

Forum: United Nation Environment Programme

Issue: Evaluating the presence of invasive species in water bodies across the Mediterranean Sea

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Introduction

A globally growing concern, [invasive species](#) can greatly impact areas, causing devastation to biodiversity and benthic community structure. These species are able to outcompete [native species](#) for food and space, impeding [local faunal and floral](#) species and eventually even replacing them. It is difficult to predict when an [alien species](#) will become invasive, as it does not always happen. Generally, the invasion process consists of several major stages, from the transport of a species into new [habitats](#) to its establishment and eventual spread. Each of these stages is limited by a set of barriers that will determine whether or not the species will move on to the next stage in the invasion process and finally become an invasive species.

The Mediterranean Sea is a hotspot of marine biodiversity with >17,000 reported marine species, of which approximately one fifth are considered to be [endemic](#). Such increased endemism and high species richness makes the Mediterranean Sea one of the world's biodiversity hotspots. However, Mediterranean marine [ecoregions](#) are amongst the most impacted ecoregions globally, due to increasing levels of human threats that affect all levels of biodiversity, severe impacts from [climate change](#), and [biological invasions](#).

Marine invasive species are regarded as one of the main causes of [biodiversity loss](#) in the Mediterranean, potentially modifying all aspects of marine and other [aquatic ecosystems](#). They represent a growing problem due to the unprecedented rate of their introduction and the unexpected and harmful impacts that they have on the environment,

economy and human health. Invasive species have become such a threat that more than 5% of the marine species in the Mediterranean are now considered non-native species. This is a general phenomenon that extends to all regions of the Mediterranean. This amounts to over 986 alien species in the Mediterranean, of which 775 were found specifically in the eastern Mediterranean. It reaches a maximum of 129 species per 100 km², and declines toward the north and west. It is vital that we track the spread of these invasive species, in order to preserve community structures endemic to the Mediterranean.

Definition of Key Terms

Invasive Species

The Executive Summary of the National Invasive Species Management Plan (NISMP) defines the term invasive species as “a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.”

Habitat

According to an article by the National Geography habitat is defined as “a place where an organism makes its home. A habitat meets all the environmental conditions an organism needs to survive.”

Native Species

According to Chris Parks, author of *A Dictionary of Environment and Conservation*, a native species is “A species that is within its known natural range, and occurs naturally in a given area or habitat, as opposed to an introduced species or invasive species. Also known as endemic species, indigenous species.”

Endemic

According to the World Health Organization, endemic refers to “the constant

presence and/or usual prevalence of a disease or infectious agent in a population within a geographic area.”

Ecoregions

According to the UN, ecoregions refers to “homogeneous area of one or more ecosystems that interact with relatively self-contained human activities.”

Climate Change

Climate change has been defined by The Wired as “the shift in worldwide phenomena associated with an increase in global average temperatures.” Although the term global warming is more often used to describe this phenomenon, most scientists prefer to use the term climate change since this term indicates the change, not only in temperature but also in the effects the climate has due to climate change.

Biological Invasions

According to the Smithsonian Environmental Research Centre, biological invasions are “a major force of change, affecting many dimensions of life on Earth.” Invasions result when species colonize new geographic regions, which are disjunct (isolated) from existing populations. Humans have dramatically altered invasion dynamics, especially with the global expansion of trade in modern times

Biodiversity Loss

According to the Britannica, biodiversity loss is “a decrease in biodiversity within a species, an ecosystem, a given geographic area, or Earth as a whole.” Biodiversity loss describes the decline in the number, genetic variability, and variety of species, and the biological communities in a given area. This loss in the variety of life can lead to a breakdown in the functioning of the ecosystem where decline has happened.

Aquatic Ecosystems

According to S.J. Marshall, in ``Reference Module in Earth Systems and Environmental Sciences, 2013, “aquatic ecosystems support a wide range of organisms, including microorganisms, invertebrates, insects, plants, and fish.”

Alien Species

According to Thomais Vlachogianni Alien species are “species, often referred to as non-native, non-indigenous or exotic species, are plants, animals, fungi and microorganisms that have been transported inadvertently or intentionally, across ecological barriers and have become established in areas outside their natural range”

Vector

Any living or non-living carrier that transports living organisms intentionally or unintentionally.

Flora and Fauna

According to the UN, flora refers to “all plant life” and fauna represents “all animal life”

Eutrophication

According to the OECD (Organization for Economic Cooperation and Development), eutrophication is defined as “an enrichment of water by nutrient salts that causes structural changes to the ecosystem such as: increased production of algae and aquatic plants, depletion of fish species, general deterioration of water quality and other effects that reduce and preclude use”

Key Issues

The Loss of Biodiversity

The Mediterranean Sea, despite representing a small part of the world’s oceans, is inhabited by an unusually rich and diverse biota. It hosts approximately 17,000 species,

hosting 4–18% of the world's marine biodiversity

The impacts of alien species on biodiversity may be categorized according to whether their introduction has had negative, positive or no impact on native biota. In most cases alien species have harmful effects on native biota. Some of the negative impacts of invasive species are significant, insidious, and usually irreversible, with implications either on individual species or at population and community levels.

They may significantly alter ecosystem functions and processes, which perhaps are the most damaging. Alteration of habitat forms or functions, such as changes of the water table level, soil properties (nutrients, nutrient cycles, pH), fire regime or vegetation structure, can make habitats unsuitable for native species, but not for alien species.

At population and community level, invasive species may out-compete native species, repressing or excluding them, indirectly transforming the structure and species composition of the ecosystem by changing the way in which nutrients are cycled through it.

Invasive species may also affect native species by acting as vectors of pathogens, pests or parasites that cause disease to native species or even kill them. In addition, genetic impacts may arise through hybridization between related native and non-native species. Such effects may be accelerated or, in some cases even caused indirectly, through fragmentation of native populations and reduced abundance.

Climate Change

Global climate change and its associated impacts on the marine domain, for example, sea warming, ocean acidification, and sea level rise (at the rate of about 1 mm per year), is an ongoing phenomenon which is certainly affecting biodiversity, human activities and health.

The Mediterranean Sea, also due to its geographic position between the temperate climate of central Europe and the arid climate of northern Africa, seems to be one of the most vulnerable regions to global climate change.

Sea warming may also have effects on the virulence of pathogens, as observed for *Vibrio shiloi*, responsible for the whitening of the coral *Oculina patagonica* in the eastern

Mediterranean. Moreover, it is responsible for the expansion of toxic dinoflagellates (algae) such as *Ostreopsis ovata*, which produces palytoxins, a serious public health hazard.

Temperature anomalies seem also to negatively affect the chemical defenses of marine organisms, allowing pathogens to act undisturbed.

Direct Economic Impacts

Management costs such as managing invasive species through the means of mechanical, chemical, and biological approaches, research and monitoring programs, reduced crop yield, job losses (such as in the case of reduced forestry production), damage to infrastructure, and impacts to international trade and tariffs.

The costs of preventing and controlling invasive species are not well understood or documented, but estimates indicate that the costs are quite high. The costs of aquatic invasive species are even less well understood than those for terrestrial species. A systematic approach is needed to develop a consistent method to estimate the national costs of aquatic invasives.

Economic costs of invasive species are much lower when funds are invested in prevention and early detection efforts. Once an invasive species spreads, management is exponentially more expensive and less efficient.

Human Well-Being

Economies and public health may be harmed by invasive species which can clog waterways, damage power lines and reduce energy production, decrease agricultural and timber output, depress tourism and spread diseases to people, domestic animals and cultivated plants.

Freshwater environments have also been invaded by a number of invertebrate invasive species that directly affect human health, including some that cause allergic reactions either through contact or consumption but also others that can exert physical damage because of people using water bodies for a range of purposes- for example recreational swimming and commercial fishing.

Furthermore, invasive species of the Mediterranean Sea can harbor pathogens and cause food poisoning, while other toxic effects can be exerted through proliferation of microscopic invasive species, or the concentration of pesticides, herbicides and heavy metals within aquatic invaders.

The Suez Canal

The Suez Canal has supplied the largest number of successfully established aliens in the Mediterranean Sea in terms of magnitude, frequency and duration of transfer. For decades, the ongoing migration of marine species through the Suez Canal has helped to explain the richness of Red Sea alien species in the eastern Mediterranean Sea, particularly in the Levant area (from Libya and Egypt in the south to Israel, Lebanon and Syria in the east).

The Suez Canal Authority is currently evaluating a new proposal for increasing the canal's depth or doubling its width to attract loaded very-large crude carriers (VLCCs) and ultra-large crude carriers (ULCCs). A deeper, wider canal will enlarge the saltwater passage to the Mediterranean and consequently enable the migration of more Red Sea species.

Shipping

Ships can transport alien species in ballast water, as hull fouling or as solid ballast (i.e. with sand, rocks, soil, etc.). Hull fouling on ships was recognized as a vector for alien introductions when non-native serpulid polychaetes were found for the first time in the Mediterranean. It is likely that some, perhaps many, other early introductions have been overlooked.

Shipping has been implicated in the dispersal of numerous neritic organisms, from microorganisms to fish. Ballast is usually taken into dedicated ballast tanks and is discharged when loading cargo or bunkering (fueling). Ballast water therefore consists mostly of port or near-port waters that can contain many viable alien organisms even after long voyages. After these organisms are flushed into a new port environment, some of them may begin to crowd out native species and disrupt local ecosystems.

Aquaculture

Market-driven demands for exotic fish and shellfish are on the rise with the increasing affluence of Mediterranean countries. This, coupled with the crisis in wild fisheries, has created a surge in development of marine aquaculture (mariculture) farming along the shores of the Mediterranean in the last twenty years

The impacts of invasive marine alien species are immense, insidious, and usually irreversible. The impacts may stem from cultured alien species that become established in the wild, from mixing of cultured and wild populations of a Mediterranean native species, and from the unintentional introduction of organisms associated with the intentional cultured species. Quarantine practices, developed to guard against diseases and pests, are often inadequate and insufficient safeguards against species that threaten Mediterranean biodiversity. Factors like urbanization, environmental pollution, eutrophication and habitat degradation commonly associated with intensive fish and shellfish farming can provide conditions that favour alien species. Many alien species are opportunistic species, which benefit from the reduced competition that follows habitat degradation

The past decade saw the introduction of European Union and national regulations aiming to control the deliberate importation of aliens and to limit their dispersal. However, mariculture policies, administration and legislation are very diverse with a lack of specific aquaculture policy in most areas, a lack of a centralized administrative framework, and overlapping between authorities.

Major Parties Involved and Their Views

Egypt

In recent years, scientists have recorded more than 700 alien species in Mediterranean waters, most of them entering through the Suez Canal in Egypt. More than 600 invasive species, many of them destructive, have established populations in their new environment, according to a 2019 report from the network of Mediterranean Experts on

Climate and Environmental Change (MedECC). Meanwhile, Mediterranean nations, including Egypt, have done nothing to slow the influx.

The Suez Canal, which connects the Red Sea to the Mediterranean Sea, revolutionized maritime travel by creating a direct shipping route between the East and the West. But over the years, the invasive species have driven native marine life toward extinction and altered the delicate Mediterranean ecosystem with potentially devastating consequences. The influx has increased significantly since Egypt doubled its capacity in 2015 with the opening of the “The New Suez Canal,” raising alarm in Europe and sparking criticism from various countries along the Mediterranean basin.

Egypt has ignored the dire warnings. “Invasive species is a huge and nonspecific category,” said Moustafa Fouda, an adviser to Egypt’s environment minister. “They can even be productive, replacing species that are overfished, bringing economic benefits or simply adapting to the new environment.” He estimated that less than 5% of invaders could be regarded as “disruptive” and that most of the shrimp, mollusks, puffer fish and crabs caused no harm. Egyptian experts also denied the invasions resulted directly from the Suez expansion. They argue that rising water temperatures brought on by global warming and untreated ballast water discharged by cargo ships spurred the exotic arrivals.

Turkey

While the number of established alien species that are located in the Mediterranean Sea exceeds 800, the number of established alien species located in the Seas of Turkey is almost 500. While 74% of the alien species in the Mediterranean Sea are introduced to the area via the Suez Canal, 80% of the alien species in the Black Sea are introduced to the area via ships’ ballast water.

Together with financial support from the Global Environmental Finance (GEF) and the coordination of the General Directorate for Nature Conservation and National Parks of the Ministry of Agriculture and Forestry, the United Nations Development Programme has launched a new project to combat invasive species in the Seas of Turkey. The opening meeting for the “Utilizing Invasive Alien Species’ Threats at Key Marine Biodiversity Areas” project was held in Ankara on the 22nd of November 2018. "This project will

implement the development of legal and institutional infrastructure, capacity enhancement and raising the awareness of the public as well as marine restoration and battling invasive alien species all together.” says UNDP Deputy Country Director Sukhrob Khojimatov

Turkey’s Environment and Urbanization Ministry has presented a documentary that highlights how invasive species have entered and are endangering local species in the Black and Mediterranean Seas in an effort to raise awareness among the public.

Italy

Mediterranean waters, increasingly warmer due to climate change and the expansion of the Suez Canal in 2015 both paved the way for the expansion of invasive jellyfish to Italian shores. The species known as *Rhopilema nomadica* under its scientific name is regarded as a great threat by the European Commission. Tourists in the south of Italy are afraid to swim in the sea because of these creatures.

According to experts, one of the ways to reduce the invasive jellyfish in numbers is consuming the animal. This is something that has been made easier since the New Year by European legislation that has relieved the rules for the distribution of so-called “novel foods”. On the other hand, the Italian Ministry of Health requires thorough research and testing, because the Mediterranean jellyfish are not the same as those consumed in Asia. Italian chefs have tried to sauté and grill the creatures, or to serve them boiled.

“The spread of invasive species is one of the greatest threats that conservation in Europe is facing. The example of the expansive jellyfish shows how easily these problems arise, how quickly they spread, and how extremely difficult it is to solve them,” warns Dalibor Dostal, director of the conservation organization European Wildlife.

Israel

The invasive fish and crustaceans buoyed by warming water temperatures are rapidly spreading toward European shores. Bella Galil, an Israeli marine biologist who studied the Mediterranean for over three decades, said much of the ecological damage is irreversible. Ms. Galil said the number of invasive species, currently about 400, has more than doubled over the past 30 years, a phenomenon she called a "historic example of the

dangers of unintended consequences." She argues that urgent action is needed to minimize the long-term impact. Ms. Galil said the continued widening and deepening of the Suez Canal had created a "moving aquarium" of species that, if unchecked, could make coastal waters inhospitable for humans.

Already, Israel is coping with an unprecedented wave of toxic jellyfish that has damaged coastal power plants and scared off beachgoers and tourists. Several other venomous species, including the aggressive lionfish, have established permanent colonies, creating a potential health hazard when they end up on plates of beach-side restaurants.

Israel's Environmental Protection Ministry said it was monitoring the process with concern since its coasts were the new species' "first stop" in the Mediterranean. It stressed that Israel could not stop the phenomenon alone but is promoting regulation to protect the most vulnerable marine habitats. With Israel increasingly reliant on the Mediterranean Sea for drinking water, the ministry said protecting the country's marine environment was "now more important than ever."

Development of Issue/Timeline

Date	Event	Outcome
Late 18 th Century	Introduction of marine species into the Mediterranean sea	The first invasive species were introduced into the Mediterranean sea
1869	Opening of the Suez Canal	The greatest influx of invaders resulted from the opening of the Suez Canal in 1869 that allowed entry of Indo Pacific and Erythrean biota.

1975 - 1979	Mediterranean Action Plan	<p>The Mediterranean countries and the European Community approve the Mediterranean Action Plan (MAP) as the institutional framework for cooperation in addressing common challenges of marine environmental degradation. The Mediterranean governments and the European Community adopt the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) in February 1976 together with two Protocols addressing the prevention of pollution by dumping from ships and aircraft and cooperation in combating pollution in cases of emergency.</p> <p>The Mediterranean Regional Trust Fund for the protection of the Mediterranean Sea against pollution is established</p>
1995	MAP Phase II	<p>In 1995, the Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II) was adopted by the Contracting Parties to replace the Mediterranean Action Plan of 1975. At the same time, the Contracting Parties adopted an amended version of the Barcelona Convention of 1976, renamed Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.</p>
2003	UNEP/MAP	<p>The United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) adopted an "Action Plan concerning species introductions and invasive species in the Mediterranean Sea"</p>
February 2004	International Convention on the Control and Management of Ship's Ballast Water and Sediments	<p>The International Convention on the Control and Management of Ship's Ballast Water and Sediments was adopted by a Diplomatic Conference. This Convention, a significant environmental achievement, provides a uniform international instrument to regulate ballast water management, though to be effective, the parties to the Convention have to implement it through appropriate national legislation and enforcement.</p>

15-18 January 2008	15th Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols	At their 15th meeting, held in January 2008 in Almeria (Spain), the Contracting Parties to the Barcelona Convention have adopted the Ecosystem Approach and agreed a road map for its implementation. Thus the EcAp becomes a specific process under the UNEP/ MAP Barcelona Convention, as its Contracting Parties have committed to implement it in the Mediterranean with the ultimate objective of achieving the Good Environmental Status (GES) of the Mediterranean Sea. The main value added of the Ecosystems Approach in the context of the Barcelona Convention is a renewed emphasis on implementation and integration that will strengthen our ability to understand and address cumulative risks and effects as well as to better focus our actions on priority targets.
2017	Action Plan concerning Species Introductions and Invasive Species in the Mediterranean Sea UN Environment/MAP	The main objective of the Action Plan is to promote the development of coordinated efforts and management measures throughout the Mediterranean region in order to prevent as appropriate, minimize and limit, monitor, and control marine biological invasions and their impacts on biodiversity, human health, and ecosystem services.

Previous Attempts to Solve the Issue

The Barcelona Convention

The Barcelona Convention (1976) and its relevant protocols, initially aimed at reducing pollution, has been updated with the adoption of new protocols. The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD), that had been adopted in 1995 and came into force in 1999, invites the Contracting Parties to “take all appropriate measures to regulate the intentional or accidental introduction of non-indigenous species” (Article 13).

The Mediterranean Action Plan

In 2003 the United Nations Environment Programme Mediterranean Action Plan

(UNEP/MAP) adopted an "Action Plan concerning species introductions and invasive species in the Mediterranean Sea". Action plan paragraph 7 recognizes that shipping is a major vector of introduction into the Mediterranean Sea. Paragraph 23 of the Action Plan strongly recommended that “Given the importance of shipping-mediated introductions of non-indigenous species into the Mediterranean ... a regional project will be developed to overcome gaps for the Mediterranean countries, and strengthen the capacities of the countries to reduce the transfer of aquatic organisms via ships’ ballast water and sediments and hull fouling”.

The EU Biodiversity Strategy to 2020

In 2011, the EU biodiversity strategy to 2020 was launched. The fifth target aims to ensure there is a comprehensive and coordinated EU-level response to prevent and control the introduction and spread of harmful invasive species : "by 2020, Invasive Alien Species (IAS) and their pathways are identified and prioritized, priority species are controlled or eradicated, and pathways are managed to prevent the introduction and establishment of new IAS" and an action aiming at filling policy gaps in combating IAS by developing a dedicated legislative instrument by 2012 will be developed.

Ballast Waters

In order to mitigate the impact of ballast water on the transfer of non-native species, chemical (use of chlorine, treatment with hydrogen peroxide or ozone, or deoxygenation) or physical (electric shock, increasing water temperature, ultraviolet, and microfiltration) treatments were first of all envisaged. But these treatments had major consequences, whether environmental, or economic (due to the boat’s being immobilized), or also for the health of the staff. A less harmful measure is now being recommended by the International Maritime Organization (IMO), a specialist United Nations body that shoulders responsibility for the international regulation of the security of maritime traffic and the prevention of marine pollution. It suggests a guide for checking and managing ballast water in order to mitigate the transfer of harmful and pathogenic organisms. The recommended measures are: exchanging ballast water out at sea; regularly cleaning the

ballast tanks to eliminate the sediment and mud that can accumulate there; discharge on land where treatment facilities exist.

Possible Solutions

Early detection and Rapid Response

Early detection of invasive species is essential because of the need for rapid action before significant populations are established. There needs to be comprehensive and cost effective surveillance procedures in place.

This can be done by making the best use of existing capacity, establishing procedures to collect, analyze and circulate information on invasive species, including identification keys for different taxonomic groups.

Furthermore, setting up an early warning system and organizing regular surveillance of high risk areas such as main entry points for commercial/tourist arrivals (airports, ports, harbours, open moorings, train stations) and areas frequently visited by tourists, entry points for spontaneous spread (coasts, border crossings of water systems shared with neighbouring countries, etc.); areas adjacent to containment facilities for potential IAS; highly disturbed areas (land clearance, construction, storm damage) and areas where disturbance is regularly occurring (roads, railways etc.); and isolated ecosystems and ecologically sensitive areas.

Containment

Containment methods should be selected with regard to their efficiency, selectivity and the undesired effects they may cause. Regular monitoring is essential and needs to be linked with quick action to eradicate any new outbreaks.

The key aims for containment should include containing the species within defined geographical boundaries thus preventing its spread to neighboring countries or expansion

to isolated and/or ecologically important areas and to postpone the species' population growth in order to develop more effective eradication techniques

Establish priority lists of invasive species for containment where appropriate in collaboration with neighboring states for which the same species are problematic. Additionally, prioritize areas for containment based on classification of natural value, degree of disturbance, importance as invasion corridors and feasibility of success. Furthermore, implementation and fund containment programmes for priority invasive species should exist. Lastly, identify and develop coordinated programmes on containment of invasive species which affect neighboring states or sub-regions.

Eradication

Eradication is an essential management tool and should be encouraged and promoted where appropriate and feasible. The design for eradication should consider impacts, reversibility of effects and risk of re-invasion of the management area (immigration rate of the alien species being eradicated should be zero). A trial eradication can be a useful tool to collect information for the assessment (e.g. bait preference and acceptance to target species, risk of destruction of non-target species, ways to minimize the risk which should determine the chances of success and address worst case scenarios. Furthermore eradication methods should primarily be selected on the basis of their efficiency, making sure that the methods are as ethical and humane as possible and comply with applicable regulations (e.g. animal welfare).

Growth of mariculture sustainably

Growth of mariculture in the Mediterranean is compatible with sustainable management of the marine ecosystem – but only if public policy and technology encourage sound practices. In order to prevent further loss of biological diversity due to the deleterious effects of the intentional and unintentional introductions of alien invasive species, while encouraging environmentally sound and responsible use of the Mediterranean marine environment for mariculture, it recommended to encourage the necessary research and development and sharing of an adequate knowledge to address the

issues of mariculture of alien species introduced or translocated (open sea and land base, containment), and the genetic and other risks from escaped or released cultured stock conspecific with native populations in the Mediterranean. Secondly, an increase among all stakeholders public awareness of mariculture-introduced or translocated alien species as a major issue affecting native biodiversity in the Mediterranean. Furthermore, there must be minimized unauthorised introductions of alien species. Lastly, a decrease in unintentional introductions (non-target species, including but not limited to disease agents and parasites) is necessary.

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Appendices

I. Biological Diversity in the Mediterranean Sea

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II. UNEP and MAP Barcelona Convention Declarations

<https://www.unep.org/unepmap/meetings/declarations>

III. UNEP/MAP Mid-Term Strategy 2016-2021

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