Variations in overwintering depth distributions of *Calanus finmarchicus* in the slope waters of the NW Atlantic continental shelf and the Labrador Sea

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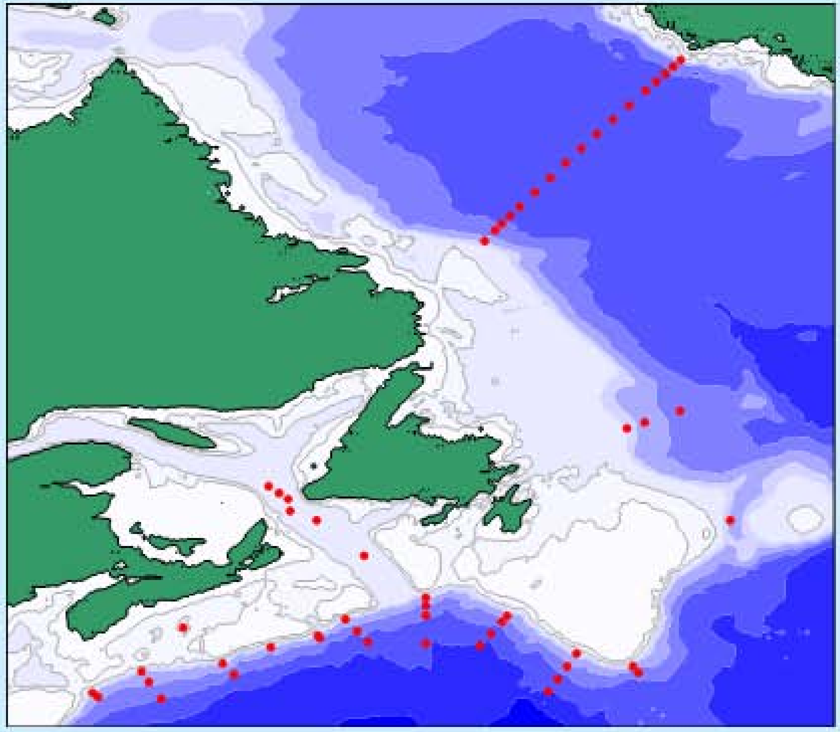
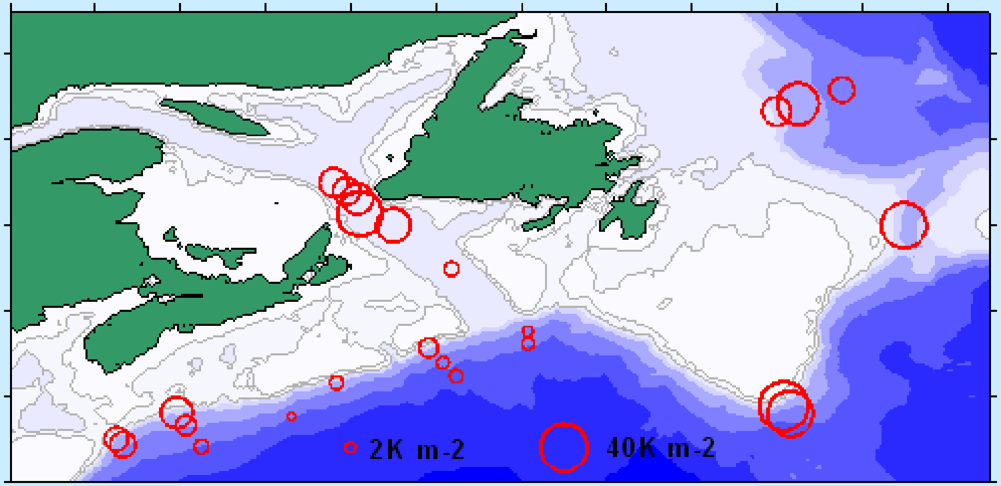


Multi-net sampling stations sampled during
fall and winter 2001, 2002 and 2003

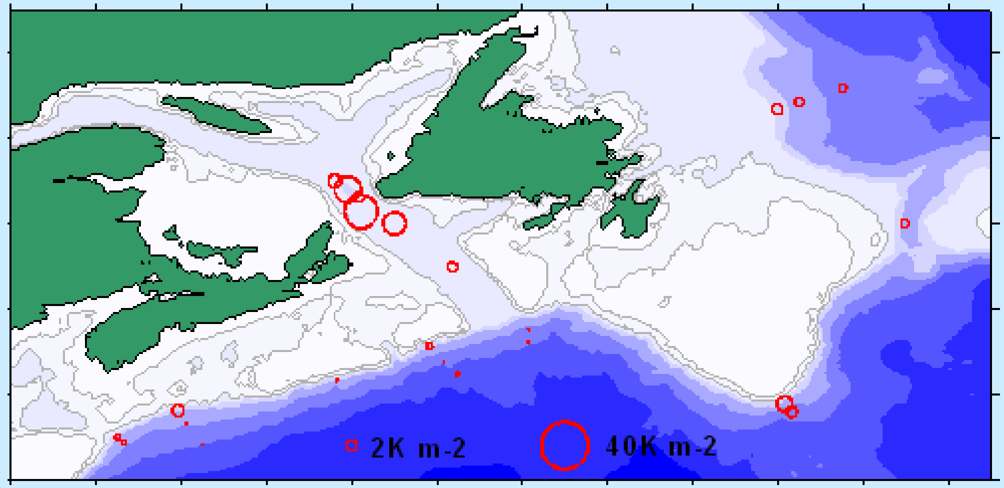
Areal abundance of late stage *C. finmarchicus* in fall in Multinet tows

- At depth – most abundant in the Cabot Strait region and in the east
- Surface layer – most abundant in the Cabot Strait region

Fall, deep, late stage (CIV-CVI) *C. finmarchicus* abundance (>100 m or >200 m)

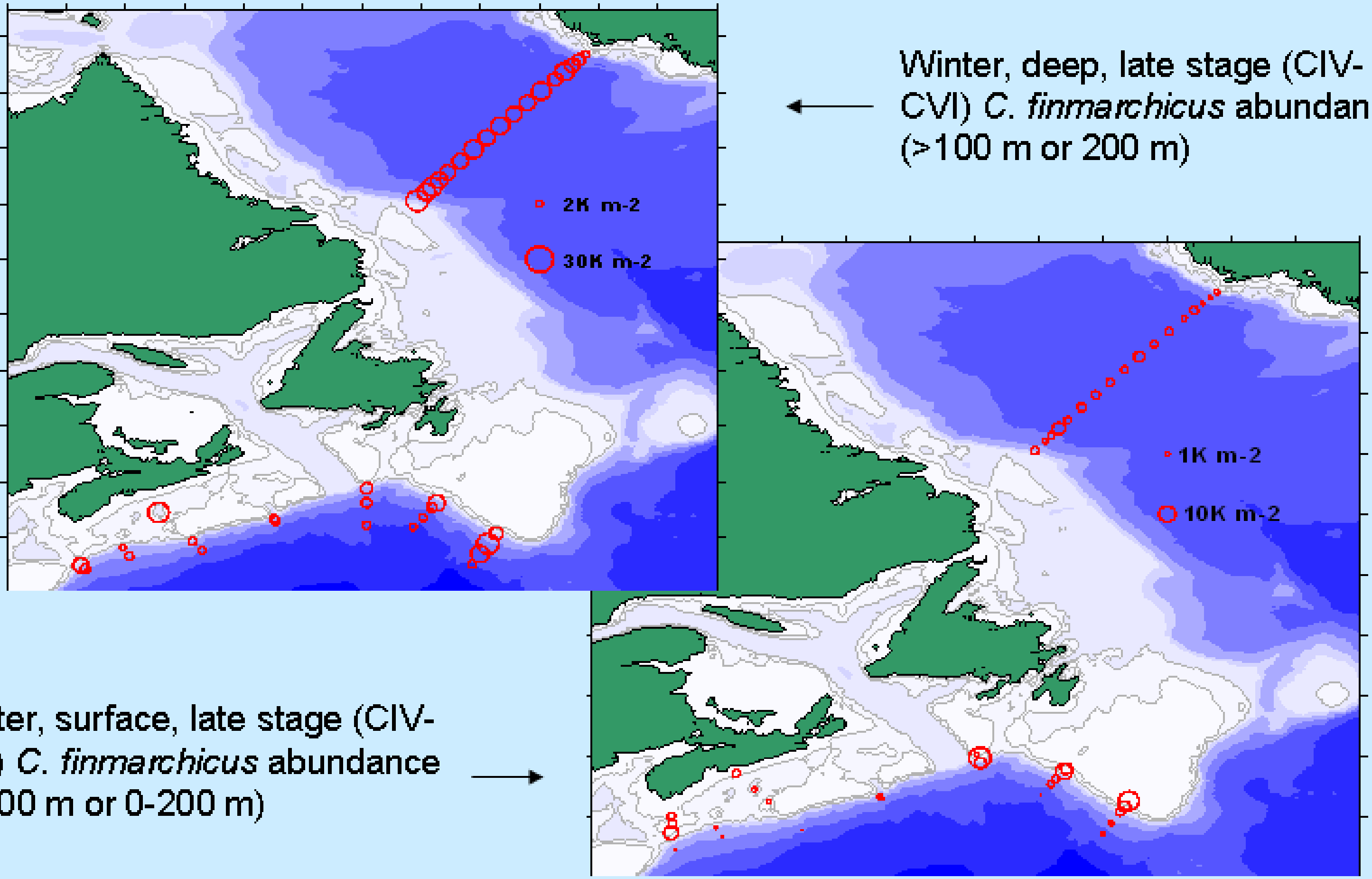


Fall, surface, late stage (CIV-CVI) *C. finmarchicus* abundance (0-100 m or 0-200 m)



Areal abundance of late stage *C. finmarchicus* in winter in Multinet tows (Dec. 2002 and 2003)

- At depth - high abundances in the Labrador Sea and off the SW Grand Bank
- Surface layer – relatively high abundances off the SW Grand Bank and St. Pierre Bank



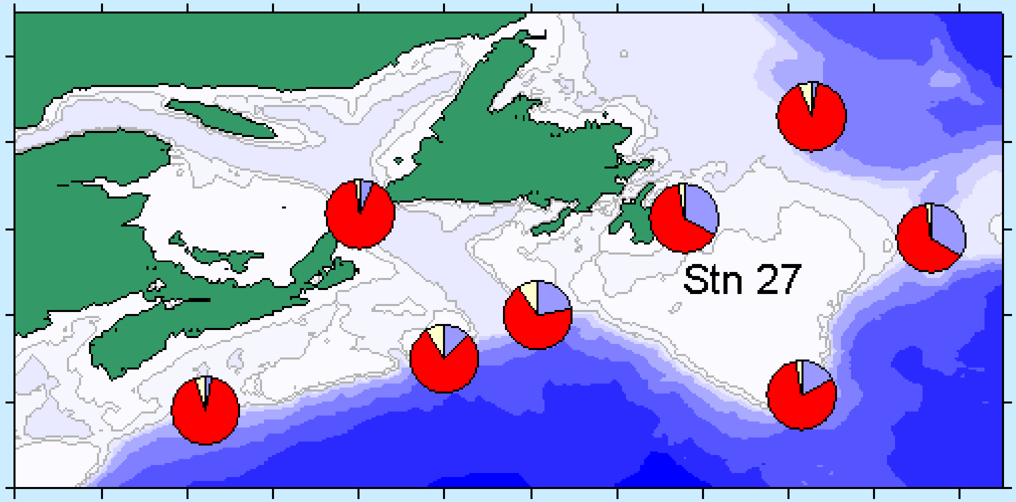
Winter, deep, late stage (CIV-CVI) *C. finmarchicus* abundance (>100 m or 200 m)

Winter, surface, late stage (CIV-CVI) *C. finmarchicus* abundance (0-100 m or 0-200 m)

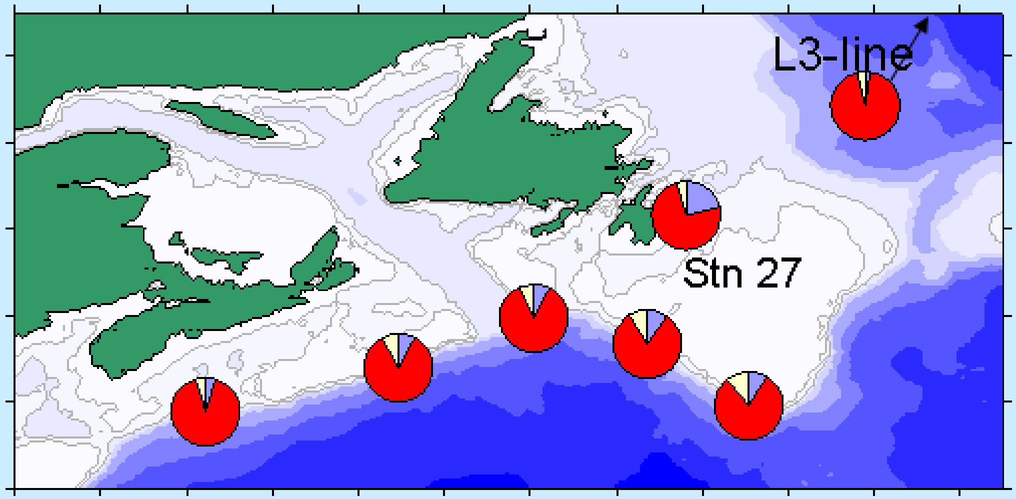
Stage composition of *C. finmarchicus* at depth in fall and winter

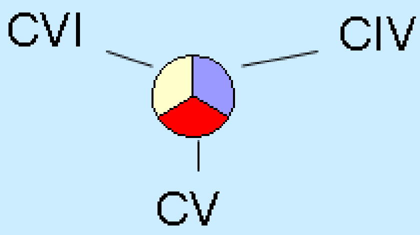
- CVs dominant in the west, the Cabot Strait region and the NE in fall and winter
- Elsewhere CIVs decrease in importance between fall and winter

Fall, deep
C. finmarchicus stage composition
Stn 27 is 175 m depth

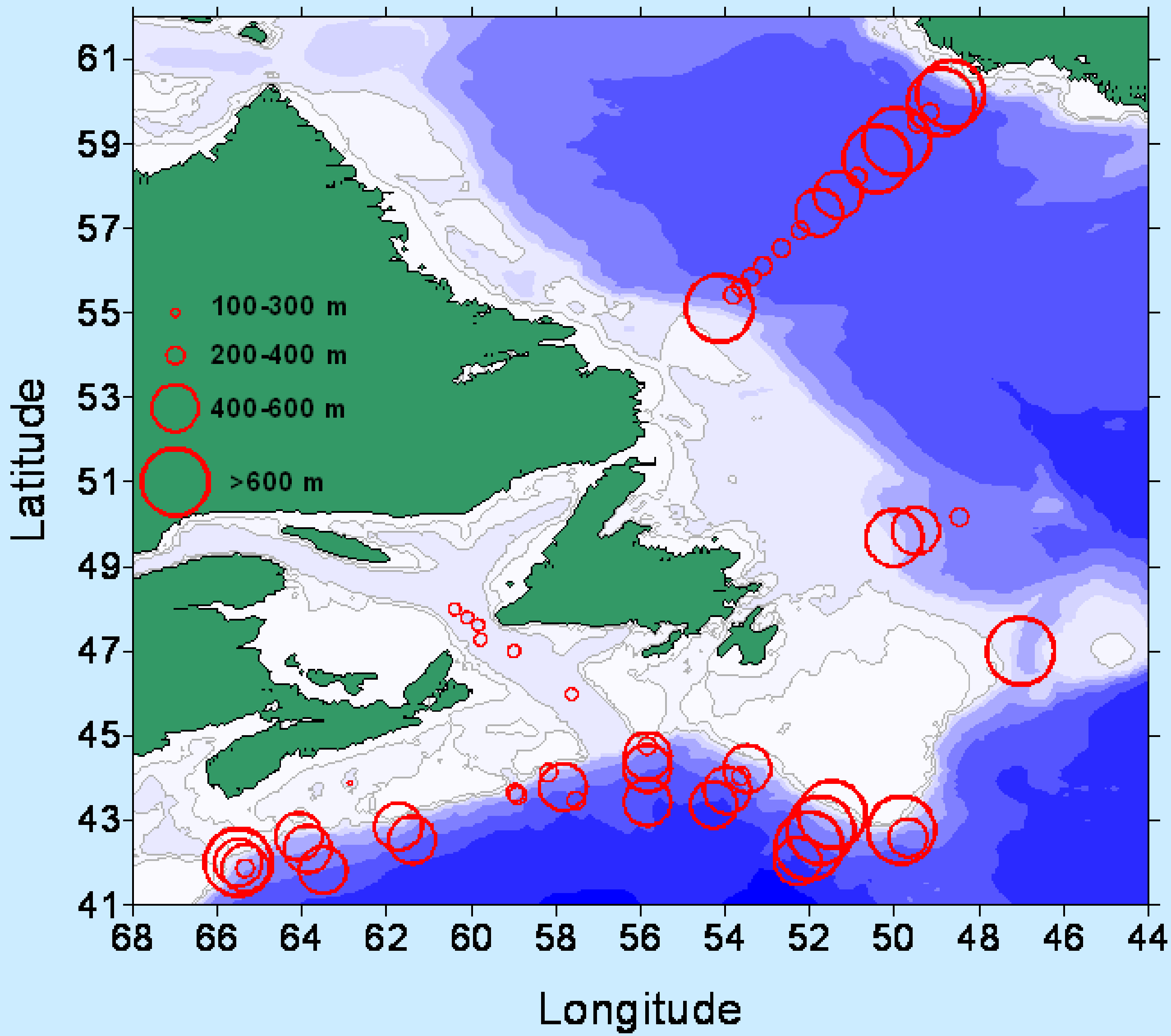


Winter, deep
C. finmarchicus stage composition
Stn 27 is 175 m deep





Regional variations in depths of maximum CV *C. finmarchicus* sub-surface abundance in fall and winter



What controls overwintering depth in *C. finmarchicus* in the NW Atlantic?

1) Preference for particular TS properties? – cool temperatures should promote reduced metabolic rates

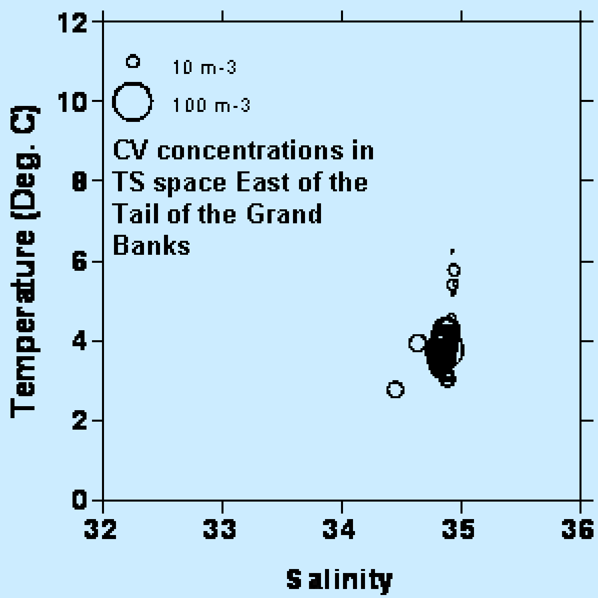
2) Avoidance of winter convection? – CVs that are within the winter mixing layer could be brought to the surface before they are “ready”

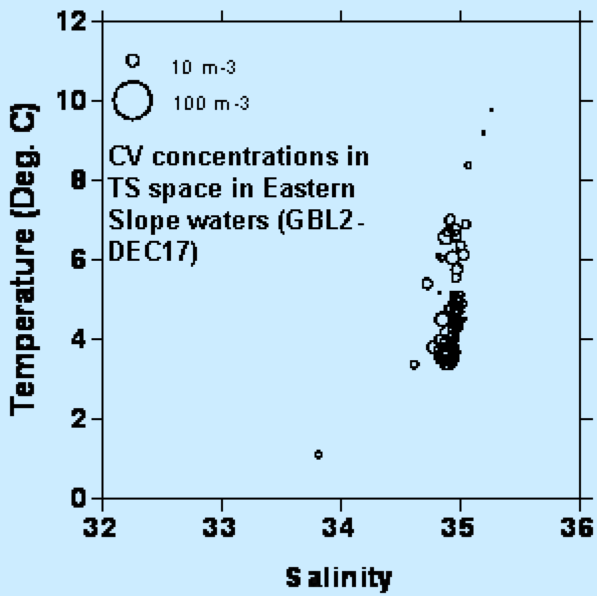
3) Light intensity? – which might be related to the presence of visual predators

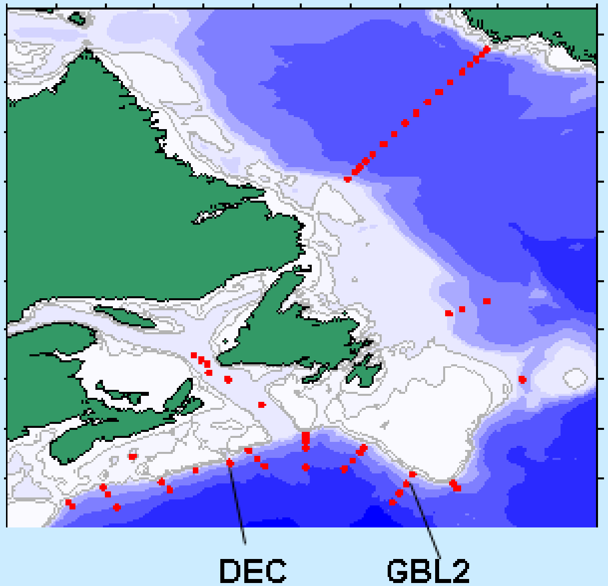
4) Avoidance of predators? – CVs should overwinter at depths where predators are not abundant

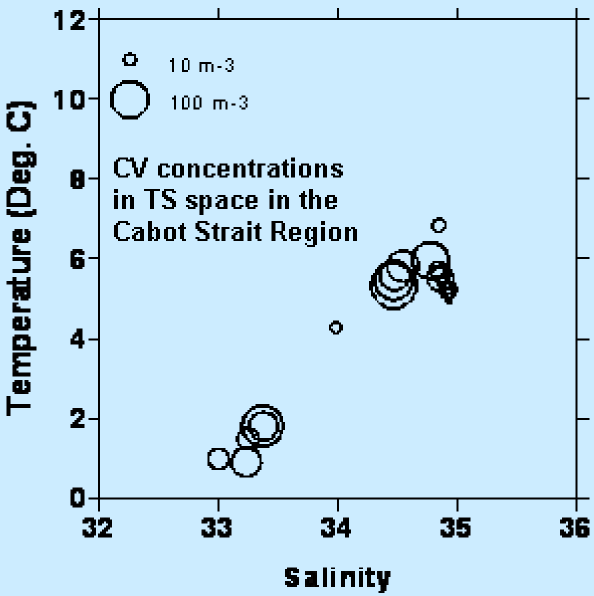
5) Lipid content? – CVs should be neutrally buoyant at their overwintering depths and buoyancy is related to lipid content

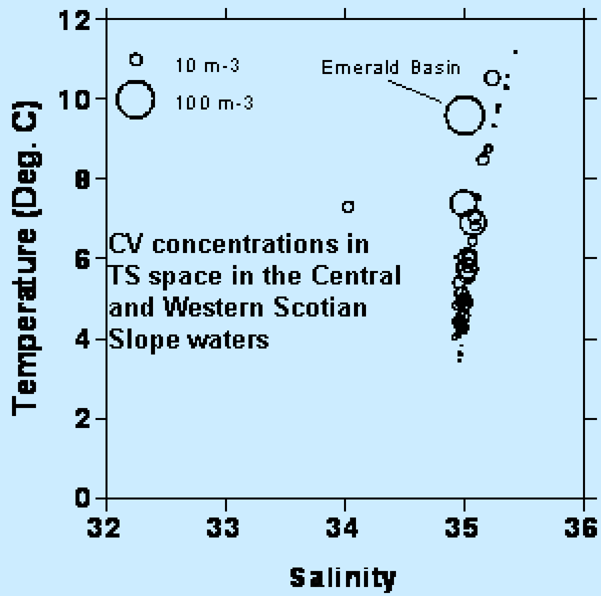
High concentrations were found at relatively low (Cabot Strait region), intermediate (Eastern regions) and relatively high temperatures and salinities (Emerald Basin), but ….





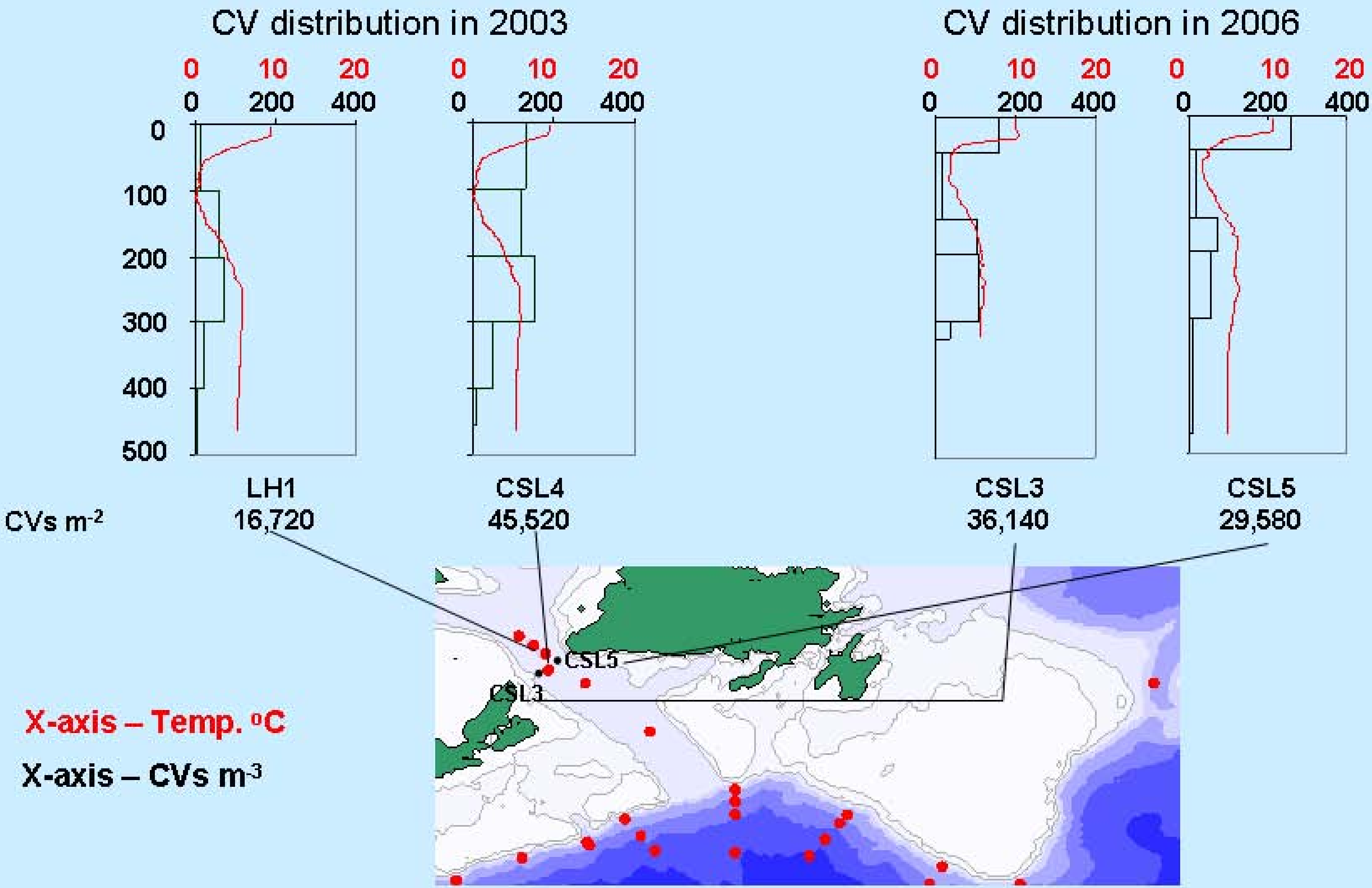






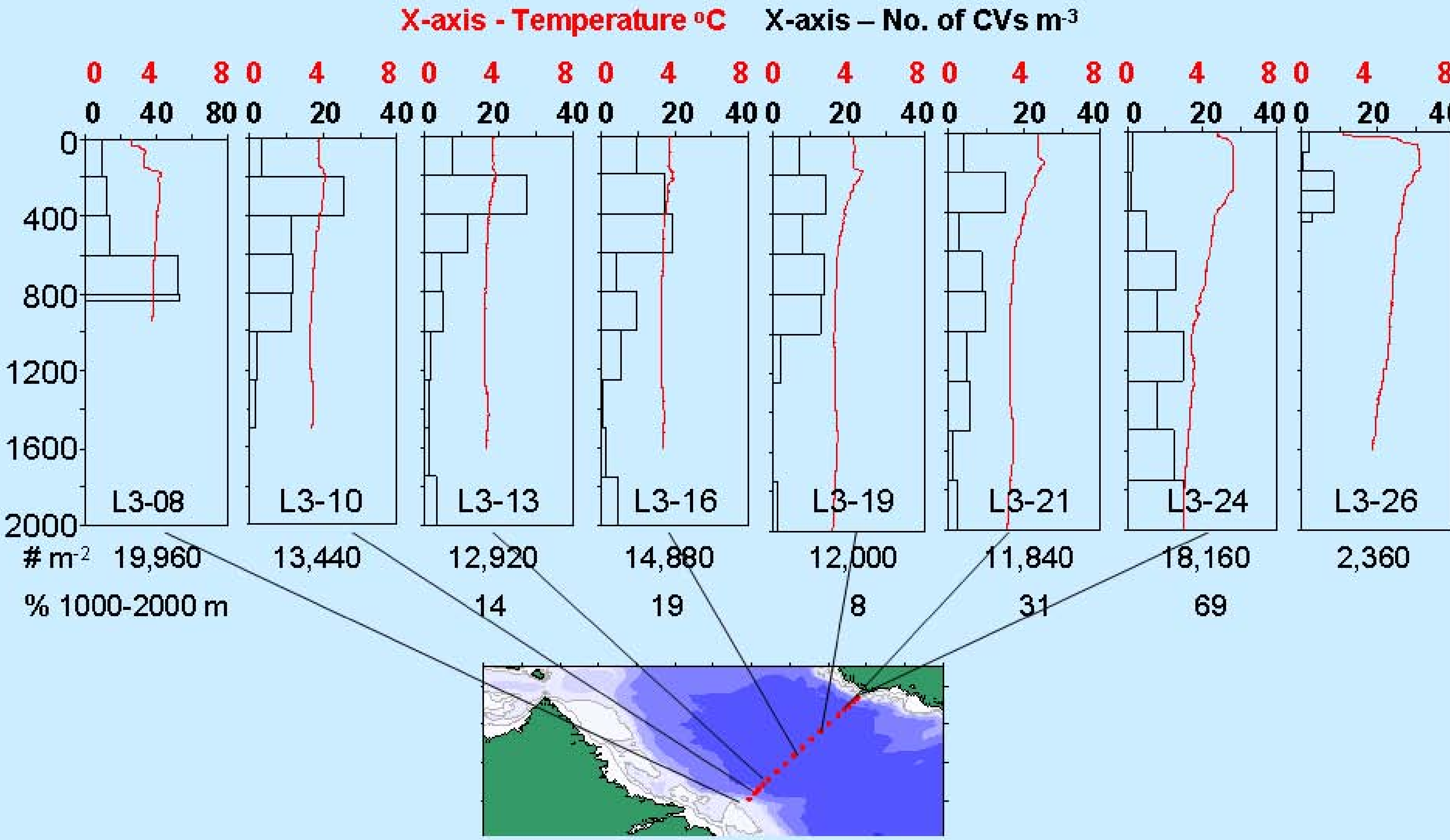
… in the Cabot Strait region, CVs were not really in the low temperature/low salinity water, as was shown by choosing different sampling depth ranges in 2006 versus 2003.

The CVs were below the depth of winter convection in 2006, but ….



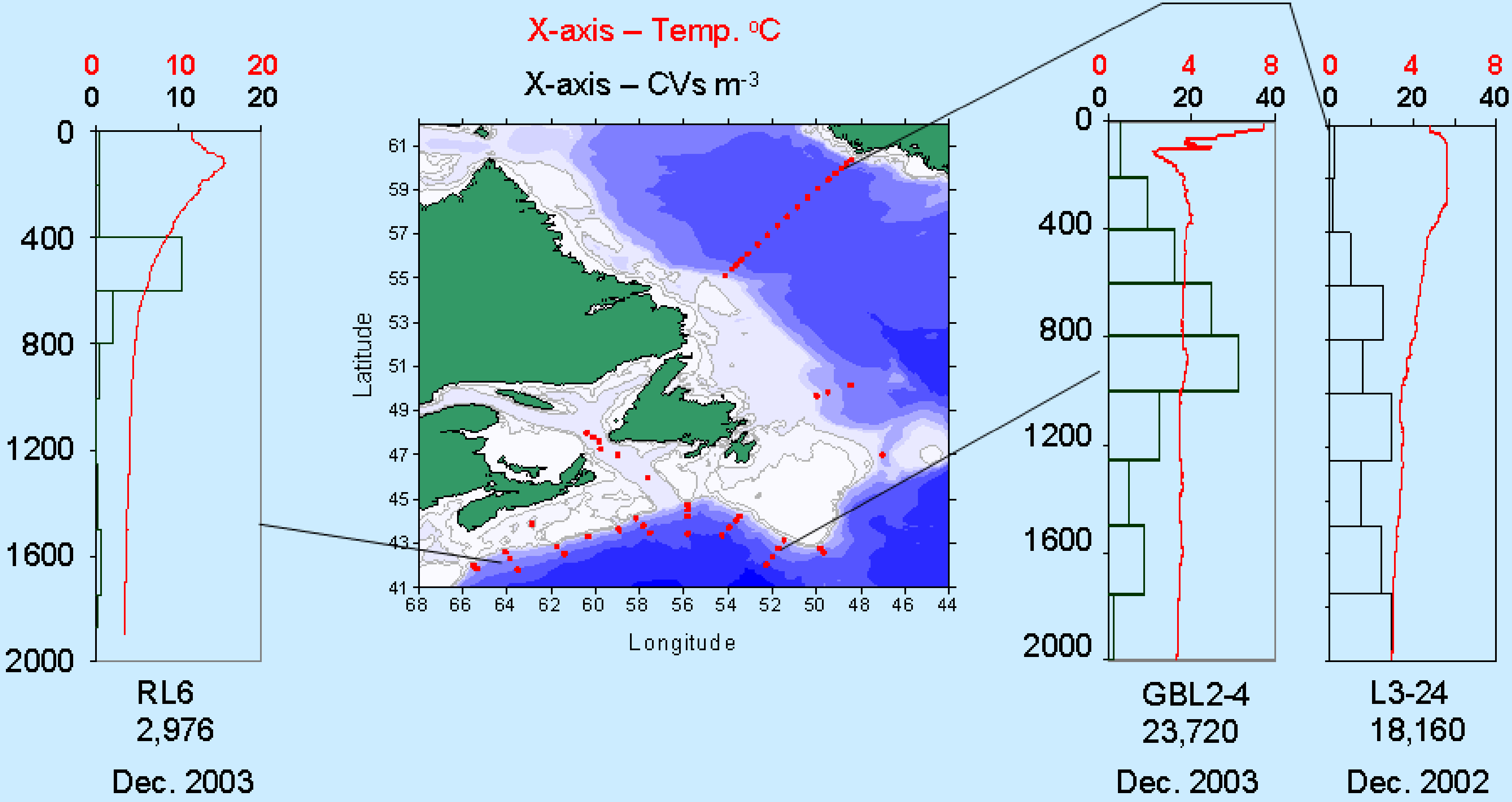
… in the western central Labrador Sea, winter mixing normally extends to 1000 m, and the CVs were most abundant at 200-400 m.

Throughout most of the central basin most CVs were at depths of < 1000 m.



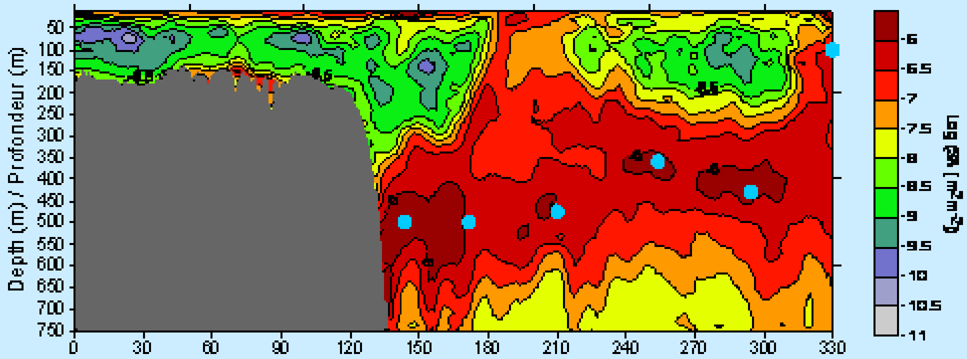
Does light intensity influence the overwintering depth distribution of CV *C. finmarchicus*?

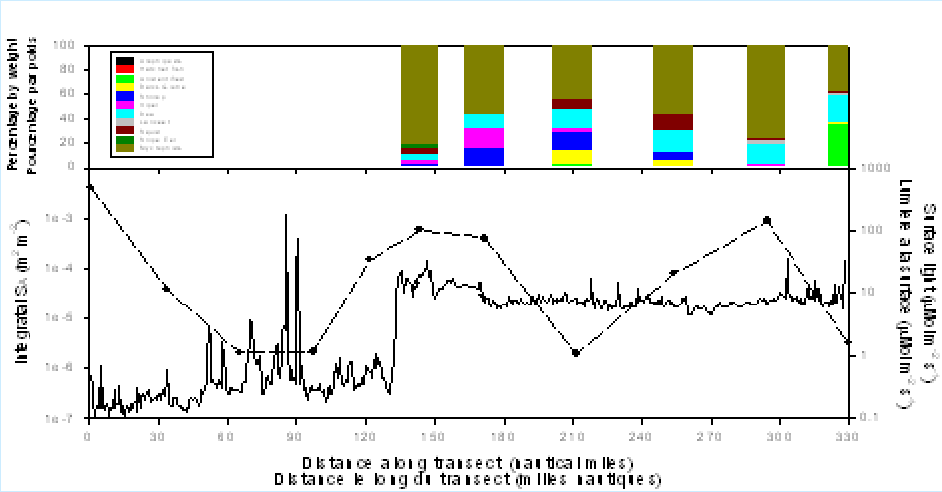
Light intensity is highest at most southerly latitudes, but the overwintering CVs were deeper in the water column at L3-24 (60°N) than at more southerly locations (GBL2-4, RL6).

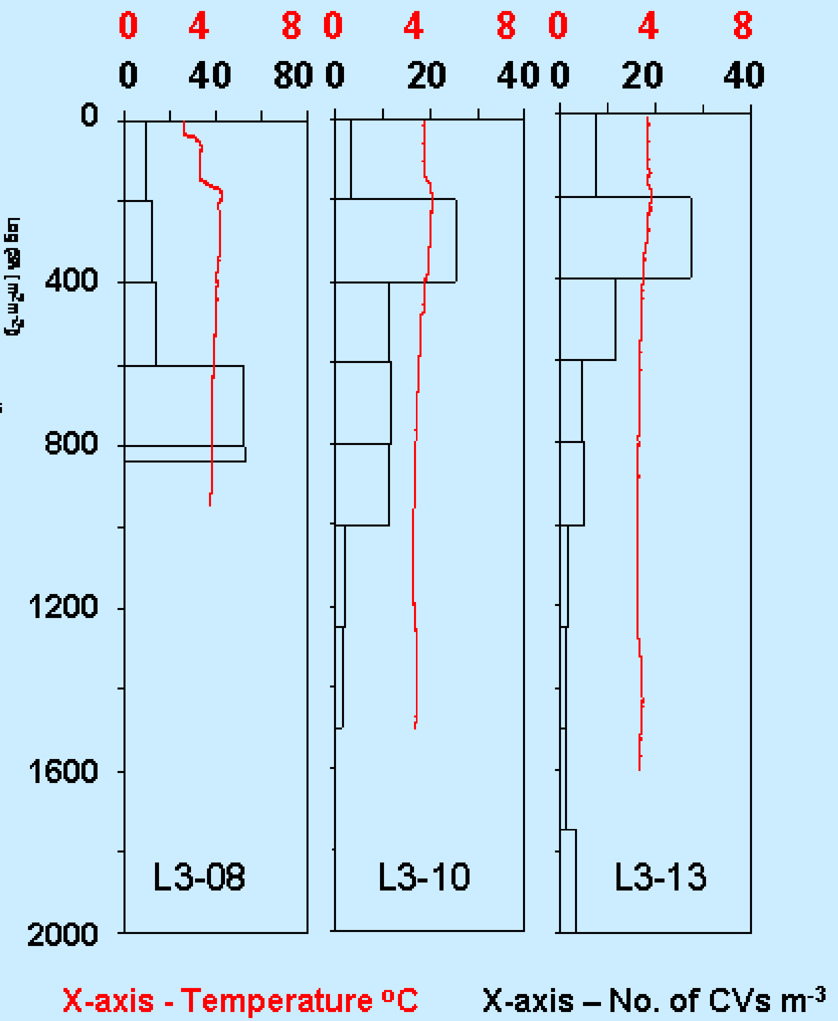


Does predator abundance influence the overwintering depth distribution of CV *C. finmarchicus*?

- There is a deep scattering layer (DSL) in June throughout Labrador Sea; 50-80% is due to myctophids
- The DSL shows extensive vertical migration, which involves only 10-20% of the integrated Sv
- The depth distribution of the CVs in December overlaps that of the DSL in June

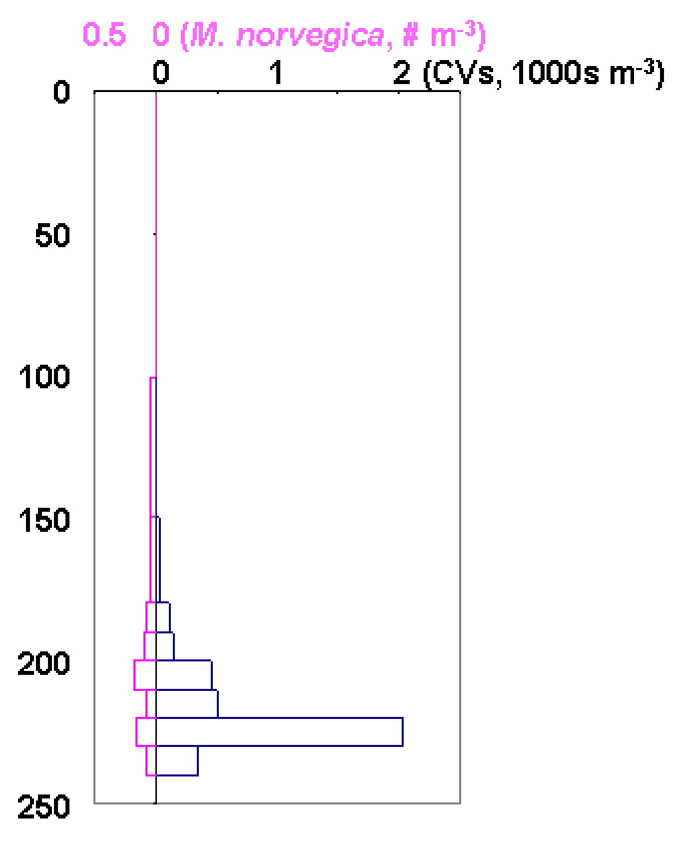




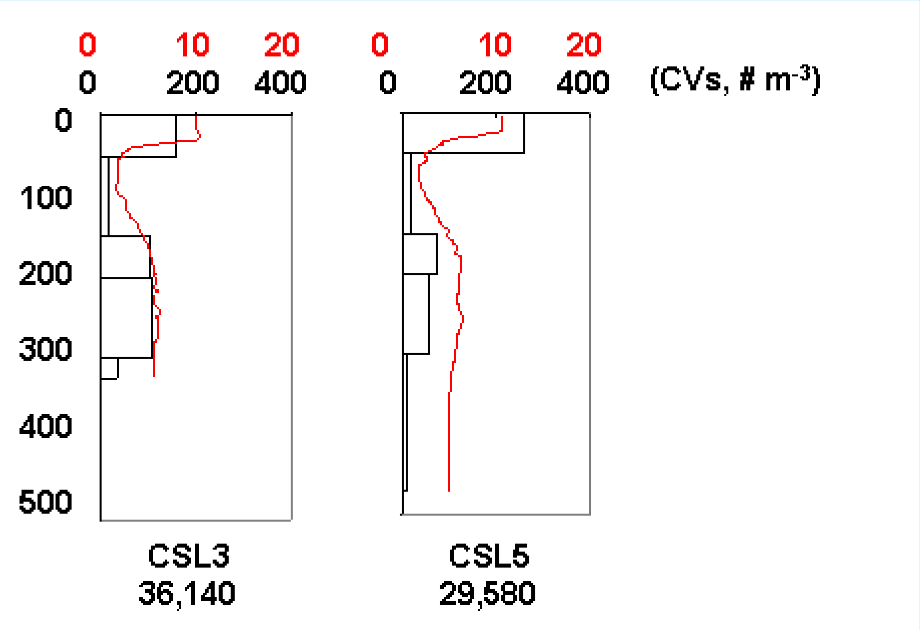


Does predator abundance influence the overwintering depth distribution of CV *C. finmarchicus* (contin.)?

- In shallow areas CVs are not in the deepest layer, which may be so as to avoid bottom-living fish
- CVs layers are co-incident with those of predatory euphausiids during the day



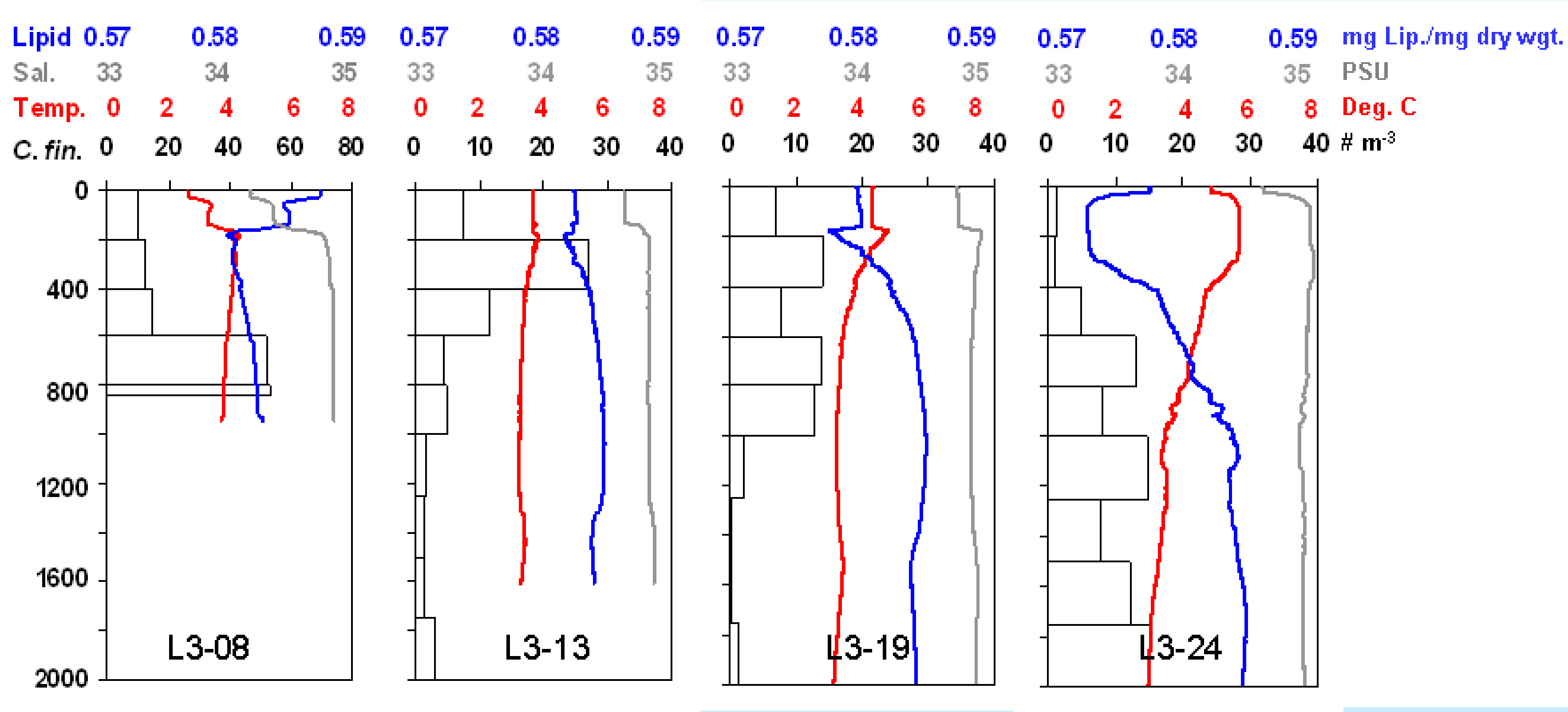
Emerald Basin
BIONESS daytime tow, Oct. 1984



Cabot Strait, Multinet tow, Oct. 2006

Could variations in lipid content account for differences in overwintering depths?

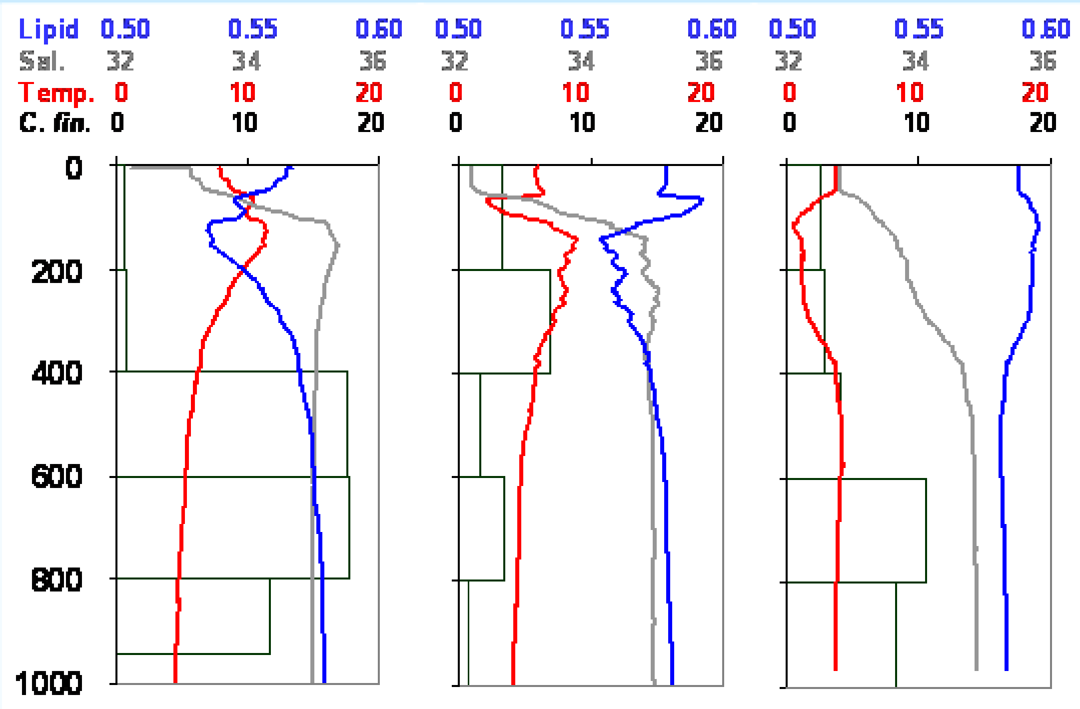
- In the Labrador Sea estimated implied lipid content varied little with depth, but most at station L3-24.
- At most stations the difference in lipid content needed to render the CVs neutrally buoyant at 0 and 2000 m was <1%. At L3-24 the difference was <3%.
- The average value at 1000 m was 0.585 mg Lip./mg dry wgt.

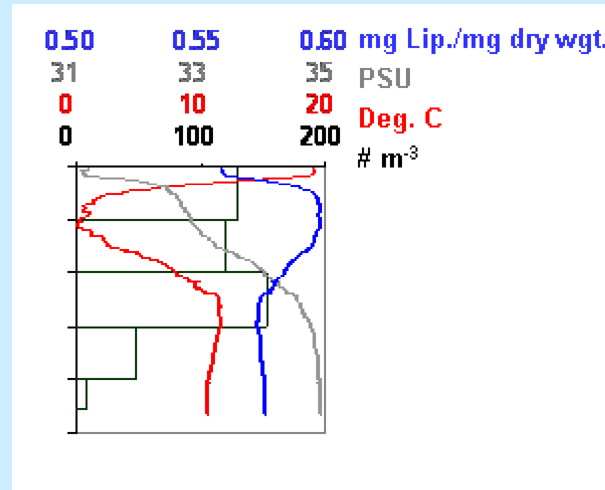


* Implied lipid content – Calculated according to Visser and Jónasdóttir (1999) assuming a lipid free dry density for CVs of 1.24 g l^{-1}

Could variations in lipid content account for differences in CV overwintering depths (contin.)?

- At stations off the Western and Eastern Scotian Shelf and the SW Grand Bank the lipid content required for neutral buoyancy varied by <1% among stations and between 500 and 1000 m
- In Cabot Strait the lipid content required was the same below 300 m as was required at the other stations below 500 m.
- The average value at 500 (or 300, CSL) m was 0.577 mg Lip./mg dry wgt.





BBL-6
Western
Scotian Shelf

DEC-17
Eastern
Scotian Shelf

GBL2-3
SW Grand Bank

CSL4
Cabot Strait

Conclusions about factors controlling depth distribution of overwintering *C. finmarchicus* in the NW Atlantic and Labrador Sea

1) In the NW Atlantic and Labrador Sea overwintering *C. finmarchicus* show depth distributions that do not seem to be influenced by TS properties of the water, except in Cabot Strait

2) In Cabot Strait overwintering CVs are below the depth of winter convection, but in the much of the Labrador Sea they are above it

3) CV overwintering depths are not related to incident light intensity

4) It is unclear whether predation influences the vertical distribution of overwintering CVs

5) Changes in lipid content are unlikely to be responsible for differences in the depth distribution of overwintering CV *C. finmarchicus*

There is no simple explanation!