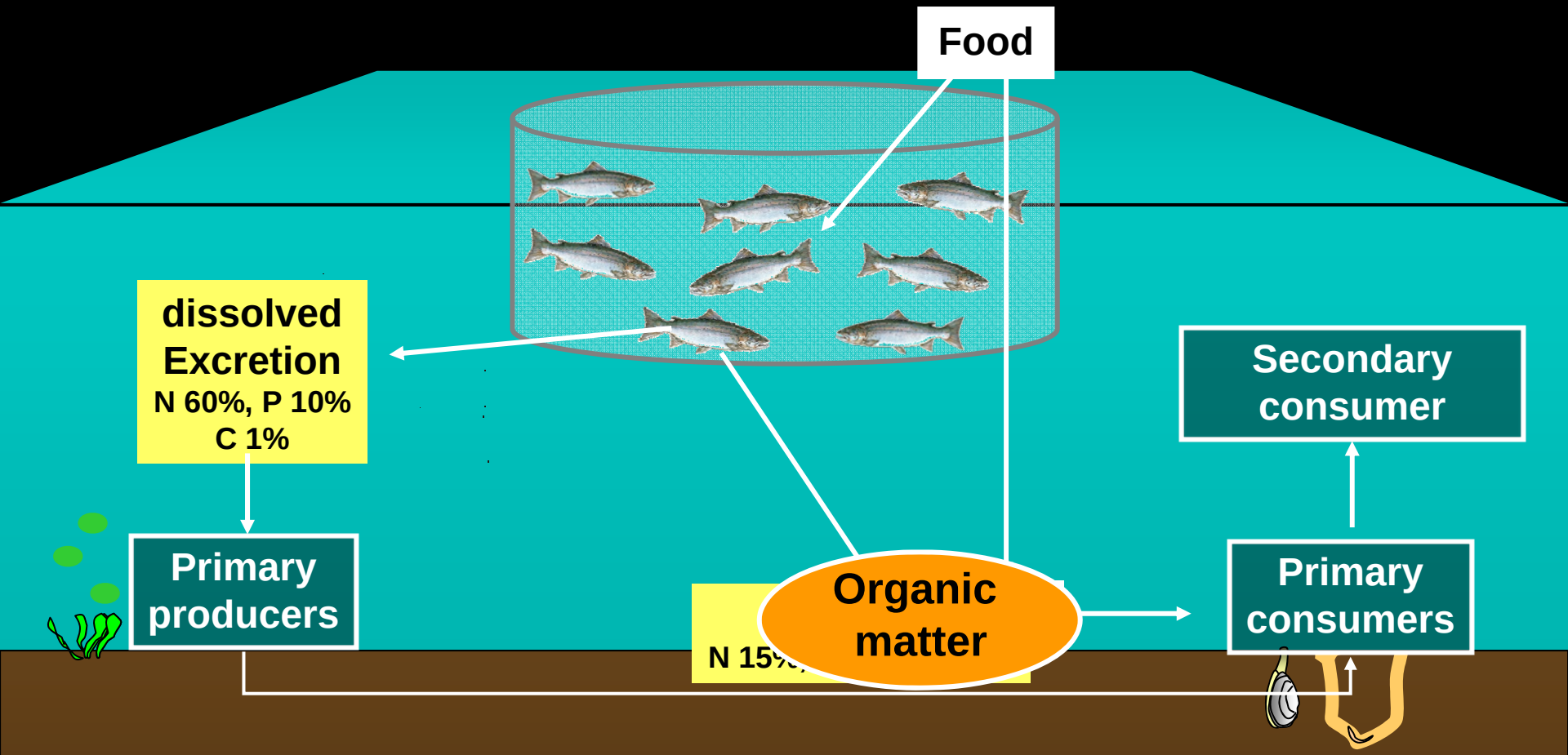
Extent of influence of salmon farms on benthic community and trophic structure

Myriam Callier
School of Biology and Environmental Science,
University College Dublin
now at IFREMER, Palavas Station, France

S. Lefebvre, K. Dunagan, M-P Bataille, J. Coughlan and T. Crowe

Funded as part of the Strategy for Science, Technology and Innovation

Aquaculture waste into the food web



Various pathways

Assimilation of aquaculture waste by the biota *(Sara et al. 2004, Lojen et al. 2005, Dolenec et al. 2007)*

Objectives

1. Determine the influence of aquaculture waste on **benthic communities**

2. Assess the contribution of aquaculture waste to benthic **organisms' diet**

1. Influence of aquaculture waste on **benthic communities**

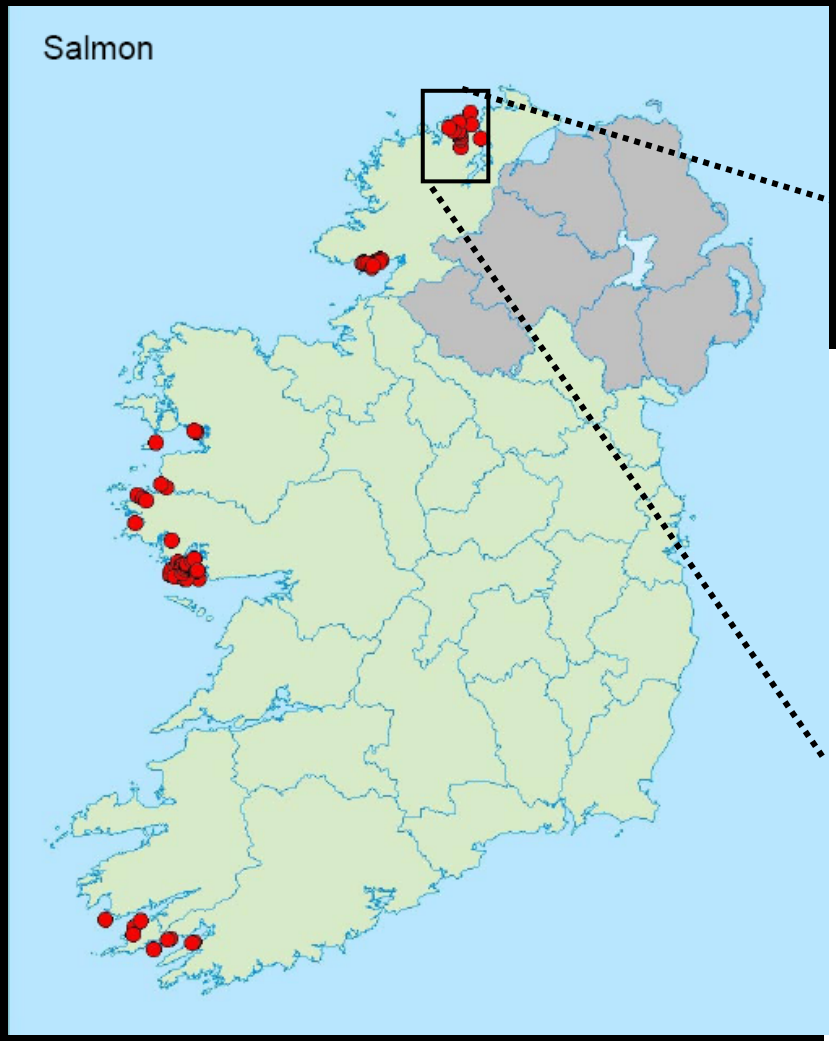
Hypotheses:

1. Abundance and diversity of benthic macrofauna will vary along transects leading away from salmon cages

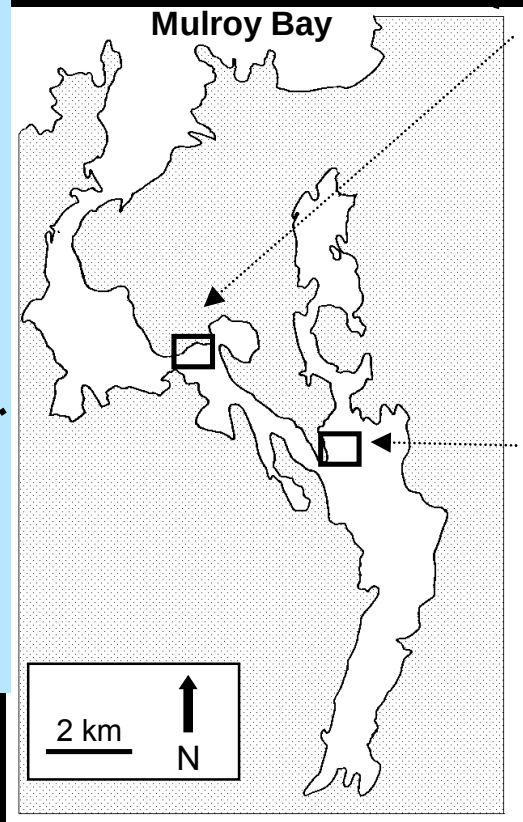
2. Benthic community structure will differ between sites located at different distances from the farm

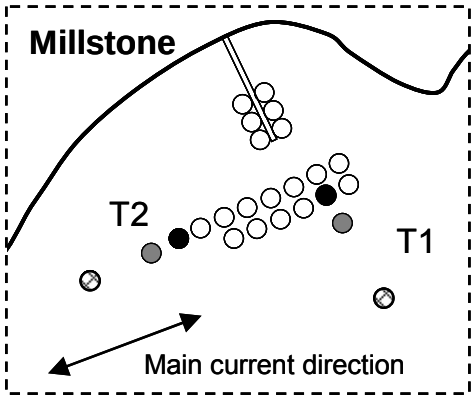
3. Extent of fish farm influence depends on residual water current direction

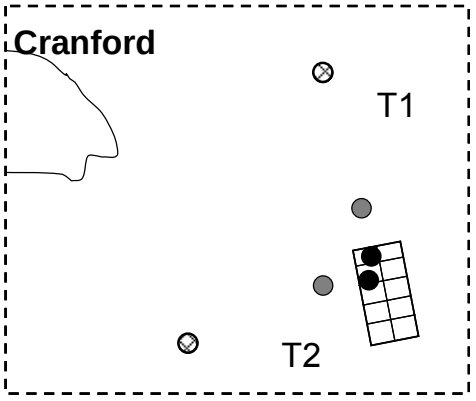
Study sites



Mulroy Bay, Co. Donegal, Republic of Ireland



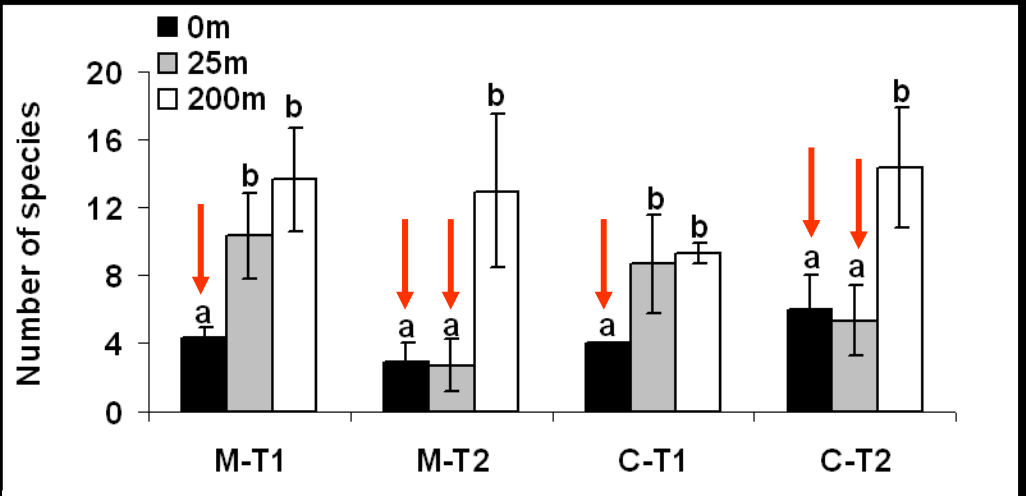




marineharvest

1- Methodology

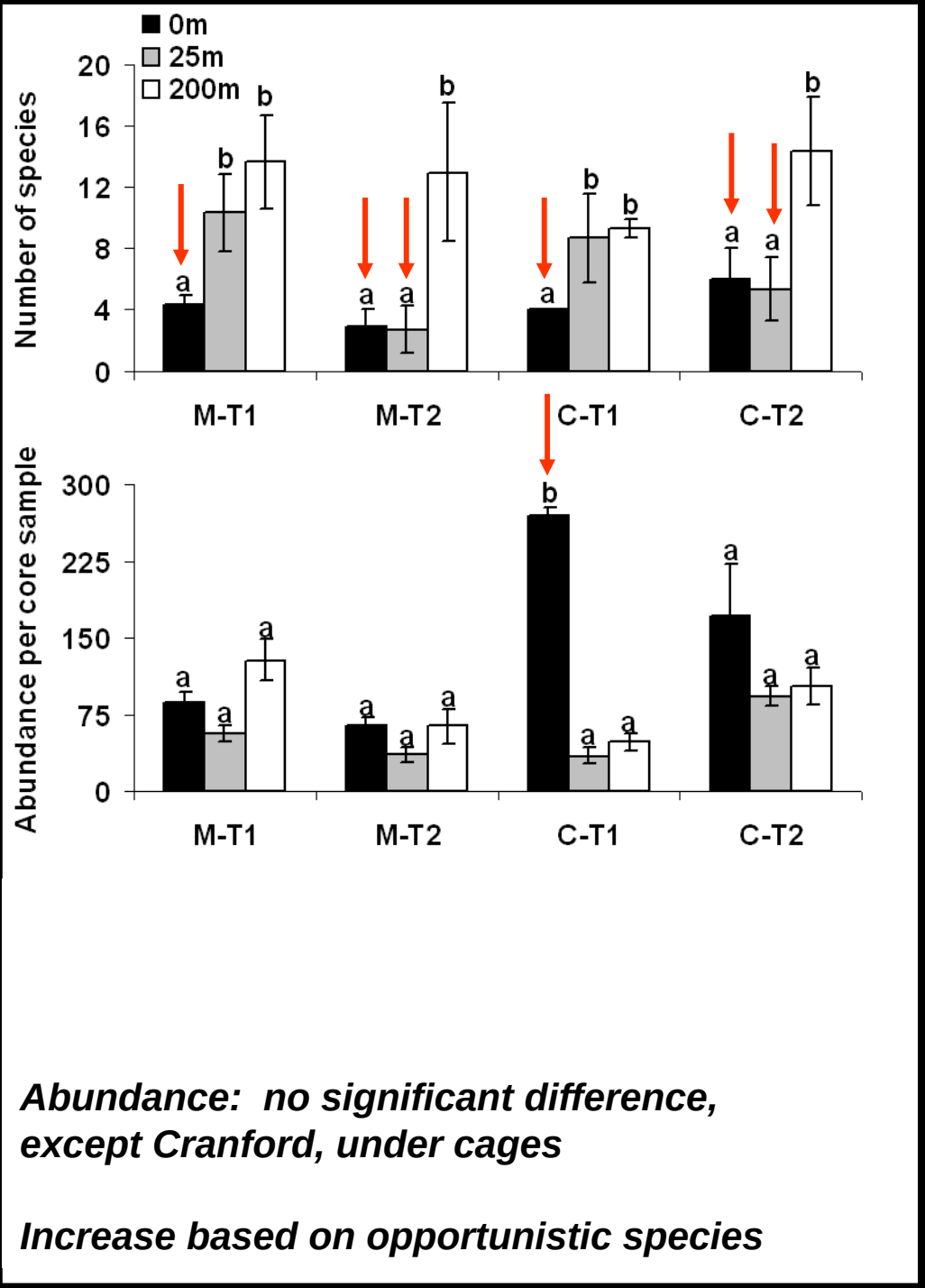
1- Results



Diversity: **lower under the cages and 25m, in the current direction**

Callier et al., in revision

1- Results

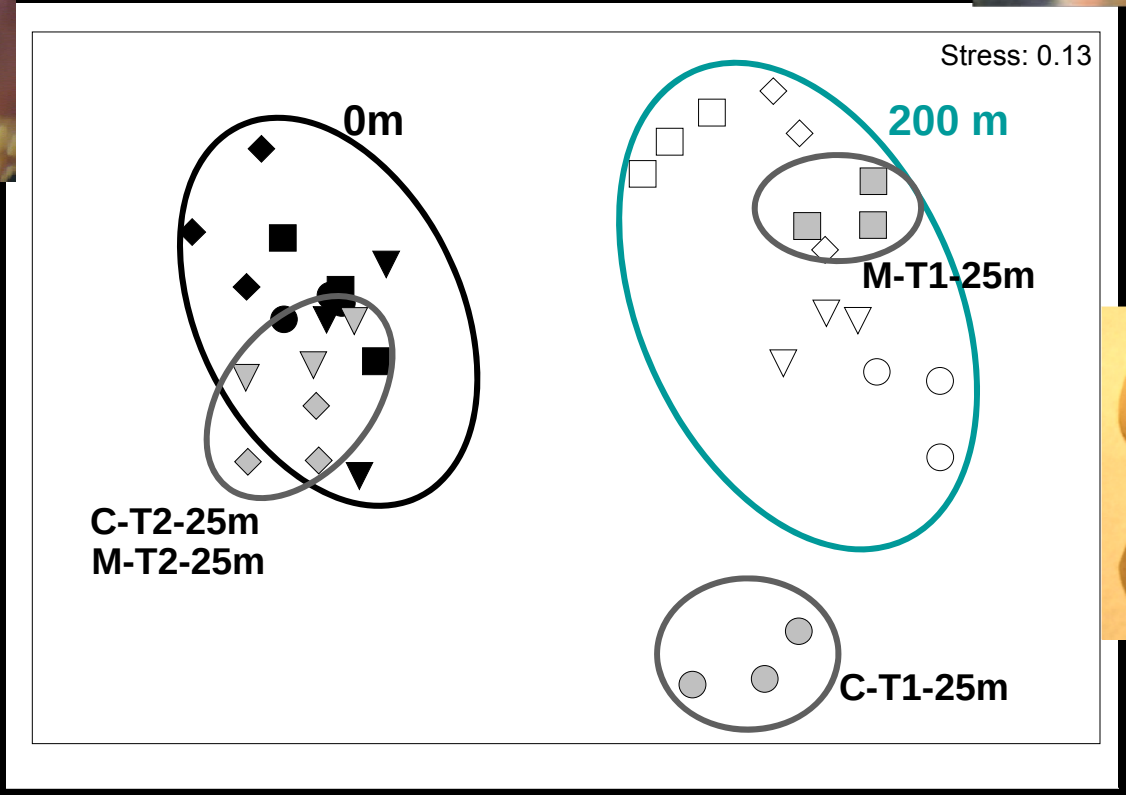


Abundance: no significant difference, except Cranford, under cages

Increase based on opportunistic species

Callier et al., in revision

1- Community structure



Organic enrichment gradient

Callier et al., in revision

1- Summary

- ✓ Localised organic enrichment due to salmon farming
- ✓ Effects extend < 25 m, perpendicular to current
- ✓ Effects extend 25-200m downstream
- ✓ Under cages: low diversity, high abundance of opportunistic species

Are these species benefiting from the organic input ?

2. Assess the contribution of aquaculture waste in the benthic **organism's diet**

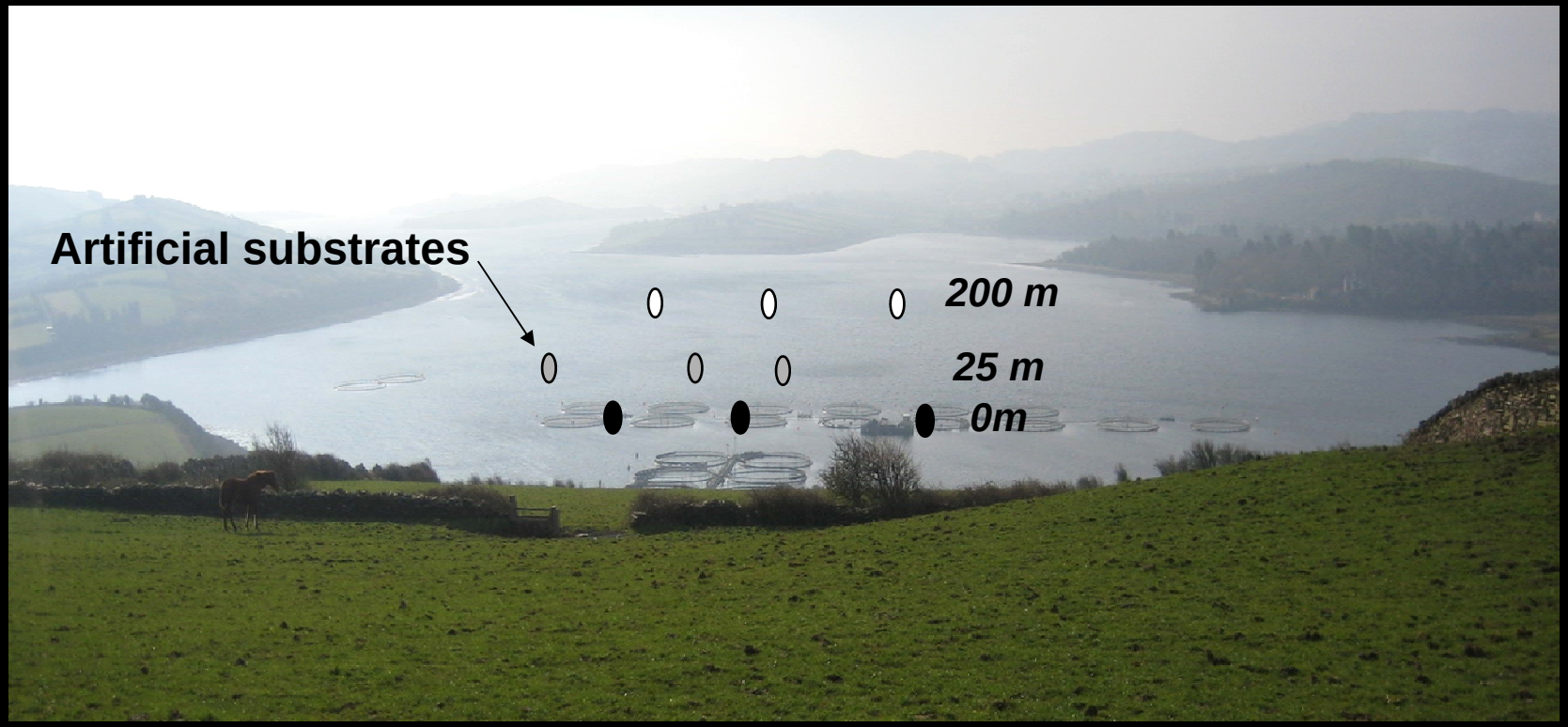
Stable isotope (SI) increasingly used to determine:

- Trophic level, pathways of OM in food webs
- Contribution of food sources to organisms' diet

Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$) efficient tracer of salmon food:

- ➢ Compared to other sources:
- Enriched in ^{15}N as contain fish/crustacen meal *(Mazzola and Sara 2001)*
- Depleted in ^{13}C as contain terrestrial vegetables (wheat, soya) *(Yokoyama and Ishihi, 2007)*

3- Methodology



2 months

2- Methodology

SOURCES OF ORGANIC MATTER

Salmon Faeces

Salmon Food pellet

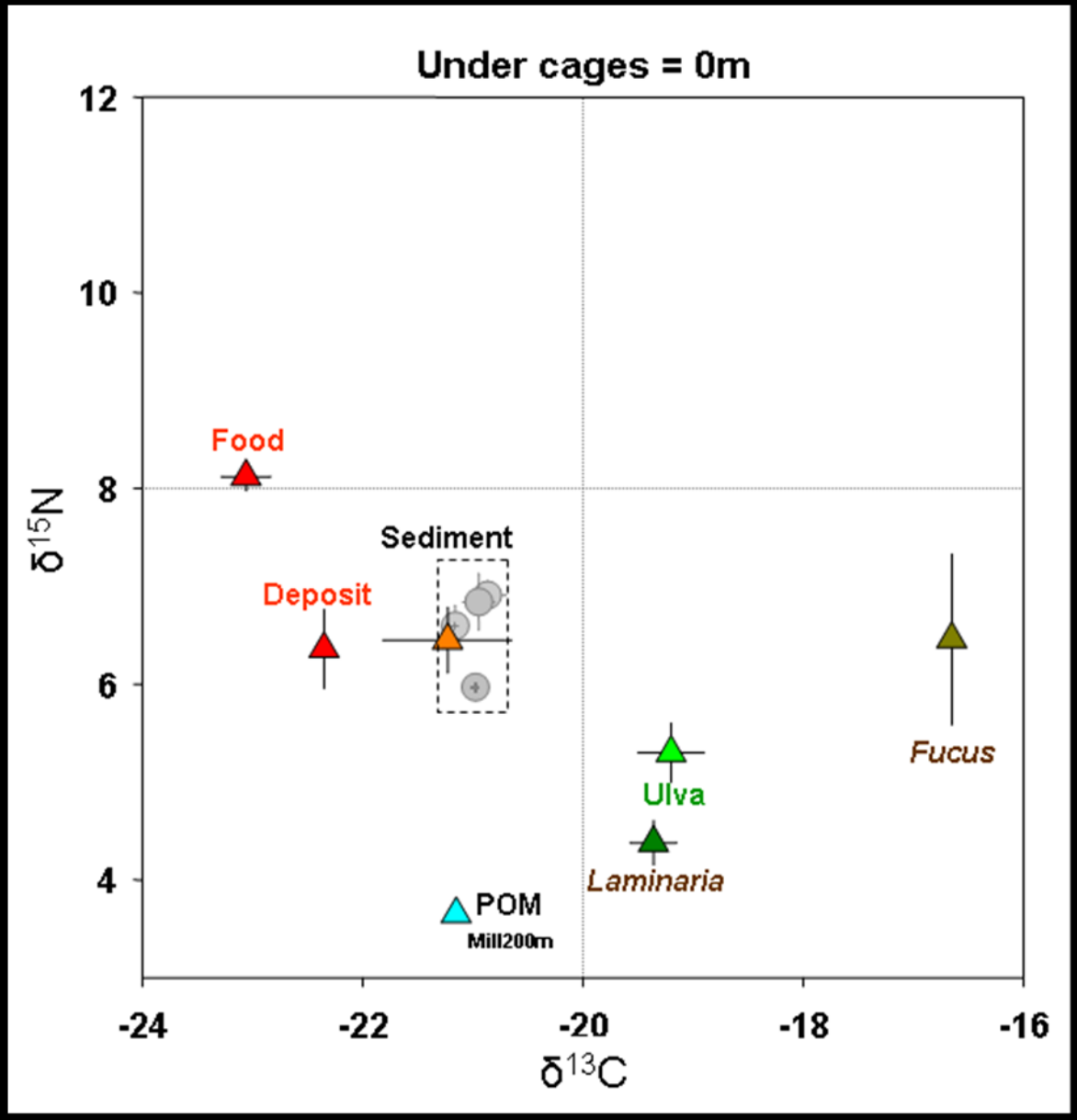
macroalgae

POM- Water samples

CONSUMERS

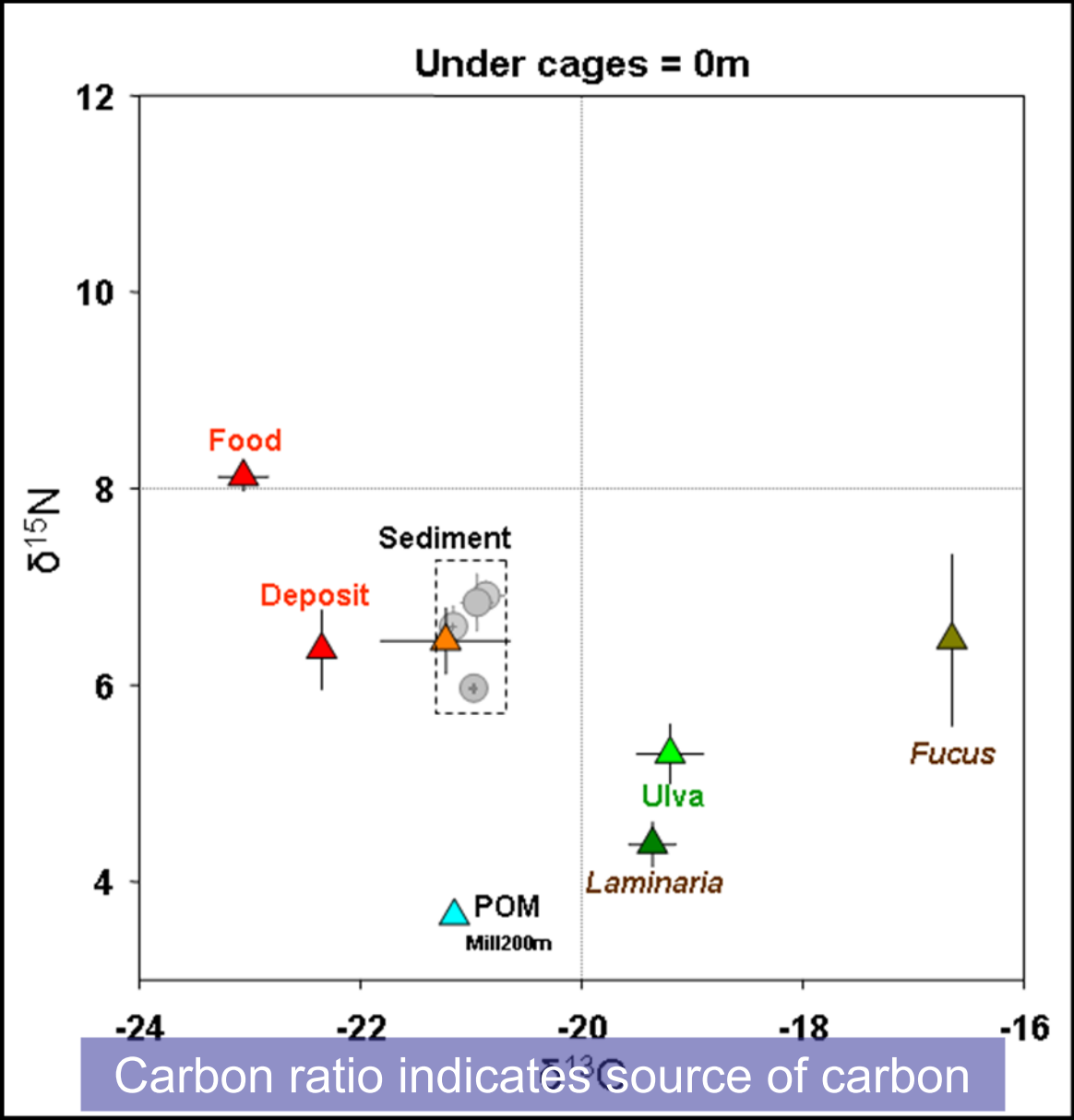
Stable isotope composition
Carbon and Nitrogen

2- Results


Under cages = 0m
12
10
8
6
4
δ15N
Food
Sediment
Deposit
Ulva
Laminaria
Fucus
POM
Mill200m
-24
-22
-20
-18
-16
δ13C

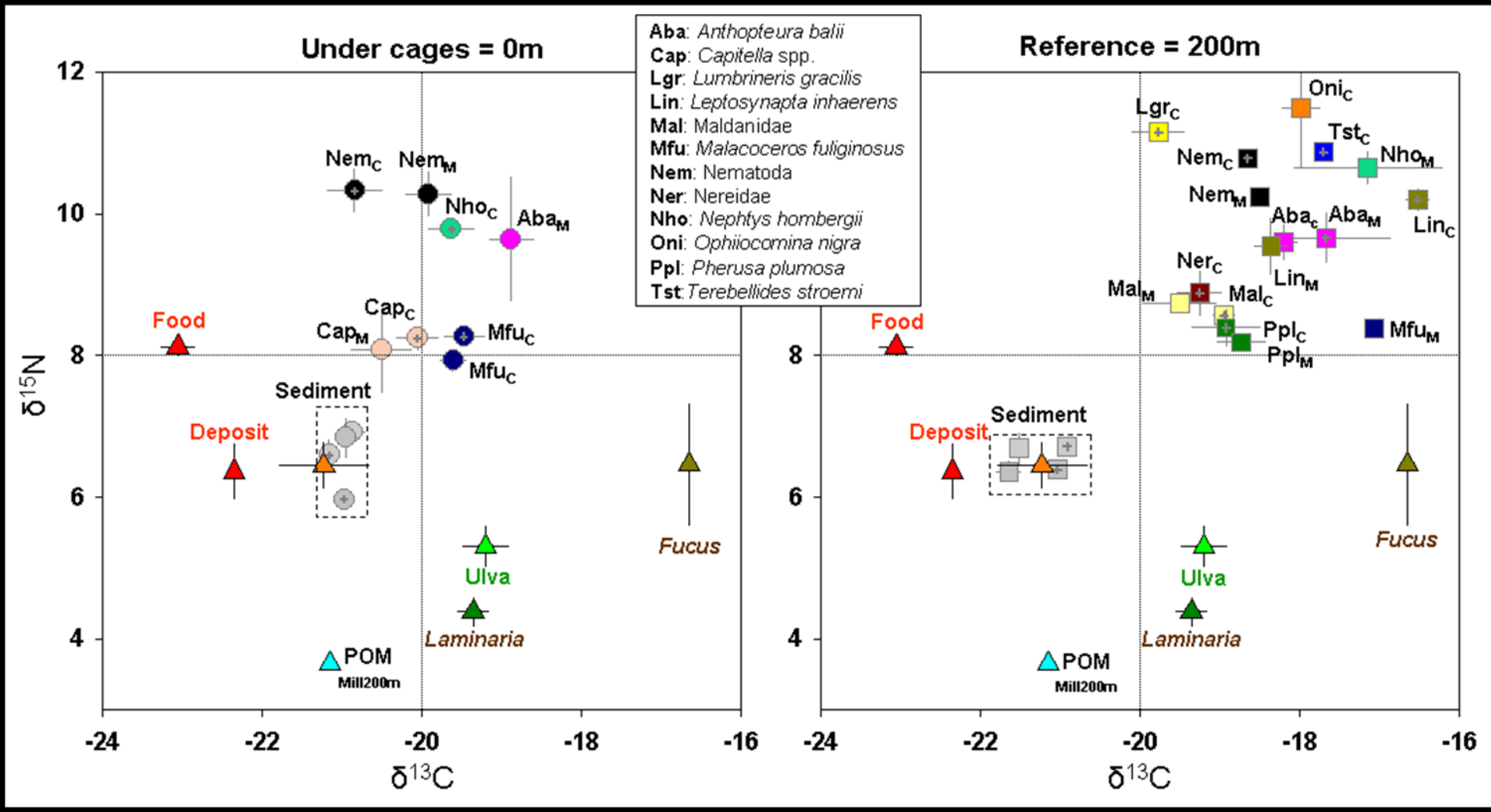
2- Results

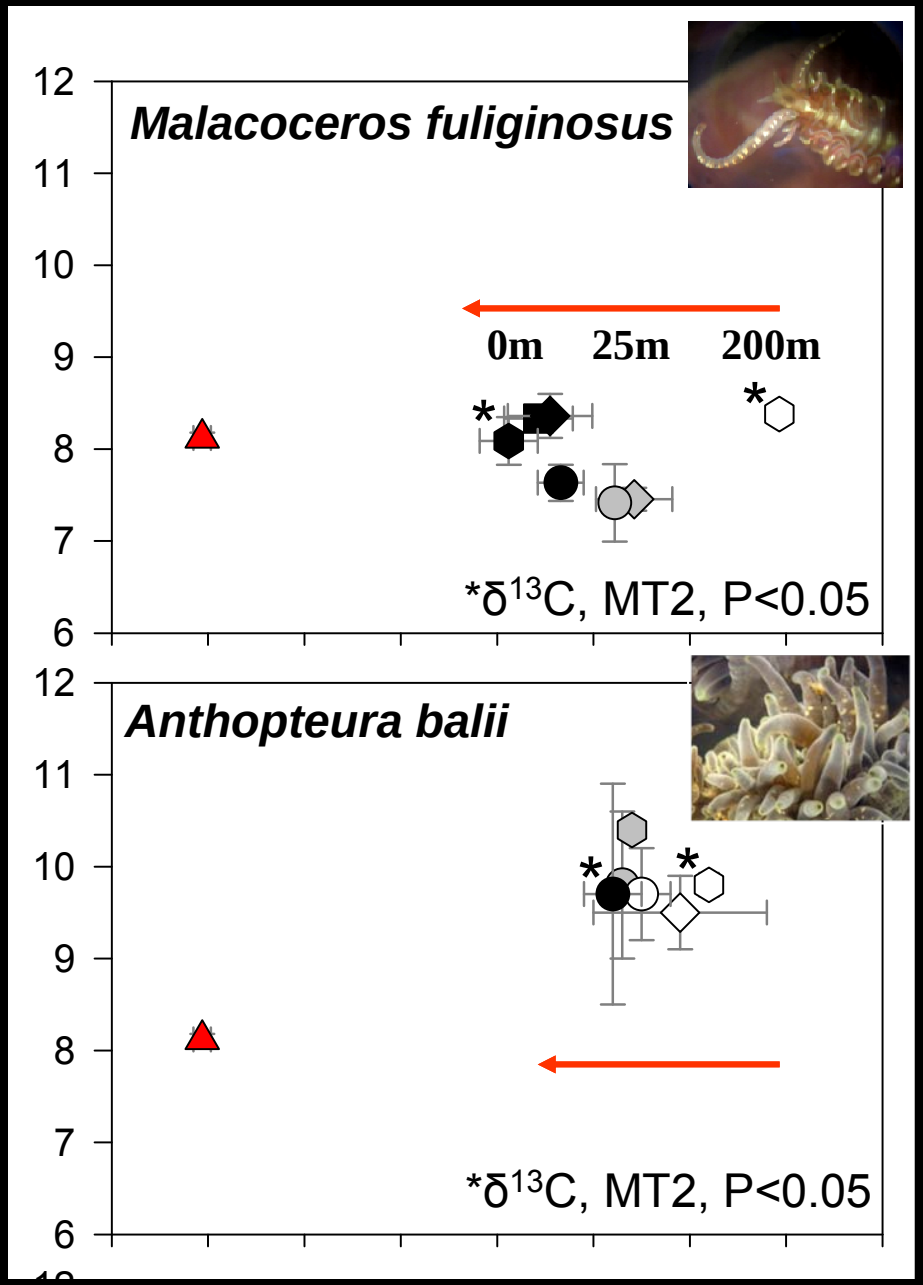
Nitrogen ratio indicates trophic position



Carbon ratio indicates source of carbon

2- Results


Under cages = 0m
Reference = 200m
Aba: Anthopteura balii
Cap: Capitella spp.
Lgr: Lumbrineris gracilis
Lin: Leptosynapta inhaerens
Mal: Maldanidae
Mfu: Malacoceros fuliginosus
Nem: Nematoda
Ner: Nereidae
Nho: Nephtys hombergii
Oni: Ophiiocomina nigra
Ppl: Pherusa plumosa
Tst: Terebellides stroemi
δ15N
δ13C
12
10
8
6
4
-24
-22
-20
-18
-16
Food
Deposit
Sediment
Fucus
Ulva
Laminaria
POM
Mill200m
Nem_C
Nem_M
Nho_C
Aba_M
Cap_C
Cap_M
Mfu_C
Mfu_C
Oni_C
Lgr_C
Tst_C
Nho_M
Nem_C
Nem_M
Aba_C
Aba_M
Lin_C
Ner_C
Lin_M
Mal_M
Mal_C
Ppl_C
Ppl_M
Mfu_M


Malacoceros fuliginosus
12
11
10
9
8
7
6
0m
25m
200m
*
*
*δ13C, MT2, P<0.05
Anthopteura balii
12
11
10
9
8
7
6
*
*
*δ13C, MT2, P<0.05

Malacoceros fuliginosus

12
11
10
9
8
7
6

0m 25m 200m

*δ13C, MT2, P<0.05

Anthopteura balii

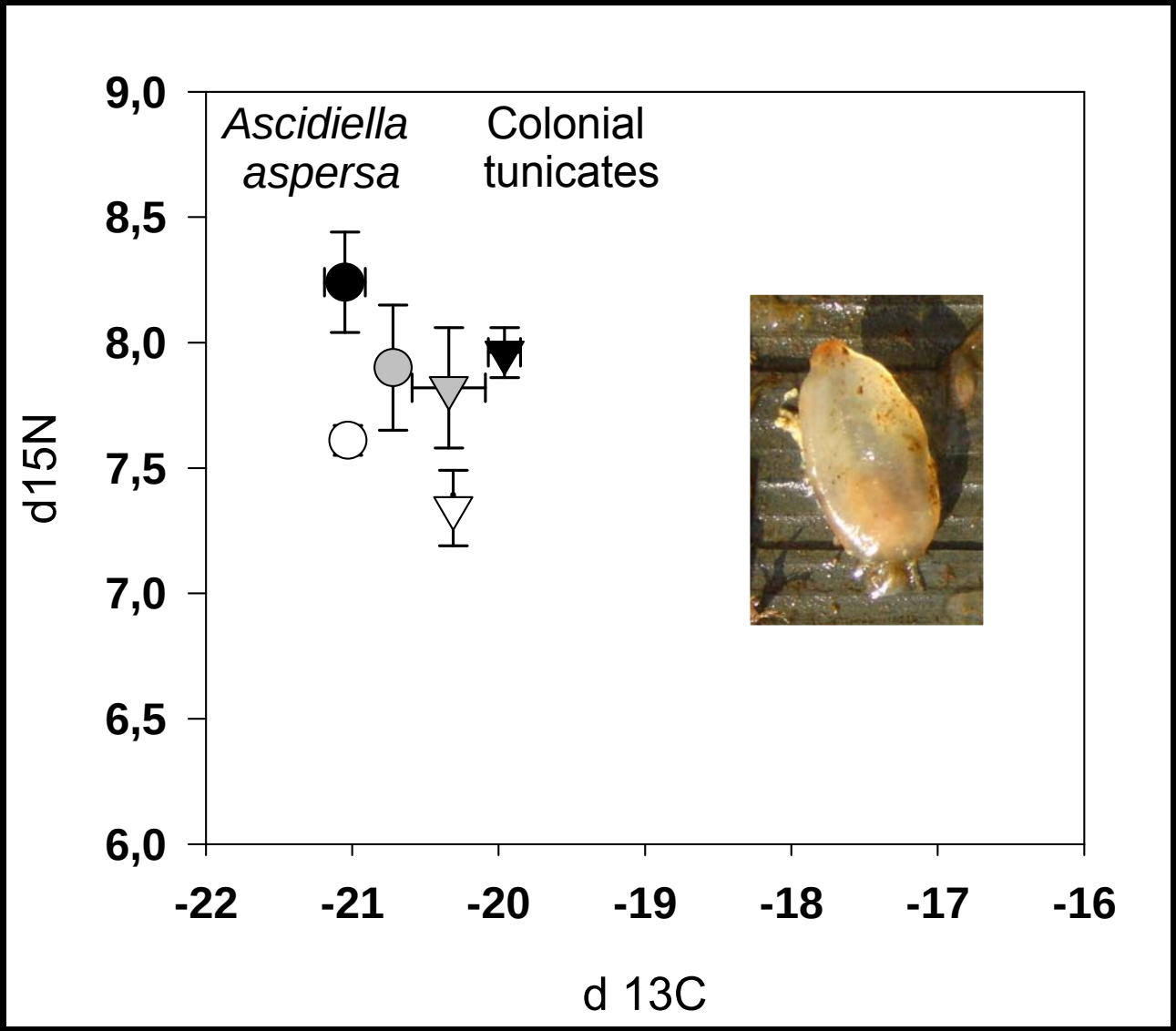
12
11
10
9
8
7
6

*δ13C, MT2, P<0.05

Nephtys hombergii

* δ13C, MT2, P<0.05
- δ15N, MT1, P<0.05

2- Results: fouling organisms



2- Summary

- ^{13}C and ^{15}N are effective tracers
- Benthic organisms feed on fish farm waste
- Fouling organisms assimilate particulate material released from fish cages

Conclusions

- ✓ Increased biomass of suspension feeders (eg. Tunicates) could decrease levels of particulate and dissolved material in the surrounding environment
- ✓ Potential mitigation strategy?
- ✓ Substrates could be used in highly sensitive environments, where small reductions in nutrient loading could be critical

Perspective

- Could the biomass of fouling organisms be increased to increase uptake of organic material?
- Could benthic species (polychaetes) be used in integrated aquaculture systems to valorise fish farm waste

Acknowledgement

HELP AND ADVICE

- Francis O'Beirn, Marine Institute
- Grainne O'Brein, BIM
- Catherine McManus, Marine Harvest Ireland

FIELD and LAB WORK

- MarBEE team!
- Special thanks to Julien, Paul and Silvia
- Divers and staff from Marine Harvest, Mulroy Bay!

FUNDING AGENCY

- Environmental Protection Agency, NDP, SSTI

Marine Institute

BIM

marineharvest

UCD DUBLIN

epa Environmental Protection Agency

NDP

SSTI

Funded as part of the Strategy for Science, Technology and Innovation