

**Eduardo Dopico and Yaisel Borrel (editors)**

**(MINECO CGL2016-79209-R)**



**SCIENTIFIC and  
EDUCATIONAL  
STRATEGIES for a  
SUSTAINABLE PORT  
ACTIVITY facing  
BIOLOGICAL INVASIONS**

*from Ports to BluePorts. Is it possible?*



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**Puerto de Gijón**

Autoridad Portuaria de Gijón



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**Eduardo Dopico and Yaisel Borrel  
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# International Workshop BluePorts 2019

From Ports to BluePorts. Is it possible?



Gijón, 05<sup>th</sup> December 2019

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### *Workshop Summary*

Preventing the introduction of invasive alien species is one of the main lines of action envisaged by the European Commission in the upcoming EU blue growth strategy. The introduction of these organisms in ports, coastal areas and watersheds is damaging aquatic ecosystems all around the world, with estimated direct costs of many millions of dollars spent on monitoring, prevention of spread and remediation of the ecosystems. Invasions by marine non-indigenous species (NIS) are thus one of the greatest threats to biodiversity and to sustainable blue economies. Ports are the main entry gates of exotic biota in European waters, principally through biofouling and ballast water. The *EU Port Reception Facility* directive obliges ports to provide adequate port reception facilities to ships delivering waste in ports.

Within this aim, it is necessary to design, test and demonstrate the "ideal" Port Reception Facility and services for ships. The goal is to create awareness and motivation within the maritime community to stop discharges at sea by designing in consensus the "**Blue Port Services**". These strategies should involve not only port stakeholders but the whole society. However, despite all the available knowledge about NIS detection and prevention strategies they are far away of being effectively implemented within the Ports. Besides this, deficiencies of communication and support between the Ports and their neighbor cities and citizens have been identified.

This situation needs to be remedied because marine biological invasions are today one of the most dangerous risks for biodiversity worldwide, and biodiversity is the basis of blue (marine) sustainable economy. Since eradication is more difficult in late than in early invasion stages, new strategies are needed to effective prevention and early detection of nuisance organisms. They should involve not only port stakeholders but the whole society because blue economy is a priority for Europe. From this perspective, researchers and professors of the University of Oviedo conducted between 2016 and 2019 the project **MINECO CGL2016-79209-R**, *Blueports: Scientific and educational strategies for a sustainable port activity facing biological invasions*

The aims of this project were:

1. To create a GIS map of biological invasion risks taking as a case study the port of Gijon (Asturias), based on maritime traffic (routes and port calls of ships entering the port), and to validate the map based on biota sampling + Barcoding and on Metabarcoding.
2. To evaluate the strategies Metabarcoding versus specific eDNA markers for biota inventory within the ports.
3. To evaluate the risks derived from ballast water, depending on ship origin and routes. Based on BW samples from ships docked in Asturias, and validated from biota sampled along transequatorial PS102 cruise.



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4. To create a social map of interests, knowledge and values around marine biodiversity and biological security of Gijon's citizens, based on a mixed GIS + citizen science approach.
5. To develop a strategy for introducing the concept of blue (as sustainable) port management in educational instances

Throughout these three years, all the research results have been published in journals of high scientific impact and the scientific career of young researchers have been promoted through Master Thesis and PhD projects.

On December 5th, 2019, the BLUEPORTS 2019 INTERNATIONAL WORKSHOP was organized in Gijon (Asturias-Spain) by the Marine Observatory of Asturias, the Gijon Port Authority and the University of Oviedo Foundation. Researchers, Port Stakeholders, Managers, Teachers, Students and Citizens concerned about Biologically Safe Ports, were invited to present and discuss their results. The topics were, among others, alternatives in methods for the detection of nuisance species from biological monitoring in ships and Port areas; the use of environmental DNA and Metabarcoding for biodiversity inventories; case studies in European Ports; public perceptions about the role of Ports in the problem of biological invasions; upcoming EU regulations; alternatives to change operational framework within ports; successful and failed experiences preventing biological and organic contamination; solutions to address conflicts between Ports and Cities; and proposals to handle Citizen enrollments and participation in projects of Citizen Science related with Ports.

The meeting was opening by the prestigious **Professor Bella Galil** (Tel Aviv University, Israel) with the Plenary Talk: ***The Suez canal and the devastation of the Mediterranean Sea biota.***

What follows below its a representative sample of the research work that, from different approaches, is currently being carried out on the protection of biodiversity in European ports that need to become blue.



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*Case studies of  
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### THE NEED FOR A TOOL TO ANALYSE THE DATA AND DETERMINE THE RISK OF INVASIVE SPECIES

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#### **Abstract:**

In recent years there has been a clear increase in society's awareness of the need to prevent the pollution of our oceans and make more sustainable use of the resources we choose from the sea (Blue Growth). This is largely due to measures taken by the European Union, which is aware of the enormous potential of Europe's coasts, seas and oceans.

Marine bioinvasions are a serious global problem as they affect all the world's seas and oceans and there have been numerous signs of such effects worldwide in recent years. This problem is largely due to maritime transport, as 90% of goods transported worldwide are transported by sea.

Following the entry into force of the ballast water convention (BWM) on 8 September 2017, which seeks to reduce the transfer of invasive aquatic species from maritime traffic, the need to develop a tool to know in advance the organisms that may appear in our waters due to maritime transport in order to establish protocols of action has become evident.

The development of this tool would be key to analyze quickly and effectively the risk generated by incrustations and ballast water, certain ships from ports at risk and, on the other hand, this tool would give the Capitanía Marítima greater resources for the inspection of ships related to the BWM Convention.



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### **LARGE-SCALE ASSESSMENT OF NON-INDIGENOUS FOULING SPECIES IN MEDITERRANEAN PORTS AND RECREATIONAL BOAT HULLS**

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#### **Abstract:**

This is the first large-scale study addressing the occurrence of non-indigenous species (NIS) on port habitats and recreational boat hulls from the Mediterranean Sea, which is both the global hotspot for marine bioinvasions and a highly-attended destination for boating traffic. We collected fouling invertebrates from 5 commercial harbours and 50 marinas spanning 7 countries from Spain to Turkey, and from about 600 boat hulls, also interviewing their owners.

The surveyed marinas had between 2 and 27 NIS, hence their role as 'hotspots of introduction' is comparable to the role of larger commercial harbours. NIS richness was related to sea surface temperature, number of berths, proximity to Suez Canal, aquaculture sites or commercial harbours, absence of pontoons, biogeographic sector and climate type. Interestingly, 71% of sampled hulls, including those that had recently been cleaned professionally, hosted from 1 to 11 NIS. Boats with high NIS richness strongly correlated to home marinas with high NIS richness. The surveyed boaters travelled considerably (on average, 67 travel days and 7.5 visited marinas per year), showing high potential for spreading NIS.



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### **DNA MTCOI BARCODES FOR BIOSECURITY ANALYSIS. A PROOF OF CONCEPT IN FRENCH POLYNESIA PORTS**

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#### **Abstract:**

DNA barcodes have been proposed for diverse applications based on species identification. One of them that is not fully explored yet is their use for biosecurity. The phylogeographical signals of mtCOI gene have been sometimes used for inferring the number of hits and the origin of biological invasions. Here we will employ mtCOI barcodes of mollusks and acorn barnacles (N=751) from ports of the Windward Islands of French Polynesia to inferring the effect of port size, maritime traffic and degree of openness in the risk of biological invasions. With 17.2% of non-indigenous species, significant differences in diversity were found among berths, and between long-time docked ships and the closest piers. A higher proportion of NIS was found from sheltered than from open ports, regardless their size and traffic. Less frequent wave washing, lower effect of currents and partial isolation in sheltered ports could explain the difference. The results suggest that port biota surveys should focus first on ports sheltered from open sea, and emphasize the value of mtCOI barcodes for early detection of potential invasive species.



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### **MONITORING NON-INDIGENOUS SPECIES IN PORT HABITATS: APPLICATION OF A PROTOCOL OF THE SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER IN THE GULF OF LA SPEZIA (ITALY)**

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#### **Abstract:**

Baseline port monitoring for non-indigenous species (NIS) is an essential tool for studying NIS introduction and spread. A standardized method coordinated within and among countries facing the Mediterranean basin has not been agreed-upon yet. In this context, it is important to test monitoring protocols that allow for the collection of homogenous data, comparable across time and space. Here we test the monitoring protocol developed by the Smithsonian Environmental Research Center (SERC), in a Mediterranean area of high propagule pressure.

The monitoring started in July 2018 in the Gulf of La Spezia (Ligurian Sea, Italy). Fifty PVC plates (14 x 14 cm) were immersed in five sites (a commercial harbour, three different marinas and a site in the proximity of a shellfish farm) and were retrieved in October 2018. The percentage cover of the sessile invertebrate species was assessed with the point count method (n=50 points). A total of 39 taxa were identified, including seven NIS, with one to four NIS for each plate. Furthermore, this method allowed us to observe new NIS arrivals in the Gulf of La Spezia - the bryozoan *Watersipora arcuata*, the sabellids *Branchiomma bairdi* and *Branchiomma luctuosum* and the ascidian *Botrylloides niger* - confirming the efficiency of the SERC protocol in the early detection. Advantages of this standardized method include cost-effectiveness, ease of application and the possibility to obtain quantitative results in a reasonably short time; therefore, it might easily be applied at a broader scale. In order to encourage the employment of this protocol along the Mediterranean coastal areas and to enhance the knowledge of fouling species distribution and identification, an International Summer School entitled "Monitoring marine alien species in ports with the SERC protocol" was organized in September 2019 at the University of Pavia, and will be repeated in 2020



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### **INTRODUCTIONS OF NON-INDIGENOUS MOLLUSC SPECIES ASSOCIATED TO PORTS. INSIGHTS FROM THE ARCHAEOLOGICAL REMAINS OF CASTILLO DE GAUZÓN (NORTH IBERIA)**

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#### **Abstract:**

The ports are hubs of species that are transferred deliberately or inadvertently via maritime traffic. The temporal scale of this type of biotic interchanges may be as old as the history of human navigation. They have contributed to shape the current patterns of human nutrition worldwide. In the field of marine resources, archaeological records close to ports and estuaries may be employed for investigating the occurrence of introduction of new fish and shellfish species of significance for human diet. In this study we did analyze shell remains found from the archaeological site Castillo de Gauzón, located near the maritime port of Avilés (Cantabric Sea, Spain). The species of molluscs consumed along the period between XII and XVI centuries were identified and compared with the species of the same groups that are found in Avilés estuary today. The results illustrate the importance of ports in terms of long-term changes of shellfish resources. This study has been funded from MINECO CGL2016-79209 and the Principality of Asturias Grant IDI-2018-00201



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### **A FUZZY MODEL TO ASSESS MARINAS AT HIGH-RISK OF BIOINVASION IN THE MEDITERRANEAN SEA**

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#### **Abstract:**

Ports and marinas are globally considered hot-spot areas of non-indigenous species (NIS) and should be prioritized for detection and management of NIS. The EU MSFD highlights the importance to achieve baseline data on NIS presence in high-risk areas. In the Mediterranean Sea, monitoring campaigns on NIS are still scattered and not yet standardized, and the implementation of long-term samplings in the numerous ports and marinas teeming the Mediterranean Sea is still difficult to accomplish. In this work we created a model to assess the level of risk of Mediterranean marinas to marine bioinvasion, based on abiotic properties of the marinas. A fuzzy inference system (based on 'if... then' rules) was elaborated on the basis of the results of a correlative analysis performed on data collected from 2012 to 2016 in 50 marinas along the Mediterranean coasts, which had highlighted the variables most responsible of high NIS richness in marinas: number of berths, proximity to the Suez Canal, climate type, proximity to aquaculture activities and to harbours. These variables were set as input of the risk model, whose output is a risk value ranging from 0 to 100. The risk model was optimised by means of a grid search on the weights assigned to the five input variables. The optimal weights were selected to fit the observed values of NIS richness recorded in the 50 marinas of our dataset. This fuzzy model will allow Mediterranean countries to promptly assess which marinas are at high-risk of invasion by collecting just few simple information (abiotic factors proper of each marina), in order to localize the surveillance and focus the survey efforts, as well as management measures, only on selected high-risk marinas.



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### RISK OF INTRODUCTION OF INVASIVE SPECIES IN BALEARES' PORT

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#### **Abstract:**

The Palmas' Port, which is located in Mallorca's island, is the largest of the five maritime ports managed by the Port Authority of Balearic Islands. It is a fishing, commercial and sport port. In addition, it is one of the most important Mediterranean ports in relation to cruise traffic.

The large number of ships, from both the Iberian Peninsula and other countries, which arrive at Palma's Port, shows the risk of invasions of exotic species that could arrive to these archipelago by port traffic.

The objective of this poster is to analyze the risk of introduction of invasive species in the Balears' islands, which could displace the Balearic natural species. Once the traffic statistics of Balears's Port have been revised, we observed that 96% of the ships that land in this port come from other Spanish ports, mainly of the Mediterranean coast. Therefore, potentially invasive alien species must reach the peninsular coast, colonize those areas and from there reach the Balearic Islands. Although there are some many species which have already invade Balears – like *Caulerpa taxifolia* and *Carpobrotus edulis*-, there are other potentially invasive species that have not yet settled in the archipelago, which could be acted upon by taking preventive techniques to prevent their colonization of the Balearic coast. Finally, we propose some alternatives to deal with the problem of maritime invasions: to carry out an exhaustive control of maritime traffic to detect possible risks of biological invasion in time, to carry out information and citizen awareness campaigns and to report the observations of exotic species to specialized agencies in their control.



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### MONITORING MARINE EXOTIC SPECIES IN THE RIA DE VIGO

**Eva Cacabelos, Patrício Ramalhosa, João Canning-Clode, Jesús Troncoso, Celia Olabarria, Jasmine Ferrario, Cristina Delgado, Sergey Dobretsov, Ignacio Gestoso**

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#### **Abstract:**

The introduction of exotic or non-native species (NIS) into the environment through maritime traffic, as ballast water or as encrusting organisms attached to hulls of ships, represent a global problem that can cause ecological and socio-economic impacts on local communities. Monitoring their impact and presence is critical for marine environmental management.

Our goal was to establish a monitoring network of sessile organisms on panels placed in ports and marinas subjected to different maritime pressure, from marine protected areas to high maritime traffic pressure, within the highly urbanized Ría de Vigo (NW Spain). The experimental design consisted of the deployment of a set of ten PVC panels in the diverse ports; half of the panels will be retrieved and replaced every 4 months to get temporal recruitment patterns, and the other half will be continuously maintained in the field to monitor the development of assemblages. Panels will be sampled periodically to identify sessile taxa to the lowest possible level under a binocular microscope. The percentage cover of each taxon and unoccupied substratum per each panel will be assessed by analysing high quality photographs from each panel with the Coral Point Count software. We present here the data obtained after the first sampling events, after 4 and 8 months of panel deployment. Preliminary analysis indicates greater recruitment and biomass of macrofouling species on port subjected to mid maritime pressure i.e. fisheries, recreational boats and short ferry crossing.

The information is needed for the future optimization of standardized surveys for the NIS monitoring and treatment of ships biofouling, targeted towards the improvement of monitoring and forecasting tools to fight against biological invasions, including pilot solutions and potential responses.





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### **CONNECTIVITY OF THE BIG BLUE OCTOPUS (OCTOPUS CYANEA, GRAY 1849) BETWEEN THE EASTERN AND WESTERN COAST OF MADAGASCAR**

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#### **Abstract:**

To avoid overfishing of *Octopus cyanea*, sustainable alternatives must be found. Fishery for the big blue octopus has a great economic value in the coastal communities of Madagascar, therefore finding alternatives that protect the species from extinction but keep supporting the economy are important. This study investigates the genetic connectivity of the big blue octopus *O. cyanea* around the island of Madagascar. Tissue samples were collected at different sites along the western, northern and eastern coast. A fragment of the mitochondrial cytochrome c oxidase subunit 1 (COI) gene was sequenced in 56 individuals from three sites. Based on 590 base pairs of the COI fragment, 21 haplotypes could be identified. Two haplotypes were shared among all sample sites. Population expansion was confirmed through moderate haplotype diversity, low nucleotide diversity and the demographic history analysis. The analysis of molecular variances revealed significant genetic differentiation among populations ( $\phi_{st} = 0.25$ ,  $P \leq 0.01$ ). Restricted gene flow between the eastern and western coast could be a consequence of the complex oceanography in the Western Indian Ocean (WIO).



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### **ENVIRONMENTAL ASSESSMENTS INCLUDING SPECIES INVASIVENESS IN INDUSTRIAL PORTS USING METABARCODING: THE PORT OF GIJON, BAY OF BISCAY, AS A CASE STUDY**

**Ibabe, A., Miralles, L., Carleos, C.E., Soto, V.,  
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#### **Abstract:**

Biological invasions are one of the main factors causing biodiversity losses globally. There is an urgent need of biomonitoring in ports, as maritime traffic is one of the main pathways for marine colonizers. Metabarcoding strategies were tested for the environmental assessment of the port of Gijon by carrying out water and sediment samplings and using Cytochrome oxidase I as genetic barcode. Fourteen Nonindigenous species (NIS) were found, from which five are considered invasive in the area: the red algae *Asparagopsis armata*, *Bonnemaisonia hamifera*, *Dasysiphonia japonica*, *Chrysomenia wrightii* and the bryozoan *Bugula neritina*. Also, a quality assessment was carried out using gAMBI biological index, and a new modified index that considers species invasiveness, Blue-gAMBI, was proposed, showing a slightly disturbed environmental status in the port of Gijon due to the presence of pollution tolerant species and allochthonous species. Metabarcoding showed to be a great tool for an early detection of nonindigenous species and results encourage the use of both, water and sediment samplings for metabarcoding based environmental assessments in ports, as in this study, the 44,7% of detected macroinvertebrate species (employed for biotic index calculations) and a NIS (*Clytia gregaria*) were found only in sediments. Along with this, the consideration of the invasiveness of the present species is something to be taken into account in future studies, since this way, it is possible to obtain a more accurate representation of the true environmental status of an area under study.



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### **ANALYSIS OF MARITIME TRANSPORT INFLUENCE ON ALIEN SPECIES INTRODUCTION IN THE GULF OF GDANSK, BALTIC SEA, POLAND**

**Iga Budzynska**

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#### **Abstract:**

Baltic Sea, due to its special, low-salinity condition is naturally prevented from invasions of many oceanic taxa. However, brackish waters do not prevent all alien species introductions. What is more, due to low salinity, the spreading of already introduced species is faster and easier in the whole basin.

This study is a review of recent invasions in Gulf of Gdansk; which is an economically important region in the South Baltic coast. Many different ways of introduction were analyzed, with a special focus on dredgers and technical vessels. Even though these types of vessels are marginal parts of maritime transport; they may be significant vectors of alien species introduction, as they are involved in work with bottom material in different European locations. It is possible that the introduction of clam *Rangia cuneata* to the Gulf of Gdańsk in 2014, was caused by dredgers, previously working in North Sea harbors. Unfortunately, due to a lack of data, this hypothesis could not be yet confirmed. Further extended research would be beneficent for the conservation of marine biodiversity in the region. Nowadays in Poland, no low or procedures are taking into account the risk of alien species introduction during dredging. To aim ecologically sustainable economic growth, a collaboration between science, low and industry is crucial.



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### **RISK ALGAE IN BALLAST WATER FACING INTERNATIONAL CONVENTIONS. LONGITUDINAL AND TRANSVERSAL ANALYSIS IN EUROPEAN SHIPS EMPLOYING DNA METABARCODING.**

**Alba Ardura, Sara Fernández, Mónica González  
Arenales, José Luis Martínez, Eva Garcia-  
Vazquez**

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#### **Abstract:**

Ballast water is one of the main vectors of transport of nuisance species among marine ports. Although treatment or interchange reduces the risks of containing harmful species, today there is no 100% efficient treatment and understanding what routes encompass a higher risk is important for designing targeted surveillance measures. In this study we have analysed ballast water from seven ships arriving in Gijón port (south Bay of Biscay, Spain) in summer 2017. DNA Metabarcoding was employed for identification of exotic species and harmful algae. One ship carried DNA of 20 risk species inside the ballast water. Three ships contained DNA of only one risk species and for the other three risk species were not detected. The results demonstrate the importance of continuous surveillance of ballast water until new 100% safe methods are applied



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### **NUISANCE SPECIES IN LAKE CONSTANCE PORTS REVEALED THROUGH EDNA**

**Gonzalo Machado-Schiaffino; Laura Clusa**

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#### **Abstract:**

Biological invasions are a global threat to biodiversity especially for aquatic resources. The distribution of alien species is associated with human activities, therefore, exotic species tend to accumulate near big urban areas through different invasion vectors such as ballast water, hull fouling, aquarium and pet releases. The Rhine River region is one of the most important in Europe. Around 60 million people live in the river basin that is connected with other large European rivers via the Rhine–Main–Danube shipping canal. The Alpine Rhine region is the main reservoir for Rhine River, with Lake Constance as the second largest subalpine lake shared by Austria, Germany and Switzerland. Here, eDNA metabarcoding was employed to inventory aquatic species from water samples in six riverine and four lake localities, including two ports, within Lake Constance region. A 313 bp fragment within cytochrome c oxidase subunit I gene (COI) was PCR amplified and sequenced with MiSeq Next-Generation Sequencing (NGS) platform. Seven invertebrate invasive species and the invasive fish *Oncorhynchus mykiss* were detected from eDNA. Species-specific primers were employed to confirm Metabarcoded species. The areas around lake ports concentrated most invasive species, followed by other lake and degraded downstream river areas. Samples taken upstream Lake Constance were free of invertebrate aliens. To establish common regulation and management actions regarding aquatic invasions in the three countries that share Lake Constance is recommended.



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### **RISK ANALYSIS FOR BIOLOGICAL CONTAMINATION BY BALLAST WATER AND BIOFOULING IN THE PORT OF EL MUSEL (GIJÓN)**

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#### **Abstract:**

Marine biological invasions are one of the most dangerous risks for biodiversity worldwide, and this is the basis for a sustainable blue economy in Europe. Ports are one of the main entry gates of exotic biota through ballast water and biofouling on ships. This work has analysed the situation of the Port of El Musel today with the aim of evaluating the risks derived from ballast water and biofouling according to the ports of origin of the ships that arrive at Gijón and the routes followed by them.

The data provided by the Port Authority of Gijón were taken from all the ships that docked at the port of El Musel from January 2004 to October 2017. With them, dynamic graphics were designed to be able to visualize the information in a fast and efficient way. These graphs were used to determine the ports from which the vessels with the highest risk of biological contamination originate. In order to determine the risk generated by each ship, a distinction is made between the possible contamination by ballast water (quantity) and by incrustations (the surface of the ship in contact with the water and the time it remains moored in the port).

As a final result, a GIS map was made in which the results obtained from the investigation were added in each of the ports of origin of the ships that dock in Gijón with the highest risk of biological contamination.



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*Scientific and  
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Approaches to face  
environmental  
problems in port  
areas*



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### **BLUEPORTS: SCIENTIFIC AND EDUCATIONAL STRATEGIES FOR A SUSTAINABLE PORT ACTIVITY FACING BIOLOGICAL INVASIONS (MINECO CGL2016-79209-R)**

**Eduardo Dopico**

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<https://www.uniovi.es/blueports2019/#top>

#### **Abstract:**

Marine biological invasions are today one of the most dangerous risks for biodiversity worldwide, and biodiversity is the basis of blue (marine) sustainable economy. Ports are main entry gates of exotic biota, principally through biofouling and ballast water. Since eradication is more difficult in late than in early invasion stages, new strategies are needed to effective prevention and early detection of nuisance organisms. They should involve not only port stakeholders but the whole society because blue economy is a priority for Europe. From this perspective, researchers and teachers of the Official Research Group ARENA (<http://arena.grupos.uniovi.es/investigacion/proyectos>) and the Grupin-013/Grupin-018 (Department of Functional Biology; Superior School of the Merchant Marine; Department of Education Sciences) of the University of Oviedo, taking the port of Gijón (Asturias-Spain) as a case study, they formed the *Blueports Research Team* with the purpose of:

- ✓ To create a GIS map of biological invasion risks taking as a case study the port of Gijon (Asturias), based on maritime traffic (routes and port calls of ships entering the port), and to validate the map based on biota sampling + Barcoding and on Metabarcoding
- ✓ To evaluate the strategies Metabarcoding versus specific eDNA markers for biota inventory within the ports
- ✓ To evaluate the risks derived from ballast water, depending on ship origin and routes. Based on BW samples from ships docked in Asturias, and validated from biota sampled along transequatorial PS102 cruise
- ✓ To create a social map of interests, knowledge and values around marine biodiversity and biological security of Gijon's citizens, based on a mixed GIS + citizen science approach





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- ✓ To develop a strategy for introducing the concept of blue (as sustainable) port management in educational instances

On this last objective, a campaign of scientific outreach was carried out in 6 Municipal Centers in which 10 participative sessions were scheduled aimed at the population as a whole. Likewise, the blue ports idea and the need to preserve the biodiversity of ports that are within cities, 14 cooperative sessions were held in 11 Educational Centers aimed at 29 groups of students of Primary and Secondary Education stages. The research conducted in *Blueports Project* was approved by the Principality of Asturias Ethics Committee with the ref. 99/16.



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### **ESTABLISHING INFORMATIVE MONITORING BASELINES IN PORTS TO DEAL WITH THE PROBLEM OF BIOLOGICAL INVASIONS**

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#### **Abstract:**

Prevention and early detection of non-indigenous species (NIS) should be the core of current environmental policies in international Ports to deal with the problem of biological invasions. Monitoring surveys in Ports are currently scarce despite the need of setting a baseline of native and exotic biodiversity and also efficient detection systems for pest species before its proliferation and spread. We have conducted a global NIS risk assessment based on revision of all reported introductions in the North Atlantic area via shipping that potentially could be dangerous for the international industrial Port of Gijon 'El Musel', north Spain. Moreover, two consecutive years monitoring surveys of the Gijon port's biota were conducted and different hull ships were sampled. Our results pointed out to 43 expected NIS, which could arrive to Gijon, and 22 native species in Gijon that could travel to other regions via maritime traffic. Port biota and ships biofouling monitoring found 17 species that were considered NIS, invasive or cryptogenic in the Port of Gijon. Only four species coincided when comparing expected and observed scenarios. The actual higher risk of invasion was represented by the bryozoan *Watersipora subtorquata/subatra*, which presence increased from year 2016 to 2017. This work represents a first step to establish a useful species baseline list to be consulted in further periodic NIS risk assessment studies. We proposed this strategy in all international industrial seaports to assess the integrity and health of port ecosystems that could help into moving current ports policies to a real 'Blueports' strategy.



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### TEACHER TRAINING AND BIOLOGY STUDENTS' PERCEPTIONS ON THE INTRODUCTION OF ALIEN SPECIES AND SEAPORTS ROLE

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#### **Abstract**

Nowadays the introduction of alien species represents a major problem worldwide, being seaports and marinas recognized as important hotspots of marine and non-marine alien species. In order to assess university students' previous knowledge about alien species related problems, a survey was carried out addressed to Education and Biology students in Asturias (northern Spain).

Fifty-three species were cited as invasive by students, but each student recognised only a few species (range 0-9). Masters students knew more species than undergraduate of the sampled degrees, and Biology students named more alien species in total). Species that most frequently appeared in the mass-media were the most reported. Few marine alien species were recognized, and seaports were considered as the main introduction *via*. Finally, students' preferences on ways to improve social knowledge on alien species and their perceptions of the relative importance in different formal educational stages are shown.

**Keywords:** Non-Indigenous Species; seaports; teacher training; Biology students, Environmental Education.

#### **Introduction**

Nowadays the introduction of alien or exotic species represents a major problem worldwide (Pyšek & Richardson, 2010; Butchart *et al.*, 2010; Early *et al.*, 2016), including marine ecosystems (Anton *et al.*, 2019). In this context, seaports and marinas are recognized as hotspots of marine and non-marine alien species, being mainly spread by ships (e.g., Ardura *et al.*, 2015; Miralles *et al.*, 2016a; Seebens *et al.*, 2016).

Education programmes on biological invasions constitute a keystone to raise awareness among citizens about the harmful consequences of Non-Indigenous-Species (NIS), through formal and non-formal environmental education (Pérez-Bedmar & Sanz-Pérez,



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2003; Ramírez-Gutiérrez *et al.*, 2018). In this context, assessing the perceptions of future teachers is of great interest to implement possible educational programmes (Fiebelkorn & Menzel, 2013; Liu *et al.*, 2015; Waliczek *et al.*, 2017).

With the aim to assess university students' previous knowledge about alien species problems a survey was conducted at the University of Oviedo addressed to undergraduate students in Biology and Childhood and Elementary Education, and to Master students.

### Material and method

Perceptions on alien species, their introduction pathways, role of seaports and social knowledge needs on non-indigenous-species were surveyed among undergraduate students of Degrees in Early Childhood Education (ECE), Primary Education Teaching (PET), and Biology (B), and Master Degree in Research and Innovation in Early Childhood and Primary Education (MRIECPE) of the University of Oviedo. These degrees have been chosen since their graduates should be able to transmit to the Society the identity and environmental problems associated with NIS that develop into invasive species. Previous wildlife knowledge and educational needs that students considered to face their professional career have been assessed (Torralba-Burrial *et al.*, 2018).

An online survey with 20 questions was designed using Google Forms. A total of 75 items were included (using a five-level Likert scale when appropriate): 6 questions to classify the respondent profile, 2 open questions to explore the exotic species recognized by students, 1 to evaluate their perceptions on the impacts of NIS on marine ecosystems, 6 to assess their knowledge about NIS introduction ways, 1 specifically addressed to the role played by seaports and 4 questions on their self-perception about exotic species and ways for increasing social knowledge about NIS.

A total of 152 students answered the survey, balanced between Education and Biology students, most of them living in coastal or near coastal localities (fig. 1). Answers were analysed with Google sheets and the Rcmdr Package v2.6-1 for the statistical Software R v3.6.2.



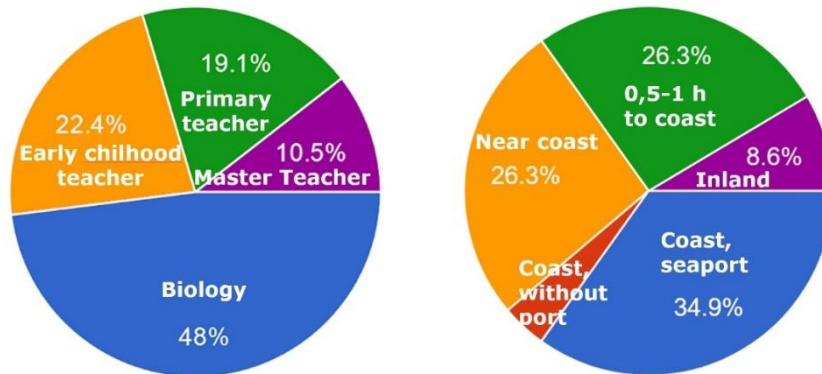
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**Fig. 1.** Students Degree / Master Program of the survey respondents, and their residence according to sea distance and seaport facilities.

## Results

A total of fifty-three species were cited as invasive by students (Table 1), being Biology students the ones who were able to identify a greater number of species (31, versus 20 early childhood future teachers and master students, and 18 primary future teachers students). However, the number of alien species recognized by each student was low and highly variable (range 0-9), with ECE students with the lower mean (1.7) and Education master students with the highest values (3.4) (Fig. 2). Significant differences were found between Education master students and undergraduate students of the three degrees: Biology (Tukey Contrasts 2.841,  $p$ -value<0.05), PET (Tukey 2.883,  $p$ -value<0.05) and ECE (Tukey 3.476,  $p$ -value<0.01).



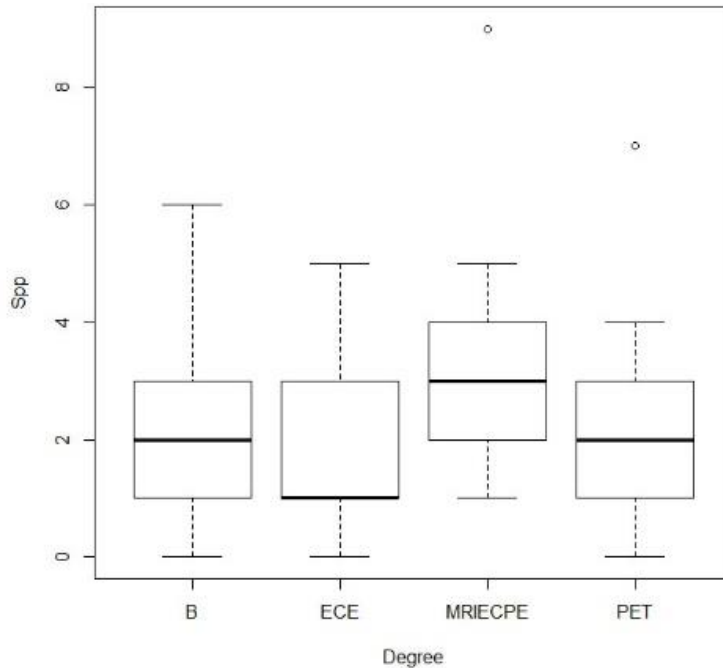
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**Fig. 2.** Number of invasive species cited by students, according with the Degree that they are student: B = Biology; ECE = Early Childhood Education; MRIECE = Master Education; PET = Primary Education Teaching.

The two species most frequently cited as invasive corresponded to the two most frequently appearing in the regional mass-media: the Asian wasp and the pampas grass. Marine alien species recognized were very scarce, belonging to the group of algae, sea stars or bivalve molluscs. By contrast, freshwater and terrestrial species were more frequently recorded (Table 1).

**Table 1.** Percentage of answers of students that cited each species as invasive. H = Habitat of alien species: F=freshwater, M=Marine, T=Terrestrial. Degree: B=Biology; ECE=Early Childhood Education; MRIECE=Master Education; PET=Primary Education Teaching. \*autochthonous species perceived as invasive by students. \*\*Exotic species not present in Spain.

Species	Common name	H	Students 'degree				Total
			B	ECE	PET	MRIECE	
<i>Vespa velutina</i>	Asian wasp	T	62	88	68	87	72
<i>Cortadella seoana</i>	Pampas grass	T	47	12	50	53	40
<i>Procambarus clarkii</i>	Red swamp crayfish	F	30	15	21	33	25
<i>Eucalyptus</i> spp.	Eucalypts	T	29	3	32	13	22
<i>Dreissena polymorpha</i>	Zebra mussel	F	26	6	7	13	16
<i>Coscinasterias tenuispina</i>	Blue spiny starfish	M	14				6
<i>Rattus</i> spp.	Rats	T		15		27	6
<i>Trachemys scripta</i>	Red-eared slider	F	5	12		13	6



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Species	Common name	Students 'degree					Total
		H	B	ECE	PET	MRIECPE	
<i>Aedes albopictus</i>	Tiger mosquito	F	5	3	7	7	5
<i>Gambusia affinis</i>	Western mosquitofish	F	11				5
Algae	Algae	M	2	9		7	4
<i>Columba spp.*</i>	Pigeon	T	3	3		7	3
<i>Sus scrofa</i>	Vietnamese pot-bellied pigs	T			11	7	3
<i>Sus scrofa*</i>	Wildpigs	T	2	9			3
<i>Acacia dealbata</i>	Silver wattle	T	3		4	7	3
<i>Cyprinus carpio</i>	Common carp	F			4	13	2
<i>Procyon lotor</i>	Raccoon	T		3		13	2
<i>Carpobrotus spp.</i>	Pigface	T	2	3	4		2
<i>Poecilia reticulata</i>	Guppy	F	5				2
<i>Myiopsitta monachus</i>	Monk parakeet	T	2	6			2
<i>Rugulopterix okamurae</i>	Asian algae	M		6			1
Blattodea (no Isoptera)	Cockroaches	T	2	3			1
<i>Sturnus spp.</i>	Starling	T	3				1
<i>Cydalima perspectalis</i>	Box tree moth	T				13	1
Pythonidae	Pythons	T	2		4		1
<i>Pacifastacus leniusculus</i>	Signal crayfish	F	2				1
<i>Buddleja davidii</i>	Summer lilac	T				7	1
<i>Reynoutria japonica</i>	Japanese knotweed	T				7	1
<i>Oenothera spp.</i>	Evening primrose	T				7	1
<i>Xenostrobus securis</i>	Small brown mussel	M		3			1
Isoptera	Termites	T		3			1
<i>Thaumetopoea spp.*</i>	Processionary moths	T	3				1
<i>Quercus suber*</i>	Cork oak	T			4		1
<i>Physalia physalis *</i>	Portuguese man o'war	M		3			1
<i>Patella spp.*</i>	Limpets	M				7	1
<i>Crassostrea gigas</i>	Japanese oyster	M	2				1
<i>Cygnus atratus</i>	Black swan	F	2				1
<i>Rhynchophorus ferrugineus</i>	Red palm weevil	T			4		1
<i>Tecia solanivora</i>	Guatemalan potato moth	T			4		1
<i>Pangasianodon hypophthalmus**</i>	Iridescent shark	F			4		1
<i>Cryphonectria parasitica</i>	Chestnut blight	T				7	1
<i>Callinectes sapidus</i>	Atlantic Blue Crab	M			4		1
<i>Cervus elaphus*</i>	Red deer	T	2				1



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Species	Common name	Students 'degree					Total
		H	B	ECE	PET	MRIECPE	
<i>Agave americana</i>	American aloe	T			4		1
<i>Lithobates catesbeianus</i>	American bullfrog	F		3			1
Simuliidae*	Blackfly	F			4		1
<i>Microtus arvalis</i> *	Common vole	T	2				1
<i>Arctotheca calendula</i>	Cape marigold	T	2				1
<i>Neovison vison</i>	American mink	F	2				1
<i>Oncorhynchus mykiss</i>	Rainbow trout	F	2				1
<i>Paulownia tomentosa</i>	Empress tree	T	2				1
<i>Linepithema humile</i>	Argentine ant	T	2				1
<i>Silurus glanis</i>	Wels catfish	F	2				1

Most students considered that exotic species cause high or strong impacts on marine ecosystems, although the number of students that considered their impact higher than garbage, microplastics, spills (industrial and urban) and/or climate change were clearly lower, and slightly lower than overfishing and coastal urbanization.

Seaports were considered as the main introduction *via* of marine alien species, and their importance as a pathway was considered equally high for terrestrial species (lower in the case of freshwater species) (Fig. 3).





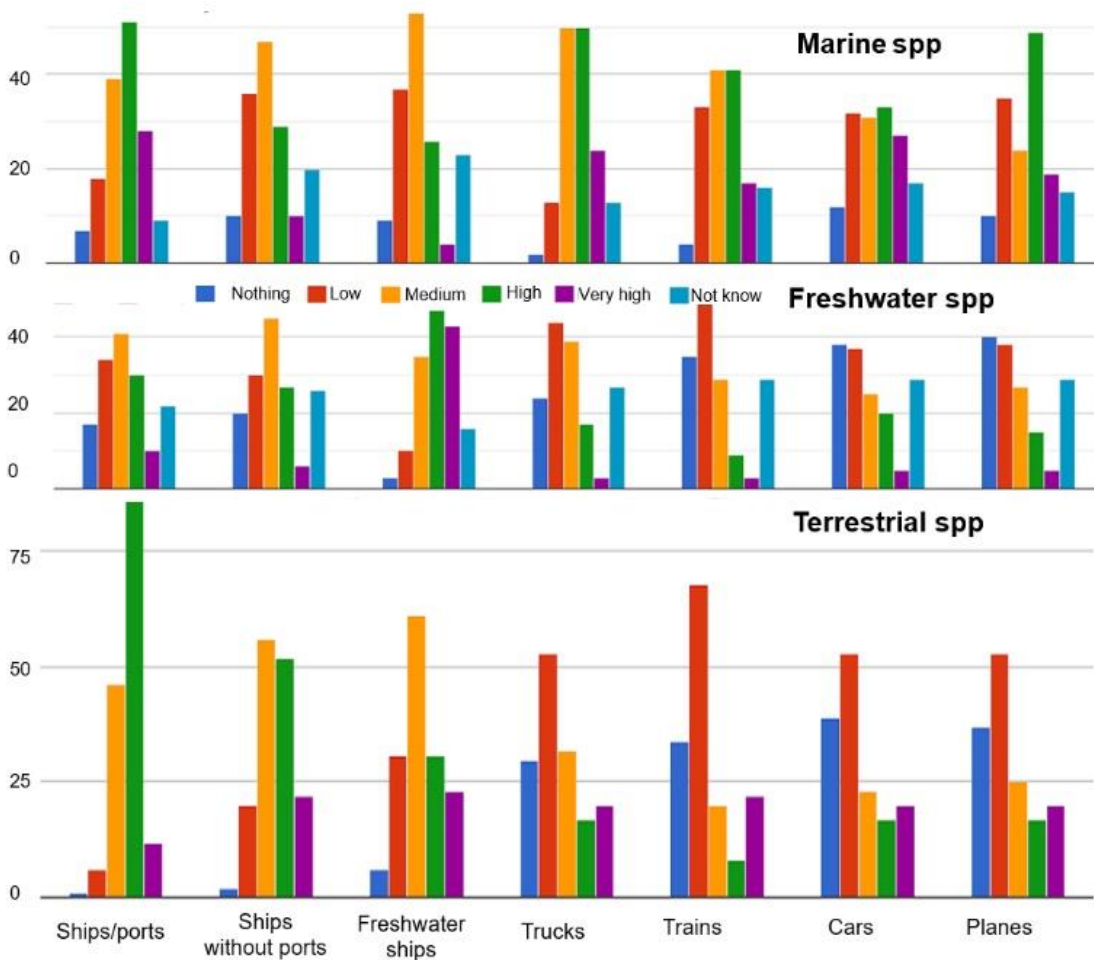
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**Fig. 3.** Students' perceptions on way of transport importance in introduction of marine, freshwater and terrestrial alien species.

The role of seaports in the alien species introduction process was considered quite important for algae and fungi, but less important in case of animal or plant alien spreading (Fig. 4).



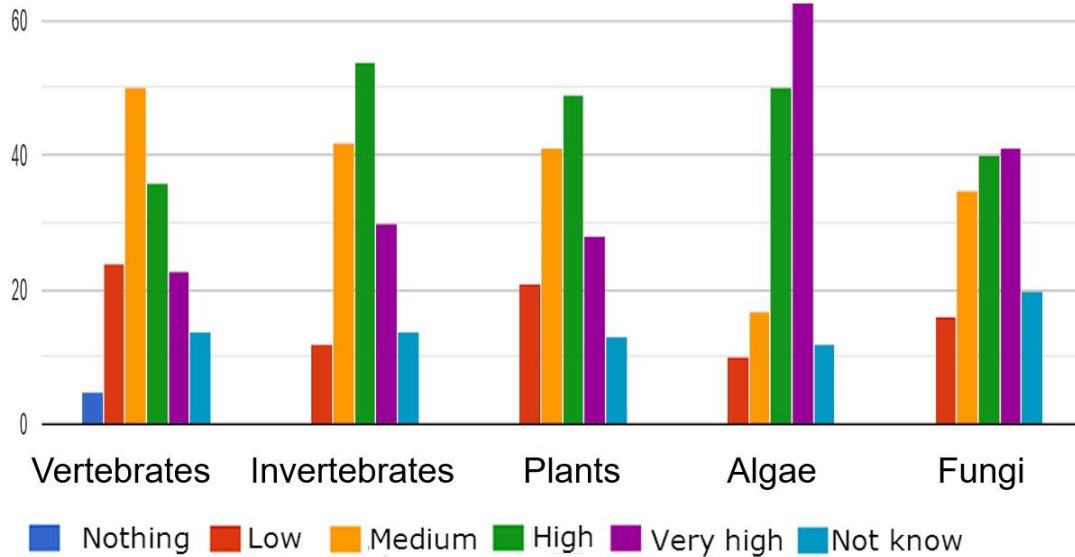
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**Fig. 4.** Students' perceptions on seaports role in the process of species introduction according to taxonomic groups.

Most university students reckoned that their knowledge about alien species and their introductory pathways is scarce or low, while more than 80% considered necessary to increase social knowledge about invasive species and their impacts. Informal education, mainly documentaries, environmental volunteering and mass-media were recognized as the main ways to improve social knowledge, followed by other types of non-formal education (Fig. 5).



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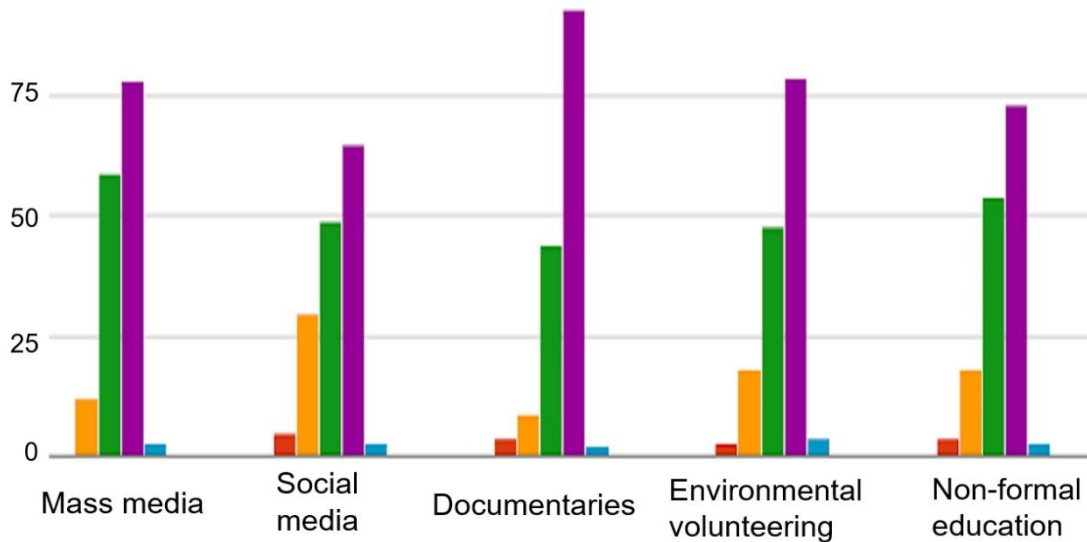


Fig. 5. Students preferred ways to improve social knowledge on alien species and their pathways.

Regarding the importance of the educational stage in formal education to improve knowledge on alien related-problems, students considered very important for enhance social knowledge according with their chronological sequence (early child education <primary school <secondary school <university)

### Discussion

Although 53 alien species appeared in total the survey, individually, students named only a few of them. Not surprisingly, master students remember more species than undergraduate students. Most students considered that their knowledge on alien species was scarce or low, showing needs for improving social knowledge on alien species and their impacts. Students knowledge on alien marine species was lower than regarding freshwater or terrestrial species, (although most of them lived by the coast or near coastal localities). However, students were concerned about problems caused by alien species on (marine) ecosystems, coherent with other surveys addressed to in-service early childhood teachers in Asturias(Sgura & Torralba-Burrial, 2019).

Future teachers and Biology students perceptions on ways to improve social knowledge on marine alien species were coherent among groups, including non-formal and formal education activities on invasive species (e.g., Colleton *et al.*, 2016; Waliczek *et al.*, 2018; Arias Rodríguez *et al.*, 2018) in different education stages, according to its chronological sequence.



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Mass-media, documentaries and environmental volunteering were chosen to complement formal education and to reach other population sectors. Nevertheless, the role of mass-media was only partially perceived as important by students. environmental volunteering, what could be integrated in citizen science programmes, is highlighted as a powerful way to improve knowledge and thus enhance social concerns on marine NIS (e.g., Crall *et al.*, 2013; Martin *et al.*, 2016; Miralles *et al.*, 2016b).

### Conclusions

- 1/ Individual students named only a few alien species (range 0-9), but 53 were cited in total in the whole survey.
- 2/ Alien terrestrial species were more cited than marine species, and species more frequently cited in local mass-media were included in most of answers.
- 3/ Most of the students considered that exotic species cause high or strong impacts on marine ecosystems.
- 4/ Seaports were considered as the main introduction *via* of marine alien species, also playing an important role in terrestrial species.
- 5/ Documentaries, environmental volunteering and mass-media were recognized as the best ways to improve social knowledge about NIS.
- 6/ Students considered activities about alien species as a need in formal education to enhance social knowledge, considering their relative importance increasing with the chronological sequence.

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### **PLASTIC AND TEXTILE MARINE LITTER AS RESERVOIRS FOR SECONDARY SPECIES DISPERSAL FROM PORTS**

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#### **Abstract:**

Marine debris is nowadays an important source of environmental and economic problems. Floating litter can be employed by marine organisms as a surface to attach and use as spreading vector. In this way, human activities are promoting expansions of potentially harmful species into novel ecosystems, putting in danger the autochthonous communities. In this project, more than 1,000 litter items were collected and classified from five beaches eastwards the port of Gijon, in Asturias, Spain. Next generation sequencing was employed to study the communities occurring in biofilm attached to items of different materials. A dominance of DNA from Florideophyceans, Dinophyceans and Arthropods was found, and four non-indigenous species were identified. Results showed a clear preference of Florideophyceans and Bryozoans to attach on textile surfaces versus plastic ones. Considering that these taxa contain several highly invasive species described to date, these data emphasize the potential of textile marine debris as a vector for dispersal of alien species. Moreover, the litter macrofauna profile was more similar with port's macrofauna in closer beaches than in farther ones, confirming that both plastic and textile marine litter can be a vector for species dispersal from ports.



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### **IMPLICATION OF PORTS AND MARINE TRAFFIC IN THE CONCENTRATION OF MICROPLASTICS IN OCEAN WATERS**

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#### **Abstract:**

Microplastics are a burden in the ocean. Of terrestrial origin in their majority, they are associated to oceanic gyres and may accumulate in enormous patches ("garbage patches"), where more than 90% of the objects are microplastics. The North Atlantic garbage patch contains a debris zone that shifts by thousands of kilometers north and south seasonally and gets periodically close to Spanish coasts. The origin of ocean microplastics being mainly from land, river plumes have been identified as main emitters. The role of anthropogenic facilities located inside estuaries, such as ports and their associated marine traffic, in ocean microplastics distribution is still largely unknown. In this study we have quantified microplastics from south Bay of Biscay offshore waters at different distances from commercial ports and zones with different marine traffic density. The effect of ports and ship traffic in the distribution of microplastics offshore has been inferred taking into account dominant currents and seasonality. The results are important for identifying offshore accumulation zones that may endanger fishing resources and represent shelters for exotic and invasive biota





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### **TOOL TO DETERMINE THE BIOLOGICAL CONTAMINATION BY BALLAST WATER AND FOULING IN THE PORT OF GIJÓN**

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#### **Abstract:**

Following the implementation of new global policies and the implementation of various international conventions, such as ballast water management, the care of seas and oceans has become a priority in many countries. In this research work, a tool was created that facilitates the analysis of the biological contamination by ballast water or fouling in the ports where it is installed.

Firstly, the risk of contamination by ballast water and fouling is determined in each of the quays of the port analysed, in this case in the Port of Gijón. Based on the risk and taking into account the origin of the possible species (depending on the route of the ship to be studied) and its method of transport (ballast water or fouling) it determines which are the possible invasive species. To accomplish this there were used biological databases in which researchers introduce the invasive species found. Once the possible invasive species in each of the piers were determined, these results were compared with those obtained by the biologists when analyzing samples collected in the berths of the Port of Gijón (of water, sediments, invertebrates and algae).

In order to present the results as visually as possible, in a GIS map, routes are made from the ports that pollute the most and in each one of the quays of the port analysed, the results obtained over this area are inserted. (PDF of the risk, possible invasive species based on traffic and invasive species already detected in the analysis).



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### DEVELOPMENT AND VALIDATION OF EDNA MARKERS FOR THE DETECTION OF CREPIDULA FORNICATA IN ENVIRONMENTAL SAMPLES

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#### **Abstract:**

*Crepidula fornicata* is a gastropod native to the northwest Atlantic that has emerged as an invader since its introduction along Europe's Atlantic coast and has caused major problems, especially in France and the Netherlands, where high densities cause habitat changes, disturb native marine fauna and lead to competition for space and food. Despite its invasive nature, there is still no regular monitoring to warn of its presence in areas at risk, such as the southern Bay of Biscay. In this work, a specific marker for this species has been developed to detect the presence of *C. fornicata* in environmental samples (eDNA) of seawater. New specific primers for *C. fornicata* amplified a region of 239 bp within the COI gene. This tool has been used to test the presence of this invasive species in 5 estuaries on the northern coast of Spain and 1 in France. The presence of *C. fornicata* was confirmed in the estuaries of A Coruña (Galicia, Spain), Eo and Villaviciosa (Asturias, Spain), while it was not detected in Santander, Bilbao (Spain) and Bayonne (France). This new method to detect *C. fornicata* could easily be implemented in regular monitoring to prevent and manage future invasions of this species.



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### **MARITIME PORTS AS SOURCES OF MACRO AND MICROPLASTIC POLLUTION IN SANDY BEACHES. A CASE STUDY IN CENTRAL BAY OF BISCAY**

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#### **Abstract:**

The enormous quantity of plastic debris is today one of the main problems for the conservation of ocean living resources. Ports are known sources of cumulative pollutants like heavy metals, polycyclic aromatic hydrocarbons and others, that tend to accumulate in neighbouring beaches carried by the currents. However, the role of ports as exporters of plastics to the surroundings has been much less studied. Moreover, the types and size of plastics that are more frequently emitted from the ports, especially microplastics, have not been identified yet. In this study the following departure hypotheses have been challenged: i) the beaches adjacent to maritime ports will contain more plastic debris than farther beaches; ii) macro and microplastic pollution may be correlated. The central Bay of Biscay coast has been analysed as a case study quantifying macro and microplastics from beaches located at different distances from commercial and fishing ports. Since the species attached to plastic fragments can be predicted from the plastic types, the profile of invasive species expected to disperse from ports using plastics as secondary vectors has been inferred based on the plastics found.



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### FISH IN PORTS: MISLABELLING AT LANDINGS

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#### **Abstract:**

For ensuring sustainability under BLUE GROWTH strategy of environmental ports, life cycle assessment should include all the activities carried out in the ports. In fishing ports, mislabelling of catch represents a threat for ecological sustainability of substituted species. In the last decades, mislabelling has been reported in different commercial fish along the supply chain (e.g. up to 30% found in markets). However, not many studies have focused on potential mislabelling at port arrival. Correct identification at landings is crucial for stock assessments, since mislabelling might originate an unbalanced exploitation, leaving species over- and misrepresented.

In this case study, we discuss the use of different molecular tools (e.g. COI, control region) to detect the proportion and direction of mislabelling at landings in black hakes (*Merluccius polli* and *Merluccius senegalensis*). A comparison of levels of misidentification along the full supply chain (i.e. starting at the landings) may reveal key points where mislabelling takes place.

To our knowledge, while mislabelling between other overlapping hake species (e.g. *Merluccius capensis* and *M. paradoxus*) has been extensively reported, there are no studies on mislabelling between black hake.



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### **SOCIAL PERCEPTION AND PUBLIC UNDERSTANDING OF SCIENCE IN ADULTS ENROLLED IN *BLUEPORTS* PROJECT SCIENTIFIC OUTREACH**

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#### **Abstract**

A positive image of science is enhanced by a better understanding of science. It also implies a higher scientific literacy level. Not only does scientific outreach play an important role in social contexts, but also all elements involved on it: researchers, governments or even public. *Blueports* project has developed a scientific outreach program in six cultural centers of the city of Gijón. University of Oviedo and Port Authority of Gijón experts were in charge of the sessions offered. The aim of this research was to assess the social perception and public understanding of science in the Asturian region. To verify that an easy-going questionnaire consisted of six items was designed. Each one was measured with a five Likert scale and analysed with descriptive statistics. It was applied on a non-probabilistic and convenience sample formed by 73 participants. On the whole, people enrolled in this scientific outreach program are highly concerned about the main role that science plays on nowadays society development and feel that government is not committed to enough. In this way, scientists, educators and experts are responsible for strengthening science-society relationships.

**Keywords:** science literacy; science outreach; blue ports.

#### **Introduction**

According to the Royal Society (1985) a better understanding of science not only does enrich a responsible citizenship, but it also enhances society awareness regarding science to make conscious decisions in their lives. Consequently, scientific literacy has individual, social, economic and even cultural benefits.

Public understanding of science entails a wide range of strategies focused on bringing science and society together. To better understand this relationship it is important to know attitudes, opinions, behaviors and activities of society regarding science (Bauer, 2008). Demoscopic scientific research, as those carried out by the Spanish Foundation



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for Science and Technology (FECYT), are key to enhance culture and scientific literacy in our social context.

Belonging to nowadays society implies the need for a certain scientific literacy. In other words, citizens must have scientific knowledge to be able to use it to solve different issues or even reach their own objectives (Pardo, 2014). However, according to Shen's definition (1975) scientific literacy does not require how to be previously literate.

Scientific outreach is part of informal educational strategies (Bonney, Phillips, Ballard and Enck, 2016) and also of scientific and cultural literacy. Furthermore, promoting scientific outreach is crucial for a better understanding of science. In this way, scientific experts play such important roles as the public itself involved in scientific activities. However, meet the demands of society's scientific culture depends on how much scientists are willing to be involved in scientific communication (Cortassa and Polino, 2015).

*Blueports* project experts have been committed to whole society and, in particular, to Asturian one, to enhance knowledge and awareness concerned to invasions by marine non-indigenous species (NIS). El Musel port and the citizens of Gijón have been the target of the scientific outreach program of this project. Through scientific outreach sessions open to the active participation of the population, scientists and citizens were able to share a common space of knowledge and commitment to the marine environment.

### **Objectives and hypothesis**

The aim of this research was to assess the social perception and public understanding of science in the Asturian region. In particular, it focused on the city of Gijón taken as a case study for the development of the *Blueports* project (MINECO CGL2016-79209-R).

In this sense, was designed a questionnaire to model this. We wanted to verify if among the participants in the science outreach sessions, the fact of obtaining a high score in the questionnaire could be related to a better perception and understanding of science.

### **Methodology**

The scientific outreach strategy of the *Blueports* project consisted of ten talks taught by eight members belonging to the two institutions involved: University of Oviedo and Port Authority of Gijón. The majority of them were researchers from scientific disciplines such as biology, civil marine and education that were conducting research in the marine environment.

These sessions of scientific talks were carried out in the cultural centres scattered around the city of Gijón with the aim of reaching the entire population. The city council was involved in the dissemination of these activities and supported the *Blueports* project from



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the beginning. It provided appropriate facilities in six of the cultural centres located in the main neighborhoods of the city. The following table (table 1) shows the arrangement of these scientific outreach activities.

Table 1. Chronological and spatial arrangement of the scientific outreach sessions of *Blueports*.

Date	Cultural Centre	Talk	Researcher
25/10/2017	'L'Arena'	He came in a boat. Noah's ark.	Eva García
08/11/2017	'Antiguo Instituto Jovellanos'	The use of DNA for the early detection of invasive species.	Alba Ardura
29/11/2017	'Ateneo de La Calzada'	Analysis of risks of biological contamination by ballast water and scale in the hull of ships arriving in Gijón.	Horacio Javier Montes
17/01/2018	'El Llano'	Ballast water from ships: solutions to prevent biological pollution.	José Manuel Cuetos
07/02/2018	'El Coto'	Fuel spills: measures to take to prevent contamination.	Marlene Bartolomé
28/02/2018	'El Llano'	Citizen science strategies in Gijón.	Eduardo Dopico
14/03/2018	'Pumarín Gijón-Sur'	Strategies to avoid emergencies in the port of Gijón.	Pablo Crabiffosse
04/04/2018	'Antiguo Instituto Jovellanos'	Marine stowaways in the port of Gijón.	Yaisel Juan Borrel
25/04/2018	'Ateneo de La Calzada'	Citizens turned into scientists: development of a citizen science program for local biodiversity conservation.	Alba Ardura
09/05/2018	'Antiguo Instituto Jovellanos'	Environmental education, starting at home.	Eduardo Dopico

Citizens interested in science and related issues were expected to attend these talks and could actively participate in the scientific proposals. Our initial idea was that all of them would be part of the research sample on scientific knowledge and interest in science. Finally we opted for a non-probabilistic sampling, in particular, a convenience one, since selected individuals were the most accessible and suitable for this investigation (McMillan and Schumacher, 2005).



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To consider from a sociocultural framework the social perception and public understanding of science of this sample, a questionnaire was designed with the following items (Table 2):

Table 2. Coding of questionnaire items.

<b>Item 1</b>	Science is part of my daily life.
<b>Item 2</b>	I participate in scientific activities.
<b>Item 3</b>	The current scientific outreach is enough.
<b>Item 4</b>	This scientific outreach session has improved my knowledge.
<b>Item 5</b>	Society development is impossible without scientific advances.
<b>Item 6</b>	Government investment in science is not enough.

Each item was measured with a five-level Likert scale, where score 1 corresponded to totally disagree and 5 to totally agree. As is appropriate, additional option corresponding to not responding or not understanding was included. On the one hand, this questionnaire was applied to the sample mentioned before. On the other hand, data collected were analyzed with descriptive statistics, such as the mean of central tendency and standards deviations of variability (Boone and Boone, 2012).

### Results and discussion

The total number of questionnaires completed during scientific outreach sessions was 73. Regarding the personal characteristics, the sample was gender-balanced: 53.4% men and 46.6% women. However, age range of the sample was significantly biased towards the group of people over 60 year of age, with the highest percentage (47.9%). The two other categories, people under 30 and people between 30 and 60 years old, corresponded to 15.1% and 37% respectively. The same happened with the academic level. The sample was significantly biased again towards 'higher' studies category (59%) whereas 'primary' education (8.2%) and 'secondary' education (32.8%) showed a lower rate (Table 3).





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Table 3. Sample characterization.

Gender		Age range			Academic level		
Man	Women	<30	30-60	>60	Primary	Secondary	Higher
53.4	46.6	15.1	37	47.9	8.2	32.8	59

First of all, gender categories were balanced unlike others as will be shown below. Therefore, results provided will be quite reliable in this case (figure 1). Both men and women highly agree with item 5 (4.32 and 4.59 respectively). However, this item has the lowest standard deviation value in men (0.96) and it means male respondents valued in the same way this statement. In addition, this two gender categories disagree the most with item 3 (men get a score of 2.61 and women 2.12).

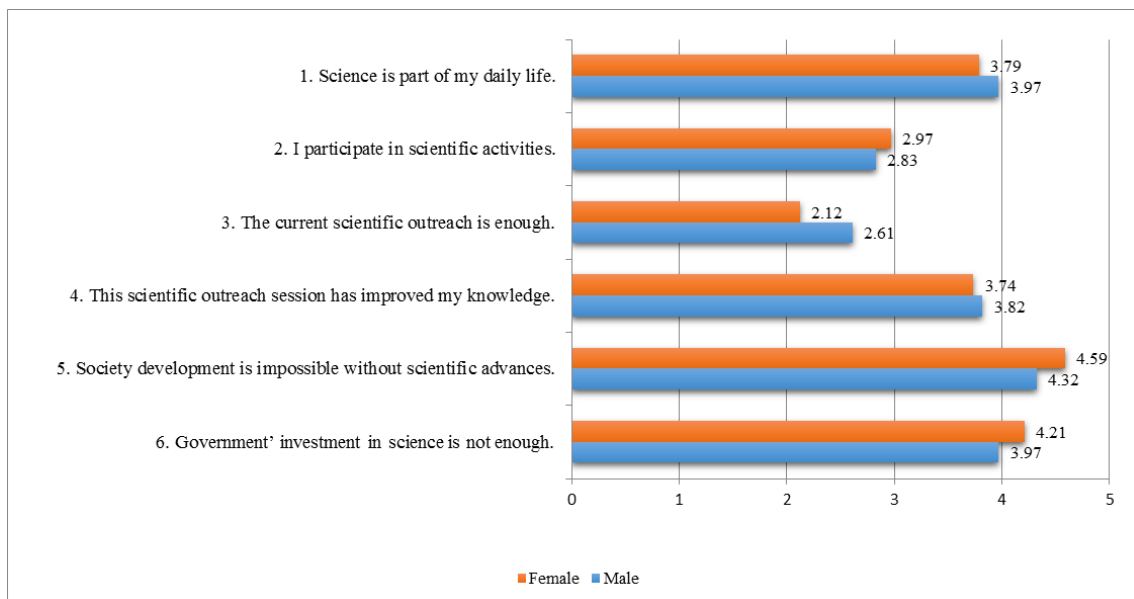


Figure 1. Questionnaire results according gender.

The following figures (figure 2 and 3) show three categories respectively but they are not as balanced as in the previous case. Despite the fact that results could be biased towards the oldest group participants, under 30 presents the highest value for item 4 (4.36) and the lowest value for item 2 (2.10). According to Spanish Foundation for Science and Technology (FECYT) latest report published in 2018, the lower age and academic level, the higher participating in scientific outreach programs. It seems that this under 30 group



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also demand more investments in science (item 6 has been the second best valued) and its scientific outreach associated. In this way it is likely to there would be higher values on item 2 in this category.

The results of participants between 30 and 60 years old and those over 60 years old are the same as the previous case (the highest punctuation is reached by item 5-4.52 and 4.59 respectively- and the lowest by item 3-1.96 and 2.12). It stands out item 5 standard deviation for '30-60' category (0.70) which is the lowest of all results explained here.

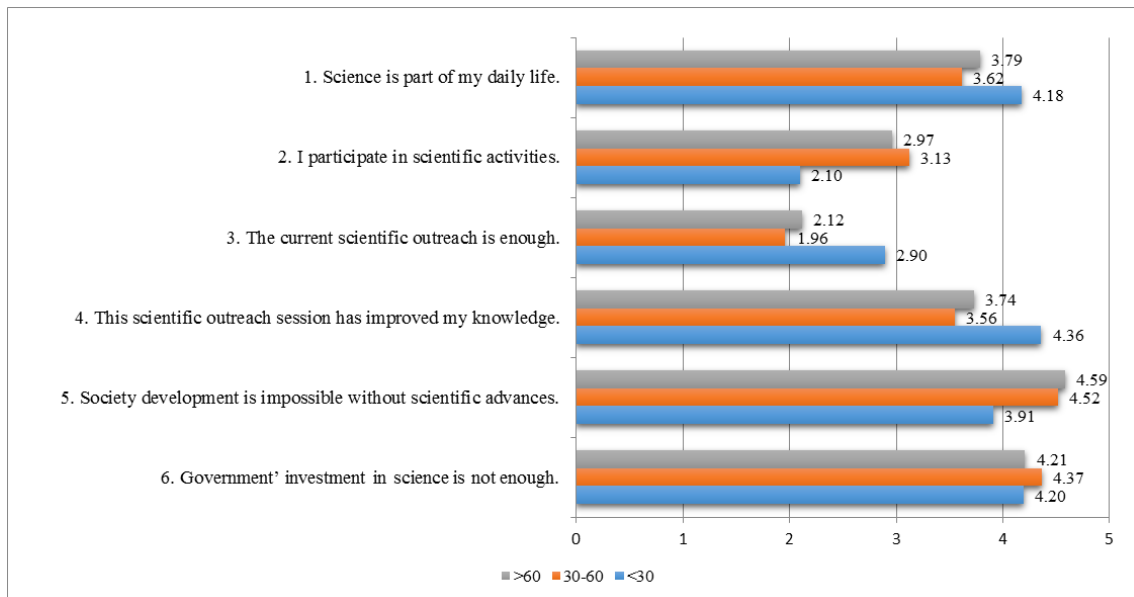


Figure 2. Questionnaire results according age.

Despite the fact that the size of academic level groups is highly different, it does not imply significant differences. As in gender case and almost all previous age categories, item 5 reaches the highest punctuation (4.00, 4.52 and 4.47 respectively). According to López and Cámara (2009) and Laspra (2018), the highest academic level of respondents, the more benefits of science they considered. On the other hand, item 3 is the lowest (2.17, 2.48 and 2.36).

Besides, in this case stands out the highest standard deviation corresponding to item 6 in 'primary' education category. In other words, the few individuals who belong to this group gave highly different punctuations.



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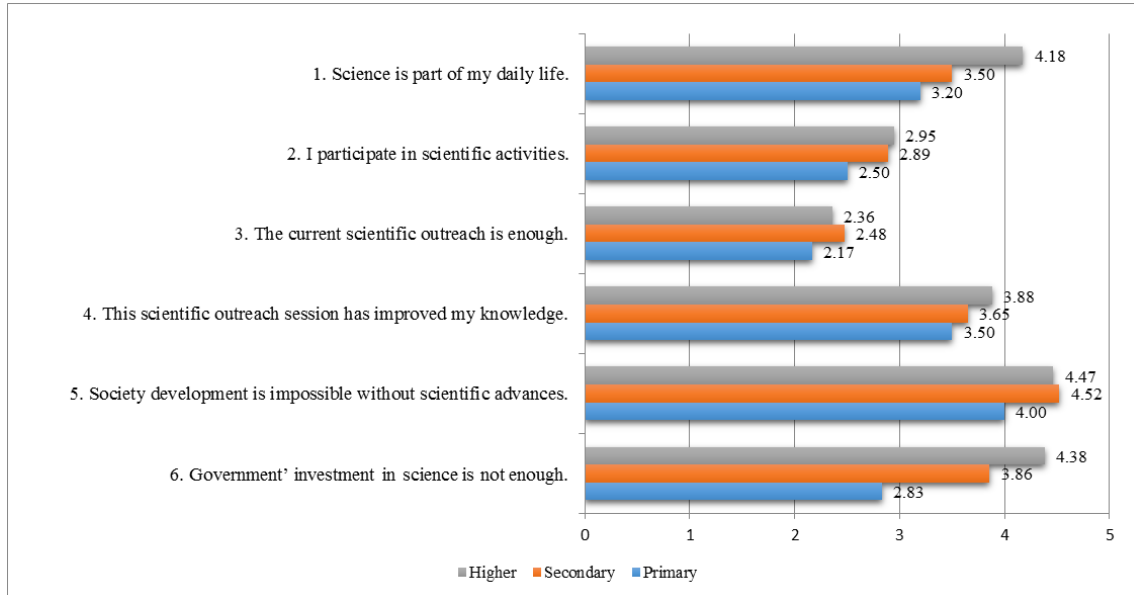


Figure 3. Questionnaire results according academic level.

Finally, in a global presentation of the results (figure 4), it can be seen that the highest punctuation corresponds to item 5 (4.44). This item also shows the lowest standard deviation (0.96). It seems that local population, or at least people enrolled in *Blueports* scientific talk sessions, is aware about the importance of scientific advances.

On the other hand, item 3 (2.38) and item 2 (2.90) correspond to the lowest punctuation in this set of items. Scientific literacy could influence social scientific participation directly (Muñoz, 2017). The results from this questionnaire show that, citizens interested in science, demand more scientific outreach activities to take part in them. And they also blame on the government for insufficient investments in science (item 6, the second best valued-4.09) and consequently, in the lack of financing of scientific outreach programs associated to researches.



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## International Workshop BluePorts 2019

From Ports to BluePorts. Is it possible?



Gijón, 05<sup>th</sup> December 2019

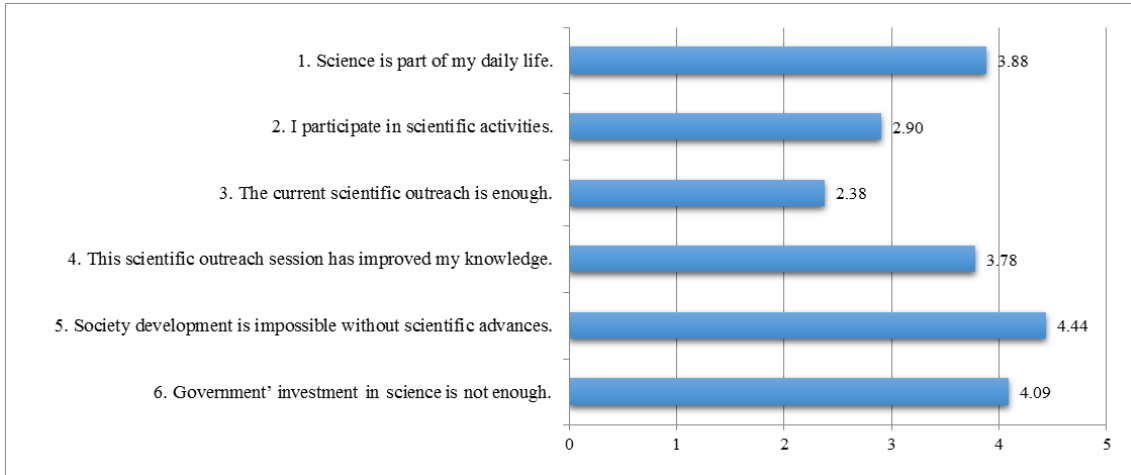


Figure 4. Total questionnaire results.

### Conclusions and proposals

We have been able to confirm that adults enrolled in the activities of scientific outreach promoted within the *Blueports* project have a positive image of science. It is important for them in a wide range of aspects of their daily lives. However, they do not participate as much as they would like in scientific activities. Is it due to the lack of government commitments regarding science? They blame on the governments, since believe that investments in science are not enough and it has negative consequences for our country and for the scientific literacy of its citizens.

Due to the uncertainty regarding government investments, scientists, educators and experts should do their best on this issue. On the one hand, researchers must be involved in scientific communication so that citizens change their minds. Despite positive results collected in this research, people who did not attend could be afraid of science as they feel so far away from scientists and their research. Better scientific communication strategies will attract and improve science-society relationships.

On the other hand, citizenship must be enrolled in more science activities. Not only should they demand this type of informal educational strategies from public administrations, they can also demand them from local research teams. For instance, citizen science programs are one of the most popular strategies to enhance society reliability on science. Society should commit to science too.



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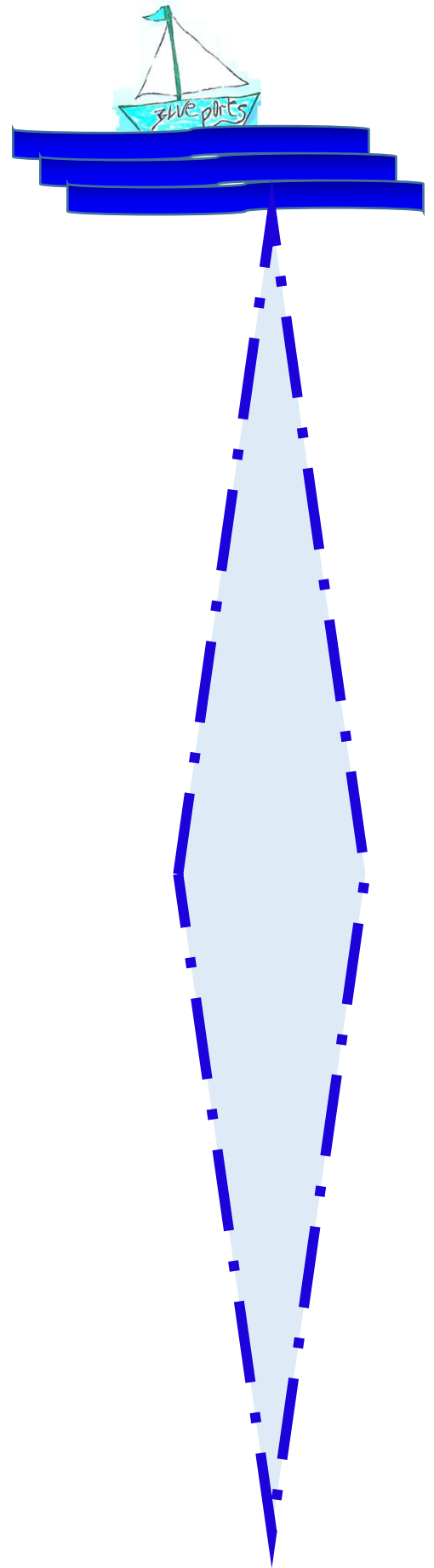


This electronic book contains the investigations presented at the International Workshop Blueports, 2019.

This scientific event was held on December 5, 2019 in two locations: the Port of *El Musel* of Gijon for presentations of scientific communications and the Culture Center *Old Institute Jovellanos*, for the exhibition of posters and the development of games of scientific content directed to schoolchildren and the general population.

For its organization, from the University of Oviedo, we have had the collaboration of the Marine Observatory of Asturias, the City Council of Gijón, the Foundation University of Oviedo and the Port Authority of the port of El Musel of Gijón. To all of them our most sincere thanks.

Likewise, this Workshop was the closing act of the project Blueports, MINECO CGL2016-79209-R.



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