Small Pelagics Sympoisum
Victoria
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Use of otolith microstructure analyses to study the relation between larval hatching time, growth and survival in Norwegian spring spawning herring

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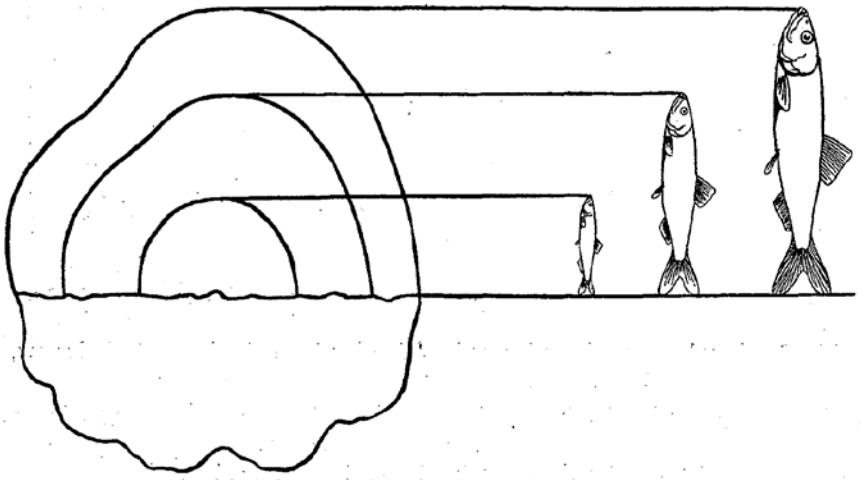
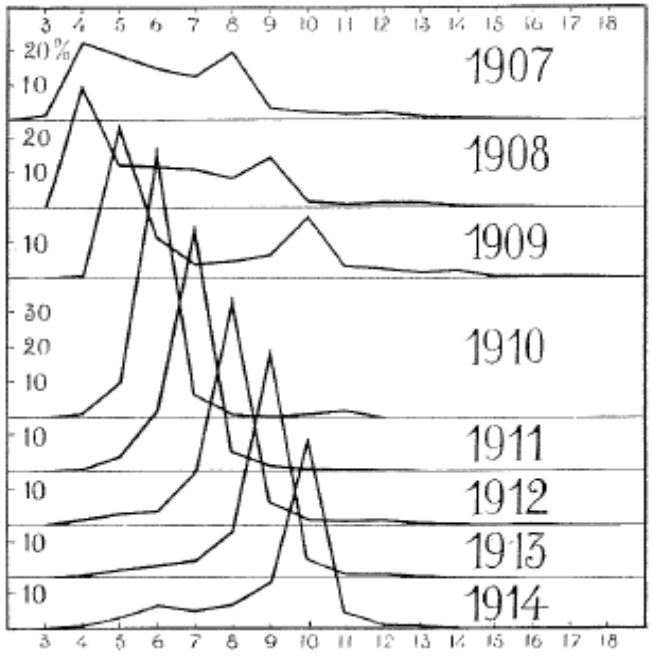
- **Johan Hjort was the first scientist to demonstrate the large year class fluctuations in NSS herring, based on age readings of scales**

- **Ever since, scientists have struggled to understand underlying mechanisms**

It starts already with energy allocation and behavioral decisions in the adult population

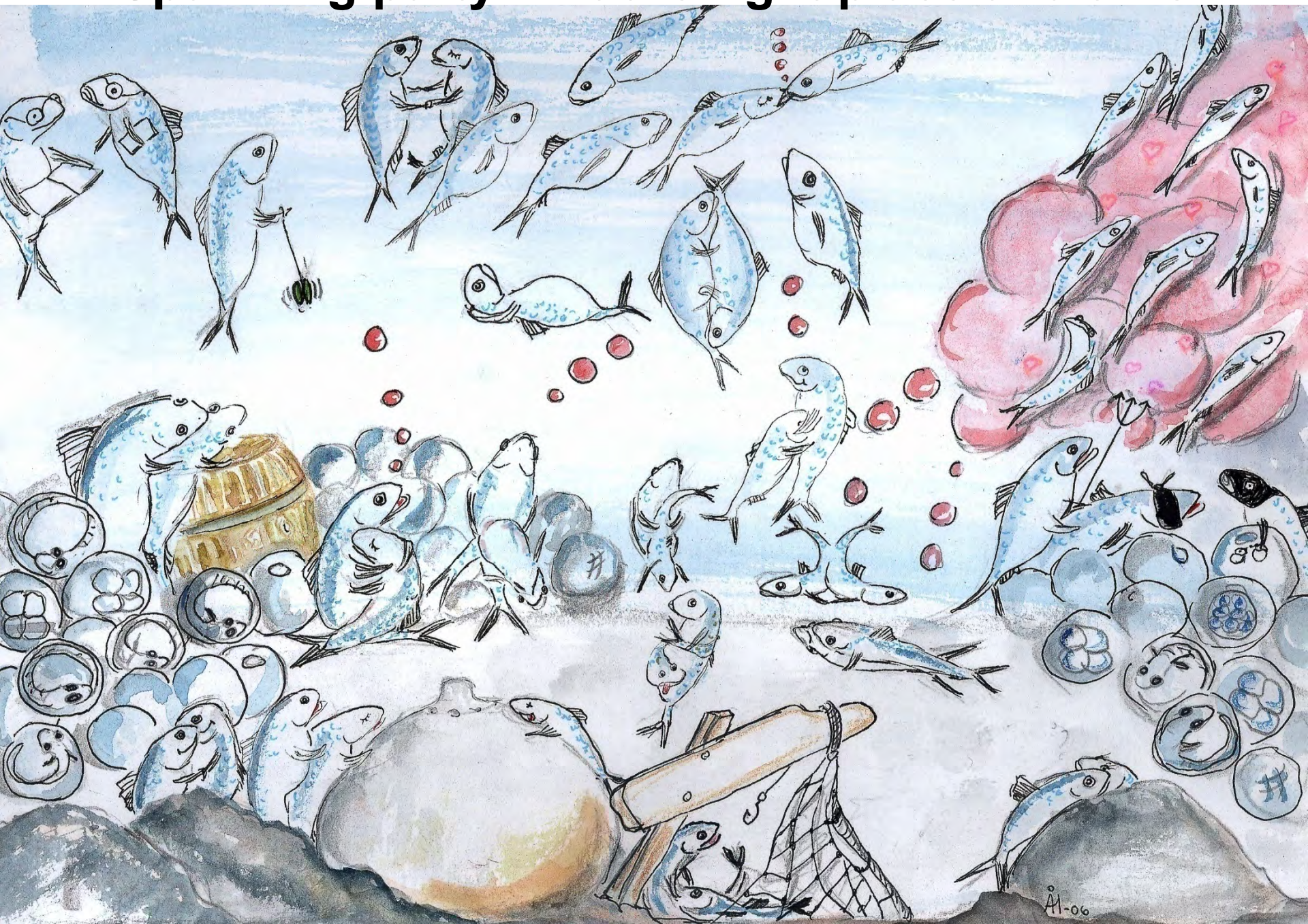




Age

1.Wintering party – Where & when to spawn?

2.Spawning party – At the right place and time?



3. After party in spring and summer

Eat and drink and get in good shape for next season ☺

But what happens with the eggs and larvae?

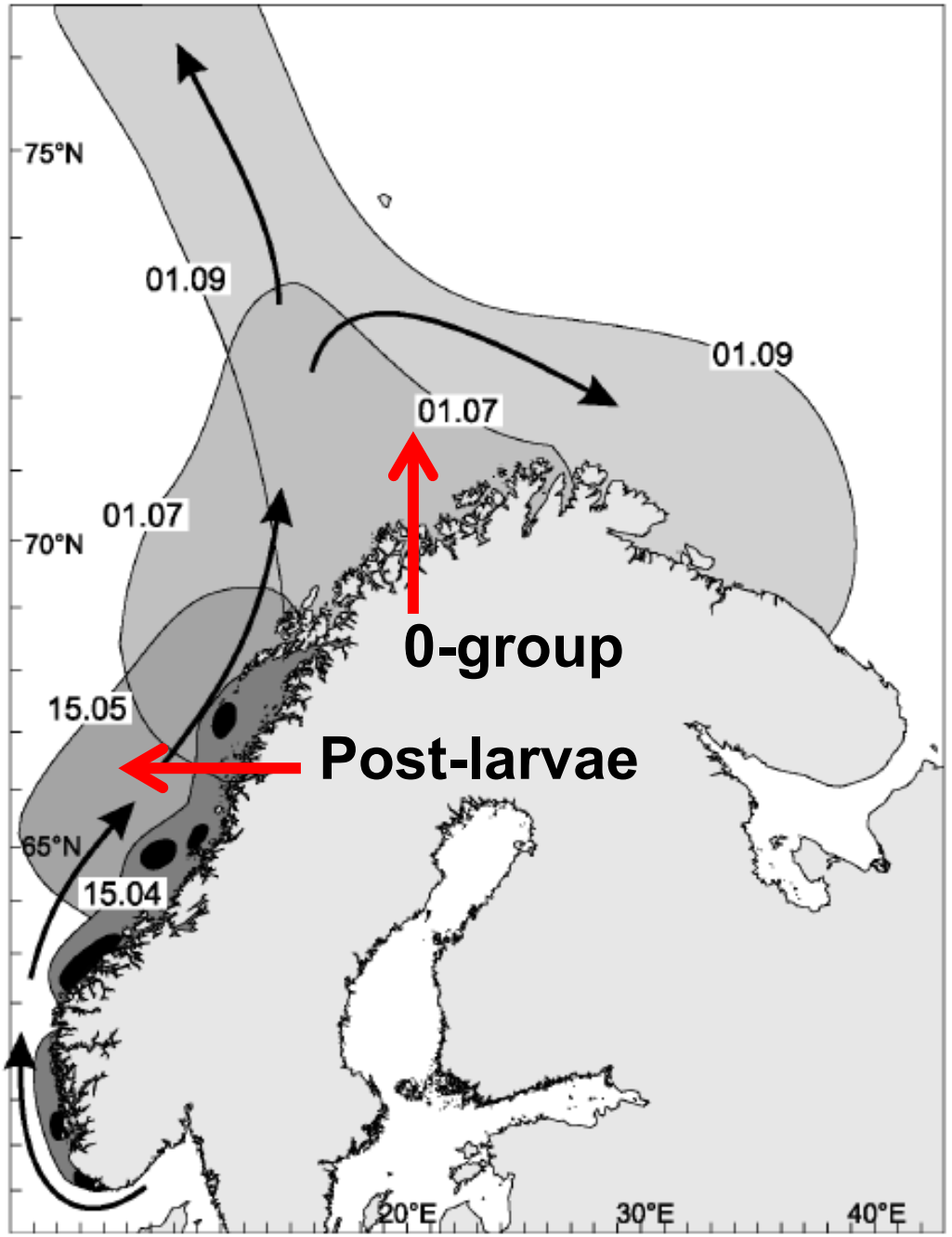
4. Early life history of NSS herring – The struggle to survive

- Eggs on hard substrata along most of the Norwegian coast.
- Larval drift into fjord nurseries along the coast and into the main nursery in the Barents Sea
- Temporal and spatial variations in environmental conditions and predation risks
- The recruitment of NSS herring is highly variable and mainly attributable to variable mortality of the larval and post larval stages

High mortality from post-larval stage to 0-group

There is a good relation between abundance at 0-group stage and recruitment at age 3 (Sætre et al 2002)

Mortality between post-larva and 0-group is the focus of present study



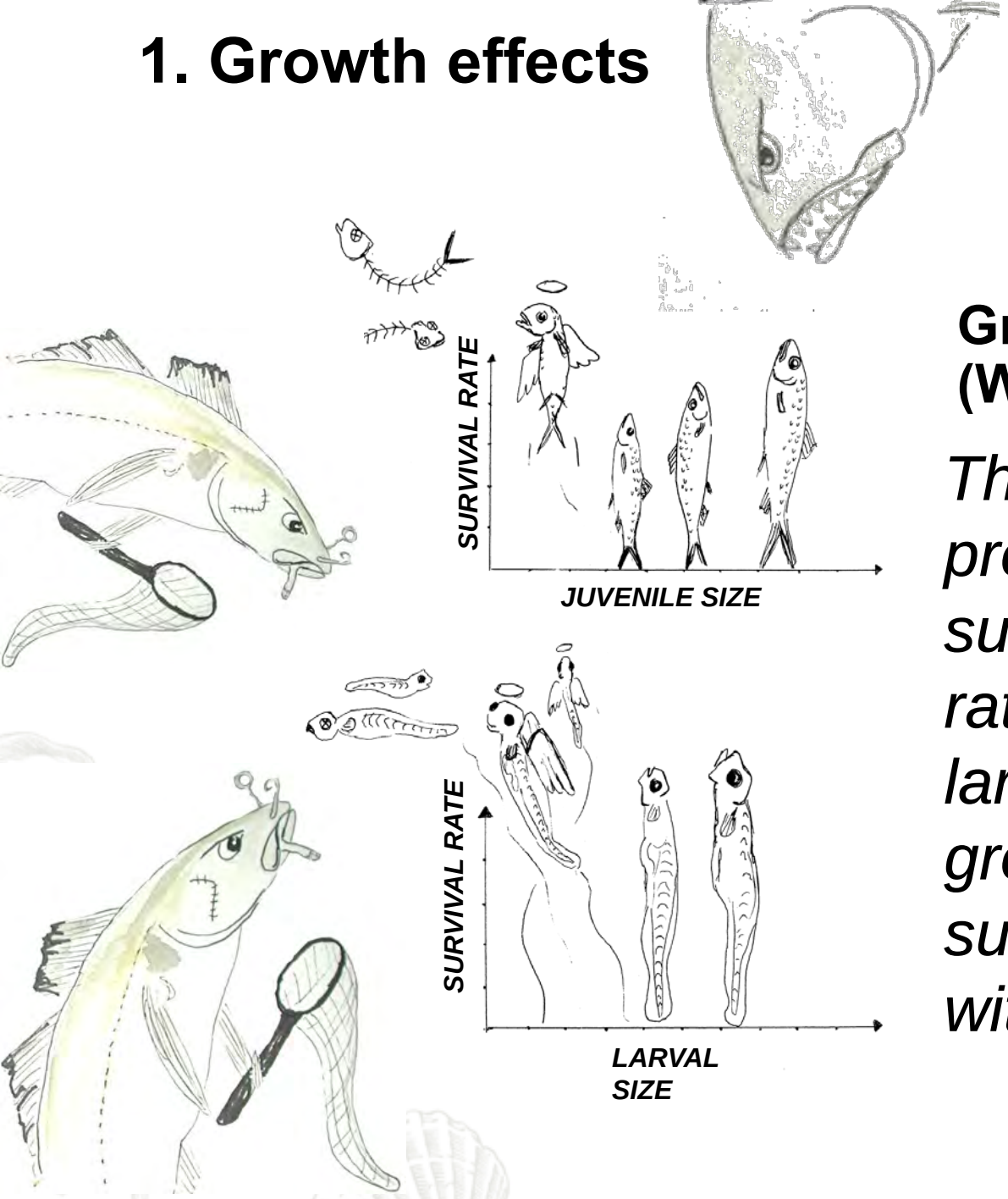
A likely reason for post-larval mortality is predation.

Even though they are many, the biomass at the post-larval stage is low, i.e. they may be wiped out given high overlap with predators

How do the survivors avoid predation through metamorphosis until 0-group in the autumn?

1. **Growth effects**
2. **Spatial effects**
3. **Temporal effects**

1. Growth effects

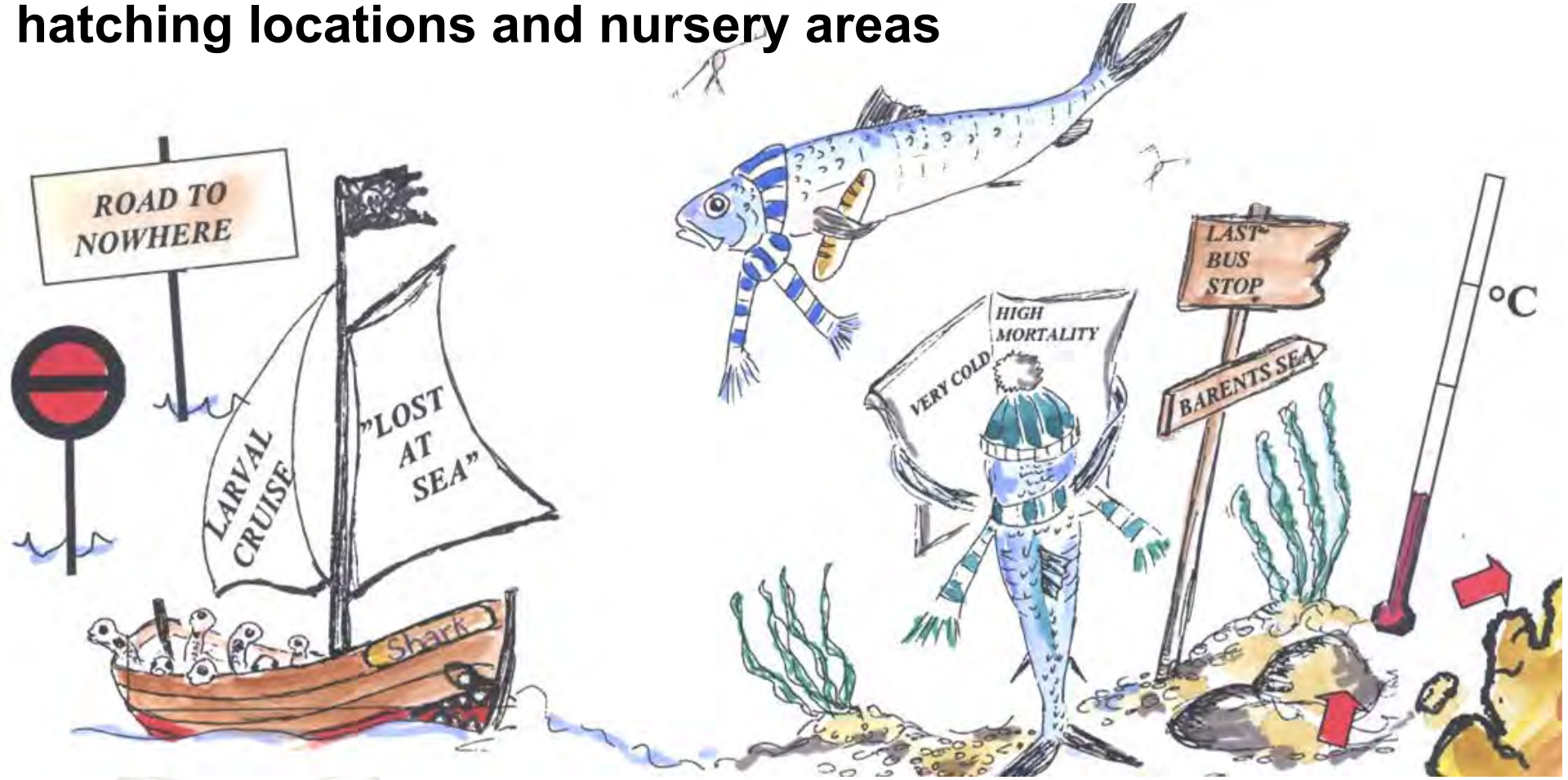


Growth rate hypothesis (Ware 1975)

The range of potential predators and the subsequent mortality rate decreases as the larvae and juvenile fish grow, which may favour survival of individuals with high growth rates

2. Spatial effects

Important for NSS herring with a large distance between hatching locations and nursery areas

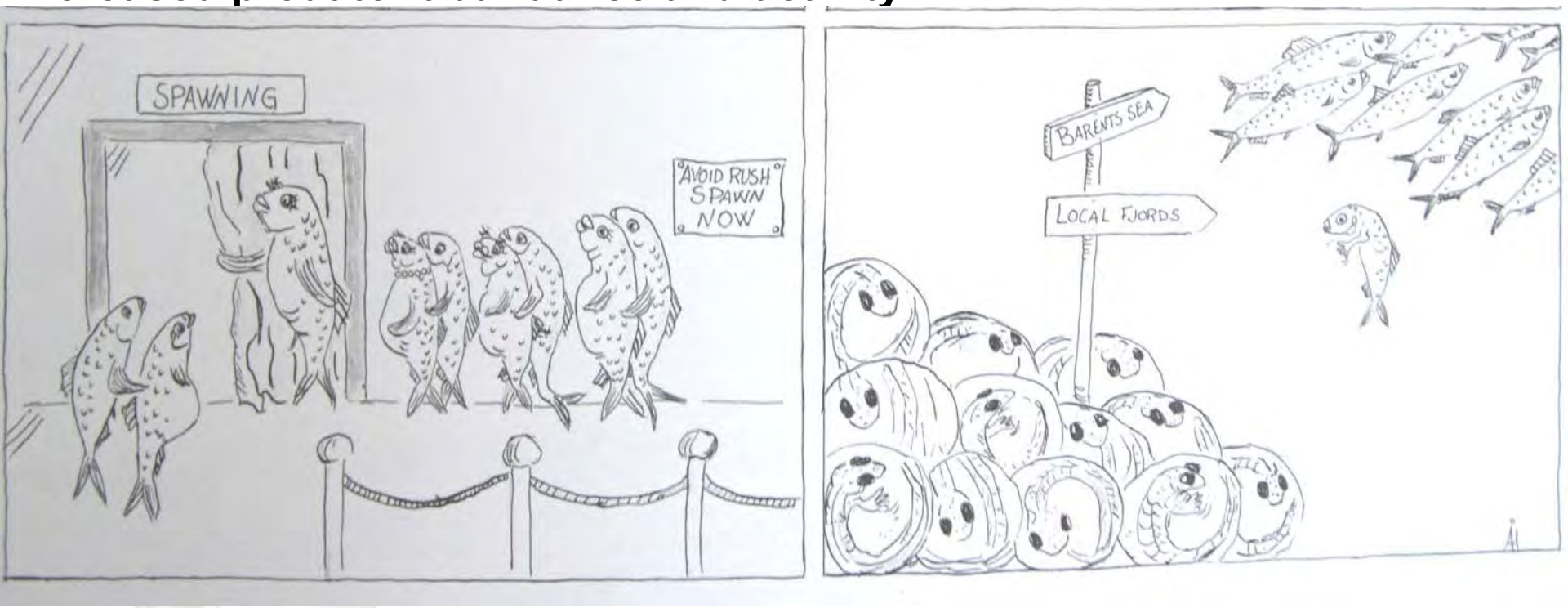


Drift out of predator areas instead of growing out of predator windows?

3. Temporal effects

Timing of spawning and hatching may play an important role for survival. Good NSS herring recruitment in years with early hatching (Husebø et al 2009)

Not advantageous to be left behind to hatch late during spring warming – Increased predator abundance and activity?



Early hatched larvae may be larger with potentially lower range of predators than late hatched larvae they are overlapping with in time and space, despite a slower post-hatch growth rate.

Main Objectives

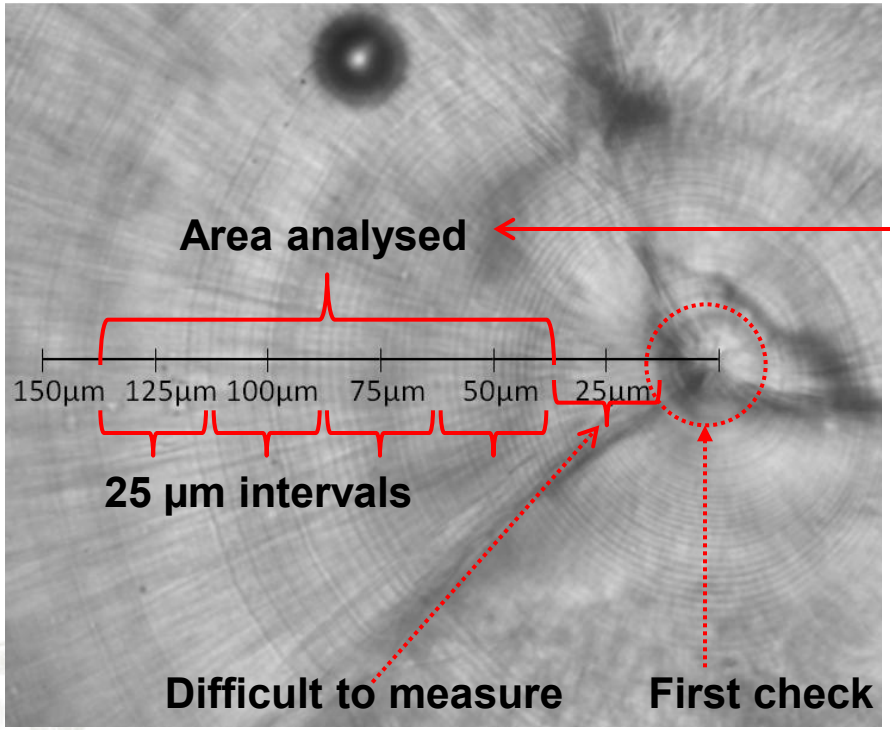
Test for growth-, spatial- and temporal effects on survival of NSS herring post-larvae

Method

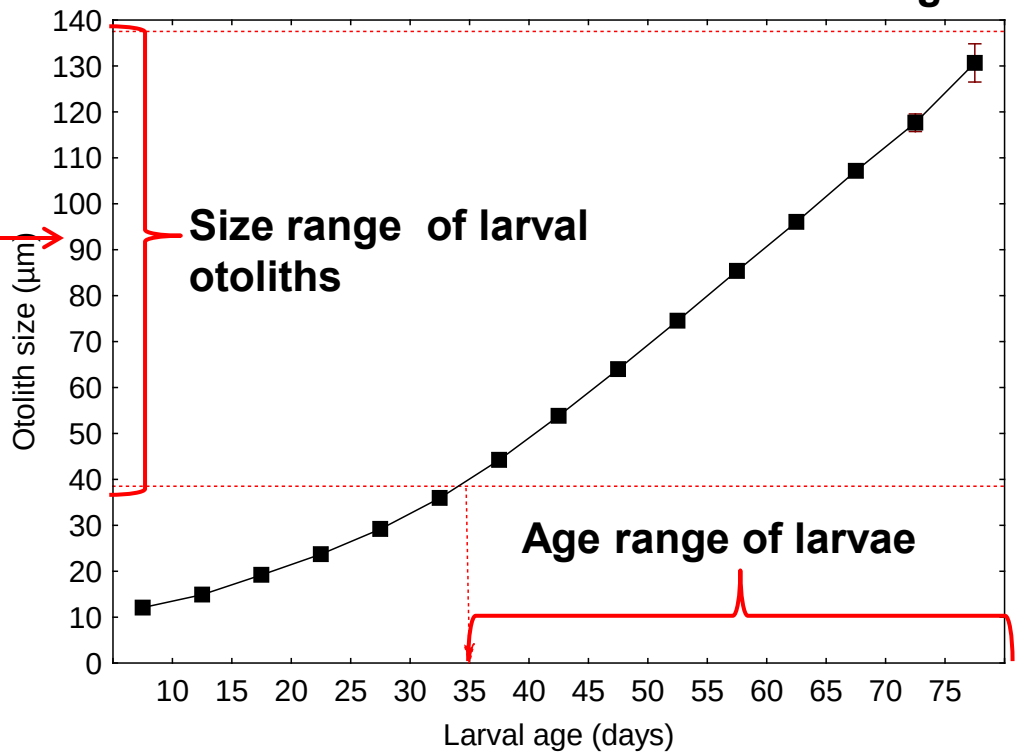
Compare daily otolith growth at selected distances from the core between post-larvae and the surviving 0-group of the same year classes.

Area in otolith analysed for daily increment widths

Example of ground and polished 0-group otolith



Otolith measures related to larval age



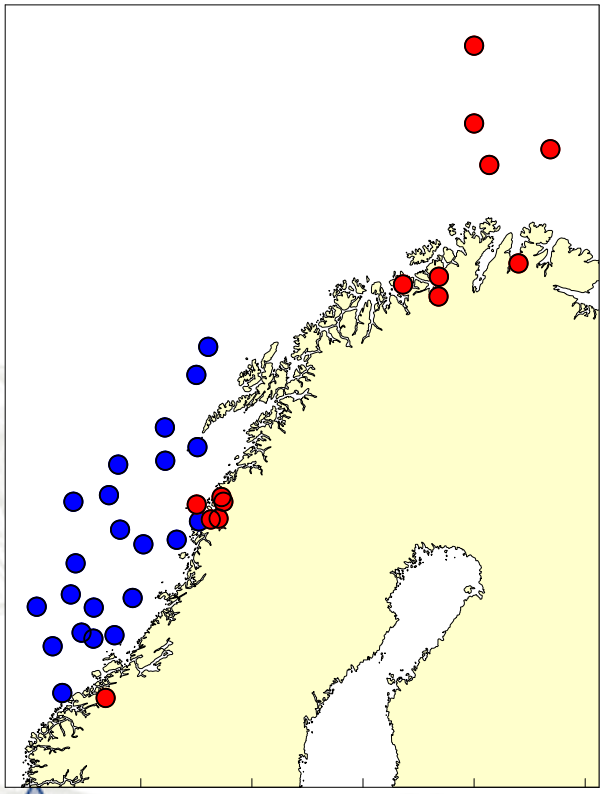
The distance from core (37.5-137.5 µm) analysed in ground otolith corresponds with otolith size range of post-larvae analysed.

Mean increment width values for 25 µm intervals around 50, 75, 100 and 125 µm were used in the statistical analyses

Overview of samples analysed for otolith microstructure

Larvae from Harstad trawl hauls in May, N=10-20 per station, total N=798, L=18-32 mm (metamorphosed at 40mm). Size in trawl=size in MIC hauls

0-group from Harstad trawl hauls in the autumn, in the Barents Sea, coast north, coast south, N=10-20 per station, total N=313, L=60-130 mm

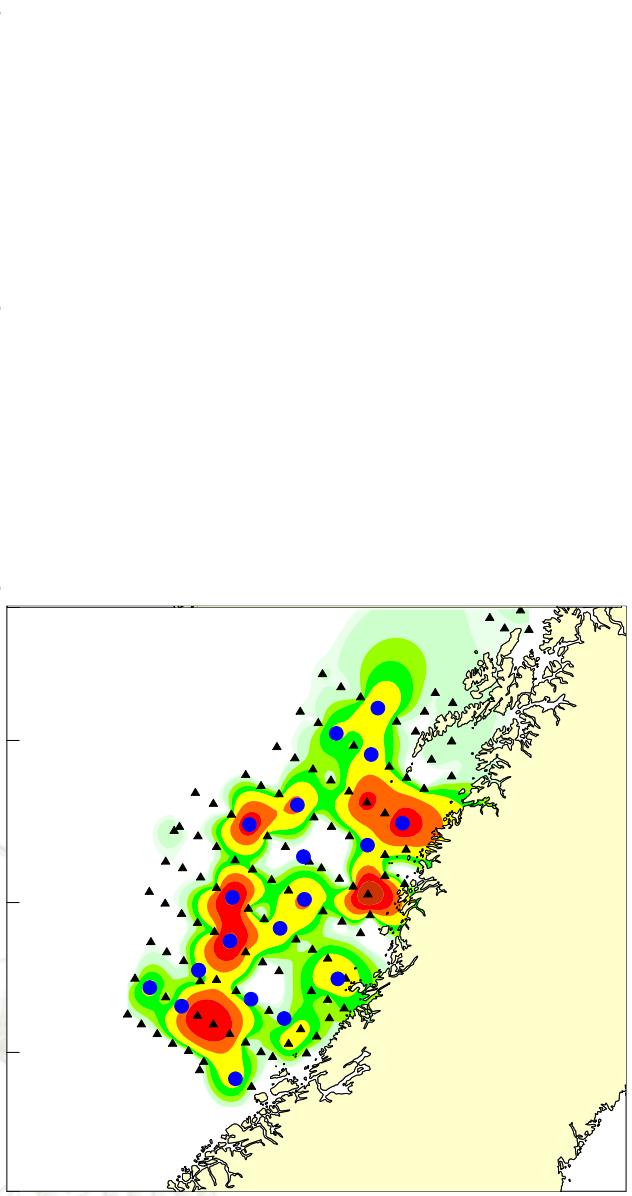


Stations with larval otolith samples (●) related to distribution and density of larvae and T (Cº) 20 m

20 m

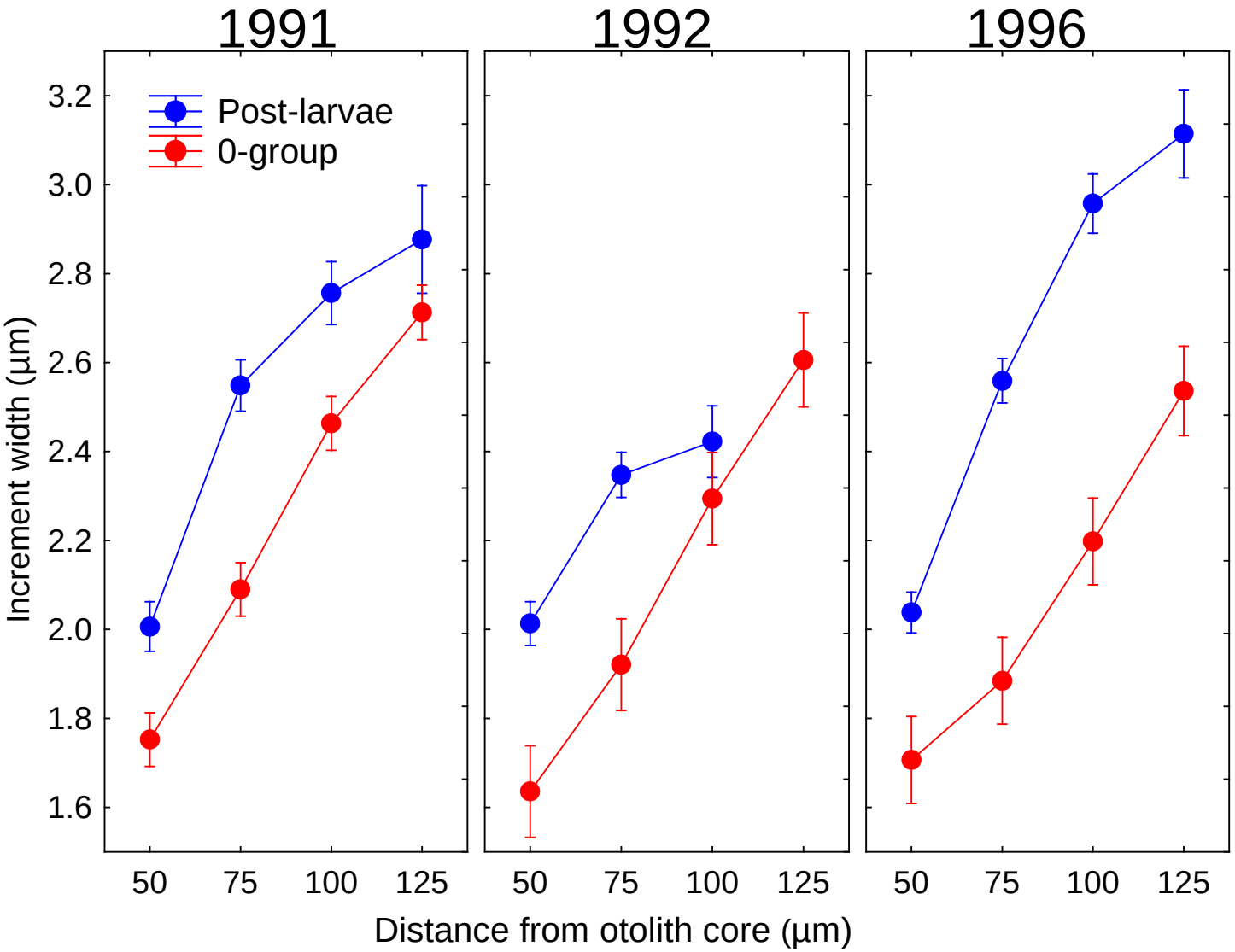
1991

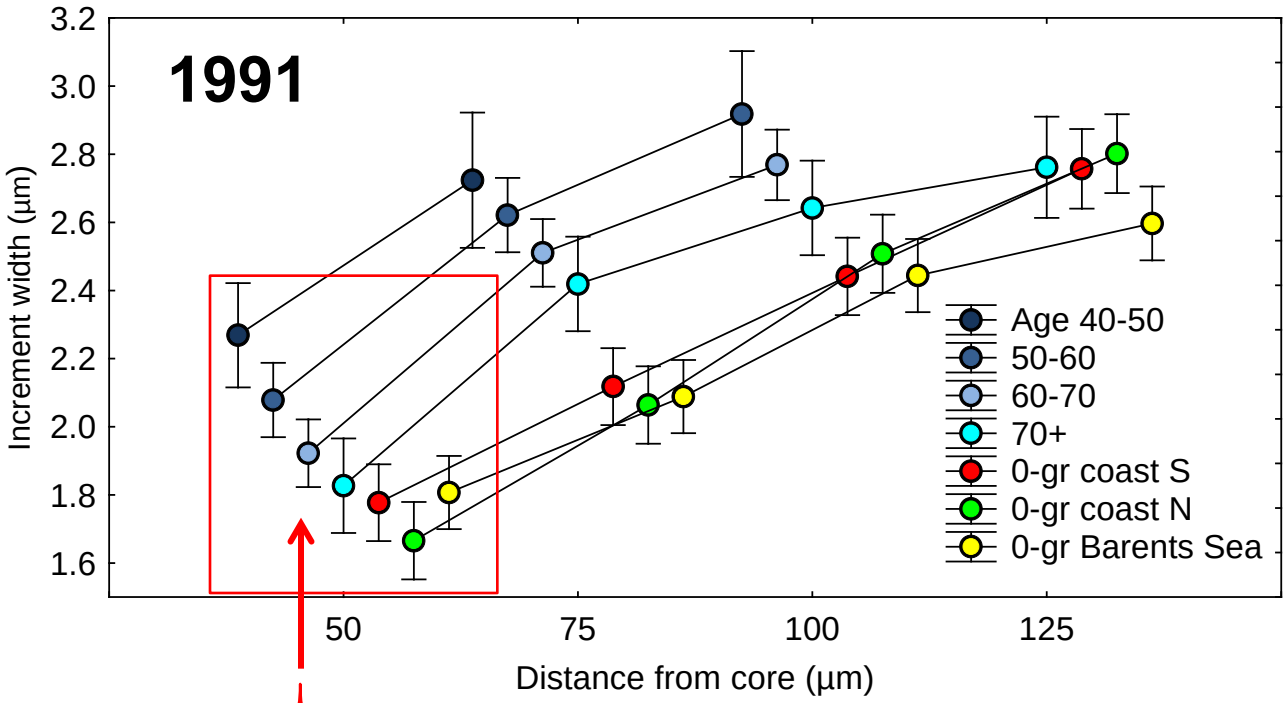
1992



Comparing daily otolith growth post-larvae vs surviving 0-group

Growth rate post-larvae > 0-group





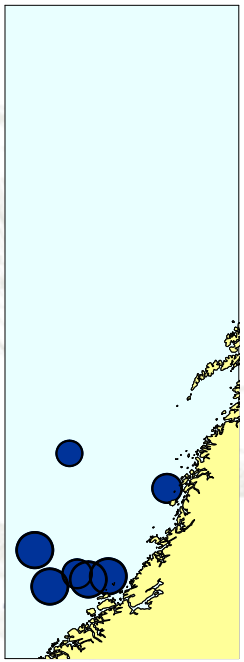
Daily otolith growth related to larval age at sampling

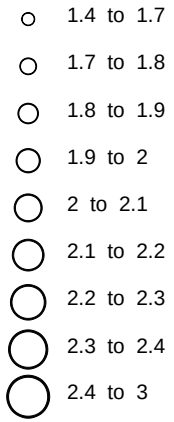
Same trend for 1991, 1992 and 1996 year classes

No spatial effect within 0-group

Spatial and temporal effect in larvae

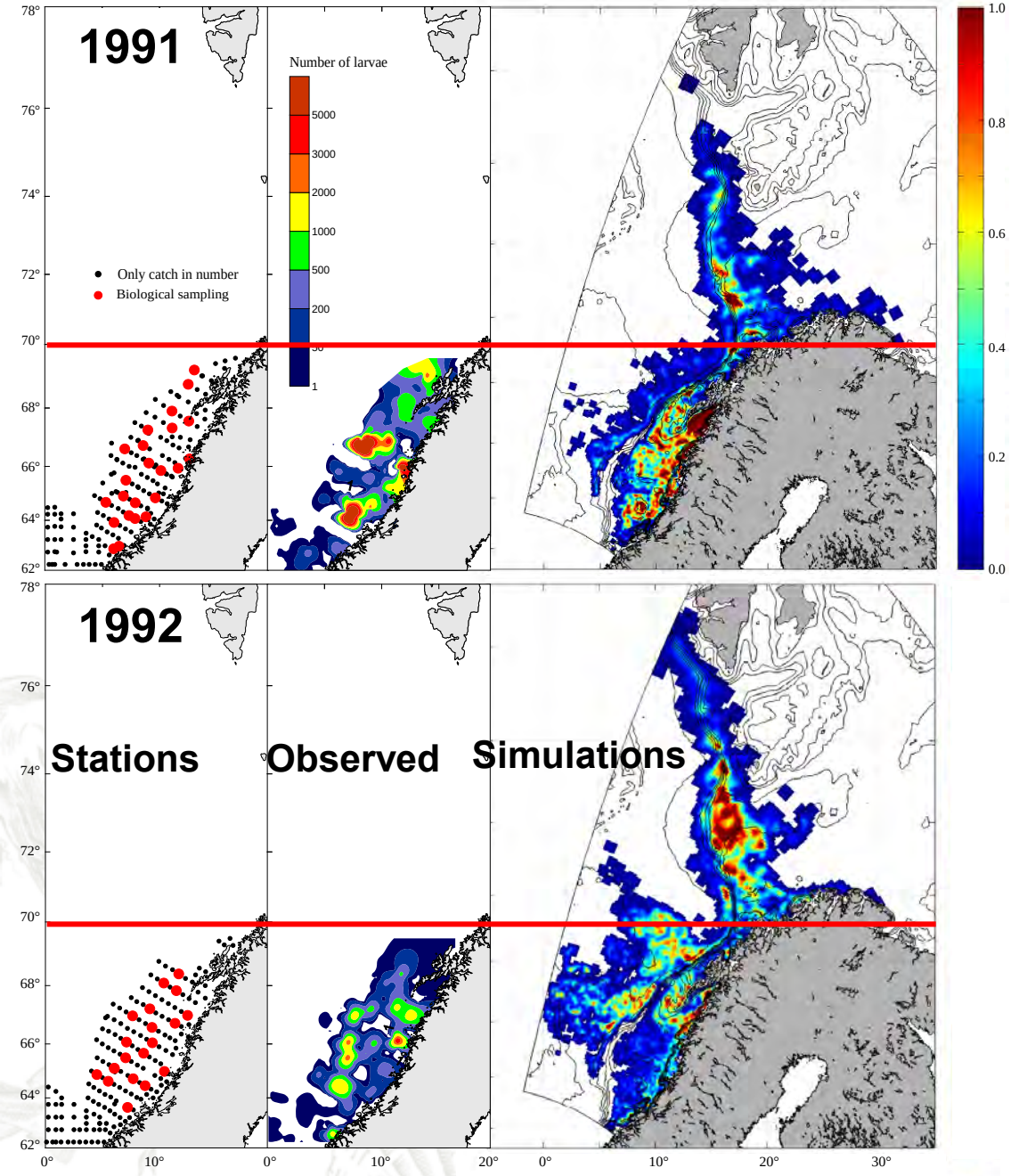
Oldest larvae north ≈ 0-group at 50µm, but not at larger distances





WHY?

Drift model results (*Husebø et al. 2009*)



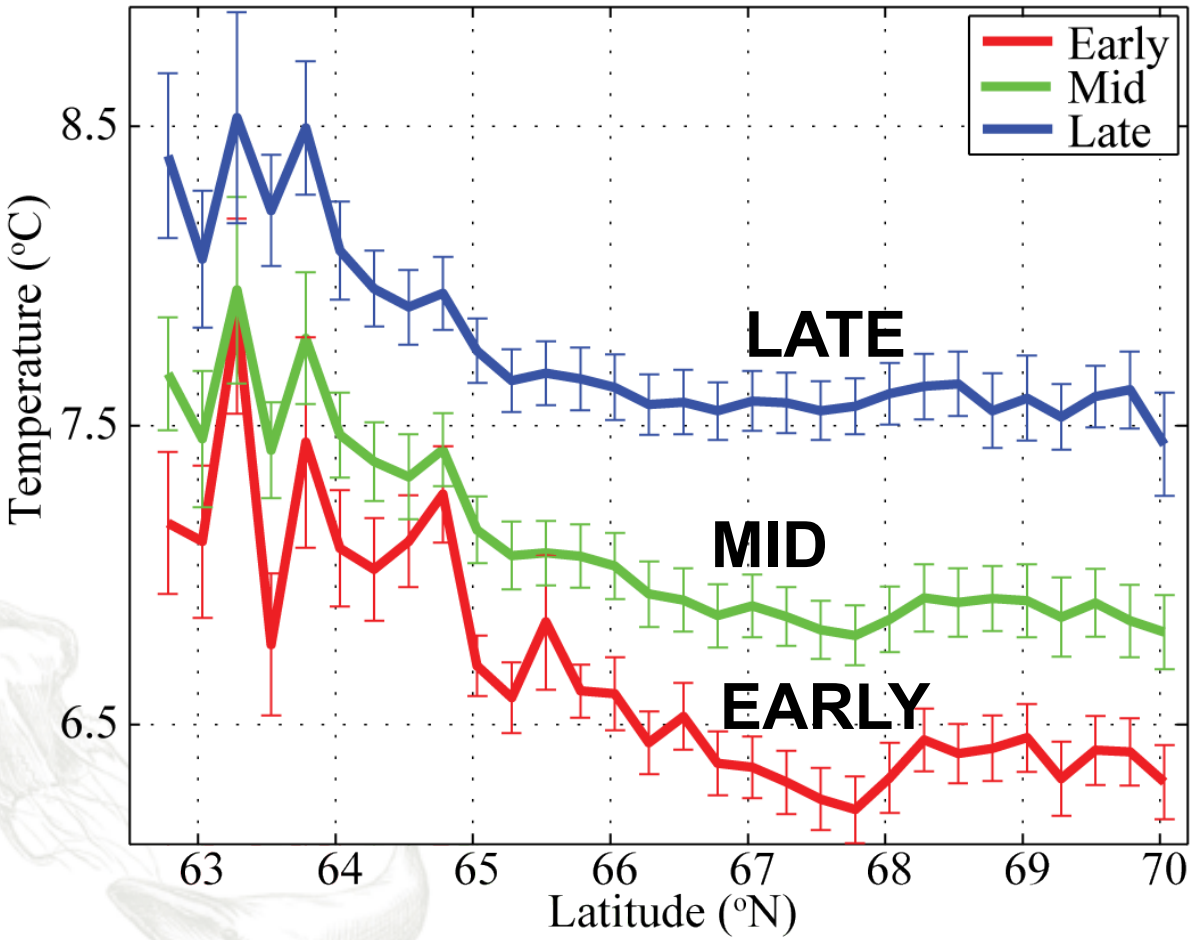
Post-larval surveys in May may not cover the whole population

A significant proportion of post-larvae may have been transported north of 70ºN

Larvae north of 70ºN are assumed to be survivors from early hatching and a rapid northward drift.

Modelled ambient temperature during 60 days of larval drift (*Vikebø et al. 2010*)

Effects of hatching time and northward driftspeed?



Indicate that survivors until 0-group originate from early hatching with rapid drift, low ambient temperature and low growth rate

Conclusions

- The daily otolith growth at selected distances from the core was significantly lower in the surviving 0-group compared with larvae
- The results indicate spatial and temporal effects with a selection for early hatching in NSS herring, which is tightly linked to drift patterns and location of nursery areas
- The survivors are slow growers, drifting in cold waters early in the season and arriving early in the nursery areas prior to the increased predator levels developing northwards during spring warming
- Still, size (not growth rate) may be important, as early hatching may also result in earlier metamorphosis, despite the slower growth.