



## Long term variations in the population dynamics of Iberian sardine (*Sardina pilchardus*) and its relation to environmental conditions and exploitation history

Malta T.<sup>a</sup>, Santos A. M.<sup>a</sup>, Santos P.<sup>b</sup> and Silva A.<sup>a</sup>

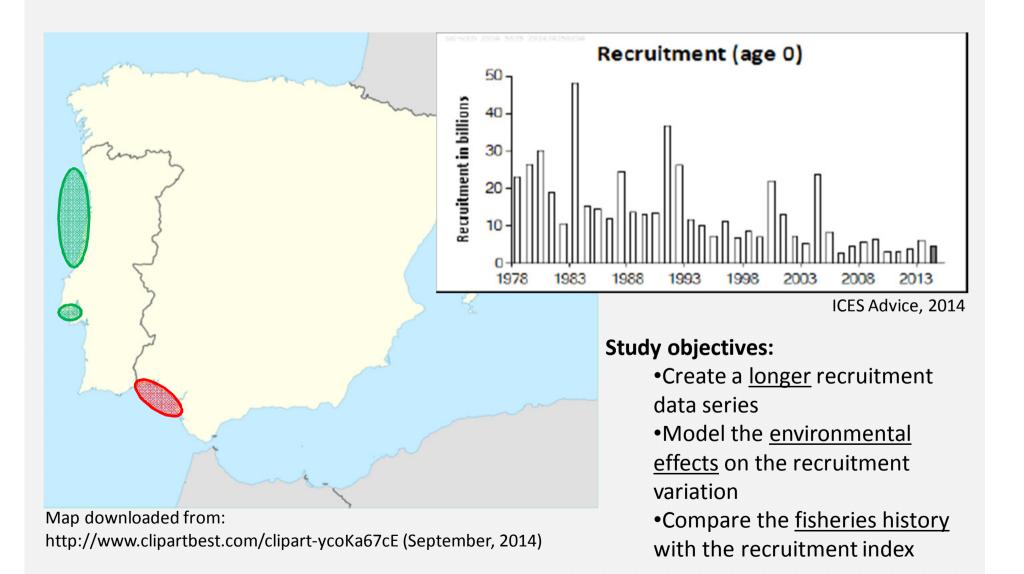
2014

<sup>a</sup>IPMA – Instituto Português do Mar e da Atmosfera

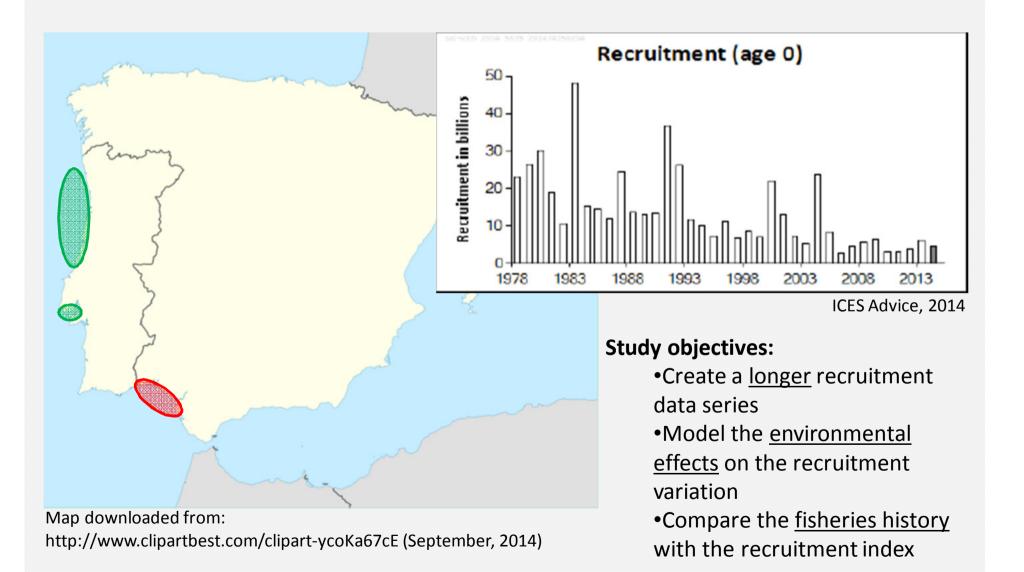
<sup>b</sup>FCUP – Faculdade de Ciências da Universidade do Porto

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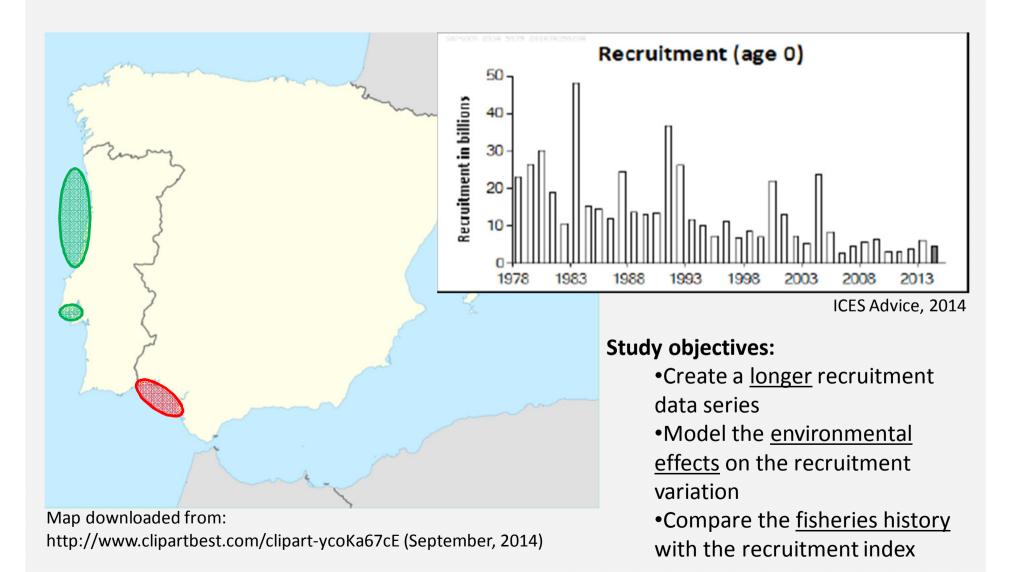
# Study what? Why? Where?



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## **Material and Methods**

#### Data

- Fisheries data (1947-2012)
  - Monthly sardine landings
  - Length and weight distribution samples
- Environmental data (1949-2012)
  - Upwelling Index
  - Sea Surface Temperatures
  - North Atlantic Oscillation Index
  - East Atlantic Pattern Index
  - Atlantic Multidecadal Oscillation Index

#### Methods

- Development of Historical Recruitment Index (HRI)
  - Estimates of number of recruits per kg landed
- HRI vs Environmental variables
  - Generalized Additive Models
- Sardine fisheries historical compilation
  - Published papers, official reports and grey literature

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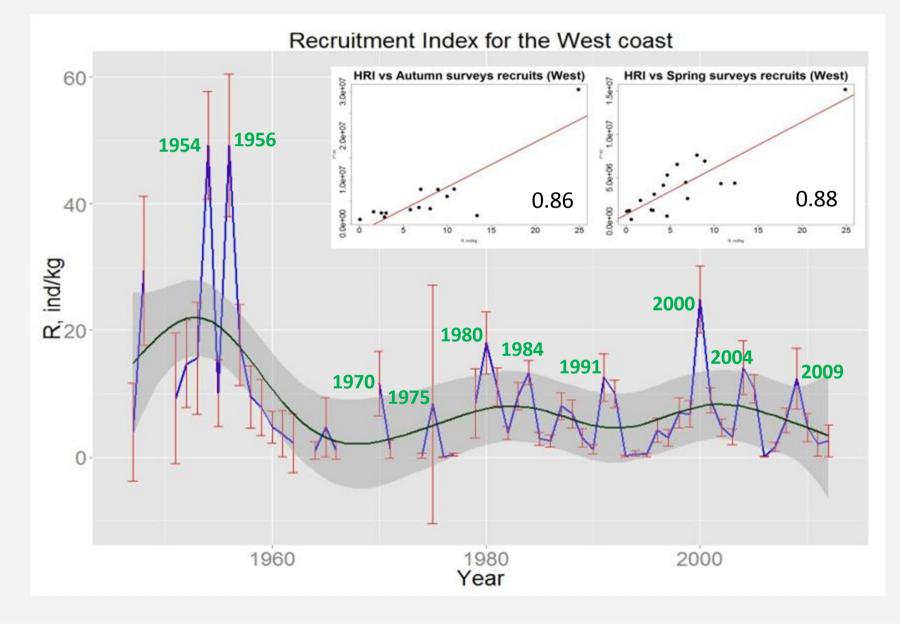
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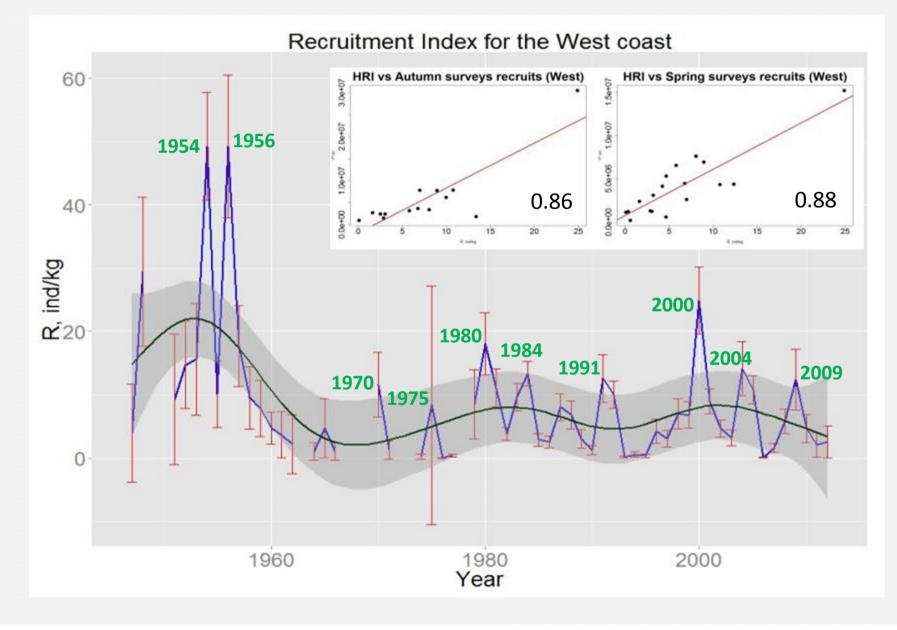
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## |HRI

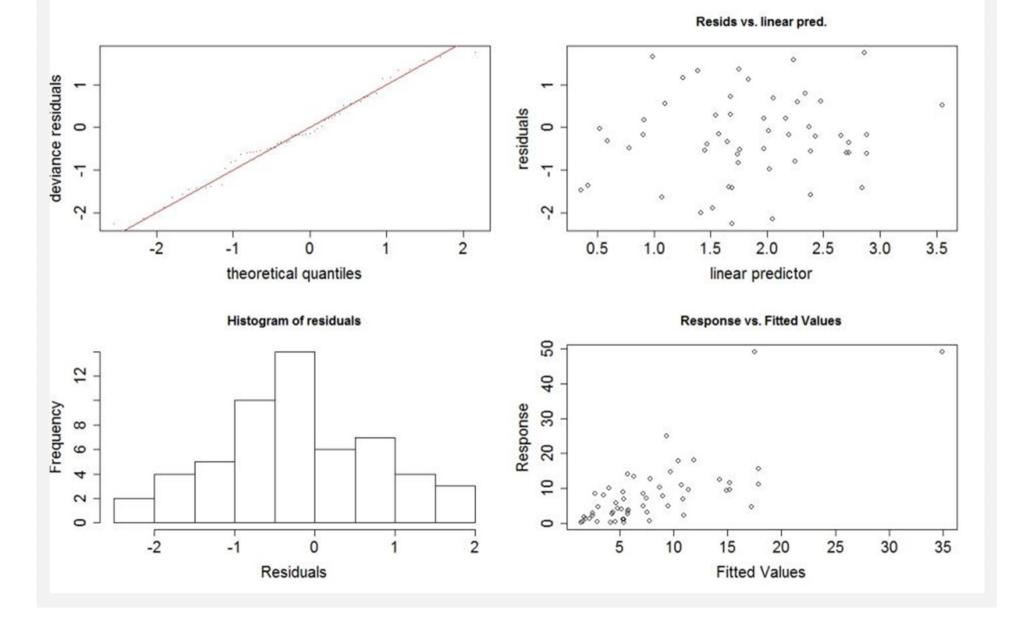


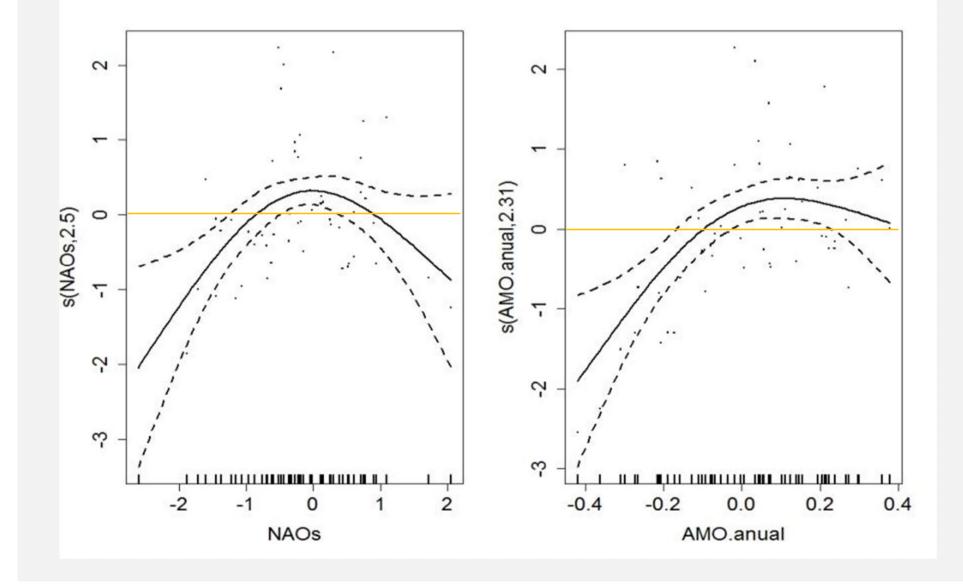
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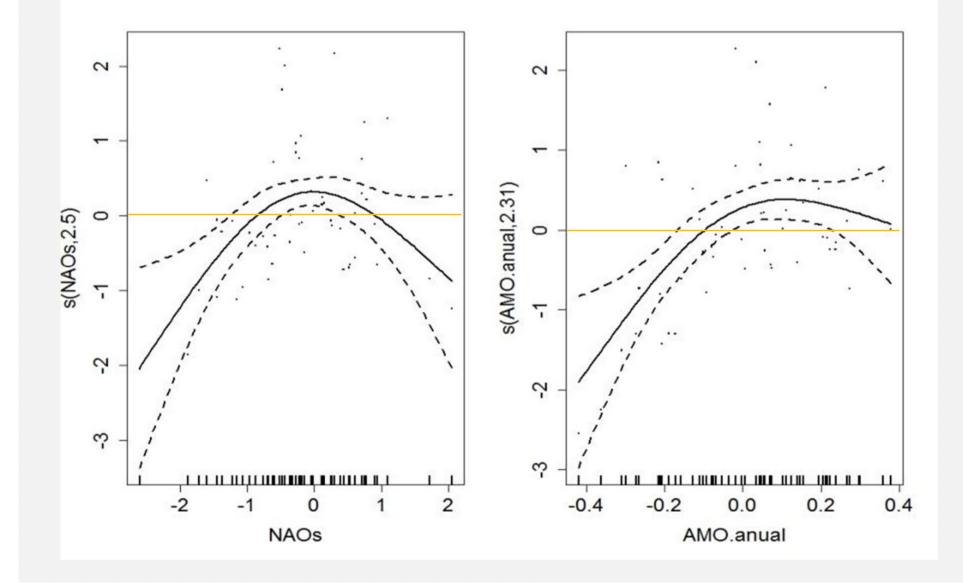


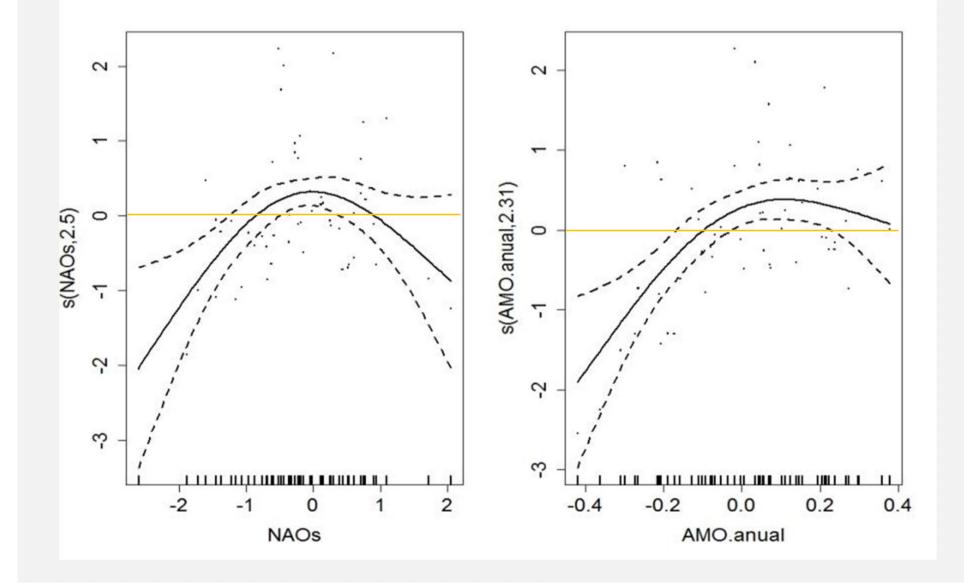
Initial Model	<ul> <li>HRI ~ s(NAOw) + s(NAOs) + s(SSTw) + s(SSTs) + s(EAw) + s(EAs) + s(aflo.w) + s(aflo.s) + s(AMO.annual)</li> </ul>
Final Model	<ul> <li>HRI ~ s(NAOs) + s(AMO.annual) + SSTs + aflo.w</li> <li>AMO.anual (p=0.0004); NAOs (p=0.002); SSTs (p=0.003) &amp; aflo.w (p=0.01)</li> <li>Deviance explained = 46.2%</li> </ul>

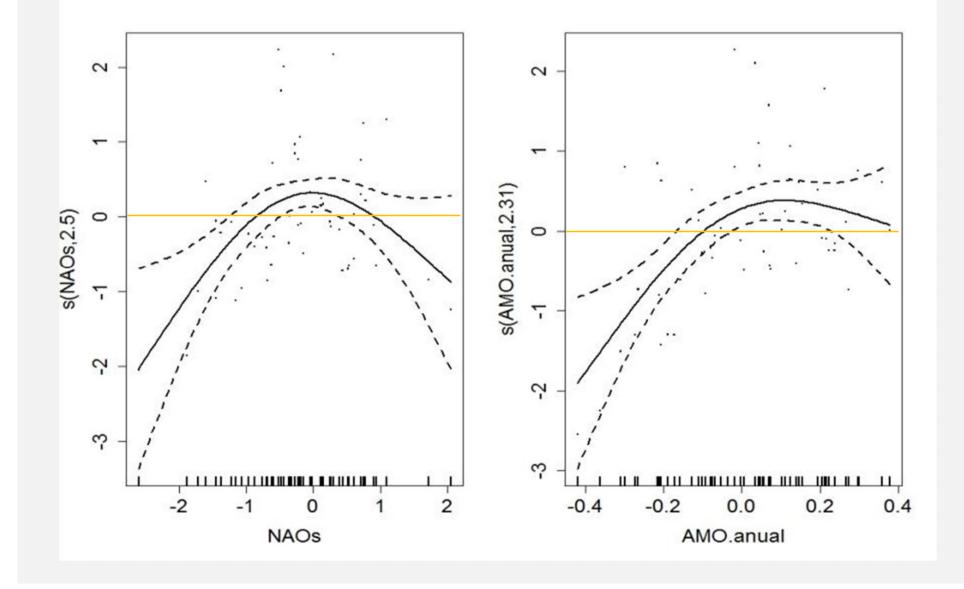
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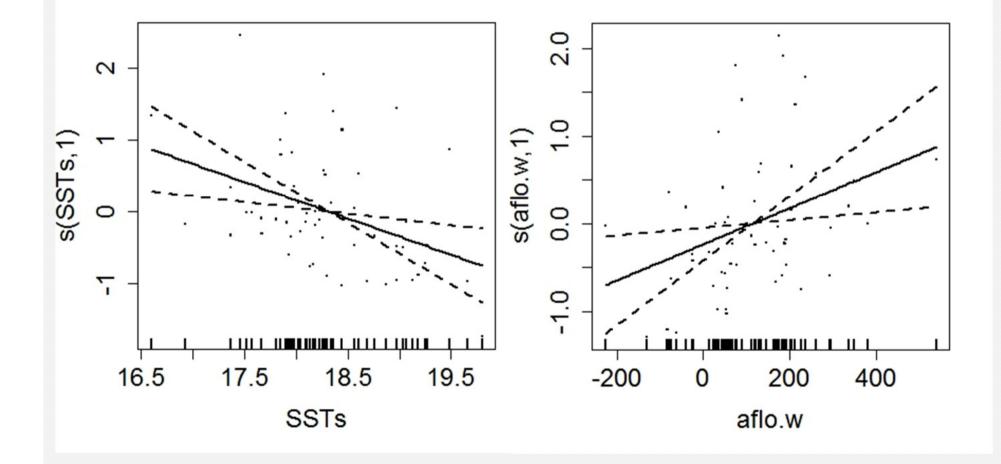




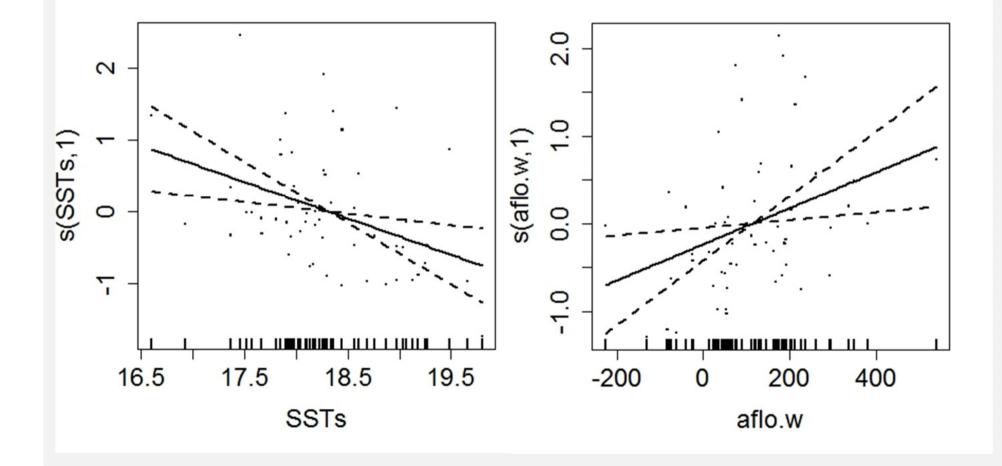


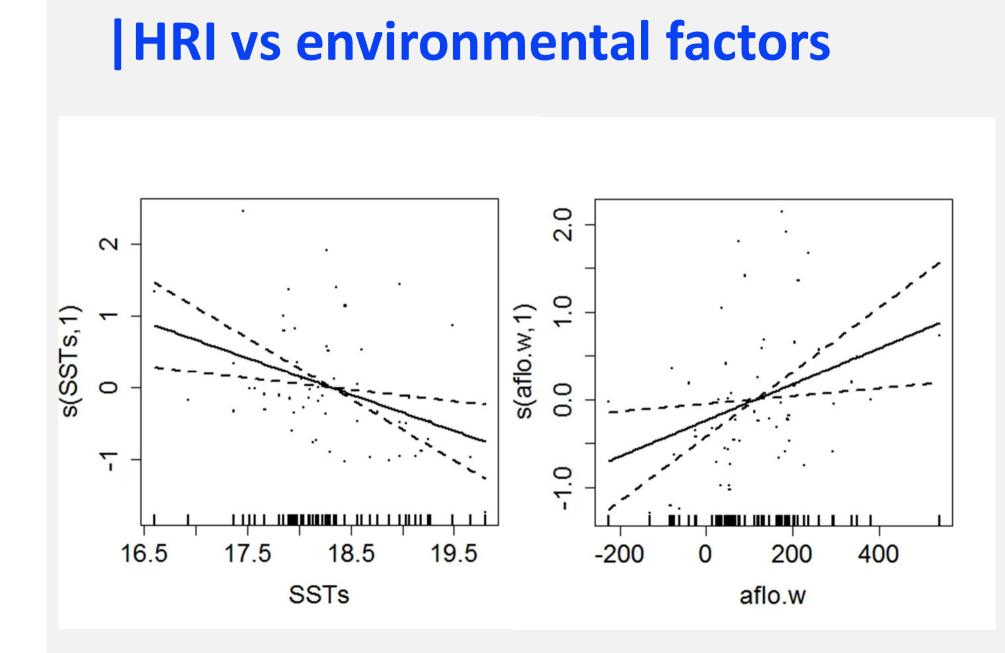




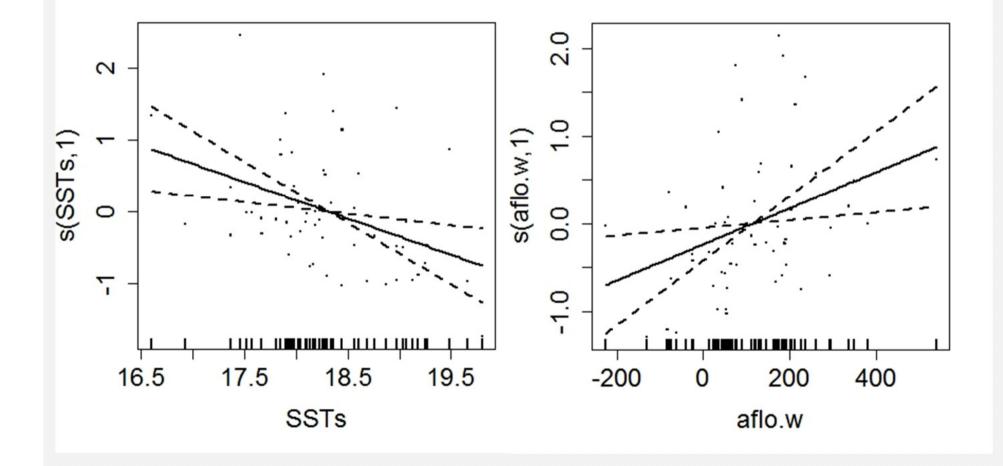




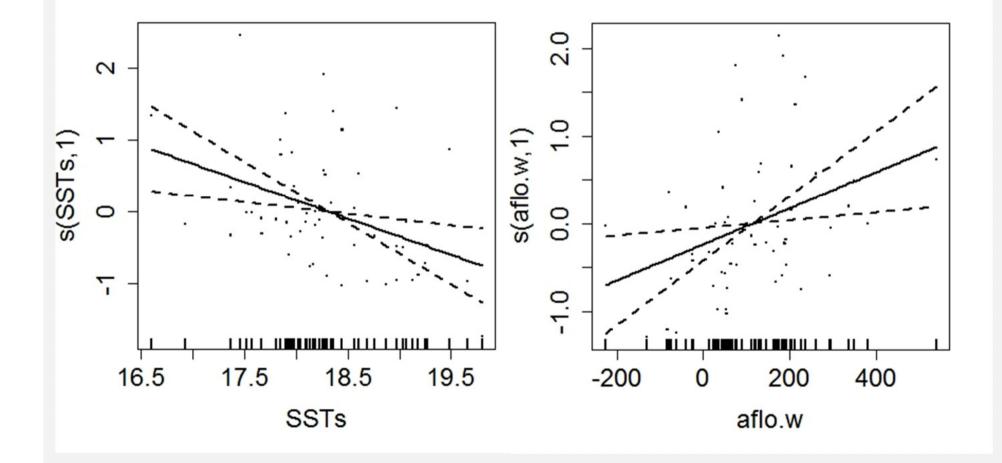




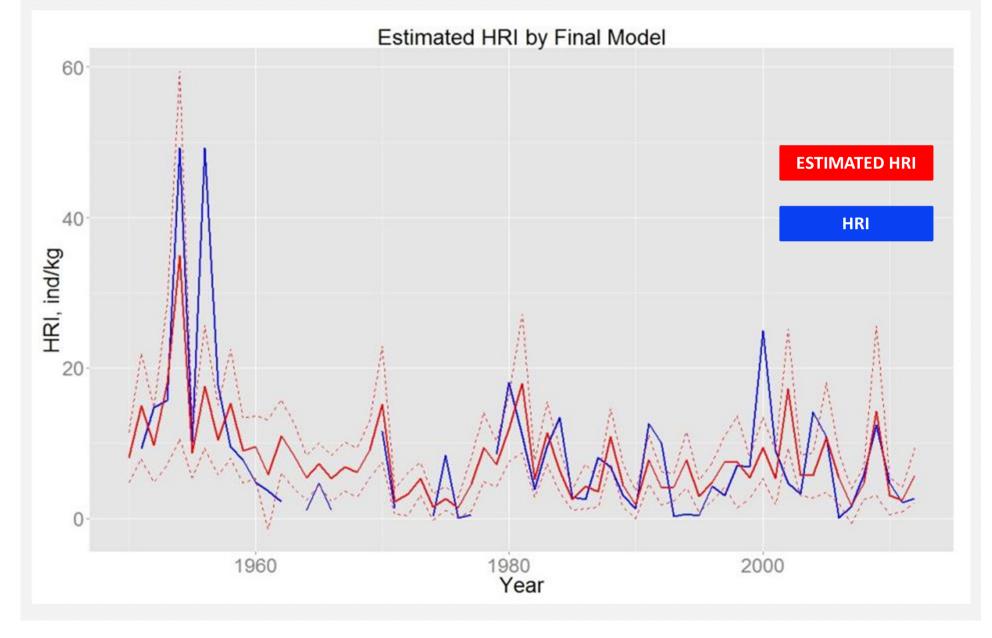




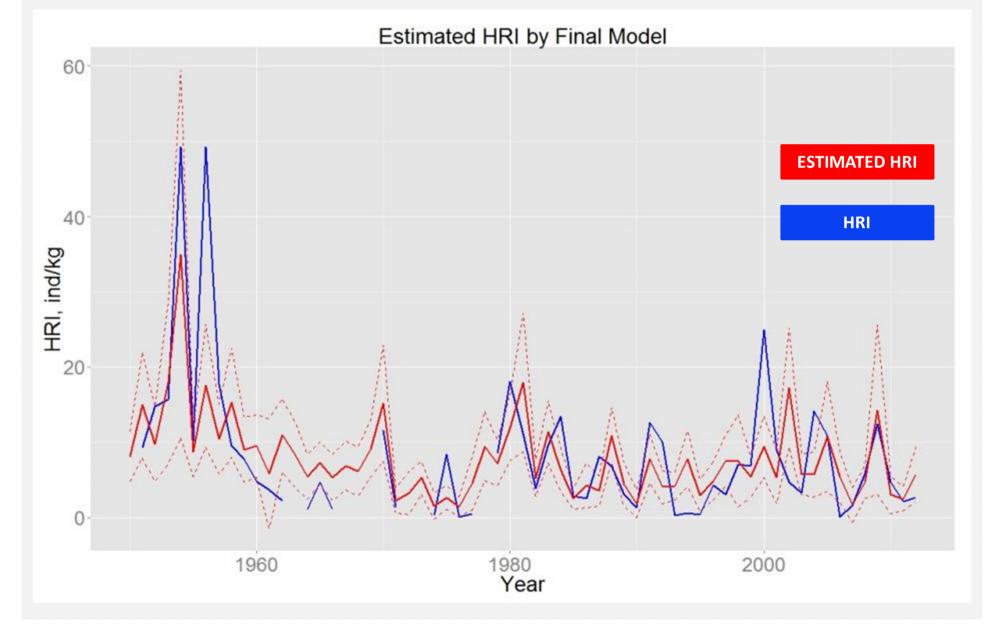




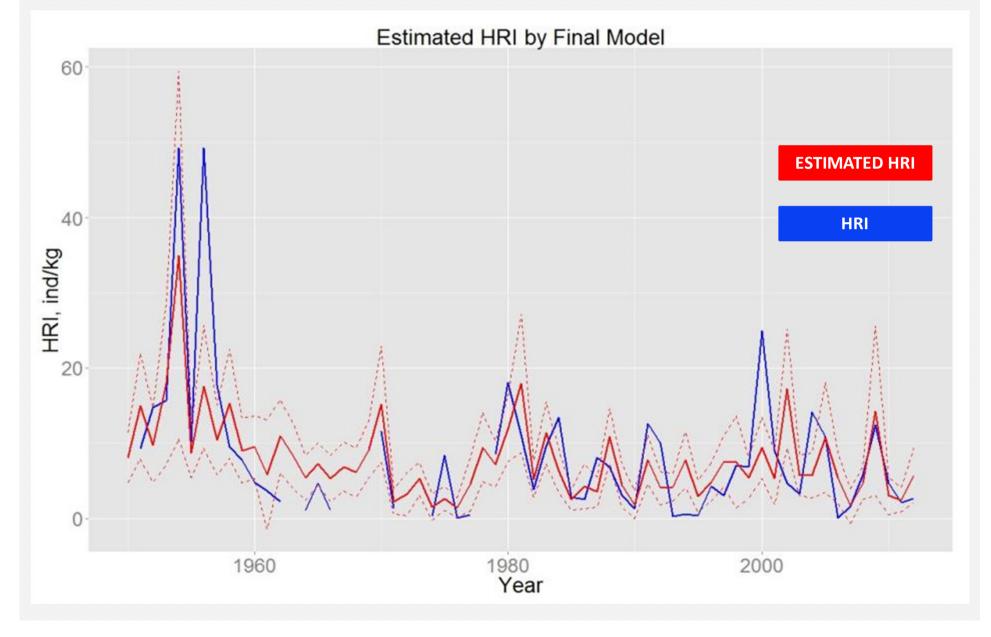
## **Estimated HRI**



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	World War II														
Events	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Socio-economic	Increased search and consumption, impulse to the canning industry	d Difficul access r material canning	aw for		sector, l	n the cann high opera narket satu	ating	Crisis ca labour c		ector, inci	rease of				al recovery of the g industry, increase orts
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	Landings,'000 t / HRI,no fish/Kg / vessels	f	7° 1	ך ג	~		M	N	∧ ∕	<u>^</u>	~	5	~	<b>•</b>	ANDINGS VESSELS HRI

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Socio-economic       Increased search and consumption, impulse to the canning industry       Difficulty to access raw material for canning industry       Crisis in the canning sector, high operating costs, market saturation       Crisis in the canning sector, high operating sector, high operating costs, market saturation       Crisis canning sector, increase of labour costs       Gradual recanning in exports         Technological       Expansion of modern purse seine, diesel propulsion       Introduction of synthetic fibers, echosounder, power blocks       Decrease in effort: no. vessels and fishing days/year halved       Gradual improvement of fishing power and efficiency due of engines, navigation systems and echolocation equipment areas, periods, gear specifications and effort for sardine fisheries.       Decrease in effort: no. vessels and fishing days/year halved       Gen. reg. conservation of fish. regulations; annual quotas (2000-2004), effort limitations, easonal closure in the north imported of engines, navigation systems and echolocation equipment areas, periods, gear specifications and effort for sardine fisheries.       Introduction of south fisheries.       Introduction of such areas, MLS       Additional regulations; annual quotas (2000-2004), effort limitations, easonal closure in the north imported of fish. resources; net/ mesh size, areas, MLS       Additional regulations; and effort for sardine fisheries.       Introduction of south fisheries areas, MLS       Additional regulations; annual quotas (2000-2004), effort limitations, easonal closure in the north imported of fish. resources; net/ mesh size, areas, MLS       Additions, and effort for sardine fisheries areas, MLS       Introduction of fish resources; net/ mesh size, areas, MLS       Introduc		World War II														
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consumption, impulse to the canning industry Expansion of moder	access ra material t canning n purse	for Introduct		sector, h costs, m	nigh opera	ting ration			ctor, incre	ease of			canning	industry, increase
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			nder, pow						adual improvement of fishing power and efficiency due to upgrade tines, navigation systems and echolocation equipement					
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## **Summary & Conclusions**

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