



PHD COURSE IN LIFE AND ENVIRONMENTAL SCIENCES

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

Name of PhD student: Agnese Riccardi

Title of PhD research: Valorization of marine biodiversity to engage local communities in the design of tailored conservation measures

Name of PhD supervisor: Carlo Cerrano

Research lab name: Zoology Lab

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):

There is a growing interest in marine social science and understanding Ocean Literacy (OL) on a global scale. It is now clear the critical importance of identifying adequate communication strategies to increase awareness, pro-ocean behavior and finally share knowledge and tools with decision-makers aimed at marine conservation measures. This research focuses on OL assessment and Biodiversity valorization and aims to define communication and engagement strategies to increase societal awareness and commitment to conservation measures. Citizen Science (CS) protocols are a dissemination tool that will be adopted to achieve the project's objectives. I'm focusing on Heterobranchia group, training volunteer divers of Mediterranean basin and triggering a capacity-building path. In this framework, temperature manipulation experiments on the life cycle are scheduled to test the embryonic development of some Heterobranchia's autochthon species.

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

- BACKGROUND

Ocean Literacy (OL) has been defined as the “understanding of the ocean’s influence on you and your influence on the ocean (Cava *et al.*, 2005). An ocean-literate person i) understand the Essential Principles and Fundamental Concepts about the Ocean, ii) can communicate about the ocean in a meaningful way and iii) is able to make informed and responsible decision regarding the ocean and its resources. In 2017, the UN proclaimed the Decade of Marine Sciences for Sustainable Development (2021-2030), concurrently with the 2030 Agenda, to reverse the decline in ocean health and improve its conservation status. The OL is considered crucial to both the Decade (UNESCO-IOC, 2021) and 2030 Agenda goals (Santoro *et al.*, 2018). Based on this framework, marine scientists and educators developed the “Mediterranean Sea Literacy” (MSL) guide adapted to the specificities of the Mediterranean region. The MSL guide, comprising 7 principles and 43 concepts adapted to the specificities of the Mediterranean Sea, is expected to raise awareness and create a Mediterranean-Sea-literate society (Mokos *et al.*, 2020).

The training and engagement of citizens develop a population of final users with a better attitude towards scientific knowledge and enhanced awareness on the nature of the science itself (Aristeidou and Herodotou, 2020). Citizen Science (CS) programs are considered stepping-stones in the nurturing of a new generation of ocean-literate citizens (Deidun *et al.*, 2022). As well as having citizens' OL goal, CS programs also have scientific and policy goals (Adler *et al.*, 2020). CS is particularly effective at addressing ecological questions at large spatial and temporal scales that cannot be covered by a small team of investigators (Jarvis *et al.*, 2015) and can provide crucial baseline information on effects of global change and for identifying locations in good or bad environmental health (Conrad and Hilchey, 2011).

Ongoing climate change is rapidly altering underwater communities, sometimes causing local extinctions or alterations in normal life cycles, and very often the disappearance of a species goes completely unnoticed. Sea slugs seem to be good indicators of regional climate shift (Goddard *et al.*, 2016; Shultz *et al.*, 2011) basically for the three following reasons:

- these organisms have evolved several defensive strategies involving aposematic coloration, making their liveries vivid and detectable to humans (useful to scuba macro-photographers);
- most of them appear to have a stenoeccious diet and mainly target sessile organisms such as cnidarians and sponges, which are very sensitive to climate change;
- Short life cycle, larval growth and development.

Their specialization in feeding, might impact species survival under a warming scenario, since the local extinction of a preferred prey could cause a reduction in feeding efficiency, providing too little energy to support the expected higher metabolic rate (Smith and Sebens, 1983). Although many other factors (e.g. nutritional state, body size, population density) affect the reproductive output of a given nudibranch species (Havenhand and Todd, 1988), temperature increase during nudibranch’s embryonic development has been proved to cause deleterious effects on embryo’s survival and hatching success (Watt and Aiken, 2003) In the present research, several parameters will be evaluated with laboratory culture, in order to highlight the temperature effect on: i) adult feeding and survival ii) spawning frequency, iii) embryonic development time and survival.

The Reef Check Italia Onlus project, “Nudibranchs and other sea slugs in the Mediterranean and the Black Sea”, is one of the projects settled worldwide and focused on the monitoring of Heterobranchia, it represents an important CS tool to collect large-scale data on this delicate group of organisms concerning their distribution and diet preferences.

In the framework of community’s engagement in climate change detection, “Local Ecological Knowledge” (LEK) has emerged as an alternative approach to collect information on species presence/abundances when historical data are lacking (Huntington, 2000; Anadón *et al.*, 2009). However, up to now, the use of LEK in the Mediterranean Sea has been limited to collecting information and describing trends in fish diversity and abundance (Azzurro *et al.*, 2011), and discarding commercially important fish species in the bottom trawl fishery (Damalas *et al.*, 2015a, b). Here we apply LEK also to examine the temporal change of habitat-forming invertebrates and other important taxa. This approach can be expanded to other Mediterranean Sea regions to reconstruct the change of this heavily exploited sea.

- SCIENTIFIC AIMS

1. Can OL and proper awareness of local sea, drive society towards a smoother acceptance of conservation measures?

Study basic knowledge levels of Ocean Literacy and develop effective educational approaches and communication strategies to contribute in the achievement of Ocean Decade and Agenda 2030 sustainability goals;

2. Can distribution and trophy of Heterobranchia be indicators of climate change effects on benthic communities? Does climate change affect the Heterobranchia life cycle?

Finalize and introduce the Heterobranchia monitoring protocol in the MPA-Engage project;

3. Can the detection of key habitats and biodiversity loss address restoration and conservation projects?

Implement tailored conservation and restoration measures in the marine environment, in order to recover the healthy state and avoid the loss of small-scale fisheries, allowing the development of sustainable and healthy practices.

- WORKPLAN AND RESEARCH ACTIVITIES

WP 1. Objective.

Define knowledge and gaps in society's awareness about the 7 principles of Ocean Literacy and the perception of the local sea.

Methods.

Ocean Literacy and sea-perception questionnaire and *vis-a-vis* interviews covering the entire society from kids to adults. The sample size was estimated using an Internet Sample Size calculator which provides an interactive way to obtain the sample size considering the population of Ancona municipality amounts, a Confidence Level (CL) of 95% and a Confidence Interval (IC) of 5.

- Questionnaires are addressed to students from elementary to high local schools. The survey is based on a quantitative method (close-ended questions). The questionnaire is divided into two sections and contains 16 questions:
 - A: Subject's demographic profile and framing of the relationship with the sea
 - B: Subject perception/knowledge about the 7 principles of Ocean Literacy responding to the key investigation questions:
 1. Are there demographic/cultural aspects vectors of different types of Knowledge and perception?
 2. Which is school students' perception/knowledge about the 7 principles of Ocean Literacy?At the end of each questionnaire session, I invite the students to ask for any doubts or curiosity, and the teachers to collaborate in ongoing indoor and outdoor activities.
- *Vis-a-vis* interviews are addressed to adults from a random local sample. The survey is based on a quali-quantitative method (both open-ended and closed-ended questions). The response rate for this method approach is usually the highest, but it will be costly in terms of time. The interview contains 19 questions. It is divided into five sections:
 - A: Subject's demographic profile
 - B: Subject-Sea relationship
 - C: Subject's perception of local sea state of health and biodiversity

- D: Subject's perception/knowledge about the Marine Protected Areas
- E: Subject's availability to be involved and/or committed to respecting and safeguarding the marine environment

responding to the key investigation questions:

3. Which is the citizen's perception of the local sea state of health and biodiversity?
4. Which is the citizen's perception/knowledge about the Marine Protected Areas?
5. Which is the citizen's availability to be involved and/or committed to respecting and safeguarding the marine environment?

At the end of each interview, I invite the subject to scan a QR code containing information about my research and local sea important aspects.

Expected/Obtained Results.

267 questionnaires have been collected from students of 2 elementary schools. Questionnaires sessions in classes of 2 middle schools are already planned and I'm currently preparing the survey addressed to high school. 20 people have been interviewed in person. Statistical analyses are planned.

WP 2. Objective.

To reconstruct historical changes in local marine habitat and biodiversity. Having a framework as clear as possible about local ecosystems could allow the implementation of tailored conservation and restoration actions in the marine environment, in order to recover the healthy state and avoid the loss of small-scale fisheries, allowing the development of sustainable and healthy practices.

Methods.

LEK protocol: *vis-a-vis* interviews with small-scale artisanal fishermen and other sea users as divers or recreational fishermen. Data collection was confidential, as interviewers did not record any sensitive personal information about respondents. At the beginning of the interview, respondents were informed about the purposes of the study and gave an informed consensus to use the provided information for scientific purposes. The interviews were conducted when the fishermen were returning from the sea, cleaning their nets and setting up the equipment. The interview was based on a standardized protocol procedure (LEK-1: exploring Local Ecological Knowledge to reconstruct historical changes) officially adopted as part of the MPA-Engage Interreg Project protocols. Each interviewee was asked the following question: "*Do you know any species which increased or appeared in your fishing area?*". It is noticeable how all respondents started by answering that "*Everything decreased...*" and then describe the situation in more detail. Respondents were asked to provide a qualitative ranking of the abundance of these taxa through time, on an annual basis, according to 6 different grades: 0 = ABSENT; 1 = RARE (once in a year); 2 = OCCASIONAL (sometimes in a year); 3 = COMMON (regularly in a year); 4 = ABUNDANT (regular in captures and abundant); 5 = DOMINANT (always in captures and with great abundance). At the end of the interview, each recorded taxa was assigned to one of these trend factors: DECREASING (D); FLUCTUANT (F); STABLE (S); INCREASING (I).

species belonging to 6 phyla (Arthropoda, Chordata, Cnidaria, Echinodermata, Mollusca and Anellida) were mentioned. Statistical analyses are in progress.

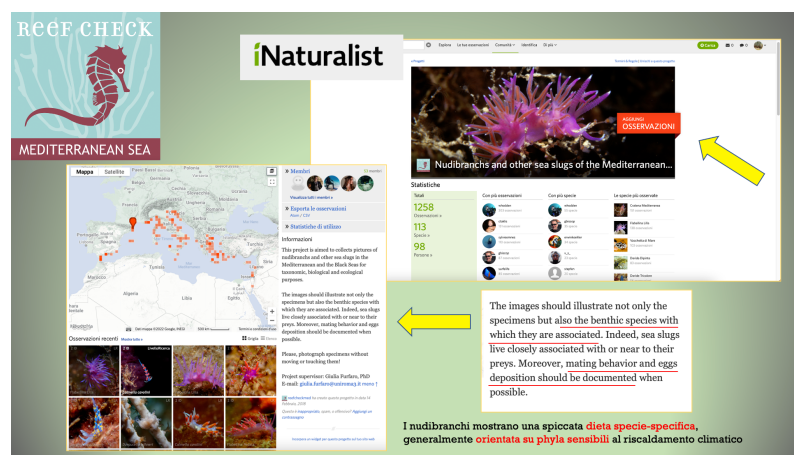
Case study 3.: Liguria Region. Alassio-Imperia. A total of 6 interviews were carried out on the 24th and 25th of August 2022. The study was addressed to local recreational and professional fishermen and divers, all between 30 and 65 years old. A total of 28 species belonging to 3 phyla (Chordata, Echinodermata and Mollusca) were mentioned. Statistical analyses are in progress.

WP 2. Objective.

Engage the local community (diving centres, local and tourist divers) in Citizen Science (CS) program to raise awareness about climate change's effects on marine habitats and ensure that any protective measures will be understood and well accepted.

Methods.

CS monitoring protocol focused on Heterobranchia's distribution and trophy in the Mediterranean basin uses the iNaturalist online platform from which data will be extracted. In this first phase, a detailed guide presentation has been created and used to train volunteers. To spare the network, it will be translated into two more languages (English and Spanish). Statistical analyses are planned.



Expected/Obtained Results.

Support for an IMBRSea master's thesis has resulted in the following data collected in the Monte Conero area: 442 sightings of 24 species have been collected during 20 dives in 7 different sites along Monte Conero Coast (Passetto, Cala Davanzali, Relitto Nicole, Due Sorelle, Secca dell'Ospedale, Sassi Neri, Scoglio della Vela), from 4,4 to 12,4 meters depth. Data were collected during the month of September, May and June 2022. The species were observed on 12 substrates having 4 different behaviors.

- REFERENCES

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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. Cortona Week 2022
2. General Course: Technology transfer and innovation. Prof. Donato Iacobucci
3. General Course: Design of research: European projects. Prof. Nicola Paone

List of periods spent abroad

- 1.
- 2.

List of conferences/workshops attended and of contributions eventually presented

1. Planning to participate in the 1st International Conference on Ocean Education and Training 2023. The conference will be held from 9th-11th January 2023 in Ghent, Belgium.
2. A New Approach For A Sustainable Blue Economy - All sessions. Attended on 18th November 2021 in Ferrara, Italy, at Sealogy- The Blue Economy European Exhibition.
3. Progetto Adriereef: Sfruttamento Innovativo Delle Scogliere Adriatiche Per Rafforzare La Blue Economy. Attended on 20th November 2021 in Ferrara, Italy, at Sealogy- The Blue Economy European Exhibition.
4. PNRR – Ripristino E Tutela Dei Fondali E Degli Habitat Marini Per Un'economia Blu Sostenibile. Attended on 19th November 2021 in Ferrara, Italy, at Sealogy- The Blue Economy European Exhibition.
5. Il Mare Del Futuro: Ricerca, Innovazione E Sostenibilità. Attended on 19th November 2021 in Ferrara, Italy, at Sealogy- The Blue Economy European Exhibition.

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. [Riccardi, A., Colletti, A., Virgili, R., Cerrano, C. "Diversity and behavior of sea slugs (Heterobranchia) in the rocky tide pools of Conero Riviera (western Adriatic Sea)." *The European Zoological Journal*, 89 1 (2022), 856-869 DOI: <https://doi.org/10.1080/24750263.2022.2095047>]

J2. *Submitted:* [Di Camillo, CG., Roveta, C., Pulido Mantas, T., Gravili, C., Cerrano, C., Calcinai B, Coppari, M., Gregorin, C., Marrocco, T., **Riccardi, A.**, Puce, S. "Bivalve-inhabiting hydroids: from guests to pests". *Reviews in Aquaculture.*]

List of publications on conference proceedings

C1. ...

C2. ...

List of other publications (books, book chapters, patents)

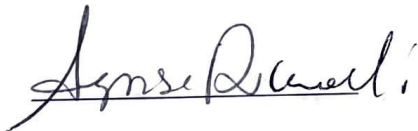
B1. ...

B2. ...

[Date]

14-10-2022

Student signature



Supervisor signature

