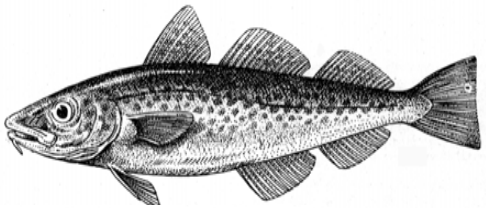
Baltijas jūras centrālās daļas ekosistēmas galvenoo zivju krājuma stāvoklis un to izmaiņu cēloņi

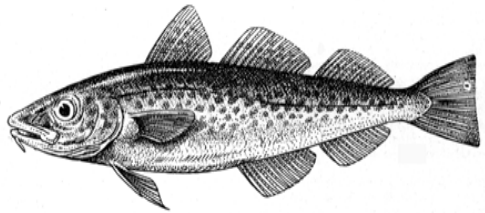
26th Annual Larval Fish Conference, Bergen July 2002

Process-oriented studies of Baltic cod recruitment

F. Köster, G. Kraus, H.-H. Hinrichsen,
J. Tomkiewicz, C. Möllmann, R. Voss,
E. Trippel, B. MacKenzie, A. Nissling,
M. Plikshs & M. St.John

Helsinki
Tallinn
Riga
Stockholm
Ar
Lysekil
Charlottenlund
Arhus
St. Andrews
Kaliningrad
Gdynia
Warnemünde
Kiel
Rostock
Hamburg





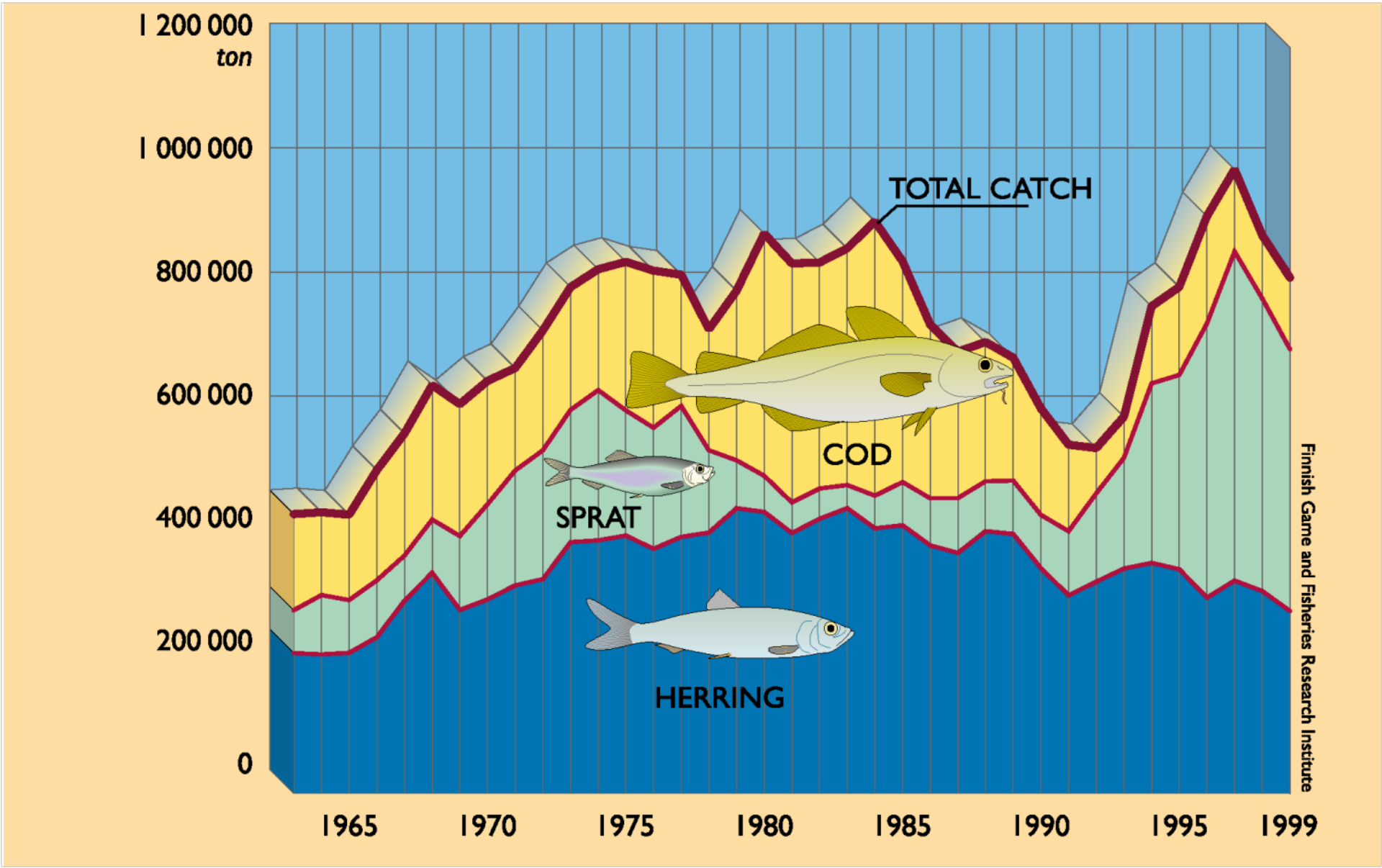
BASYS – Baltic Sea System Study –

Baltic CORE STORE Baltic Project

BECAUSE

GLOBEC Germany

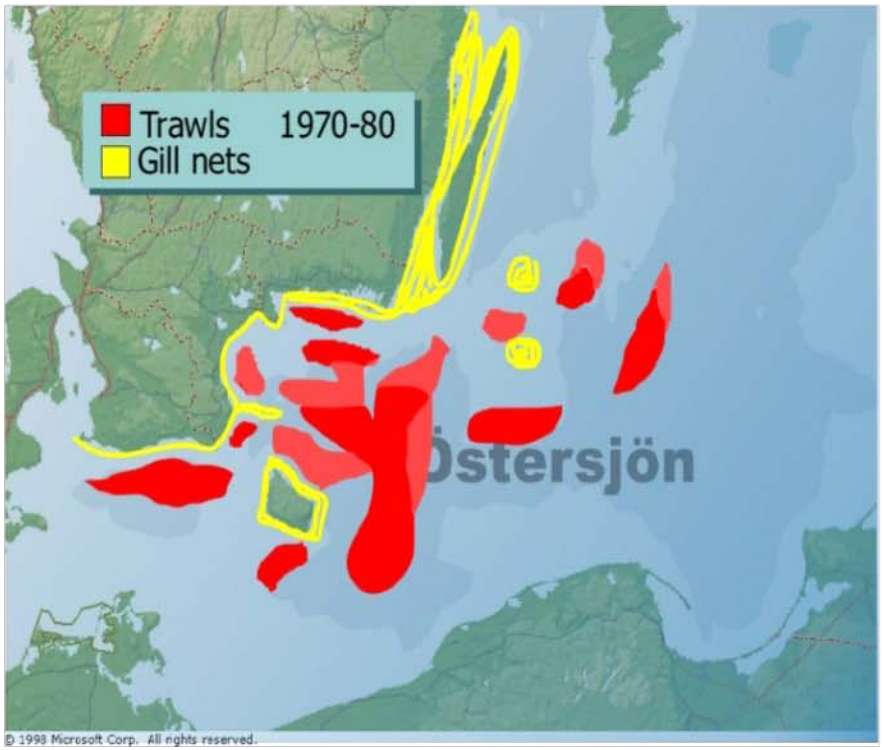
Zivju nozvejas

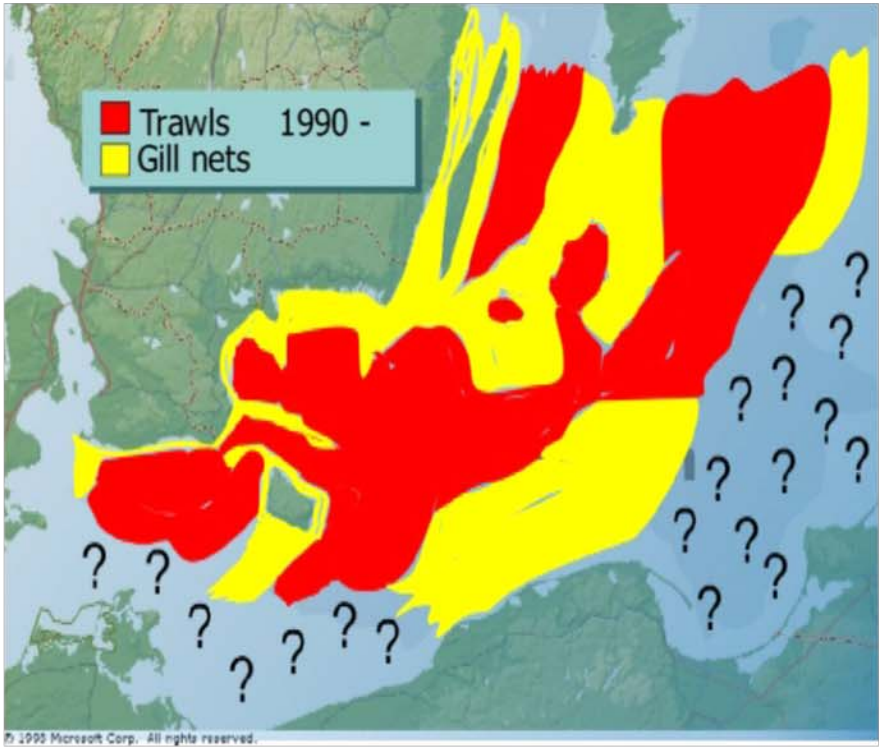


Zivju nozvejas

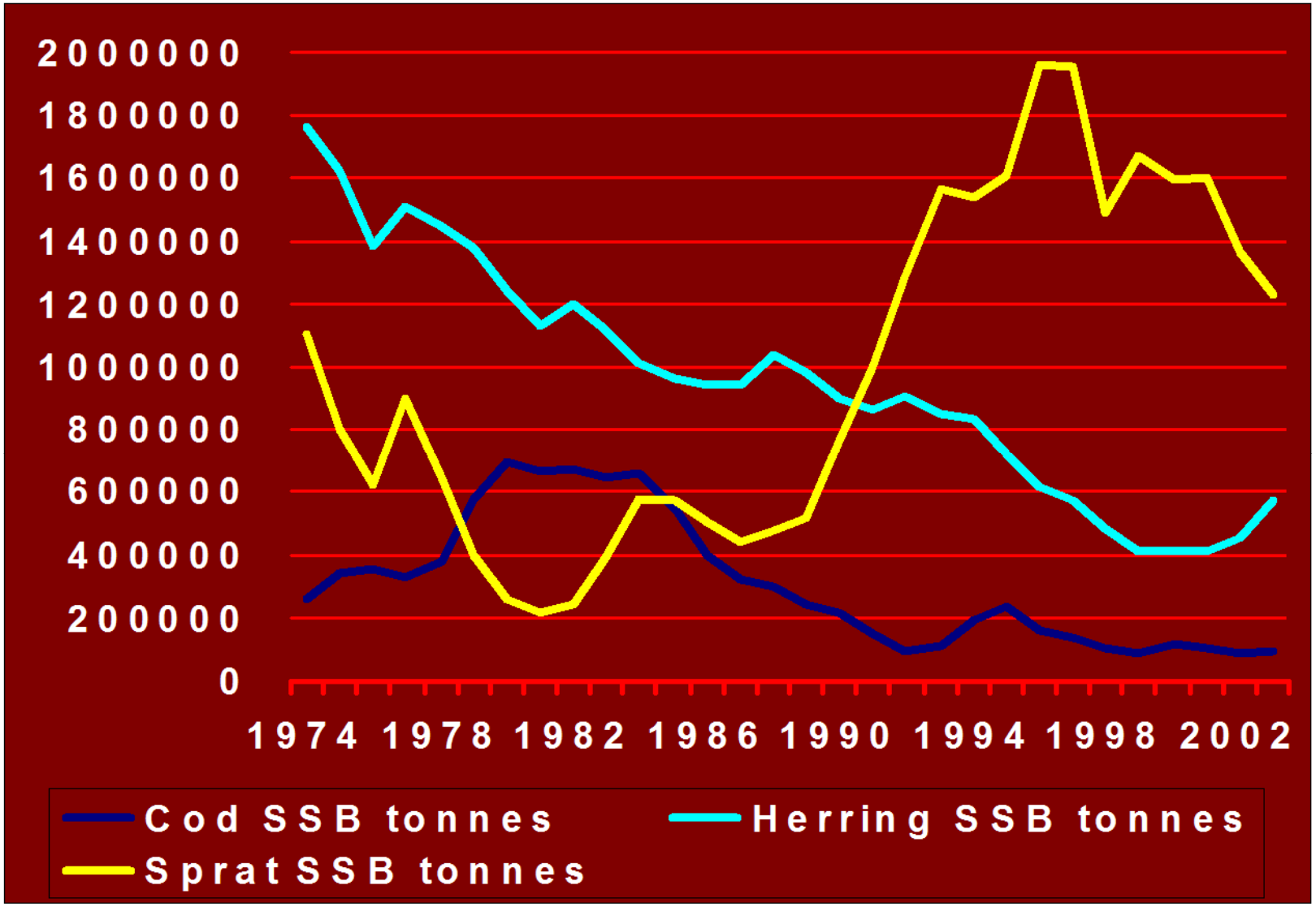
Changes in fishery….
When research and management actions in 1990s were almost completely focused on cod trawl fleet -

Gillnet fishery was expanding and developing!





Zivju nārsta krājuma dinamikas



Mencas loma ekosistēmā

Death in the Baltic Sea ecosystem in 1980 and 2000 (tonnes)

	1980 Herring	1980 Sprat	1980 Cod	2000 Herring	2000 Sprat	2000 Cod
Yield	280 000	58 000	350 000	175 000	390 000	90 000
Eaten by cod	359 000	183 000	143 000	52 000	148 000	4 000
Other causes	356 000	62 000	83 000	202 000	286 000	47 000
Total	995 000	303 000	576 000	429 000	473 000	141 000

Mencas loma ekosistēmā

Effects of cod predation in 1980s in the northern Baltic

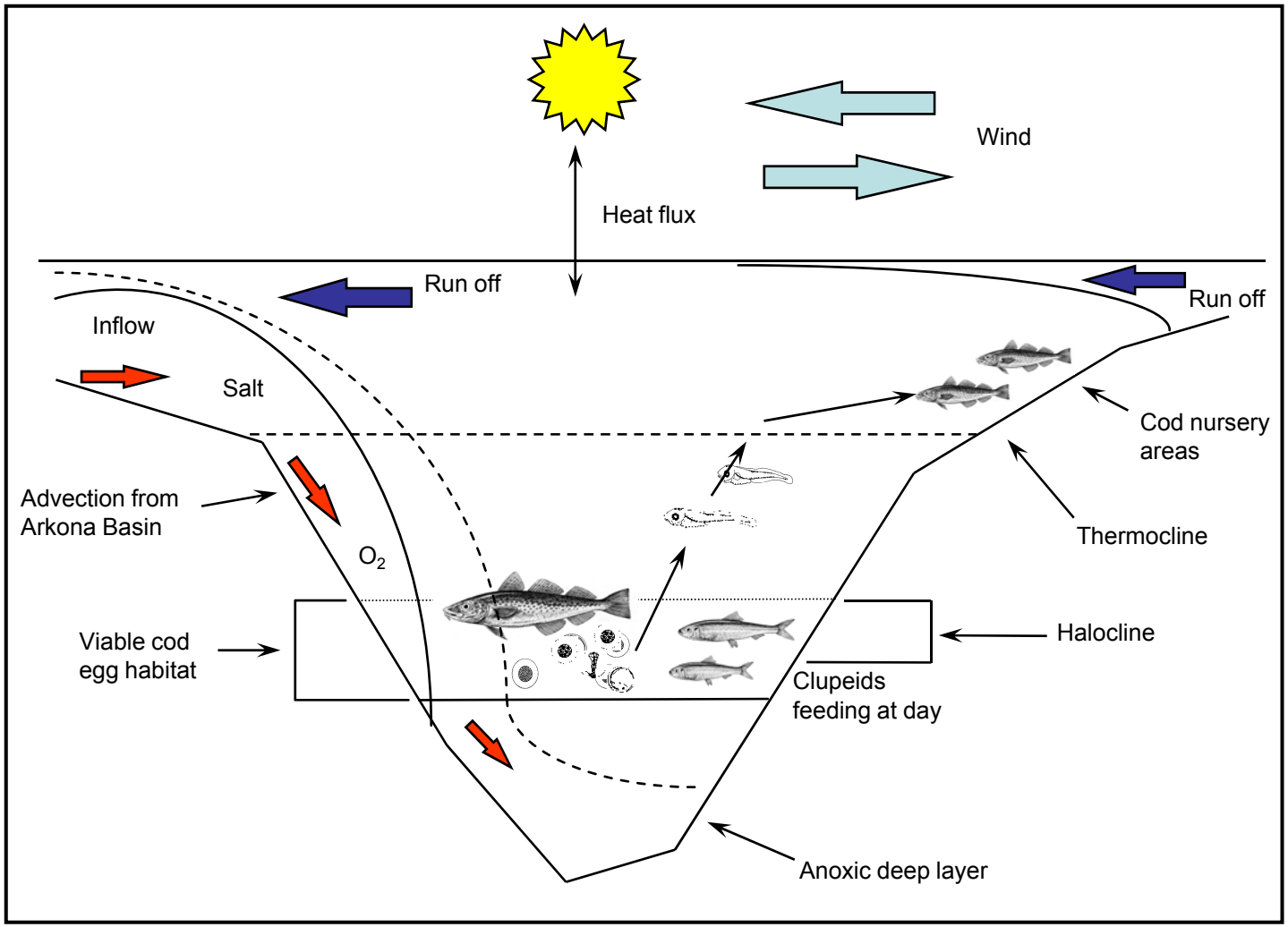
Other food used by cod (~1.5 million tonnes/year)

COD IS A VACUUM CLEANER

- **Fourhorn sculpin stocks depleted**
- **Eel-pout stocks depleted**
- **Sand goby stocks depleted**
- **Sand eel stocks depleted**
- **Snakeblenny disappeared**
- **Butterfish disappeared**

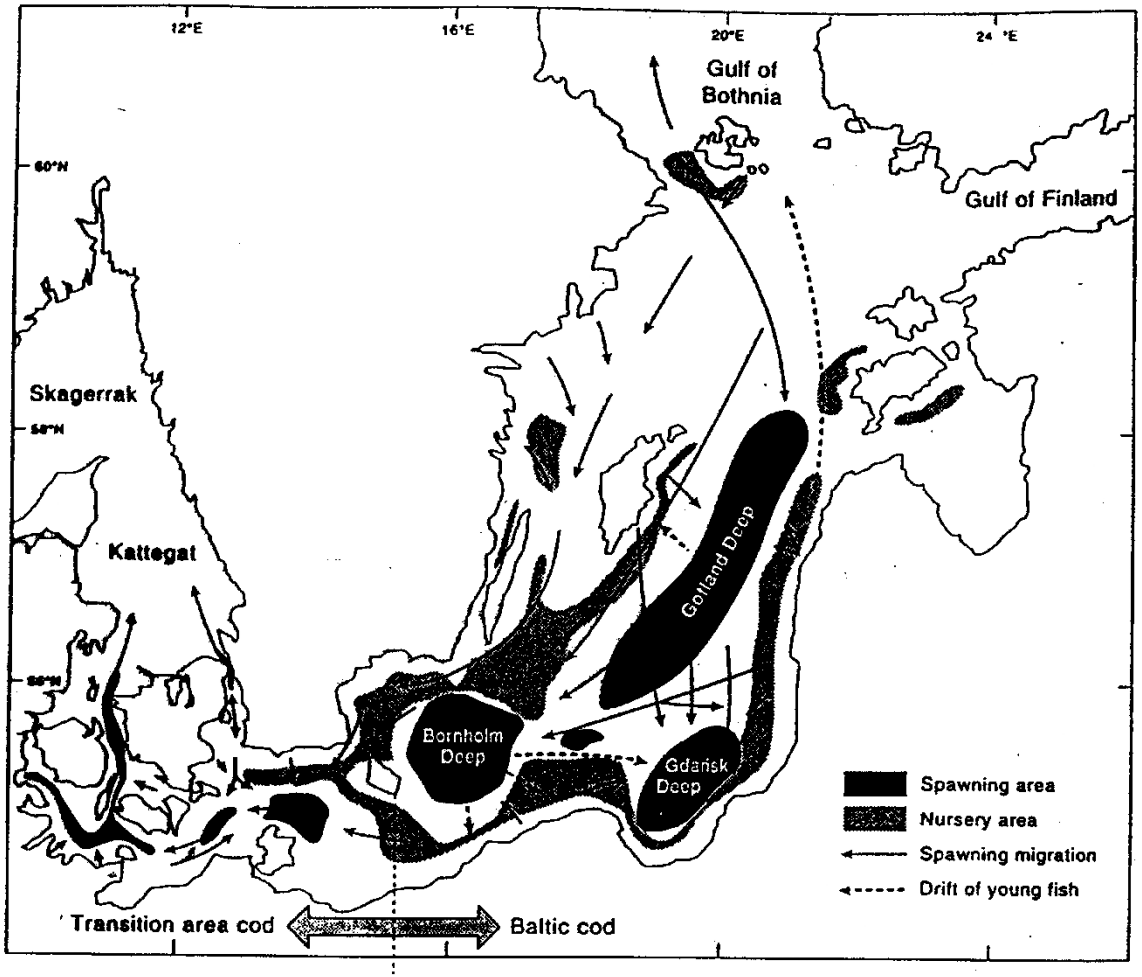
- **Recovery of these stocks observed in late 1990s**

A CENTRAL BALTIC BASIN SYSTEM



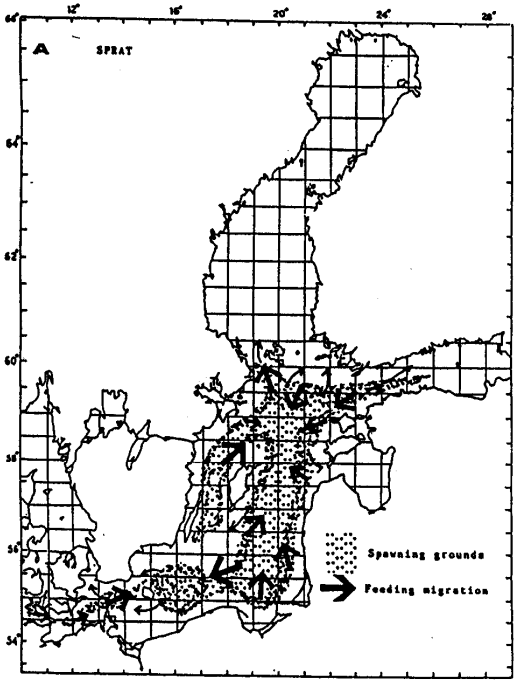
Izplatība un migrācijas

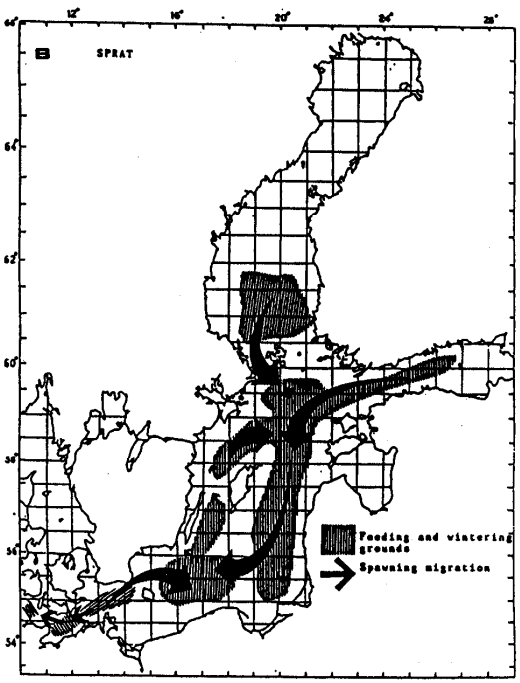
Menca

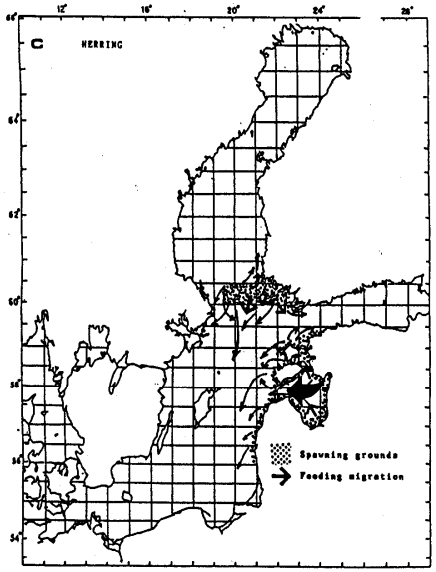


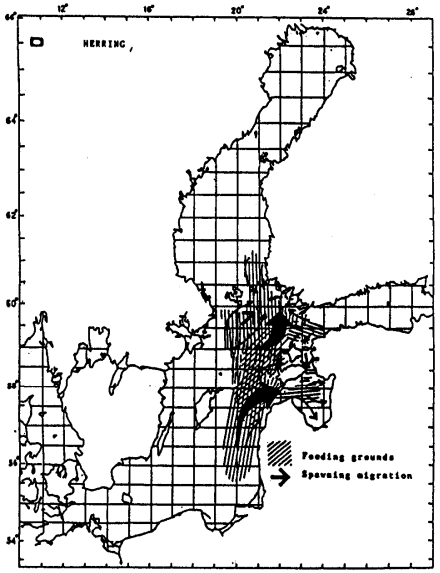
Izplatība un migrācijas

Reņģe









Brētliņa

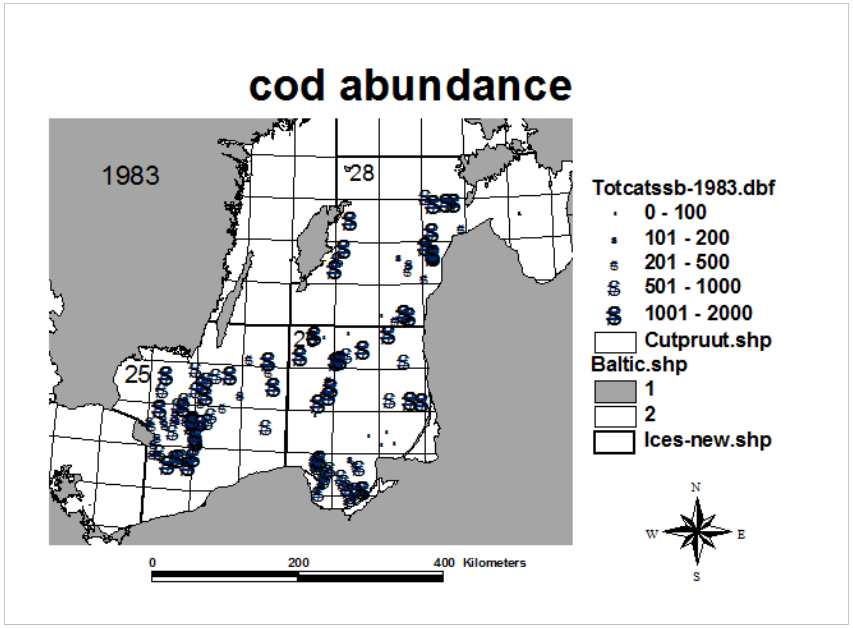
Mencas izplatība

High year in 1983

SSB: 671 000 t

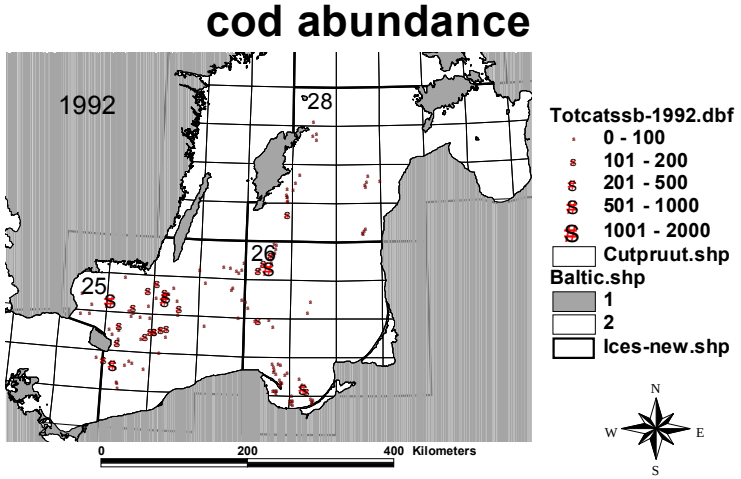
Cod distribution and abundance

in 1983 and 1992 in SDs 25, 26 and 28

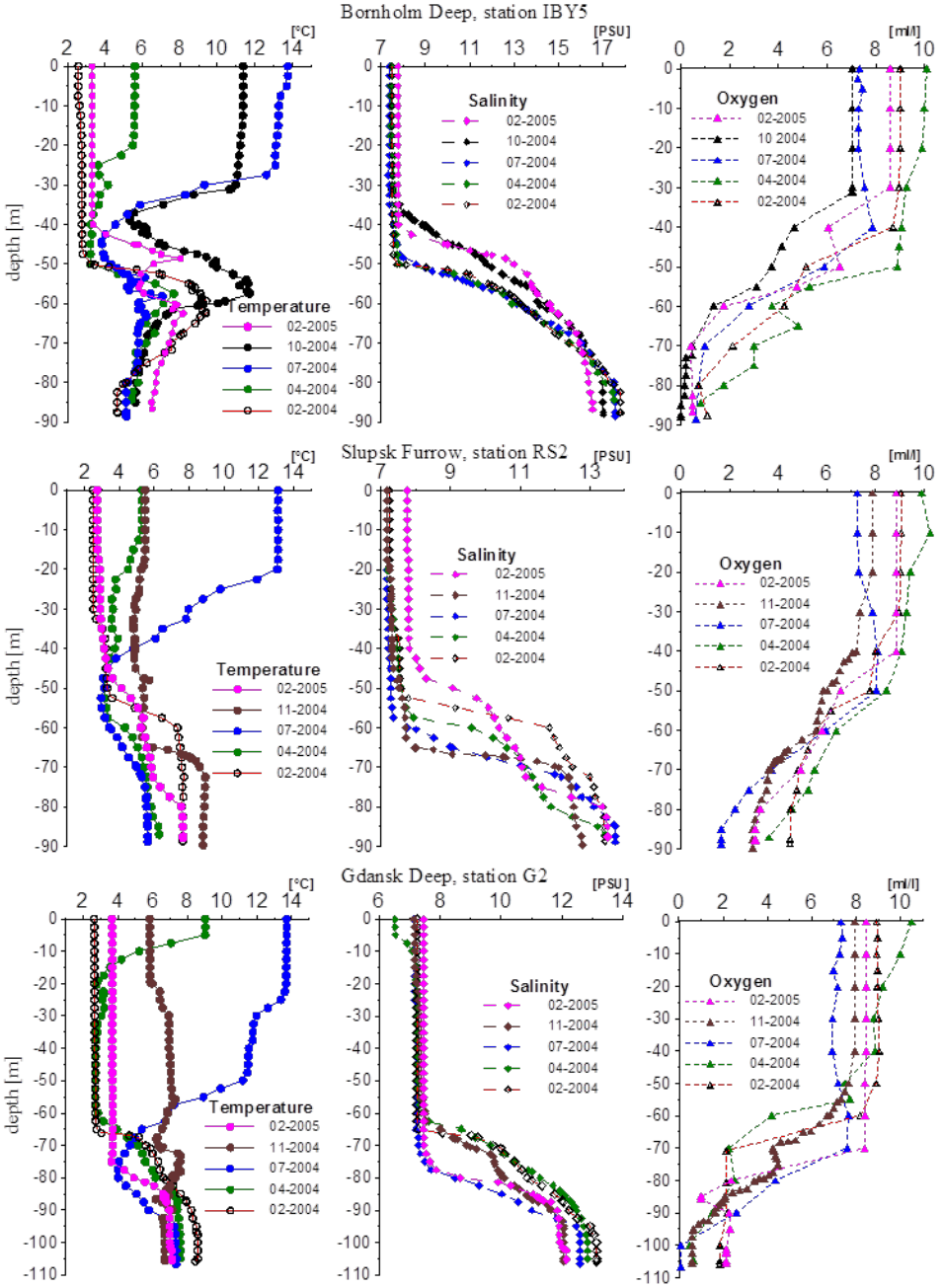


Low year in 1992

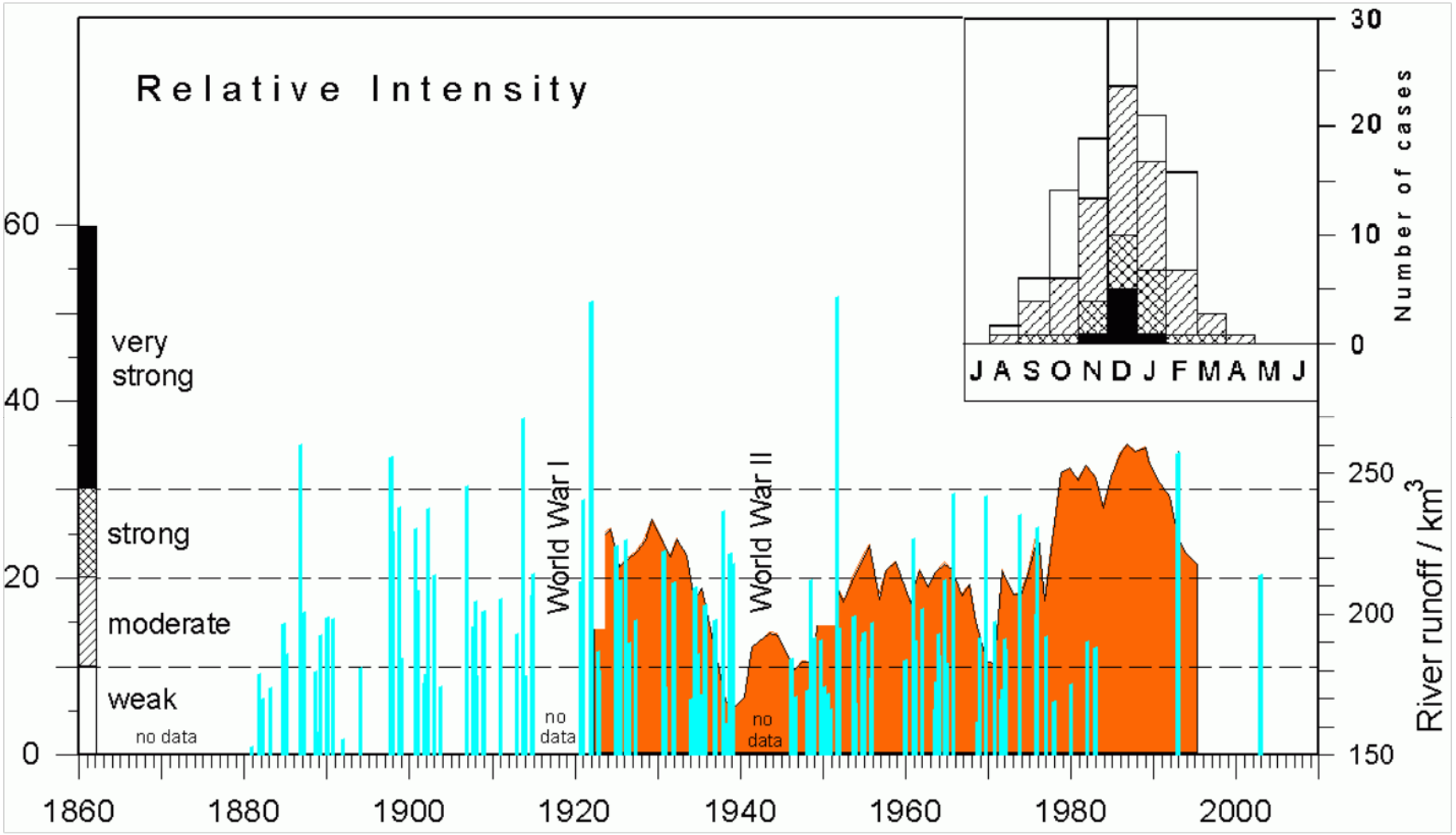
SSB: 92 000 t



Hidroloģiskās īpatnības

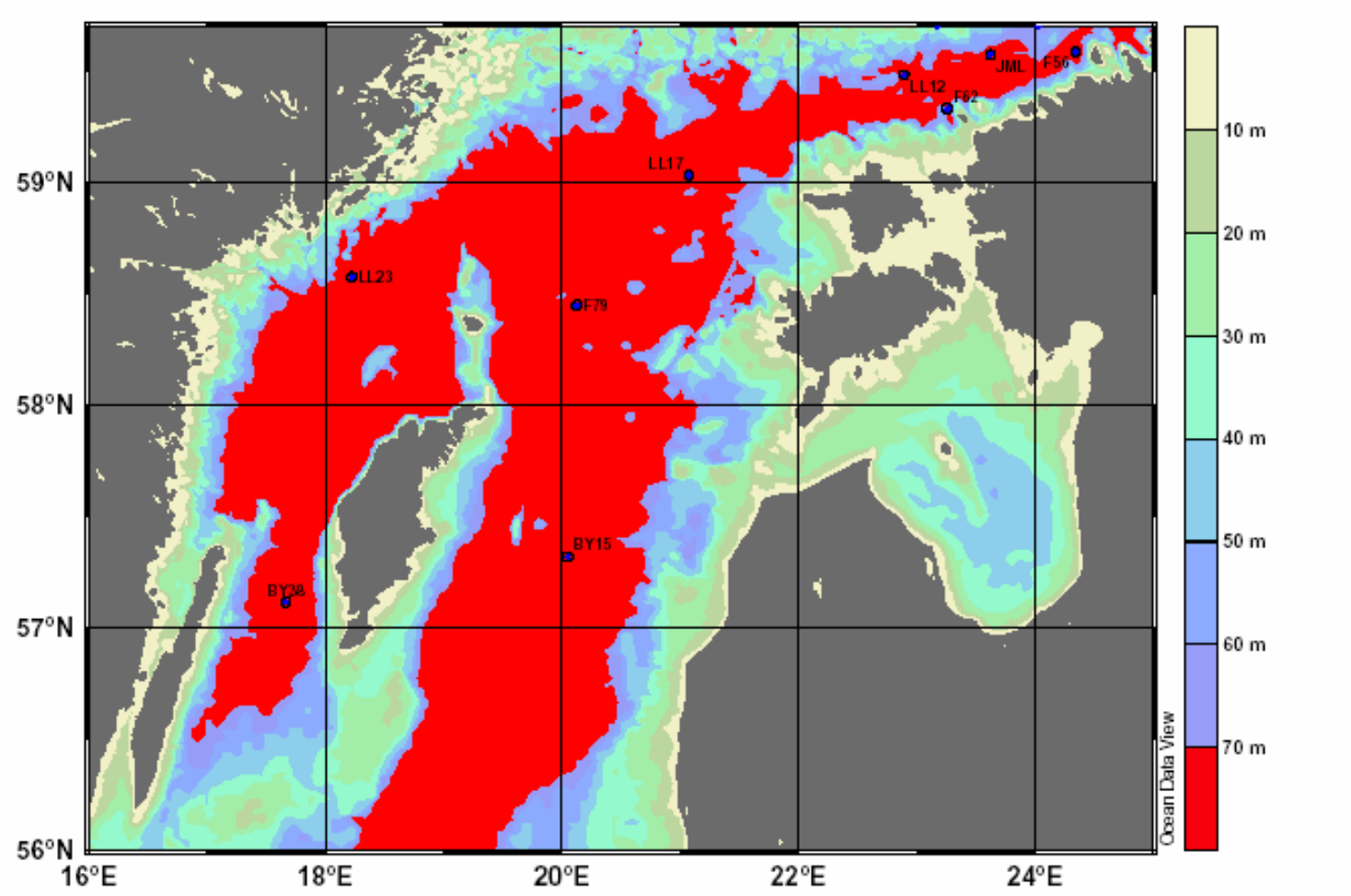


Hidroloģiskās īpatnības

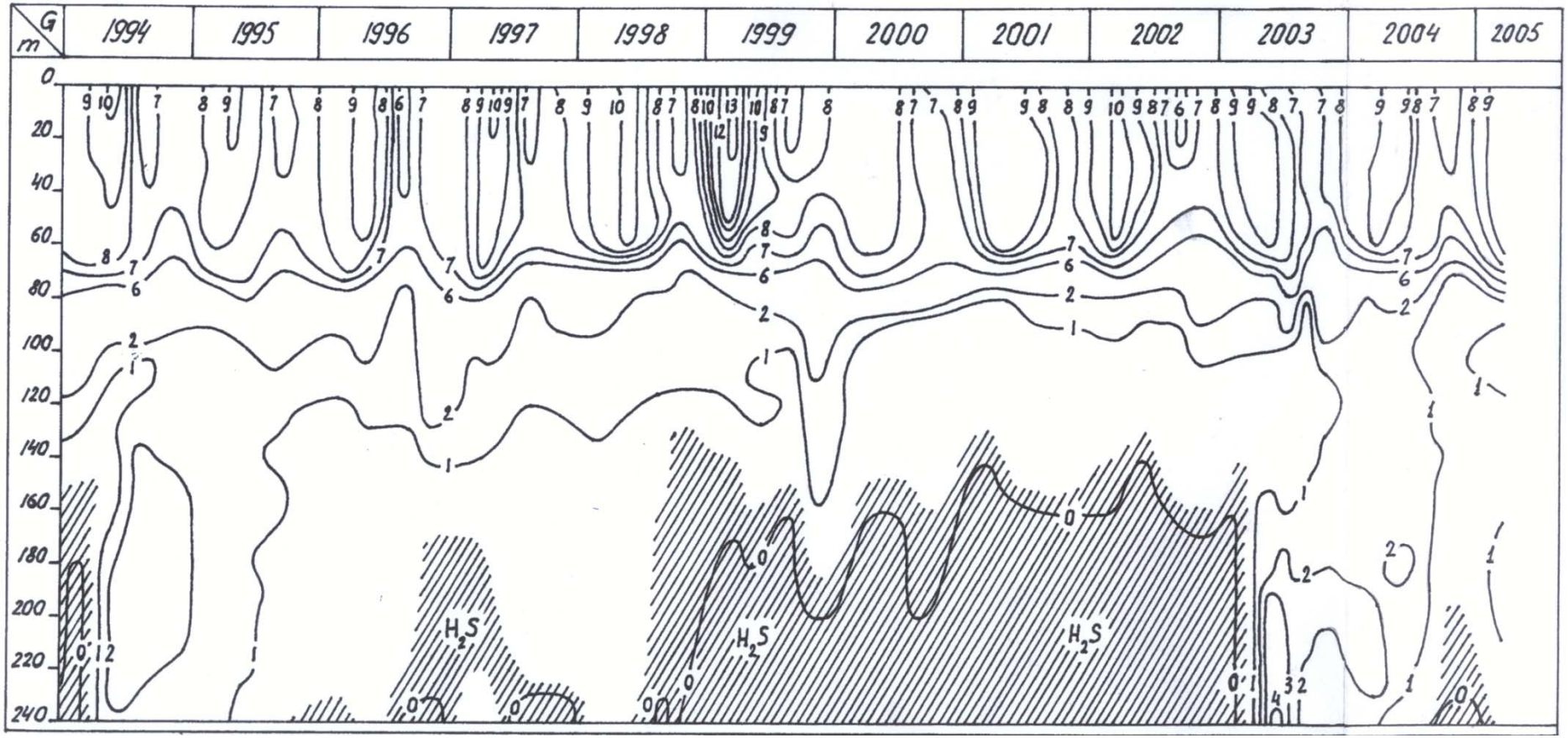


Hidroloģiskās īpatnības

Presently in the Baltic Main Basin there is very little oxygen. Below 70 m depth there is no oxygen or less than 2ml/l (results summer 2004)



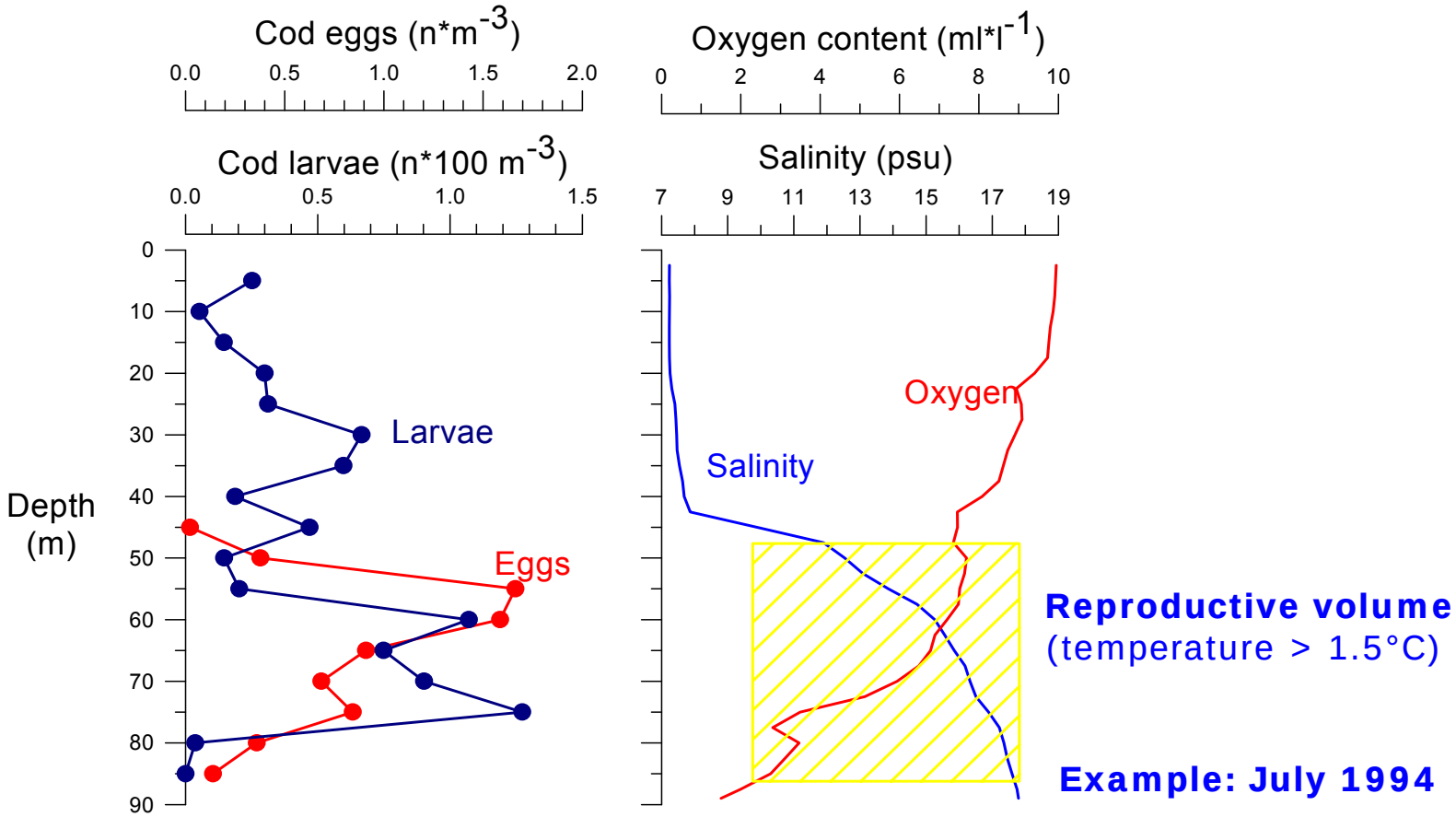
Hidroloģiskās īpatnības



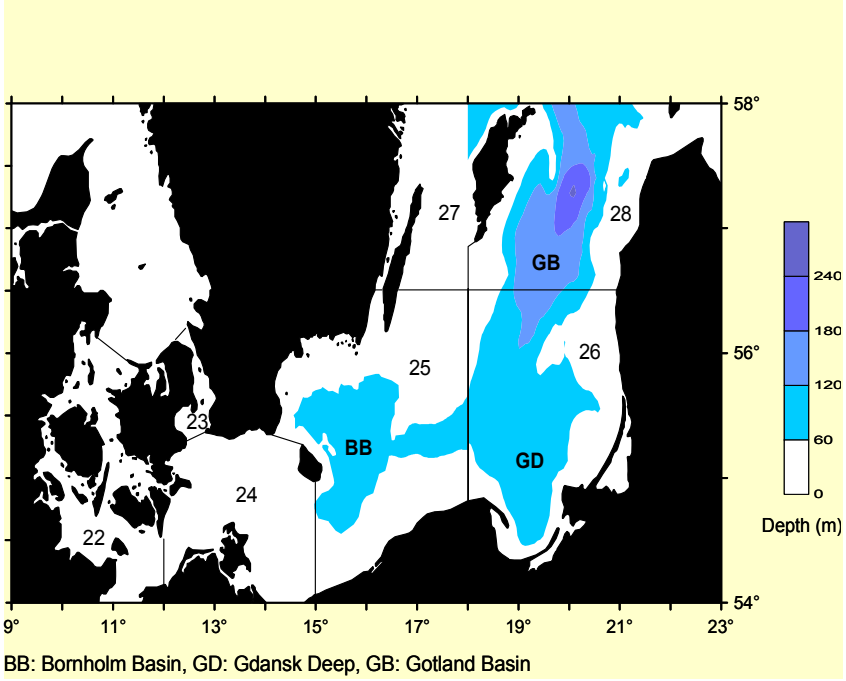
Skābekļa koncentrācijas (ml/l) izmaiņas Gotlandes ieplakas ziemeļos (37 stacija) 1994.-2005.gadā

VERTICAL DISTRIBUTION OF EGGS & LARVAE

Definition of the reproductive volume

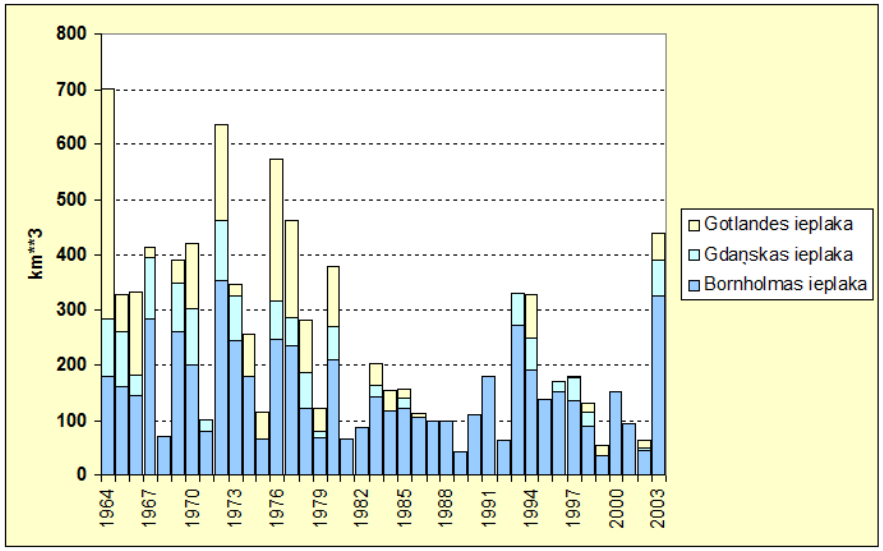


Hidroloģiskās īpatnības

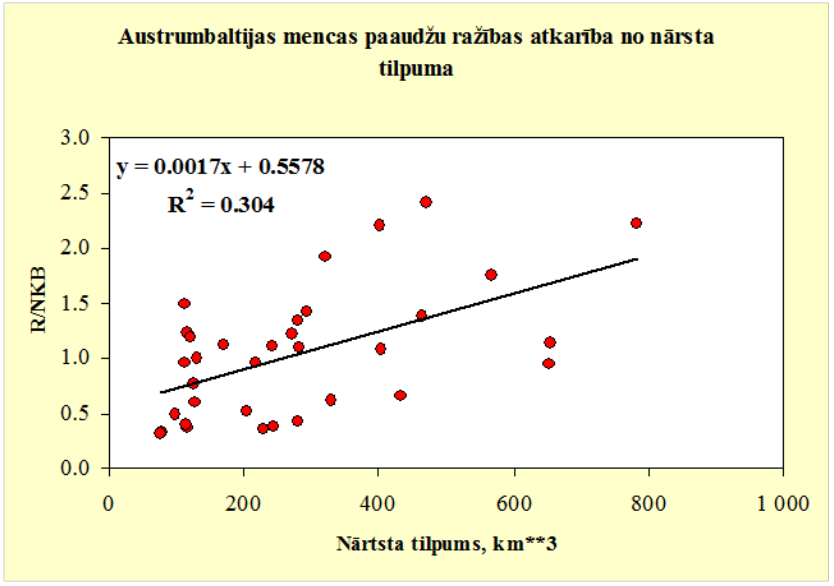


BB: Bornholm Basin, GD: Gdansk Deep, GB: Gotland Basin

Austrumbaltijas mencas nārsta vietas

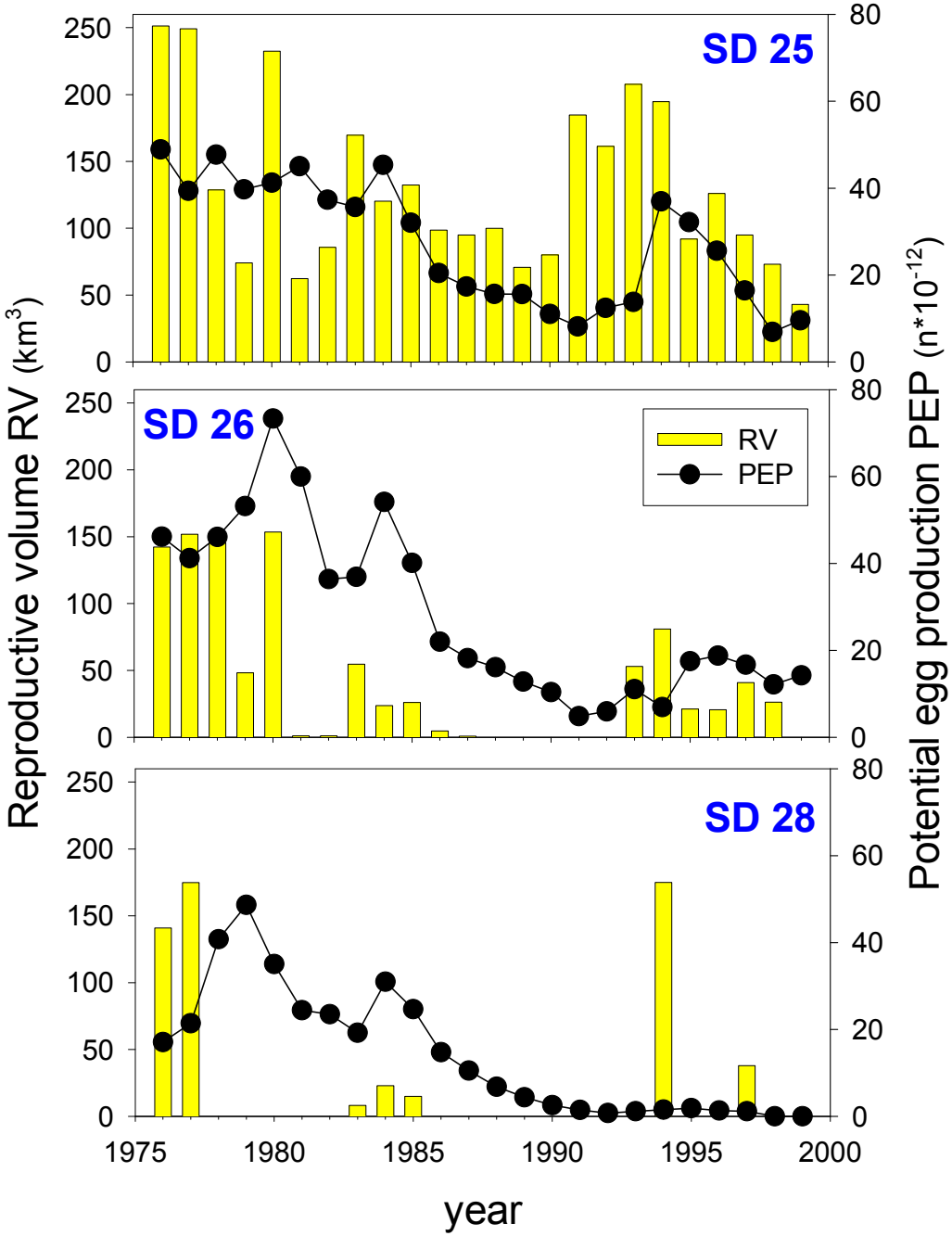


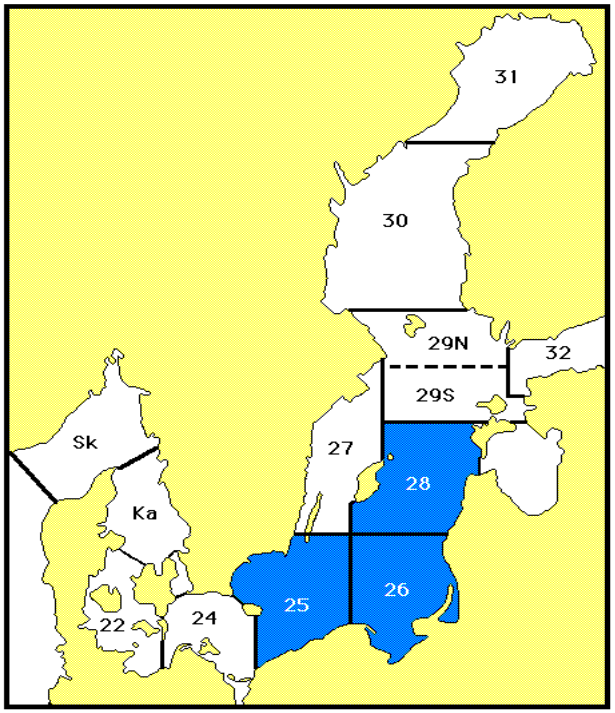
Mencas nārstam piemērotā slāņa tilpums (km^3) Austrumbaltijā (O_2>2ml/l, S>11$^0/_{00}$)



SPAWNING HABITAT

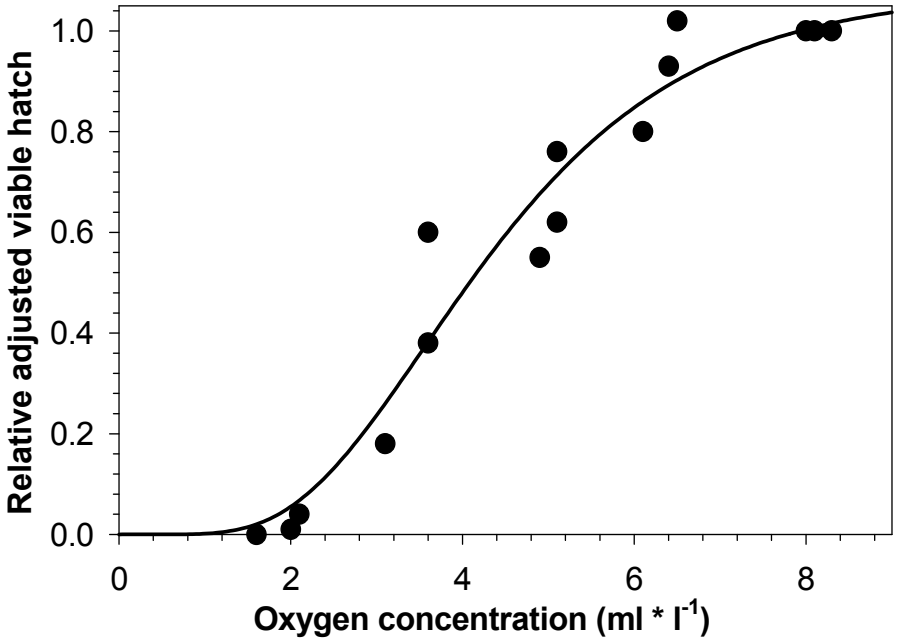
Potential egg production (PEP) and reproductive volume (RV) in different areas

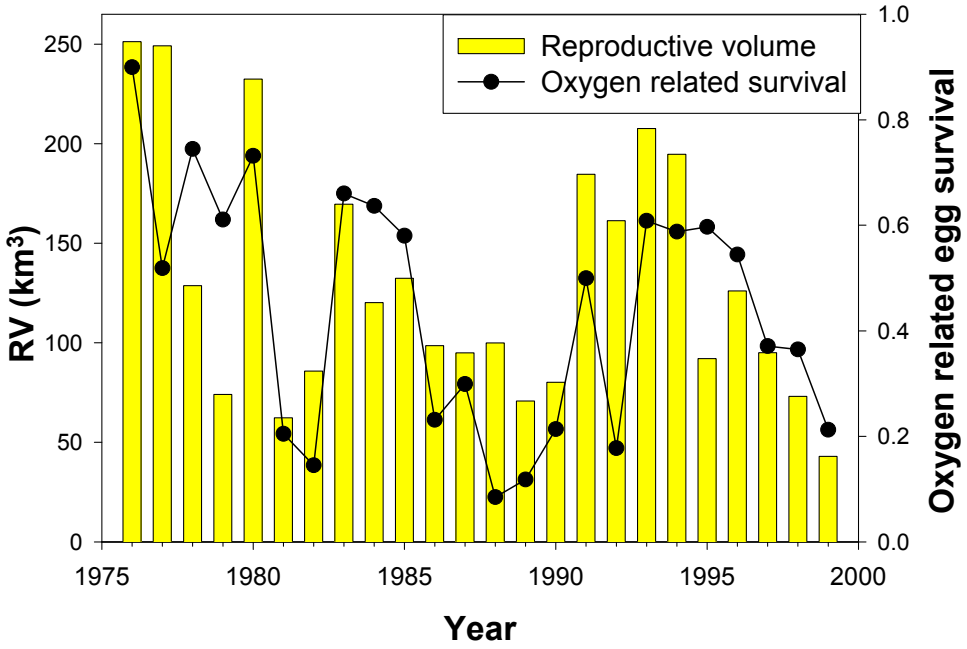




EGG SURVIVAL I

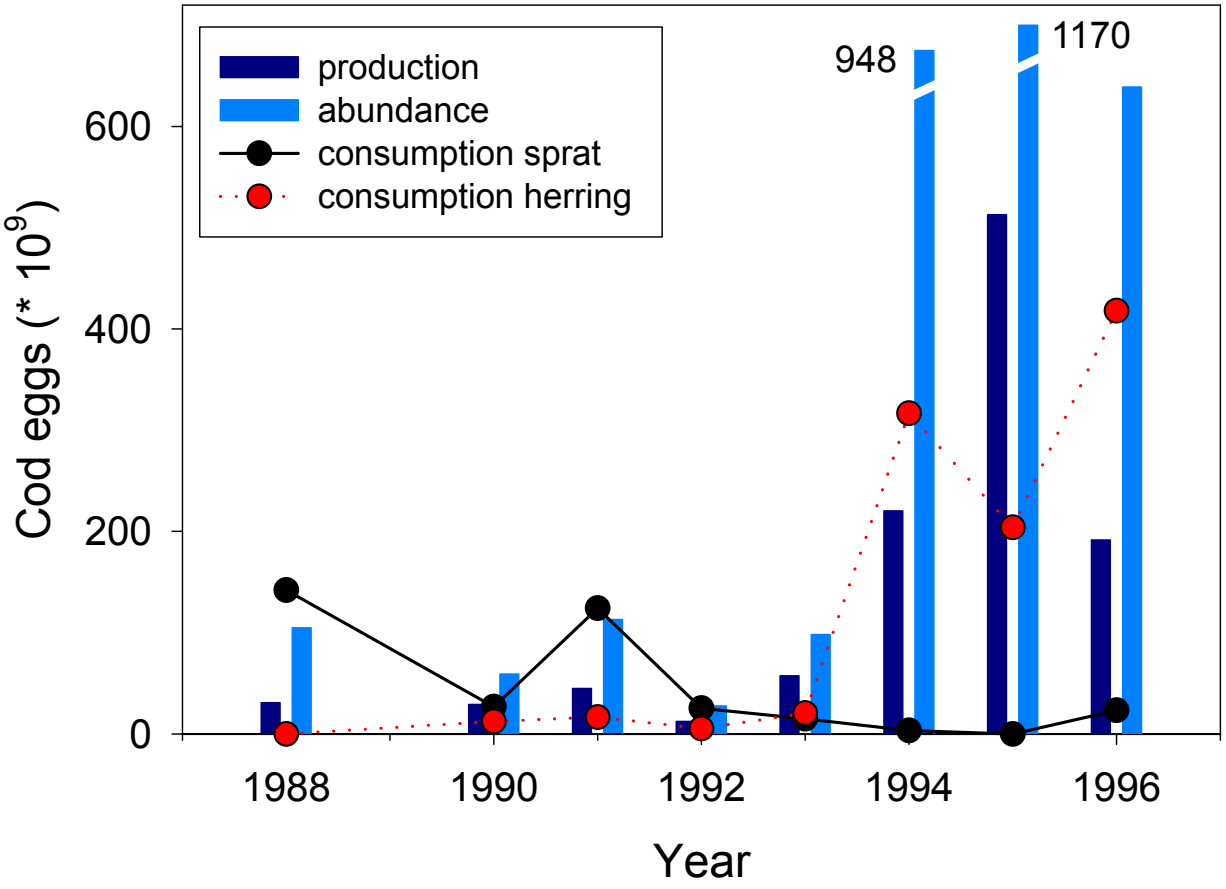
Viable hatch vs. oxygen content & oxygen related survival based on modelled vertical distribution & measured hydrographic conditions in SD 25





EGG SURVIVAL II

Daily consumption of cod eggs by clupeids at peak spawning vs. production & standing stocks (SD 25)

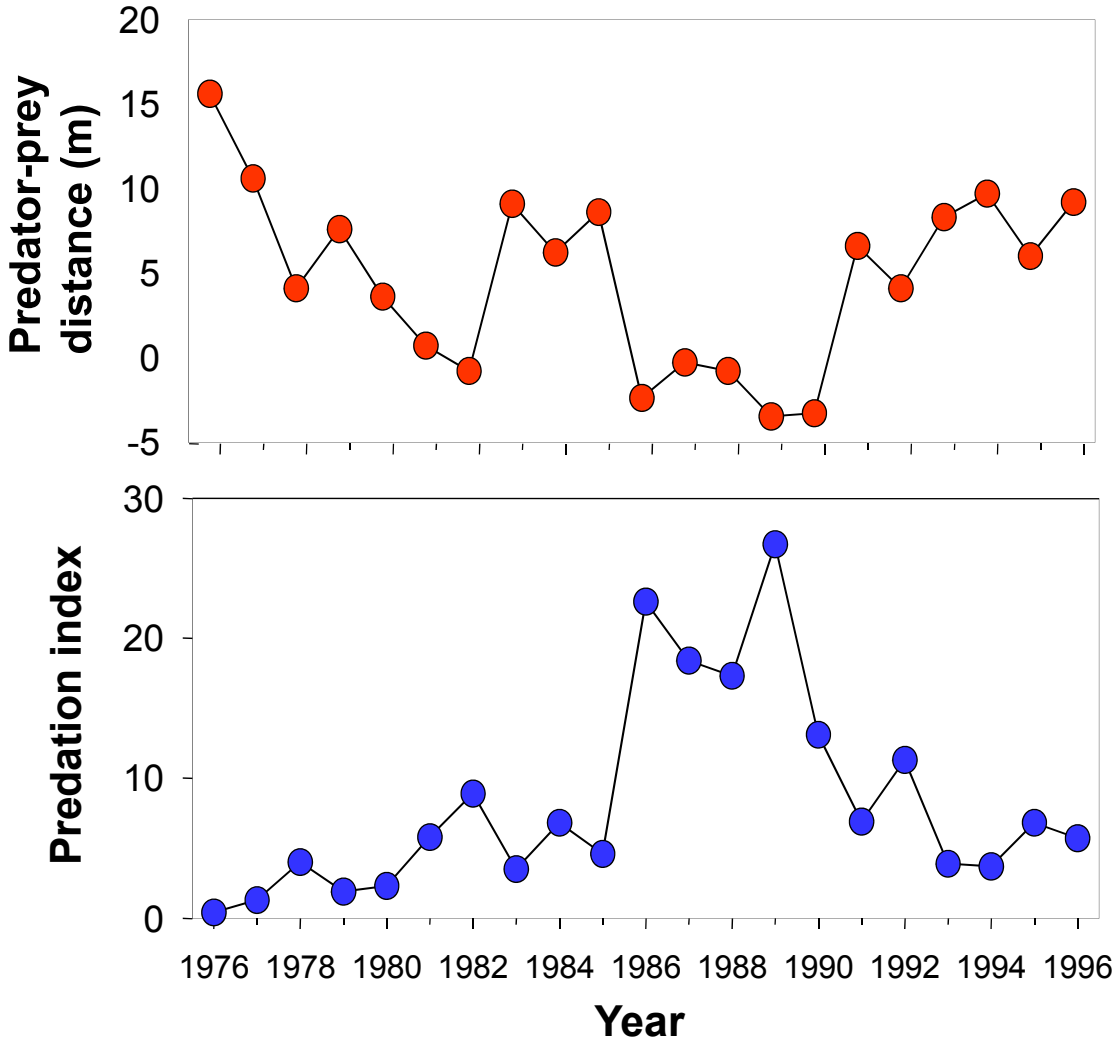


Overestimation of sprat predator stock (in 10^9) (test for May/June 99):

MSVPA	DEPM	acoustic
28.8	12.1	9.5

EGG SURVIVAL III

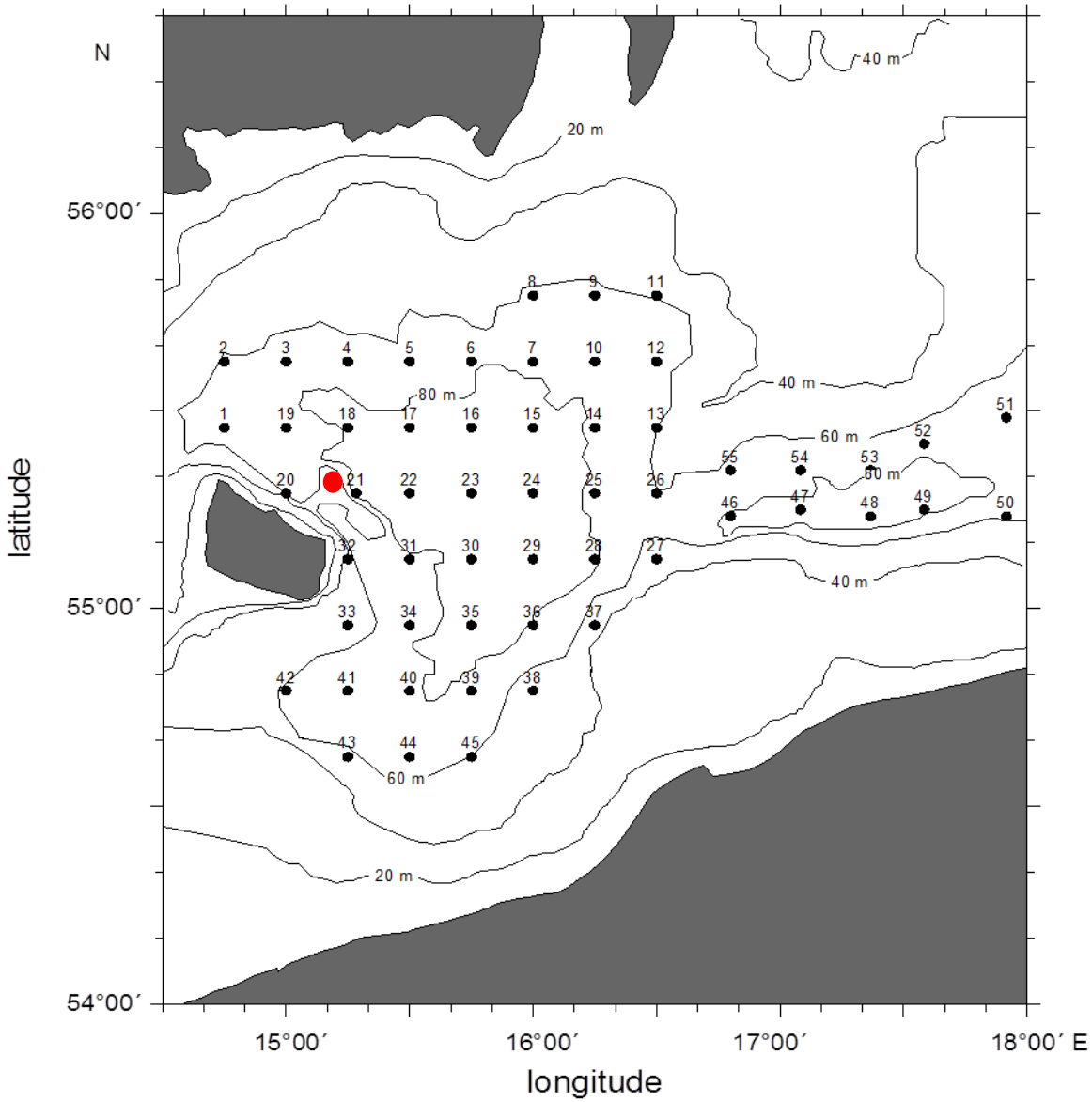
Predation by sprat and herring on cod eggs



Vertical overlap index: distance between egg and clupeid dwelling depths (m)

Egg predation: individual intake coupled to overlap & predator abundance

PLANKTON STATION GRID

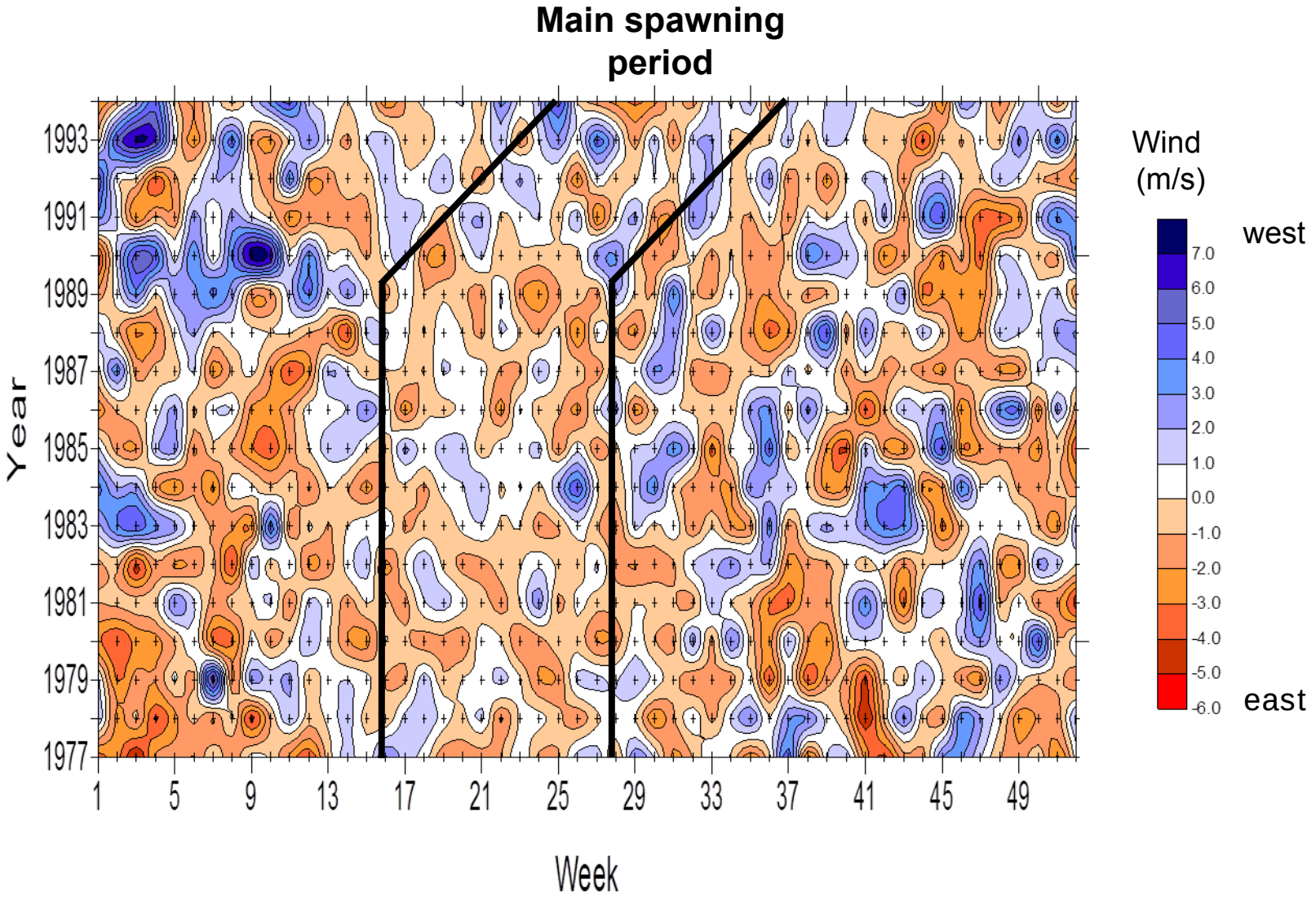


Ichthyoplankton & hydrography stations in the Bornholm Basin & Stolpe Trench

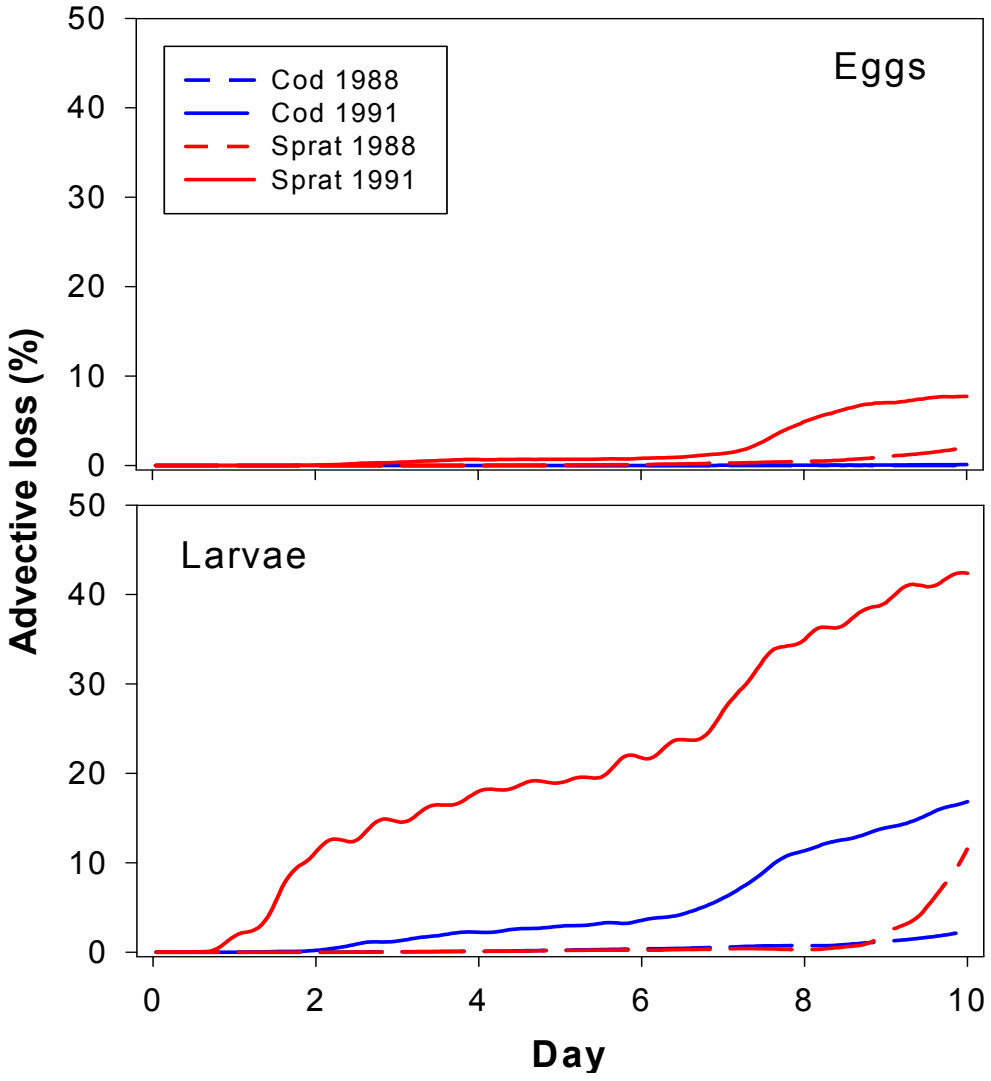
Position of Christiansö (weather station) ●

DRIFT OUT OF STUDY AREA ?

Anomalies of weekly-averaged wind speed at Christiansø, 1977-1994



DRIFT OUT OF STUDY AREA



Advective losses estimated from hydrodynamic model runs in

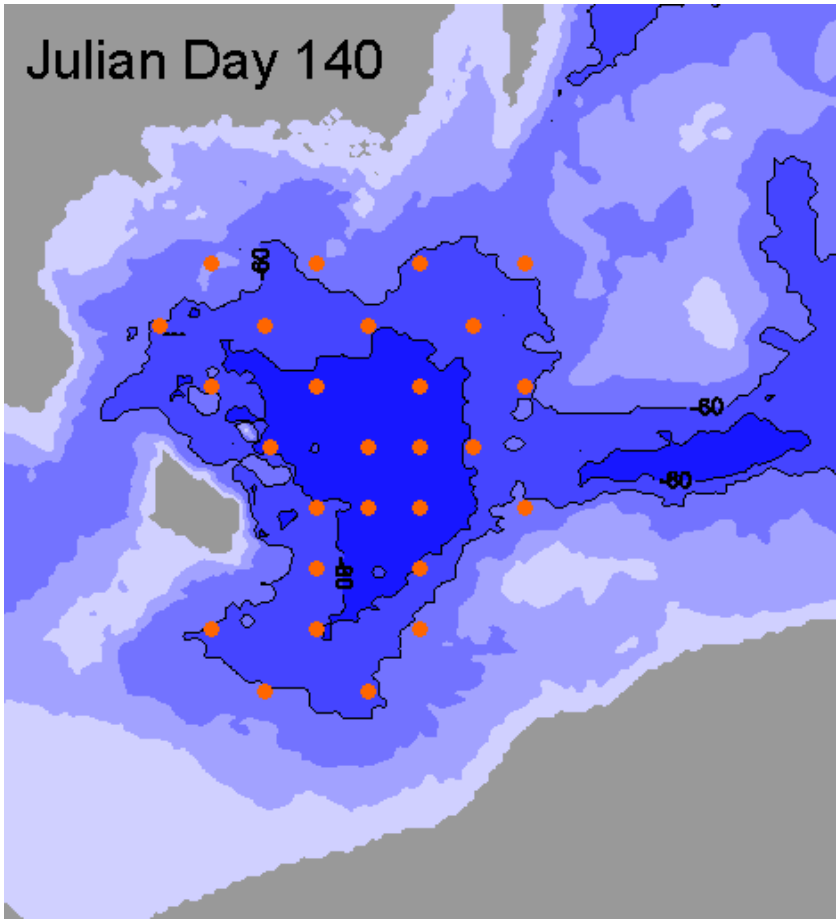
May 1988: low wind speed from variable directions

August 1991: high wind speed from westerly direction

DRIFT OF LARVAE

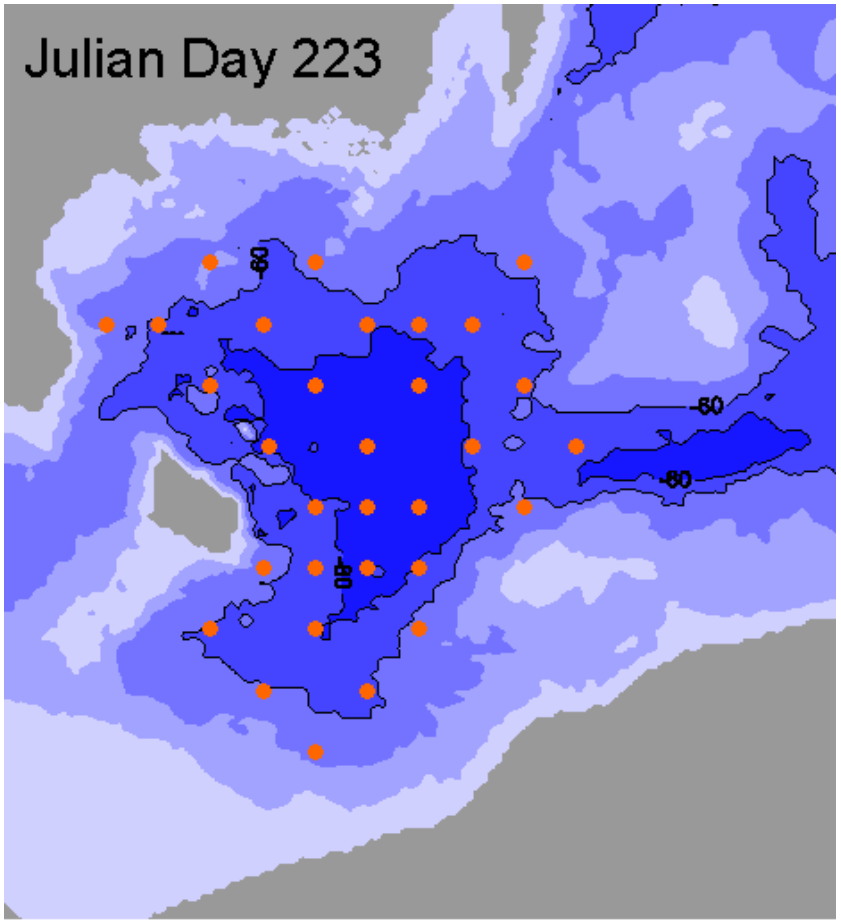
Retention in spawning area

1988



Transport into shallow areas

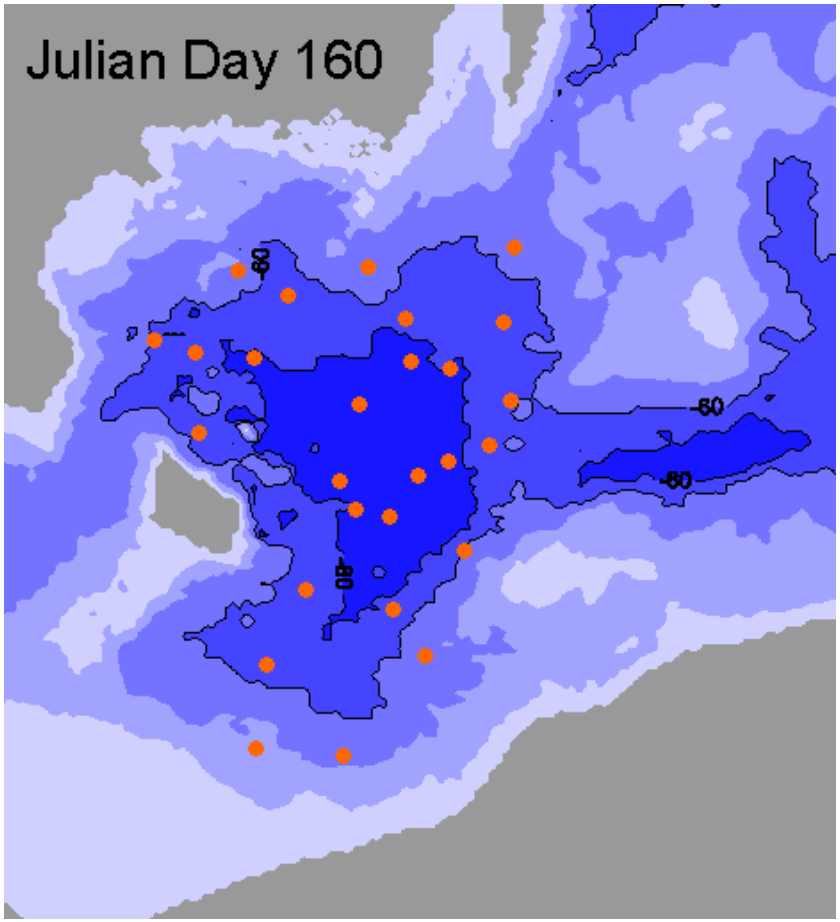
1991



DRIFT OF LARVAE

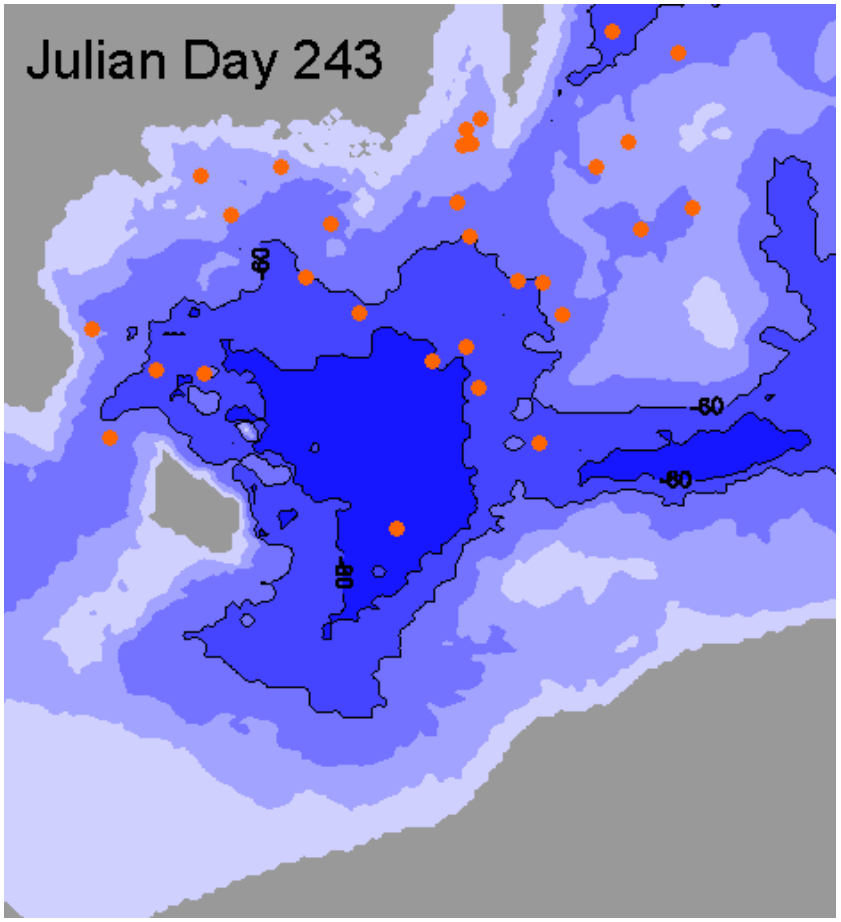
Retention in spawning area

1988



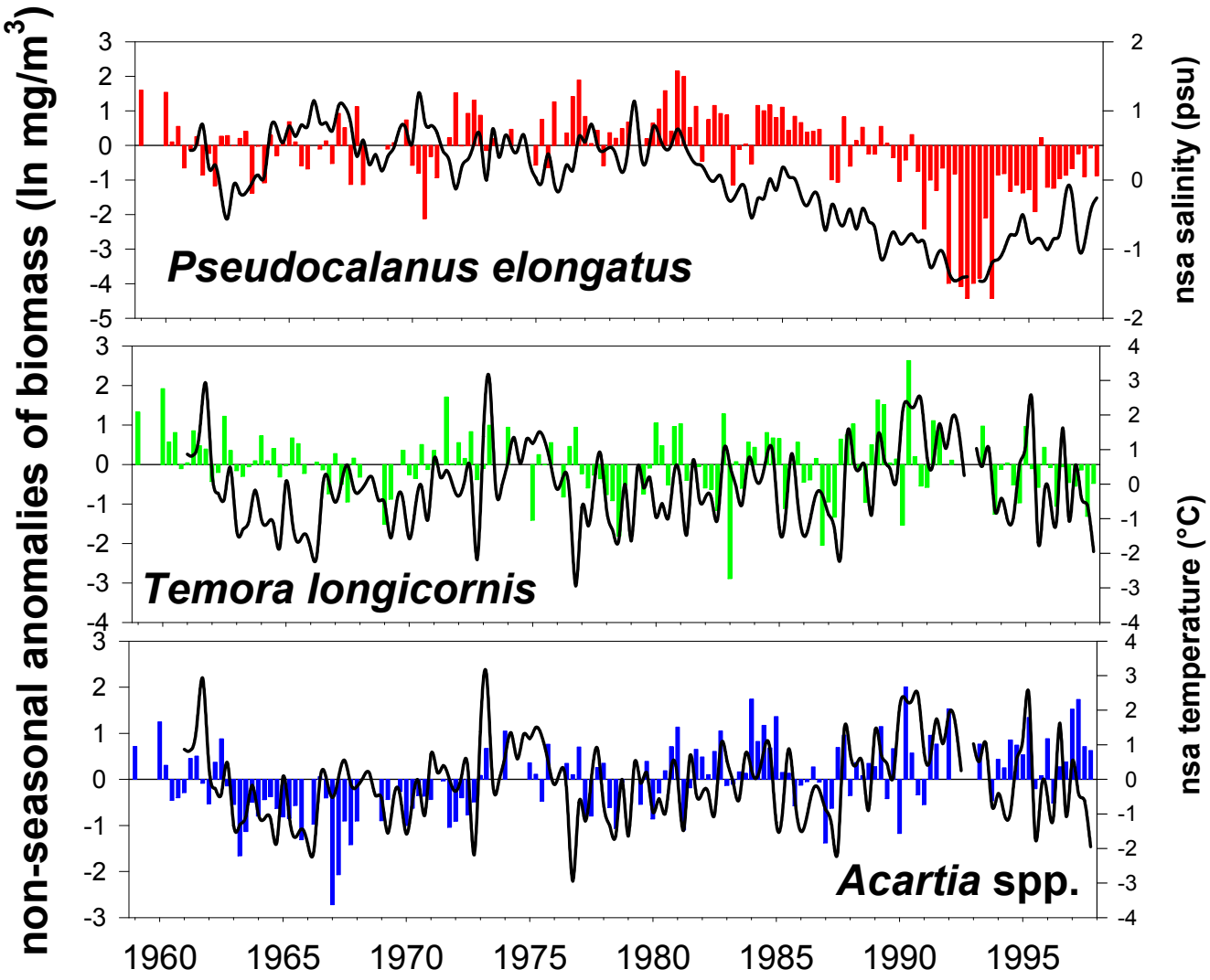
Transport into shallow areas

1991



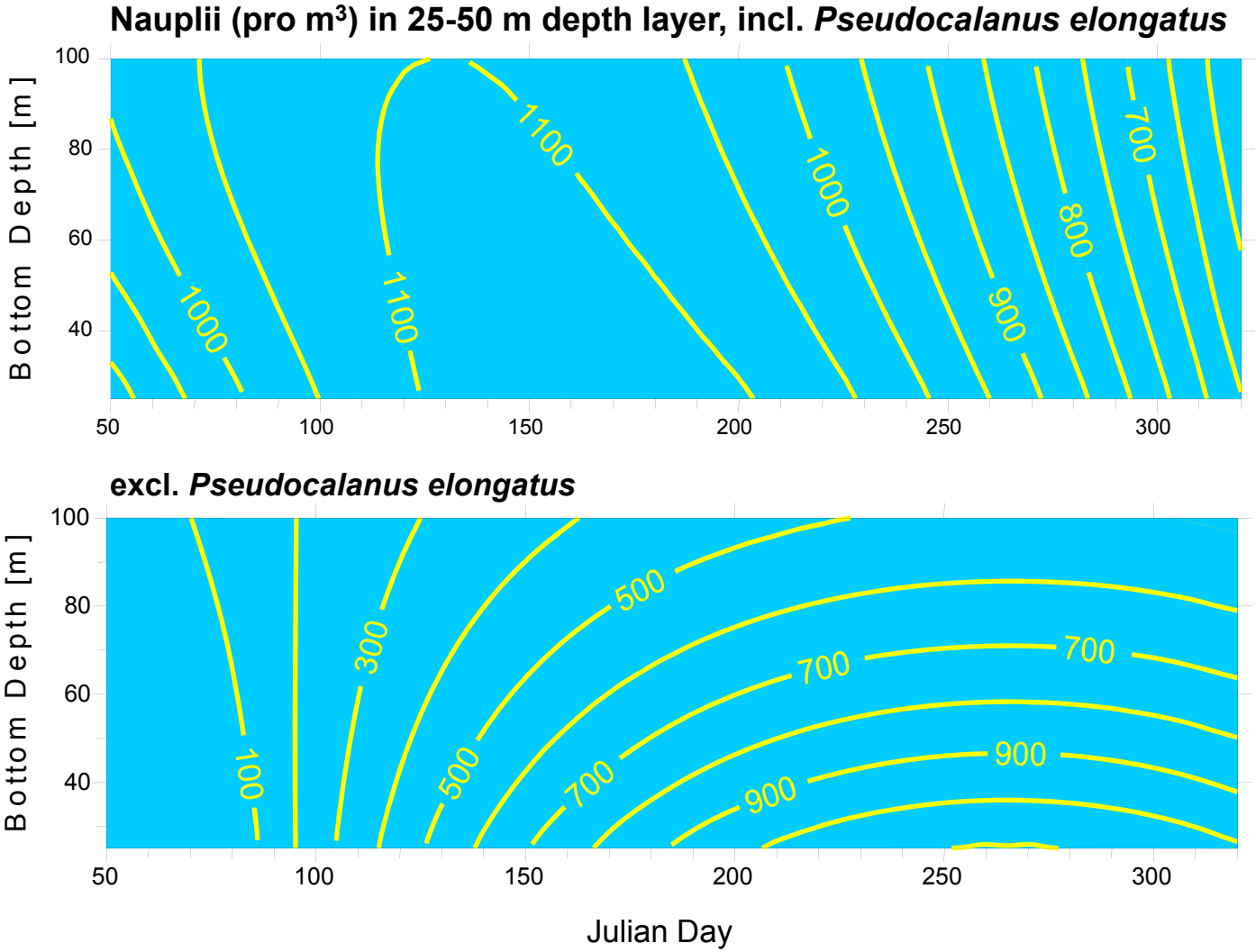
PLANKTON PREY

Development of copepod species in the Baltic Sea

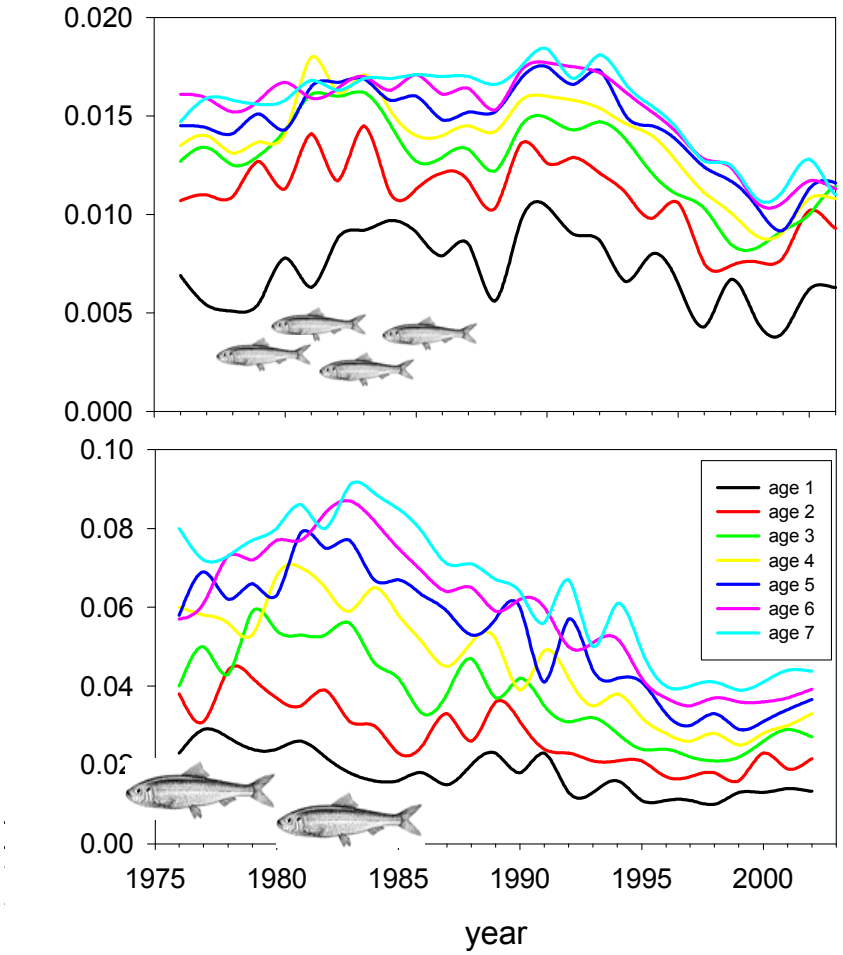


ZOOPLANKTON PREY FIELD

Idealized seasonal development of nauplii prey field for cod larvae in relation to bottom depths



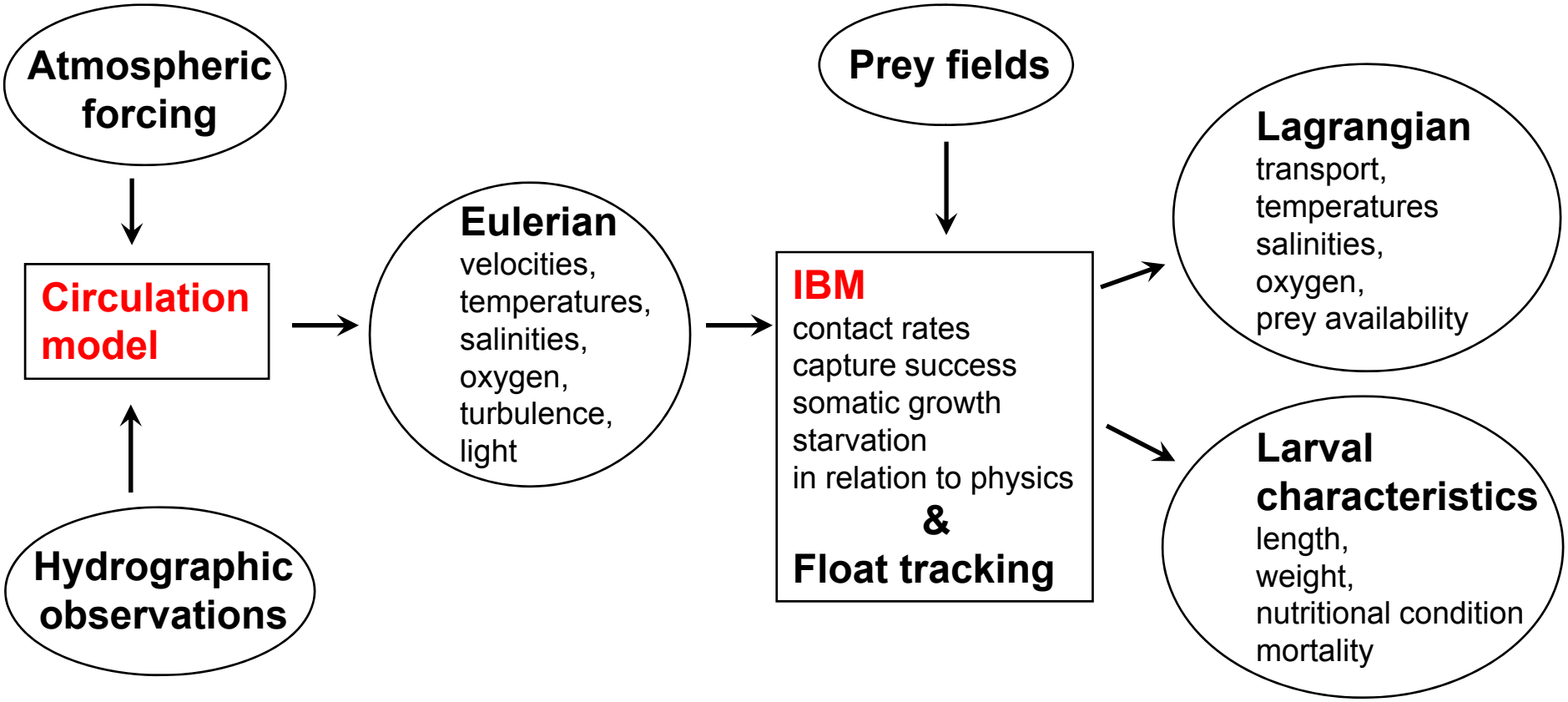
Brētliņas un reņģes svars pa vecumiem



Reasons for changes:

- **Changes in food composition**
- **Changes in plankton community**
- **Changes in density and abundance**
- **Enviromental changes**
- **Cod predation changes from high to low**

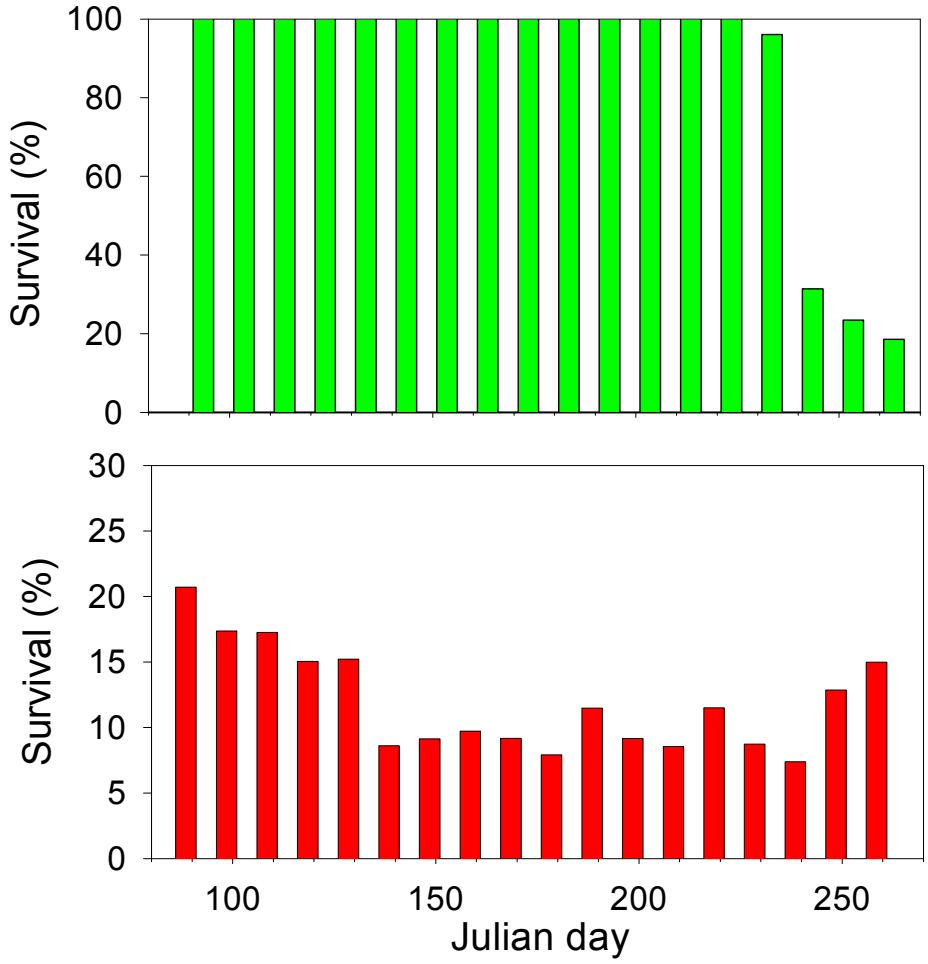
COUPLED IBM & HYDRODYNAMIC MODEL



modified after Hinckley et al. (2000)

LARVAL SURVIVAL

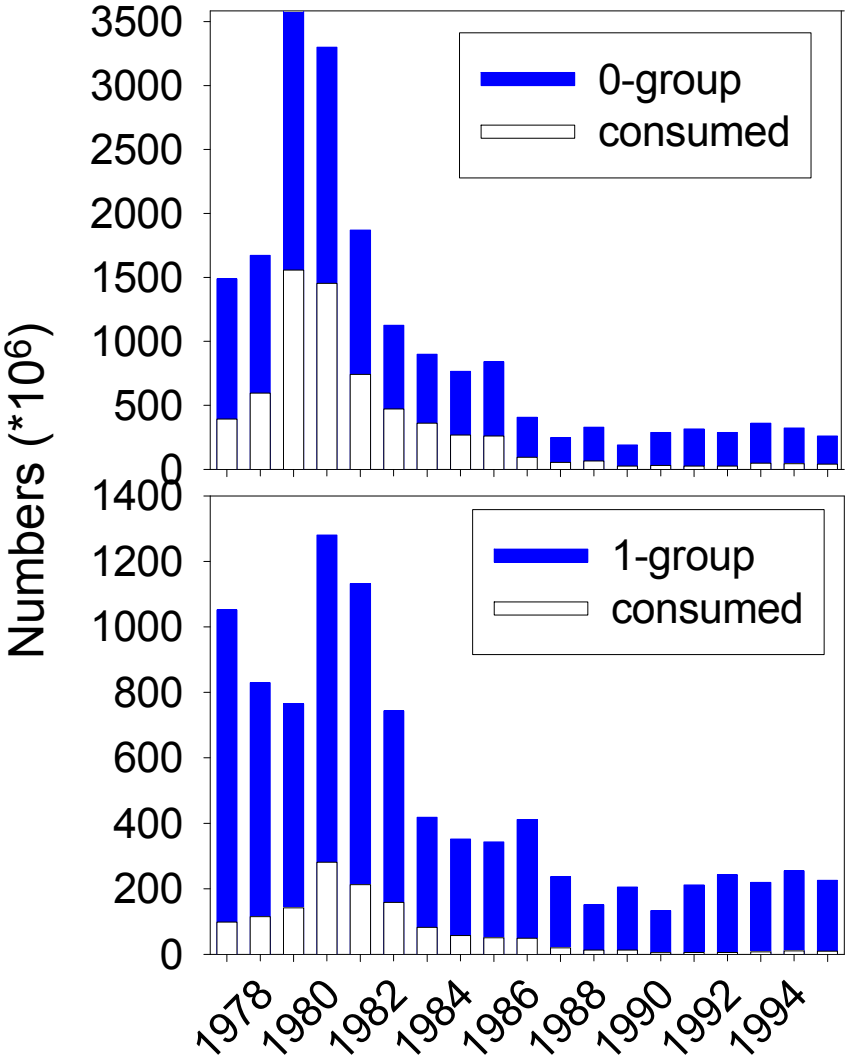
Output of coupled IBM / hydrodynamic model: seasonal development of larval survival



Scenario including *P. elongatus*

Scenarios excluding *P. elongatus*

CANNIBALISM



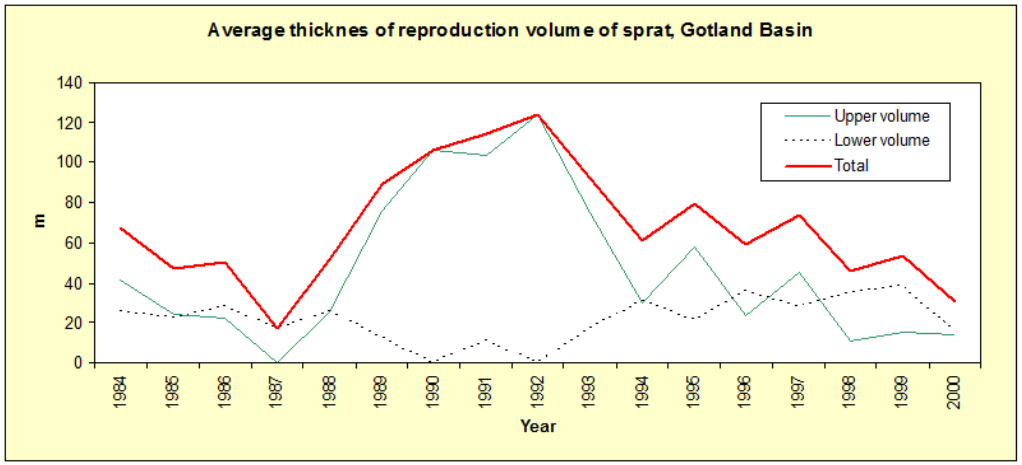
0-group abundance: beginning of 3rd quarter

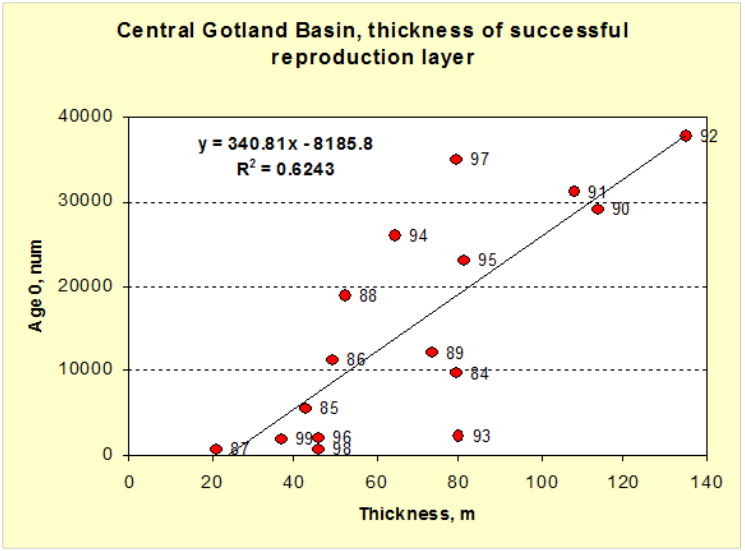
1-group abundance: beginning of 1st quarter

Set-up:
variable weight at age in stock & stomach, individual daily rations, tuned by XSA

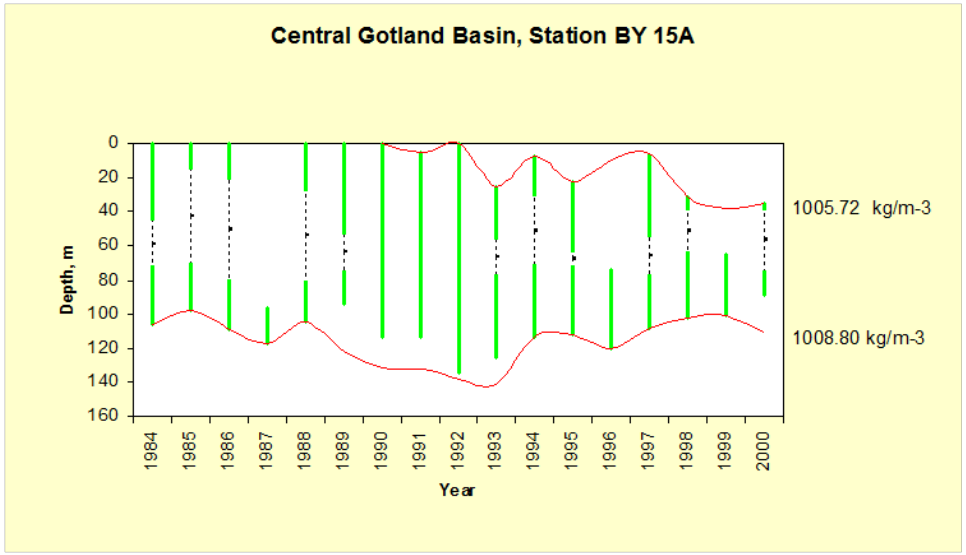
constant suitability coefficients

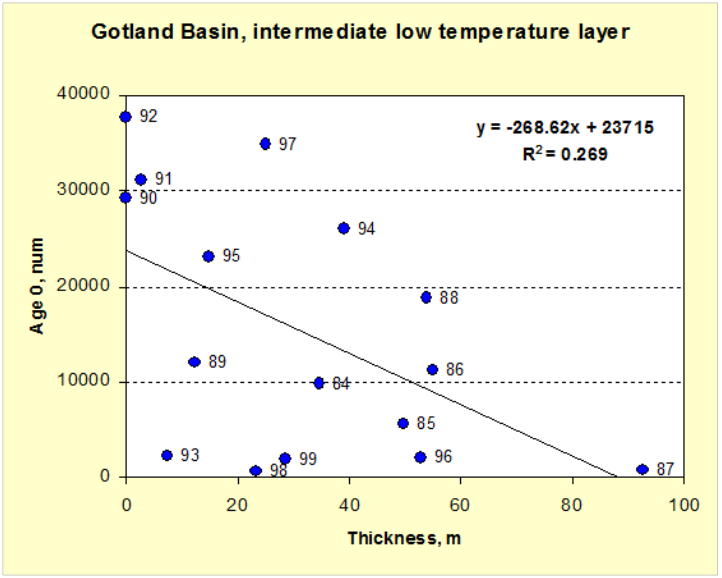
Brētliņas nārsta tilpums?





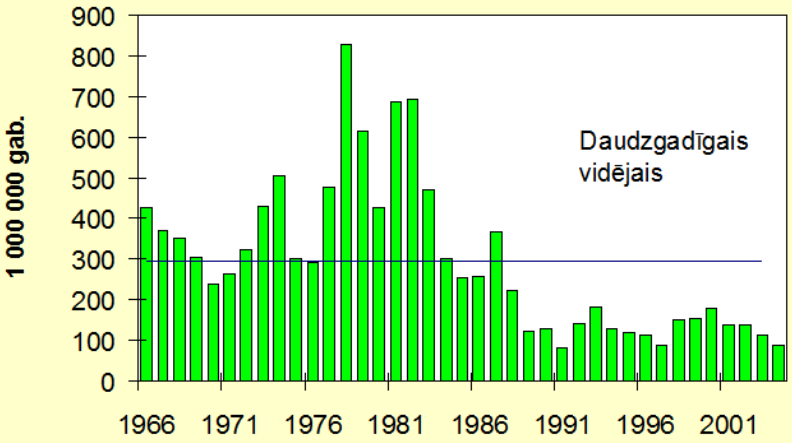
Brētliņas nārstam piemērotā slāņa biezums (m) Austrumbaltijā (O_2>1.0ml/l, t°>4 °C)



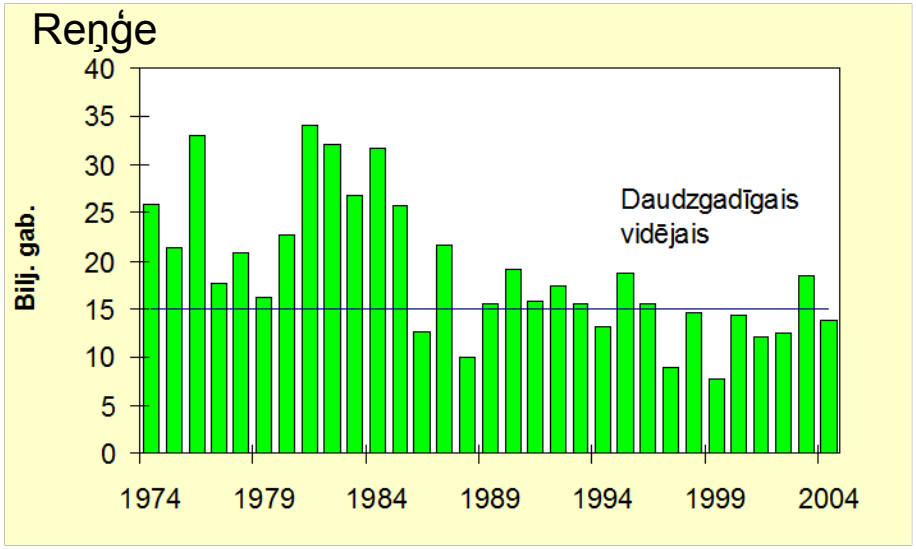


Papildinājums

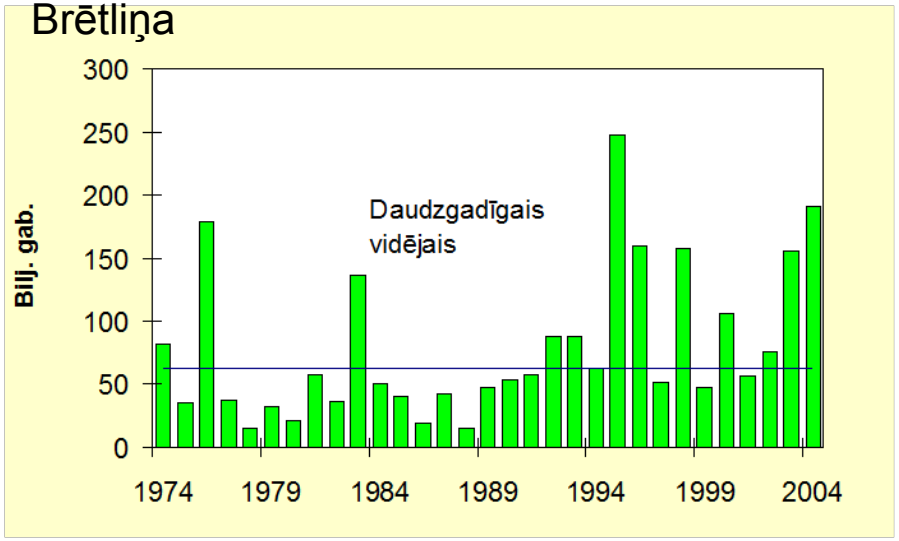
Menca



Reņģe



Brētliņa



Ekosistēmas izmaiņas

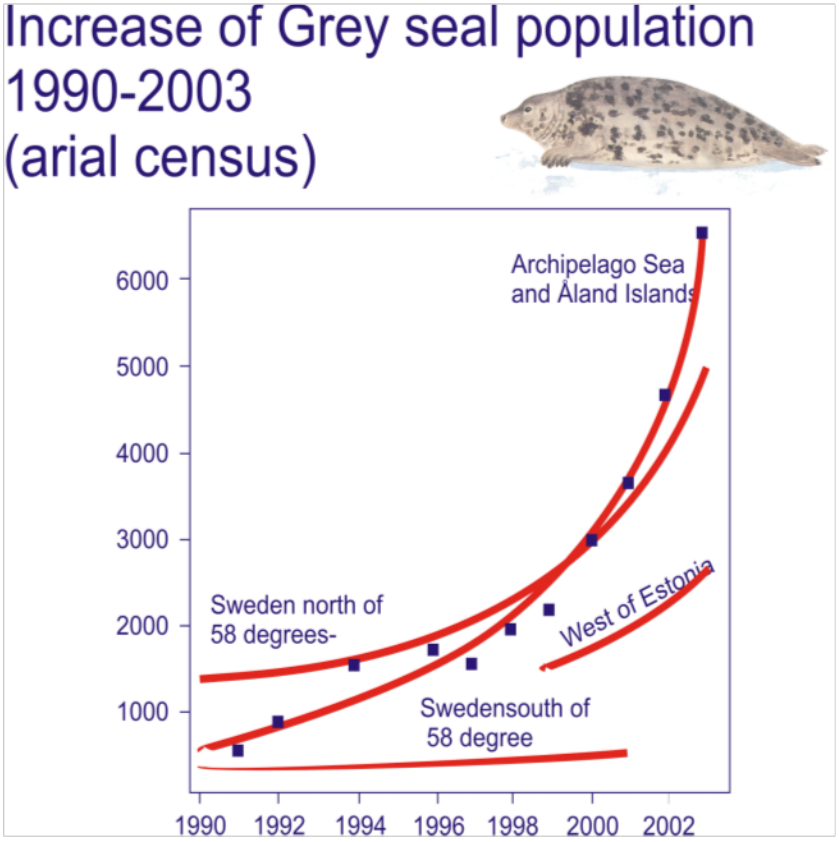
Baltic Sea Ecosystem Change:
Effects on fish stocks 1970-2004:

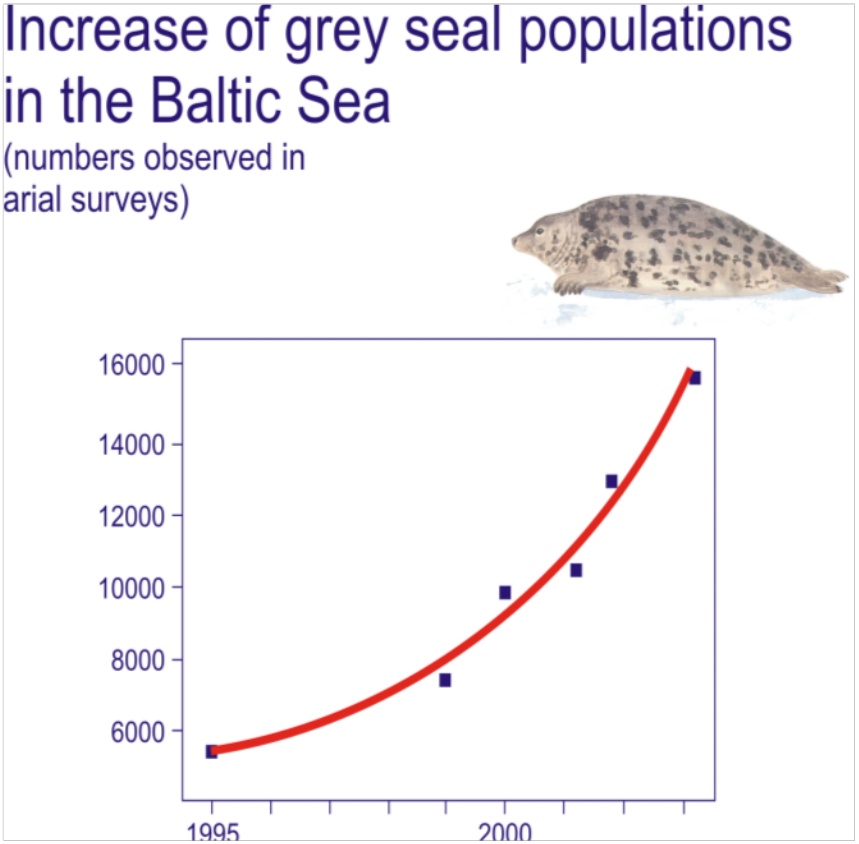
- **Effects on abundance:**
  - cod stocks low
  - sprat stock high
  - herring in the Main Basin reduced
- **Effects of ecosystem:**
  - sprat and herring stocks are dominating the system
  - sprat and herring predation on cod eggs high
  - marine plankton species low
  - fresh water plankton species dominate
  - herring/sprat competition of food high
  - herring and sprat growth rate decreased (density dependent events??)

Ekosistēmas izmaiņas

New players coming into the system:

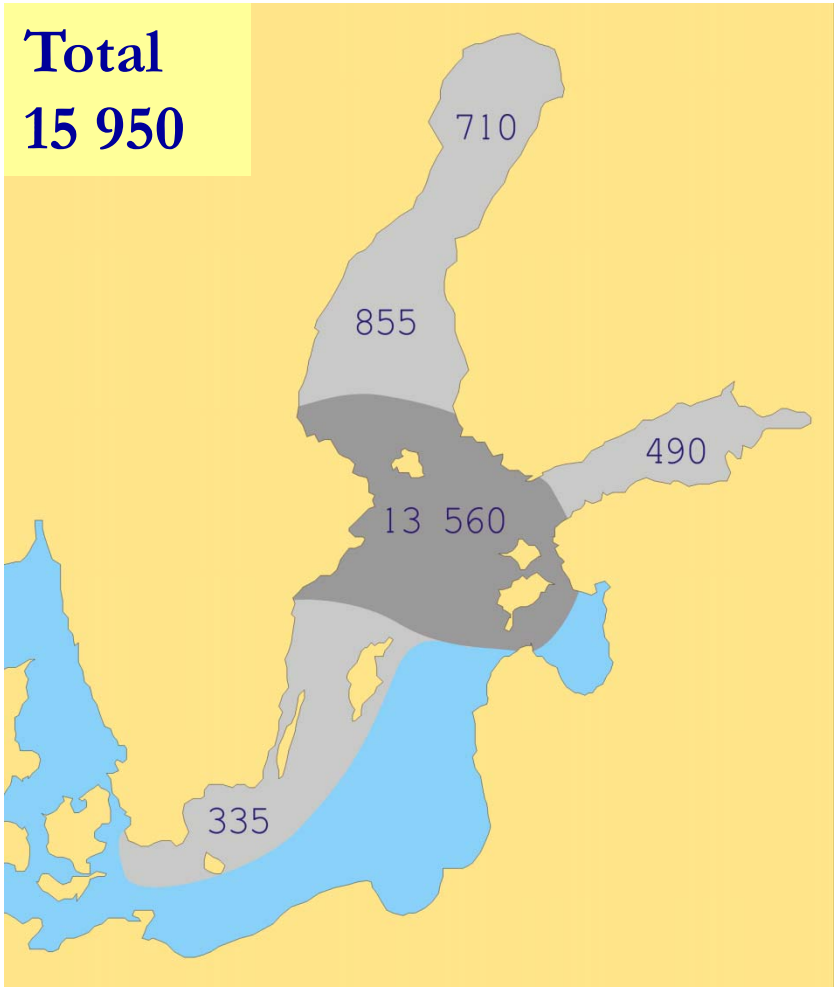
Seals / herring and seals / salmon interaction: Population growth of seals





Ekosistēmas izmaiņas

Number of grey seals in 2003



Rough estimate of fish consumed by gray seals annually:

~30 000 – 40 000 tonnes