



EcoFilm_ShellFising

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EcoFilm
Shellfishing



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Film: Ecological and Sustainable Management of the Shellfish Harvesting on Foot

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INTRODUCTION

This document develops the training program as a part of the project **Film: “ECOLOGICAL AND SUSTAINABLE MANAGEMENT OF THE SHELLFISH HARVESTING ON FOOT”**. In the framework of the Erasmus +. KA2 - Cooperation for Innovation and the Exchange of Good Practices. Strategic Partnerships for vocational education and training. Call 2016.

The training program ECOLOGICAL MANAGEMENT AND ECONOMIC SUSTAINABILITY OF SHELLFISHING ON FOOT ACTIVITY has been developed by the members of the consortium as a response to the needs of the sector which is looking for tools to do the shellfishing activity in a sustainable way.

This training program will be converted in a video, which will be the final deliverable of the project.

Inputs have been provided by partners with a high expertise in this field:

- **Liga para a Protecção da Natureza (LPN) - Portugal**
- **FUNDACIÓN PARA LA PESCA Y MARISQUEO (FUNDAMAR) - Spain**
- **Cooperative M.A.R.E. SOC. COOP - Italy**
- **The University Recep Tayyip Erdogan Universitesi – Turkey**
- **SGS Tecnos (Spain)**



1. CHARACTERIZATION OF THE MARINE ENVIRONMENT AND SPECIES OF INTEREST IN SHELLFISHING

General objectives of the module:

The shellfishing activity takes place in natural environments. Therefore, it's important to have in mind a series of basic concepts: Identify the biotic and abiotic components of the coastal ecosystem and integrate the shellfish species into it, including the species' relations with each other and with the physical environment.

1.1 THE COASTAL OR INSHORE ECOSYSTEM

The ecosystem is defined as an ecological system that encloses all organisms and the environment in which they live, it includes all biological and physical components that characterize a given area or scale of observation. It also includes the relation between species, populations and communities with the physical factors that surround them.

As in any ecological system, a marine ecosystem, includes all of the living things (biotic factors) in a given area, interacting with each other, and also with their non-living environment (abiotic factors)

Abiotic factors are the environmental characteristics of the ecosystem: temperature, salinity, waves, currents, physical environment (substrate), light, nutrients (such as nitrates and phosphates), organic compounds, dissolved gases, etc.

Biotic factors are the living components of the ecosystem. They depend on each other to a greater or lesser extent. For example: Algae are consumed by different animals, including the sea urchin. Predators, such as the crabs, keep urchin populations and prevent the disappearance of algae

1.2 THE ABIOTIC ENVIRONMENT IN THE COASTAL SYSTEM

Biological communities are distributed along the littoral shore according to environment gradients (abiotic factors: water temperature, light, transparency, salinity, dissolved oxygen, currents, pressure, rocks, tide level, coastal slope, bottom substrate) and their composition, abundance and distribution are influenced by biotic factors such as food availability, competition with other species, predation.



1.2.1 TYPES OF COASTS AND BEACH CHARACTERISTICS

- a) Depending on the degree of exposure to environmental gradients (wind, waves, tidal range) and coastal disposition, three degrees can be considered: exposed, semi-exposed, and protected coasts.
- **The exposed coasts** are areas of cliffs, where the sea and the wind beat hard. The organisms that live here are characterized by their adaptations to the inclement weather in this type of environment. It is the characteristic place for the collection of barnacles.
 - **On semi-exposed coasts** the sea does not beat as hard as they are a bit more sheltered. Semi-erect areas are good for the common sea urchin, which can develop an excavating behavior to suit the swell. The effect of the wind is less hard.
 - **The protected coasts** are in places very sheltered from the action of the wind and the waves. It is the characteristic place of shellfish bivalves, such as clams, cockles, razors, etc.
- b) Depending on the dominant substrate, three types of coasts can be distinguished: **rocky, sandy and silt coasts**. These three types of substrate will depend in two main factors, the size and granulometry of the main matrix. From rocky shore, (very hard and permanent), to sandy (with different type of particles sizes) to silty and clayey (more common in estuaries and lagoons). These types of substrate will depend on dominant hydrological dynamics: currents and waves that set different sedimentations conditions.

For shellfish, the main substrate will determine the type of species that can settle, and for the shellfishing activity this will be affect the type of harvesting, the target species and the necessary tools.

1.3 PHYSICAL-CHEMICAL FEATURES OF SEA WATER. ADAPTATIONS OF THE ORGANISMS TO THE ENVIRONMENT

One of the most particular characteristics of sea water is that it is salty. But why is that?

Salt in the ocean comes from rocks on land. The rain that falls on the land contains some dissolved carbon dioxide from the surrounding air. This causes the rainwater to be slightly acidic due to carbonic acid (which forms from carbon dioxide and water).

As the rain erodes the rock, acids in the rainwater break down the rock. This process creates ions, or electrically charged atomic particles. These ions are carried away in runoff to streams and rivers and, ultimately, to the ocean. Many of the dissolved ions are used by organisms in the ocean and are removed from the water. Others are not used up and are left for long periods of time where their concentrations increase over time.

Two of the most prevalent ions in seawater are chloride and sodium. Together, they make up over 90 percent of all dissolved ions in the ocean. Sodium and Chloride are 'salty.'



There are other salts in sea water, such as magnesium chloride in smaller proportions. The quantity of salt content in sea water is called **Salinity** and is measured in grams of salt per kilo of water or so much per thousand (‰). The average salinity of the oceans is 35 ‰ but it is not equal in all seas. In warm-water seas, where there is more sunshine, water evaporates more and salt is more abundant in relation to water: in the Red Sea the salinity is 41 ‰ whereas in cold seas like the Baltic Sea the salinity is Of 10 ‰.

Although the clams tolerate a fairly wide range of salinity, the optimum range is between 25 ‰ and 35 ‰. Salinity affects mollusk areas, in times of very intense rainfall, excessive fresh water coming from rivers causes deaths on the shoals. It is estimated a lower salinity limit of 15 ‰ for Manila clams and 20 ‰ for carpet shells, more sensitive to these variations. Below those limits, clams can die.

The fundamental dissolved gases are oxygen and carbon dioxide. The first is used by almost all marine organisms to breathe; the second is used by algae and marine plants to make photosynthesis, and also by some animals to build their skeletons and shells

Sunlight is essential for life at sea. The suspended particles that exist in the water cause the light to diffuse and expand until it extinguishes to a certain depth. The photic zone is one in which sunlight penetrates. It is at a variable depth depending on the turbidity of the waters, being the maximum that reaches 200 meters in tropical areas of very transparent waters. Upper to this depth we can find most of the photosynthetic producing organisms and the other associated consumer organisms.

The temperature of the sea depends on the heat of the solar radiation accumulate by water. Since the light only penetrates in the first 200 meters, the waters become colder to a greater depth. At a variable depth, no more than 200 meters, there is a marked decrease in temperature called thermocline.

Bivalves tolerate a fairly wide range of temperatures: from 10° C to 30° C, with an optimum for growth between 15 and 20° C.

MOVEMENTS OF SEA WATERS: WAVES, TIDES AND CURRENTS

There are three types of movements of the sea: waves, tides and currents:

- **The waves** originated by wind action at the superficial waters are transmitted by long distances.
- **The tides** are very wide waves that raise and lower the sea level. They are caused by the attraction exerted by the Moon and the Sun on the mass of oceanic water.

(Tide table) With the tide table we can know the ideal time to harvest shellfish. We must take into account that the indicated time is usually the solar time, which we will correct according to the time difference established in each State; The height is usually established with respect to a historical zero (recorded lowest tide), so the lower the value the better the tide to fish. Note that when the low tides are too low, the high tides are too high and vice versa. This is due to the cycle of spring tides / neap tides caused by the relative position of the Sun and Moon.



- **Currents are seawater** movements in a given direction caused by prevailing winds, earth's rotational movement, tides and density differences between bodies of water. (Gulf Stream explained)

COASTAL ZONATION: THE ENVIRONMENTS IN THE COAST.

On the coast, two very different environments are observed, each one with its peculiarities sheltering different organisms: the pelagic zone and the benthic zone.

The pelagic zone is inhabited by animals and plants that live floating (planktonic) or swimming (nektonic) in the water column, such as sardines.

The benthic zone is linked to the bottom, such as algae or bivalve mollusks. The benthic coastal environment comprises the following zones according to the tide level: the supralittoral zone, which is the upper part of the beach where the splashes arrive and which is only covered with water during the high tides; the mesolittoral or intertidal zone, which is periodically covered by water and passes from the aquatic to the terrestrial environment (depending on whether it is low or high tide) and the infralittoral zone, which is never emerged.

In these environments the conditions for life are very different from each other, and will be colonized by organisms with different vital requirements and disturbance tolerance.

Thus, **at supralittoral zone**, due to lack of water there will be animals that endure long periods of high temperature, desiccation, salinity in the environment and insolation, such as *Balanus* or periwinkles. These animals are adapted to almost terrestrial conditions.

At **mesolittoral or intertidal zone**, with less immersion time anemones and polychaetes will be present. This zone undergoes drastic changes in its environmental conditions daily, organisms have to adapt to constant variations of temperature, salinity, time of emersion, etc.

At **infralittoral zone** inhabit animals that require to be submerged permanently, as the lobster.

The bivalve mollusks harvested by foot are generally located at the intertidal and infralittoral zones.

1.4 THE BIOTIC ENVIRONMENT. BIOLOGICAL COMMUNITIES CHARACTERISTICS AND TROPHIC RELATIONS. IDENTIFICATION OF ORGANISMS IN THE COASTAL AREA.

TROPHICAL CHAINS IN THE MARINE ENVIRONMENT

The biotic environment comprises not only communities but also the relations between species and individuals. Among these, trophic relations are extremely important. Trophic relations have a range of levels depending on "who eats whom"

Algae, **the producers** (seaweeds and phytoplankton), comprise the first trophic level in a community; primary consumers (herbivorous and filter feeders such as clams and mussels) occur at the second trophic level; secondary consumers (carnivores) at the third, and so on.



Secondary consumers are carnivorous animals that devour these primary consumers, as is the case with most fish.

Tertiary consumers are large carnivorous predators. They form this group animals like the dolphins, the sharks, the tunas and the same human being.

To complete this chain **the decomposers** that feed on dead organic matter. Much of it is microscopic bacteria and fungi that inhabit the bottoms.

PLANKTON, BENTHOS AND NEKTON.

According to their way of life and distribution along the water column, the different marine organisms are divided in:

Plankton: set of organisms that cannot win the energy of currents, waves and wind. They live floating in the water. Almost all of them are small, mostly microscopic. Although some have systems of locomotion and can make movements, they generally move mainly carried by sea currents, tides or winds. Within this group, we can differentiate phytoplankton (plant part of plankton) and zooplankton (animal organisms of plankton).

Phytoplankton can synthesize its own food through the process of photosynthesis. Its volume is such that marine phytoplankton produces most of the oxygen we consume all living things on Earth. It is composed mainly of microscopic algae called diatoms, dinoflagellates, brown-gold algae, green algae and blue-green algae.

Zooplankton includes small animals, some microscopic. Many shellfish species (bivalves, barnacle, sea urchin) live their early stages of development as larvae forming part of zooplankton.

Phytoplankton: diatoms are the dominant algae of phytoplankton;

Zooplankton: foraminifera, are single-celled animals with a shell; Crustacean copepod, are the basis of feeding a multitude of animals, from mollusks to whales; Mollusk larva, most of the species shellfish (bivalves) live their early stages of development as larvae forming part of the plankton.

Occasionally, certain species of plankton become so abundant that they are seen at first sight on the surface of the sea altering the sea color: red tides by phytoplankton and dinoflagellates. These natural proliferations can pose a problem for human health, producing intoxications by consumption of mollusks that assimilated the toxins.

Benthos: They live close to the ocean bed, sometimes fixed to the substrate; in the sand or mud. Many organisms present this form of life: algae, annelids, mollusks, corals, stars, crustaceans, bottom fish, etc. Almost all shellfish species are benthic.

Benthic on rocky substratum: limpet, periwinkle, sea urchin, brown algae, crustaceans.

Benthic on sandy loam substrate: Clam, cockle, razor, polychaete, sole, green algae.



Infauna organisms: Many animals, including most of the shellfish species, live buried the soft substrates of the coast (sand and silt) forming a characteristic community.

It should be taken into account that many benthic organisms, such as mollusks, have planktonic larvae floating freely in the sea until they perform metamorphosis (drastic changes that convert them into adults) and *settlement*: the moment when they will pass to the benthic environment (the beaches).

Nekton: organisms who live free in the water, who can swim and move on their own, and which have little relation with seabed. Many of the cephalopod mollusks (such as squid or sepia), most fish (not linked to the bottom), cetaceans (dolphins and whales) and some reptiles (sea turtles) are part of this group.

Plankton, benthos and nekton examples



2. CHANGES IN THE MARINE ENVIRONMENT AND ITS IMPACT ON SEAFOOD ACTIVITY AND PUBLIC HEALTH

General objectives of the module:

To identify the human activities that have negative impacts at coastal environment and explain the good practices capable of minimizing these impacts.

When we complain that a beach is dirty or that there is a low amount of fish or seafood, we must reflect on what is happening to the marine environment. Pollution, habitat change and loss, overfishing are examples of a bad attitude towards the environment that sustains us and represents the main problem affecting our coasts.

2.1 DEFINITION OF HEALTH AND HYGIENE. INTRODUCTION

Hygiene comes from the Greek word "Hygiene", which means healthy, which brings health. Health is a state of physical, mental and social well-being (not just the absence of disease).

The consumption of mollusks can cause some diseases related to pathogens present in these organisms, hence are a number of sanitary regulations, from the extraction to the commercialization, that have to be fulfilled to guarantee the safety in shellfish products.

In addition, red tides cause an additional problem, causing mollusks to accumulate toxins that can cause serious illness to the animals and the people who consume them. It is important, therefore, to attend to the alerts and closing periods of shellfish shoals caused by these episodes.

On the other hand, mollusks can suffer several diseases, which are often aggravated in shoals grown by the high density of individuals. This can cause significant losses to the shellfishers, since there are diseases that can kill the population of the shellfish shoal.

2.2 CONTAMINATION AND ITS SOURCES

The Oceans receive most of the human waste either from land, from direct ship discharges or due to air pollution.

Types of Contamination:

Microbiological contamination, caused by pathogens (bacteria, viruses), which transmit diseases such as gastroenteritis, hepatitis, etc. The urban areas adjacent to the coast, pouring into the rivers, can cause with their fecal waste the contamination of the waters with bacteria and viruses, causing the closure of seafood areas and causing human health problems.

Microbiological contamination can lower the classification of waters for mollusk harvesting, as shown in the table below.

CLASS	MICROBIOLOGICAL STANDARD	REQUIRED TREATMENT
A	<i>Escherichia coli</i> : 230 MPN/100g of flesh and	No treatment



	intravalvular liquid (method ISO TS 16649-3) Salmonella spp.: absent	
B	Escherichia coli: ≤ 4.600 MPN/100g of flesh and intravalvular liquid (ISO TS 16649-3 method)	1) Depuration in approved plants; 2) Natural depuration in areas classified suitable for depuration. 3) Transformation into approved plants.
C	Escherichia coli: ≤ 46.000 MPN/100g of flesh and intravalvular liquid (ISO TS 16649-3 method)	Long-term relaying (≥2 months) or transformation into approved plants. The competent authority can establish a purification time of less than 2 months based on a risk analysis carried out by the operator himself.
Not allowed	If the values founded are higher than 46,000 Escherichia coli per 100g of flesh and intravalvular liquid (ISO TS 16649-3 method)	Harvesting not allowed

Organic contamination. Often, excess organic nutrients cause the proliferation of certain species that can reproduce excessively and occupy large areas, cause depletion of oxygen and can cause the death of many animal and plant species: eutrophication.

“Blooms” of green algae. Green algae species of the genera *Ulva* and *Enteromorpha* are very common on the coast. They expand rapidly when the waters are charged with nitrates. Their uncontrolled proliferation can cover the bottoms of the shellfish shoals and cause large deaths due to asphyxiation of bivalves (clams, cockles, ...).

Chemical Contamination

- a) caused by **organic chemicals** such as petroleum, gasoline, plastics, pesticides, solvents, detergents, etc. They have a high permanence in the water because they are difficult to degrade by the microorganisms. They can cause various renal, hepatic, nervous disorders, reproductive, cancers, etc.
- b) caused by **inorganic chemicals**, such as acids, salts and heavy metals mainly from industry, agriculture or mining. Even in small amounts, they can cause serious damage to organisms and are very persistent in the natural environment. Heavy metals such as lead, cadmium, or mercury are very toxic and accumulated by living things. Some organisms will be ingested by others and thus accumulate more toxic in the body, increasing the toxicity of animals along the food chain: bioaccumulation.
- c) **Radioactive contamination** creates serious problems in living beings, such as congenital defects, genetic mutations (hereditary changes in DNA), cancer and even death from



poisoning.

The thermal pollution is caused by the increase in the temperature of seawater caused by the release of the hot water used in industrial refrigeration. This decreases the ability of water to retain oxygen, thereby affecting organisms with gills, which breathe in water.

Solid wastes are diverse objects made of materials such as metal, glass and plastics, which remain many years in the environment. The damages to the marine fauna are varied, as entanglements in abandoned arts, bottles or plastic. Another type of damage is produced by ingestion of waste. In addition, many of these solid wastes are also chemical contaminants (batteries, plastics, tires, ...). In some harvesting activities, salt is used to make specimens dig up their way out of the substratum. Although the salt itself does not have a long term harmful effect, it is not uncommon to find plastic packaging at the shellfish areas left away by the shellfishers. This is an example of bad practice since plastic has an extremely prolonged impact in the environment.

Invasive species: When a species are introduced into an ecosystem it does not usually have natural predators and can successfully compete with native species, which can be displaced and even endangered. When an alien species behaves like this, affecting the species of the area, it is called an invasive species. These can become very harmful in an ecosystem, completely altering the relations between species.

Sargassum muticum is a brown seaweed. Grows from half-tide to infralittoral areas. It is thought to have gained worldwide distribution through being transported with Japanese oyster (*Crassostrea gigas*). Currently, the alga is widespread along atlantic european coasts. Causes economical and ecological problems such as problems in shellfish farming or preventing the penetration of light. Not to be confused with *Cystoseira* (native brown seaweed genus, favourite of sea-urchin as food resource).

Caulerpa is a tropical algae genus common in the aquarium hobby. Has become an invasive species in the mediterranean coasts due to they are freed from natural predators. It causes lower biodiversity and modifications over invaded habitats.

Bioaccumulation

Bioaccumulation is the incorporation of persistent substances (heavy metals, insecticides, solvents) into the tissues of living organisms. As these substances are replanted from organism to organism through the food chain, the concentration increases in animal tissues: zooplankton [0.004 ppm] → fish [0.5 to 2 ppm] → osprey [25 ppm]

2.2.1 THE BLACK TIDES

Although most the oil that ends up in the sea comes from the land (from domestic waste, cars and gas stations, refineries, industries, etc.) and causes diffused and prolonged pollution in time, oil tanker accidents are the most known sources of oil pollution and cause serious environmental disasters. Oil can lead to death to organisms through poisoning, loss of defenses by ingestion or



contact, carcinogenic effects, reproduction problems, destruction of larvae and juveniles, etc. The long-term chronic effects of animals in contact with hydrocarbons must also be considered.

(Prestige). The Prestige was an oil tanker which sank in 2002 off the Galician coast, causing several black tides.

2.2.2 THE RED TIDES.

The red tides are caused by a massive proliferation (bloom) of certain phytoplankton microalgae (and dinoflagellates) at the marine environment. The name of red tide is due to the color change of the water caused by the pigments they produce, although this does not always happen, and an increase of toxin-producing microorganisms can occur without changes in the color of the water. Similarly, episodes of red tides may not be toxic, because the species that cause them do not produce toxins.

The effects of red tides are particularly damaging to the shellfish sector. Bivalves such as cockles or clams are not affected, but by filtering the water, they accumulate the toxins in their body. These toxins can be assimilated by humans by consuming the mollusks and producing toxic effects that can become very serious. It is important to monitor the contamination in order to avoid collecting the affected bivalves. The collection, however, may resume after the disappearance of the toxin. In fact, bivalves are able to self-purify if the toxin is no longer present in water.

It is important to periodically check the type and density of phytoplankton to ensure that shellfish is safe. Poaching of mollusks in unauthorized areas may pose a risk to public health.

Although the causes of a red tide are natural (increased water temperature, lack of water movement due to lack of strong winds, etc.), there are human activities that can cause them to appear, as well as increase the frequency, intensity and extension of toxic phytoplankton proliferation. Thus, pollution from organic waste from land-based activities (eutrophication) can alter the normal dynamics of algae populations and lead to blooming of toxic species. Overfishing can cause an alteration in the marine food chain by catching fish species that feed on phytoplankton, which could facilitate algal blooms and a red tide episode. Intensive aquaculture in vulnerable areas is also related to the proliferation of microalgae causing toxin episodes at sea.

2.2.3 BALLAST WATERS

Ballast water is used in navigation to provide stability to ships when traveling empty. The boat takes water from the environment in which it is to compensate for the lack of cargo and stores it in tanks. When the water is expelled again it is often far from the place where it was taken. In that environment, it can introduce animals and plants that are foreign to that ecosystem. In addition, ballast water may contain viruses, bacteria and other pathogenic microorganisms. This is a serious environmental problem because foreign species introduced by ballast water can affect or compete with local species, causing an imbalance in the ecosystem. Mismanagement of ballast water is therefore one of the causes of biological contamination and can cause health problems.



(Invasive species in ballast water) Mussel zebra. The bacterium *Vibrio cholerae*, responsible for cholera disease, can be transported in the ballast water.

2.2.4 COASTAL WORKS WITHOUT CONTROL IN COASTAL ECOSYSTEMS

It is necessary to carefully assess the consequences of carrying out maritime works in certain areas and to try to make buildings compatible with the proper functioning of coastal ecosystems and mollusk settlement areas, particularly in fragile areas or with a special protection interest. The uncontrolled works in the littoral zone, like ports, piers, urbanizations, dredges and fillings; They cause damages in the environment and in the zones of shellfish. They cause variations in water circulation patterns, sedimentation and erosion; Generate profound changes and degeneration of coastal communities.

2.2.5 OVEREXPLOITATION

Some marine species are in danger of extinction and fishing for many others is increasingly scarce due to the uncontrolled extraction of their populations. Overexploitation is defined as the action of over-utilization of natural resources. As with any animal or plant organism, the overfishing of shellfish species destabilizes populations, resulting in a decrease in the size of the mollusks of the shoals and their densities. This has repercussions on reproduction: the following year less people will be born and, over time, may result in the disappearance of populations. In addition, depletion of the population created by overexploitation can determine changes in the surrounding ecosystem and affect other related species.

1) *Patella candei* is a species of exclusive Limpet of the Canary Islands that is in danger of extinction due to the overexploitation of its populations by the lack of regulation of the shellfish activities.

2) The growing demand for sea urchins in the market and slow growth compared to other shellfish species threaten the sustainability of the exploitation of this valuable resource. It is necessary, therefore, to have a management system that allows the rational use of seafood resources, analyzing and avoiding the causes of overexploitation. For this, research on the biology of exploited species is important

(Poaching) Poachers (unregulated shellfish) do not respect quantities or sizes, so they not only steal, but also endanger the sustainability of shellfish shoals and the fishing sector.

2.2.6 GLOBAL WARMING

Climate change or global warming is a modification of the climate that leads to a future growth of temperatures due to human activity, which has increased the generation of greenhouse gases, mainly carbon dioxide. These gases are produced mainly by combustion engines of industrial activity and transportation.



The effect of gases on global warming is best understood by the example of a greenhouse: the gases work like the glass walls of a greenhouse, keeping the heat inside.

(Greenhouse effect)

In addition to rising temperatures, global warming implies sea level rise, ice and glacier decline, alteration of oceanic and local circulation, increase in extreme events (floods, droughts, gales), etc. All these variations cause changes in the behavior of the species. As for shellfish, global warming will cause changes in coastal ecosystems that will endanger the livelihoods of many species. It will affect the movements of water bodies and productivity, reducing the production of shellfish. Rising sea water temperature will lead to the development of phytoplankton populations causing red tides. Extreme events, such as floods, will affect bivalves such as clams and cockle by reducing salinity.

The FAO (Food and Agriculture Organization of the United Nations) warns that responsible fishing practices need to be implemented much more widely, and that existing management plans should be expanded to include strategies to address climate change

2.2.7 REPLANT OF BREEDING AND PROPAGATION OF DISEASES

One of the main causes of introduction of diseases in the shellfish shoals is the replant of broods from infected populations. The replant of brood from a shoal with sick individuals or the breeding planting of which we do not know the provenance should be avoided.

2.2.8 CLOSING GATES OF LAGOONS

Coastal lagoons are areas in which a stretch of saltwater is separated from the sea by a low sandbank or coral reef. These ecosystems have a vital role for the coastal biodiversity, as they offer shelter, feeding grounds, and nursery areas for birds and coastal fish. These areas are also important grounds for shellfish. Human-induced structural changes in the lagoon environment, such as the increase of water retention time and water level normalization cause serious damage to the ecosystem and cause eutrophication.

2.3 THE NEED TO KEEP THE ENVIRONMENT

2.3.1 CONSERVATION OF COASTAL ECOSYSTEMS. WHAT CAN WE DO?

In order to avoid producing environmental impacts in the littoral environment derived from the fishing activity, we can follow a series of norms, or good practices, that derive from knowledge and respect to the environment.

GOOD ENVIRONMENTAL PRACTICES IN THE SHELLFISHING SECTOR



- Carry out information and training campaigns in the associative entities of the sector on conservation, waste management and pollution
- To comply with the laws on the management of seafood resources
- Respect the rest periods of the different species in order to allow the recovery of the shellfish populations
- Maintain maximum hygiene and care in the handling of catches
- Reduce packaging to the maximum, generating less waste and saving on packaging materials
- Do not discharge into the sea waste, organic waste, plastics or waste of any kind
- Do not deposit the disused fishing gear in the port or on the coast
- Use native species in the farming, as they achieve a better balance with the receiving environment and avoid the risk of disappearance of other species
- Avoid biological contamination due to abuse in the cultivation of alien species, such as the Manila clam (*Ruditapes philippinarum*) or the wakame (*Undaria pinnatifida*). Carry out previous adaptation studies for these species
- Not to exceed the capacity of management of a space putting at risk the future viability of the shellfish populations
- Do not use illegal fishing gear, that causes alterations in the environment or that damage the populations
- Respect for biological diversity in the work area

2.4 CONSEQUENCES OF BAD PRACTICES OF SHELLFISHING ON HUMANS

2.4.1 FOOD SECURITY. DISEASES CAUSED BY THE CONSUMPTION OF MOLLUSKS

There are three groups of diseases that may occur due to the consumption of mollusks:

1. Poisoning caused by toxins produced by toxic phytoplankton responsible for red tides
2. Infections caused by bacterial or viral agents
3. Diseases caused by heavy metals, such as mercury, or chemical contaminants, such as pesticides.

Below it is explained each one of these three groups of diseases

1. The main toxins associated with shellfish consumption and their effects on humans are:

- Paralyzing toxin: causes a progressive paralysis that can lead to cardiorespiratory arrest and death of the individual if not urgently hospitalized.
- Diarrheal toxin: produces diarrhea, accompanied by vomiting, chills, headache and fever.
- Neurotoxic toxin: produces diarrhea, vomiting and pains in the abdomen. Also, neurological dysfunctions, temperature changes, muscle aches, dizziness, anxiety.
- Amnestic toxin: causes vomiting, diarrhea, abdominal pain and neuronal damage: disorientation, confusion, convulsions, memory loss and, in some cases, death.



The seriousness of these intoxications justifies the need to control the production areas of shellfish to ensure the good sanitary conditions of the shellfish product.

2. Infections caused by bacterial or viral agents:

- Bacteria: Among the most dangerous microorganisms are those of enteric or fecal origin, waste water discharges or improper handling. Salmonella, Shigella, Escherichia coli. Cause gastroenteritis of different severity.
- Viruses: Their presence in fish products is due to water pollution or poor handling. Viruses can withstand the depuration process of mollusks.

3. Infections caused by heavy metals or chemical pollutants:

Mollusks found in coastal areas are exposed to chemical contaminants and heavy metals of different origin: rivers, marine currents, urban discharge, etc Pesticides, heavy metals, medical waste, etc. can be accumulated by bivalve mollusks and alter their quality, as well as cause public health problems when consumed. As in the case of biotoxins, it is necessary to control the production zones in terms of their levels of heavy metals, organochlorines and hydrocarbons to ensure the good state of shellfish products.

2.4.2 SANITARY STANDARDS IN THE FIRST STAGES OF THE PRODUCTION CHAIN OF LIVE BIVALVE MOLLUSKS

Both the production of mollusks and their commercialization are subject to a number of health regulations which are summarized below for the first stages of the process.

2.3.2.1 SANITARY RULES RELATING TO SHELLFISH PRODUCTION ZONES

Except for depuration, which is specific to bivalve mollusks, the following sanitary regulations apply to any shellfish marketed live.

- a) The areas of shellfish and aquaculture are classified into three categories depending on the quality of their waters:
 - Class A zones: These are the best quality areas of the water and mollusks can be marketed directly for consumption, without the need for prior depuration.
 - Class B zones: These are areas of lower quality, where fecal contamination is detected above the allowable limits for direct consumption of mollusks, so mollusks must be purified.
 - Class C zone: These are zones with higher pollution, so that the mollusks will undergo a greater treatment (re-installation and depuration) if they are destined for consumption.

In order to establish such a classification of shellfish production areas, the competent authority should establish a sampling program to check the microbiological quality of bivalve mollusks, the



possible presence of biotoxins and chemical contaminants. If sampling indicates that the essential health standards are not met, the affected production area should be closed to mollusk harvesting

b) The basic aspects for the collection and transport to a depuration or first sale center are:

- ✓ Avoid mollusk damage in collection and handling. Mollusks must be protected from blows or crushing as well as extreme temperatures or contamination due to poor handling
- ✓ Each batch of live bivalve mollusks sent to a depuration or marketing center must be accompanied by a registration document

DEPURATION

By depuration, bivalve mollusks filter clean water for a variable time in order to eliminate microorganisms. The depuration allows to substantially decrease the bacterial count, although it is ineffective in reducing the concentrations of viruses, biotoxins or chemical contaminants.

At first, the water to be used in the depuration is filtered and subjected to treatments that will eliminate the microorganisms by ultraviolet light, ozonation or chlorination.

2.3.2.2 SANITARY CONTROL AND POPULATION SUPERVISION

In addition, the competent authorities shall carry out checks on these stages through periodic inspections of production areas, doing sampling plans, laboratory analysis, inspections in depuration and dispatch center, and storage and transport controls for live bivalve mollusks.



3. SUSTAINABLE MANAGEMENT OF SHELLFISHING ON FOOT

General objectives of the module:

To know the ecological behavior of bivalve populations and to understand the necessary biological notions to obtain maximum sustainable yield from shellfish shoals without jeopardizing future extractions.

3.1 DEFINITION OF SUSTAINABLE MANAGEMENT AND SUSTAINABLE MAXIMUM EXPLOITATION

The sustainable management of the populations seeks that the resources will last in time, by extracting resources of a shellfish shoal in a rhythm adapted to the rate of recovery of the population. The opposite would involve bad shoal management. In addition, mismanagement means an obvious economic loss because the best performance of a shellfish shoal is not achieved.

The maximum **sustainable exploitation** of the resource is the maximum that can be extracted from a shellfish shoal without the populations resenting, ensuring that in the next harvest period we can continue to harvest shellfish. This is achieved by understanding the functioning of the populations and taking management measures (minimum sizes, closures, extraction quotas ...) according to the studies of the area.

(Overfishing)

3.1.1 ECOSYSTEM SERVICES

According to the definition made by "The Millennium Ecosystem Assessment" in 2005, Ecosystem Services are the "benefits that people obtain from ecosystems". These services can be split up in 4 categories: **supporting**, **provisioning**, **regulating** and **cultural**. Often, Ecosystem Services are little considered as their importance is not always economically calculable, the benefits are not considered.

Instead, these services have a great importance on the economic and well-being of human beings, but the price data that reflects the value of those benefits are often not available and hard to calculate.

For what concerns shellfish, Brumbaugh and Toropova in 2008 tried to hypothesize a number ecosystem services that derive from the presence of natural or managed populations (Table.1)

<p>Supporting</p> <p><i>By creating structurally complex shell habitat and performing a wide array of ecological functions, bivalve populations can substantially modify benthic and pelagic communities at different trophic levels and alter energy flow and nutrient cycling over the scale of entire coastal</i></p>	<ul style="list-style-type: none"> - Cycling of nutrients - Nursery habitats
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<i>ecosystems (Cranford et al. 2007).</i>	
<p>Regulating</p> <p><i>Regulating services are those that derive from the action of shellfish on ecosystem processes. These services indirectly favor human beings and they derive from the capability of shellfish to improve water quality through filtration, reduce shoreline erosion and stabilize estuarine sediments</i></p>	<ul style="list-style-type: none"> - Water quality maintenance - Protection of coastlines from storm surges and waves; - Reduction of marsh shoreline erosion - Stabilization of submerged land by trapping sediments
<p>Provisioning</p> <p><i>Provisioning services are the products or goods people obtain from a restored or maintained shellfish population. They include foodstuffs and raw materials for building and manufacturing (Northern Economics, 2009)</i></p>	<ul style="list-style-type: none"> - Commercial, recreational and subsistence fisheries - Aquaculture - Jewelry and other decoration (shells)
<p>Cultural</p> <p><i>Cultural services provided by shellfish are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. (Northern Economics, 2009)</i></p>	<ul style="list-style-type: none"> - Tourism and recreation - Symbolic of coastal heritage

Table1. Ecosystem Services provided by Shellfish. Source: Adapted from Brumbaugh and Toropova, 2008; Northern Economics, 2009

Supporting and Regulating

Cycling of nutrients, nursery habitats, water quality maintenance

Because they are filter feeders, shellfish can greatly influence nutrient cycling in estuarine/coastal marine systems and maintain the stability of the ecosystem.

Suspension-feeding bivalves serve to couple pelagic and benthic processes because they filter suspended particles from the water column and the undigested remains, ejected as mucus-bound feces and pseudofeces, sink to the sediment surface.

Benthic infauna uses some of this organic components resulting from shellfish metabolism as a nutrient source. At the same time this components can also enter in the microbial loop or in the water column.

This flux or cycling of carbon, nitrogen and other essential materials is vital for the continuity and stability of any living system and acts to keep the system in balance.

This concentrated deposition of feces and pseudofeces also enhance water quality. The increased biodeposition of organic matter in sediments leads to increased bacterial denitrification that can help to remove nitrogen from estuarine systems.



Further, filter-feeding shellfish not only remove nitrogen from the water column; they also incorporate a high proportion of it into their tissues. When the shellfish are harvested, the nitrogen is removed from the system, thereby recycling nutrients from sea to land (Shumway et al. 2003). They can also be a source of food for many marine species.

Shellfish, such as oysters and clams, as a direct result of their suspension-feeding activity, serve to reduce concentrations of phytoplankton and suspended inorganic particles, thereby increasing light penetration through the water column. This certainly can affect the total available nutrients because some of these will be used by shellfish. So, in case of eutrophic situation caused by anthropogenic nutrient enrichment, this could have a good effect on the environment reducing excess nutrients that can stimulate excessive nektonic plant growth in coastal waters, but could cause damage if it occurs in oligotrophic conditions.

The increase of the light penetration through the water can also favor the proliferation of species disadvantaged by turbidity as benthic algae and benthic aquatic plants like seagrasses, which are important nursery areas.

Ecosystem modeling suggests that restoring shellfish populations to even a modest fraction of their historic abundance could improve water quality and aid in the recovery of seagrasses, which can further reduce sediment resuspension and improve light conditions. In addition, researchers suggest that robust populations of shellfish can suppress harmful blooms of phytoplankton, such as the “brown tides” , and help modulate blooms of other types of harmful plankton, including “red tides”.

For what concerns the nursery areas, bio-constructions made by some kind of shellfish can be a shelter or nursery area for many marine species that are often epibiontics and grow by exploiting the hard substrate of the shellfish's shells.

Protection of coastlines from storm surges and waves, reduction of marsh shoreline erosion, stabilization of submerged land by trapping sediments.

This bio-constructions aforementioned, mostly related to some shellfish species such as oysters and mussels can provide another Ecosystem Services: the shoreline protection from erosion.

Mussels and oysters, indeed, can create a sort of reef along the coastline that can serve as natural breakwater, protecting the shoreline against the erosive force of wind, reducing bank erosion, decreasing loss of aquatic vegetation beds behind the reefs and finally, stabilizing sediment.

Provisioning

Commercial, recreational ad subsistence fisheries, Aquaculture, Jewelry and other decoration (shells)

Shellfish coming from coastal areas, tidal flats or lagoon/estuarine areas are an essential subsistence food source for human beings. Shellfish are bought and consumed for their nutritional benefits as well as their taste. They are healthy sources of protein, rich in vitamins and minerals, low in fat and a good source of omega-3 fatty acids.

Bivalve molluscs are not only harvested on natural stock, but various species are farmed in aquaculture facilities (oyster, mussels, clams). Aquaculture activities bring two benefits to humans:



the production of foodstuff and the gains associated with activity. Often, for example with regard to clams, natural stock management is reduced only to certain activities such as sowing and cleaning of the seabeds.

Shellfish fisheries and aquaculture can also indirectly bring local environmental problems to the attention of nearby communities. In many countries, public health standards under which shellfish fisheries and aquaculture operate demand clean waters (insert European legislation). As a result, the presence of shellfish fisheries and aquaculture often results in increased monitoring of environmental conditions of estuaries and coastal waters. Moreover, the economic hardships suffered by communities following closure of shellfish fisheries and culture operations due to water contamination have often provided the political impetus for improvement in sewage treatment plants or programs to fix local septic systems. However, in some cases shellfish aquaculture activities can cause environmental damage, for example by the introduction, voluntary or accidental, of alien species.

In addition to being harvested in commercial, recreational and subsistence fisheries for their edible meat, clams, oysters and other mollusks are removed for other purposes, like the decorative one (pearls), beaches nourishment (shells), natural water filters (shells).

Cultural

Some coastal communities base a large part of their economy on shellfish harvesting and consumption. These communities often have ten-year traditions with regard the collection methods and tools, the recipes etc...

These traditions are an important cultural heritage that often is an engine for a thriving tourism interested in knowing these traditions and enjoying the excellent cuisine.

Conclusions

Wild stocks of bivalve shellfish are susceptible to overexploitation by fishermen and have generally been depleted from estuaries and coastal areas worldwide. Shellfish in soft sediments occupy an essentially bi-dimensional bottom habitat; are largely sessile or fossorial; they can often be located by some surface clues, such as siphon openings, if not directly in the line of sight of fishermen; and, along with epifaunal bivalves like mussels, are readily accessed by fishermen because of their occupation of shallow or intertidal depths. All these characteristics combined with failures of fisheries management help to explain widespread depletion of bivalvia shellfish.

Maintaining a high abundance of suspension-feeding bivalves in estuarine and coastal areas ecosystems helps restore beneficial functions and conditions that characterized the ecosystems prior to extensive human intervention. For this reasons and for the growing awareness of the importance of ecosystem services provided by suspension-feeding shellfish, environmental advocates have increasingly pursued shellfish restoration as a component of restoring historical baseline conditions and functioning of estuarine and coastal areas.



3.2 HOW NATURAL POPULATIONS OF MOLLUSKS BEHAVE. POPULATION DYNAMICS

Populations are not static and vary over time in terms of the total number of individuals that comprise them. Thus, some individuals die, others are born and larvae eventually join the shellfish shoals (**recruitment**).

(Scheme of operation of a population of mollusks)

(recruitment, growth) and exit (death or capture)

To quantify a population of mollusks, rather than the number of individuals, biomass is used. The biomass of a population is the total weight of the population. In natural shoals, a balance is reached between the amount of live biomass formed (recruiting or adult organisms that grow and increase their weight) and lost biomass (dying individuals). With too much biomass in the population, competition between individuals would increase (for food, for space) and increase mortality.

The formula that expresses the variations of the biomass (productivity) of a population of mollusks, that is, the amount of living matter that is renewed each year is:

$$V = R + G - D$$

V= Variation of the biomass of the population.

R = Recruitment of new individuals.

G = Growth of individuals in the population.

D = Death of individuals

THE RATIONAL MANAGEMENT OF A SHELLFISHING SHOAL. HOW DOES BEHAVE A NATURAL POPULATION WHEN IT IS EXPLOITED?

At first, when we begin to extract shellfish from a natural shoal, if we increase the extractive activity we also increase the number of catches. But there will come a point where the catches will decrease even if we increase the extractive effort because the population is not able to replenish the biomass at the rate that loses it, that is, it is overexploiting the shellfish shoal.

For this not to happen there are two basic rules in the operation of any shellfish shoal:

- ✓ Do not remove mollusks not yet reproduced.
- ✓ Remove a number of mollusks that do not endanger the population so the resource can be maintained for future extractions.

If we fish too much, exhausting the population's capacity for renewal, or if we chase too small individuals who have not yet reproduced, we can reduce and even exhaust the population. Studies of populations (distribution, biomass) and their capacity for renewal (reproduction, recruitment, growth, mortality) are needed in order to know the maximum sustainable management of a shellfish shoal.



(Fishing management)

HOW DO WE ADJUST THE EFFORT OF THE SHELLFISHING SECTOR TO OBTAIN THE MAXIMUM SUSTAINABLE PERFORMANCE AT THE LESS COST?

(Maximum sustainable yield)

The maximum sustainable yield of a resource is the maximum of catches that can be extracted indefinitely. Managing shellfish shoals meeting this criterion is cost-effective and sustainable.

3.3 MANAGEMENT MEASURES TO AVOID OVEREXPLOITATION.

The fundamental objective of management measures is to maintain the performance of populations at optimal levels of exploitation.

To do so, the following restrictions may be included:

- ✓ Minimum catch size, which corresponds to the first set and from which it can be captured.
- ✓ Respect the minimum size regulation
- ✓ Catch rate or extraction quota: the amount of shellfish that can be extracted from a shoal, so that no more individuals are captured than are necessary to maintain the viability of the stocks.
- ✓ Effort regulation by restricting the number of licenses for the extraction (regulates the extraction effort by limiting the number of people with access to the resource), or the local and temporary closures (for example in the breeding season), which regulate the Effort by temporarily limiting access to the resource.

In the annex we can find a list different regulations to avoid overexploitation in each country.

(Shellfishing Management plans)

Rational, sustainable and realistic management plans, promoted by the sector itself, contributing their knowledge and attending to scientific criteria, supervised and supported by the Administration; are the best way to ensure the development of coastal communities dependent on natural resources.

3.4 TYPES OF ORGANISATIONS OF SHELLFISHING ACTIVITY ACCORDING COUNTRY

A resume of the most important types of shellfishing were identified and described (Table1).

Table 1- Resume of types of shellfishing , tools and species considered by the present project.

	Type of shoreline	Tools	Species/Taxa	Description	Regional denominations
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On Foot	Sandy beach and muddy shores	Hand Hoe Fork Salt Fish-spear	Biavalves Plychaeta Razor clams	Mainly by digging using manual tools while low tide allows for. There are some specific “no-digging” techniques: use of salt, “figa	Multiple local tools, names and traditional techniques just as regions
	Inside water. Sandy and muddy shores	Hand-Rake Fork Shovel & sieve Chisel/Fork & fishing-mirror-box	Bivalves	By using hand-operated dredge with iron teeth which are handled with the rod attached to the shoulder or back	The use of fishing-mirror-box is sometimes allowed (IT) (SP, razor clams with traditional fork)
	Mixed at beach/till chest. Sandy and muddy shores	Hands Hoe Fork Hand-Rake	Bivalves	Alternating the two previous techniques during the working-day	Multiple local tools, names and traditional techniques as regions
	Exposed rocky shore Boat only as transport to inaccessible rocky coast	Scraper Chisel Dip net Ropes	Barnacles Mussel seed (SP)	Scrapping rocks with manual tools while low tide allows for Idem, on islands, islets and cliffs	Great popularity in Galicia (SP)
	Shallows and tide pools. Protected/ semi exposed	Hands Knife/Sickle Chisel Hook Dip net	Gasteropoda <i>Anemonia spp</i> Sea-urchin Seaweeds <i>Palaemon spp</i> Mussel seed	Catching, cutting and scrapping on rocks with manual tools	
	Use of a boat to reach the collection point. Manual dredge handled on foot. Sandy and muddy shallows Certain degree of mechanical support. Muddy shallows of coastal lagoons	Hand-Rake (long rod) Individual hydraulic dredge (Idrorasca)	Bivalves	On anchored boat, by using hand-operated dredge which are handled with the rod attached to the shoulder and by performing body movements It is requested the presence of an operator on foot to guide the dredge into the water	<i>Idrorasca</i> (IT)
	On Board/Diving (Manual Tools)	By diving. Apnea	Buoy Hands Razor Hook Scraper	Razor clams Sea-urchin Seaweeds <i>Anemonia spp</i>	By hands or manual tools. Diver uses free diving techniques with a snorkel mask



Fishing Vessels	Air supply	Idem + Scuba tank Compressor	Abalone Polychaeta <i>Holothuria spp.</i> Mussels	By hands or manual tools. Diving equipment with an air supply system provided from the boat	or not allowed (PT)
	Traps-Pots. Rocky beds	Fishing baskets Clay/plastic vessels	Crustaceans Decapods	By releasing trap-lines (trawls) and heaving up them a few hours later with an engine	Multiple types according to species and regions
	Mechanized dredge	Towed rake Beam Trawl	Bivalves <i>Rapana venosa</i> <i>Holothuria spp.</i>	Drag on the seabed by using engine power	There are usually engine power legal restrictions <i>Algarna</i> (TK) <i>Endeño remolcado</i> (SP, less of 10 GT)
	Hydraulic dredge. Muddy and sandy beds. Offshore	Hydraulic dredge	Bivalves	Drag on the seabed raising the substrate by means of a jet of water favouring the entry of clams	Many local variants. “Turbosoffiante” vessels (IT) Dreç (TK)



4. IMPROVEMENT OF SHELLFISHING TECHNIQUES

General objectives of the module:

To know the set of techniques that can be used to stabilize and improve the production of shellfish shoals.

4.1 HARVESTING NATURAL POPULATIONS

A marine crop can be defined as a means of promoting or enhancing growth and, therefore, production for commercial purposes, protecting, nourishing and raising organisms in certain areas. It consists not only in sustainable extraction but also in the care, control and protection of the crop at different stages.

Depending on the degree of control to which a crop is subjected, two types of exploitation are distinguished: intensive and extensive crops.

Intensive culture (aquaculture) is characterized by a high concentration of animals, a feed allocation to the cropping system and a control of the cropping means.

In contrast, **harvesting of natural populations (shellfishing)** is characterized because it is carried out without fertilization or nutrient supply to the environment. The development takes place in unmodified natural environments or in bounded aquatic extensions, where natural production and water quality determine the success of the crop. The main advantages of harvesting are the use of natural resources, low initial investment and cheap maintenance. On the other hand, the productions, as well as their quality, are not uniform since they depend to a great extent of uncontrolled variations in the climate and in the dynamics of the natural populations. Thus, in harvesting seabeds, the key to rational management lies in the maximum sustainable management of natural production.

We classify as **extensive management of natural populations** the one in which certain aspects are controlled to improve the production of a natural shoal. The main not-harvesting works that can improve the performance of the shellfish shoals is the care of the seabed (eliminating wastes or algae blooms), pouching surveillance, control of population densities (spread or unfolding) and the planting of juveniles. Other works and aquaculture techniques as gates construction, massive substrate modification, sowing of non-native species; who can cause high environmental impacts are not advised. In any case, public administration of each country must avoid or prohibit as believe to be opportune in accordance with his own and international environmental laws.

(Shellfish on foot in Galicia region, Spain) The common practices in the by foot shellfish shoals in Galicia are the techniques of extensive semi-cultivation, which comprise one or two phases of the vital stage, namely the phases of pre-fattening and fattening of the seed. The five species that account for the highest percentage of shellfish production are cockle (*Cerastoderma edule*), cross-cut carpet shell (*Ruditapes decussatus*), carpet shell (*Venerupis corrugata*), Manila clams (*Ruditapes philippinarum*) and banded carpet shell (*Tapes rhomboides*). The first four are exploited in the form of shellfish on foot while the banded carpet shell is extracted by shellfishing on boat. Since the end of



the last century, with the professionalization of the sector, the seafood sector underwent a deep change, beginning to develop the training plans and actions that enabled its modernization. It evolved from a purely collecting mentality to another sower, and there were organizational and productive changes of some relevance

The following are the improvements perceived by the sector in recent years: **(Professionalization of the Galician shellfish farmers, Marugán Pintos)**

Organization: Greater organization and self-financing. Representativeness and integration of shellfish farmers in decision making. We moved from territorial confrontations to cooperation between communities.

Poaching: Surveillance is done to control poaching. Standards are respected: minimum sizes, catch caps and control points are created. They went from beaches that were not used to the regeneration of unproductive areas. Areas and working times were well delimited.

Management: Specific management plans were created by the shellfish farmers themselves. They are done semi-cultivation work: pre-harvest and cultivation, cleanings, ... Evolution of an extraction mentality to another one, being aware in the need to work and take care of the beach. Increased training and information to the sector. Increase in production and income. All shellfish farmers have the operating license in order. Access to social security was obtained: health coverage, retirement.

Marketing: Auction sale and price increase. Pre-bid and minimum withdrawal price. Sorting by size. Improvement in seafood manipulation; Quality and prestige. Development of experiences in diversifying activities such as fishing tourism

4.2 ENVIRONMENTAL AND BIOLOGICAL PARAMETERS AND CONDITIONS THAT INFLUENCE THE GROWTH PROCESS.

The development of bivalves depends on the environmental conditions of the growing area, mainly the temperature and the availability of food. Thus, the growth of species will vary from one area to another.

The physicochemical characteristics of sea water (mainly temperature and salinity) must be in a range tolerated by the shellfish species. Seasonal variations should also be taken into account. The amount of dissolved oxygen must be high, there must be few particles in suspension and little turbidity in the water. Other chemical parameters affecting are: CO₂ (carbon dioxide), SH₂ (hydrogen sulfide), residual Cl₂ (chlorine), nitrites, ammonia, heavy metals, etc.

The most desirable characteristics for a bivalve shoal are in areas protected from the swell, but with good movement of water, without large algae deposits and avoiding all type of contamination.

Other important factors are the granulometry of the substrate, the slope of the beach or the productivity of the ecosystem.



4.3 TECHNIQUES OF SEED OBTAINING: NATURAL AND FARM COLLECTION.

Collection of seeds.

In an extensive management, the seed can be obtained through methods controlled in hatcheries or using systems of capture in the environment (recruitment).

In some cases, such as oysters or mussels, the seeds can be picked up in the environment, with the help of artifacts called **collectors**, in which the seeds are naturally fixed. Seed collection techniques in the environment seek to increase recruitment of the larvae by providing additional substrates that facilitate fixation. These techniques are used more for epifaunal species, which live on the substrate, such as oysters, scallops and mussels, rather than for the infaunals, that live buried, like the clams.

(Oyster Collectors)

To place the collectors, we must study the ideal moment in which there is greater presence of larvae of the species in the water. If we place too soon, the collectors can be covered with silt, algae or other organisms. If we set too late, few larvae will be fixed to our collectors.

In **hatcheries**, selected reproducers are maintained under controlled conditions of temperature, light, salinity and feeding. The setting is generally induced by varying the temperature. After fixation and metamorphosis, the larval life ends and the seedling phase begins until it reaches the necessary size for sowing.

In hatcheries, the reproductive performance is higher than in the natural environment, obtaining a large quantity of quality seed. In addition, hatcheries allow the supply of seed at any time of the year.

(Clam hatchery)

For the sowing of clam seed on the beach, although it can be done directly bypassing the stage of pre-fattening when the juveniles are 3 or 4 mm, the ideal is to do it with pre-fattened breeding of 12 to 15 mm. which will better withstand unfavorable environmental conditions. The pre-fattening can be made on the beach or in suspended cultivation (ropes, tables, pans)

4.3.1 CONDITIONS THAT DETERMINE SETTLEMENT: ACTIONS TO FACILITATE THE RECRUITMENT OF BIVALVE MOLLUSKS

For the rearing of clams and cockles there are suitable collectors, but there are environmental factors that determine the number of larvae that are successfully recruited, so that by knowing them, we can perform actions that favor larval settlement. In the location of crops, it should be sought the protection of

strong currents and tides, which can drag the larvae and reduce the success of recruitment. The crops will be placed in protected areas or artificially protected.



On the other hand, some larvae prefer certain types of substrates. Thus, gastropods (such as the periwinkle) settle in places with an abundance of algae, which they use as food and shelter. Clams prefer a sandy-loam substrate of a certain size, with gravel or pieces of shells. The cockles prefer substrates of clean slime or very fine sand. Sea urchin larvae settle exclusively over previous sea urchin beds.

To facilitate the natural recruitment, we must:

To make good harvesting. As example, barnacle larvae need the presence of adults to fixing at the substrate, so harvesting must not scrap big areas, it is better to scrap by belts. Also the sea urchin harvesting must avoid to decimate populations to allow recruitment of new individuals.

To avoid overexploitation. Fertilization in many mollusks is external. To be able to find eggs and spermatozoa in the water that guarantee the subsequent recruitment of larvae, there is a need for an abundance of adults to produce gametes.

4.3.2 TRANSPORT AND HANDLING OF THE SEED. METHODS OF SOWING

The seed of the shellfish has to be treated with care, it is even more fragile than the already grown mollusks, so that in its transport and handling must take into account the following standards:

- ✓ Good treatment. It will be avoided the compilation of too much seed, which may lead to clumping or breakage. Blades or other instruments that may cause physical damage to shellfish shall not be used.
- ✓ Refrigeration: transport temperatures should be low (about 0 ° C) to lower the metabolism activity of mollusks.
- ✓ Rapidity: During transport and handling, the seed have no food and can only breathe the oxygen from the water in their shells, so the sowing has to be done quickly.

The planting season can be distributed throughout the year, avoiding moments with more rain and storms.

The ideal time to sowing is spring. The growth has a variable duration, depending on the species and the productivity of the shoal, until the clams get the commercial size for their consumption.

The sowing can be made directly on the substrate or protected in the first months by a plastic net. The convenience of using or not methods of protection will depend on the quantity of predators in the area.

(Example: Engorgement of clams in bounded areas of the natural environment)

1. The clams are planted with a homogeneous distribution, with a density of 250 clams / m², manipulating them carefully so that there is no breakage in the shells.
2. The clams can be covered with a supplementary protection for the first 2 or 3 months, consisting of a plastic net above the crop. Additional protective measures may be used, for example by coating the surface of the park with a layer of gravel



3. When sizes of 30-35 mm are obtained, an unfolding will be done (spread over the available surface, so that they have more space and can grow more), until the moment of its collection, with a minimum size of 38- 40 mm.

During the growth, the mortality is mainly caused by predation of crabs, starfish, etc. If the sowing tasks are done correctly, the survival is usually 70-80%.

4.4 CONDITIONING AND MAINTENANCE OF SEAFOOD MANAGEMENT AREAS.

different actions can be done that favor the managed populations. These can be divided into actions on the populations and actions on the environment

4.4.1 ACTIONS ON POPULATIONS:

Unfolding

Due that there are many mollusks in the same area, to reduce competition among them, they are unfolded, which consist of removing individuals from areas where they are in high density and planting them in areas of low density making a more homogeneous distribution in the area. It is often done with the cockle (*Cerastoderma edule*), which is a species in which many individuals are usually attached together in the same area.

Replants

It consists of taking individuals from one area to another because the destination area is more suitable (easy access, no pollution, ...)

Sowings

New individuals are brought from nurseries or collectors in the area

Actions on predators

Predators are key species for ecosystem functions. Their elimination is often counterproductive

Predators are especially dangerous when the seed has a small size and is therefore more vulnerable. Before sowing, mollusks should be protected by eliminating possible predators from the planting area. If during 15 days we leave in the upper part of the beach the sand that we are going to use to stop sowing, we will have eliminated a large part of the potential predators of our breeding.

One of the most prevalent groups of bivalve predators are the gastropods. They are carnivorous snails that, by means of a specialized organ, perforate the shells to accede to the meat of the mollusks. Examples: *Ocenebra* and *Nucella* genus

(*Nucella* and *Nassarius*)



Nassarius is a frequent gastropod in the shellfish shoals. It fulfills an important ecological function, since it is scavenger and clean of corpses the seabed. However, it has an undeserved bad reputation among the shellfish sector because it resembles *Nucella*, which itself is a predator of bivalves, a gastropod perforator.

Other groups of animals that feed on bivalve mollusks are starfish, crabs, flatfish such as plaice or sole and seabirds such as oystercatcher.

Actions taken on the environment: cleaning of wastes and algae blooms

In areas of low current and low water renewal rates such as estuaries, inland lagoons or estuary bottoms, algae may accumulate especially in the late spring and early summer. When decomposed, the algae consume oxygen in the environment and can produce significant mortalities in bivalve mollusks.

To avoid mortality, we must remove the layer of algae when they are at their maximum production level (June-July) to prevent them from re-colonize the area. Algae are removed with different agricultural tools such as trails and forks or with small boats carrying and adapted fishing gear with the aim of removing algae. Small tractors or specialized machines can also be used.

Green algae of the genera *Ulva* and *Enteromorpha* often cover the shoals when sunlight and water temperature increase. The phenomenon becomes more evident in places with little water renovation (estuaries and estuary funds). *Sargassum muticum* is an invasive alga that can also cover the substrate of the shoals.

(Beds of brown seaweeds) Not all seaweeds on the beach are harmful: brown seaweed harvests from the kelp forests are seasonal processes balanced with the ecosystem and provide shelter and food to diverse associated fauna (sea fleas, insects, polychaetas, birds, ...)

4.5 RECOVERY OF DEGRADED ZONES AND EXHAUSTED SHOALS: METHODS TO APPLY ON THE ENVIRONMENT AND THE POPULATION

Sometimes shellfish shoals suffer significant losses of shellfish production. There are several reasons why a shellfish shoal does not produce much shellfish:

- Recruitment may be scarce; new generations do not compensate for losses to maintain populations. This may be due to the fact that there are few breeding adults in the mollusk population, for having extracted them during the breeding season, for example (not respecting biological stops), that the environmental conditions are unfavorable for the recruitment of juveniles in that beach, by strong currents, for example; or that there is a high mortality of recruited larvae or juveniles.
- The growth of individuals is slow. Because there is little food in the environment or because the environmental conditions are unfavorable
- Natural mortality is high. Because there are many predators, because the environmental conditions are unfavorable or because there is contamination.



- Shellfish mortality is high. Because many mollusks are caught and those that remain cannot maintain populations, because many discards are made due to inadequate use of the gear, which damages the environment; or because there is a lot of poaching.

When we find cases like this, we must manage the seafood activity of the area so as not to deplete shellfish resources. For this we must calculate how much the shoal produces and establish norms that allow the recovery of the populations of mollusks. To properly manage a shellfish shoal or recover a population of depleted mollusks there are a number of procedures that can be carried out and are summarized below: ***(Procedures, problems and measures in the management of the shoals "Lombos do Ulla" and "Bohído ")***

1. Periodic evaluation of the productive state of the shoal

- a) Seafood is not homogeneously distributed throughout the shoal. It may be due to differences in mortality or recruitment in different areas of the shoal, or by trailing individuals from one area to another by the currents. Solution: Subdivide zones in the shoal and establish a rotating operating system in those subareas
- b) The density of individuals is low. Either because of lack of recruitment, high mortality or shellfish overexploitation. Solution: Reduce extraction effort in the area
- c) Few individuals attain legal size for consumption. Due to overexploitation or the presence of diseases. Solution: Reduce the extraction effort and analyze the pathologies of mollusks in the area.

2. Daily control of extractive activity.

- a) Decrease in catches. Either the extraction effort has been reduced or the abundance of individuals has decreased dramatically. Solution: If the problem is not by reducing the extraction effort, the extraction should be stopped and the causes analyzed.
- b) Decrease in the number of shellfish fishermen. Lead by a loss in the abundance of stocks, by a decrease in the sale price or by the emergence of a more profitable alternative activity. Solution: Stop the extraction and analyze the causes if the loss does not correspond to the decrease in the selling price or with the appearance of more profitable alternative activities.
- c) Gradual decrease in catches per day. Generated by the loss of abundance in the shoal. Solution: The extraction must be stopped or reduced

3. Periodic monitoring of catch sizes

- a) Progressive diminution of the average size of the catches and of the individuals that reached size of commercialization. Caused by a gradual reduction of abundance or by an increase in poaching. Solution: Increase vigilance. If the losses are not caused by poaching, stop the extraction.

4. Monitoring of the sale price



- a) When reduced, it must be caused by decreased size, quality (shell color, size of food, etc.) or by mismatch between supply and demand. Solution: Reduce quota by shellfish or change shellfish shoal.

(Control points) Once the extraction has been completed, the product is classified and weighed daily in the so-called "control points", a step prior to being sold in the auction. Organized by the shellfish, they are meeting places after the capture, usually on the beach or in facilities very close to the sea. They control quotas, sizes and weights. Juveniles or excess quotas are returned to the sea. In addition to self-monitoring, these meetings increase governance and promote sustainable management in clusters.

4.5.1 TOOLS AND EQUIPMENT USED IN SHELLFISHING ON FOOT

The tools used in shellfish by foot are quite simple and some come from tools used in the field works. The most common tools are:

- **Hoes.** Excavate and remove the substrate to catch intertidal species.
- **Forks.** They are used for the capture of species such as cockles that live buried in the most superficial layer of the substrate. It is also used in cleaning algae. The little fork is also used in the capture of the sea urchin.
- **Sickles.** They are used for "dry" catch, one by one, of bivalves such as clam, cockle or Wedge clams; also in the collection of algae.
- **Fish-spear.** Rod as a spear for the capture of razor clams and bivalves. Like sickles, they are tools "to the hole": extracting the bivalves one by one.
- **Scraper.** To extract barnacles and mussels; is also used to collect mussel seed or limpets.
- **Hand-rakes.** It is used in water and requires a lot of physical effort. It has teeth that remove the substrate and lift the mollusks, which are retained in the cope, which is made of metal rods. The brailer is formed by a metallic framework that supports a network cup and has no teeth.
- **Idrorasca.** is a manual dredge which exploits the thrust of a engine to move the sedimen with the hydraulic power of the water. This type of dredge must be handled by a fisherman inside the water, on lagoons or coastal seabeds, till 100/150 cm of depth .

4.5.2 RESEARCH APPLIED TO SEAFOOD

Many of the limitations of the activity have been corrected thanks to the knowledge acquired with scientific research. Knowledge of species biology, reproduction, population dynamics of managed species; the search for new species for the shellfish; the improvement of semi-cultivation techniques and the tools used; the study of the pathologies of the crop species; improvements in depuration, processing of shellfish products and market techniques; are some of the pillars that will enable the development of shellfish.



4.5.3 FUTURE IMPROVEMENT

The shellfish sector has two major challenges: the increase in the economic returns of shellfish activity and the improvement of business organization and safety in the management and ownership of shellfish shoals .

The increase in economic returns is due to the improvement in the quality of shellfish products and a control of the evolution of prices, by improving the sector in the commercialization and the diversification of its activities. The increase in income should avoid short-termism and consider the increase in income at the end of the year, abandoning the mentality in which what is "caught in the day", which does not think about the future and the evolution of the sector.

For conventional economy, shellfishing is an example of minor role economic activity. Nevertheless, from the "blue economy" viewpoint, it provides multiple benefits:

- It depends on natural cycles and is involved in the littoral ecosystems preservation.
- It allows coastal multifunction. It is compatible with other uses: fishing, tourism, sports, navigation.
- It earns sustainable incomes for local habitants and it palliates of rural abandoning of coastal small towns.
- It is basic link of the comercialization chain. It provides goods to other market actors: treatment system, distributors, fishmongers, restaurateurs, ng industry, ...
- Seafood is a valuable tourism strategy

5 THE MARKETING OF SHELLFISHING PRODUCTS

General objectives of the module:

Get to know the links of the marketing process of the fishery products and the strategies that are used today to increase the income of the shellfishers

5.1 STRATEGIES FOR INCREASING MARINE PERFORMANCE

5.1.1 TAKING CONTROL OF THE RELATIONSHIP BETWEEN THE OFFER AND THE DEMAND

It is convenient to bring products to the market when they are most in demand: adjust the production of the shoals to the market demand. If we improve the planning of the production cycle, we can adjust to the demand and concentrate production in the periods where the highest prices are recorded. To do that we must evaluate the market situation and take measures to adjust the value of the catches at a sustainable level in certain periods. A guild or producer organization should consider avoiding the capture of certain species when there is little or no demand for the product on the market or the prices obtained are low and thus link the catch plan with the marketing strategy.



(Withdrawal price) In the case of downward bids, shellfish can be removed from the market when prices fall below a set level. This level is called the "withdrawal price". In order to guarantee a minimum income for shellfish farmers, producer organizations can pay compensation and, in turn, apply for Community compensation (EU). In order to be entitled to these economic compensations, withdrawals must be subject to occasional excesses of production. Producer Organizations can take measures to ensure that the product is not thrown away: in the case of shellfish, live mollusks can be returned to the sea.

5.1.2 GENERATE ADDED VALUE

Another initiative to increase revenues is to add additional value to products or by-products of the sea in their processing or presentation. Some guilds of Galicia elaborate barnacles in pâté to take advantage of discards or barnacles of little commercial value.

(Added value) It is the value that a productive process (canned p.e.) provides to the existing added value of the raw material. Making pâté of barnacle with little valued in fresh (small size or thickness) adds value in the market.

5.1.3 THE USE OF QUALITY BRANDS

Promoting the quality of seafood is essential. The implementation of quality labels is becoming increasingly necessary to protect local products from the massive entry of others from abroad, which in many cases, the consumer does not know how to differentiate.

(PescadeRías) *PescadRías* is the quality brand of artisanal fishing in Galicia, including shellfish. It guarantees the quality and traceability of local products.

Existing labels or marks to guarantee the specific quality of food products may be based on names linked to a geographical origin (Protected Designations of Origin or Protected Geographical Indication) or designations linked to modes of production (generic or Specialty Traditional Guaranteed).

The shellfish sector would benefit from this type of quality seals as they grant the recognition of superior quality and help to compete with other regions, internationalizing the brand of the product and the area. In addition, access to the promotion in markets, both inside and outside, is facilitated. Another advantage of this type of certification is that it helps to preserve the collective heritage of the region.

Among the disadvantages are the economic ones, due to the high cost of the certification process. For this reason, it is important, if we decide to opt for this type of certification, the promotion of partnerships to face these investments.

We can divide Certifications into two categories according to purpose: quality of the food and environment protection.



Quality of the food:

The European Union has issued specific legislation covering the domains and traditions of food quality brands: **PDO**, **PGI** and **TSG** (Protected Designation of Origin, Protected Geographical Indication; Traditional Specialty Guaranteed).

OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Environment protection and quality of the food:

The European Union has regulated organic aquaculture, setting the criteria for organic production and organic products which can be identified with the **BIO** brand. This certification guarantees both product quality and respect for the environment.

of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91

of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control

of 5 August 2009 amending Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007, as regards laying down detailed rules on organic aquaculture animal and seaweed production.

In the same way there are a non-governmental institutions that take care of both this aspects with reference to aquaculture, for example **GLOBALG.A.P.** (Good Agricultural Practice)

Environment protection: quality brands related to non-governmental institutions. The most important are: **MSC** (Marine Stewardship Council), for fishery; **ASC** (Aquaculture Stewardship Council) for aquaculture; **Friends of the Sea**, both for fishery and aquaculture. This type of brands certify that the product has been fished/hunted ethically and environmentally friendly.

As far as shellfish are concerned, there are few certified products in Italy and are all related to aquaculture: the most important are the **Scardovari Mussel** that has recently obtained the **PDO** brand and the **Mediterranean Mussel-Mytilus galloprovincialis** collected by **Marevivo srl** of Castro Marina which has been recently certified **Friends of the Sea**. For what concerns the **BIO** brand, some mussels and clams farms were certified along the Italian coast. This "BIO clams" (*Tapes philippinarum*) are harvested on foot in some Italy lagoons.

Recently, a company that fish clams (*Chamelea gallina*) in the Adriatic Sea (by boat with hydraulic dredge) have started the procedure to obtain **MSC** certification.

5.1.4 SELLING JOINTLY AND ASSOCIATIVELY

Some of the problems of the commercialization of seafood products are:



- a) dispersion of the markets, which generates a fragmented and unequal supply
- b) absence of efficient logistical structures, resulting in distribution problems; and
- c) market control by intermediaries, particularly in small markets where buyers enter into agreements to fix product prices, harming shellfishers.

It is therefore beneficial to concentrate the supply of seafood at a certain point. The greater number of buyers, the better will be the prices in the first sale, because the auctions are more competed and price control is avoided.

5.1.5 GIVE PUBLICITY TO THE SHELLFISH

By putting ads on the radio, in newspapers; to distribute information leaflets (nutritional properties, seafood recipes), to make advertising gifts, to bring the products to food fairs and gastronomic festivals and, in general, to promote the image of seafood as a healthy food and high quality, high protein and low calorie.

(O *noso mar* brand)



ANNEXES

ANNEX 1: REGULATIONS TO AVOID OVEREXPLOITATION

Minimum sizes Portugal

(Portaria nº 27/2001, de 15 de janeiro, com as alterações dadas pelas Portarias; nº 402/2002, de 18 de abril, nº 1266/2004, de 1 de outubro, nº 82/2011, de 22 de fevereiro, nº 119/2014 de 3 de junho, nº 170/2014, de 22 de agosto e Reg. (CE) 302/2009 de abril e Portaria nº 247/2016, de 14 de setembro)

In Italy there are no specific regulations for fishing on foot except for recreational fishing (e.g. maximum of 5 kg each one per day; no fishing licenses are needed). There is a regulation on shellfish fishing in general, but it concerns mostly shellfish fishing by boat and cites only marginally the fishing on foot and the rake used for this type of fishing, with a small description.

“For “rake on foot” and “rake without the use of force”, are meant tools for the capture of shellfish driven exclusively by human energy. There are essentially two types; in fact, the lower mouth can be equipped with a metal blade, or teeth. The tool can be provided with textile mesh bag or net collection basket or grid metallic. The tool can be used on foot or on board a boat, in the latter case the towing and recovery are totally manual.”

“The fishing of clams with rake on a foot [...], in areas that are not under concession, is permitted only beyond the limit of half a mile from the concession limits.”

“In the Tyrrhenian Sea, days of weekly rest for the use of gears known as rakes by boats and rakes without the use of power and walking, are limited to holidays only.”

Regulation:

In many lagoon or estuarine areas of Italy (particularly in the regions Emilia Romagna, Veneto, Sardinia, Toscana, Lazio) the collection of shellfish on foot is carried out. Usually, the management is in the hands of Consortia that bring together a certain number Cooperatives. Every cooperatives have a certain number of boat, every boat is an Individual Firm with a fishing license and may or not have a sea lagoon area under concession. Most boats do not have a private area under concession, so the Consortium locates each day a fishing zone and a specific number of boats that can go to fish in that zone, with a maximum allowable collection amount for each one.

Every day the Consortium communicates the number of boat and the list of fishermen who can go to fish, and the maximum allowable amount.

Management plans are made by Consortia and include information about: number of licences; species allowed; tools and techniques selection; daily amount allowed; minimum sizes; temporary closures of some zone; presence of nursery zone; areas for clams growth; areas for the storage of empty shells; surveillance; cleaning; sowing and reseeding the shellfish beds.



European legislation of shellfishing

European legislation on bivalve shellfish (the most important type in terms of quantitative and economic production of the largest commercial group defined as shellfish) can be divided into two groups: the one relating to hygienic sanitation aspects and the one which deals with fishing management aspects.

1. Hygienic sanitation aspects

In Italy, health surveillance of bivalve shellfish production areas is based on some European regulations:

- Reg. CE: , , e of 29 April 2004 as amended;
- of 15 November 2005 as amended;
- of 5 December 2006 as amended;
- of 24 October 2006 as amended;
- of 8 December 2015, COMMISSION REGULATION (EU) 2015/2285 of 8 December 2015 amending Annex II to Regulation (EC) No 854/2004 of the European Parliament and of the Council laying down specific rules for the organization of official controls on products of animal origin intended for human consumption as regards certain requirements for live bivalve molluscs, echinoderms, tunicates and marine gastropods and Annex I to Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs.
- of 5 April 2017 laying down methods of sampling and analysis for the control of levels of dioxins, dioxin-like PCBs and non-dioxin-like PCBs in certain foodstuffs and repealing Regulation (EU) No 589/2014

In addition to these, some international reference documents should be added:

- CEFAS “ November 2005 as amended;
- European Commission Report DG (SANCO) 2012-6542 – MR FINAL

2. Fishing management aspects

The regulations is different depending on whether the activity is exercised in the Mediterranean or in other EU seas. The reference regulations are:

- Mediterranean fishing: of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94 – as amended.
- Fishing in other seas of the European Union: of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms – as amended.

All of these European regulations about hygienic sanitation aspects and fishing management aspects, have been applied by individual countries at national and regional level and periodically updated.



- Rep. Atti n. 79/CSR dell'8 luglio 2010

Spain

Local fishermen, including shellfishers on foot, are traditionally organised in associative organizations (“cofradías”, associations of “mariscadoras”, producers companies).

The **management plans** are proposed by fishermen organizations from traditional regions. They must be based on profitability and sustainability criteria, must be reviewed each year and endorsed by proper authority. The managing plans must comply with minimums from **fishing laws** and from annual general plans. Some other regions, where there is weak governance and/or recreational shellfishing, local administration can propose management by its own.

These plans include economic and environmental sustainability criteria: number of permissions, species allowed, tools and techniques selection, catch limits, minimum sizes, temporary closures. Also, plans can schedule non-extractive tasks (surveillance, regeneration or cleaning) and aquaculture tasks (sowing and reseeded the shellfish beds).

Local implementation of management plans depends on multiple social, economic, cultural and environmental factors.

Coastal management in Spain is transferred to regional governments (“Comunidades Autónomas”). So, each “C.A” has own regulation.



ANNEX 2: THE PREVENTION OF LABOR RISKS IN SHELLFISHING

PURPOSE OF PREVENTION AND DEFINITIONS

The Prevention of Occupational Risks aims to establish a level of protection of the health of workers against the risks derived from working conditions adopting a set of activities and measures. It is understood as a work risk the possibility of a worker suffering a certain damage derived from work. Damage from work can be illness, disease or injury.

PROFESSIONAL DISEASES IN SEAFOOD AND ITS CAUSES

The shellfish work is done outdoors. When the temperature decreases, workers can suffer hypothermia. With moisture, the sensation of cold increases, and this physical agent can cause long-term rheumatic diseases, back pain, sciatica, muscular contractures and osteoarthritis. Exposure to cold, wind and moisture can cause urinary tract infections (cystitis). Areas exposed to chafing can be colonized by fungi (mycosis).

Excess heat and prolonged exposure to the sun may cause heat stroke. Sunburn can also cause burns, dermatitis (inflammation of the skin) and even cancerous lesions. In addition, the rays of the sun can be increased by the reflection of these in the water, being able to cause injuries in the eyes.

Other ailments can be related to the psychic pressure of adapting to the tide schedule, which can alter sleep cycles, family duties and daily routine.

But undoubtedly, forced postures, excessive load and insufficient rest cause the most frequent and important disorders in the shellfish exercise: musculoskeletal disorders.

MUSCLE-SKELETAL DISORDERS

Musculoskeletal disorders are changes in the muscles, tendons, nerves or joints that can occur in any area of the body, although the most common are those affecting the neck, back and upper extremities. General symptoms of musculoskeletal disorders include muscle and joint pain, and tingling sensation.

The musculoskeletal disorders that occur most frequently in the shellfish exercise are:

- **INJURIES IN THE PULSE:** over time specific lesions may appear, such as carpal tunnel syndrome. It can be caused by a multitude of causes, such as repetitive movements or arthritis.
- **TENDINITIS:** is the inflammation of the muscle tendons of the pulse and elbow. (Tendinitis: causes and exercises)
- **TENOSYNOVITIS:** is an inflammation and thickening of a protective covering that is on the tendons. It can be caused by an infection, an injury, an overload.



- **SPRAINS AND FRACTURES:** they are generated as a result of an abnormal movement, in which the ligaments that hold the joint are stretched or broken. The fracture is a rupture of a bone by a blow.
- **LUXATION:** These are caused when a bone of the joint leaves the site when performing an abnormal movement.
- **BACKACHE:** pains in the lower back caused by injuries, sudden movements and forced postures sustained over time.
- **JOINT INJURY (ARTHROSIS):** Progressive wear of one or all of the joint elements.
- **ARTHRITIS:** is an inflammation of one or more joints with pain, swelling, stiffness and limited movement. They're produced as a result of exposure to moisture and cold.

LOAD LIFTING

Very often, improper lifting of loads can lead to many musculoskeletal disorders, such as tendinitis, sprains or muscle pulls. To lift a weight, we must keep our back straight and flex the legs for the load to fall on them.

When transporting goods by hand, the load must be distributed between the two hands to carry the straight spine.

It is necessary to take into account the maximum weights to load and the convenience of using carts to transport the merchandise. Although under ideal conditions up to 25 kg can be loaded, no more than 15 kg should be loaded. habitually.

PREVENTIVE MEASURES AND INDIVIDUAL PROTECTIVE EQUIPMENT

In shellfishing activity it is advisable to get tetanus vaccine as we can cut or injure ourselves with fishing gear, glass or bottom irons. The personal protective equipment is the equipment (accessory or accessory) that the worker carries or holds and which protects him from one or several risks that may threaten his safety or health. Some personal protection equipment in the shellfish industry are:

- **Gloves:** protect against cold and risk of cuts and infections. They should be comfortable and allow the hand to move freely.
- **Wetsuits:** protects the body from cold and moisture.
- **Wrist straps:** protect against injuries due to the pulse.
- **Girdles:** their use prevents lumbar diseases.
- **Visors, dark glasses and protective creams** prevent the risks associated with prolonged exposure to the sun.

In the shellfish triage process there are also adopted forced positions. The ideal is to use tables with a slight inclination that avoids postures and forced movements and makes the selection of seafood more comfortable.



Other preventive measures are related to our daily way of life, since we can practice physical exercise on a regular basis in our day to day, which helps us to stay in shape and prevent musculoskeletal disorders. Specific physiotherapy programs aimed at improving res

ponsiveness to work efforts are useful.

(Prevention of Musculoskeletal Disorders)