In-situ observations on physical-biological variables – IMR field activities

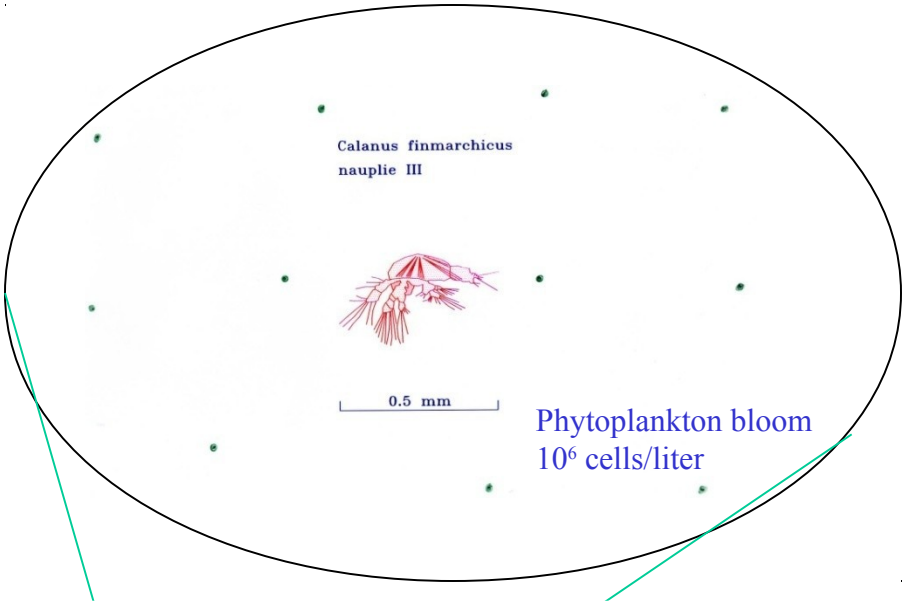
Svein Sundby

Bekkjarvik Gjestgiveri

17-19 August 2015

INSTITUTE OF MARINE RESEARCH
HAVFORSKNINGSINSTITUTTET

From the scale phytoplankton – to zooplankton - to fish eggs and larvae

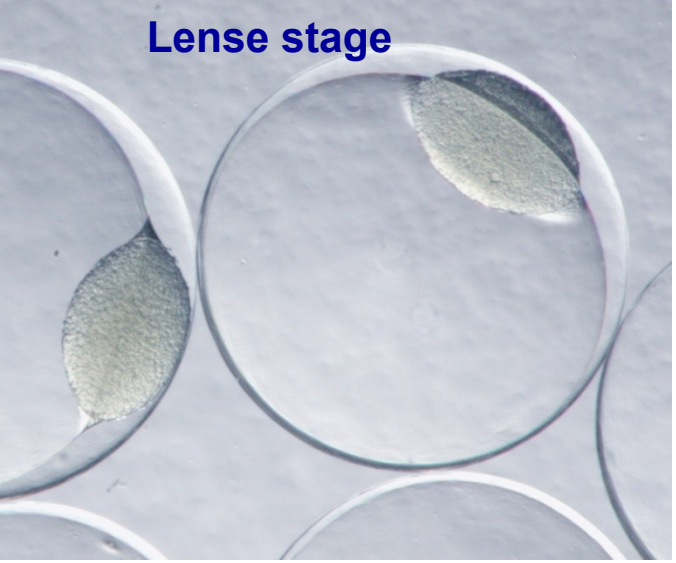


From micro- to meso-cosmic scales:

Trophic level	**Concentration**	**Separation distance**
Larval fish:	~ 1 - 10 m^{-3}	~ 1 m
Copepods:	~ 10^3 – 10^4 m^{-3}	~ 1 dm
Phytoplankton:	~ 10^9 - 10^{10} m^{-3}	~ 1 mm
Virus:	~ 10^{13} m^{-3}	> 0,1 mm

Cod egg

Lense stage

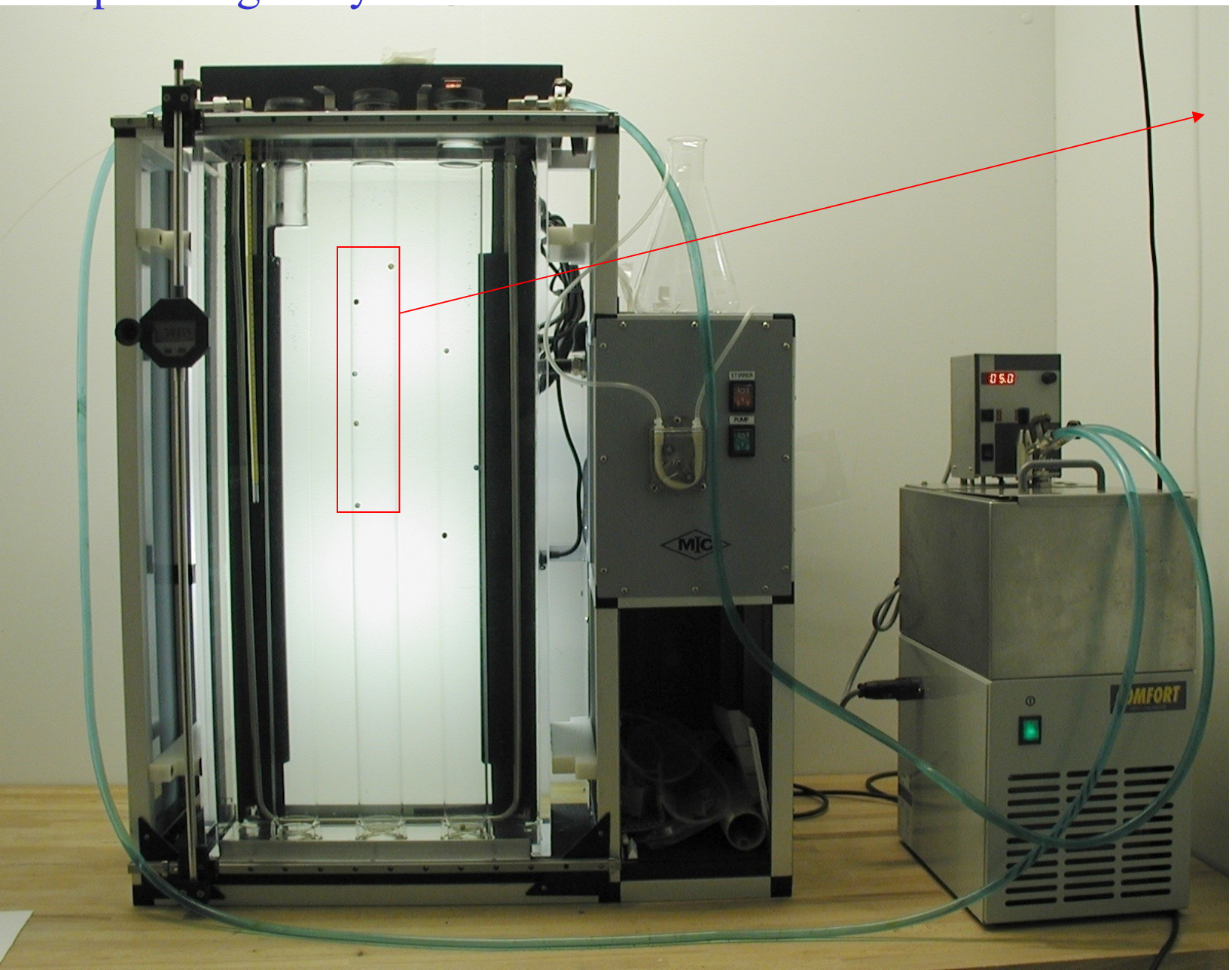


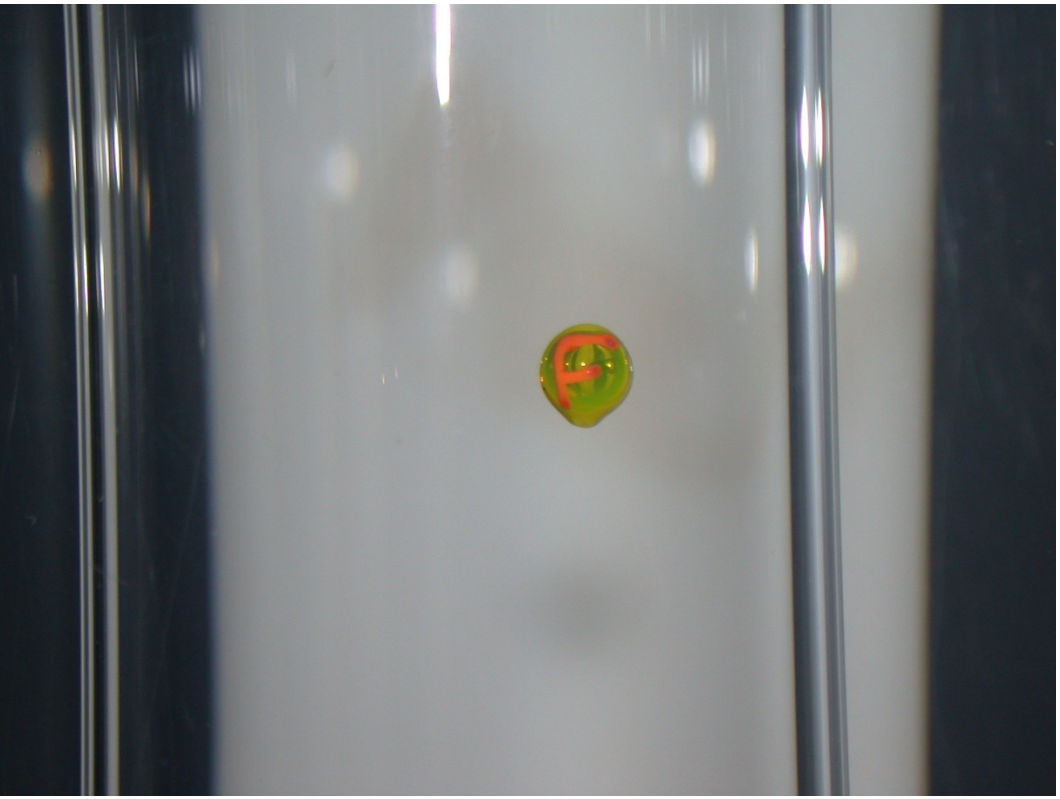
Embryo developing

Prior to hatching

KILO (2013)

Density gradient column for measurements of specific gravity





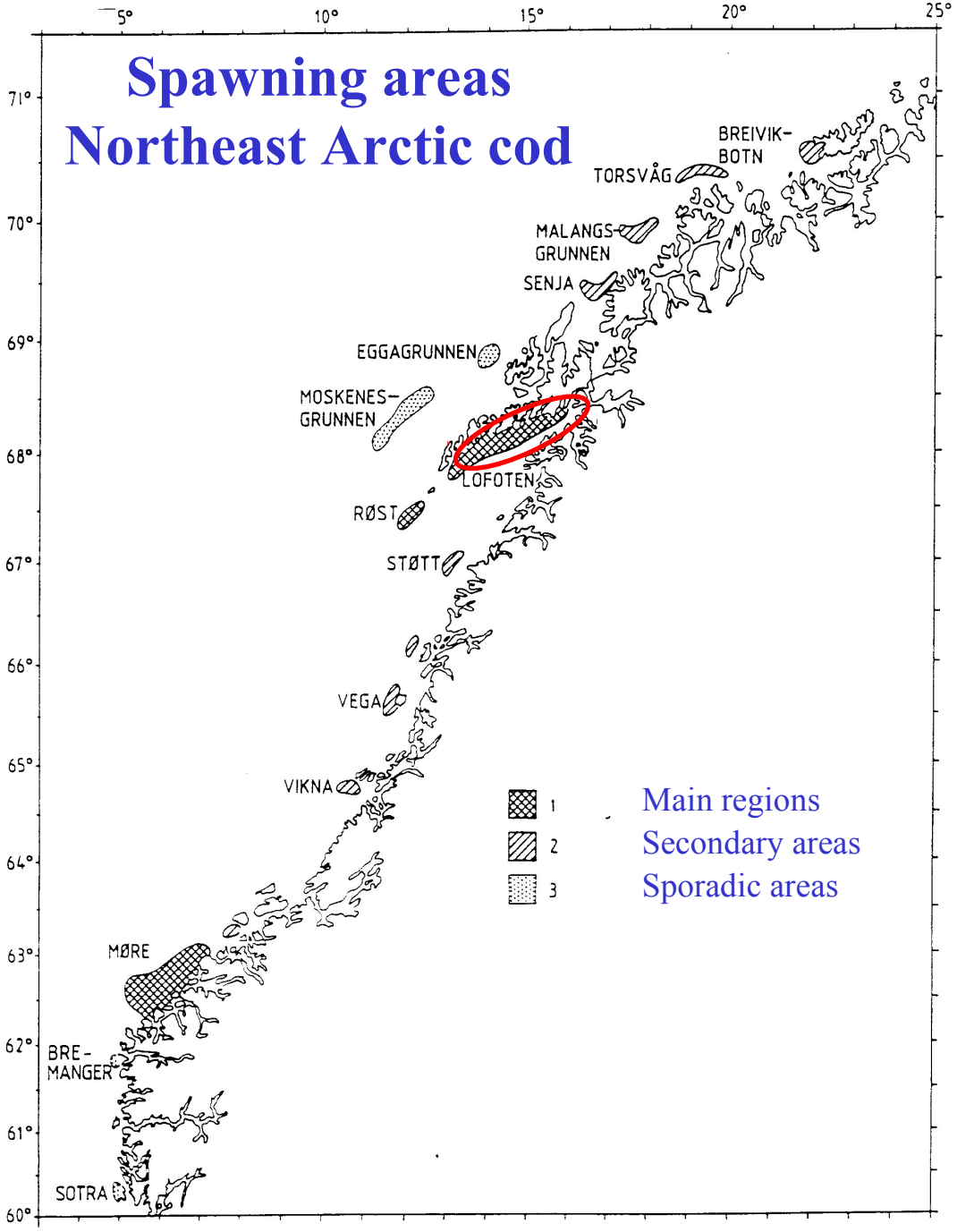
The calibrated glass floats

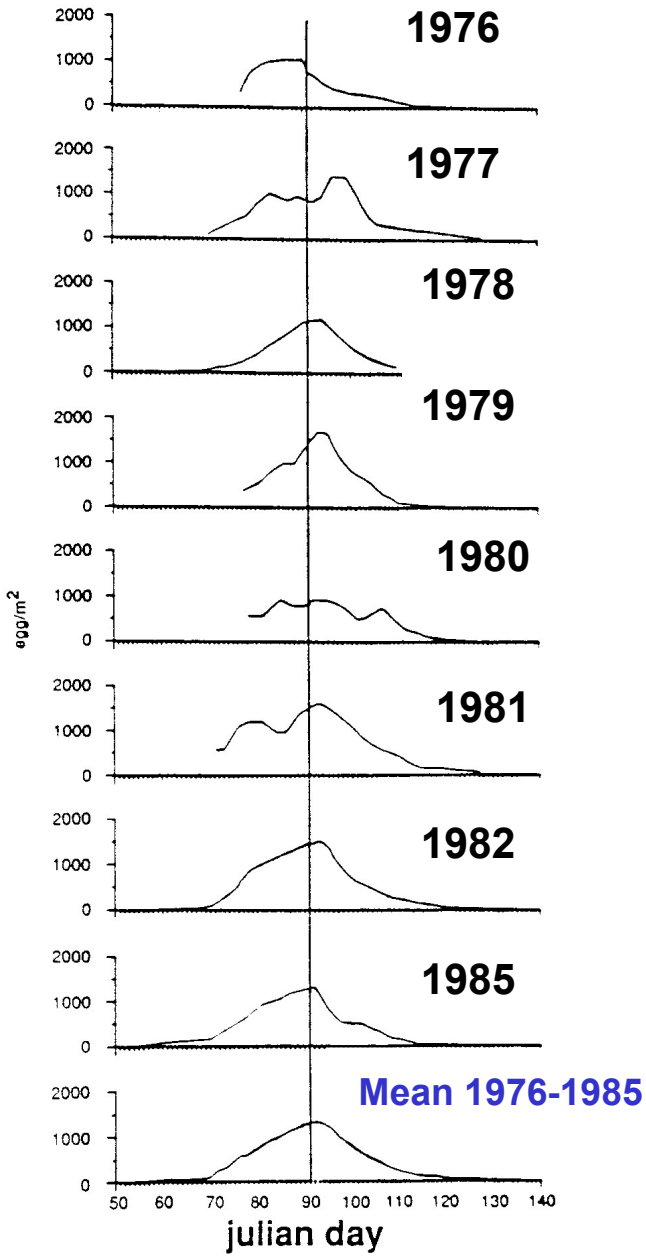
The sertificate of density of the floats refers to 23°C.

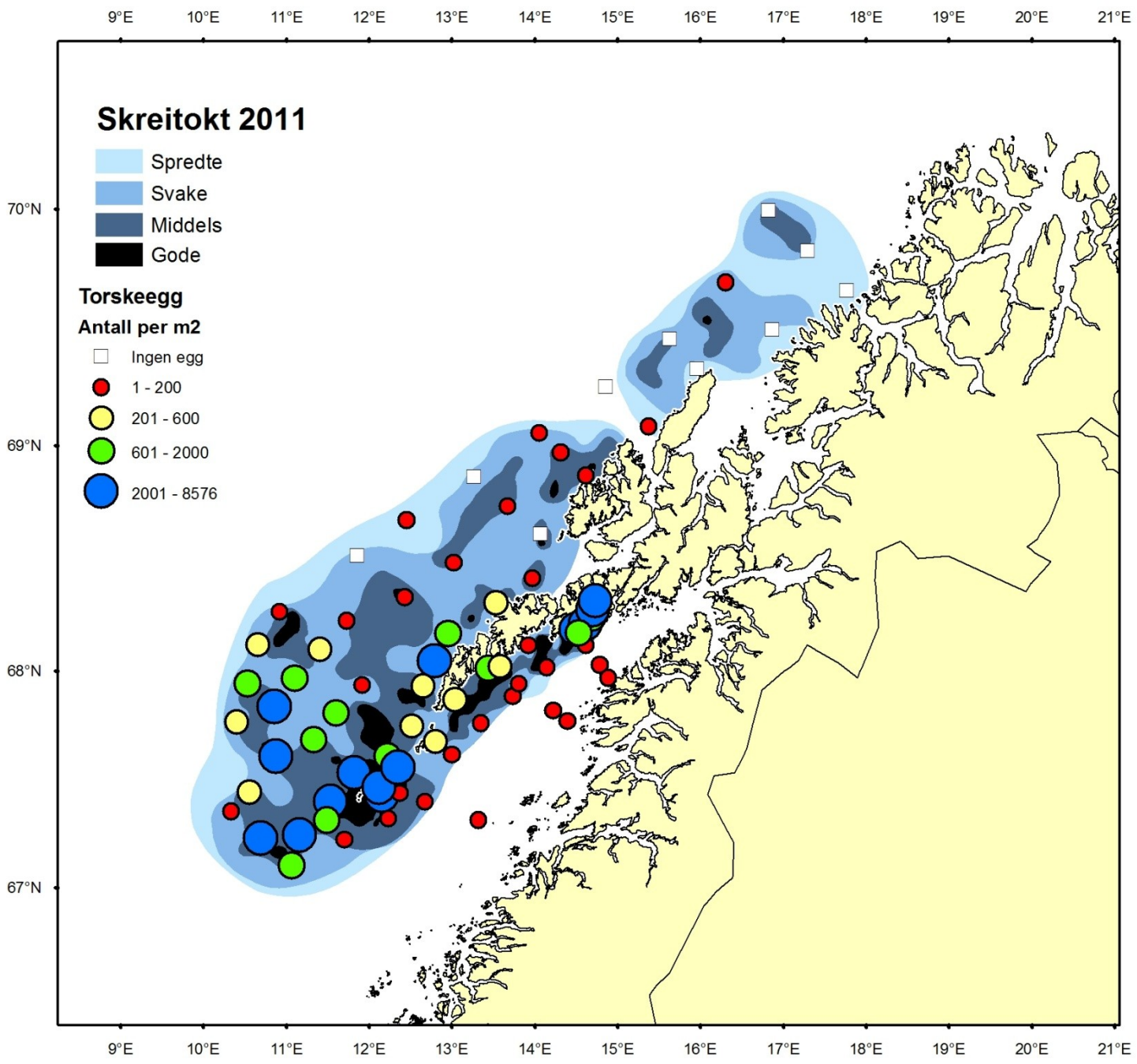
The accuracy of density is +/- 0,0002 g/cm^3.

The density correction per 1 °C is 0,000028 g/cm^3 .

Spawning areas Northeast Arctic cod

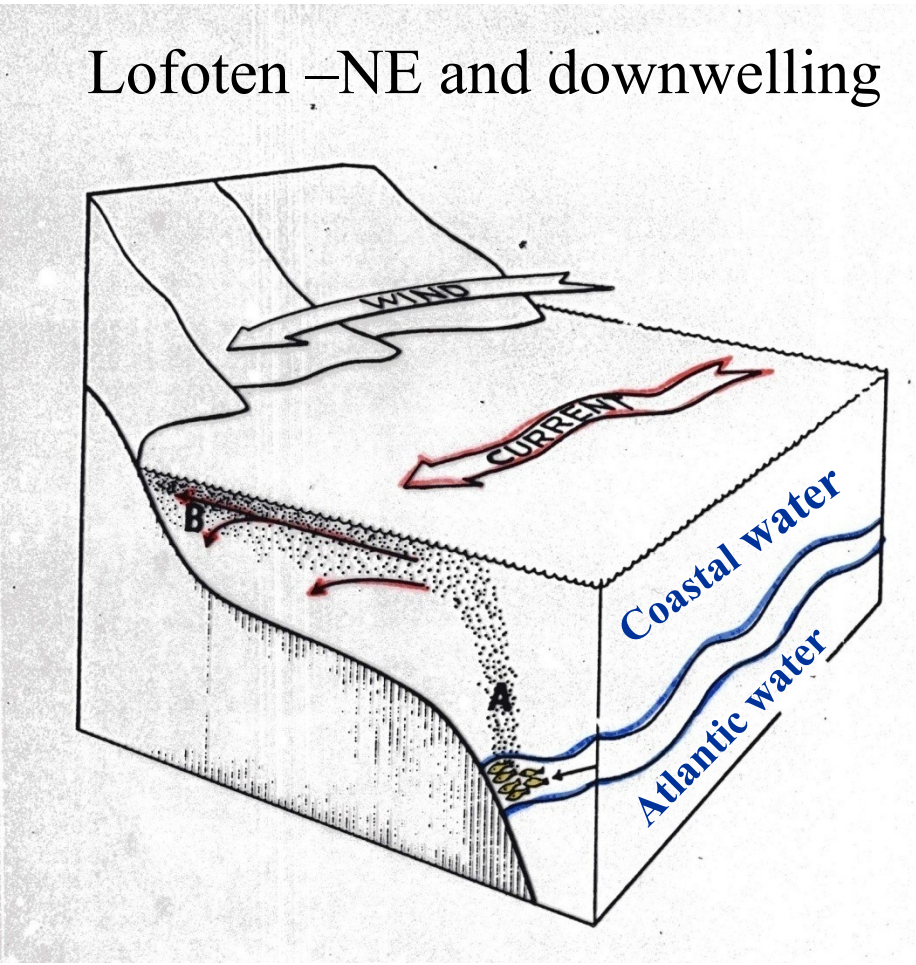





Skreitokt 2011
Spredte
Svake
Middels
Gode
Torskeegg
Antall per m2
Ingen egg
1 - 200
201 - 600
601 - 2000
2001 - 8576
9°E
10°E
11°E
12°E
13°E
14°E
15°E
16°E
17°E
18°E
19°E
20°E
21°E
70°N
69°N
68°N
67°N

Max. egg conc. ~ 10^4 m^{-2} - 10^2 m^{-3}

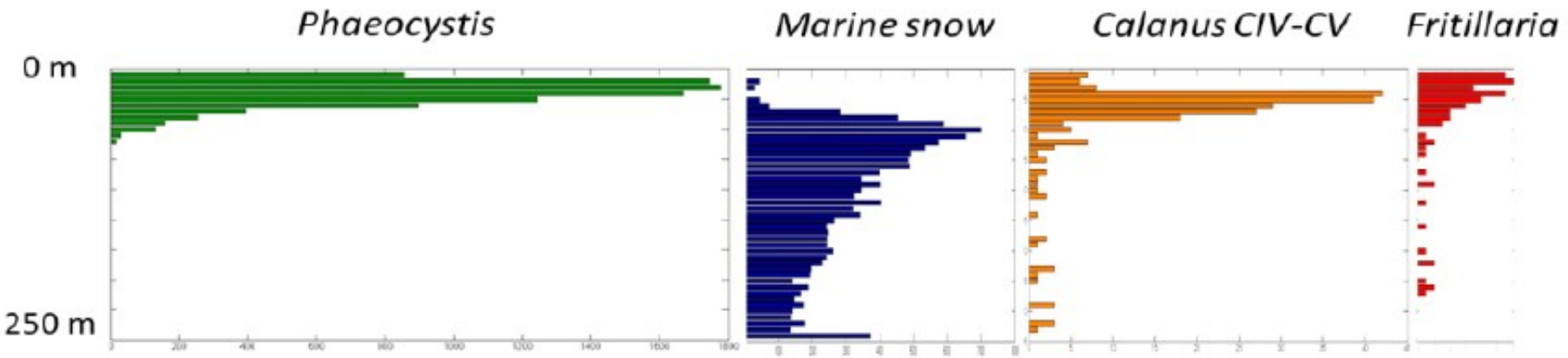
Lofoten –NE and downwelling



HYDROGRAPHY AND PLANKTON SAMPLING

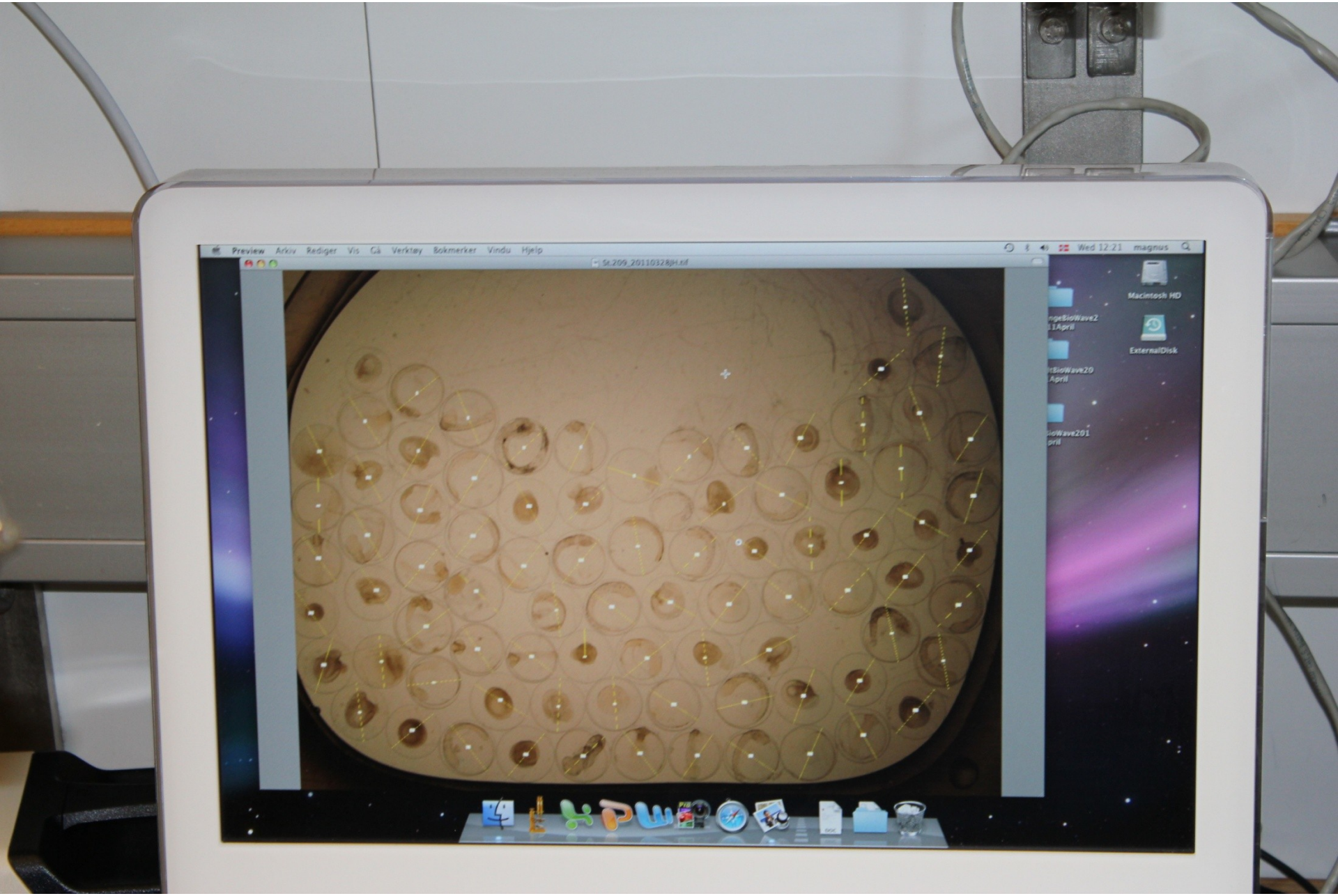
- CTD (SeaBird)
- CTD bottles (Rosette)
- ADCP
- Fluorescense (Chl-a)
- Video plankton recorder
- Messor
- Plankton nets
  - VP2
  - Multinet (Hydrobios)
  - MOCNESS
  - Plankton pumps
- Acoustics

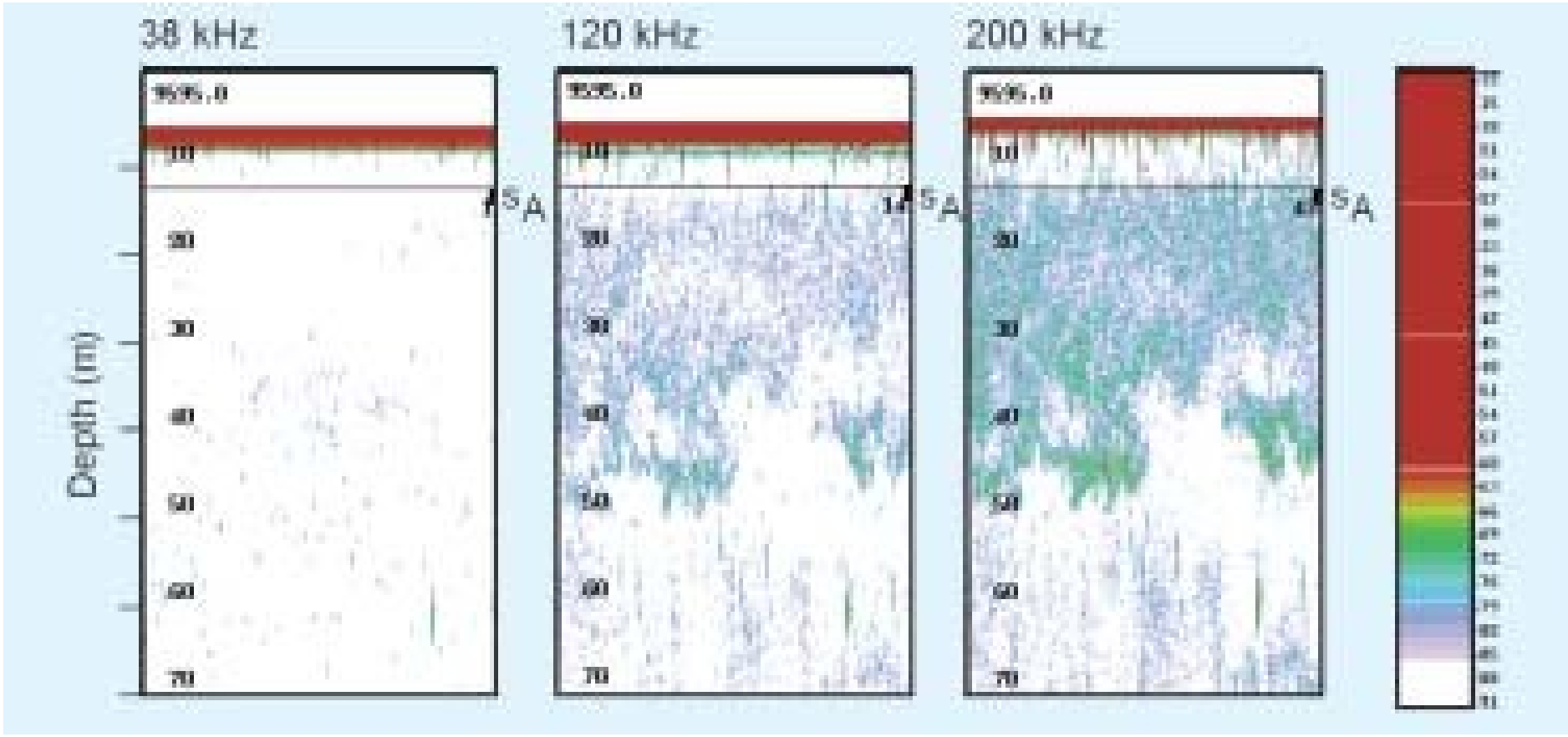
Video plankton recorder Vestfjorden April 2015



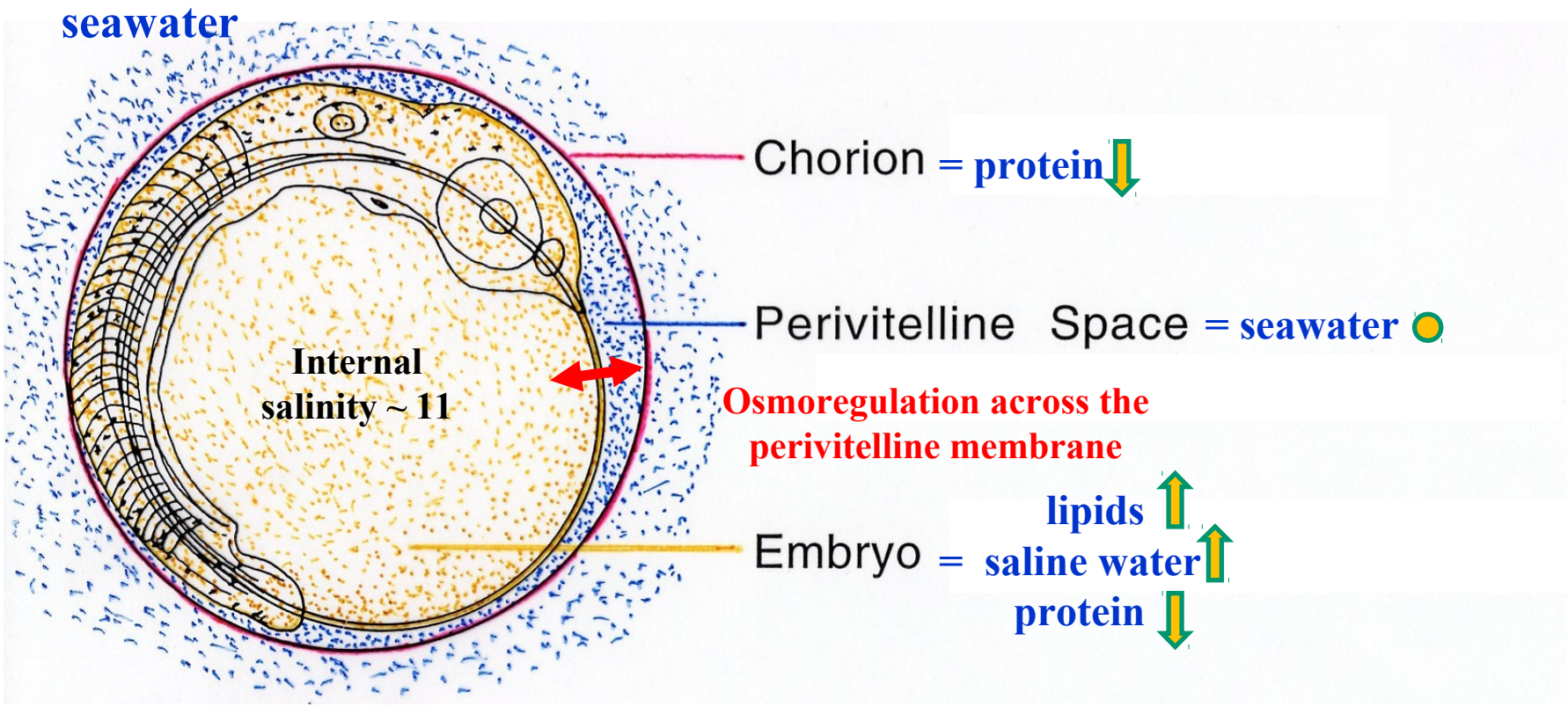
Falk-Petersen et al. (2015)

Hydrobios Multinet (0.25 m², 5 nets opening/closing)


Preview Arkiv Rediger Vis Gå Verktøy Bokmerker Vindu Hjelp
Wed 12:21 magnus
St.209_20110328JH.tif
Macintosh HD
ExternalDisk

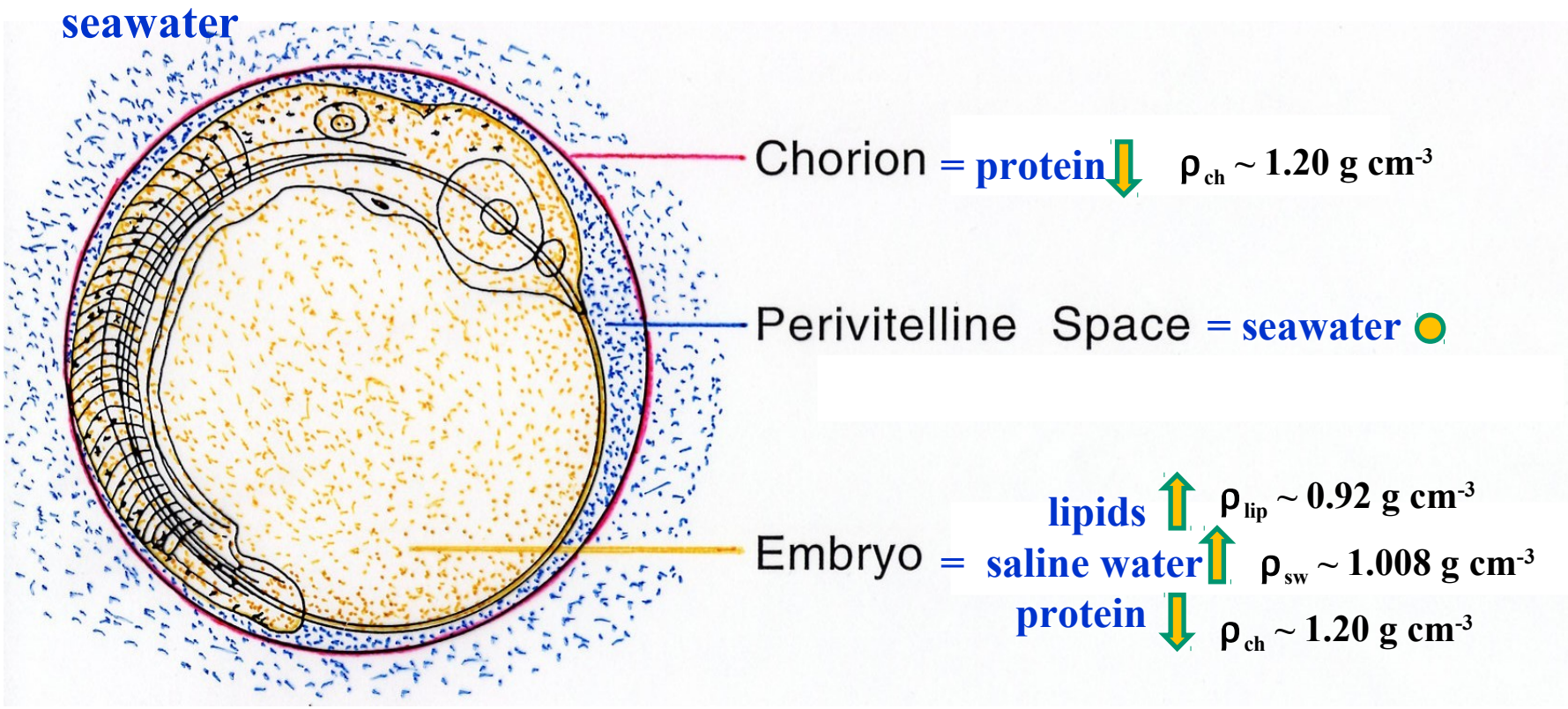

38 kHz
120 kHz
200 kHz
Depth (m)
SA
SA
SA

Structure in fish eggs



Sundby and Kristiansen (submitted)

Structure in fish eggs

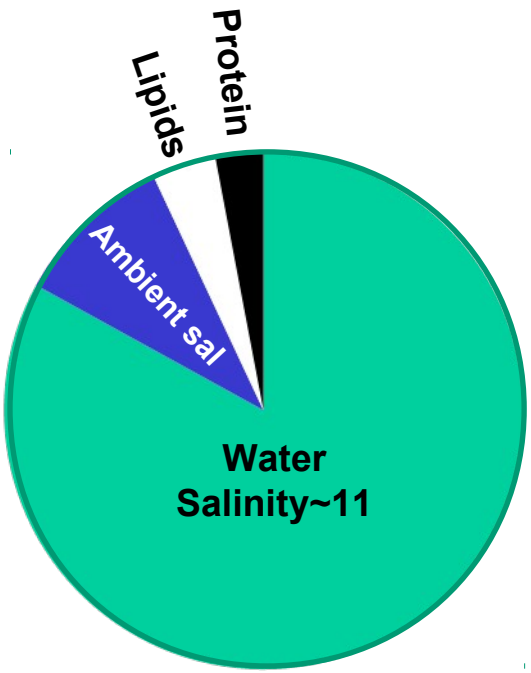


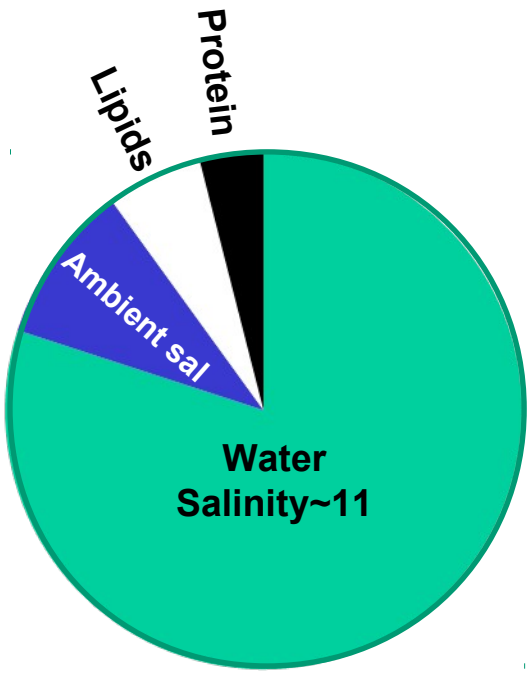
Specific gravity in the fish egg, ρ_e, is determined by the specific gravities, ρ_x, and fractional volumes, V_x/V_e, of chorion, perivitelline space, and embryo +yolk:

$$\rho_e = [(\rho_{ch} \cdot V_{ch} + \rho_{per} \cdot V_{per} + (\rho_{lip} \cdot V_{lip} + \rho_{sw} \cdot V_{per} + \rho_{pro} \cdot V_{pro})] / V_e$$

Sundby and Kristiansen (submitted)

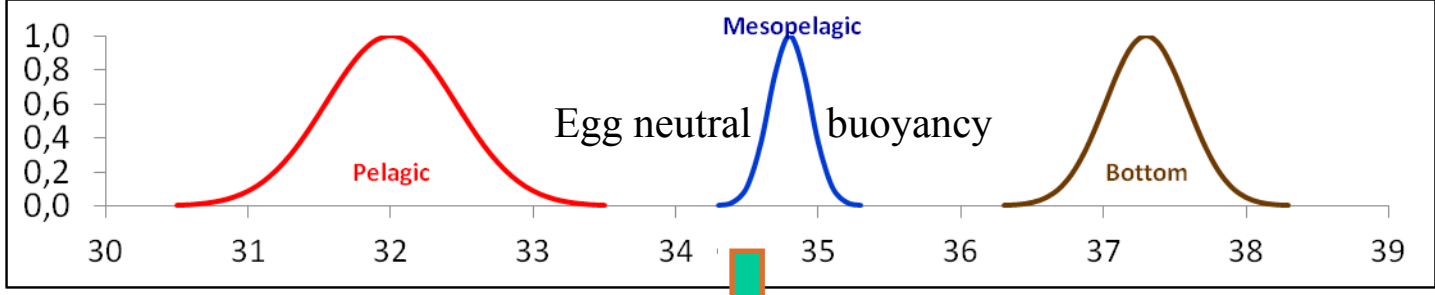
T = 5 °C → Thermal expansion → T = 15 °C

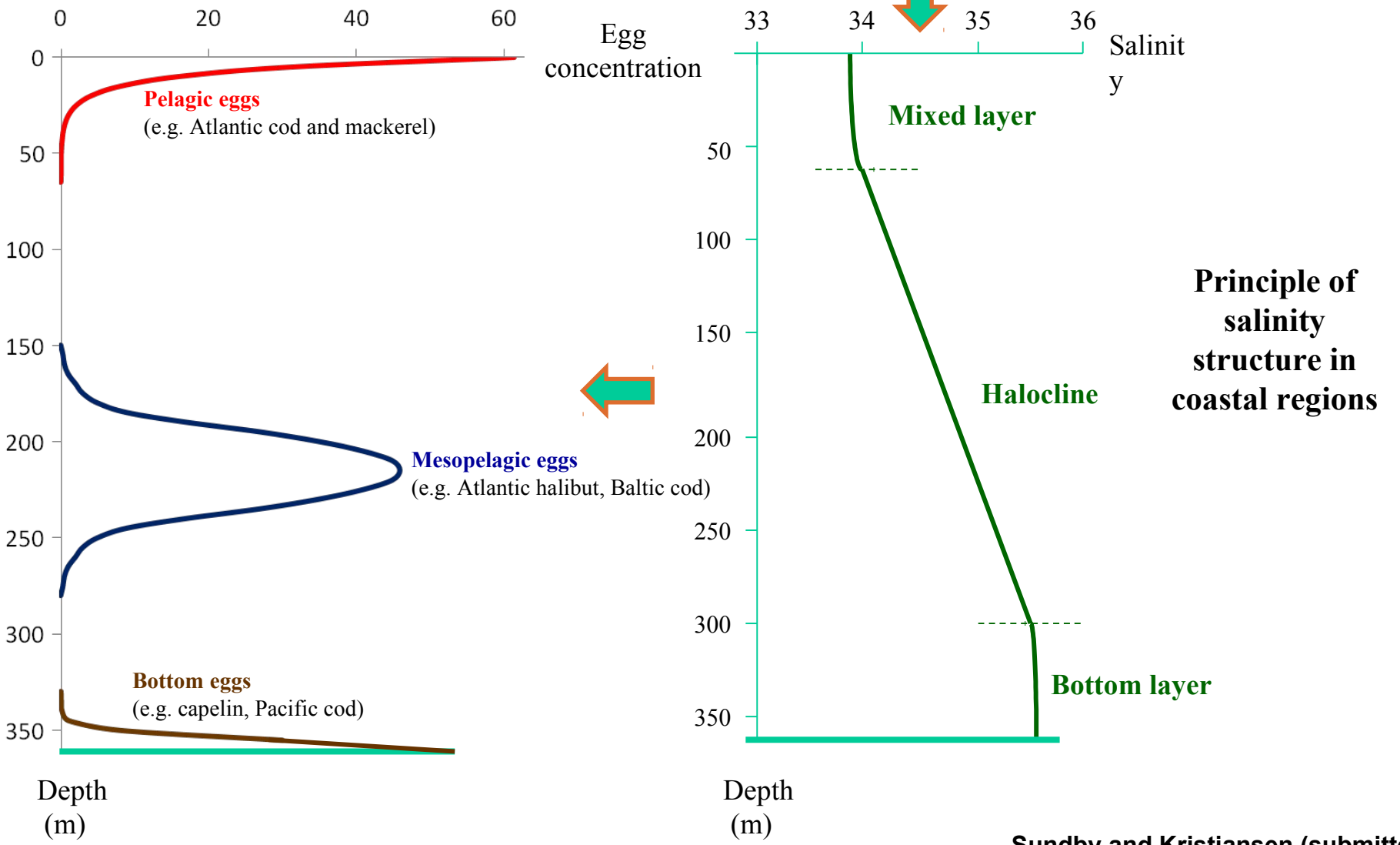




Ambient salinity
~ 30- 35

Summary of Sundby (1983;1991)



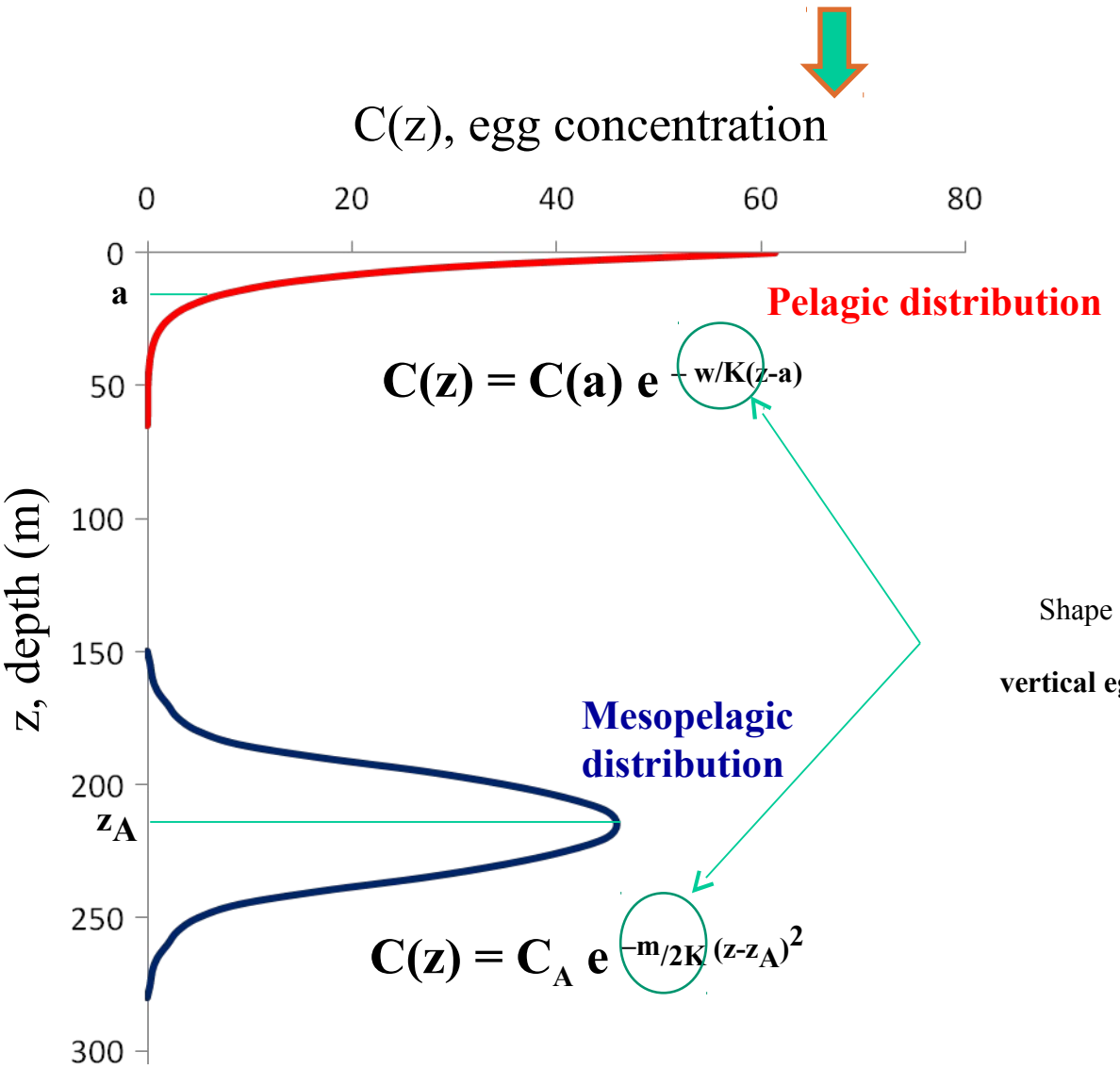


Principle of salinity structure in coastal regions

Sundby and Kristiansen (submitted)

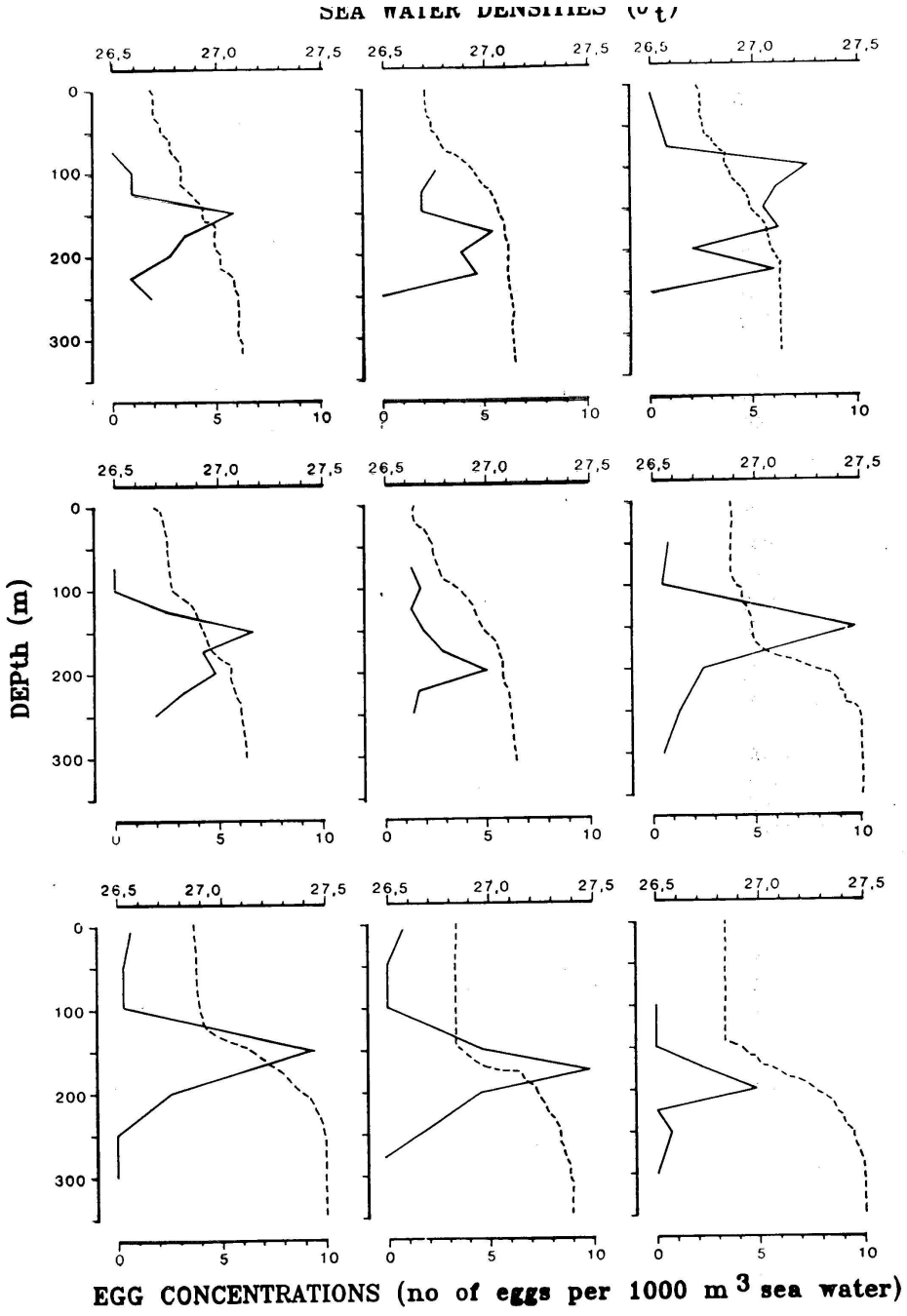
Basic principle - balance between **vertical diffusivity** and **egg buoyancy**:

$$K(z) \cdot \partial C(z)/\partial z = - w(z) \cdot C(z)$$



Shape of the vertical profile determined by the ratio between **vertical egg velocity, w**, and **eddy diffusivity, K**.

Sundby (1991)



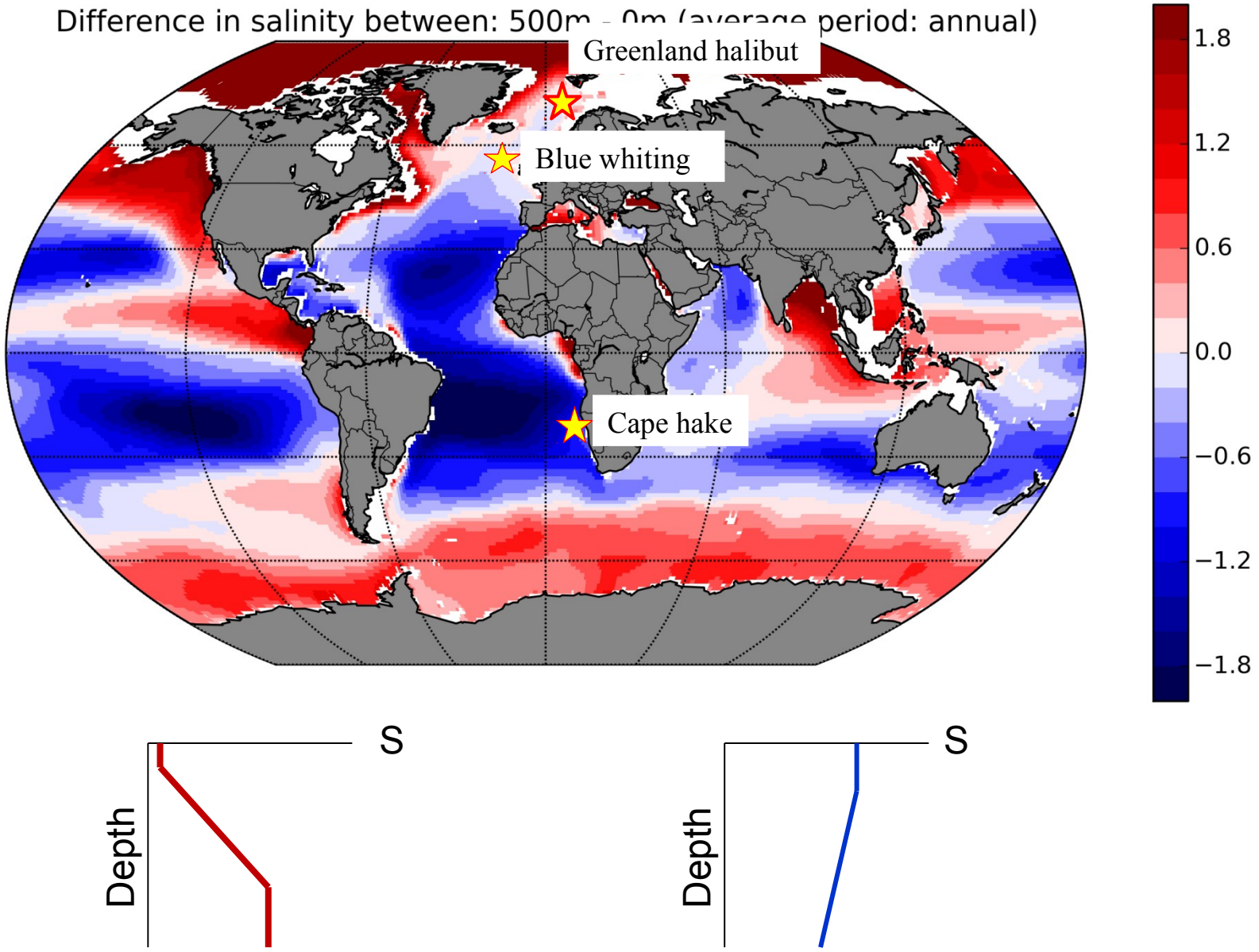
Kveiteegg i Ballangen:

$N^2 = 0.5 \times 10^{-4} – 2.0 \times 10^{-4}$ (s^{-2})

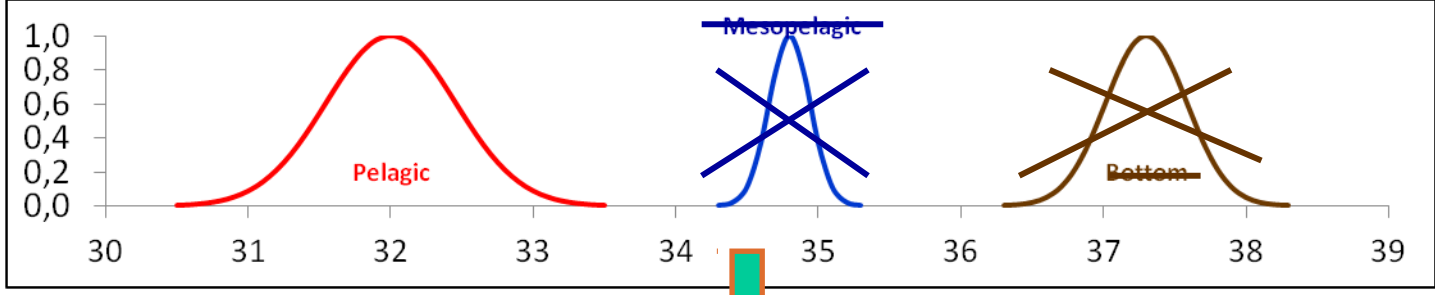
$K_z = 0.1 – 0.5$ $(cm^2\ s^{-1})$

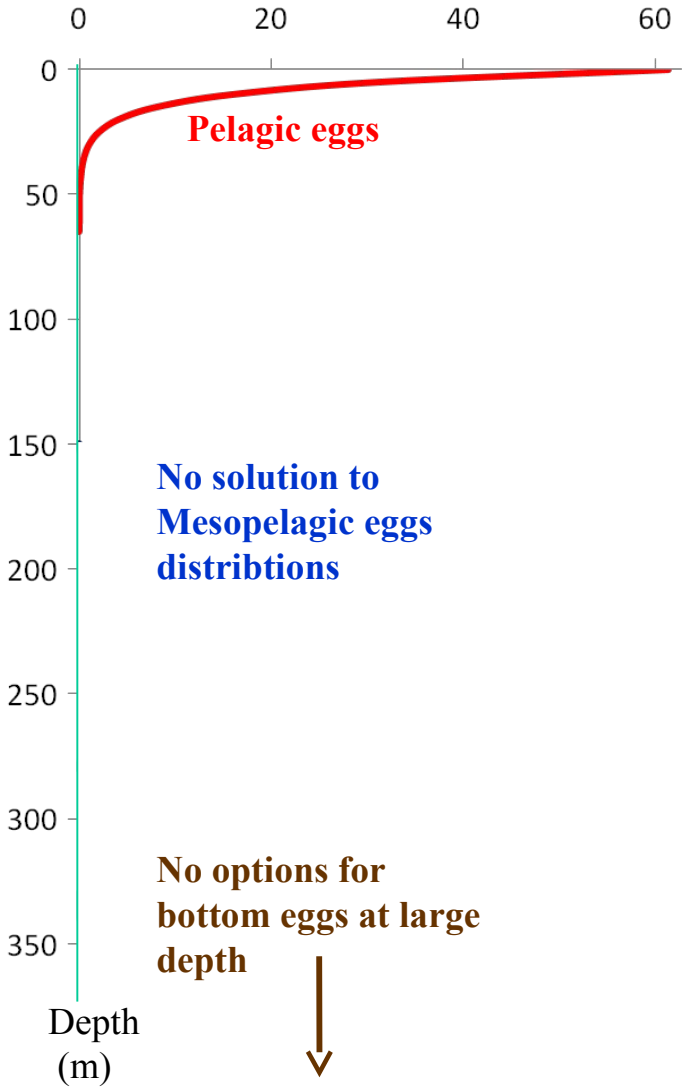
$\Rightarrow$

$\sigma = 0.4 – 1.6$ (m)



Sundby and Kristiansen (submitted)

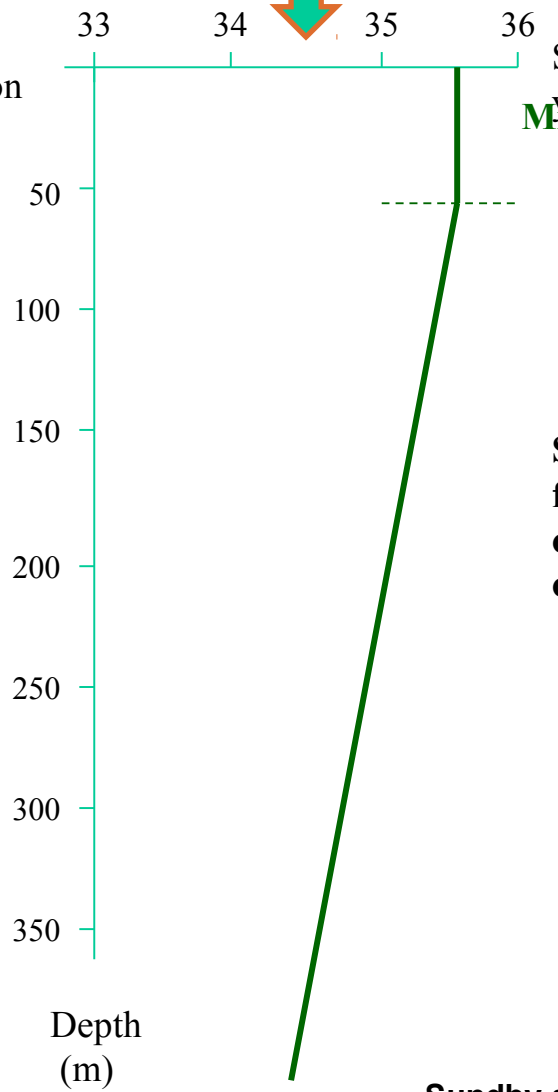




Egg concentration

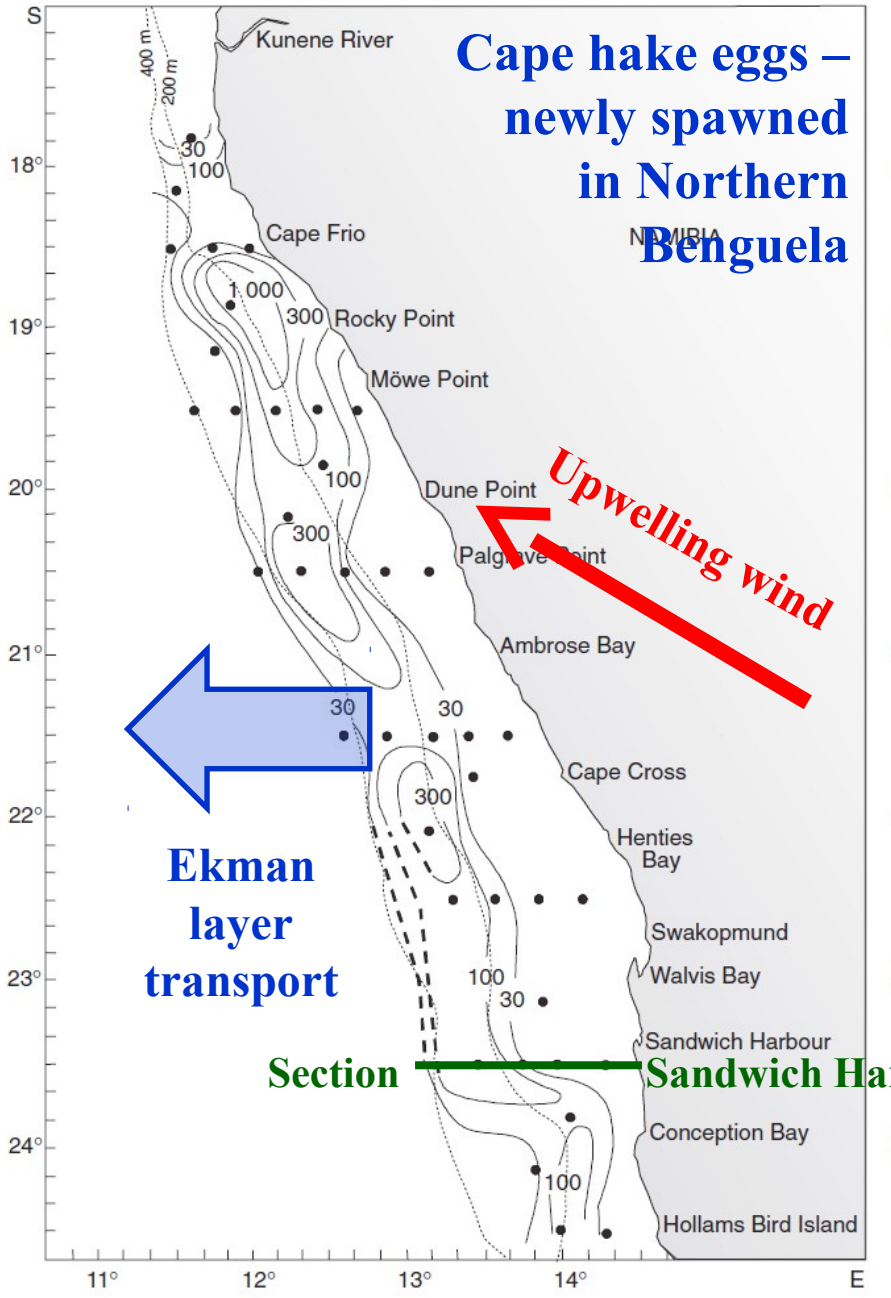
No solution to Mesopelagic eggs distribtions

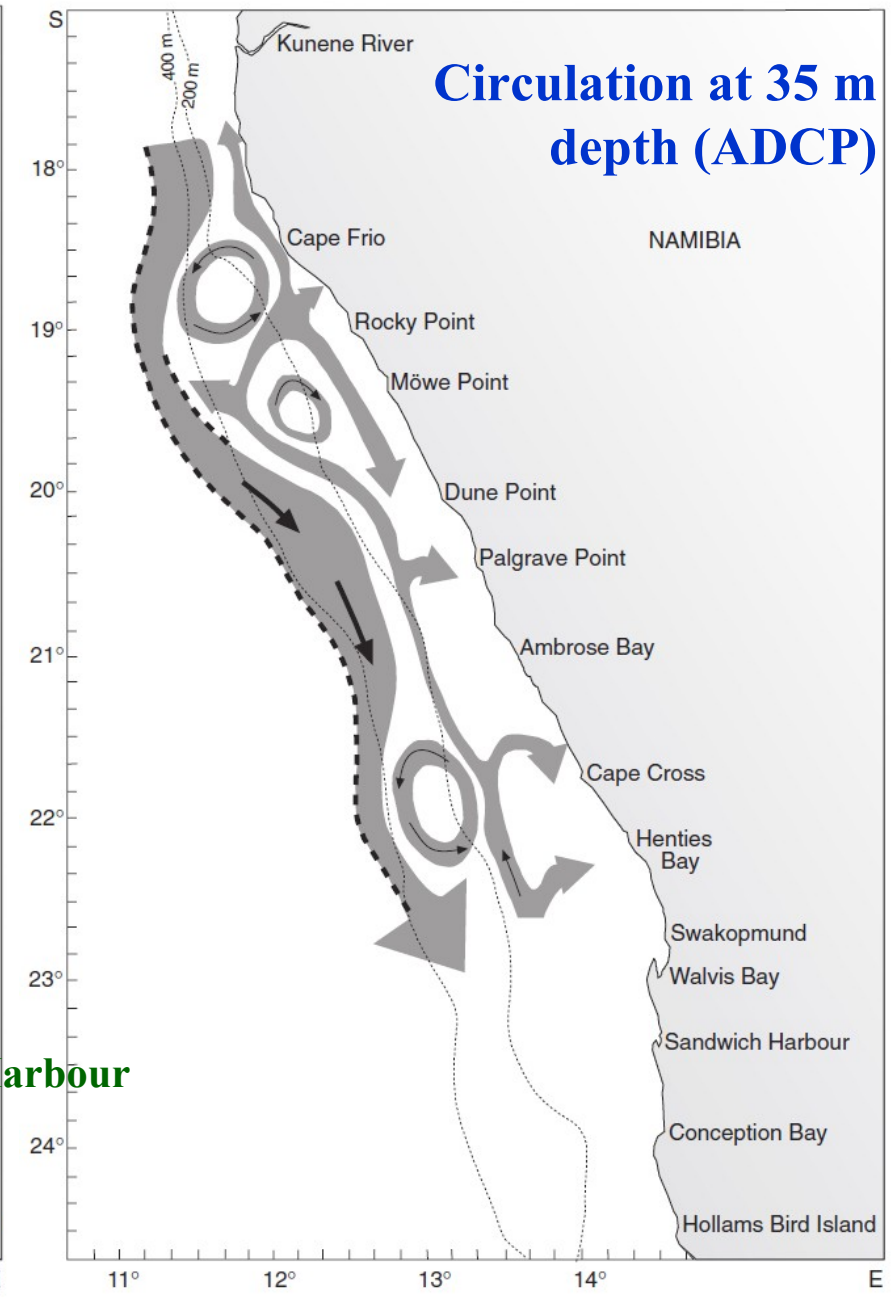
No options for bottom eggs at large depth



Salinity profile for the major part of the world's oceans

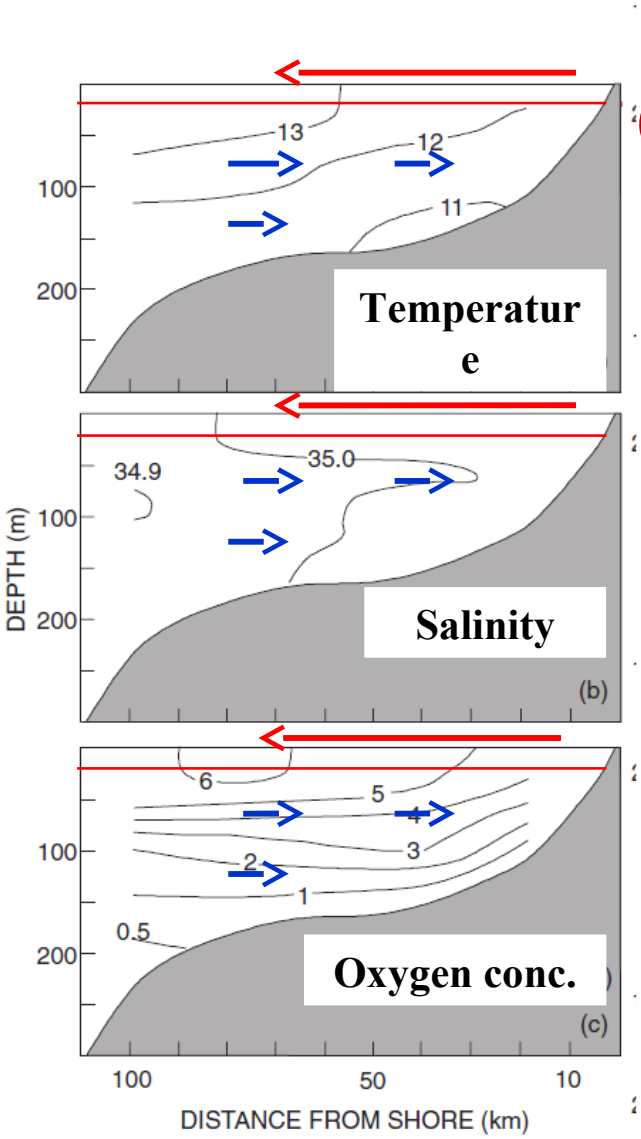
Sundby and Kristiansen (submitted)





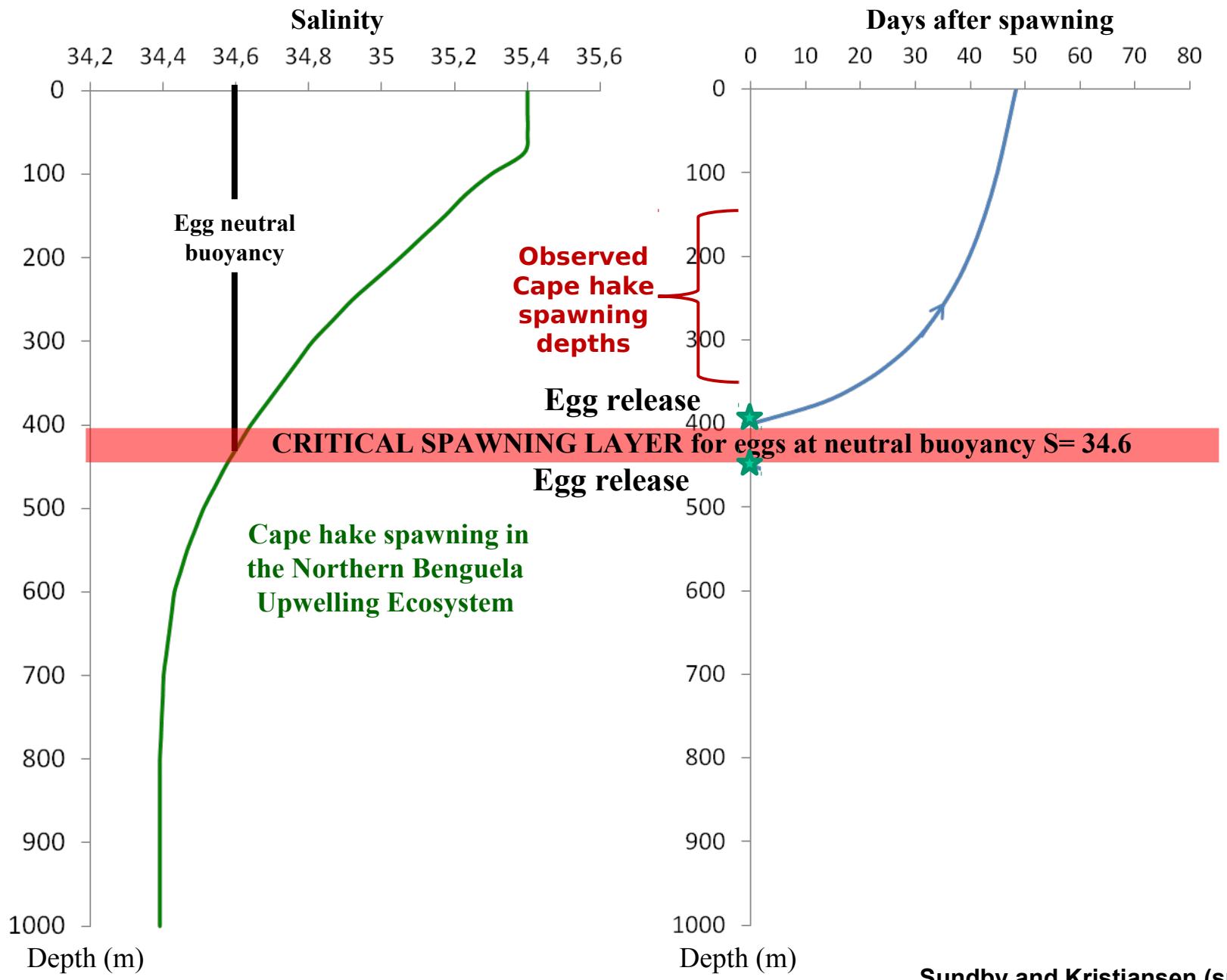
Sundby *et al*. (2001)

Sandwich Harbour Section



DISTANCE FROM SHORE (km)

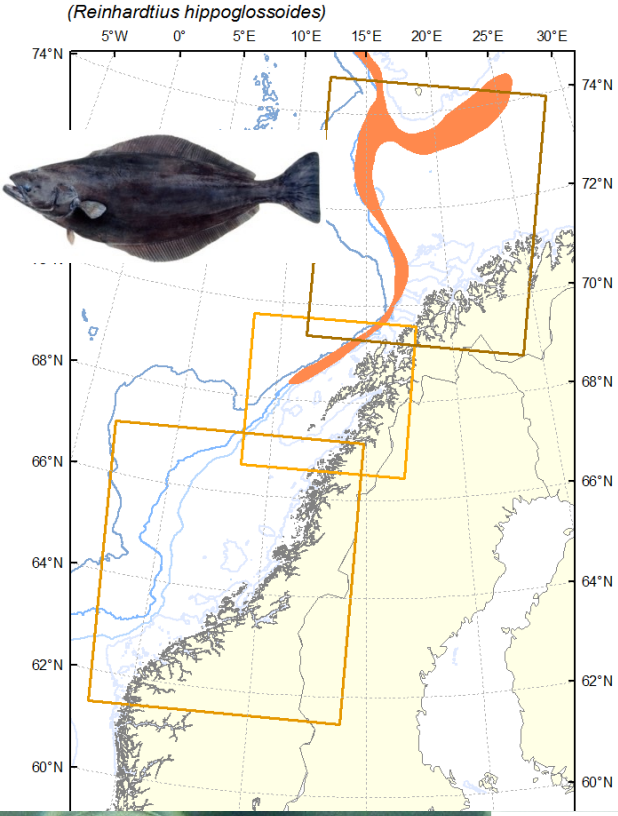
Sundby *et al.* (2001)



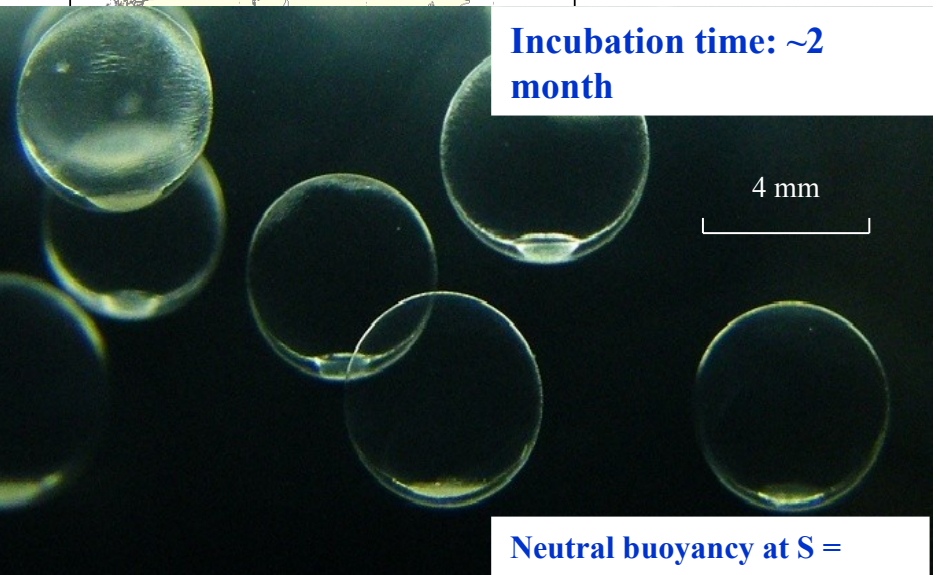
Sundby and Kristiansen (submitted)

Spawning area for Norwegian/Barents seas Greenland halibut

(Reinhardtius hippoglossoides)

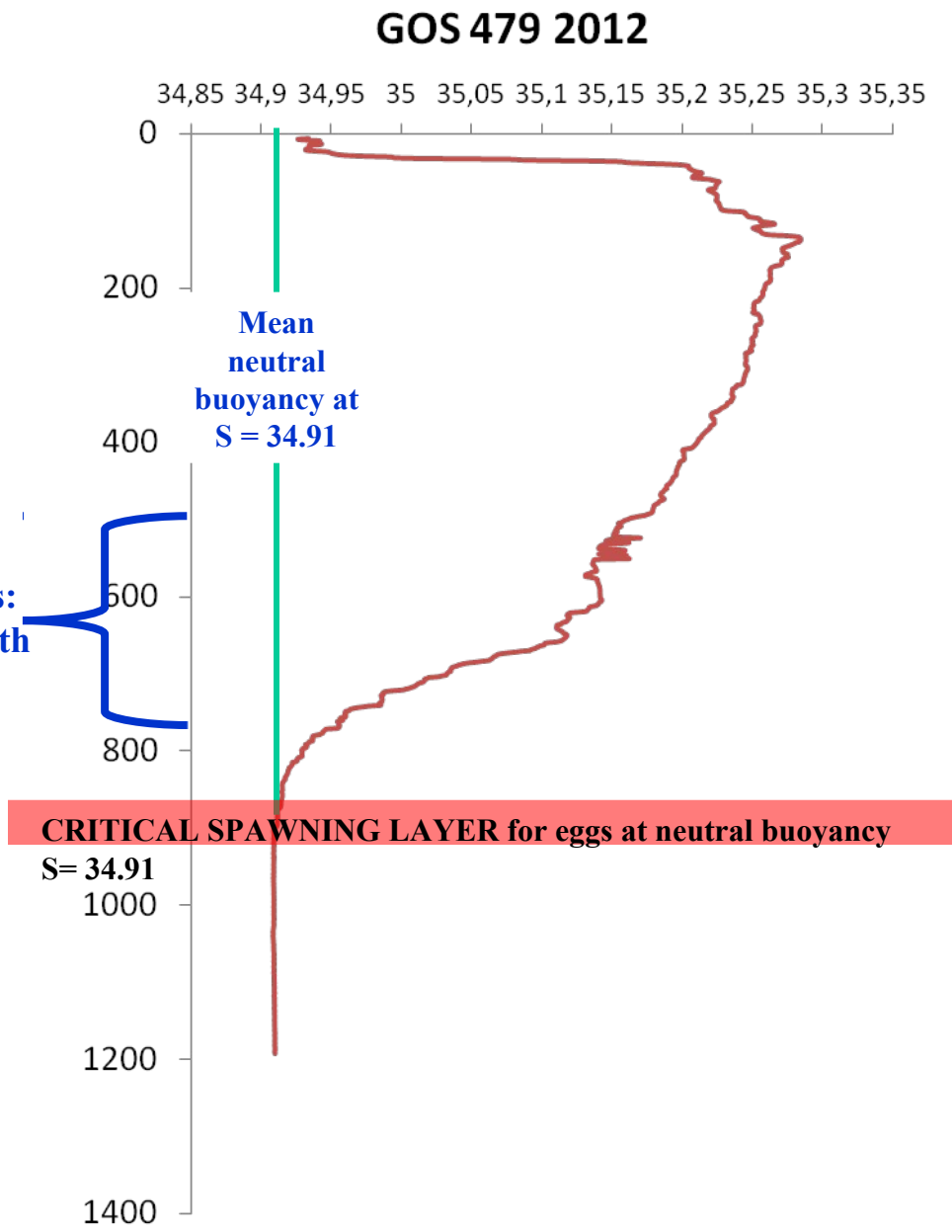


Spawning depths:
~ 500 -800 m depth

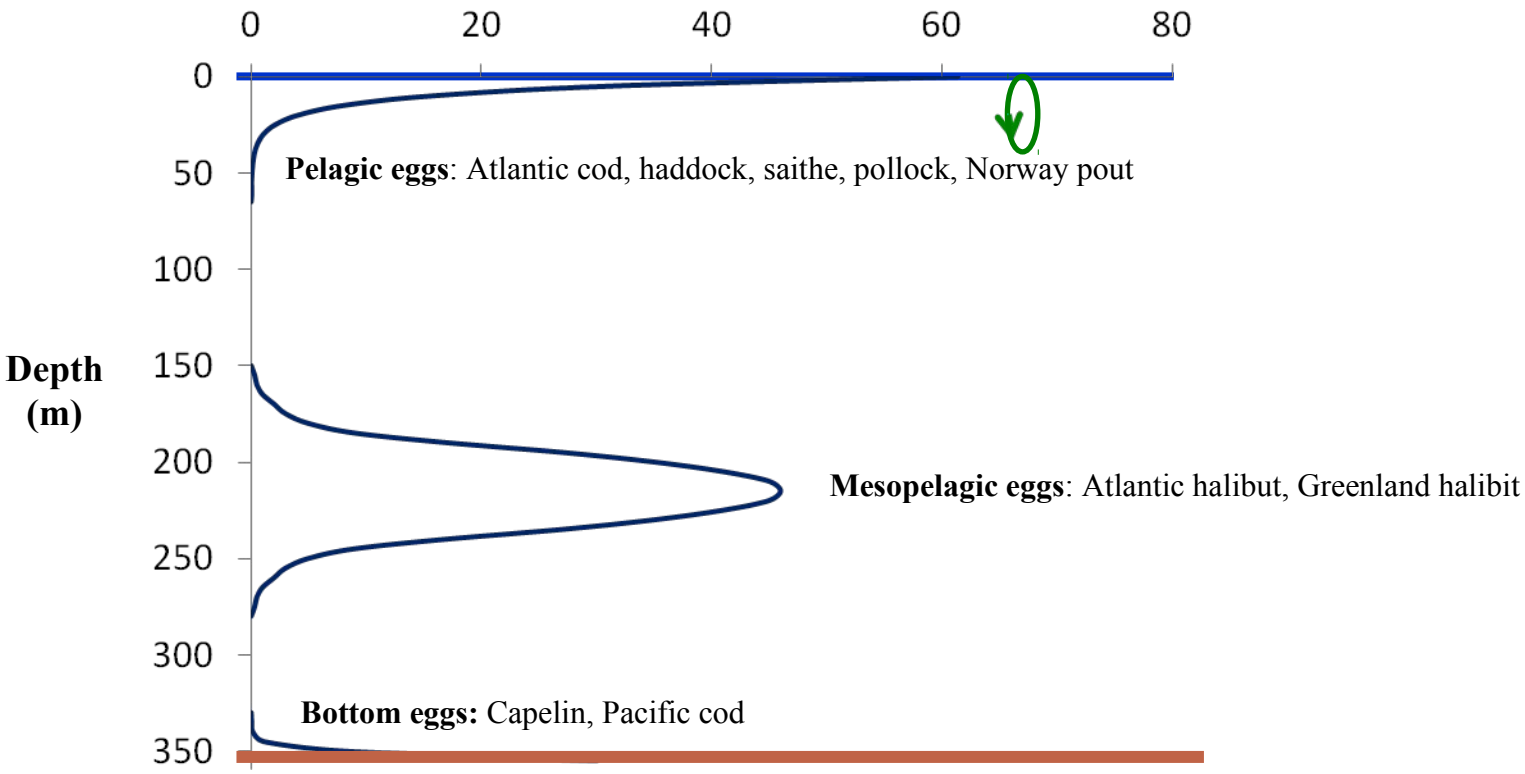


Incubation time: ~2 month

Neutral buoyancy at S =

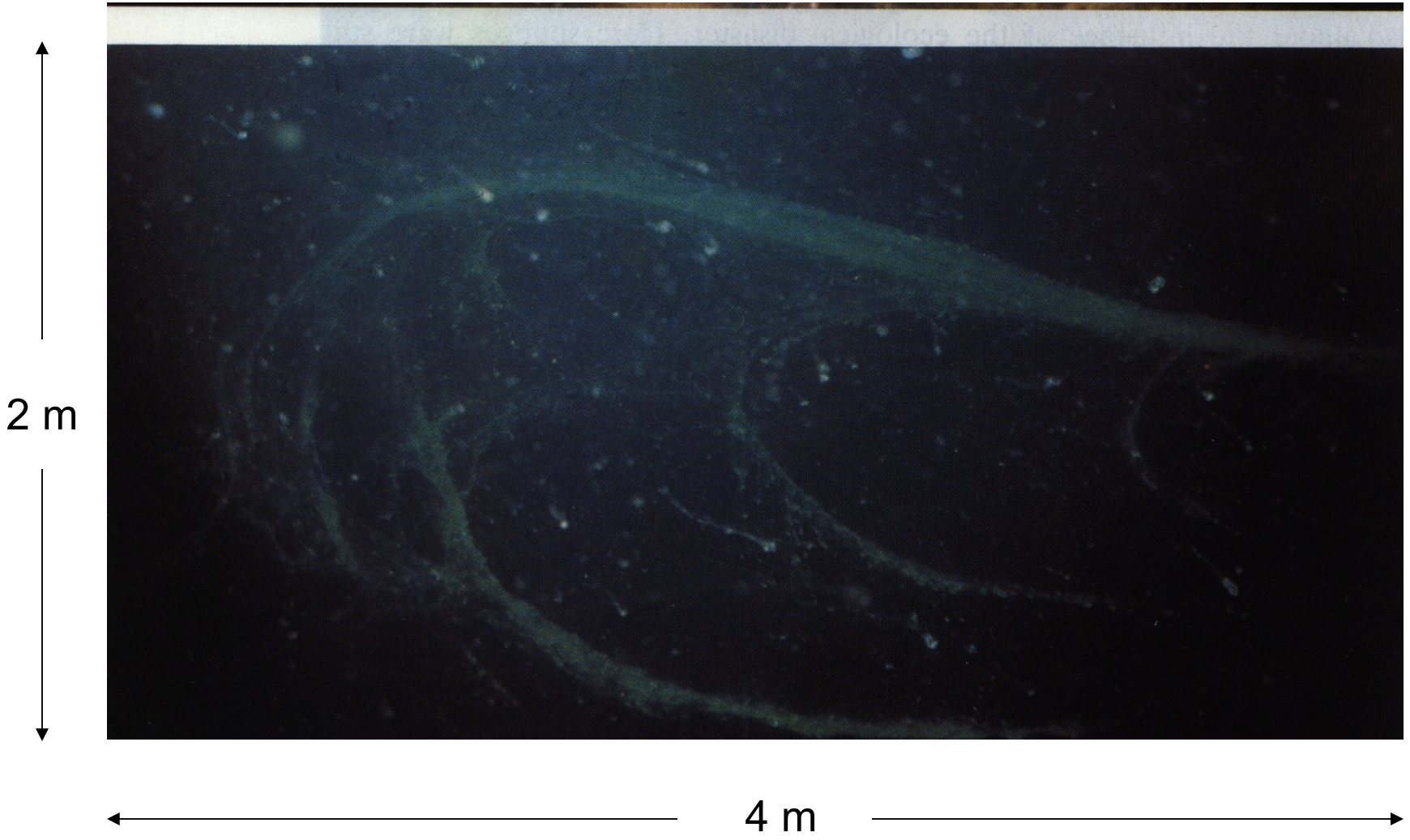


The 3 major types of vertical distributions

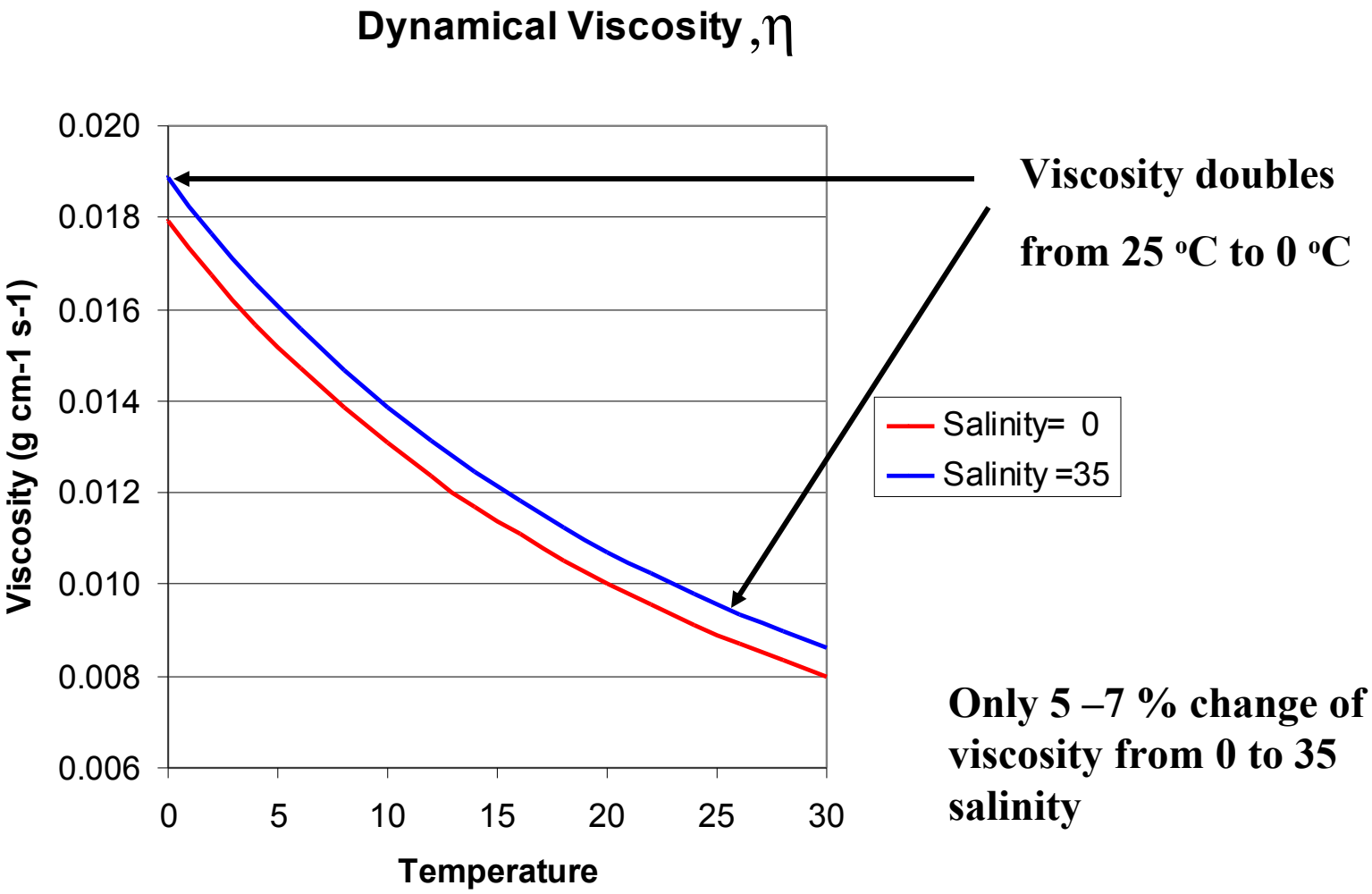


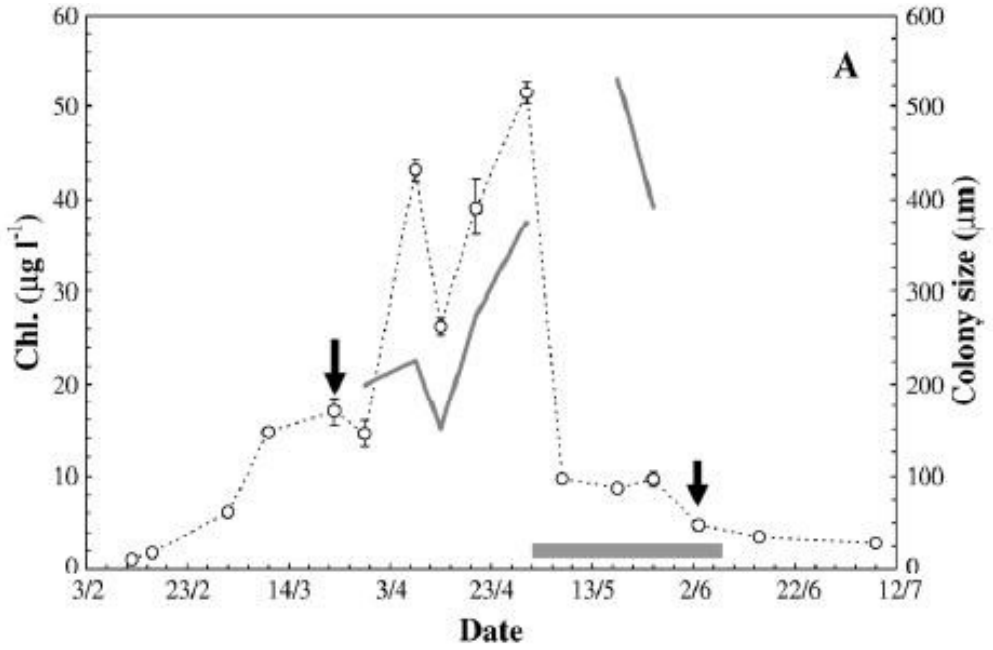
KILO (2013)

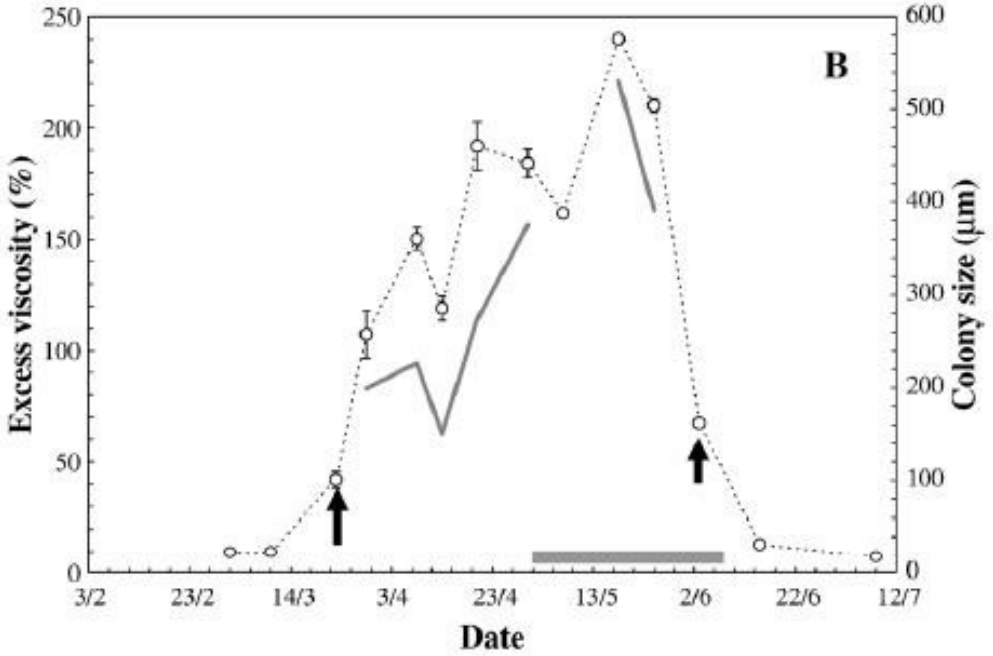
Illustration 4: Mucus event in Adriatic, 1983. Giant mucus streamer in 5 m depth. Field of view approx. 8 m2 (Stachowitsch, 1990)



Viscosity as a function of temperature and salinity



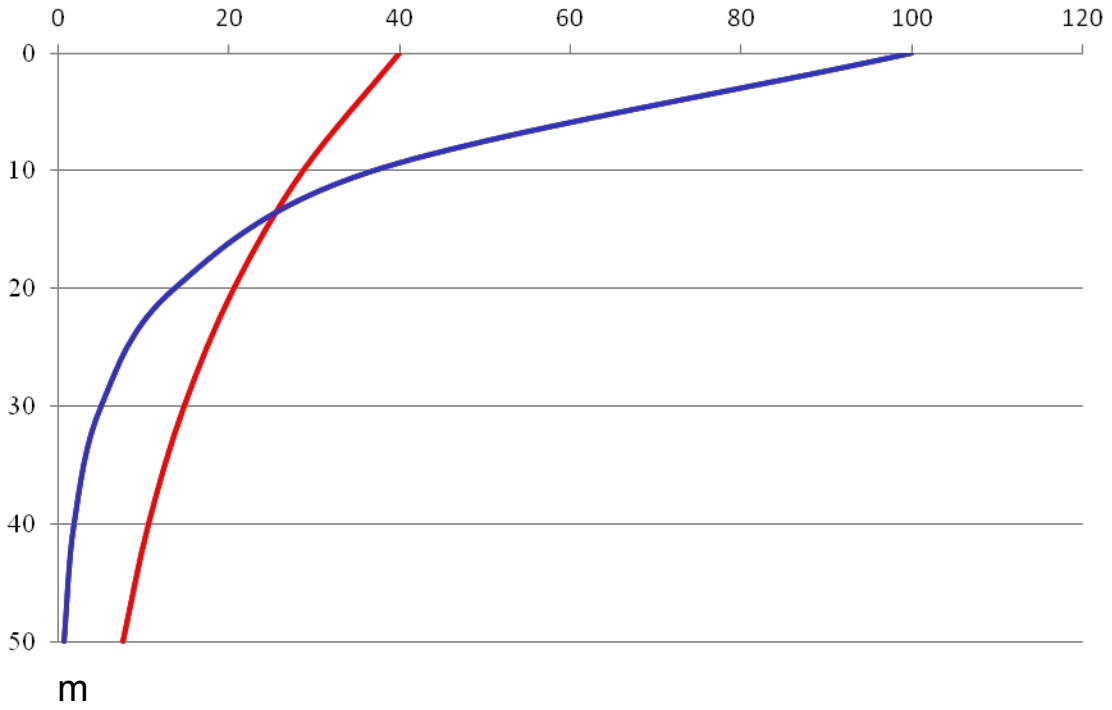




Seuront *et al.* (2006)

How will a 200 % excess viscosity influence the vertical distribution of pelagic fish eggs?

Case study:
Mackerel eggs in the North Sea
Wind speed 5 m s^{-1}

$$C(z) = C(a)\, e^{-(w/K)(z-a)} = 100\, e^{-(0.0013/0.0132)z}$$

$$C(z) = 40\, e^{-(0.00043/0.0132)z}$$