Multiple aspect trajectories: a case study on fishing vessels in the Northern Adriatic sea

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Outline

- Scenario & Motivations:

  Fishing in the Mediterranean Sea

- Framework at a glance

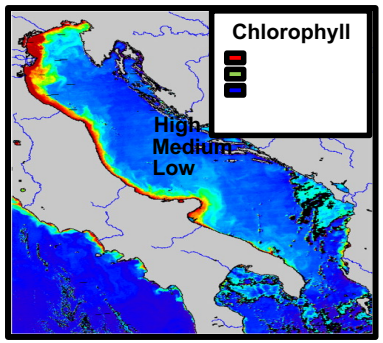
  Datasets & Trajectory reconstruction and enrichment

- Analyses & results

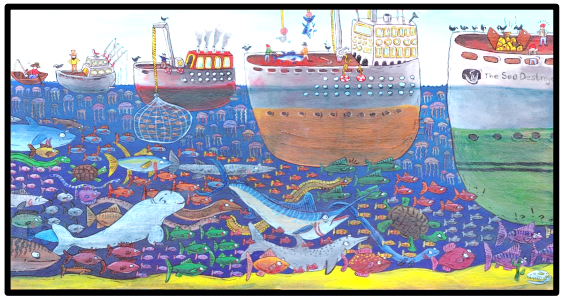
- Future work

Scenario

The most productive area of the Mediterranean sea

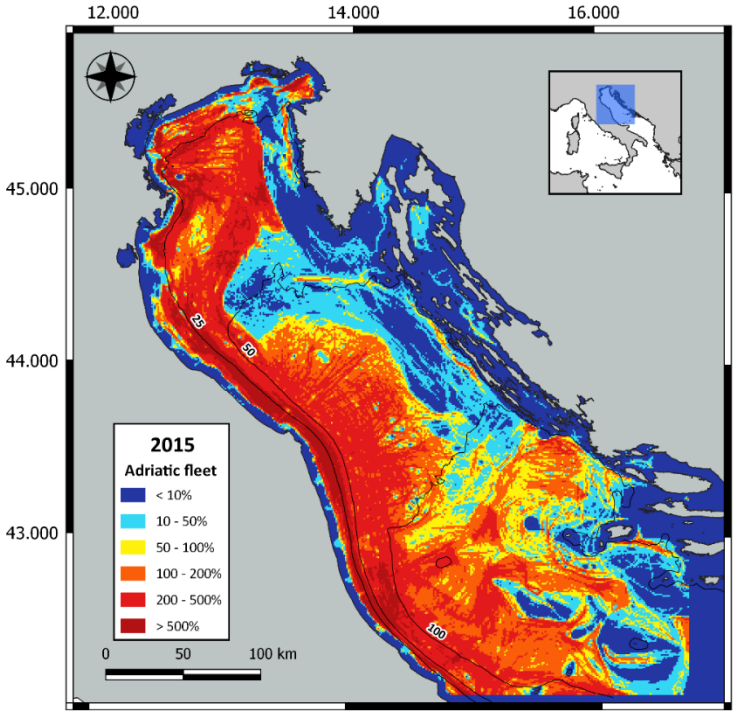


One of the most intensively fished area in Europe



Multispecific & Multigear Fisheries

Very high fishing pressure



Northern and Central Adriatic Sea is Overexploited

Goals and contributions

- Development of **effective fishery management** plans to reduce unsustainability of exploitation and ensure a productive and healthy ecosystem.

- Improve the **knowledge of the spatio-temporal aspects** of the fishing activities in the Northern and Central Adriatic Sea.
  - Detecting the fishing grounds and their seasonal and annual variation
  - Spatial and temporal distribution of the main species
  - Checking the AIS coverage and its reliability

- Use of **MobilityDB** to create and analyse semantic trajectories.

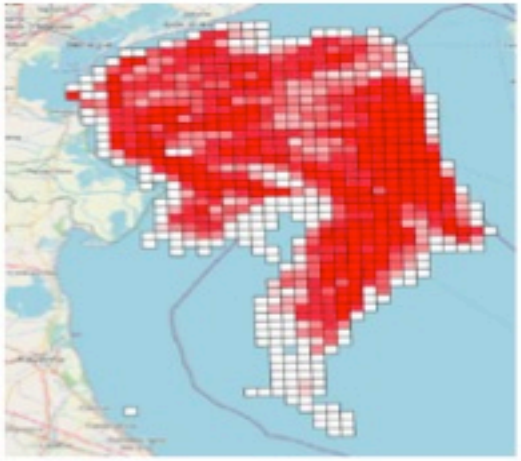
Framework at a glance

Landing data

AIS data

trajectory reconstruction and enrichment

Data analysis



Datasets

AIS: Automatic Identification System

STATIC INFORMATION

- MMSI: Identification Number
- Name
- Call Sign (IRCS)
- Length
- Type Of Ship

DYNAMIC INFORMATION

- Ship's Position
- Time (UTC)
- Course Over Ground

Collected by the local radio antennas

Daily **landing** reports: Amount of fish sold at the Chioggia Fish Market

STATIC INFORMATION

- MMSI: Identification Number
- Date
- Species Id
- Quantity in kg

Trajectory reconstruction from AIS data

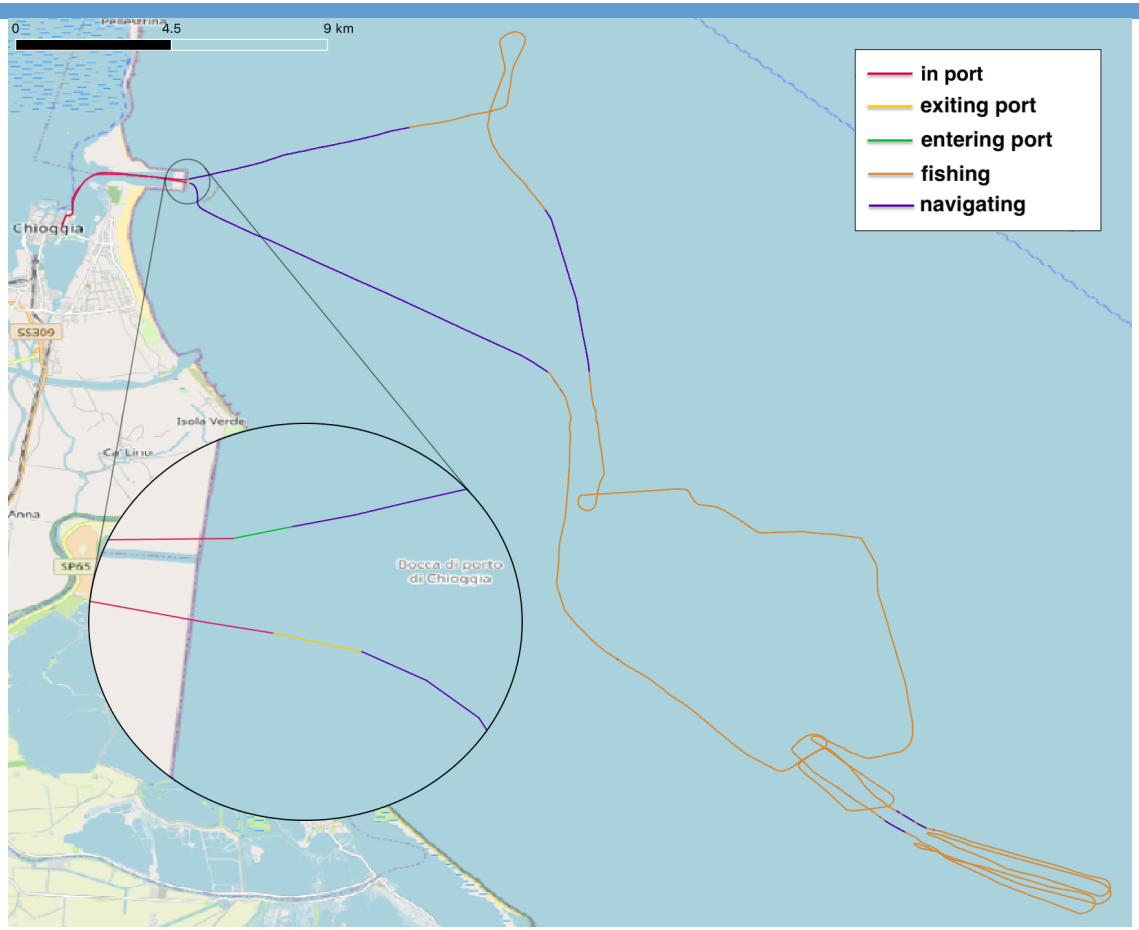
- Four years data (2015-18)
- The movement of the vessels is reconstructed by **linear interpolation**.
- It is split into **trajectories** (trips) relying on various criteria
  - e.g., a trip ends when a vessel is in the port without any transmission for a period longer than a fixed time
- And each trajectory is **annotated** …
  - **Long-term aspects** associated with the whole
    e.g., MMSI, fishing gear, anomaly
  - **Volatile aspects** associated with segments
    e.g. speed, activity, transmission, position with respect to the port.

Multiple aspect trajectories [Bogorny et al.]

Examples of Annotations

- Anomaly (long-term):
  - (0) normal trip
  - (1) no transmission for more than 30 minutes outside a port area
  - (2) trip always inside a port area
  - (3) trip duration over 24 hours

- Activity (volatile)
  - (0): in port
  - (1): exiting from port
  - (2): entering to port
  - (3): fishing
  - (4): navigating



Catch distribution

- Uniform Distribution:

$$d_U(s, sp) = \frac{s.len}{tr.len\_fishing} * catch.sp$$

where *s* is a segment of tr and *sp* is a species.

- Weighted Distribution:

$$d_W(s, sp) = \frac{\alpha(s.cell, sp) * s.len}{\Sigma_{s' \in tr \wedge s'.activity = fishing}(\alpha(s'.cell, sp) * s'.len)} * catch.sp$$

where α is the fishing coefficient associated with a grid cell (3x3 km^2)

$$\alpha(c, sp) = |\{tr \in T \downarrow sp \mid tr \cap c \neq \emptyset\}| * \Sigma_{tr \in T \downarrow sp} \Sigma_{s \in tr \cap c \wedge s.activiy = fishing} s.len$$

MobilityDB & QGIS

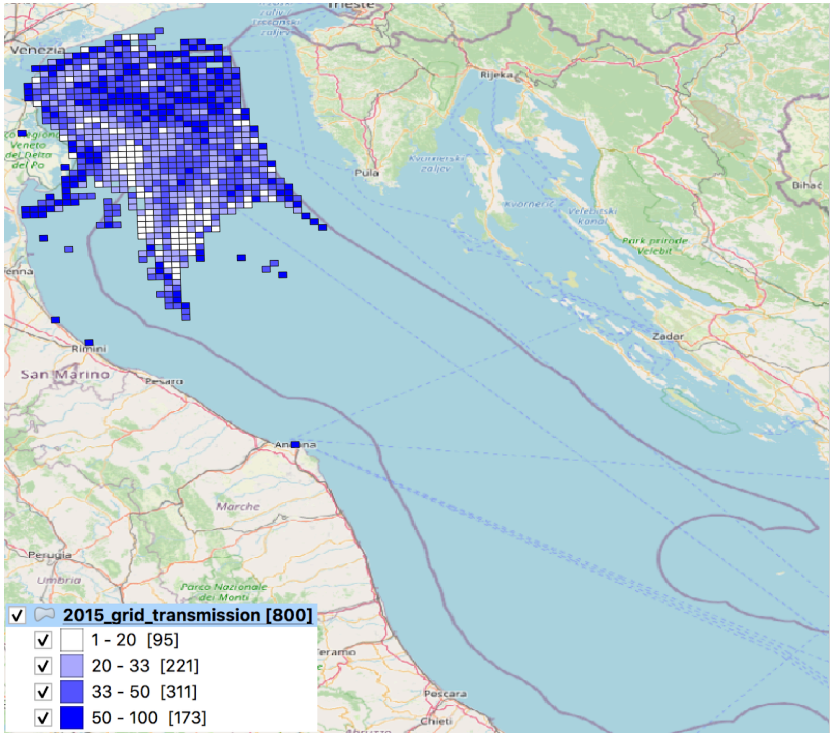
MobilityDB: Open source extension to PostgreSQL and PostGIS

- Temporal types and spatio-temporal operators to manage moving objects.
- Creation of objects of type `tgeompoint`
  - ⇒ linear interpolation is implemented by the system
- Representation of multiple aspect trajectories
  - ⇒ possibility to annotate the whole trajectory or single segment composing the trajectory

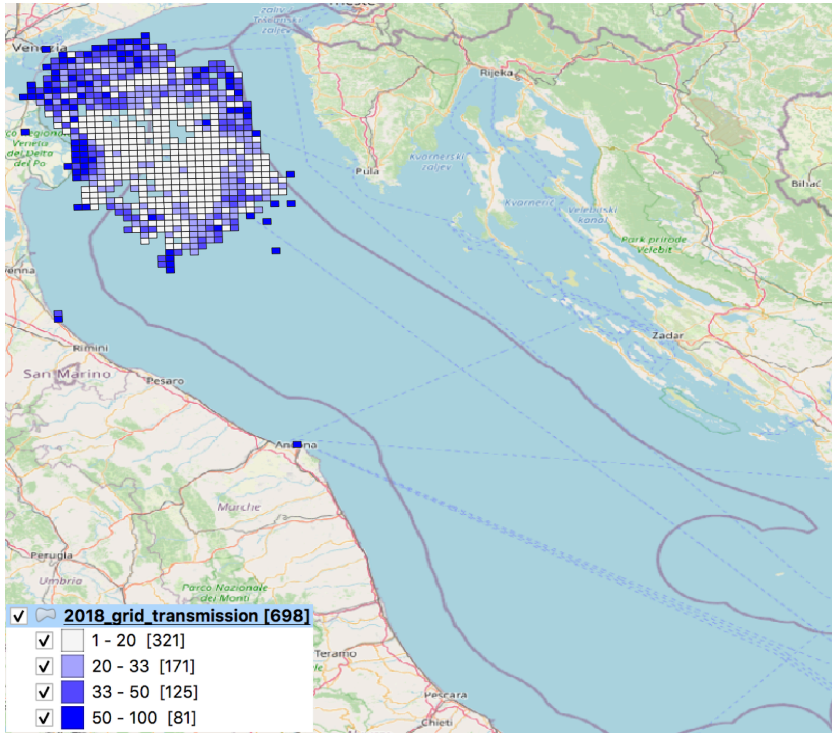
QGIS: Open Source GIS to support viewing, editing and analysis of geospatial data.

Spatial coverage of AIS

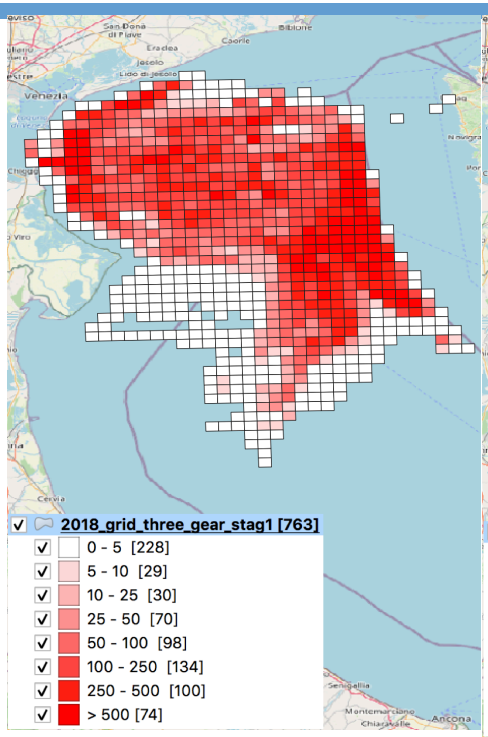
In 2015 almost the whole fishing zone suffers from lack of transmission over 50%

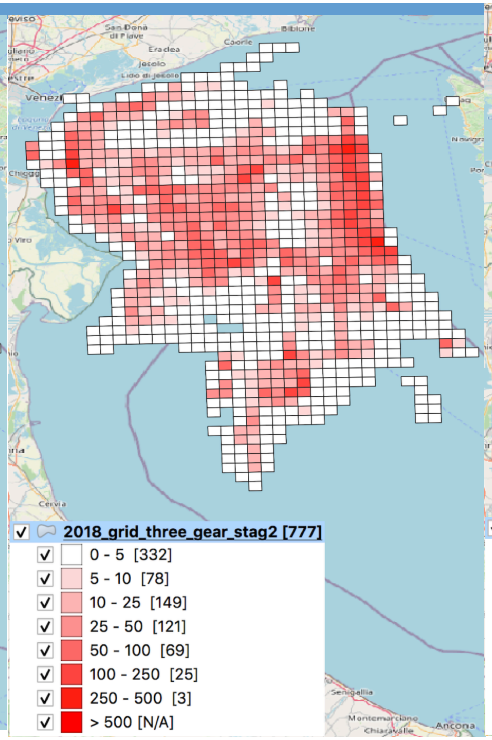


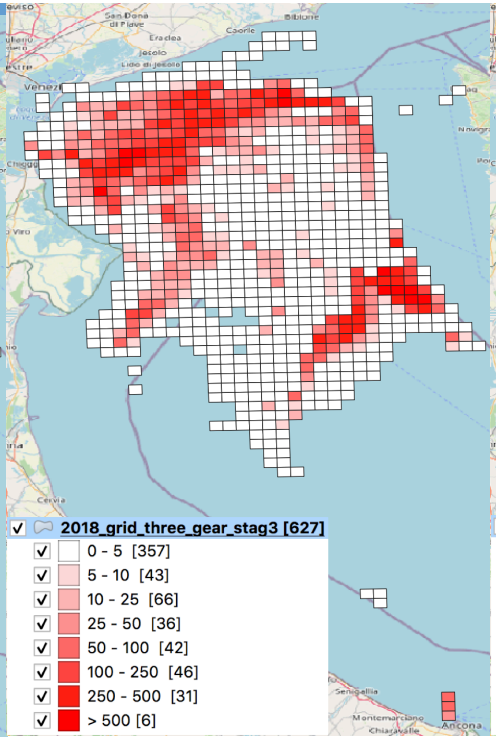
In 2018 the phenomenon is reduced and located close to the coast and along the territorial water borders

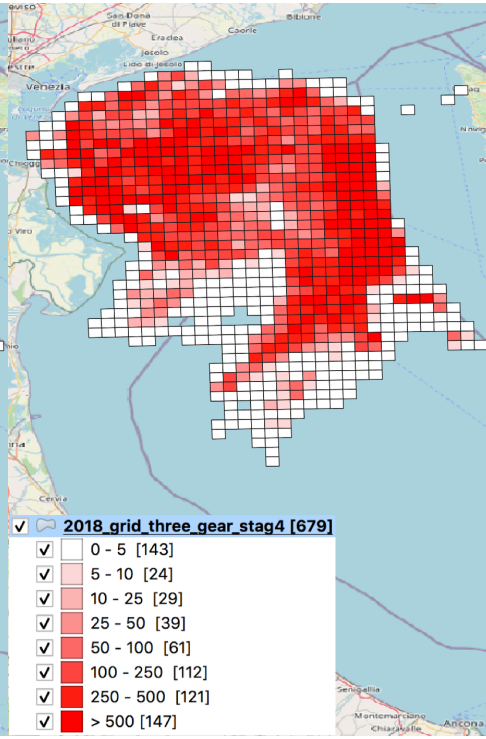


Seasonal Variation of fishing grounds





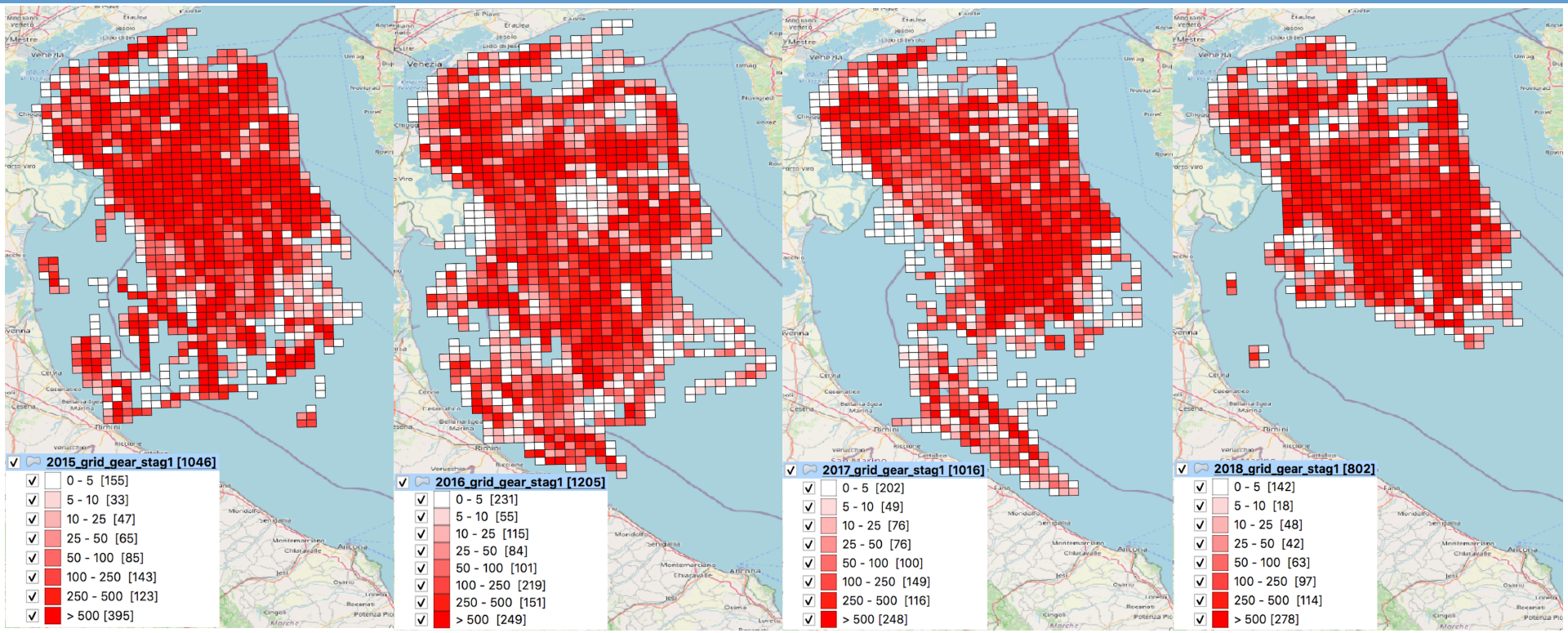




Winter 2018 Spring 2018 Summer 2018 Autumn 2018

Sepia Officinalis

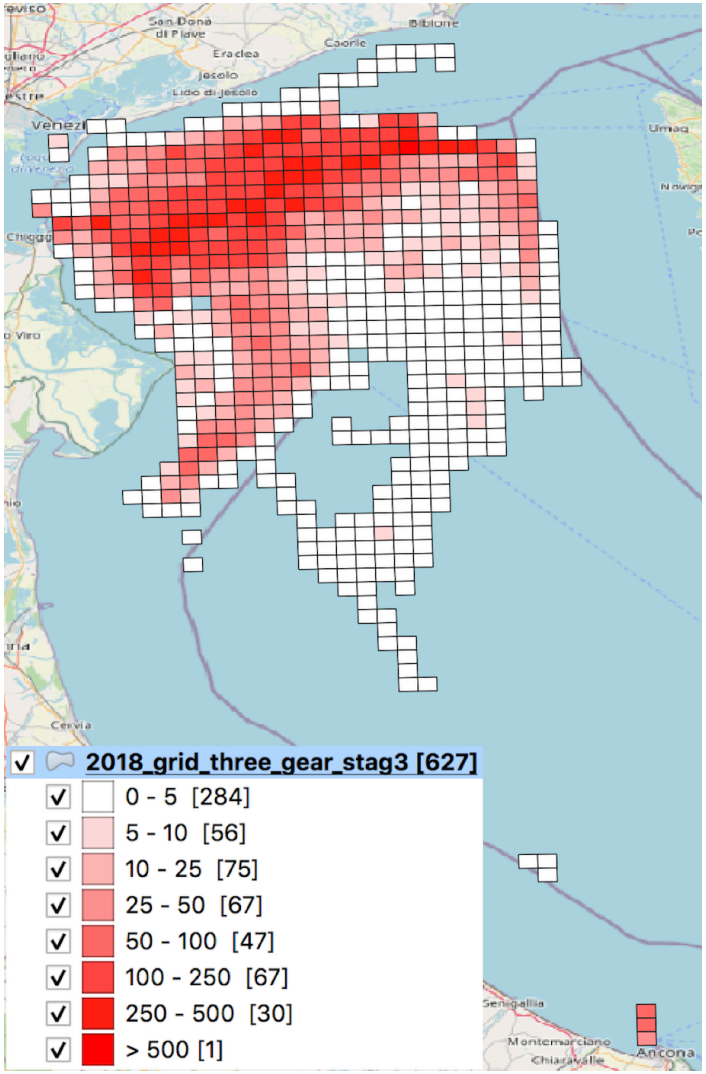
Fishing ground variation along the years



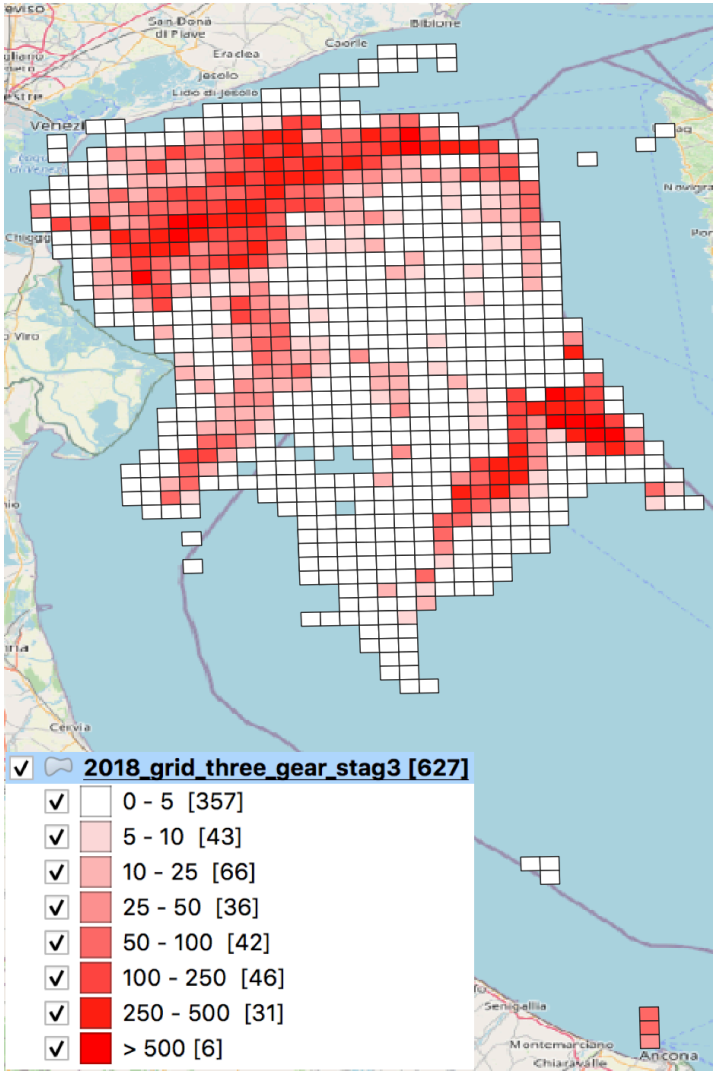
2015 2016 2017 2018

Engraulis encrasicolus

Uniform vs Weighted Distributions



Uniform Distribution



Weighted Distribution

Future work

- Predict the distribution of the fishing effort and the relative catches.
- Detect recurrent fishing patterns and anomaly behaviours.
- Investigate the impact of COVID19 on the fishing activities.