

MareFrame



Granger-causality analysis of Gadget model outputs and environmental drivers.



Hello!

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 **CSIC**
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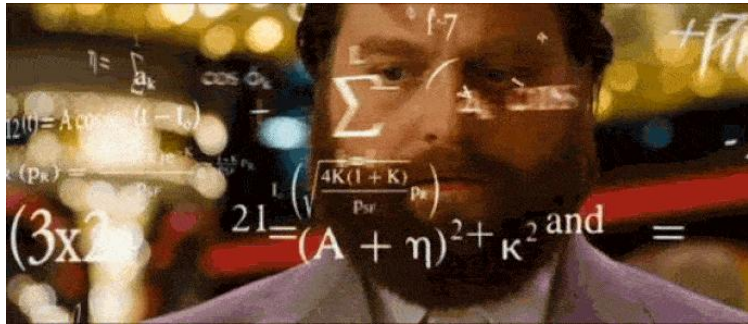


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1.

THE GENERAL PROBLEM FOR FISHERIES MODELLERS



Models for ecosystem-based fisheries management



2.

A SOLUTION PROPOSAL
FOR ANCHOVY FISHERY
IN THE GULF OF CADIZ

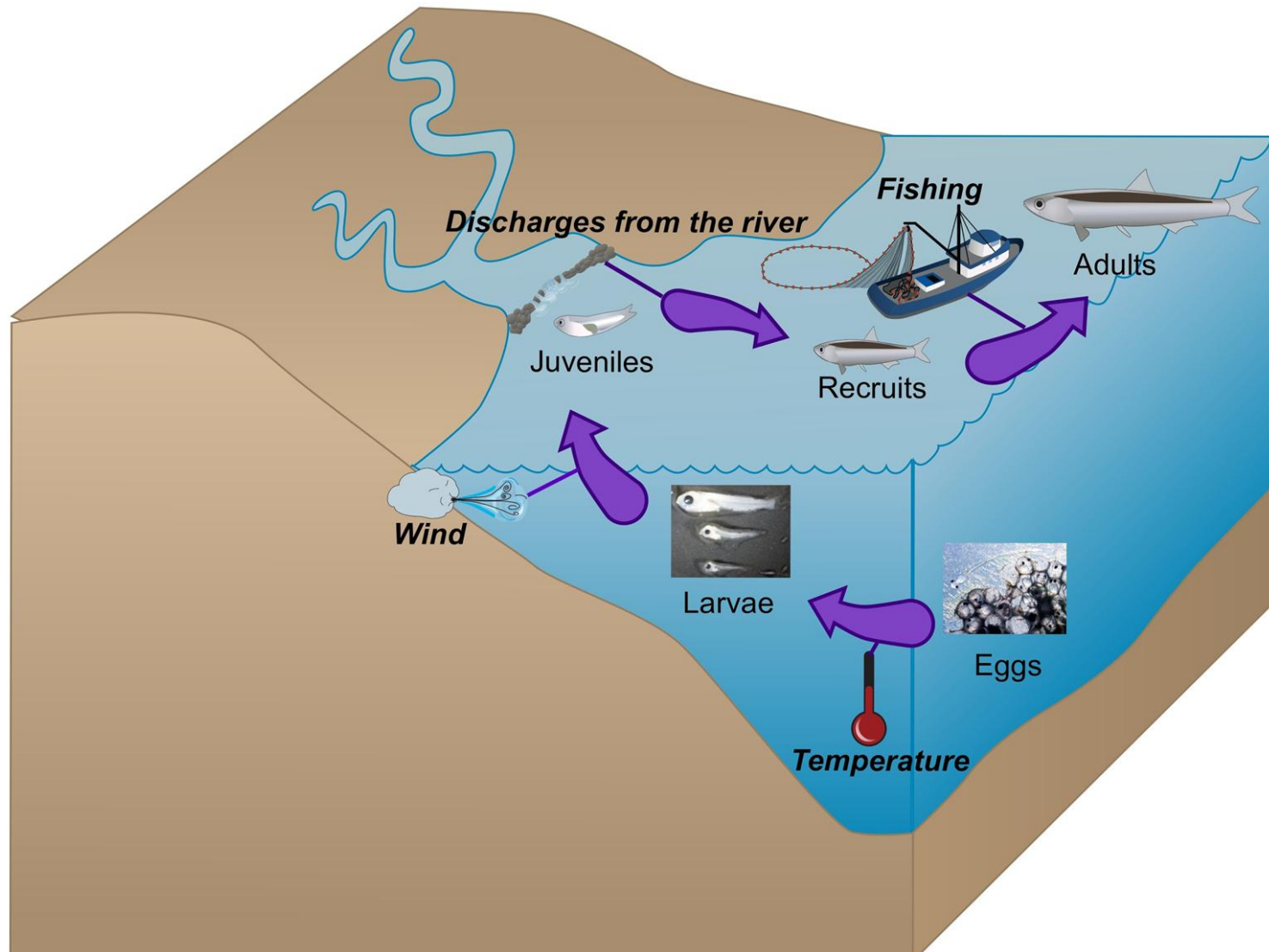
Anchovy in the Gulf of Cádiz



Engraulis encrasicolus

3.646.276,35 EUR in the first quarter of 2016, is the most important fishery in the region representing 10% of the Andalusian commercial landings

Environmentally-based recruitment



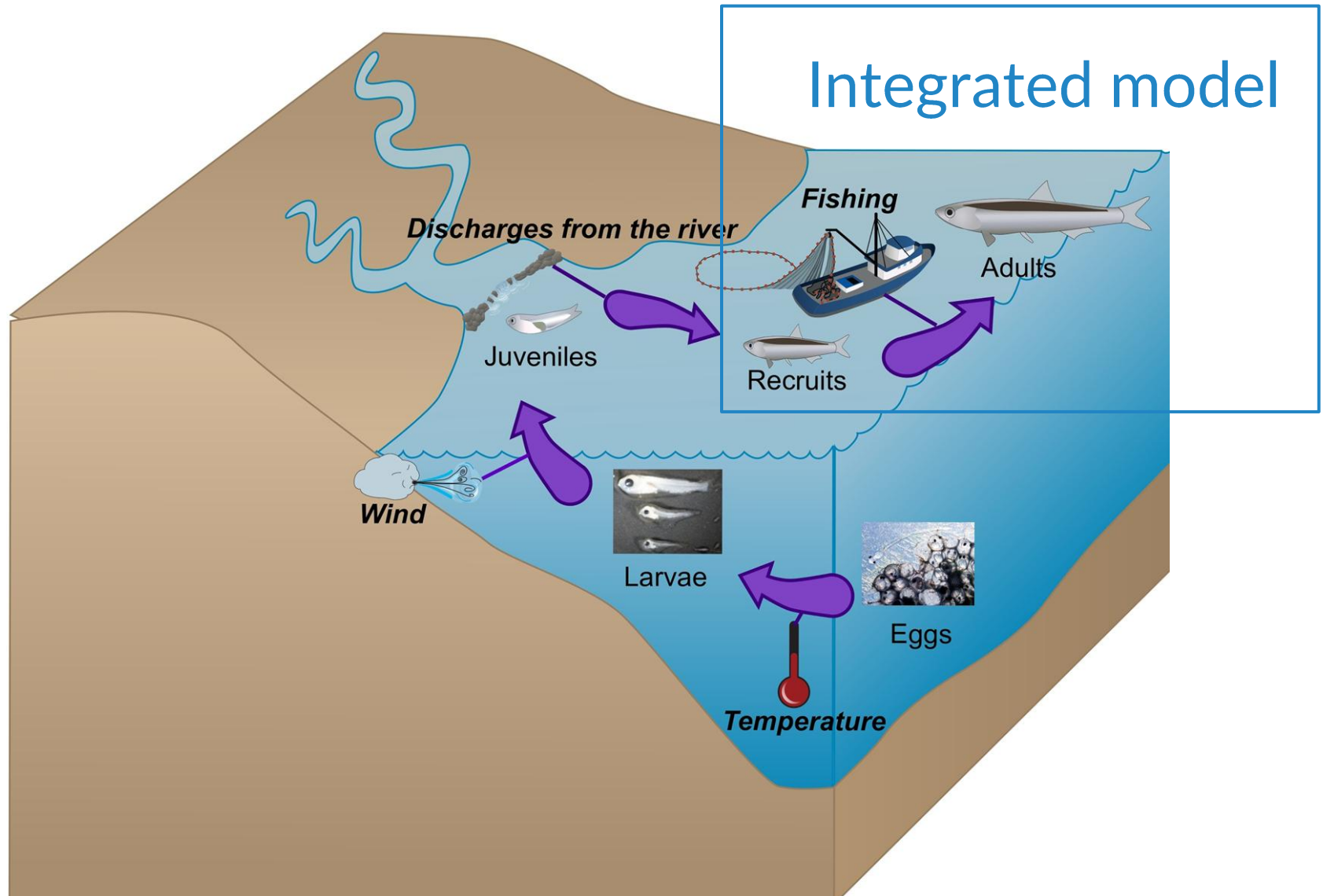


Ecosystem
approach to
fisheries
EAF

The approach

Expand an integrated model to incorporate the ecosystem approach

Model implementation



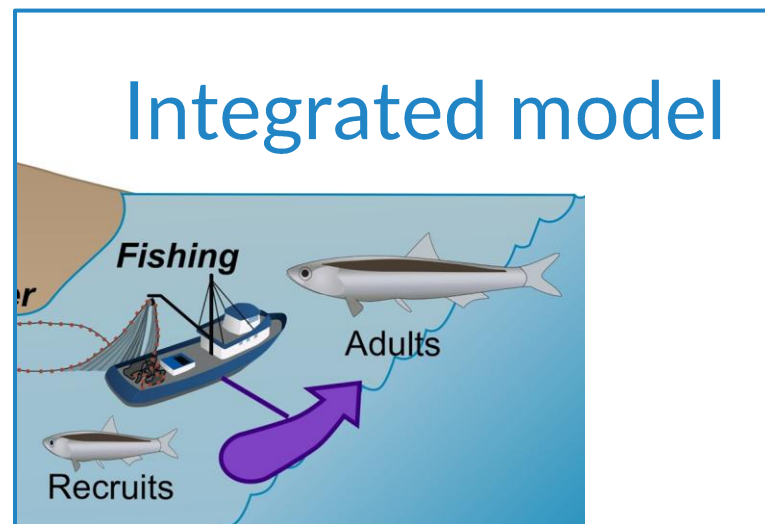
Model implementation

Integrated model

A model that includes a lot of information, i.e:

- ? Survey abundance, age-length composition
- ? Spawner-recruit relationships
- ? CPUE and effort
- ? Direct estimates of abundance from mark-recapture or line transect methods.

GREAT ADVANTAGE: Consistency
“The inclusion of auxiliary information along with catch-age data allows for unbiased estimation”
(Quinn 2003)



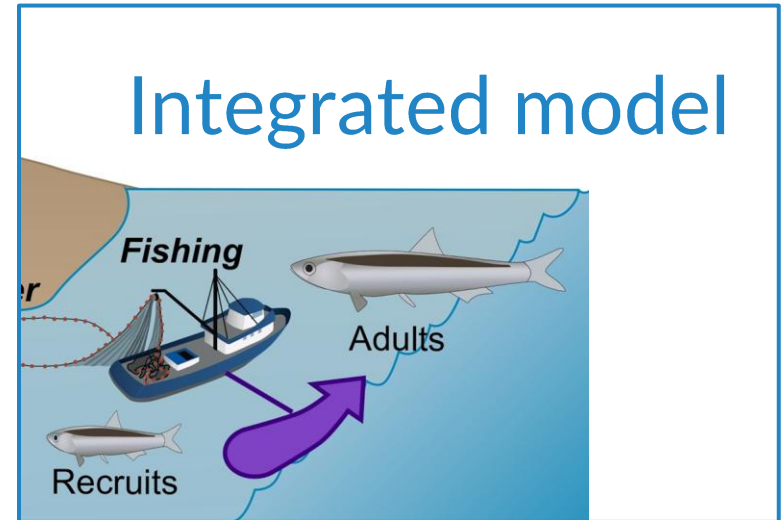
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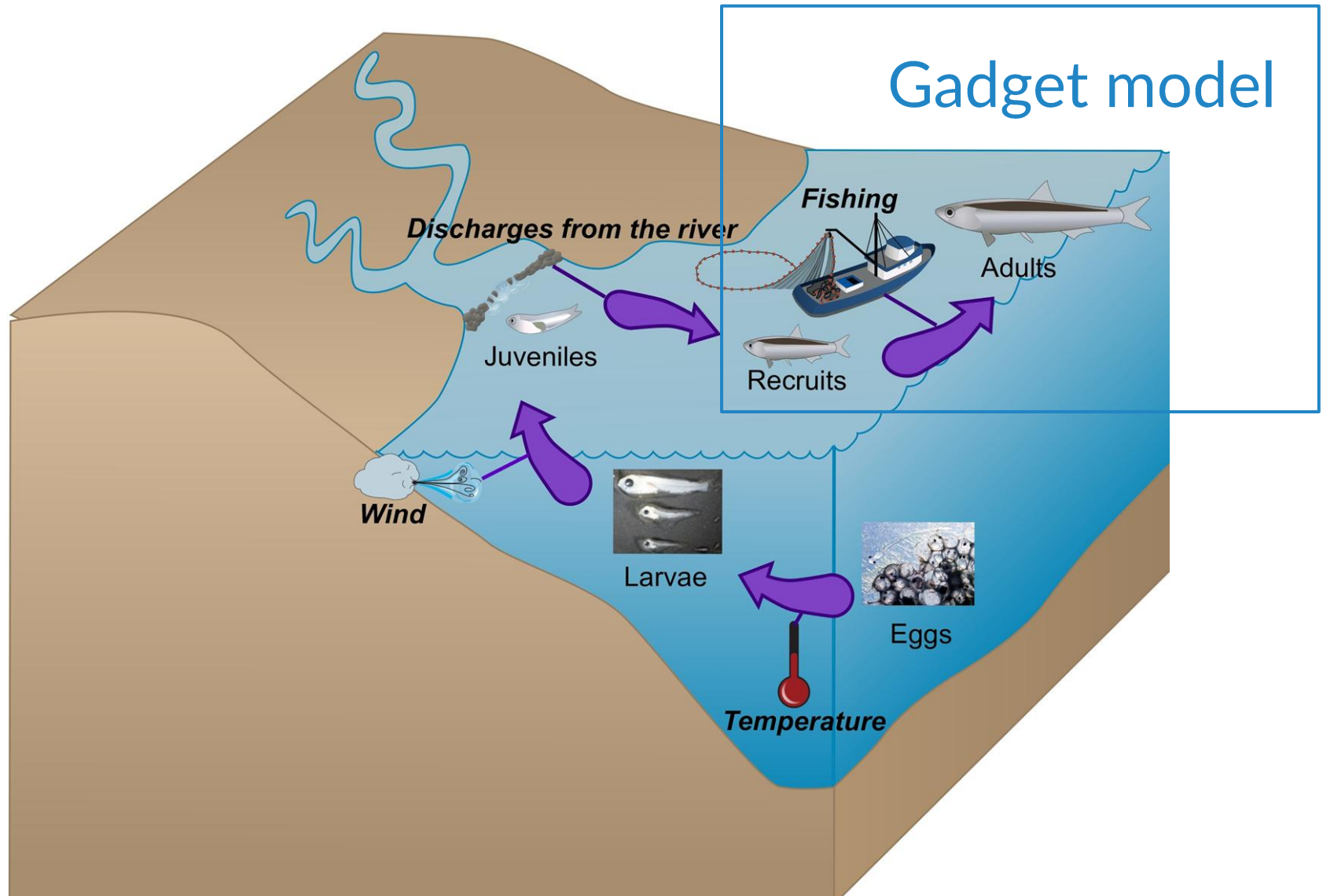
GREAT ADVANTAGE: Consistency
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(Quinn 2003)



Examples:

- SS3
- Gadget

Model implementation



Model implementation

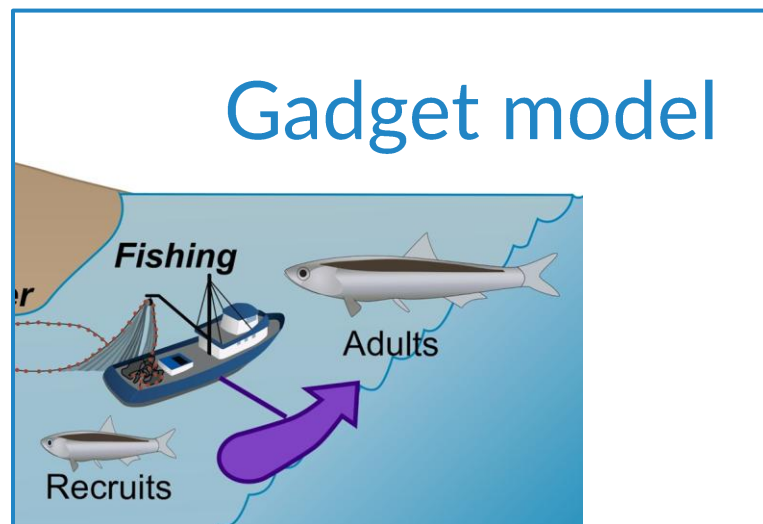
Gadget

A parametric, age-length-structured model. For this implementation we used:

- ❑ Landings 1988-2015
(Numbers, Age and length distributions)
- ❑ 3 Acoustic Surveys
(Numbers, Age and length distributions)

ADVANTAGES:

- It is used in assessment (Cod, ling, hake)
- Data input and data output automated in R (data.frames, mfdb and Rgadget packages)
- Multiarea and multispecies

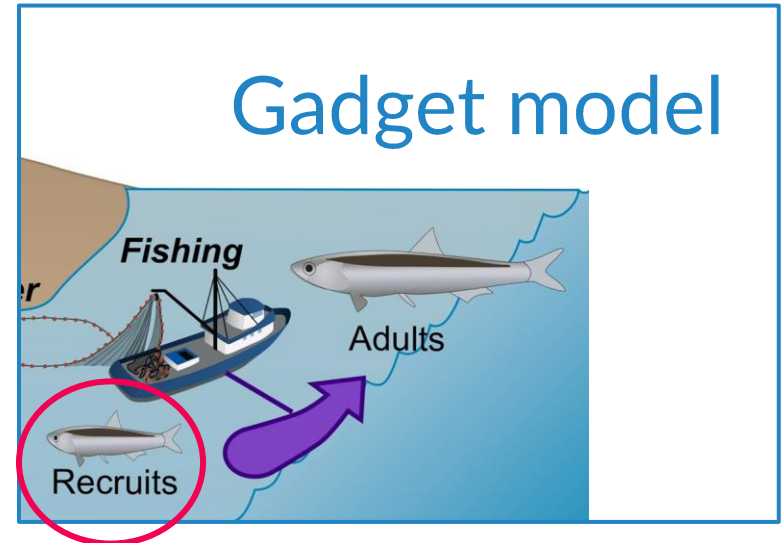


Model implementation

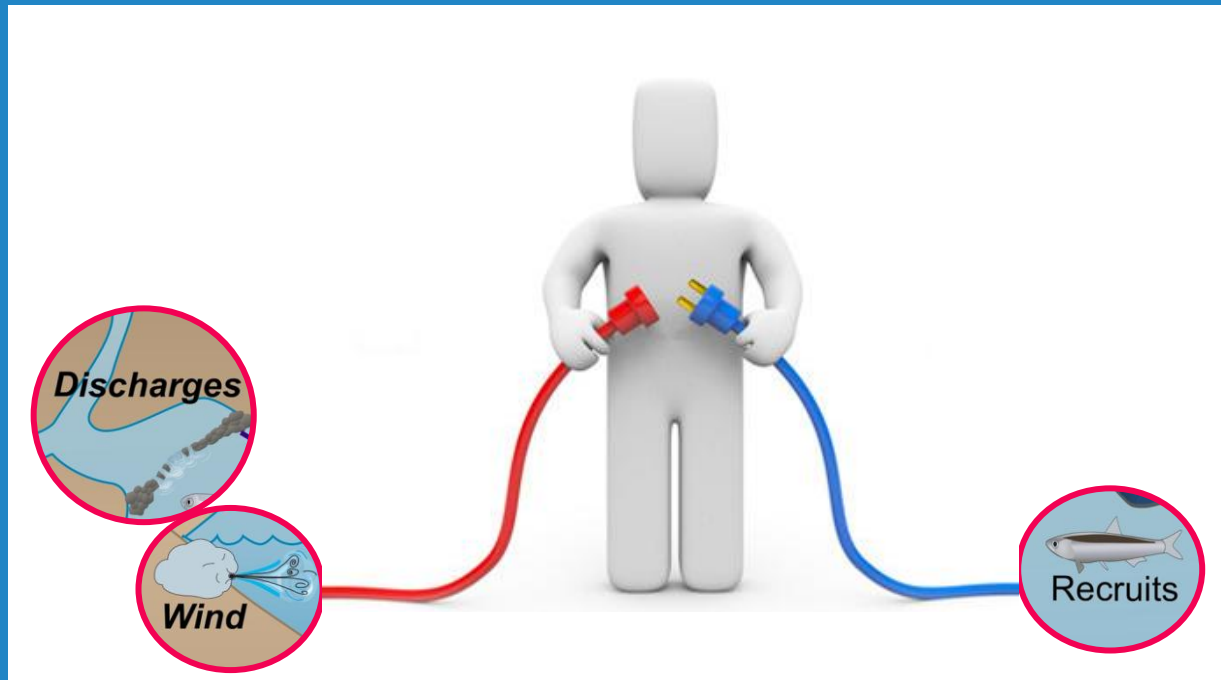
Gadget

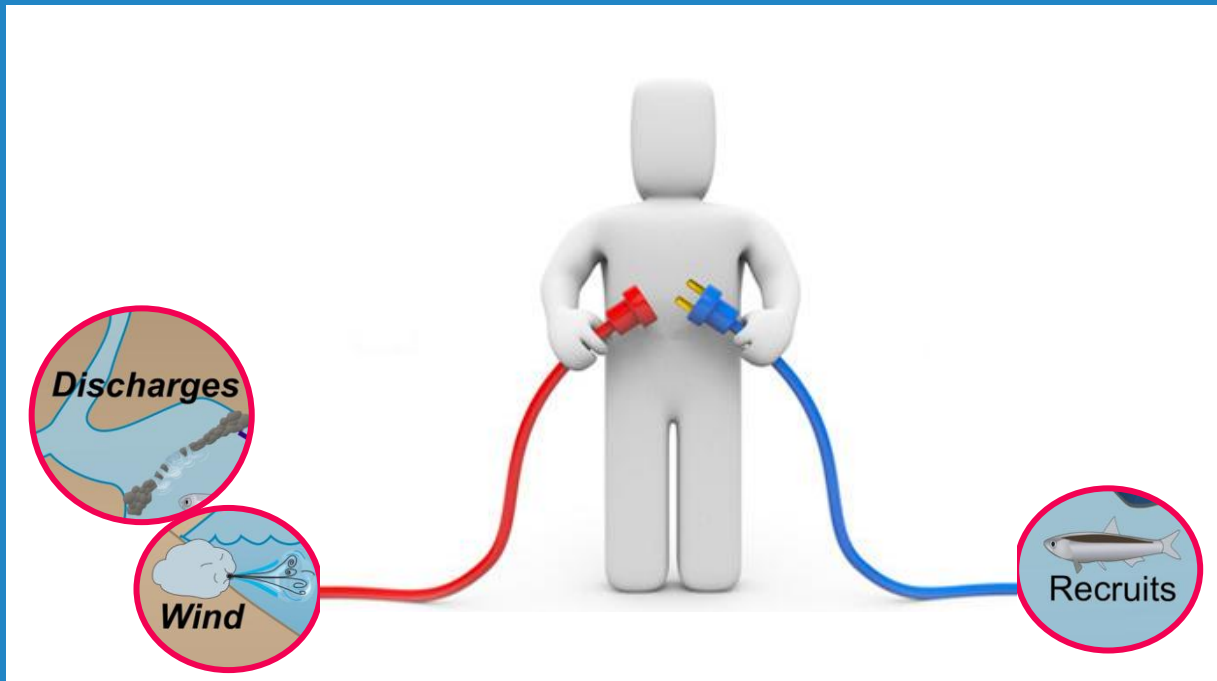
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- ❑ Landings 1988-2015 (Numbers, Age and length distributions)
- ❑ 3 Acoustic Surveys (Numbers, Age and length distributions)



Simulation and
log-likelihood
optimization





Granger-causality

Provides a framework that uses predictability to identify causation between time-series variables

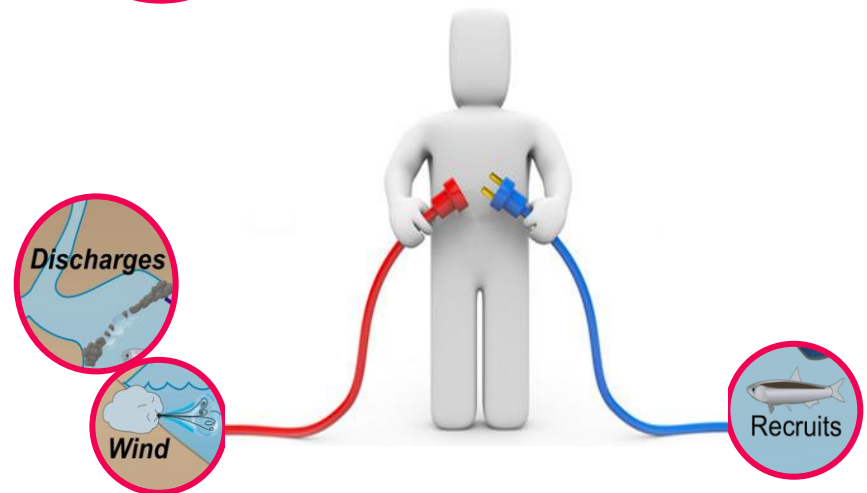
Granger-causality

Granger-causality concept says that an stationary time-series variable X is said to "Granger-cause" (Granger, 1969) the stationary time-series variable Y , if past values of X help to predict the current value of Y better than just the past values of Y do.

$$Y_t = a + \alpha_1 Y_{t-1} + \cdots + \alpha_L Y_{t-L} + \beta_1 X_{t-1} + \cdots + \beta_L X_{t-L} + \epsilon_t$$

Test

$$H_A : \beta_i \neq 0$$



Granger-causality

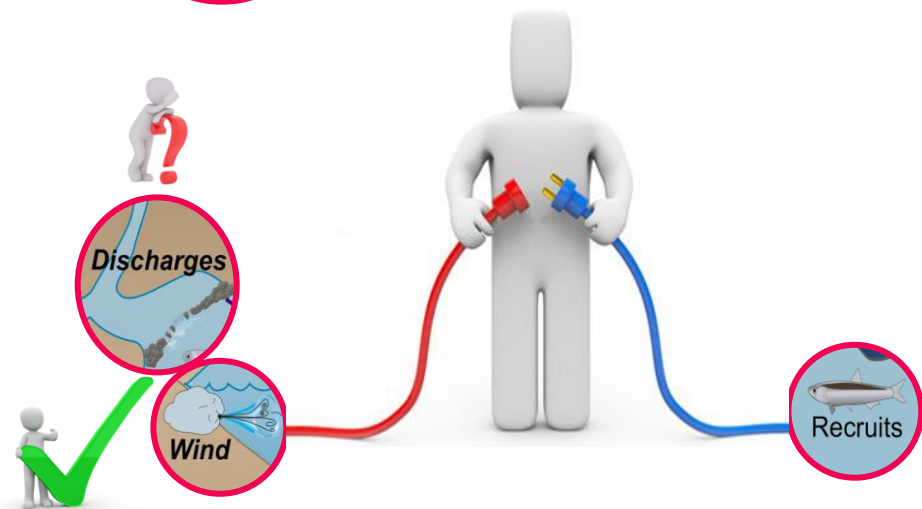
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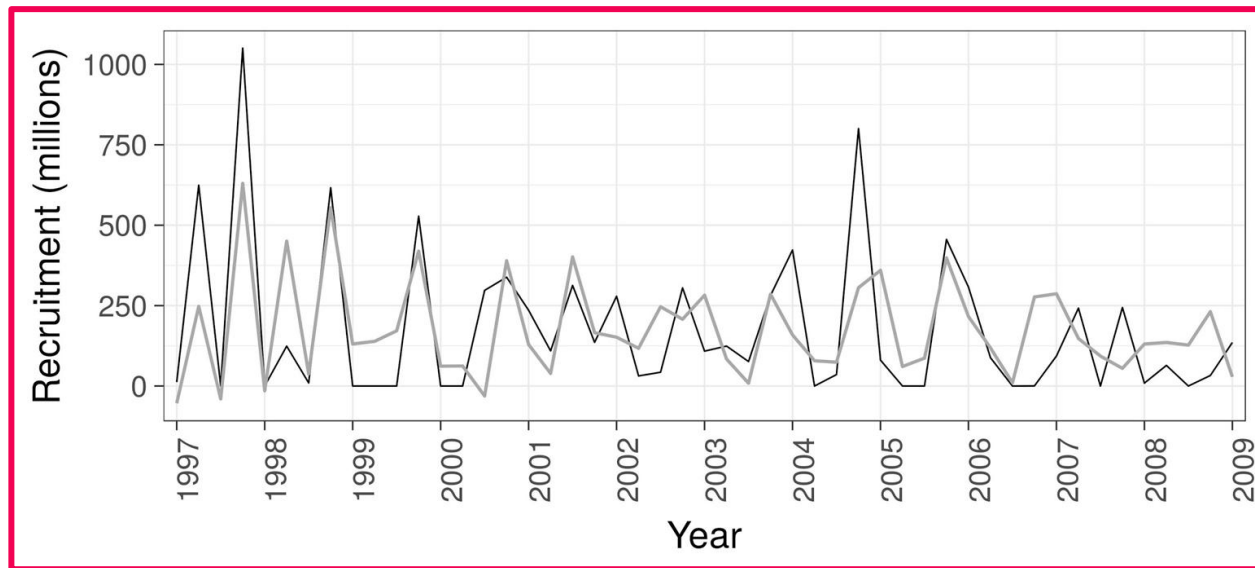
WARNING: A well specified model is needed: No serial autocorrelation, no roots outside the unit circle



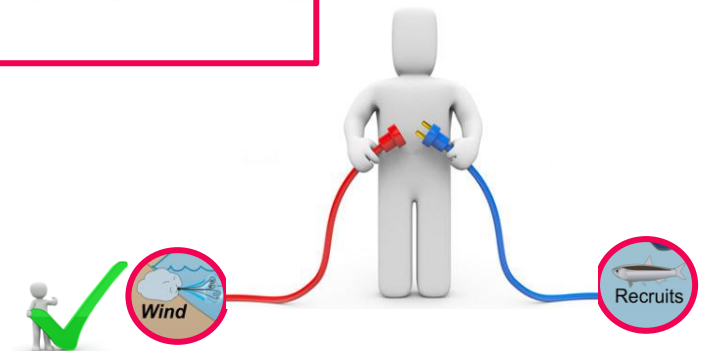
Recruitment-environmental factor relationship



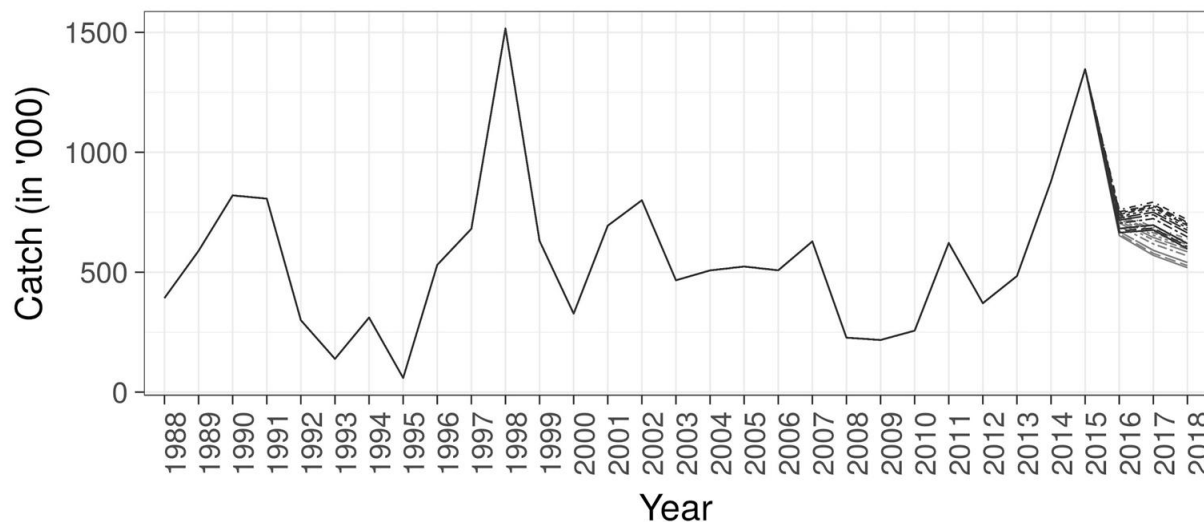
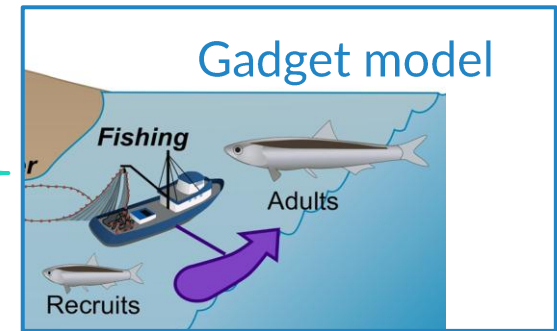
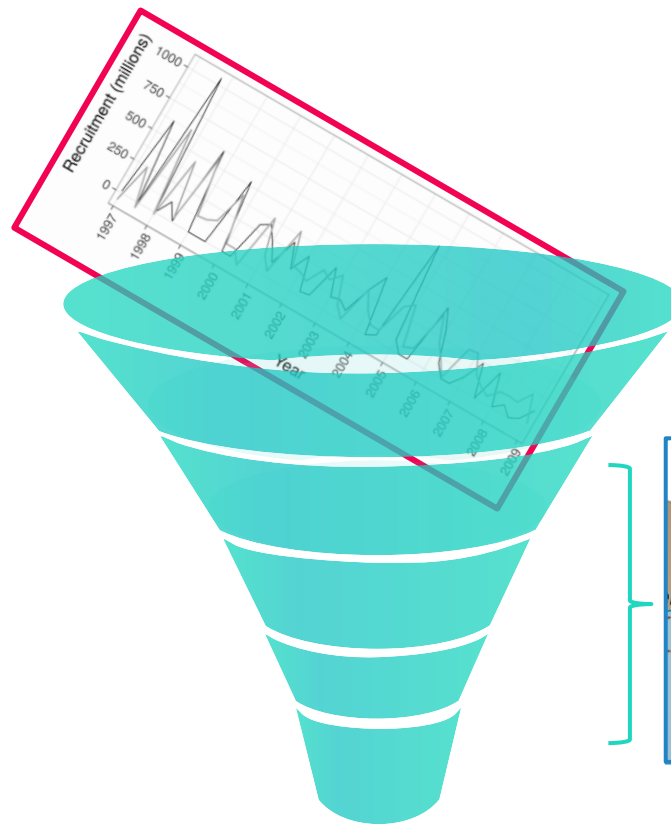
$$R_t = a + \alpha_1 R_{t-1} + \cdots + \alpha_L R_{t-L} + \beta_1 W_{t-1} + \cdots + \beta_L W_{t-L} + \epsilon_t$$



Comparison between Gadget recruitment output time series (black line) and fitted values (grey line).



Forecast

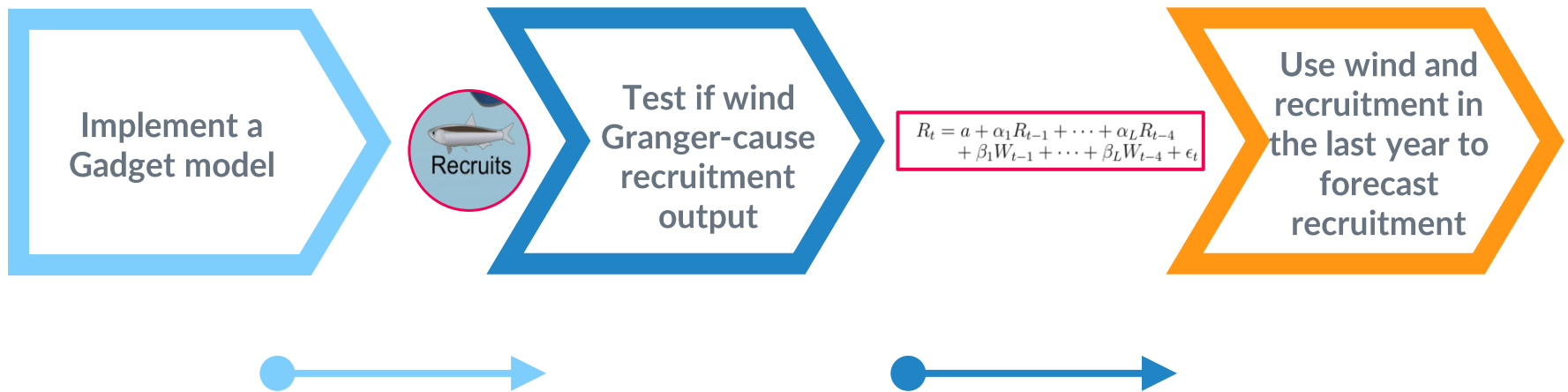


Three years forward projection with a Gadget simulation in two different wind scenarios: Good wind conditions (dark grey) and bad wind conditions (light grey).

3.

SUMMARY

The process



Concepts and conclusions



Integrated models

Owing to their capacity to consistently combine diverse information, **they should detect the variability induced by external drivers (e.g. environment) on key components of the stock dynamics (e.g. recruitment)** in cases where these external drivers are relevant but not yet identified or incorporated into the modelling exercise.



Granger Causality

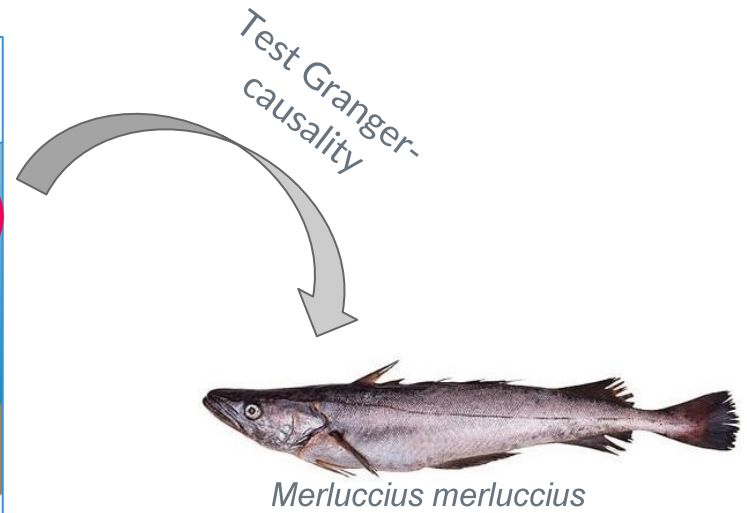
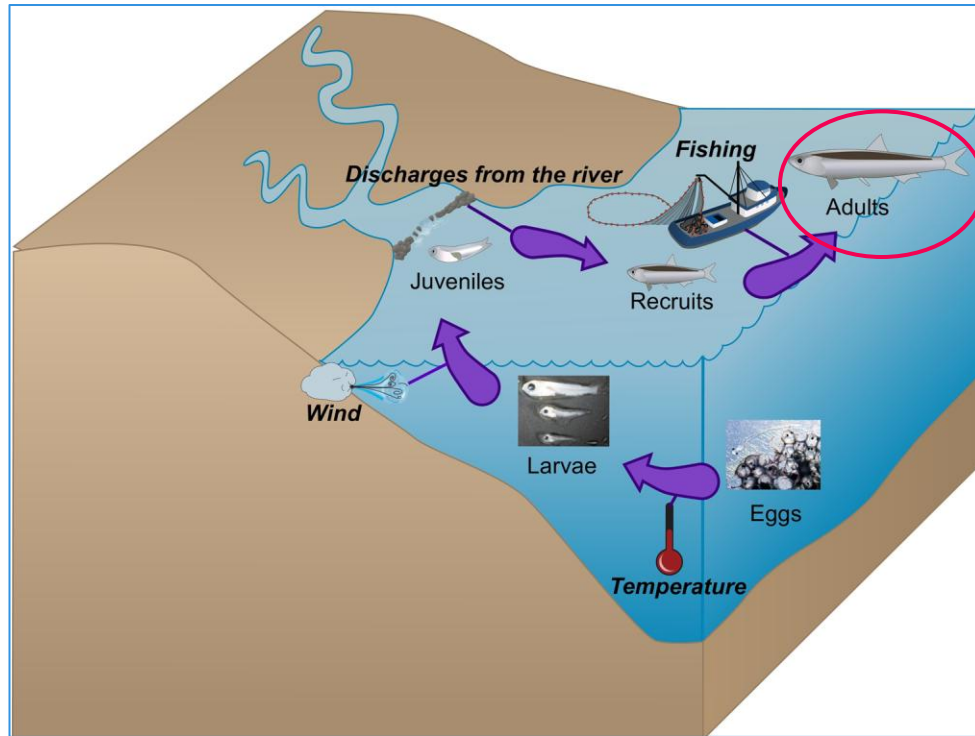
Is a great tool to test “causality” and provides a functional form of the “cause” over the “effect”.



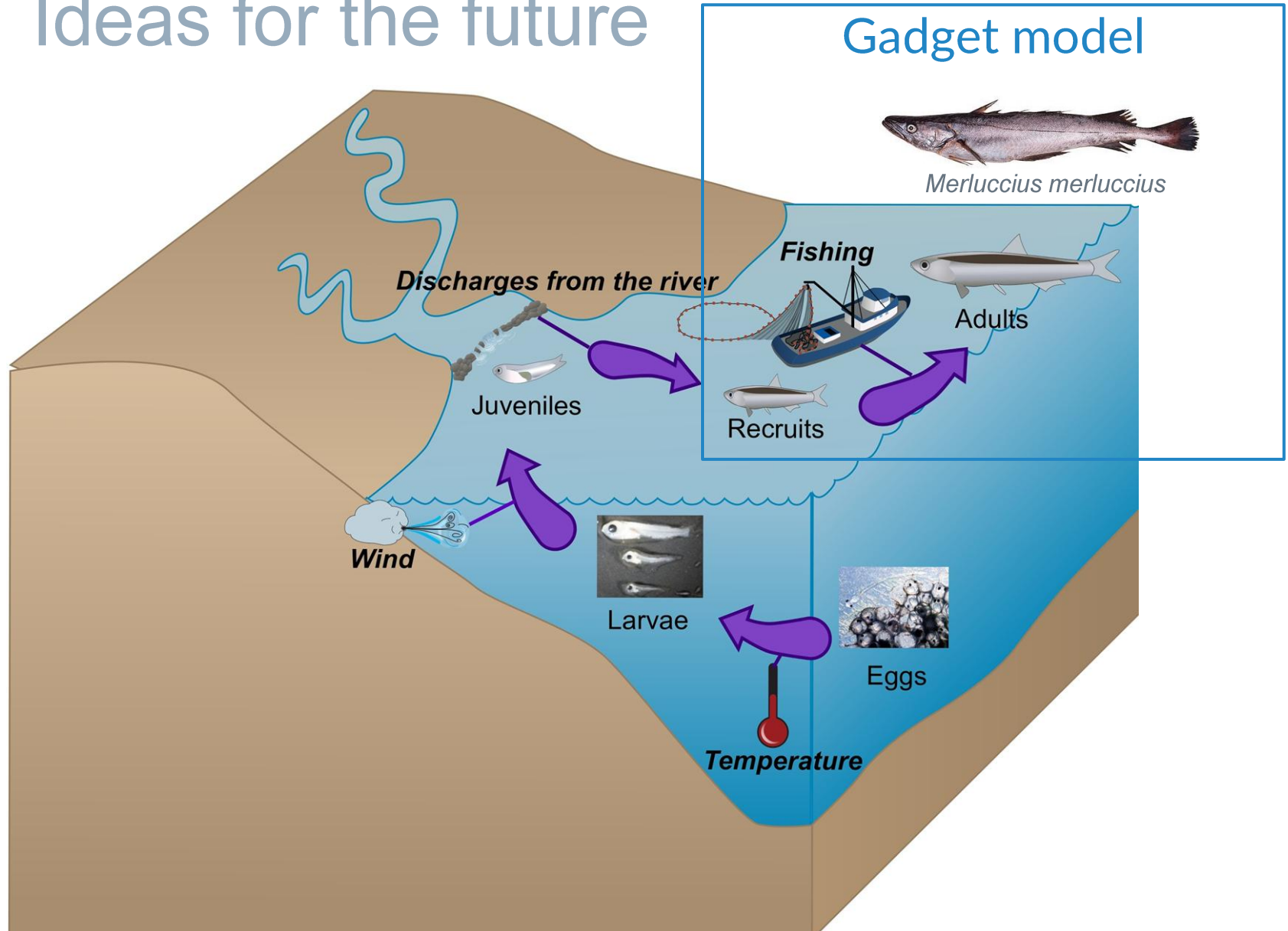
Wind and anchovy recruitment in Gulf of Cadiz

- ❓ We have confirmed the relationship between wind and recruitment
- ❓ We have proved that wind “Granger-cause” recruitment.
- ❓ We have incorporated wind in the integrated model (Gadget) for forecasting
- ❓ We have presented a form of ecosystem-based fisheries model

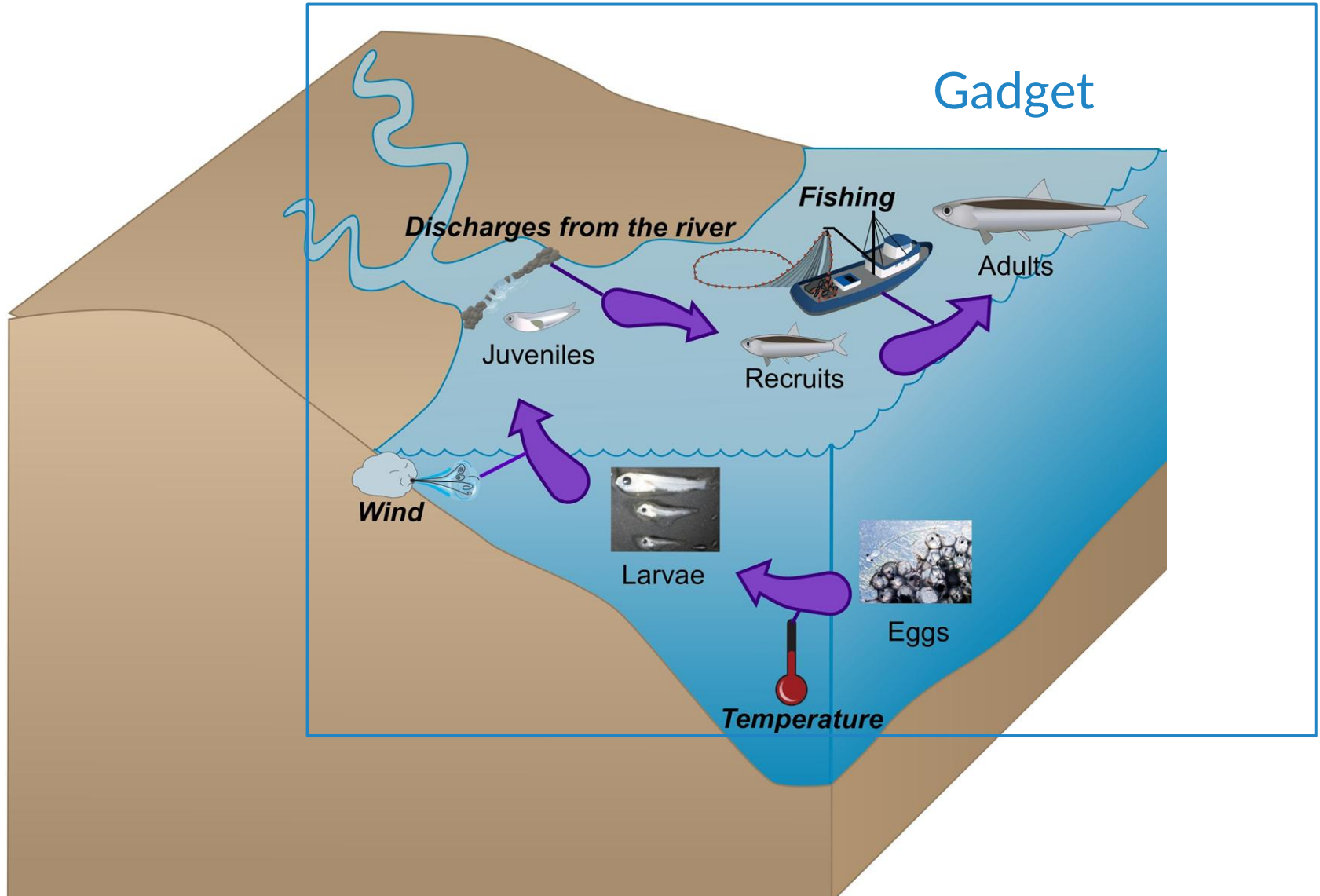
Ideas for the future



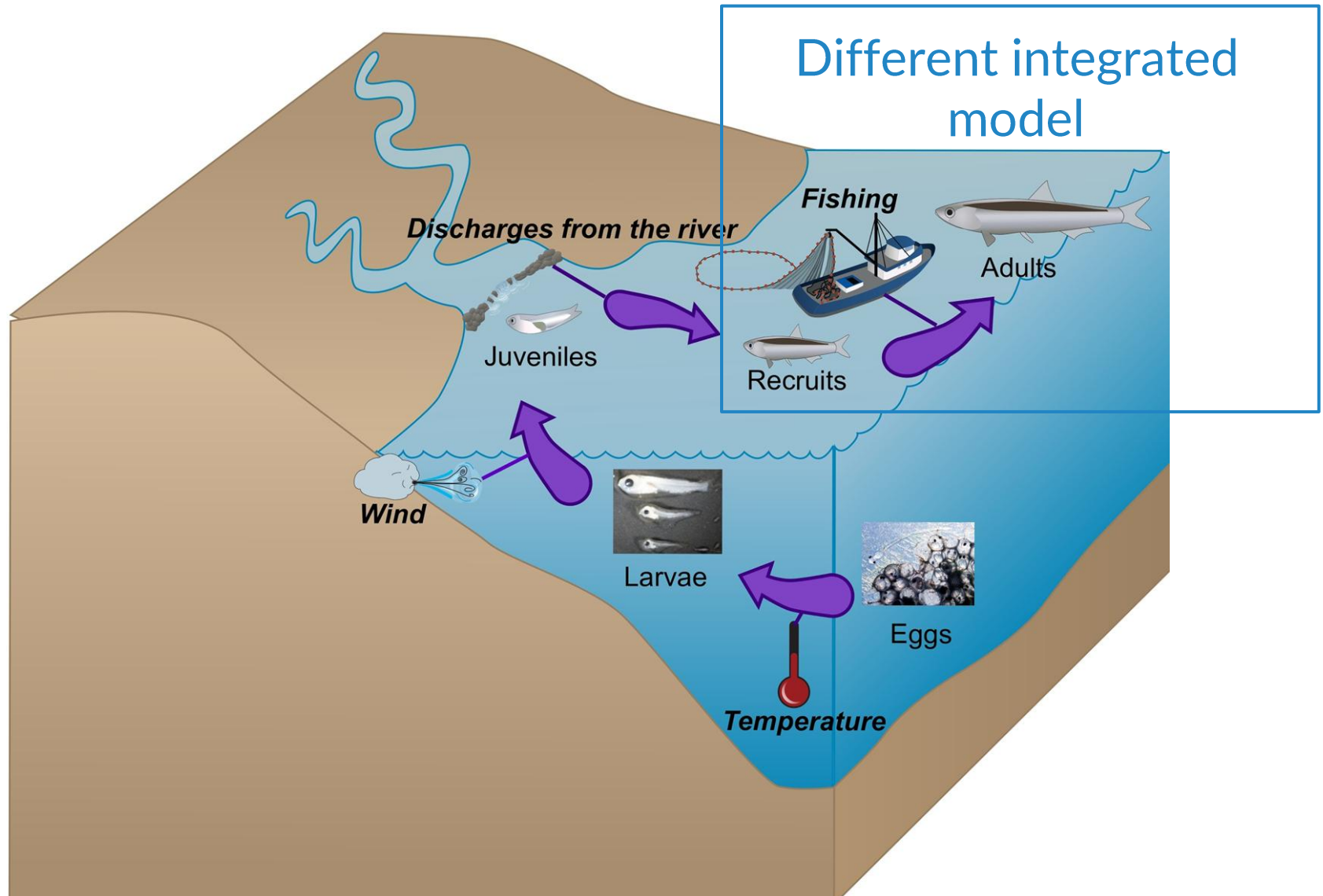
Ideas for the future



Ideas for the future



Ideas for the future



Thank you!

Any questions?

You can find me at:



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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613571



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