

Alien Species: What They Are and Their Presence in the Adriatic Sea

Abstract

Alien species are organisms introduced intentionally or accidentally into ecosystems outside their natural range. They are today recognised as one of the main threats to marine biodiversity. In the Adriatic Sea, a semi-enclosed basin subject to significant anthropogenic pressures, the spread of alien species is becoming a growing concern. Some of them, classified as invasive alien species (IAS), can rapidly expand, displace native communities, and create ecological, economic, and even health-related problems. The Interreg Italy-Croatia project **ALIENA** (Aligning Efforts to Control Non-Indigenous Species in the Adriatic Sea) was launched to better understand and address this challenge through coordinated action and scientific cooperation between Italy and Croatia.

What Are Alien Species, and Why Are They a Problem?

Alien species – also known as **non-indigenous species (NIS)** – are organisms found outside of their natural distribution range, often due to human activities such as shipping or aquaculture.

Not all alien species are necessarily harmful. Many fail to establish stable populations, while others coexist with native species without major impacts. However, a subset - the **invasive alien species (IAS)** - can spread quickly, reproduce efficiently, and alter the balance of the invaded ecosystem.

The introduction of alien species in the Adriatic follows pathways mainly linked to human activities. The main **pathways of introduction** include:

Navigation and ballast water: Ships discharge ballast water to maintain stability during voyages. This water often contains plankton, larvae, and microorganisms collected in distant ports, which are then released into new ecosystems.





Biofouling on ship hulls: Marine organisms attach to ship surfaces, crossing entire oceans. Even small yachts or fishing boats can transport alien algae, mussels, or barnacles and other living organisms between ports.

Aquaculture and trade: Shellfish farming, stocking, and ornamental trade are also important pathways. Farmed species (e.g., mussels, oysters) may carry parasites or associated organisms, and releases from ornamental aquaria can also introduce new species into the wild.



Artificial corridors: The Suez Canal serves as a major entry point for Indo-Pacific species into the Mediterranean Sea, a phenomenon known as “Lessepsian migration” (named after the Frenchman who made the Canal, Ferdinand de Lesseps).

Secondary spread: Once established in one location, alien species can naturally disperse to adjacent areas, as already observed in several parts of the Adriatic.



Alien species become problematic when they:

- Compete with and displace native species;
- Alter habitats (e.g., invasive algae forming dense mats on rocky shores);
- Impact fisheries and aquaculture (e.g., damaging gear or introducing diseases);
- Affect tourism (e.g., algal blooms that discourage bathing);
- Pose health risks (e.g., toxic microalgae are dangerous to bathers).

In the Adriatic Sea, more than **200 non-indigenous species have been recorded** to date, with around 14 considered invasive.

What Is Being Done to Manage the Problem?

Managing alien species in the Adriatic Sea is a complex challenge, as once an aquatic species has established itself, complete eradication is almost impossible. For this reason, **prevention and early action** are considered the most effective strategies. At the European level, **Regulation (EU) 1143/2014** requires member states to identify, monitor, and control invasive alien species, while the **Marine Strategy Framework Directive** treats them as a key indicator of environmental health. Globally, the International Maritime Organisation's Ballast Water Management Convention helps limit one of the main entry routes: ballast water from ships.

Current management approaches can be grouped into three levels:

- **Prevention and biosecurity:** Reducing new introductions through ballast water treatment, anti-fouling coatings on ships, and stricter controls in aquaculture and trade.
- **Early detection and rapid response:** Strengthening monitoring networks and alert systems to identify newcomers quickly and act before they spread.
- **Control and mitigation:** When species are already established, efforts focus on containing their spread and reducing impacts, for example, through removals, fisheries adaptation, or public health measures.

Despite these efforts, challenges remain: enforcement of rules is often weak, knowledge on distributions and impacts is incomplete, and economic resources are limited. This makes **regional cooperation and shared strategies across the Adriatic** essential, ensuring countries can act together against a problem that knows no borders.



ALIENA's Role in Addressing the Spread of Alien Species in the Adriatic

ALIENA's goal is to establish a shared scientific basis and coordinated management strategies for alien species, recognising that the Adriatic Sea is a common and shared basin that knows no national boundaries. The project focuses on building a joint knowledge and monitoring system to identify species that threaten biodiversity and socio-economic activities. Within this framework, the ALIENA project also aims to develop early warning tools for marine management and public health, support decision-makers, improve monitoring approaches, and increase awareness among stakeholders.

A shared dataset

The project has created a **comprehensive database of all alien (non-native) species found in the Adriatic**. At the **Mediterranean level**, more than **1,100** such species have been recorded. Specifically in the **Adriatic Sea**, **216** alien species are currently listed.

Looking at each country, Italy has identified **273 non-native species**, of which **18** are considered **invasive**. Croatia has recorded **116 non-native species**, including **9 invasive** ones.

Target species

From this broad dataset, a shortlist of **target species** has been identified for focused research and monitoring. These were selected based on their ecological impact, economic consequences, and relevance across multiple Adriatic areas. They include:

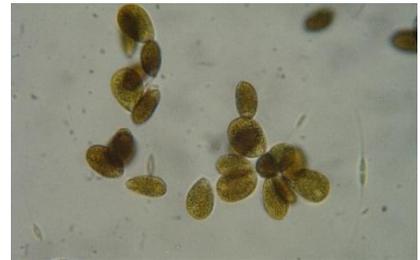
Rugulopteryx okamurae: an invasive brown alga first detected in the Adriatic in 2023, capable of overgrowing rocky substrates and replacing native seaweed communities. Furthermore, it can be massively deposited on beaches after storm surges and interfere with bathing tourism.





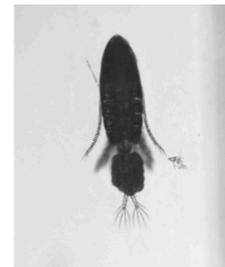
Codium fragile subsp. fragile: a green alga ranked among the “100 worst invaders in Europe,” notorious for its slimy masses that foul beaches and interfere with fisheries.

Ostreopsis cf. ovata: a toxic microalga responsible for harmful algal blooms, with direct health effects on bathing tourism and other recreational seaside activities.



Mnemiopsis leidyi: the “sea walnut,” a comb jelly that causes massive blooms, clogs fishing nets, and competes with fish larvae for plankton.

Pseudodiaptomus marinus: an invasive copepod impacting local plankton communities.



Focusing on these species, the ALIENA project can test monitoring protocols, evaluate risks, and propose management tools.



Italy – Croatia



Pilot areas

The project operates in **four pilot areas**, representative of different environmental and socio-economic contexts:

1. Rocky shores of **Apulia** (Italy);
2. **Gulf of Trieste** (Italy);
3. **Western Istrian coast** (Croatia);
4. **Kaštela and Šibenik Bays** (Croatia).



Each pilot site contributes local expertise and data, while sharing methodologies to build a common Adriatic approach.



Conclusions

Alien species are more than just a scientific curiosity; they are a real and pressing issue for the Adriatic Sea. Their impacts range from biodiversity loss to economic costs for fisheries and tourism, as well as public health risks.

Projects like ALIENA demonstrate how international cooperation, bringing together scientific research and policy, can help address complex challenges. By building shared databases, identifying priority species, and testing innovative monitoring techniques, the ALIENA project is contributing to a better understanding and management of the Adriatic Sea.

Ultimately, addressing alien species in the Adriatic Sea is important not only for marine ecosystems, but also for the cultural, economic, and social well-being of the communities connected to this unique sea.

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