# Diet composition and food selectivity of Sprat (*Sprattus sprattus*) in Hardangerfjord – a fjord off western Norway

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EPIGRAPH coastal- and fjordecology

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*Sprattus sprattus*
(Clupeidae)

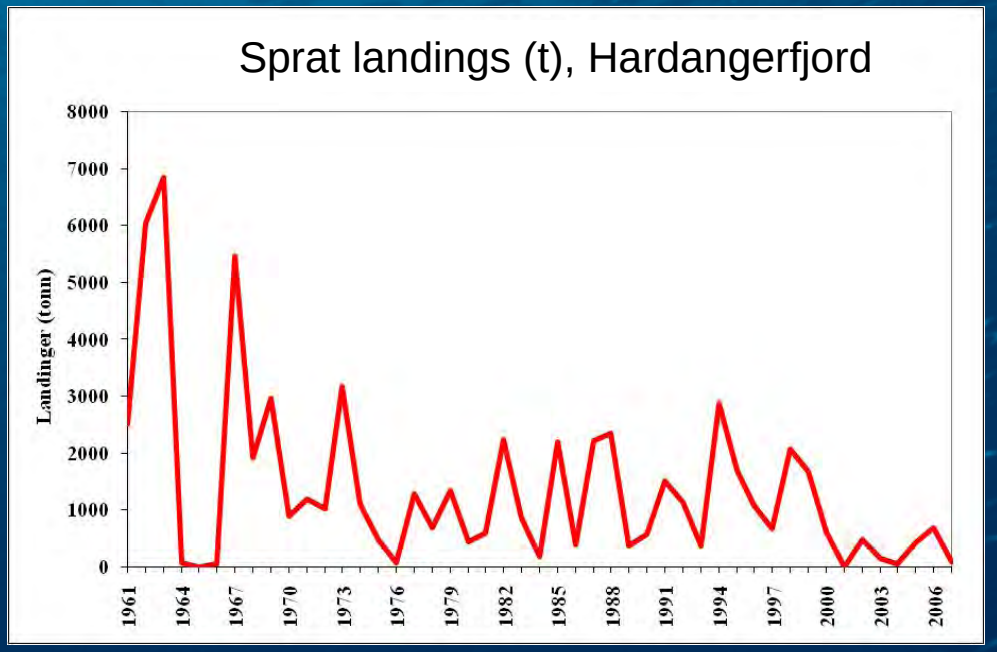
- Planktivorous, schooling

- Spawning in January-July
- Local spawning in fjords

- Population dominated by 1-2 year classes.
- Large interannual variations
- Sprat fishery on 0-1 year old, starts in summer/ autumn

Sprat fishery have long traditions in Norwegian coastal areas.

Reductions in landings of fjord sprat since 1961



# Aims

- Describe the diet of *Sprattus sprattus* in Hardangerfjord, April 2009
- Study feeding preferences
- Spatial patterns in diet and prey field

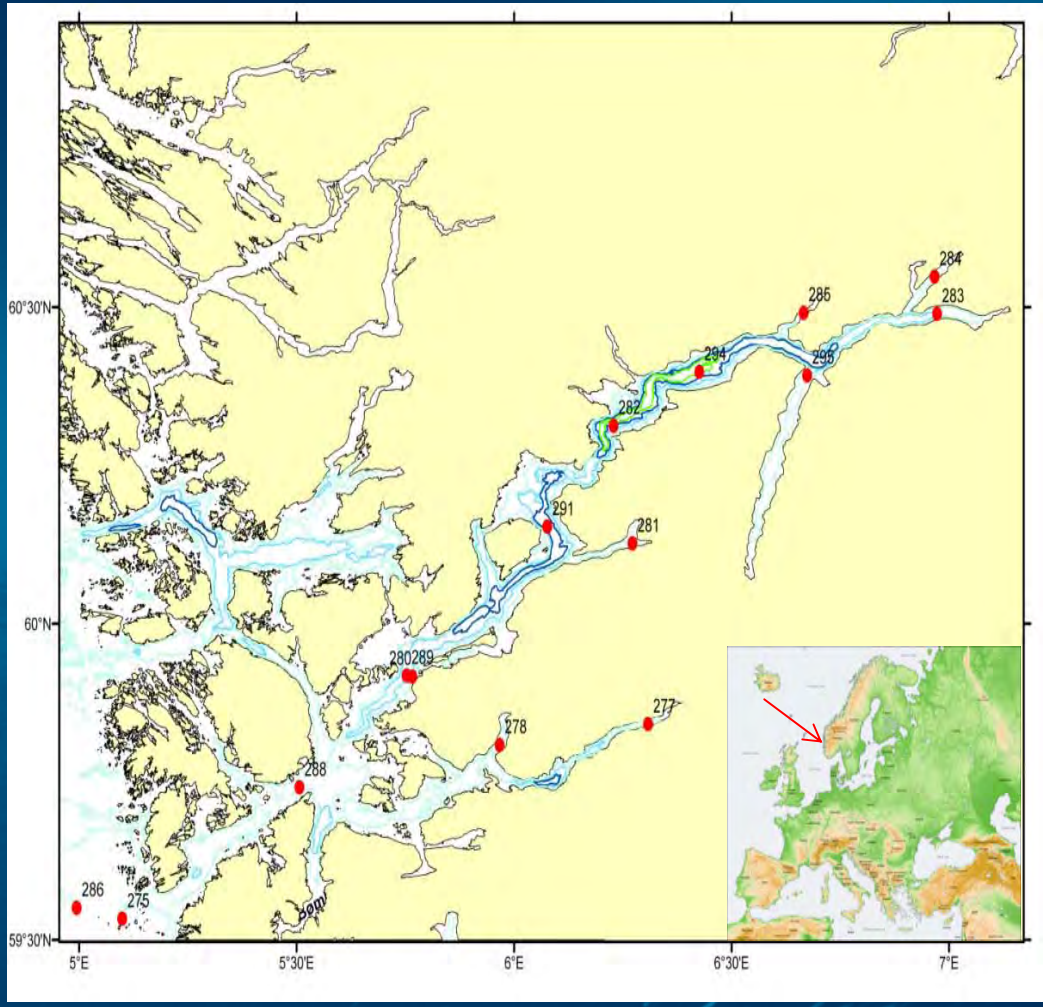
EPIGRAPH
coastal- and fjordecology

# The Hardangerfjord

- Length: 180 km
- Maximum depth 893 m
- Sill depth 150 m
- Several silled basins

Large input of fresh water from rivers and glacier melt.

Water above sill depth usually stratified throughout the year



*RV* Håkon Mosby
3. - 8. April 2009

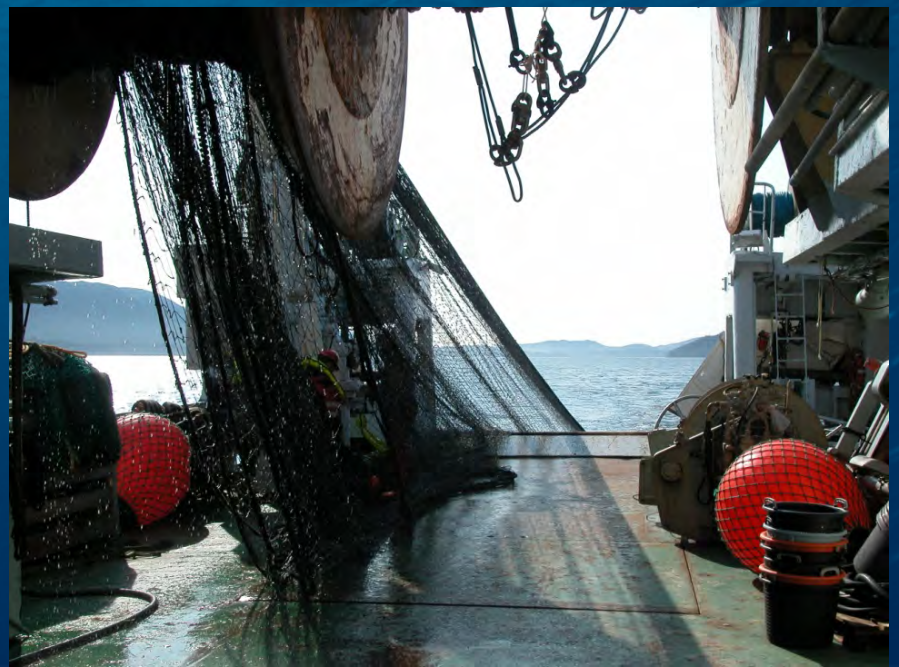
# Sampling

## Zooplankton :

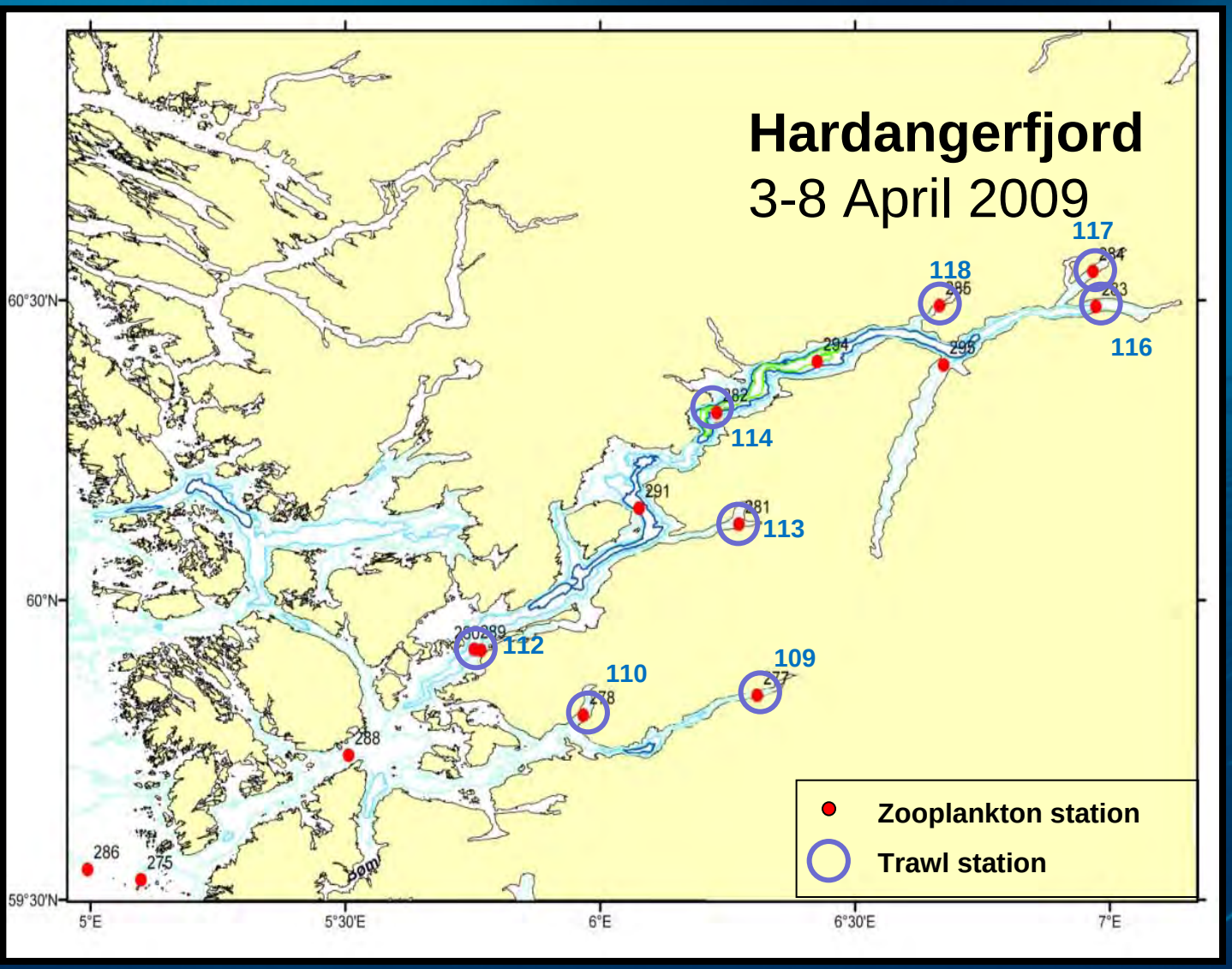
- MOCNESS (180 µm) 7 depth strata
- WP2 (180 µm) 100-0 m
- Juday (90 µm) 100-0 m

## Fish:

Pelagic trawl (”Firkløvertrål”) 26 x 26 m, with flotations.



# Sampling




15 zooplankton stations

8 trawl stations

# Gut content analysis

20 fish stomachs pr station
Fish: Total length and weight

State of digestion
Total stomach weight

Prey identified to lowest possible taxonomic level
Enumeration
Dryweight of each prey category

# Partial Fullness Index (PFI)

$$PFI_{i,k} = \frac{S_{i,k}}{L_k^3} \times 10^4$$

$S_i$ =Weight (g) of prey species *i* in the stomach of fish *k*
$L_k$ =Length (cm) of fish *k*

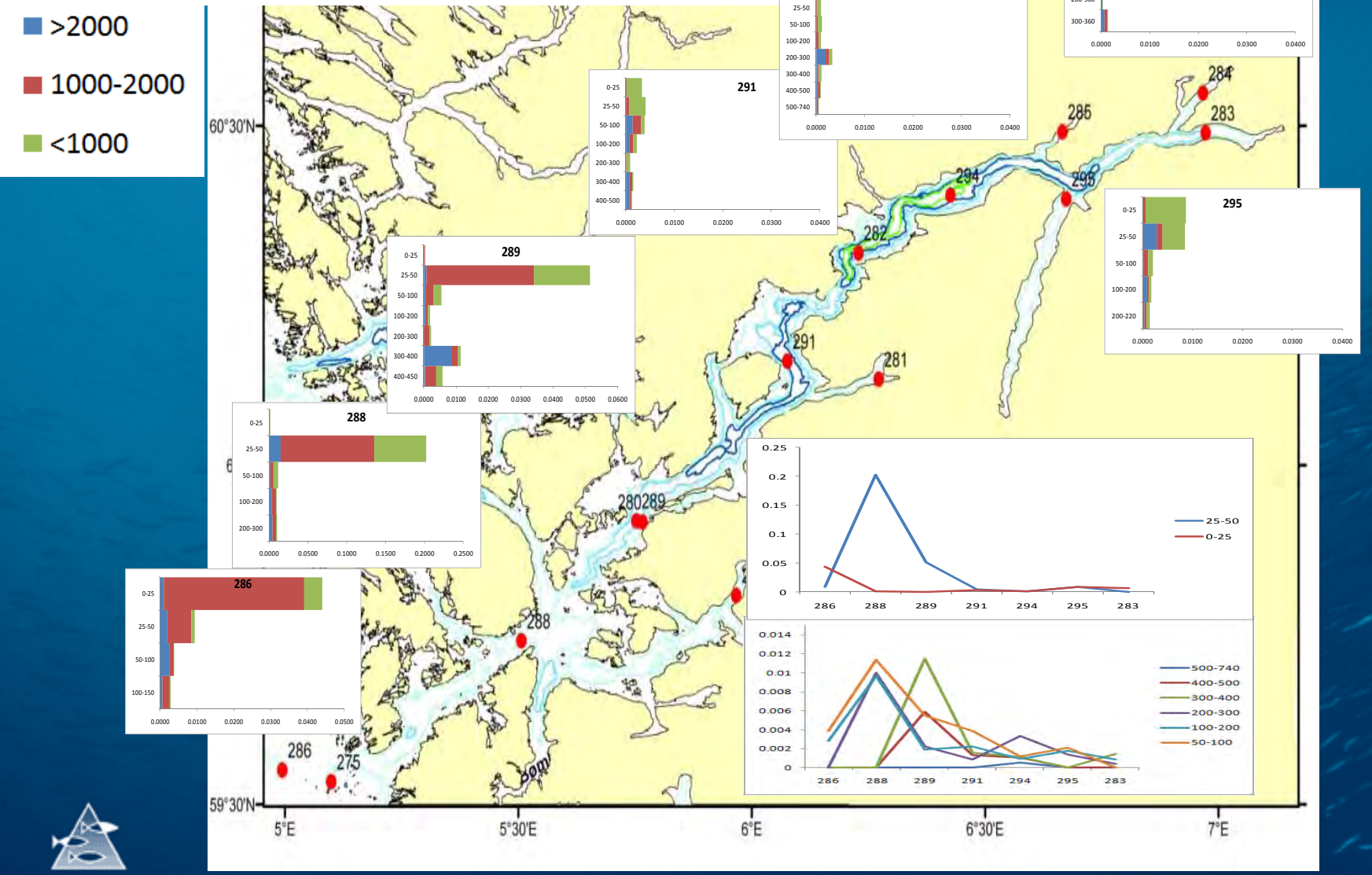
# Total Fullness Index (TFI)

$$\sum_{j=1}^{n} PFI_{i,k}$$

*(Lilly and Fleming, 1981)*

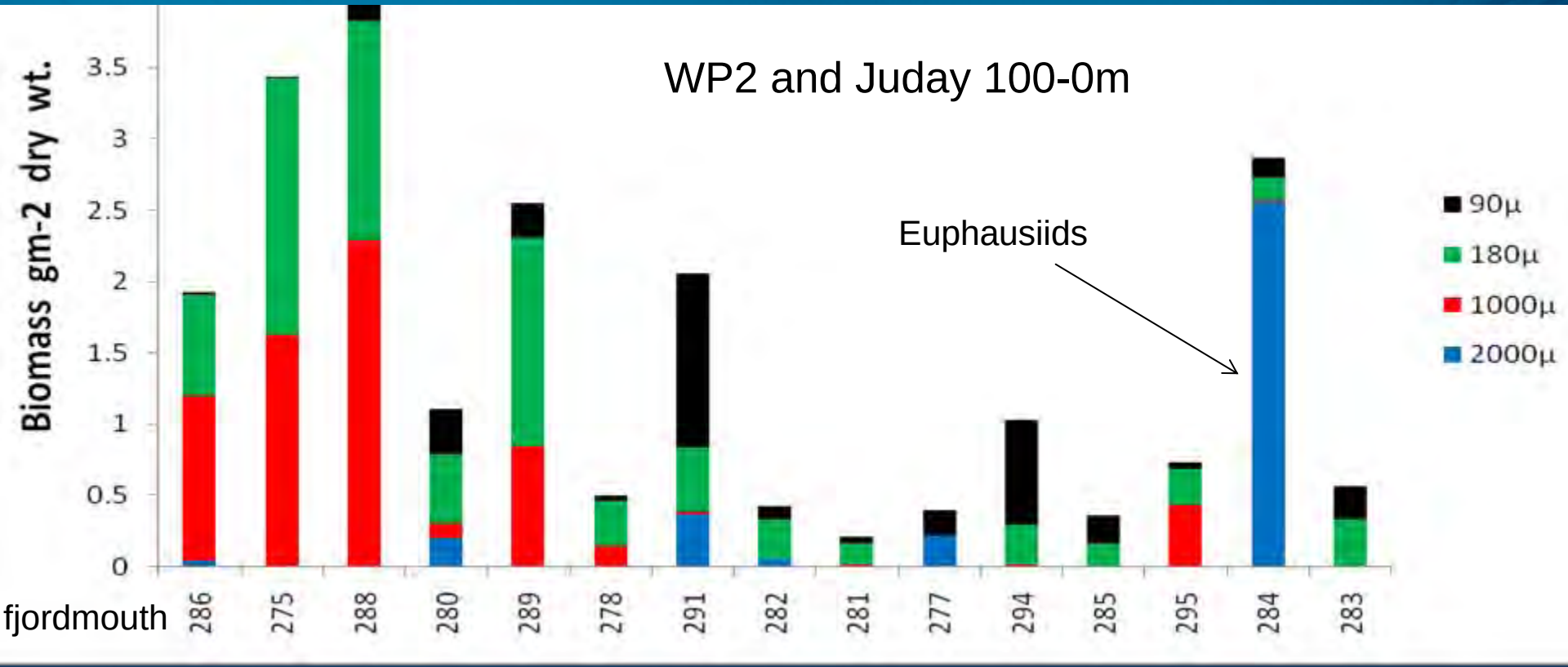
# Results: Vertical distribution of zooplankton biomass (dw g/m$^3$).

MOCNESS 180 µm

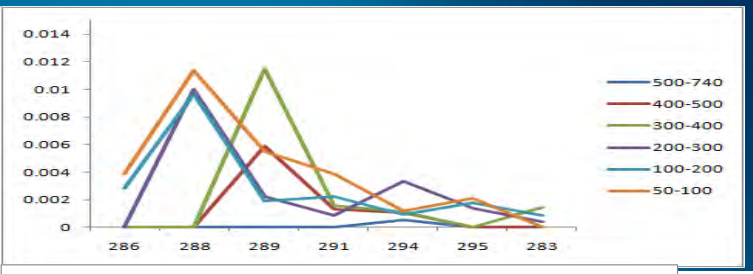


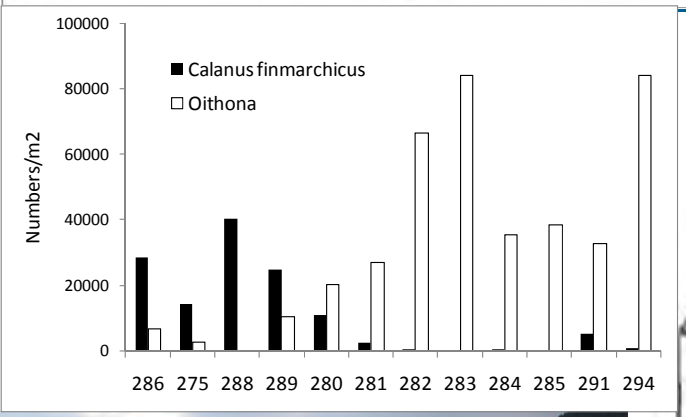
# Zooplankton distribution

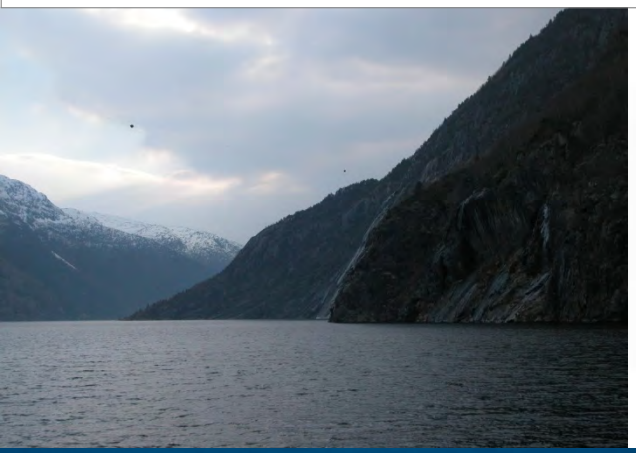
- Decreasing zooplankton biomass along the fjord aksis (mouth – head)
- Higher proporton of large sized zooplankton in the outer area.

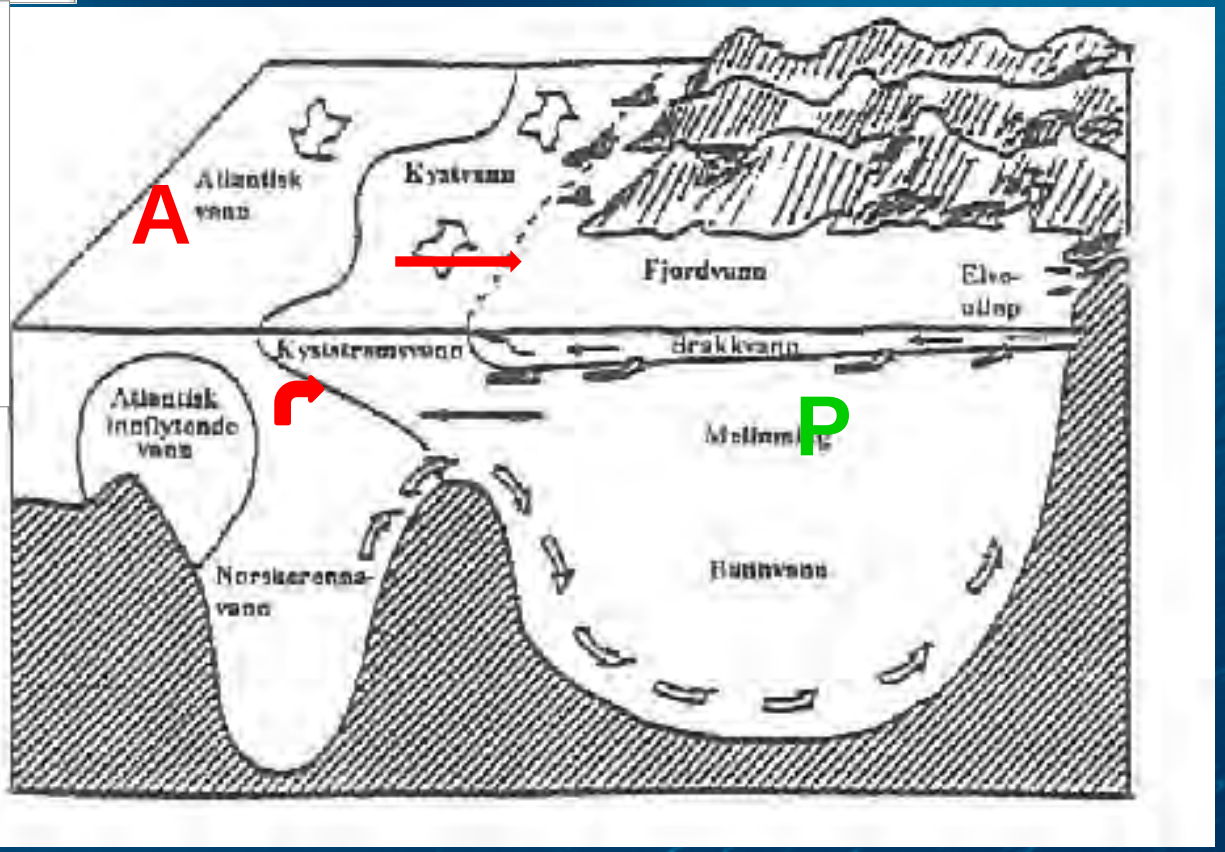


# Advective fjord system

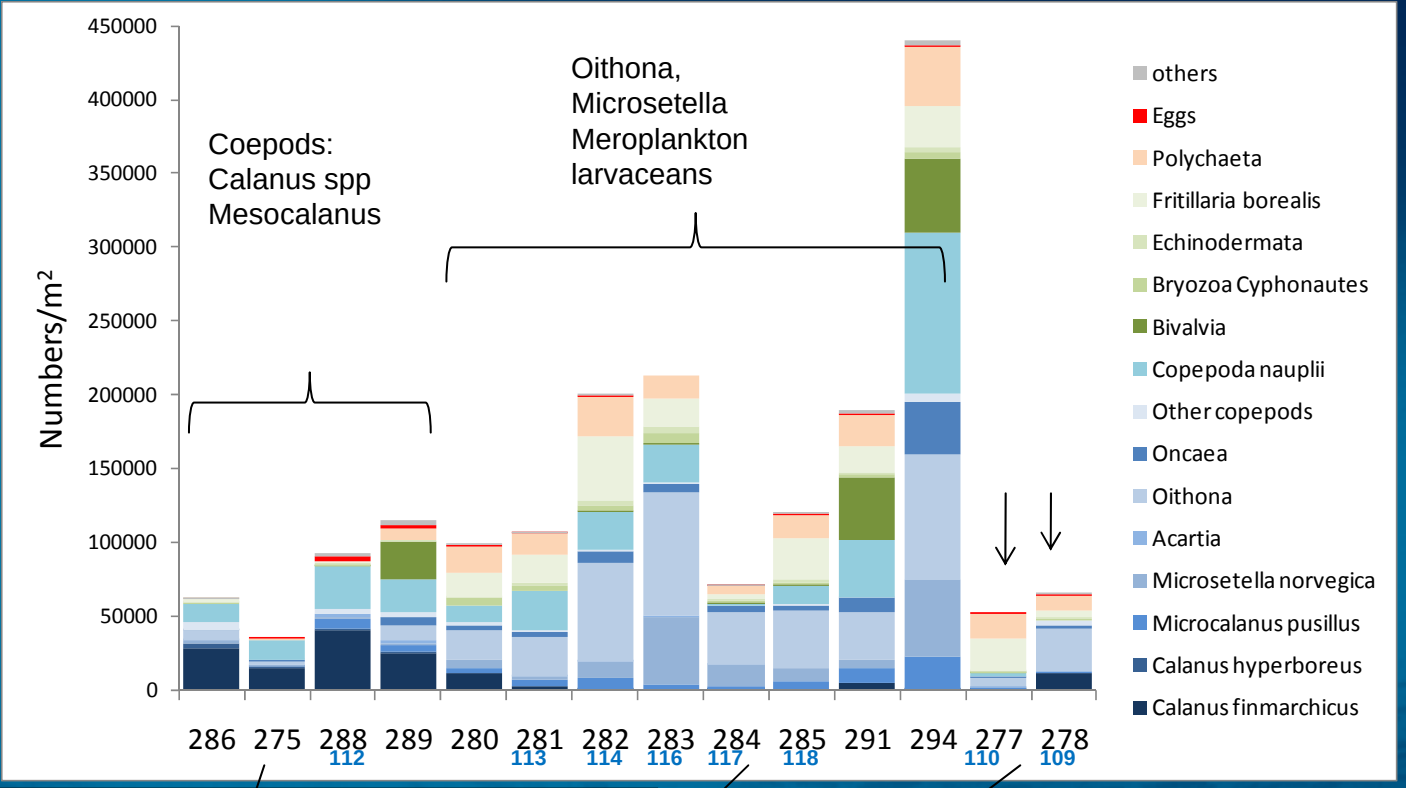


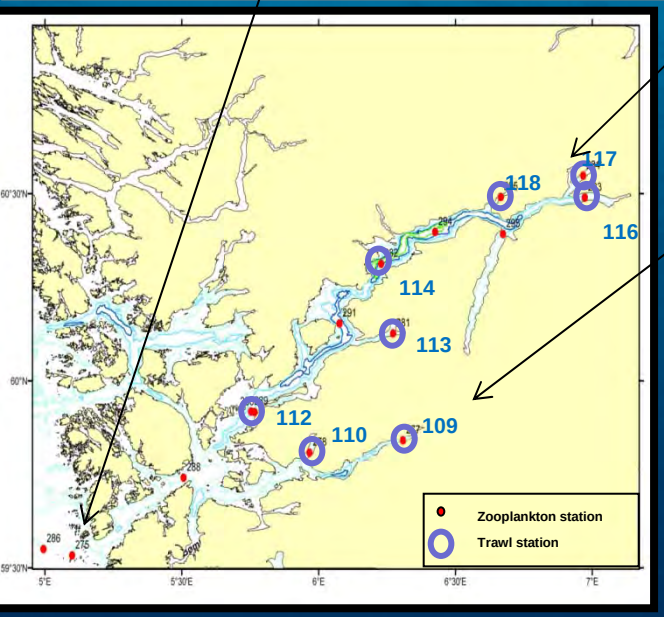





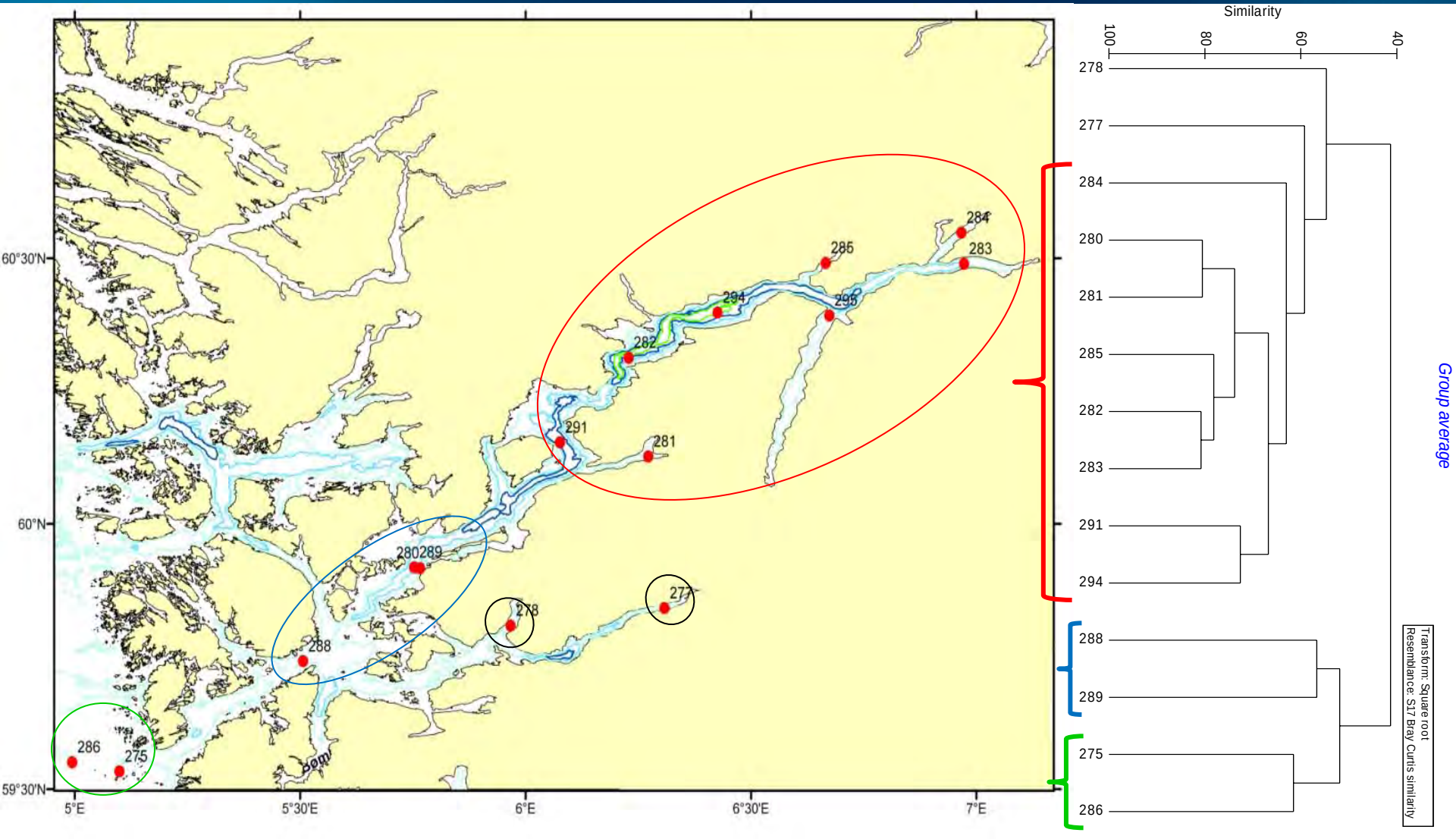

Advection of zooplankton may exceed local production



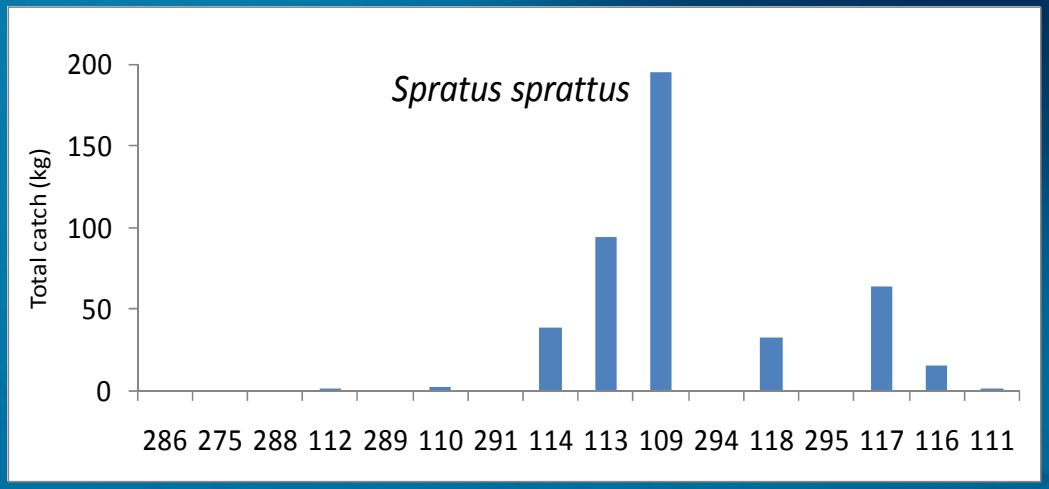

# Zooplankton species composition, 100-0 m

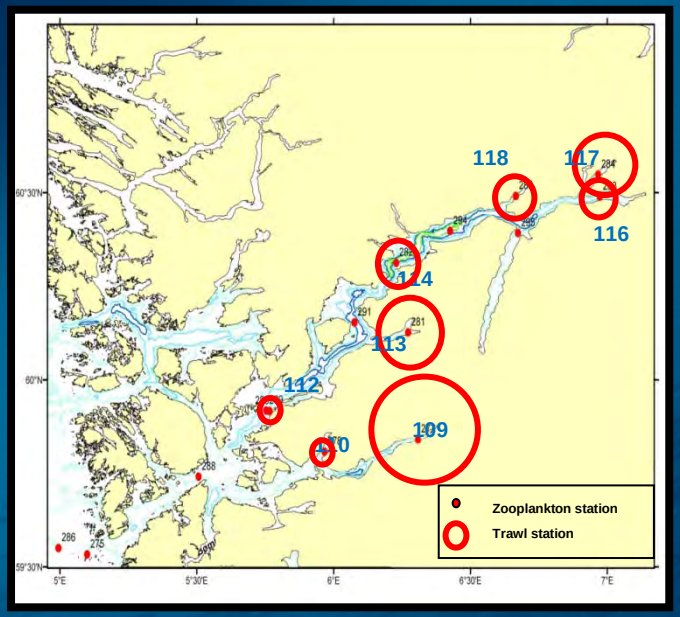
Dominated by small copepods, larvaceans and meroplankton (polychaeta, bryozoa).



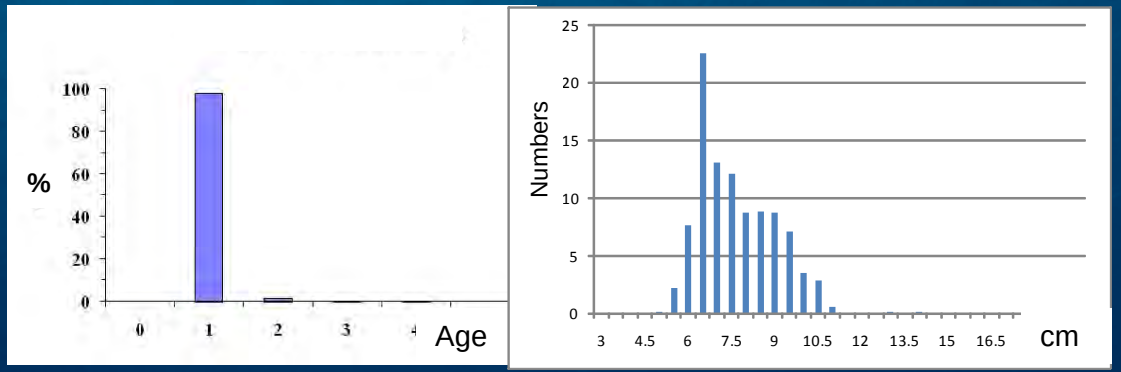

# Cluster analysis on zooplankton species composition (Juday, 90µm, 100-0m)

# Sprat distribution




Patchy distribution in the upper 50 m. Highest abundances in the inner parts of the fjord branches.




The sprat population was dominated by 1 year old (98%)

Size distribution 5-15 cm

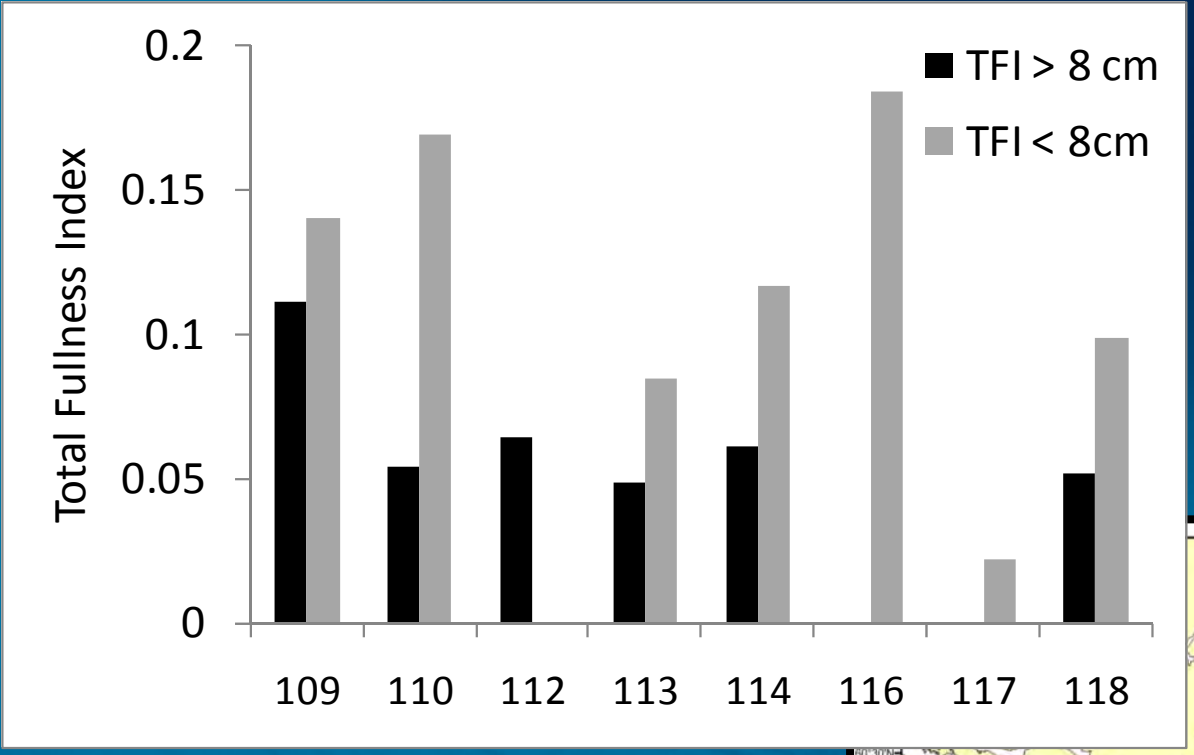
# Gut content

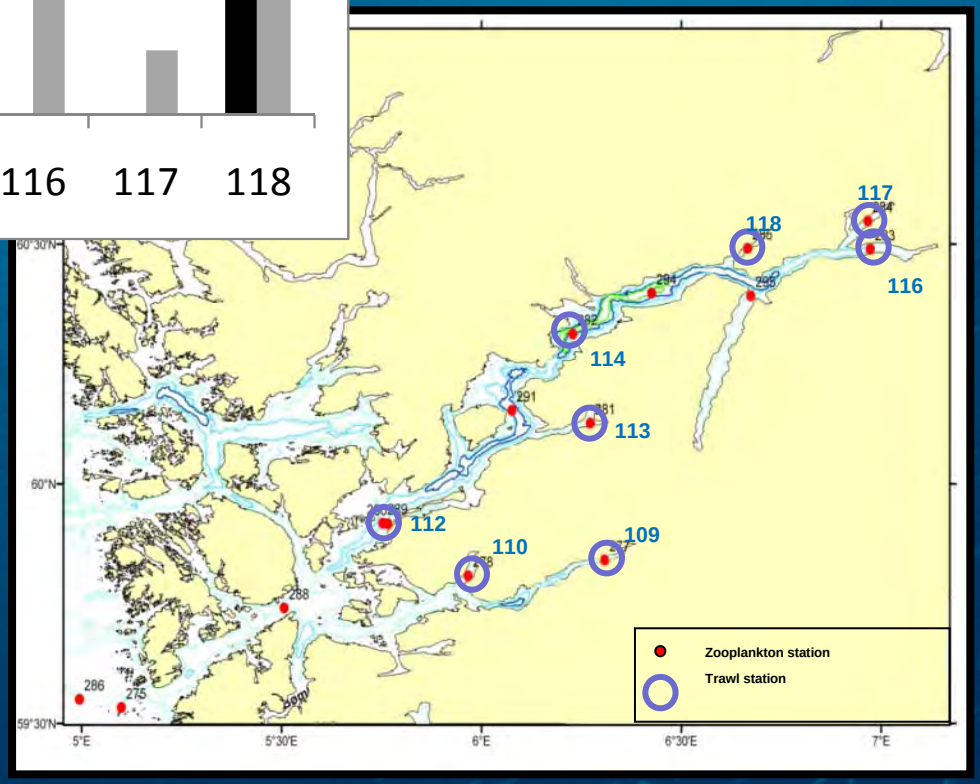
- Total number of stomachs: 159
- Number of empty stomachs:  16
- Number of prey categories: 44

# Prey items
## (frequency of occurences in sprat stomachs %)

| | | % |
|---|---|---|
| Copepods | Oithona sp. | 10 |
| | Microsetella norvegica | 9 |
| | Copepoda unid. | 7 |
| | Temora longicornis | 4 |
| | Acartia sp. | 3 |
| | Copepoda nauplius | 3 |
| | Harpacticoida | 2 |
| | Calanus sp. | <1 |
| | Calanus nauplius | <1 |
| | Centrophages hamatus | <1 |
| | Metridia longa | <1 |
| | Microcalanus sp. | <1 |
| | Para/Pseudocalanus | <1 |
| Meroplankton | Polychatea (Spionid) | 5 |
| | Bryozoa (Cyphonautesl) | 1 |
| | Echinodermata (pluteus) | <1 |
| | Balanus nauplius | <1 |
| | Bivalvia | <1 |
| | Gastropoda | <1 |
| | Decapod zoea | <1 |
| Eggs | Euphausiid eggs | 43 |
| | Invertebrate egg (Orange 0,27 mm diam.) | 6 |
| | Fisheggs | 1 |
| | Littorina eggs | <1 |
| | Pareuchaeta eggsac | <1 |
| | Egg unidentified. | <1 |
| Other | Oncaea borealis | 1 |
| | Euphausiacea nauplius | 1 |
| | Evadne sp. | 0 |
| | Podon sp. | 0 |
| | Conchoecia sp. | <1 |
| | Ctenophora, kammerbiter | <1 |
| | Cypris | <1 |
| | Decapoda sp | <1 |
| | Fishlarvae unid. | <1 |
| | Fritillaria sp. | <1 |
| | Oikopleura sp. | <1 |
| | Amphipoda | <1 |
| | Hydromedusa | <1 |
| | Siphonophora | <1 |
| | Tomopteris sp. | <1 |
| | Tunicata larvae | <1 |
| | Terrestrial material/prey | <1 |
| | Phytoplankton (diatoms) | |

# Total Fullness index



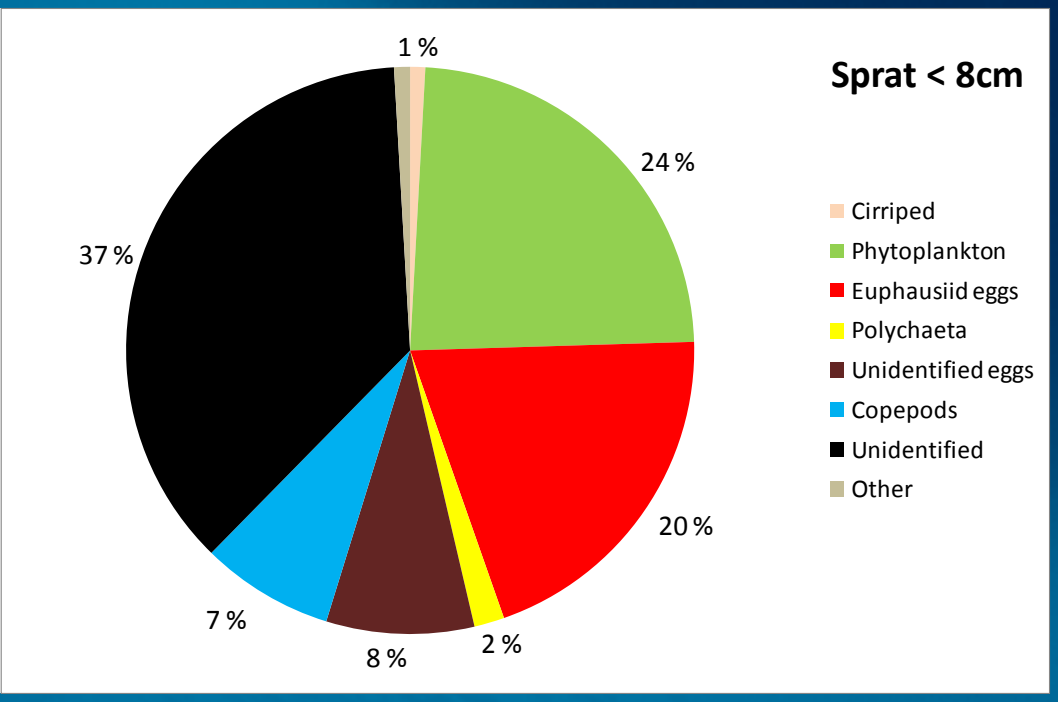



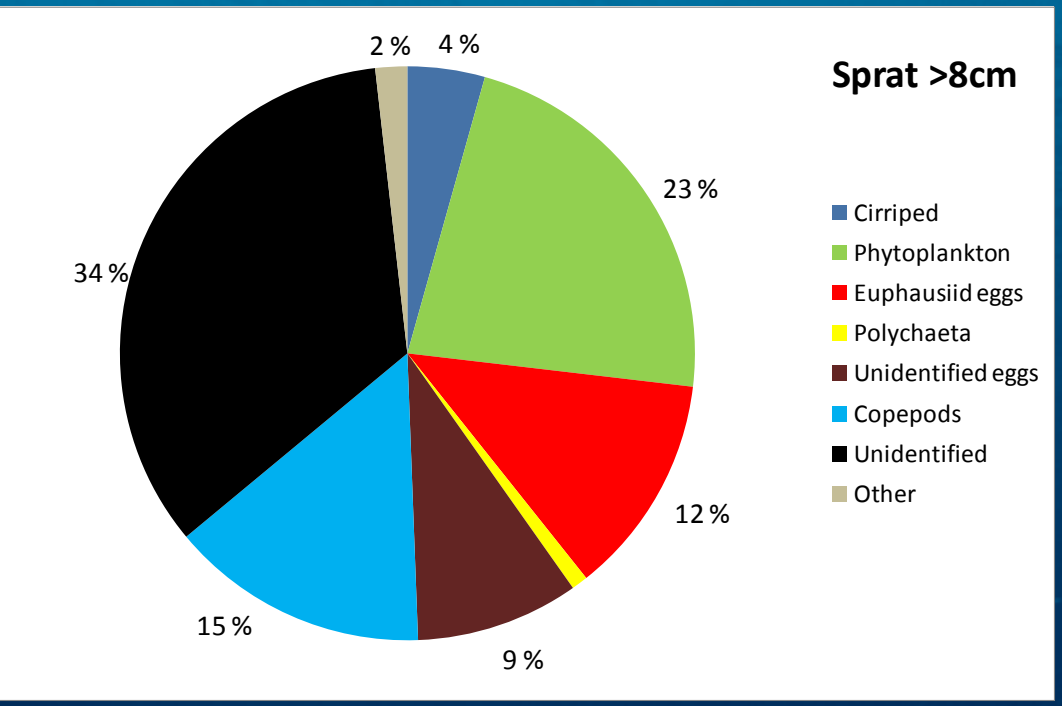

Small fish had higher TFI than large fish

Highest TFI at Stn 109 (large fish) and stns 110,116 (small fish)

Low TFI in the main fjord (stns 112,114)

# Gut content (PFI, %) Predator size



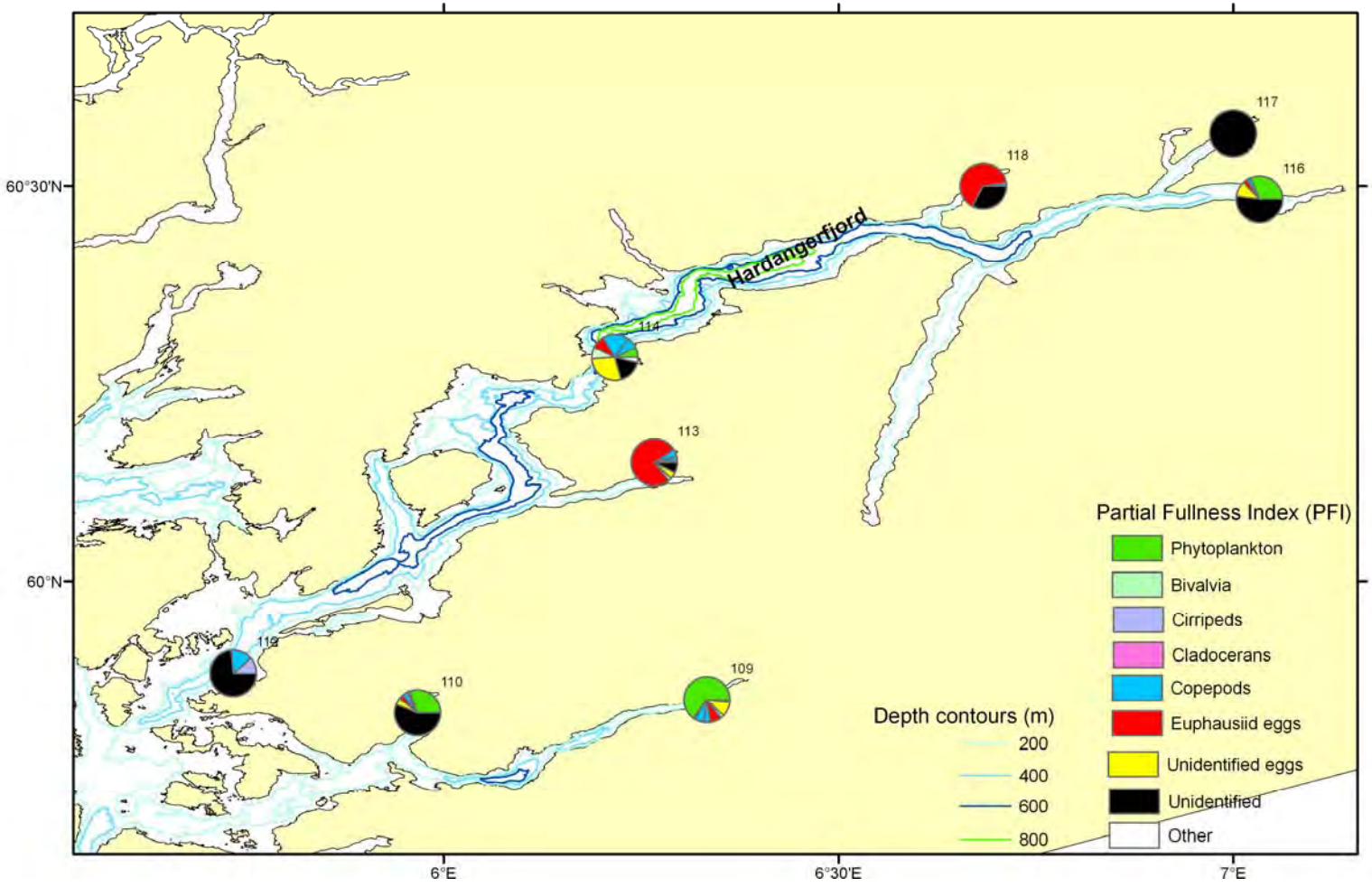




Small fish (< 8cm) higher proportions of euphausiid eggs

Large fish (>8 cm) higher proportions of copepods

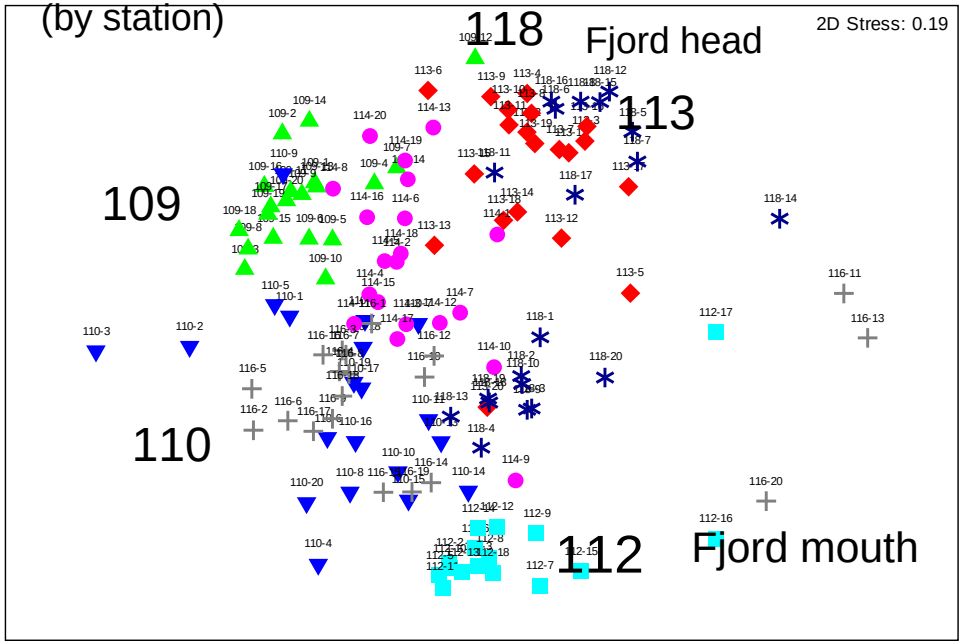
Phytoplankton and eggs were important prey in both size groups.

# Spatial variation in diet (PFI)



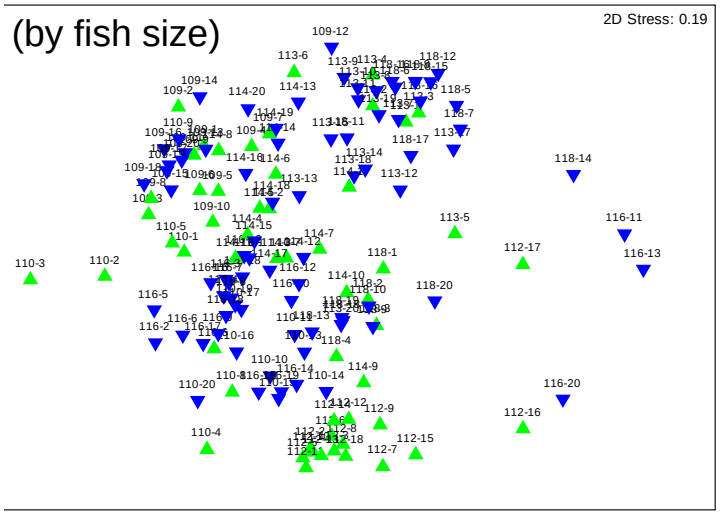
**MDS** Gut content
(by station)

Transform: Square root
Resemblance: S17 Bray Curtis similarity




**MDS** Gut content
(by fish size)

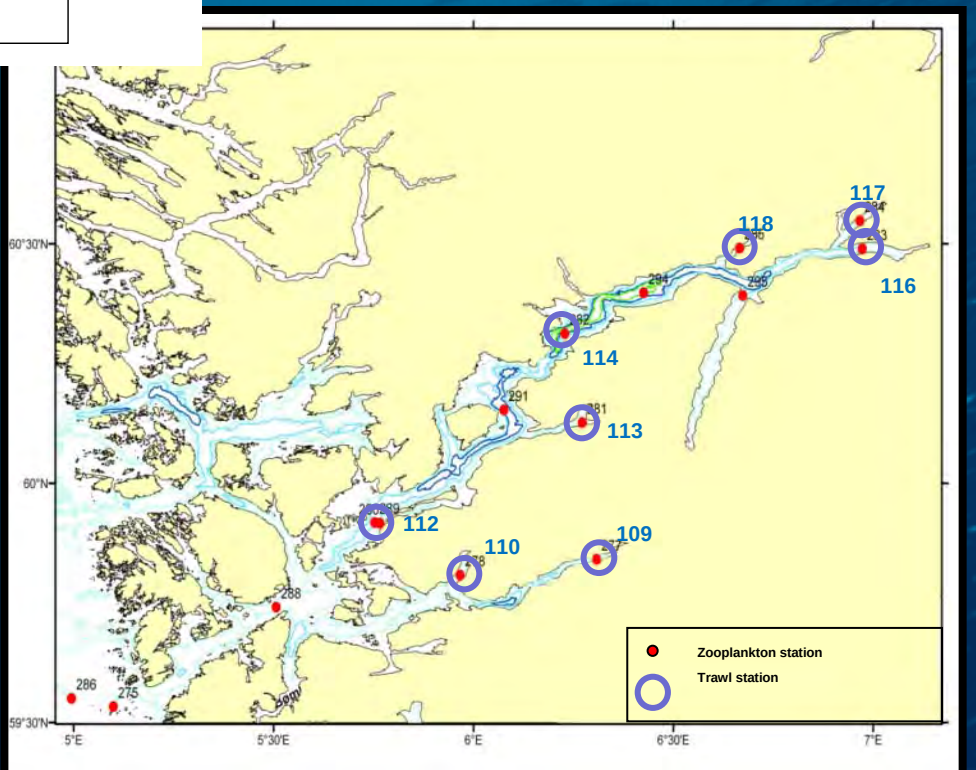
Transform: Square root
Resemblance: S17 Bray Curtis similarity



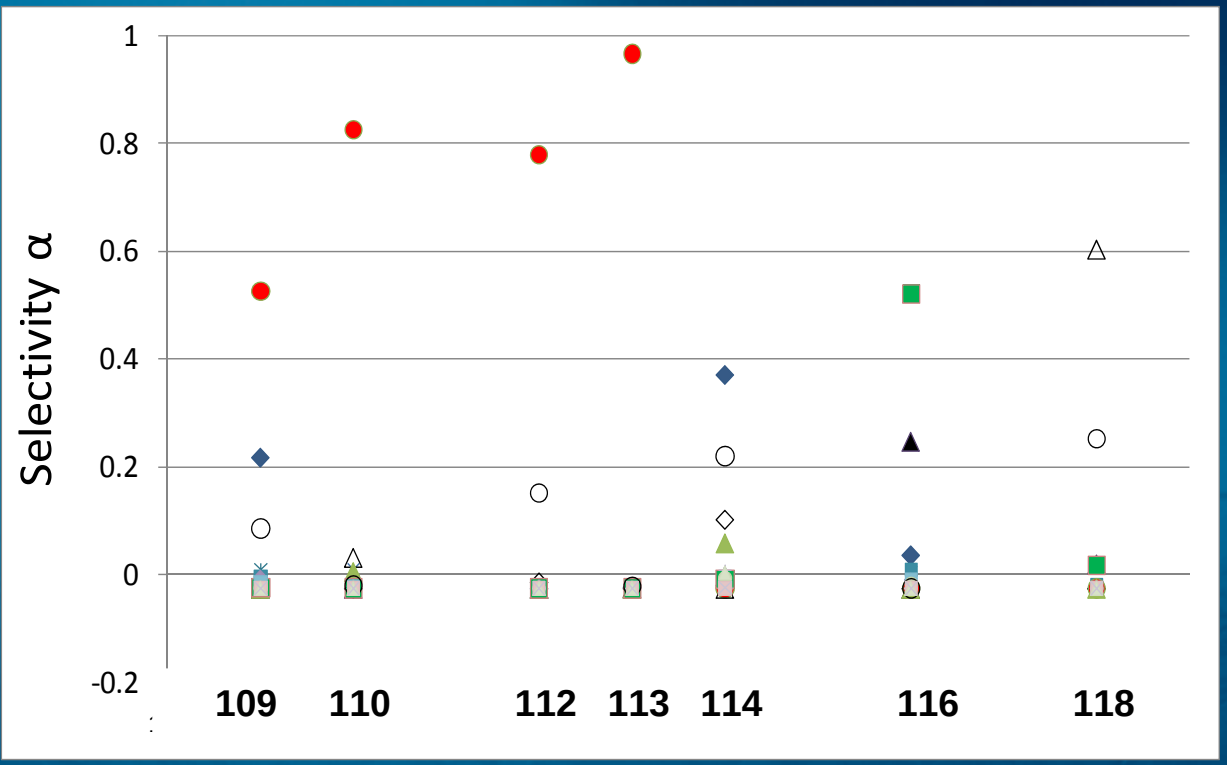

Fish from the same station cluster together.

Cluster analysis demonstrated a ”gradient” from ”outer” to inner” stations.

Large and small fish did not cluster separately



# Selectivity




Positive:

- Euphausiid eggs
- *Temora longicornis*
- *Acartia*
- Harpacticoida
- Microsetella
- Bivalvia
- Fish eggs

$$\alpha_i = \frac{r_i/e_i}{\sum_{j=1}^{k} (r_j/e_j)} - 1/k$$

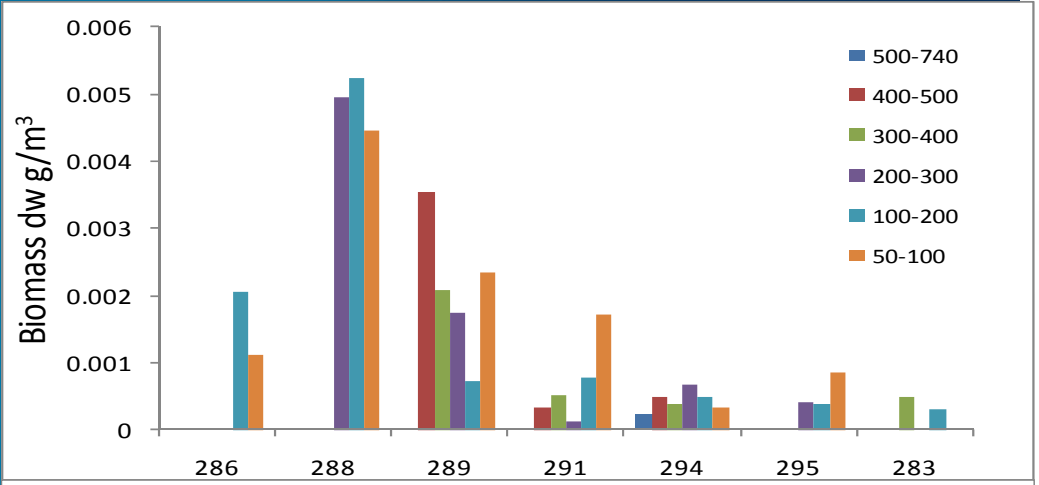
$r_i$ proportion of *i* in stomach

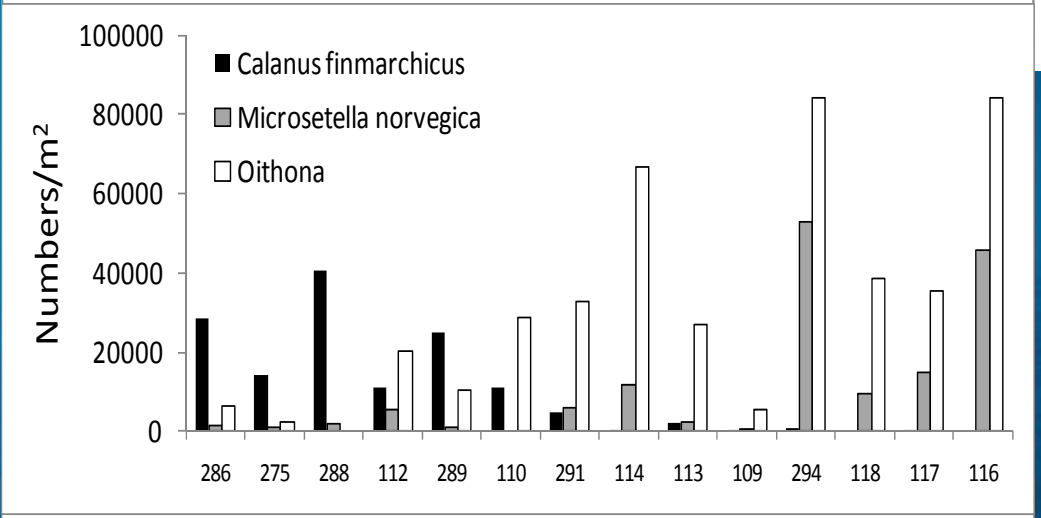
$e_i$ proportion of *i* in environment

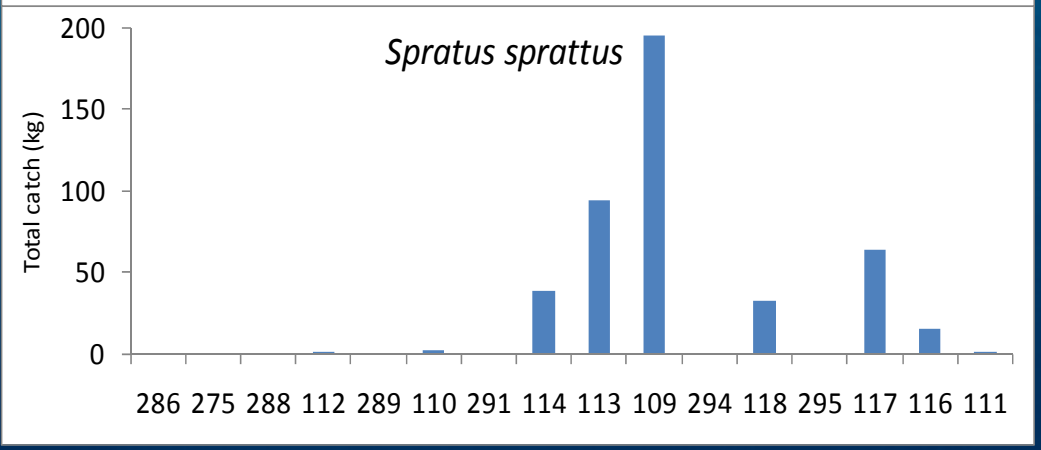
Chesson (1983)

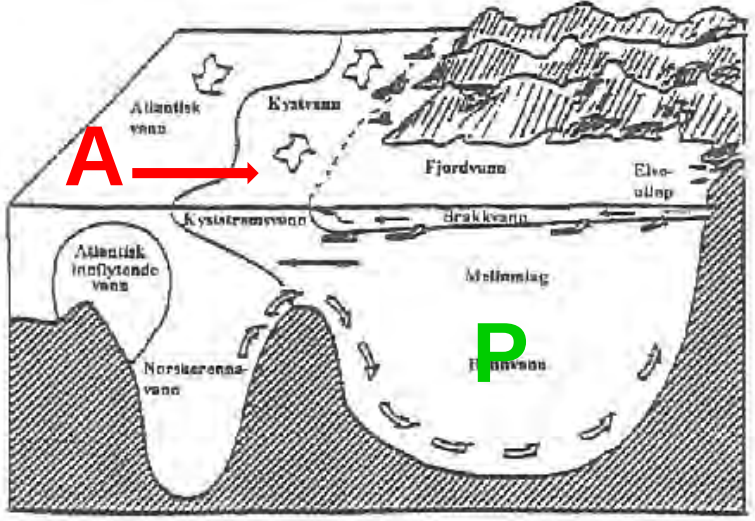
# Selectivity

| Positive | Low or negative | Others (in stomachs but not in net tows) |
|---|---|---|
| Euphausiid eggs | Appendicularians | Balanus larvae (cirripeda) |
| *Temora longicornis* | Echinoderm larvae | Insect larvae |
| *Acartia* | *Calanus* | Invertebrate egg (Orange 0,27 mm diam.) |
| Harpacticoida | Copepoda nauplii | Phytoplankton (diatoms) |
| Microsetella | *Oithona* | |
| Bivalvia | *Oncaea* | |
| Fish eggs | Spinoid larvae | |
| | Cyphonautes larvae | |




Distribution of sprat vs prey distibution

Sprat feeds mainly on local production

# Summary

- High diversity, and high spatial variation in the diet of sprat in Hardangerfjord, April 2009.
- Phytoplankton (diatoms), euphausiid eggs and copepods was the most important prey (by weight)
- Sprat showed positive selection for euphausiid eggs, *Temora* and *Acartia*.
- The distribution of sprat in the inner parts of the fjord may relate to higher abundances of preferred prey, less predation and less competition in the inner fjord areas.