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Biodiversity is ours: let's take care of it

Handbook for Secondary Schools that Support Marine Life Conservation

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A. Introduction

A.1 The SEA MARVEL project

The project SEA MARVEL is under the Interreg Italia-Malta framework.

The main objectives of this project are:

- to increase the understanding of the risks to the marine ecosystem;
- to mitigate the effects of plastic pollution;
- to make the exploitation of marine resources sustainable;
- to monitor the arrival of alien species (those animal or plant species that come from other environments and pose a threat to native species);
- to assess presence of apex vulnerable predators such as dolphins, whales and turtles in Natura 2000 sites, including the European ecological network for the conservation of natural and semi-natural habitats.

Particular attention is paid to studying the biodiversity of Italian-Maltese waters because, from the analyses of this environment, it is possible to understand how the entire Mediterranean Sea is changing due to climate change and other effects by humans;
The project includes field research and citizen science activities (involving local communities in the research world) to evaluate the presence and distribution of species sensitive to climate change and human activities. Furthermore, the project will make it possible to understand the reality of alien species and the consistency of plastic waste in Natura 2000 sites.

The project is working at the following six Natura 2000 sites:

- Oriented Nature Reserve Oasi del Simeto, located in Catania (Sicily);
- Marine Protected Area Isole Ciclopi, situated in Aci Trezza, in the province of Catania (Sicily);
- Pelagie Islands Marine Protected Area, located in Lampedusa, in the region of Agrigento (Sicily);
- Marine Protected Area “Capo Milazzo”, located in Milazzo, in the province of Messina (Sicily);
- Marine Protected Area around the island of Gozo, situated in the Maltese archipelago (Malta);
- Għar Lapsi and Filfla Marine Protected Area, located in the Maltese archipelago (Malta).

A.2 What this publication is for

This booklet is intended for secondary school students and teachers to understand the topic of biodiversity, to highlight the importance of recognising its beauty and characteristics. This booklet also provides practical ideas for making direct observations of biodiversity and to find solutions to protect the richness of the marine environment.

The publication offers approaches and resources to understand how the European Union (EU) member states have given themselves common rules and shared, quantified objectives to keep natural ecosystems healthy, starting with those inhabited by the most fragile and vulnerable species. In fact, the EU has succeeded over time in building the largest network of protected natural areas, the Natura 2000 network, which is present in all member states and protects increasing portions of their territory.

A.3 How to use

This booklet, is divided into two main parts. The first is dedicated to understanding the concepts of biodiversity, habitat, ecosystem, natural capital, and ecosystem services. The latter refers to all those services that are offered to us by the natural environment.

The second part of this booklet contains ideas and suggestions for three possible activities in the form of challenges that can be organised between either classes in a school or even between different schools.

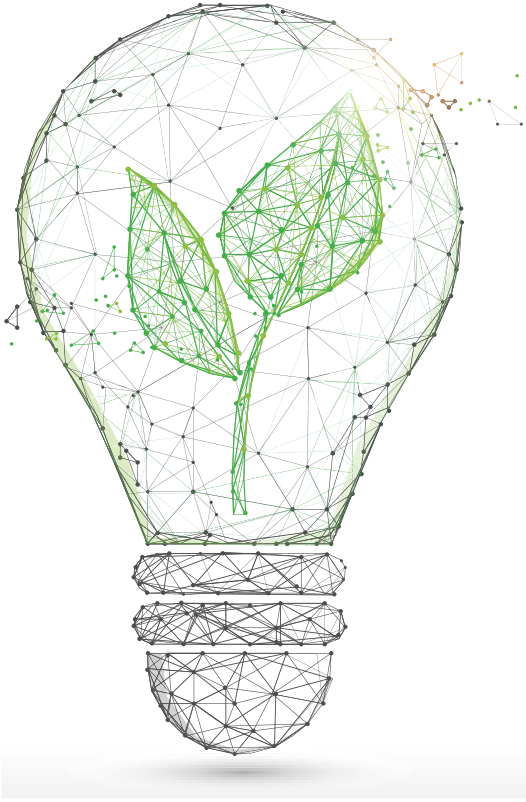
A.4 Challenges Overview

In the proposed challenges, classes may compete by either answering queries or through the preparation of technical papers on the specific proposed topics.
The main themes of the three proposed challenges in this booklet include the following:

Theme I : Communication campaign for the park authority - A park authority asks the class to prepare a communication campaign promoting the local Natura 2000 site network.

Theme II: Begin to act - The challenge involves writing a concrete action plan in which students can play an essential role in protecting biodiversity by promoting actions in which they are personally involved.

Theme III: Describe biodiversity – This will involve preparing a popular article (title, images and content) on mapping animal and plant species in a Natura 2000 site.



B. The Key Themes

B.1 Biodiversity

Biodiversity - a term made up of the words “biological” and “diversity”- denotes the variety of all life forms on Earth: from the most microscopic bacterium to the blue whale to trees that can have lived for millennia.

While women and men working in science have been using this term for a long time, newspapers and television stations began to discuss the topic after the 1992 Earth Summit in Rio de Janeiro, a major event organized by the United Nations (UN) to address environmental protection issues worldwide. On that occasion, people also started talking about ‘sustainable development’, a way of reconciling people’s social and economic needs with maintaining an environment in good condition.

In the Rio de Janeiro Earth Summit, held in 1992, sustainable development was described as a way to meet the needs of today’s populations while ensuring a healthy and viable world to leave to future generations.
This concept respects what many indigenous people have handed down along generations as this ancient proverb:

“The Earth is not an inheritance received from our Fathers, but a loan to be returned to our Sons”.

One of the main agreements signed in the Rio de Janeiro Earth Summit was the Convention on Biological Diversity (CBD),

Diversity of Species in Maltese waters

an international treaty with three main objectives:

- preserving biodiversity
- using it in a sustainable way
- ensure a fair sharing of the benefits arising from the utilization of genetic resources.

The implementation of the CBD is monitored by the Conference of the Parties (COP)[1]. This authority meets every two years to review progress, define priorities for action and decide how to implement them.

Ten years after the *1992 Rio Earth Summit,* in April 2002, a **Strategic Plan** was written to give new impetus to the implementation of the biodiversity commitments, and all the states that signed the agreement committed themselves to achieving a significant reduction in the rate of biodiversity loss by 2010. As we shall see, some of these targets have been completely met, some less so, and some not at all, which is why it is crucial for all citizens and students, to be kept informed about these issues and to have their say on what happens.

B.2 Categories and species

Scientists schematically divide biodiversity into three broad categories:

- **genetic diversity:** the diversity found within the same species that makes it possible for no individual to be identical to another. There may be very similar individuals, but even twins are not identical to each other, there is no blackbird identical to another or no olive tree identical to another olive tree. This maintenance of diversity is the characteristic that allows animal or plant populations to adapt to changing conditions in their living environment;

- **species diversity:** the manifestation of this category is most evident because each plant or animal or other species is different from the other;

1 https://www.cbd.int/cop/

- **ecosystem diversity:** the diversity of ecosystems in which different species live. For example, the sea, forests, deserts or grasslands.

To better understand the term 'species', we can say that it is a group of animals or plants with similar characteristics that can mate with each other and generate fertile offspring. In fact, two animals of different species, such as the donkey and the horse, can mate but they produce an unfertile offspring.

Species can be divided into **subgroups** (subspecies) that consist of individuals even more similar in their characteristics than compared to others of the same species. It is estimated that there are more than 8 million species of plants and animals on Earth. To date, just over 1 million have been examined and studied.

As we said, biodiversity is essential for the survival of life on Earth. Indeed, all species, large and small, are interconnected in a network of highly complex relationships that enable ecosystems to function and maintain a healthy and sustainable environment.

Despite this great richness of species, biodiversity faces many dangers, the most important of which are the loss of natural habitats (e.g., due to urban sprawl or intensive agriculture, or deforestation), pollution, climate change, the spread of invasive species - the monitoring of which is one of the objectives of the SEA MARVEL project - and overexploitation of natural resources. **These factors can cause a reduction in species diversity and the loss of ecosystems that are vital to the survival of human communities and all life forms.**

B.3 The home of all species: the habitat

Another term we need to understand biodiversity better is 'habitat', that is the environment in which plants, animals or other organisms live and grow. Habitats provide the most suitable living

conditions for each particular species, which have different needs from one another. This is why there is a great variety of habitats: different species - those that need heat just as much as those that need cold, those that live by rivers or have become accustomed to living in deserts - that need to find food and shelter there.

Habitats can be very different from one another, depending on climatic conditions, land's surface (e.g., desert or glaciers), and the potential availability of water, heat, or other elements. A habitat or a group of habitats that have relationships with each other can be considered an ecosystem.

B.4 Ecosystem

The word 'ecosystem' combines the terms 'ecological' and 'system'. Ecosystems include all kinds of living things such as plants, animals, bacteria, fungi which constantly interact with each other and which depend on their non-living natural environments such as soil, climate, or water for life.

Mediterranean marine life

Ecosystems can be terrestrial or aquatic and can be of any shape or size. A habitat or a group of habitats that have relationships with each other can also be considered an ecosystem, and several habitats together form a large ecosystem.

Ecosystem functions are the result of living organisms interacting with each other and their environment, which includes processes like exchanging energy and nutrients, as well as decomposition. Moreover, only healthy ecosystems can perform these functions, providing clean water, allowing peatlands (environments where there is an abundance of slow-moving, low-temperature water where plants, almost all herbaceous, grow) to retain carbon, or allow forests to purify the air and soil, or marine environments to produce oxygen and help keep temperatures constant.

If one condition changes within an ecosystem - for example, the temperature rises by a single degree, or the amount of water is reduced - all the species within it must adapt to this change. Let us take the increasingly frequent case of long periods of drought in environments where droughts rarely occur.

What can happen? For example, some plant species that need water disappear, and others show up that can tolerate long periods of water shortage. This change may affect the birds that are dependent on that plant that is no longer there for food or protection, or nesting. Thus, these birds are forced to move to continue to find the conditions necessary for their survival.
In turn, other animal or plant species that were connected to these bird species - either because they fed on them or depended on them for seed dispersal - will undergo significant changes that will, in turn, generate other adaptations in the system.

The same thing happens in the marine environment: changes in temperature and the presence of plastic, waste or pollutants can bring about changes whereby

species that had adapted to live in these waters disappear and species from other environments arrive (so-called alien species) that can severely alter the relationships that existed in this ecosystem.

B.5 An asset of all

The concept of 'natural capital' was proposed to make people understand that everything produced by ecosystems - including water, clean air, timber and nutrients - ensures life on Earth and has an economic value that can somehow be calculated and above all is a common good that must be safeguarded.

For example, when starting an industrial activity, one must consider not only how many economic resources are needed to build and operate the facilities but also those needed to regenerate natural resources, such as clean air or water, that are used in the production cycle.

Many methods can be used to regenerate these resources. One of these is carbon offsetting whereby carbon dioxide is removed from the atmosphere.

Red Starfish (*Echinaster sepositus)*

Carbon dioxide (CO_2) is one of the main greenhouse gases generated during many human activities ranging from industrial production to home heating, from using cars to generating electricity to using aircrafts. Removing CO_2 can be done by planting new trees or using technologies that capture carbon dioxide and do not allow it to escape into the atmosphere.

It is important to realize that the Earth's productive capacity is not infinite, precisely because natural capital and ecosystem services - as we will see in the next section - can be degraded by anthropogenic activities, namely derived directly from humans. The good news is that although the human society is capable of ruining ecosystems, humans can also improve them through actions that keep these systems healthy and balanced.

B.6 Humans and the environment: ecosystem services

The term *ecosystem services* refers to the benefits all populations and people obtain from ecosystems. One example is the production of clean water used for human purposes, the production of food (fruits, fish, etc.), the regulation of the climate (if there were no seas or forests, the climate would change very quickly), the opportunity to experience beautiful and relaxing natural environments[2]. In other words, ecosystems provide essential services that sustain human life and well-being. Other examples are forests that continuously provide wood, food and habitat for wildlife but also absorb carbon dioxide from the atmosphere and regulate the climate. Meadows and green areas provide space for play and recreation, reduce air pollution, and provide habitats for wildlife.

[2] For a more in-depth look at the valuation of ecosystem services in the European Union, please refer to https://publications.jrc.ec.europa.eu/repository/handle/JRC120383

Oceans provide food, clean air and regulate the global climate.
As can be understood, there are various types of ecosystem services grouped into four broad categories:

1. supply or provision service;
2. regulation service;
3. support service;
4. cultural service.

B.6.1 Supply services: Food, timber and fuel

The so-called ecosystem service of *supply* is the provision of goods and resources from ecosystems to meet human needs. These goods and resources can be of a food nature, such as fish, agricultural products or fruits, or of a non-food nature, such as timber, fuels (coal, gas, oil) and other raw materials. This category also includes services that provide clean air, fresh water for human and agricultural uses, and raw materials for producing medicines.

These are fundamental human survival and well-being services, without which, we could not survive on our planet. The problem of over-extraction of resources negatively impacts the ecosystems that produce these services.

It has to be ensured that such activities are done in a sustainable manner. Therefore harvesting of wild resources including fishing has to be sustainable and does not compromise the ecosystems' capacity to regenerate that resource and be available for future generations. To understand this better, let us try to imagine this situation: every year there are 100 sardines that are capable of generating another 100 sardines each. If we fish more than 100 sardines each year, which is how many sardines are produced each year, fewer and fewer will be born until there are no more sardines. This is a very simple example, but it represents what is happening worldwide with overfishing: we take more fish than nature can produce again the following year.

B.6.2 Regulation services

Regulating ecosystem services is the ability of ecosystems to regulate natural processes and maintain the balance of the environment. These services include regulating climate, purifying air and water, preventing flooding, protecting against soil erosion and reducing the impact of natural disasters.

One example is the ability of trees, during photosynthesis, to absorb carbon dioxide from the atmosphere and produce oxygen, thus providing what all living things need to breathe. Marshes and wetlands absorb and filter water, reducing the risk of flooding and improving water quality. Coral reefs and sand dunes provide protection against coastal erosion and storms.

The regulating service is essential for human well-being and the ecosystems' survival. In order to maintain this ecosystem service efficiently it is necessary to keep ecosystems healthy by adopting sustainable agricultural and forestry techniques, reducing pollution and the emission of greenhouse gases such as carbon dioxide as mentioned earlier.

B.6.3 Support services

The *supporting ecosystem service* is the ability of ecosystems to provide a life and survival-friendly environment for animal and plant species. Among these services, the most significant include soil formation, photosynthesis, cyclical food production and exchange between species,

and the creation of habitats for wildlife.

The sustainable management of this service includes the conservation of natural ecosystems, the promotion and increase of biodiversity, and the reduction of negative impacts on communities and the environment.

B.6.4 Cultural services

The ecosystem service of *cultural values* refers to the ability of ecosystems to provide cultural and social benefits to human communities.

This includes the possibility of observing natural landscapes (think of the beauty of waterfalls, the chance to watch a beautiful sunset or the beautiful scenery of the Mediterranean scrub), admiring historical and archaeological sites, or being able to stop in areas of recreation and spirituality.

For example, among the beauties to be admired in Sicily and Malta, there are certainly all the places that are protected and are part of the Natura 2000 site network, which, guarantees the protection of large portions of the territory, and offers visitors a unique experience of immersion in nature and an opportunity

to learn about the history and culture of the place.

The service of cultural values is vital for human well-being, social cohesion and the cultural identity of communities. The sustainable management of this service involves the preservation of natural ecosystems and, above all, encouraging the participation of local communities in managing their territory, which is an asset to all, a common good. It is extremely important for all local communities to be aware of the treasures of their territories and to play a role as custodians of these treasures. ***Citizen science*** is an opportunity for everyone to monitor the characteristics of a natural environment. Through their scientific observations and the sharing of this data with their communities, they can keep an eye on the value of biodiversity, can quickly notice any threats and be able to contribute towards its preservation.

B.7 The State of Nature in Europe

Nature in Europe and all its environments - the seas, mountains, forests and plains - face a major challenge within the next 10 years. The institutions and states of the European Union will have to step up measures to protect it, mitigate the effects of climate change and significantly reduce the consumption of natural resources.

In recent decades, the European environmental and climate policies have helped improve the environmental situation, Nonetheless, everyone's input is required to keep improving and to maintain a good environmental status.

In particular, it is important for all European citizens to be

personally involved in solving these problems, to help reduce pollution, the presence of waste in natural environments, and to personally monitor the condition of ecosystems through observation and information-gathering activities under the name of citizen science. These are activities that the SEA MARVEL project promotes, especially within the Natura 2000 protected sites in Malta and Sicily, along with other activities such as celebrating international days, cleaning up litter, and activities to inform local communities about the importance of biodiversity.

B.8 The EU and Biodiversity

The European Union is committed to protecting and preserving biodiversity and has recently drawn up the Biodiversity Strategy, which has 2030 as its targets. The goal is to achieve major improvements for natural environment and, consequently, for people, the climate and the entire planet. The strategy, consisting of a set of goals and the actions needed to achieve them, is part of an even more important project called the European Green Deal. This deal aims to guarantee economic and social growth for all European citizens while ensuring that the environment remains in good condition.

B.8.1 The most important acts

The 'Birds Directive'[3] which dates back to 1979 is the European Union's oldest environmental

[3] https://eur-lex.europa.eu/IT/legal-content/summary/conservation-of-wild-birds.html#

Scopoli's shearwater (Calonectris diomedea)

law. It was intended to protect all 535 species of wild birds naturally occurring in the EU but focused mainly on 195 species and subspecies of birds that required special protection of their habitats. For this reason, all EU member states were asked to identify the areas where these species live and breed to protect them even more. In this way, a network of ***Special Protection Areas*** (SPA) was established that includes all the territories most suitable for the survival of these bird species.

The 'Habitats Directive'[4] was adopted in 1992 and ensures the conservation of 1780 animal and plant species and 233 habitat types. For many species and habitats listed in the directive, EU Member States must identify and designate Special Areas of Conservation (SAC) to ensure that each habitat type and species is effectively protected throughout the EU.

The areas that are particularly affected by the two directives constitute the Natura 2000 Network, which covers all the countries that are part of the European Union and is a unique vantage point of the beauty of the European natural world.

B.8.2 Natura 2000

Over time the Natura 2000 network has become the world's largest network of protected areas. It aims to safeguard Europe's most valuable and threatened species and natural habitats through a selection of Natura 2000 sites and boundaries carried out by the EU member states.

To date, 2639 sites in the Natura 2000 network have been identified by the Italian Regions. In particular, 2360 Sites of Community Importance (SIC) have been identified, of which 2302 have been designated as Special Areas of Conservation (SAC), and 639 Special Protection Areas (SPA), 360 of which are type

[4] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:IT:PDF

C sites, that is, SPA coinciding with SIC/SAC (source: https://www.mase.gov.it/pagina/sic-zsc-e-zps-italia , 11/05/2023).

Natura 2000 sites in Italy protect a total of 132 habitats, 91 species of flora and 120 species of fauna (including 22 mammals, 10 reptiles, 17 amphibians, 29 fish, 42 invertebrates) under the Habitats Directive, as well as about 385 bird species under the Birds Directive. These Directives form the nub of EU policy on biodiversity conservation.

Malta has a total of 326 protected areas, 55 Natura 2000 sites - 22 Special Protection Areas (Birds Directive) and 40 Sites of Community Importance (Habitats Directive) - as well as 271 sites designated by national laws. The Network consists of more than 27,000 natural sites - of which detailed information can of each be obtained using the *viewer* developed by the European Environment Agency at this address https://natura2000.eea.europa.eu/ - which are located in all Member States, and cover just under 20% of the entire territory of the EU and almost 10% of all the seas that are part of the national waters of the Member States.

The Blue Lagoon in Comino Island, Malta.

B.8.3 Strategy 2030 for Biodiversity

The ***EU Biodiversity Strategy 2030***[5] is a very comprehensive, ambitious long-term plan to protect nature and reverse ecosystem degradation. The strategy aims to increase the quality of Europe's biodiversity by 2030 and includes specific actions and commitments, mainly in response to the most serious threats to biodiversity.

The strategy includes specific commitments and actions to be realized by 2030, including:

- the expansion of the network of protected areas that are part of the Natura 2000 network

- the launch of a very important plan to restore environments that are currently degraded (exemple, those where there have been fires or are affected by desertification processes, those where there have been fires or are affected by desertification processes)

- implementing actions to improve biodiversity, such as those planned at diplomatic level, to bring those states that are not currently collaborating onto the path of biodiversity protection.

[5] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_it

B.9 Threats to biodiversity

Several factors seriously endanger the richness of biodiversity, the main ones being:

- **The loss and degradation of natural habitats:** destruction and fragmentation of habitats constitute a problem for animals having to move from one area to another in search of food or new territories to inhabit and the degradation of specific habitats due, for example, to desertification processes (20% of Italian territory is at risk of desertification) or the melting of glaciers;

- **Climate change:** global warming and rising sea levels are the most obvious consequences of climate change, but there are also other less obvious effects, such as ocean acidification and hotter, drier summers that can increase the frequency of fires;

- **Alien species:** some species - introduced by humans or moved autonomously because they have found better living conditions - may compete with local species for resources and habitats, compromising the native species' ability to survive;

- **Overexploitation of resources:** overfishing and hunting, mining, intensive agriculture and pollution can deplete natural resources, generating major imbalances in the food chain of an ecosystem, causing loss of biodiversity;

- **Pollution:** Air, water and soil pollution can affect living organisms' health and reduce their ability to survive. Pollution can also alter natural habitats and interactions between species.

B.9.1 Climate Change

Global climate change has been recognized as a factor influencing marine ecosystems and is causing significant changes in the distribution, habitat and migrations of many marine species. Apex predators, cetaceans, play an important ecological role in marine environments and are widely recognized as indicator species of ecosystem well-being. The study and understanding of the potential consequences of climate change on cetaceans is essential to determine which species and populations are most vulnerable and which require conservation actions.

Research aimed at understanding cetacean distribution allows us to gain knowledge on the spatio-temporal effects of climate change on marine biodiversity. From 1997 to today, around the Maltese Islands, in a research area of 120,000 km^2, all the species of cetaceans have been studied and monitored annually by the Conservation Biology Research Group of the University of Malta and with the assistance of volunteers of the Biological Conservation Research Foundation (BICREF). This type of monitoring and research may allow for the development of effective and timely management of anthropogenic activities in support of marine Natura 2000 sites and their conservation targets.

Saddled seabream (Oblada melanura)

B.9.2 Invasive alien species

These are non-native species (that is species that are not native to a given place or habitat), often with no predators to keep their populations balanced. They can cause extensive damage to native species to that environment by competing with them for food, expanding rapidly and causing severe losses to biodiversity. The Mediterranean Sea is, unfortunately, rich in animal and plant alien species, which have found optimal living conditions here due to changes in environmental conditions.

B.9.3 Indiscriminate withdrawals

Unsustainable use of natural resources occurs when harvesting exceeds the reproductive capacity of plants, animals or wild ecosystems. Europe's use of its biological resources exceeds its ability to reproduce. For example, fish resources are at serious risk from overfishing, which is the overharvesting of a specific fish species caught faster than it can reproduce.

Loggerhead sea turtle (Caretta caretta)

B.9.4 Pollution

Pollution from anthropogenic activities is a significant cause of biodiversity loss. For example, intensive agriculture severely impacts the balance of the ecosystem: the use of pesticides and herbicides results in the elimination of insects and plants that are harmful to agriculture but essential for the life of other species. Likewise, the fertilizers used often result in very high nutrient loads from cultivated fields into groundwater and the sea, introducing nitrogen and phosphorus that modify the chemical composition of the environment, compromising its health.

C. Biodiversity in Sicily and Malta

All the world's islands have similar but, at the same time, unique characteristics because they were formed at different ages and had very different geographical situations, environments and levels of isolation.

These characteristics have meant that the evolution and genetics of some species, both animal and plant, followed different trends than similar species but living in areas connected to the mainland, especially on small and distant islands. This condition is common to Malta and Sicily and their individual reefs and islets. In fact, if we focus on some species, even those that appear most common, we realize that Maltese territory and much larger Sicily have evolved differently and have taken on sizes, colourations, habits and behaviours not found elsewhere. Among the species that have diversified and thus adapted more than others are the terrestrial reptiles. This is because reptile species not flying

Salema (Sarpa salpa)

and unable to swim (apart from a few exceptions such as sea turtles) have remained isolated for millions of years in areas that were often really small, such as those of an islet or even a stack (a large rock in the middle of the sea, uninhabited and without any connection to the island itself). Consider that islands represent only 5 per cent of the entire land mass. Still, they harbour and provide suitable habitats for the survival of 17 per cent of the species of plants and birds on Earth.

Loggerhead sea turtle (Caretta caretta)

Have you ever wondered why all classified living species have two names: a scientific one and a so-called vernacular one? The scientific name is the same in all languages of the world, as it enables scientists to identify that precise species they are talking about. It consists of two Latinized names written in italics; the first, with a capital initial, refers to the genus, the second specifying the species has a lowercase initial. The so-called vernacular name changes from language to language and often from region to region within the same country. Therefore, it would not allow for the exact identification of the species.

Another term that is important to learn is *endemic*, which is an attribute given to organisms living exclusively in a specific territory.

C.1 Sicily

Sicily is one of the richest territories in terms of biodiversity in the Mediterranean basin, an extraordinary richness in diversity envied by the whole world often taken for granted.
Not everyone knows that in Sicily one may find:

- 24 reptile species;
- 5 species of amphibians;
- 155 species of nesting birds, and approximately another 80 species of migratory passage birds;
- 43 species of mammals, of which 20 species are Chiroptera (a scientific classification of an order of bat species).

For example, near Aci Trezza the Nature Reserve of Lachea Island and Cyclops Rocks, established in 1998 by the Region of Sicily, is home to a lizard named in Latin, *Podarcis sicula ciclopica*. At first sight, it looks like an ordinary lizard, but this reptile lives exclusively on this tiny island surrounded by the sea.

And this fact, in connection with what we described earlier about the fragility of ecosystems, speaks volumes. If, for some reason, the environment in which this lizard lives changes, it is not difficult to imagine that this species would find difficulty in living in its natural habitat and would probably become extinct given that is only present on an isolated rock.

Lava rocks and Lachea Island in the Marine Protected Area "Isole Ciclopi", Aci Trezza, Sicily.

The richness of Sicilian biodiversity in avifauna, i.e., bird species, can be represented by multiple species such as Bonelli's eagle (*Aquila fasciata*), whose breeding population has increased after many years of activism against poaching, the Lanner falcon (*Falco biarmicus*), a small hawk also highly threatened by humans, which is very difficult to see because it nests in very high rock walls inside which it camouflages itself with its colors, and the White stork (*Ciconia ciconia*), which has more than 60 stable pairs during the breeding season, many of which are found in the Gela Plain area and some in the Catania plain. Other Sicilian breeding species, characterized by their bright colors, are the European roller (*Coracias garrulus*) and the European bee-eater (*Merops apiaster*). In addition, Sicily represents an oasis for migrating species, many of which stop during the winter in the so-called wintering period. Some examples are the Eurasian hoopoe (*Upupa epops*), with its very fast flight, the unmistakable Northern lapwing (*Vanellus vanellus*), and the very long-

White stork (Ciconia ciconia)

range migrant European golden plover (*Pluvialis apricaria*).

But Sicily's incredible wealth of biodiversity can also be found in its sea, and its well-known shoals: the submerged mountains that start from the depths of the sea and reach just a few meters from the surface. Researchers from ISPRA (the Italian National Institute for Environmental Protection and Research) have studied these environments in depth, obtaining fascinating results. They have explored Banco Graham di Pantelleria, Banco Avventura and Banco Terribile to understand biodiversity around Sicily.

During explorations, 150 different animal and plant species were found under the surface, of which

18 are protected, 31 are sensitive by international conventions, and 13 are considered protected environments.

Cushion coral (*Cladocora caespitosa*)

The survey of data on protected species in the Sicilian seas made it possible to find information on 123 protected species, including plants, sponges, cnidarias, molluscs, crustaceans, echinoderms, fish, reptiles, birds and mammals.

But it is important to remember that in the Sicilian Sea, there are shoals of large madrepores (a particular order of corals), which are similarly beautiful as the madrepores found in tropical seas, such as those belonging to the species *Cladocora caespitosa*, in Italian called "Madrepora a Cuscino".

The seas surrounding Sicily are rich in cetacean species, from the coastal *Tursiops truncates* also commonly called the Bottlenose dolphin, to the more pelagic Sperm whale (*Physeter macrocephaly*) which is the largest living animal with teeth. Other resident cetacean species include the Fin whale (*Balaenoptera physalus*), Striped dolphin (*Stenella coeruleoalba*), Common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), Long-finned pilot whale (*Globicephala melas*) and Cuvier's beaked whale (*Ziphius cavirostris*). Sightings of Rough-toothed dolphin (*Steno bredanensis*), and False killer whale (*Pseudorca crassidens*) are occasional. It should be mentioned that rarer species such as the Orca (*Orcinus orca*), the Dwarf sperm whale (*Kogia sima*) and the humpback whale (*Megaptera novaeangliae*), have also been observed.

In addition, the Monk seal (*Monachus monachus*), has

always been present in the Sicilian waters. This species has been hiding in the most remote places but is now being recorded more frequently, and has prompted research societies, to start a specific projects aimed at collecting information for this species around Sicily.

Also of great importance is the presence of the Loggerhead sea turtle (*Caretta caretta*), not only as a massive presence in the seas surrounding Sicily but also as an increase in the number of laying sites along Sicilian beaches. Such marine reptiles, together with the large leatherback turtle (*Dermochelys coriacea*), demonstrate the rich biodiversity of these seas, which was already known in the 1700s. At that time, the Strait of Messina was considered the *"paradise of zoologists"* as the unique oceanographic conditions generated by the constant alternation of tidal currents and of the upward motions of the waters, combined with a great heterogeneity of the seabed, made it so that scholars, coming from different parts of the world, came to the shores of the Strait, to study abyssal fish which systematically were and still are stranded alive. This gave the possibility of finding rare species directly on the beach, instead of carrying out expensive and demanding oceanographic campaigns in the depths of the sea. This framework of Sicily's marine resources makes clear the importance of protecting such a valuable natural heritage and encourages reflection on the urgent implementation of effective environmental protection and preservation strategies, both locally and at the regional, European-Mediterranean level.

Loggerhead sea turtle (Caretta caretta)

C.2 Malta

The Maltese archipelago is located in the central Mediterranean and approximately 93 km south of Sicily and 290 km north of the African continent, and consists of a group of three islands, Malta and the two smaller islands of Gozo and Comino, together with a series of smaller uninhabited islets, which are found scattered around the 271 km long coastline of the main island. Islets such as Filfla, St. Paul's Islands and Fungus Rock are of a very high conservation value in that each harbours endemic species, as well as distinct plant communities.

With a relatively small land area of 316 km², Malta displays an interesting variety of flora and fauna on the islands and its surrounding water. Malta's isolated yet central position in the Mediterranean has led to some species exhibiting elements of Western Mediterranean, Eastern Mediterranean, and North African and Sicilian affinity. The historical interchange of species has particularly influenced the composition of plants and animals that currently inhabit the Maltese Islands. The urban fabric, which covers around 22.3% of land area, is also important for certain species that have managed to adapt to living alongside man and use man-made structures as refuges. Such species include various species of birds, bats and reptiles but also several invertebrate species.

Across the Maltese Islands, 29.12% (92 km²) of the land area are considered as protected areas, of which over 43.6 km² form part of the EU Natura 2000

Warty crab (Eriphia verrucosa)

network. Malta's marine Natura 2000 network encompasses 18 sites and covers over 4100 km², equivalent to more than 35% of Malta's Fisheries Management Zone.

Malta's indigenous flora amounts to some 1,200 species of flowering plants with around 25 strict endemics. The endemic - Maltese Rock Centaury, Maltese Cliff-Orache and Maltese Everlasting - are included amongst the top 50 Mediterranean sland plants at the brink of extinction.

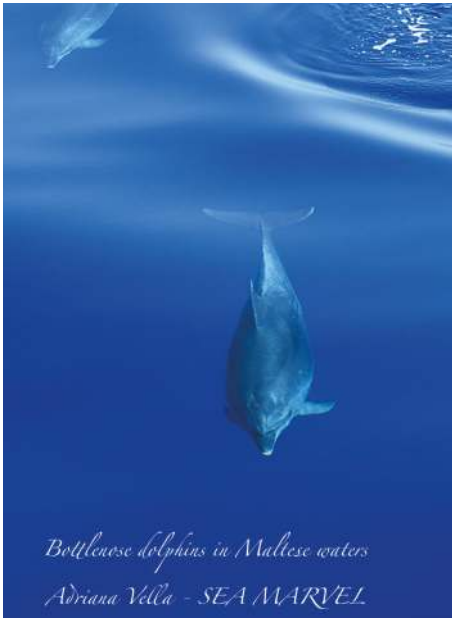
Some animal species in Malta are worth mentioning. Certainly, the Maltese freshwater crab (*Potamon fluviatile* ssp. *lanfrancoi*), the Maltese top-shell (*Steromphala nivosa*), the Maltese wall lizard (*Podarcis filfolensis*), the Mediterranean chameleon (*Chamaeleo chamaeleon*), the Painted frog (*Discoglossus pictus*), the Turkish gecko (*Hemidactylus turcicus)*, the Algerian whip snake (*Coluber algirus*) that probably entered the island on some cargo ship from Africa, the Western whip snake (*Coluber viridiflavus*), the Cat

Chameleon (Chamaeleonidae)

snake (*Telescopus fallax*) the only species of venomous snake found in Malta. Malta is home also to a subspecies of the Sicilian shrew (*Crocidura sicula* ssp. *calypso*) which is endemic to the island of Gozo. Some other interesting endemic species for Malta include the Maltese field beetle (*Pimelia rugulosa* ssp. *melitana*), the Meadow brown (*Maniola jurtina* ssp. *hyperhispulla*) and the Swallowtail (*Papilio machaon* ssp. *melitensis*). While in terms of flora, it is important to mention numerous species of orchids, including the Maltese pyramidal orchid (*Anacamptis urvilleana*) and the Maltese everlasting (*Ophrys melitensis*).

The importance of Maltese biodiversity has been echoed in various works, with authors expressing the necessity to safeguard the country's natural heritage. Benefits derived from ecosystem services, such as provision of food and raw materials, freshwater and clean air, are indeed considered to be indispensable life-support services. These greatly contribute to the human well-being and quality of life of the Maltese population.

The waters of the Maltese Archipelago are clean and very rich in species of fauna and flora; such richness makes fishing for Malta a vital activity, just think that once, in the local currency (the Maltese lira), the Common dolphinfish *(Coryphaena hippurus)* was depicted, as this species was a a symbol of the richness of the island's fisheries. In addition, the beautiful seabed and a number of shipwrecks surrounding the archipelago has led to the emergence and development of more and more diving centres. But it is essential to understand that the characteristics of such a rich marine environment present highly favourable conditions for the life of numerous species of marine mammals. Among them, the Bottlenose dolphin *(Tursiops truncatus);* the Common dolphin *(Delphinus delphis)* and the striped dolphin *(Stenella coeruleoalba)* which is constantly present in pelagic waters, feeding on small fish, cephalopods and marine crustaceans. The striped dolphin is a very fast and elegant dolphin, capable of performing great leaps and aerial acrobatics and often approaching sailing



Bottlenose dolphins (Tursiops truncatus)

boats, swimming alongside them. In the same aquatic environment, there is the seasonal presence of the Fin whale *(Balaenoptera physalus),* which, at certain times of the year, especially in the spring months, with the growth of plankton *(krill),* approaches the coast to feed on them. The deeper, more offshore waters, on the other hand, one may find the Sperm whale *(Physeter macrocephalus)* which is the largest extant odontocete, which is capable of diving to considerable depths to prey on the giant cephalopods found in large quantities in these waters. Another species capable of deep and long dives is the Cuvier's beaked whale *(Ziphius cavirostris),* which dives where depths exceed 600 to 800 meters to feed on cephalopods. Another vital presence is that of the Long-finned pilot whale *(Globicephala melas),* a beautiful black cetacean that can often be observed far from the coasts and with calm sea conditions, stays on the surface, keeping its head above water and watches the area around it, in the classic behaviour called "spy hopping." Such behaviour is also typical of the Risso's dolphin

Risso's dolphin (Grampus griseus)

(Grampus griseus), which is characterized by a grey and "scratched" colouration; these scratches are actually streaks that, as the years go by, increase more and more, until the longer-lived individuals become almost completely white, especially in some parts of the body, such as on the head.

In addition, over the decades, other rare species have been observed in these waters, such as the False killer whale

(*Pseudorca crassidens*), and the humpback whale *(Megaptera novaeangliaea).*

Among sea turtles, the most common species is the Loggerhead sea turtle (*Caretta caretta*), which is easily observed throughout the waters surrounding the archipelago and nests on the islands beaches. Uncommon is the Green turtle (*Chelonia mydas*), and the Leatherback turtle (*Dermochelys coriacea*) is extremely rare and is the most giant existing sea turtle with a length up to two meters.

Finally, the vast presence of the European storm petrels (*Hydrobates pelagicus*) in Malta should be highlighted regarding marine avifaunaas half of this species' world population resides there. Among the species that nest on the Maltese Islands are the shearwaters, including the Scopoli's shearwater (*Calonectris diomedea*), of which 3 per cent of the world's population is found in the archipelago, the Cory's shearwaters (*Calonectris borealis*), and the lesser Yelkouan shearwaters (*Puffinus yelkouan*), which in large groups fly almost continuously, skimming the sea surface. The local population in Malta accounts for 10 per cent of the world's population. Finally, the Yellow-legged seagull (*Larus michaellis*), the most giant resident breeding bird in the Maltese Archipelago.

Cory's shearwater (Calonectris borealis)

Loggerhead sea turtle
(Caretta caretta)

D. What can we do?

In view of the immense biodiversity and the constant anthropogenic pressures threatening this diversity means one crucial thing: we have to rethink our relationship with the planet and find balance to allow humankind and all other animal and plant species to survive.
Scientists agree that the three most important actions to start living in balance with nature and in a sustainable way are:

1. Transforming food production and consumption so that we produce enough for everyone but in a sustainable way. This can be achieved even by making some changes at home and during our every day life choices, such as: eating a more plant-based diet, choosing food that has not been produced in a way that causes deforestation, and consuming locally produced foods that are not packaged using plastics.

2. Address climate change by reducing greenhouse gas emissions and investing in alternative renewable energy. We can also tackling climate change by reducing greenhouse gas emissions through the use of alternative renewable energy. At home we can also reduce waste, use energy-efficient appliances, favor suppliers of electricity that use renewable sources and make less use of private cars.

3. Support biodiversity by actively slowing climate change and protecting wildlife from its effects. Apart from taking actions towards reducing greenhouse gas emissions which reduces the impacts of climate change on biodiversity, we can further support biodiversity by taking part in citizen science activities. Through citizen science activities one can participate in biodiversity monitoring and share the collected data on specific citizen science platforms. One can support conservation scientists by reporting sightings of vulnerable species such as dolphins, whales and turtles.

E. Challenges

E.1 Challenge 1

Theme of the challenge: Communication campaign for the park authority

A park authority commissions a communication campaign to promote the local Natura 2000 site to publicize its richness and variety of animal and plant species and habitats. Produce the proposal accompanied by images of the logo and some hypotheses for an advertising product (poster, playbill).

Tips and operational hints

To set up an effective communication campaign to enhance and protect a Natura 2000 site the following criteria should be taken into account:

Know your target audience: it is essential to understand the audience you intend to reach with your communication campaign. This helps determine the campaign's right tone, language and visual style.

Identify campaign objectives: it is crucial to define the objectives of the communication campaign, both at a general and specific level. For example, the general objective could be to increase public awareness of the importance of Natura 2000 sites, while the specific objective could be to encourage visitors to respect the fauna and flora present.

Choose a catchy title: the title of the communication campaign must be short, catchy and easy to remember. In addition, it must capture the audience's attention and communicate the campaign's core message.

- **Use appealing images:** the images used in the communication campaign must be of high quality and effectively represent the landscapes, fauna, and flora of the Natura 2000 site. In addition, they must be able to arouse positive emotions in the audience.
- **Creating an effective slogan:** the slogan must be short, easy to remember and communicate the campaign's main message. In addition, it must evoke an emotion in the audience and move it to action.
- **Write clear and informative texts:** texts must be clear, informative and easily understood by the audience. In addition, they must be able to communicate the campaign's main message effectively.
- **Use the right communication channels:** choosing the right channels to reach the target audience is essential. For example, the campaign could use social media, online or offline advertising, or experiential marketing activities.
- **Involve the local community:** involving the local community can help create a sense of ownership of the Natura 2000 site and encourage people to participate in the communication campaign.

E.2 Challenge 2

Challenge theme: Take action

Often, even in protected areas and Natura 2000 sites, there is a need for greater animal or plant species protection, or there are large quantities of waste that can compromise the ecosystem's functionality. The second challenge's theme is therefore geared towards drawing up a real action plan in which individuals can play an important role in protecting biodiversity, promoting actions in which they are personally involved, but with the aim of also involving other representatives of their community.

Tips and operational hints

- **Identify the main characteristics** of the site you intend to enhance by accessing the European Union's online databases (if it is a Natura 2000 Network site). If it is not a protected area and there is no online data already available, a local bibliographic search or field research (at least for certain animal and plant species) can be carried out to understand the biodiversity present.
- **Highlight the main threats** to the site and the species it hosts (this could be the presence of litter or pollution, excessive anthropic pressure or the presence of too many motor vehicles or motorbikes, paths that ruin fragile habitats).
- **Identify short-term and long-term improvement goals** (example, in the short term, clean the whole area of waste; in the long term, reduce or eliminate the source of waste in that area).

Devise the most suitable means of achieving the action plan's objectives, starting with what is considered a priority, namely: involving students or other community representatives in this operation.

Experimenting with the identified tools and their direct application in the field.

Understand how you can measure whether you get results or not. This is very important to fine-tune the tools. In fact, if we realize that a particular action, we had planned does not achieve the expected results, it is good to change it and try another one.

Communicate the results to the whole community. Signs can be made to be put up, letters sent to local authority representatives (mayor, councillors), but also letters sent to newspapers and television stations to explain what the Action Plan is all about.

E.3 Challenge 3

Challenge theme: Describing biodiversity

A park authority commissions a communication campaign to promote the local Natura 2000 site to publicize its richness and variety of animal and plant species and habitats. Produce the proposal accompanied by images of the logo and some hypotheses for an advertising product (poster, playbill).

Tips and operational hints

To set up an effective communication campaign to enhance and protect a Natura 2000 site the following criteria should be taken into account:

- **Know your target audience:** it is essential to understand the audience you intend to reach with your communication campaign. This helps determine the campaign's right tone, language and visual style.
- **Identify campaign objectives:** it is crucial to define the objectives of the communication campaign, both at a general and specific level. For example, the general objective could be to increase public awareness of the importance of Natura 2000 sites, while the specific objective could be to encourage visitors to respect the fauna and flora present.
- **Choose a catchy title:** the title of the communication campaign must be short, catchy and easy to remember. In addition, it must capture the audience's attention and communicate the campaign's core message.

- **Use appealing images:** the images used in the communication campaign must be of high quality and effectively represent the landscapes, fauna, and flora of the Natura 2000 site. In addition, they must be able to arouse positive emotions in the audience.

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- **Involve the local community:** involving the local community can help create a sense of ownership of the Natura 2000 site and encourage people to participate in the communication campaign.

F. Resources

F.1 Biodiversity and the environment

Some important sources of information are:

• The most up-to-date system on biodiversity data in the European Union (https://biodiversity.europa.eu/): the Biodiversity Information System for Europe, a collaboration between the European Commission (the EU"s governing body) and the European Environment Agency.

• The European Environment Agency (https://www.eea.europa.eu/) contains the most critical and up-to-date information on the environment in all member states;

• A viewer of the 27000 sites of Natura 2000 sites (https://natura2000.eea.europa.eu/): a tool through which detailed information on all areas of the Natura 2000 network can be obtained.

F.2 Environmental Education

There is a wide range of resources for environmental education which are listed here:

• Public educational resources (https://natureforall.tiged.org/discovery/resources/?btnSearchFilters=Search): a range of resources in different languages on nature-related topics from different countries.

• Education for Sustainable Development in Biospheres Reserves and other Designated Areas (https://mio-ecsde.org/protarea/book/Final_ESD_in_BRs_in_one_file.pdf): a resource document in English

for educators, focusing on the functioning of ecosystems, biosphere reserves and sustainable development within them.

F.3 Citizen science

EU-citizen. science (https://eu-citizen.science/): platform reporting on current and past citizen science projects within the EU iNaturalist (https://www.inaturalist.org/) is a joint initiative of the California Academy of Sciences and the National Geographic Society to share scientific experiences also with reports via App

Ornitho (https://www.ornitho.it) is the typical information platform of Italian ornithologists, birdwatchers, and many national and regional ornithological associations whose aim is the study and conservation of birds, birdwatching and their promotion.

BioBlitz (https://www.bioblitzitalia.it) is an educational citizen science activity in which scientists, families, students, teachers and other community members work together in nature to find and identify as many living species as possible. Includes “Blue Bioblitz” section on marine biodiversity.

Observation.org (https://observation.org) is a platform to share species observations and scientific experiences on global biodiversity.

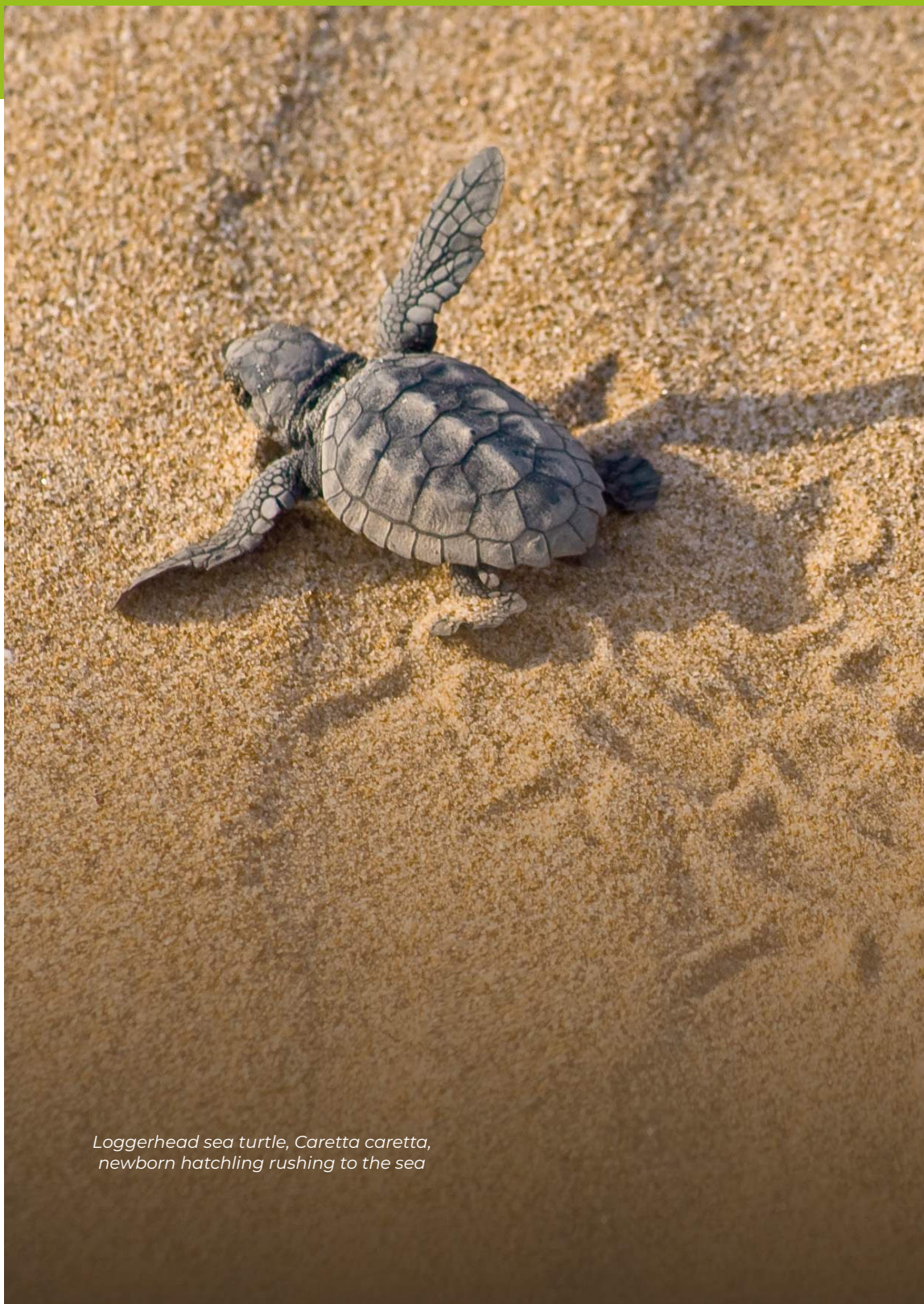
BICREF (The Biological Conservation Research Foundation) (https://bicref.org.mt/notices-to-mariners/) it is a nonprofit non government organisation and it has facilitated the reporting of dolphins, turtles and other marine species by filling in the sighting report at the link provided.

F.4 European Initiatives

At the European level, there are many exciting and challenging initiatives and educational programs, including:

- Eco-Schools Network (https://www.ecoschools.global/national-offices): includes many European schools with many useful materials, activities, and festivals, dedicated to biodiversity;

- MEdIES (https://medies.net/): the Mediterranean Initiative for Environmental Education and Sustainability, a network of 6000 educators and hundreds of schools throughout the region.



Loggerhead sea turtle, Caretta caretta, newborn hatchling rushing to the sea

Università di Catania

L-Università ta' Malta

This publication, produced within the SEA MARVEL - Save, Enhance, Admire Marine Versatile Life project funded by the Interreg Italia-Malta program, is aimed at pupils and teachers of secondary schools, offering support to understand the theme of biodiversity, its importance and its beauties with specific focus on Sicily and Malta. It illustrates key concepts and also serves to understand how the European Union has set itself common rules and objectives to keep natural ecosystems healthy and establish the Natura 2000 Network, the largest network of protected areas in the world. This booklet offers operational ideas for three challenges that can be organized between different classes or schools.

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