

PHD COURSE IN LIFE AND ENVIRONMENTAL SCIENCES

Report Form for PhD student annual evaluation (XXXVI and XXXVII cycles)

Name of PhD student: Francesca Neri

Title of PhD research: Relationships among phytoplankton, nutrient concentration and hydrology in the northern Adriatic Sea based on a Long-Term historical data set.

Name of PhD supervisor: Prof.ssa Cecilia Totti

Research lab name: Marine Botany Laboratory

Cycle:

XXXVI

XXXVII

PhD Curriculum::

Marine biology and ecology

Biomolecular Sciences

Civil and environmental protection

DISVA instrumentation labs/infrastructure eventually involved in the project:

Actea Mobile Laboratory

Advanced Instrumentation lab

Aquarium

MassSpec lab

MaSBiC

Simulation/informatics lab

Other. Please, indicate:

ABSTRACT (1000 characters, including spaces):

Due to its fast turnover and high sensitiveness to the environmental parameters, phytoplankton diversity and trends have been included in the MSFD for the GES assessment. I studied the seasonal cycle, interannual trends, biodiversity and community composition (in terms seasonal relevant species and species interactions), in two LTER stations (one coastal and one offshore) located in the Northern Adriatic Sea (NA), highlighting (i) the role of the mixing/stratification regime and the direct/undirect riverine inputs in affecting the phytoplankton community and (ii) importance of combining indicators (including the Graph-Network Analysis) to study phytoplankton diversity. Now I will apply and test several phytoplankton indicators for the GES assessment on regional scale (Mediterranean Sea). Data from the oceanographic model that I am validating will be used to study the relationships between phytoplankton and hydrodynamic parameters.

Part 1. Scientific case of the PhD Research (2 to 3 pages, including figures)

BACKGROUND AND AIMS

The Northern Adriatic Sea (NAS), the northernmost basin of the Mediterranean Sea, represents one the most productive areas of the Mediterranean Sea. In the NAS, the phytoplankton community is highly influenced by the oceanographic conditions, such as the Western Adriatic Current, which conveys southwards the nutrient-rich waters from the northern subbasin (Artegiani et al., 1997; Campanelli et al., 2011; Marini et al., 2008), the Eastern Adriatic Current, which flows northwards along the eastern coast, bringing Ionian saltier, warmer and more oligotrophic waters (Poulain and Cushman-Roisin, 2001), and the stratification/mixing regime (Neri et al., 2022). Phytoplankton trends are also largely affected by meteorological changes and anthropogenic pressure (Cibic et al., 2018; Grilli et al., 2020; Ninčević Gladan et al., 2010; Totti et al., 2019). The fast turnover and the high sensitiveness to environmental conditions make the phytoplankton an optimal proxy reflecting the main changes in the marine ecosystems, and for these reasons this descriptor has been included in the Marine Strategy Framework Directive for the assessment of the Good Environmental Status (GES) of pelagic habitats.

The objective of my PhD research is to evaluate the potential changes in terms of physico-chemical parameters, and abundance and composition of phytoplankton communities in the northern Adriatic Sea, related to meteorological and hydrological variations, and to anthropogenic pressures. Furthermore, the aim is also to depict a detailed information on the community structure and composition of phytoplankton community in terms of both abundances and significant taxa, the main constraints affecting their trends and the effects of extreme climate events.

During the first year I analysed a big dataset (1988-2018) referred to a Long-Term Ecological Research (LTER) offshore station (and thus not directly affected by riverine inputs) to characterize the trophic status and phytoplankton community structure and to depict their trends (Neri et al., 2022). Then I compared the environmental community structure and trophic conditions of two LTER stations (one coastal and one offshore) differently affected by oceanographic conditions, highlighting: (i) a different phytoplankton annual cycle between the two stations and a higher similarity in summer, due to the spreading south-eastwards of

riverine water in stratified conditions; (ii) the importance of the combination of different indicators, including the Graph-Network analysis, for the study of the phytoplankton community; (iii) higher diversity offshore (Neri et al., submitted). I also created two databases of abundances of potential toxic phytoplankton species and occurrence of poisoning events (such as DSP and PSP) using data that were collected from the ARPAs and IZSSs of different Italian. These databases will give information on the trends of the HAB phenomena (Accoroni et al., submitted).

During the second year I focused on the validation of an oceanographic model that will provide data that will be useful to study the relationships between phytoplankton and oceanographic conditions. Moreover, I worked on the identification and use potential indicators, based on both phytoplankton and zooplankton data, for the Good Environmental Status assessment in the Marine Strategy Framework Directory. Furthermore, I have started to work on the extraction of environmental DNA from filter to study the phytoplankton community using a metabarcoding approach.

WORKPLAN AND RESEARCH ACTIVITIES

WP 1. Validating an oceanographic model covering the Adriatic Sea

The validation was done on for two models, the Regional Ocean Modeling System (ROMS) for the hydrodynamics and the Simulating WAVes Nearshore model (SWAN) for the waves, that are part of the Coupled Ocean-Atmosphere-Wave-Sediment Transport modeling system (COAWST). ROMS and SWAN domain comprises the whole Adriatic Sea basin (until the strait of Otranto) with 1 km horizontal grid resolution. To use data from models, the model needs to be validated with observational data. For this reason, model performance was assessed for several variables (temperature, salinity, sea surface height, ocean current speed) by the comparison with observational data for the 2018-2019 period from in situ measurements and data from models that were already validated (through Copernicus website). RMSE (Root Mean Square Error), BIAS and Pattern Correlation Coefficient were applied to statistically validate the comparison.

Preliminary results showed that the coupled model (ROMS and SWAN) is able to reflect the observational data. At the completion of the model validation, data of temperature, salinity, sea surface height and ocean current speed from the model will be able to be used in the same way of observational data, such as for the study of the relationships between phytoplankton and oceanographic conditions.

WP 2. Testing the efficiency of indicators for the assessment of the Good Environmental Status in the pelagic habitats in the framework of the Marine Strategy based on of phytoplankton and zooplankton Mediterranean data.

The Mediterranean Sea, due to its heterogeneity and biogeographic differences, is an optimal case study to test the efficiency (at regional scale) of different indicators, combined with multivariate approaches, for the environmental assessment and the characterization of patterns in species compositions.

Data of phytoplankton were collected from ARPAs (Agenzia Regionale per la Protezione Ambientale) in all the Italian coast since 2015 to 2020. Traditional biodiversity indexes (e.g. Shannon diversity index and Pielou's

evenness) were combined with non-traditional ones, such as the Rao index. Multivariate statistical approaches (e.g. Non-Metric Multidimensional Scaling and clustering techniques) were used to look for patterns along the Mediterranean coasts. For each region, temporal changes were studied using the Local Contributions to Beta Diversity index (LCBD; a beta diversity measure) and the Importance Value Index (IVI) was calculated to potentially reveal the phytoplankton genus responsible for the modification in the community structure. Phytoplankton and zooplankton data, collected from the same periods and regions, were combined to look for a plankton life form indicator. This study will give information on the applicability of many indicators in the environmental assessment on a regional scale.

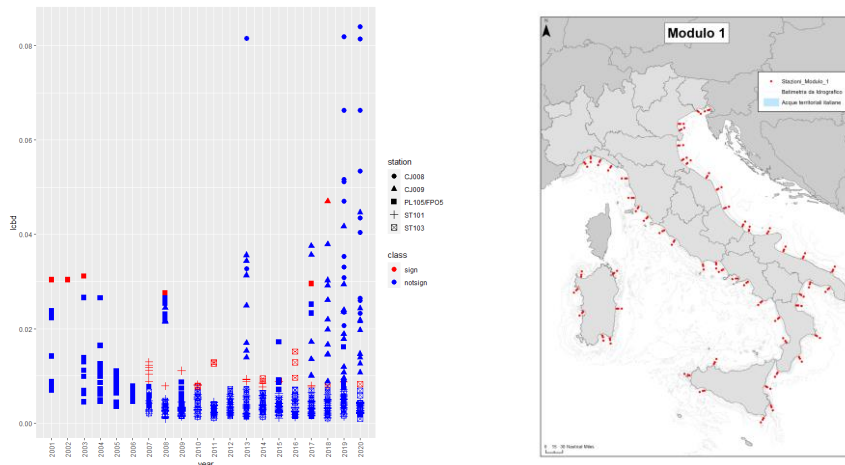


Fig. 2 Local beta diversity calculated for several stations on the period 2001-2020 (left) and maps of the stations and transects located along the Italian coasts (right).

WP 3. Future objectives: (i) The study of the phytoplankton community using metabarcoding approach and comparing the results with those obtained by microscopy. (ii) Effects of extreme climate events, such as heatwaves, droughts and floods, on phytoplankton community.

REFERENCES

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Neri, F., Romagnoli, T., Accoroni, S., Campanelli, A., Marini, M., Grilli, F., Totti, C., 2022. Phytoplankton and environmental drivers at a long-term offshore station in the northern Adriatic Sea (1988–2018). *Cont. Shelf Res.* 242, 104746.

Neri, F., Romagnoli, T., Accoroni, S., Ubaldi, M., Garzia, A., Pizzuti, A., Campanelli, Grilli, F., A., Marini, M., Totti, C., 2022. Phytoplankton communities in a coastal and offshore stations of the northern Adriatic Sea approached by network analysis and different statistical descriptors. *Ocean Coast Manag* (submitted).

Ninčević Gladan, Ž., Marasović, I., Grbec, B., Skejčić, S., Bužančić, M., Kušpilić, G., Matijević, S., Matic, F., 2010. Inter-decadal variability in phytoplankton community in the middle Adriatic (Kaštela Bay) in relation to the North Atlantic Oscillation. *Estuar. Coast.* 33, 376–383. <https://doi.org/10.1007/s12237-009-9223-3>

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Totti, C., Romagnoli, T., Accoroni, S., Coluccelli, A., Pellegrini, M., Campanelli, A., Grilli, F., Marini, M., 2019. Phytoplankton communities in the northwestern Adriatic Sea: Interdecadal variability over a 30-years period (1988–2016) and relationships with meteorological drivers. *J. Mar. Syst.* 193, 137–153.

Part 2. PhD student information on the overall year activity (courses/seminars/schools, mobility periods, participation to conferences)

List of attended courses/seminars/schools

1. Individual internship at the Department of Information Engineering (UnivPM) (September – December 2021, 48h), Prof. Fabrizio Marinelli
2. Complex networks (October – November 2021), Prof.ssa Maria Grazia Ortore
3. Elements of Marine Policy (May 2022), Prof.ssa Emanuela Fanelli

List of periods spent abroad

1. One month (30/05/2022 – 30/06/2022) at the National Institute of Biology in Piran (Slovenia)

List of conferences/workshops attended and of contributions eventually presented

1. Neri F., Romagnoli T., Accoroni S., Campanelli A., Marini M., Grilli F., Totti C. (2021) Phytoplankton and environmental drivers at an LTER-offshore station in the northern Adriatic Sea (1988-2018). *Gruppo di Algologia della Società Botanica Italiana. Riunione scientifica annuale*, Catania, 12 November 2021.
2. eLTER time series for ecologists workshop (online, 21 March 2022)
3. Neri F., Accoroni S., Campanelli A., Garzia A., Grilli F., Marini M., Romagnoli T., Ubaldi M., Totti C. (2022) Phytoplankton community at a LTER offshore station in the northern Adriatic Sea (1988-2018). *Incontro Giovani Ricercatori in Ecologia e Scienze dei Sistemi Acquatici*, Cagliari (online), 25-26 May 2022.
4. Neri F., Romagnoli T., Accoroni S., Garzia A., Ubaldi M., Campanelli A., Grilli F., Marini M., Totti C. (2022) Phytoplankton composition and long-term variations in two coastal and offshore marine sites (northern Adriatic Sea). *Società Italiana di Botanica Marina*, online, 14-17 June 2022.
5. ABIOMMED project meeting and workshops (online, 12th and 13th of July 2022)
6. 9th Congress of the Italian Society for Evolutionary Biology (SIBE), Ancona, 4-7 September 2022
7. Workshop on the MSFD pelagic habitats (Ancona, 22nd and 23rd of September 2022)

Part 3. PhD student information on publications

If not yet published, please indicate the publication status (submitted, accepted, in preparation...)

List of publications on international journals

J1. Neri, F., Romagnoli, T., Accoroni, S., Campanelli, A., Marini, M., Grilli, F., Totti, C. “Phytoplankton and environmental drivers at a long-term offshore station in the northern Adriatic Sea (1988-2018)”.

Continental Shelf Research, 242, 104746. (2022) <https://doi.org/10.1016/j.csr.2022.104746>

J2. Accoroni S., Ubaldi, M., Bacchiocchi, S., Neri, F., Siracusa, M., Buonomo, M.G., Campanelli, A., Totti, C. “Palytoxin-Analogues Accumulation in Natural Mussel Banks during an *Ostreopsis cf. ovata* Bloom”.

Journal of Marine Science and Engineering, 10, 1402. (2022) <https://doi.org/10.3390/jmse10101402>

J3. Neri, F., Romagnoli, T., Accoroni, S., Ubaldi, M., Garzia, A., Pizzuti, A., Campanelli, Grilli, F., A., Marini, M., Totti, C. “Phytoplankton communities in a coastal and offshore stations of the northern Adriatic Sea approached by network analysis and different statistical descriptors” (2022, submitted to *Ocean and Coastal Management*).

J4. Accoroni, S., Cangini, M., Angeletti, R., Arcangeli, G., Bacchiocchi, S., Barile, N., Contiero, L., Costa, A., Di Taranto, A., Escalera, L., Fedrizzi, G., Garzia, A., Longo, F., Macaluso, A., Melchiorre, N., Milandri, A., Milandri, S., Montresor, M., Neri, B., Neri, F., Gallo, P., Piersanti, A., Rubini, S., Scortichini, G., Suraci, C., Susini, F., Vadrucci, Maria, R., Verniani, D., Virgilio, S., Vivaldi, B., Vodret, B., Totti, C., Zingone, A. Marine phycotoxin levels and profiles in shellfish—14 years of data gathered along the Italian coasts. (2022, submitted to *Marine Pollution Bulletin*).

List of publications in Italian Journals/Conference Proceedings

C1. Neri, F., Romagnoli, T., Accoroni, S., Ubaldi, M., Garzia, A., Pizzuti, A., Campanelli, Grilli, F., A.,

Marini, M., Totti, C. “Phytoplankton composition and long-term variations in two coastal and offshore marine sites (Northern Adriatic Sea)”. (2022, *Biologia Marina Mediterranea*).

Ancona, 07/10/2022

Student signature



Supervisor signature