



THE SPECIES IN THE IMAGE ARE NOT TO SCALE

MUSSEL FARMING ECOSYSTEM



1/ EUROPEAN SHAG

Gulosus aristotelis desmarestii
Similar to the cormorant, this species is native to marine coastal environments and is rarely found inland. A gregarious species, it nests mainly on islands in Istria, Dalmatia and Sardinia. Although some individuals are sedentary and loyal to their nesting sites, most of the Adriatic population is short-distant migrant and is present in the Gulf of Trieste all year round, with a peak between May and December. It uses mussel farms both for feeding and roosting, perching on the horizontal floats. During the breeding season, it develops a crest, visible from late autumn to early spring. It normally swallows small fish while diving underwater, and not at the surface as the cormorant often does. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

2/ COMMON TERN

Sterna hirundo
Also known as "sea swallow" due to its long, pointed wings, it is a gregarious species and a long-distance migrant that travels from northern Europe to the tropical Atlantic coasts and South Africa for wintering. It arrives in the Friuli Venezia Giulia region in late March, and several hundred pairs nest in the Grado and Marano Lagoons and in the Reserve of Val Stagnon in Koper. It feeds on small marine or freshwater fish swimming on the surface, but also on molluscs, crustaceans, marine worms and insects. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

3/ COMMON EIDER

Somateria mollissima
This large, diving sea duck has a circumpolar distribution, but the southernmost edge of its range reaches the northern Adriatic Sea and the Ligurian Sea. Present in the Gulf of Trieste with only a few individuals in the 1970s, since 1999 it has been nesting at the mouth of the Isonzo River, later extending also to the area of the Duino cliffs. It can be seen all year round at the mussel farms in Duino, which it frequents to feed on molluscs (especially mussels) and crustaceans, to moult and to nest and raise its ducklings. Currently, the number of common eiders ranges from 60 to 80 individuals. It exhibits a pronounced sexual dimorphism. It is known for its soft, thick down, which it uses in the nest to protect its eggs from the cold; in some northern European countries, its feathers are still collected today by the local population to make duvets, jackets, pillows and other items.

4/ MUTE SWAN

Cygnus olor
This species is large in size and all pure white in colour. When it flies, the beating of its wings makes a loud noise that can be clearly heard even from far away. It inhabits a wide variety of both freshwater and brackish wetlands. It can be found all year round at the mouth of the

Timavo River, where it nests. Migrating flocks can be spotted between January and March. Some breeding pairs live also between the V-shape valley of Muggia and the Lazaret area. An omnivorous species, it feeds on algae and aquatic plants, small fish and various marine and terrestrial invertebrates. Similar to the mallard, it frequents the mussel farms, even with its offspring, to feed on algae and organisms typical of that environment.

5/ GREAT CORMORANT

Phalacrocorax carbo sinensis
This piscivorous species is highly gregarious and inhabits shallow coastlines, inland freshwater and brackish wetlands, canals, rivers and also mountain streams. Since 2008, it has also been nesting in the Friuli Venezia Giulia region, namely at a site in the Grado Lagoon and in two quarries in the north-eastern part of the region. Unlike the *carbo* subspecies, which also nests on bare ground and rocky cliffs along the Atlantic coastline, it prefers dead trees. Although some individuals are sedentary, this species is a short-distance migrant, present in the Friuli Venezia Giulia region all year round. It can be found within the mussel farm environment to feed and to roost in the evening.

6/ RED-BREADED MERGANSER

Mergus serrator
It is a diving duck specialised in catching small fish and aquatic invertebrates. Instead of the lamellae characteristic of anatids, its bill has developed serrated edges and its tip is curved downward, suitable for gripping prey. This gregarious species nests in northern Europe and winters in coastal seas and lagoons. It can be found at the mussel farms from November to April.

7/ RED-THROATED DIVER

Gavia stellata
It nests in the Arctic tundra and regularly winters in the upper Adriatic Sea. Although this species is generally solitary, it may also form small colonies. It can be found at sea and lagoons. It is often associated with the black-throated diver, a species with which it shares the same habitats. A medium-distance migrant, it can be seen at the mussel farms from November to April, where it feeds mainly on fish and aquatic invertebrates. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

8/ GREAT CRESTED GREBE

Podiceps cristatus
It is the largest grebe species and feeds on small fish, aquatic insects, molluscs and frogs. It dives underwater to catch fish or when it feels threatened. Its fascinating mating ritual includes the exchange of waterweeds for the construction of the floating nest. This gregarious species nests in wetlands, lakes and flooded quarries in the lowlands and foothills. A medium-distance migrant, it frequents the mussel farms to feed and can only be seen at sea during wintering and migration, from October to March.

9/ BLACK-NECKED GREBE

Podiceps nigricollis
This small piscivorous diving bird inhabits fresh, salt or brackish waters alike and nests in wetlands in northern Europe. It is a medium-distance migrant and is not highly gregarious outside the breeding season. During migration and in winter, it can be seen along the coast and in the lagoon, more sparsely in the Trieste area. In the Friuli Venezia Giulia region, it has nested in the cane thicket of Lake of Cavazzo. From October to April, it can be found near the mussel farms, which it frequents for feeding. It feeds on fish, larvae, molluscs, crustaceans and insects.

10/ BLACK-THROATED DIVER

Gavia arctica
This skilled diving bird is highly adapted to aquatic environments: it can travel long distances without ever surfacing. It only moves to inland areas to hatch its eggs. It nests in Arctic and Subarctic regions, in the wetlands of the tundra and taiga. It migrates south to overwinter, and the upper Adriatic Sea is one of the most important sites for the species in the Mediterranean Sea. It is generally silent during the wintering period, whereas it has a distinctive call, similar to a dog barking, when it migrates. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

11/ GREY HERON

Ardea cinerea
This gregarious species nests in tall trees, forming colonies called "heronries". It is the most widespread species of the Ardeidae family, as it occurs in all wetland environments and nests in running and standing freshwater habitats, in brackish coastal lagoons or in Alpine valley floors alike. At the mussel farms in Duino, it can be found near the fish farming cages, where it goes to look for preys. It feeds on medium-sized fish and molluscs, but also on reptiles, amphibians and other small terrestrial animals. Unlike other long-necked species (such as swans, geese, storks, cranes), when it flies it holds its neck curved in an S-shape.

12/ VELVET SCOTER

Melanitta fusca
This diving duck is the largest of the genus *Melanitta* and has a wingspan of as much as one metre. It is a medium-distance migrant and nests in freshwater bodies across the Arctic region, but most individuals moult and winter at sea, mainly in shallow waters not far from shore. It feeds on small fish, molluscs, crustaceans and worms that it catches while diving, but also on insects and larvae. During the wintering period, it can be seen only irregularly at the mussel farms, whereas it occurs more frequently between Monfalcone and Grado.

13/ MALLARD

Anas platyrhynchos
It is the most common dabbling duck in the wetlands of the Friuli Venezia Giulia region, where it nests. This omnivorous, gregarious species can

be either a medium-distance migrant or a sedentary bird. It exhibits a pronounced sexual dimorphism. Often found in shallow waters, it can be seen all year round at the mussel farms in Duino, which it frequents to feed on the numerous animal and plant marine organisms living on the floats, headlines and droppers.

14/ YELLOW-LEGGED GULL

Larus michahellis
This gregarious, omnivorous and opportunistic species can be found all year around. Worth of notice is the dispersal of young birds, which move across northern Europe to then return to the Mediterranean Sea to reproduce once they have reached sexual maturity (4 years). It occurs all year round at sea side near the mussel farms, which it frequents to feed. It nests in colonies in lagoons, in the city of Trieste and in various coastal sites. Its "sister" species from northern Europe is the herring gull (*Larus argentatus*), which has pinkish — instead of yellow — legs, and can be found in the Friuli Venezia Giulia region during the wintering period.

15/ DUNLIN

Calidris alpina
This gregarious wader nests in the north European tundra and bogs. Typically coastal in the wintering period, it occurs at the mussel farms in Duino during high tides, when the muddy areas where it feeds — mostly on annelids and gastropods, but also insects — are flooded. It prefers to roost on the floats of the furthest mussel farms from the coast, where seagulls can also be found, probably because these areas are less used by birds of prey such as sparrowhawks and peregrine falcons, which could disturb or prey on it. In winter, it loses its black belly patch and become a grayish-brown bird, hence its name (from the word "dun", i.e., "of a greyish-brown colour").

16/ SANDWICH TERN

Thalasseus sandvicensis
It is one of the largest tern species, typically marine and gregarious, with a crest adorning its head. This piscivorous species catches small fish near the water surface, but is also able to descend almost vertically for 15-20 metres and dive into the water. It comes to Italy for wintering. It nests in the Venice Lagoon and could eventually also nest in the lagoons of the Friuli Venezia Giulia region following the construction of artificial islets with characteristics suitable for the species. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

17/ BLACK-HEADED GULL

Chroicocephalus ridibundus
This numerous gregarious species nests mainly in the Venice Lagoon and in the delta of the Po River; only a few pairs live in the Grado Lagoon. In February, it shows its breeding plumage with a distinctive dark brown hood. It is a medium-distance migrant that frequents the mussel farms for feeding and roosting all year around. In win-

ter, some flocks can be seen moving towards the sea in the evening, where they spend the night, to then return to inland areas during the day.

18/ MEDITERRANEAN GULL

Ichthyophaga melanocephalus
It lives in brackish wetlands, nests in the Venice Lagoon, and in winter migrates along the coastal zone crossing the sea, lagoons and agricultural areas of the lowlands. It is a gregarious species that can be found at the mussel farms from March to October, which it frequents to feed on fish. **The species is included in Annex I of the Birds Directive 2009/147/EC.**

19/ BOGUE

Boops boops
This semi-pelagic fish is widespread in the eastern Atlantic Ocean, the Mediterranean Sea and the Black Sea. It inhabits coastal waters with different types of seabed such as rock, sand, mud and seagrass meadows. It is omnivorous and mainly feeds on seaweeds, crustaceans and plankton. Highly gregarious, it forms schools that can be also large and move towards the surface especially at night. It can be seen feeding at the mussel farms throughout the year.

20/ COMMON EAGLE RAY

24/ PELAGIC STINGRAY
31/ COMMON STINGRAY
32/ BULL RAY
Myliobatis aquila – *Pteroplatytrygon violacea* – *Dasyatis pastinaca* – *Aetomylaeus bovinus*
These are cartilaginous fish (like sharks) that have been increasingly seen at the mussel farms of the Trieste coastline in recent years, mainly in the summer, during their breeding season, when they exhibit certain distinctive behaviour, such as repeatedly rubbing against the mussel farming longlines. They feed mostly on bivalves and gastropods that they search for on the seabed, moving the sand using their snouts and pectoral fins, and on fish such as the European pilchard (*Sardina pilchardus*) and the Atlantic horse mackerel (*Trachurus* sp.). Like most cartilaginous fish, they are included in the IUCN red lists as vulnerable or endangered species. Nevertheless, Italy stands out as one of the world's largest markets for the import and distribution of shark and ray meat.

26/ LONG-SNOUDED SEAHORSE

Hippocampus guttulatus
It is a bony fish widespread in the Mediterranean Sea, the Black Sea and the North Atlantic Ocean. It mainly inhabits sandy seabeds with seagrass and algae meadows. It is ovoviviparous and shows a peculiar breeding behaviour: the female lays the eggs in the male's incubator pouch. It forms long-term mating pair bonds (family), living a rather sedentary life. It is omnivorous and can be found both at the bottom and along the droppers of the mussel farms in search for food such as algae, crustaceans, molluscs, annelids and the numerous invertebrates that grow on the shells of mussels, and on the headlines and floats of the mussel farms.

21/ LEERFISH

Lichia amia
This pelagic coastal species is gregarious — especially in its juvenile stages — and predatory; it feeds mainly on fish and cephalopods, but also on molluscs and crustaceans. It reproduces in spring and summer near the coast and can be frequently seen feeding at the mussel farms. It is a commercially important species.

22/ GILT-HEAD BREAM

Sparus aurata
This strictly coastal marine fish is very common in the Mediterranean Sea; it inhabits sandy seabeds

and seagrass meadows. As it tolerates large salinity changes, it can be frequently found at river mouths and in lagoons. It is an omnivorous species and feeds mainly on invertebrates such as molluscs, crustaceans and marine worms, which are abundant in the areas of the mussel farms that it frequents to feed. Thanks to its robust teeth, it can easily crush the hard shells of mussels. It is a commercially important species, also bred in fish farms.

23/ POOR COD

Trisopterus minutus
This benthopelagic species is widespread in the Atlantic Ocean and western Mediterranean Sea. It lives in areas with sandy and muddy seabeds, where it feeds on crustaceans, polychaetes and fry. It can be found in schools at the mussel farms, where it feeds and breeds during the winter period.

25/ CARAMOTE PRAWN

Penaeus (Melicertus) kerathurus
This crustacean is native to the Mediterranean Sea and common in the Adriatic Sea. A benthic species, it lives on sandy and muddy seabeds, either in littoral or deep waters. It occurs in estuaries and lagoon areas, mainly in the post-larval and juvenile phases. It is a fossorial species and is most active during twilight or night hours. This fishing species is particularly appreciated for commercial purposes. It can be found on the seabed under the droppers of the mussel farms, where it feeds mainly on molluscs, crustaceans and polychaetes.

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It is a bony fish widespread in the Mediterranean Sea, the Black Sea and the North Atlantic Ocean. It mainly inhabits sandy seabeds with seagrass and algae meadows. It is ovoviviparous and shows a peculiar breeding behaviour: the female lays the eggs in the male's incubator pouch. It forms long-term mating pair bonds (family), living a rather sedentary life. It is omnivorous and can be found both at the bottom and along the droppers of the mussel farms in search for food such as algae, crustaceans, molluscs, annelids and the numerous invertebrates that grow on the shells of mussels, and on the headlines and floats of the mussel farms.

27/ FAN MUSSEL

Atrina fragilis
This large bivalve mollusc belongs to the family *Pinnidae* and inhabits the Mediterranean Sea and the North Atlantic Ocean. It lives on muddy seabeds, vertically embedded in the substrate via its byssal threads, buried up to about half the length of its shell (unlike the better known *Pinna nobilis*, which is only buried for a third). At the mussel farms, it can be found on the muddy seabed, where it feeds by filtering mainly phytoplankton. The shell is triangular in shape, with thin, fragile valves and a smooth or slightly wrinkled outer surface.

28/ COMMON BRITTLESTAR

Ophiothrix fragilis
It is an echinoderm, such as sea urchins and cucumbers, and can be found across the Mediterranean Sea, with a wide range of colours and sizes. It lives both on rocky seabeds, within the intertidal zone, and on sandy and muddy seabeds among seagrass meadows. In the mussel farms, it is found numerous along the droppers between the mussels, but is also abundant on the seabed underneath.

29/ BROWN SEA CUCUMBER

Ocnus planci
Native to the north-east Atlantic Ocean, it is now found throughout the Mediterranean Sea. It is a benthic organism of the *Phylum* of Echinodermata, such as sea urchins and starfish. This sea cucumber shows a peculiar buccal membrane with retractile tentacles suitable for catching the food laying on the muddy seabed. It can be found on the seabed underneath the mussel farms.

30/ SNAKE BLENNY

Ophidion barbatum
This marine fish has a peculiar elongated and laterally compressed body. It is widespread in the Mediterranean Sea and in the eastern Atlantic Ocean, from Senegal to Cornwall. The species is nocturnal, resting and hiding in sandy seabeds, in which it burrows starting from the tail. Its presence along the Trieste coastline has been proved through the recording of the peculiar sounds produced by this fish. It feeds on invertebrates and can be found on the sandy seabeds near the mussel farms, which it frequents to feed.

33/ LOGGERHEAD SEA TURTLE

Caretta caretta
It is the most common sea turtle in the whole Mediterranean Sea. The Gulf of Trieste is the feeding site for juveniles, which can find their food in its shallow waters: seaweeds, but above all crustaceans, molluscs, small fish and jellyfish, which they catch with their beak-like sharp mouth and powerful jaws. It uses the mussel farms precisely for feeding. Due to global warming, its nesting range — once limited to southern areas — has gradually expanded, extending to the whole Adriatic Sea and reaching the Veneto coastline in recent years. **The species is listed in Annexes II and IV of the Habitats Directive 92/43/EEC.**

34/ PARALEUCILLA MAGNA

Paraleucilla magna
This calcareous sponge of the genus *Paraleucilla* is an alien invasive species of Atlantic origin, first identified along the Algerian coast in 2004, but now widespread across the Mediterranean Sea. Its spread was attributed to aquaculture farms and maritime traffic. It grows both on hard substrates and in seagrass meadows. At the mussel farms in the Gulf of Trieste, it has

been detected along the headlines connected to the floats, where this filter-feeder grows by feeding on plankton.

35/ BLUE CRAB

Callinectes sapidus
It is an invasive alien species native to the US Atlantic coastline, accidentally introduced to the Mediterranean Sea as its pelagic larvae were transported passively in the ballast water of ships. The first documented record in Italy occurred in 1949 precisely in the Friuli Venezia Giulia region, in Grado. Currently, its presence is widely recorded throughout the Adriatic and Tyrrhenian Seas. It is a voracious omnivorous predator (it feeds on fish, crustaceans and molluscs) that can extraordinarily adapt to different salinity and temperature levels, and therefore proliferates in lagoons and estuarine environments. It shows a very high reproduction rate and its acclimation has been facilitated by climate change, and the ensuing increase in average winter temperatures. At the mussel farms, it has been detected both on the seabed and on the droppers, which it is able to reach as it is a skilled "swimming crab".

36/ MEDITERRANEAN FANWORM

Sabella spallanzanii
A polychaete annelid, it lives inside a paper-like tube secreted by itself. This benthic filter feeder can be found on sandy and soft seabeds, but also in harbour docks and under buoys. It also grows along the droppers of mussel farms, where it finds nourishment by filtering plankton and suspended matter, catching them using the filaments of its branchial crown. When disturbed, it retracts into the tube.

37/ STAR ASCIDIAN

Botryllus schlosseri
It is a colonial ascidian formed by numerous animals (zooids), enclosed in gelatinous sheets arranged in regular groups that develop horizontally. It forms gelatinous encrustations on hard substrates: in mussel farms, it is commonly found on the shells of mussels, but can also be seen among seagrass and seaweeds.

38/ BERGHIA VERRUCICORNIS

Berghia verrucicornis
This marine nudibranch (a gastropod mollusc of the family *Aeolidiidae*) inhabits the American and European Atlantic coasts and the Mediterranean Sea. A characteristic typical of this species of nudibranchs is the presence of numerous cerata (finger-like projections extending from its mantle) all over its body. It feeds on anemones, which it finds numerous on the shells of mussels and along the headlines connecting the droppers of the mussel farms.

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