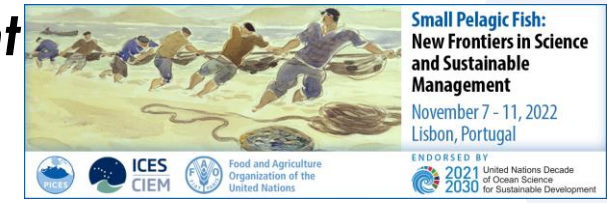


Hatch earlier or late? Survival of sardine (*Sardina pilchardus*) juveniles in response to environmental variability, parental effects, and growth conditions.

Andreia V. Silva*, Isabel Meneses, Susana Garrido, Paulo B. Oliveira, Eduardo Soares, Cristina Nunes and Alexandra A. Silva

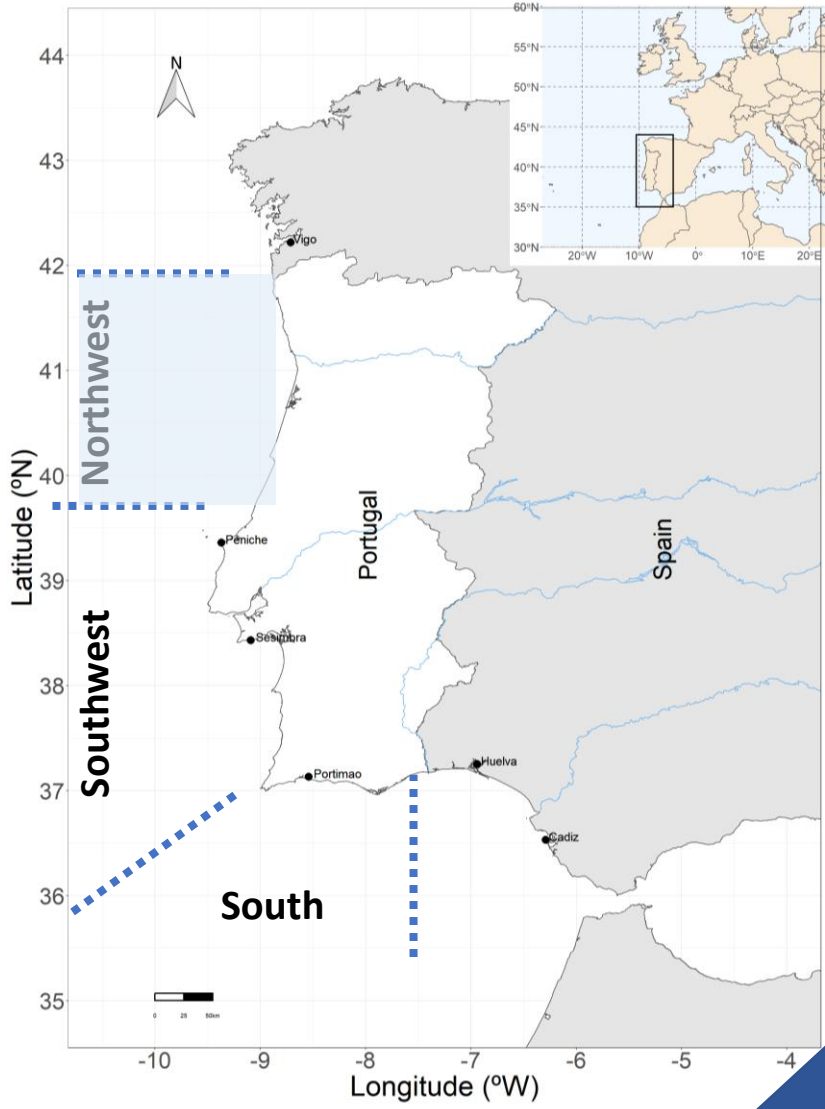
sardinha 2020
pnab programa nacional de amostragem biológica
IPMA
REPÚBLICA PORTUGUESA MAR
Cofinanciado por: mar 2020 PROGRAMA OPERACIONAL MAR 2020
PORTUGAL 2020
UNIÃO EUROPEIA Fundo Europeu dos Assuntos Marítimos e das Pescas

Background

- Sardine is a very important resource in Iberian Peninsula, namely in the Portuguese coast, where it is the main target species of the purse seine fishery .

- The Northwest Portuguese waters are the main nursery area of sardine in the Iberian Peninsula.

- Complex area: upwelling events, river run off.



Background

- Recruitment to the Iberian stock shows inter-annual fluctuations, a cycle with a periodicity of 4 years and a long term downward trend.

- These fluctuations likely result from factors that act on early life-history stages, which are thought to be strong affected by environmental and ecosystem changes and maternal conditions.

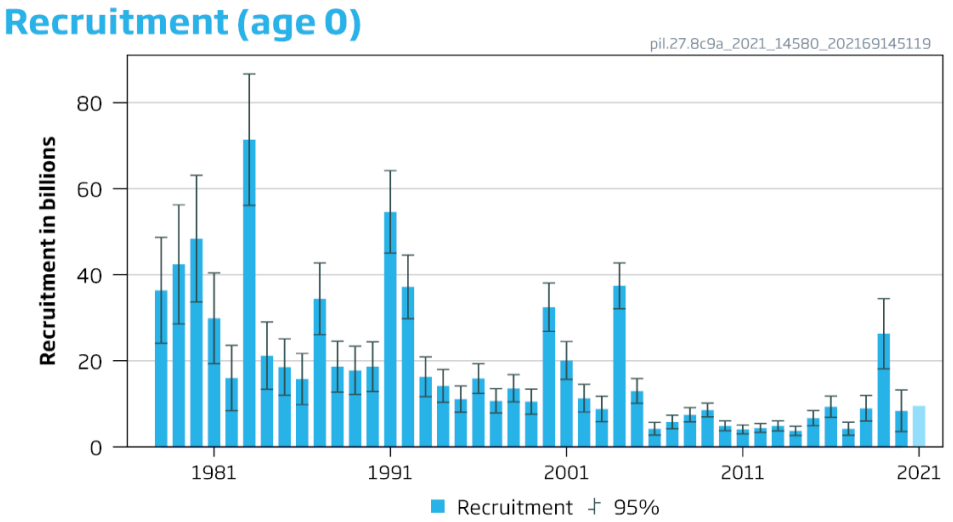


Fig. Sardine time series recruitment. Source: ICES, 2021 (advice sheet)

Goals

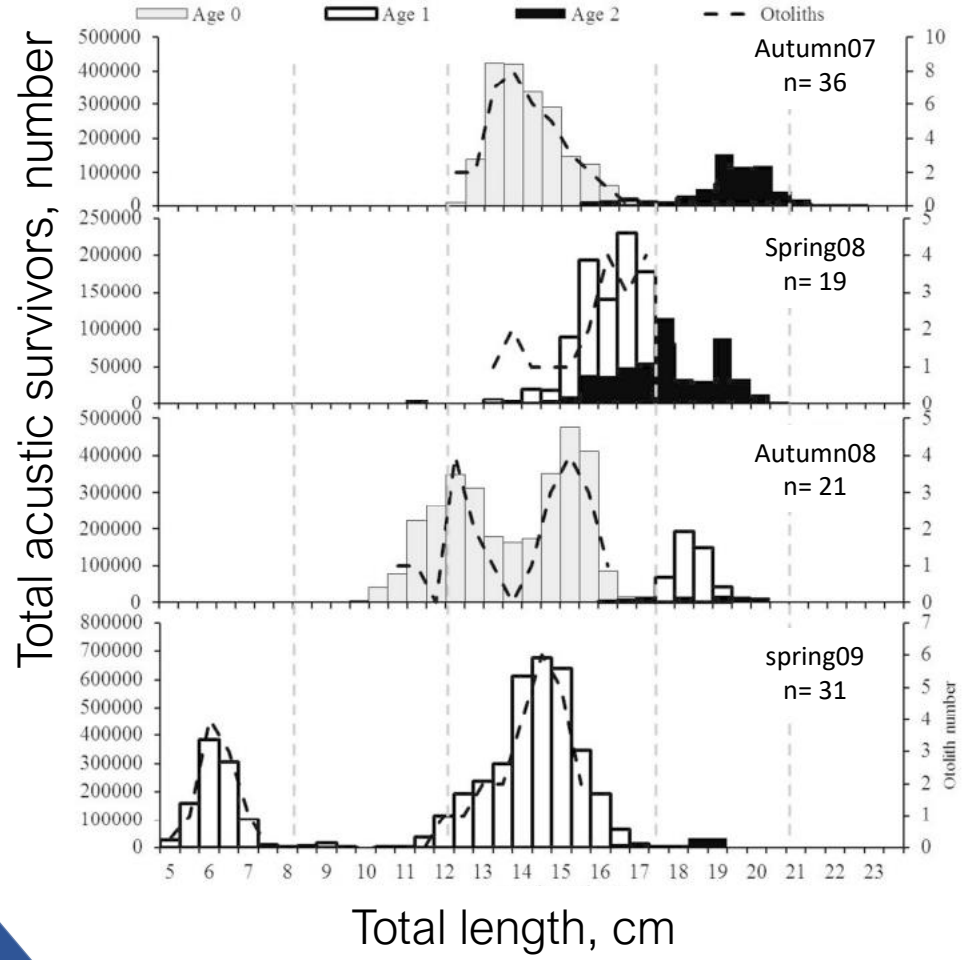
01 Relate the seasonal abundance of survivors with female reproductive activity and body condition and with sea surface temperature, chlorophyll-a and upwelling at the time of hatch.

02 Relate survivorship with larval and early juvenile growth

Methods

DATA COLLECTION - Surveys

- Random number of sardine juveniles by length distribution from 4 surveys

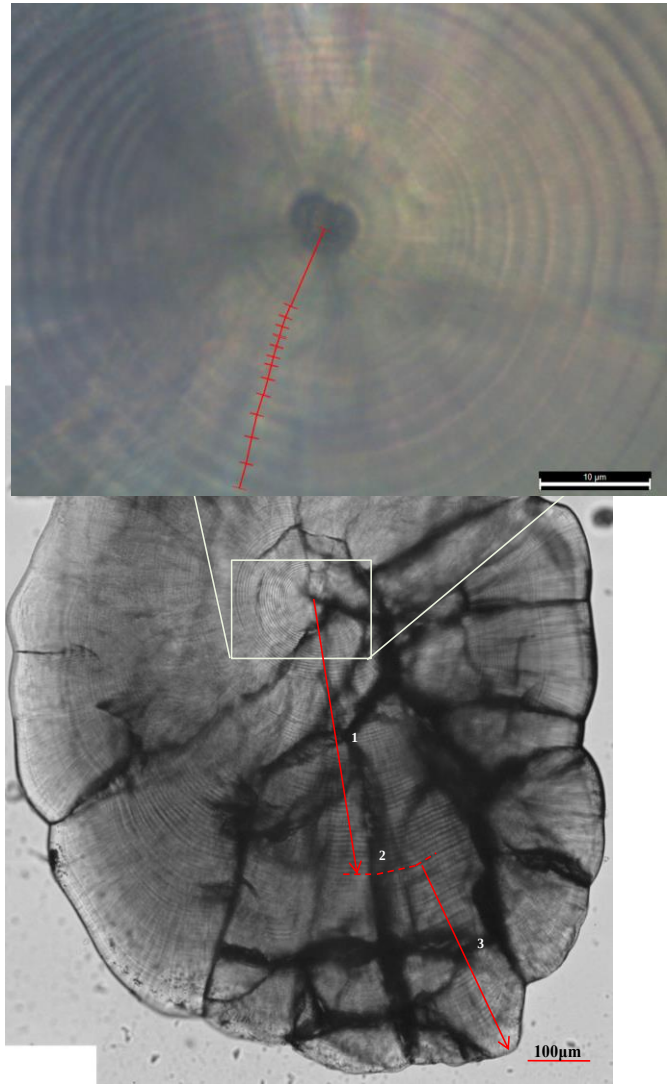


- Sardines were measured (nearest 0,5 cm) and both otoliths were extracted.

Methods

Daily age analysis

- Micrographs were manually combined (200x).
- Nucleus area was read at 1000x.
- Measure of increments width.
- Daily ages were calculated from the total number of rings plus 4 days, the average duration of the first-feeding period.
- The hatch date was calculated subtracting the age from the date of sampling.



Methods

DATA COLLECTION- Monthly samples at harbour

- Parental Variables

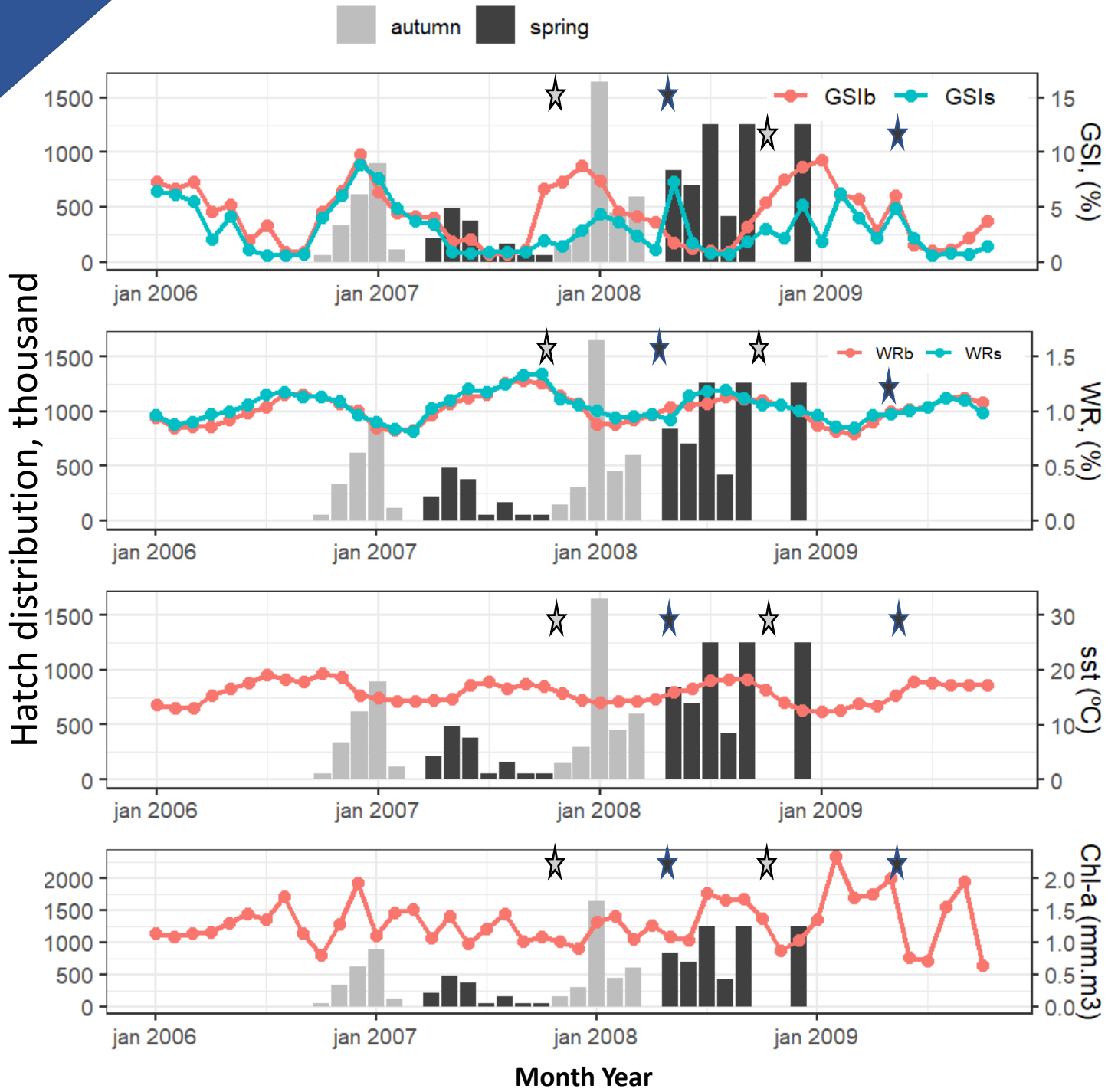
  - Gonodossomatic index (GSI) = Gonad Weight/Gutted weight x 100; for big (TL=> 19cm) sardines and small sardines (TL< 19 cm).

  - Fulton's condition index (K) = Gutted weight/length^3 x 100; for big and small sardines.

- Environmental variables

  - Sea Surface Temperature (SST)
  - Chl α
  - Upwelling (Upw)

} North Atlantic Regional SST, provided by Ocean and Sea Ice Satellite Application Facility (EUMETSAT)



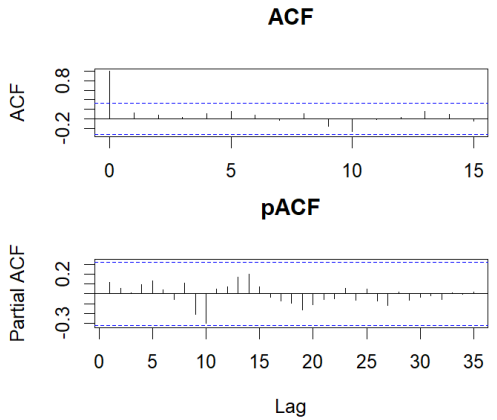
Results

Hatch Dates

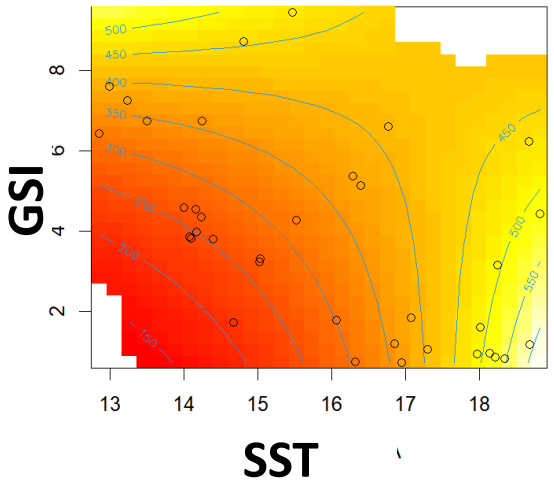
- Hatch of winter survivors coincides with a period of:
  - High values of GSI lagged 1 month
  - Low values of WR lagged 1-2 months
  - Low values of SST
- Hatch of summer survivors coincides with a period of:
  - Low values of GSI
  - High values of WR
  - High values of SST
- No consistent relationship between Chr α and hatch distribution

Results

Survivors and parental and environmental variables

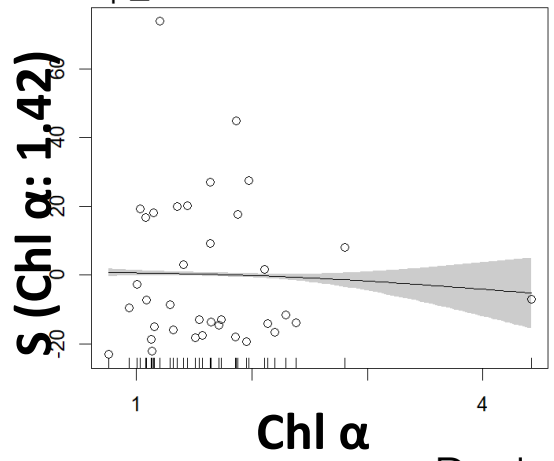


p_value =0.75



gam (survivors ~ te(SST, GSI, k=c(4,4)) + s(Chl α, k=3)+s(upwel, k=3), family=quasipoisson, gamma=1.4)

p_value =0.27

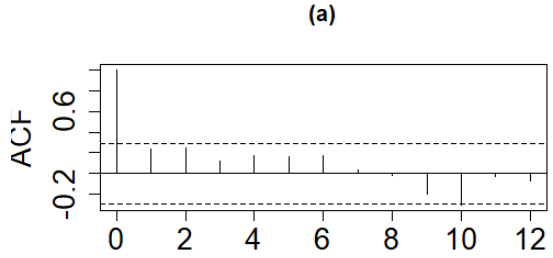


- High number of survivores are found with higth values of GSI and low SST and at low levels of GSI and high SST

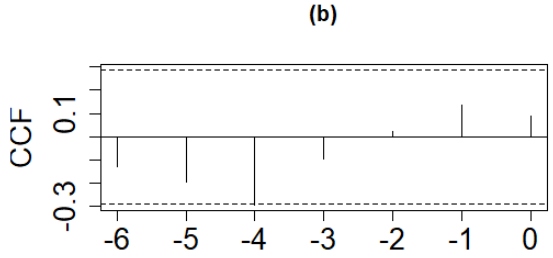
Deviance explained = 18%

Results

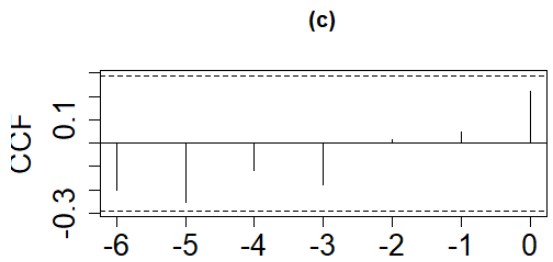
Survivors and parental and environmental variables



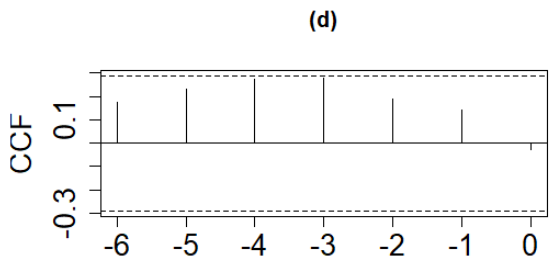
Lag: Survivors



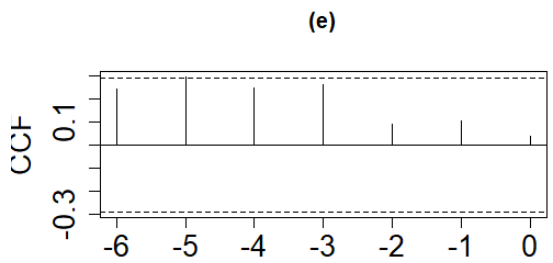
Lag: Survivors: GSIb



Lag: Survivors: GSIs



Lag: Survivors: Wrb

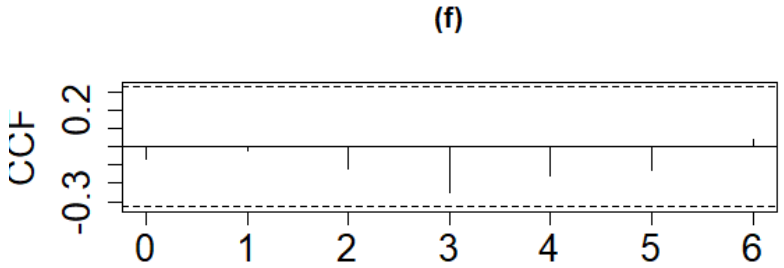


Lag: Survivors: Wrs

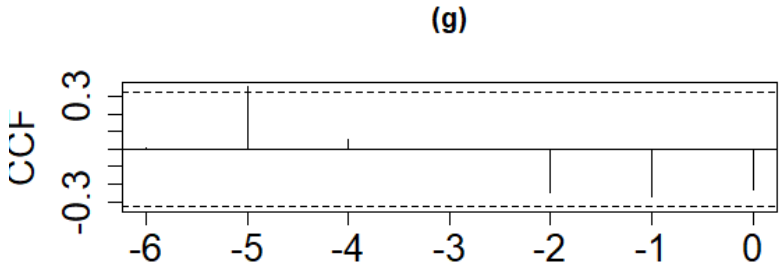
- Number of survivors didn't show autocorrelation.
- Hatch dates and GSIb show significant negative correlation at lag 4.
- No signigicant correlation with GSI peak of small females.
- Survivors lags 3 months from the WR peak of large and small females.

Results

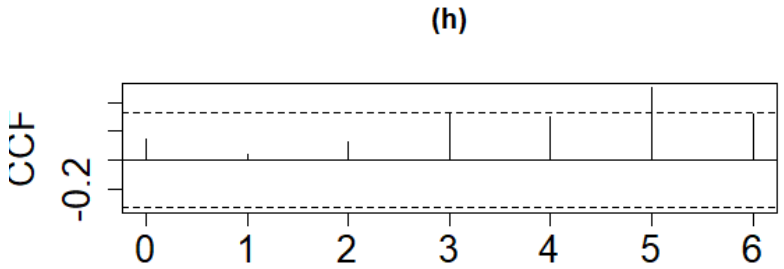
Survivors and parental and environmental variables



Lag: Survivors: SST



Lag: Survivors: Chl a

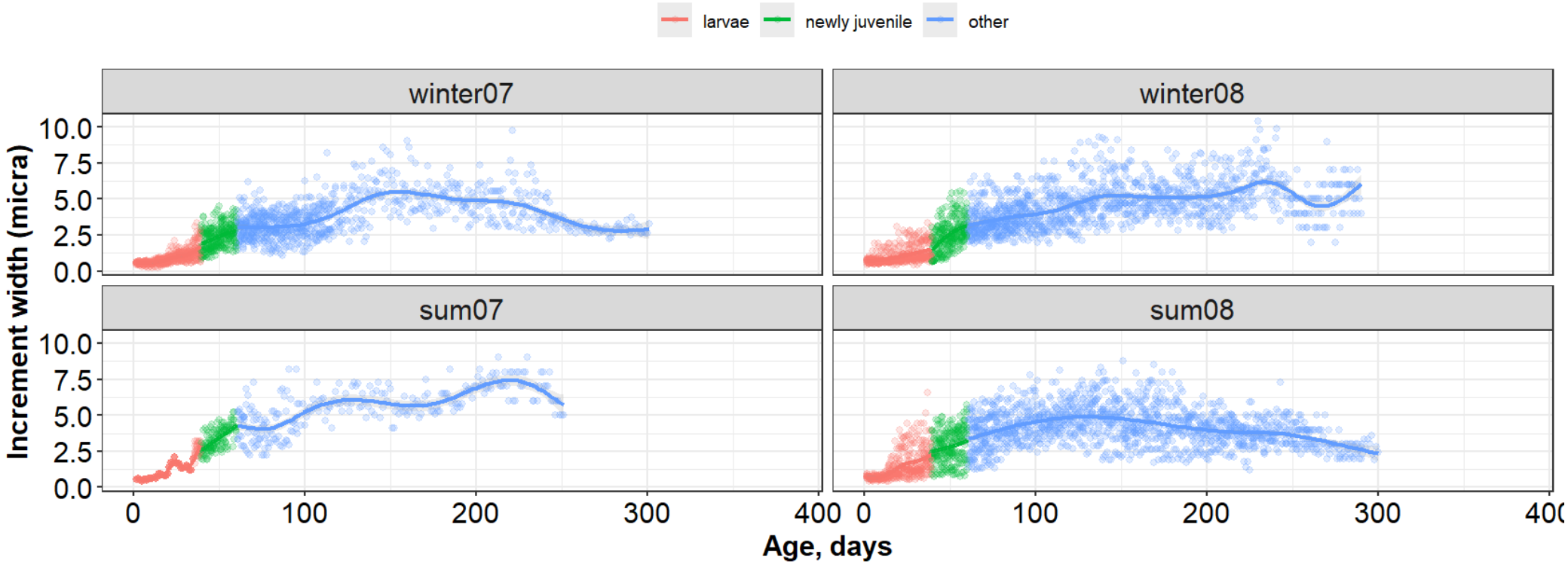


Lag: Survivors: Upwel

- No significative correlations were found between survivors and SST.
- The Chl α is significative correlated with survivors hatched 5 months before.
- The upwelling is significative correlated with survivors hatched 3 months after

Results

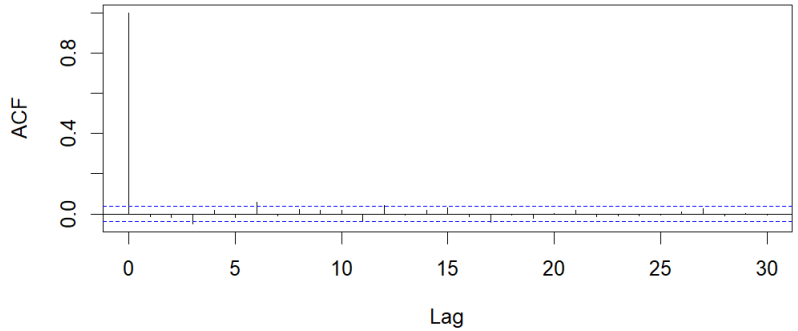
Early live growth



- Sardines hatch in winter showed sub daily rings difficult to distinguish.
- First daily ring was visible on average 5.2 µm ± 0.4 SD distance from the nucleus.
- Increment widths under 15 days vary between 0.24 µm and 0.44 µm (0.65 ± 0.2 SD).

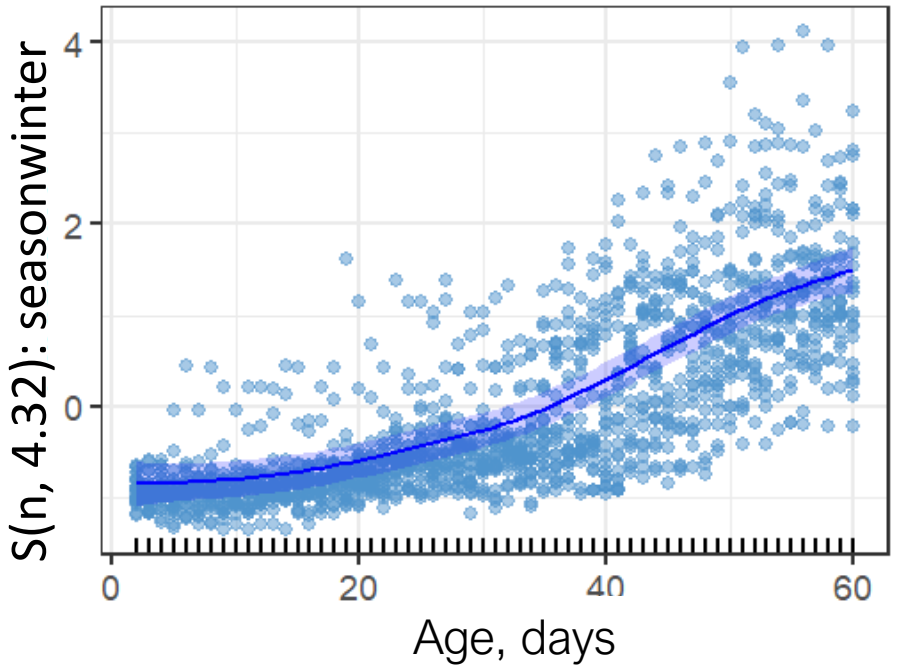
Results

Early live growth

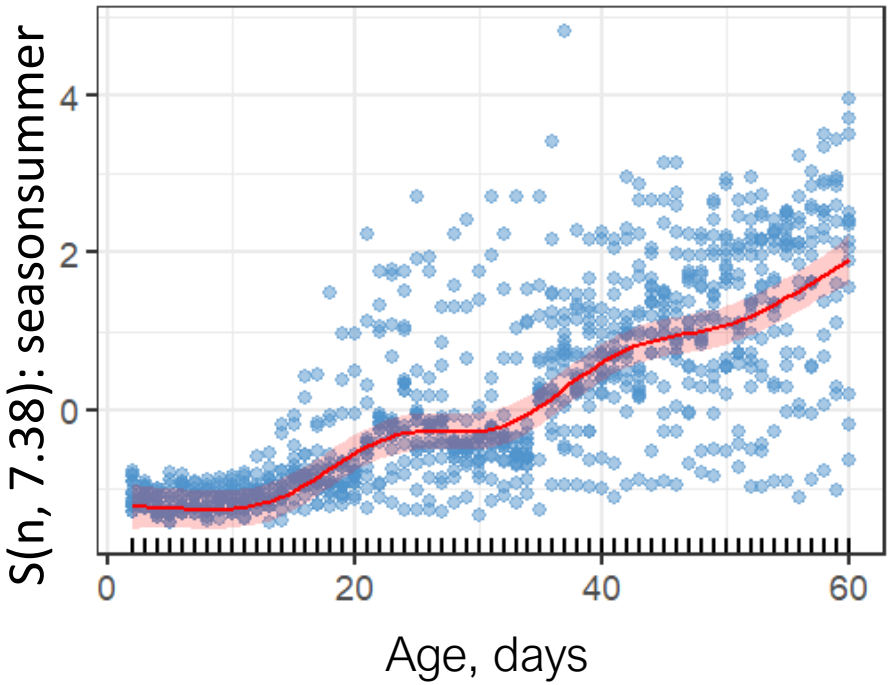


gamm(width ~ s(n,by=season)+s(upwel),
random=list(otol=~1),
correlation = corARMA(form=~ growth|otol,p=3))

s (daily age in winter): p_value <2e-16***



s (daily age in summer): p_value <2e-16***



Deviance explained = 60.2%

What's best? Hatch earlier or late?

	Winter survivors	Spring Survivors
Months of births	October - March	May - September
Spawning season	Main spawning season	Outside main spawning season
GSI	Medium or higher;	Minimum
SST	Lower or intermediate	Higher
Growth early stages	Slow growth in larval stages	Fast growth in larval stages

Discussion

Winter Survivors

- More survivors when:

  - GSI higher
  - SST lower

- Our results indicate hatch peak outside the reprodutive peak

Other environmental factors conferred the periods of intermediate GSI values with advantages that enhanced their survival

Discussion

Summer Survivors

- More survivors when:
  - GSI lower
  - SST higher
  - Wr higher

- Hatch peak occurs with low GSI values, however:
  - Some residual spawning activity,
  - better maternal condition,
  - environmental conditions.

Faster growth in larval and juvenile stages coud improve the changes of survival.

Discussion

Winter vs Summer: growth diferences

Winter survivors

SST ≈ 14ºC

Energy accumulation in summer months, to produce higher quantity of eggs in winter.

Summer Survivors

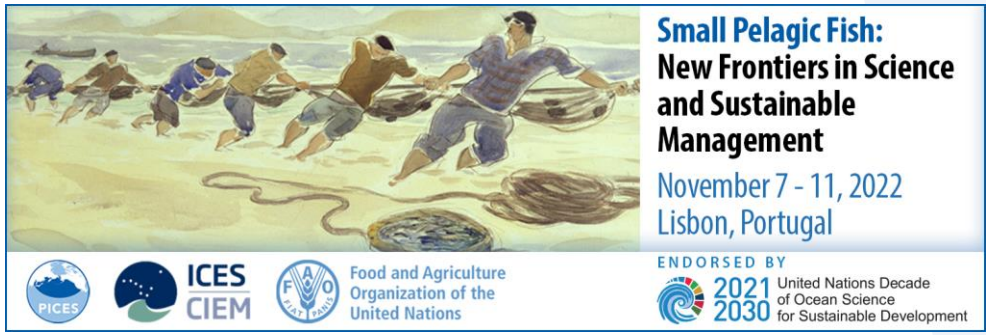
SST ≈ 18ºC

More food and highest temperatures seems to be related with faster larvae growth.

Sardine seams to be subject to growth-selective mortality

Future Research

- 2007 and 2008 were atypical years in terms of environmental conditions (PBOliveira, pers. comm);
- Compare with other years with contrasting recruitment
- See egg abundances for the same area and seasons;
- Examine variability of the circulation pattern;
- Include zooplankton abundance in the analysis.



Thank you
For your attention

COMMENTS

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