

ShARed Governance of Sustainable fisheries and aquaculture activities as leverage to protect marine resources in the Adriatic sea

WP3– Governance framework

D3.1.3 Application document as output from the assessments resulting from D3.2.6

*Study on recent trends in nutrients levels in the upper Adriatic sea and how
trends are linked to the sea primary production*

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Project acronym: ARGOS

Project ID number: 10255153

Project title: ShARed GOVERNance of Sustainable fisheries and aquaculture activities as leverage to protect marine resources in the Adriatic Sea

Priority Axis: Environment and cultural heritage

Specific Objective: 3.2 - Contribute to protect and restore biodiversity

Work Package: WP 3 - Governance framework

Activity: 3.2 - Maritime Spatial Planning assessment

Partner in charge: LP Autonomous Region of Friuli Venezia Giulia

Partner involved: all project partners

URL: <https://www.italy-croatia.eu/argos>

Status: Final version

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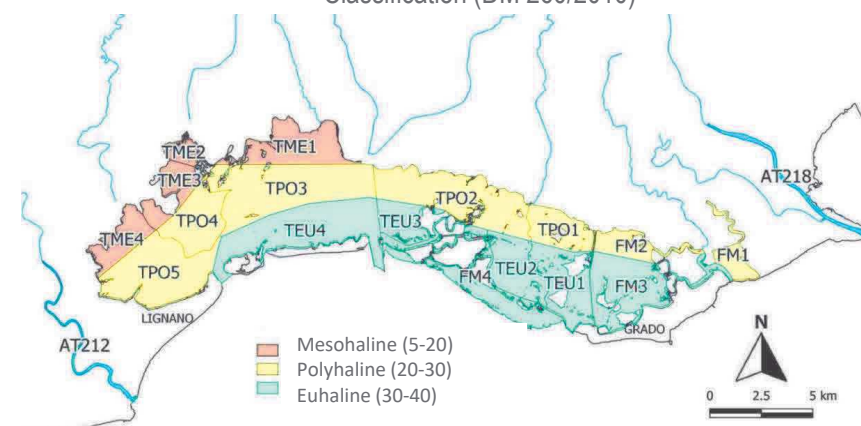
Author: OGS National Institute of Oceanography and Applied Geophysics





WATER FRAMEWORK DIRECTIVE (WFD/2000/60/EC)

- Legislative Decree no 152/2006;
- Typing (DM 131/2008);
- Monitoring (DM 56/2009);
- Classification (DM 260/2010)



17 water bodies

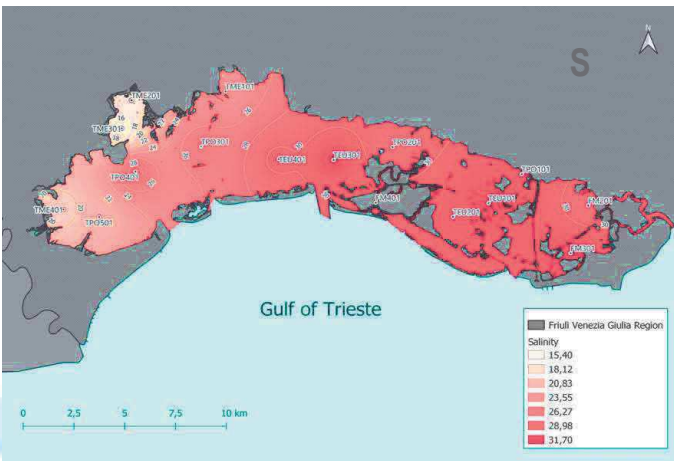
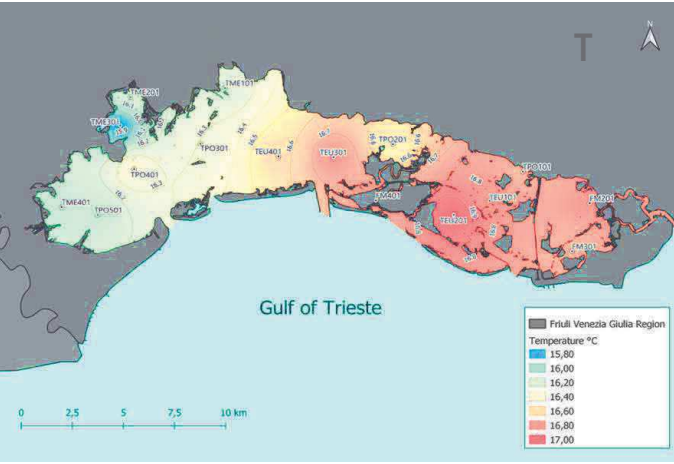
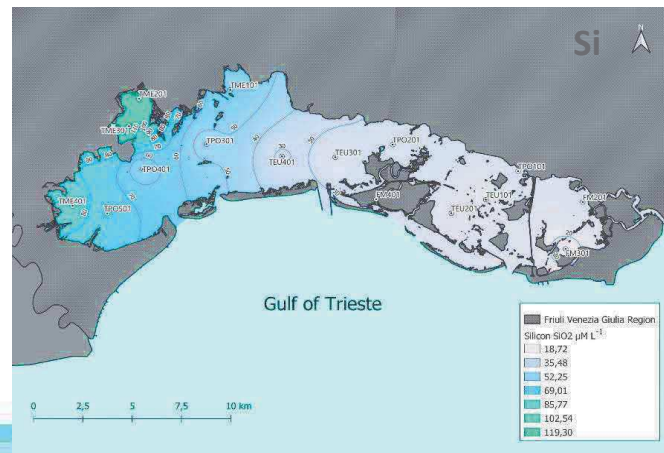
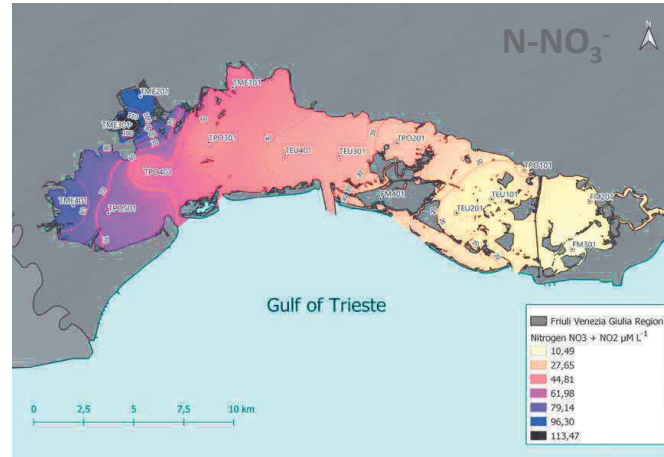
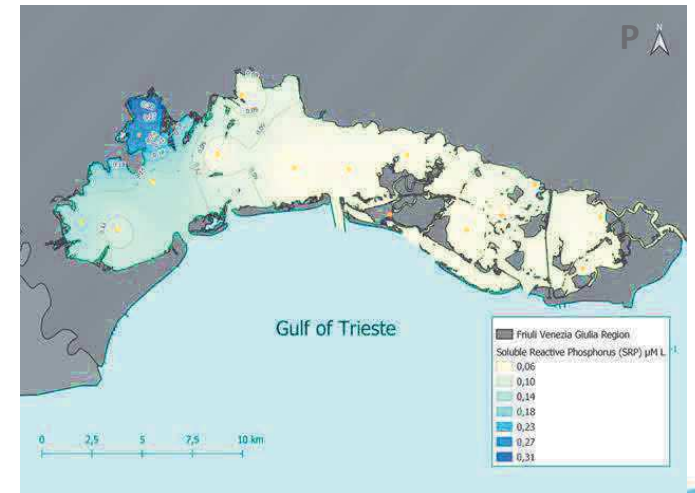
- The Marano and Grado Lagoon, located in the northern part of the Adriatic Sea, is an extremely important wetland and it covers an area of 160 km² (about 1/3 of Venice Lagoon);
- Ecological importance: It has been designated as a Special Area of Conservation (SAC IT3320037) according to the Natura 2000 European Directive.
- It is an example of conflict between conservation needs and human uses: main pressures are tourism, fishery, mussel and fish farming, dredging, industrial sites (Hg contamination), nitrate from agricultural practices (Ramieri et al 2011; Sladonja et al 2011; ECSS Vol. 113, 2012; Saccon et al 2013).
- Since 2016 the lagoon is affected by blooms of the invasive non indigenous species *Mnemiopsis leidyi* (Malej et al. 2017).

Data presented by A. Acquavita (ARPA FVG) at the ARGOS - Scientific Conference on Fishery - STATUS AND PERSPECTIVES OF THE FISHERY SECTOR IN THE ADRIATIC SEA (26th May 2022, AQUAFARM – Pordenone, Italy)

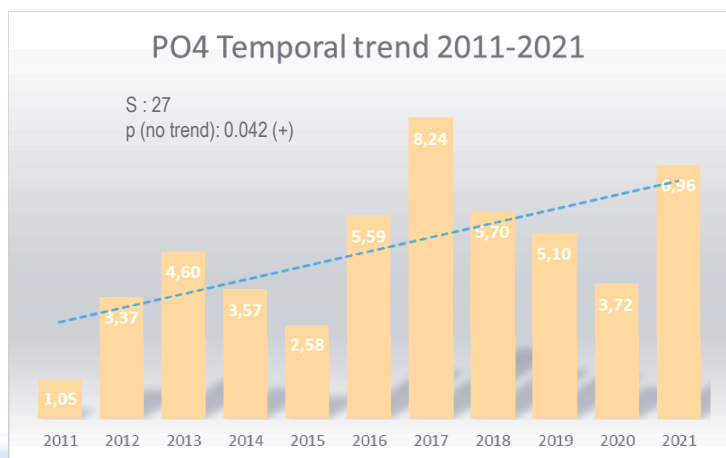


SAMPLING FREQUENCY (FROM 2010 TO 2021)

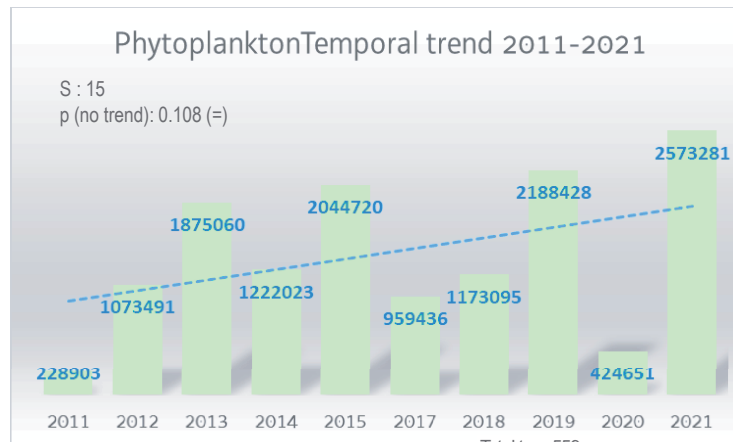
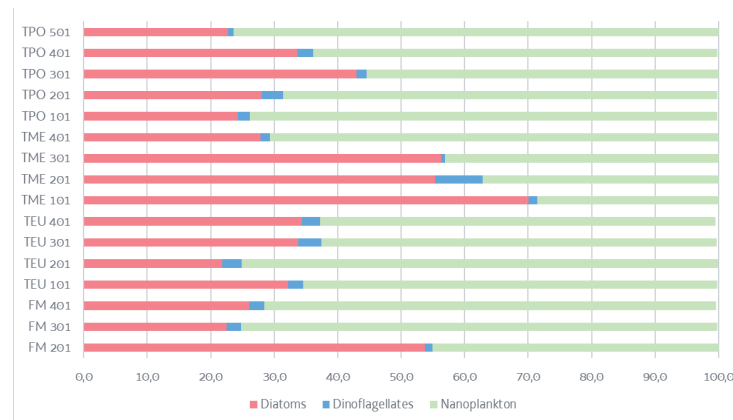
- Monthly from 2010 to 2015;
- Seasonally from 2016 to 2021.



Data presented by A. Acquavita (ARPA FVG) at the ARGOS - Scientific Conference on Fishery - STATUS AND PERSPECTIVES OF THE FISHERY SECTOR IN THE ADRIATIC SEA (26th May 2022, AQUAFARM – Pordenone, Italy)

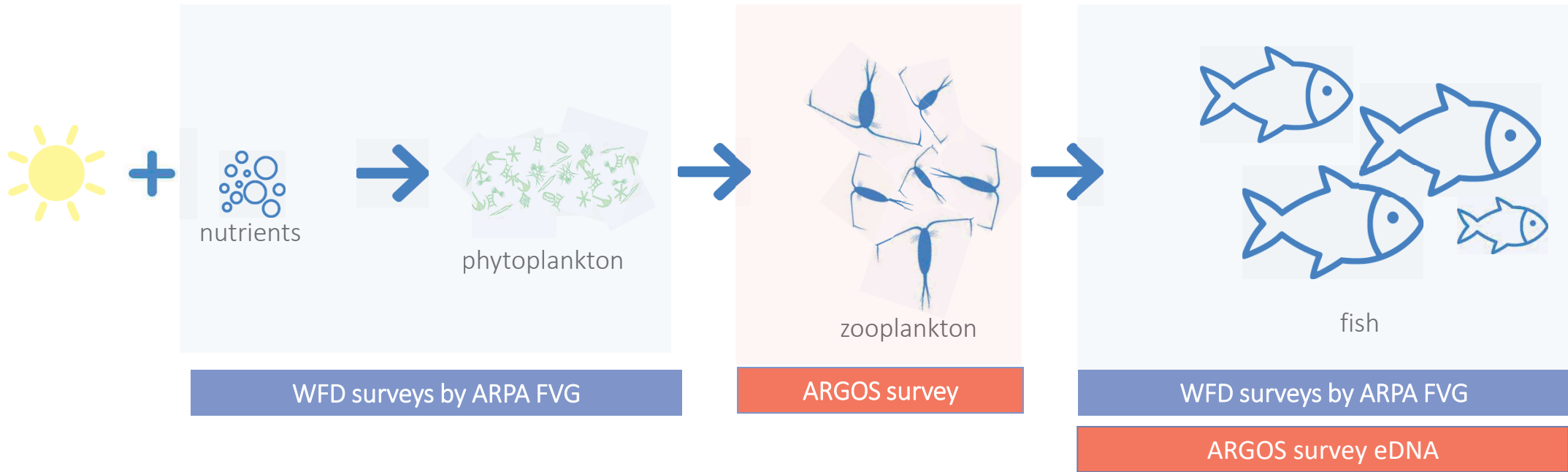


- Extreme heterogeneity from both spatial and seasonal distribution of physico-chemical parameters
- Nitrate inputs still represent a concern that deserves attention
- Nanoplankton represents a significant fraction of total phytoplankton
- No net positive or negative trends were found for nutrients and phytoplankton abundance



Total taxa 559
Diatoms 247
Dinoflagellates 159
Nanoplankton 55
Others (flagellates and coccolithophores) 98

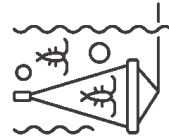




Zooplankton sampling and lab analysis



Marano and Grado Lagoon



Bongo net



stereomicroscope



- ✓ 6 sites
- ✓ monthly sampling for May to November 2021

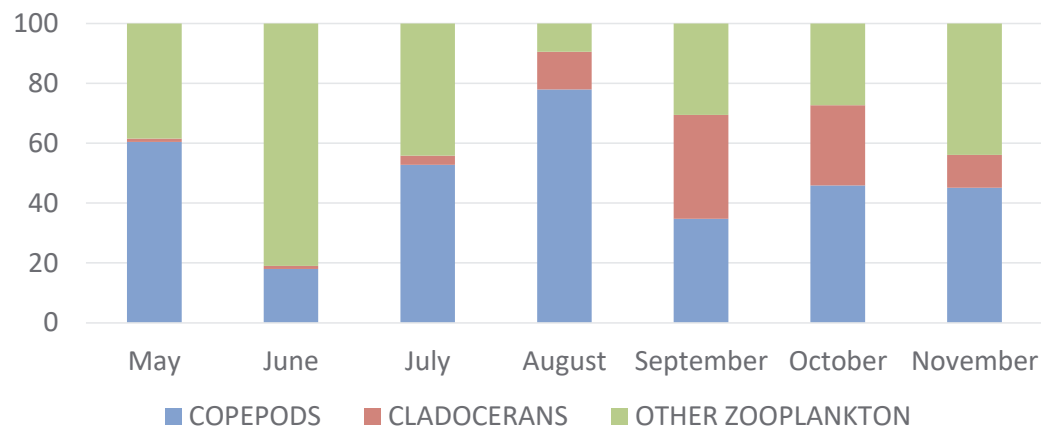
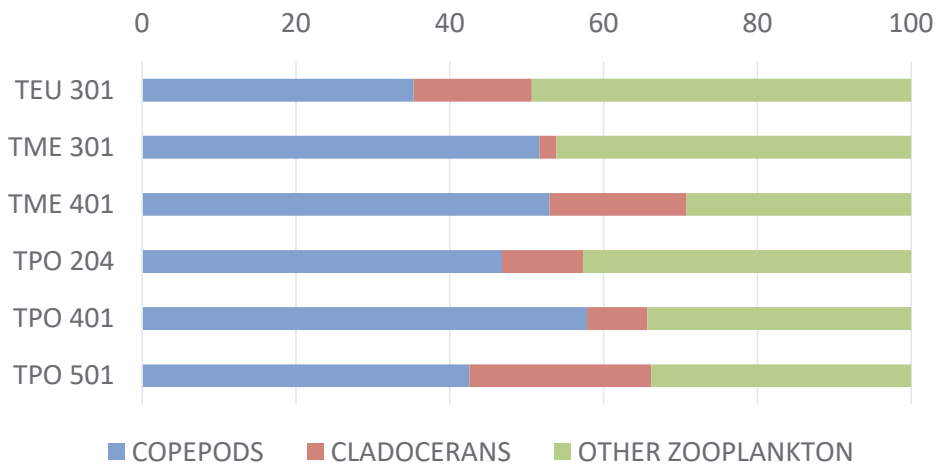
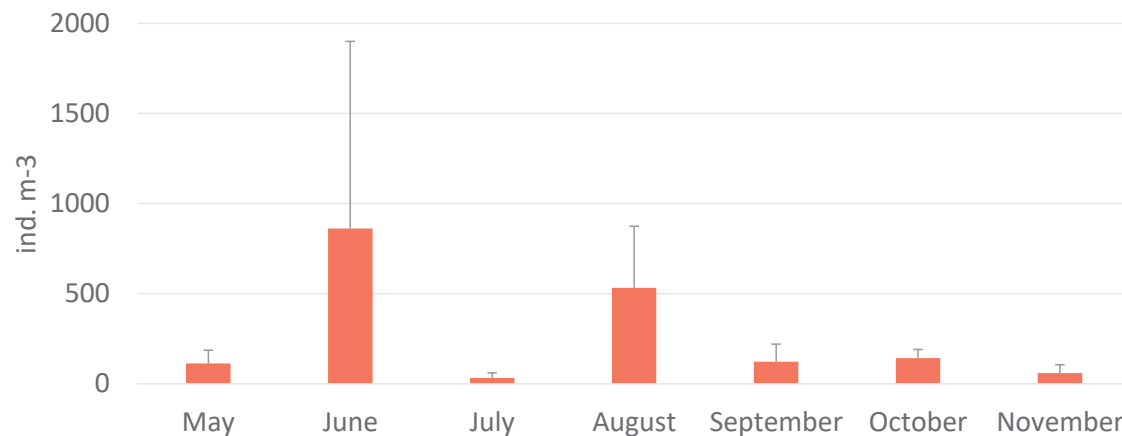
42 zooplankton samples analysed

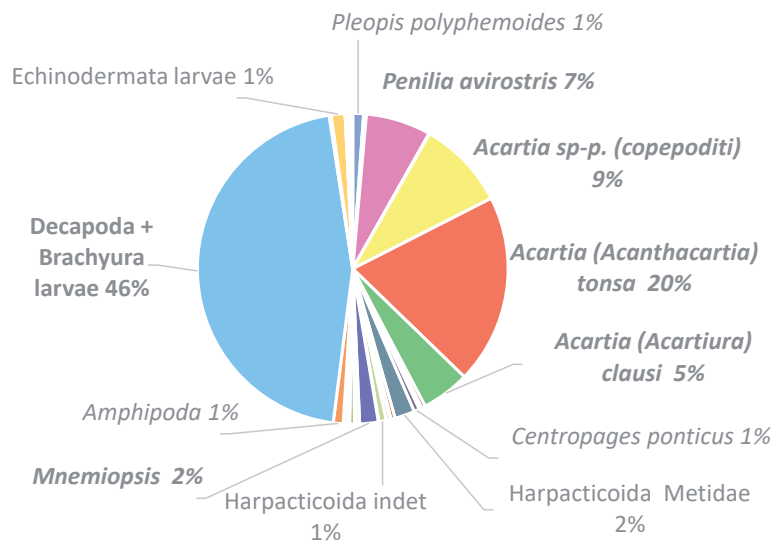
83 taxa of which 30 identified at species level

Average zooplankton abundance range:

Min in July : 33 ± 28 ind m^{-3}

Max in June: 862 ± 1037 ind m^{-3}





Mnemiopsis leidyi (NIS)



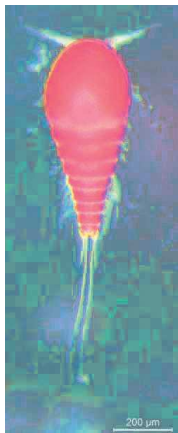
Brachyura larvae (crab larvae)



Rhithropanopeus harrisi
Dyspanopeus sayi (NIS)



Penilia avirostris



Harpacticoida Metidae



Oithona davisae (NIS)



Acartia (Acanthacartia) tonsa (NIS)

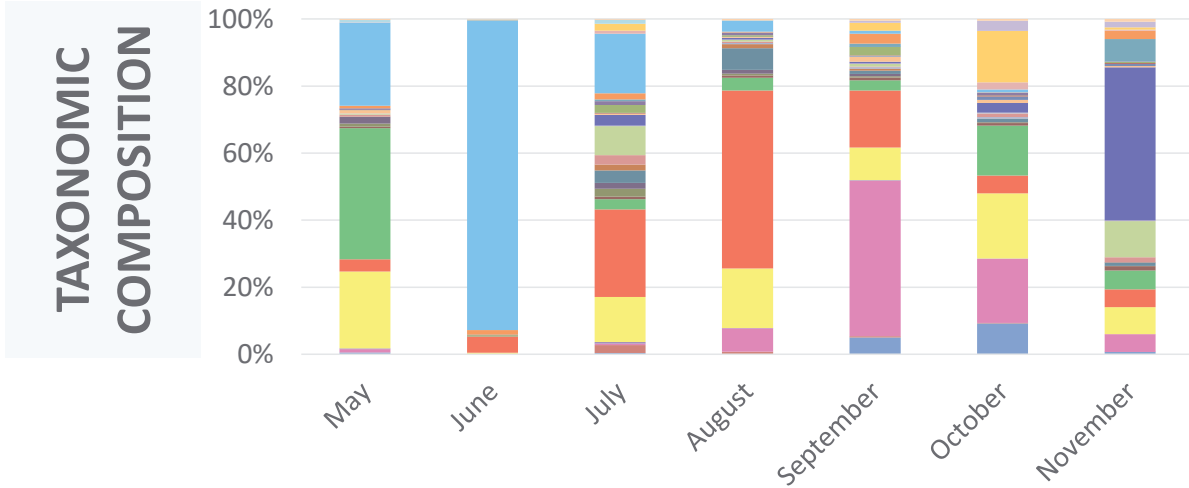


A. (Acartiura) margalefi and *A. (Acartiura) clausi*



Pseudodiaptomus marinus (NIS)

■ Brachyura larvae
 ■ *A. clausi*
 ■ *Acartia copepodites*
 ■ *A. tonsa*
 ■ *Penilia avirostris*
 ■ *Mnemiopsis*



✓ dominance of herbivore and omnivore-herbivore taxa

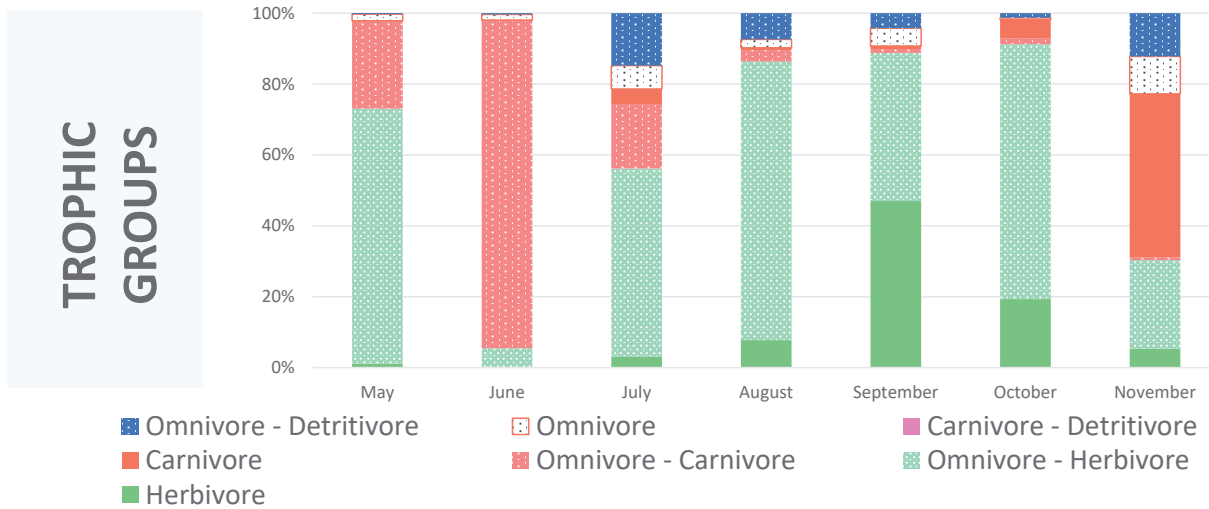


Copepods *Acartia* spp.



Cladoceran *Penilia avirostris*

✓ only in June + November omnivore-carnivore and carnivore taxa dominated the community



Brachyura larvae (crab larvae)



Mnemiopsis leidyi (adult and cydippids)





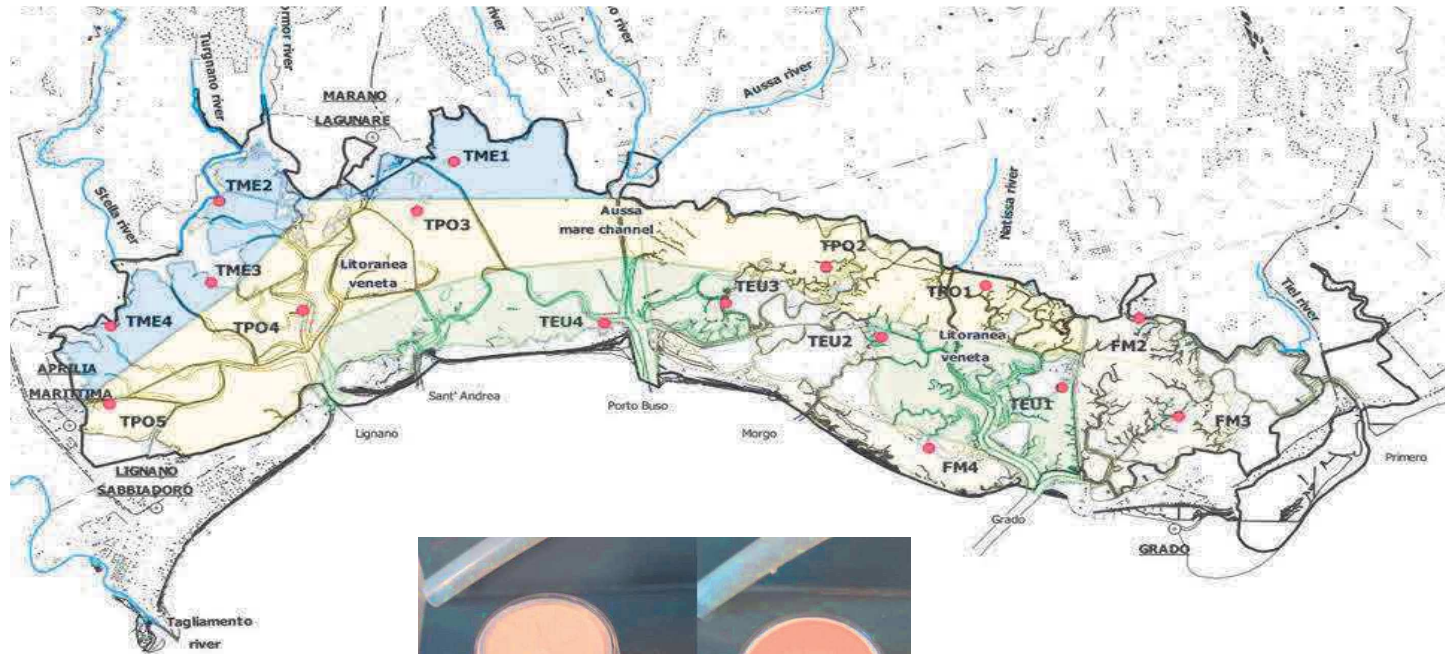
eDNA: environmental DNA

DNA that is released by an organism into the environment in the form of skin cells, faeces, urine, hair, mucus, excretions, saliva, blood, gametes, and remains after death.

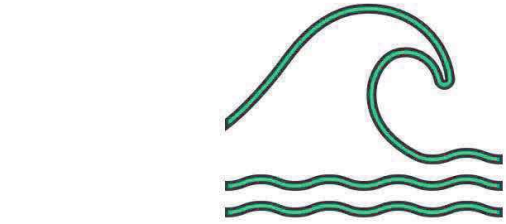
- It can remain for up to several **weeks** in water and for years or **decades** in soil and sediment.
- It can be collected and analyzed for the study and monitoring of **biodiversity**.
- It gives valuable information for the **management** of species of interest, **endangered** species, alien and **invasive** species, and the general state of the **ecosystem**.



Fishbio



- 16 sites in the Grado and Marano Lagoon
- Sampling was carried out during WFD fish surveys in Spring and Autumn 2021



1-1.5 L of water filtered at 1.2 µm porosity



DNA metabarcoding

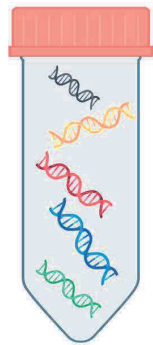


Molecular technique that allows the identification of organisms whose DNA is present in an environmental sample (water, sediment, soil). It relies on a **DNA region that differs from species to species**.

In this case we used a **fish-specific** DNA region (12S rRNA)



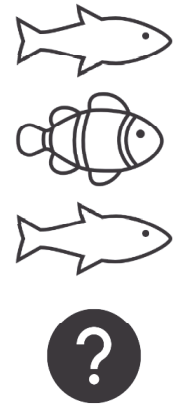
DNA extraction



Amplification & Sequencing



Identification (comparison with public databases)

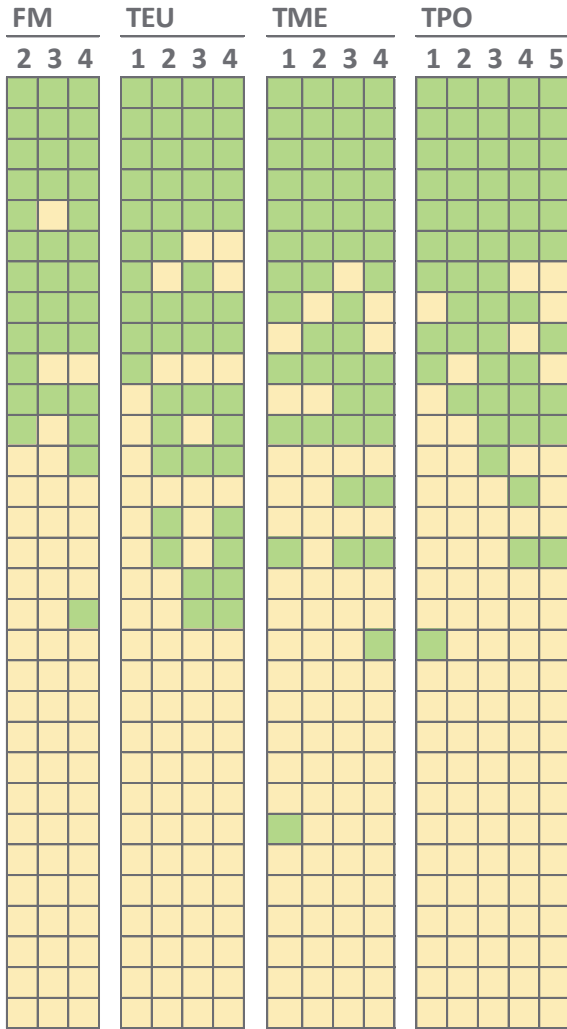




Results: 31 species detected

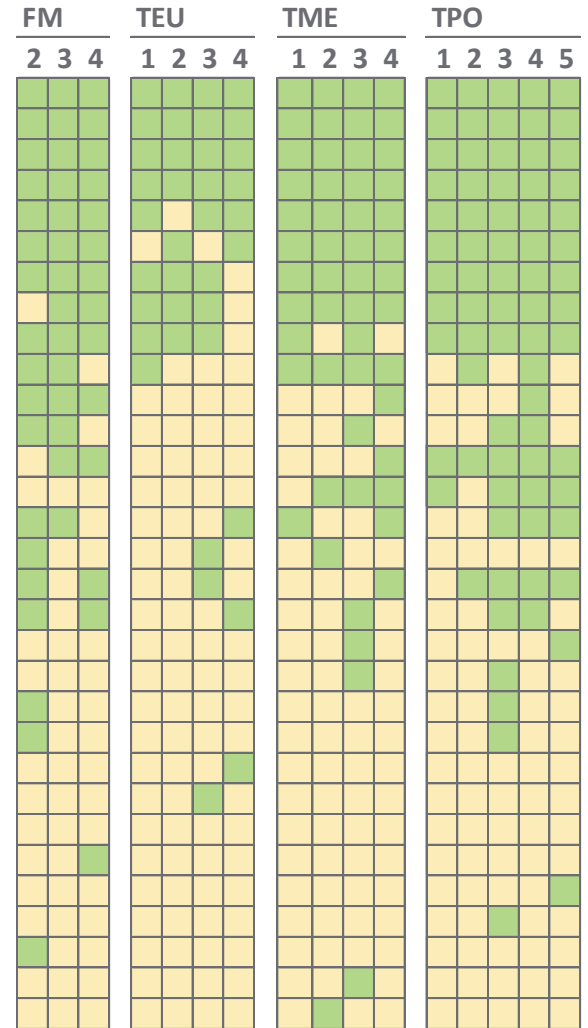
SPRING

- Sparus aurata*
- Atherina boyeri*
- Chelon auratus*
- Dicentrarchus labrax*
- Oncorhynchus mykiss*
- Chelon ramada*
- Aphanius fasciatus*
- Syngnathus typhle*
- Zosterisessor ophiocephalus*
- Mugil cephalus*
- Sardina pilchardus*
- Solea solea*
- Gobius niger*
- Salmo trutta*
- Pomatoschistus minutus*
- Engraulis encrasicolus*
- Squalus acanthias*
- Chelon labrosus*
- Anguilla anguilla*
- Alosa fallax*
- Mustelus mustelus*
- Trachurus trachurus*
- Symphodus melops*
- Pomatomus saltatrix*
- Salmo salar*
- Scomber scombrus*
- Sprattus sprattus*
- Pomatoschistus knerii*
- Hippocampus hippocampus*
- Torpedo marmorata*
- Arnoglossus laterna*



AUTUMN

- Sparus aurata*
- Atherina boyeri*
- Chelon auratus*
- Dicentrarchus labrax*
- Oncorhynchus mykiss*
- Chelon ramada*
- Aphanius fasciatus*
- Syngnathus typhle*
- Zosterisessor ophiocephalus*
- Mugil cephalus*
- Sardina pilchardus*
- Solea solea*
- Gobius niger*
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Results: comparison with Water Framework Directive survey

WFD-ARPA FVG

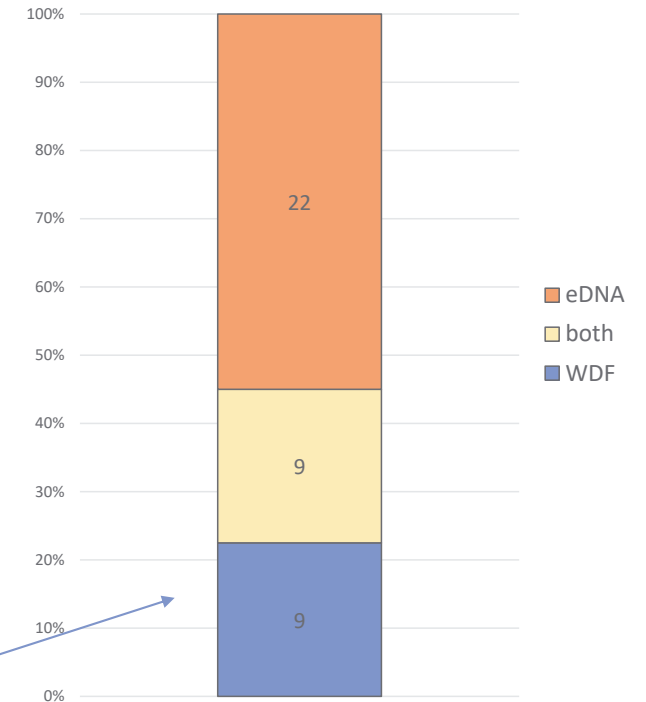
Belone belone
Chelon saliens
Knipowitschia panizzae
Nerophis ophidion
Platichthys flesus
Pomatoschistus canestrinii
Pomatoschistus marmoratus
Salaria pavo
Syngnathus abaster

eDNA-ARGOS

Aphanius fasciatus
Atherina boyeri
Chelon auratus
Chelon ramada
Dicentrarchus labrax
Sardina pilchardus
Sparus aurata
Syngnathus typhle
Zosterisessor ophiocephalus

Alosa fallax
Anguilla anguilla
Arnoglossus laterna
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Squalus acanthias
Symphodus melops
Torpedo marmorata
Trachurus trachurus

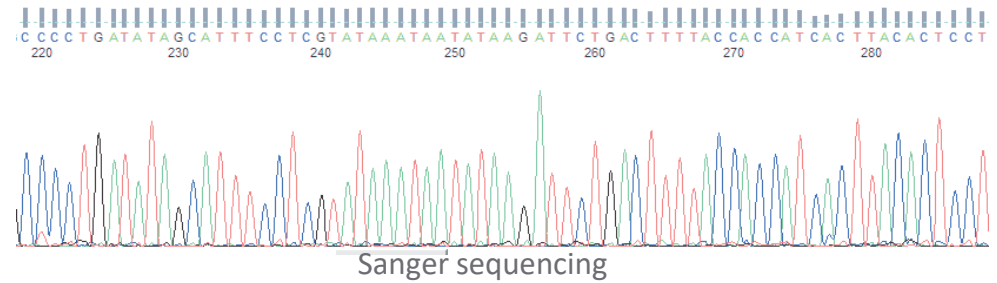
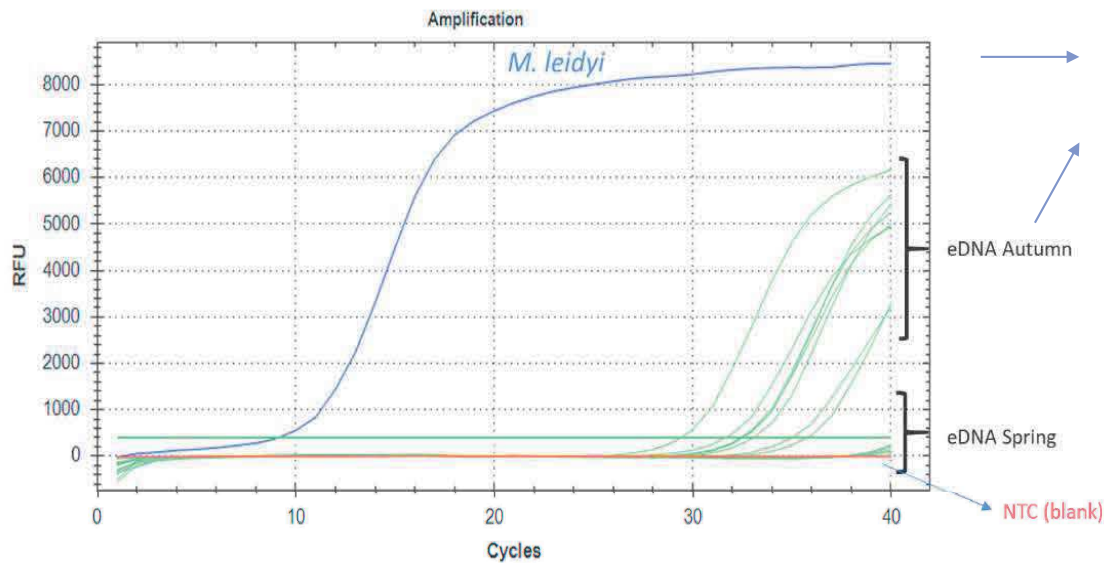


lack of reference sequences

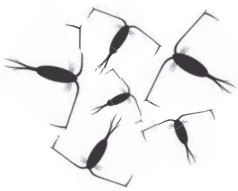


Mnemiopsis leidyi eDNA detection

Use of species-specific primers and Real-Time PCR to detect an important non indigenous invasive ctenophore and provide an **early warning** for its presence and potential **blooms**.



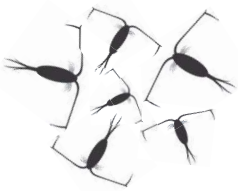
The DNA of *Mnemiopsis leidyi* was detected in all Autumn samples, while Spring samples gave no signals. This result is in agreement with zooplankton sampling data.



Conclusions



- Argos provided an important contribution to the knowledge of the food web in the Marano and Grado Lagoon: this study and the NOCE di MARE project are the first zooplankton surveys carried out in this area
- herbivorous and omnivorous taxa dominated the zooplankton communities, confirming **the important role of zooplankton in transferring energy from the primary producers (phytoplankton) to higher trophic levels (fish) in the lagoon**
- 6 non indigenous species (NIS) were identified in zooplankton samples (3 of which were first records in the study area)
- the molecular approach was crucial to identify meroplanktonic species (e.g. crab and fish larvae)
- eDNA analysis was successfully applied to the Marano and Grado Lagoon : more than 30 fish species and *Mnemiopsis leidyi* were detected
- some fish species (e.g., *Allosa fallax*, *Anguilla anguilla*) have been detected only by metabarcoding
- in the perspective to implement a site-specific eDNA program in the Marano and Grado Lagoon, the DNA of missing species should be directly extracted and sequenced from lagoon specimens and added at the reference databases to increase its resolution
- the combination of molecular techniques with more traditional approaches can significantly **improve the assessment and the monitoring of the lagoon biodiversity and can be used for invasive species early warning.**



Acknowledgments



Our special thanks go to **Nicola Bettoso** (ARPA FVG), **Lisa Faresi** (ARPA FVG) and **Diego Borme** (OGS) for their help in field sampling and the precious suggestions about the fish fauna of the lagoon of Marano and Grado, **Sergio Stefanni** (SZN) for his help for e-DNA protocol and molecular results' discussion and **Alessandro Acquavita** (ARPA FVG) for his indispensable collaboration for this presentation.

Thank you for your attention