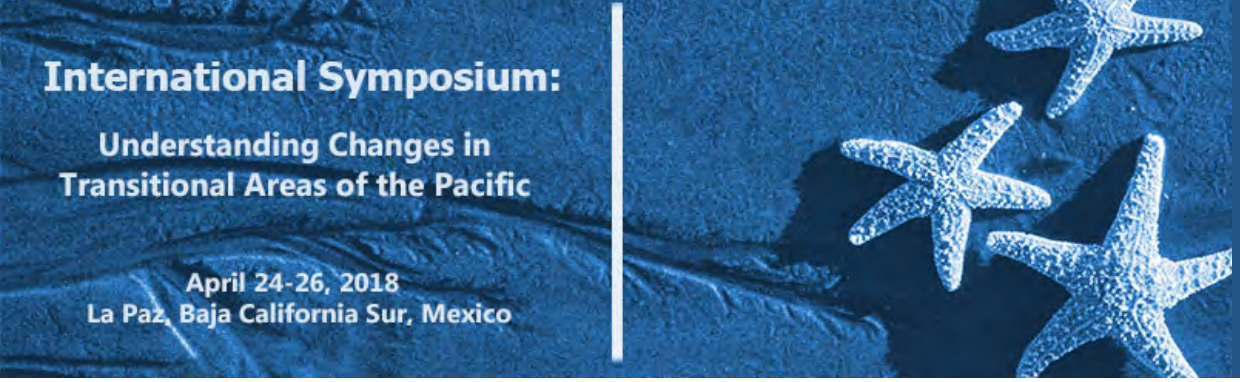

Session 2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

Dynamics of the transition zones between distribution sub-areas of Jack Mackerel (*Trachurus murphyi*) in the South Pacific

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CIENCIA Y TECNOLOGIA

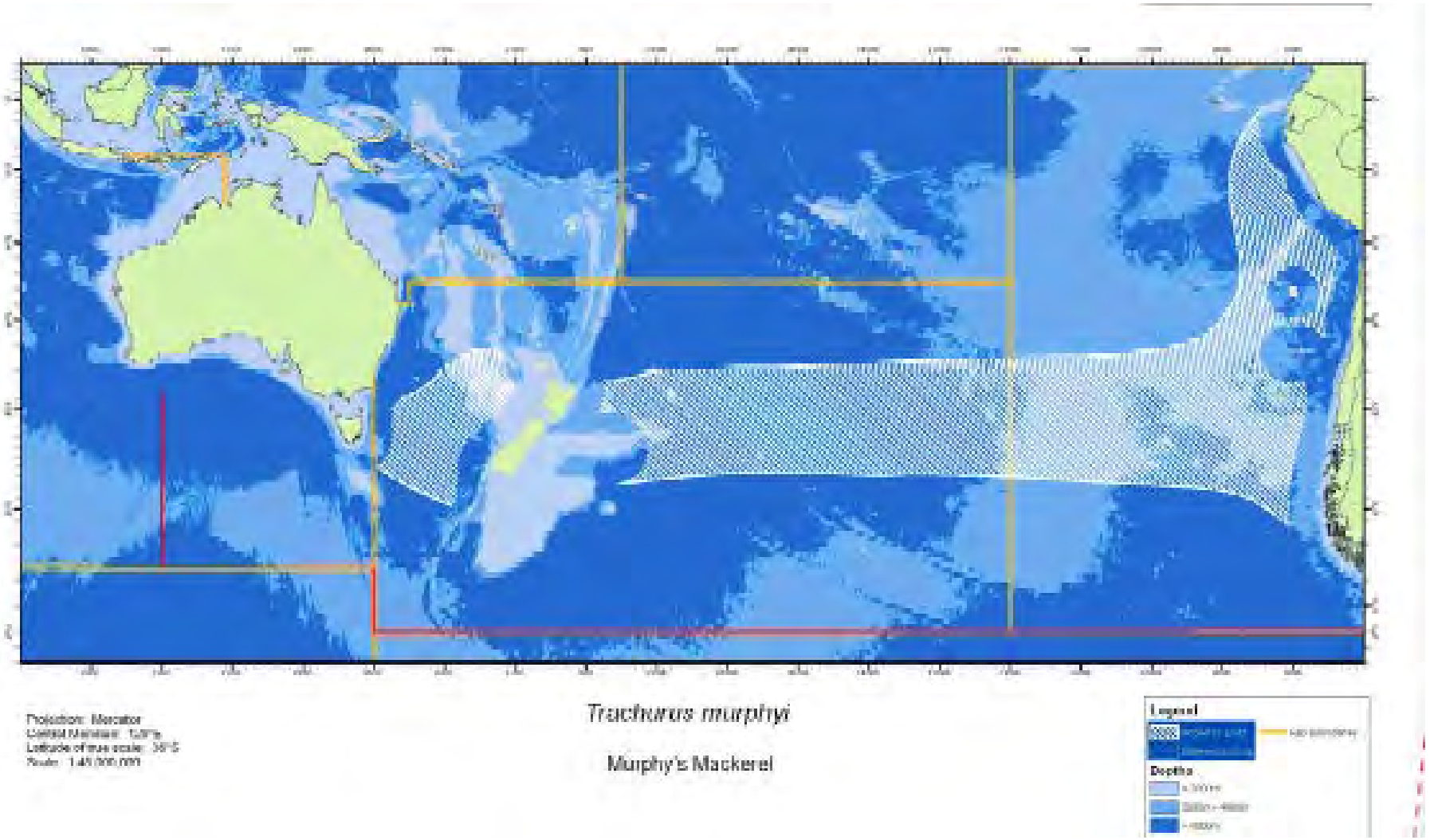
Institut de Recherche pour le Développement

SPRFMO
South Pacific Regional Fisheries Management Organisation

Outline

- Introduction: Jack mackarel population structure.
- Introduction: Ecological niche and environmental tolerance.
- Methods
  - Spatial distribution models
  - Cluster analysis
- Results
- Conclusions and perspectives

Introduction



SPRFMO
South Pacific Regional Fisheries Management Organisation

Introduction

- Hypothesis on Jack mackerel population structure
  - Hypothesis 1: **Jack mackerel caught off the coasts of Perú and Chile each constitute separate stocks which straddle the high seas.**
  - Hypothesis 2: **Jack mackerel caught off the coasts of Perú and Chile constitute a single shared stock which straddles the high seas.**
  - Hypothesis 3: **Jack mackerel caught off the Chilean area constitute a single straddling stock extending from the coast out to about 120°W.**
  - Hypothesis 4: **Jack mackerel caught off the Chilean area constitute separate straddling and high seas stocks.**
- Metapopulation hypothesis

- How many stocks?
  - Important for assessment and management

Introduction

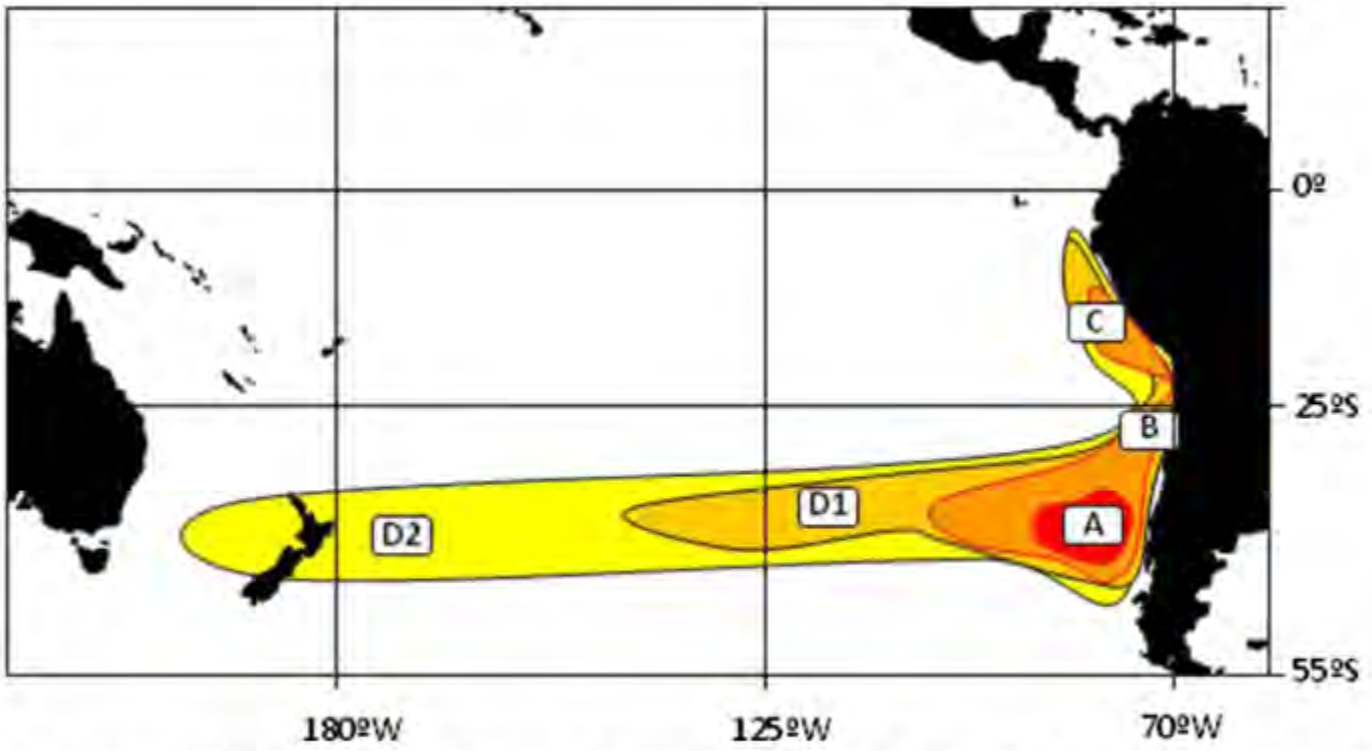
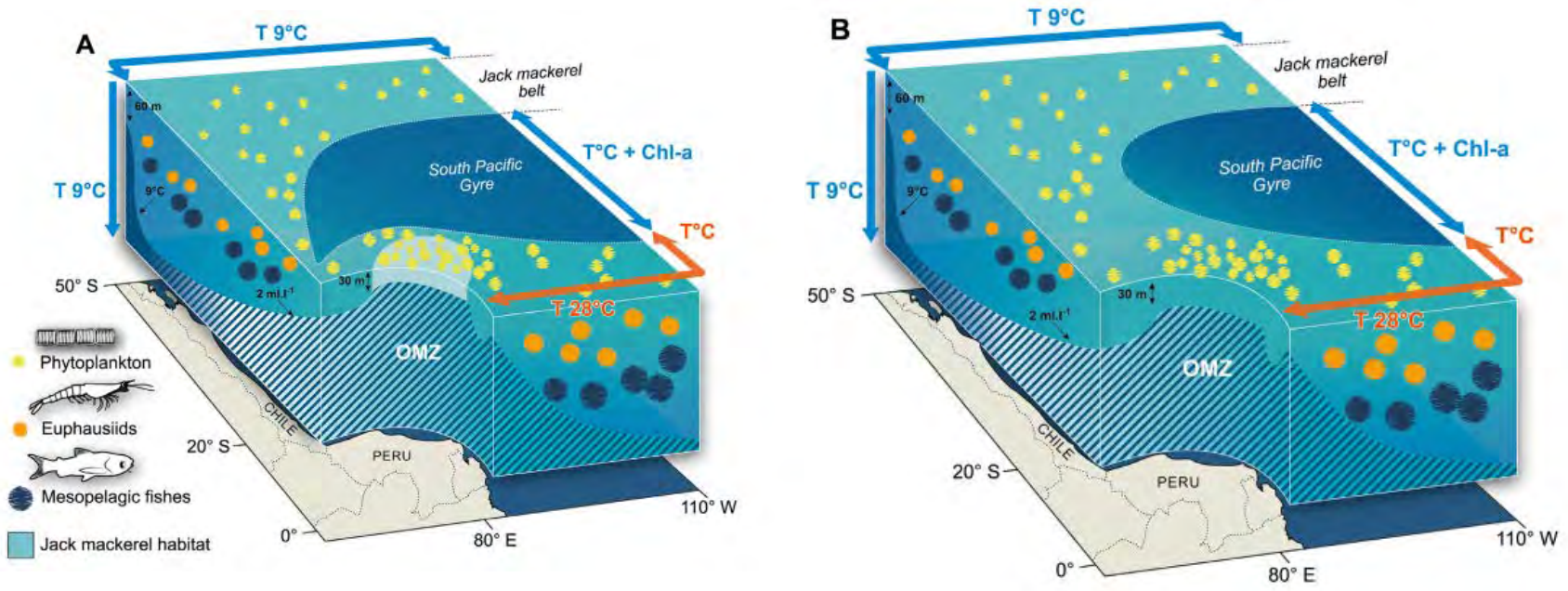


Fig. 1. Extension and abundance of the Chilean jack mackerel, during periods of low (red area) to high abundance (yellow area). The letters in rectangles show the major patches of density. A: Central Pacific-Centre South Chilean stock; B: Northern Chilean stock; C: Peruvian stock; D1 and D2: Central South and Southwest Pacific Ocean stocks respectively.

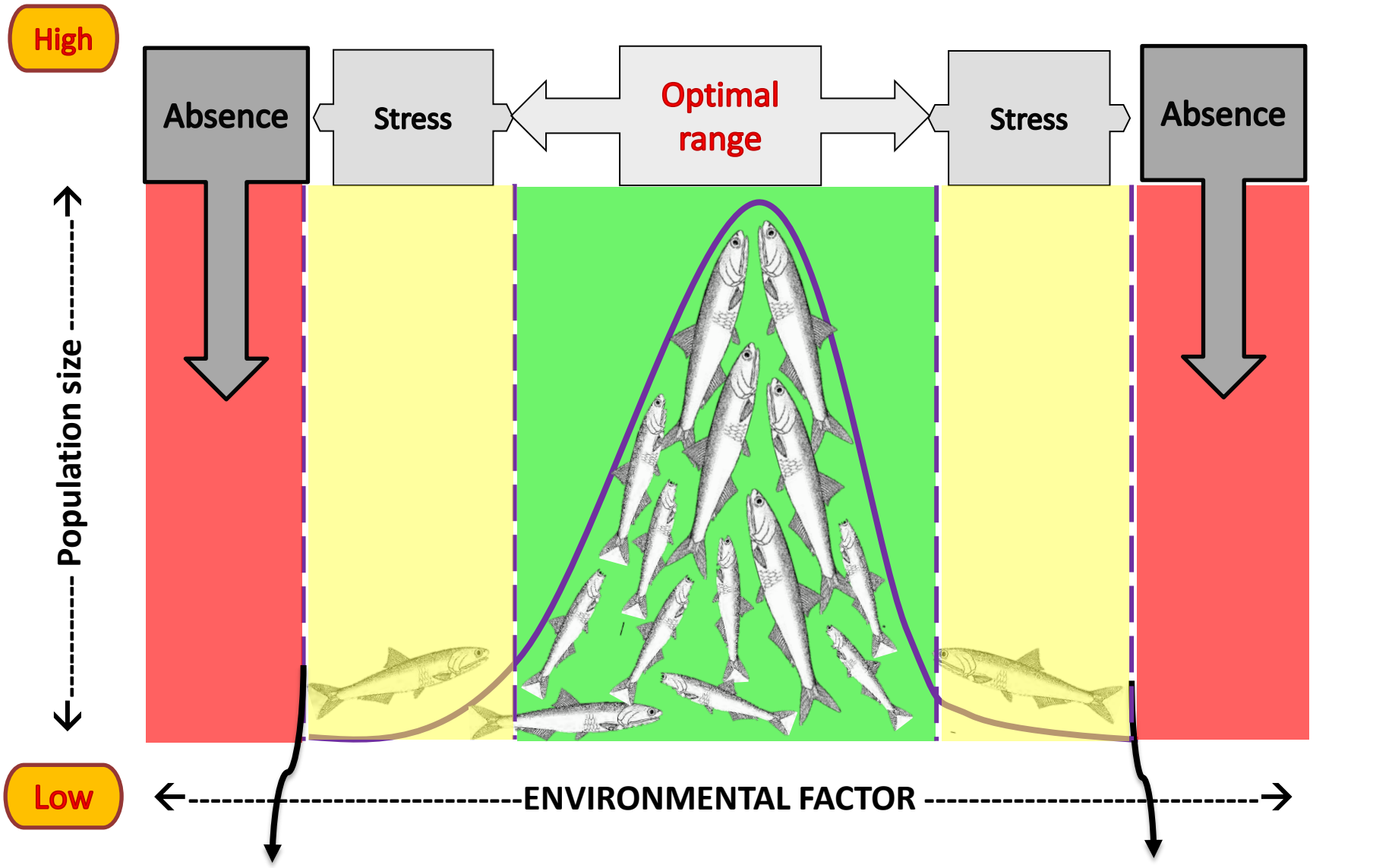
F. Gerlotto et al.: Aquat. Living Resour. 25, 341–355 (2012)

Introduction



A. Bertrand et al. / Progress in Oceanography 146 (2016) 199–211

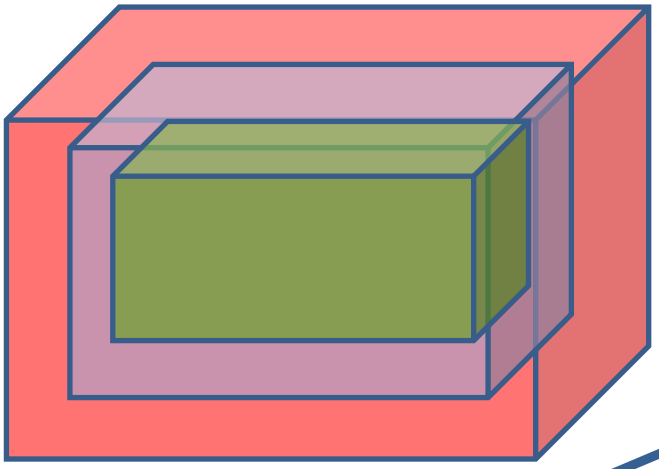
Introduction: Ecological niche



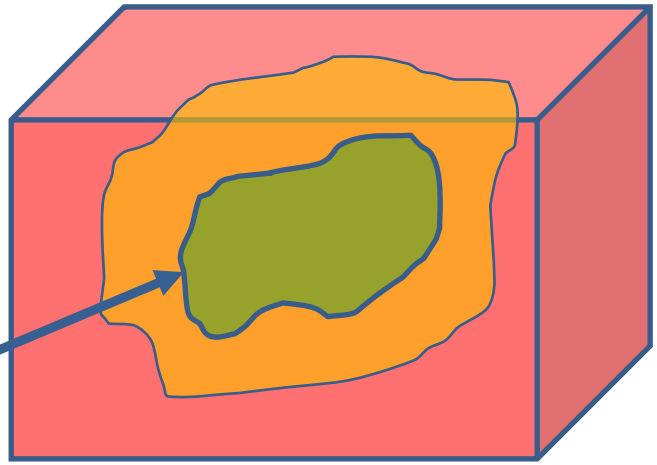
Introduction: Ecological niche

Interactions between environmental factors are possible!

Without interactions



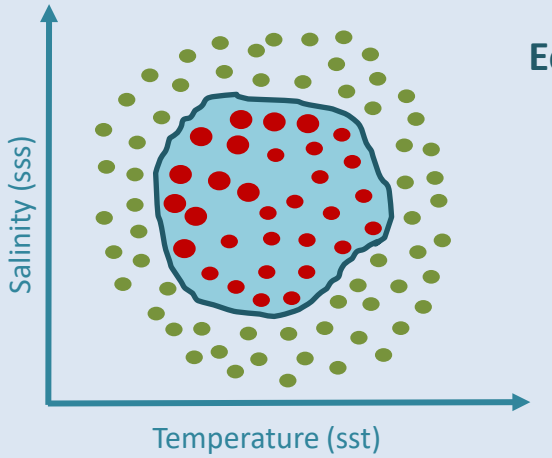
With interactions



Boundary = **Identification of the niche**

Introduction: Ecological niche models

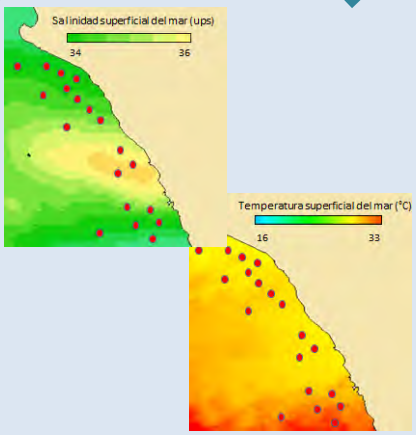
Ecological space



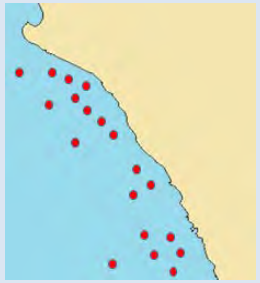
Ecological niche model

✘ ~~Latitude, Longitude~~
✔ SST, SSS

Geographical space



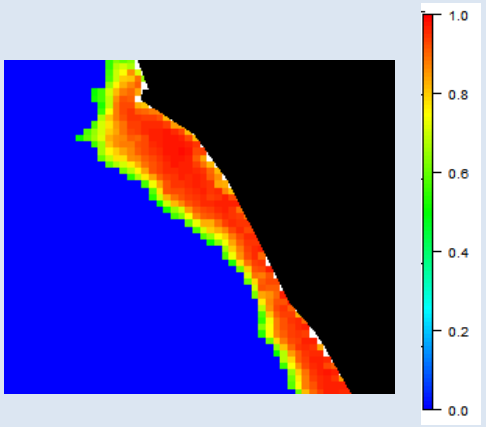
Environmental data



Presence records

INPUT

OUTPUT



Spatial distribution

Objective

- Classify the distribution area of Jack Mackerel according to the temporal variability in the habitat suitability for Jack mackerel (*Trachurus murphyi*).

Methods

1) **NICHE MODELS**

- R
- mgcv
- kali

GAM : PA + Environmental data

2) **SPATIAL-TEMPORAL PREDICTION**

- Global domain
- 1/4º resolution
- Oct 1997 to Dec 2015

Niche model

3) **HABITAT SUITABILITY INDEX**

- HSI values logit<thr set to zero

HSI = (logit – thr) / (1-thr)

Methods

4) **ESTIMATION OF TREND, SEASONALITY AND ANOMALIES**

- **Trend**
- **Seasonality**
- **Anomalies**

Decomposed the time series from each square of the grid

5) **ANALYSIS FOR EACH SQUARE OF THE GRID**

- **Mean of trend**
- **Coefficient of variation of trend**
- **Standard deviation of seasonality**
- **Length of range of seasonality**
- **Standard deviation of anomalies**

Mean habitat quality
Inter annual stability
Seasonal stability
Strength of the seasonality
Impact of extreme events

Methods

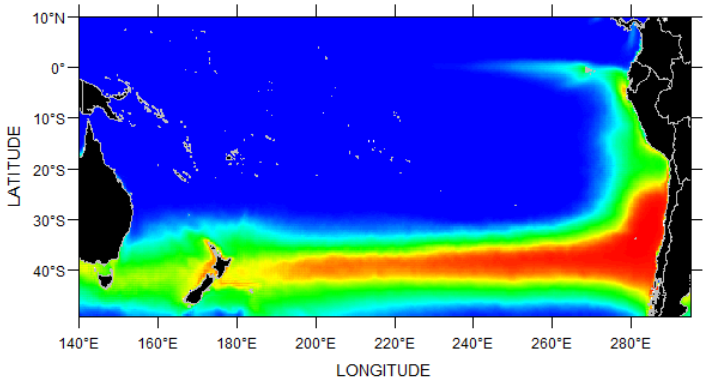
6) **CLASSIFICATION OF EACH SQUARE OF THE GRID**

- **k-mean clustering**

Data classified in n clusters

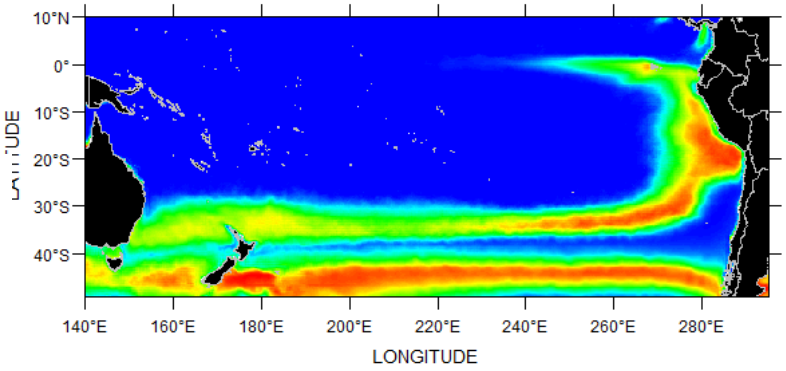
7) **ECOLOGICAL INTERPRETATION FOR EACH CLUSTER**

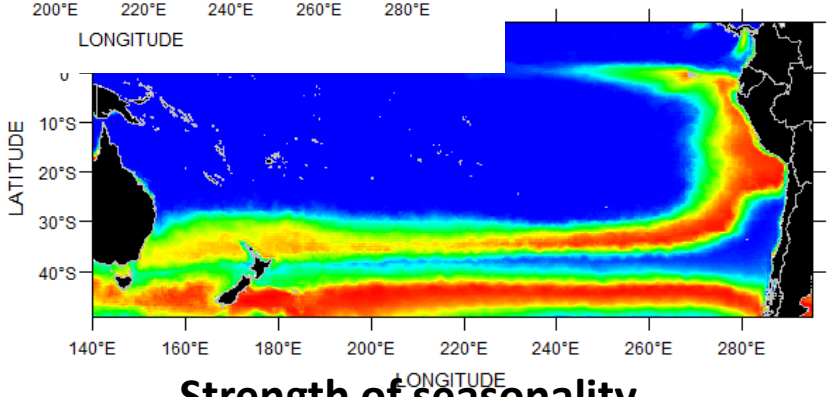
Results



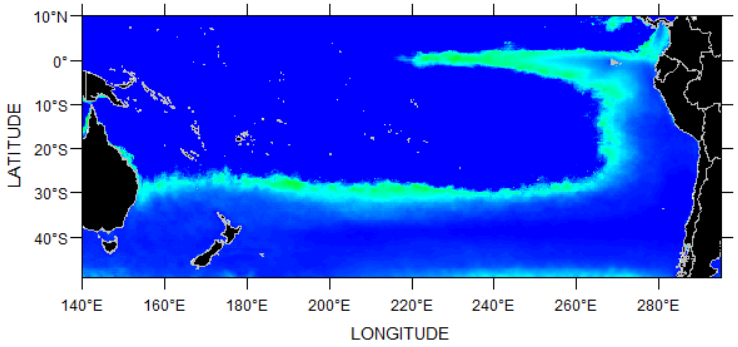
Mean habitat quality

Seasonal stability



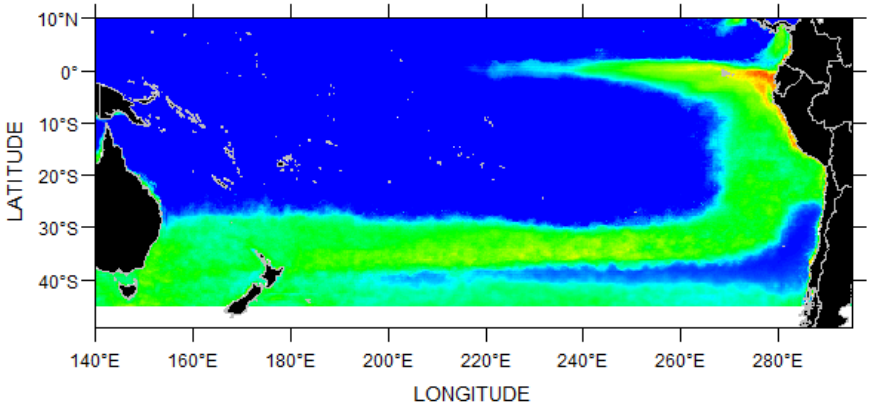


Strength of seasonality

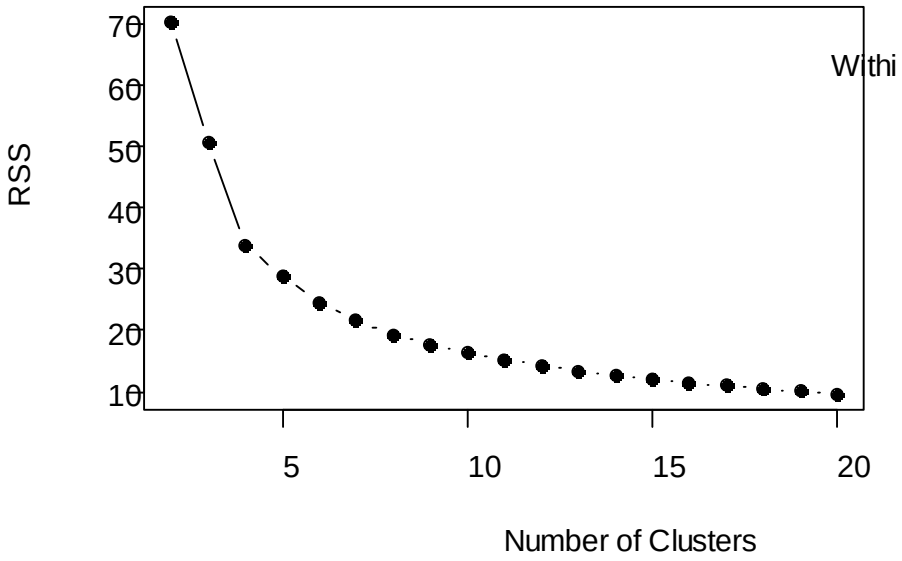


Interannual stability

Impact of extreme events



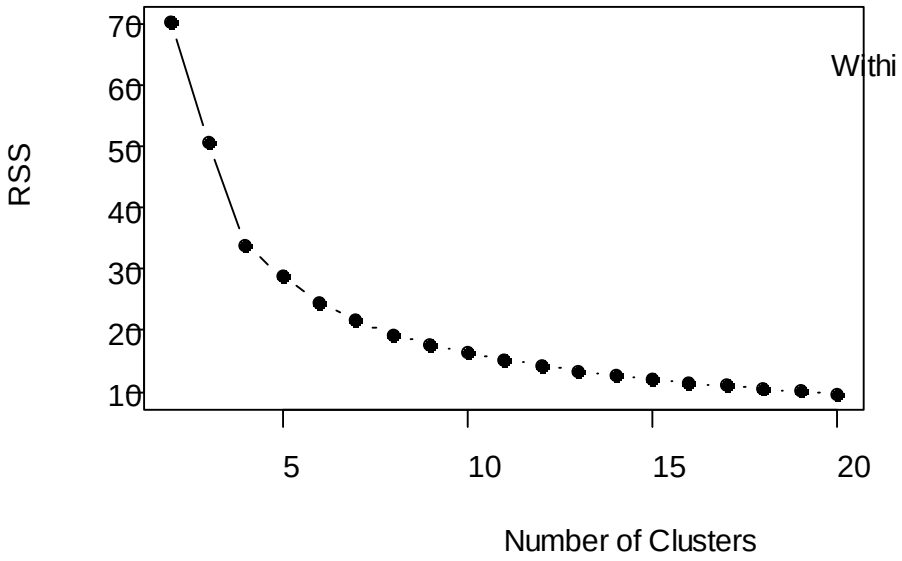
Results



8 clusters =
2 stable areas + 1 transition zone

	1	2	3	4	5	6	7	8
meanHQ	0.33	0.67	0.51	0.91	0.71	0.79	1	0.42
interStab	0.04	0.14	0.12	0.29	0.12	0.15	1	0.07
SeasonStab	0.11	0.09	0.08	0.32	0.13	0.19	1	0.1
SeasonStrength	0.79	0.91	1	0.3	0.69	0.48	0.1	0.85
extremeEvents	1	0.76	0.72	0.48	0.8	0.7	0.19	0.86

Results



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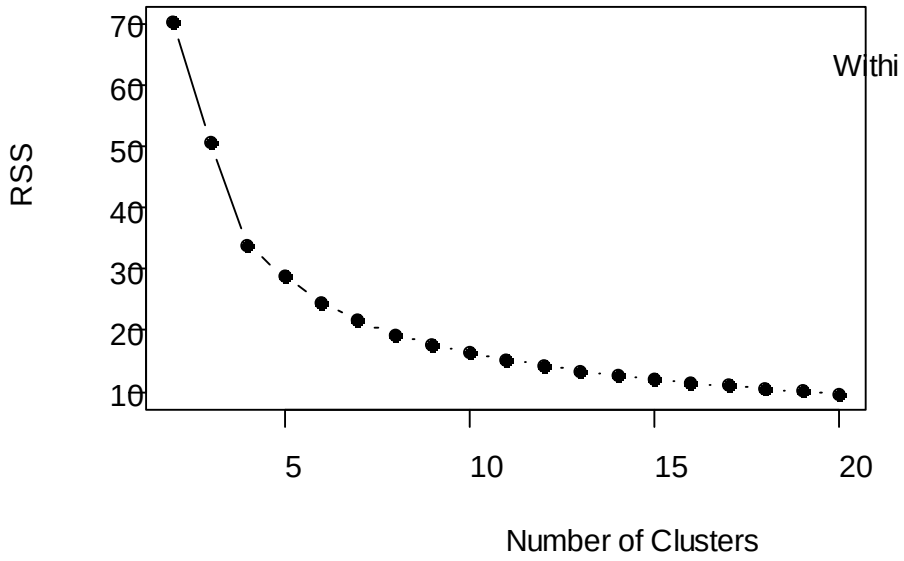

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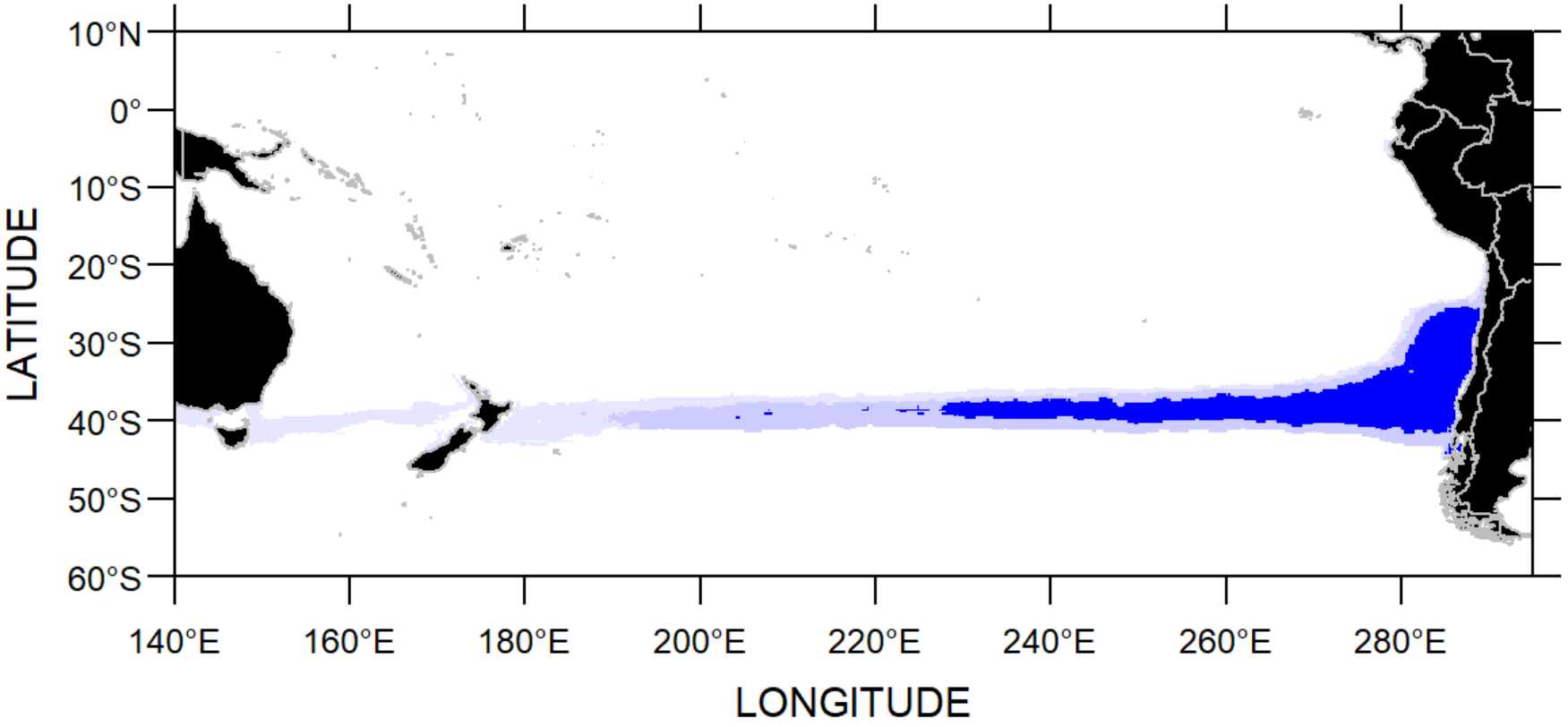
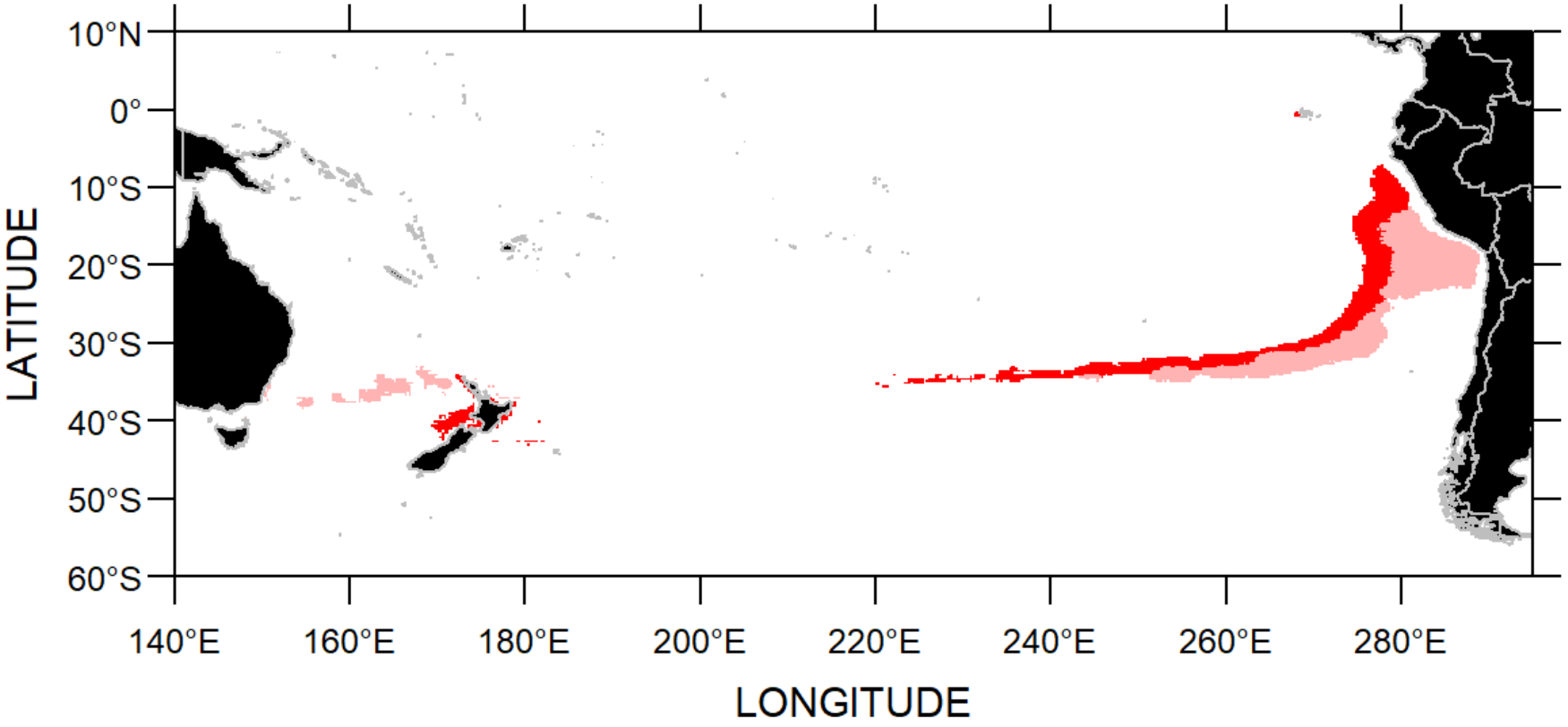
Results



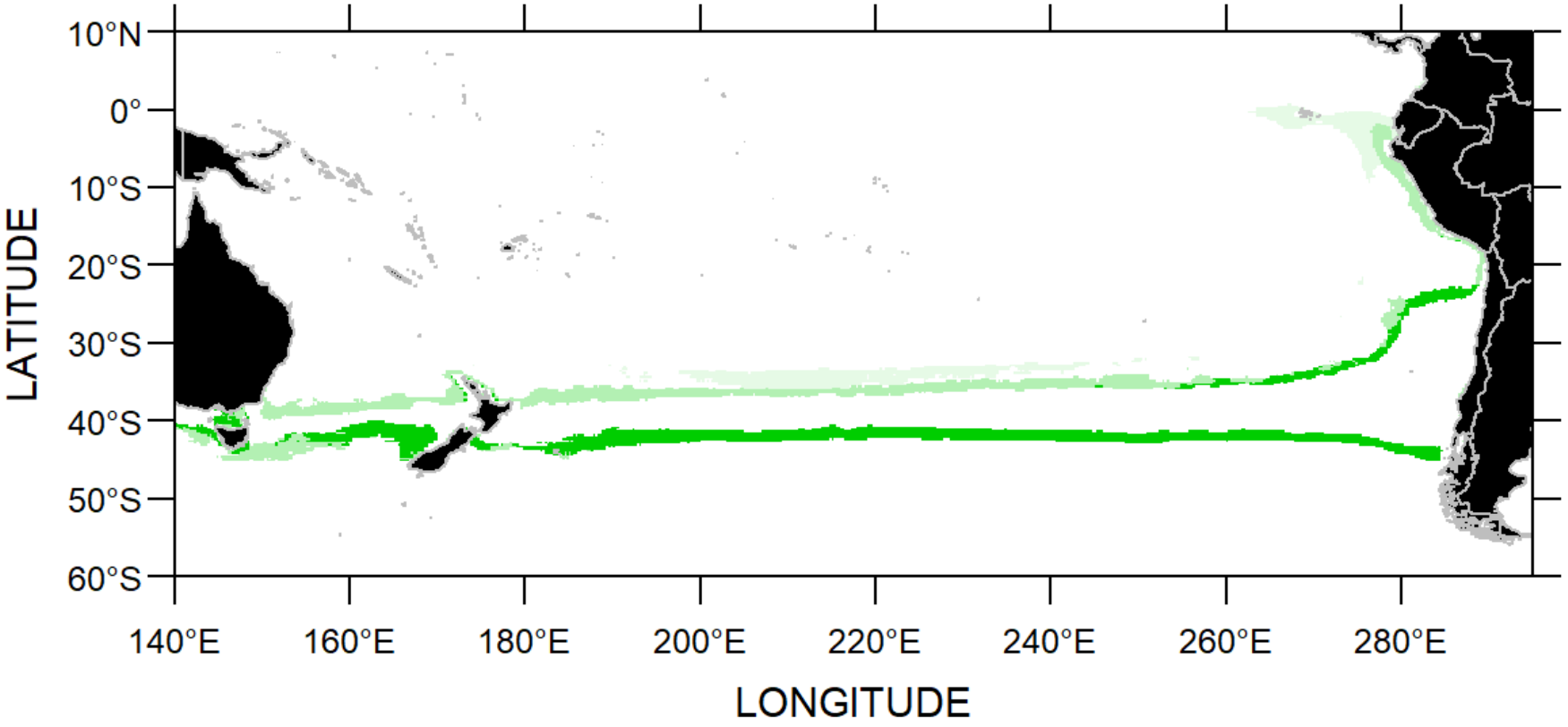
- **Highest habitat quality**
- **Low interannual variability**

Results



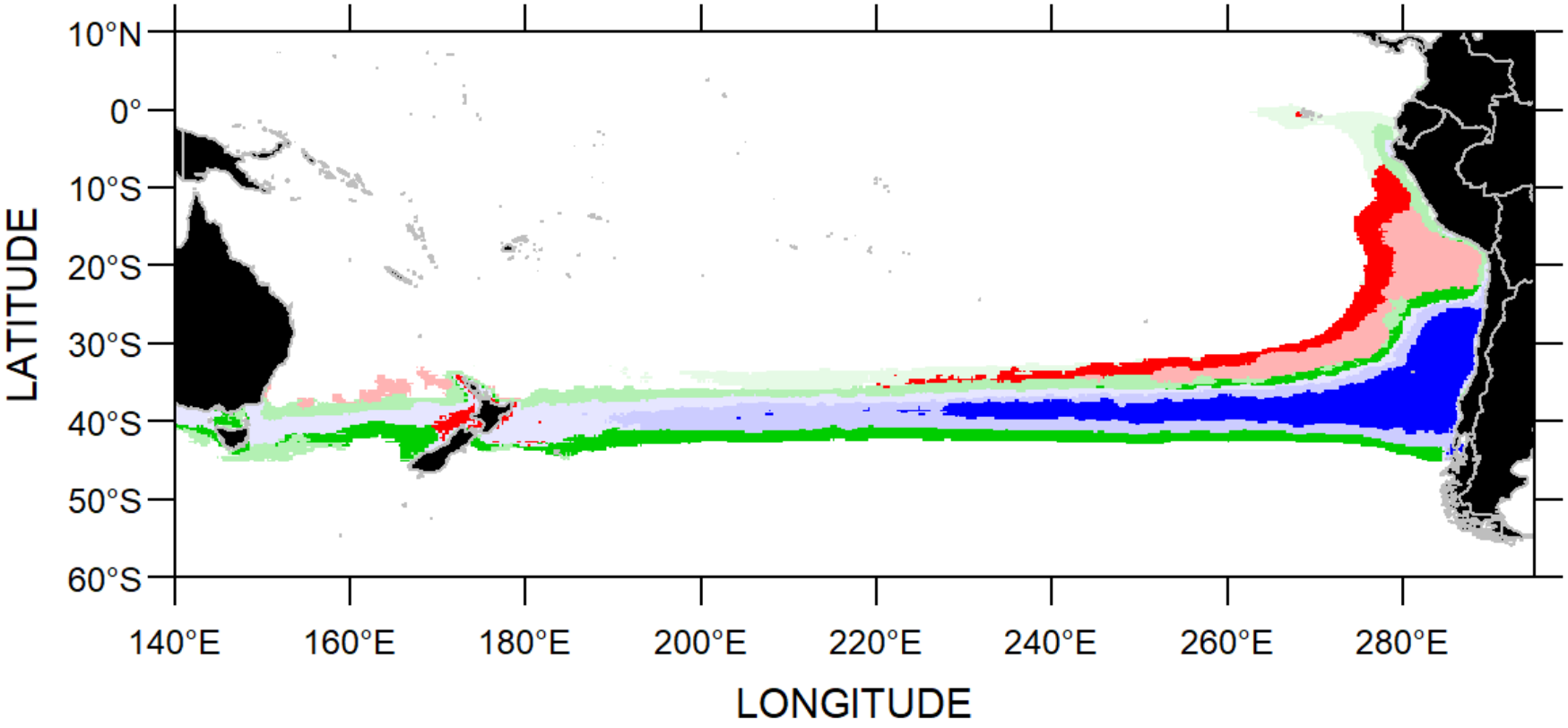
- **Medium habitat quality**
- **Moderate interannual variability**

Results



- **Medium habitat quality**
- **Highest interannual variability**

Results


10°N
0°
10°S
20°S
30°S
40°S
50°S
60°S
LATITUDE
140°E
160°E
180°E
200°E
220°E
240°E
260°E
280°E
LONGITUDE

Conclusions

- The temporal variability in the habitat suitability for Jack mackerel defines at least two distribution areas.
- The transition zones show a high interannual varibility, making posible a continuity in the distribution under some environmental conditions.
- Our results are consistent with the metapopulation hypothesis for Jack mackarel population structure.

Perspectives

- Consider different time windows for the analysis (multiple regimes).
- Include oxygen in the analysis (models, reanalysis).
- Include high seas distribution data for Jack mackerel.
- Consider different stages (e.g. adults, juveniles) in the habitat modelling.

Acknowledments

- Travel support from PICES.
- SPRFMO’s Scientific Committee.
- IMARPE staff.
- IFREMER.