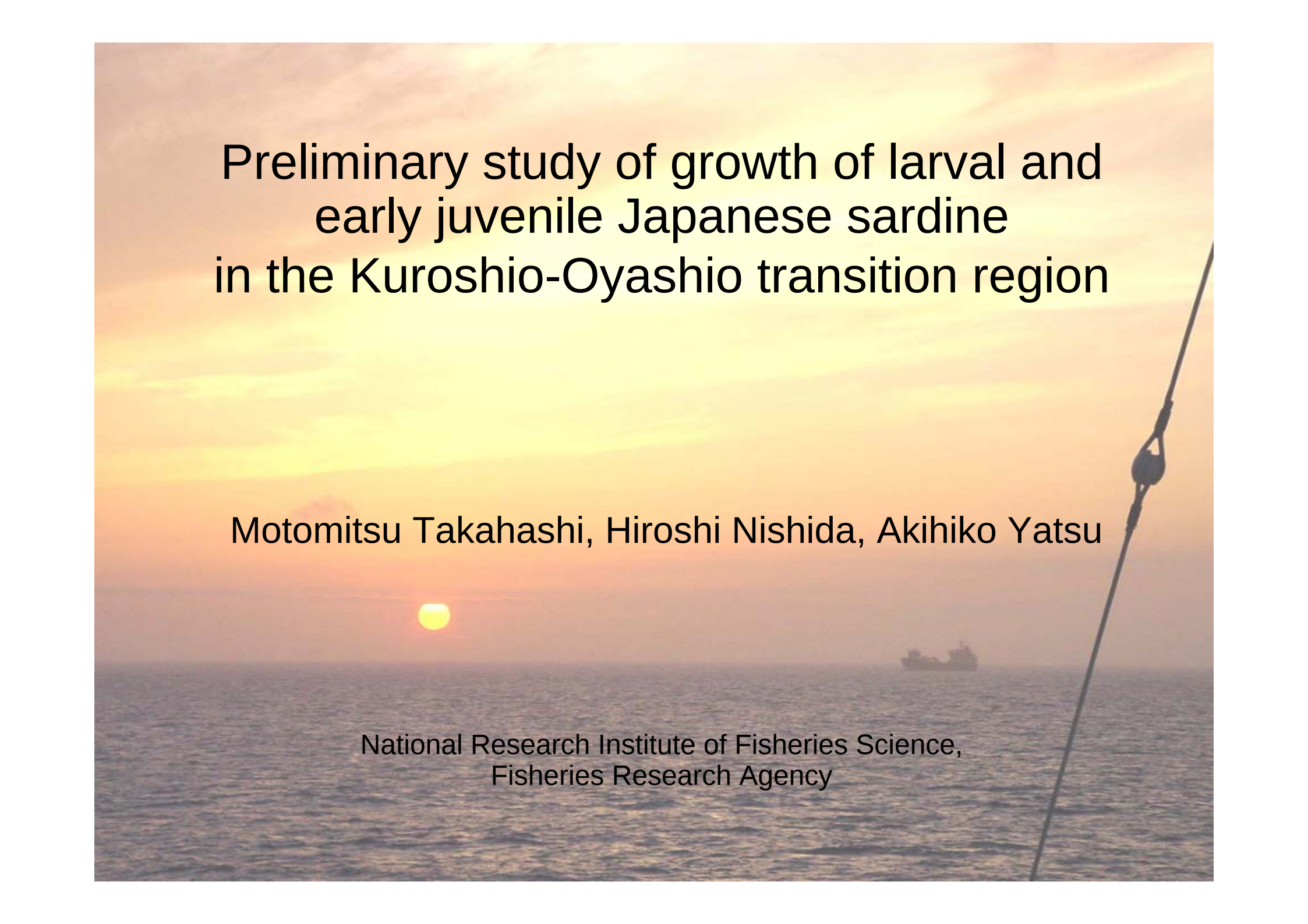


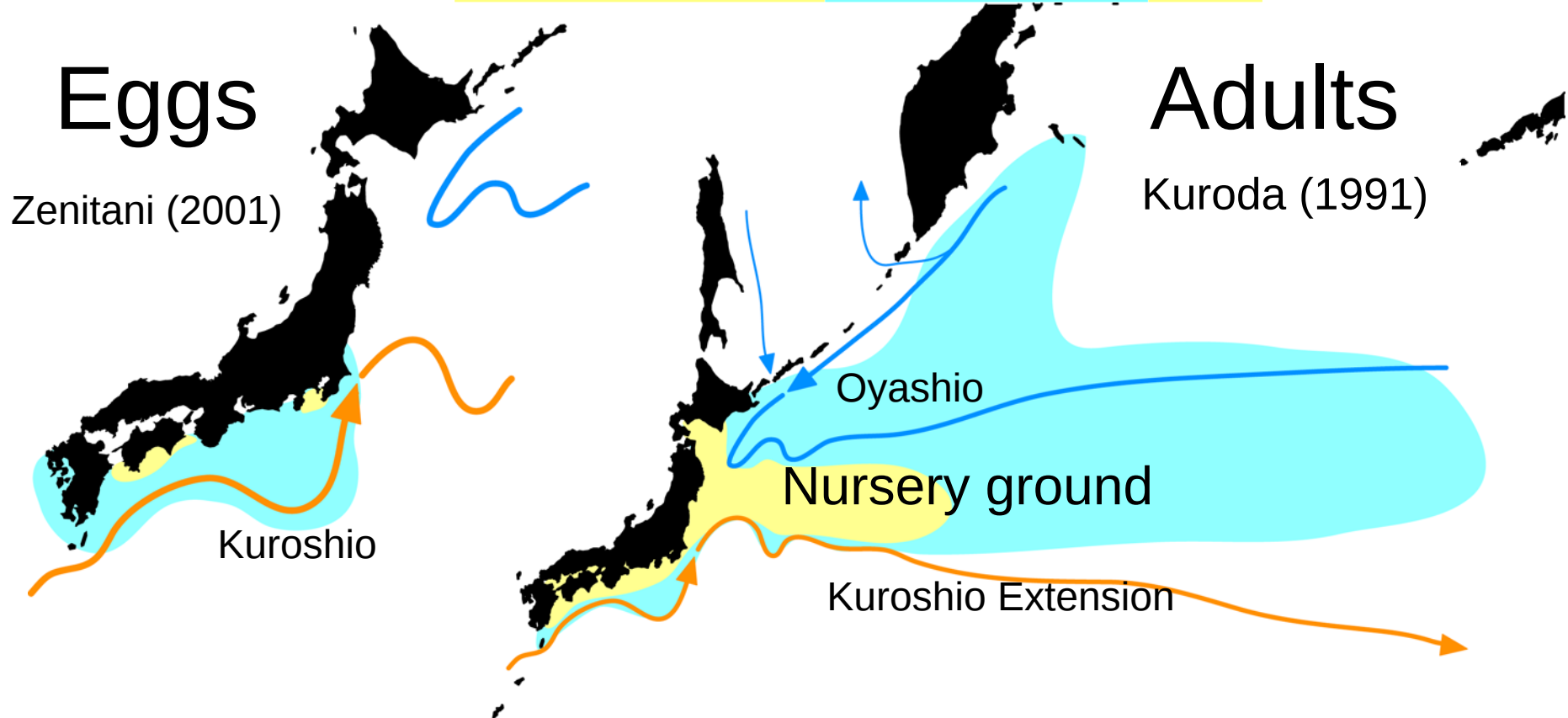
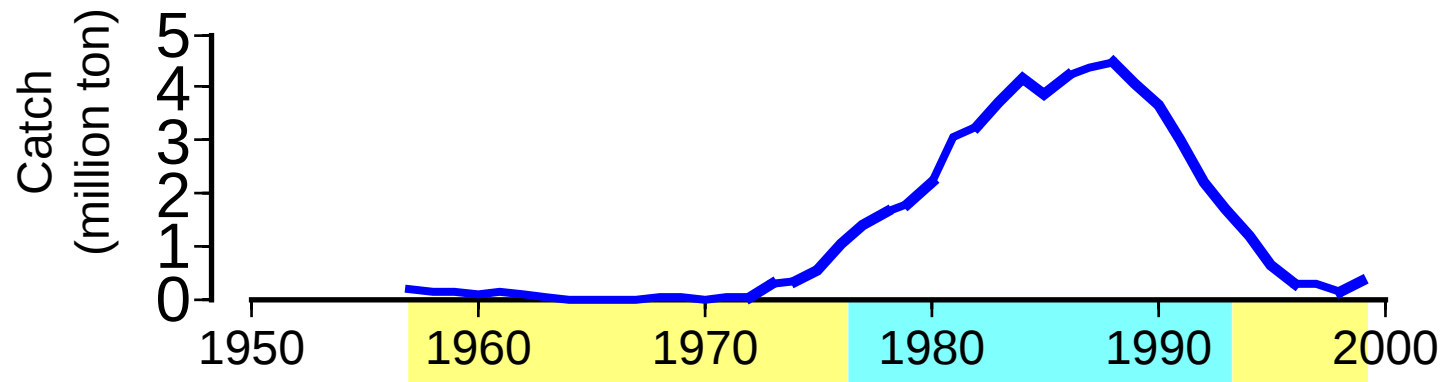


Preliminary study of growth of larval and early juvenile Japanese sardine in the Kuroshio-Oyashio transition region

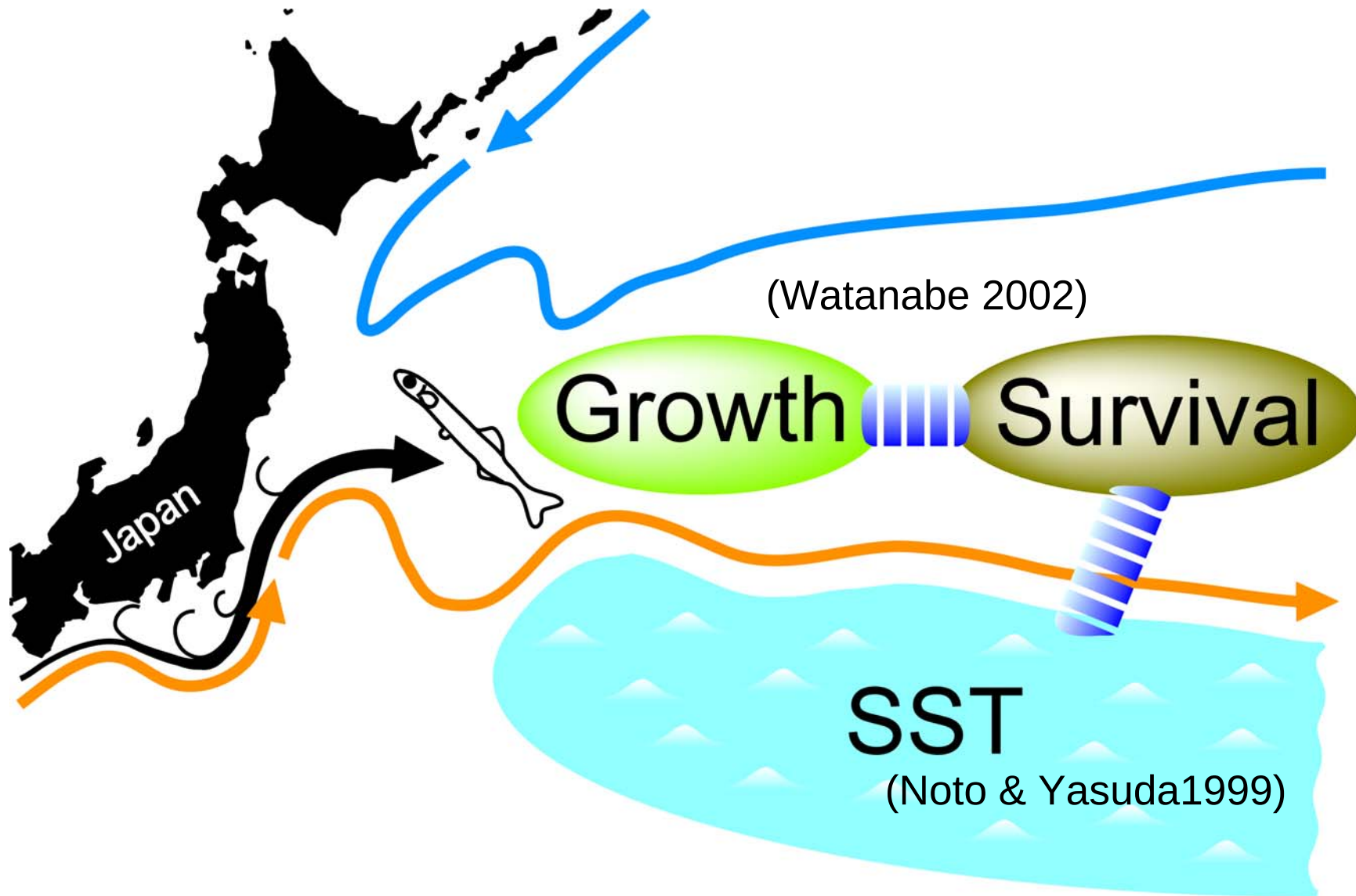
Motomitsu Takahashi, Hiroshi Nishida, Akihiko Yatsu

National Research Institute of Fisheries Science,
Fisheries Research Agency

Distribution ranges in eggs and adults



Survival hypotheses



Objectives

Growth of larval and early juvenile Japanese sardine in the nursery grounds

- Growth variability in relation to...



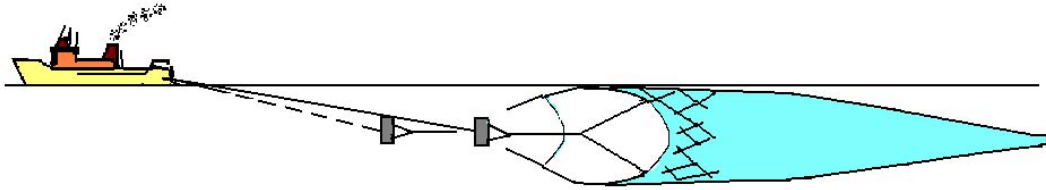
Environmental conditions

- Sea surface temperature (SST)
- Available prey density

Survival rate & Juvenile abundance

- Comparison to anchovy growth

Sampling procedure



Survey period: 1997-2002

(May-Jun. during night)

Sub-surface trawl (Larva & Juvenile)

Net opening: 25 x 25 m

Mesh aperture (cod end): 10 mm

Towing duration: 30 min.

speed: 3-4 knot

NORPAC net (Zooplankton)

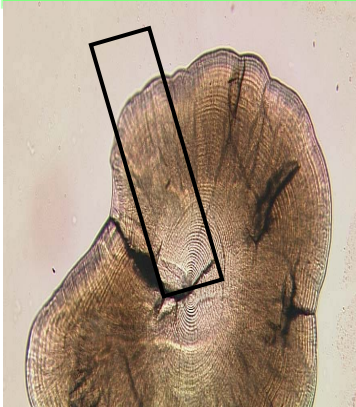
STD cast (SST)



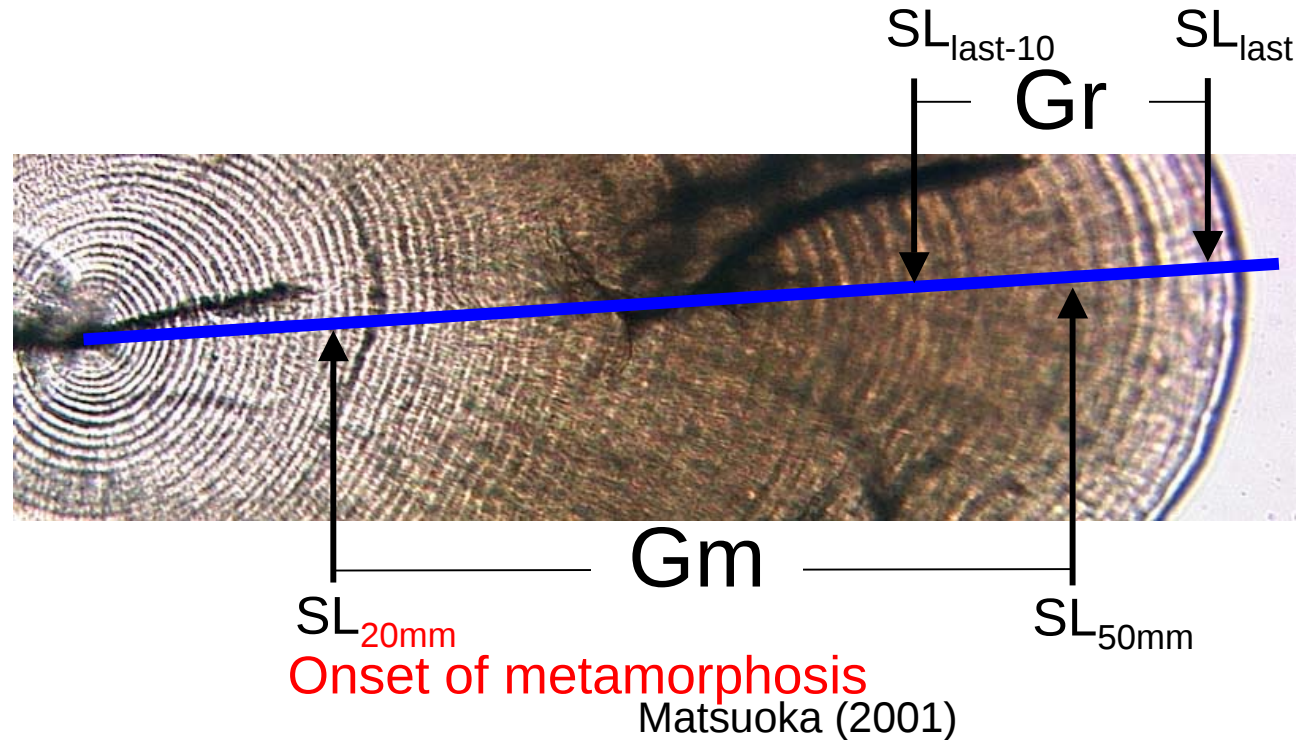
Growth analysis

$$\text{Gr} \left(\begin{array}{l} \text{Recent 10-day} \\ \text{growth rate} \end{array} \right) = (SL_{\text{last}} - SL_{\text{last-10}}) / 10$$

Spec. No
2000T37-05

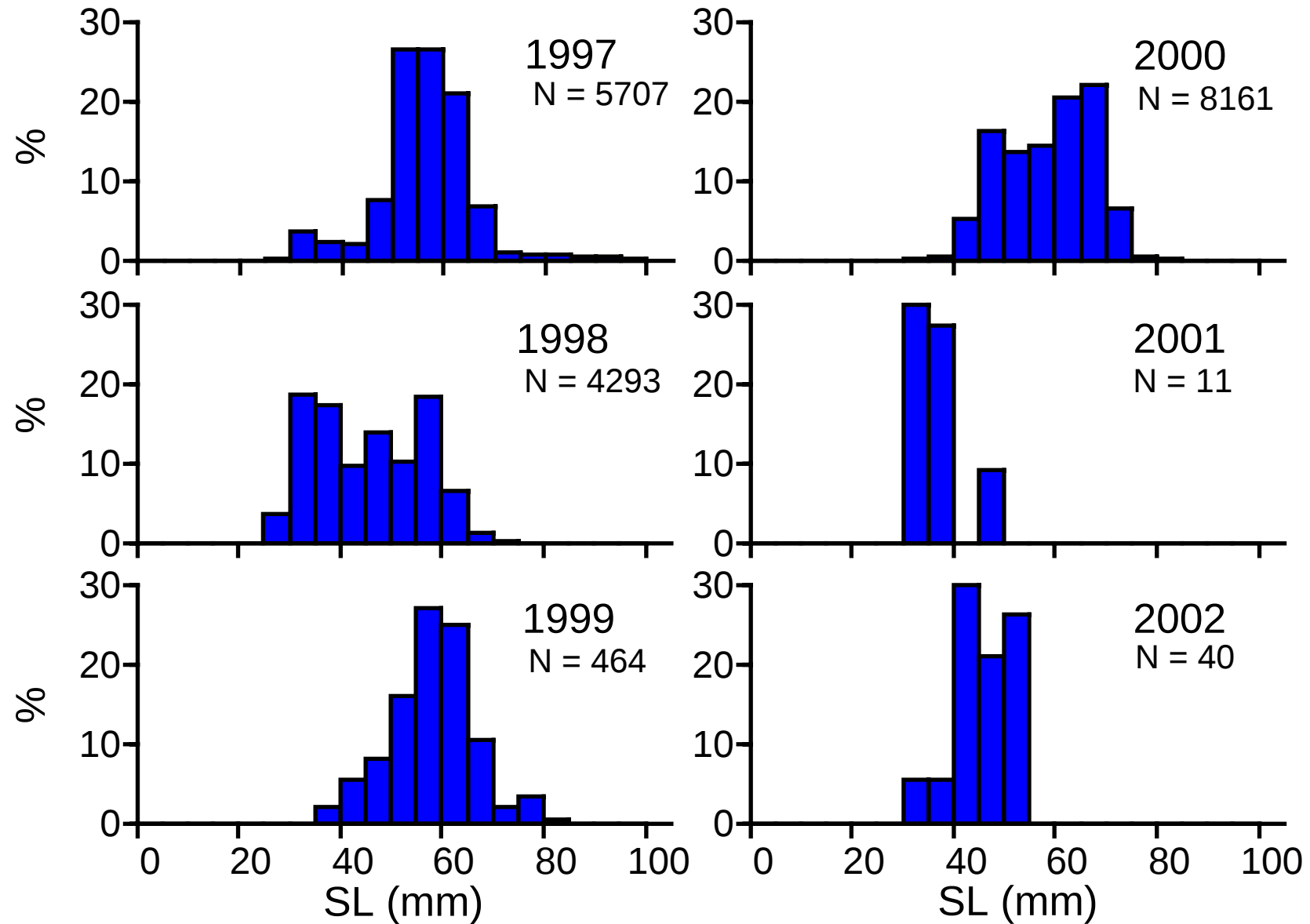


55.8 mm SL
68 in days

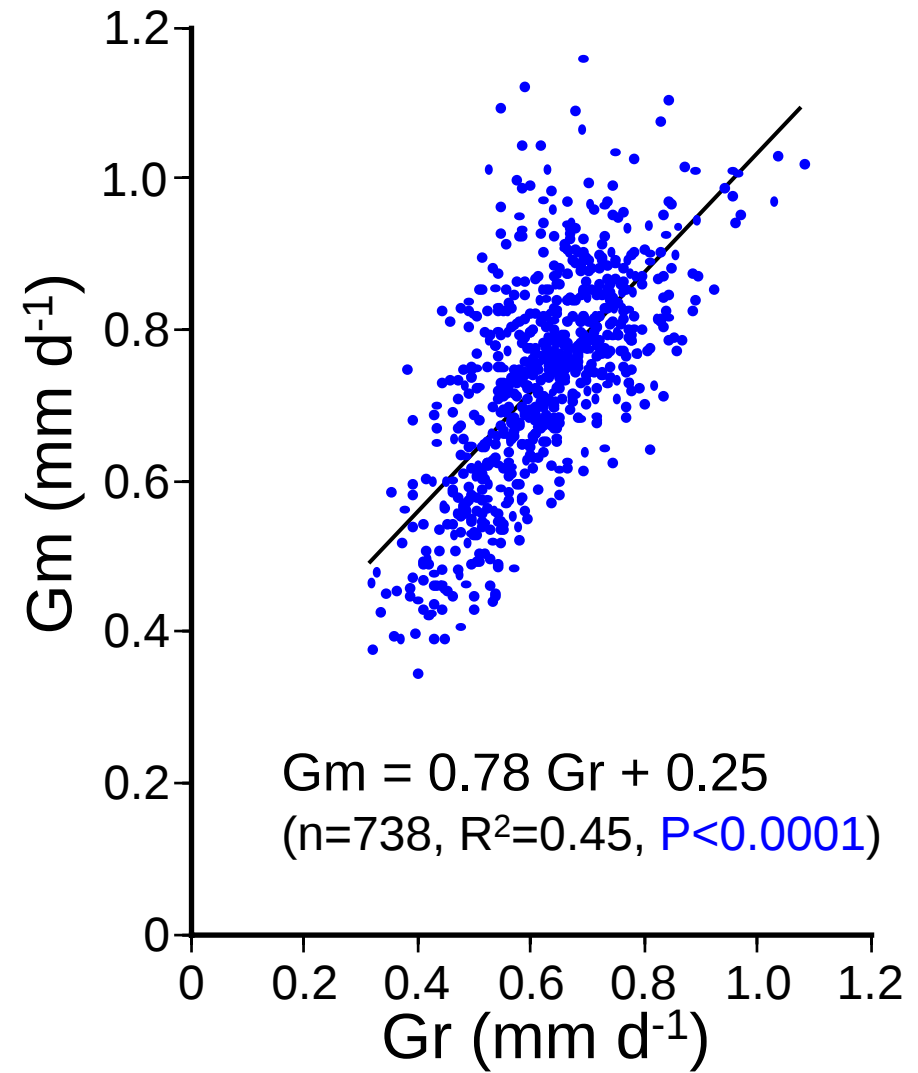
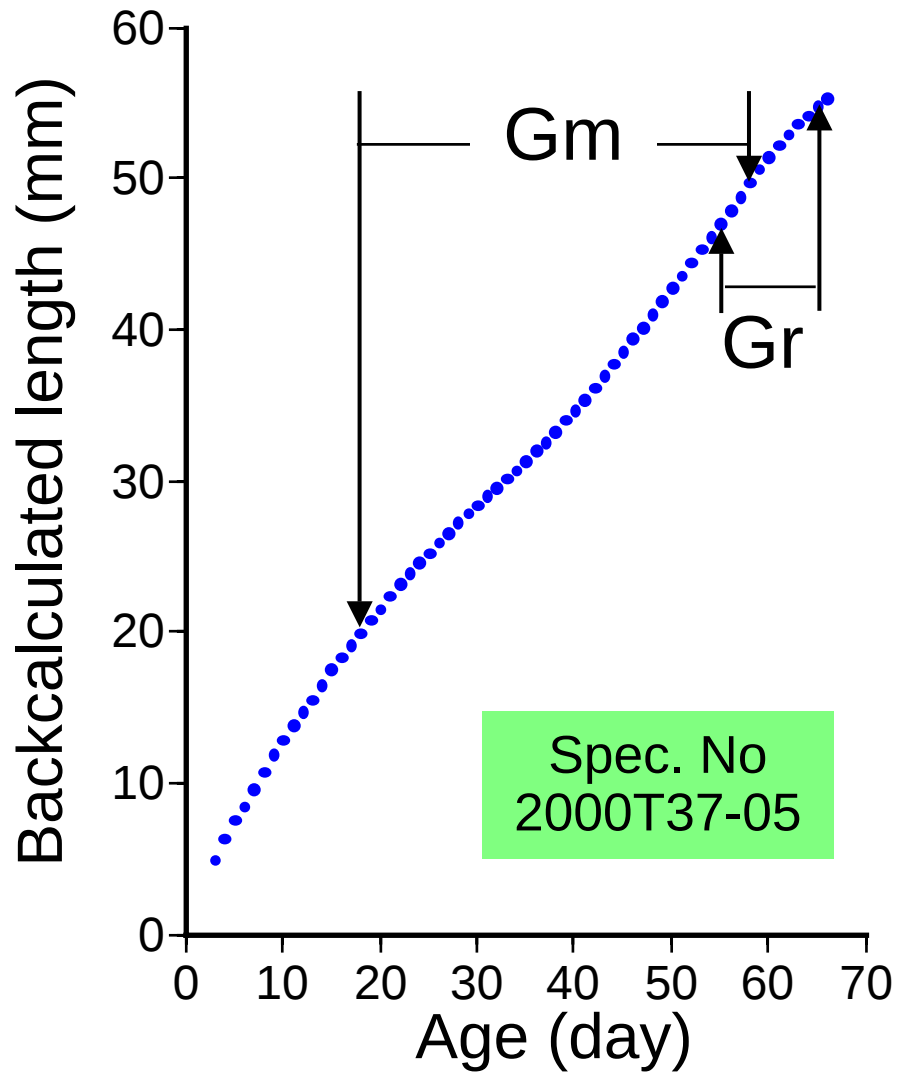


$$\text{Gm} \left(\begin{array}{l} \text{Growth rate after} \\ \text{the onset of meta-} \\ \text{morphosis} \end{array} \right) = (SL_{50\text{mm}} - SL_{20\text{mm}}) / t_{20-50\text{mm}}$$

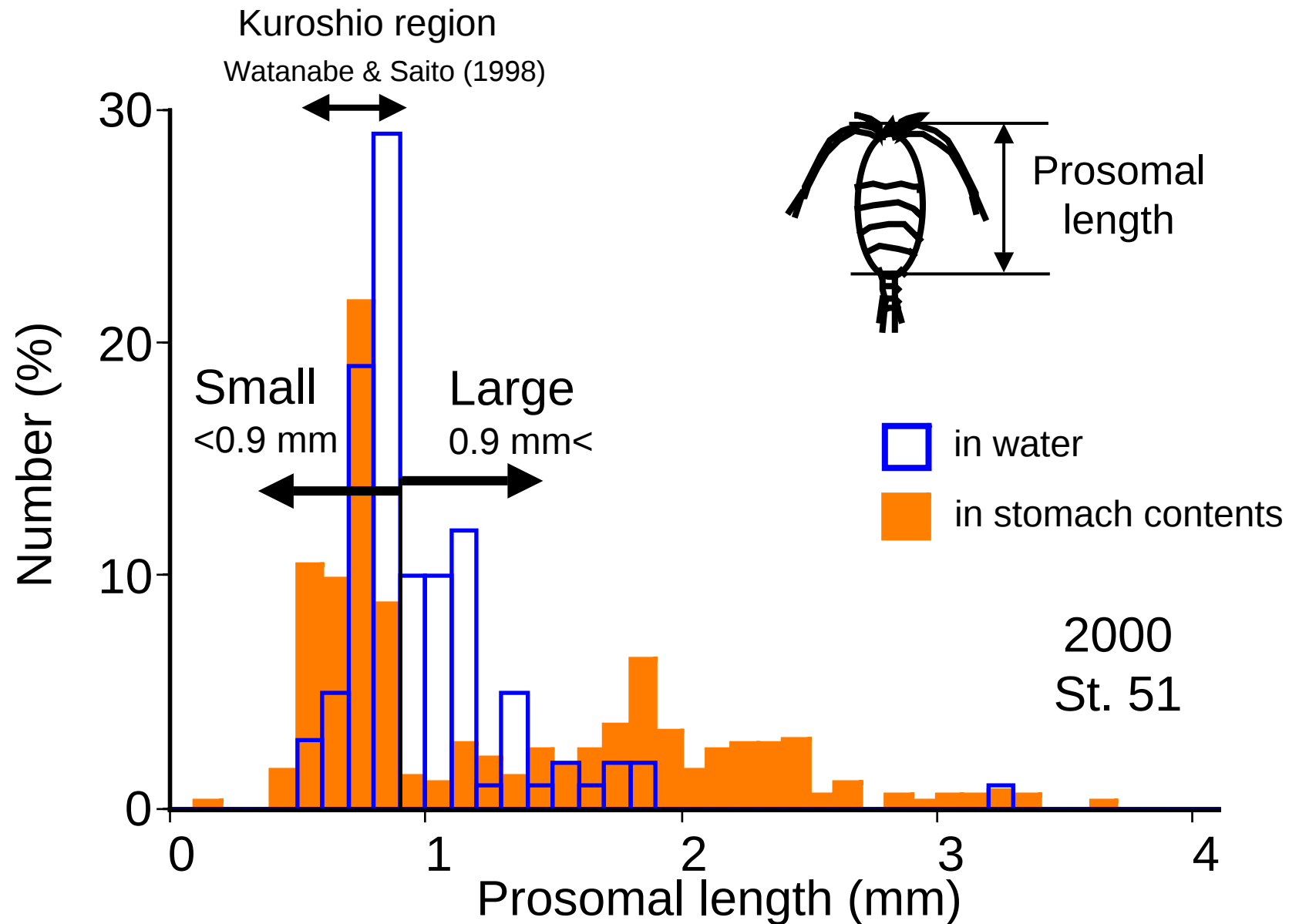
Body length



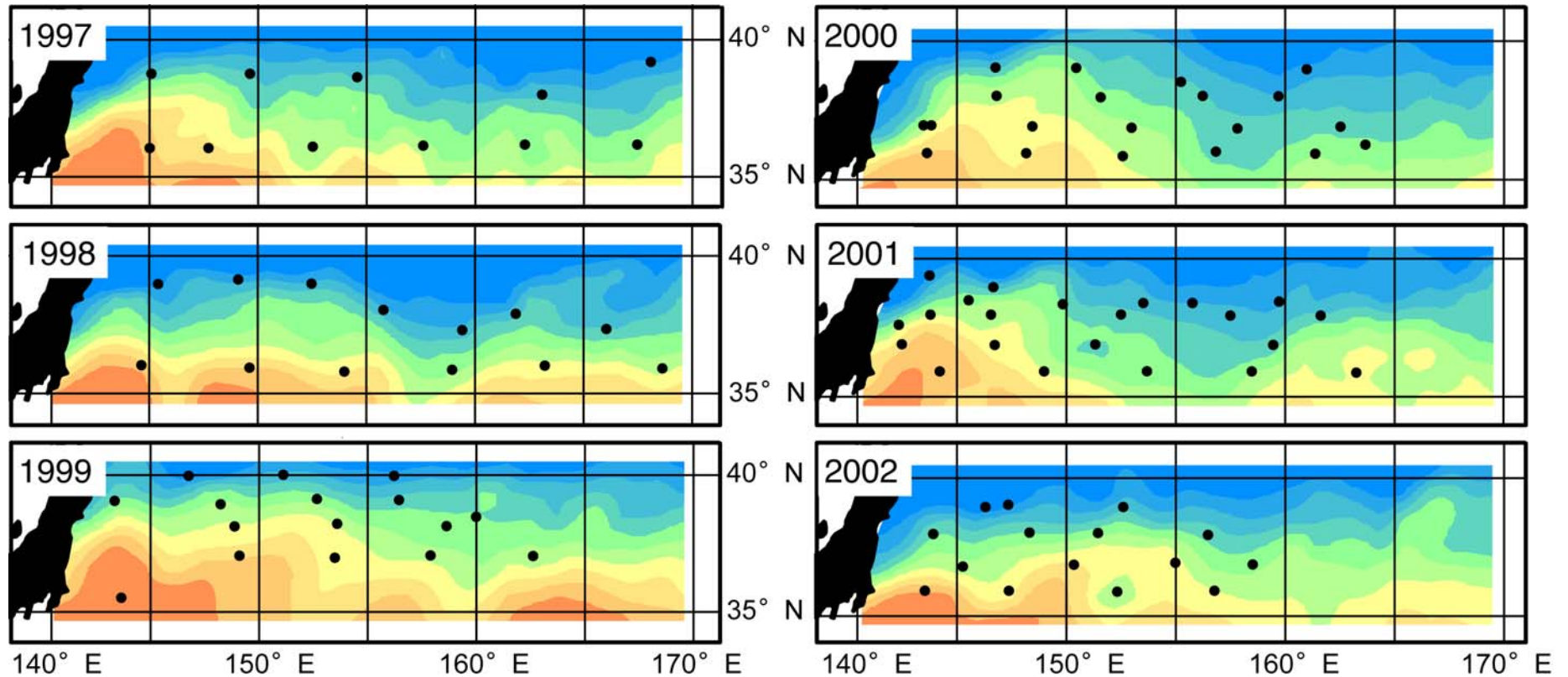
Gr and Gm



Available copepods for early juveniles



Sampling location and SST



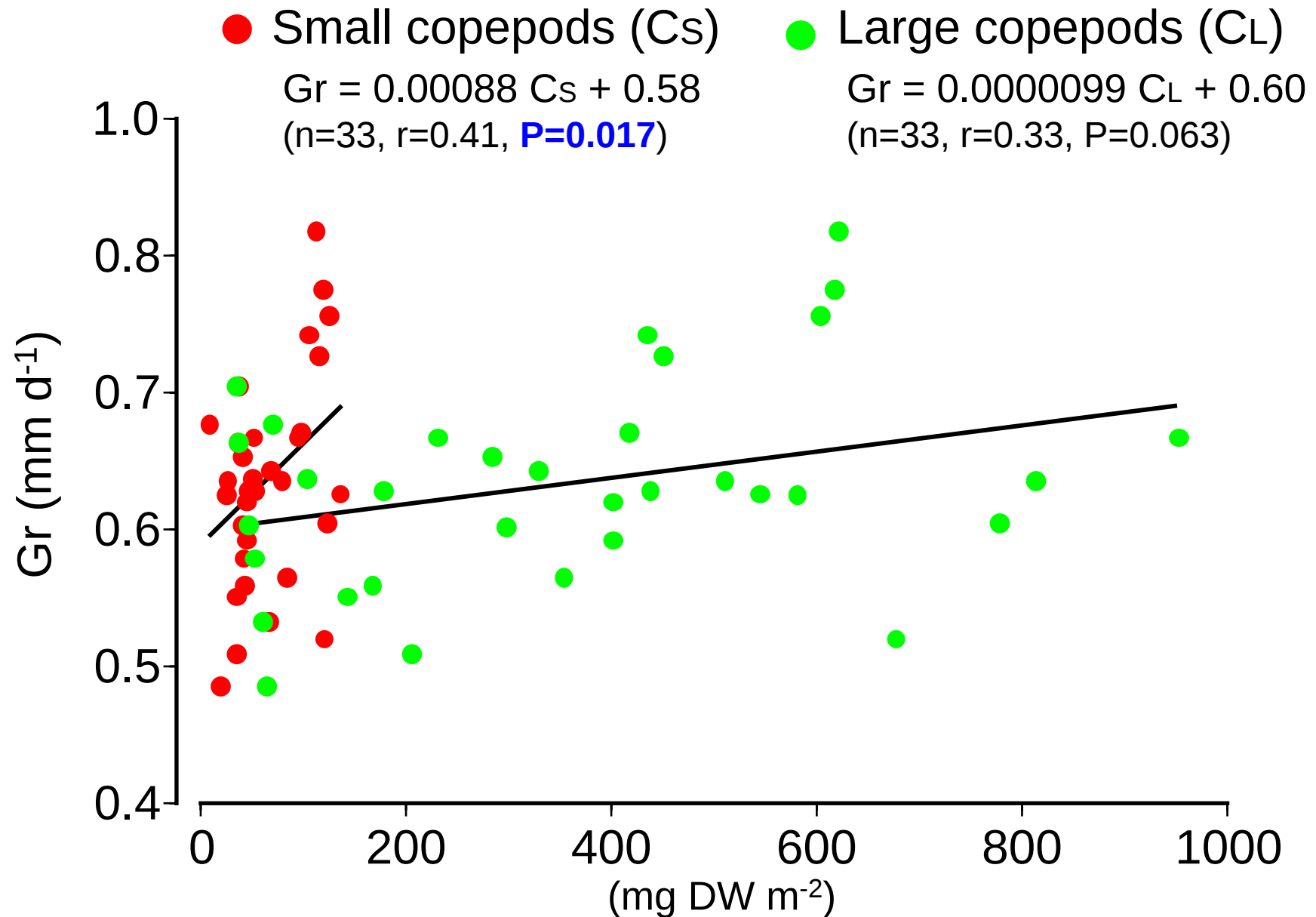
Survey area: 35-40°N
140-170°E



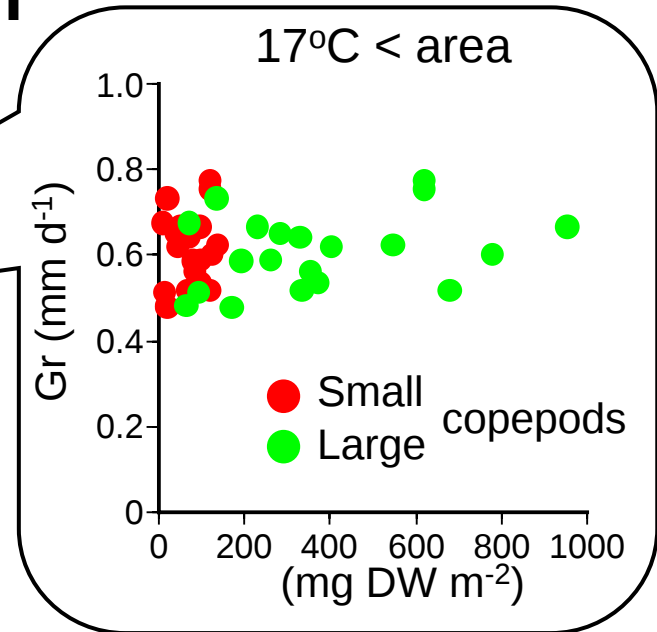
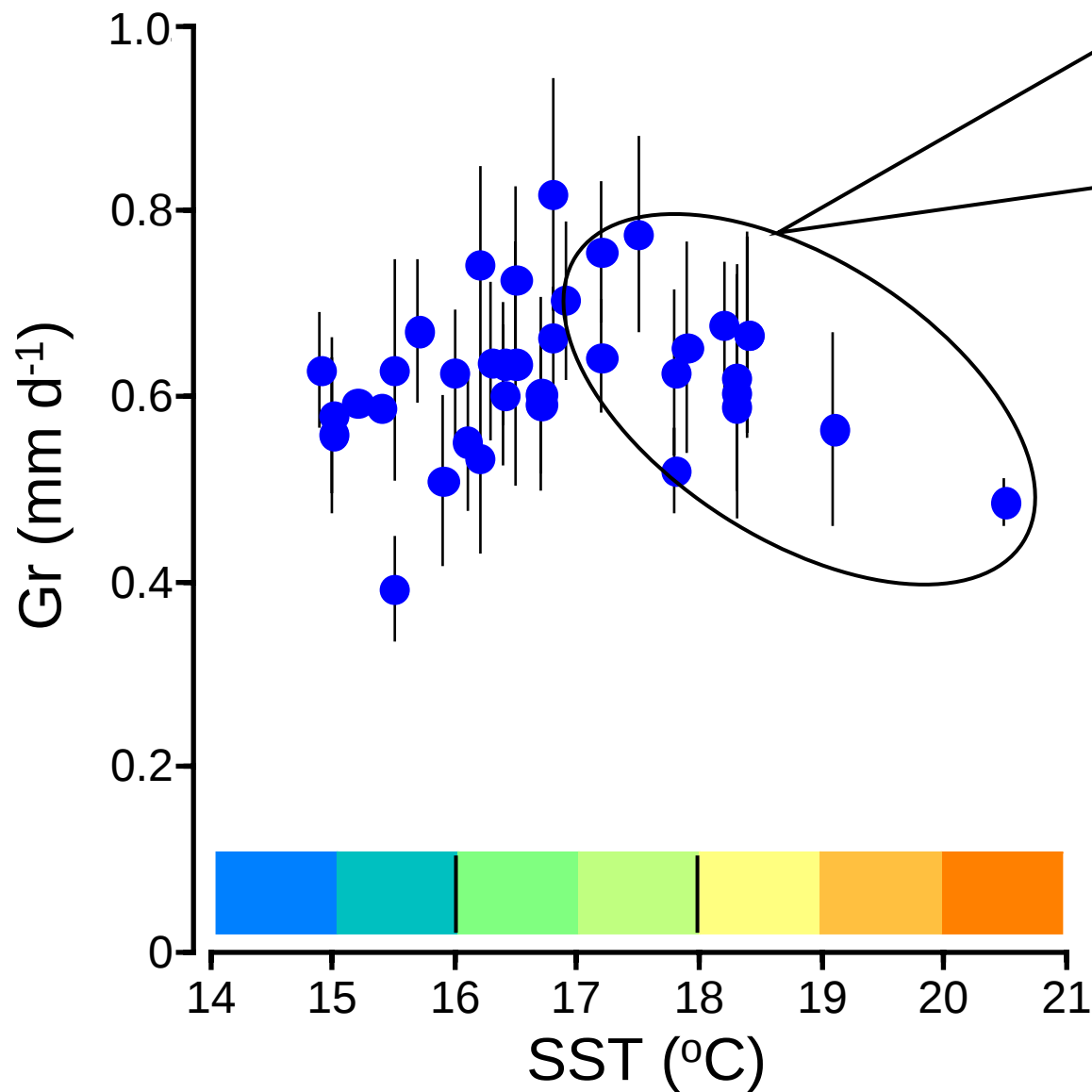
● 3 trawl hauls a night

SST range : 12 - 22°C

Gr and available copepod density



Gr and SST



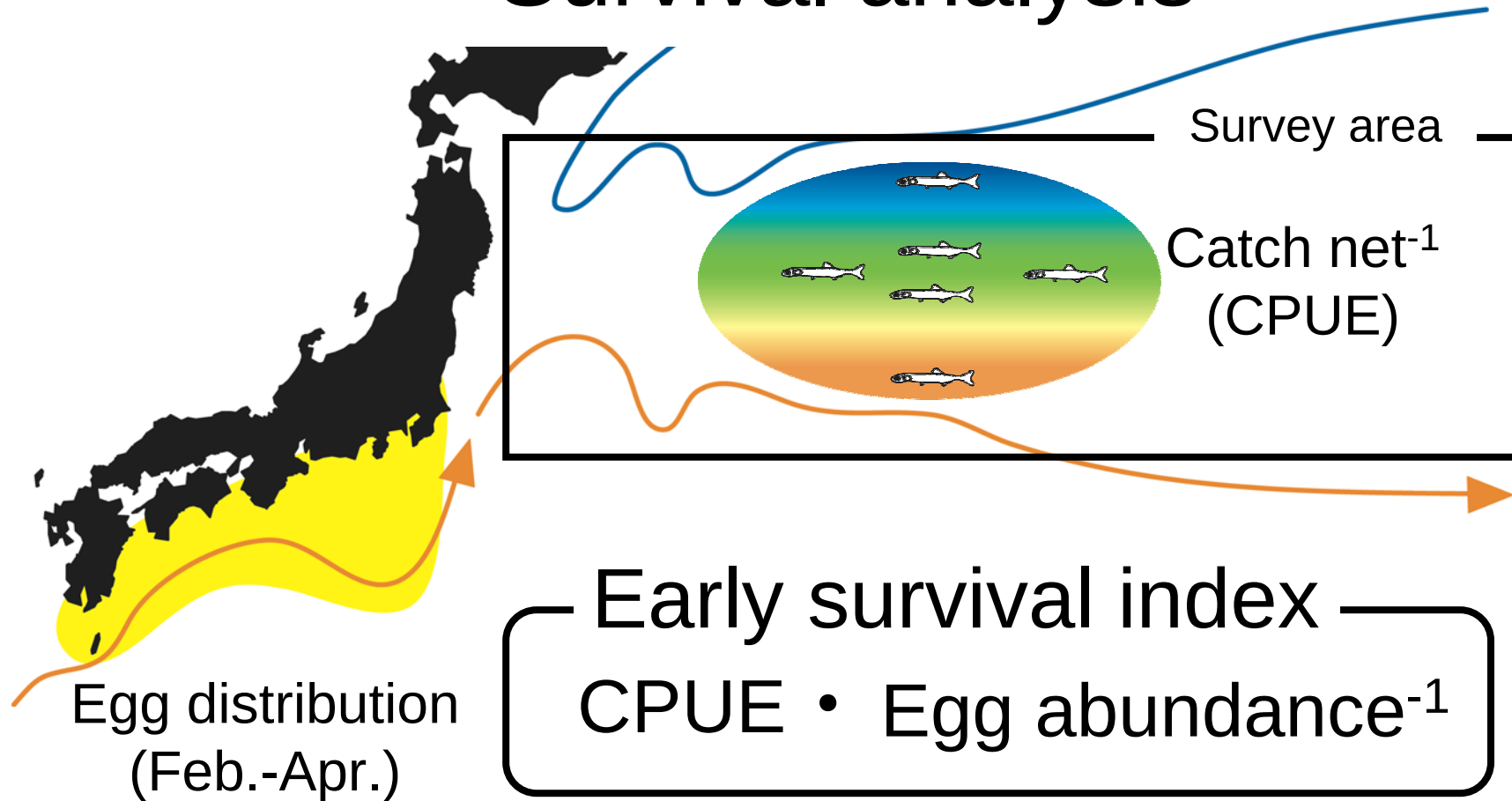
16 - 18 $^{\circ}\text{C}$

Preferable to growth

< 16 $^{\circ}\text{C}$, 18 $^{\circ}\text{C}$ <

Cold/warm for growth

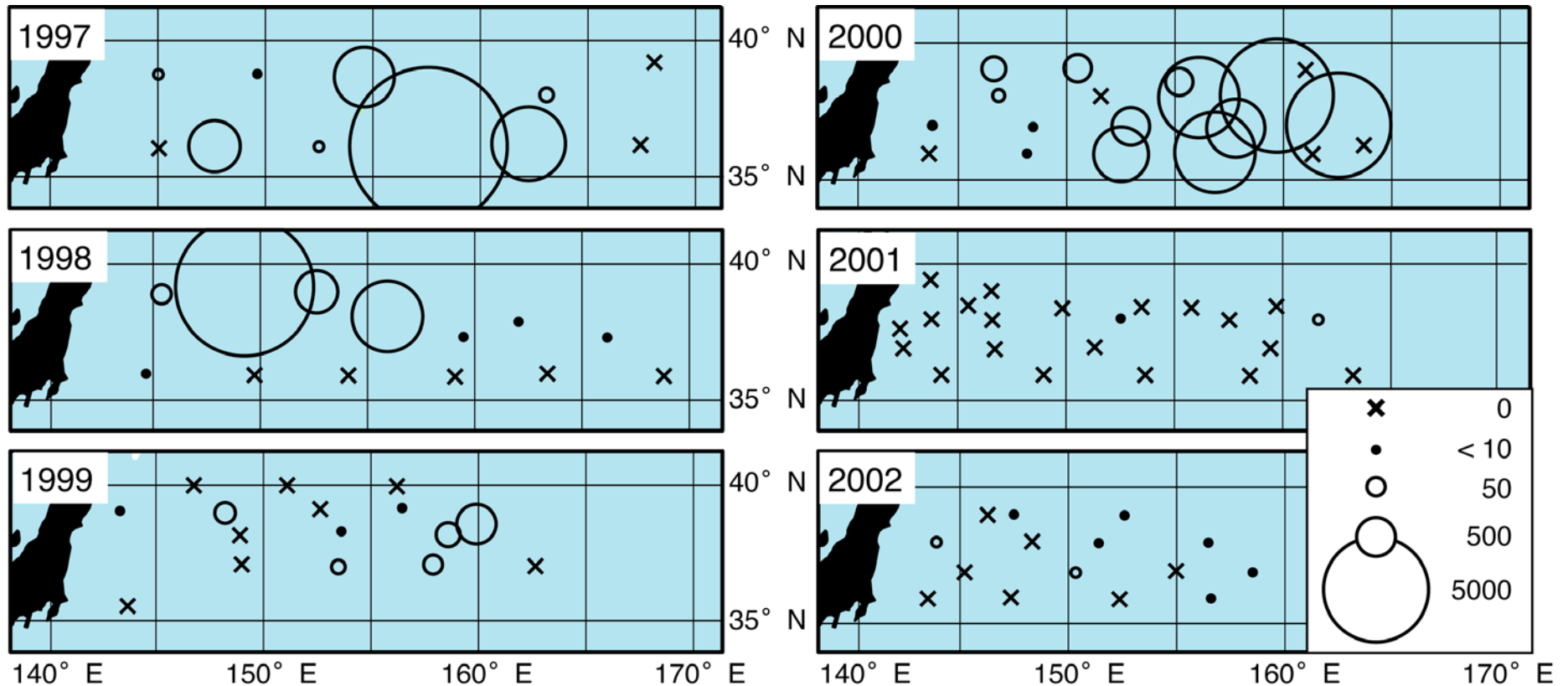
Survival analysis



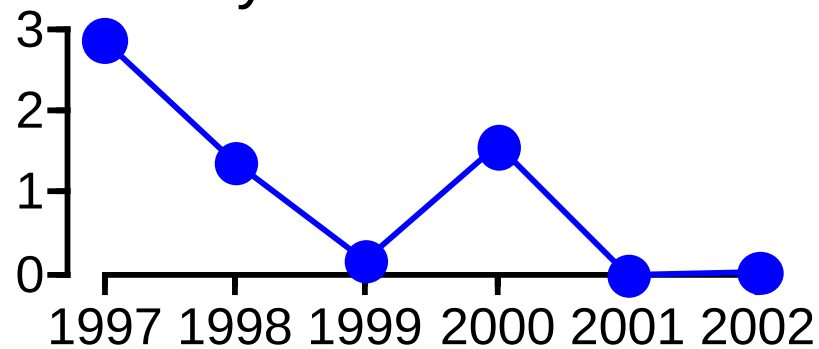
Abundance index (t=SST)

$$\sum_{t=10}^{20} CPUE(t) \cdot \text{Area}(t)$$

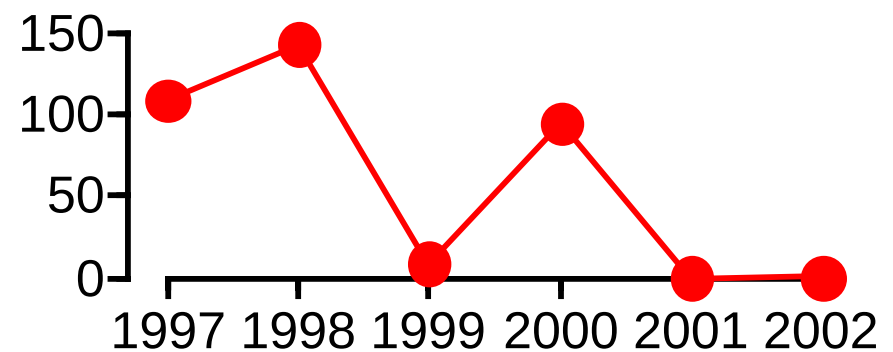
Survival and abundance index



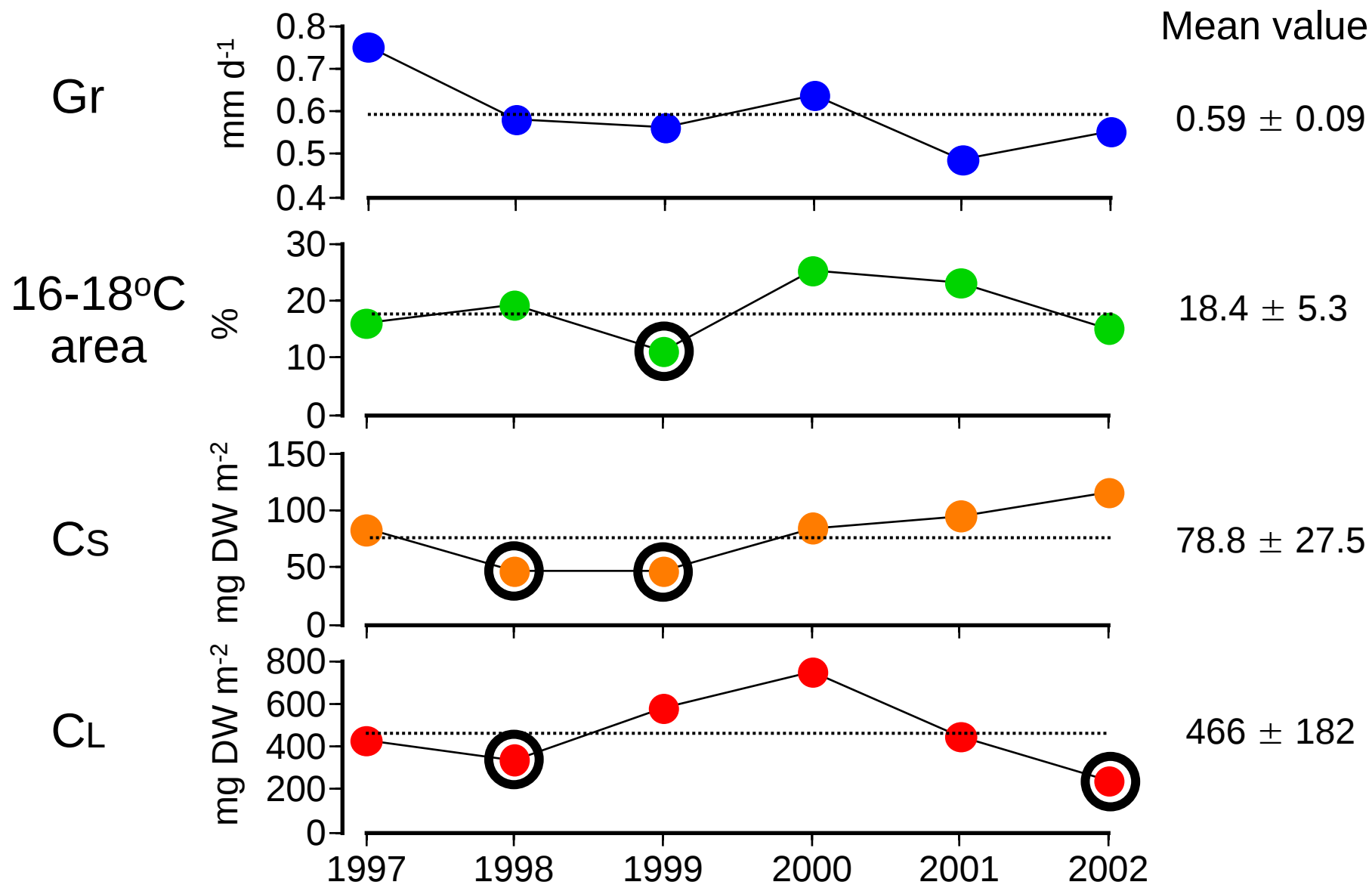
Early survival index



Juvenile abundance index

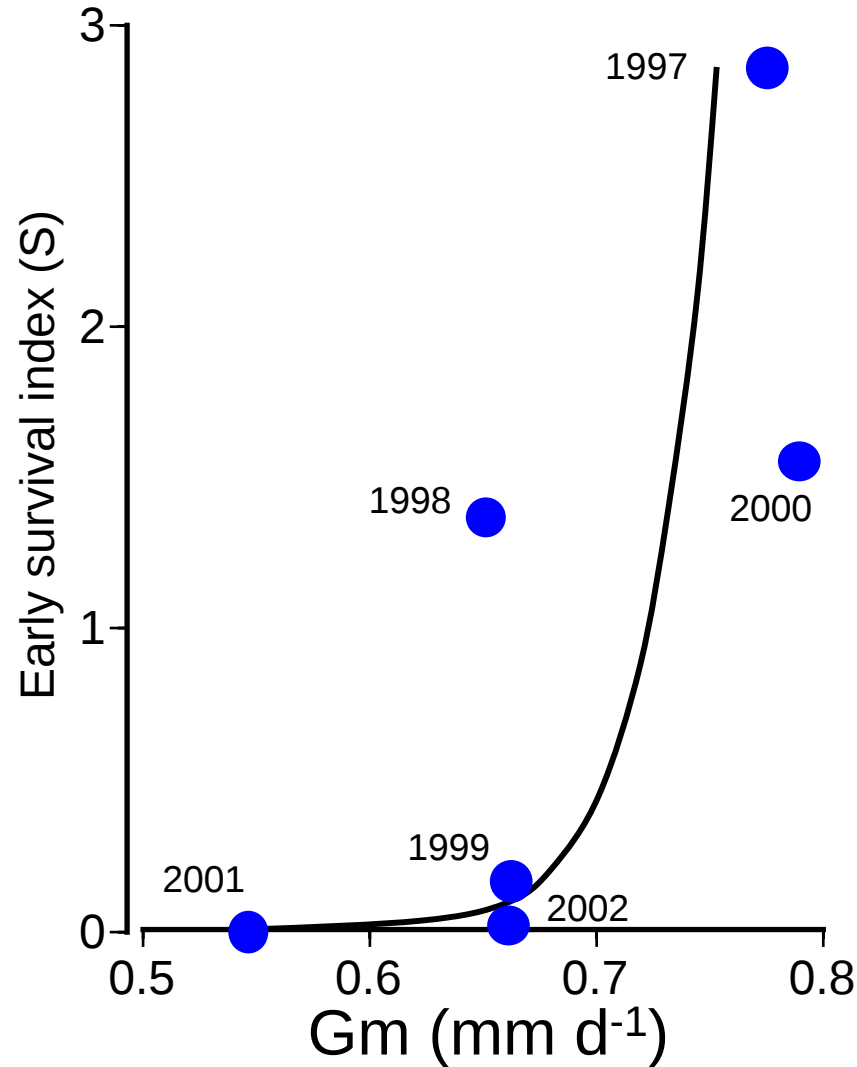


Gr and environmental conditions

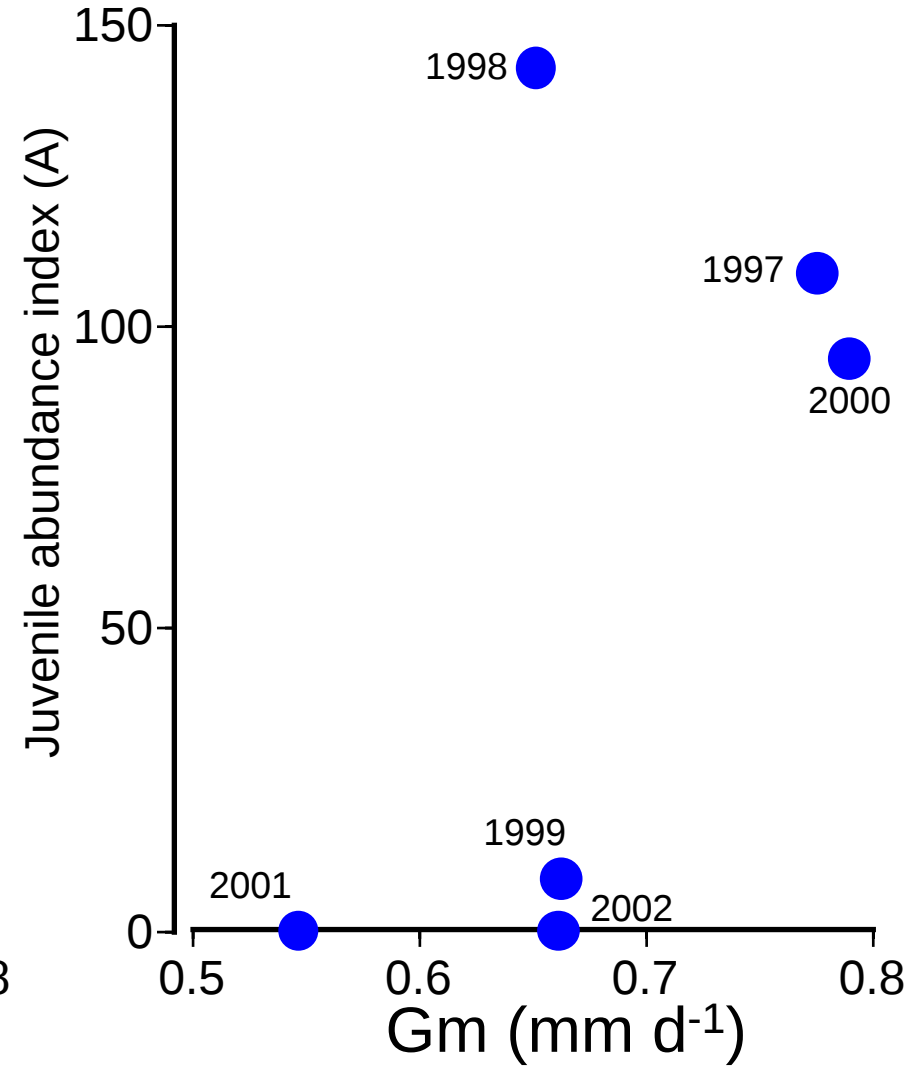


Gm and juvenile abundance

$Gm = 0.72 S^{0.04}$
(n=6, r=0.85, **P=0.031**)



$Gm = 0.62 A^{0.04}$
(n=6, r=0.76, P=0.081)



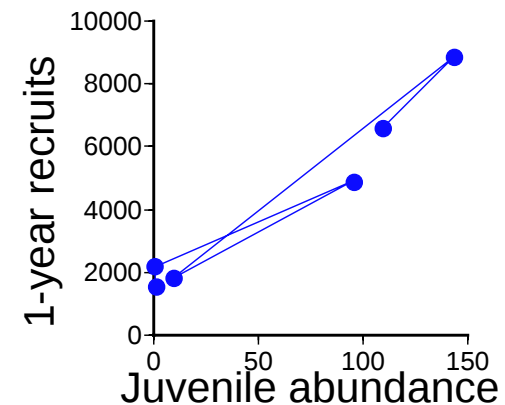
Conclusion 1

Gr $\equiv$ Gm $\longleftrightarrow$ $\left[\begin{array}{c} \text{Small} \\ \text{Large} \end{array} \right]$ copepod density

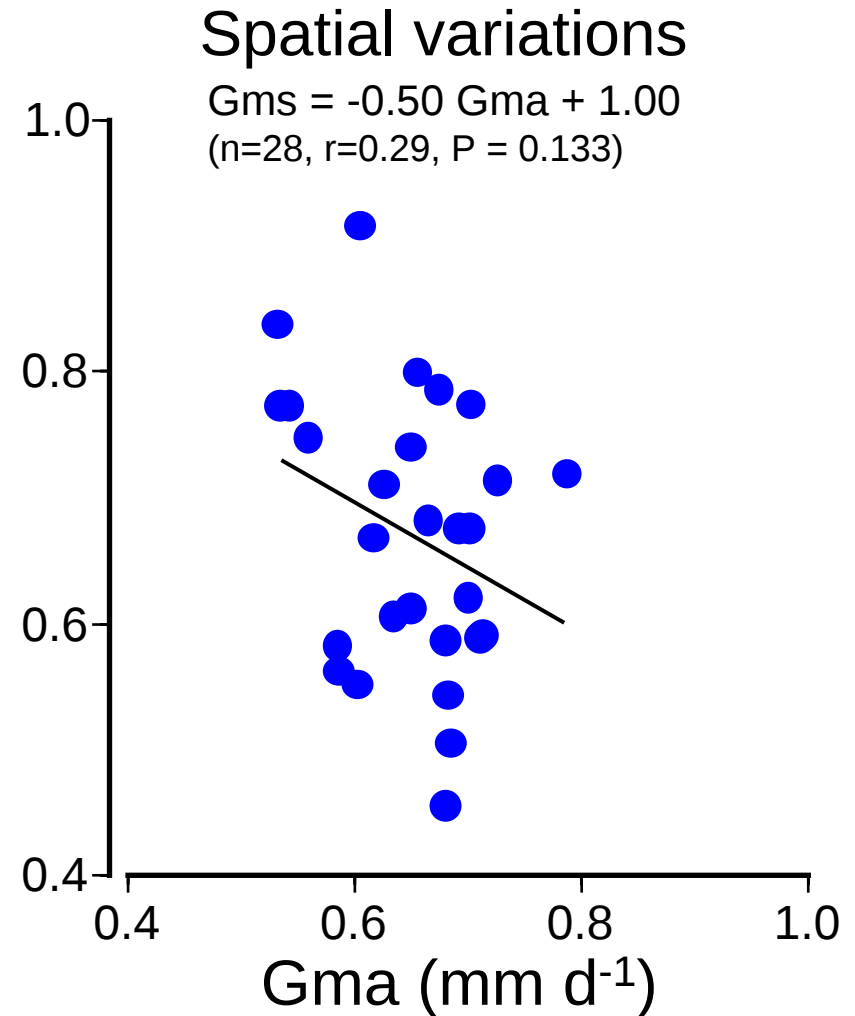
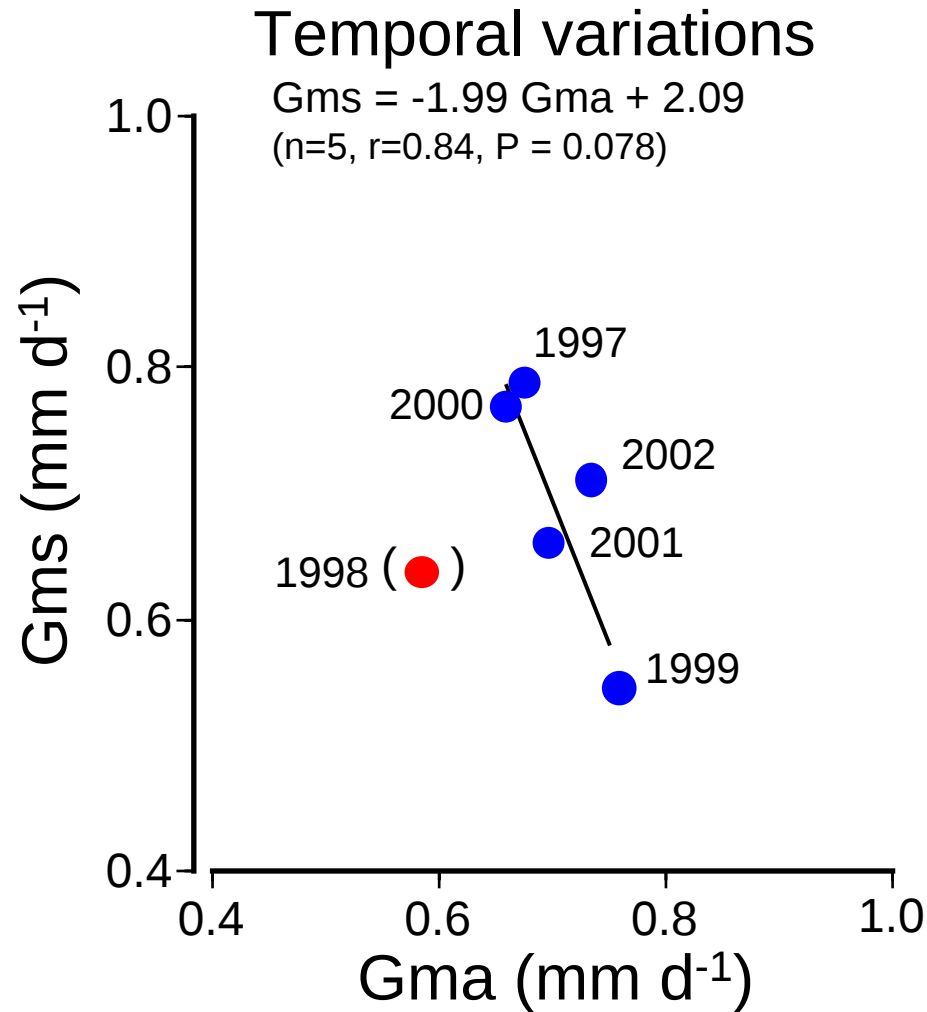
SST < 16°C 16 - 18°C 18°C <

	1997	1998	1999	2000	2001	2002
Gm	++	-	-	++	--	-
SST	-	+	--	++	++	-
Cs	+	--	--	+	++	++
CL	-	--	+	++	-	--

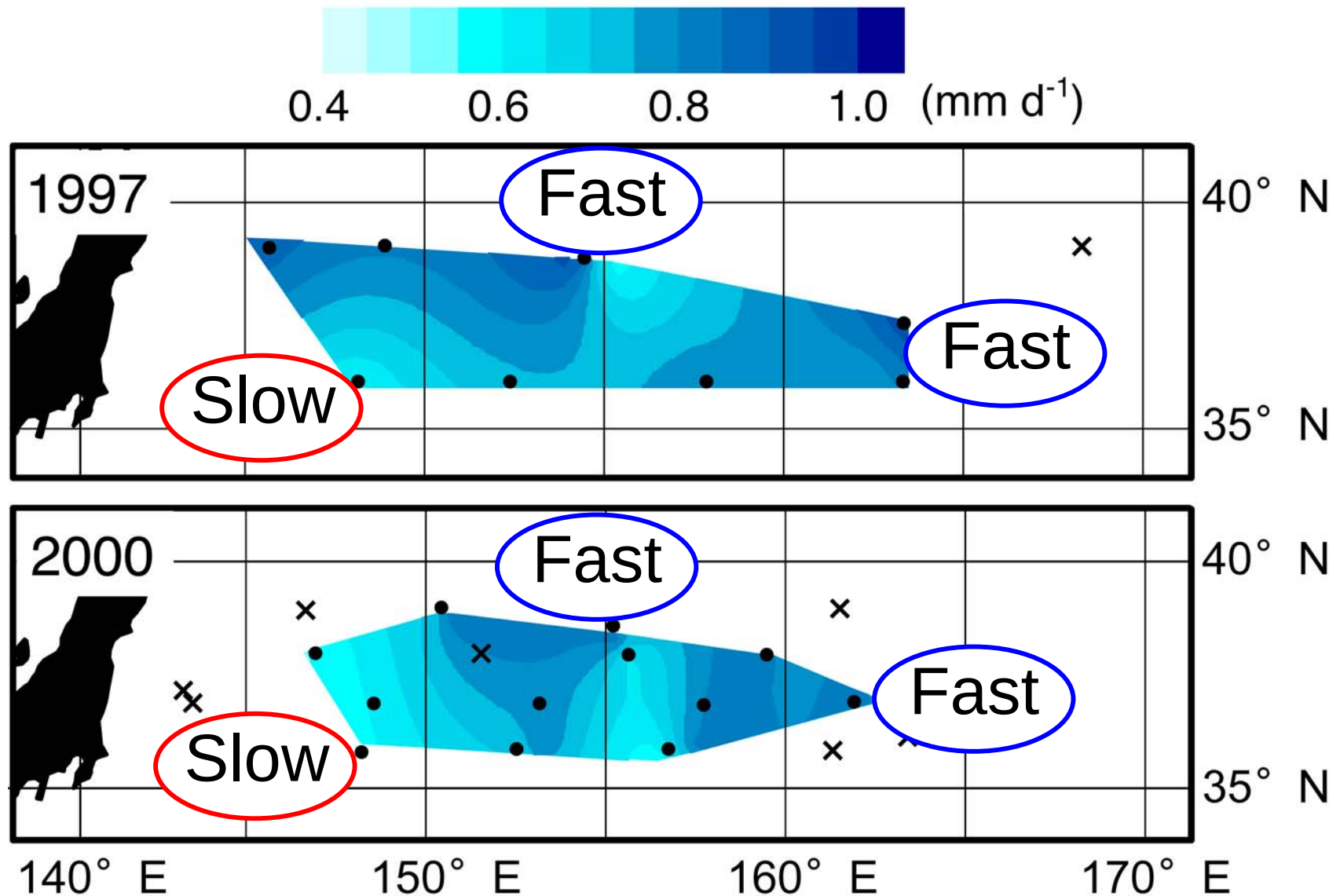
Gm $\longleftrightarrow$ Early survival rate
 Juvenile abundance
 $\updownarrow$
 1-year recruits



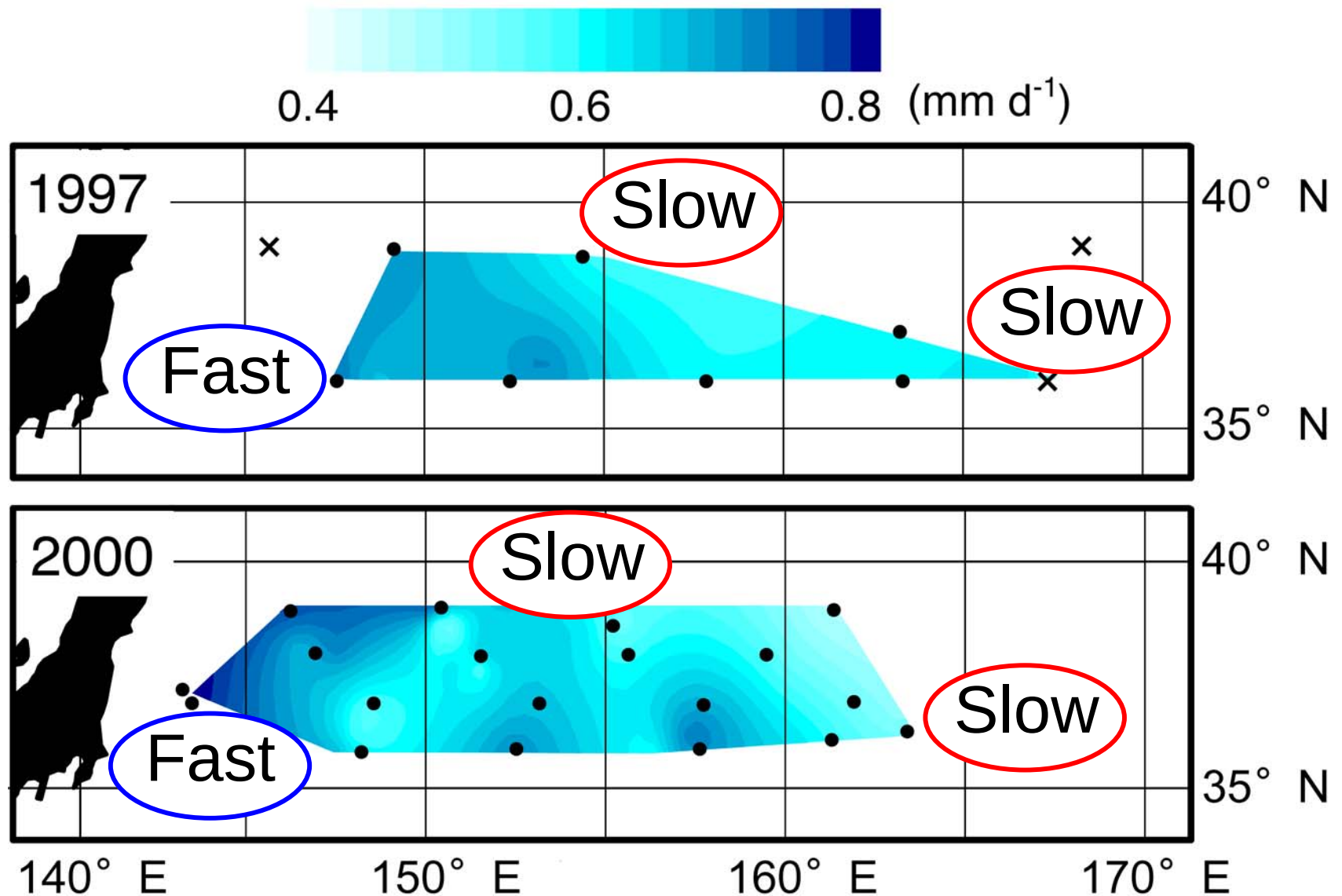
Growth rate comparison between sardine (Gms) and anchovy (Gma)



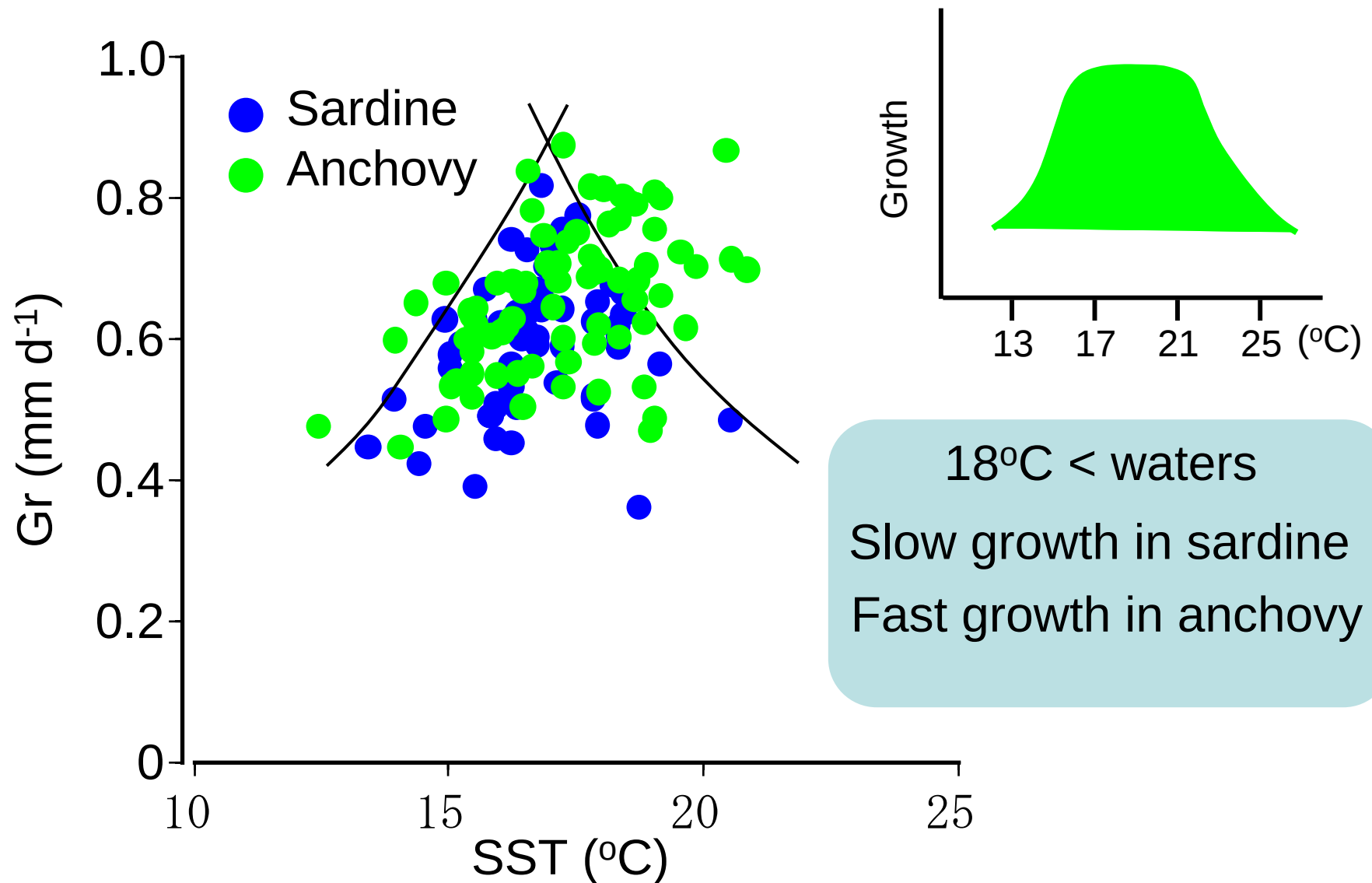
Spatial variation in Gm



Spatial variation in Gm of juvenile anchovy



SST and Gr of sardine/anchovy



Conclusion 2

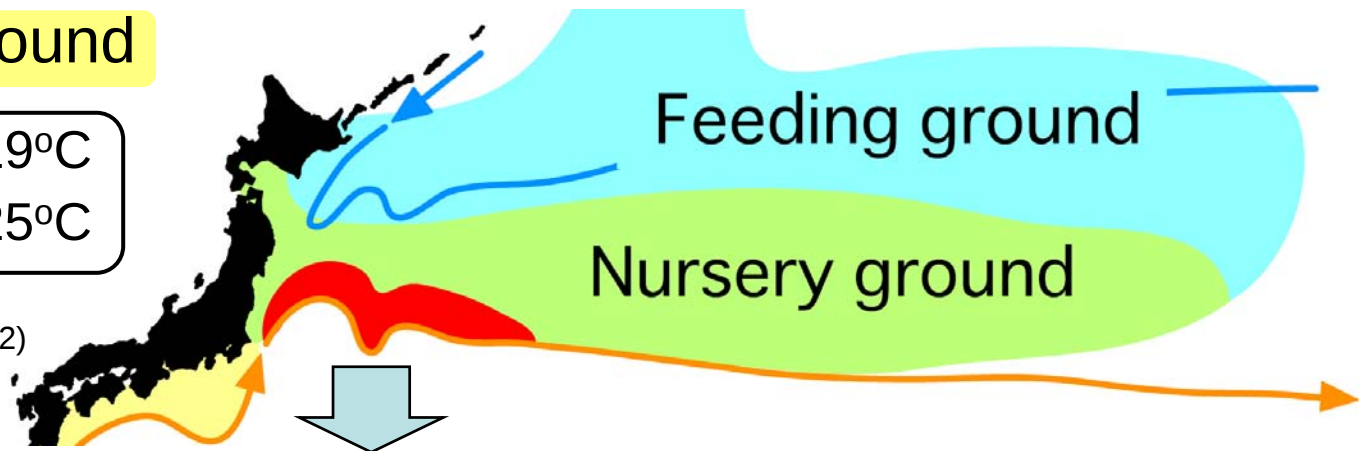
Sardine growth was a spatially and temporally negative function of anchovy growth

Spawning ground

Sardine 16-19°C
Anchovy 15-25°C

(Zenitani 2001)

(Tsuruta & Takahashi 1992)



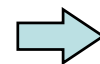
Regulation of entering the nursery ground

Available prey

SST

Rich

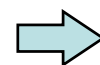
16-18°C



Sardine

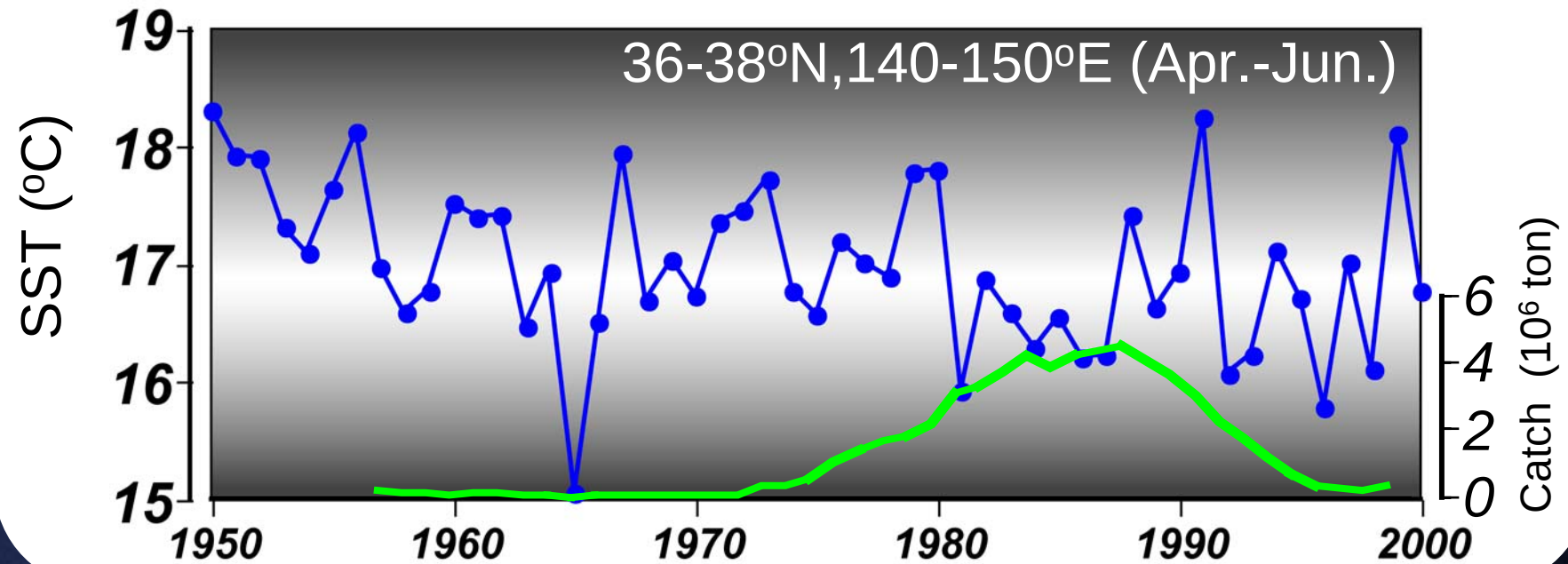
Rich

18°C <



Anchovy

Interannual variation in SST in the southwestern waters



Growth and survival in the Kuroshio-Oyashio transition region

