

How is the ocean represented in school textbooks in Chile? An analysis of curricular content and images of marine fauna

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ABSTRACT

Although we are currently in the Decade of Ocean Sciences for Sustainable Development, Chile seems to be lagging behind in marine education. Research has shown the importance of animal imagery in generating a bond between students and their environment, and strengthening interest in conservation. The objective of this study is to contribute to ocean literacy research in Latin America, by describing coverage of ocean content in the Chilean primary school curriculum and textbooks. Content analysis was undertaken concerning textual and pictorial materials. Learning Objectives of the science primary curriculum were reviewed, and the number and type of fauna species shown in images were recorded. For each textbook, we recorded the number of marine and terrestrial animals, categorized endemic, native, and exotic species, and whether the name of the animal was labeled with the image. The results show that only three Learning Objectives of the primary curriculum explicitly define content associated with the ocean. Of the total animal images, slightly more than twenty percent are marine fauna. The great majority of the marine animals shown are native, however, most of the time the image is not reinforced with the name of the species. Considering that school textbooks are the foundation of formal education, this preliminary study indicates that there is a content deficit when teaching about the relevance of the ocean and its animal species in primary school textbooks in Chile, covering only three ocean literacy principles in the science curriculum. However, this study recognizes that important improvements have been made in prioritizing natural science teaching with images of native species.

Descriptors: Ocean decade, School curriculum, Marine fauna, School textbooks.

INTRODUCTION

The value of the ocean has been recognized by many authors. Understanding the ocean is fundamental to understanding life on Earth; the ocean covers 71% of the Earth's surface, and is responsible for around 50% of current oxygen

production, regulates climate, provides food, work, medicine, and energy, and is also important spiritually or culturally for many communities (Schoedinger et al., 2006; Ocean Literacy Network, 2013; Fauville, 2019). Care for the ocean has become one of the world's political priorities for these reasons. In 2015, the United Nations General Assembly incorporated Sustainable Development Goal #14, which focused on conserving the ocean and using marine resources sustainably (Naciones Unidas, 2015). The Decade of Ocean Sciences for Sustainable Development

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2021-2030 was recently declared with seven priority areas. Of these priorities, this study will focus on education, ocean culture, and ocean literacy (IOC-UNESCO, 2019).

Ocean literacy has been succinctly defined as the understanding of the influence of the ocean on persons and the influence of persons on the ocean (Cava et al., 2005), which includes any person that lives near or far from the ocean. This concept has been accepted for more than 20 years in the USA and more than 10 years in Europe (Fauville, 2019; Mokos et al., 2022). An ocean-literate person: (a) understands the basic concepts of the functioning of the ocean; (b) can communicate clearly about the ocean; and (c) can make informed and responsible decisions about the ocean and its resources (Cava et al., 2005). Ocean literacy is based on seven Essential Principles and five fundamental concepts (NOAA, 2013), described concisely with their fundamental concepts in Mogias et al. (2022) and summarized as follows:

- Principle 1: The Earth has one big ocean with many features.
- Principle 2: The ocean and life in the ocean shape the features of the Earth.
- Principle 3: The ocean is a major influence on weather and climate.
- Principle 4: The ocean made the Earth habitable.
- Principle 5: The ocean supports a great diversity of life and ecosystems.
- Principle 6: The ocean and humans are inextricably interconnected.
- Principle 7: The ocean is largely unexplored.

In the USA, it was noted in 2004 that the school curriculum should include ocean topics from the earliest school levels, and provide educational experiences to prepare the next generation (United States Commission on Ocean Policy, 2004). Since then, there have been collective efforts to integrate the principles of ocean literacy in both non-formal education activities and formal education within the school curriculum (Ocean Literacy Network, 2013), aligning them with the National Standards of Science Education (National Research Council, 1996; Strang et al., 2007). UNESCO developed a

guide for ocean literacy teaching in four languages to be used in educational establishments around the world (UNESCO, 2018). One of the initiatives of the Ocean Science Decade was the creation of a manual to increase ocean literacy for educators (Halversen et al., 2021) and an up-to-date guide with tools to incorporate the ocean in school curricula (IOC-UNESCO, 2022). Despite these efforts, the implementation of ocean literacy strategies faces important challenges of coordination (Strang et al., 2007); fulfilling Sustainable Development Goal 14 globally will require an increased financial commitment, improved coordination, and the implementation of educational strategies (UNESCO, 2020).

This area of education needs to promote a personal connection with the marine environment and encourage active participation of people in their role as responsible citizens in environmental problems (Fauville, 2019). Education and effective communication are fundamental to the formation of an informed citizenry and the development of conservation policies (Márquez-García & Jacobson, 2019). Thus, to make biological diversity visible, which is often imperceptible and unknown to society, and to reduce the environmental crisis (Rozzi et al., 2003), the effective communication approach of Ferrés (2007) may be implemented. In this approach, knowledge becomes a “desired object” by combining traditional oral communication and a narrative with visual images as a motivating instrument to transmit a message. Several authors have emphasized the importance of images in student learning (Prendes, 1996; Perales, 2006), and in recent decades education has been changing; multimodal content that uses different methods of representation and communication has been gaining strength (Kress et al., 2000).

Chile, with more than 6400 miles of coastline, should be a country recognized for its marine identity. However, in Chilean society, little is known and communicated within the country about its marine biodiversity, functioning, and relevance. A quarter of the Chilean population lives in coastal districts (Ministerio de Relaciones Exteriores, 2020). Chile is highly productive in marine cultivation and is one of the principal extractors of marine resources in Latin America (FAO, 2018). Chile has institutional

commitments to the conservation, protection, and sustainable use of biodiversity (such as the National Biodiversity Strategy 2017-2030), and in 2016 the Ministry of Foreign Relations led the Council of Ministers in the creation of the National Oceanic Policy. This was approved in 2018. This policy details thirty norms, laws, conventions, and international agreements where the policy could be currently applied. Among the nine objectives of the Policy, the most relevant to this study is objective number seven: “To promote public awareness and understanding of the ocean, strengthening the bonds that citizens have with the ocean”. Among its specific actions, it details “implementing a communication strategy to raise the valuation of biodiversity in all sectors of the society”, and “executing a permanent program of education and public dissemination of information about marine conservation” (Gobierno de Chile, 2018). Later, the National Oceanic Program was approved (Ministerio de Relaciones Exteriores, 2021); which includes 38 actions to be performed to fulfill the various commitments of the National Ocean Policy. Very recently there was a discussion about integrating the concept of Ocean Territory (“maritorio”) and “Chile Oceanic Country” in the development of the new Constitution, including the extent of the ocean territory, the cultural bonds, and the need for the State to protect the ocean (Iniciativa Convencional Constituyente, 2022), but its incorporation is not yet certain.

Considering the global concern to promote ocean literacy, and taking into account that Chile is in the process of implementing ocean policies at this political moment when the Chilean government shows interest in strengthening marine conservation (Ministerio del Medio Ambiente, 2022), the main objective of this study was to contribute to the Latin-American understanding of the current state of ocean sciences contents in national curricula and school textbooks. In particular, we aimed to review the primary school curriculum and textbook coverage of Chilean marine fauna and ocean issues, and use quantitative data to identify gaps in ocean education in Chile. This was done by content analysis, considering that school textbooks historically and currently continue to be the material basis of the teaching process in the school system, and thus represent the first step in promoting ocean literacy in formal education. The study

analyzed (a) ocean content in the school curriculum and its association with ocean literacy principles, and (b) animal images in primary school textbooks, to define the frequency and characterization of marine animals shown in the images. Images were used as an indicator of marine science topics in the school textbooks, and as a fundamental semiotic resource providing educational environmental content.

SCHOOL SCIENCE EDUCATION IN CHILE

The formal education system in Chile is governed by national and international evaluation standards through the school curriculum or curricular bases. These define the learning goals that are relevant for society and indicate the learning objectives expected for each level (Ruiz et al., 2016). There is a centralized curriculum system for the whole country, valid for the public, private subsidized, and private schools. The same situation applies to school textbooks. The Chilean Ministry of Education supplies students in primary and secondary school with one free-of-charge textbook per course per subject, along with a workbook common to all students across the country. Some private and subsidized private schools may decide to use alternative textbooks by different authors; however, these must follow the same curriculum program. The last curriculum program was created in 2012 for grades 1 to 6 (Supreme Decree n°439), and in 2015 for grades 7 to 8 of primary education (Supreme Decree n°614). New textbooks are generally published every two years; however, few changes have been made to the content structure since the curriculum program has not changed since 2012. Recently, the Chilean government is fostering a campaign to reuse a selected percentage of books from one year to another, to reduce the use of paper, and encouraging the implementation of workbooks in digital format (El Mostrador, 2022). Chilean curricular program defines three axes for primary education in Natural Sciences; Life Sciences, Physics and Chemical Sciences, and Earth and Universe Science (Ministerio de Educación, 2012), with more than half of the content (51.5%) in the Life Sciences axis (Ruiz et al., 2016). Science education in the Chilean school system centers on understanding scientific concepts, unlike Singapore, Canada, or England, which place emphasis not only on learning concepts but also using them in practice (Barraza and Walford,

2002; Meneses et al., 2013). In particular, care of the environment has a minimum presence compared to the other topics and was only found in the content of grades 2-4 (7 to 10 years old) (Ruiz et al., 2016). Topics of ocean literacy and marine science issues are underrepresented areas in the school curriculum and textbooks worldwide (Mokos et al., 2020; Mogias et al., 2021; Mogias et al., 2022). In Latin America, Brazil is taking the first steps to analyze and integrate marine content into the school curriculum, given the international context of the Decade of Oceanic Sciences (Pazoto et al., 2021). In Chile, the only review of marine content in the school curriculum is that of Fanta (2021), which analyzed the curriculum bases from preschool to high school, finding the words “sea” and “ocean” only 16 times in the primary and secondary educational cycle, highlighting the weakness of school marine education in Chile.

ANIMAL IMAGES IN SCHOOL TEXTBOOKS

School textbooks have been and are currently the predominant educational medium in the school system (Prendes, 1996). They are important instruments in the transmission of knowledge associated with cultural and ideological models, which contribute to constructing a national identity (Espinoza, 2012). School literacy has traditionally been centered on learning the written language, considering images and diagrams as complements to the textbooks. However, it is important to change the focus to multimodal literacy (Manghi et al., 2016). Several analyses of textbooks reinforce the importance of visual elements (Kress et al., 2000). There is a need to integrate visual learning in education, highlighting the present insufficient visual literacy of both teachers and students (Perales, 2006; Unsworth, 2006; Painter et al., 2013). Visual imagery is particularly relevant in science teaching and learning since visual displays transform objects of study and data that were invisible into a visible image of the results, which in a school context will allow future scientists to explain databanks and portray complex data (Prosser, 2007). Also, the way children build concepts and relationships is different from the way teachers present them and differs depending on context and previous knowledge (Prosser, 2007). Therefore, visual imagery is fundamental

as a pedagogical resource in the learning process. Animal images are especially important to create a link between the students and content associated with the environment, care, and conservation. Globally, most of the natural sciences textbooks contain images associated mainly with animals (not plants), due to the greater attractiveness of animals to people (Marrero, 2010; Rodríguez et al., 2014), in particular the ability of animal images to generate a bridge to promote care of the environment (Myers and Saunders, 2002).

Two studies in Chile have investigated the presence of animals in school science textbooks, focusing especially on conservation, and analyzing the content of native and exotic species, but neither differentiated information about marine species. Rozzi et al. (2000) reported that less than 20% of the examples illustrated or described in school textbooks from 1975 to 1995 included native species of fauna and flora; there was an emphasis on exotic species, especially from Europe. Celis-Diez et al. (2016) studied biodiversity in primary and secondary school textbooks; they counted 243 animal species, of which 67.9% were exotic, and although the native fauna and flora increased to 30%, at least until 2012 school children had more access to information about exotic than native flora. None of these studies specified information about endemic species in textbooks. For the marine environment, the geographical characteristics of the Chilean coast, with isolated wilderness areas, have generated endemism including charismatic marine mammals such as the Juan Fernández fur seal (*Arctocephalus philippii*) classified with conservation status as Least Concern, Chilean dolphin (*Cephalorhynchus eutropia*) classified as Near Threatened, or the iconic and strongly commercialized Juan Fernandez Rock Lobster (*Jasus frontalis*) classified as Data Deficient (IUCN, 2022). These important, endemic species could be used in local textbooks as examples when learning about conservation issues and concurrently address ocean literacy principle 5.

METHODS

This study performed a quantitative document content analysis (Bardin, 1991; Weber, 1990) implemented on textual material of the school

curriculum program and pictorial material of the textbooks, to obtain data on (a) the presence of ocean contents in primary school curricula and its association with ocean literacy principles, and (b) the number and types of marine fauna shown in images as a representation of ocean content to engage students. The data analysis is quantitative and descriptive, creating frequency tables to show the coverage of ocean content in the Chilean primary school system. The graphics were made in excel software, no statistical program was used.

OCEAN CURRICULAR CONTENT

The data of the study consist of the curriculum program defined by the Education Ministry of Chile in the Natural Sciences sub-sector of the complete cycle of primary education, which includes grades 1 to 8 (6 to 14 years old). The material analyzed comprised two curricular science programs: for grades 1 to grade 6 (6 to 12 years old), the curricular program of 2012 was analyzed (currently valid in 2022). This program includes the axes of life sciences, physical and chemical sciences, and earth and universe sciences (Ministerio de Educación, 2012). For grades 7 to 8 (12 to 14 years old), the latest curricular program of 2015 was analyzed (currently valid in 2022). This program includes the biology, physics, and chemistry axes (Ministerio de Educación, 2015). For both natural sciences curriculum programs, Learning Objectives (LO) were reviewed one by one for each grade (grades 1-8). Firstly, the LO that declared sea or ocean content were recorded in a table. Then to identify and filter the content that could use marine or terrestrial fauna to illustrate content in images, we selected the LO that explicitly contained the terms: animals, living organisms, fauna, ecosystems, and food webs (to direct the analysis of the textbooks). These terms were identified in the LO of grades 1, 2, 4, 5, and 6, but not in grades 3, 7, and 8, therefore, five grades out of the eight grades of primary school were selected for analysis of the corresponding textbooks. The ocean literacy principles (Cava et al., 2005) were used to frame the ocean content described in the learning objectives.

IMAGES OF MARINE FAUNA

The second material analyzed comprised the textbooks developed for teaching natural science in

Chilean primary education, created by the Ministry of Education in 2018 (Ministerio de Educación, 2018). Textbooks are given free to the public, private subsidized, and private schools in Chile (the same textbooks were used in 2019). The student textbooks reviewed were five: grades 1, 2, 4, and 6, created by the Department of Pedagogical Studies of 'Editorial SM', and the grade 5 textbook created by the Department of Pedagogical Studies of 'Editorial Crecer Pensando'.

For this research, "image" was defined as an exclusively graphic representation of living beings, objects, or phenomena that accompanied the written text, which may be illustrations or photographs. The content of fauna images in the school textbooks of each of the five grades selected was assessed, to record the proportion of marine vs. terrestrial fauna, and whether the images were of species native to Chile or exotic.

For the documentation, only images of marine species were analyzed, not those of freshwater (wetlands, rivers, or lakes), except for a few aquarium fish images that serve as general examples of animals that live in aquatic environments for grade 1 and grade 2. In landscape images, for example of a beach or sea floor, we counted each of the species visible. The animals of the Antarctic such as seals and penguins were counted as native since a proportion of this territory is considered to be part of Chile. To ensure the validity of the data record, textbooks were reviewed by two marine biologists, and the images that needed precise identification of species, such as fish and jellyfish were identified by specialists (detailed in acknowledgments).

To collect the data, the school textbooks were reviewed page by page. Every time an animal image was represented, the following information and categories were recorded in an excel spreadsheet: school grade, thematic unit, page number, type of animal (e.g., squirrel, fish, crocodile), the common name of the species when it was possible to identify it in the photograph or realistic illustration (e.g., common sea lion), animal category: native, exotic or domestic, category marine or not, and frequency (e.g., 5 records of puma in grade 4 school textbook). The totals for marine and terrestrial fauna, and the categories native, exotic, and domestic were calculated by grade. To fulfill the objective of the study, we separated

only the marine species. The categories native and exotic were included following Celis et al. (2016). The endemic category was added and quantified to differentiate between native and endemic marine species per school grade and to highlight if there was any use of charismatic or commercial endemic species. Each marine image was also classified and accounted by grade as with or without a name, determining whether there was identifying text with the common name, either as part of the image or in the accompanying text. This determined how often the opportunity to reinforce the visual information with the name of the species was taken or missed. To identify which marine animals were most used in school textbooks images, the number of records for each animal type was quantified (e.g., seagulls, sea lions).

RESULTS

MARINE CURRICULAR CONTENT

From the textual analysis, the natural sciences curricular bases for the complete cycle of primary education (grades 1-8) included 118 Learning Objectives (LO); and 15 of them contained the selected terms of animals, living beings, fauna, ecosystems, sea, ocean or food chains, which could include examples of marine species (Table 1). However, of the 118 LO, only one unit, 'The Earth and its changes' in grade 5 (10-11 years old) included ocean information. Three LO (2,5%) that specifically declared ocean content, are associated with the following ocean literacy principles according to Cava et al. (2005):

- LO 12 Describes the distribution of fresh and saltwater on Earth, considering the ocean, glaciers, rivers and lakes, groundwaters, clouds, water vapor, etc., and compares their volumes, recognizing the relative scarcity of fresh water. Related to principle 1a.
- LO 13 Analyzes and describes the characteristics of the ocean and lakes:
 - Variation in temperature, luminosity, and pressure with depth. Related to principle 1d.
 - Diversity of flora and fauna. Content associated with principles 5a, 5c.
 - Movements of water, such as waves, tides, and currents. Related to principle 1c.

- LO 14 Investigates and explains the positive and negative effects of human activity on the ocean, lakes, rivers, and glaciers, proposing protective actions and communicating their results. Associated with principle 6e, 6g.

The word native was mentioned to highlight species that live in Chile; however, we did not record the concept of endemic species in the learning objectives of the five textbooks analyzed.

PRESENCE OF MARINE SPECIES

The pictorial analysis recorded 349 images of animals in the five natural sciences school textbooks analyzed, of which 81 (23%) are marine animals and 268 (77%) are terrestrial animals. All the school textbooks contained marine species, although the learning objectives did not specify ocean topics. Figure 1 shows the number of terrestrial vs. marine animals per analyzed grade. Most animal images were found in textbooks of grades 1 and 2 (116 and 112), with the curricular contents about nature and fauna; most terrestrial species were for grade 1 (106), while the largest number of marine species were in grade 2 textbooks (40). It was followed by grade 5 (14), the grade which has three learning objectives related to ocean content. There is a correlation between the content description of the curriculum learning objectives of grade 2 with the highest number of marine animal images since four LO have specifically animal contents (Table 1). There was no trend to increase or decrease the number of marine animal images in textbooks from grades 1 to 6 (Figure 1).

PRESENCE OF ENDEMIC, NATIVE, AND EXOTIC SPECIES

The most frequent marine animals registered in the textbooks analyzed in the pictorial analysis were fish, with 21 records; 10 endemic and 11 exotic. The second most frequent were penguins, with 7 records that represent five species. The third most frequent were sea lions, with 6 records of three species. Other groups were less frequent—seals, whales, and jellyfish (4 records), sea otters and seagulls (3 records), octopuses, lobsters, crabs, krill, sea urchins, dolphins, and king crabs (2 records), and 12 other species (one record) (Table 2).

Table 1. Learning Objectives of the primary education curriculum from Chile, with specific concepts of animals, living beings, fauna, ecosystems, ocean, or food webs.

Grade	Axis	Topic	LO	Description of Learning Objectives
1	Life Sciences	The diversity	LO1	Observe and compare the characteristics of animals.
			LO5	Recognize and compare a number of Chilean plants and animals.
2	Life Sciences	The diversity of life	LO1	Observe, describe and classify vertebrates as mammals, birds, reptiles, amphibians and fish.
			LO3	Observe and compare the characteristics of the life stages of different animals.
			LO5	Observe and identify some native animals in danger of extinction
			LO6	Identify and communicate the effects of human activity on animals and their habitat.
4	Life Sciences	Energy and ecosystems	LO1	Recognize that an ecosystem is composed of living (animals, plants, etc.) and non-living elements.
			LO2	Observe and compare adaptations of plants and animals that allow them to survive in ecosystems.
			LO3	Give examples of food chains, identifying the functions of organisms in different ecosystems of Chile.
			LO4	Analyze the effects of human activity on Chilean ecosystems.
5	Earth and Universe Sciences	The Earth and its changes	LO12	Describe the distribution of fresh and salt water Earth, considering ocean, glaciers, rivers and lakes, groundwater, clouds, water vapor, etc. and compare their volumes, recognizing the scarcity of fresh water
			LO13	Analyze and describe the characteristics of oceans and lakes: variation in temperature, luminosity and pressure, diversity of flora and fauna, movement of waters, waves, tides, currents.
			LO14	Investigate and explain positive and negative effects of human activity in the oceans, lakes, rivers and glaciers, proposing actions to protect them.
6	Life Sciences		LO2	Represent energy transfer from photosynthetic organisms to other living beings by food webs in different ecosystems.
			LO3	Analyze the effects of human activity on food webs.

The exotic polar bear, native to the Northern Hemisphere, appears on three occasions in grade 1 and grade 2 textbooks (6-7 years old), with the same frequency as native species such as the sea otter (*Lontra felina*). There was little representation of native species of commercial importance with extraction bans and known conservation problems, for example, there were two records of the king crab (*Lithodes santolla*) and one of Chilean abalone (*Concholepas concholepas*).

Figure 2 shows the number of endemic, native, and exotic marine species by school grade. Only two marine endemic species were represented

in images, the Juan Fernandez sea lion and the Juan Fernandez lobster. They were both in the same landscape but not labeled with their name. The largest number of native marine species (31) was recorded in grade 2, again in correlation with the LO on animal content. Figure 2 also shows the total numbers of each category, with a notable prevalence of native marine species - 65 (63+2 endemics) or 80% - over exotic marine species (16). Only fourteen of the 65 native marine species (22%) had the name of the species labeled in the text; eight in grade 2 and three in the grades 4 and grade 6 textbooks.

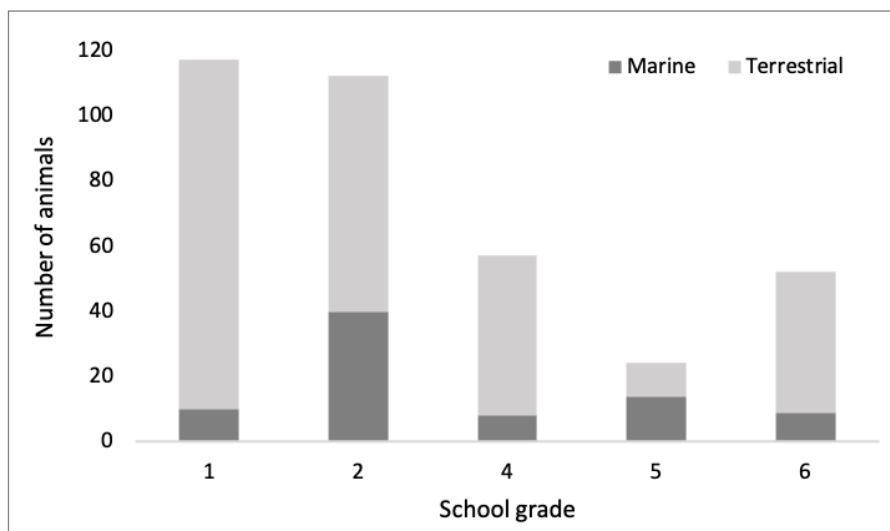


Figure 1. Number of terrestrial and marine animals registered in each textbook per school grade.

Table 2. Frequency of animal images registered more than one time in the school textbooks analyzed.

Animal	N°
Fish	21
Sea gull	3
Penguin	7
Sea lion	6
Seal	4
Whale	4
Sea otter	3
Polar bear	3
Dolphin	2
King crab	2

DISCUSSION

As expected, the results show limited marine coverage in Chilean primary school curricula and textbooks. Within the educational system, learning from school textbooks still has the most influence on teaching practice (Perales, 2006), and thus has great power in the formal education of citizens and society (Apple, 1989). Considering that education should be a driver of social change (Apple, 1989), science teaching in schools is an important foundation that influences the commitment of young people to social and environmental issues (Lewis and Leach, 2006).

Hence, a deeper understanding of marine coverage in the curriculum and school textbooks is vitally important.

A survey of the perception of science in Chile found that more than fifty percent of respondents think that science and technology contribute to the improvement of the environment (CONICYT, 2019), but it is difficult to make a real contribution to the environment if there is not enough baseline knowledge on the native fauna and their ecosystems as part of the natural patrimony, and harder still to define measures for species conservation. Rozzi et al. (2003) noted that biodiversity must be made visible to reduce the crisis of knowledge and decrease biodiversity loss in the long term. To conserve biodiversity, it is important to consider its political character and the relevance of integrating the human component in the process of conservation (Araos, 2017; Márquez-García and Jacobson, 2019). Educational institutions have a fundamental role in increasing visibility, teaching students in formal education both the content and individual and collective responsibility of humans for the conservation of nature (Saylan and Blumstein, 2011).

There has only been one exploratory study of ocean literacy and connection with the ocean in Chile (Pizarro-Mora et al., 2022), and the only data on

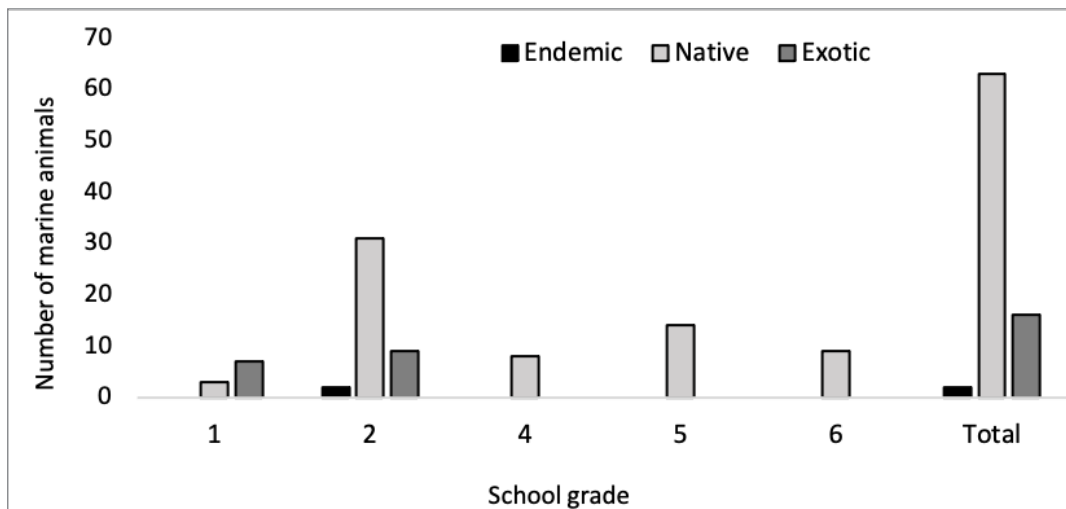


Figure 2. Number of endemic, native, and exotic marine animals in each textbook per school grade, and the total amount for each category.

marine awareness of Chileans suggests that there is little awareness of the ocean and its influence on people (Aguirre and Godoy, 1989). Due to this poor research, understanding, and communication of the relevance of the ocean in Chile, the curricular program must be aligned with the objectives of ocean literacy for the country and worldwide. This is considering the Sustainable Development Goals, the challenges of the Decade of the Ocean, and the new goals of the Chilean National Ocean Policy which is to be implemented. According to our results, only one unit of the curriculum of Chilean primary education considers the importance of the ocean; it has three learning objectives explicitly associated with the ocean, which are centered mainly on world oceanographic dynamics and the importance of freshwater on the planet. These contents correspond to the ocean literacy principle number 1 (ocean features), 5 (biodiversity), and 6 (ocean-human interconnectivity), results consistent with the Mogias et al. (2021) research on Greek textbooks, where most of the concepts of ocean literacy were associated with principle 1 and 6. They attributed the presence of principle 1 to the fact that oceanographic concepts generally come to mind first when people think about knowledge of the ocean. The presence of principle 5 is directly related to the images of fauna in textbooks that attract the interest of young students (Marrero, 2010; Rodríguez et al., 2014), although images of marine animals were in this case more associated with the general content of fauna in early grades.

Principle 6 is related to human issues; therefore, it is easy to comprehend its presence. Overall, the school curriculum in Chile shows a deficit in coverage of the seven ocean literacy principles, and relevant content about ocean issues is missing. The results of the analysis of pictorial material from secondary Greek education textbooks, by Mogias et al., (2021) and Mogias et al., (2022) show that marine visual resources are poorly used in Greece; they used fewer images in the textbooks than the results of this study. There are no other studies of Chilean school textbooks that analyze the image content of marine fauna with which to compare or evaluate changes. However, the results could be considered deficient, given that Chile has thousands of miles of coastline, a good proportion of the population lives near the ocean, and the first years of school is when students assimilate most knowledge.

Concerning the image analysis of native, endemic, and exotic animals, our results highlight a significant increase in the percentage of native marine species currently shown in school textbooks, compared with previous studies (Celis-Diez et al., 2016; Rozzi et al., 2000). These results lead us to hope that similar changes may be seen for terrestrial species. This result is promising, considering the importance of using local examples from real life that allow students to make connections between educational content and the situation of their surroundings, and make the protection of native species more feasible (Ballouard et al., 2011; Scott, 2015). Results demonstrate that

endemic marine species are not commonly identified in images. A low proportion of the textbook images of native and endemic species include the common name of the species. Thus, an opportunity is missed of emphasizing the importance of species unique to the Chilean territory. This is relevant since according to the analysis of images in educational contexts, to enhance learning it is necessary to orient their use with verbal labels that support the information in the images (Perales, 2006).

The results indicate a relatively low (compared with terrestrial) use of marine species images to illustrate learning objectives of the primary school curriculum: to show curricular contents of animals of Chile, native animals in danger of extinction, examples of a food web, and to analyze human activities in Chilean ecosystems (Table 1). As expected, most of the species used to illustrate marine fauna are fish, likely due to their being the first association people have when thinking about ocean animals. Including more native species and marine biodiversity is a challenge for the development of the next set of national textbooks. It is also notable that images of marine environments are mostly associated with Antarctic ecosystems. While it is very important to know and understand these (especially for world climate change), the Chilean Antarctic territory is a long way from urban centers, and there is little chance that school children and citizens will know it personally. This is reflected in the number of images of different species of penguins and seals (charismatic species), but with few images of the animals of sandy or rocky beach ecosystems, which are the most characteristic and extensive of the Chilean coast and have fauna that may be observed, recognized locally, and even be consumed as food sources. It is important to pay attention to the content and the way students learn about species diversity in school textbooks, keeping in mind that the authors can select the form and graphic content to be represented in the textbooks according to their motivations (Kress et al., 2000) and experience. It is unclear, and not the aim of this study, but there could be an intention to omit the importance of the marine territory and its species, the overexploitation of marine species, and the low priority of their conservation. It could also be due to social and historic unawareness of the value of the ocean and its biodiversity.

Finally, based on the coverage of marine content in the learning objectives of the primary school curriculum and the number and types of marine fauna images in the school textbooks, it appears that ocean topics are not sufficiently covered to address ocean literacy principles. There is no stated emphasis in the curriculum on highlighting the importance of the Chilean coasts and their biodiversity as a significant part of the national identity. Given the conditions, principles, and concepts of ocean literacy (Cava et al., 2005), Chilean citizens have deficient access to formal education for improving ocean literacy.

In line with background information and this preliminary research, the proposals are:

- Support Latin American countries to incorporate ocean literacy principles and concepts into primary school curricula so that objectives of the “Decade of Ocean Science” are reached worldwide.
- Align the Chilean primary education curricular program with international standards of ocean literacy.
- Increase the presence of marine fauna images in school textbooks to engage and acquaint children with the natural environment and its relationship with society.
- Support school textbook curriculum designers with marine science content, to improve the authors’ knowledge and awareness of the ocean.
- Suggest school textbook curriculum designers label animal images with the common and local names of the species, to reinforce species identification and appropriation.
- Incorporate more images of native and endemic marine animals in school textbooks, including flora and fauna that can be observed and recognized in daily life to generate a link and local identity with marine wildlife.
- Improve teacher training to strengthen skills and tools to teach about the ocean in Latin American countries that have only recently begun to discuss ocean literacy subjects.
- Communicate the results of ocean literacy research to the community and educational stakeholders to demonstrate the importance

of improving ocean education in formal education.

- Take advantage of political and social movement opportunities to improve the awareness of ocean protection and measures in the educational system.

CONCLUSION

The present study supports international calls for action to strengthen and implement school educational measures to improve ocean literacy and the urgent need to raise ocean conservation awareness, to achieve the Decade of Ocean Sciences Sustainable Development Goals. Chile belongs to the list of world countries with limited marine science curriculum content in schools. While this research is a first attempt and baseline to analyze ocean coverage in school textbooks in Chile, it is valuable for being the first analysis of marine fauna in the Chilean school system. More learning objectives associated with ocean literacy principles should be included in the next curriculum development, along with more images of native and endemic marine fauna in school textbooks, as an important pedagogical resource to capture schoolchildren's attention at an early age. Marine fauna species are underrepresented compared with terrestrial animals in Chilean school textbooks. However, over a period of fewer than ten years, images of native animals are now predominant over exotic species. This shows a positive change in teaching nature-related topics.

Chile, a coastal country currently considering a National Ocean Policy, must implement educational changes in formal marine education to align with international standards and improve ocean literacy efforts. Latin American countries should follow the example of the United States and Europe, as well as Brazil, which has incorporated ocean literacy principles into its school system.

To have a better understanding of the presence of ocean literacy in the school curriculum and textbooks in Chile, it is recommended that this exploratory research be continued in greater depth; analyzing textbooks of the complete primary and secondary school cycle, integrating the analysis of other important ocean topics such as; marine flora, ocean-climate connection, overfishing, and others. Also, it is relevant to incorporate the analysis of

other curriculum subjects (not only natural sciences), following the detailed analysis of education textbooks such as Mogias et al. (2021), Mogias et al. (2022), and Stasinakis (2021). We hope this research will contribute towards an initial understanding of ocean education in the school system in Chile, and encourage more research on educating and communicating ocean sciences in Latin America.

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AUTHOR CONTRIBUTIONS

C.C.: Investigation; conceptualization; methodology; writing - original draft.

L.C.-U.: Conceptualization; supervision; methodology; review & editing.

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