

# Roggenplaat nourishment

## Ecological considerations

Tom Ysebaert | Roggenplaat workshop, 4 February 2016



# Roggenplaat nourishment

- AIM:

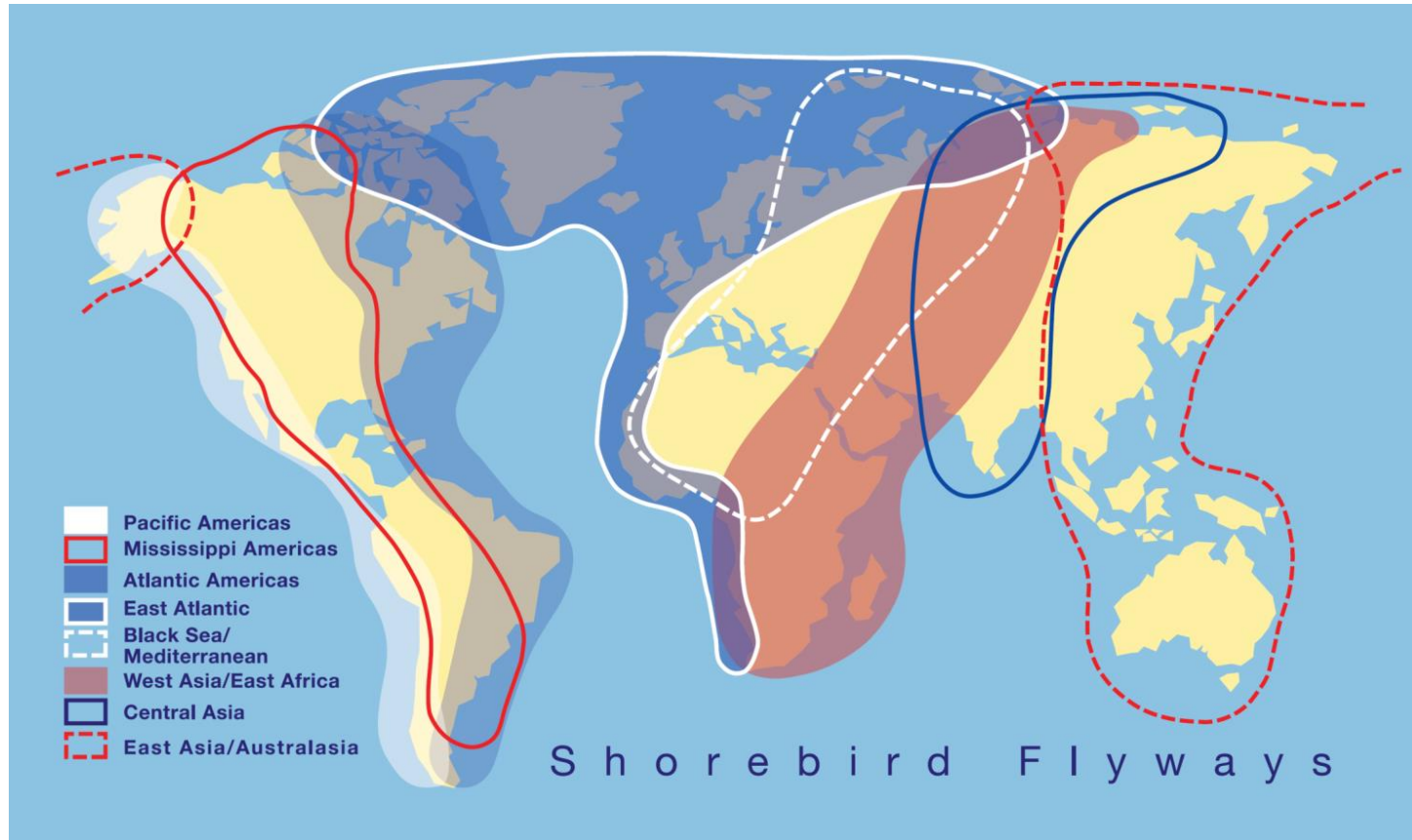
*De voorkeursaanpak van de MIRT-verkenning is het suppleren van een zodanige hoeveelheid zand, dat **de foerageerfunctie voor de steltlopers van het mondinggebied van de Oosterschelde de komende 25 jaar in stand wordt gehouden** en een toename van golfaanval op de dijken van Schouwen wordt voorkomen.*

# Roggenplaat nourishment

## ■ Outline

- Oosterschelde: Natura2000 area
  - Trends in waterbird numbers
- The intertidal ecosystem
- Lessons learned previous intertidal nourishments
- Roggenplaat: ecological conditions

# Oosterschelde: international importance



# International importance

	1% norm	2007/2008 - 2009/2010				Max.
		Najaar	Winter	Voorjaar	Zomer	
<b>Rotgans</b>	2000	5.3	6.2	6.0	-	6.2
<b>Kanoetstrandloper (w)</b>	4500	5.4	5.3	-	-	5.4
<b>Rosse Grutto (w)</b>	1200	4.2	4.3	3.1	nvt	4.3
<b>Brandgans</b>	4200	1.5	4.3	3.5	-	4.3
<b>Scholekster</b>	10200	4.2	2.9	1.3	2.2	4.2
<b>Slobeend</b>	400	4.0	3.1	2.1	-	4.0
<b>Zilverplevier</b>	2500	3.2	2.5	3.8	-	3.8
<b>Smient</b>	15000	1.3	2.8	-	-	2.8
<b>Lepelaar</b>	110	2.7	-	-	1.5	2.7
<b>Bonte Strandloper (w)</b>	13300	2.6	2.6	-	-	2.6
<b>Wulp</b>	8500	2.5	1.9	1.4	1.7	2.5
<b>Kluut</b>	730	1.1	-	2.0	1.2	2.0
<b>Pijlstaart</b>	600	1.5	1.9	-	-	1.9
<b>Grauwe Gans</b>	5000	1.6	1.2	-	-	1.6
<b>Drieteenstrandloper</b>	1200	1.6	-	1.3	-	1.6
<b>Bergeend</b>	3000	-	1.4	1.2	-	1.4
<b>Rosse Grutto (d)</b>	7200	-	-	1.3	-	1.3
<b>Steenloper (w)</b>	1500	1.1	-	-	-	1.1
<b>Goudplevier</b>	9250	1.0	-	-	-	1.0



# Conservation status

- National Park Oosterschelde (2002)
- Natura2000, Bird Directive, Habitat Directive (2007)
- Ramsar Convention
- Water Framework Directive

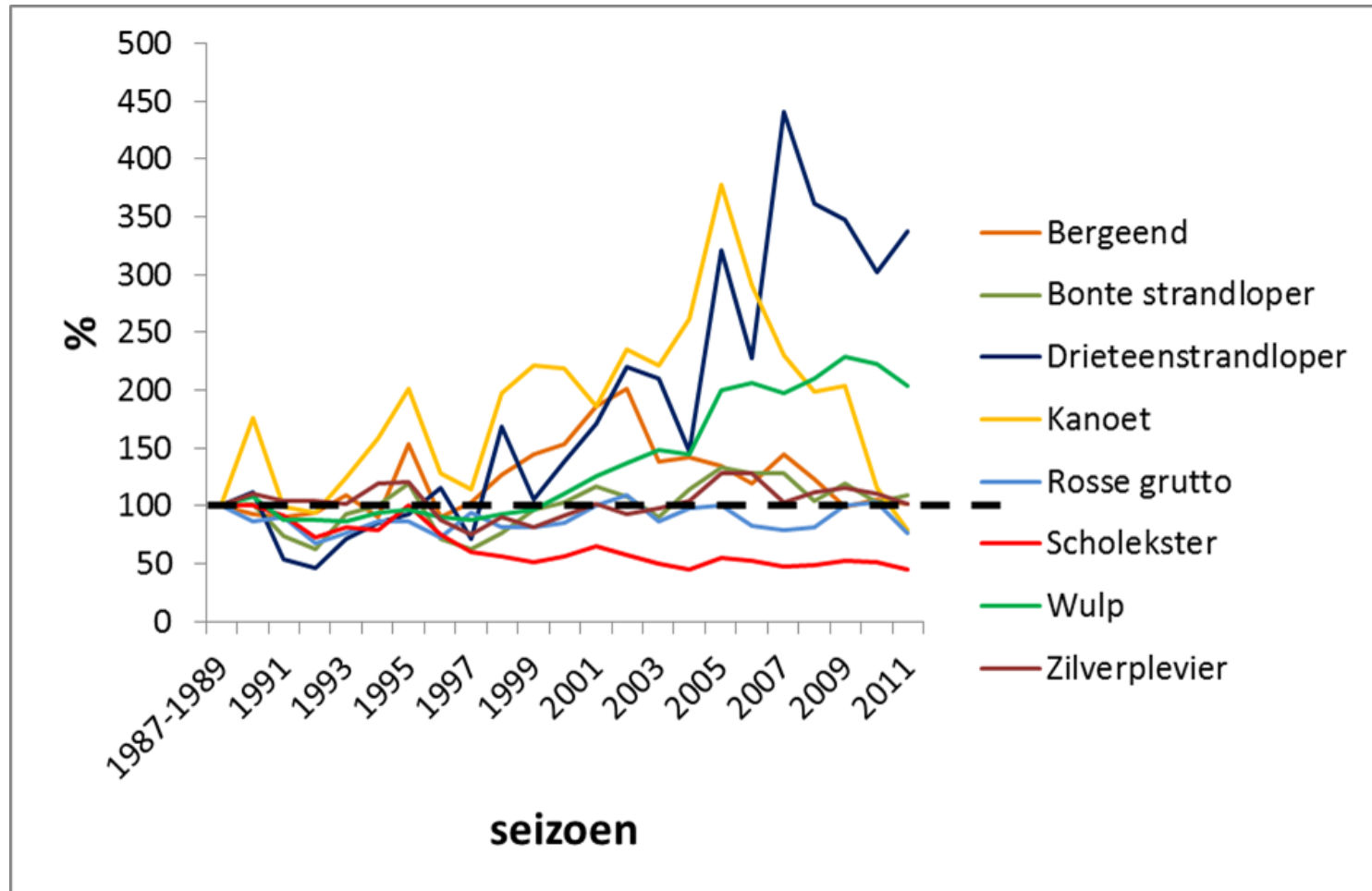


CONVENTION ON WETLANDS

(Ramsar, Iran, 1971)

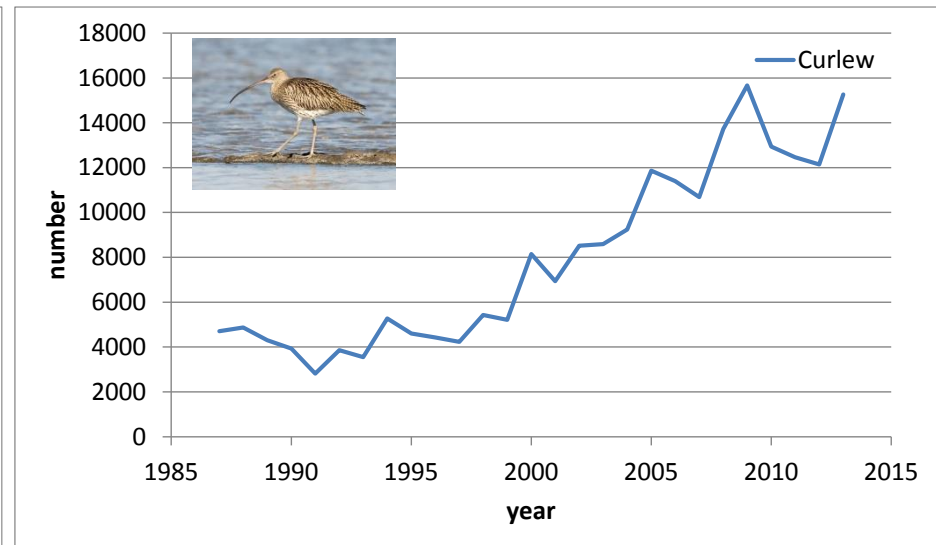
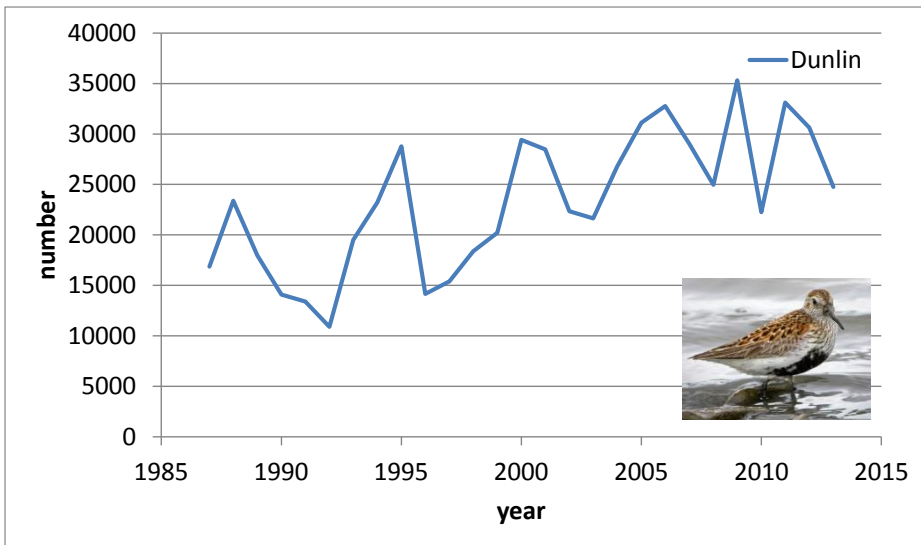
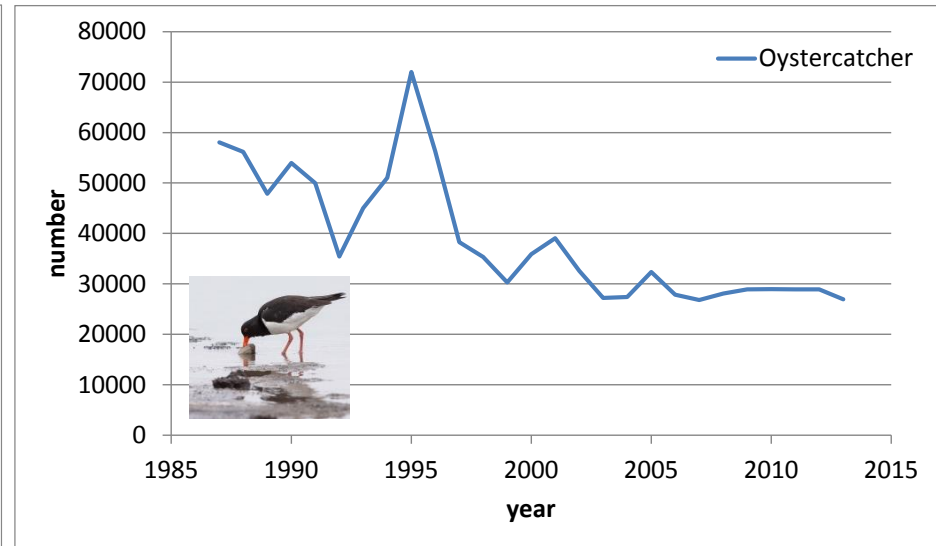
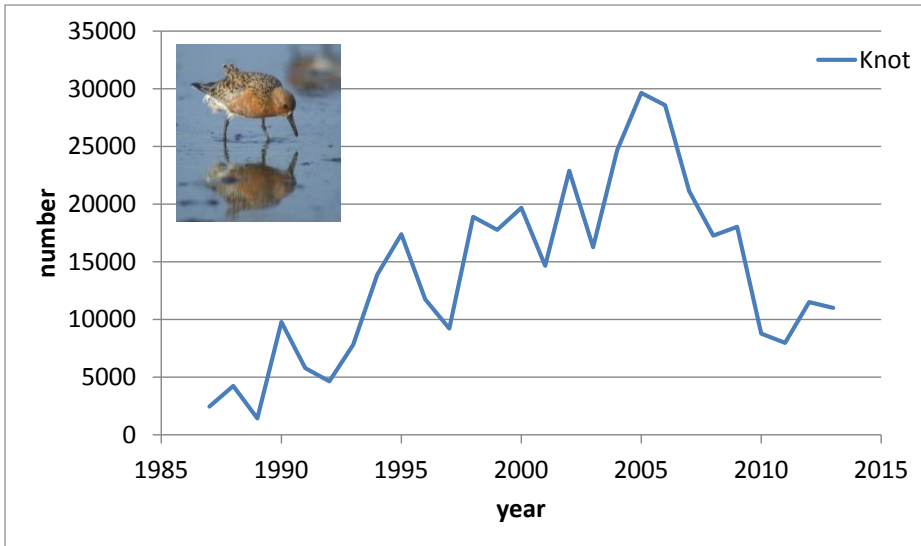


# Trends



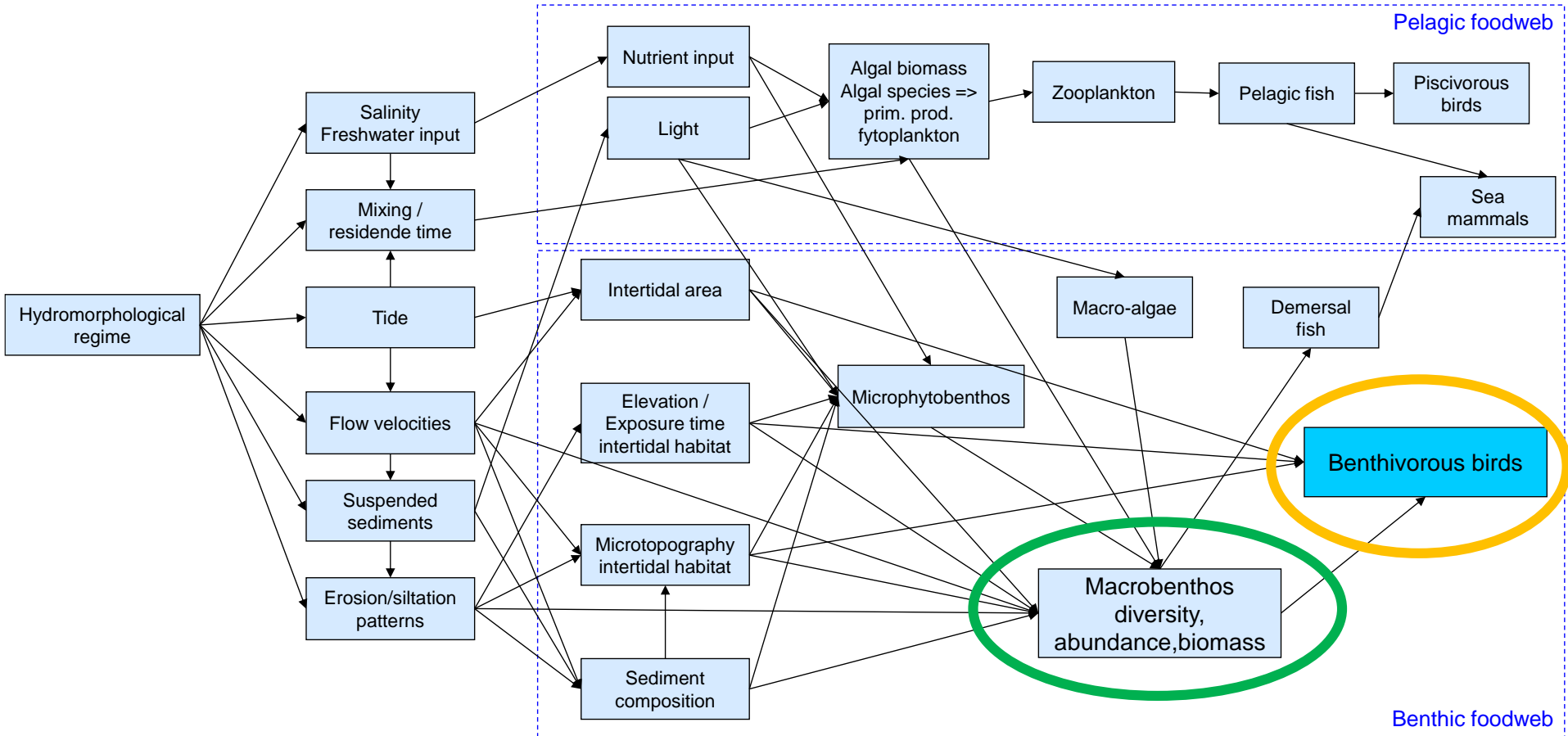
de Ronde, J., Mulder, J., Duren, L. van., & Ysebaert, T. (2013). *Eindadvies ANT Oosterschelde*. Middelburg: Rijkswaterstaat.

# Trends (winter)

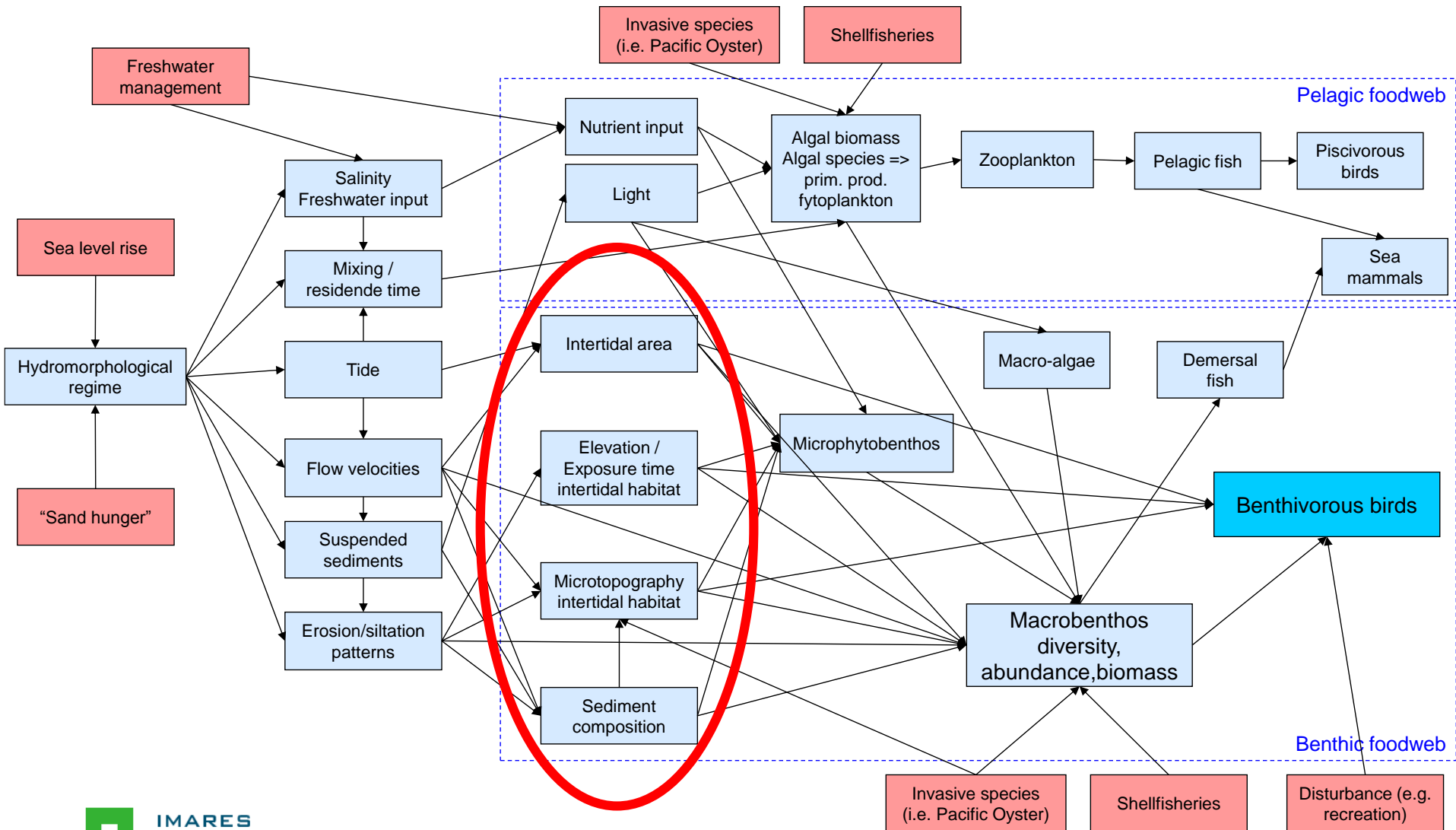




# The intertidal ecosystem



# The intertidal ecosystem: human impacts

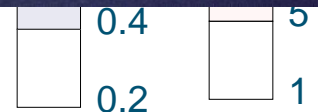
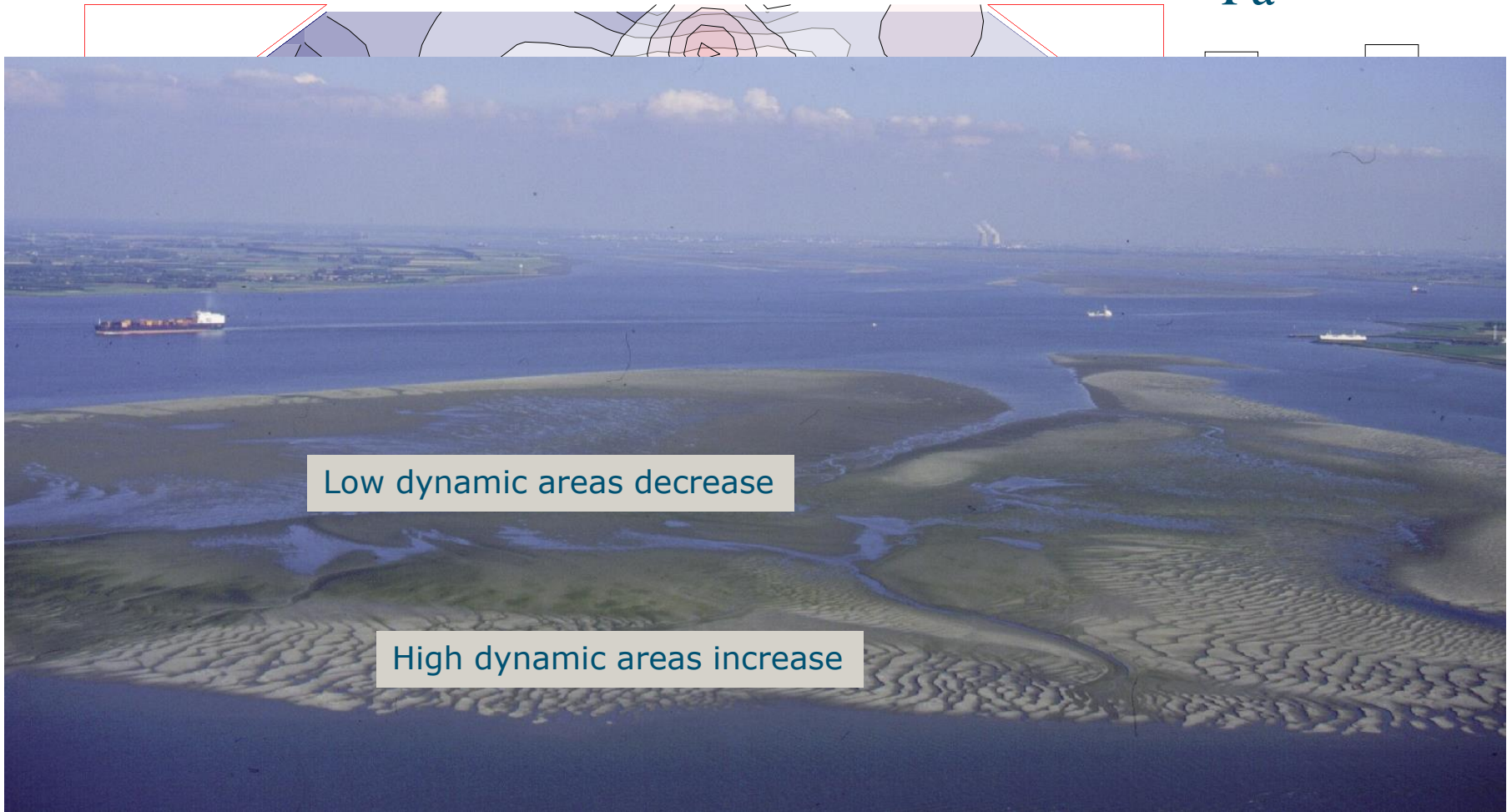


# Benthos in the intertidal

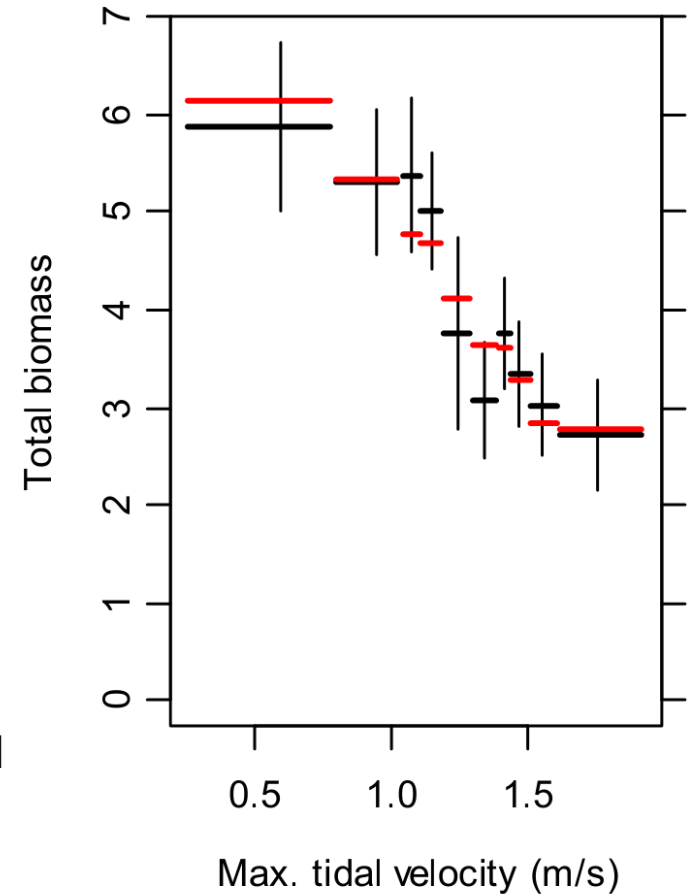
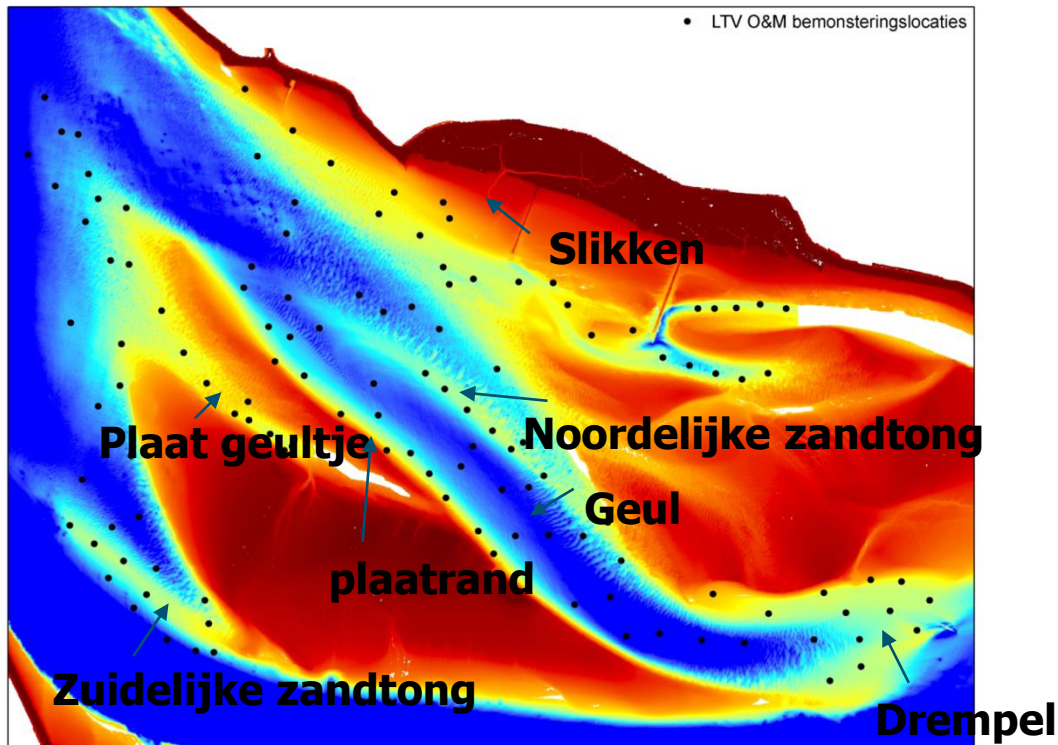
- Influenced by:
  - Hydrodynamics
  - Sediment composition
  - Chlorophyll a
  - Emersion time

# Shear stress and benthic macrofauna

Pa AFDW

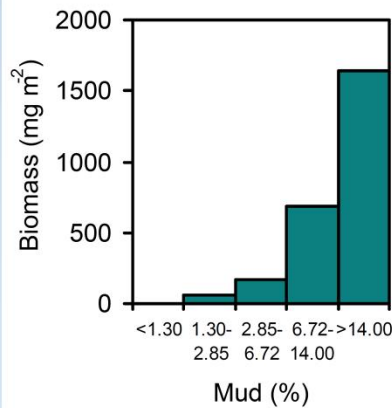


# Current velocity and benthic biomass

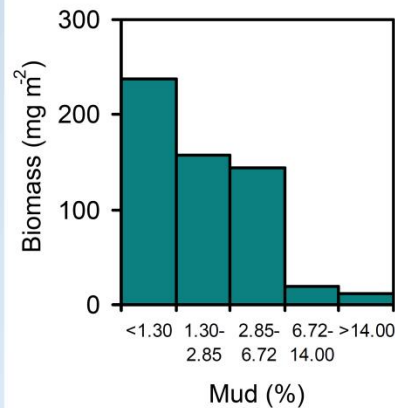


# Benthic biomass and sediment composition

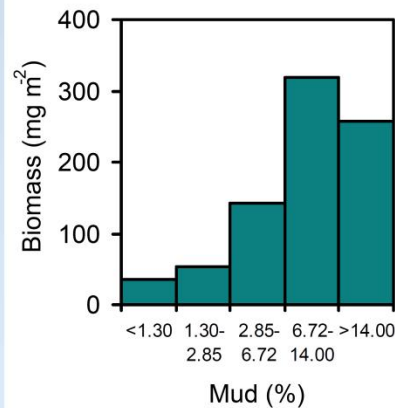
Zeeduizendpoot  
(*Nereis diversicolor*)



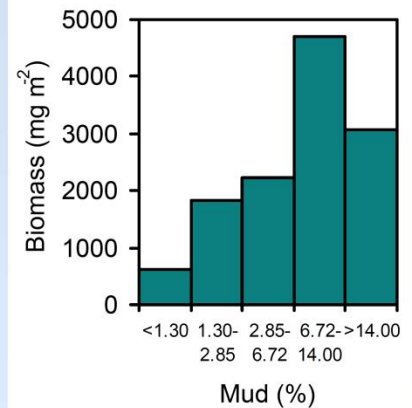
Zandzager  
(*Nephtys cirrosa*)



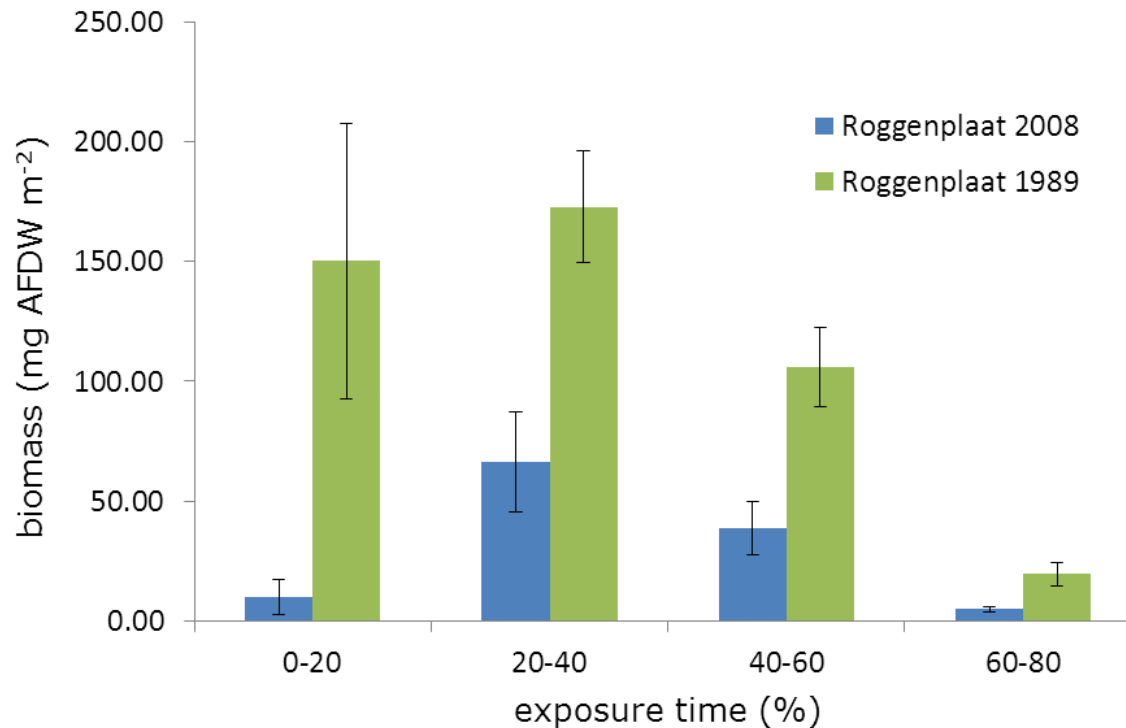
Wadslakje  
(*Hydrobia ulvae*)



Nonnetje  
(*Macoma balthica*)

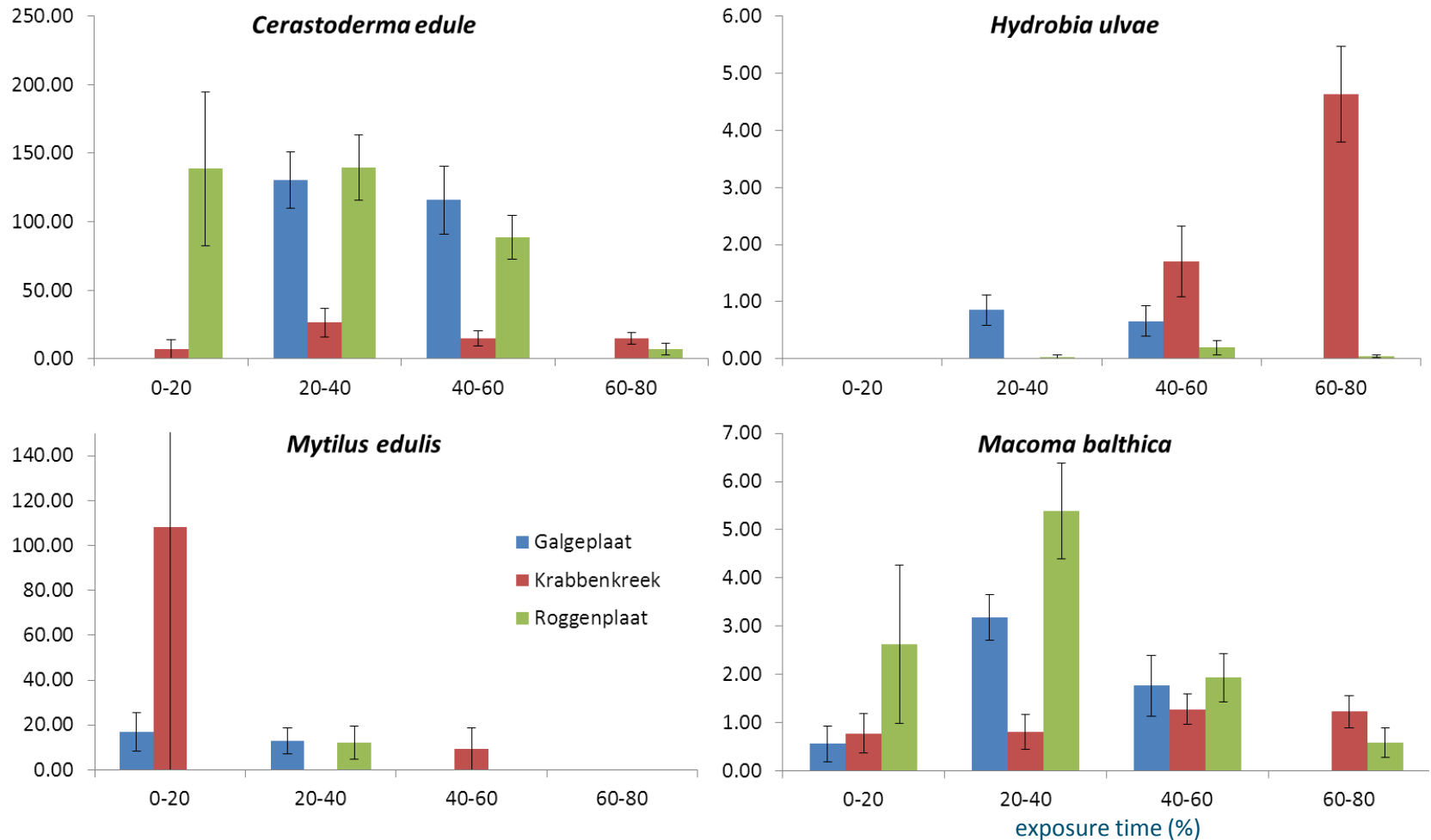


# Benthic macrofauna and emersion time



de Ronde, J., Mulder, J., Duren, L. van., & Ysebaert, T. (2013). *Eindadvies ANT Oosterschelde*. Middelburg: Rijkswaterstaat.

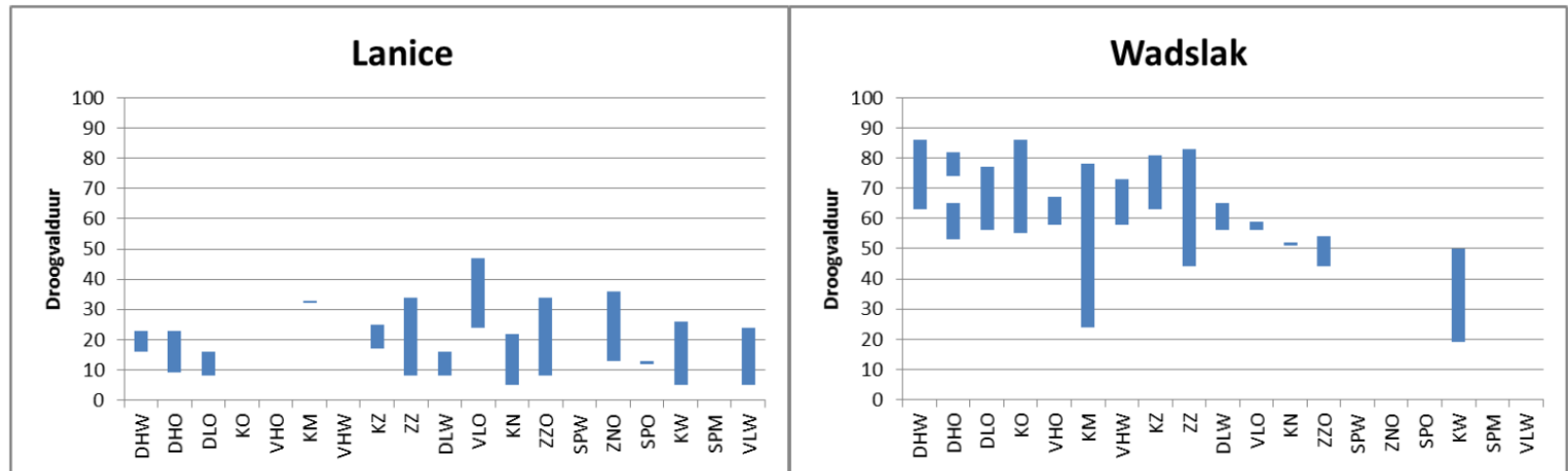
# Benthic macrofauna and emersion time



de Ronde, J., Mulder, J., Duren, L. van., & Ysebaert, T. (2013). *Eindadvies ANT Oosterschelde*. Middelburg: Rijkswaterstaat.



# Benthic macrofauna and emersion time

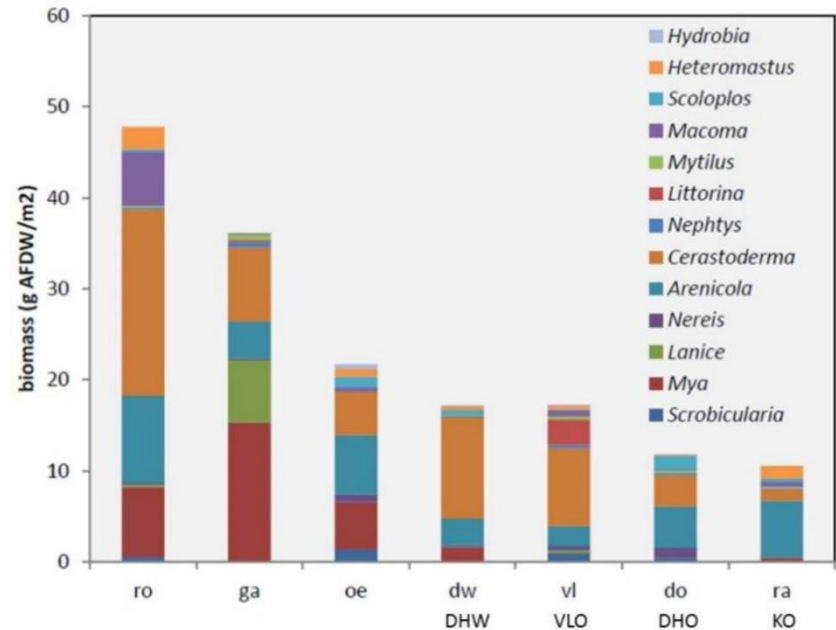
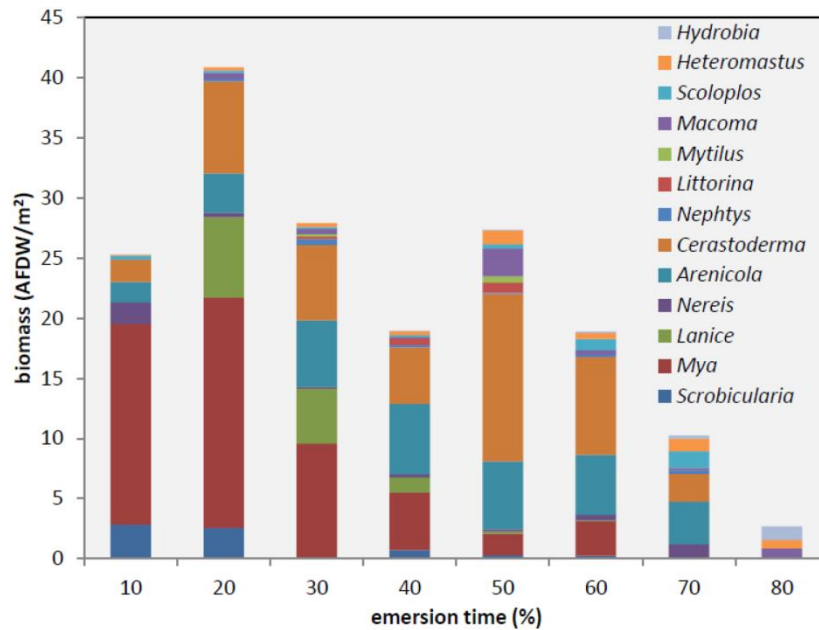


Figuur 15: Voorkomen van de zandkokerworm (*Lanice*) in de diverse telgebieden ten opzichte van de droogvalduur.

Figuur 14: Voorkomen van het wadslakje (*Hydrobia*) in de diverse telgebieden ten opzichte van de droogvalduur.

*Bouwmeester, 2015*

# Benthic macrofauna and emersion time



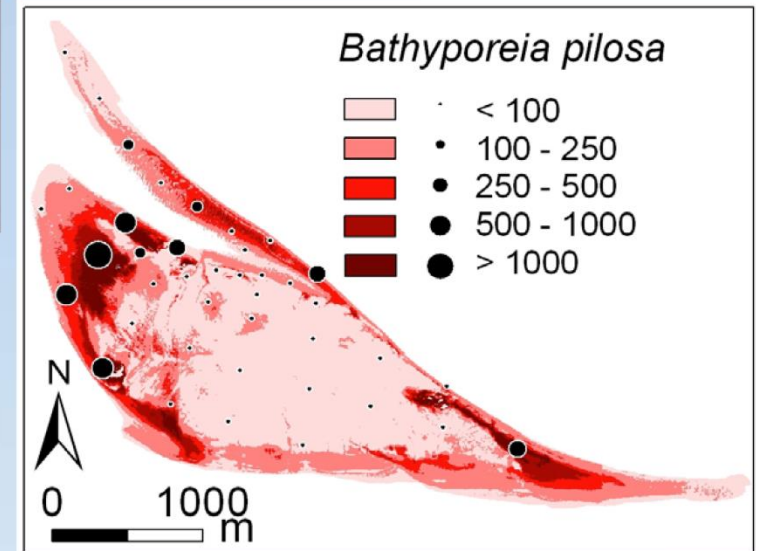
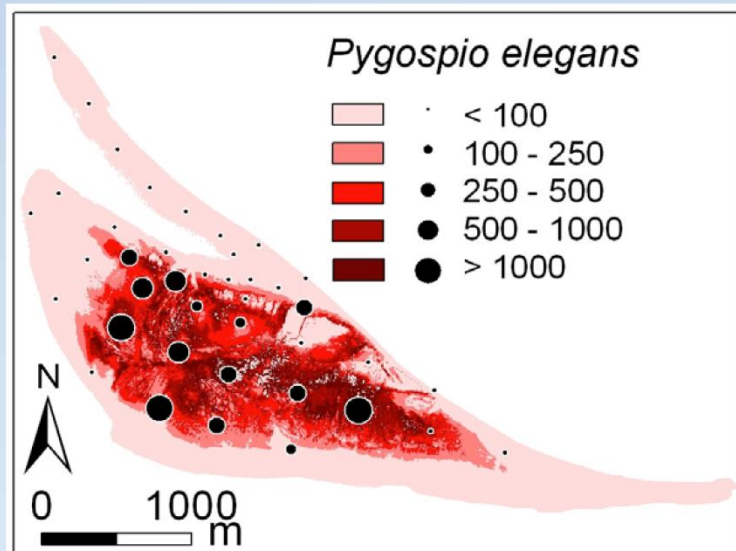
Zwarts et al., 2011

# Remote sensing and GIS

## Modelling macrofauna distribution



Predicted and observed macrobenthos biomass

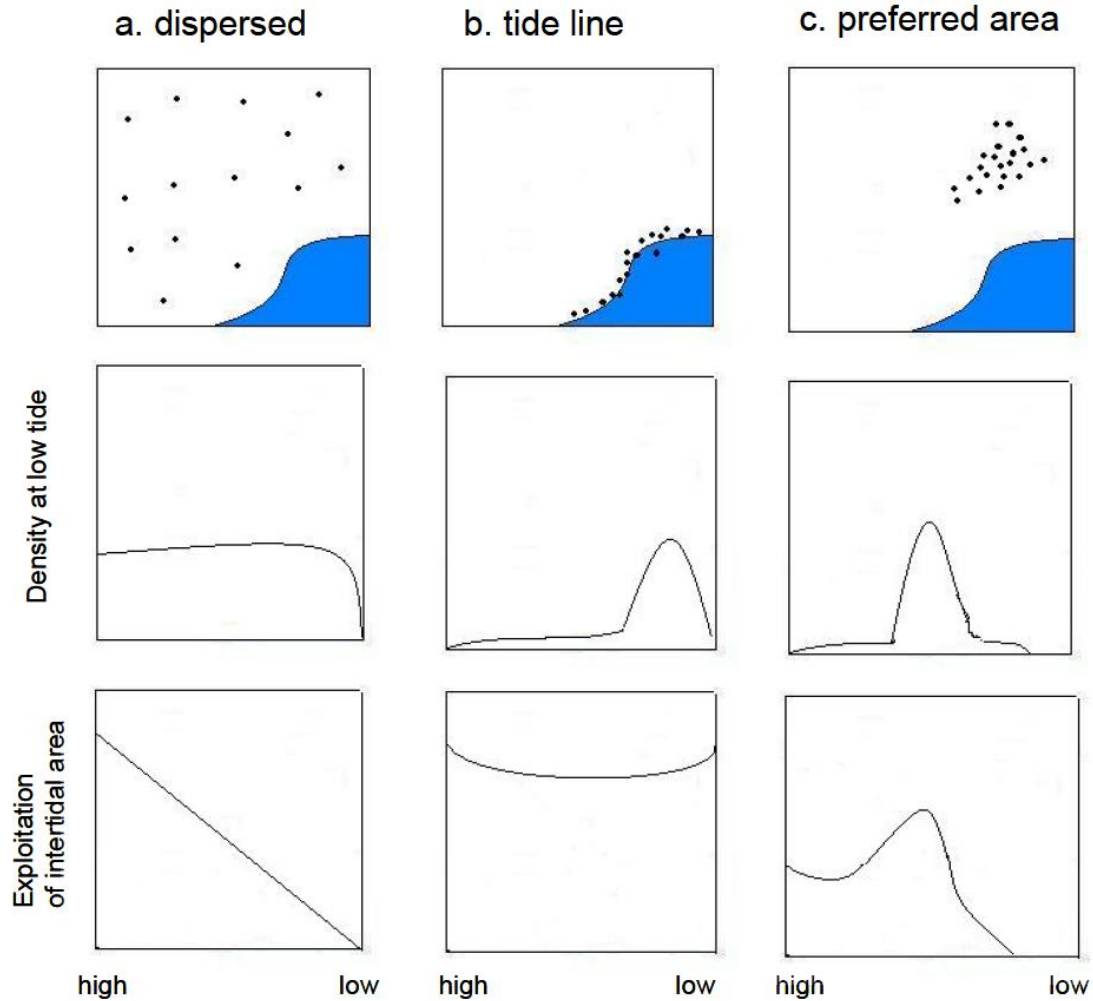


# Benthivorous birds in the intertidal

## ■ Waders need:

- Feeding area
- Food
- Feeding time
- (roosts)
- => minimum rate of food intake to maintain condition

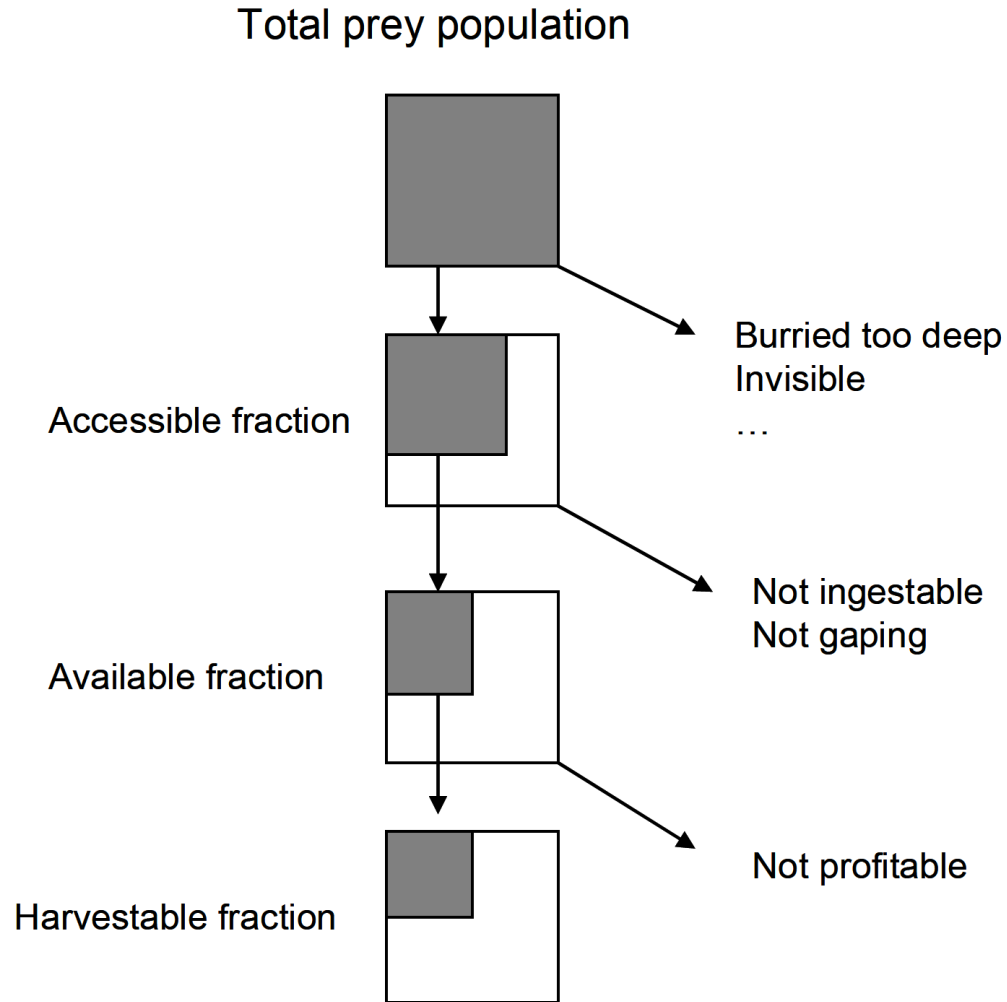
# Tidal behaviour differ among species



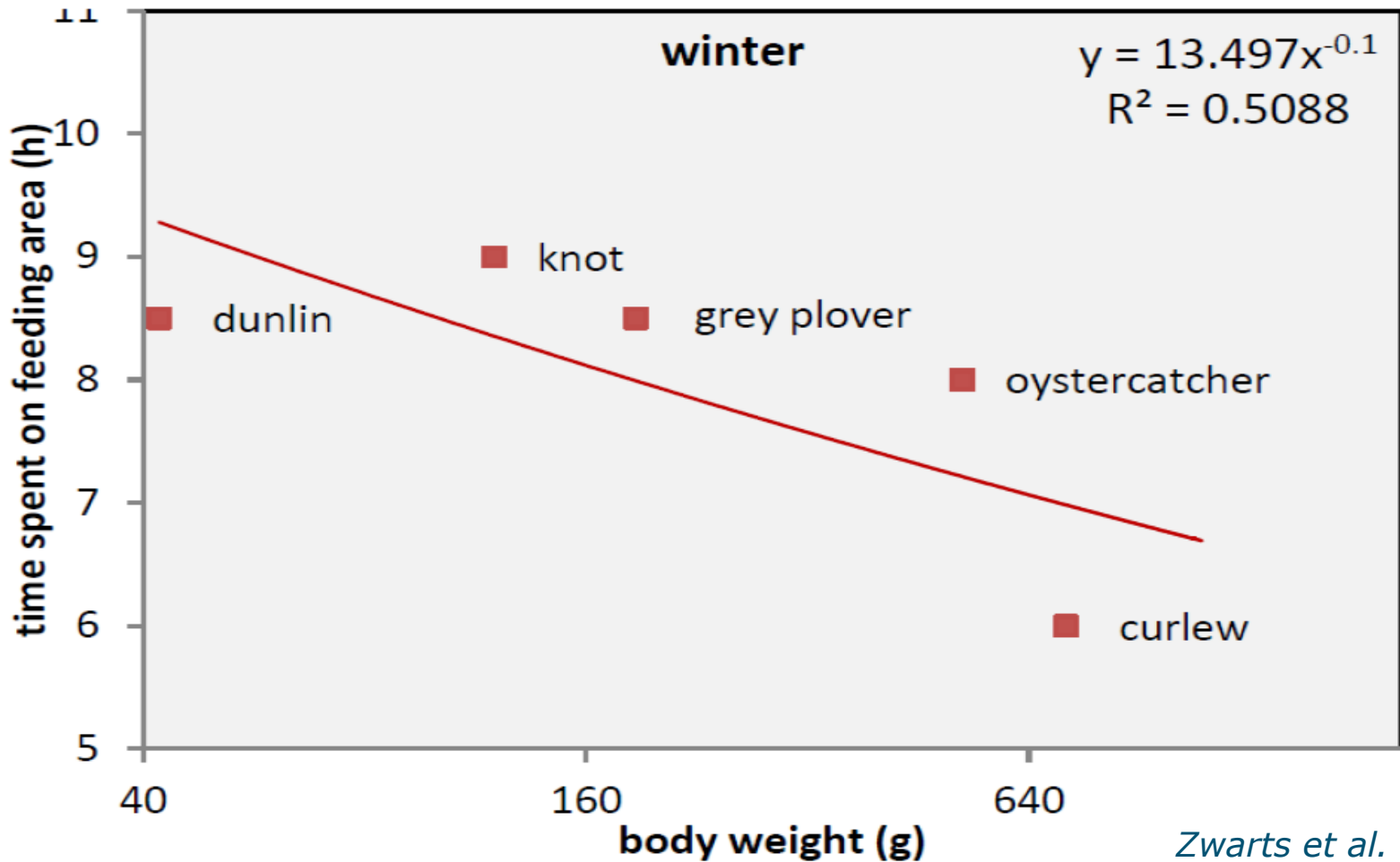
# Diet differs among species

Bird species	Scientific name	Main prey	%-bivalves	%-Worms	%-other foods
Oystercatcher	<i>Haematopus ostralegus</i>	Bivalves	80	10	10
Knot	<i>Calidris canutus</i>	Bivalves	75	1	24
Bar-tailed Godwit	<i>Limosa lapponica</i>	Worms	3	94	3
Avocet	<i>Recurvirostra avosetta</i>	Worms	5	90	5
Grey Plover	<i>Pluvialis squatarola</i>	Worms	6	87	7
Ringed Plover	<i>Charadrius hiaticula</i>	Worms	0	78	22
Dunlin	<i>Calidris alpina</i>	Worms	14	70	16
Sanderling	<i>Calidris alba</i>	Worms	1	60	39
Curlew	<i>Numenius arquata</i>	Mixed	46	35	19
Redshank	<i>Tringa totanus</i>	Mixed	7	46	47
Shelduck	<i>Tadorna tadorna</i>	Otherwise	35	5	60

# Harvestable fraction



# Foraging time needed differ among species

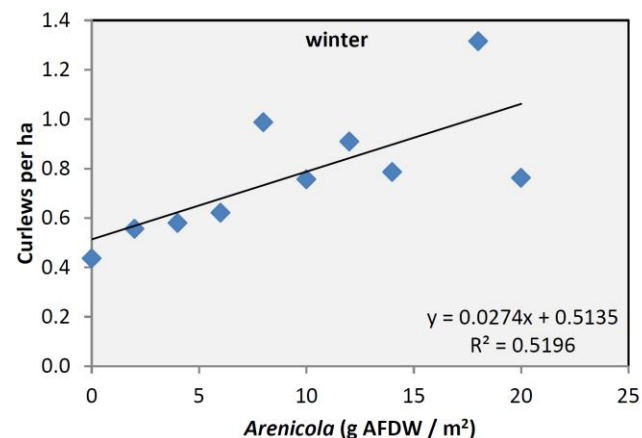
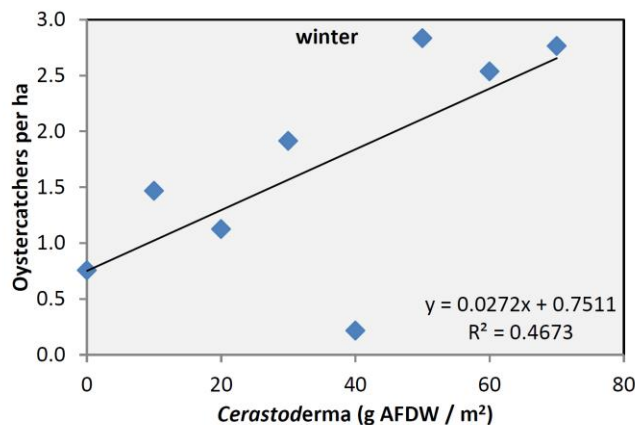


Zwarts et al. 2011

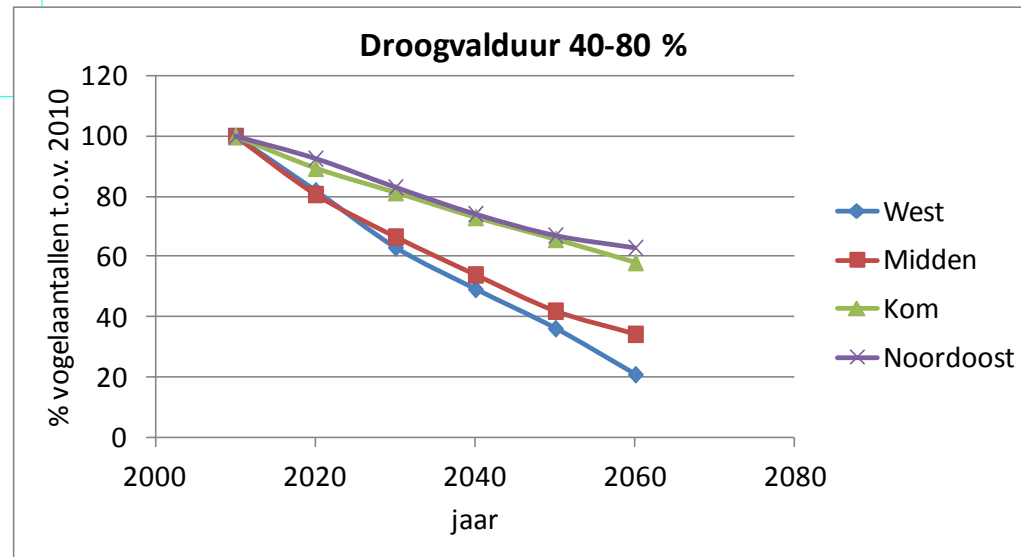
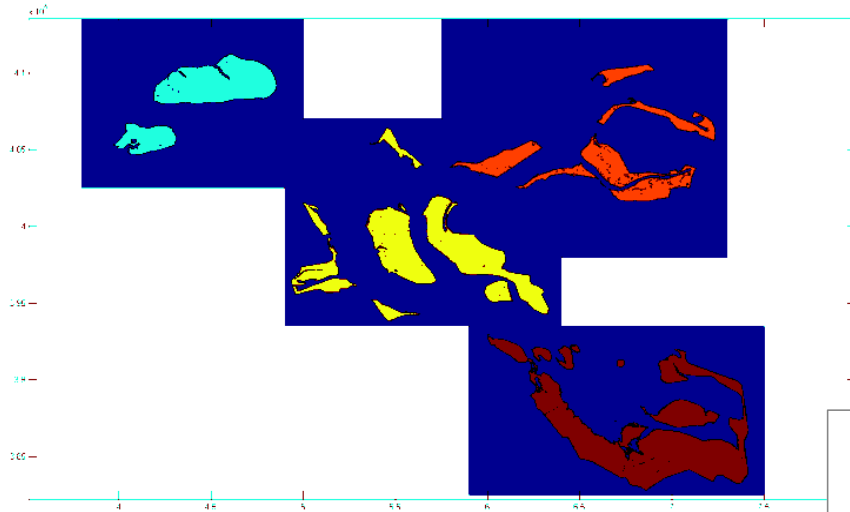


# Recent research Oosterschelde

- Field observations in 2009 and 2010 (Zwarts et al. 2011):
- Prey choice differ among species: summer crabs/shrimps, in winter mainly worms and bivalves.
- Emersion time 40-80 % crucial for survival (i.e. sufficient foraging time)



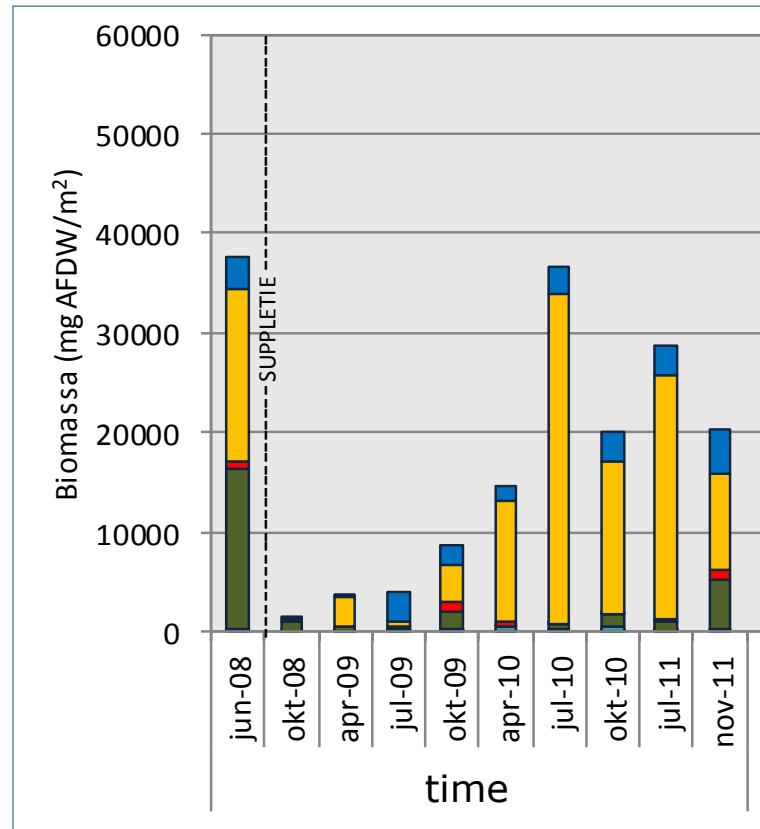
# Prediction bird numbers



de Ronde, J., Mulder, J., Duren, L. van., & Ysebaert, T. (2013). *Eindadvies ANT Oosterschelde*. Middelburg: Rijkswaterstaat.

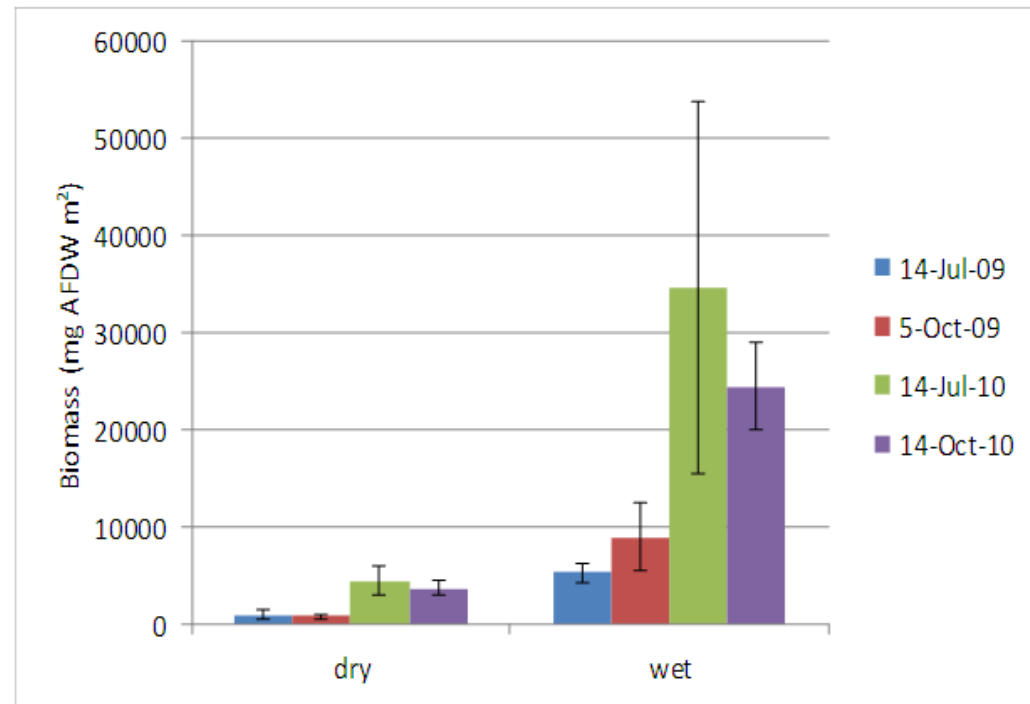
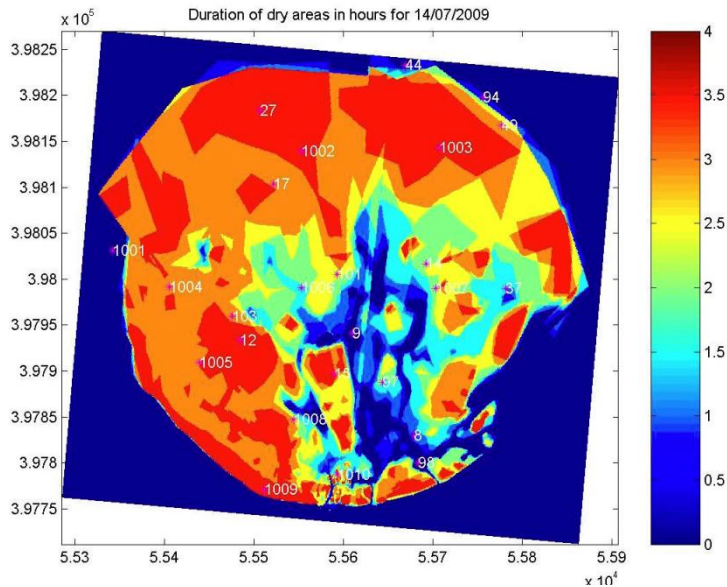
# Lessons learned nourishments

- Galgeplaat: Recovery of total biomass of benthic macrofauna



# Lessons learned nourishments

- Galgeplaat: Recovery of total biomass of benthic macrofauna

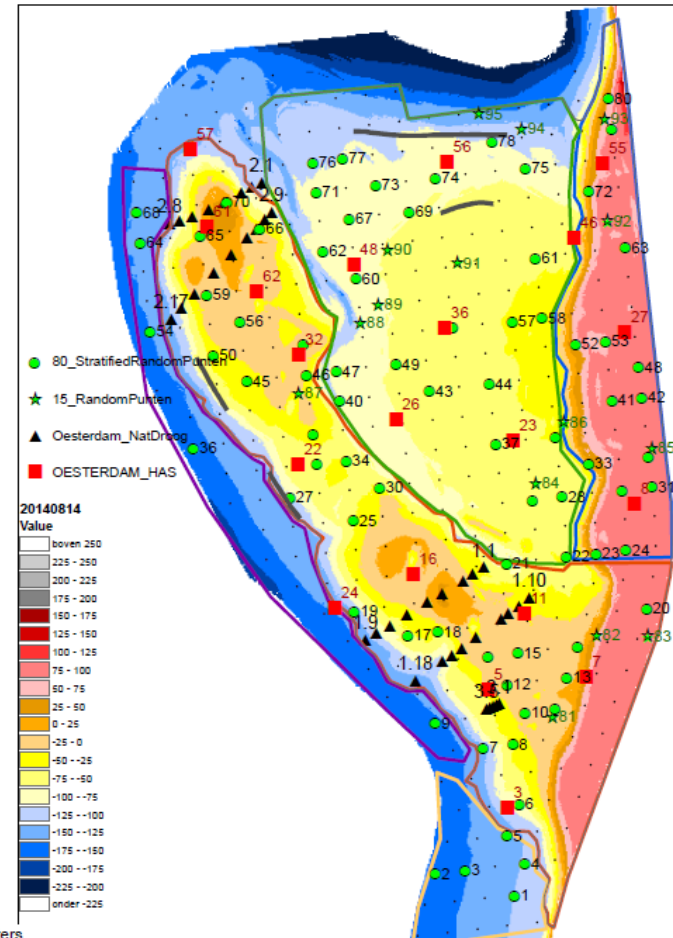


# Galgeplaat nourishment



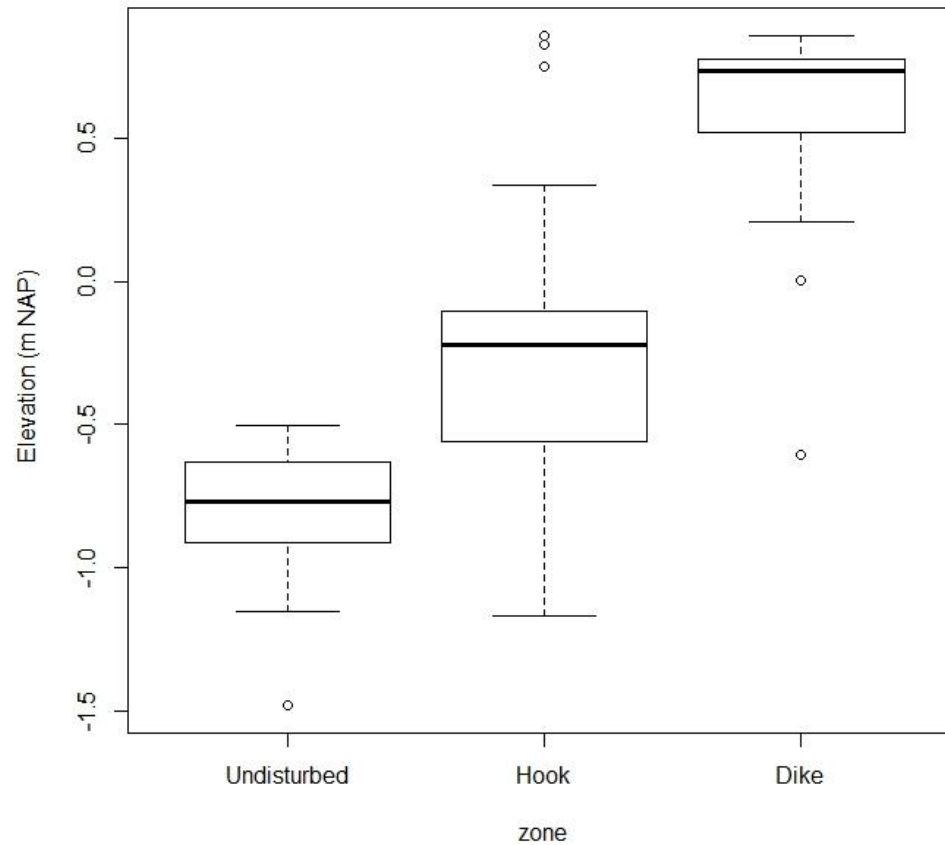
# Oesterdam benthos survey September 2014

- Sampling points
- Analysis: three subareas



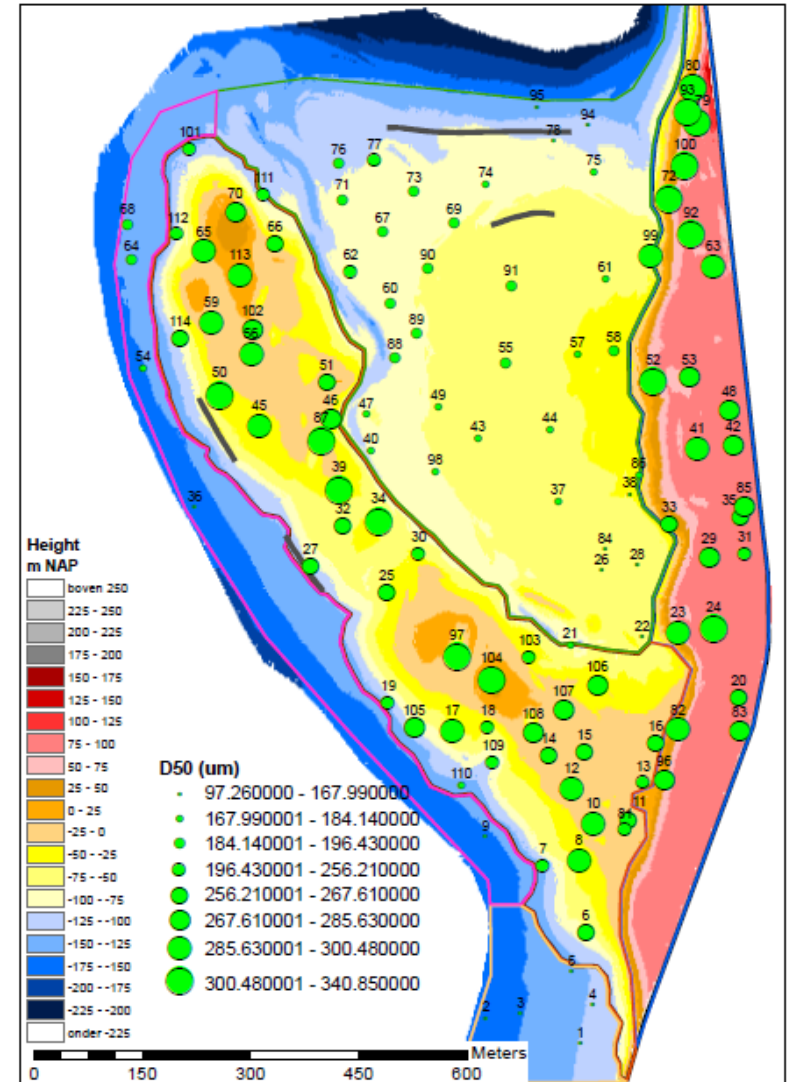
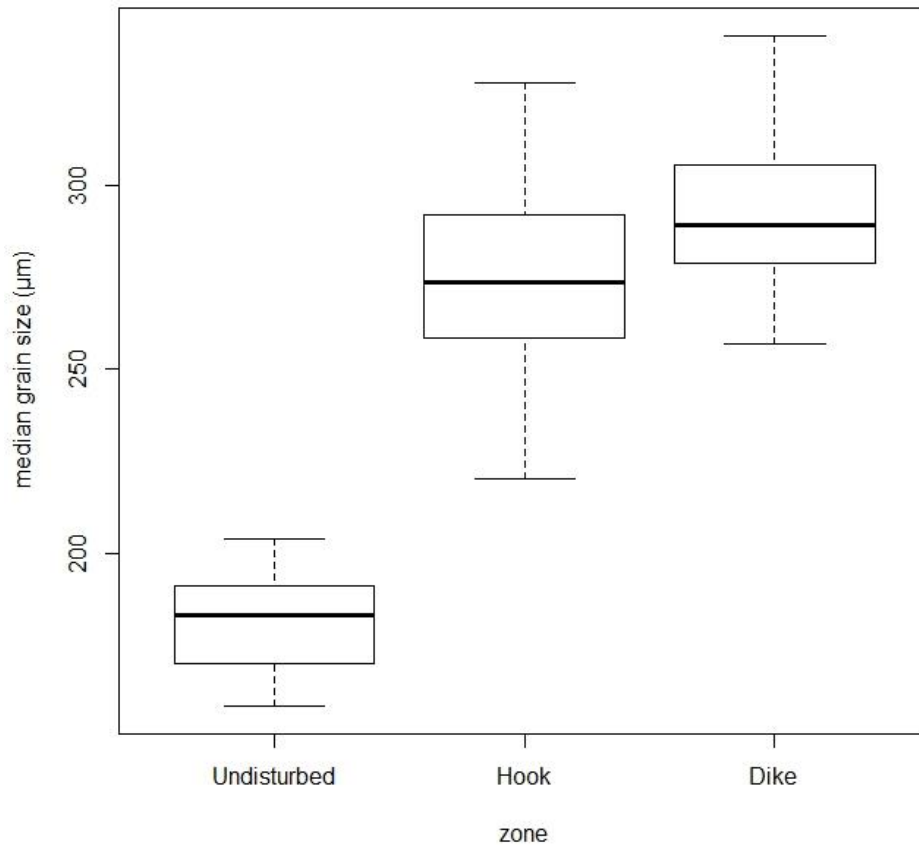
# Oesterdam benthos survey September 2014

## ■ Elevation



# Sediment

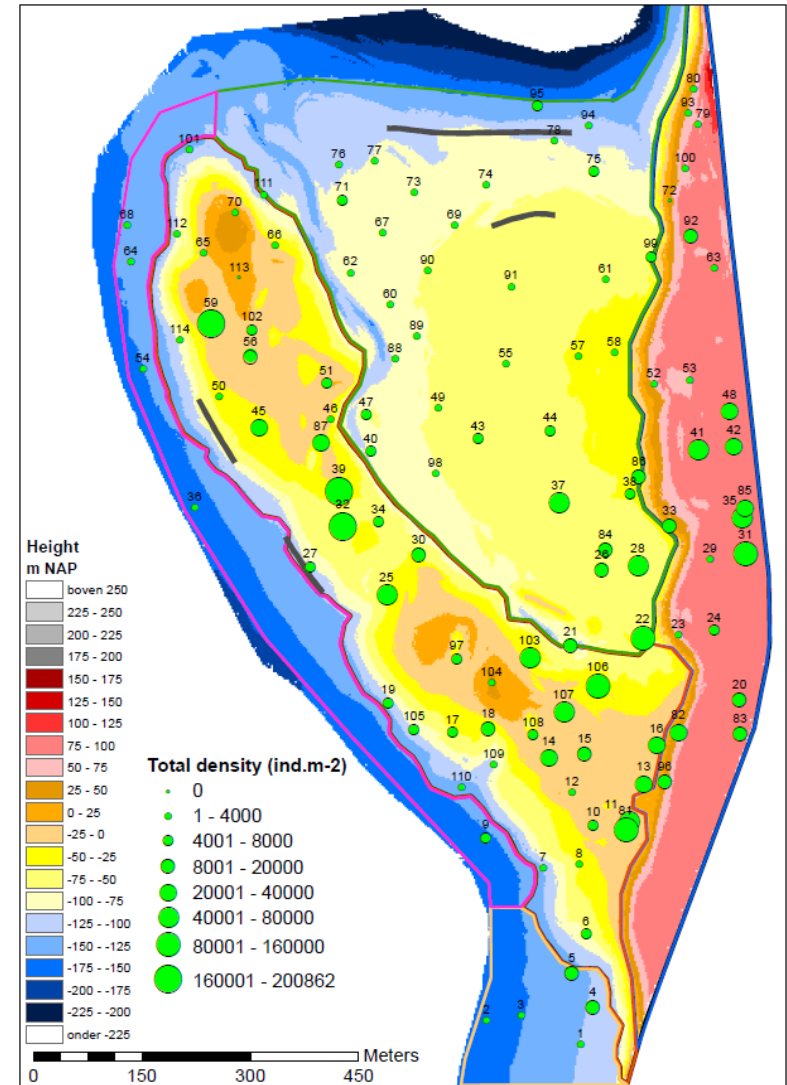
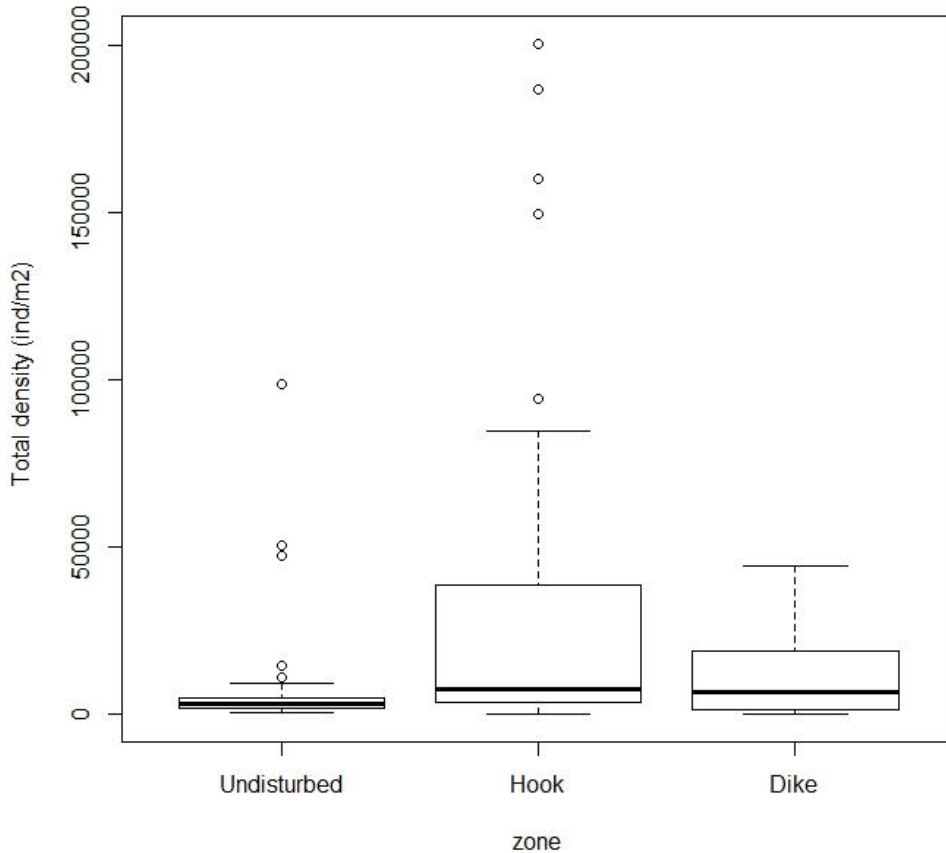
## ■ Median grain size ( $\mu\text{m}$ )





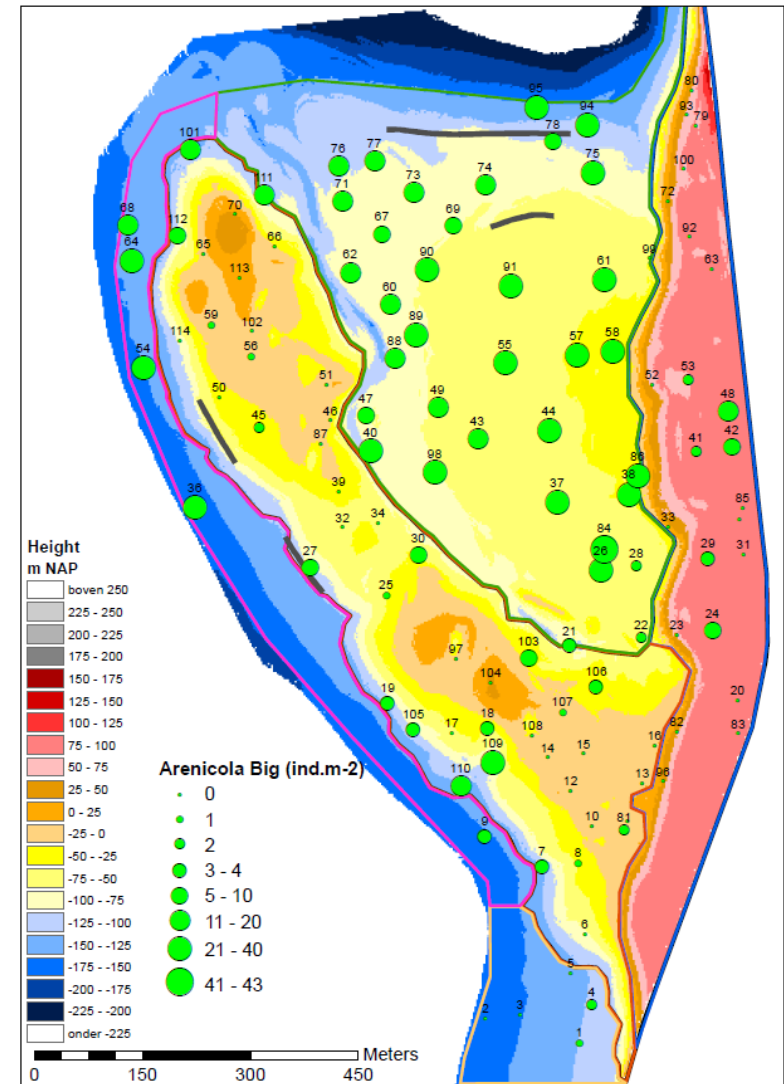
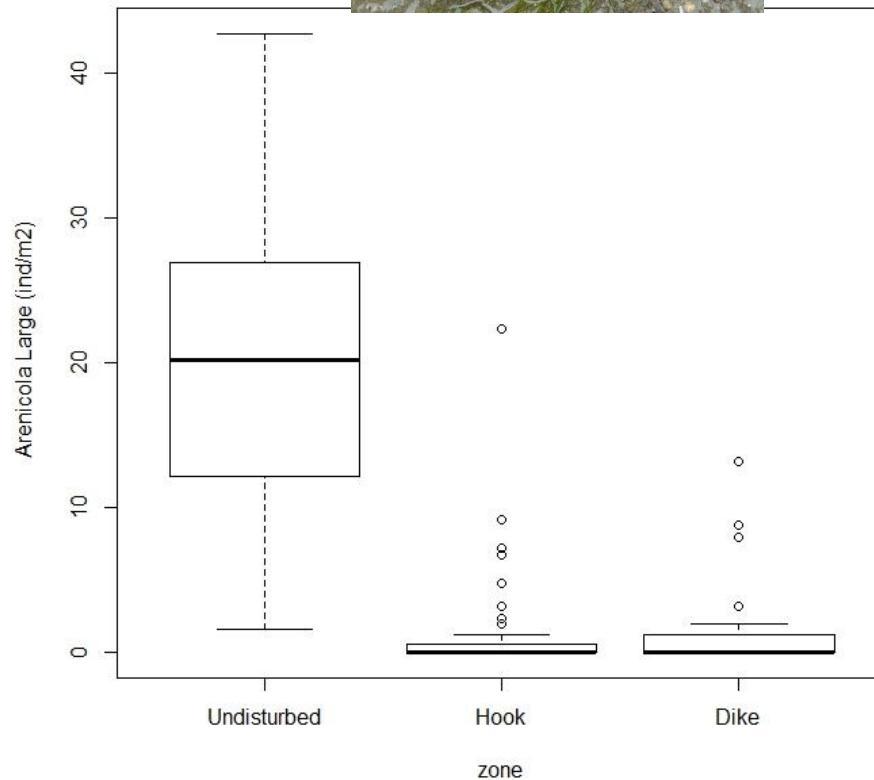
# Oesterdam benthos survey September 2014

## ■ Total density (ind.m<sup>-2</sup>)



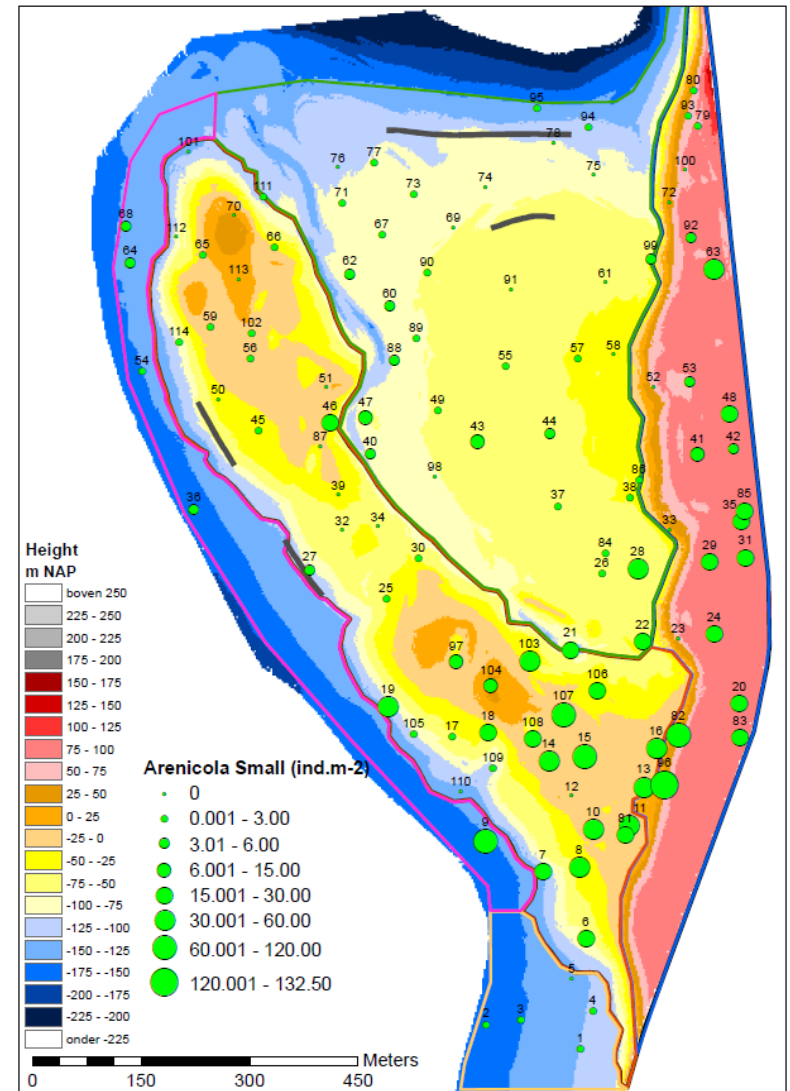
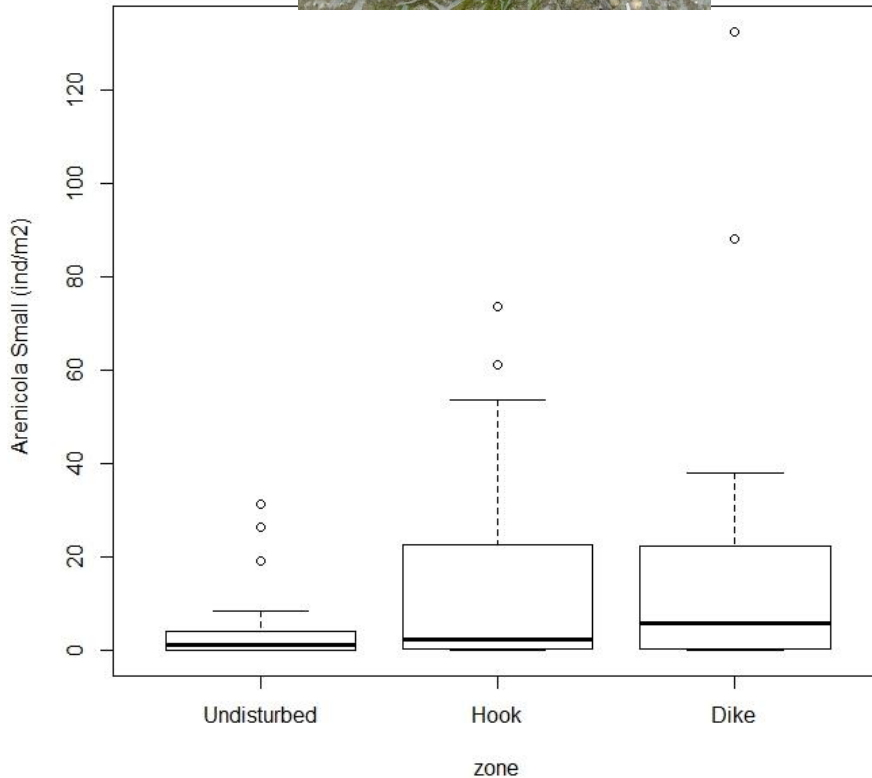
# Oesterdam benthos survey September 2014

## ■ *Arenicola marina* (LARGE)



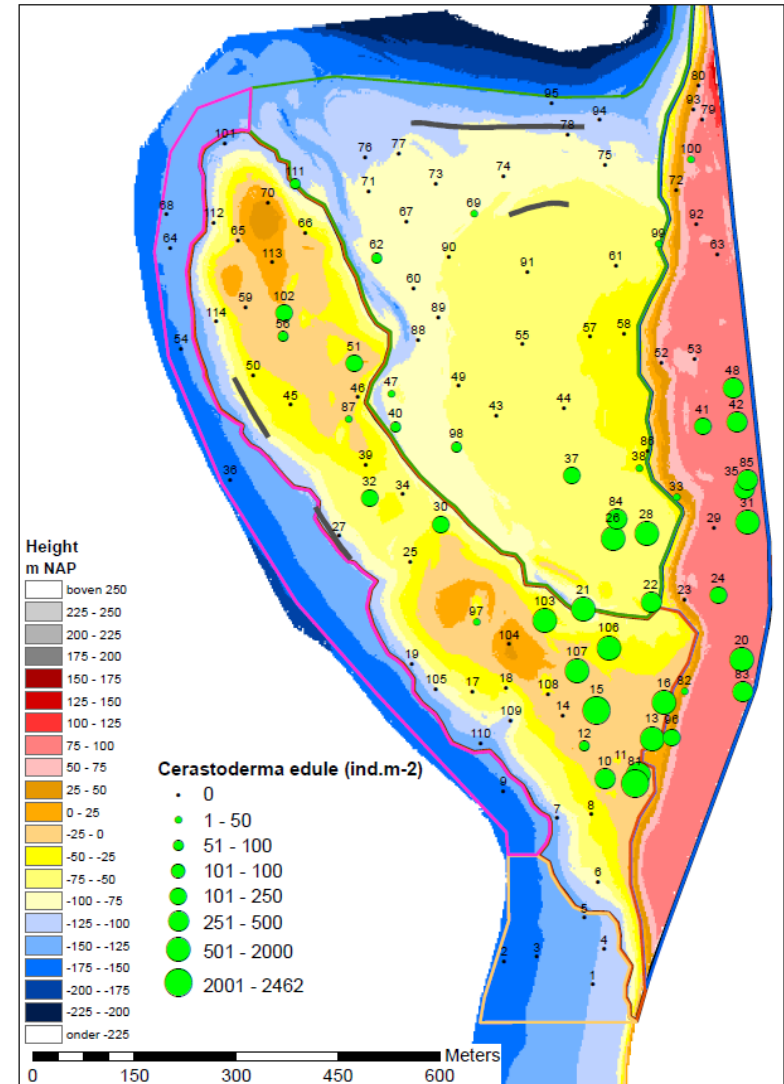
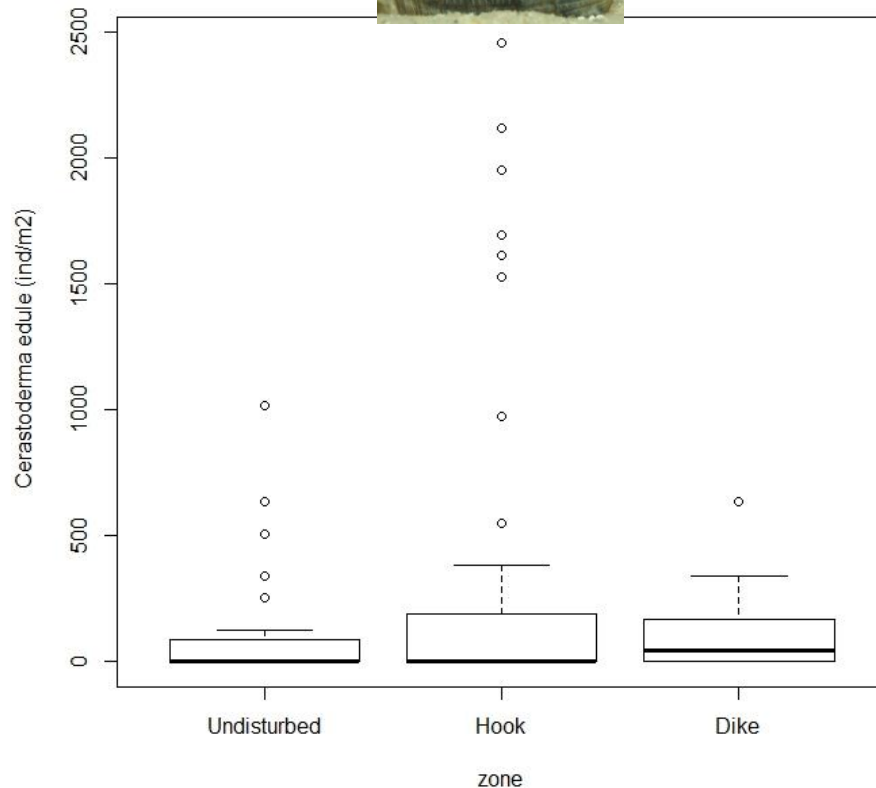
# Oesterdam benthos survey September 2014

## ■ *Arenicola marina* (SMALL)



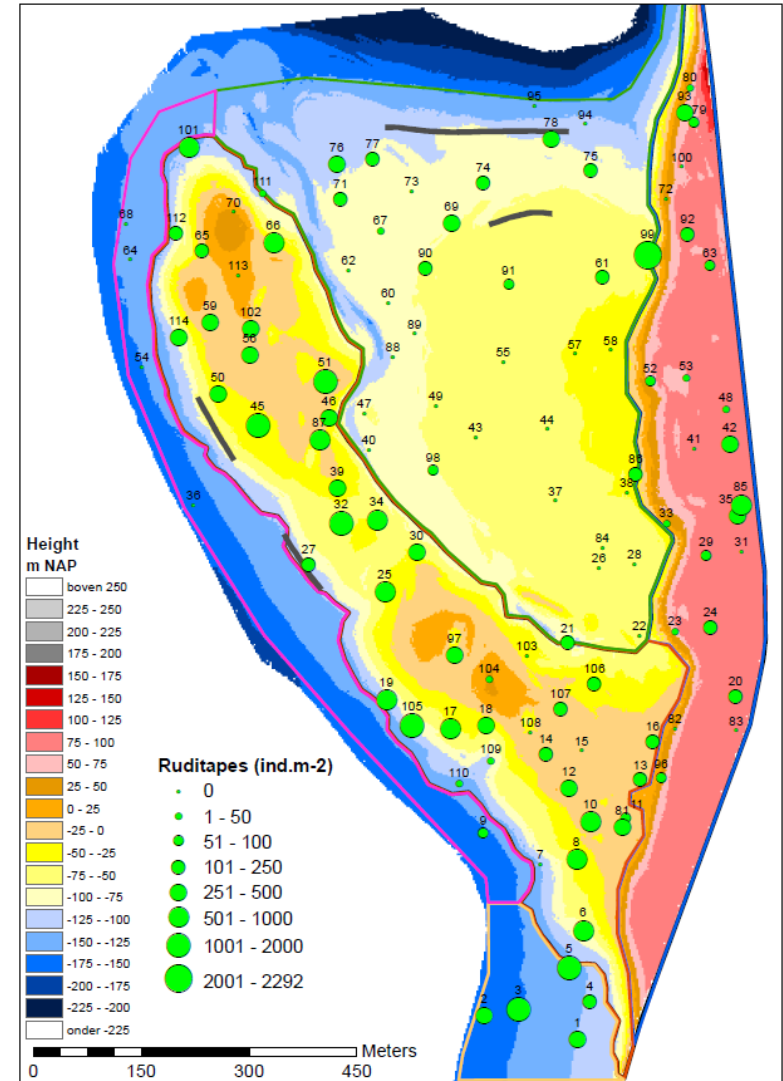
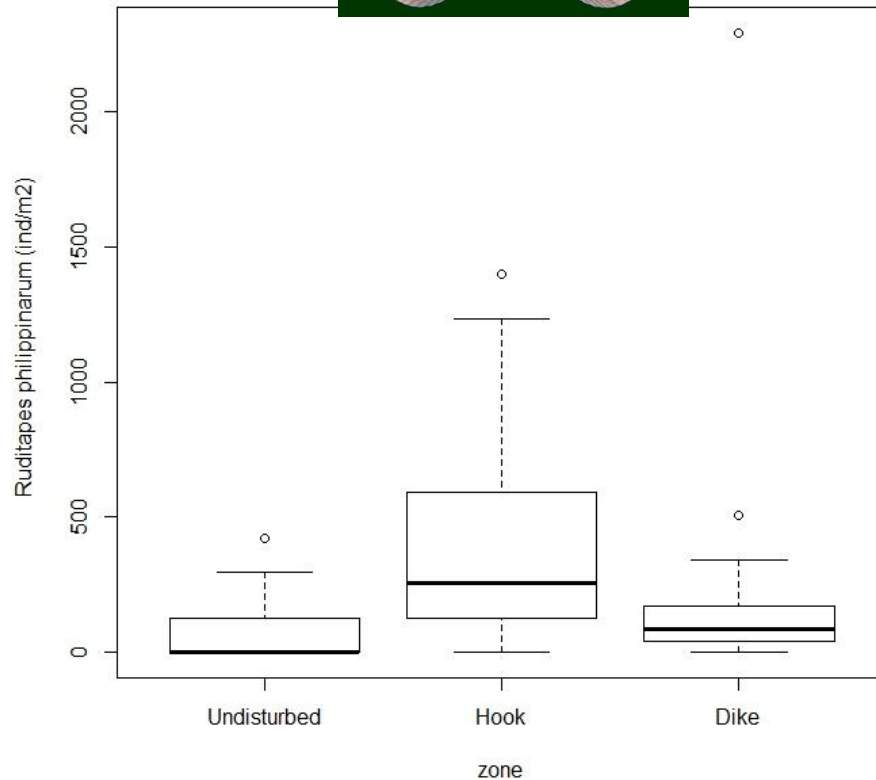
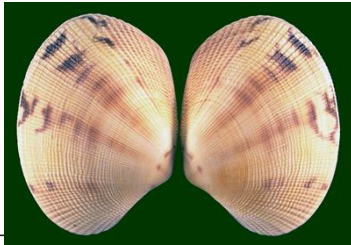
# Oesterdam benthos survey September 2014

## ■ *Cerastoderma edule* (ind.m<sup>-2</sup>)



# Oesterdam benthos survey September 2014

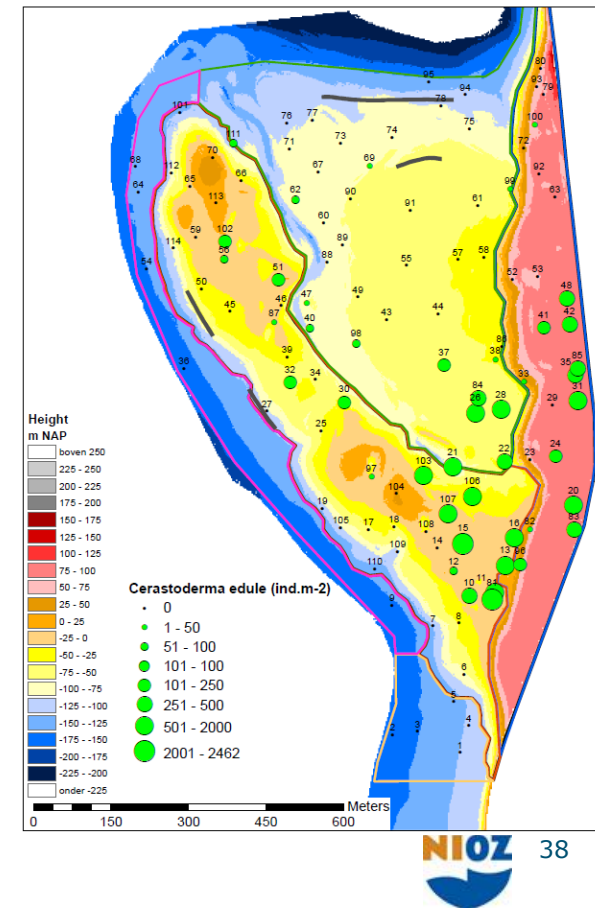
## ■ *Ruditapes philippinarum*



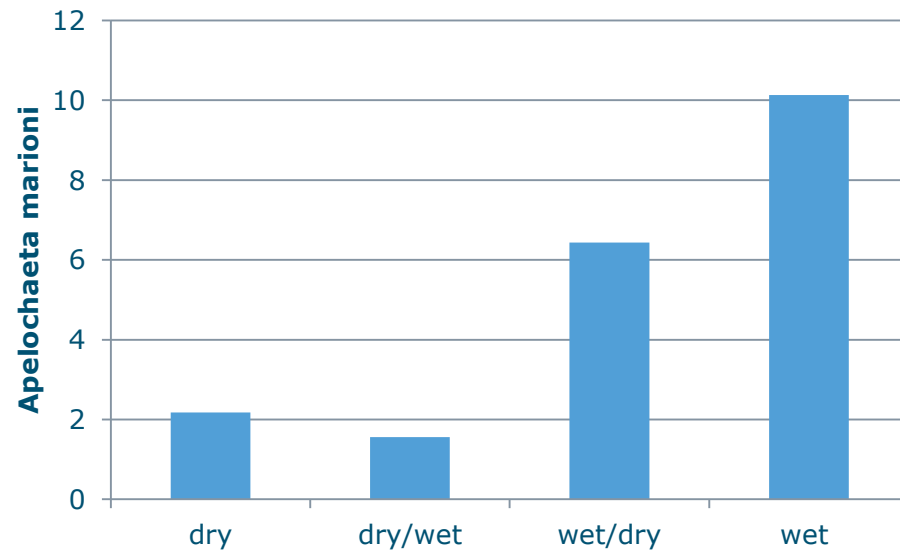
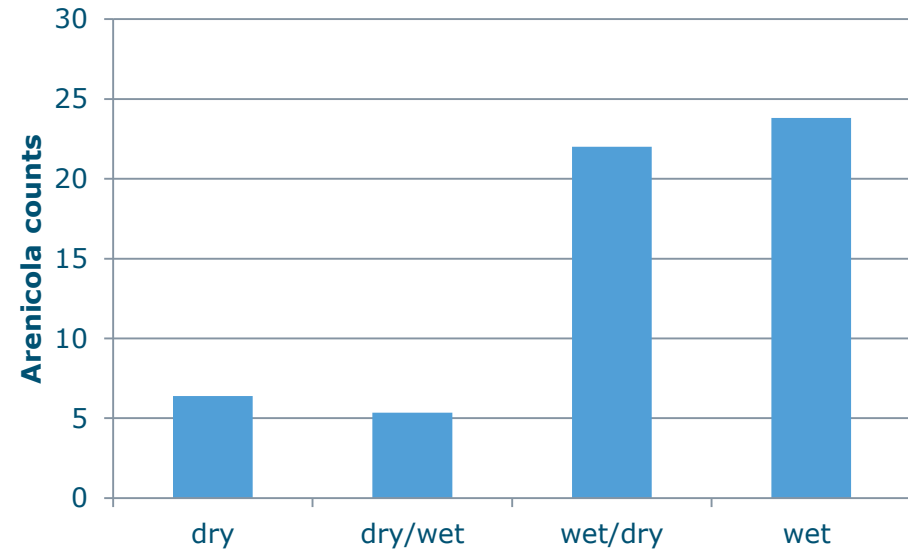
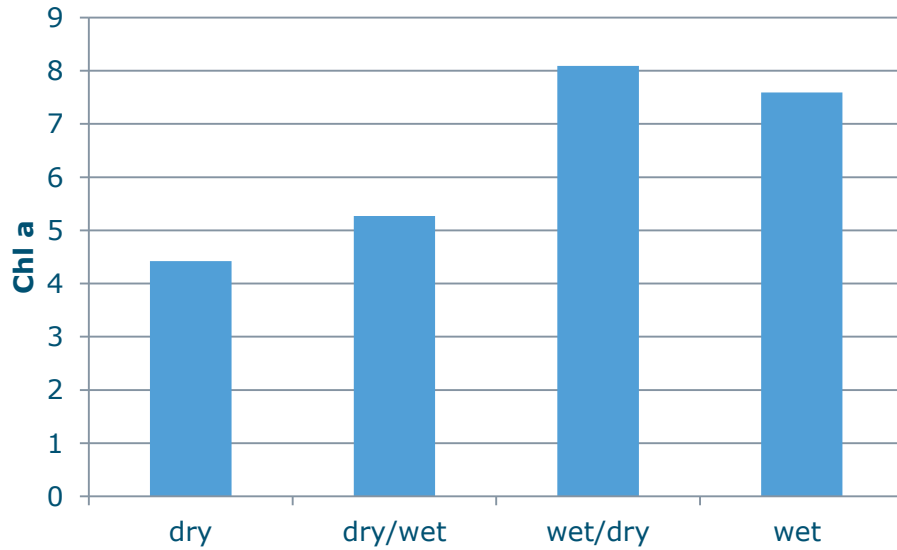
# Oesterdam benthos survey September 2014

## ■ Conclusions:

- Successful settlement of many species after one year
- Faster recolonization compared to Galgeplaat
- Non-indigenous species
- Not homogeneous, hotspots
- Hypotheses:
  - Biotic interactions: *Arenicola*
  - Abiotic conditions



# Relations abiotics - biotics

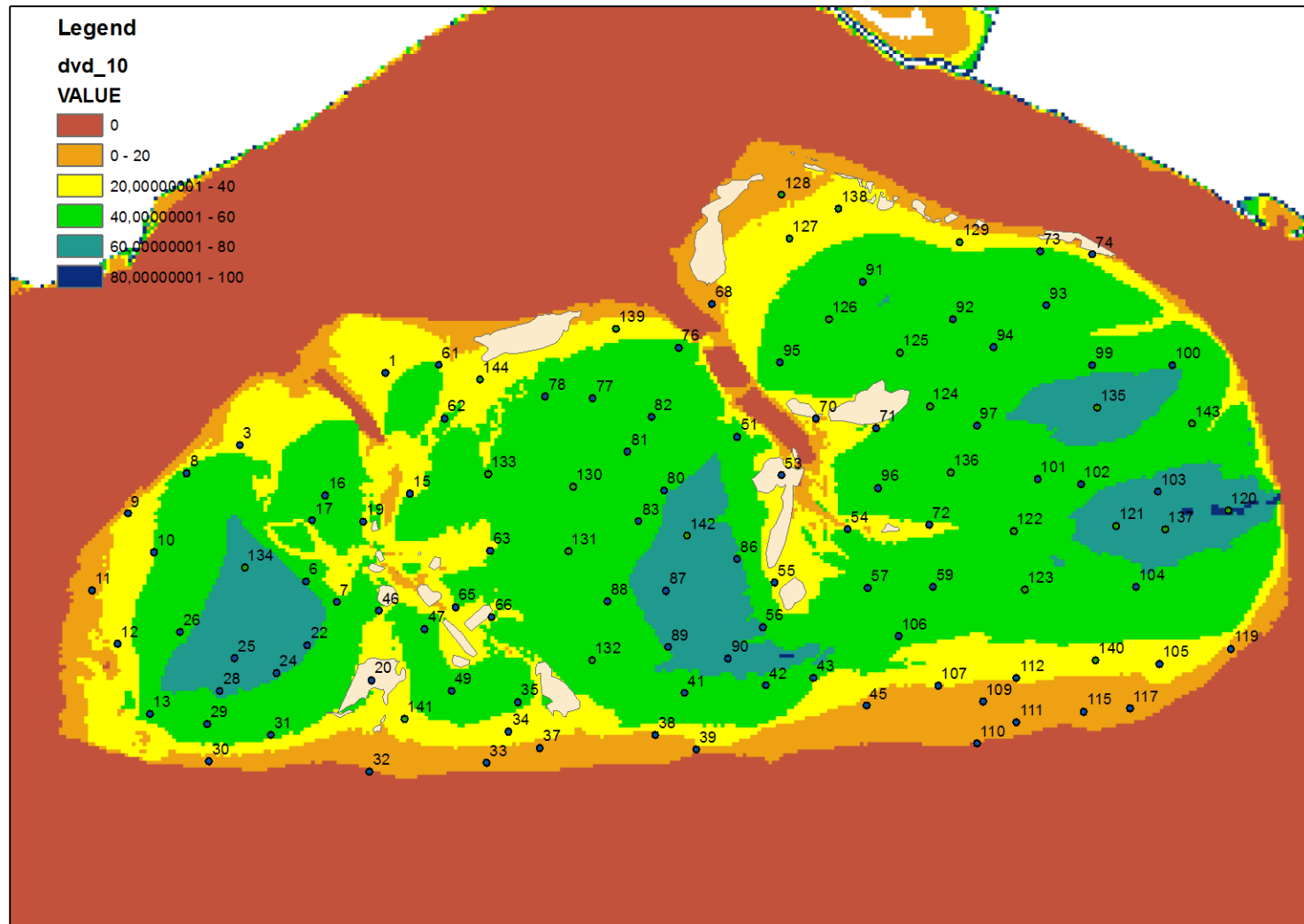


# Roggenplaat characteristics: T0 monitoring



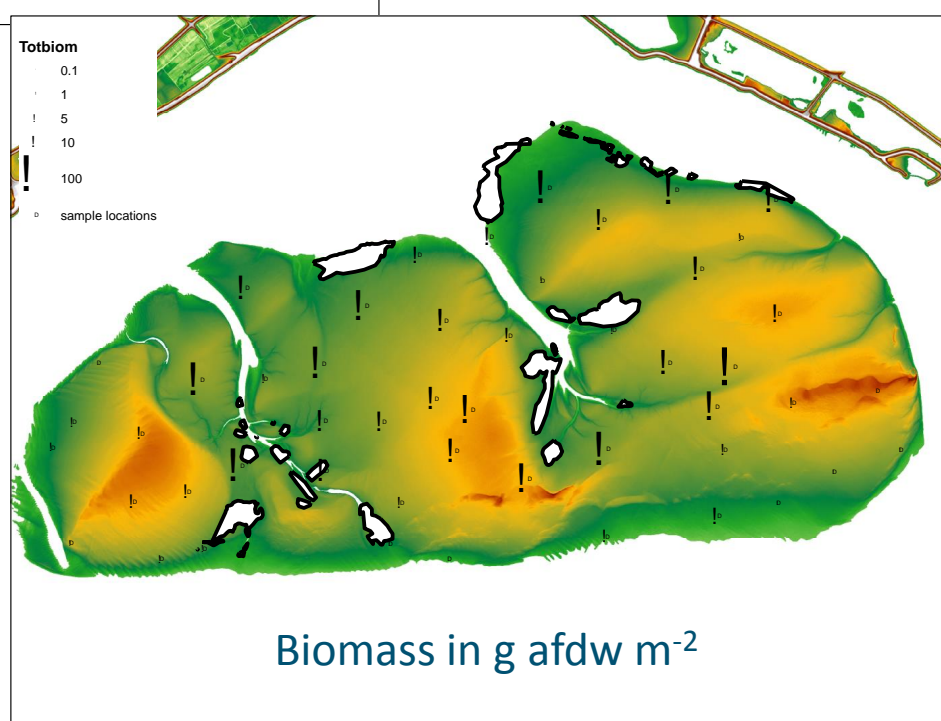
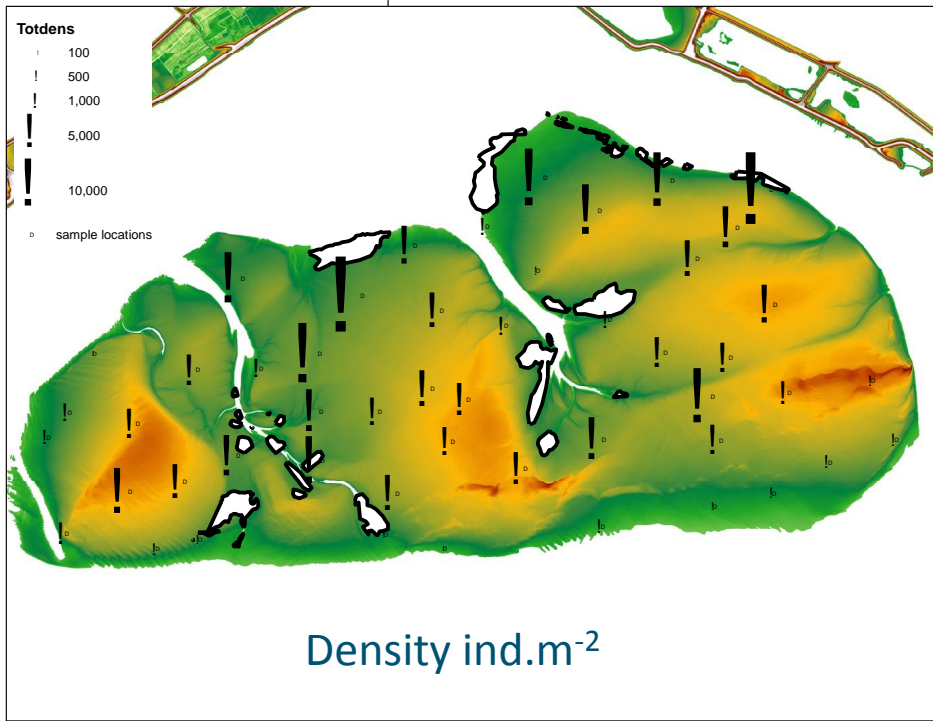
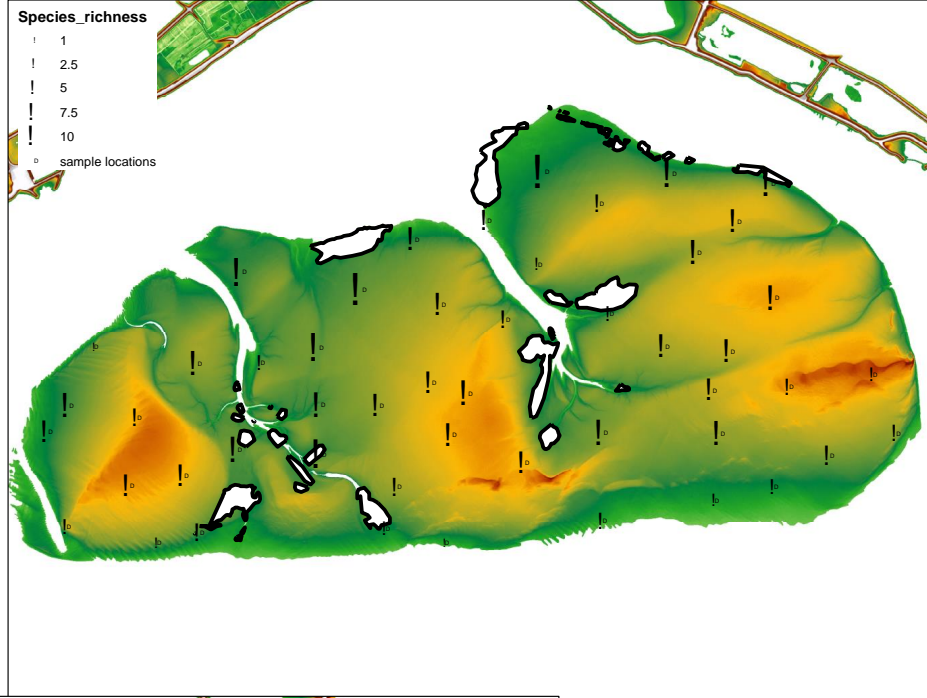


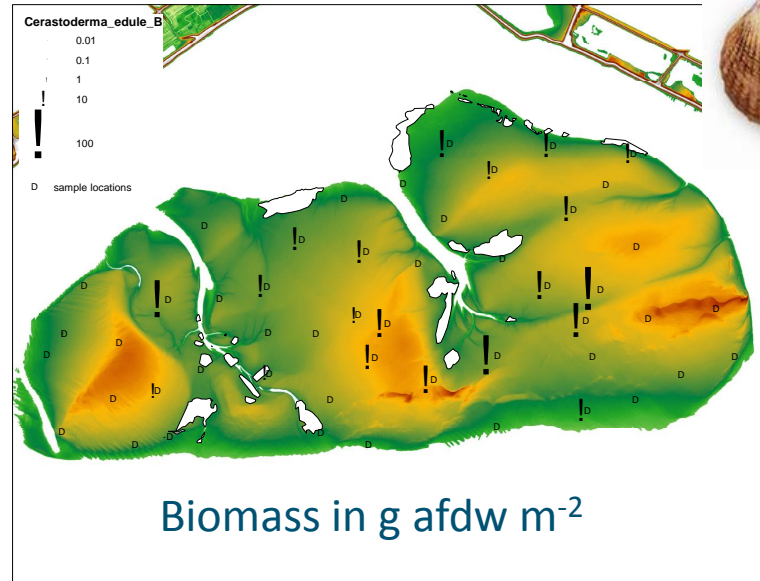
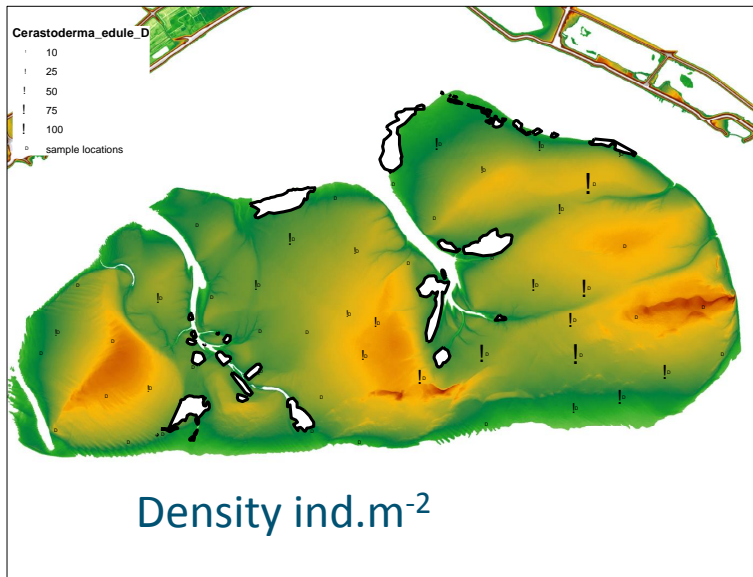
# Benthic macrofauna survey



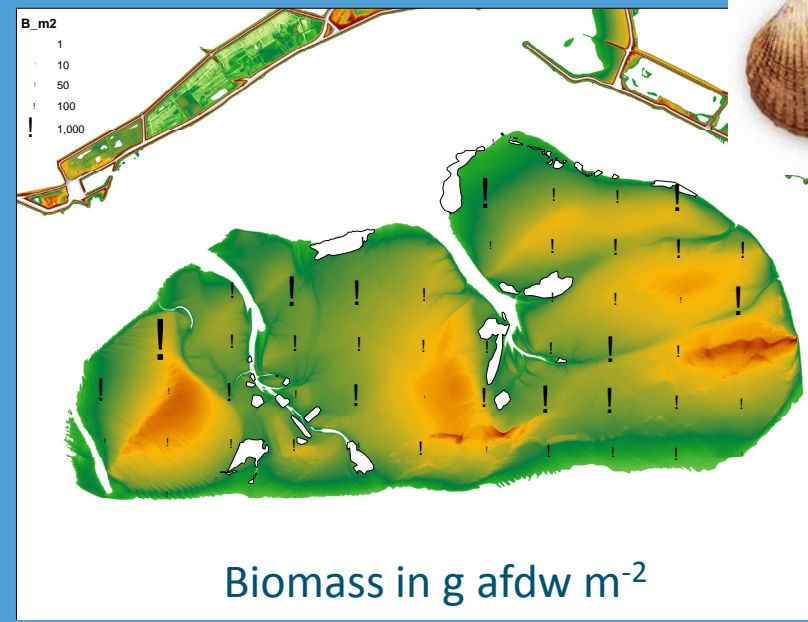
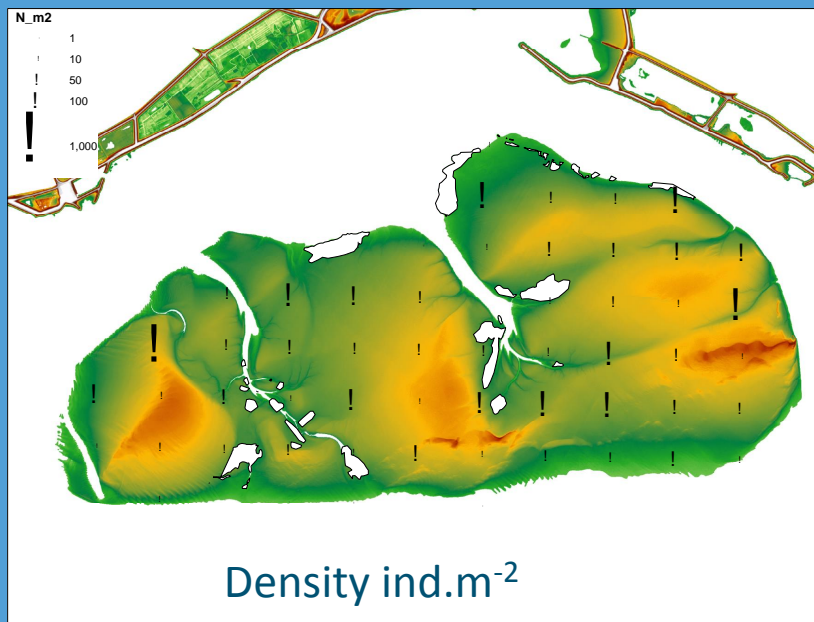
# Benthic macrofauna survey: occurrence

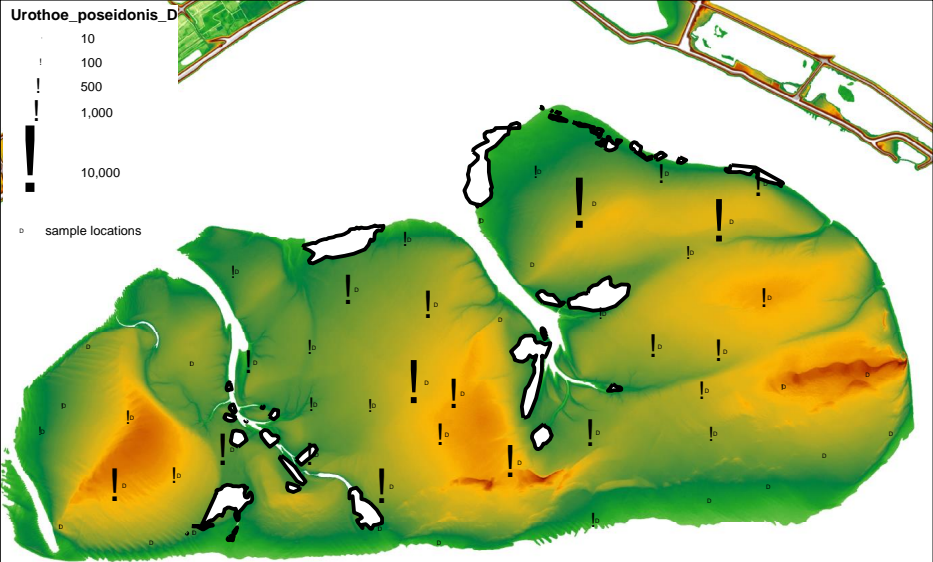
Species	%
Scoloplos armiger	90
Urothoe poseidonis	80
Macoma balthica	76
Arenicola sp.	62
Aphelochaeta marioni	56
Cerastoderma edule	50
OLIGOCHAETA	48
Eteone sp.	46
Pygospio elegans	46
Phyllodoce mucosa	44
Nephtys hombergii	42
Lanice conchilega	38
Corophium arenarium	34
Peringia ulvae	32
Ruditapes philippinarum	30





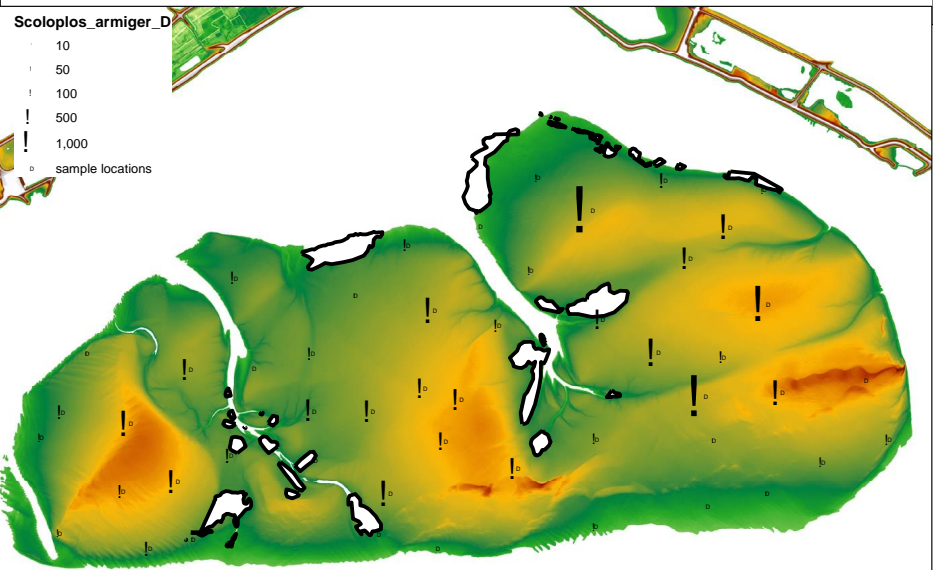
### Kokkel survey IMARES



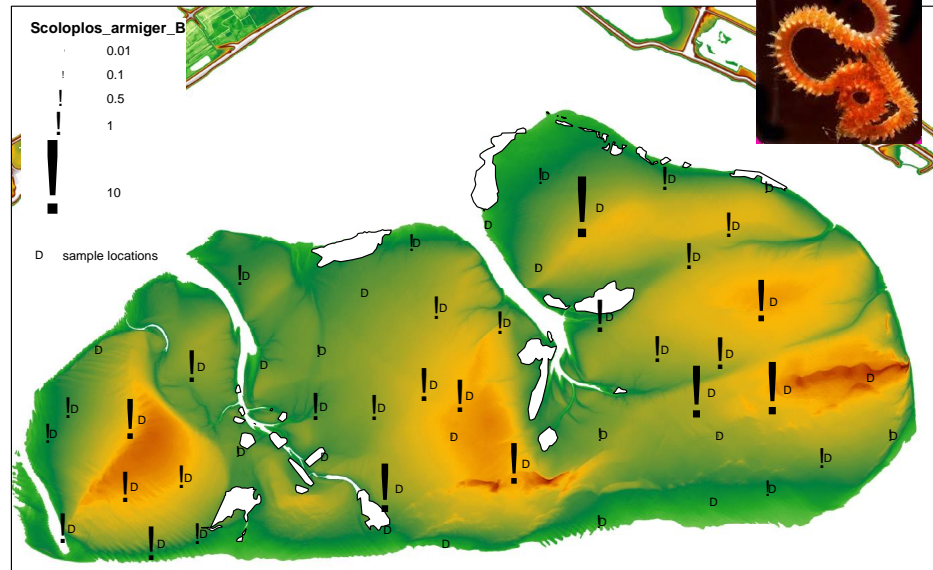


Density ind.m<sup>-2</sup>

Biomass in g afdw m<sup>-2</sup>



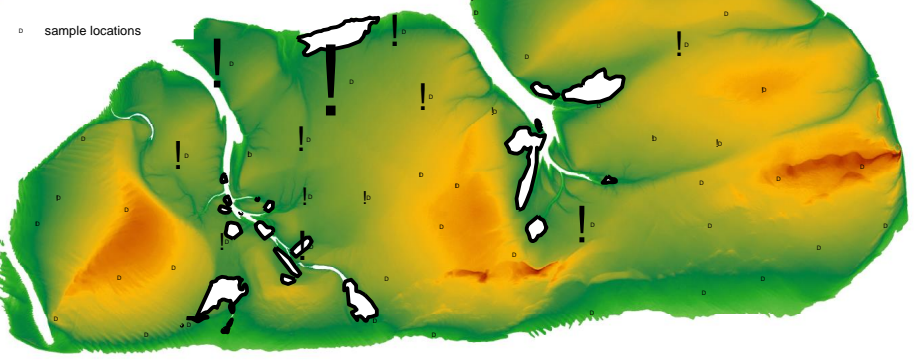
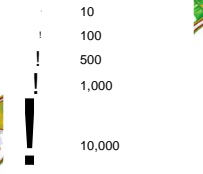
Density ind.m<sup>-2</sup>



Biomass in g afdw m<sup>-2</sup>



**Aphelochaeta\_marioni\_D**

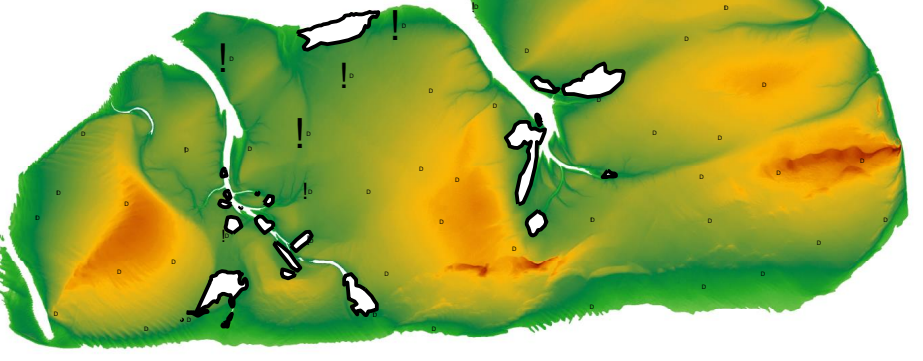
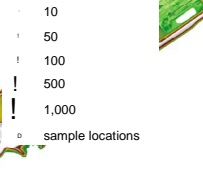


Density ind.m<sup>-2</sup>



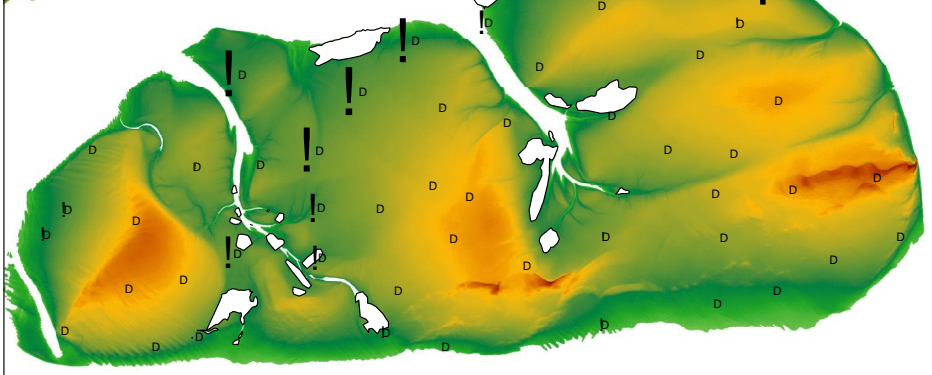
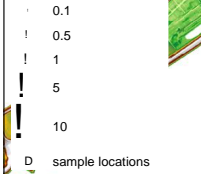
Biomass in g afdw m<sup>-2</sup>

**Lanice\_conchilega\_D**



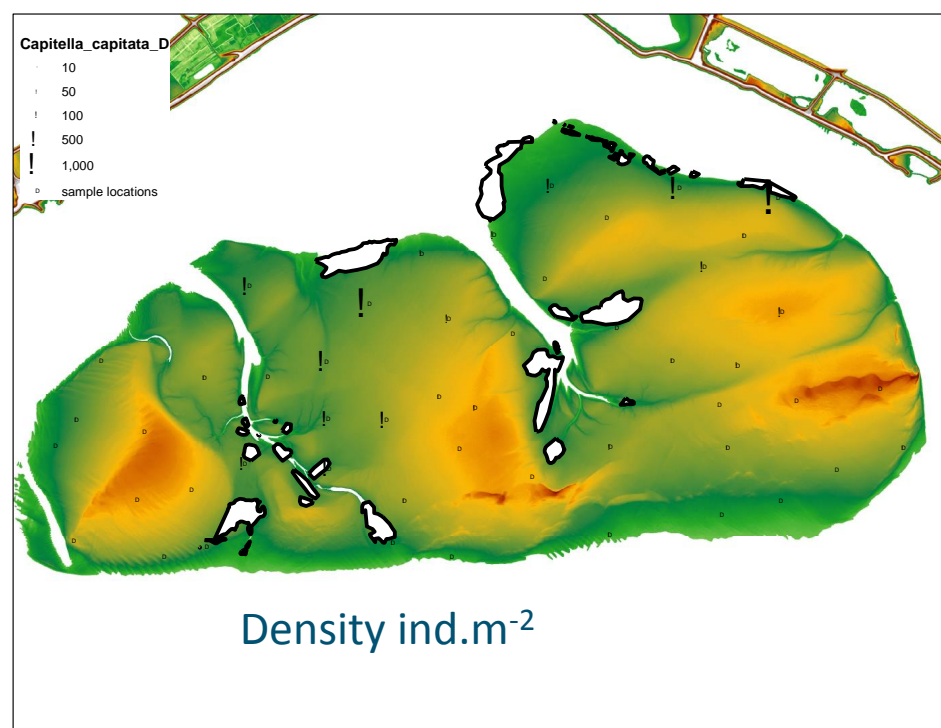
Density ind.m<sup>-2</sup>

**Lanice\_conchilega\_B**

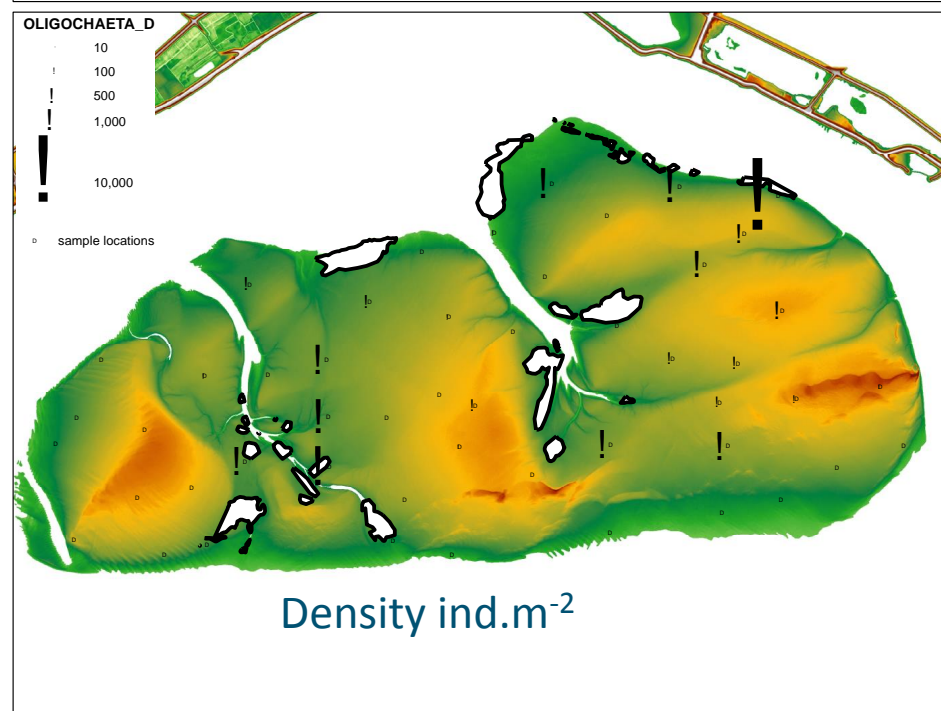


Biomass in g afdw m<sup>-2</sup>

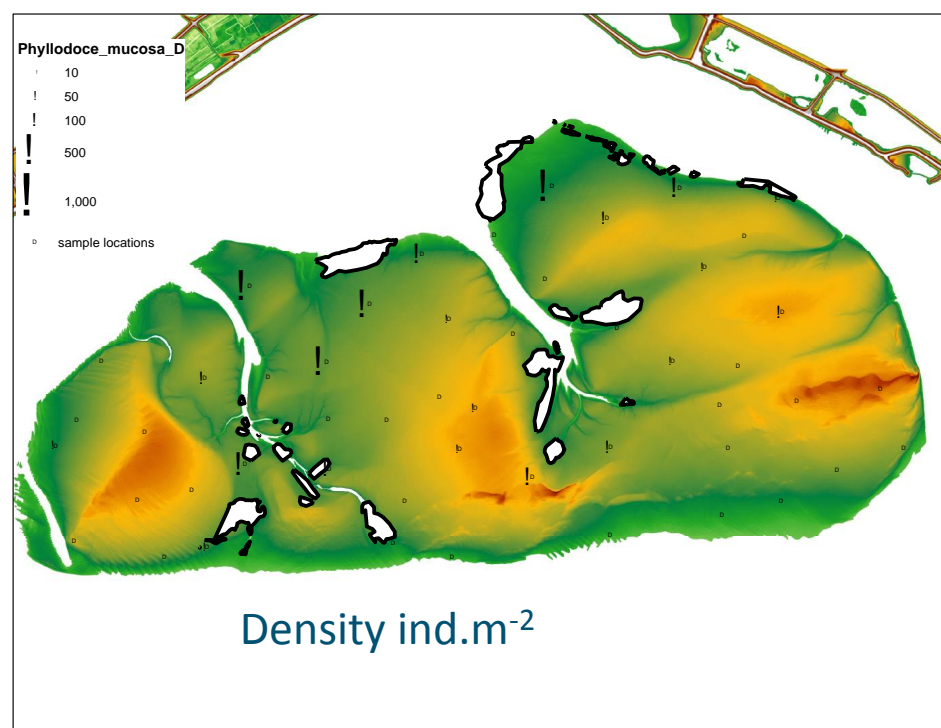




Biomass in g afdw m<sup>-2</sup>

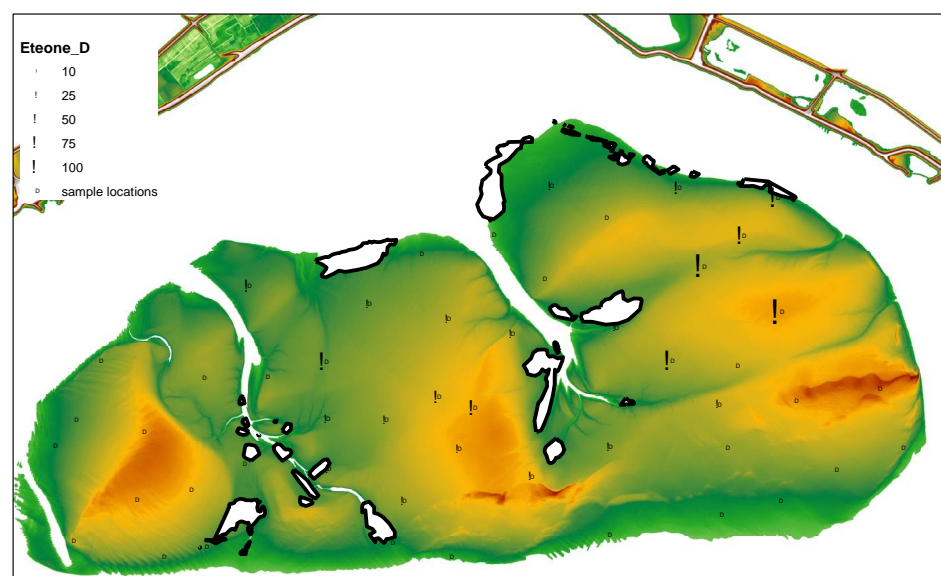


Biomass in g afdw m<sup>-2</sup>



Biomass in g afdw m<sup>-2</sup>

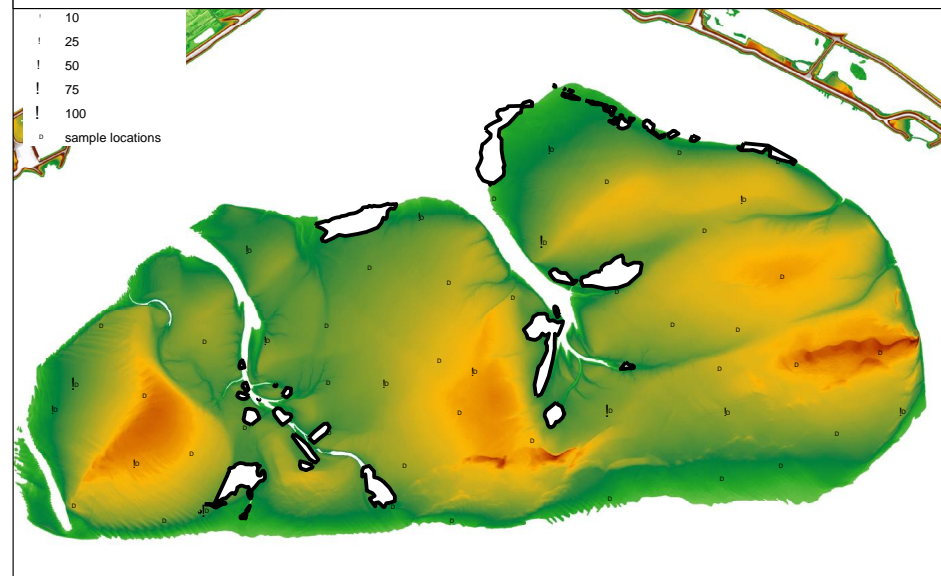




Density ind.m<sup>-2</sup>



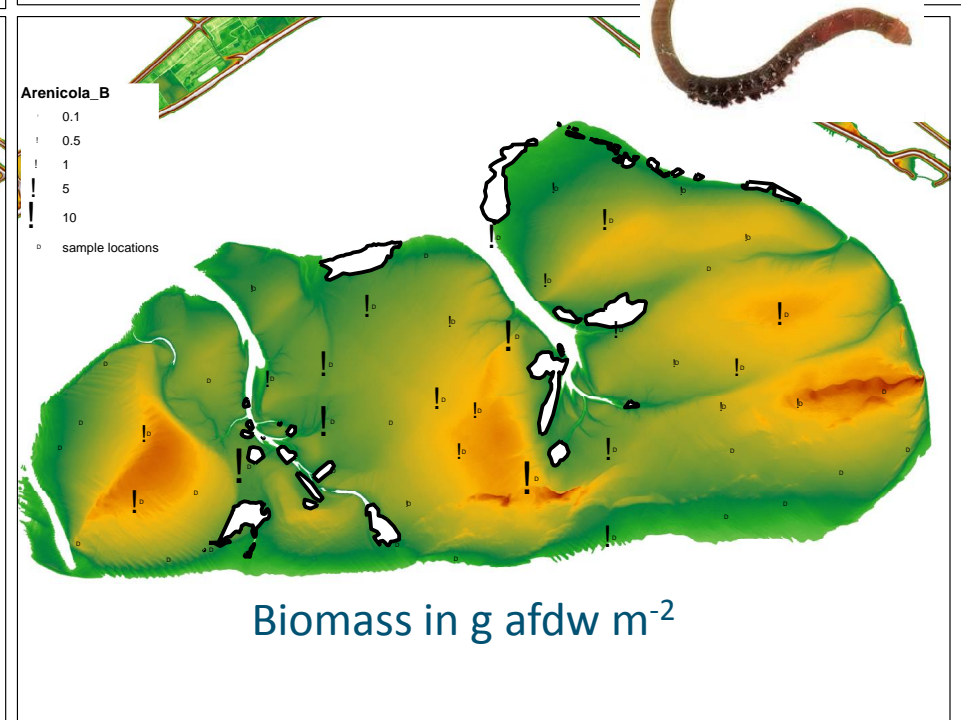
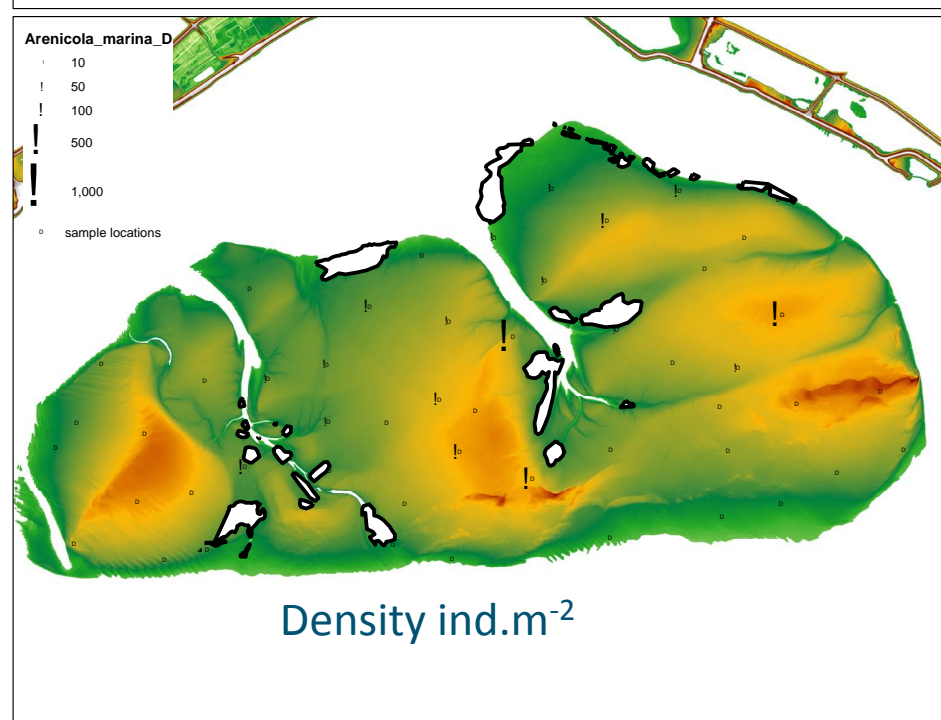
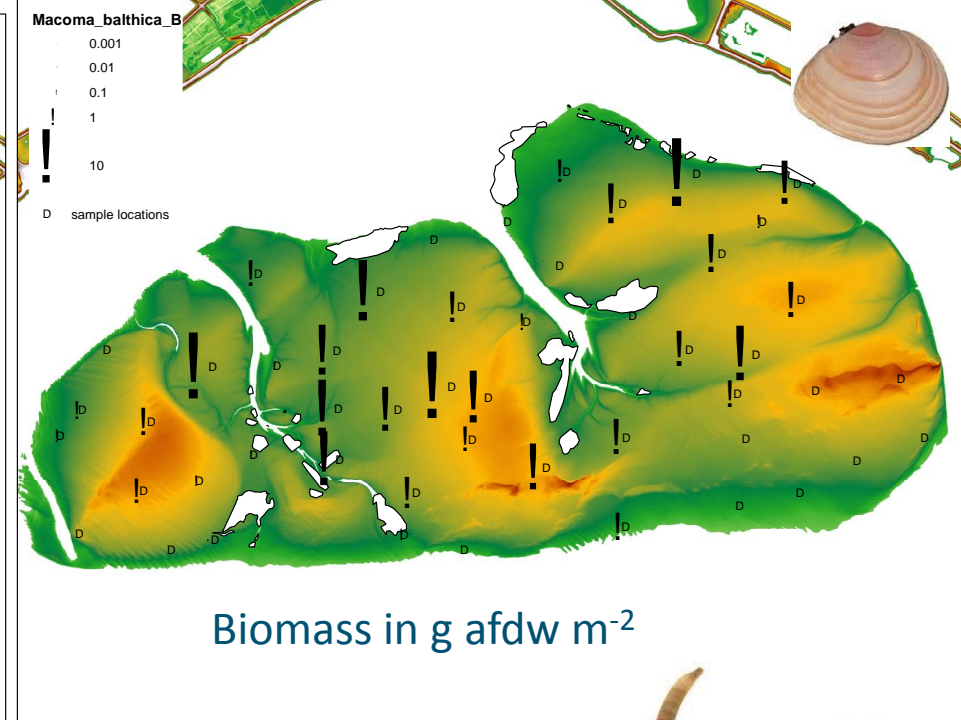
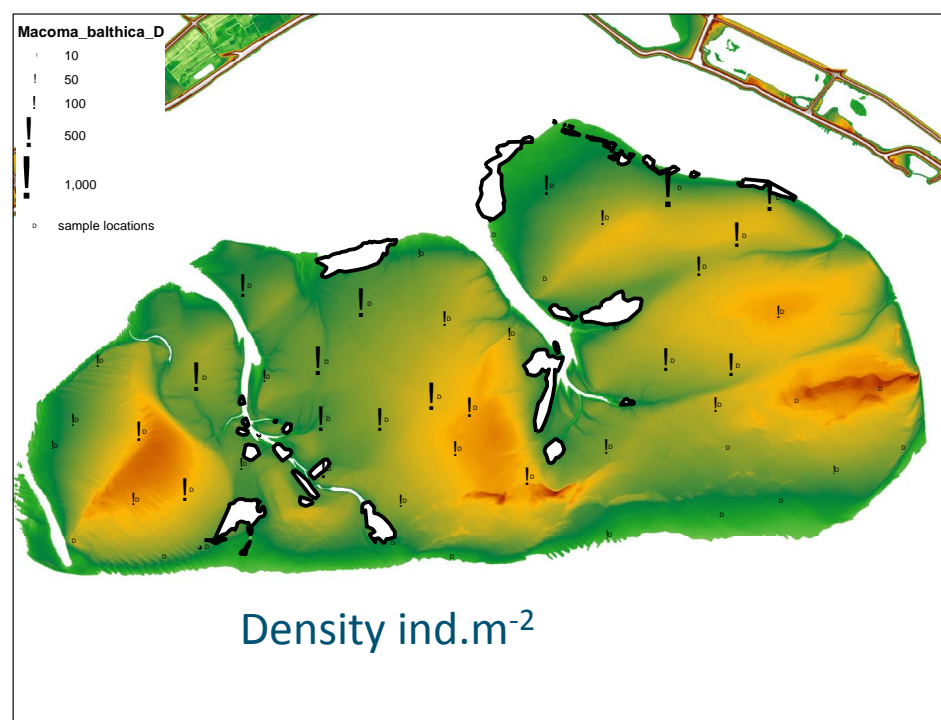
Biomass in g afdw m<sup>-2</sup>

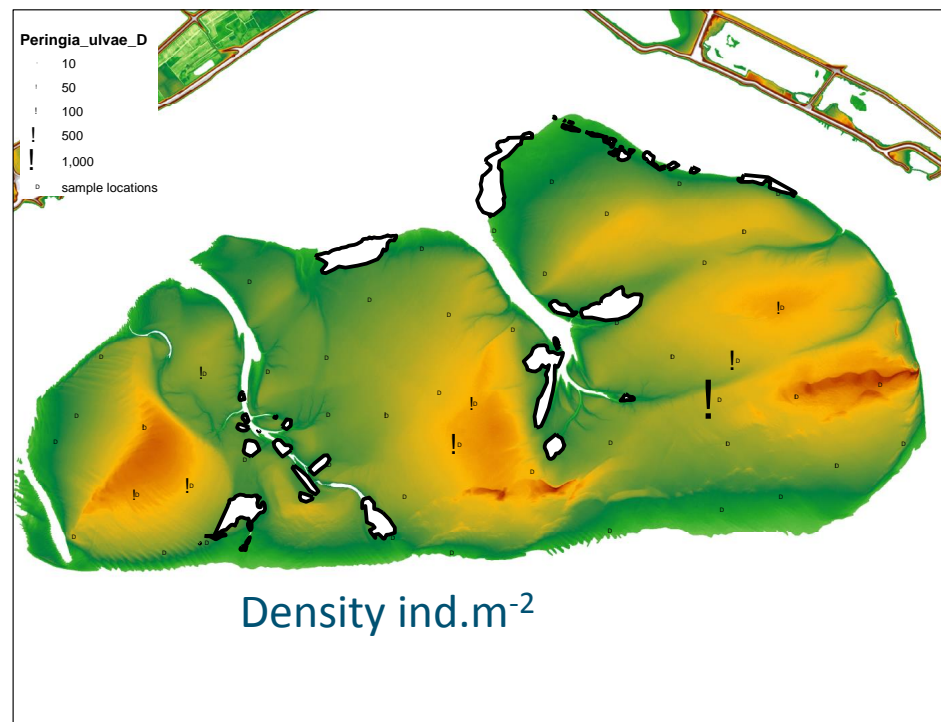


Density ind.m<sup>-2</sup>

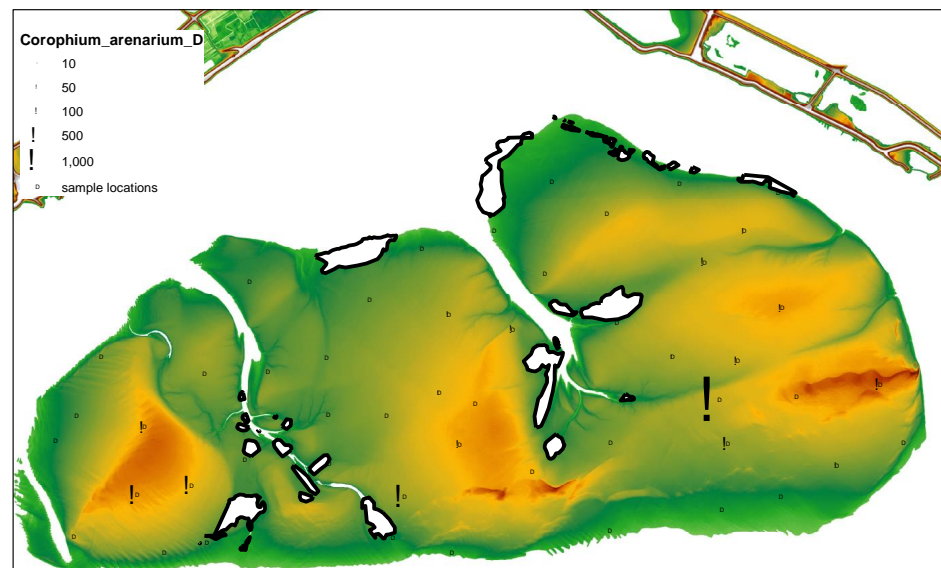


Biomass in g afdw m<sup>-2</sup>





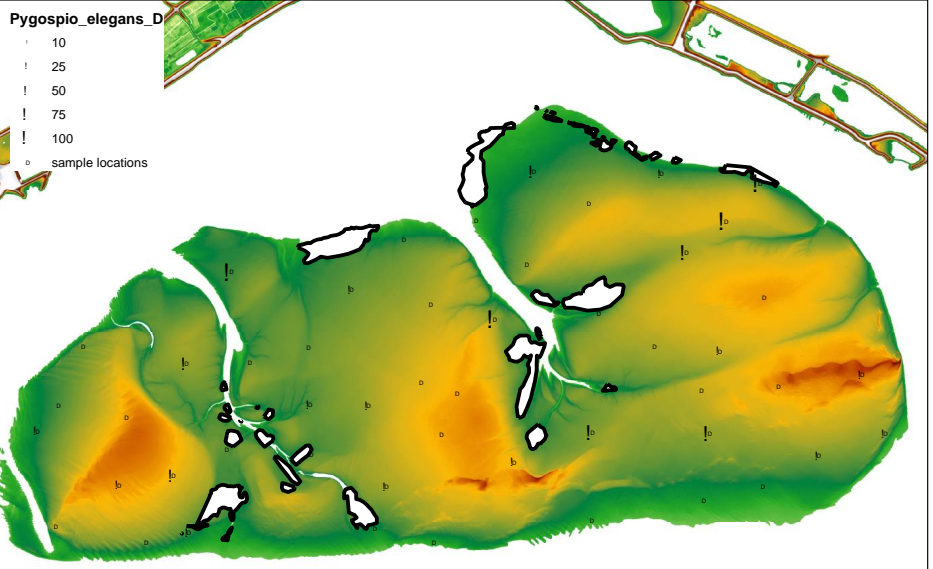
Biomass in g afdw m<sup>-2</sup>



Biomass in g afdw m<sup>-2</sup>

Pygospio\_elegans\_D

- 10
- 25
- 50
- 75
- 100
- sample locations



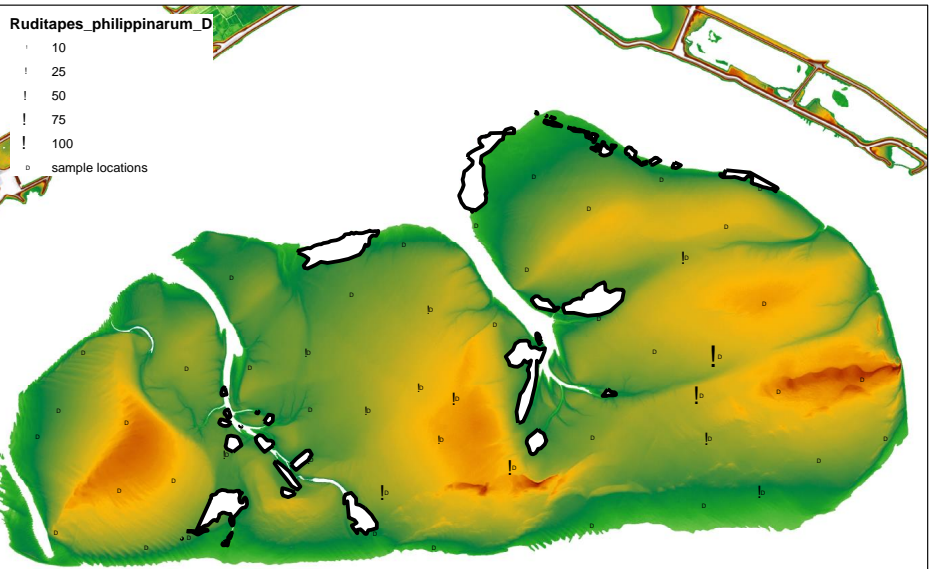
Density ind.m<sup>-2</sup>



Biomass in g afdw m<sup>-2</sup>

Ruditapes\_philippinarum\_D

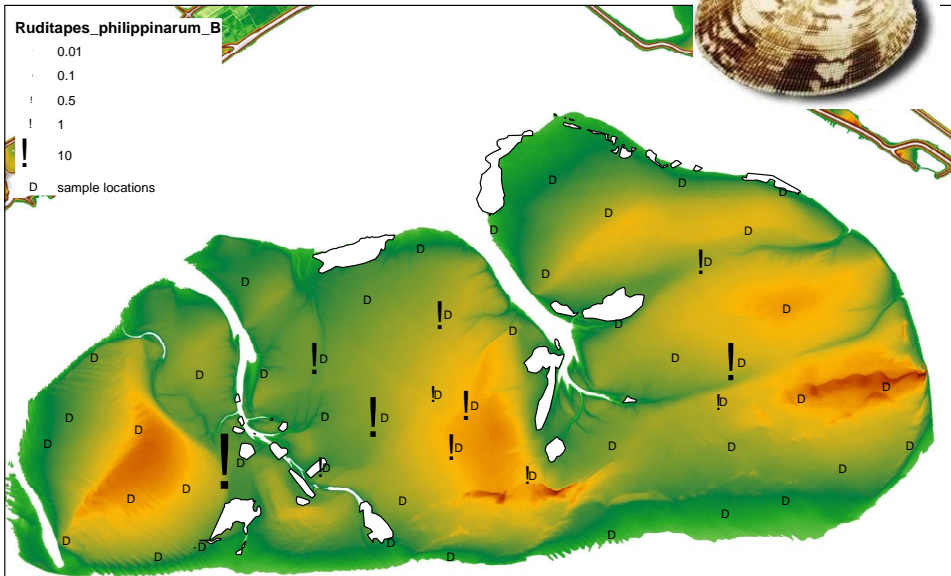
- 10
- 25
- 50
- 75
- 100
- sample locations



Density ind.m<sup>-2</sup>

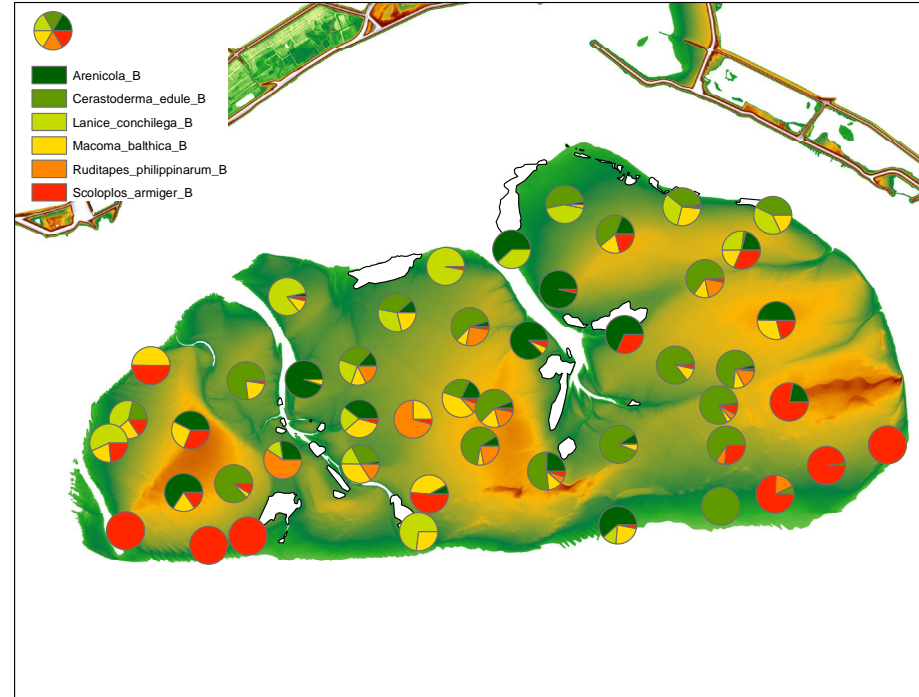
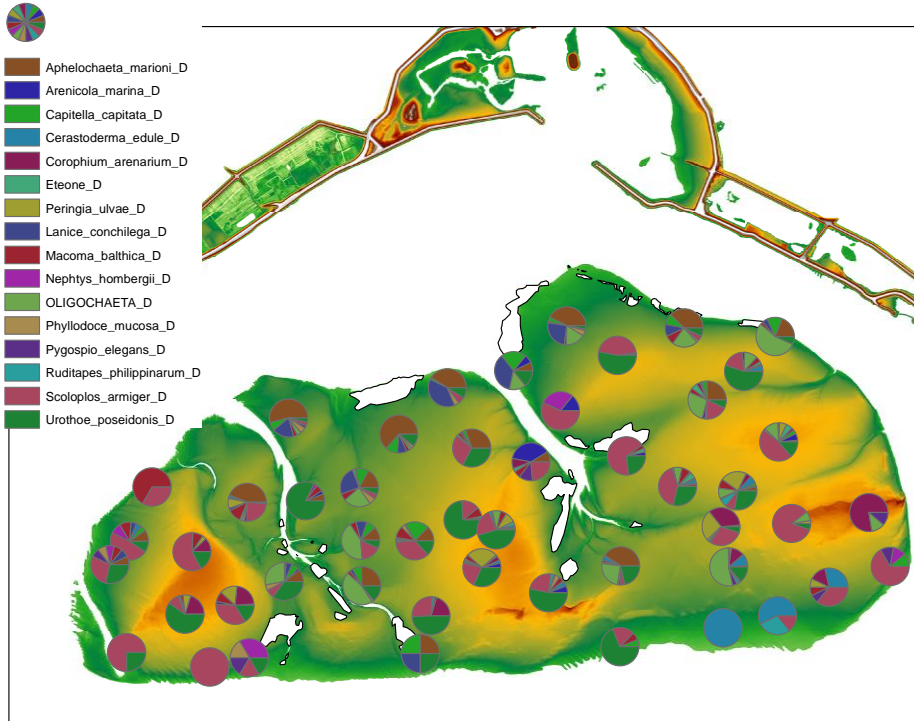
Ruditapes\_philippinarum\_B

- 0.01
- 0.1
- 0.5
- 1
- 10
- sample locations



Biomass in g afdw m<sup>-2</sup>



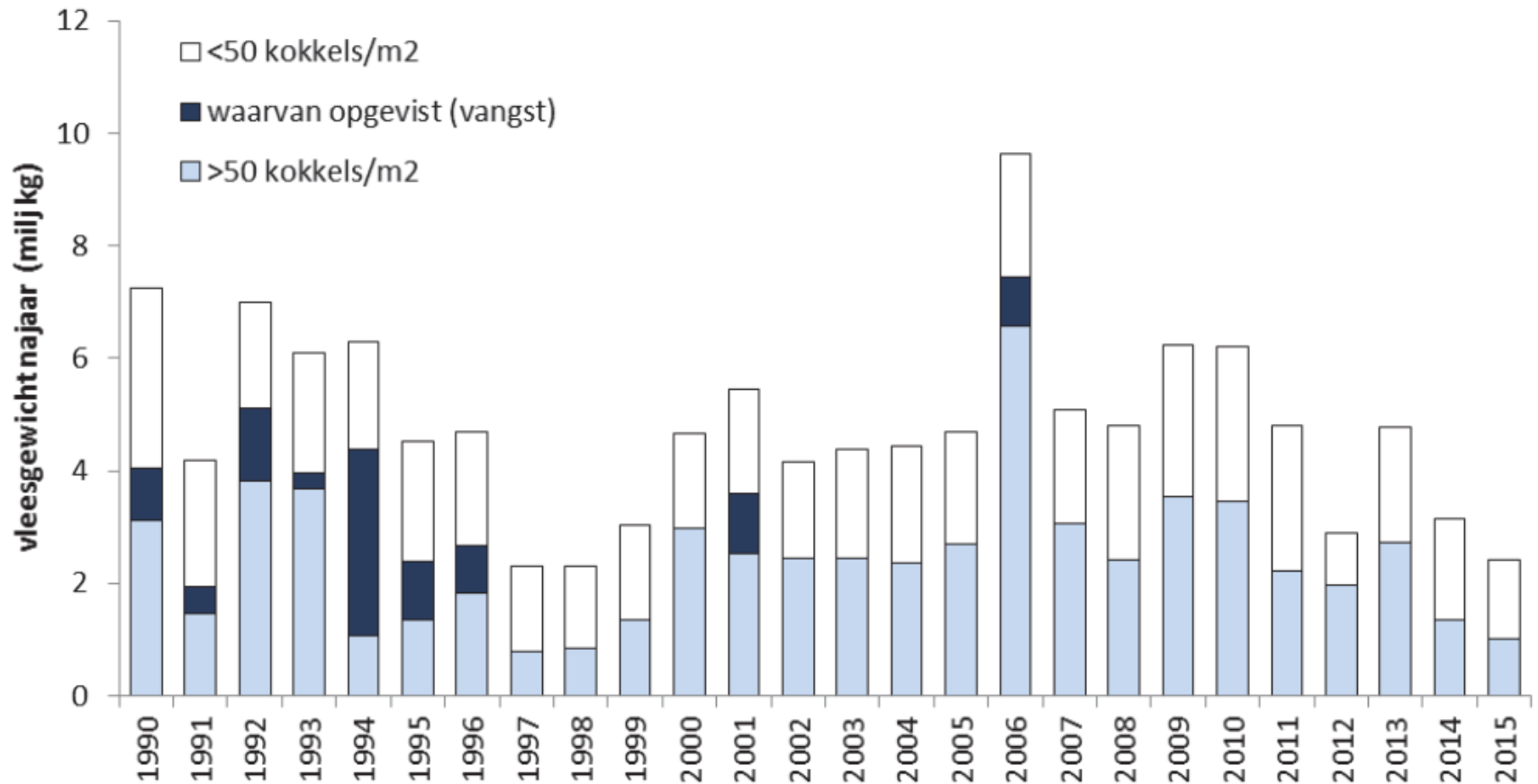


# Comparison 1985 – 1989 - 2015

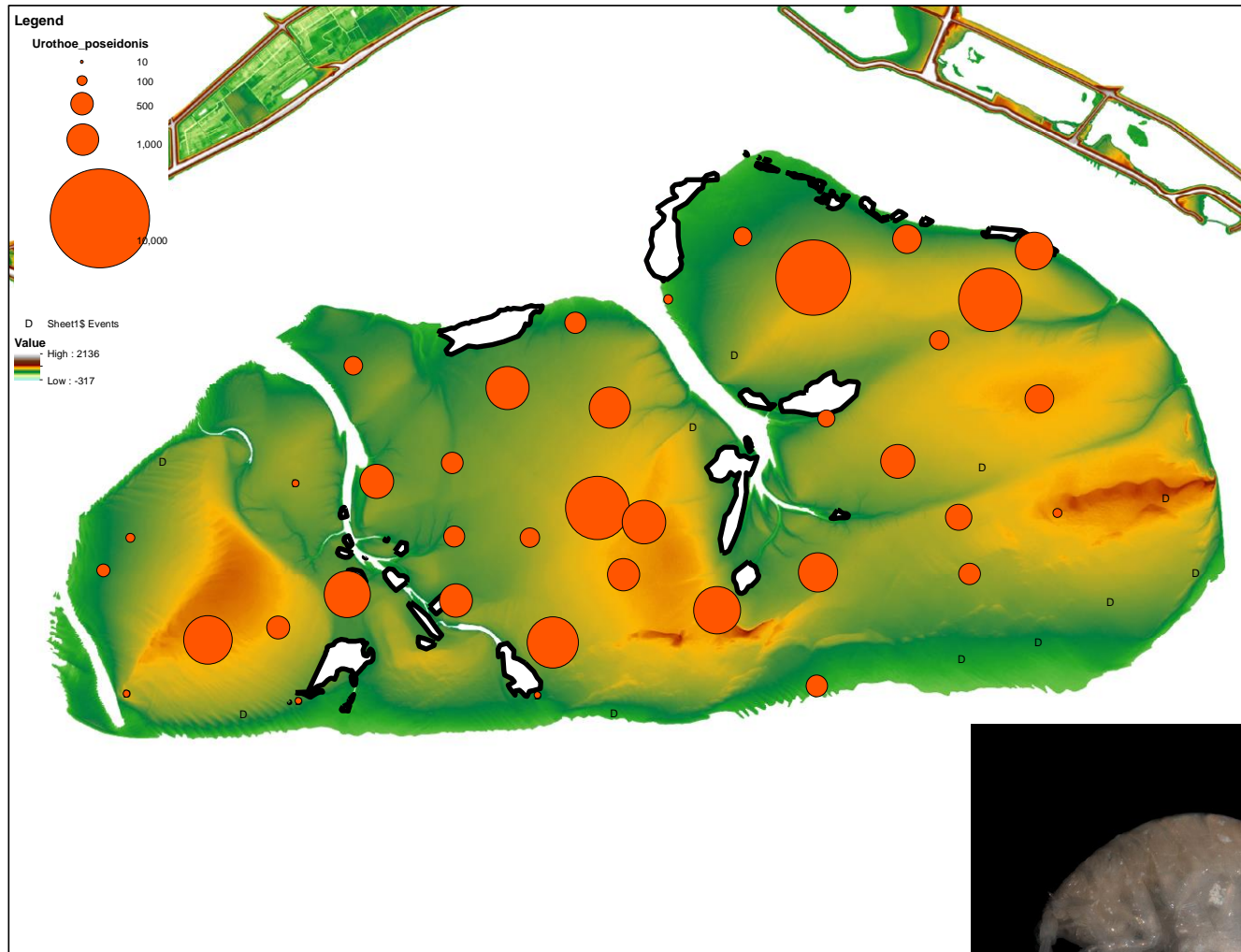
Species	%	% 1985	% 1989
Scoloplos armiger	90	90	87
Urothoe poseidonis	80	14	17
Macoma balthica	76	87	65
Arenicola sp.	62	79	82
Aphelochaeta marioni	56	60	47
Cerastoderma edule	50	86	67
OLIGOCHAETA	48	78	70
Eteone sp.	46	63	31
Pygospio elegans	46	90	65
Phyllodoce mucosa	44	57	43
Nephtys hombergii	42	53*	57*
Lanice conchilega	38	12	26
Corophium arenarium	34	46*	36*
Peringia ulvae	32	85	33
Ruditapes philippinarum	30	-	-

# Cockle biomass

	Density	Biomass
Interecos Roggenplaat autumn 1985	28989	57.8
Interecos Roggenplaat autumn 1989	11791	116.2

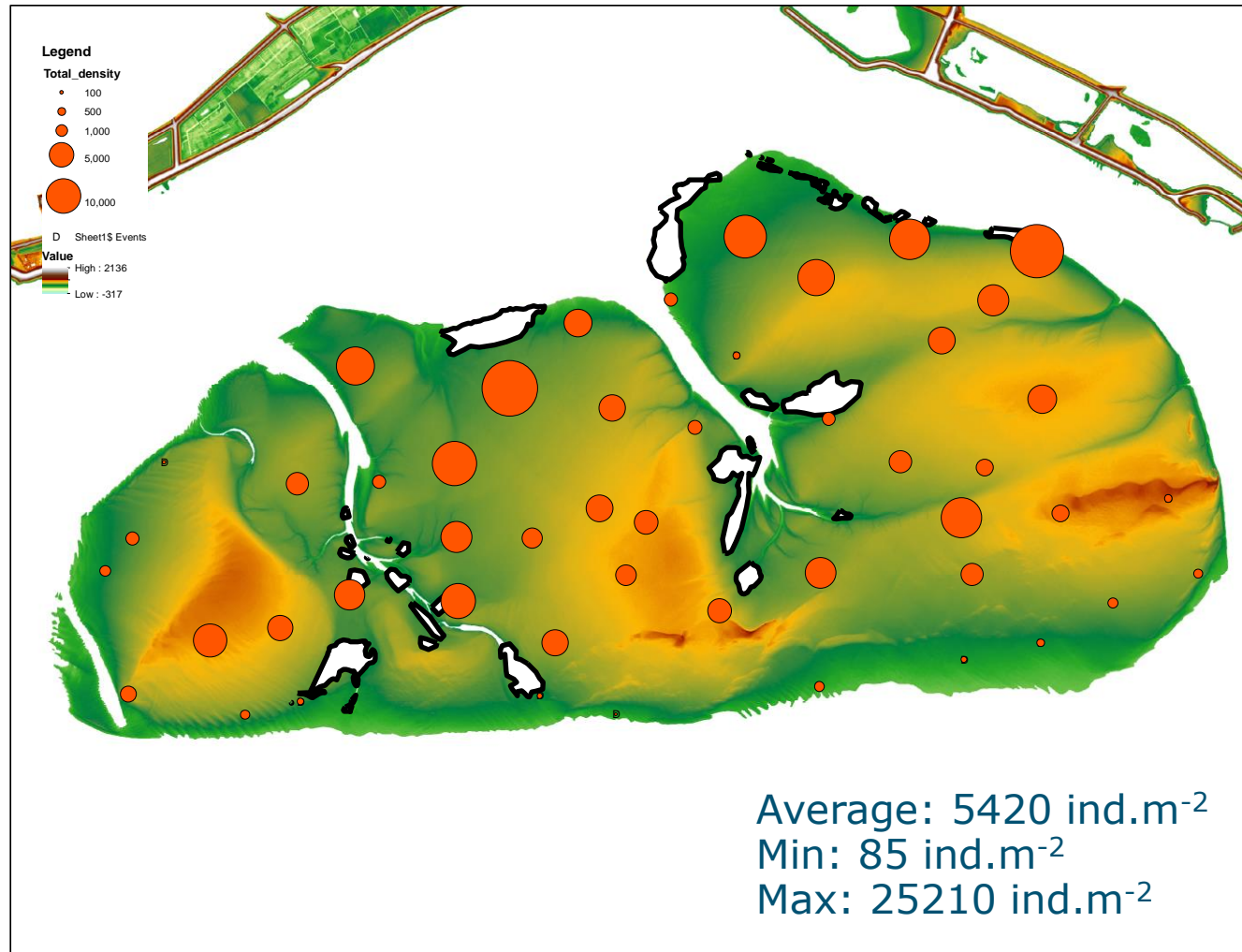


# Benthic macrofauna survey: *Urothoe poseidonis*

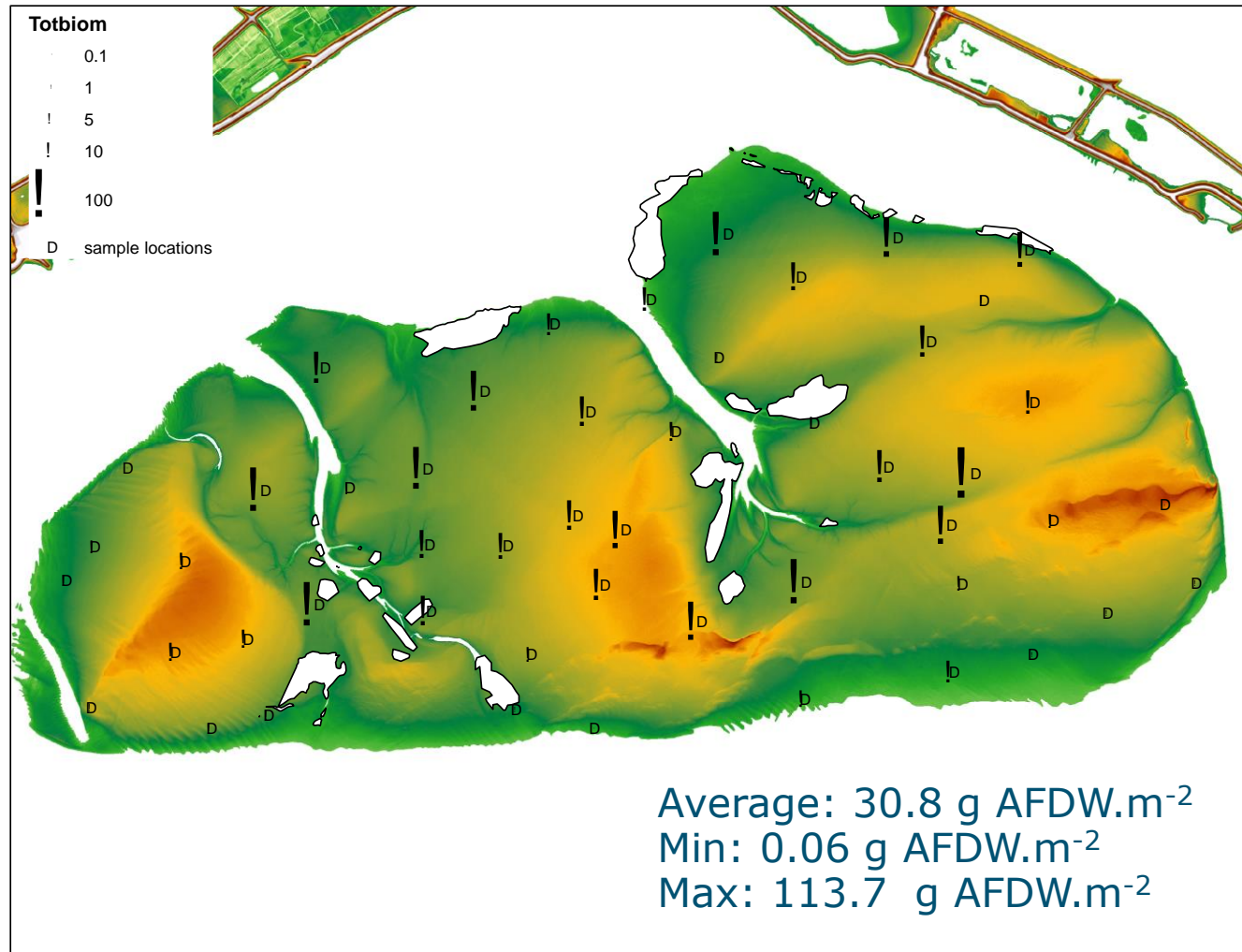




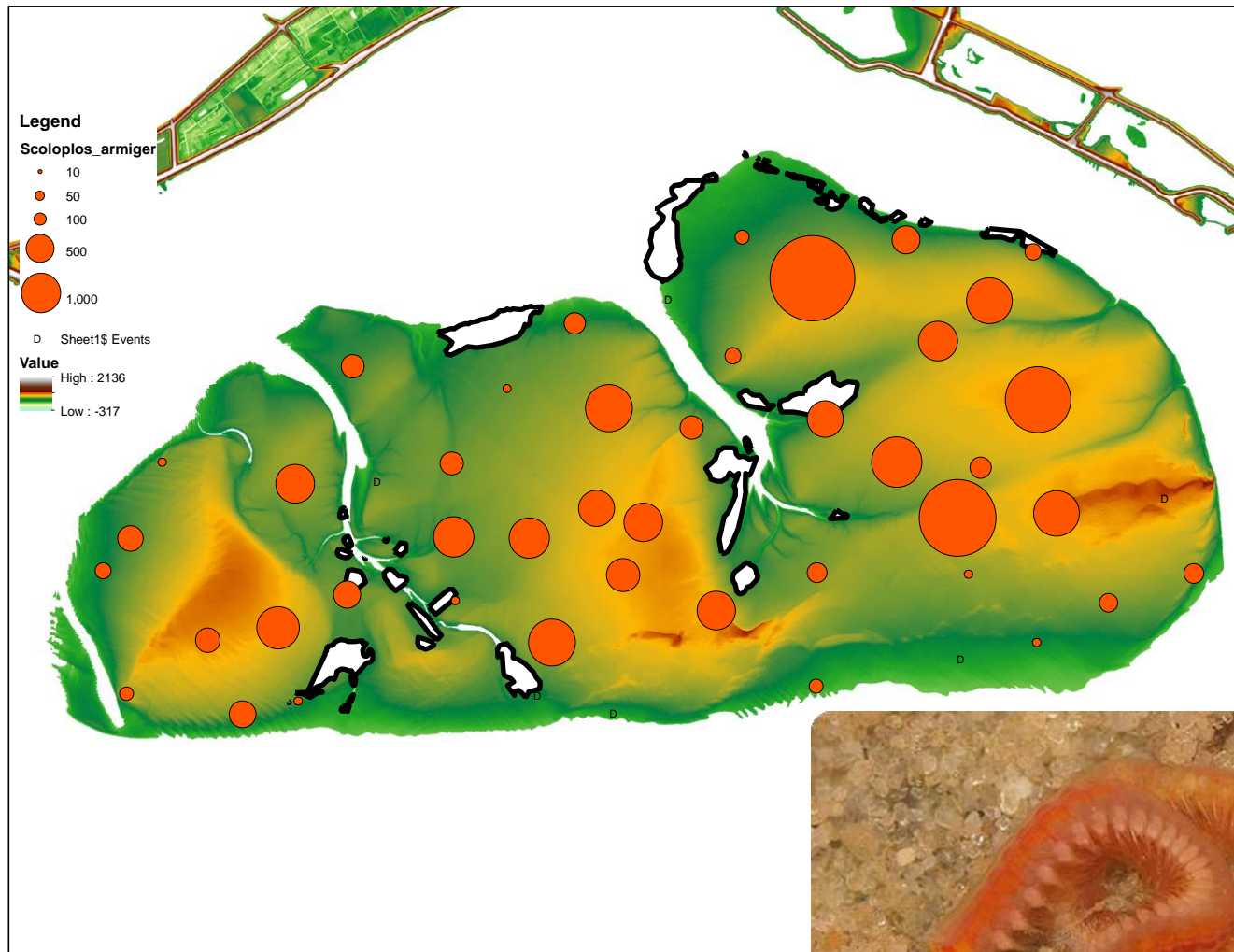
# Benthic macrofauna survey: total density



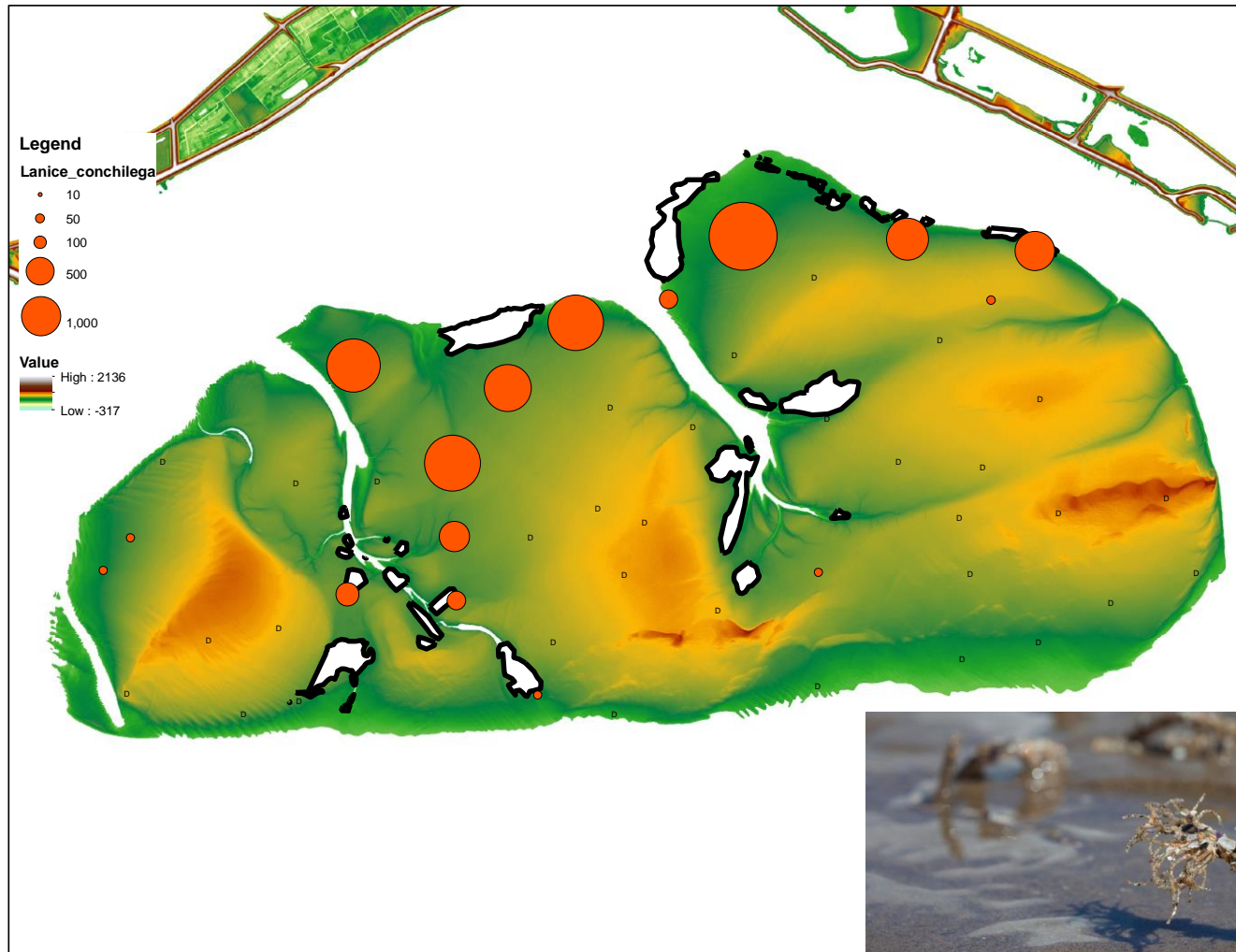
# Benthic macrofauna survey: total biomass



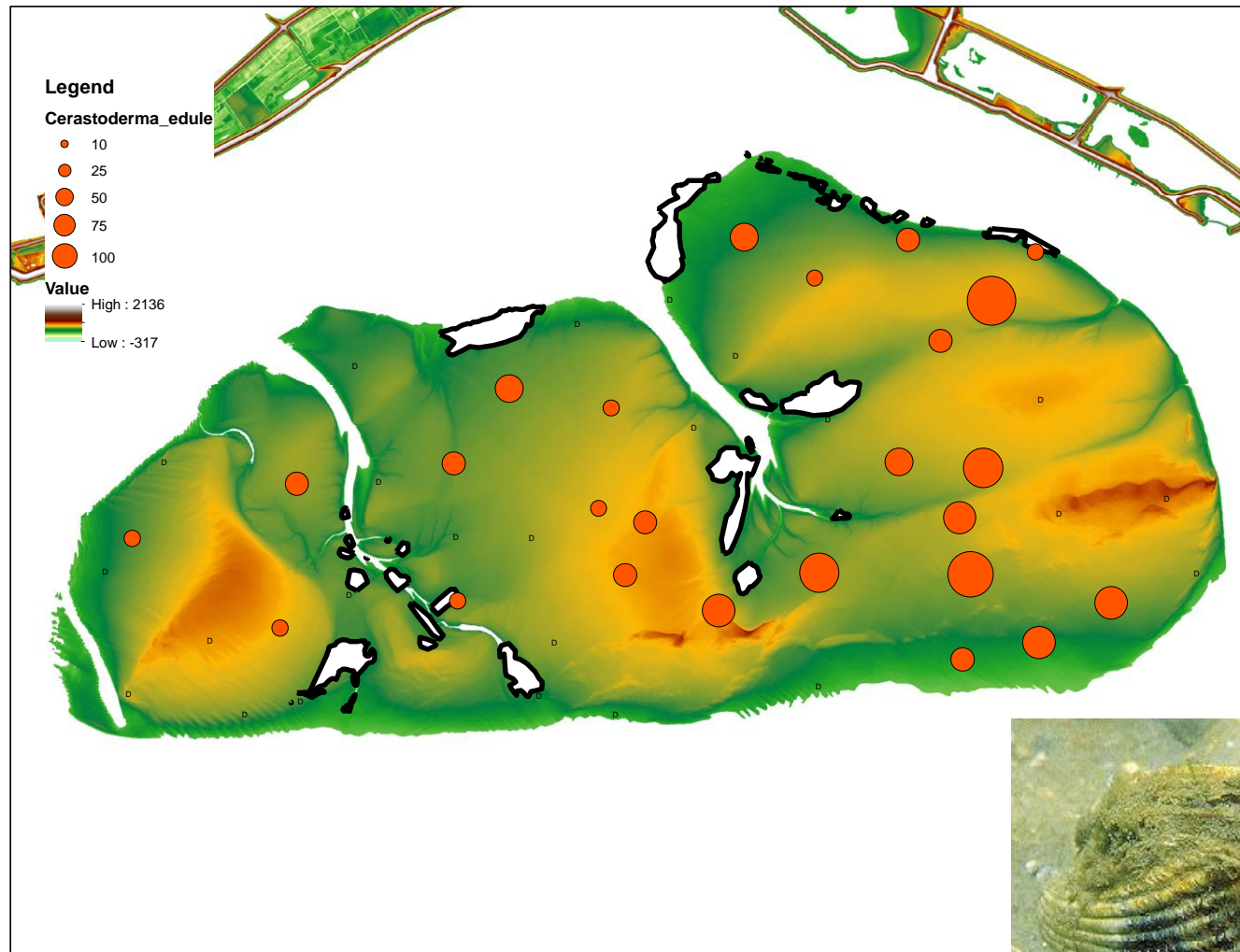
# Benthic macrofauna survey: *Scoloplos armiger*



# Benthic macrofauna survey: *Lanice conchilega*



# Benthic macrofauna survey: *Cerastoderma edule*



# Benthic macrofauna survey: community

