

4.6. Environmental DNA and citizen science

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| Project | Environmental DNA and citizen science for exploration, inventory and safeguarding of biodiversity |
| Organisation | Universidad de Oviedo |
| Research location | Oviedo, Spain |
| Cooperation partners | University of Perpignan (France), Klaipeda University (Lithuania) |
| Team | Three senior staff researchers, two post-docs and three Ph.D students |
| Funding sources | National Spanish Grant for Societal Challenges; Asturias Regional Grant; Port of Aviles |
| Websites | http://www.uniovi.es/ https://oma.uniovi.es/proyectos/bioinvasiones (targeted at the volunteers in Spanish) |

ORGANISATIONAL BACKGROUND ●●●

Conserving biodiversity is the key to a healthy, sustainable life for future generations. In this project a monitoring tool based on DNA present in the environment was developed and tested. This helps to build a database of species without disturbing wildlife to create an inventory of European biodiversity. Citizens are involved in the project in diverse ways, and contribute to the inventory. Volunteers photograph biota, remove potentially harmful exotics (by hand) and obtain DNA to catalogue native life.

According to the interviewee, Spain in general is not very conscious of animal lives or of the environment. The present research is necessary to prevent potential suffering or extinction of biota (animals and other) in the future. The researchers therefore developed e-DNA markers for the study of biodiversity, and in particular to find out how and to what extent invasive species evolve and gain ground. Early detection of such invasive species is important, otherwise it becomes impossible to remove them. Examples include certain species of mussels in the Mediterranean sea and the Atlantic ocean.

The method deploys citizens (near beaches) as early detectors. They helped to make a list of invertebrates in aquatic environments which are considered invasive. An early project proposal was submitted in 2013 and is running until end of 2016.

FUNDING ●●●

This project is partially supported by the following grants and institutions:

- National Spanish Grant for Societal Challenges CGL2013-42415-R, Multidisciplinary tools for alert and control of marine bio-invasions: environmental DNA, ICT and Citizen Science (2014-2016);
- Asturias Regional Grant GRUPIN14-093, Marine natural resources in the Anthropocene (2015-2017);
- Port of Aviles (Asturias), Control of the invasive species *Xenostrobus securis*.

PROBLEM BEING ADDRESSED ●●●

The future of humans depends upon living natural resources, which are inextricably linked with biodiversity. Future healthy and sustainable biodiversity relies on a good knowledge of present ecosystems. Biota inventories 'in the wild' are generally carried out by experts and follow sampling protocols that involve intrusive practices (electrofishing, netting, trapping etc.), especially in aquatic ecosystems where the species cannot be easily observed and quantified. Recent developments in environmental DNA (eDNA) make it possible to identify species from their DNA traces left in the water. This can be used to create an inventory of elusive and scarce organisms without disturbing wildlife. Current methods are still expensive and require high expertise in bioinformatics to analyse massive numbers of DNA sequences. Improvements are required to quantify the abundance of species of interest, expanding the methodology to all taxonomic groups, and making technology accessible to modest budgets.

In this project the researchers developed protocols and instruments for accurate, accessible, non-invasive and non-disturbing creation of an inventory of aquatic European biodiversity from DNA traces present in water. The original project is focused on marine biota. Case studies are centred in coastal areas of the Baltic, Cantabrian and Mediterranean seas.

RESEARCH DESIGN AND SOLUTION ●●●

The aim of the network is the exploration and safeguarding of local coastal biodiversity through respectful, non-invasive procedures, and it aims to:

- Develop protocols and instruments for accurate, accessible, non-invasive and non-disturbing inventory of aquatic fauna, through: visual tools such as photographs and videos and cheap, innovative molecular tools based on environmental DNA, to save lives and promote the welfare of wild animals.
- Bring together people of different age and activity sectors for environmental actions (coastal cleaning, control of exotic biota, biodiversity monitoring), in a network of citizen scientists. Day activities in senior education programmes for retired people, children in surf schools, members of the general public in continuous education, university students, primary and secondary schools, fishermen's associations and guilds, scuba diving clubs, port authorities and regional authorities were targeted, contacted and invited to participate.
- Involve authorities, managers, stakeholders and general public in creating the biota inventory using the newly developed non-invasive methods in order to increase conscious treatment of biodiversity.

The team also offers workshops for people who are interested in finding out how DNA is extracted, etc. The group started off enthusiastically, opening up the lab to those who wanted to help collect samples at the beaches. Participants seemed to enjoy that very much. Also the group received feedback information from the participants, and learned that their ways of transmitting their information was not very good. They then organised a 'club', with workshops on various topics, to engage the public. That worked better, demonstrating some degree of internal reflexivity to optimise the value of their outcomes.

As an example of citizen science, with photos rather than eDNA: in Oviedo people were asked to upload old pictures (up to decades ago) with the year indicated. These people were then asked to take a new picture in the same location. This resulted in thousands of pictures that were used to identify how vegetation has changed over the years. Exotic invasive plants and their migration patterns were identified in this way.

In Spain, over 200 citizen scientists aged eight to eighty-two were recruited. They worked on collecting DNA; helped organise a photograph exhibition about biodiversity; children learned to recognise native and exotic biota, and visited Oviedo University, for example during the Week of Science. In the port of Aviles (Spain) they collectively discovered a plague of alien mussels. Supported by port authorities, the multi-age volunteer group handled the invasive species by removing them by hand.

GRAND CHALLENGE BEING ADDRESSED ●●●

The societal challenges addressed revolve around the sustainable use of natural resources and protecting and conserving biodiversity. The team uses the following approach:

- Reconciling reliable biodiversity inventory with respect for animals in their natural habitats; the values of environmental conservation and sustainable management of natural resources and biodiversity are natural outcomes of this project.
- Involving the general public of all ages in science, thereby filling the gap between highly specialised science in research and academia and public scientific knowledge. When young students (primary and secondary education) share their activities they engage them in responsible research and scientific practices, and awaken their interest in science and knowledge, as well as in environmental issues. The same can be applied to seniors, since they involve mature students who are above retirement age in our activities.

The research teams indicated that the problem of exotic species is that they outcompete the native population. For example, the native population of a certain species of mussels disappeared from one marina in less than two years. If the new species gets out of the marina, it could spread to other places. But the new ones cannot be eaten, since they are small, but simultaneously accumulate heavy metals faster by growing faster. Then starfish, for example, which may eat these mussels could die because of the heavy metals, which poison them slowly by gradual accumulation and so on up the food chain to fish and then human beings. Mercury can be a particular problem, since it is taken up before it disappears into sediments due to the fast growth of the mussels. Similar examples exist in the case of plants, which hinder e.g. bird nesting and cause other problems downstream from this.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

In principle, the team believes that current academic knowledge should be publicly shared with citizens to support conscious and respectful treatment of local biodiversity. Moreover, it is simply impossible to make an inventory of all coastal biodiversity without the help of local citizens; there is not and will never be an adequate workforce for such a huge task. This project therefore intends to involve volunteers of all ages in a network of citizen scientists. Target groups and stakeholders in the research are scientists, managers of natural resources, national and regional authorities, fishermen's associations and guilds, surf schools, marina and yacht clubs, graduate and undergraduate students, senior citizens involved in lifelong learning and the general public. Scientists and managers are in charge of biodiversity inventories. Regional and national authorities have the competences for environmental issues. Fishermen and people engaged in recreational maritime activities are key stakeholders for marine biodiversity. The good response to the project from seniors gave the idea of introducing the value of multi-age groups in citizen science.



The young people involved are also concerned about the future of our society: they were helped to come into contact with experienced people so that they could learn from them. Patience and flexibility in environmental conservation are invaluable lessons for children and young people. The energy and enthusiasm of children turns out to be positively contagious for the older volunteers as well, creating a pleasant working environment.

The general public was addressed through various media, however the social impact of some scientific discoveries were found to have negative side effects. Local media reported on the team's discovery of an invasive mussel in Aviles port (November 2015) and some regional officers requested a port closure, subsequently alerting the port authorities. Following this, the research team has changed the message for the media. For example, the words used are more subtle such as "Presence of exotics" instead of "Biological invasion". The team learned a lesson in science communication, which the use of carefully chosen wording to avoid unnecessary public alarm and sensationalism being caused inadvertently by inexpert journalists.

EVALUATION AND DISSEMINATION ●●●

The project is carried out by a relative small group of researchers, many of whom are Ph.D or Post-doc. The research carried out to date is the beginning of a more ambitious project on the best way of combining citizen science and molecular techniques for biodiversity study and environmental safeguarding. Although interaction with the public is not the main expertise of this group of scientists, the team needs to tackle this aspect if they want to be really efficient in their approach. Despite the small size of the research team, they reported their findings directly derived from the project in nineteen international journal publications (since 2015) *Marine Pollution Bulletin* and *Marine Environmental Research*, *Aquaculture Research*, *Citizen Science*, a feature article in *National Geographic Magazine*, and 75 other publications since 2010 have mentioned the project's objectives. The impact of the project is relatively significant in terms of the outreach to civil society. The citizen science approach was presented at the International Conference of Citizen Science in San Jose (California) in February 2015. At local level the initiative was widely publicised in media (radio, newspapers, TV, Internet via University communication agency) and they gave informative talks at port facilities, high schools, Oviedo and Klaipeda universities (Perpignan in January 2016) and surf schools. The picture exhibition, coastal clean-up and surf school engagement were publicised using the same channels, for positive feedback to the participants. Stakeholders such as fishermen's guilds and associations, government agencies and clubs were contacted directly by the researchers, by telephone, email and/or personal visits. The dissemination activities are broad and frequent, despite the fact that in Spain and particularly in Southern Spain, the issue of protecting biodiversity still receives very little attention (socially and financially). This project is an attempt to improve this situation by increasing the awareness of the importance of protecting biodiversity.