

*This is an Accepted Manuscript of an article published by Taylor & Francis in Journal of Biological Education on 17 October 2017, available online: <http://www.tandfonline.com/doi/full/10.1080/00219266.2017.1385509>*

*An embargo period of 18 months applies to this Journal.*

*This paper has received funding from the European Union (EU)'s H2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 643712 to the project Green Bubbles RISE for sustainable diving (Green Bubbles). This paper reflects only the authors' view. The Research Executive Agency is not responsible for any use that may be made of the information it contains.*

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# 'Generation Nemo': motivations, satisfaction and career goals of marine biology students\*

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Supplemental data for this article can be accessed at <https://doi.org/10.1080/00219266.2017.1385509>.

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## ABSTRACT

Marine biology is an increasingly preferred study major and career among youth. This is particularly the case of countries with extensive coastlines, such as Italy. In order to understand what exactly is fuelling this trend, and whether it culminates in the successful absorption of marine biologists as valued workforce by society, this study investigated the motivations, satisfaction and career goals of marine biology undergraduate students in Italy. Although it was expected that scientific literacy in formal education plays an important role in motivating marine biology students, the results showed that intrinsic motivations and informal education play a more crucial role. The students consider realistic career options, although these imply having to leave the country. The results of this study were used to make recommendations on the importance of marine and ocean literacy in the formal educational system in Italy, and the general improvement of scientific literacy in formal school education. Recommendations were also made on the potential improvements that can be made by higher education institutions, to better equip marine biologists with the skills required by emerging sectors in society. Finally, considerations were made regarding the dimensioning of supply, offer and marketing of employment opportunities for marine biologists in Italy.

## KEYWORDS

Students; marine biology; career; informal learning; scuba diving

*There is one quality that characterises all of us who deal with the sciences of the earth and its life – we are never bored.*

Rachel Carson

## Introduction

Post-school choices by young people are made in multiple ways and through the interplay of factors which depend on students' trajectories over time (Bøe et al. 2011; DeWitt et al. 2013; Holmegaard, Ulriksen, and Madsen 2014; Uitto 2014). In this interplay, school education is expected to be one of the factors shaping young people's decisions to continue with higher education and choice of major (Archer, DeWitt, and Wong 2014; Bøe et al. 2011; Edwards and Quinter 2011; Eidimtas and Juceviciene 2014; Lyons 2006; Robertson 2000). During the educational history of a school pupil, teachers can become role models, stimulating a growing interest in various subjects and offering encouragement and advice (Archer, DeWitt, and Wong 2014; Aschbacher, Li, and Roth 2010; Beggs, Bantham, and Taylor 2008; Eidimtas and Juceviciene 2014; Powell and Boyd 2012; Salehjee and Watts 2015). Quality, quantity and style in which knowledge is imparted to students can be influential in stimulating the desire to investigate a given subject further through higher education (DeWitt et al. 2013; Eidimtas and Juceviciene 2014; Malgwi, Howe, and Burnaby 2005; Powell and Boyd 2012; Wang and Staver 2001).

During school, young people tend to conceive their initial career goals, with the general school learning experience having either positive (DeWitt et al. 2013; Edwards and Quinter 2011; Robertson 2000; Salehjee and Watts 2015; Uitto 2014), or negative (Bojuwoye and Mbanjwa 2006), or mixed influences (Powell and Boyd 2012; Robertson 2000; Wang and Staver 2001) on career aspirations and choices. Career considerations are likely to continue all the way through undergraduate studies and thereafter (Holmegaard, Ulriksen, and Madsen 2014; Robertson 2000). In this context, the decision whether or not to pursue studies in a given major after enrolment is critical, and the overall higher education experience is expected to be very influential on this decision. In some cases, it provides students confirmation that they have made the right choice of major, with students selecting a career in that major (Gill and Golding 2001; Henderson, Stanisstreet, and Boyes 2007; Robertson 2000; Salehjee and Watts 2015). In other cases, it leads students to realise that the wrong choice of major has been made, or it represents the stage in which students make their first considerations ever about a specific career (Holmegaard, Ulriksen, and Madsen 2014; Malgwi, Howe, and Burnaby 2005; Salehjee and Watts 2015). It can broaden the students' horizons by introducing them to a spectrum of careers they were originally unaware of, concerning a specific subject (Sauermann and Roach 2012). It can encourage or discourage students to pursue a given field, based on positive or negative curricular experiences, respectively (Lopatto 2007; Malgwi, Howe, and Burnaby 2005; Salehjee and Watts 2015; Sauermann and Roach 2012). It can also remain an interim phase, during and after which the student is still unsure as to what career possibilities to consider, whether or not the right choice of major has been made (Abu Talib and Tan 2009; Daniels et al. 2011).

Upon completing a course of studies, graduates may decide to continue with postgraduate education, to opt for a career in research or academia, to find employment with private or public companies and institutions, or other. Key questions include whether their career goals are realistic, whether they ultimately succeed in accomplishing these goals, and whether higher education institutions have been able to offer proper guidance and advice concerning available career opportunities (Gill and Golding 2001; Henderson, Stanisstreet, and Boyes 2007; Holmegaard, Ulriksen, and Madsen 2014; Maltese and Tai 2011; Sauermann and Roach 2012; Woolston 2014).

Many studies have focussed on Science, Technology, Engineering and Mathematics or STEM, to assess the influences and motivations of undergraduate students, scientists and academics to choose a particular subject of study (Aschbacher, Li, and Roth 2010; Bøe et al. 2011; DeWitt et al. 2013; Powell and Boyd 2012; Robertson 2000; Salehjee and Watts 2015; Uitto 2014; Wyss, Heulskamp, and Siebert 2012). This research effort has been meant to answer to increasing concerns regarding the reluctance of young people to choose higher education and career paths in STEM in some parts of the world (e.g. Aschbacher, Li, and Roth 2010; DeWitt et al. 2013; Wyss, Heulskamp, and Siebert 2012). When disentangled, however, the 'STEM problem' is revealed to be unequally distributed among STEM sciences, with some, including the life sciences such as biology and zoology, still remaining quite popular (Bøe et al. 2011; Henderson, Stanisstreet, and Boyes 2007; Jenkins 2016; Maltese and Tai 2011; Prokop, Prokop, and Tunnickliffe 2007; Robertson 2000).

Biology is a top pursued science subject in school, and school pupils enrolling in biology classes are more likely to subsequently enrol and earn degrees in STEM, when compared with fellow students not enrolling in such classes (Gill and Golding 2001; Maltese and Tai 2011; Uitto 2014). Marine biology, in particular, is receiving increasing attention by the new generations, both as a major and as a career (Gill and Golding 2001; Guest, Lotze, and Wallace 2015; Henderson, Stanisstreet, and Boyes 2007; Lambert 2006; Smail 1988; Woolston 2014). The career of the marine biologist has been defined as 'one of the most fascinating', 'an extreme job in science', 'cutting edge', and 'cool' (Owen 2014; Thomas 2009).

The growing attraction towards marine biology is evident among young people from countries with extensive coastlines (e.g. FAO 2017; Guest, Lotze, and Wallace 2015; Kappel 2014). In Italy, a country with 8309 km of coastline, the fascination with the marine world is reflected in the opening of new undergraduate and postgraduate courses and classes in marine biology and related subjects, such as marine ecology, at various universities in the country (approximately 15 as of March 2017; Centro Studi Orientamento 2017; Online Appendix 1), and in the increasing fraction of academic enrolments per year (Longhi 2017). With regards to this phenomenon of growth, two questions arise.

The first question is what exactly is fuelling it? School education, specifically scientific preparation, could play a significant role. The school educational system in Italy has been subjected to various reforms, although the physical, mathematical and natural sciences have always featured as curricular subjects (Bertonelli and Rodano 2003). Today, the equivalent of a first grade secondary school license ('Licenza di Scuola Media') has a study and examination plan including mathematical, physical and natural sciences (Scipioni 2010). Further, common learning outcomes of all second grade or high school ('Licenza di Scuola Media Superiore') curricula encompass the patronage of fundamental contents, procedures and methods of investigation of physical and natural sciences, and the understanding of the specific formal language of mathematics (Scipioni 2010). A second grade or high school license offers a spectrum of choices including the 'Liceo Scientifico', a high school with a four-year programme specifically addressing the sciences (Militerno 2004). Although the 'Liceo Scientifico' was introduced in 1923 by the Gentile reform, the mathematical, physical and natural sciences became its true focus following another reform (Bottai reform of 1940) and WWII. The ultimate structure of the 'Liceo Scientifico' is the outcome of yet another reform (Gelmini reform of 2010), whereby the curricular plan sacrifices more hours dedicated to the humanities in favour of the natural sciences, and experimental plans of applied science teaching are approved in some schools.

Undergraduate education is also likely to play a role in fuelling interest in marine biology among young Italians. The structure of undergraduate studies in Italy went through significant changes starting in 1999, with reforms now dividing these into a first level degree or 'Triennale' lasting three years, and a second level degree or 'Magistrale' lasting two years (UNIVPM 2016). This division makes it possible for students enrolling in the first level degree to receive broad theory and methodological preparation on a given subject, and then decide to continue with the second level degree to receive a more advanced and specialised preparation. Thus, a broad preparation in biology during the first level degree would probably give students the opportunity to be exposed to the basics of marine biology, and to be motivated to pursue further education and training during the second level degree in marine biology.

The second question concerns whether the growing interest in marine biology among young people in Italy matches with an equally growing number and spectrum of career opportunities for marine biologists in the country. Given the popularity of marine biology in Italy (Longhi 2017), it should be expected that during their formation, undergraduate students are stimulated and presented with a variety of career choices upon completion of their degree. This stimulus should derive both from the overall undergraduate experience and from the students' own perceptions of careers in marine biology. This study used quantitative and qualitative research methods to answer the above questions, by examining the motivations, satisfaction and career goals of marine biology undergraduate students at a popular Italian university. Particular attention was paid to the potential role of school education, and of the general first level degree experience, in shaping the choice to study and pursue a career in marine biology, and to students' career goals before and after enrolling in marine biology. Answering these questions has important

implications for education, curricular and career advice. The results of this research will assist the Italian educational system in understanding how to exploit the potential of the growing interest in marine biology among youth. The results will also shed light on the attractive aspects of enterprising a marine biology programme, with an evaluation of the satisfaction levels of students enrolled; these are valuable elements of feedback to any Italian university offering or pre-paring to offer marine biology programmes. Last, the results will reveal the extent to which marine biology students are committed to a career featuring marine biology, with direct implications for the dimensioning of supply, offer and marketing of employment opportunities in Italy. Given the growing importance of addressing those issues affecting the 8309 km of Italian coastline today (Rochette 2009), also underpinned by the Blue Growth strategy for the Mediterranean Sea (Piante and Ody 2015), this study represents a positive contribution towards enhancing the preparation and motivation of relevant, and supposedly sought, personalities such as marine biologists.

### **Case study**

The study was done at the Department of Life and Environmental Sciences (DiSVA) of the Polytechnic University of Marche (UNIVPM), Italy. This university is located in the harbour city of Ancona, on the central eastern Italian coast. The marine biology programme at UNIVPM was the first ever made available to undergraduate students in the country following the reorganisation of undergraduate studies started in 1999 (UNIVPM 2016). At UNIVPM, the first level degree in biological sciences already includes marine biology in the study programme, with a second level degree entirely dedicated to marine biology (Online Appendix 1). Following the second level degree, students have the choice to enrol in postgraduate studies in marine biology, including PhDs and second level Master's degrees (DiSVA 2017a). For the academic year 2016–2017, UNIVPM has seen a 67% increment in the number of enrolments in the second level degree in marine biology (Longhi 2017).

### **Method**

For this study, both quantitative and qualitative methods of data collection were deployed, including a structured questionnaire survey and face to face semi-structured interviews targeting students enrolled in the second level degree in marine biology. Despite the different ontological and epistemological bases of qualitative and quantitative research approaches, their combined use can be complementary, generating different types of intelligence about a study subject and expanding its understanding (Creswell 2009; Ritchie 2003). Both methods of data collection served a contextual, explanatory, evaluative and generative function, whereby the researchers were able to assess the profile of the average student enrolled in the marine biology course; the factors influencing the choice to enrol in marine biology; the level of satisfaction of the student with the degree; and the career goals and expectations of the student after the completion of the degree. The quantitative and qualitative data were collected concurrently during 2015 and 2016, with the identities of the participants remaining anonymous.

### **Questionnaire survey**

A structured questionnaire survey was developed during 2015, characterised by five sections. The first section included five questions covering demographic details. The second section included three questions on the choice to enrol in the marine biology course. The third section included six questions on education preceding enrolment in the course. The fourth section included three questions on the evaluation of the course. The fifth and last section included seven questions on career goals. The questionnaire was administered online to all second year students enrolled in the second level degree in marine biology during 2015 (who in total were 84) and 2016 (who in total were 82). The questionnaire was made available throughout the whole academic year in 2015 and 2016. The survey was closed in November 2016.

### **Face to face interviews**

Face to face interviews were run parallel to the questionnaire survey administration. The interviews contained 11 questions covering demographic details; the choice to enrol in the marine biology course; evaluation of the course; and career goals. During 2015 and 2016 both first and second year students enrolled in the second level degree in marine biology were randomly approached in laboratories and lecture rooms and invited to participate in the interview. Invitations were extended during October 2015 (beginning of the academic year 2015–2016), March 2016 (middle of the academic year 2015–2016), and November 2016 (beginning of the

academic year 2016–2017). During the interviews, answers were audio recorded with the consent of the student.

### ***Data analysis***

The data sets from the quantitative and qualitative research were not merged but were used to support one another (Creswell 2009). Data from the questionnaire surveys were captured in Microsoft Excel (2010) and analysed using descriptive statistics. The data collected from the interviews were transcribed in Microsoft Word (2010) and translated into English. The transcripts were subsequently subjected to thematic analysis.

## **Results**

### ***Questionnaire survey***

#### ***Demographic details***

A total of 82 students participated in the questionnaire survey, representing approximately 50% of the total number of enrolled second year students during 2015 and 2016. The participants were 63% male and 37% female. They were born between 1981 (age 34–35) and 1994 (age 22), and they were mostly Italian, from outside of Ancona. About 60% claimed to come from families having an income in line with the national average, although 6% were coming from families with incomes much lower than the national average. The majority of the students were supported financially by their families, although 14% claimed to have received a study grant and 18% to have some sort of job. Most of the respondents were scuba divers (77%), having attained certifications equivalent to PADI Open Water Diver or Advanced Open Water Diver, between 2007 and 2016. The students had logged between one and 250 dives following certification, with the majority not having exceeded 50 dives.

#### ***Choice to enrol in marine biology***

Almost half of the respondents stated that they had been interested in marine biology and had wanted to study marine biology since childhood. A good proportion, however, had decided to study marine biology either during the first level degree or during the last years of high school (31% and 24%, respectively). The students were motivated to study marine biology primarily by two factors: they had always been fascinated by marine organisms; and they wished to live a life of travelling and adventure, as they perceived the typical life of a marine biologist. About 17% of the respondents had decided to study marine biology because they were scuba divers and wanted to deepen their knowledge of marine environments. A similar proportion had chosen the course because of a personal connection with the coast and the sea. Most students believed that pursuing marine biology studies would not guarantee immediate job opportunities. They also believed that marine biology would be a difficult subject to study. UNIVPM was chosen mainly as it was perceived to be one of the best in the country (62% of the respondents). About 10% of the students also claimed that this university offered a more interesting course curriculum compared with others.

#### ***Education preceding enrolment***

Most students came from a secondary education background of scientific studies ('Liceo Scientifico'), with a few mentioning also classical studies ('Liceo Classico') and technological studies ('Istituto Tecnologico'). About 70% felt that they had received an average to good scientific preparation for subsequent undergraduate studies. However, over 60% asserted that simple biological and chemical principles (e.g. differences in respiration between animals and plants, photosynthesis) were not imparted properly during school. Another 30% maintained that their science teachers were generally not well prepared. About 60% agreed that they had not received any exposure and education related to marine environments during school and that rather teachers tended to only mention terrestrial ecosystems. Experiences such as museum visits or field outings organised by the schools were rare. Knowledge in marine biology prior to university had been acquired mainly through informal and non-formal learning. The main sources of information included documentaries (82%) and books (45%). Other sources included the exploration of web pages, forums and social networks (38%); park, aquaria and museum visits (37%); regular practice of sports and recreational activities (35%); and nature and science magazines (33%).

### *Evaluation of the course*

The marine biology course received good reviews by the students, with 17% giving an overall score of AQ2 'excellent' and 42% 'very good'. In the specific, theory and lectures received the best ratings (good to excellent by 72% of the students). Laboratory sessions were rated as average to good by 60%, although field exercises received the same score by over 70%. The interactions between teacher and student were rated good to excellent by 75%. Peripheral infrastructure and services (e.g. library, common areas, secretary's office, and IT services) received average to good scores by over half of the respondents. Suggestions to improve the course included: more flexibility on behalf of support offices; reorganising of the class and exam timetable to avoid cluttering; the introduction of intermediate exam sessions; a more practical approach in teaching (more field and laboratory sessions); more exposure to the English language; and more focus on topics of relevance such as fishing and the protection of iconic species. Most students (80%) did not participate in internship or exchange programmes during the course. Those who did participate mentioned field trips to marine tropical areas and Erasmus exchanges in Europe. The greatest difference perceived by the students between the academic system abroad and the local one included the availability of more funding and how funding is used, being reinvested in students and research. The second main difference perceived was a more practical approach abroad with more laboratory and fieldwork sessions, versus a more theoretic approach in Italy. Both these differences were seen as advantages able to provide more opportunities abroad as opposed to locally.

### *Career goals*

Before deciding to study marine biology, the students had mixed views about their career goals. More than half knew they wished to either work in research and academia or become documentarists. Other popular aspirations included working for environmentalist associations, and studying marine biodiversity, especially charismatic species like sharks and dolphins. Less popular aspirations included teaching in schools and aquaculture. While studying marine biology, the respondents grew more interest in jobs related to environmental protection and conservation (86%); research (80%) mostly in marine ecology, marine zoology and ecotoxicology; management of Marine Protected Areas (70%); scientific divulgation (57%); environmental monitoring (60%); and environmental impact assessment (54%). Over 60% of the respondents were interested in postgraduate studies, either at the same university or abroad. The majority (86%) also believed that having attained some sort of scuba diving certification would be useful for their selected career path.

### *Face to face interviews*

#### *Demographic details*

A total of 29 students, 21 females and 8 males, participated in the face to face interviews. Of these, 18 were enrolled in their first year and the remainder were in their second year. They were 25 years old (var [X] = 10) and coming from outside of Ancona, with formal residence in cities such as Rome, Milan, and Perugia, among others. Most students were just studying and receiving financial support from their families, in line with responses provided in the questionnaire survey. Only five students had completed their first level degree at UNIVPM, with the rest having studied elsewhere. The most mentioned backgrounds included biological sciences and environmental sciences, with two students also stating that their first level degree curriculum already had a marine biology focus. Two-thirds of the students were certified scuba divers, and the remainder were generally going to certify in the next 12 months, as part of a module offered by the university during the course. Diving students had become certified in a period between 2005 and 2014 and were mostly the equivalent of a PADI Advanced Open Water Diver or a Rescue Diver.

#### *Choice to enrol in marine biology*

The top motivation to study marine biology was a passion for the sea since childhood (14 people), followed by contact with the sea (12 people), and water based activities including scuba diving and snorkelling (11 people). Other motivating factors included a passion for animals, curiosity, and contact with museums, aquaria, books, movies and documentaries. When asked if and who/what influenced the students in their choice, the most common answer was relatives (12 people) who were either scuba divers (nine people) or marine biologists (three people). School

teachers were mentioned as a relevant influence by four students. There was a strong connection between the choice to study marine biology and scuba diving activities. Students perceived the qualification of scuba divers important for their career aspirations (eight respondents), with other motivators including a passion shared with family members (six respondents), curiosity (six respondents), and the love for the sea (five respondents). While five students claimed that scuba diving influenced their decision to study marine biology, four declared that studying marine biology influenced their decision to become scuba divers. Two students stated that the two decisions sort of grew in parallel. Ten students believed that practising scuba diving activities aided the study of marine biology, by equipping students with additional skills that can be exploited for the purpose of research. Marine biology was also seen as beneficial to scuba diving activities, by making the students more sensitive towards the environment and by allowing them to recognise a variety of species, making the diving experience more fun and interesting. UNIVPM was selected as one of the best universities and having an excellent reputation for its marine biology programme (14 students). Features originally attracting the students included the study programme (seven people), the reputation of the lecturers (five people), the opportunities for laboratory and fieldwork (five people), and the connections with universities abroad (four people). The selection of Ancona was mostly based on suggestions and encouragements by first level degree lecturers (ten people), internet searches (nine people), and colleagues (eight people).

### *Evaluation of the course*

Most students were satisfied with their course of study. In particular, they made reference to the passion transmitted by the lecturers, the good organisation of the course in general, and the timetable. Complaints regarded the study didactic material/support and focus of some modules (five people). Some students were also disappointed with the limited time dedicated to laboratory and field sessions, with the perceived disinterest of some lecturers, and with the study overload, especially during the first semester of the first year.

### *Career goals*

At the end of their studies and in a few years, the majority of the students (17) saw themselves having some sort of experience abroad, mostly doing research (14 students). The students felt that going abroad would increase their opportunities either to find a job or to continue with postgraduate education, as opposed to staying in Italy. Six people wished to work in Marine Protected Areas, either as managers or as researchers. A few students mentioned jobs at laboratories (two), organisations (two), and in scuba diving (two). Most students (23) saw scuba diving as featuring in their career, either for research, or for monitoring and sampling, or for education purposes.

## **Discussion**

School education was not determinative in the choice to study marine biology. Factors including a passion for the marine world since childhood, the contact with nature (also through sports including scuba diving), the media (books and documentaries) and the encouragement of relatives were more influential. These findings are in agreement with those by a number of studies investigating influences in higher education and career aspirations. These studies highlight the persuasive role of parents and family (Archer, DeWitt, and Wong 2014; Aschbacher, Li, and Roth 2010; DeWitt et al. 2013; Prévot, Clayton, and Mathevet 2016; Robertson 2000; Salehjee and Watts 2015); of the media (Archer, DeWitt, and Wong 2014; Aschbacher, Li, and Roth 2010; Wyss, Heulskamp, and Siebert 2012); and of out-of-school childhood experiences associated with the subject of interest (Archer, DeWitt, and Wong 2014; Aschbacher, Li, and Roth 2010; Cooke, Miller, and White 2006; Robertson 2000).

The students remained generally happy with the scientific preparation received during school, which was necessary for subsequent higher education in their field of choice. Further, most of the participants in this study had come from science high schools ('Liceo Scientifico'). However, there was a slight dissatisfaction with some features, such as the poor preparation of science teachers and the limited exposure to concepts of marine biology, with an overemphasis on terrestrial biology. This result highlights the lack of effect of the formal school education experience on the desire to study marine biology. This poor performance was compensated by the more influential connection with the natural world, either directly through actual experiences in nature, or indirectly through the media, which instigated such desire. A recent study by Prévot, Clayton, and

Mathevet (2016) revealed that contact with nature during childhood is a specific predictor of the decision to pursue studies and a career in the environmental sciences. According to Fogg (1976), Smail (1988), and Woolston (2014), the media including television shows, movies and books tend to particularly glamorise the career of the marine biologist, sparking in youth an interest which is then fuelled through aquaria and museum visits. The impact of the media tends to persist throughout the undergraduate studies, and in this study is reflected in the decision by marine biologists to become documentarists and to travel (Gill and Golding 2001).

An intrinsic passion tended to drive the students' choice to study marine biology. A genuine interest in a subject is generally the strongest determinant to pursue studies, and possibly a career, featuring that subject (Archer, DeWitt, and Wong 2014; Beggs, Bantham, and Taylor 2008; Edwards and Quinter 2011; Malgwi, Howe, and Burnaby 2005). The growing interest in marine biology among young people is also likely linked to society becoming more exposed to problems of marine conservation, resulting in greater awareness regarding the importance of protecting marine environments, ecosystems and species (Baumgartner and Zabin 2008; Colleton et al. 2016; Gill and Golding 2001; Guest, Lotze, and Wallace 2015; Hamilton and Safford 2015; Jefferson et al. 2015; Lambert 2006), with particular attention towards the charismatic and flagship species (Brito and Vieira 2016; Hawkins et al. 2016; Jefferson et al. 2014; Shapiro et al. 2016). In addition, practical ways to deal with issues of coastal and marine conservation, including the establishment of Marine Protected Areas, may have played a significant role in stimulating interest among youth in the field of marine biology (Bianco, Koss, and Zischka 2016; Nicoll et al. 2016; Pearse et al. 2013).

The university experience was positive for the students, who tended to be satisfied with their study programme, particularly the preparation received and the interaction with the lecturers. The decision to specialise in marine biology during the first level biology degree by a large proportion of the students suggests that the first level degree successfully acted as a 'buffer' phase, giving students a first taste of marine biology and assurance in the desire to further explore the subject. This finding is important, in that change of major throughout undergraduate studies can cause significant stress to students on many levels, such as financial, bureaucracy and time (Beggs, Bantham, and Taylor 2008). Preventing such stress can ensure that students follow as smooth as possible a transition from higher education to employment, although this is not always guaranteed (Malgwi, Howe, and Burnaby 2005; Salehjee and Watts 2015). The students considered a career featuring marine biology after the degree, and their views on career were broadened compared with those prior to enrolment. There were also evident perspective adjustments from more romanticised scenarios (e.g. making documentaries, environmentalism and the study of charismatic species) to more realistic scenarios (e.g. ecotoxicology, environmental impact assessment and governance). However, in comparison with the actual variety of career possibilities which are conceived nowadays, for example, those outlined by the Stanford University's Hopkins Marine Station career page (Stanford University 2017), the students' views remained limited.

Notwithstanding the positive feeling of the students, there was a shared understanding and sort of acceptance that marine biology does not offer immediate career opportunities, at least not in Italy, and that the field of marine biology is highly competitive. This result is partly in agreement with those of research finding that graduates in the life sciences, including marine biology, tend to value job satisfaction but have low expectations concerning job security and pay and associate their future career with some degree of stress (Henderson, Stanisstreet, and Boyes 2007).

The economic recession started in 2007 and consequent job cuts, which are still evident, can be blamed for the reality as perceived by the participants in this study (Il Fatto Quotidiano 2012). However, the limited suite of career opportunities made available to marine biologists in the Italian context may be the result of at least another three connected issues. First, it may result from the potential lack of attention by government and part of the general public towards problems affecting the Italian coastline (Amato 2001; Koutrakis et al. 2010; Kreiken 2008; Rochette 2009). While this scenario is changing on various regional scales (Koutrakis et al. 2010) the country may still be slow at giving due weight to these problems. By consequence, the image of marine biologists, who would be able to investigate and find solutions to these problems, is not taken advantage of. Whether or not this is the case, marine biologists coming from Italy tend to perceive their employment potential as being neglected by academia and by society, as reflected

in a number of blogs and magazine articles (e.g. Liuni 2016; Sacchelli 2015). Second, poor curricular advice, coupled with the views of students, can lead to narrow-minded career goals which do not consider the variety of opportunities available to those with a background in marine biology (Sauermann and Roach 2012; Sullivan et al. 2005; Woolston 2014). Last, while emerging sectors may seek to employ marine biologists with certain competencies, education bodies responsible for the preparation of curricula may not yet be able to catch up with offering these competencies, thus limiting the career possibilities for marine biologists entering the market (European Commission 2015; Gill and Golding 2001; Sullivan et al. 2005).

### **Implications and recommendations**

The status quo concerning past, present and future influences in the studying and career decisions of marine biologists in Italy can be enhanced through a variety of actions. These would have to be implemented by lower and higher education institutions and by the employment market with its role players. However, in this case, some of these actions require concerted efforts by government, the educational system, employers, and probably other stakeholders such as scientists and scuba diving agencies. While recommended as a result of this study, these actions are generalizable to a variety of contexts worldwide.

Marine biology should somehow feature in formal school education. While the results of this study seem to lean to the opposite view, they actually support a discourse of ocean literacy and marine biology in schools. Indeed, the inclusion of basic marine biology in schools is not justified in the necessity to stimulate interest in the biological sciences and in marine biology, as it was demonstrated that such interest tends to grow autonomously. Rather, it should be exploited as an opportunity to raise awareness of the oceans and the seas, and of marine issues affecting global communities and economies today (Castle, Fletcher, and McKinley 2010; Fauville, Säljö, and Dupont 2013; Guest, Lotze, and Wallace 2015; McKinley and Fletcher 2012; Plankis and Marrero 2010). The poor performance of scientific education in schools, and the views shared by marine biology students on career goals, point to a general lack of support for and attention in the marine environment and marine environmental issues by government and its institutions. This in turn is translated into lack of vision concerning the sustainable exploitation of ocean natural capital for blue economies, the inability to solve critical problems affecting the coastline, and the damage of economies relying on the oceans and the seas for survival. As a result, the spectrum of employment opportunities made available to marine biologists remains restricted, as it is confirmed by the results of this study. Re-adjusting these perspectives would need to start from the bottom, specifically looking at formal school education. The inclusion of some basic marine biology may improve awareness of marine environments and of the importance that these play in society and economy. While it would not be intended to stimulate interest in studying marine biology, it should try to stimulate better-informed decisions and policies in the future. A new generation of decision makers would thus become able to better appreciate marine careers and give proper consideration to marine biology as a profession.

In some countries with extensive coastlines, such as Australia, USA and Canada, the school system is opening up to the integration of marine education in the formal education structure (Guest, Lotze, and Wallace 2015; Lambert 2006; Stepath 2006). Informal and non-formal learning also represent critical contexts for the acquisition of knowledge (Fauville, Säljö, and Dupont 2013) and, as demonstrated by the results of this study, they can end up completely replacing the role of formal education in imparting knowledge, skills, interests and values. The success by the various role players from nongovernmental organisations to media and family in this respect is laudable. In the context of education, however, the school remains an essential instrument needing to be exploited for the purpose of giving youth contact with global ecological issues (Carr 2016).

The results of this study point to some dissatisfaction by students with the level of preparation of school science teachers. The perceived poor preparation by school science teachers is likely to actually reflect a broad suite of factors, including unattractive curricular contents (Lyons and Quinn 2010); conventional methods used to deliver subjects, including transmissive pedagogy (Angell et al. 2004; Aschbacher, Li, and Roth 2010); poor instruction (Aschbacher, Li, and Roth 2010); uninspiring teachers (Elliott and Paige 2010; Powell and Boyd 2012); lack of extra-curricular activities (Aschbacher, Li, and Roth 2010); perceived irrelevance of science in society

and daily lives (Stuckey et al. 2013); and lack of attention to the role of identity development in students' orientation towards science (Aschbacher, Li, and Roth 2010; Prokop, Prokop, and Tunnicliffe 2007). These factors may result in the poor performance of school pupils in the natural, physical and mathematical sciences, which appears to be the case of Italy (Gavosto 2014). Scientific literacy among younger generations can be improved through additions and changes to school curricula. Some of these have been tested and have proven to be useful in achieving this goal. Examples include the introduction of 'exotic' topics (Angell et al. 2004); engaging delivery methods that would not be detached from everyday situations and informal contexts (Angell et al. 2004; Bøe et al. 2011); out-of-school and field-based learning (Braund and Reiss 2006; Jenkins 2016; Miglietta, Belmonte, and Boero 2008; Prokop, Prokop, and Tunnicliffe 2007); Environmental Education Materials (EEM) (Viteri, Clarebout, and Crauwels 2014); interest-driven subject curricula (Häussler and Hoffmann 2000); project-based learning (Baumgartner and Zabin 2008); integrated courses (Angell et al. 2004; Baumgartner and Zabin 2008); and special courses (Baumgartner and Zabin 2008; Jenkins 2016).

Based on the perspectives of the participants in this research, it can be concluded that the undergraduate experience of marine biology students is positive and stimulating. The most praised tools at the disposal of the marine biology programme are the themes covered, the study material, the lecturer-student relationships, and the practical sessions. These tools can also be used to address the concerns emerged during this study, through a mild yet relevant re-dimensioning of the curriculum. The students placed a strong emphasis on the importance of field and laboratory work, the exposure to the English language, scuba diving, and the university delivering education with a vision of those future scenarios working marine biologists would have to face. Within limits, these expectations could be met with minimal effort, resulting in a win-win situation for both academic institutions and marine biologists entering the employment market. On the one hand, the perceived gap between the academic system abroad and that in Italy would become smaller, also reducing clear risks of human capital flight, the so-called 'brain drain'. On the other hand, it would equip students with those skills required by emerging sectors seeking marine biologists. This, in particular, would enhance the presence of active marine biologists in different societal ambits, and consequently the appreciation for marine biology as a multi-faceted discipline contributing substantially to society.

Scuba diving plays a central role both as a motivator to pursue marine biology and as a valuable curricular skill to possess as a marine biologist. Various papers have highlighted the importance of scuba diving for the marine sciences, and the important link existing between the study of marine biology and the physical exploration of the underwater world (Bianco, Koss, and Zischka 2016; Brylske 2013; Goulder, Scott, and Scott 2013; Lang et al. 2013; Pearse et al. 2013). In this case, the marine biology programme already gives students an opportunity to exploit the potential of scuba diving for the curriculum and for the acquisition of important skills. This effort should continue to be encouraged, also as it espouses the added value of scuba diving for marine biology with that of field-based learning and research training (Brylske 2013; Goulder, Scott, and Scott 2013; Pearse et al. 2013). This encouragement should be made with additional considerations of how to better connect the image of marine biologists with the broader scuba diving industry and community. The appreciation of marine biologists with scuba diving skills by the scuba diving industry could see positive outcomes. These include the creation of new certifications schemes and employment opportunities for marine biologists, also in a tourism context; the improvement of relations between the scuba diving industry, the scientific community and the general public through education, public engagement and Citizen Science (Cerrano, Milanese, and Ponti 2016; Thiel et al. 2014); communication with governance authorities; and new marketing strategies with a competitive edge for the scuba diving industry. Recent findings have shown that indeed the scuba diving industry wishes to have stronger ties with the scientific community (Lucrezi et al. 2017), and marine biologists can represent an important link in this process.

The proper absorption and appreciation of marine biologists by society remains the greatest challenge. In Italy, the concerns of marine biology students are sadly confirmed by recent figures (DiSVA 2017b), showing that 38% of marine biologists find employment within a year of graduation (a lower percentage compared to the previous year), primarily in the private sector, and earning about one-third of the national average income. Of these people, the majority are employed on a part-time basis, working in the trade, consultancy and other services, without

connections with their degree. While marine biologists who have just completed a degree tend to continue with their formation (70%), only 12% enrol in a PhD. Within three years of graduation, the proportion of employed marine biologists remains the same, with a similar proportion also giving up on job searching. The statistics also show that employment in research and education has dropped significantly from 40% in 2014 to 8% in 2015. It is important to be able to guarantee opportunities to those who develop aspirations in marine careers, through adequate, flexible and dead-end-free career structuring; effective communication between emerging marine sectors and higher education institutions on what is expected from today's generation of marine biologists; and proper job advertising (European Commission 2015; Gill and Golding 2001; Henderson, Stanisstreet, and Boyes 2007; Sullivan et al. 2005; Woolston 2014). These processes can kick off and gain relevance if the necessary support and investments are made, starting with the national government and then moving to the broader European political landscape. The Italian coastline is among the top most developed coastlines in the Mediterranean Sea (Piante and Ody 2015). The waste of available competencies, especially when the Blue Growth is representing one of the mainstreams of sustainable development in the next future, highlights the urgency to change the vision of decision makers and recognise the opportunities made available by the generation of marine biology workforce.

## **Conclusions**

Marine biology increasingly attracts young generations through the fascination of underwater environments and by the interplay of factors including a growing passion since childhood and the influence of family and the media. Italy, a country with an extensive coastline, has an increasing need to deal with serious issues of coastal and marine management but also hosts a growing population of youth who are seemingly equipped with the necessary skills to work on these issues. Unfortunately, aspirations to pursue marine biology and marine careers are accompanied by low expectations for the future. This phenomenon is leading and is likely to continue to lead, to 'brain drain' of Italian marine biologists. Strategies to ensure that the image of marine biologist is both appreciated and taken advantage of include: better engagement in scientific literacy since school education; changes in undergraduate curricula, offering competencies that are required by emerging sectors; clearer career goals; the engagement of alternative industries, such as scuba diving tourism; more support and investment by government and the broader European political landscape; and public education in order to sensitise people to contemporary problems affecting coastlines and the sea. Looking into these strategies may not immediately solve all issues highlighted by this study, but it will be a first step helping 'generation Nemo' find its place in the world.

## **Acknowledgements**

We extend our deepest gratitude to all students who participated in this research. Special thanks go to Barbara Calcinai and Daniela Pica, and to the whole department of DiSVA. The research was approved under the ethics code EMS2016/11/25-0239.

## **Disclosure statement**

This paper reflects only the authors' view. The Research Executive Agency is not responsible for any use that may be made of the information it contains

## **Funding**

This study was funded by the Green Bubbles RISE project, [H2020-MSCA-RISE-2014]. The project has received funding from the European Union Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement number 643712.

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