

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

from Ports to BluePorts. Is it possible?

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



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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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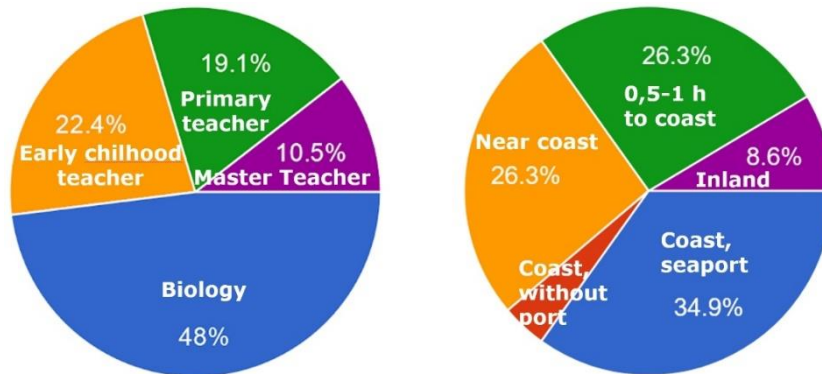


Fig. 1. Students Degree / Master Program of the survey respondents, and their residence according to sea distance and seaport facilities.

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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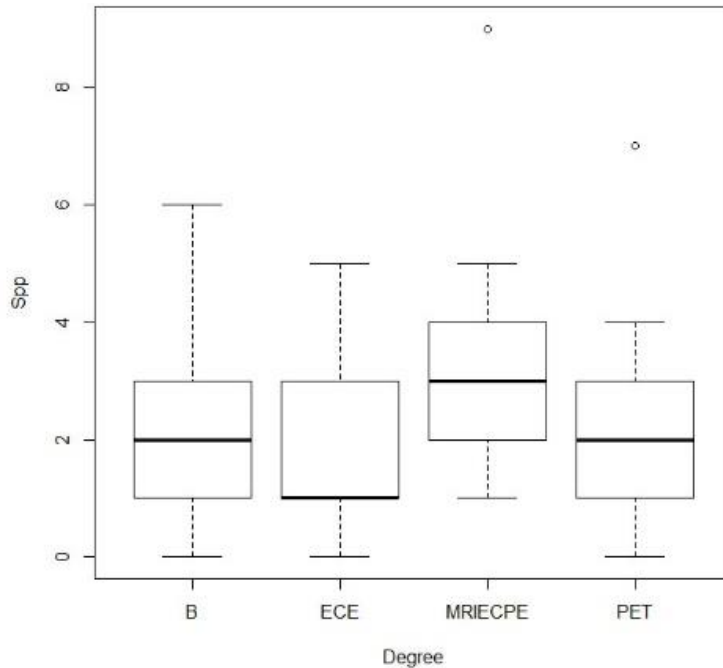


Fig. 2. Number of invasive species cited by students, according with the Degree that they are student: B = Biology; ECE = Early Childhood Education; MRIECE = Master Education; PET = Primary Education Teaching.

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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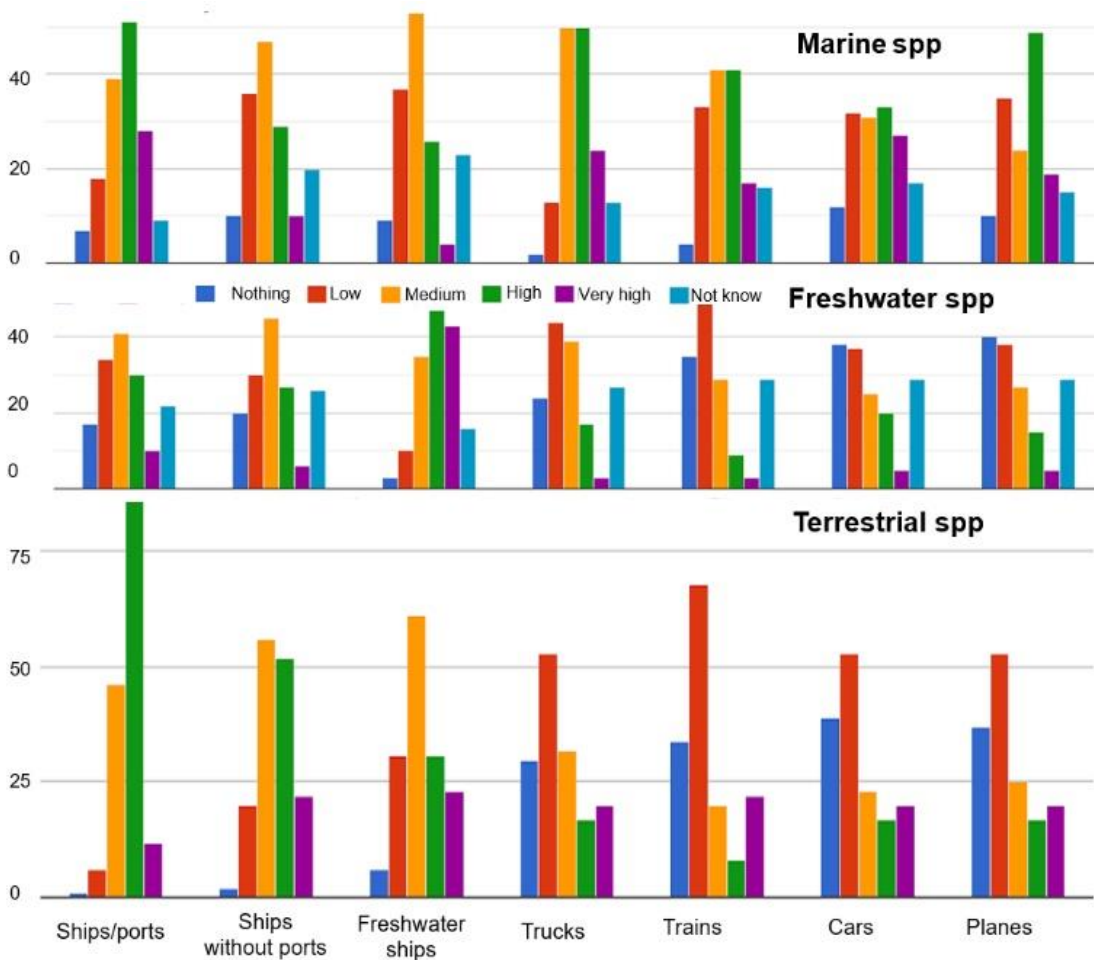


Fig. 3. Students' perceptions on way of transport importance in introduction of marine, freshwater and terrestrial alien species.

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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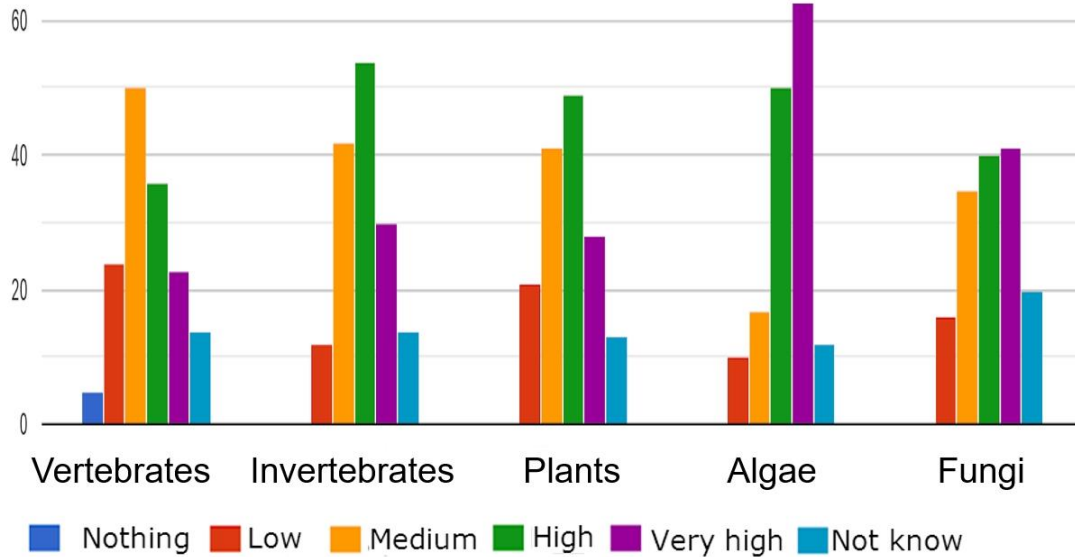


Fig. 4. Students' perceptions on seaports role in the process of species introduction according to taxonomic groups.

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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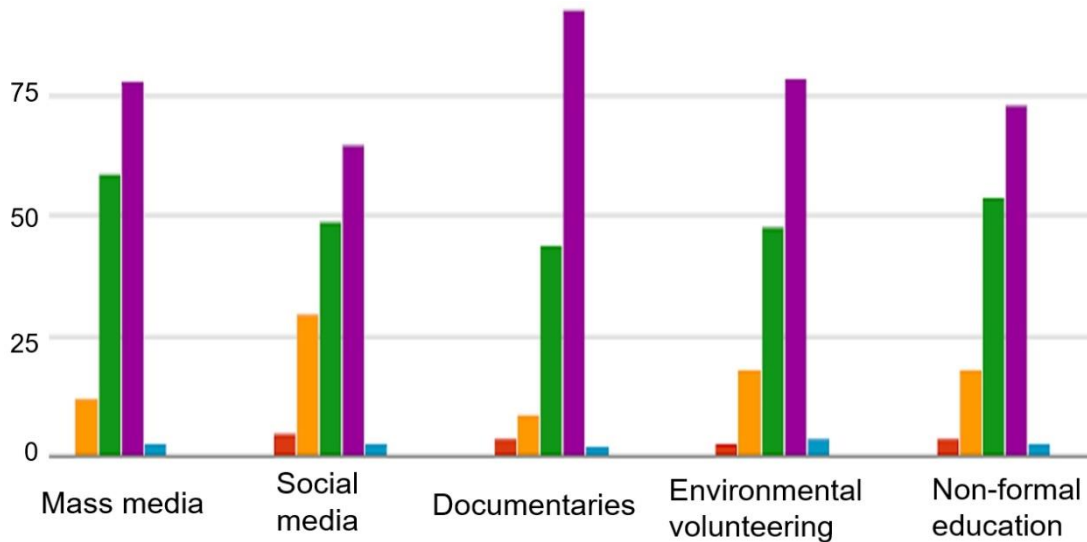


Fig. 5. Students preferred ways to improve social knowledge on alien species and their pathways.

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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