# » SEASONAL AND SPATIAL CHANGES OF LATE LARVAE AND JUVENILE FLATFISHES ALONG THE DUTCH COAST, SOUTHERN NORTH SEA

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# » FLATFISH ASSEMBLAGES: Dutch Coast

## Maasvlakte 2 Land Reclamation

- Total area ca 2,000 hectares , 13 km of quay walls & 12 km sea defences
- Sand, 1st phase construction by 2013, 240 million $m^3$, 365 million $m^3$ (by 2033)
- Trailing Suction Hopper Dredgers extract sand form offshore sites (7 to 20 km off the coast)

Start, Jan 2009

Oct. 2009

April 2010

April 2011

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Impacts on the receiving marine ecology?

Water Framework Directive (EU WFD; 2000/60/EC)
Marine Strategy Framework Directive (EU MSFD; 2008/56/EC)

**Ecosystem integrity assessment**

**Effects on (flat)fish assemblages from ...**

1. disruptive pressure on habitat /spawning stock biomass
2. direct effects on fish survival
3. indirect effects on survival
   -food availability, predation, energy budgets

**could fish be a sensitive measure of ecological integrity and impacts?**

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**Ecosystem integrity assessment**


**W**ater bodies in Europe: **I**ntegrative **S**ystems to assess **E**cological status and **R**ecovery; ***University of Duisburg-Essen***

## Biological elements response/ indicators

- sensitivity to human pressure (calibration)
- accurate and robust indication
- reference conditions
- technically feasible
- bound by time and budget constraints
- easy interpretation by non-specialists

## Objectives

1. Modelling of fish assemblages for use in defining reference conditions
2. Functional linkage between larval supply and flatfish habitat

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## Methods Field:

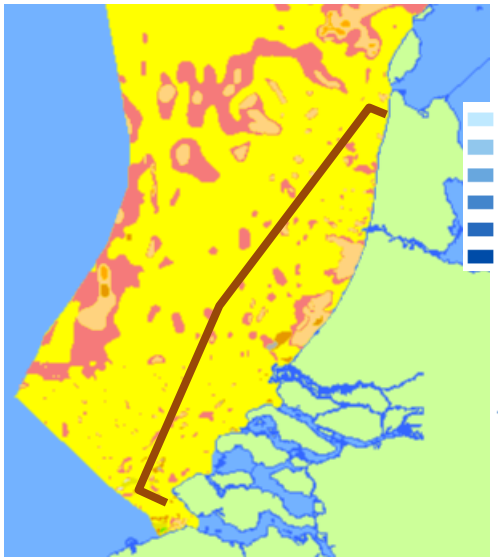
**Design**

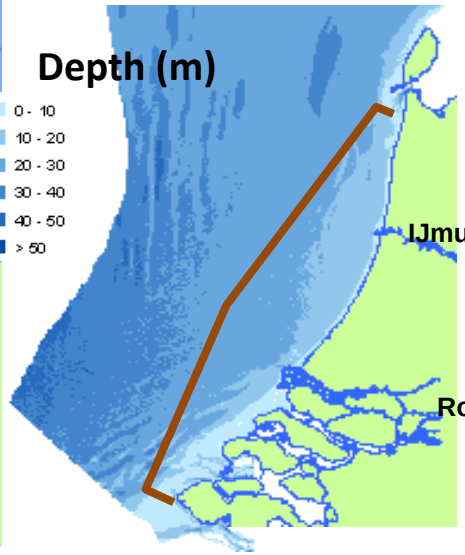
100 stations & 3 seasonal cruises
April, July & October 2007,
5m to 25m chart datum, stratified &
fully randomized sampling sequence




## The study area:

Sediment & Bathymetry



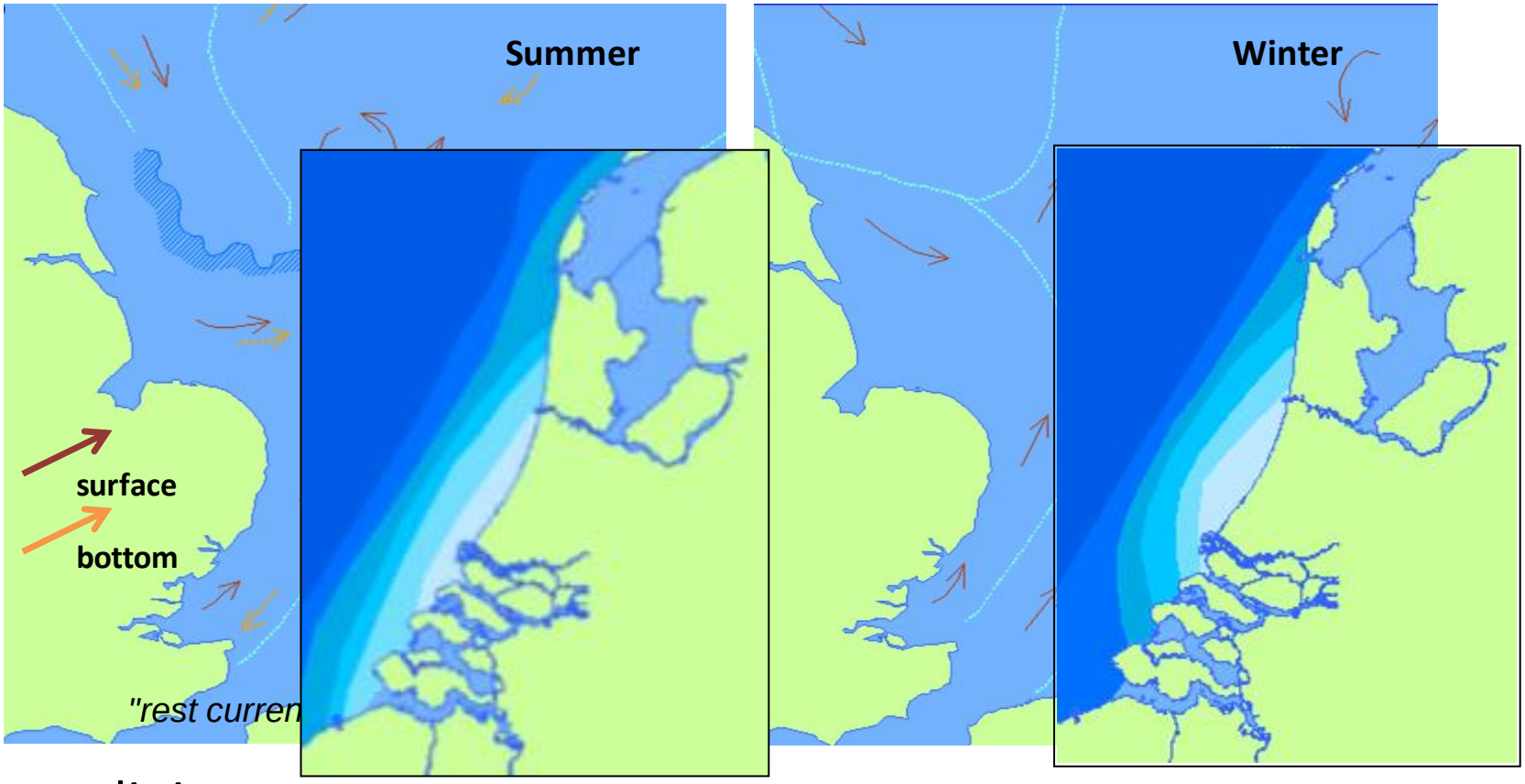



http://www.noordzeeatlas.nl/en/index.html

# » FLATFISH ASSEMBLAGES: Dutch Coast

## The study area

residual currents & water masses




http://www.noordzeeatlas.nl/en/index.html

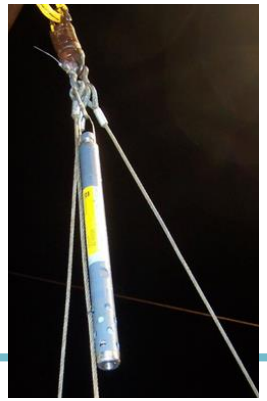
salinity

# » FLATFISH ASSEMBLAGES: Dutch Coast

## Methods Field:

**Gear**
-MIK trawls
2m Ø 1500µm body &
500µm codend
5m above bottom
2 knots, approx. 3200$m^{-3}$
samples

-**Beam trawl**
2m wide; 19mm & 9mm
approx. 2500$m^{-2}$ samples



Water Quality
parameters

# » FLATFISH ASSEMBLAGES: Dutch Coast

**Beam Trawl survey (Demersal )**

Juvenile/adult density (ind./1000 $m^2$)
Species ID, Standard length & Weight (Fulton K)

Size class analysis
0+, 1 and 2+ flatfishes

**MIK survey (Pelagic)**

Juvenile & Larval density (ind./1000 $m^3$)
Species ID, Standard length
Stomach content

**Multivariate Datasets**

**ENVIRONMENTAL VARIABLES**

| | |
|---|---|
| Temperature | Station depth |
| Salinity | Latitude |
| Chlorophyll | Cruise (degree day) |
| % silt (bottom) | |
| Total Suspended Matter | |

Ordination
Cluster analysis

**PELAGIC & DEMERSAL Flatfish ASSEMBLAGES**

# » LARVAL ASSEMBLAGES: Dutch Coast

**Assemblages:**
Redundancy Analysis (RDA)

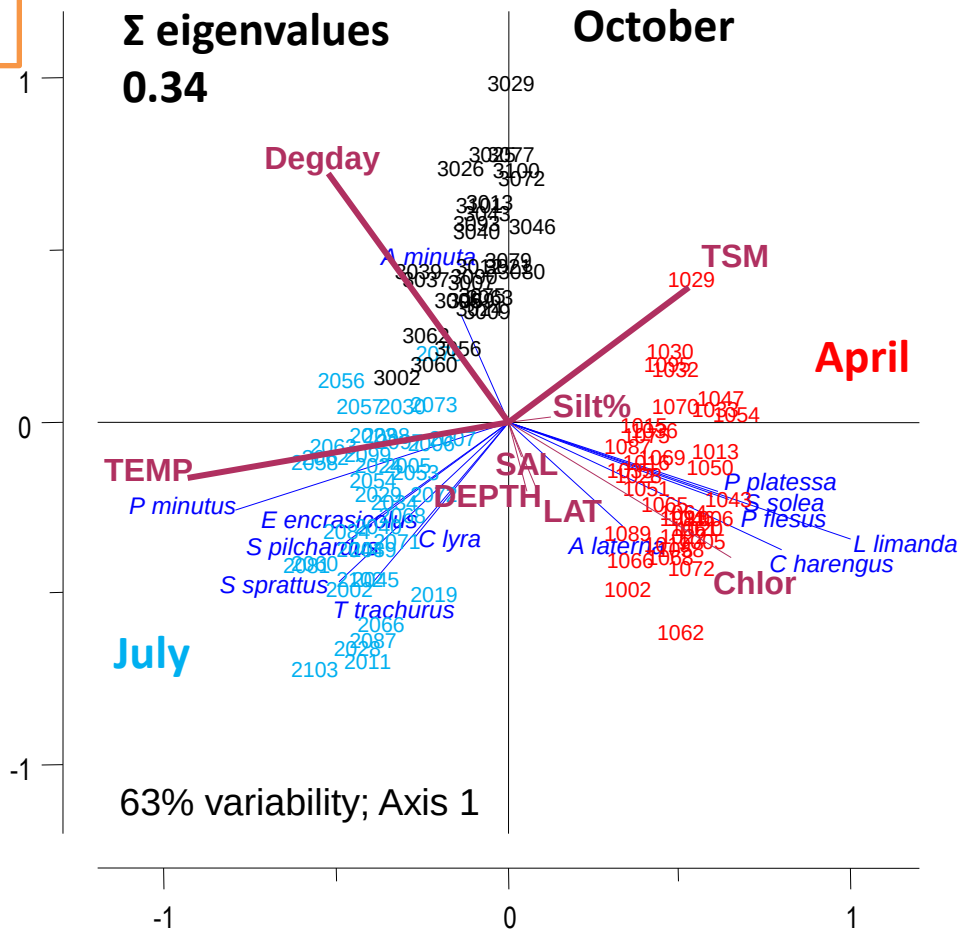
-Strong seasonal effect

-Flatfish dominated in April

-Peak diversity in Summer

-Model: **TEMP : Degday : TSM**
79% explained variance

-TSM relevant?



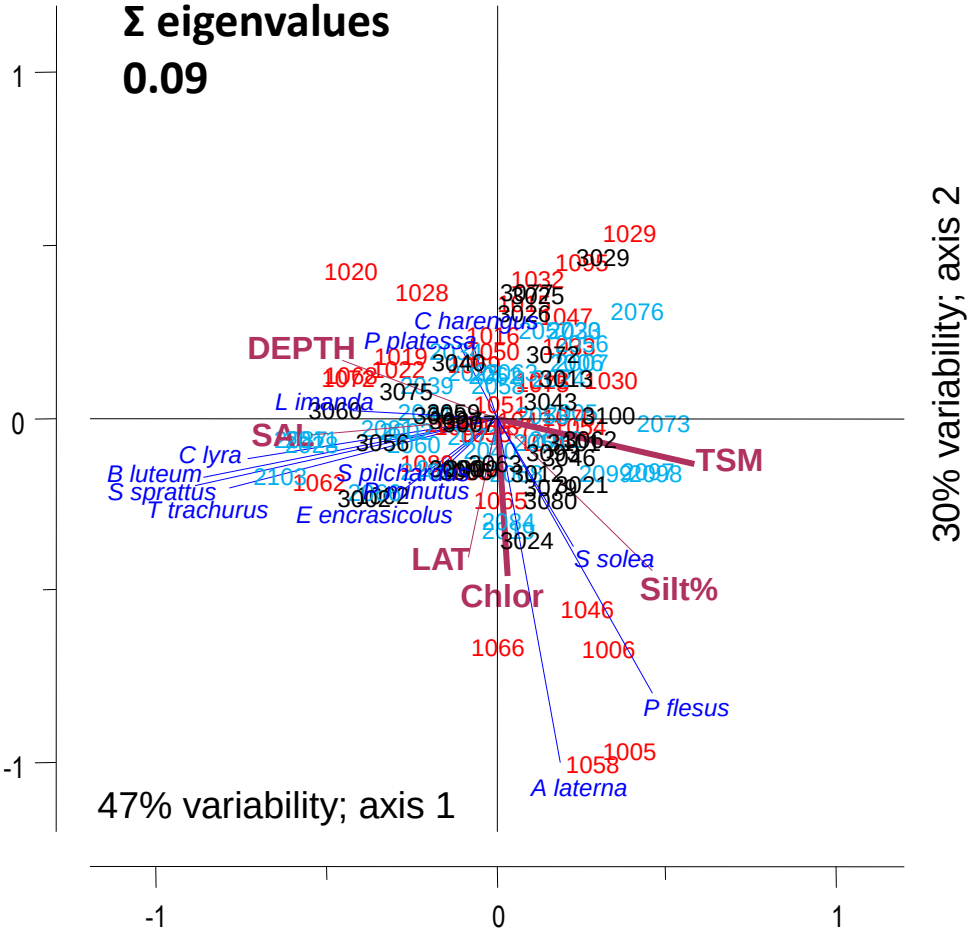
# » LARVAL ASSEMBLAGES: Dutch Coast

**Assemblages:** partial RDA
Covariates TEMP + Degday

- Model: **TSM : Chlor**
21.2% explained variance, but very low predictive power

is TSM driving the assemblage structure or are they linked by a 3rd unknown variable?

… most explanatory power in the seasonal effect



# » LARVAL ASSEMBLAGES: Dutch Coast

**Assemblages:**

Cluster analysis (Bray-Curtis similarity and SIMPROF test) & SIMPER (PRIMER v6)

| April | A1 | A2 |
|---|---|---|
| ***P flesus*** | - | 4.3 (ind/1000m$^3$) |
| ***A laterna*** | - | 2.2 |
| ***L limanda*** | 3.3 | 1.3 |
| ***C harengus*** | 14.0 | 4.1 |

*Solea solea, Pleuronectes platessa, Microchirus variegatus*

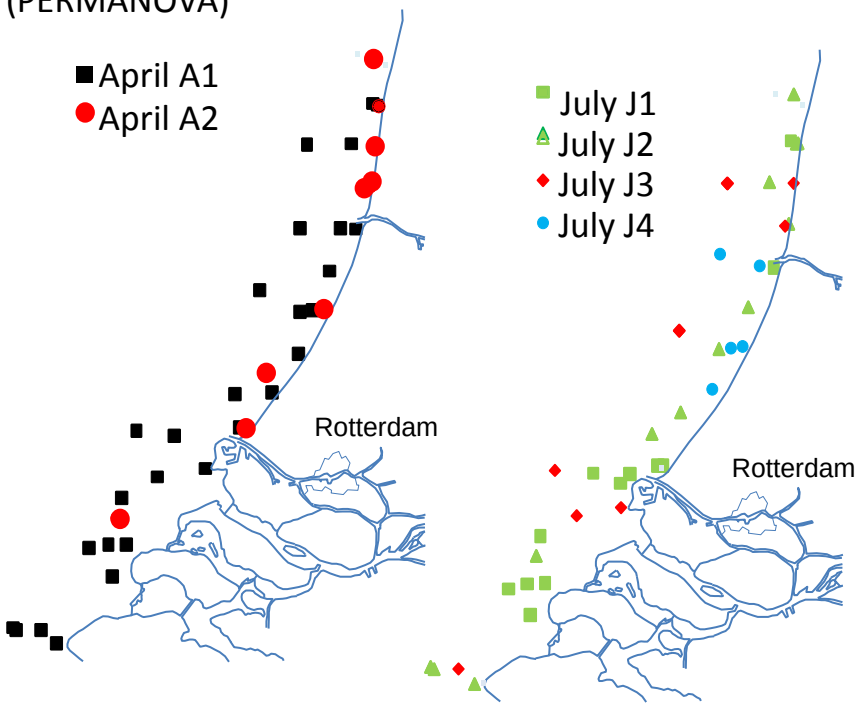
| July | J1 | J2 | J3 | J4 |
|---|---|---|---|---|
| ***T trachurus*** | - | - | 5.5 | 1.3 |
| ***C lyra*** | - | - | 7.4 | - |
| ***E encrasicolus*** | - | - | 7.6 | 1.1 |
| ***S sprattus*** | 3.9 | - | 10.3 | 0.7 |
| ***P minutus*** | 7.7 | 10.4 | 25.8 | 1.4 |
| ***S pilchardus*** | - | 6.5 | - | - |

*Arnoglossus laterna, Buglossidium luteum, Psetta maxima*

Significant spatial segregation

$p<0.05$ (PERMANOVA)

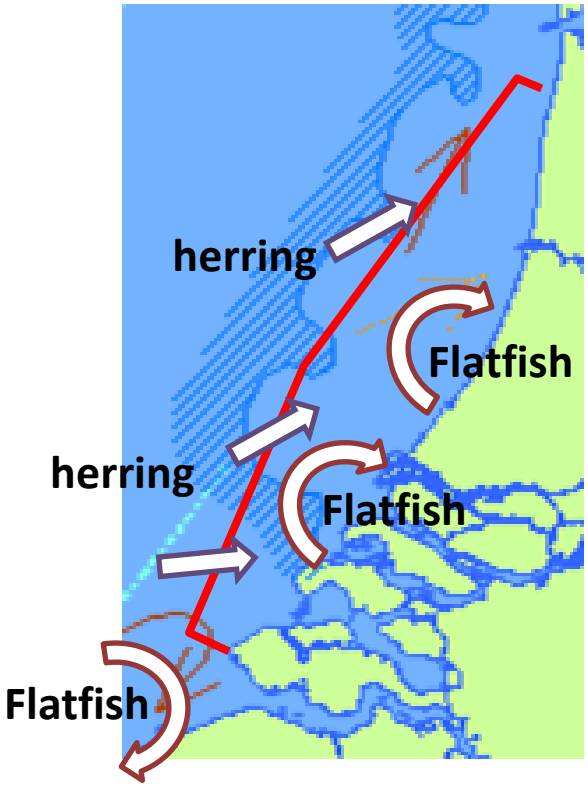
No effect



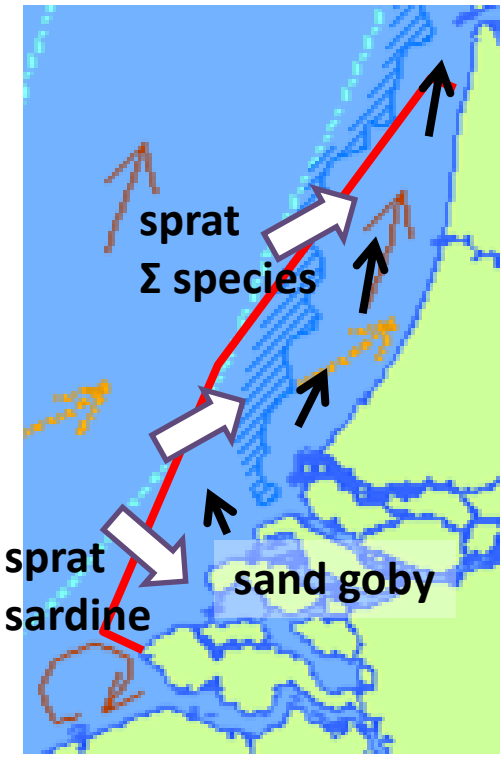

**No assemblage differences in October**

# » LARVAL ASSEMBLAGES: Dutch Coast

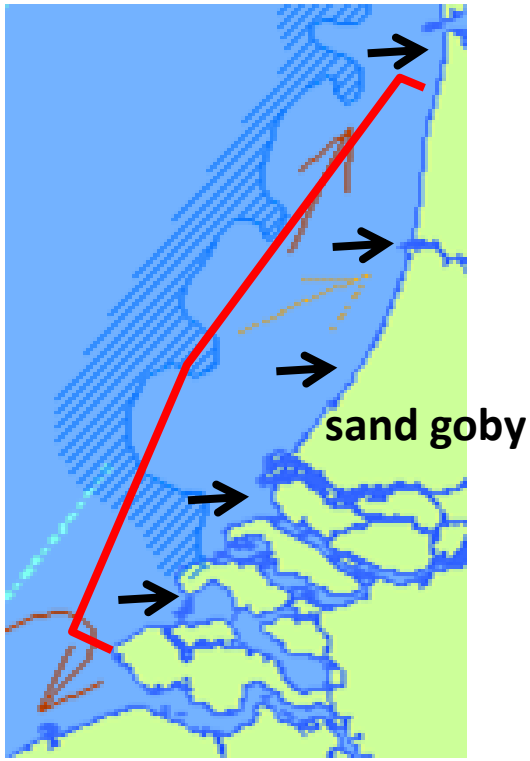
## Conclusions (1)




spring




summer




autumn

# » Juvenile flatfish assemblages: Dutch Coast

**Assemblages:**
Redundancy Analysis (RDA)

-Month instead of Degday

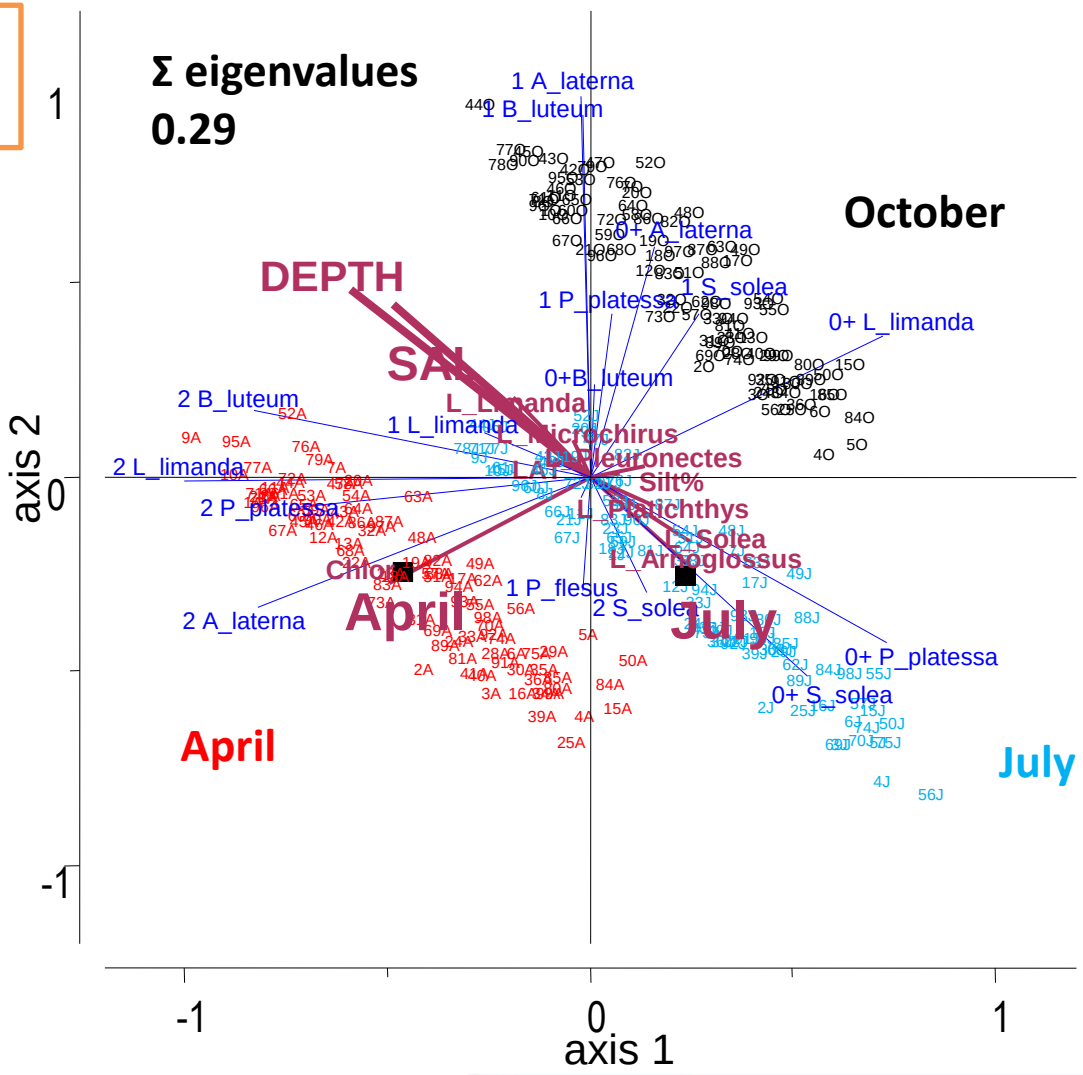
-Larvae included as explanatory variables

-Model: **Month : DEPTH: SAL**
85% explained variance

-Larva do not explain structure of 0+ flatfish

-Juvenile abundance probably not controlled by larval supply

-Size class differences related to differential temporal and spatial use of the area



# Flatfish ASSEMBLAGES: Dutch Coast

## Conclusions (2):

### Larval assemblages

- Flatfish larvae dominate in the Spring
- Main predictive variables Season and Temperature. Seasonal spawning.
- TSM and Chlorophyll may have structuring roles but with very low predictive power
- Species diversity and seasonality best chances for a predictive model

### Juvenile flatfishes

- Assemblages segregate by size groups reflecting seasonal and spatial variability in usage of the nursery
- Main predictive variables Month, Depth and Salinity. Habitat characteristics
- Larvae abundance (supply of recruits) does not explain abundance of juvenile flatfishes, flatfish assemblages probably controlled by postsettlement mechanisms… or is it sampling bias?

# Flatfish ASSEMBLAGES: Dutch Coast

## Questions to answer & Future work

• Can we derive a reference condition?
• Need to account for interanual variability in recruitment. Longer datasets
• How to improve the models, more sampling or better designs?
are the models good enough? Sensitivity analysis
• can we predict, logistic and multinomial logistic regression analysis -probabilities
• are fish (all stages) suitable for biomonitoring and impact assessment?

8th Flatfish symposium, IJmuiden

# Thank you!

Port of Rotterdam
PROJECT ORGANIZATION MAASVLAKTE 2

WISER

THE UNIVERSITY OF HULL
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