

# THE OCEANS AND HUMAN HEALTH CHAIR: the sea of health

**THE OCEANS AND HUMAN  
HEALTH CHAIR:  
the sea of health**

*Dedicated to all those who take care of the sea,  
and to all those cared for by the sea*



**Other sponsors:**



Ajuntament de  
Tossa de Mar



Generalitat de Catalunya  
**Departament d'Acció Climàtica,  
Alimentació i Agenda Rural**

©: Oceans and Human Health Chair (2021)

Text: Stefania Minuto and Josep Lloret

Illustrations: Boris Mörker

Photographs: Lluís Mas Blanch, Maria Velasco and other photographers

Coordination: Josep Lloret

Design, layout and printing: Roger Digital Press & Print, Figueres

Legal deposit: GI 1314-202

ISBN: 978-84-093-4683-7

# Contents

Preface by Prof. Lora E. Fleming and Dr. Joan San . . . . .	8
Introduction . . . . .	12
1. The Oceans and Human Health Chair: the conservation of the marine environment and the well-being of people . . . . .	14
2. The sea of health: protecting our sea is protecting our health. . . . .	24
3. Healthy foods from the sea as part of the Mediterranean diet. . . . .	30
4. Blue spaces: sustainable recreational activities at sea, health and well-being. . . . .	48
5. The pharmacy of the sea: the bioactive potential of marine organisms as a source of new medicines . . .	64
6. Marine reserves: sustainability and the future . . . . .	76
7. Activities of the Oceans and Human Health Chair . . . . .	96
7.1. Communication and dissemination. . . . .	98
7.1.1. Audiovisual and events. . . . .	98
7.1.2. Talks and conferences aimed at the public. . . . .	102
7.1.3. Books . . . . .	104
7.1.4. Others. . . . .	108
7.2. University courses . . . . .	109
7.3. Research. . . . .	112
7.3.1. Conferences of experts . . . . .	112
7.3.2. Doctoral thesis “Oceans and Human Health”. . . . .	114
7.4. The Chair and younger students: lectures and activities for Secondary and High School education . .	114
7.5. Citizen participation activities. . . . .	115
7.6. Advisory activities to administrations for the management of marine ecosystems. . . . .	118
8. Acknowledgements . . . . .	124
9. Bibliography . . . . .	126

# Preface

Even before 2018, I have watched the ongoing evolution of the Chair of Oceans and Human Health (<http://www.oceanshealth.udg.edu/en/what-is-it.html>) with great interest and admiration. On one level, it is a unique collaboration between people and institutions – the City of Roses and the University of Girona with sponsorship from the Fishermen’s Association of Roses, the Fishmongers Guild of Catalonia, the City of Tossa de Mar and the D.G Fisheries of the Gvt. of Catalonia – to explore the interconnections between the health of both the local environment and the people who live there. At this “on the ground” level, the Chair has already co-created a vision with local people and experts of how to try to live more sustainably with the natural environment, focusing on seafood, blue tourism and biodiversity/natural marine products. This has led to the creation of a myriad of projects, including testing if interacting with the marine environment can improve the health and wellbeing of people with cancer, as well as diverse dissemination and engagement activities around the interactions between our health and the health of the ocean cooperatively involving children and schools, marine and health experts, artists, and local businesses.

And yet on another level, the Chair of Oceans and Human Health is a potential model of co-creation with community and expert involvement around the essential interactions between our health and the health of the ocean for all of us! As Dr Josep Lloret has laid out (<https://dugi-doc.udg.edu/handle/10256/18311>), the Chair has co-developed and tests four principles to encourage improved participatory processes in oceans and human health: bottom-up, “think local”, transdisciplinary and trans-sectorial, and “balance the many voices.” Surely these are principles and a model that be applied to and practiced locally and cooperatively in other “blue communities” around the world!

And finally for me, the Chair is an exemplar and symbol of hope. As a physician and epidemiologist and a research in Ocean(s) and Human Health for over 3 decades, so often the messages I and other experts both provide and hear around the health of the ocean and humanity are negative: climate and other environmental change, chemical and other pollution, decimated fisheries, etc. Even though I know that it takes endless listening, interacting and just plain hard work, the Chair of Oceans and Human Health proves that we can truly think globally and act locally to make a difference for both the ocean and our health.

**Prof. Lora E. Fleming**

Director of the European Centre for Environment and Human Health and Chair of Oceans, Epidemiology and Human health at the University of Exeter Medical School, Truro Cornwall, United Kingdom



Photo: Maria Velasco

# Preface

## *My friend, the sea*

I experience and understand the sea intensely, from a symbolic perspective, like the dynamics of human life.

Everything comes out of the sea and goes back into the sea.

The sea is water and the human body is made up of 75% water. The same body that, as it ages, loses its ability to retain that water; in other words, loses its ability to live fully.

The sea is a source of births, of transformations and rebirths. Looking at the sea, and watching the waves come and go with a rhythmic sound, different at every moment, I return to the rhythm of life. The rhythm of a score governed by the silence of the ledger lines of the stave and the notes, the sound of the waves. However, the paradigm of Heraclitus tells us that you will never bathe twice in the same river (the sea) because the water has already passed, in the same way that you will never live two lives, the one you wanted and the one you live.

Sea and life once again together and accompanied by death. Because life and death are the same, they have no meaning without each other; they are the opposites that are conjoined, like 0 and 12 on our clocks.

Waves are the result of the movement of water pounding against the reefs, as life impacts people.

The salt water of the sea, its movement constant, changing, uncertain, unforeseen and surprising, is nothing but a total picture of our human life.

It should come as no surprise that, when immersed in the sea, the human body experiences feelings of fullness and serenity. Even the gravity is different.

I experience, understand and enjoy my friend the sea to the full, which is nothing but the reflection of the life of all humanity.

Thank you Josep, for giving us this opportunity, with your scientific approach, to reflect on the oceans and all those living beings that inhabit it.

**Dr. Joan San**

Dean of the Faculty of Medicine at the University of Girona  
and co-director of the SeaHealth research group





Photo: Maria Velasco

# Introduction

In this book you will find a small sample of how, since its birth, the Oceans and Human Health Chair has contributed to the protection of the oceans and people's health. The Chair represents a model of collaboration between people with different ideas and expertise who are pulling in the same direction to face the environmental and health challenges in order to leave our future generations with a world equal to or better than the one we have experienced. The Covid-19 pandemic and climate change remind us that we all live under the same roof and bathe in the same waters. The Chair is an example of understanding between people who know that only by working together can we face the present and future risks that threaten our seas and oceans and, in turn, our health. The Chair works with an objective, honest, independent and universal spirit, in order to advance the protection of marine ecosystems that are essential for our economic and social well-being, but also for our health. The Chair is a local example that this new model is possible, and which has been recognised internationally as an example that can be "exported" to other coastal communities on the planet (not directly, but by adapting it to the unique environmental conditions and the social and economic aspects of each location).

Marine ecosystems are and will be fundamental for healthy eating, for environmentally friendly tourism and also offer a genuine 'sea pharmacy' where new medicines can be discovered to treat diseases such as cancer and where healthy activities (swimming, sailing, diving, etc.) can be practised that respect the environment and benefit our physical and mental health. The seas and oceans, as health assets, are a real tool for preventing and curing the diseases that affect people. At a time when the health of our planet is deteriorating at a rapid pace, the Chair aims to play its small part in changing the course of things, acting locally but thinking globally. All this would not be possible without the interest of the people who, from the founding of the Chair, put their time, ideas and efforts into sailing together in this same direction, lovers of the sea who collaborate with the Chair (patients, divers, scientists, doctors, environmental and health experts, fishermen, politicians, business people, the general public, etc.). To all these people who work voluntarily, selflessly, passionately and honestly in ensuring that our daughters and sons can continue to enjoy and experience the sea healthily, we thank you very much! And of course, thank you to the sponsors who allowed the Chair to be born (Roses Town Council, Fishermen's

Association of Roses and the Fishmongers Guild of Catalonia and University of Girona/Girona, Region of Knowledge Foundation) and to the sponsors who have helped to make to grow it (Tossa de Mar Town Council and General Directorate of Fisheries and Maritime Affairs of the Generalitat de Catalunya the Autonomous Government of Catalonia). We look forward to continuing to sail together for many years to come!

**Dr. Josep Lloret**

Director of the Oceans and Human Health Chair

# 1. The Oceans and Human Health Chair: the conservation of the marine environment and the well-being of people

*The world of the Oceans and Human Health Chair, ►  
with the main international collaboration connections.*

Illustration: Boris Mörker



The Oceans and Human Health Chair was founded in Roses in 2018 thanks to a collaboration between the University of Girona (UdG) and Roses Town Council, to which were later added the Fishermen's Association of Roses and the Fishmongers Guild of Catalonia.

**The activity of the Chair is based on an interdisciplinary and innovative field of research into the complex relationships that are established between the health of the seas and oceans and the health of people, and is centred on three main topics: healthy foods from the sea, the benefits of sustainable recreational activities at sea, and the bioactive potential of marine organisms as a source of new medicines.**

In addition to promoting research, which is carried out through the SeaHealth research group at the University of Girona, the Chair holds talks, courses, conferences and exhibitions to disseminate knowledge about the link between the sea and people's health, and the need to preserve marine ecosystems in order to conserve human health.

The aim of the Chair is the study and promotion of the conservation of marine ecosystems, health and the prevention and treatment of certain diseases, aspects that have often been treated independently, but which are in fact closely related. These goals can only be achieved if marine ecosystems are viewed from a holistic perspective which encompasses a wide range of academic disciplines.

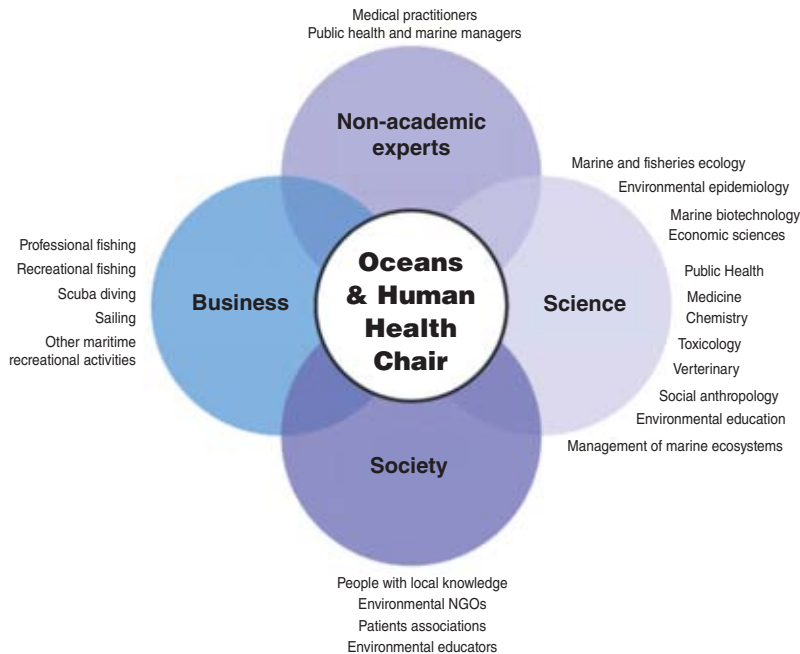
For this reason, the Chair was created with an interdisciplinary spirit, including, among others, marine biology, public health and medicine, environmental epidemiology, veterinary, medicine, environmental epidemiology, veterinary medicine, management of marine ecosystems, social anthropology, chemistry and toxicology, marine biotechnology, environmental education and the social and economic sciences, and a vocation of service to society, because it wants to get its message across to different sectors of the population, from the youngest to the oldest.



*Municipality of Roses, headquarters of the Oceans and Human Health Chair.*

Photo: Lluís Mas Blanch

The Chair is made up of experts from different universities, research centres, hospitals, primary care centres (CAPs) and administrations. At the organizational level, it consists of a director, a Monitoring Committee (comprising the director, a representative of the Universitat de Girona and a representative from each of the sponsoring bodies) and an Advisory Board (made up of people of recognized standing in the field of the topic “Oceans and Human Health”). The Chair has a trans-sectoral spirit, including the tourism and fisheries sector, NGOs, and patient foundations, among others (Fig. 1).



*Fig. 1. The foundations of the Oceans and Human Health Chair.*

Source: Lloret *et al.* (2020)



In addition, the Chair aims to be an example for demonstrating that “bottom-up” collaboration offers enormous opportunities for participation by coastal communities in supporting solutions that benefit everyone, especially those living on the coast or making a living from the goods and services provided by the sea (Fig. 2).



*Fig. 2. The principles of the Chair to encourage a new participatory process in the field of “Oceans and Human Health”.*

Source: Lloret *et al.* (2020)

The experience of the Chair represents a model for the Mediterranean area and for Europe for encouraging the involvement, commitment and participation of universities and research centres, administrations, companies, coastal communities and the public in general in the study and preservation of marine ecosystems and human health, with the aim of addressing global health and environmental concerns more effectively (priority actions, especially after of the Covid-19 pandemic).

Initiatives such as the Chair are integrated at different levels:

- The Chair contributes to the development of responsible maritime tourism and fishing activities and co-management plans, in the dissemination of the health benefits of the Mediterranean diet and the practice of sustainable activities in blue spaces.
- The objectives of the Chair support the introduction of maritime policies by contributing to the European Union’s Marine Strategy Framework Directive and its application in Catalonia (2030 Maritime Strategy of Catalonia) and Spain (Marine Strategies).
- Studies on the subject of Oceans and Human Health are essential for the “Blue Economy” promoted by the European Union.
- The Chair shares and promotes the 17 Sustainable Development Goals associated with the 2030 Agenda for Sustainable Development and Global Health of the United Nations (UN), in particular Objectives 3, 4 and 14 (Fig. 3) and therefore it has joined as a partner in the UN’s “Decade of Ocean Science for Sustainable Development 2021-2030” (<https://oceandecade.org>) which promotes the sustainable use of the oceans.
- The Chair also collaborates with the “One Health” Initiative, a global strategy aimed at strengthening interdisciplinary collaboration in all aspects of human health, animal health and environmental health ([www.onehealthinitiative.com](http://www.onehealthinitiative.com)).

# SUSTAINABLE DEVELOPMENT GOALS



*Fig. 3. The Sustainable Development Goals associated with the 2030 Agenda for Sustainable Development and Global Health promoted by the United Nations.*

While the United States had led studies on “Oceans and Human Health” for many years, such initiatives in Europe have been scarce. In 2013, the European Marine Board laid the first stone in Europe on this issue, and since then projects such as BlueHealth (<https://bluehealth2020.eu>) and SOPHIE (<http://www.sophie-project.eu>) have been promoted.

The Chair has been part of the SOPHIE expert group, contributing its knowledge and being participants in various working groups. The BlueNetCat network of researchers in Catalonia, in which the Chair participates, also supports this integrative idea (<https://www.bluenetcat.eu>).

In Catalonia and Spain, the Oceans and Human Health field of research has not been developed in an integrated manner, although there are different research teams working on various topics relating to this field. However, the relationships between marine ecosystems and human health are still quite unknown and therefore new studies need to be promoted. In 2019, the Generalitat de Catalunya (the Autonomous Government of Catalonia) awarded the Oceans and Human Health Chair a diploma for its contribution in achieving the objectives of the 2030 Maritime Strategy of Catalonia.

The **SeaHealth** group at the University of Girona is the first interdisciplinary research group to investigate the relationship between the health of marine ecosystems and human health; **Roses Town Council** is interested in promoting studies on the sea and health, as well as in disseminating knowledge of this field to society, bearing in mind that the sea and health are concepts that are fundamental for the society and economy of Roses; the **Fishermen's Association of Roses** is one of the main fishermen's guilds in Catalonia and is interested in achieving sustainable fishing and promoting healthy and sustainable fishery products; the **Fishmongers Guild of Catalonia** is a non-profit association whose fundamental mission is the promotion of the sustainable and healthy consumption of healthy and sustainable fishery products; **Tossa de Mar Town Council** is funding a pre-doctoral scholarship on "Oceans and Human Health", which is awarded to a young researcher, with the aim of creating scientific knowledge that will make it possible to generate sustainable and healthy tourism activities in the town; the General Directorate of Fisheries and Maritime Affairs of the Generalitat de Catalunya (the Autonomous Government of Catalonia) finances various dissemination activities of the Chair.

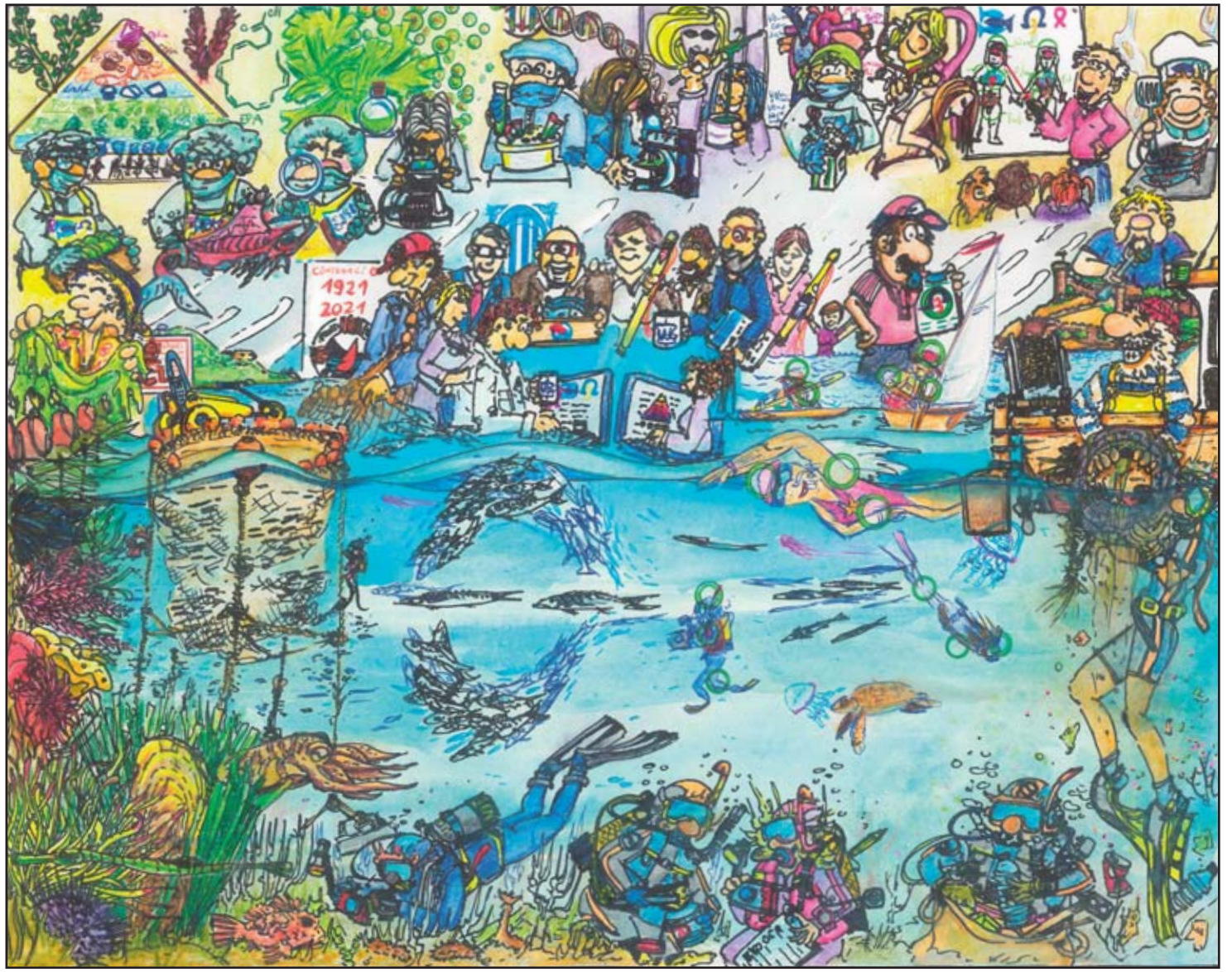


Photo: Lluís Mas Blanch

## **2. The sea of health: protecting our sea is protecting our health**

*The people of the Chair: experts, citizens, companies, sponsors, etc.* ►

Illustration: Boris Mörker



Coastal civilizations have used the sea in order to obtain food and as a means of trade, but also as a source of traditional medicinal products and bioactive compounds to make pigments, oils, fragrances and fuels, and to carry out all those economic activities related to leisure and coastal and maritime tourism.

Numerous studies have been conducted in recent decades that analyse the impact of humans and climate change on marine ecosystems and their resources, but few have linked the marine environment to human health. The benefits and risks arising from the sea have received growing interest from science and society in recent years, and have led to the emergence of a new field of research called “Oceans and Human Health”.

Among the benefits that marine ecosystems bring to people’s health and well-being, there are three main benefits:

- Healthy foods from the sea
- The health benefits associated with life on the coast and the practice of recreational activities at sea
- The bioactive potential of marine organisms as a source of new medicines

The Oceans and Human Health Chair conducts and promotes research studies and initiatives and dissemination on these three topics.

There are different factors, both anthropogenic and environmental, that put the benefits provided by marine ecosystems at risk, and which are also studied by the Chair, such as pollutants, pathogens, biotoxins, overcrowding, overfishing and climate change.





Photo: Maria Velasco

The main working area of the Chair (Cap de Creus, Gulf of Roses and Tossa de Mar in the Costa Brava) offers the possibility of comparing the benefits to health and well-being of environmentally friendly activities, such as swimming, diving, sailing and kayaking, compared to other activities that have a greater impact on the marine environment. The Costa Brava is a unique but, at the same time, fragile environment with a wide diversity of vulnerable habitats and species. It is an area with a great maritime tradition of fishing and tourism, of great scenic and ecological value. This makes it a health and sustainability laboratory for studying how marine ecosystems can contribute to people's health.

The area in which the Chair is active includes two important marine protected areas: the Cap de Creus Natural Park and the Medes-Montgrí Islands, and other Natura 2000 areas in the Gulf of Roses and off the coast of Tossa de Mar. The great biodiversity and productivity of the area is due to the natural conditions, where rivers discharge and the action of the north wind (the 'Tramuntana') play a key role. There are a multitude of very diverse seabeds such as rocks, mud, *Posidonia oceanica* meadows, coralligenous assemblages, calcareous gravel (Maerl beds) etc. that promote a great diversity of habitats and species, among which there are many that are endangered and included in international conventions for the protection of flora and fauna.



Photo: Maria Velasco

### **3. Healthy foods from the sea as part of the Mediterranean diet**

*Healthy foods from the sea: from fishing to the table.* ►

Illustration: Boris Mörker







Photo: Maria Velasco

It is also a lifestyle characterized by socialization during meals, moderate food consumption, consumption of local foods, and the habitual practice of physical activity, and has been associated with lower risk of suffering from cardiovascular problems and other chronic diseases such as diabetes, neurodegenerative diseases and colorectal, gastric and liver cancers, and also breast cancer in menopausal women.

Within the Mediterranean diet, fishery resources (fish, seaweed and seafood) are a natural source of omega-3 and other important nutrients for health. Ensuring a sustainable food system, so that future generations can continue to enjoy these benefits, requires a fisheries policy that promotes the preservation of fishery resources and sustainable aquaculture.

A sustainable food system is one that provides and promotes safe, nutritious and healthy food without at any time compromising food safety or the environment from which it comes.

Omega-3s are a type of essential lipid that our body cannot synthesize and therefore must be incorporated into the diet. They are essential for our health because they contribute to the development of the skeleton and the structure and functioning of the brain. Marine omega-3s (DHA and EPA) are synthesized by phytoplankton and algae, and accumulate through the food chain to seafood and fish.





Photo: Maria Velasco

According to the **White Paper on Fish and Fisheries Management in Catalonia**, published in 2020, Spain has the largest fishing fleet in the entire European Union (23.6% of the total), and ranks third in the number of vessels (9,300 vessels) after of Greece and Italy. The **Spanish Fisheries Confederation (CEPESCA)** is the largest fishing business organization in Europe and one of the largest in the world, with 38 associations of fishing boat owners, 810 companies, 869 vessels, 10,000 workers and a turnover of 1 billion euros. The **Fishmongers Guild of Catalonia** is a non-profit association that represents Catalan fishmongers, with a family tradition, from parents to children, and a common feeling that defines the spirit of a fishmonger. The fishing sector is relevant for its economic and social impact on the territory. Despite this, demand is much higher than the productive capacity of the sector and, therefore, imports exceed exports.

Workers and shipowners in the professional fishing industry come together in historical institutions, deeply rooted in the territory, known as **fishermen's guilds**. The fishermen's guilds meet in **Territorial Federations**, and these come together in the **Catalan National Federation**. Fish markets are the area in those fishing ports authorized to land catches, where the marketing of fishery products begins. Catches are recorded in the markets, creating information on traceability and key information for fishery resource management policies. The main fishing gear on the Catalan coast is **trawling, small-scale fishing gear, seine net, bottom longline and surface longline**.

According to the latest FAO report for 2020, total fish production has increased on all continents in recent decades (Fig. 5). However, there are differences by continent: while it has almost doubled in the last 20 years in Africa and Asia, in Europe it has declined since the late 1980s, with a slight recovery in recent years, and in the Americas it experiences ups and downs from the peak in the mid-1990s, mainly due to fluctuations in catches of small pelagic fish such as anchovies.

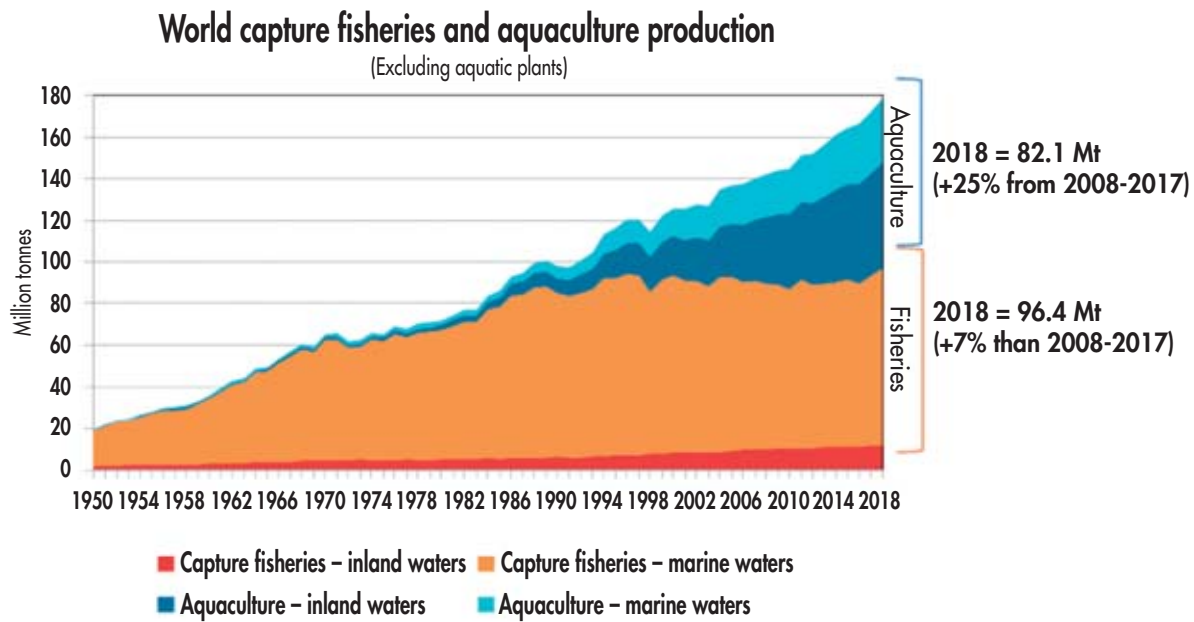


Fig. 5. Regional contribution to fishery and aquaculture production (FAO, 2020).

China is the largest producer of fish (35% of world production). Apart from China, a significant proportion of production, in 2018, comes from other countries in Asia (34%), followed by the Americas (14%), Europe (10%), Africa (7%) and Oceania (1%).

World production of fishery products (fish, crustaceans, molluscs and other aquatic animals) reached about 179 million tonnes in 2018. Of this figure, 156 million tonnes were used for human consumption, equivalent to supply an estimated annual yield of 20.5 kg per capita, and the remaining 22 million tonnes (12.3%) were destined for non-food uses, mainly to produce fishmeal and fish oil for livestock feed and oils used in aquaculture and for dietary supplements (omega-3 capsules).

The Chair has carried out various projects for the conservation and the appreciation of fishery products. With these projects, the Chair has shown how natural omega-3s from local, sustainably caught fish are a key element in determining the quality of fish and for the health of consumers. The local population is becoming more and more aware of their personal health, and the appreciation of fishery products for their ability to prevent various types of diseases is a new marketing tool which has not been widely used so far. The dissemination of the benefits of omega-3s in fish, in relation to the health of consumers, undoubtedly contributes to the consumer valuing the quality of fishery products more highly, and also appreciating the need to preserve them.



Photo: Maria Velasco

## GALP OMEGA-3 PROJECT (2018-2019)



[www.oceanshealth.udg.edu/ca/galp-omega.html](http://www.oceanshealth.udg.edu/ca/galp-omega.html)

The GALP Omega-3 project has assessed the omega-3 content of the 40 most important fishery species on the Costa Brava.

According to this study, omega-3s are mainly concentrated in the muscles of oily fish (sardines, anchovies, mackerel, etc.) and to a lesser extent in the liver of white fish (hake, monkfish, etc.) (Fig. 6).

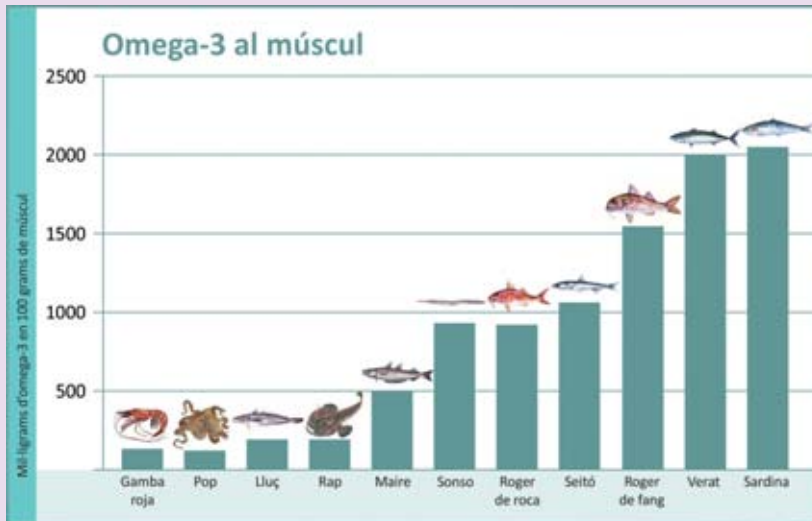


Fig. 6. Omega 3 fatty acid content in the muscle of the most important exploited species in the Costa Brava region.

On the Costa Brava, the most fished species are sardines (*Sardina pilchardus*) and anchovies (*Engraulis encrasicolus*), which account for 64% of the total catch: therefore, these species provide the largest amount of “zero kilometre” omega -3 for the villages of the Costa Brava.

Western consumers are consuming fewer and fewer fish (per capita) and, over the years, the value of fish in the diet has been declining to the detriment of other sources of protein such as meat and eggs. This is a phenomenon that is happening even in the Mediterranean countries, where fish and seafood have traditionally been a key element of the so-called “Mediterranean diet”.

Research into the effects of omega-3s on people’s health is highly topical. Currently, omega-3s are being studied for their potential protective effects in the prevention of cardiovascular disease, certain types of cancer, some neurological conditions such as Alzheimer’s, and cognitive decline. New studies are also emerging into its potential benefits in relation to the prevention (not treatment) of other diseases. In addition to omega-3s, fish is considered an excellent food for its content of other micronutrients that are very important for health, such as vitamins B and D, zinc, iron, iodine, selenium, choline and taurine.

According to the most recent studies, the effectiveness of omega-3s in the form of capsules (dietary supplements) for human health is questionable and their production is one of the causes of overexploitation of fisheries. Except with certain pathologies, for which omega-3 capsules can provide health benefits, the importance for people of consuming locally caught fish is stressed.



Generalitat de Catalunya  
**Departament d'Acció Climàtica,  
Alimentació i Agenda Rural**



---

## THE GALP MARINE ECOSYSTEMS AND CANCER PROJECT (2020)

---



[www.oceanshealth.udg.edu/ca/galp-ecosistemes-marins-i-cancer.html](http://www.oceanshealth.udg.edu/ca/galp-ecosistemes-marins-i-cancer.html)

**The Marine Ecosystems and Cancer has studied the relationship between marine ecosystems and cancer from the point of view of disease prevention, emphasizing the preservation of the marine environment and the need to fish in the most sustainable way possible.**

Many people's diets do not include the right amounts of fish and omega-3 and, instead, can be characterized by the consumption of foods with high energy value, rich in added sugars and unhealthy fats, red and processed meat and dairy products, which provide an excess of omega-6 fatty acids (inflammatory) and saturated fats.

A high consumption of red meat and processed meat has been associated with an increase in the incidence of colon and rectal cancer. Whereas fish and seafood represents a valid substitute for meat because it provides quality protein and healthy omega-3 fatty acids.

In the province of Girona, about 4,000 new cases of cancer are diagnosed annually (around 10 each day). Colorectal cancer is the most common form of cancer in the province of Girona, followed by prostate and breast cancer.



**OMEGA 3, FISH AND CANCER**

- 1 To know benefits of omega 3 fatty acids.**  
This project wants to inform about benefits of the consumption of fish and omega 3 fatty acids for human health and its relationship with the potential prevention of certain types of cancer.
- 2 Schools and youth.**  
Numerous activities will be carried out for students and teaching staff to disseminate the importance of the consumption of fish and omega 3 fatty acids for human health.
- 3 Fishing sector and Primary Care Centers.**  
The fishermen and fishmongers, as well as the health personnel of the Primary Care Centers, will participate in the activities and thus will be able to better transmit knowledge to consumers.
- 4 Sustainability and conservation.**  
The project wants consumers to bet on the consumption of local fish and omega 3 and on sustainable fishing gear to guarantee marine resources for future generations.

Universitat de Girona  
 Institut Català de la Salut  
 Equip d'Atenció Primària  
 Centre d'Onco  
 Departament d'Agricultura, Ramaderia, Pesca i Alimentació  
 Unió Europea  
 Fons Europeu  
 Marítim i de la Pesca

Infographic: Manuel Acaide

**FISH CONSUMPTION AND HUMAN HEALTH**

Scientific studies show that the consumption of fish helps reduce mortality from cardiovascular diseases, since they contribute to lower triglycerides, platelet aggregation and arrhythmias.

The potential protective effect of omega 3s against the development of certain cancers, such as colorectal, is being investigated.

There are studies that have linked the intake of marine omega 3 with a decrease in depressive symptoms in adults and dementia.

Omega 3s also help fight inflammatory processes and contribute to the health of the body's skeleton.

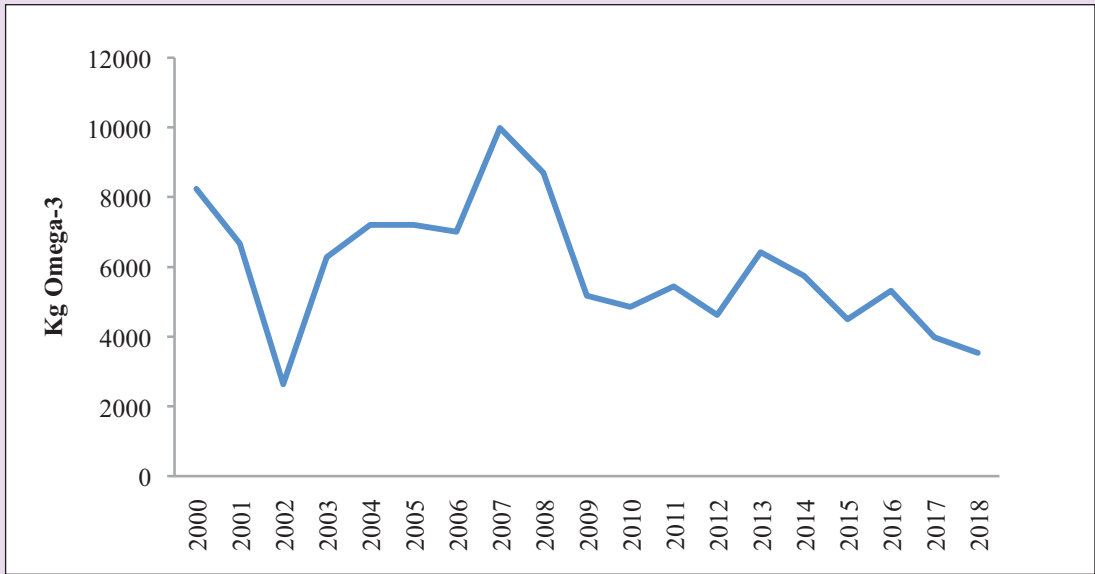
Its possible beneficial action in the prevention of diseases such as cystic fibrosis is being studied.

Universitat de Girona  
 Institut Català de la Salut  
 Equip d'Atenció Primària  
 Centre d'Onco

However, if everyone followed the medical advice in consuming omega-3, with current consumption patterns (in which few high-value species are consumed and there is a large amount of waste of unwanted fish at sea), there would not be enough omega-3 for everyone. Catches of many omega-3-rich fish, such as sardines (*Sardina pilchardus*) or anchovies (*Engraulis encrasicolus*) have declined in recent years. In addition, the fat levels of sardines and anchovies caught on the Costa Brava have declined in the last 10 years.

Rising sea temperatures due to climate change may have affected the productivity and composition of the plankton that anchovies and sardines feed on, affecting not only the amount of fat but also the quality.

This means the consumer is increasingly deprived of this source of natural healthy and local food: further proof that fishing stocks need to be conserved in order to preserve people's health (Fig. 7).



*Fig. 7. Decrease in omega-3 from sardines caught on the Costa Brava. Catch reductions in recent decades are directly associated with a decline in omega-3 fatty acids available to consumers.*

The research activities of the Chair also aim to promote the consumption of sustainable zero km (caught locally) fish and seafood while encouraging the consumption of undervalued species that are not widely overexploited (horse mackerel, bogue, poor cod, etc.).

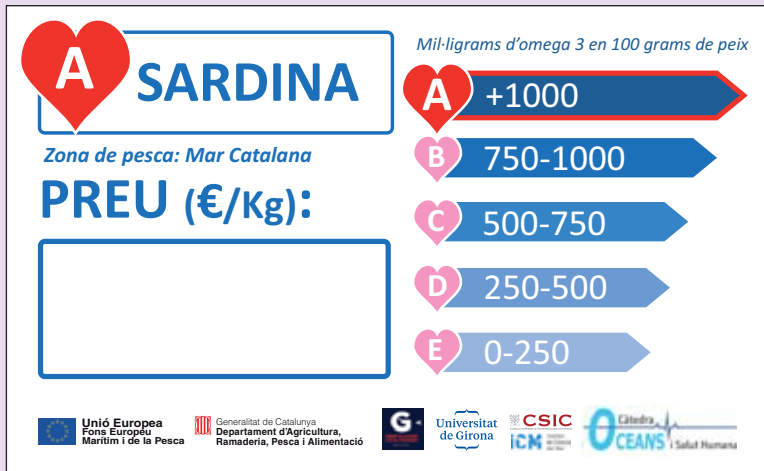


Fig. 8. Labelling of the category relating to the content of omega-3 fatty acids (milligrams of omega-3 per 100 g of muscle).

One of the objectives of the GALP Omega-3 project was to develop a system for classifying the most important fish species on the Costa Brava by omega-3 content, and labels were created with an omega-3 ranking that identifies 5 classes (A to E) according to the omega-3 content (measured in milligrams per 100 g of muscle) (Fig. 8).

Alternative or complementary sources of omega-3s were identified during the project:

- “New” Omega-3s from species which, with global warming due to climate change, have been increasing on the Costa Brava in recent years, such as round sardinella (*Sardinella aurita*), white prawn (*Parapenaeus longirostris*) and bullet tuna (*Auxis rochei*). In addition to fish, some bivalve molluscs (mussels and oysters) and some seaweeds should be added.

- “Traditional” Omega-3s from species that were previously consumed and that have now lost gastronomic value, such as bogue (*Boops boops*), chub mackerel (*Scomber scomber*), poor cod (*Trisopterus minutus capellanus*), grey mullet (*Liza spp*), horse mackerel (*Trachurus trachurus*), etc., which are species whose commercial value should be restored.
- Omega-3s from species that store most of these fats in the liver, as with blue whiting, even taking into account the contaminants that accumulate in this organ such as methylmercury.

Between May and June 2020, training talks were held for teachers on the subject fish consumption under the framework of the Mediterranean Diet, part of the Marine Ecosystems and Cancer project. This involved twenty teachers from eight institutes and five schools. The results of the study were presented in November 2020 through a webinar aimed at the general public.

Also, every year the Chair participates at Fairs and Forums dedicated to food. The Chair was present at the Third Congress of Catalan Cuisine 2018-2019 in Girona; at the FòrumLab-Gastronomic Forum Barcelona in 2018, invited by CajaMar, and in 2019, at the same Forum and at the invitation of the Alícia Foundation, we gave a talk, open to the public, on fishery products and health in the session “Food of the Future. Food of the Sea” (<https://www.forumgastronomicbarcelona.com>). In March 2021, the Chair took part in the first edition of Gastromar, a professional conference on seafood cuisine and health in Ampolla (Tarragona) organized by GastroEvents and the Alícia Foundation.

The Chair, as part its commitment to society, during the GALP Omega-3 project donated the leftover fish from the sampling process to the “La Sopa” Reception and Social Services Centre in Girona, a social and welfare organization aimed at the “homeless” or those in a situation of severe poverty or social exclusion, in order to contribute to the health of vulnerable people.



Photo: Lluís Mas Blanch

## **4. The blue spaces of the sea: sustainable recreational activities at sea, health and well-being**

*Recreational activities at sea and on the coast as a source of health and well-being.* ►

Illustration: Boris Mörker



Blue spaces are outdoor environments where there is water accessible to humans, either directly (taking part in activities by the sea or in the water) or indirectly (for example, seeing the sea or listening to the sound of the waves). There are several studies that indicate that “blue spaces” can have positive effects on both the physical and mental health of people who take part in activities such as walking by the sea, snorkelling (observation of the sea floor using a breathing tube and goggles), diving, swimming or sailing, whether through encouraging exercise, the benefit from making social relationships or producing a sense of well-being.

In some countries, green prescriptions are already being issued, but Blue Prescriptions, despite the enormous potential of the seas and oceans to improve people's health and well-being, have not yet been sufficiently utilised in the field of community medicine.

In Scotland, Japan and New Zealand, various community medicine studies and initiatives have proliferated in relation to the capability of “green spaces” to improve people’s well-being, which have led to the design of Green Prescriptions, which are nature-based health interventions. However, there have been few initiatives of this kind relating to the sea and thus very little is known about the possible health benefits of practicing activities at sea or on the coast.

A recent study, conducted on the English coast, shows that people living near the sea lead a healthier lifestyle compared to people living inland, because they do more physical activity and suffer less stress and depression. Scientific evidence also indicates a possible cognitive improvement in people with mental illness and disorders through participating in physical activities on the coast or at sea.



In recent years, there has been a growing interest among the scientific community in assessing the possible positive effects on health by practicing activities at sea or on the coast. However, research has focused primarily on “green spaces” such as forests, fields and urban parks, and very little is known about the potential health benefits of so-called “blue spaces”. There are studies of blue spaces centred on rivers and lakes, and in green spaces (forests, fields and urban parks) that show similar effects on well-being, although, in comparative studies, the superior effect of blue spaces in comparison to green spaces has been shown.

**In a previous study on the effects of diving, the Chair has been able to show that diving benefits the health of divers, especially those suffering from a chronic illness.**

**Subsequently, the MedPan projects, “Blue Prescription” (E-Health grant from the Official College of Physicians of Girona) and the Marine Ecosystems and Cancer project (GALP Costa Brava), have contributed to the study of how maritime recreational activities, carried out in marine protected areas such as the Cap de Creus Natural Park, can play a significant role in promoting the health and well-being of people.**

In addition, the Chair is collaborating on a doctoral thesis carried out at the University of Barcelona and the National Institute for Physical Education of Catalonia (INEFC) on the social benefits of sports activities in the natural environment. This thesis is part of the European BOSS (Benefits of Outdoor Sports for Societies) project. This project aims to increase the participation of the general public in open air physical activity in order to improve the health of the population, at the same time as designing a framework for the collection of clear and comparable evidence of its social effects.

---

## MEDPAN PROJECT (2019)

---

[www.oceanshealth.udg.edu/ca/small-projecte-medpan.html](http://www.oceanshealth.udg.edu/ca/small-projecte-medpan.html)

**The MedPan Project has evaluated the health benefits of a marine reserve such as Cap de Creus.**

The conclusions drawn are based on published scientific studies and the perceptions of experienced professional instructors in the Cap de Creus area and the society's interest in maritime recreation as healthy activities, having searched papers published in various journals and non-scientific websites specializing in maritime recreational activities.



Photo: Joan San

### SWIMMING

Swimming improves various psychological aspects in autistic children. It can also improve cardiorespiratory fitness or stamina in adults, healthy children and young people, pregnant women, children with asthma, and adults with osteoarthritis.

Cold water swimming is an activity that can contribute to a healthy lifestyle, and is associated with a lower prevalence of obesity among swimmers compared to the general population.

Swimming fosters a strong sense of freedom, puts you in touch with nature and yourself, improves concentration, coordination and the ability to face fear and be alone. It provides a sense of peace, revitalization, awareness and relaxation and lowers physical barriers in cases of physical disabilities.



Photo: Bernd Mörker

## DIVING

Diving benefits physical and mental health and is “relaxing”, decreasing anxiety and stress and improving attention, self-knowledge and sleep.

It is a good way to burn calories and strengthen the muscles in various parts of the body and brings psychological and social benefits to people with disabilities, and for people wounded in war, relieving chronic pain and symptoms of depression.

Physically, it facilitates movement in people with physical disabilities compared to movement on land.

Its mental health benefits seem greater than the practice of other sports. The salutogenic effect is notable immediately after diving. From a psychological point of view, one study suggests that the salutogenic effect of diving stems from experiencing a state of full consciousness and openness associated with slow, deep breathing, characteristics similar to those developed during meditation.



Photo: SK Kayak / Aneliya Trendafilova

## KAYAKING

Kayaking can improve balance by activating the muscles of the torso through paddle movement, so it is important for the prevention of falls in the elderly in particular. It is an enjoyable activity, has significant benefits for well-being for everyone, regardless of physical limitations, and provides a sense of self-confidence and motivation. It offers an important experience for social inclusion and is low impact so that people with disabilities can row together with people without physical limitations, and people of different ages and different backgrounds can socialize, increasing self-confidence.

It can bring many contrasting sensations and experiences depending on the state of the sea, feelings of calm, tranquillity and silence on days of good weather, and adrenaline and intense feelings, respect for nature and even fear, when the sea is rough. In all cases, it contributes to a sense of freedom and autonomy. It’s exciting for kids and for adults it’s a way to find peace, relaxation, contemplation and a connection with nature, an exciting activity that positively affects self-esteem.



Photo: Tatiana Hetier

## **SAILING**

This sport provides quality of life for both healthy people and patients with various medical conditions, taking into account physical aspects (including pain) mental/emotional/psychological aspects and social aspects, as all these patients improve after a sailing course.

Adapted sailing can bring positive experiences for people with disabilities. It is a tool for social integration and can provide physical and psychological health benefits, as well as direct contact with sport and nature, strengthening group cohesion, creating new bonds and friendships.

Independent sailing can help improve the different skills of people with tetraplegia such as mobility, mood, social, role functions, injury control, feelings of depression, community reintegration, resilience and access to natural environments. In the field of competition, it improves skills related to precision and perfectionism, and general mobility and coordination.



Photo: Agrosurf

## **SURFING, WINDSURFING AND STAND UP PADDLE-BOARDING (SUP) OR PADDLE SURFING**

Studies indicate that there are therapeutic benefits of surfing suitable for physical rehabilitation, especially in the fields of orthopaedics and neurology: these activities provide a stimulating environment and contribute to improved balance and motor coordination.

SUP can be considered a low-impact sport and easier to adapt to as it does not require wind or wave conditions (unlike the other two sports) and can be practiced in calm waters.

Practicing this activity requires a very high level of concentration in order to achieve good coordination, maintain balance and to keep oneself safe, aspects that contribute to improving overall mental and emotional well-being.



Photo: Lluís Mas Blanch

Physical activity is beneficial for health and is recommended by the World Health Organization (WHO), as it helps maintain a body mass appropriate for each age and reduces risk factors for diseases such as obesity, cardiovascular disease and cancer. The Costa Brava is an ideal blue space for physical and mental health in general, for the prevention of chronic diseases or for helping in the recovery of people who have suffered certain diseases or undergone intensive treatments.



Photo: Maria Velasco



---

## BLUE PRESCRIPTIONS E-HEALTH PROJECT (2020-2022)

---

[www.oceanshealth.udg.edu/ca/galp-ecosistemes-marins-i-cancer.html](http://www.oceanshealth.udg.edu/ca/galp-ecosistemes-marins-i-cancer.html)

**The Blue Prescriptions project is being evaluated in Roses and Tossa de Mar, using smart watches. It is important to prove whether observing marine flora and fauna using diving goggles and snorkel, without using a tank, and other activities such as walking by the sea or swimming in the sea, can contribute to improving physiological parameters such as heart rate, blood pressure and sleep hours in cancer patients, and thus increase their well-being.**

The project has the participation of the CAP (ABS) of Roses (Catalan Institute of Health), the CAP of Tossa de Mar, the Catalan Institute of Oncology, Oncolliga Girona and the Roses Foundation Against Cancer.

The project has provided a new technological solution to assess the physical health status of participants, complementary to the focus groups and health perception surveys which form part of the GALP Marine Ecosystems and Cancer study: the use of smart watches.

Blue Prescriptions is funded by e-Health COMG 2020, a grant for research and innovation projects in health technologies awarded by the Official College of Physicians of Girona (COMG) and the UdG Health Campus



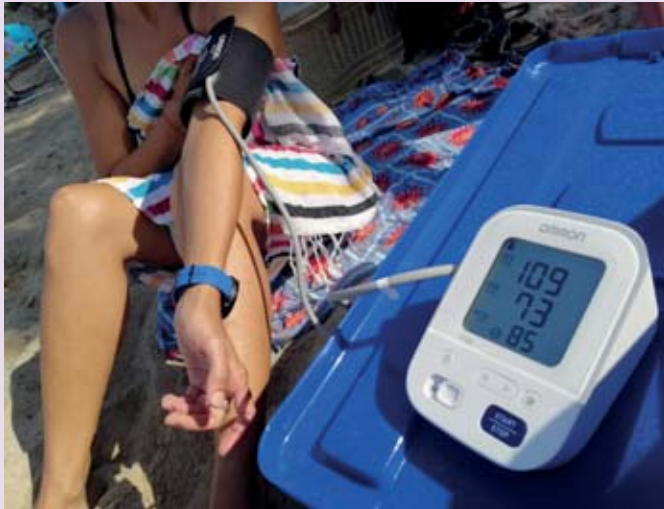


Photo: Eva Fontdecaba



Photo: Stefania Minuto

aimed at work that contributes technological solutions for patients or medical professionals and that contributes to improving people's health and quality of life.

For the first time, the Blue Prescriptions project integrates the value of the landscape and marine diversity in the well-being of people, which would further strengthen the need to preserve assets and ecosystem services that can help preserve people's health. The seascape is a cultural value and part of personal identity that can benefit people with cancer. Reconnection with the natural environment, and specifically the marine environment, has not been explored in the Mediterranean.

---

## **AIGUA PROJECT (2019)**

---

[www.oceanshealth.udg.edu/ca/projecte-aigua.html](http://www.oceanshealth.udg.edu/ca/projecte-aigua.html)

**The Aigua Project is a ProemAID integration project which, since 2016, has aimed to reconcile refugees who have just experienced a traumatic experience during the crossing, with the sea, and positively influence their community integration, through swimming courses.**

During 2019, in conjunction with the Educa, Aprèn, Esport Association, a swimming goggles collection program was carried out for refugees on the island of Lesbos and a poster was presented at the International Congress of Sports and Cooperation to publicise the summer campaign on the island of Lesbos.







In 2020, a charitable activity was carried out in collaboration with the NGO Proem-Aid and Sònia Cervià in order to publicise the problem of refugees in the Mediterranean in schools, for which eleven roll-up posters were made that the NGO uses during talks in schools and other contexts. And during 2021 there will be talks in schools.

ProemAID ([www.proemaid.org](http://www.proemaid.org)) is a non-profit organization, created in 2015 as a result of the migration crisis by a group of emergency professionals (firefighters from the province of Seville), carrying out rescue operations on the Mediterranean sea, the main stage of the tragic migration situation.

# Proyecto Agua

#MisiónActitud

[www.proemaid.org](http://www.proemaid.org)

# Proyecto Lesbos

#MisiónActitud

[www.proemaid.org](http://www.proemaid.org)








# Proyecto Mediterráneo

#MisiónActitud

[www.proemaid.org](http://www.proemaid.org)









As part of the project, ProemAID volunteers give courses of swimming lessons to refugee children and adults from vulnerable groups in the Refugee Camp on the island of Lesbos (Greece). It is a collaborative project in which ProemAID has been working with various NGOs since 2017. In 2019 the NGO established a collaboration with the German NGO Sea-Eye in a project on board the ship Alan Kurdi (in memory of the small child who brought all our attention to the impending migration crisis) in which work is currently underway. Coordinated and managed by the German NGO, ProemAID provides the project with human resources, professional volunteers, and materials for rescue and lifesaving efforts.

With a totally innovative project called “Aigua” (Water), the Chair is carrying out a solidarity project for refugees.



Photo: Sònia Cervià, collaborator with the Chair in the project on Lesbos (Greece)



Photo: Stefania Minuto

## 5. The pharmacy of the sea: the bioactive potential of marine organisms as a source of new medicines

*The pharmacy of the sea. Biotoxins (fuchsia), cytotoxic potential (orange), anticoagulant potential (dark blue), ►  
antibacterial potential (light blue), antitumor potential (brown), antioxidant potential (black),  
anti-inflammatory potential (violet), antifungal potential (light green), antiviral potential (dark green).*

Illustration: Boris Mörker



The marine environment contains a large number of pathogens and the marine organisms and the many marine species – from bacteria, fungi and microscopic algae to more complex organisms such as macroscopic algae, plants and animals – produce bioactive compounds as mechanisms to combat them, with differing potential: antibacterial, antioxidant, antiviral, anti-inflammatory, antitumor, anticoagulant, antifungal, etc.

**Marine biotechnology - the branch of science that investigates the bioactive potential of marine species in order to discover new medicines - is currently of great scientific relevance and of great interest to the biopharmaceutical industry. The Oceans and Human Health Chair states that it can achieve a Sustainable marine biotechnology must be achieved to preserve and not overexploit the marine organisms that produce bioactive compounds.**

In the Mediterranean, different species of animals have been found that have bioactive potential, especially benthic organisms (those that live in contact with the seabed), and that can lead to the discovery of new drugs for diseases such as cancer.





Photo: Lluís Mas Blanch

### **Antibacterial potential**

Mackerel (*Scomber scombrus*) contains compounds with antibiotic potential in its viscera that inhibit the growth of various strains of bacteria. The pompano fish (*Trachinotus ovatus*) has a protein that inhibits bacterial growth.

### **Antioxidant potential**

Most studies into antioxidant potential are focused on the effects of omega-3s present in fish muscle and, in some species, in the liver and gonads. Oils from the muscle of different species such as scorpion fish (*Scorpaena notata*), brown meagre (*Sciaena umbra*), pilchard (*Sardine pilchardus*), horse mackerel (*Trachurus mediterraneus*) and rainbow wrasse (*Coris julis*) have antioxidant potential.

There are also molecules in non-omega-3 marine organisms with antioxidant properties in the muscles of fish such as thornback ray (*Raja clavata*), in hematocytes and various tissues of bivalves such as mussels (*Mytilus galloprovincialis*) and fan mussels (*Pinna nobilis*), and even in the shells of the white prawn (*Parapenaeus longirostris*).

### **Cytotoxic potential**

Cytotoxins can cause the death of a particular type of cell. Some studies evaluate the cytotoxicity of some cnidarian species, such as snakelocks sea anemone (*Anemonia sulcata*), beadlet anemone (*Actinia equina*) and barrel jellyfish (*Rhizostoma pulmo*) and opisthobranchs of the genus *Aplysia*.

Viral infections are currently a new challenge for humanity due to climate change and biodiversity loss. The current Covid-19 pandemic and other diseases for which no cure has yet been discovered, such as the AIDS virus (HIV), Ebola, bird flu or influenza A, cause millions of deaths around the world and serious problems for the economy. It is necessary to find new molecules to help fight these viral infections and, if possible, find a vaccine. In addition, viral infections in marine organisms are very common in fish farms.



Photo: Lluís Mas Blanch

Currently, one of the most widely used drugs in the world are anti-inflammatory drugs such as acetylsalicylic acid (aspirin) or ibuprofen. However, some anti-inflammatory drugs cause damage to the digestive tract, so new molecules with anti-inflammatory bioactive potential must be sought.

Another great challenge for humanity is cancer, which is one of the non-infectious diseases with the highest incidence and mortality among the world's population and, therefore, the treatment and cure of this disease is a priority for the medical sector and the pharmacist. For this reason, new types of treatments and medications, which complement or replace aggressive chemotherapy, need to be discovered for the treatment of cancer.

#### **Antiviral potential**

Algae could be potential antiviral agents against coronavirus species related to severe acute respiratory syndrome: research is being carried out into how red algae, such as *Lectina griffithsin*, green algae of the genus *Ulva* and brown algae of the genus *Fucus* may contribute to this goal.

#### **Anti-inflammatory potential**

Extracts of some bony fish such as longfin tuna (*Thunnus alalunga*) and cnidarians such as snakelocks sea anemone (*Anemonia sulcata*) and beadlet anemone (*Actinia equina*) have anti-inflammatory properties. Extracts of the common mussel (*Mytilus edulis*) may help fight the inflammation associated with the proliferation of some breast cancer tumour cell lines.

#### **Antitumor potential**

Among the sessile organisms, the gorgonians *Eunicella singularis* and *Leptogorgia sarmentosa* and the sponges *Spongia officinalis*, *Spongia agaricina* and *Axinella damicornis* stand out, suggesting that other species of these fauna groups could synthesize molecules with antitumor potential. Some fish species have molecules with antitumor properties and are endangered because their habitats are threatened, such as the greater pipefish (*Syngnathus acus*), a fish inhabiting *Posidonia oceanica* meadows, or the bluefin tuna (*Thunnus thynnus*).



Photo: Lluís Mas Blanch

Although biotoxins are known to have a negative effect on human health, some can have beneficial effects. Some invasive species that produce biotoxins, such as the spotted porcupine fish, pose a threat to health and at the same time an opportunity to discover new drugs.

New drugs of marine origin could be anticoagulants. There are cardiovascular diseases, strokes or ischemias, which occur due to the uncontrolled aggregation of blood cells and therefore it is necessary for the body to produce anticoagulant molecules capable of preventing this.

Fungal infections in humans are very common and range from the most common, such as “athlete’s foot” and candidiasis, to the most serious, such as an aspergilloma, caused by a fungus of the genus *Aspergillus*, which affect mainly people with depressed immune systems.

### **Biotoxins**

The mauve stinger (*Pelagia noctiluca*), nudibranchs such as *Dendrodoris limbata* and marine gastropods such as *Neptunea antiqua* are the subject of studies for the pharmaceutical use of the toxins they produce. The tetrodotoxin (TTX) produced by the puffer fish (*Takifugu rubripes*), due to its high toxicity, poses a risk to human health. However, TTX is currently being studied as a potent analgesic treatment for pain caused by some types of tumours, and for chronic pain. It should be noted that the sighting of another species of puffer fish, the silver-cheeked toadfish (*Lagocephalus sceleratus*), is becoming more frequent in various areas of the Mediterranean. The specimens arrive from the Red Sea through the Suez Canal.

### **Anticoagulant potential**

There are marine organisms that produce anticoagulant molecules. For example, the skin of the spotted ray (*Raja montagui*), the shell of the Norway lobster (*Nephrops norvegicus*) and the tentacles of the barrel jellyfish (*Rhizostoma pulmo*).

### **Antifungal potential**

Sessile organisms (those attached to the substrate) are more susceptible to fungal infections and therefore have antifungal defence mechanisms. The speckled sea squirt (*Clavelina oblonga*), the yellow sponge (*Axinella damicornis*), and the echinoderms white spot cucumber (*Holothuria polii*) and royal cucumber (*Stichopus regalis*), are examples of species that have compounds with antifungal potential.



Photo: Lluís Mas Blanch

---

## LA CAIXA - CAP DE CREUS PROJECT (2017)

---

[www.oceanshealth.udg.edu/ca/la-caixa-cap-de-creus.html](http://www.oceanshealth.udg.edu/ca/la-caixa-cap-de-creus.html)

**The La Caixa-Cap de Creus project has evaluated the bioactive potential of the Cap de Creus Natural Park.**

The La Caixa project has documented that around 20% of the species of marine macroinvertebrates and fish documented in Cap de Creus have bioactive potential, with 20% classified as vulnerable, protected under an agreement, a royal decree, protection treaty or on the red list of the International Union for Conservation of Nature (IUCN), thus demonstrating for the first time that marine reserves can help protect marine species that may lead to new medicines in the future.





---

## CRIMA PROJECT (2019-2021)

---

[crima.icm.csic.es](http://crima.icm.csic.es)

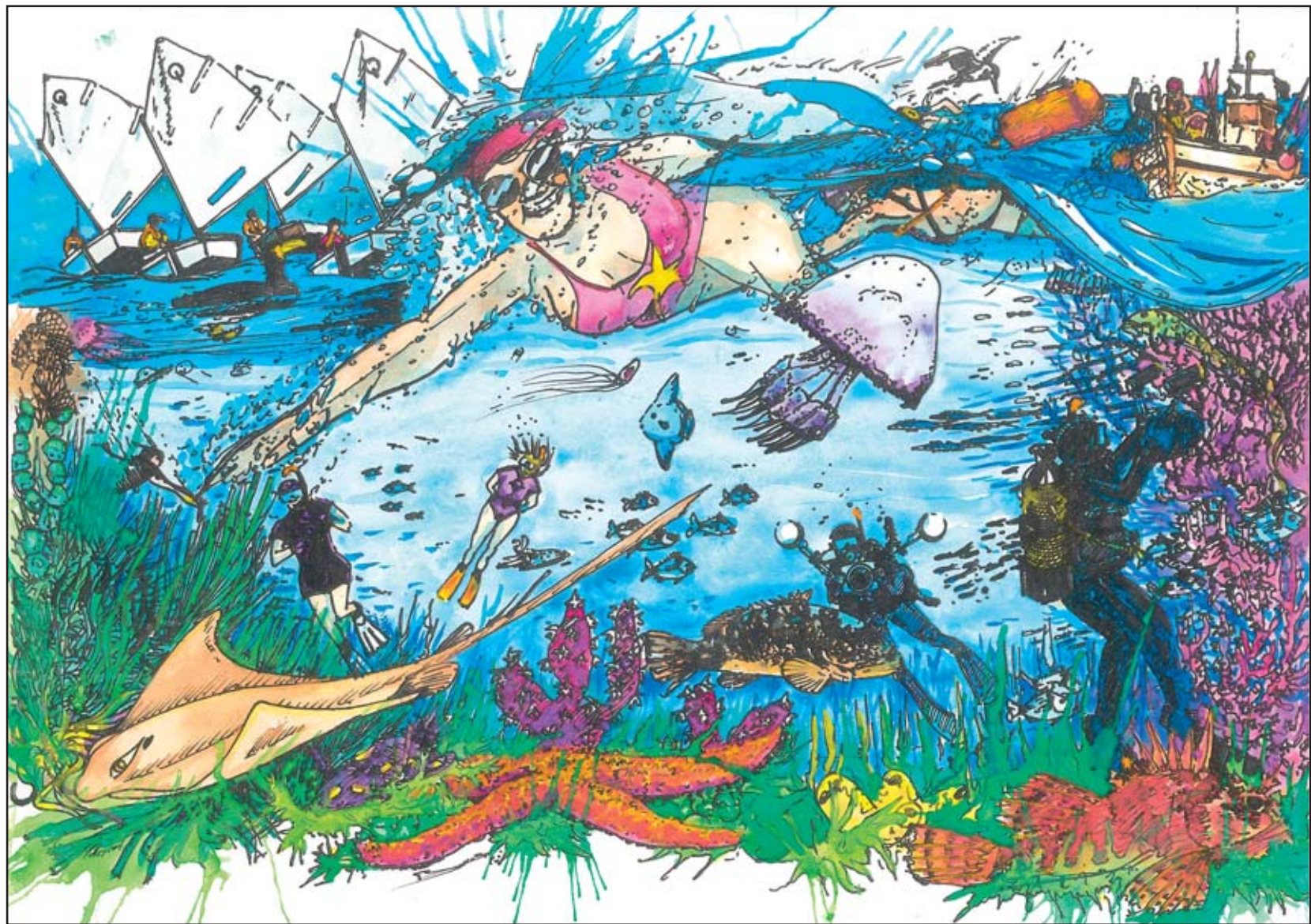
**The CriMa project has assessed the bioactive potential of discard from trawl fishing on sensitive habitats such as crinoid seabeds.**

According to the results of the CriMa project, 14% of the species discarded by trawl fishing on crinoid seabeds in Blanes produce molecules with some kind of bioactive potential. These species include soft corals (e.g. *Alcyonium palmatum*), tunicates (e.g. *Ascidia mentula*), and bony fish (*Osteichthyes*) such as mackerel (*Trachurus trachurus*), hake (*Merluccius merluccius*), and cartilaginous fishes (*Chondrichthyes*) such as the small-spotted catshark (*Scyliorhinus canicula*). 68% of all bioactive potential species studied in the discard are vulnerable to trawl fishing.

## 6. Marine reserves: sustainability and the future

*Blue spaces: a place to practice sustainable and healthy recreational activities.* ►

Illustration: Boris Mörker



Marine reserves protect essential goods and services, such as healthy foods rich in omega-3s, blue spaces for healthy recreational activities, and places where species of potential pharmacological interest live and are protected. Marine reserves are a tool for the protection of fishery resources, blue spaces and the pharmacy of the sea. The La Caixa - Cap de Creus project and the CriMa project have also shown that the protection of vulnerable habitats is important due to the presence of species with bioactive potential for the creation of new drugs.

Marine reserves are an ideal place to practice different recreational marine activities beneficial for physical and mental health, and which, when practiced well, are environmentally sustainable, thus constituting a kind of “Blue Gym” that must be preserved for future generations. For this reason, a form tourism management that makes tourism sustainable is a priority and analysing how marine reserves contribute to the preservation of marine ecosystems, in which tourists and locals carry out maritime activities that help to promote health, is required.



Photo: Lluís Mas Blanch

---

## LA CAIXA - CAP DE CREUS PROJECT (2017)

---

[www.oceanshealth.udg.edu/ca/la-caixa-cap-de-creus.html](http://www.oceanshealth.udg.edu/ca/la-caixa-cap-de-creus.html)

**The La Caixa - Cap de Creus project has been assessed for the first time the potential risks and benefits for people's health, arising from the sea of the Cap de Creus Natural Park.**

It was the first work of its kind carried out in a Mediterranean marine reserve on the subject of Oceans and Human Health, to assess the role that marine reserves play in relation to human health. The project has been estimated the contributions of omega-3 fatty acids (EPA and DHA) from the species most caught by both artisanal fishing methods, such as longline, seine or lift-net, used within Cap de Creus, as well as for other more industrial fishing gear, such as trawling or purse seine fishing, around Cap de Creus.

The species fished with artisanal methods that provide (in kilos per catch) a higher content of omega-3 for local consumers are the conger (*Conger conger*), the greater amberjack (*Seriola dumerili*) and the bonito (*Sarda sarda*). The most fished species with trawling and purse seine around Cap de Creus are small pelagics such as anchovies (*Engraulis encrasicolus*) and sardines (*Sardina pilchardus*) and, therefore, will be the species that will ultimately provide more omega-3 to the local population in relation to catches.



Photo: Lluís Mas Blanch

The quantity and quality of omega-3 depends on the characteristics of the fish, but also on the habitat in which they live. Marine reserves protect habitats from the impacts of fishing and therefore the quality and quantity of the fauna (small animals such as polychaetes, gastropods, crustaceans and other small invertebrates, which live at the bottom of the sea, and which the fish feed on). In this way, a relationship can be established between the goods and services provided by a marine reserve such as Cap de Creus, the fish that live there and human health.

In particular, some fragile marine habitats such as crinoids seabed and calcareous gravel (maerl beds) are very important for the content in omega-3 fatty acids they can provide. In the GALP Omega-3, La Caixa - Cap de Creus and CriMa projects (coordinated by the Institute of Marine Sciences-CSIC and the Chair), it has been shown, among other things, that habitat protection is a indispensable tool in being able to conserve the omega-3 fatty acids of the fish that feed in these habitats.





---

## THE GALP OMEGA-3 (2018-2019)

---



[www.oceanshealth.udg.edu/ca/galp-omega.html](http://www.oceanshealth.udg.edu/ca/galp-omega.html)

**The GALP Omega-3 project has evaluated the content of omega-3 fatty acids extracted from the most valued species caught on the Costa Brava.**

The GALP Omega-3 and La Caixa - Cap de Creus projects have studied the omega-3 in two species of great interest to fishing such as the red mullet (*Mullus barbatus*) and the striped red mullet (*Mullus surmuletus*), which are mostly distributed in the mud and in the calcareous gravel (maerl) seabeds respectively. This study has shown that the amount of DHA-type omega-3s is higher in calcareous gravel habitats than in mud habitats, which demonstrates the need to protect calcareous gravel (maerl beds).



---

## CRIMA PROJECT (2019-2021)

---

[crima.icm.csic.es](http://crima.icm.csic.es)

The CriMa Project “Scientific and social initiative to investigate the trade-offs between exploitation and conservation of sensitive marine habitats: Crinoids and Maerl bottoms”, has helped to provide useful information for better management of these habitats, to maintain their conservation and, at the same time, their productivity.

### Calcareous gravel (Maerl beds)

The habitat of interest to fishing known as calcareous gravel, also known as maerl or rhodolite seabeds, is a plant formation composed of the accumulation of very slow-growing (approximately 1 mm per year) calcareous red algae that are distributed along the continental shelf, mostly between 20 and 90 metres deep. In the Mediterranean, the most common species of red algae that form the calcareous gravel are *Phymatolithon calcareum* and *Lithothamnion corallioides*, which are protected by law. It is a habitat that is home to a wide variety of fauna and flora because it offers very suitable breeding and refuge areas.

**ICM** **CriMa** **Universitat de Girona**  
 Scientific and social initiative to investigate the trade-off between exploitation and conservation of sensitive marine habitats: Crinoids and Maerl bottoms

**GOAL 01** Consolidate a framework of ecological integrity of habitats based on the changes that can be tolerated in relation to the effects of fishing

**GOAL 02** Propose responses with different strategies to balance the conservation and exploitation of habitats

**GOAL 03** Link the quality / health of marine habitats and their resources with human health

**GOAL 04** Raise public awareness through a scientific and social platform

2 habitats: crinoids and maerl seabeds  
 2 areas: with and without trawling (Cap de Creus & Cabo de Palos Natural Parks)  
 2 zones: Catalan and Murcia coasts

UNIÓN EUROPEA FONDO EUROPEO MARITIMO Y DE PESCA (FEMP) **CriMa**

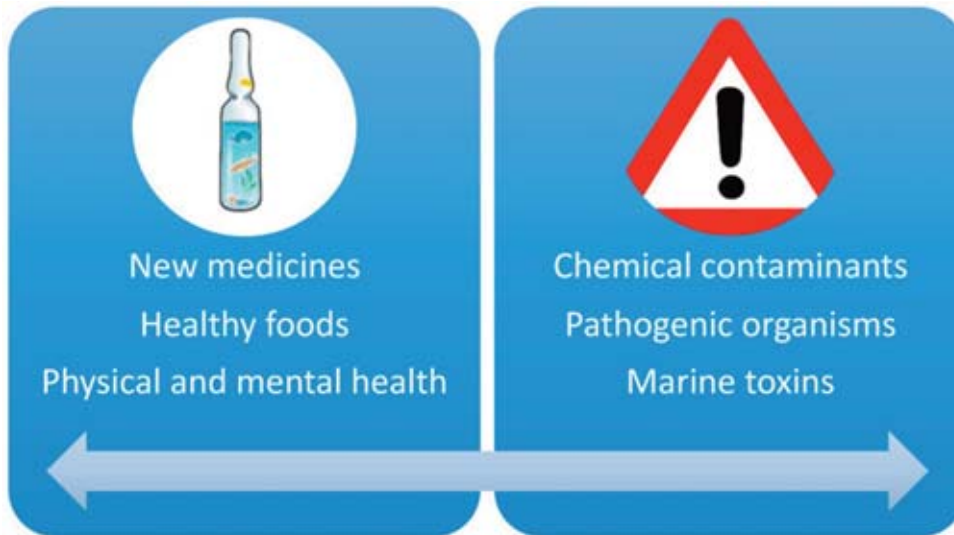
It is also a very vulnerable habitat, especially to the disturbance of trawling, and is very sensitive to acidification and warming of seawater. It is a protected habitat and trawling is prohibited on these grounds, according to the EU Habitats Directive.

### Crinoid seabed

Crinoids or sea lilies are echinoderms. *Leptometra phalangium* and *Antedon mediterranea* are the two most representative crinoid species in the Mediterranean that form large aggregations on the continental shelf between 100 and 200 metres deep, creating an ideal habitat for the survival and reproduction of some commercially important fish species, such as hake, monkfish or red mullet. These characteristics mean crinoid seabeds are both essential habitats and sensitive to disturbance caused by trawling, the only fishing activity that takes place on these seabeds. But they are not protected by any European regulations or the Habitats Directive. Trawling on these beds is neither regulated nor restricted.

The goal of the Oceans and Human Health Chair is to demonstrate that marine ecosystems are essential to human health and well-being, but they are also a source of risk that needs to be well managed in order for the risk to be limited: various factors relating to human activity such as overfishing, pollution and climate change are jeopardizing the benefits from the sea and increasing the risks.

These factors have an indirect impact on people's health, given the decline in marine omega-3 stocks in the species that could be a source of new medicines, and in the conservation of Blue Spaces for healthy recreational activities (Fig. 9).



*Fig. 9. Current and emerging problems from the sea: benefits (left) and health risks (right).*

Source: Lloret et al. (2020)



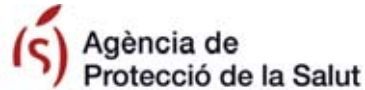
Photo: Lluís Mas Blanch

Eating fish has benefits for our health, although pollutants such as methylmercury from the metallurgical and plastics industries and factories, which have been dumped into the sea for decades, should be considered. Ingestion of plastic by fish, birds and marine mammals can cause their death. In addition, plastics in the sea degrade into microplastics, which results in organisms ingesting them and accumulating them in their tissues.

Fishery products can also cause some health problems due to the presence of certain contaminants, parasites such as *Anisakis* and biotoxins. The presence of parasites is not only a health problem, but the physical condition of the host (i.e. the fish) maybe diminished to a greater or lesser degree by the presence of such parasites.

*Anisakis* are small, white, elongated, cylindrical worms measuring between 0.5 to 3 cm (nematodes of the Anisakidae family). The main species of parasitic nematodes found on our coasts are *Anisakis simplex*, *Pseudoterranova decipiens*, *Contracaecum* spp. and *Hysterothylacium* spp. They are parasites that need to parasitize on different hosts in order to complete their life cycle. Marine mammals are the ultimate hosts, and expel anisakis eggs to the marine environment through faeces. The larvae, which swim freely, are eaten by small crustaceans and these, in turn, are eaten by fish and cephalopods, some of which form part of our cuisine, such as the blue whiting, anchovy, mackerel, bream, hake, sardine, cod, monkfish, squid, octopus or cuttlefish. Approximately 5% of the fish caught on the Catalan coasts are infected by anisakis, with the blue whiting being the species with the highest prevalence (11.7%), and the sardine, the least parasitized species (1.8%).

Our body is able to get rid of the parasite, which usually disappears after three weeks from the initial infection, although in very rare cases, endoscopy has been necessary. The first symptoms of anisakidosis can appear from one to two weeks after infection and range from a tingling in the neck to, in the most severe infections, intense abdominal pain, nausea, vomiting and diarrhoea. However, cases of people with an allergy to anisakis, who may suffer from simple urticaria to anaphylactic shock, have also been reported. In this case, the parasite does not need to be alive to cause an allergic response, as the reaction is caused by the antigens (proteins) of the anisakis. In Europe, about 600 cases of anisakidosis have been reported, with an average of 5-10 cases per year per hospital.



---

## ANISAKIS PROJECT AND FISH HEALTH WORKSHOP (2010-2012)

---

[www.oceanshealth.udg.edu/ca/anisakis.html](http://www.oceanshealth.udg.edu/ca/anisakis.html)

**The Anisakis project funded by the Ministry for the Ecological Transition and the Demographic Challenge, described for the first time the importance of studying the factors that determine the health status of commercial species of fish, such as their physical condition, reproductive potential, and the presence of parasites.**

The Anisakis project emphasized the importance of fish health, especially during critical periods of their life (before spawning, migration or in the early stages of life), as an element essential for the sustainability and profitability of fisheries.

In March 2017, the Chair organized a seminar at the Institute of Aquatic Ecology, entitled “Oceans and Human Health,” led by Professor Lora Fleming, director of the European Centre for Environment and Human Health at the University of Exeter, United Kingdom. Professor Lora Fleming is a world renowned expert on the subject of Oceans and Human Health and has contributed her ideas in developing the work of the Chair since its creation.



A poster entitled “Potential health benefits of marine resources in a protected area: the example of Cape Creus” was also presented at the conference “Biodiversity and Health in the Face of Climate Change - Challenges, Opportunities and Evidence Gaps” which took place in Bonn (Germany), organized by the German Government and the World Health Organization.

The Fish Health Workshop ([www.oceanshealth.udg.edu/en/fish-health-workshop.html](http://www.oceanshealth.udg.edu/en/fish-health-workshop.html)) brought together eight scientists from Spain, France, Italy and Ukraine with differing knowledge regarding fish health in order to discuss recent advances in this field, knowledge gaps, and future research needs.

Parasites, energy reserves and the reproductive potential of fish were selected as the best indicators of fish health for fisheries management purposes, and the need to study these indicators in the most important fishery species was highlighted.

Among the solutions that have had the support of the Chair are marine protected areas, the diversification of consumption towards non-overexploited and local fish species which have been caught in a sustainable way and the adoption of a healthy and environmentally friendly lifestyle.

One of the Chair's recent areas of study relates to the growing economic sectors of the so-called Blue Economy, such as cruises, the transport of goods by sea and renewable energy (offshore wind). These activities, which involve large financial sums at an international level but which often have little local economic value, have an impact on the marine environment which needs to be evaluated and properly managed.

Cruises and cargo ships are a major source of air and water pollution. In addition, cruises are also a major source of infectious diseases with many people living on board in close proximity, a clear example of a leisure activity at sea that is currently neither sustainable nor healthy. With regard to offshore wind energy, despite the emergence of new technologies, the location of wind farms in vulnerable parts of the Mediterranean means that the potential benefits of this type of installation (reduction of atmospheric CO<sub>2</sub>) can be easily outweighed by the risks they involve for the marine environment (marine mammals, fish, turtles, habitats, etc.) and to birds. Thus, offshore wind farms can severely affect the goods and services of marine reserve ecosystems.



Photo: Peter Hansen via Unsplash.



Photo: Andrey Sharpilo via Unsplash.

---

## INTERREG PHAROS<sub>4</sub>MPAS PROJECT (2019)

---

[www.oceanshealth.udg.edu/ca/el-projecte-pharos4mpas.html](http://www.oceanshealth.udg.edu/ca/el-projecte-pharos4mpas.html)

**The PHAROS<sub>4</sub>MPAs project explored how Mediterranean marine reserves are affected by various maritime activities such as tourism, wind energy, tourist cruises, maritime freight transport, within the framework of the European Union's Blue Economy.**

Up to eight institutions from all over Europe took part in the project which was led by WWF France ([www.pharos4mpas.interreg-med.eu](http://www.pharos4mpas.interreg-med.eu)).

At the national level, the Chair and other collaborating entities have been in charge of recreational sailing, diving and recreational fishing, while integrating artisanal fishing.

The aim of the project is to provide mitigation measures to maintain the good environmental status of marine ecosystems in the face of the growing Blue Economy, while providing recommendations for European, national and regional administrations, based on environmental, social, economic and management criteria.

### **Pleasure boating**

In the marine reserve of Cap de Creus, in a single cove of only 20 hectares, there can be up to 90 boats anchored a day. Anchoring has one of the biggest impacts on marine protected areas: depending on the

type of anchor size - the length and size of the chains and the characteristics of the anchorage area - sensitive habitats such as *Posidonia oceanica* meadows, coralligenous assemblages and calcareous gravel (maerl) are irreversibly affected. But there are other important ecological impacts. Pleasure boating can also be a source of conflict with other economic activities, such as aquaculture, professional artisanal fishing, recreational fishing and diving. In addition, the increase in the arrival of mega-yachts is a growing risk factor in marine reserves.



Photo: Josep Lloret

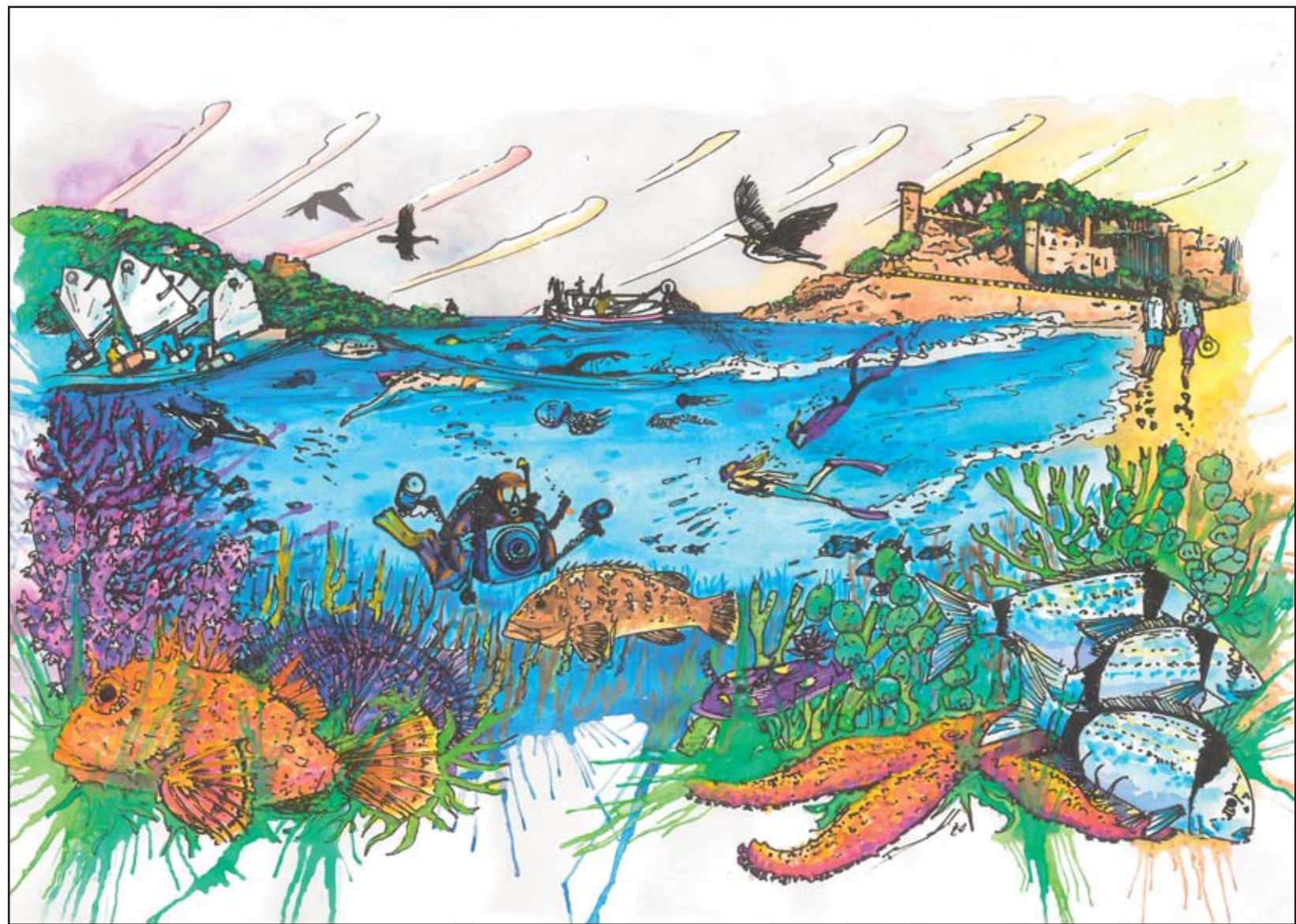
### **Recreational fishing**

Recreational fishing increases fishing pressure on marine resources, conflicting with professional fishing, particularly artisanal fishing. Recreational fishing is, as yet, not properly regulated and data on its real impacts is lacking. Recreational fishermen can also damage sensitive habitats, introduce exotic species and pollute the sea through lost or abandoned fishing gear.

## 7. Activities of the Oceans and Human Health Chair

The Oceans and Human Health chair, sailing to the future!  
Because the health of the sea is our health

*The activities of the Chair at sea.* ►  
Illustration: Boris Mörker



## 7.1. Communication and dissemination

### 7.1.1. Audiovisual and events

#### “Oceans and Human Health” Exhibition



The Oceans and Human Health Chair organized this exhibition to show the complex relationships that are established between marine ecosystems and human health and well-being. In collaboration with various experts in marine biology, medicine, health, veterinary medicine and social sciences, many of whom are connected to universities, research centres, hospitals, administrations and NGOs in Catalonia, the Exhibition was arranged around six themes:

- Medicines of the sea
- Medicines to combat cancer and other diseases
- Omega-3s from fish and habitat quality
- Allergies from the sea: parasites, jellyfish, fish, etc.
- Sea, health and well-being
- Marine biotoxins
- Pollutants (Mercury, Persistent Organic Pollutants, POPs and others)

The exhibition opened at Ca l’Anita, in Roses, on 22nd May, 2019, and was visited by more than 200 people. During the following years, the exhibition toured and was shown at the Faculties of Medicine and Sciences at the University of Girona, at the House of Culture in Tossa de Mar and at the Museum of History in Sant Feliu de Guíxols, thanks to the collaboration with the Martí Casals Chair of Rural Medicine and Health, and at the Nautical and Fishing Training School of Catalonia, in Ametlla de Mar (Tarragona) until June 2021.





### ***My friend the sea* Documentary**

Scientific: direction Josep Lloret.

Production: Oceans and Human Health Chair and Polimarc Films.

*My friend the sea* (La meva amiga la mar) is a documentary that deals comprehensively with the health benefits and risks from the sea, and that brings together the experiences and knowledge of professionals, researchers and technicians from different research centres, universities, hospitals, administrations and companies, from different areas of knowledge such as marine biology, medicine, public health and environmental education, among others. It was sponsored by Roses Town Council, the Fishermen's Guild of Catalonia, the Fishermen's Guild of Roses and Tossa de Mar Town Council and has been translated into Spanish and English with the help of the General Directorate of Fisheries and Maritime Affairs of the Generalitat de Catalunya.

It premiered at Roses, on Empordà TV, during September 2020, and is the first documentary ever made on the subject of Oceans and Human Health in Catalonia and Spain. During 2020 and 2021, it has been broadcast on more than 30 local television stations in Catalonia and Spain. The documentary has been selected for the "SCINEMA International Science Film Festival 2021". SCINEMA (<https://scinema.org.au/>), organized by the Royal Institution of Australia, which is the most important international science film festival in the southern hemisphere.



Photo: Josep Lloret

## “Sea and Health” Day

The “Sea and Health” Day is the Chair’s innovative way of communicating the relationships between marine ecosystems and human health. During these conferences, scientific lectures and workshops are organized at the Roses Municipal Theatre and trips are made on the Magic Catamaran, sailing the audience from the Port of Roses to Cap de Creus, where wildlife and underwater flora observation sessions are held.

The 1st Sea and Health Day was held on 28th and 29th September 2018. The first opening lecture was given by Dr Joan San, dean of the Faculty of Medicine at the UdG.

On 29th September, aboard the Magic Catamaran, the director of the Cap de Creus Natural Park (Victòria Riera) explained what the park does to protect the marine ecosystem, while different researchers from various universities and research centres in Catalonia gave short presentations in the form of interactive workshops.

In total, more than twenty experts from the multidisciplinary team of the Chair took part, with various specialties such as marine biology or toxicology; doctors from different disciplines such as oncology, allergology, cardiovascular risk, environmental epidemiology and neuroscience; and other disciplines such as chemistry, ethnography and pharmacology, from various institutions: University of Girona, Catalan Institute of Oncology, Catalan Institute of Health, ICM-CSIC,



CEAB-CSIC, University of Rovirai Virgili, Hospital Clínic, Germans Trias i Pujol University hospital, ISGLOBAL, Department of Health, Hospital del Mar, Bellvitge Biomedical Research Institute, IRTA, PharmaMar, Museum of History of Sant Feliu de Guíxols, Martí Casals Chair of Rural Medicine and Health.

The 2nd “Sea and Health Day” was held on 28th and 29th September 2019, in Roses, to publicize the main benefits for human health - especially cancer - in relation to the consumption of marine products.

During the morning of 28th September, there was the trip on the Magic catamaran and, during the journey, different researchers gave short talks on the subject of Oceans and Human Health. In the afternoon, there were lectures at the Roses Municipal Theatre focusing on the theme “Health and fish”, particularly in relation to the consumption of fish in contributing to the prevention of certain types of cancer, thanks to the omega-3 fatty acids fish contain. Two medical experts in the field were invited: Dr Antonio Agudo (director of the Nutrition and Cancer Unit of the Catalan Institute of Oncology in Barcelona), who gave a lecture on diet and cancer, focusing on how the consumption of fish and seafood can help prevent certain types of cancer; and Dr Joan San, dean of the Faculty of Medicine and co-director of the SeaHealth research group associated with the Chair, who gave a lecture on how the consumption of fish and seafood can contribute to mental health.

Photo: Josep Lloret



At the conclusion of the day’s proceedings, the Directorate General of Fisheries and Maritime Affairs of the Department of Agriculture, Livestock, Fisheries and Food presented eight awards for the best initiatives relating to the Maritime Strategy of Catalonia, seven of which went to various institutions and companies who collaborate with the Chair.

During the “Sea and Health” Day, the swimming goggles donated by participants were also collected for the benefit of the Educa, Aprèn, Esport Association, which is a charitable campaign helping refugees on the island of Lesbos.

### Roses Health Day

On 15th June, 2019, the Chair took part in the 3rd Roses Health Day, held on the streets of Roses, organised by CAP Roses, Roses Against Cancer Foundation, the pharmacies and fire brigades in Roses. The Chair carried out personalized visits to the “Sea and Health” exhibition at Ca l’Anita and set up a stand on the street.

### 7.1.2. Talks and conferences aimed at the public

#### “How to Live Longer and Better”

This conference, led by Antoni Salamanca, was held on 9th November, 2018, in Roses. Mr Salamanca explained to the audience the concept of Blue Zones as a factor relating to the people’s longevity. The discovery of the first Blue Zone by National Geographic and reporter and journalist Dan Buettner came in 2004, and since then a series of studies have been carried out which were explained by the speaker.

### **Round Table Discussion of the Martí Casals Chair of Rural Medicine and Health at the UdG**

During June 2019, the Chair participated in this round table discussion under the umbrella of the Conference on “Tourism, development and health”, organized by the Martí Casals Chair of Rural Medicine and Health at the UdG in the Museum of History of Sant Feliu de Guíxols. The discussion was developed around the book by Joaquim M. Puigvert and Narcís Figueras, *Balnearios, veraneo, literatura. Agua y salud en la España contemporánea* (Health resorts, summer, literature. Water and health in contemporary Spain, 2018).

### **Boat Show 2019**

On 13th October, 2019, a talk was given at the Barcelona Boat Show as part of the sessions on sustainability, organized by the Generalitat’s Maritime Strategy of Catalonia.

### **9th Conference “Empordà, the landscape as an economic asset”**

On 19th October, 2019, the Chair participated in the “The sea of Monturiol” round table discussion at the 9th Conference “Empordà, the landscape as an economic asset”.

### **Cosmoacción 2019**

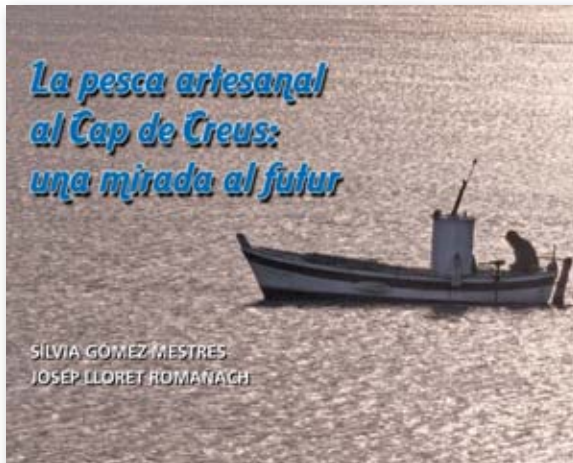
On 7th November, 2019, the Chair took part in round table discussion, “The hidden value of water” within the Cosmoacción program of the Environmental Forum Foundation and La Caixa, during which the importance of water for people’s health was discussed.

## Other activities

Since 2018, the Chair has taken part in various national conferences such as: SEMFYC, “The sea as an integral health space” organised by Som Mar; “A Sea of Changes”, by the Generalitat de Catalunya, and “Tavern Conversations: a polluted sea” by the Palamós Fishing Museum.

### 7.1.3. Books

#### *Small scale fishing in Cape Creus: a look into the future*



This book is the first publication on artisanal fishing that combines studies of biology and social anthropology in a protected marine area. Artisanal fishing has fed the coastal populations of Cap de Creus and its culture throughout history and, today, several international organisations backed by scientific studies, claim artisanal fishing as the most sustainable fishing method.

The aim of the book is to offer a perspective on the future without losing the essence of a past that provides the keys to the adaptation of artisanal fishing to the transformations of the contemporary world through social, economic and environmental sustainability.

The book was presented on 28th May, 2017 in the port area of Port de la Selva.

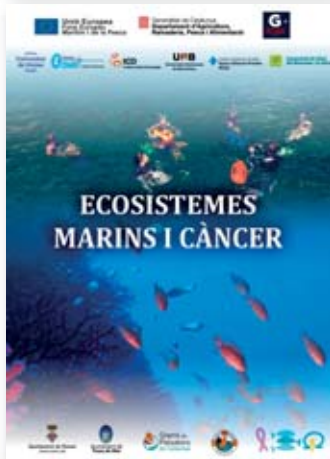


Photo: Lluís Mas Blanch



## **Superguide and mini-guide to Omega 3 from the Costa Brava**

These guides are a tool for professionals and the general public in better understanding the benefits of consuming Omega 3 from fish, which most species caught on the Costa Brava contain. For the first time we analyzed the Omega 3 fatty acids of the most commonly caught fish on the Costa Brava.



## **Marine ecosystems and cancer guide**

This Guide explains how marine ecosystems provide healthy seafood to prevent certain types of cancer and how recreational activities at sea and near the coast help in the recovery of cancer patients.



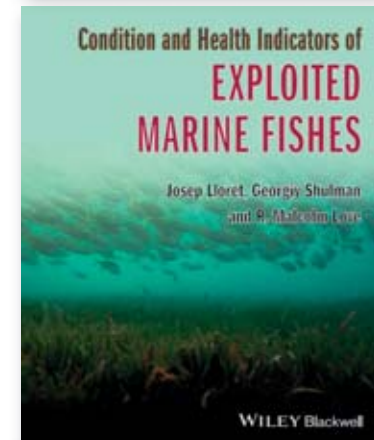
## “Recreational fishing” and “Pleasure boating” manuals

These manuals assess the impact of recreational fishing and pleasure boating on the Mediterranean marine reserves and propose recommendations for the management of these activities in line with environmental, social and economic criteria.



## “The condition and health indicators of exploited marine fishes” book

This book is a world reference on the condition of fish of interest to fisheries and its application in marine ecology.



#### **7.1.4. Others**

##### **Website**

[www.oceanshealth.udg.edu](http://www.oceanshealth.udg.edu)

##### **YouTube channel**

[www.youtube.com/channel/UCmwZFa\\_FJhCl6EM2n-mZazg](http://www.youtube.com/channel/UCmwZFa_FJhCl6EM2n-mZazg)

The website of the Chair describes the objectives of the Department, its members and the practical details (location, supporters, etc.) in Catalan, Spanish and English. It is a very important dissemination tool for students and researchers, for citizens interested in the subject, and for professionals in the fishing, tourism sectors and in the management of natural spaces. It has explanatory texts, and photographs and videos from various creators. This is available in Catalan, Spanish and English.

The Chair has also created a YouTube channel where the different videos published by the Chair and the recordings of the conferences are uploaded.

##### **Facebook, Instagram and Twitter**

In order to communicate more directly with users of different ages, the Chair has also created social media profiles on Twitter, Facebook and Instagram.

## **Women with Science Blog**

In collaboration with the blog “Mujeres con ciencia” (Women with Science), from the University of the Basque Country, every year the Chair publishes a document which presents the excellent researchers and managers of the marine environment, collaborating with the Chair, who work in studying the relationships between the oceans and health and in preserving marine ecosystems and the health and well-being of people. Enthusiastic and expert in their work, they also offer us their vision and opinion on the role and leadership that women should have (and that the Chair fully shares) on a key topic so that future generations can continue to enjoy the health benefits that the seas and oceans offer, while minimizing risks. As part of this initiative, between 2019 and 2021, a dozen women scientists and technical collaborators of the Chair have been put forward as female scientific role models.

<https://mujeresconciencia.com/2019/05/07/la-mar-de-salud>

<https://mujeresconciencia.com/2021/02/24/la-salud-de-la-mar-es-tambien-nuestra-salud>

## **Merchandising**

We have produced various publicity materials advertising the Chair, including t-shirts, as well as a logo and promotional video in different languages (Catalan, Spanish, English, French, German and Arabic).

## **7.2. University courses**

### **18th International Summer School on the Environment Congress (ISSE 2018): “Oceans and Human Health: exploring the relationships between marine ecosystems and human health and well-being”**

The course “Oceans and Human Health: exploring the relationships between marine ecosystems and the health and well-being of people” took place on 28th September, 2018 at the Roses Municipal Theatre and was co-organized by the Institute of Environment and the Chair under the framework of the “18th International Summer School on the Environment (ISSE 2018)”.

The course was aimed at professionals from different fields (marine biology, medicine, pharmacy, veterinary medicine, biotechnology, environmental and health technicians, marine reserve managers, etc.) and levels (university students, university professors and secondary school teachers, researchers, doctors, etc.), recognised with the awarding of 0.5 credits for UdG students on all degree courses in the Faculty of Letters and the Faculty of Nursing, on the degree courses in Biology and Environmental Sciences in the Faculty of Science, and the Medicine degree in the Faculty of Medicine.

### **International Course on Oceans and Human Health 2019**

The Chair participated in the summer course “Does Human Health and Wellbeing Depend on Healthy Ocean?” on Oceans and Human Health organized on 5th – 7th June 2019 by AZTI in Donostia (Basque Country). This course - co-organized by AZTI, the Sophie project (EU) and the Chair, among others - brought together more than 40 people (scientists, experts, students, etc.) from different European countries, to present and discuss the latest studies on oceans and health. The experiences of the Chair were presented to the audience.

### **University final thesis research papers**

Since its inception, the Chair has contributed to the teaching and research for various final degree projects (TFG) at the University of Girona, which have addressed aspects as diverse as the spot-fin porcupinefish, omega-3 in fish and the positive health effects of recreational activities at sea.



Photo: Lluís Mas Blanch

## **7.3. Research**

### **7.3.1. Conferences of experts**

#### **SOPHIE Expert Group Workshop**

The Chair participated in the meeting of European experts on 24th - 25th April 2018 on the topic “Oceans and Human Health” (SOPHIE Expert Group Workshop) which took place in Dublin (Ireland), coordinated by the European Marine Board. The meeting brought together more than twenty experts (marine biologists, doctors, administration specialists, etc.) to discuss joint future initiatives in this new field of research and management in Europe.

#### **The Oceans and Human Health Conference**

The Oceans and Human Health conference was held online on 5th October, 2020 as part of ‘The Ocean Decade Virtual Series’. The example of the Chair was presented as a tool for citizen-scientific collaboration in relation to the preservation of the oceans and people’s health ([www.youtube.com/watch?v=aRzXlp7-nwA](http://www.youtube.com/watch?v=aRzXlp7-nwA)).

The Ocean Decade Virtual Series, organised by the UNESCO Intergovernmental Oceanographic Commission, is a series of high-level interactive virtual scientific dialogues aimed at mobilizing the global ocean community and promoting transformative partnerships and innovative solution-oriented activities to achieve the results of the UN Decade of Ocean Sciences for Sustainable Development ([www.oceandecade.org/events/129/The-Ocean-Decade-Virtual-Series](http://www.oceandecade.org/events/129/The-Ocean-Decade-Virtual-Series)).

#### **International Human Health and the Ocean in a Changing World**

In the same year, on 2nd and 3rd December, 2020, the Chair participated in another Congress with the same purpose: the International Human Health and the Ocean in a Changing World organised by Boston College, the Center Scientifique de Monaco and the Prince Albert II Foundation in Monaco.

The purpose of this conference was to provide an update on the various risks the oceans are exposed to through human activities and the threats that these activities, and the resulting degradation of the oceans, pose to human health, but also to consider the various benefits that the ocean can contribute to the health and well-being of populations.

## Biovoices

In December 2020, the Chair participated in the international workshop “Connecting marine bio-based products for a sustainable future” on food deriving from fish., BIOVOICES is a project that aims to support local action plans for the Bioeconomy, ensuring the commitment of all stakeholders through an exchange platform for experts.



### Friday Talks: scientific seminars every Friday at the Institut de Ciències del Mar (ICM-CSIC)

In March 2021, the director of the Chair presented the talk “Oceans and Human Health”, at the “Friday Talks” seminars of the ICM-CSIC.

### 7.3.2. Doctoral thesis “Oceans and Human Health”

The doctoral thesis “Oceans and Human Health” is being developed in collaboration with ISGLOBAL and with the co-financing of Tossa de Mar Town Council, which allows a young researcher to be taught and study this subject. Tossa de Mar Town Council thus joins the efforts to promote sustainable and healthy tourism while de-seasonalizing tourism activities in the municipality.

### 7.4. The Chair and younger students: lectures and activities for Secondary and High School education

Since its inception, the Oceans and Human Health Chair has been holding workshops and conferences at various ESO (compulsory secondary education) and High schools, aware of the role in educating young people in the conservation of marine ecosystems and human health.



Setmana de la Ciència de la UdG



Centre Escolar Empordà de Roses



Since 2018, talks have been given at more than twenty secondary education and high schools, such as the Center Escolar Empordà school in Roses, and the Institut de Vilablareix, aimed at high school students. Also, during 2019, there was a guided tour of the exhibition “Sea and Health” at the Faculty of Sciences of the UdG, as part of Science Week. The Chair also took part in a walk organised by a student from the Institut Illa de Rodes school as part of their research work.

## 7.5. Citizen participation activities

### Seabed cleaning



On 27th October, 2019, the Chair participated in a campaign to clean the beach at Almadrava in Roses and adjacent seabeds, in collaboration with the Diving Centres of Roses, Club Badia de Roses, Winapp, Runwomanrun, Medi Ambient-Roses, providing the divers with the materials needed to carry out the underwater cleaning. 140 people took part, collecting 560 kilos of waste from the sand and water. A banner was presented for the occasion.



Foto: Eduard Marquès. (Paddel Surfing for Science)

## Study of microplastics at sea

In 2020 and 2021, the Chair participated in a citizen science project which, for the first time, has studied the presence of microplastics on the Catalan coast, led by a team from the University of Barcelona and the NGO Surfrider Foundation Europe (<https://surfrider.eu>).

Every fortnight, with the help of groups of citizens using kayaks or paddle boards, samples were taken by dragging a 330 micron mesh that collects the microplastics along the shoreline, an area for which no data exists.

The data should make it possible to know the concentration of microplastics, their impact and the material, origin and age of the microplastics in order to help find solutions, make people aware of the problem and reduce their presence. For this occasion, the Chair bought the sampling gear used at Cap de Creus.



(Roses Foundation Against Cancer).

## Women's Race: The Chair Against Cancer

In 2020, the Chair participated in the 13th Roses Women's Race and in the Castelló d'Empúries Women's Race. These activities are related to the study into the relationship between marine ecosystems and cancer, in which cancer patients, members of the Roses Foundation Against Cancer and the ABS Castelló d'Empúries, have participated. The races are fundraising activities to research new cancer treatments.



## **On TV!**

The Chair participated in the informative program on the fish from the markets on the Costa Brava La mar de bé (The Sea of Good), from the Xarxa Brava: episode 10 “The sardine”. The Xarxa Brava is an action from the GALP Local Fisheries Action Group Association that wants to make market fish, the variety of species that sold on the Costa Brava, their nutritional properties and gastronomic quality more widely known.

## **7.6. Advisory activities to the administration for the management of marine ecosystems**

### **Cap de Creus Fisheries Co-Management Committee**

In January 2021, the Chair became part of the Cap de Creus Fisheries Co-Management Committee, which will regulate fishing in the marine waters of the Cap de Creus Natural Park as well as in the inland waters in the vicinity.

The Co-Management Committee for Professional Fishing in Catalonia, formed by members of the fishing sector, with small scale fishermen from the guilds of Llançà, Port de la Selva, Cadaqués and Roses, as well as the Territorial Federation of Fishermen’s Guilds of Girona; members of the scientific community, with representatives from the Catalan Research Institute for the Governance of the Sea (ICATMAR); members of entities linked to social aspects and the protection of the environment, with representatives of Low Impact Fisheries of Europe (LIFE) and IAEDEN-Salvem l’Empordà.



Photo: Lluís Mas Blanch

## **Roses Centre for the Sea**

The Chair contributes with the scientific advice and the drafting of the study project on the loggerhead turtle (*Caretta caretta*), to the creation of the Centre for the Sea, a Thematic Centre of Marine Biodiversity and Human Health in Roses, for the study and the conservation of marine ecosystems, the promotion and recovery of Health, the sustainability of tourism and fisheries, and the creation of skilled jobs for young people.

## **European Charter for Sustainable Tourism of the Cap de Creus Natural Park and Montgrí Natural Park, the Medes Islands and Baix Ter**

The Chair is a permanent member of the European Charter for Sustainable Tourism of the Cap de Creus Natural Park and, in October 2021, participated in participatory workshops, organised by the Montgrí Natural Park, the Medes Islands and Baix Ter, for the creation process of the European Charter for Sustainable Tourism 2021-2025.

The world of research, tourism companies and all professional categories involved in tourism, administrations, the people of the Park and travellers can collaborate by creating memorable travel experiences in the territory for 365 days a year in the name of professionalism, learning, exchange and conservation and good management of natural resources.

## **European Commission: Scientific, Technical and Economic Committee for Fisheries (STECF)**

Since 2008, the Chair has been contributing scientific advice to the European Commission on marine resources for fishery sustainability in Europe's seas and oceans.



Photo: Giorgia Doglioni via Unsplash

### **GALP Costa Brava**

During 2019, the Chair was part of the Board of the GALP Costa Brava, an association that works together with the fishing sector of the Costa Brava for the environmental, social and economic sustainability of the sector.

### **Scientific Committee of the Medes Islands Marine Reserve**

The Chair has been a member of the scientific committee of the Montgrí Natural Park, the Medes Islands and Baix Ter since 2020.





Photo: Lluís Mas Blanch

## 8. Acknowledgements

The Oceans and Human Health Chair would like to thank all the enthusiastic collaborators who have participated in the various activities of the Chair since 2018, especially Joan San, Àngel Izquierdo, Eva Fontdecaba, Elisa Berdalet, Lora E. Fleming, Ana Sabatés, Montserrat Demestre, Rafael Abós-Herràndiz, Joan Bartra, Stefania Minuto, Manuel Alcaide, Sebastian Biton-Porsmoguer, Sílvia Alemany, Rosario Allué, Maria Basagaña, Mònica Campàs, Arnau Carreño, Jorge Diogène, Mireia Gascon, Sílvia Gómez, Carles Pàramo, Lluïsa Mas, Montse Marquès, Juan Pedro-Botet, Maria Pery, Francesc Peters, Boris Mörker, Lluís Mas Blanch, Maria Velasco, Xavier Pintó, Marta Planas, Anna Sanchez-Vidal, Martí Trepà, Cristina Vendrell, Manel Espinet, Victòria Riera, Poñç Feliu, Margarida Casadevall, Anna Masdeu, Eduard Inglés, Míriam Rocher, Francesc Galí, Imma Gelabert, Albert Durch, Josep Maria Dacosta, Cristina Pérez-Portabella, César López, Montserrat Demestre, Magda Vila, Maria Jesús Uriz, Alfredo García, de Vinuesa, Laia Viure, Maria Basagaña, Martí Nadal, Wilma Zijlema, Cristina Vert, Rosa Subirós, Albert Forneguera, Sònia Cervià, Albert Alemany, Lídia Feliu, Rafael Marcos, Uryen Blázquez, Carla Pérez, Pau Magester, Alba Serrat, Cristina Mañas, Míriam Pascual, Maxi González, Antoni Salamanca, Enrique García Vicedo, Albert López, Aneliya Trendafilova, Francesc Aguer, Maria Rosa Lloret, Diving Centre Poseidon Roses, Centre d'Immersió Roses, Roses Sub, SK Kayak Llançà, Roses Foundation Against Cancer, Fishermen's Guild of Catalonia, Xavier Torrent, Salva Manera, Feliu Gasull, Nino, Jaume Cusí, Jordi Corbera, Educa Aprèn Esport Association, Proemaid, PharmaMar and Planet tuna.

We would especially like to thank the founding sponsors and the people who work for them: Roses Town Council; Fishermen's Association of Roses, the Fishermen's Guild of Catalonia, and the University of Girona.

We also extend our gratitude to the institutions that have made it possible for the Chair to grow: Tossa de Mar Town Council and the General Directorate of Fisheries and Maritime Affairs of the Generalitat de Catalunya.

**Finally, we want to thank all the citizens who have participated in the activities of the Chair, because without them, nothing would have been possible.**



Photo: Lluís Mas Blanch

## 9. Bibliography

- AGLAGO E. K.; HUYBRECHTS I.; MURPHY N. *et al.* (2020). “Consumption of Fish and Long-chain n-3 Polyunsaturated Fatty Acids Is Associated With Reduced Risk of Colorectal Cancer” in a *Large European Cohort Clin Gastroenterol Hepatol* 18(3):654-666.e6, <https://doi.org/10.1016/j.cgh.2019.06.031>
- BOWEN, R. E.; DEPLEDGE, M. H.; CARLARNE, C. P.; FLEMING, L. E. (2014). *Oceans and Human Health: implications for society and well-being*. Wileyblackwell, UK., 318 p.
- CABRAL, R. B.; BRADLEY, D.; MAYORGA, J.; GOODELL, W.; FRIEDLANDER, A. M.; SALA, E.; COSTELLO, C.; & GAINES, S. D. (2020). “A global network of marine protected areas for food”. *Proceedings of the National Academy of Sciences of the United States of America*, 117(45), 28134-28139. <https://doi.org/10.1073/pnas.2000174117>
- CAMINS, E.; DE HAAN, W. P.; SALVO, W. S.; CANALS, M.; RAFFARD, A.; SANCHEZ-VIDAL, A. (2020). Paddle surfing for science on microplastic pollution- *Science of The Total Environment*, Volume 709, 136178, ISSN 0048-9697. <https://doi.org/10.1016/j.scitotenv.2019.136178>
- CANGIR (2016). *El càncer a Girona 2010-12*. N<sup>o</sup>5 Novembre 2016. Unitat d’Epidemiologia i Registre de Càncer de Girona (UERCG), Pla Director d’Oncologia (PDO), Institut Català d’Oncologia (ICO). [http://ico.gencat.cat/ca/professionals/serveis\\_i\\_programes/registre\\_del\\_cancer/](http://ico.gencat.cat/ca/professionals/serveis_i_programes/registre_del_cancer/)
- CARREÑO, A.; LLORET, J. (2017). La importància de per a la salut humana la protecció dels recursos marins del Parc Natural de Cap de Creus. <http://www.oceanshealth.udg.edu/pujades/filesInforme%20UdG%20novembre%202017.pdf>
- CARREÑO, A.; HARDY, P.-Y.; SÁNCHEZ, E.; MARTÍNEZ, E.; PIANTE, C.; LLORET, J. (2019). Safeguarding Marine Protected Areas in the growing Mediterranean Blue Economy. Recommendations for Leisure Boating. PHAROS4MPAs project.
- CARREÑO, A.; DEMESTRE, M.; DIOGÈNE, J.; FONTDECABA, E.; GASCON, M.; GÓMEZ, S.; IZQUIERDO, A.; MAS, L.; MARQUÈS, M.; PEDRO-BOTET, J.; PERY, M.; PETERS, F.; FLEMING, L. E. (2020). “The Roses Ocean and Human Health Chair: A New

Way to Engage the Public in Oceans and Human Health Challenges”. *International journal of environmental research and public health*, 17(14), 5078. <https://doi.org/10.3390/ijerph17145078>

CARREÑO, A.; GASCON, M.; VERT, C.; LLORET, J. (2020). “The Beneficial Effects of Short-Term Exposure to Scuba Diving on Human Mental Health”. *International journal of environmental research and public health*. 17. <http://doi:10.3390/ijerph17197238>

CARREÑO, A.; LLORET, J.; IZQUIERDO, A. Saving the pharmacy of the sea: “How does global change affect species with bioactive potential in the Mediterranean?” *Mètode Science Studies Journal*, 11 (2021): 209-217. <https://doi.org/10.7203/metode.11.17002>

CARREÑO, A.; LLORET, J. (2021). “The vulnerability of fish and macroinvertebrate species with bioactive potential in a Mediterranean marine protected area”. *Aquatic Conservation Marine and Freshwater Ecosystems* 31(6) <https://doi.org/10.1002/aqc.3498>

CÀTEDRA OCEANS I SALUT HUMANA, Universitat de Girona, Institut Català d’Oncologia (ICO), ABS Roses, Universitat Autònoma de Barcelona, Corporació de Salut del Maresme i la Selva. (2020). Ecosistemes marins i càncer. <http://www.oceanshealth.udg.edu/pujades/files/guia-eco-salut-final-baixa.pdf>

CÀTEDRA OCEANS I SALUT HUMANA, Universitat de Girona, Institut de Ciències del Mar-CSIC, Institut Català d’Oncologia (ICO). (2019). Superguia omega-3 de la Costa Brava. Projecte GALP Grupos de acció local del sector pesquero. [http://www.oceanshealth.udg.edu/pujades/files/super-guia\\_tot.pdf](http://www.oceanshealth.udg.edu/pujades/files/super-guia_tot.pdf)

CERVIÀ, S. (2010). Proyecto agua: mar y salud en el drama migratorio. Asociación Española de Técnicos de Natación. Volumen XLIII, núm. 4 octubre-diciembre 2020.

CHIA, W. Y.; KOK, H.; CHEW, K. W.; LOW, S. S.; & SHOW, P. L. (2021). “Can algae contribute to the war with Covid-19?”. *Bioengineered*, 12(1), 1226-1237. <https://doi.org/10.1080/21655979.2021.1910432>

DAVIES, T. E.; MAXWELL, S. M.; KASCHNER, K.; GARILAO, C.; & BAN, N. C. (2017). “Large marine protected areas represent biodiversity now and under climate change”. *Scientific reports*, 7(1), 9569. <https://doi.org/10.1038/s41598-017-08758-5>

- EUROPEAN MARINE BOARD (2013). “Linking oceans and human health: a strategic research priority for Europe”. Position paper 19 of the European Marine Board, Ostend, Belgium.
- FAO. 2020. *The State of World Fisheries and Aquaculture 2020. Sustainability in action*. Rome. <https://doi.org/10.4060/ca9229en>
- FAO. 2020. *The impact of COVID-19 on fisheries and aquaculture – A global assessment from the perspective of regional fishery bodies: Initial assessment*, May 2020. No. 1. Rome. <https://doi.org/10.4060/ca9279en>
- FLEMING, L. E.; BROAD, K.; CLEMENT A.; DEWAILLY, E.; ELMIR, S.; KNAP, A.; POMPONI, S.A.; SMITH, S.; SOLO, H.; GABRIELE, G.; WALSH, P. J. (2006). “Oceans and Human Health: emerging public health risks in the marine environment”. *Marine pollution bulletin* (53), p. 545-560.
- FLEMING, L. E.; McDONOUGH, N.; AUSTEN, M.; MEE, L.; MOORE, M.; HESS P.; DEPLEDGE, M.H.; WHITE, M.; PHILIPPART, K.; BRADBROOK, P.; SMALLEY, A. (2014). “Oceans and Human Health: a rising tide of challenges and opportunities for europe”. *Marine environmental resources* (99), p. 16-19.
- FLEMING, L. E.; DEPLEDGE, M.; BOULEY, T.; BRITTON, E.; DUPONT, S.; EATOCK, C.; GARSIDE, R.; HEYMANS, J. J.; KELLETT, P.; LLORET, J. *et al.* (2021). “The Ocean Decade-Opportunities for Oceans and Human Health Programs to Contribute to Public Health”. *American journal of public health*, 111(5), 808-811. <https://doi.org/10.2105/AJPH.2021.306229>
- GARCÍA-DE-VINUESA, A.; DEMESTRE, M.; CARREÑO, A.; LLORET, J. “The Bioactive Potential of Trawl Discard: Case Study from a Crinoid Bed Off Blanes (North-Western Mediterranean)”. *Mar. Drugs* 2021, 19, 83. <https://doi.org/10.3390/md19020083>
- GARRETT J. K.; CLITHEROW T. C.; WHITE M.; LLORET, J.; TRENDILOVA, A.; CARREÑO, A.; ALCAIDE, M.; SAN, J. (2019). Els beneficis de les activitats marítimes recreatives sobre la salut i el benestar de les persones: l'exemple del Parc Natural del Cap de Creus. Projecte MedPAN Reserves marines i salut humana. <http://www.oceanshealth.udg.edu/ca/small-projecte-medpan.html>

- GÓMEZ, S.; CARREÑO, A.; SÁNCHEZ, E.; MARTÍNEZ, E.; LLORET, J. (2019). Safeguarding Marine Protected Areas in the growing Mediterranean Blue Economy. Recommendations for Recreational Fisheries. PHAROS<sub>4</sub>MPAs. project.
- HERNÁEZ, Á.; & ESTRUCH, R. (2019). “The Mediterranean Diet and Cancer: What Do Human and Molecular Studies Have to Say about It?”. *Nutrients*, 11(9), 2155. <https://doi.org/10.3390/nu11092155>
- JENNINGS, S.; STENTIFORD, GRANT D.; LEOCADIO, A. M.; JEFFERY, K. R.; *et al.* (2016). “Aquatic food security:insights into challenges and solutions from an analysis of interactions between fisheries, aquaculture, food safety, human health, fish and human welfare, economy and environment”. *Fish and Fisheries*, 17 (4). 893-938. ISSN 1467-2960 <https://doi.org/10.1111/faf.12152>
- LLORET, J.; ZARAGOZA, N.; CABALLERO, D.; RIERA, V. (2008). “Impacts of recreational boating on the marine environment of Cap de Creus (Mediterranean Sea)”. *Ocean & Coastal Management*, volume 51, Issue 11, p. 727-778.
- LLORET, J. (2010). “Human health benefits supplied by Mediterranean marine biodiversity”. *Marine pollution bulletin* (60), p. 1640-1646.
- LLORET, J.; FALIEIX, E.; SHULMAN, G. E.; RAGA, J-A.; SASAL, P.; MUÑOZ, M.; CASADEVALL, M.; AHUIR-BARAJA, A. E.; MONTERO, F. E.; REPULLÉS-ALBELDA, A.; CARDINALE, M.; RÄTZ, H-J.; VILA, S. & FERRER, D. (2012). “Fish Health and Fisheries, Implications for Stock Assessment and Management: The Mediterranean Example”, *Reviews in Fisheries Science*, 20:3, 165-180. <http://dx.doi.org/10.1080/10641262.2012.695817>
- LLORET, J.; RÄTZ, H. J.; LLEONART, J.; DEMESTRE, M. (2015). “Challenging the links between seafood and human health in the context of global change”. *Journal of the Marine Biological Association of the UK*. <https://doi.org/10.1017/S0025315415001988>

- LLORET, J.; BERDALET, E.; DUPONT, S.; ABÓS-HERRÀNDIZ, R.; YONVITNER, Y.; FLEMING, L. E. (2020). “Coronavirus Covid-19: a master science class”. *Science in society* (Apr 2020).
- LUND, E. K. (2013). “Health benefits of seafood; Is it just the fatty acids?”, *Food Chemistr* 140 (3), 413-420. <https://doi.org/10.1016/j.foodchem.2013.01.034>
- MARTÍNEZ-GONZÁLEZ, M. A.; SALAS-SALVADÓ, J.; ESTRUCH, R.; CORELLA, D.; FITÓ, ROS, E., & PREDIMED INVESTIGATORS (2015). “Benefits of the Mediterranean Diet: Insights From the PREDIMED Study”. *Progress in cardiovascular diseases*, 58(1), 50-60. <https://doi.org/10.1016/j.pcad.2015.04.003>
- MOZAFFARIAN D.; WU JH. Omega-3 fatty acids and cardiovascular disease: effects on risk factors, molecular pathways, and clinical events. *J Am Coll Cardiol*. 2011;58(20):2047-2067. <https://doi:10.1016/j.jacc.2011.06.063>
- NABAVI, S. F.; BILOTTO, S.; RUSSO, G. L.; ORHAN, I. E.; HABTEMARIAM, S.; DAGLIA, M.; DEVI, K. P.; LOIZZO, M. R.; TUNDIS, R.; & NABAVI, S. M. (2015). “Omega-3 polyunsaturated fatty acids and cancer: lessons learned from clinical trials”. *Cancer metastasis reviews*, 34(3), 359-380. <https://doi.org/10.1007/s10555-015-9572-2>
- NIH NATIONAL INSTITUTES OF HEALT (2019). Omega-3 Fatty Acids Fact Sheet for Health Professionals <https://ods.od.nih.gov/factsheets/Omega3FattyAcids-HealthProfessional>  
Omega-3 Fatty Acids Fact Sheet for Consumers <https://ods.od.nih.gov/factsheets/Omega3FattyAcids-Consumer>
- OLAFSDOTTIR G.; CLOKE P.; VÖGELE C. (2017). “Place, green exercise and stress: An exploration of lived experience and restorative effects”. *Health & Place*. 46. <http://doi:10.1016/j.healthplace.2017.02.00>
- PEÑUELAS, J.; GERMAIN, J.; ÁLVAREZ, E.; APARICIO, E.; ARÚS, P.; BASNOU, C.; BLANCHÉ, C.; BONADA, N.; CANALS, P.; CAPODIFERRO, M.; *et al.* (2021). “Impacts of Use and Abuse of Nature in Catalonia with Proposals for Sustainable Management”. *Land* 2021, 10, 144. <https://doi.org/10.3390/land10020144>



- PHARMAMAR (2020). PharmaMar anuncia resultados positivos de Aplidin® contra el coronavirus HCoV-229E. <http://www.pmfarma.es/noticias/28280-pharmamar-anuncia-resultados-positivosde-aplidin-contra-el-coronavirus-hcov-229e.html>
- PORSMOQUER, S.; BOU, R.; LLORET, E.; ALCAIDE, M.; LLORET, J. (2020). “Fatty acid composition and parasitism of European sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) populations in the northern Catalan Sea in the context of changing environmental conditions”. *Conservation Physiology*. 8. <https://doi.org/10.1093/conphys/coaa121>
- SAM SCIENTIFIC ADVICE MECHANISM. (2017). “Food from the Oceans - How can more food and biomass be obtained from the oceans in a way that does not deprive future generations of their benefits? High Level Group of Scientific Advisors”. *Scientific Opinion* No. 3/2017.
- SERRA-MAJEM, L.; TOMAINO, L.; DERNINI, S.; BERRY, E. M.; LAIRON, D.; NGO DE LA CRUZ, J.; BACH-FAIG, A.; DONINI, L. M.; MEDINA, F. X.; BELAHSEN, R.; PISCOPO, S.; CAPONE, R.; ARANCETA-BARTRINA, J.; LA VECCHIA, C.; & TRICHOPOULOU, A. (2020). “Updating the Mediterranean Diet Pyramid towards Sustainability: Focus on Environmental Concerns”. *International journal of environmental research and public health*, 17(23), 8758. <https://doi.org/10.3390/ijerph17238758>
- SIMOPOULOS A. P. “The importance of the omega-6/omega-3 fatty acid ratio in cardiovascular disease and other chronic diseases”. *Exp Biol Med (Maywood)*. 2008;233(6):674-688. <http://doi:10.3181/0711-MR-311>
- SIMMONS, T. L.; ANDRIANASOLO, E.; MCPHAIL, K.; FLATT, P.; & GERWICK, W. H. (2005). “Marine natural products as anticancer drugs”. *Molecular Cancer Therapeutics*, 4(2), 333-342. <http://www.ncbi.nlm.nih.gov/pubmed/15713904>
- STEVENSON, S. L.; WOOLLEY, S.; BARNETT, J.; & DUNSTAN, P. (2020). “Testing the presence of marine protected areas against their ability to reduce pressures on biodiversity”. *Conservation biology: the journal of the Society for Conservation Biology*, 34(3), 622-631. <https://doi.org/10.1111/cobi.13429>

WHITE, M. P.; S.; WHEELER, B.; FLEMING, L.; & DEPLEDGE, M. (2016). “The ‘Blue Gym’: What can blue space do for you and what can you do for blue space?” *Journal of the Marine Biological Association of the United Kingdom*, 96(1), 5-12. <http://doi:10.1017/S0025315415002209>

WHITE M. P.; WHEELER B. W.; HERBERT S.; ALCOCK I.; DEPLEDGE M. H. (2014) “Coastal proximity and physical activity: Is the coast an under-appreciated public health resource?” *Prev Med*.69:135-140. <http://doi:10.1016/j.ypmed.2014.09.016>

WORLD CANCER RESEARCH FUND/AMERICAN INSTITUTE FOR CANCER RESEARCH. Continuous update projecte. Diet Nutrition, phisical activity and cancer. Expert Report 2018. Disponible on-line [www.dietcancerreport.org](http://www.dietcancerreport.org)

URIZ, M. J.; MARTIN, D.; TURON, X.; BALLESTEROS, E.; HUGHES, R.; & ACEBAL, C. (1991). “An approach to the ecological significance of chemically mediated bioactivity in Mediterranean benthic communities”. *Marine Ecology Progress Series*, 70(2), 175-188. <https://doi.org/10.3354/meps070175>

## Web

<https://www.theblueeconomy.org/>

<http://www.fao.org/sustainable-development-goals/en/>

<https://oceandecade.org>

[http://agricultura.gencat.cat/web/.content/o8-pesca/politica-maritima/enllacos-documents/fixters-binaris/ESTRATEGIA-MARITIMA-2030-Pla-2018-2021\\_CATALA.pdf](http://agricultura.gencat.cat/web/.content/o8-pesca/politica-maritima/enllacos-documents/fixters-binaris/ESTRATEGIA-MARITIMA-2030-Pla-2018-2021_CATALA.pdf)

<https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas/default.aspx>

<https://bluehealth2020.eu>

<http://www.sophie-project.eu>

<https://www.blunetcat.eu>

<https://dietamediterranea.com/>

[https://canalsalut.gencat.cat/ca/vida-saludable/alimentacio/la\\_dieta\\_mediterrania/Manifest-cientific-eolica-marina-CAT.pdf](https://canalsalut.gencat.cat/ca/vida-saludable/alimentacio/la_dieta_mediterrania/Manifest-cientific-eolica-marina-CAT.pdf) (csic.es)



ISBN 978-84-093-4683-7



9 788409 346837