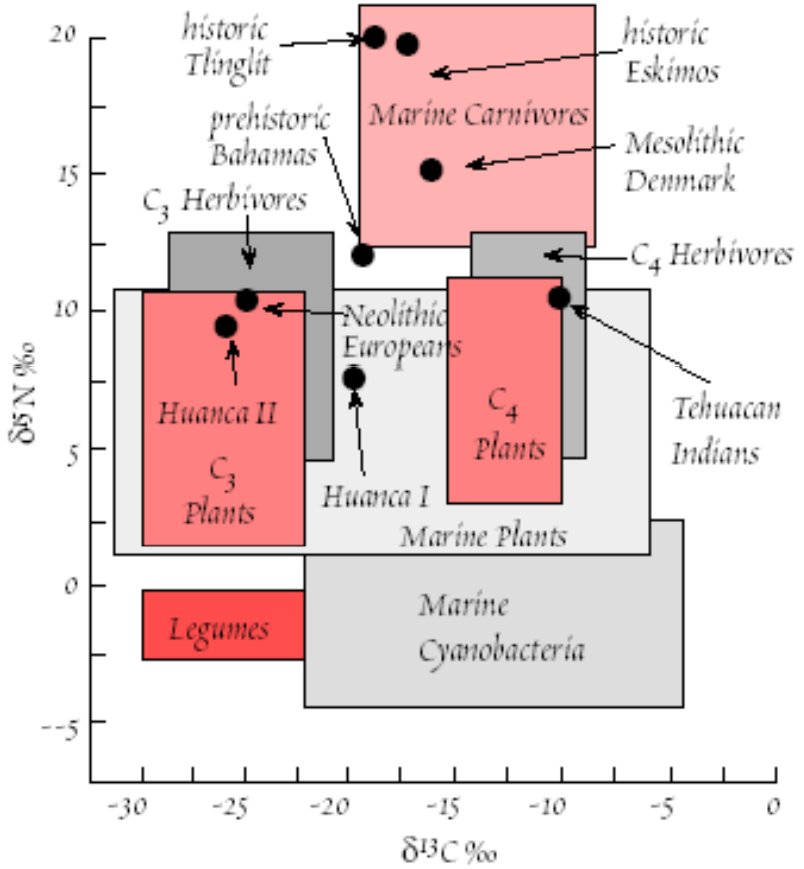



Figure 33.10. $\delta^{13}C$ and $\delta^{15}N$ of various food stuffs and of diets reconstructed from bone collagen and vegetable matter charred onto pots by DeNiro and colleagues. The Huanca people were from the Upper Mantaro Valley of Peru. Data from pot sherds of the Huanca I period (AD 1000-1200) suggest both $C_3$ and $C_4$ plants were cooked in pots, but on $C_3$ plants during the Huanca II period (AD 1200-1470).

# Composition de la ressource trophique

Calcul de la signature isotopique de la ressource trophique :

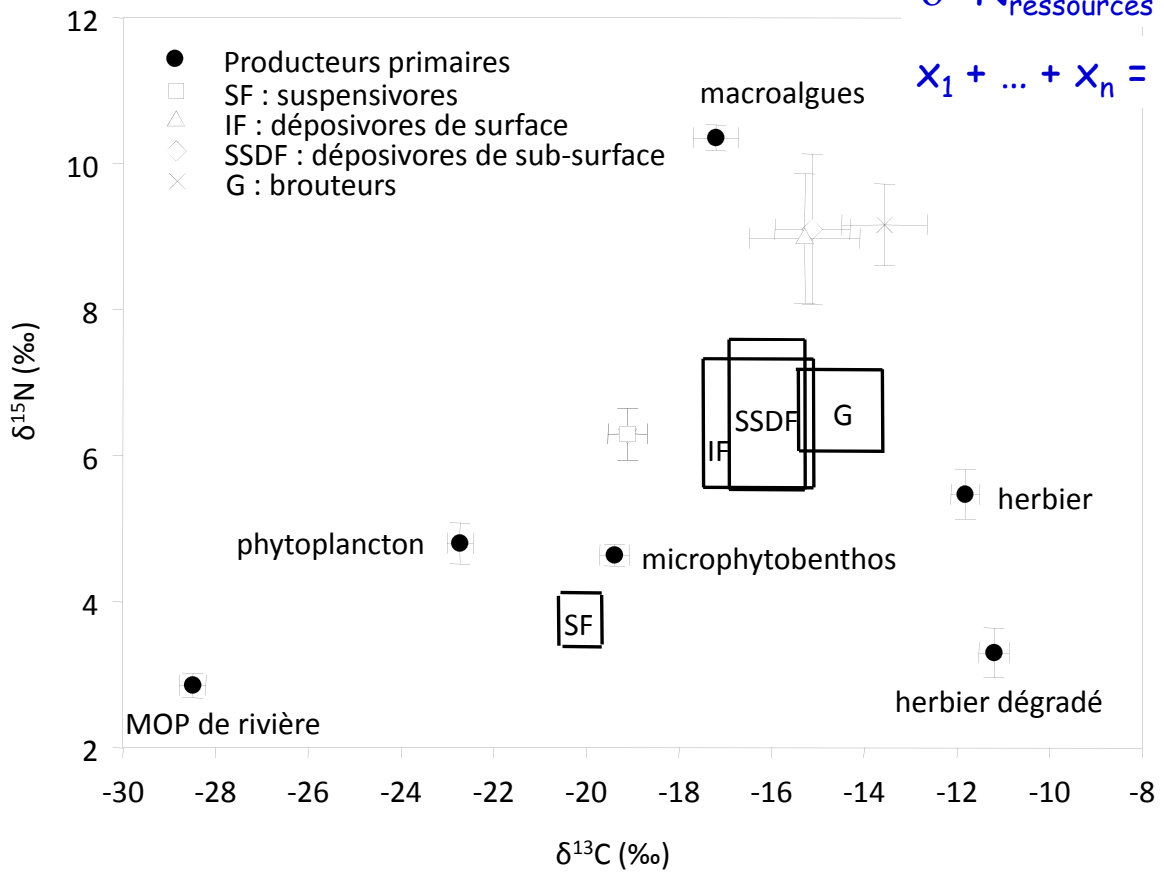
$\delta^{13}C_{ressource} = \delta^{13}C_{consommateur} - \Delta^{13}C$ $\Delta^{13}C$ : fractionnement isotopique

$\delta^{15}N_{ressource} = \delta^{15}N_{consommateur} - \Delta^{15}N$ $\Delta^{15}N$ : fractionnement isotopique

Modèle de mélange : $\delta^{13}C_{ressources} = x_1\ \delta^{13}C_{source\ 1} + \ldots + x_n\ \delta^{13}C_{source\ n}$

$\delta^{15}N_{ressources} = x_1\ \delta^{15}N_{source\ 1} + \ldots + x_n\ \delta^{15}N_{source\ n}$

$x_1 + \ldots + x_n = 1$




Dubois et al. (2014)

# Etude du réseau trophique

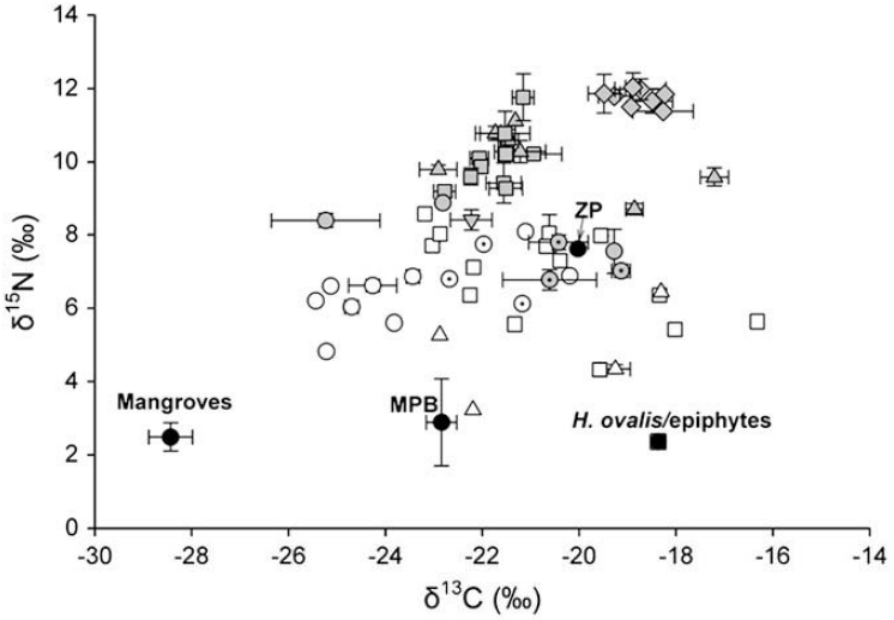



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

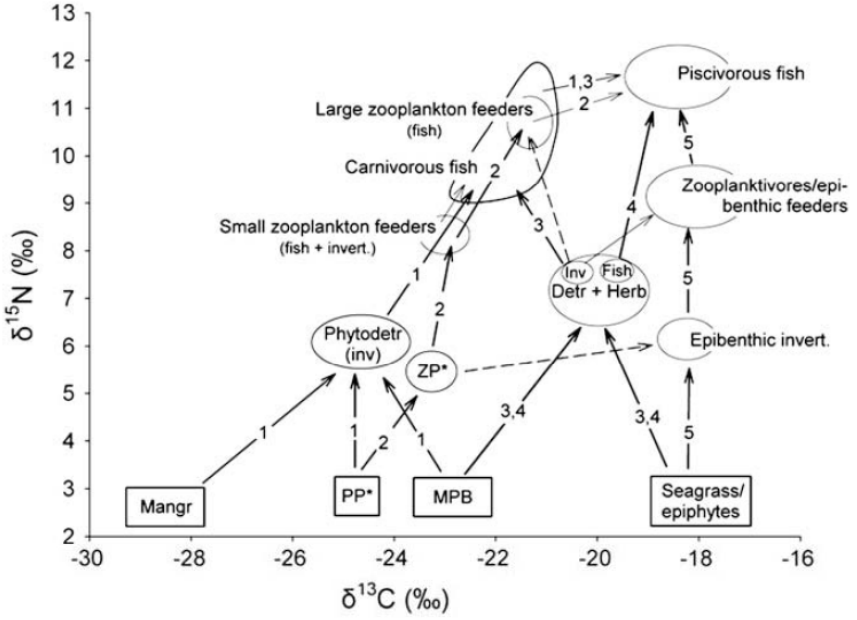



**Fig. 7.** General model for the Deluge Inlet food web showing the main trophic pathways based on stable isotope results from this study. Squares correspond to the ultimate carbon sources, and ellipses to consumers. Shapes delimitate isotope values of all or most species within the trophic group. Arrows indicate main trophic links. Darker arrows suggest stronger links, dashed arrows weaker, and light arrows indicate links of intermediate importance, as suggested by stable isotope analysis. The five main trophic chains are indicated: (1) mangrove-microphytobenthos based; (2) plankton based; (3) and (4) seagrass-microphytobenthos based; and (5) seagrass based. See details in text. Primary producers: Mangr = mangroves; MPB = microphytobenthos; PP = phytoplankton. Consumers: Phytodetr (inv) = invertebrates phytodetritivores; Detr + Herb = detritivores and herbivores; ZP = zooplankton. * – Estimated values, as phytoplankton and estuarine zooplankton were not sampled in this study.

Abrantes et Sheaves (2009)

# Indices de réseau trophique

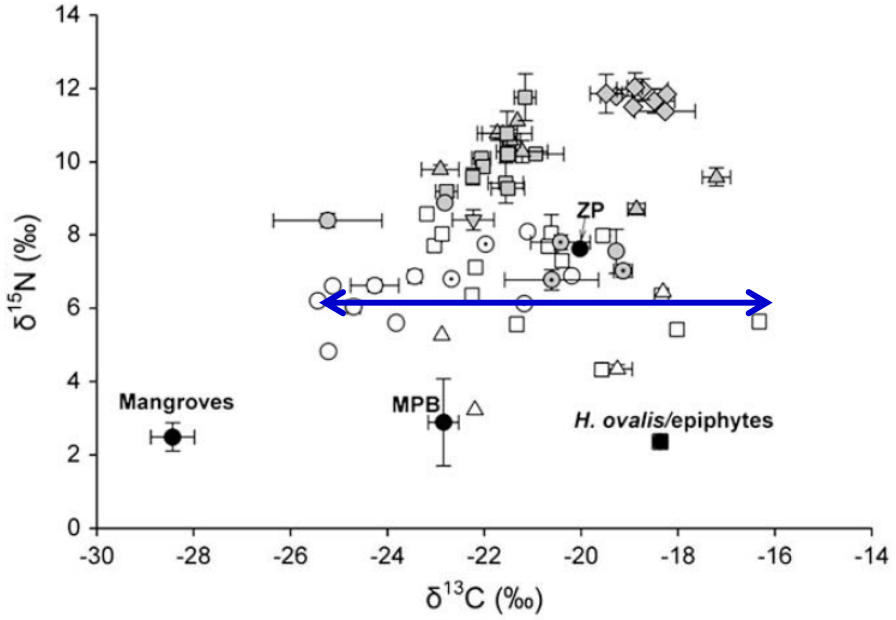



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

Gamme de variation du $\delta^{13}C$ : diversité des ressources trophiques utilisées

Abrantes et Sheaves (2009)

# Indices de réseau trophique

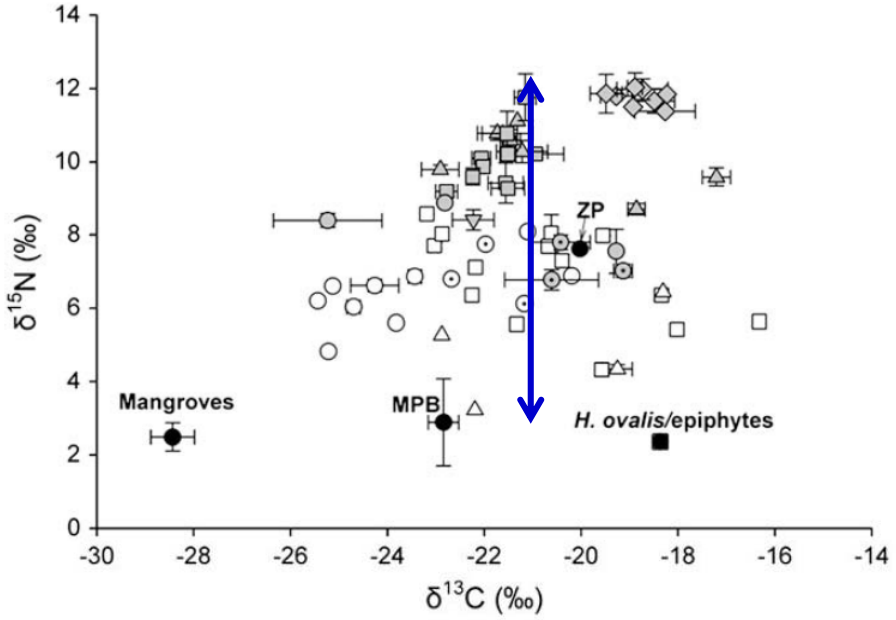



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

Gamme de variation du $\delta^{15}N$ : diversité des niveaux trophiques trophiques

Abrantes et Sheaves (2009)

# Indices de réseau trophique

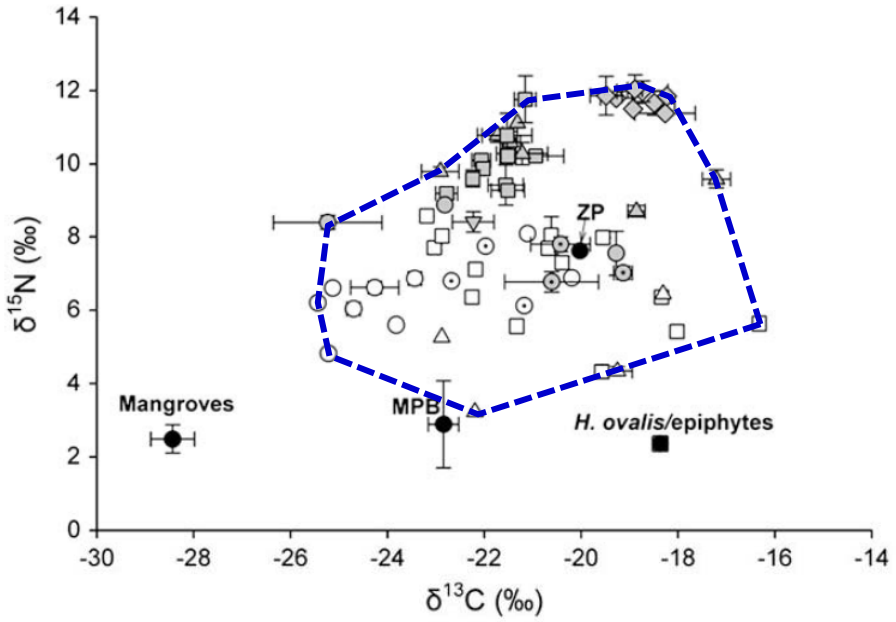



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

Surface $\delta^{13}C$ x $\delta^{15}N$ : diversité trophique

Abrantes et Sheaves (2009)

# Indices de réseau trophique

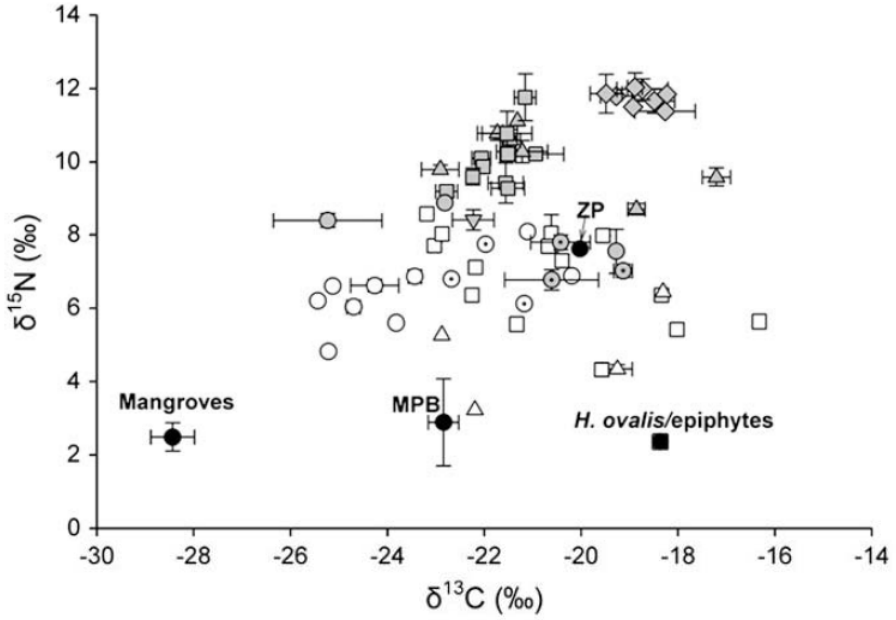



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

Autres indices

redondance trophique

équitabilité trophique

→ Stabilité du fonctionnement trophique

Abrantes et Sheaves (2009)

# Etude du réseau trophique

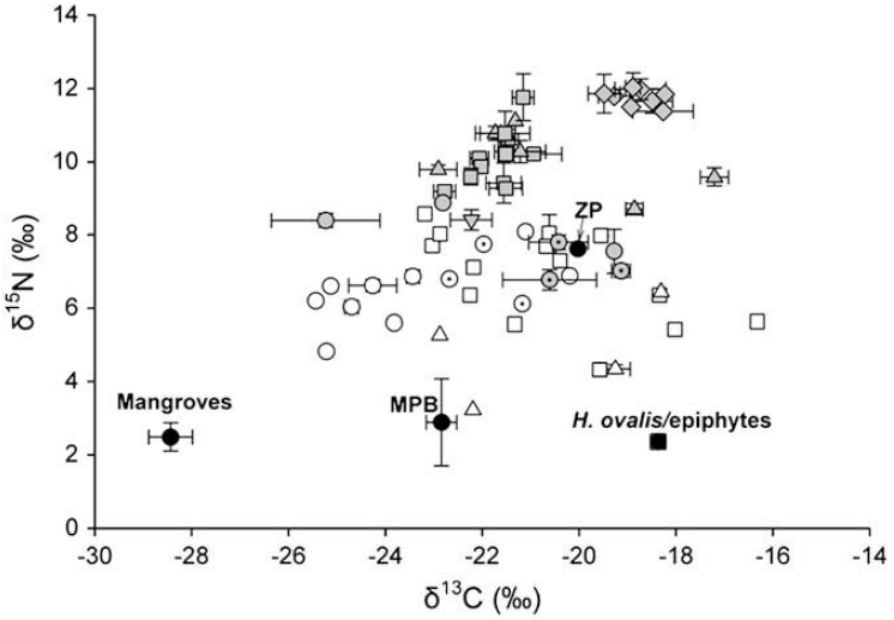



**Fig. 2.** Mean $\delta^{13}C$ and $\delta^{15}N$ (±SE) of producers and zooplankton (black symbols), invertebrates (white symbols) and fish (grey symbols) from Deluge Inlet. $\delta^{15}N$ levels corresponding to the different trophic levels are indicated on the right of the graph (see text). Invertebrates: ○ – bivalves, ⊙ – gastropods; ▽ – polychaetes; △ – peracarids; □ – decapods. Fish: ◯ – herbivores; ⊙ – detritivores; ▽ – omnivores; △ – planktivores; □ – carnivores (macrobenthic carnivores and minor piscivores); ◇ – major piscivores. MPB = microphytobenthos; ZP = zooplankton.

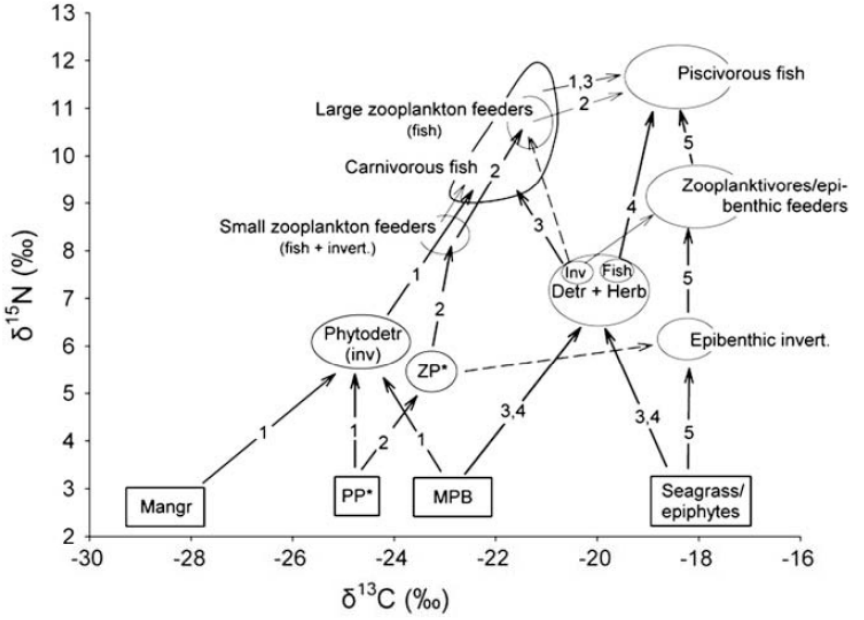



**Fig. 7.** General model for the Deluge Inlet food web showing the main trophic pathways based on stable isotope results from this study. Squares correspond to the ultimate carbon sources, and ellipses to consumers. Shapes delimitate isotope values of all or most species within the trophic group. Arrows indicate main trophic links. Darker arrows suggest stronger links, dashed arrows weaker, and light arrows indicate links of intermediate importance, as suggested by stable isotope analysis. The five main trophic chains are indicated: (1) mangrove-microphytobenthos based; (2) plankton based; (3) and (4) seagrass-microphytobenthos based; and (5) seagrass based. See details in text. Primary producers: Mangr = mangroves; MPB = microphytobenthos; PP = phytoplankton. Consumers: Phytodetr (inv) = invertebrates phytodetritivores; Detr + Herb = detritivores and herbivores; ZP = zooplankton. * – Estimated values, as phytoplankton and estuarine zooplankton were not sampled in this study.

⟶ Nécessité de mesurer les isotopes de chaque compartiment

**Le problème du phytoplancton**

Abrantes et Sheaves (2009)

# Signatures isotopiques du phytoplancton

Le phytoplancton ne peut pas être extrait du pool de MOP pour une mesure directe

Les $\delta^{13}C$ et $\delta^{15}N$ du phytoplancton varie fortement dans le temps et dans l'espace

Approche empirique

$\delta^{13}C = 1{,}430\ Ln([Chl\ a + pheo]) - 23{,}7$

$\delta^{15}N = 5{,}58 - 0{,}339\ (1 + ln([NO_3^-]/[NO_3^-]_{hiver}))$

Station Bizeux (Dinard)

$\delta^{13}C = 0{,}248\ Salinté + 1{,}34\ Ln([Chl\ a]) - 30{,}2$

$\delta^{15}N = 5{,}40 - 1{,}40\ ([NO_3^-]/[NO_3^-]_{hiver})$

Station Comprian (Arcachon)

SOMLIT

MOSLIT

Ecosphère Continentale et Côtière

Liénart et al. (soumis)

Savoye et al. (soumis)

# SOMLIT et réseau trophique

| | |
|---|---|
| Identifier les compartiments | Pico-nanoplancton<br>Microphytoplancton<br>Composition de la MOP |
| Quantifier les compartiments | Chlorophylle *a*<br>Pico-nanoplancton<br>Microphytoplancton<br>Composition de la MOP |
| Identifier les liens entre compartiments | $\delta^{13}C$, $\delta^{15}N$ |
| Quantifier les flux entre compartiments | $\delta^{13}C$, $\delta^{15}N$ |

Site SOMLIT : mise à disposition des données de composition de la MOP et des $\delta^{13}C$ et $\delta^{15}N$ du phytoplancton ?