Comparing apples and oranges: a statistical approach to compare the impact of active and passive fishing gears on epibenthic communities

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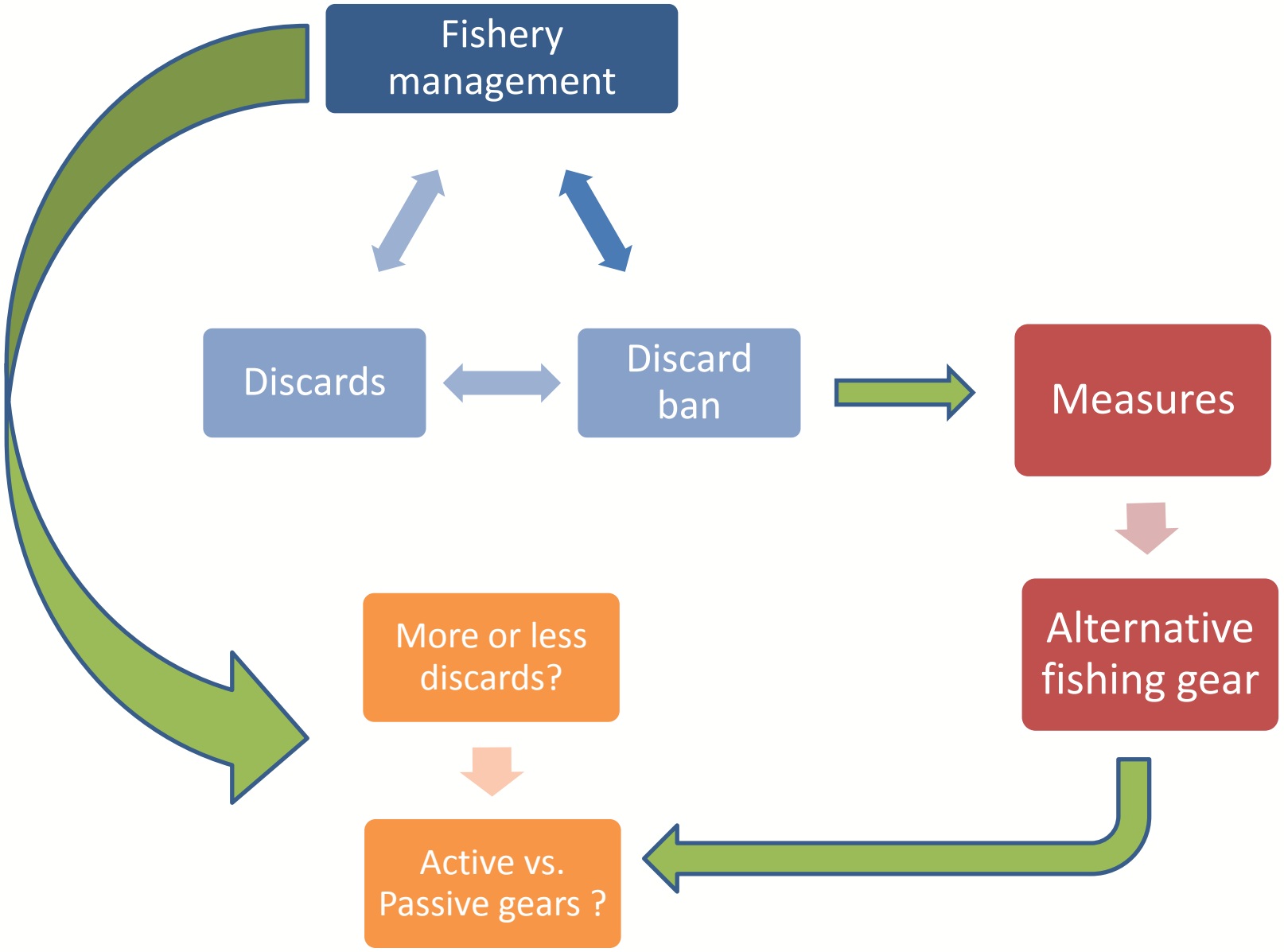
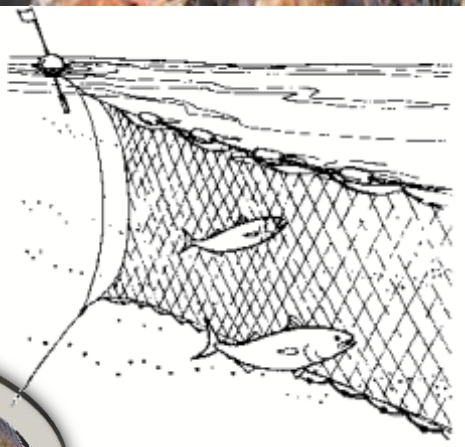

Fishery management
Discards
Discard ban
Measures
Alternative fishing gear
More or less discards?
Active vs. Passive gears ?


Yipie!
IN
UIT

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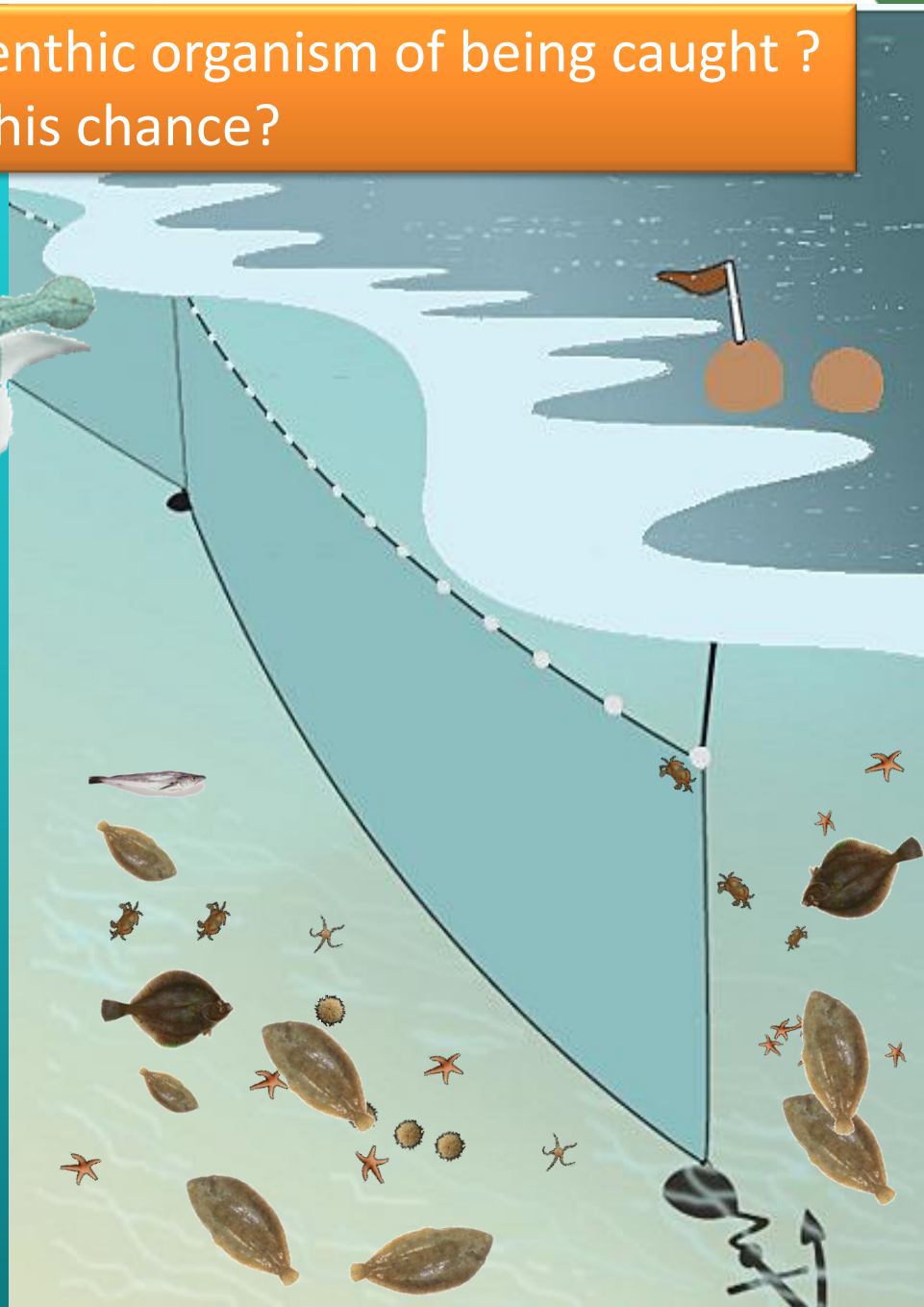
- What is the chance for an epibenthic organism of being caught ?
- Which variables contribute to this chance?



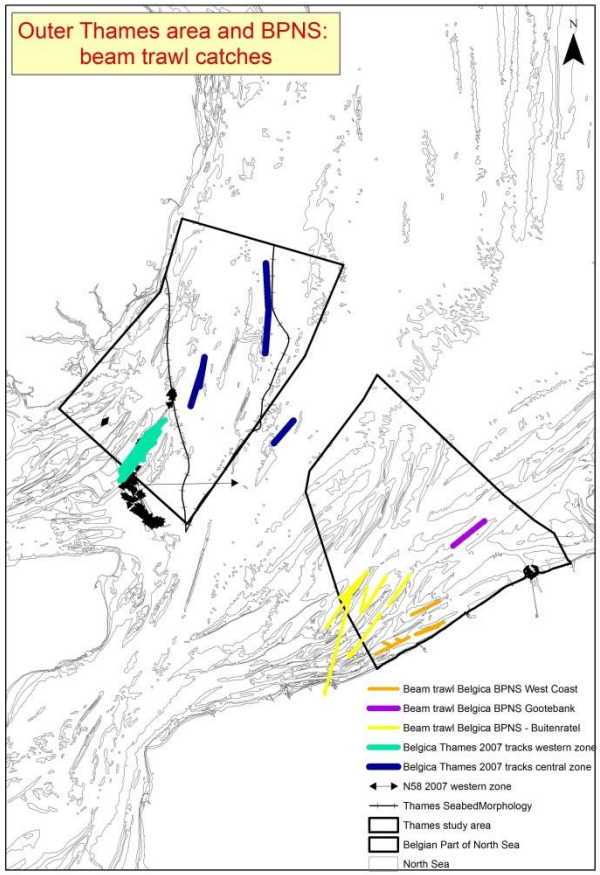
Discards

≈ fishing effort !

+ gear type ?

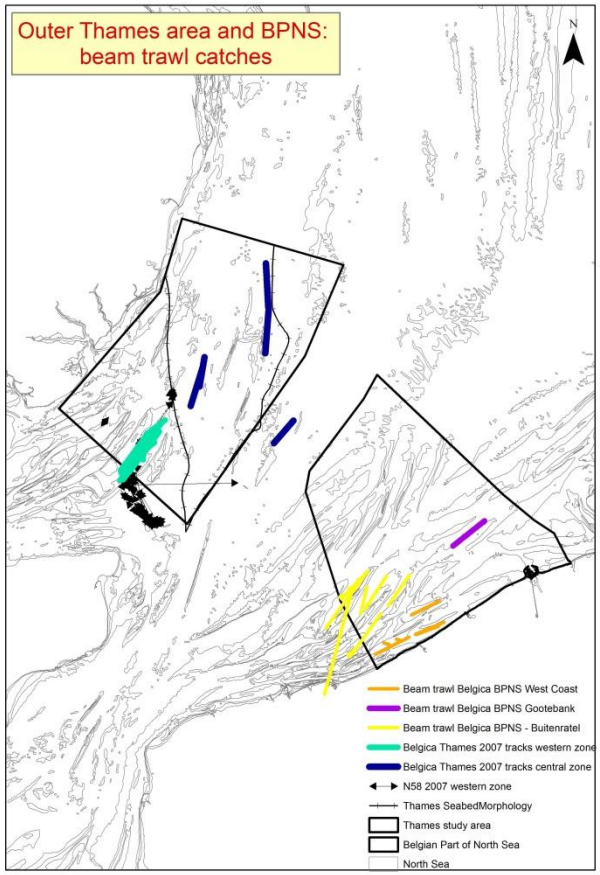
+ epibenthos population size ?

+ predictors for variation in discard composition ?


Outer Thames area and BPNS:
beam trawl catches
N
Beam trawl Belgica BPNS West Coast
Beam trawl Belgica BPNS Gootebank
Beam trawl Belgica BPNS - Buitenratel
Belgica Thames 2007 tracks western zone
Belgica Thames 2007 tracks central zone
N58 2007 western zone
Thames SeabedMorphology
Thames study area
Belgian Part of North Sea
North Sea

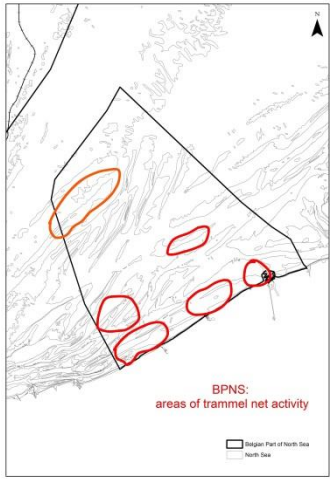

Norwegian Sea
Sverige
Sweden
Norge
Norway
Suomi
Finland
Eesti
Estonia
Latvija
Latvia
North Sea
Danmark
Denmark
United
Kingdom
Ireland
Éire
Nederland
Netherlands
Polska
Poland
Česká rep
Czech Rep
Slovensko
Slovakia
Österreich
Austria
France
România

Sole fishery & discards



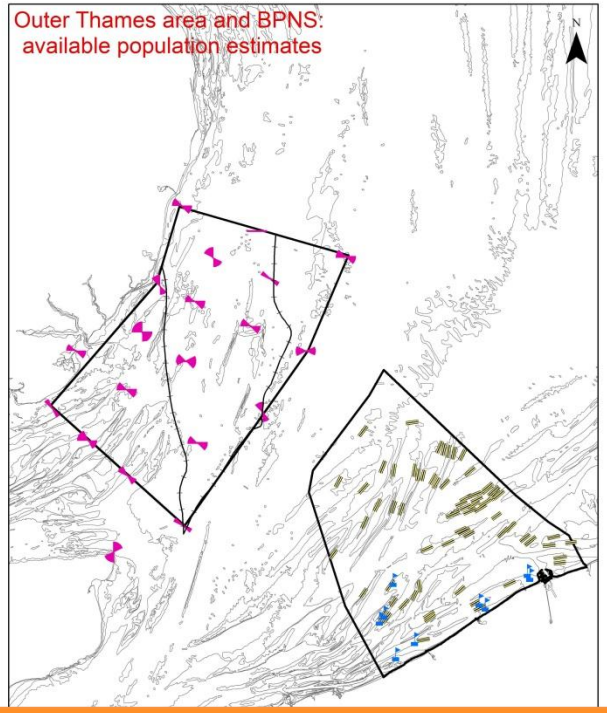
- R.V Belgica + commercial vessel
- 4m beamtrawl
- Ticker chain and chain mat
- Mesh size: 80 mm
- 2004-'10

BPNS
Trammel net catches



- 4 commercial vessels
- **F**leets: 300 - 3600m long, net 2 to 10 km
- Soaking time: 7-20h
- Mesh size: 100 mm
- 2006-'10

Epibenthos population estimates



Outer Thames

- 2m epibenthos trawl (2007) ; MALSF (REC)

BPNS

- 8m beam trawl (2001-'10) ; RV Belgica
- 3m beam trawl (2009), RV Zeeleeuw

Mesh size: 10 and 22 mm

How to compare numbers ?

Active:
- ‘tow path’
- Fishing effort expressed as fished hours or swept area

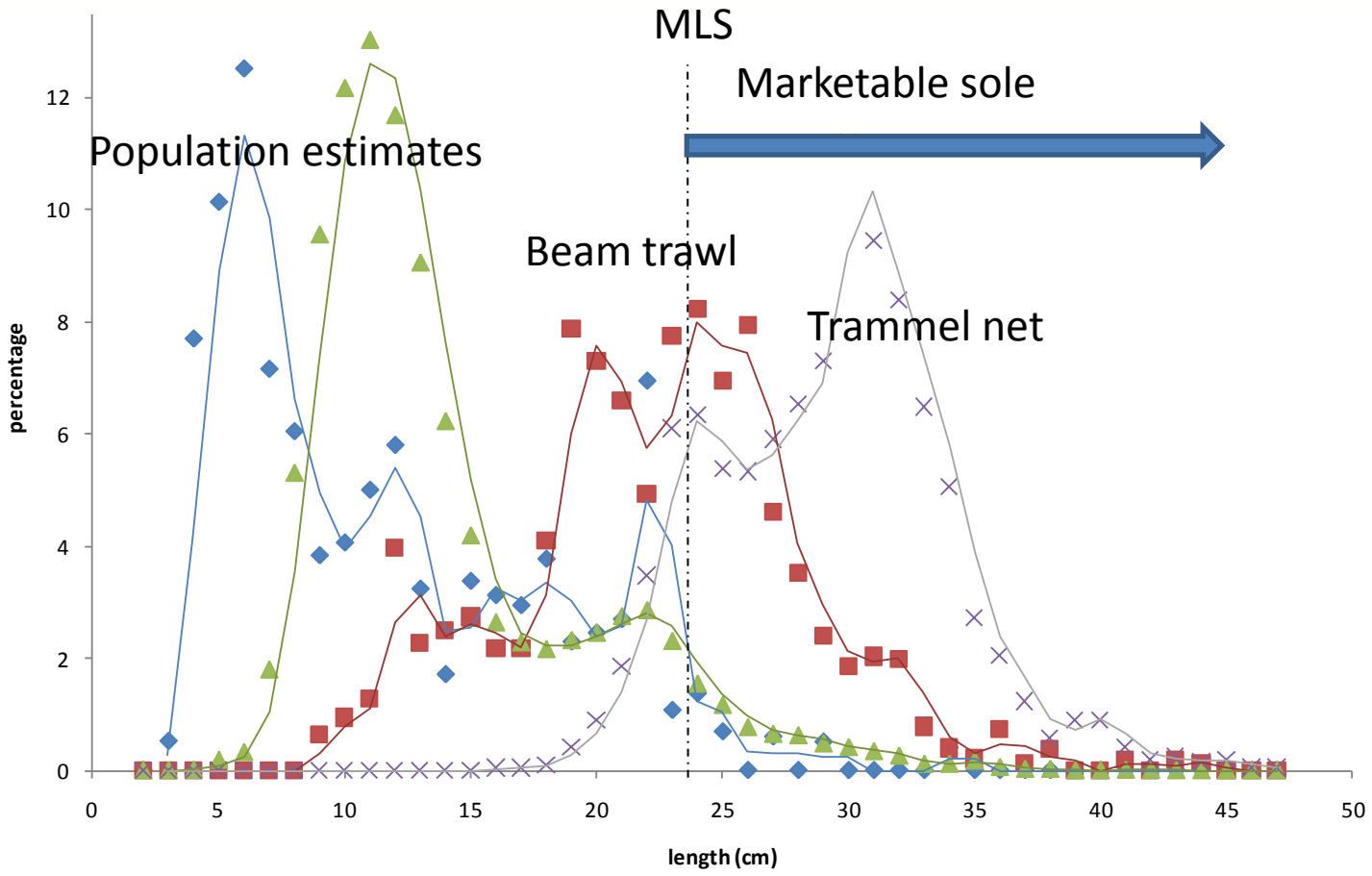
PASSIVE:
- No ‘tow path’
- Fishing effort expressed as net length and soaking time

Epibenthos population estimates expressed as numbers per surface unit

→ CPUE nor epibenthos estimates comparable → DPUE ?

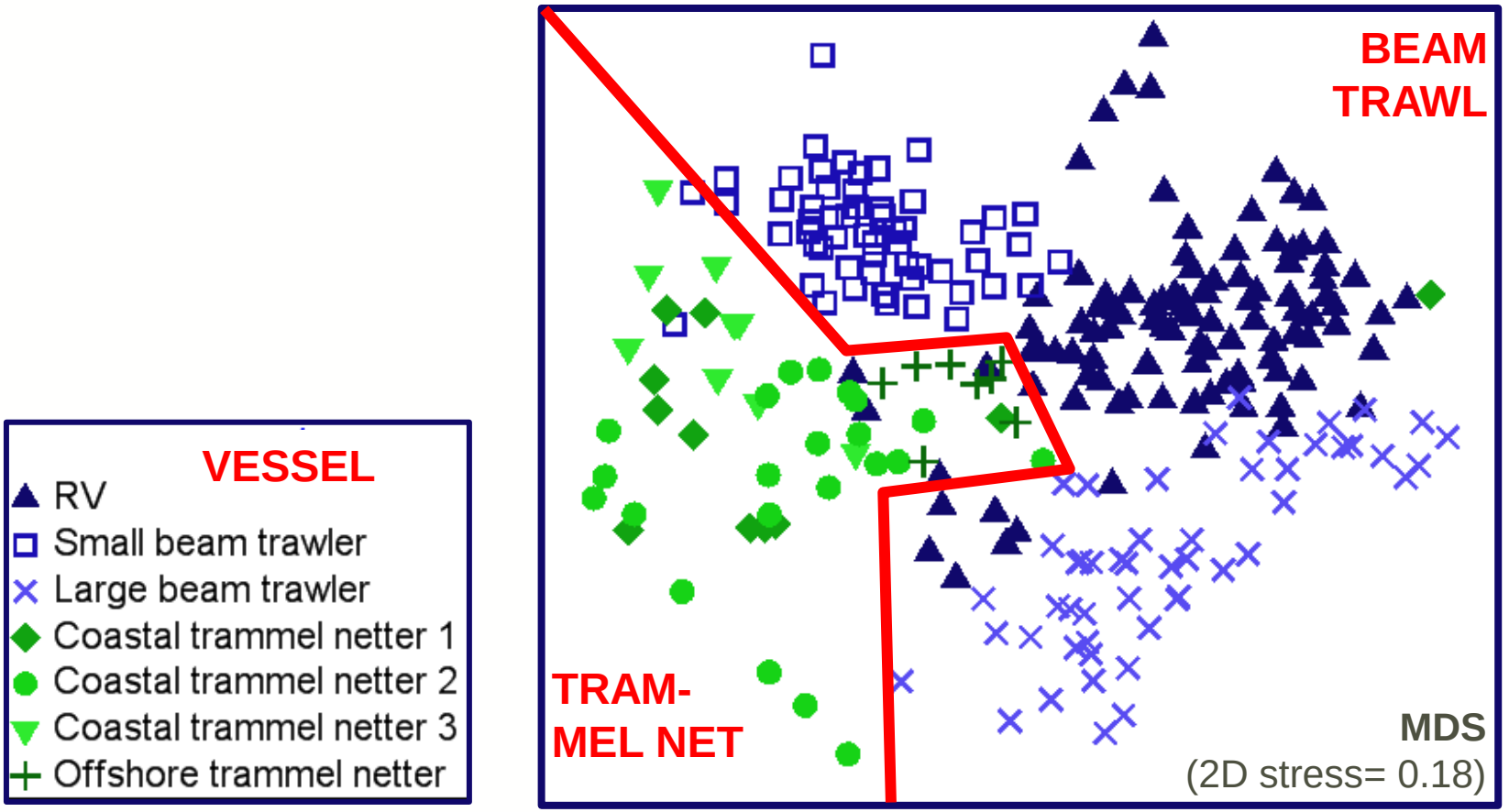
Standardizing discards per fishing effort ?

Sole landings per length class for different fishing techniques

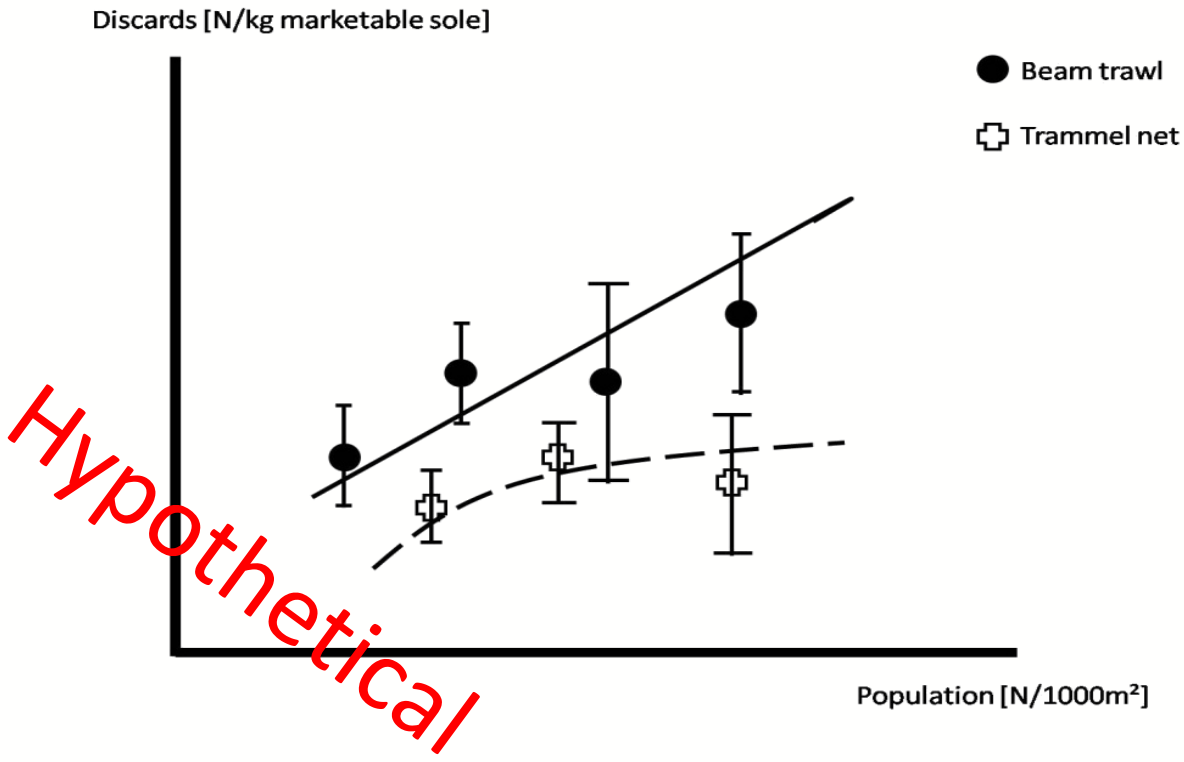


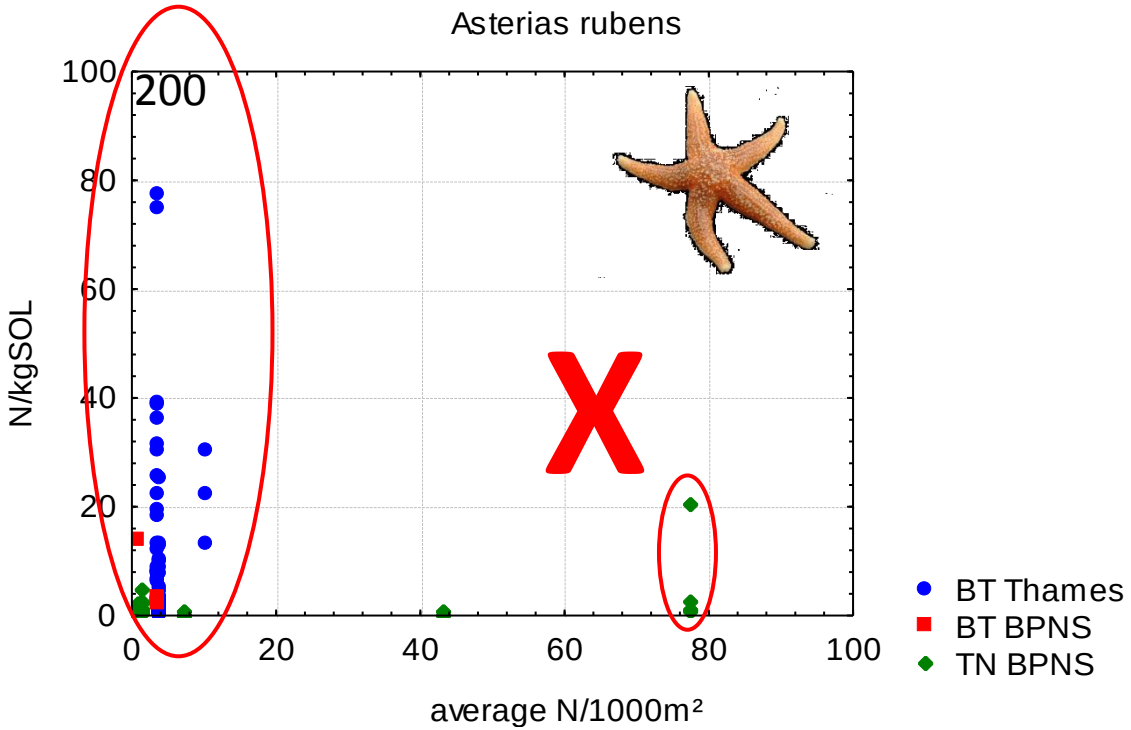
→Epibenthos discards expressed as number per kg marketable sole !!

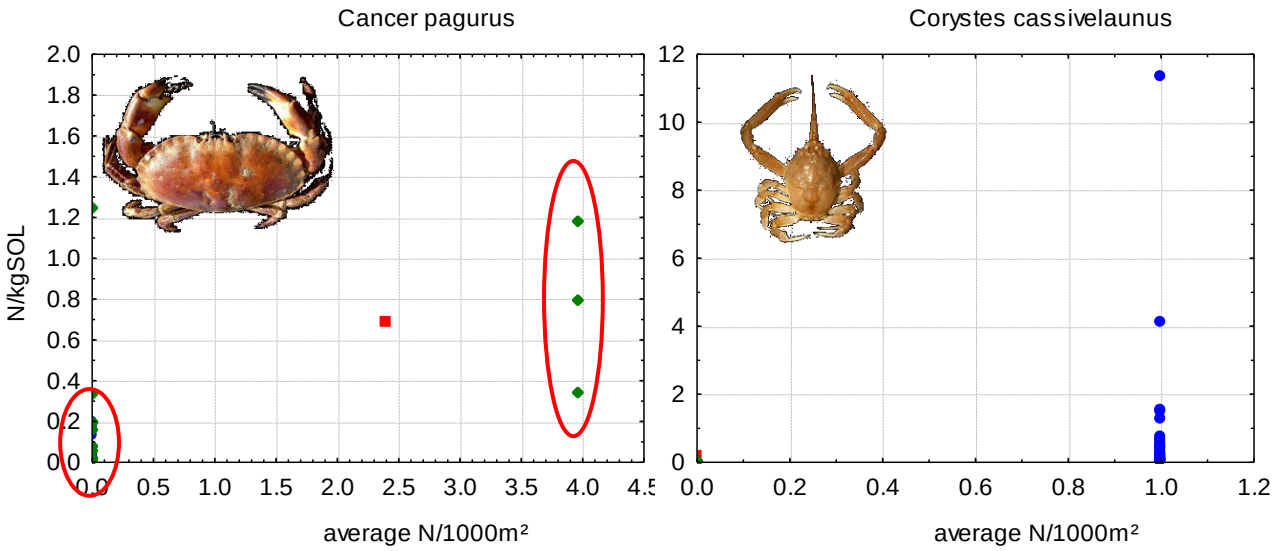
Standardized epibenthos discards per kg marketable sole



Impact of epibenthos population size on discard rates ?




Asterias rubens
200
X
N/kgSOL
average N/1000m²
BT Thames
BT BPNS
TN BPNS

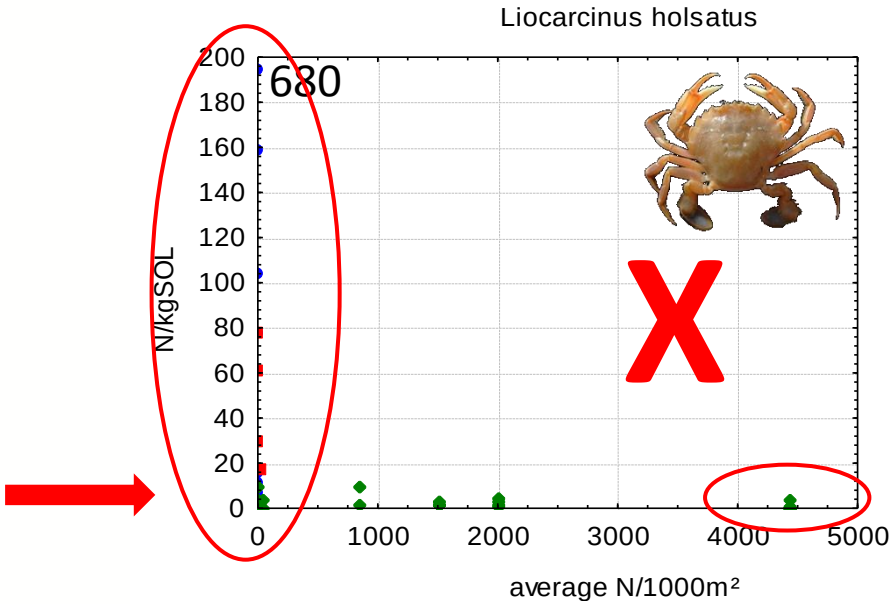

Cancer pagurus
Corystes cassivelaunus
N/kgSOL
average N/1000m²
average N/1000m²

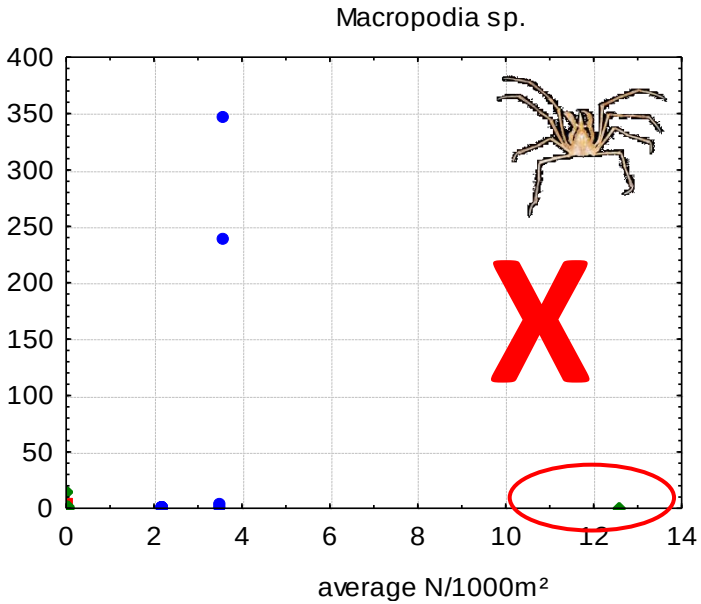
	Trammel net BPNS Mean (SD)	Beam trawl BPNS Mean (SD)	Beam trawl Thames Mean (SD)
Liocarcinus holsatus	1.9 (2.4)	88.6 (129.4)	126.5 (279.8)
Asterias rubens	2.6 (5.3)	106.6 (110.0)	18.7 (35.9)
Cancer pagurus	0.5 (0.6)	0.7 (-)	0.1 (0.1)
Macropodia sp.	1.9 (4.6)	1.3 (1.8)	49.1 (116.0)
Ophiura sp.	0.4 (0.4)	32.8 (24.4)	5.1 (10.4)
Pagurus /Diogenes	0.8 (1.2)	4.4 (2.7)	17.9 (47.0)
Corystes cassivelaunus	0.1 (<0.1)	0.2 (-)	0.9 (2.2)

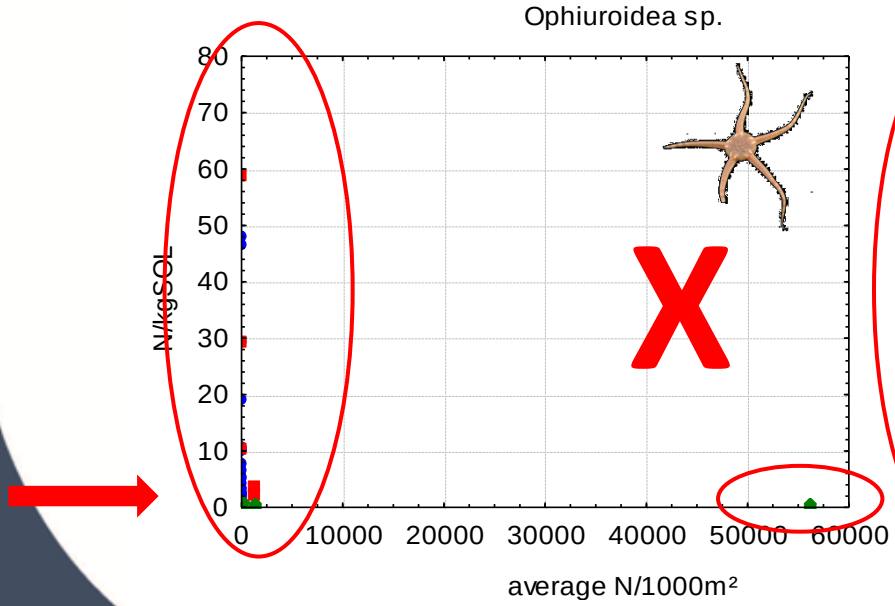
X 50

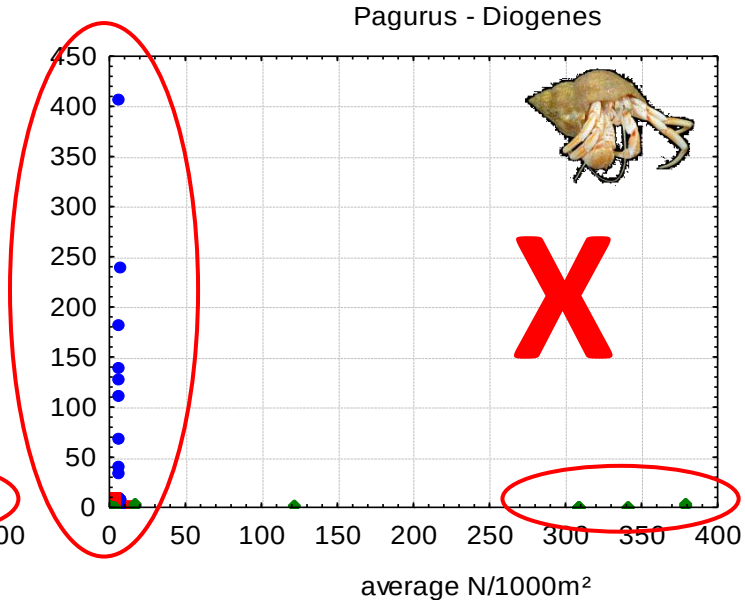
X 50

X 30





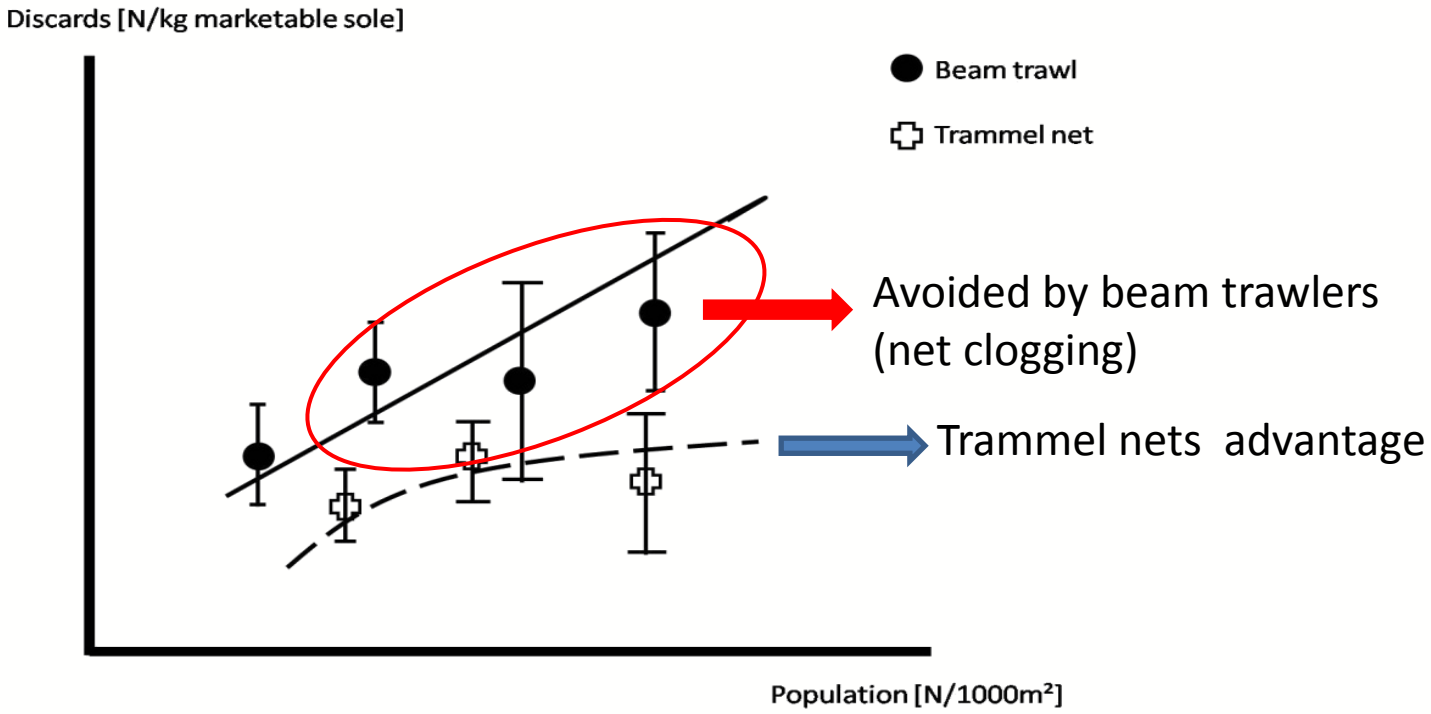




BT Thames
BT BPNS
TN BPNS

- Epibenthic discard rates much higher in beam trawl catches
  → but discard volume varies a lot

- Low impact of epibenthos population size on discard rates
  → edible crab attracted to 'struggling' species in trammel nets?



Discards

≈ fishing effort + gear type !

+ epibenthos ~~composition~~ size

+ epibenthos composition ?

+ location + period + habitat + depth ?

median grain size and mud content

Primer - Permanova

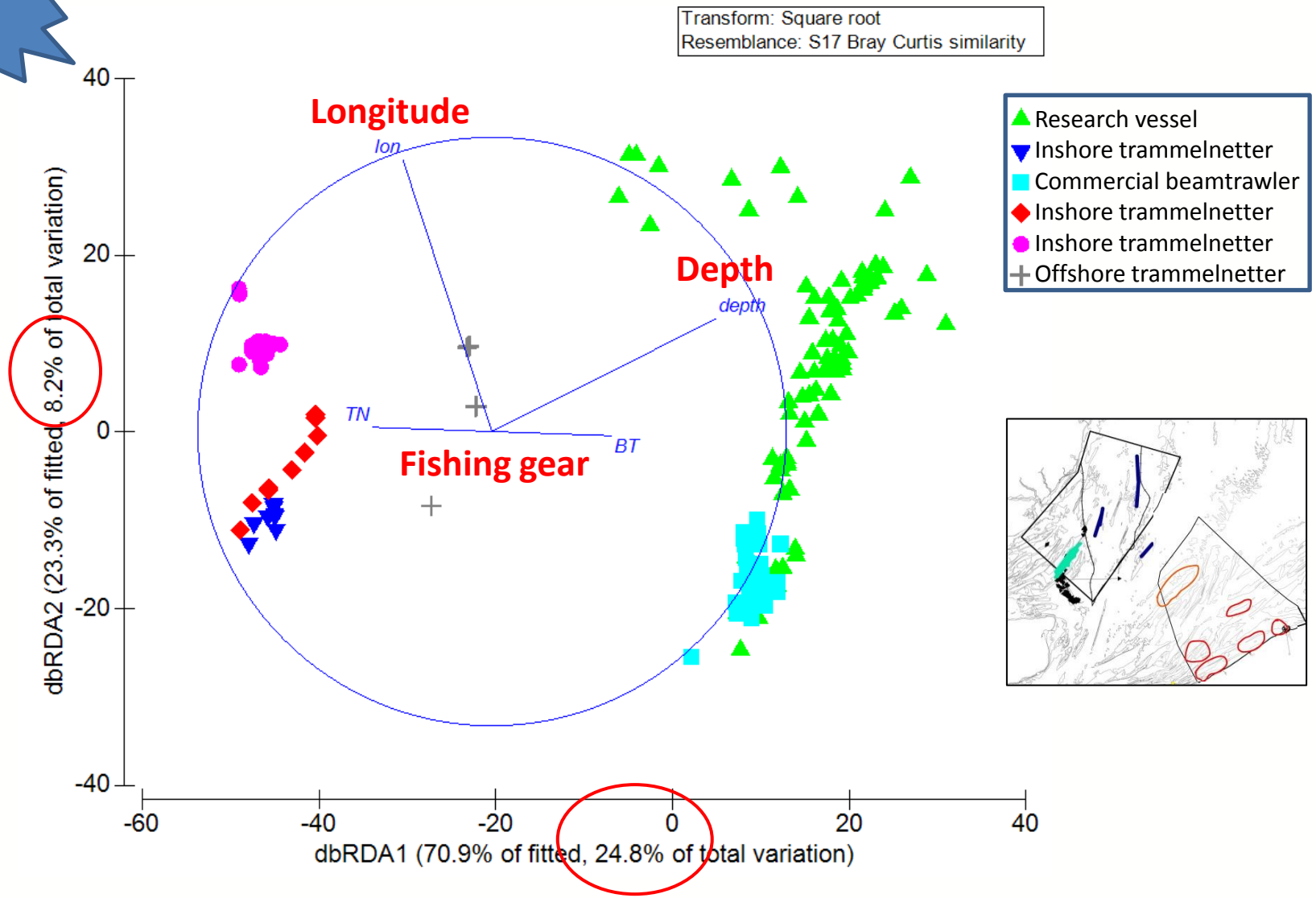
→ Distance-based linear models (DISTLM)

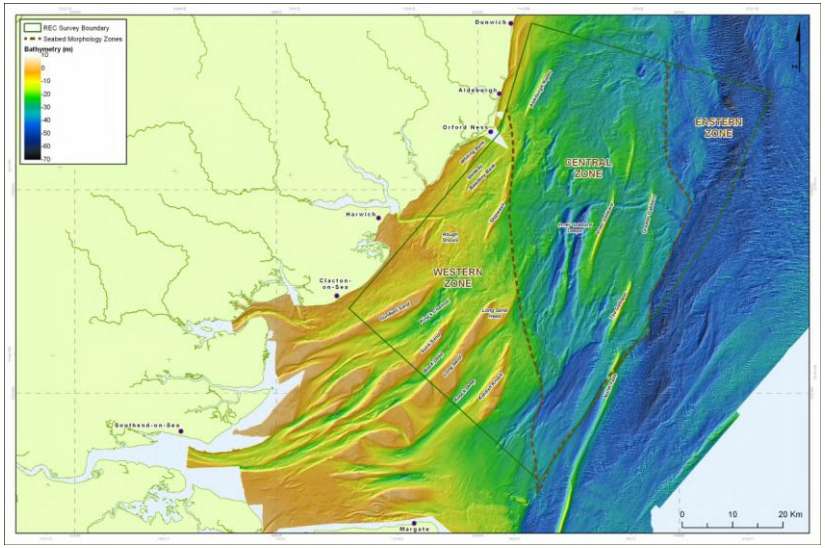
→ Bayesian Information Criterion (BIC)

→ Forward selection of parameters

→ Collinearity tested through Draftsman plots and Spearman ranking

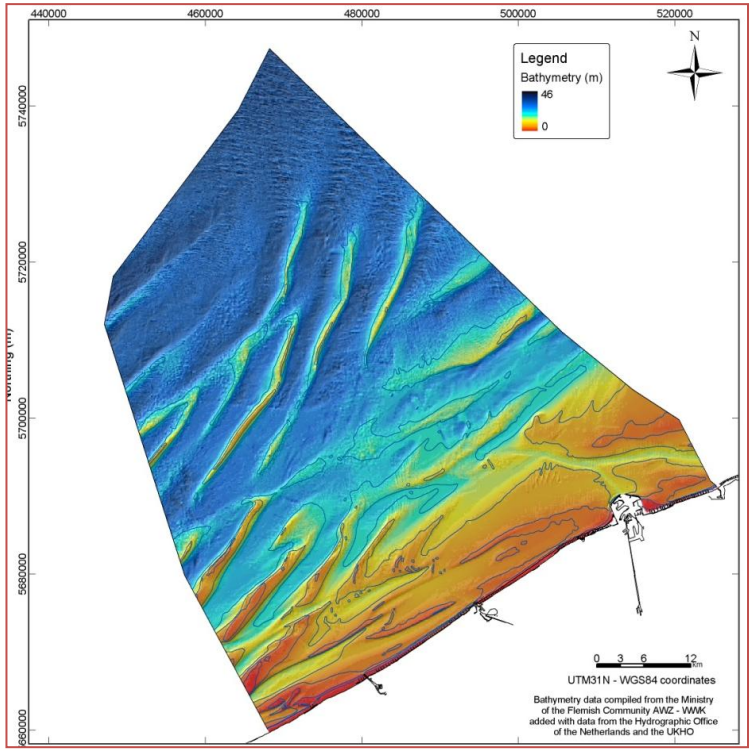
ICES IVc


Transform: Square root
Resemblance: S17 Bray Curtis similarity
Longitude
lon
Depth
depth
TN
BT
Fishing gear
Research vessel
Inshore trammelnetter
Commercial beamtrawler
Inshore trammelnetter
Inshore trammelnetter
Offshore trammelnetter
dbRDA2 (23.3% of fitted, 8.2% of total variation)
dbRDA1 (70.9% of fitted, 24.8% of total variation)
40
20
0
-20
-40
-60
-40
-20
0
20
40



Longitude as proxy for **regional differences** in species composition between western and eastern part of SNS

Shallow subtidal sandbanks
5-50 m depth



average epibenthos density per 1000m² in the area

	Annelida	Arthropoda	Chordata	Cnidaria	Echinodermata	Mollusca	Total
Thames (2m trawl)	0.1	160	36	0	232	10	439
BPNS (8m trawl)	3	119	37	1	285	144	570
BPNS (3m trawl)		993	55	2	1585	214	2594

epibenthos diversity in the area

	Annelida	Arthropoda	Chordata	Cnidaria	Echinodermata	Mollusca	Total
Thames (2m trawl)	1	26	23	1	5	10	65
BPNS (8m trawl)	6	18	43		3	20	84
BPNS (3m trawl)		8	21	1	3	11	44

epibenthos species discarded

	Annelida	Arthropoda	Chordata	Cnidaria	Echinodermata	Mollusca	Total
BT Thames	2	29	26		5	12	74
BT BPNS	1	8	11		3	8	32
TN BPNS		15	8		3	9	36
TN+BT BPNS	1	16	14		3	13	48

BPNS

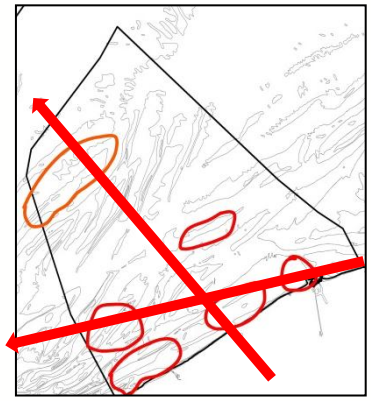
DISTLM – epibenthos discards

	BIC	SS (trace)	Pseudo-F	P-value	Proportion (%)	Residual df
Marginal tests						
latitude	-	10,2	4.1	0.0008	6.8	56
longitude	-	16,8	7.1	0.0001	0.1	56
mgs	-	12,9	5.3	0.0001	8.6	56
sf	-	10,70	4.3	0.0003	7.1	56
depth	-	17,79	7.5	0.0001	0.1	56
month	-	9,55	3.8	0.0011	6.4	56
Gear	-	29,46	13.6	0.0001	0.2	56
Sequential tests						
+gear	451	29,46	13.6	0.0001	19.6	56
+longitude	448	15,54	8.1	0.0001	10.3	55
+depth	445	11,51	6.6	0.0001	7.6	54
+latitude	444	7,22	4.4	0.0001	4.8	53

Depth ⇗ → DPUE ⇘

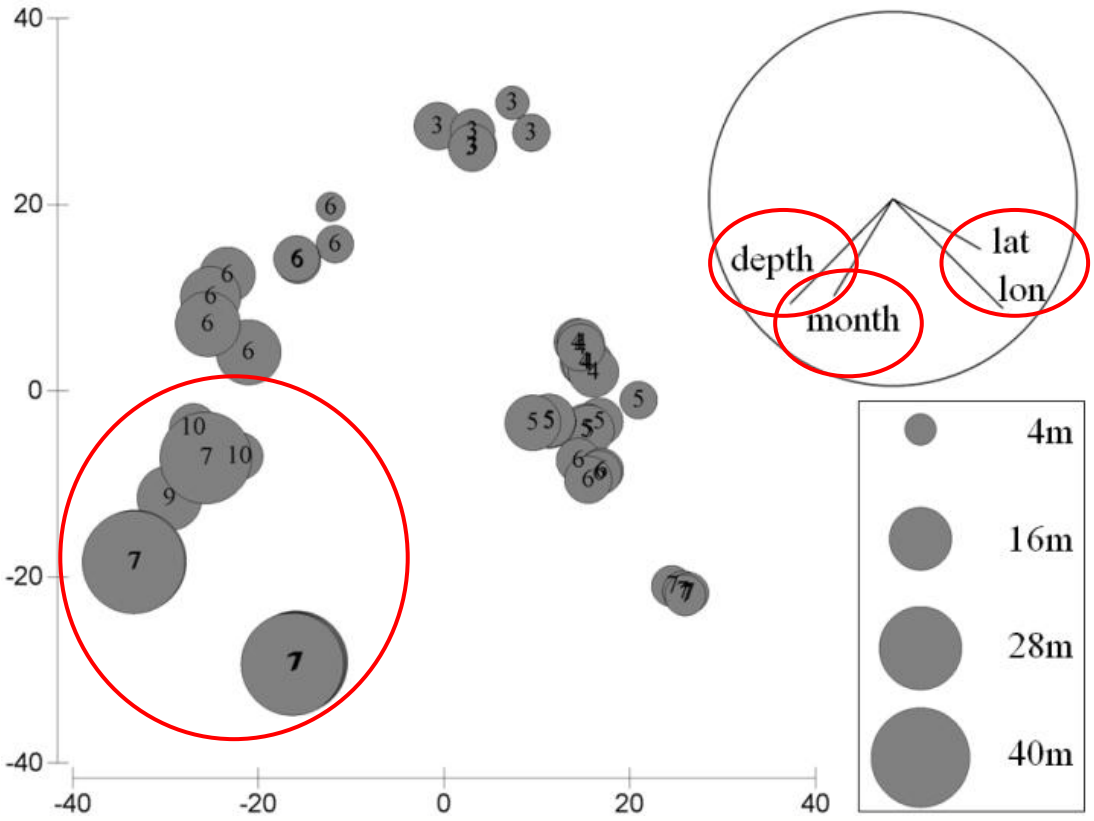
Trammel nets

Habitat type



Sand ← Mud

Coastal → Offshore



summer-autumn → CPUE ↘ & DPUE ↗

- Epibenthos discard composition differs significantly between beam trawls and trammel nets
- More sessile organisms discarded in beam trawls
- More mobile crustacean species discarded in trammel nets

- Variation in discard composition is also dictated by location and depth, and thus by region & habitat type
- For trammel net fishery DPUE negatively correlated with fishing period (≈ CPUE)

Results based management to reduce discards ?

- **Trammelnets may be favoured** over beam trawling
  → but nuance necessary (most beam trawlers cannot easily convert)

- **Technical adaptations** to reduce epibenthic discards in beam trawls
  (e.g. Fonteyne and Polet, 2002; Revill et al., 2005; Wade et al., 2009)

- Clear influence of location and habitat type (= epibenthic community present)
  → **Guidelines** to reduce discard rates should be **area & habitat specific**

- Discard **thresholds** must be **region-specific** , not gear specific

- Influence of fishing period
  → **population dynamics** of target ánd discarded organisms needed

Fishermen can minimize discards by actively using this information to judge (a priori) where and how to fish

A few more thoughts

- what about influence of engine power or **other gear types**?

- What about **discard survival rate** (= post-capture mortality)
  e.g. *Cancer pagurus* and other crabs → good survival in beam trawling, but probably 100% mortality (crushed) in trammel nets

- How to reduce variation in discard compositon due to location when comparing more areas simultaneously?
  → **traits based analyses** through functional epibenthic groups (e.g. scavengers vs. visual predators or sessile vs. mobile species)

WAKO II - An integrated impact assessment of trammel net and beam trawl fisheries. Final Report.
Brussels : Belgian Science Policy - Research Programme for a Sustainable Development, 229 pp.

Depestele J, Courtens W., Degraer S., Haelters J., Hostens K., Houziaux J-S., Merckx B., Polet H., Rabaut M., Stienen E.W.M., Vandendriessche S., Verfaillie E. & Vincx M. (2011)

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