ADAPTA BLUES

"Adaptation to climate change through management and restoration of European estuarine ecosystems".

C3.4.Report of the results of the scoping activities

Deliverable ID	**C3.4**
Action	**C3**
Issue	**1.1**
Due Date of Deliverable	**31/09/2021**
Submission Date	**31/06/2021**
Dissemination level[1]	**PU**
Lead partner	**The Nature Conservancy Europe**
Contributors	**FIHAC**
Grant Agreement No.	**LIFE18 CCA/ES/001160**

With the contribution of the LIFE Programme of the European Union

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Contents

1 INTRODUCTION

The present Deliverable analyses the potential restoration of the European flat Oyster in the Atlantic Coast of the Iberian Peninsula (Spain and Portugal). With this purpose, three tasks have been implemented:

- **The identification of areas in the Atlantic coast of the Iberian Peninsula colonized in the past by *O. edulis* reefs and drivers of loss: Historical ecology approach**.
  This Task (Chapter 2 and Annex 1) has documented the historical ecology of the flat oyster in the Iberian Peninsula. Through the revision of scientific and grey literature and historical archives and the consultation to local stakeholders, the sites where historically the species was present, the extractions techniques used throughout the history, the uses of the species as well as the national and international trade networks, the landing prices and regulations and the cultivation have been documented. Most of this information is compiled in Annex 1 where the story telling of the species is described.
  The information obtained under this Task has been compiled in three complementary formats:

  1. A description of the historical ecology of *Ostrea edulis* in the Atlantic Coast of the Iberian Peninsula (Chapter 2 and Annex 1).
  2. An excel with a chronological inventory of the estuaries where beds of *Ostrea edulis* have been historically cited.
  3. A Google Earth file (kmz) with the location of the sites where beds of *Ostrea edulis* have been historically cited.

- **Identification of areas in the Iberian Peninsula where *O. edulis* could be restored: Iberian Peninsula scale.**
  Under this Task (Chapter 3) a broad site selection analysis at a large scale has been performed. The selection of potential estuaries for restoration in the Atlantic Iberian coast has been obtained through a two-step approach. The first step recognizes those estuaries where *Ostrea edulis* is currently present and the second identifies estuaries where the species were historically present (more than one historical reference) and today meet favourable conditions for the species settlement.

- **Identification of areas in the Iberian Peninsula where *O. edulis* could be restored: Local scale.**
  This last Task has studied the restoration potential of two case studies: Bay of Santander and Estuary of Santoña (Chapter 4). The Habitat modelling of *Ostrea edulis* in these coastal areas has considered met oceanic, physicochemical and geographic conditions and species requirements.

2 THE IDENTIFICATION OF AREAS IN THE ATLANTIC COAST OF THE IBERIAN PENINSULA COLONIZED IN THE PAST BY O. EDULIS REEFS AND DRIVERS OF LOSS

2.1 Introduction

This Chapter documents the locations along the Atlantic coast of Spain where *Ostrea edulis* beds have been reported throughout history. The information collected has been compiled in an excel with a chronological inventory of the estuaries where beds of *Ostrea edulis* have been cited through history and a google earth file (kmz) with the exact ubication of the citations.

Additionally, the historical ecology of the species along the Atlantic coast of Spain has been documented. Section 2.2 is a summary of the review performed. The complete historical ecology review is available in Annex 1, where the information collected (with indication of the original citations) is structured in eight sections: Locations where the species was historically present, national and international trade networks, landing prices, uses, extractions techniques, regulations and oyster aquaculture.

2.2 Identification of areas colonized in the past by *Ostrea edulis*

The information collected has been compiled in an excel (II_*Ostrea in Spain and Portugal*) with a chronological inventory of the Atlantic estuaries where beds of *Ostrea edulis* have been cited through history and a google earth file (*III_Ostrea historical locations*) with the exact ubication of citations. We have obtained 134 citations for the presence of *Ostrea edulis*, corresponding to 44 estuaries from Spain and Portugal, since the Mesolithic and Paleolithic to the present time. The estuaries which accounted most citations are Santoña, Santander, Suances, Pontevedra, Vigo and Taxus. Citations from the Mesolithic and Paleolithic correspond to locations that today are far away from the coast and the first citation for an estuary is in 1785 for San Vicente de la Barquera. The complete chronological inventory of each citation is included in Annex 5, Section 5.1 with indication of the reference document and an extract from the original text.

2.3 Historical ecology of *Ostrea edulis* in the Atlantic Coast of the Iberian Peninsula

This section compiles chronologically, for different historical periods, the sites where oyster beds were present (attending to the location code provided in the excel file that accompanies this document), commercial networks, landing prices, extraction tools, regulations and causes of depletion. A specific review of each of these issues is deal in Annex 1.

-Prehistory-

Oysters were used in **Prehistory** however, their use is very scarce during the Upper Paleolithic and increases considerably during the Mesolithic and the Neolithic. During the glacial periods the coastline was further to the north, so the archaeological sites that would be located near the estuaries would be under water today. However, we do not know what those estuaries were like, nor if molluscs were as abundant as they are today. In some deposits from these times, there are appreciable amounts of limpets, but not oysters, or other estuarine species, thus with the data currently available, it is thought that estuarine species began to be exploited in the Mesolithic (Gutierrez -Zugasti; Pers. Com.).

In the North coast of Spain, oyster shells accumulations always appear in direct relation to estuaries. Oyster is not the most abundant mollusc found in the **Prehistoric** sites of the Cantabrian Sea, but when it appears it does in large proportions and sometimes forming enormous shells accumulations close to rivers or springs (Madariaga, 1969). Different studies show deposits with abundant exploitation of *Ostrea edulis* in the Mesolithic (Arenillas, La Trecha, La Fragua, El Perro, La Chora, Mazaculos, Coberizas, La Pila, Kobeaga II) and Neolithic (Kobaederra, Pico Ramos, Santimamiñe, Les Pedroses) (Gutierrez-Zugasti, 2008) (Locations 1-13 in the excel and kmz files).

Neanderthal subsistence strategies and settlement patterns, especially for coastal settlement and use of marine resources, have been found not only in northern Iberia, but also in Atlantic Europe. Evidence of systematic shell collection has been found at El Cuco (see Gutierrez-Zugasti et al., 2013a for a detailed study of the shells assemblages). The increasing abundance of sites with evidence of coastal resource exploitation shows not only that these resources were not exclusively utilized by anatomically modern humans but also that they were extensively exploited by Neanderthals.

Moreover, shell tools have been identified in the early Neolithic levels at Santimamiñe cave (Basque Country). These artifacts are the first evidence of shell tools to be identified in Northern Spain in an early Neolithic shell midden context. Thus, Cuenca et al (2010) defend that shell tools were frequently used in subsistence activities during the Mesolithic and early Neolithic for the working of wood, plants, or animal skin (Cuenca et al., 2010).

In Prehistory, oysters were collected using shellfish picks or sea pebbles that were abundant on the coast. It is also likely that there were storage places in natural shelters on the coast in contact with the sea, where they were kept when the excess did not allow for total consumption or transport (Madariaga, 1969).

The next Figure indicates the locations (code: 1-13; 120-123; 129,131) where the presence of oyster shells accumulations was detected in the Prehistory.

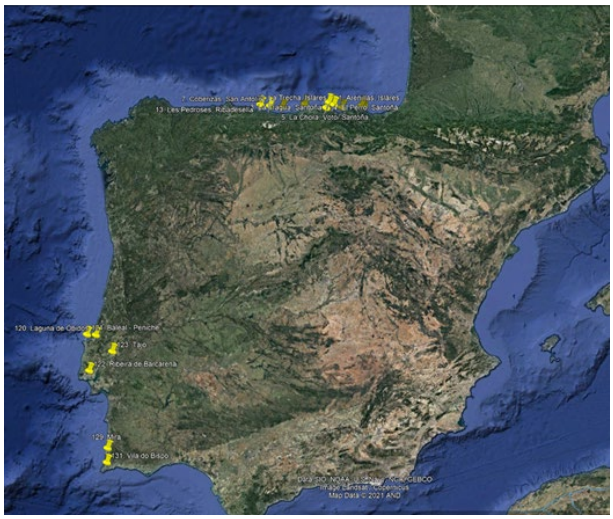


Figure 1. Locations with the presence of O. edulis in the Prehistory.

- Iberian communities- Romans- Middle Age-

In the **Iberian communities,** between the 400s and the 200s BC, there is a clear link between the appearance of shellfish remains and the proximity of the sites to the coastline. The appearance of shells in coastal Iberian settlements indicates an exploitation of maritime resources, whether or not for food purposes (Nadal, 2017).

The **Romans** felt a great attraction for this food when they colonised the Iberian Peninsula, and proof of this are the remains of Roman shells found for instance in the Castillo de la Riera (Covadonga) (Madariaga, 1969). The most consumed species is *Ostrea edulis*, which is also the one with the greatest presence in the interior areas and further from the coast.

Various Roman writers speak about the transfer of oysters from Galicia to the capital of the Roman Empire (Gomes, 2013) and Cornide Saavedra (1788) remarks that Apicius possessed the art of preserving oysters for a long time, as he sent them from Italy to the Emperor Trajan, when he was in Persia.

Although, the importance of marine molluscs is reduced inland, their presence represents a change of uses compared to the Iberian communities. This implies a technical and political change (pacification of territories) so that marine resources reach the interior in an acceptable time for their consumption in good conditions (Nadal, 2017).

In the **Middle Ages** there are references on the use and exploitation of oysters (Gomes, 2013). In that time, oysters were considered an elitist species and this mollusc was destined almost exclusively for the privileged tables of the aristocracy, and it was not very common for people markets (Escudero, 2006).

The next Figure indicates the locations (code: 119, 124, 127) where the presence of oyster was documented in the Roman times.

Figure 2. Locations with the presence of O. edulis in the Roman Times.

-16th, 17th and 18th Century (1500s,1600s and 1700s)-

In 1541 (**16th Century**) the Spanish council of the Indies sent a Royal cédula to Rodrigo de Bastidas, bishop of Venezuela and Cabo de la Vela, in which he is asked for information on the introduction of canoes and Indians in the oyster fisheries of Cabo de Vela and the convenience of placing there a person who was in charge of justice.

During the **17th Century** oysters appeared with some frequency in markets of Castilla, normally from the Galician coast. However, during the next Century there are hardly any references to its consumption in these markets (Escudero, 2006). In the 17th Century oysters are recognised as a highly valuable product. In the year 1690 Manuel Xironda y Torres (Gregorio de Silva Mendoza, X) Duke of Infantado, sent a letter where he narrates the arrival of the Queen to La Coruña, the gifts she received (oysters, pickled fish, a watch) and the festivities that took place in her honour. Also, in the year 1697 Fray Manuel Pimentel sent a letter to his relative, the Count of Benavente (who made him Abad of Celanova) announcing the shipment of twelve barrels of oysters.

The first studies about the status of the oyster beds in the Atlantic coast of the Iberian Peninsula were carried out in the **18th Century** by Cornide Saavedra (1788) and by Sañez Reguart (1791, 1793, 1795). Cornide Saavedra in his treatise "An essay on the history of fish and other marine products of the Galician coast" (1788) documents the abundance in the Rías of Vigo, Arosa and Ferrol although the author expresses his concern about the excessive extraction and the risk of their extinction. He is the first author to document the extinction of oysters in an estuary, the Ría del Burgo (Coruña). At the same time, Sañez Reguart (1791) Royal Commissioner of Marine and Fisheries, in his Historical Dictionary of National Fishing Gear, points out that the most productive sites for oysters were in Galicia, probably due to a police control since ancient times. He mentions the existence of beds also on the coasts of Asturias and Cantabria, and particularly

in the bridge of San Vicente de la Barquera. He fairly recommends the oysters from San Vicente de la Barquera, because "oysters were so tasty and of such a good size that a load of them were brought in their shells to Madrid in 1785, and they were presented and celebrated by natives and foreigners who occupied the first tables". In the 18th Century it is though that oyster grows in a short time and multiplies so prodigiously that "According to accurate and truthful observers, it takes no more than twenty-four hours for an oyster egg to develop its first shell" (Sañez Reguart, 1973).

At the end of the Century some towns, aware of the risk of extinction, regulated the extraction of oysters (Sañez Reguart, 1793). This is relevant, because for the first time in northern Spain, the need to regulate and limit the exploitation of oysters is recognized.

In San Vicente de la Barquera oysters were collected just in certain seasons and only the largest ones, while in La Barca (Galicia) the fine imposed on anyone found taking oysters from the first of May to the end of August was thirty reals. Fishing was permitted from September to April, but even if in this season any of the registered fishermen used iron hooks for the extraction (call Raño), were fined. In addition to the specific regulations to each territory or jurisdiction, the general regulations indicated that fishermen may never take advantage of oyster beds in enclosed areas, such as bridge spats, or oyster beds built by private individuals who owned them wit by Royal permission, since immemorial time (Sañez Reguart, 1973).

Both the Habsburgs in the 17th Century and the Bourbons in the 18th Century enjoyed oysters both pickled and fresh, and even the clergy themselves enjoyed this mollusc. Regarding the cooking, Cornide Saavedra (1788) describes different styles to cook oysters. He states that the "repugnance that some people find in eating them raw has led to the invention of various condiments according to the diverse tastes of modern cookers". One of the simplest and most common, but no less tasty, is to serve them fried in oil, coated with cornflour, and where there is none, with any other, or with grated breadcrumbs and a little lemon juice. Also, among the various stews, it is particularly delicious when it is cooked in a scallop shell and is made with oil, lemon, parsley, pepper and breadcrumbs, which are put on top to form a delicate crust. Although many oysters are consumed in this way on the coast of Galicia, the most regular way is to reduce them to pickled oysters; by which means they are preserved and can be transported, over long distances.

In the year 1792 it is documented the extraction of oysters in the sandy areas of Adal-Treto (Santoña) for the court of Carlos IV and it is known that the Royal supplier Manuel Ojeda, requests terrestrials to be employed in the collection in order to supply the royal tables. With five cattle males, he brought from Laredo to Madrid, 18 barrels of oysters of two arrobas each barrel (414 kg), pointing out that the trip was intended to be done in 12 days maximum, what in his opinion was the time tolerated by oysters inside barrels (Escudero, 2006). Oysters are preserved by placing them fresh in their own shell, and in a barrel, that cannot be opened or

receive air from the outside. They are also kept in barrels in their own liquid for many days, but they must be fried or boiled (...) otherwise they become corrupt (Cornide Saavedra, 1788).

The first mention to some kind of aquaculture on the Spanish Atlantic coast is made by Sañez Reguart (1794). He indicates that in some parts of Galicia, there are large harvests that lay on the seabed or on bridges. He proposes to extend this practice to sites on the coasts of Asturias and Cantabria and particularly to the Port of San Vicente de la Barquera, where the large amount of stone that shelters the spats of its magnificent and ancient bridge serves as a perfect deposit. At the end of the Century in foreign countries, many people appreciate the so-called green oysters. To obtain this color, oysters are deposited in certain beds along the seashores. These areas are filled with green algae and "in the space of three to four days the oysters, begin to take a greenish look: however, they remain for six weeks in such places. The most priced green oysters are those prepared in England" (Cornide, 1788; Sañez Reguart, 1794).

The following Figure indicates the locations where the presence of oysters was documented in the 1600s (code: 93 and 96) and 1700s (code: 30 and 68).

Figure 3. Locations with the presence of O. edulis in the 1600s and 1700s.

-19th Century (1800s)-

Commercial oyster fishing in the natural beds of northern Spain began in the **19th Century**. From 1860 onwards, it seems that its arrival to stores was progressively greater, perhaps due to the number of concessions that were made and fundamentally due to the improvement in transport (railways) and communication routes that made it possible to shorten the distances between the harvesting areas and the sale points (Escudero, 2006). In Carril, mussels cooked in water and pickled mussels were consumed in large quantities (year 1869), and barrels of oysters were sold in Madrid under the misleading trade name of "mussel oysters" (Pérez-Rubín, 2010). In the year 1890, although most of this shellfish market was fresh, another small part was brought to the

market processed, both canned and pickled, this latter being the main production of the processing industry in Santoña (Escudero, 2006).

At the end of the Century, the curative properties of fresh oysters are highlighted. They were recommended for their richness in iodine and bromine to cure "scrofula and even consumption". Maybe this led to a heightened demand for, and possible overexploitation of oysters.

The gourmets of that time, particularly valued the Belgian oysters from Ostend because "they come out fat and juicy; and thanks to certain care they acquire a greenish tint that gives them that succulent flavour". Unscrupulous counterfeiters tried to artificially imitate this colour and, before sale, the molluscs were dipped in a bath of dissolved copper salt (Pérez-Rubín, 2010). In the year 1855 Spanish newspapers emphasize that “The oyster is an exciting appetite that opens the desire to eat” and refers to Montaigne who wrote that "Being subject to colic or depriving yourself of eating oysters, are two ills for one since it is necessary to choose between the two." In the year 1874, another newspaper refers to Me Payen, who states that sixteen dozen of oysters represent the 315 grams of azotic substance necessary for the daily nutrition of a man of medium height: consequently, to feed one hundred people during a day, only with these molluscs, nineteen are needed one thousand two hundred.

In the first half of the Century, it seems that the main natural oyster beds (in terms of quantity and abundance) in northern Spain were located in Galicia, but in the middle of the Century, there is a decline in catches of highly valued coastal species (Pérez -Rubín, 2010). By 1860 some voices accused the French of being the direct cause of the depletion of the natural beds due to the abusive extraction carried out in past times, withdrawing the spats to harvest them in their sandy areas, and leaving the Spanish beds exhausted and annihilated (Escudero, 2006). As a consequence, in the year 1866 the Permanent Commission of Fisheries initiated a series of works (inquires sent to the maritime Departments) to know, first-hand, the situation of the natural parks. The conclusions gave evidences about the poor activity, qualifying the status of the oyster beds as "regrettable" (Escudero, 2006). In Cantabria the study proposes preserving for seedlings the beds of the Bulga de Cuncio in Pesués, the one at the base of Monte Lloza in San Vicente; in the NE of the Zapedo bridge and in La Vuelta Ostrera (Suances) (Escudero, 2006).

For a better understanding of the situation in the natural beds, in 1869, Mariano Paz Graells was commissioned for two months to carry out a detailed study of the oyster beds along the north coast of Spain (from the border of Portugal to France) (Published as Graells, 1870). He concluded that most of the beds in the north of Spain were exhausted due to overexploitation. Attending to his observations, the only abundant bed in Galicia was located between Rivadeo and Castropol. The reason is explained by the control of abuses and the compliance with the closed season. It was only allowed to fish with Angazo, which respected the legal size. In most of the estuaries he notices the depletion of the beds. Graells calls the Ría of Ortigueira the Arcachon

of Galicia, but remarks that while in the year 1864 the natural beds were abundant and 100 oysters were sold for half real, in 1869 there was only one remaining bed and the price for 12 oysters was 5 reals. In Asturias the beds in Avilés, Villaviciosa and Rivadesella are almost completely disappeared. In Cantabria, Graells found beds in different estuaries, although Tina Menor is specially mentioned for its remarkable good conditions. Oysters are abundant and to protect them, he proposes their declaration as "Beds of mother oysters reserved for the repopulation of the extinct ones in the Asturian shores". In San Martín de la Arena oysters are also caught in considerable quantities. From Punta de Plata, to the mouth of the river Saja-Besaya, the whole of the right bank is occupied by oysters, forming real beds in some places, although the largest bed is found in Vueltra Ostrera. In this estuary there are 29 boats dedicated to oyster fishing and the extraction in Cudón, Mar, Bárcena and Suances achieved 1.200.000 oysters /6,000 duros; and 10 reals/100 oysters in the year 1868. In the Basque Country he found oyster spats in Mundaka, Ondarroa, Portugalete, Zumaya, Orio and San Sebastián.

From this study, he concludes that the Cantabrian coast was less devastated than Galicia, where their agglomeration into large beds facilitated harvesting and overexploitation and highlights the abundance of the natural beds of Tina Menor, San Martín de la Arena in Cantabria and Bayona, Pontevedra, Camariñas, Ortigueira and Rivadeo in Galicia. Attending to his findings and indications about the need to conserve certain natural beds to be used as "mother oyster beds reserved for restocking" a Royal Order raises in March 24, 1874 for the **protection of certain estuaries**. This was the first initiative to protect and control the abusive exploitation of the Spanish oyster beds. In this document a selection of exhausted natural beds in the Cantabrian area and where the collection of oysters was forbidden, were allocated exclusively for reproduction: Camariñas, Tina Menor, San Vicente de la Barquera and San Martín de la Arena (Escudero, 2006).

In France, Spain and Great Britain, the beginning of research into fisheries biology (marine biology applied to fishing and aquaculture) was triggered by the decline in catches of highly valued coastal species such as oysters and salmon. Acclimatisation of all kinds of useful exotic animal and plant species were developed around the French Zoological Acclimatisation Society (created in 1854). During the first 14 years of this bulletin, nearly 90 articles on aquaculture were published, including those by the spanish Álvaro Reinoso (1856) and Ramón de la Sagra (1857). In the European Atlantic, the best aquaculture installations were located in France (Arcachon Bay, Aiguillon Inlet, Ile de Ré, Concarneu), while in the Mediterranean they were more developed in Italy (Comacchio Lagoon, Lake Fusaro and Taranto Sea). Most of these installations were taken as reference models in Spain for the different aquaculture techniques (Pérez-Rubín, 2010). By the year 1862, the Spanish King Francisco Asís de Borbón encouraged the first steps for the development of modern aquaculture techniques. After visiting in Novelda (Alicante, 1862) "the first trials of artificial fish farming", he commissioned Mariano P. Graells to study the

feasibility of establishing this novel technique on the Crown's land in La Granja de San Ildefonso (Pérez-Rubín, 2010).

The Fish Farming Manual was published by Graells In July 1864 to serve as a Spanish guide. He can be described as the first modern fisheries biologist in the country, as he was able to plan and develop coherent applied research into aquatic reseources, promoting the modernisation of extraction techniques and the introduction of modern aquaculture, made up of molluscs, crustaceans and fish. He was responsible for the development of the national maritime industry in the 19th century and was also responsible for the overall management of the entire sector, comprising fishing, shell fishing and aquaculture (Pérez-Rubín, 2010).

The following figure indicates the places where the presence of oysters was documented in the 1800s.

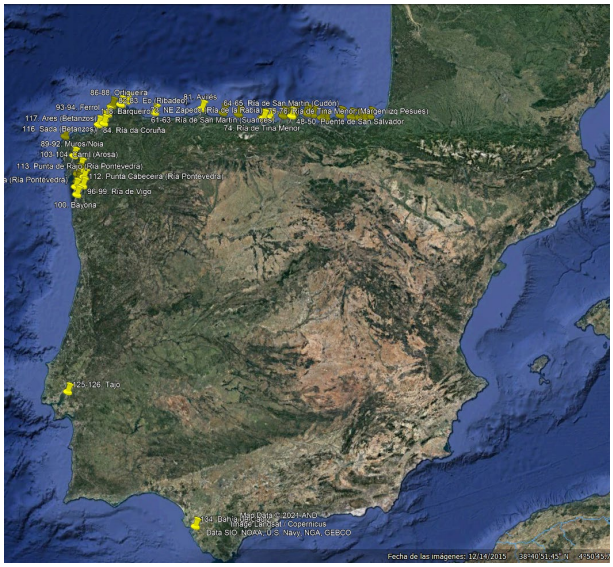


Figure 4. Locations with the presence of O. edulis in the 1800s.

-20th Century (1900s)-

In the first half of the **20th Century**, *O. edulis* spread mainly through the Cantabrian Sea, being still abundant in Galicia, from whose estuaries in 1935 more than 50 million specimens were extracted annually (Sánchez, 1936, Andreu 1968). However, In the second half of the Century, episodes of high mortality and overfishing decimated the European and Spanish populations of *O. edulis*. In Galicia, (…) between the years 1950 and 1960 the natural beds of the Rías de Vigo, Arousa and Muros practically disappeared due to overexploitation (Gomes, 2013; Pérez-Camacho, 1987).

In the 1970s, the tendency for the natural beds of Galicia and the rest of the peninsula is to reduce and disappear. Despite new management practices and intensive restocking programmes, the production of *O. edulis* has not recovered. The natural beds once common in the estuaries of Oriñón, Treto, Suances, Cudón, Santoña and Santander have considerably

reduced, and some of them are exhausted. The main cause of their disappearance is attributed to fishing, industrial pollution (Suances) and, to a lesser extent, to the impurities of the estuaries and ports and the emptying of tanks and bilges from ships (…) (Madariaga, 1969).

In Santoña, Ajo and San Salvador it is possible to find beds. In San Salvador (Bay of Santander) there is a bed of *O. edulis* and *Griphea angulata* which, despite its continuous exploitation by tonnage, has an important stock. Unfortunately, the existence of a mineral washing installation in its proximity makes it practically unusable from the bromatological point of view and are used for the supply of shells for domestic animal feed (Madariaga, 1969).

In the 70's the preference of regular consumers is for the flat oyster, of better quality than the Portuguese, but flat oyster is an expensive delicacy, only accessible to certain people who can pay 300 pts for a dozen (Madariaga, 1969).

The following figure indicates the places where the presence of oysters has been documented in the 1900s (Locations code: 29,33,36,39,40,50,57,58,63,65,80,90,91,98,99,105,106).

Figure 5. Locations with the presence of O. edulis in the 1900s.

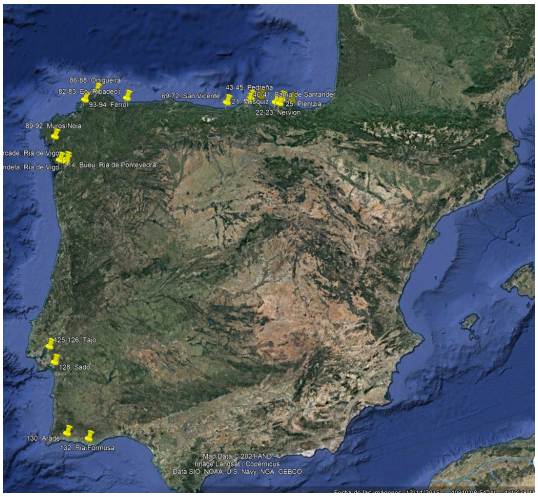
-21st Century-

In the beginning of the **21st century** (2007) *Bonamia ostreae* is detected in Spain for the first time. *Bonamiosis ostreae* or hemocyte disease of the European flat oyster, *Ostrea edulis*, is a protozoal disease caused by *Bonamia ostreae*. It is transmitted directly from oyster to oyster, causing tissue perforation and high mortality, especially in oysters older than 18 months. Currently (2021) all the strategies aimed at fighting the parasite have failed and *Ostrea edulis* has practically disappeared from País Vasco, Cantabria and Asturias where its presence is sporadic and not consolidated in beds. Its presence is documented in Urdaibai, Muskiz, Nervión Estuary (Zierbena, Getxo), Plentzia and Gorliz (Ibisate, 2011); it is punctually present in the Bay of Santander (outer of Raos pier, Astander and Pedreña wall), Quejo (Joyel estuary) and

Helgueras (Pers. Com.) in Villaviciosa (Doménech, 1995) and Bueu, Noia y Ortigueira (Ría de Vigo), Barallobre (Ría de Ferrol), Ría de Ribadeo, Redondela and Arcade (Pers.Com.).

The following figure indicates the places where the presence of oysters has been documented in the 2000s (locations code: 20, 21, 23, 24, 25, 26, 37, 38, 41, 45, 72, 83, 88, 92, 95, 101, 102, 114, 126, 128, 130, 132)

a) Current presence (2000s) of *O. edulis*



b) Current and historical presence of *O. edulis*

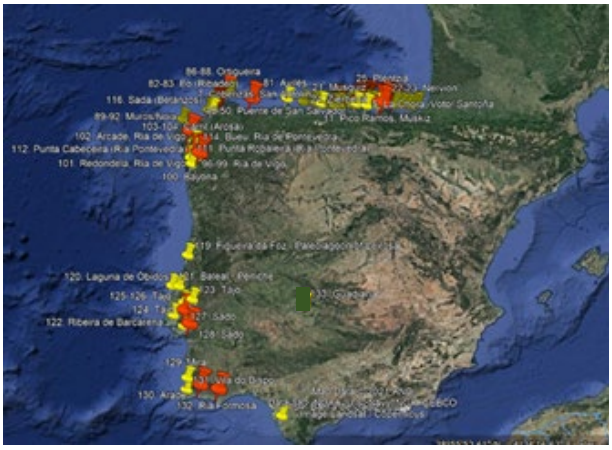


Figure 6. (a) Locations with the presence of O. edulis in the 2000s and (b) Locations with current presence (red colour) and throughout the history (yellow colour).

3 IDENTIFICATION OF AREAS IN THE IBERIAN PENINSULA WHERE *O. EDULIS* REEFS COULD BE RESTORED: IBERIAN PENINSULA SCALE

The identification of areas where *O. edulis* could be restored at the Iberian Peninsula scale is developed through a two steps approach (Figure 7).

The first step is devoted to address the estuaries where *Ostrea edulis* is currently present, although as far as we have documented, oysters do not form beds in any of these estuaries. Attending to the review performed in Chapter 2, and available in the excel file accompanying this document, nowadays *Ostrea edulis* is present in 16 estuaries of the Iberian Peninsula: Oka, Muskiz, Nervión Estuary (Zierbena, Getxo, Plentzia, Gorliz); Bay of Santander (outer of Raos pier, Astander and Pedreña wall), Quejo (Joyel estuary), Helgueras, Villaviciosa, Bueu (Ría de Pontevedra), Noia (Ría de Noia), Ortigueira (Ría de Ortigueira), Barallobre (Ría de Ferrol), Ría de Ribadeo, Redondela and Arcade (Ría de Vigo) in Spain and Sado, Arade and Villa Formosa in Portugal. Since the species is already present in these sites, our hypothesis is that these environments could have suitable conditions for the restoration.

The second step addresses the estuaries where the species were historically present and also today meet favourable conditions for their settlement. The historical review performed in Chapter 2 shows that numerous estuaries in the Atlantic coast of the Iberian Peninsula housed flat oyster throughout history, particularly in the 1800s, which is the period with the most complete and detailed data. However, to avoid an over estimation on the selection of potential sites for restoration, the estuaries with just one citation were discarded. The search for estuaries with favourable settlement conditions has been based on the quality criteria established by the Water Framework Directive (2000/60/CE). Estuaries hydromorphologically altered, or with insufficient chemical or ecological status in the period 2015-2021 were also discarded. Thus, the set of estuaries selected in the application of this second step approach is made up of: Oriñón, Santoña, San Vicente de la Barquera, Tina Menor Tina Mayor, Arosa (external water body) and Betanzos (external water body).

The final selection of estuaries suitable for restoration integrates the estuaries selected in step 1 or 2. The complete list of the 23 estuaries proposed at the Atlantic Iberian Peninsula scale is indicated in Figures 7 and 8.

	Step 1	Step 2					Final Selection
Name of oyster bed	Current Presence	# Historical citations	Hydromorphycally Altered	Ecological Status 2015-2021	Chemical Status 2015-2021	Compliance with the criteria	
Pasajes							
Urumea							
Oria							
Urola, Zumaya							
Ondarroa							
Estuario del Oka							Oka: external water body
Muskiz							Muskiz
Estuario del Nervion							Zierbena, Getxo, Plentzia, Gorliz
Ría Oriñón							Oriñón
Estuario de Santoña							Santoña
Helgueras							Helgueras
Joyel							Joyel
Ría de Ajo							
Bahía de Santander							Bay of Santander
Ría de San Martín de la Arena							
San Vicente de la Barquera							San Vicente de la Barquera
Oyambre							
Tina Menor							Tina Menor
Tina Mayor							Tina Mayor
Estuario del Sella							
Ría de Villaviciosa							Villaviciosa
Ría de Avilés							
Estuario del Eo							Eo
Ría de la Coruña							
Ría de Camariñas							
Ría de Ortigueira							Ortigueira
Ría de Muros/Noia							Noia: external water body
Ría de Ferrol							Barallobre
Ría de Vigo							Redondela, Arcade
Ría de Arosa							Arosa: external water body
Ría de Pontevedra							Bueu
Ría de Cedeira							
Ría de Betanzos							Betanzos: external water body
Ría de Barqueiro							
Figueira da Foz							
Laguna de Óbidos							
Baleal - Peniche							
Estuario del Tajo							
Sado							Sado
Mira							
Arade							Arade
Ria Formosa							Ría Formosa
Bahía de Cádiz							

Step 2 legend:

	Very good or good ecological status/ Good chemical status
	Moderate ecological status
	Cited once/Hydromorphologically altered/Insufficient ecological status/not achieve the good chemical status

Figure 1. Approach for the selection of the potential estuaries for flat oyster restoration in the Atlantic Iberian Peninsula. Estuaries selected in the Step 1 and 2 are highlighted in dark and light green, respectively.

a) Step 1: Currently present (2000s)

b) Step 2.1: Historically present

c) Step 2.2: Favourable conditions

d) Final selection

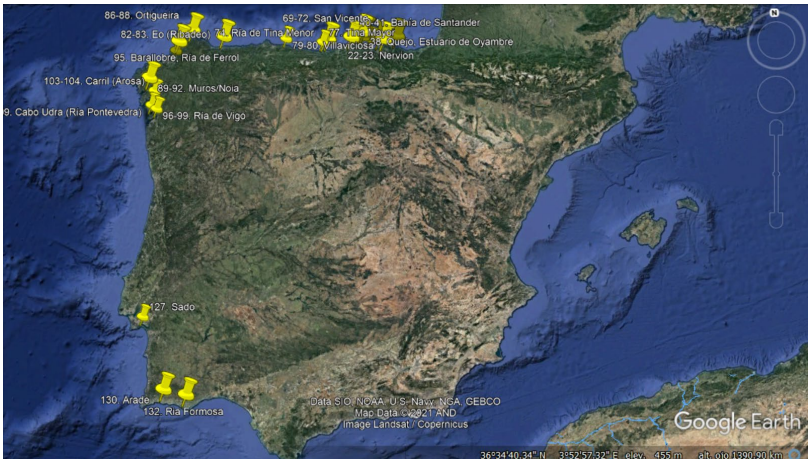


Figure 8. Location of the estuaries preliminary selected at each step (a-c) and final selection (d) of potential estuaries for flat oyster restoration in the Atlantic Iberian Peninsula.

4 IDENTIFICATION OF AREAS IN THE IBERIAN PENINSULA WHERE *O. EDULIS* REEFS COULD BE RESTORED: LOCAL SCALE

4.1 Objectives

The purpose of this task is to analyse the potential for oyster reef restoration in the Iberian Peninsula.

4.2 Study sites

Based on the review performed (Chapter 2) and the areas identified at the Iberian Peninsula scale (Chapter 3) two sites were selected to analyze the potential for the restoration of the flat oyster, *Ostrea edulis*: the Bay of Santander and the Santoña Estuary. These two estuaries represent the present (Santander) and the past (Santoña) of *Ostrea edulis* in the Atlantic coast of the Iberian Peninsula.

Today, *Ostrea edulis* is punctually present in different locations of the Bay of Santander, specifically in the Raos pier, Astander and Pedreña. The Bay has a surface area of 2,346 ha and a perimeter of 97 km (Figure 9a) and the tidal area represents 67% of the total surface (1573 ha). The main freshwater input comes from the Miera River, which flows into the south of the Bay, and has an average annual flow of 8.2 m^3/s. The Bay of Santander also receives the contributions of three other small rivers of lesser importance, through the Boo, Solía and Tijero creeks. The estuary is well oxygenated, moderately enriched, well renewed at each tidal cycle and occasionally altered for short periods of time when episodes of torrential rain in the Miera River occur. The tidal wave and the wind are the main factors determining the hydrodynamics. Within the Bay, the most significant tidal currents are registered in the area of the mouth.

The estuary of Santoña, had flat oysters during the 19th century and until the beginning of the 20th Century (Figure 9b). With an approximate surface area of 18 km^2, this estuary is exposed to average tidal runs of 2.8 meters, which determine, to a large extent, the presence of extensive muddy and sandy tidal areas. The tidal areas represents over 67% of the total area. The action of the semi-diurnal tide makes it a completely mixed estuary, with maximum velocities over 0.96 m^3/s at the mouth. Freshwater inputs come from surface runoff, small streams and mainly from the Asón River, with an average flow of 16 m^3/s. Like most of the rivers originated in the Cantabrian Mountains, the Asón River is short, has steep slopes and significantly contribute with suspended solids to the estuary, influencing its physical and chemical characteristics. During periods of high rainfall and extreme flows (>150 m^3/s), maximum increases in turbidity are recorded in the estuary.

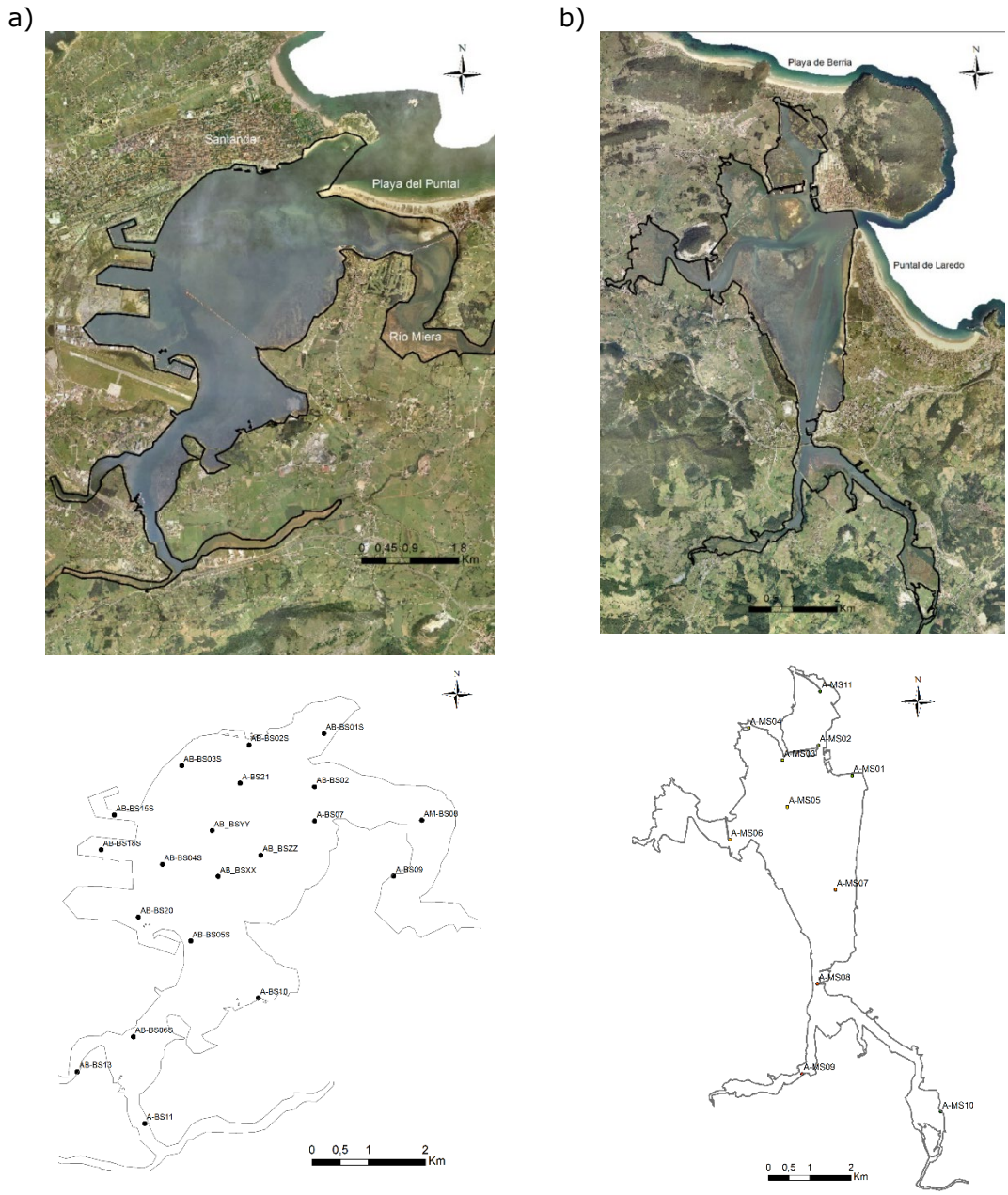


Figure 9. Study areas and location of sampling station: a) the Bay of Santander; and b) Santoña Estuary.

4.3 Methodology for site selection

4.3.1 Identification of potential areas for restoration

The potential areas for restoration are the result of considering together two elements of analysis: The biological suitability of the species and the habitat suitability.

The selection of optimal sites for healthy oyster reef development is obtained by superimposing Biological and Habitat Suitability maps. The result is a map showing the sites with optimal habitat suitability and the probability to achieve the conditions required for the optimal growth of the species (biological suitability).

4.3.2 Biological Suitability

The Biological Suitability analyses the adequacy of the physical-chemical conditions of the study area and their proximity to the requirements of the species, defined through its optimum growth range. The two variables selected as predictors to identified the optimal growth conditions in the study areas are temperature and salinity.

The calculation begins analysing the complete data series available for temperature and salinity (2005-2018). For each variable and sampling site, the percentage of records of the analysed time series in which the variables have been within the optimal growth conditions for the species is calculated to obtain the probability to achieve the optimal conditions. Thus, the results for each sampling site are expressed in a percentage scale from 100% (maximum probability of finding optimal conditions at a certain site), to 0% (no probability of finding optimal conditions for the growth of the species).

Table 1 shows the optimal growth ranges for the two variables. Thresholds have been established from scientific literature and from sites with conditions close to the study areas. *Ostrea edulis* is euryhaline and eurythermal enabling it to inhabit inshore waters and estuaries. It requires temperatures between 12-20 ° C for spawning, while larval growth and adequate survival rates are achieved with salinities above 20 ‰

Once the probability for each variable is analysed, the biological suitability for the sampling site is established as the critical criterion value, according to which the suitability is determined by the variable with the lowest probability value.

The spatial probability maps for the study area are obtained by interpolating the biological suitability results using the Kriging tool (34 m cell size in Santander and 32 m in Santoña). The maps express the probability that each cell meets the optimal conditions for the growth of the species.

Species	Temperature (ºC)	Salinity (PSU)
Ostrea edulis	12 - 20	>20

Table 1. Variables and criteria for the evaluation of the biological suitability (1) Aquatic Species Information Programme. Ostrea edulis, 2004.

4.3.3 Habitat suitability

Habitat suitability evaluates the biotope, its suitability to the requirements of the species (meteo-oceanic factors) and how close is to optimal conditions. Bivalves habitat is established based on requirements relating to bathymetry, granulometry, recovery time, current velocity, water quality, sediment quality, classification of shellfish production areas and spill toxicity

(Table 2). *Ostrea edulis* grows in the tidal zone, with recovery time below 0.6 days, and current velocities currents below 0.35 m/s.

The application of these criteria to each variable makes it possible to delimit optimal and non-optimal areas for the species development. The habitat suitability of the species is obtained by superimposing these two zones. Since the information examined comes from modelling and polygons, the results obtained are continuous maps for the entire study area. However, this general approximation is limited by the information available at each study area. The information available from the Bay of Santander is much better than from Santoña. Consequently, the habitat suitability in the Bay of Santander analyses all the variables considered in the methodology, while in Santoña the study has been carried out without recovery time and toxicity data.

Habitat Suitability	*Ostrea edulis*
Depth (m)[2]	<0 m
Recovery time (days) [6]	≤0.6
Currents (m/s) [7]	0.35
Quality of Water bodies [11]	Good-Very Good
Quality of Sediments [8]	ICQ>0.65
Classification of shellfish production areas [9]	A and B
Toxicity of discharges [10]	0,1,2

*Variable only applied in Santander Bay.

Table 2. Variables and criteria used to define the Habitat Suitability of Ostrea edulis: Depth, Granulometry, Recovery Time, Currents, Quality of water bodies, Sediment Quality, Classification of shellfish production areas and Toxicity of spills. (2) Aquatic Species Information Program. Ostrea edulis, 2004; (6) Gomez et al., 2014; (7) Aypa, 1990; (8) Revilla, et al., 2006; (9) Order MED/6/2017 (BOC); (10) Puente et al., Under preparation; (11) Water Framework Directive 2000/60/EC.

4.3.4 Variables and data sources

To reflect the conditions as accurately as possible, the data used are derived from *in situ* measurements (salinity and temperature) and numerical modelling (currents, recovery time, toxicity of discharges). Tables 3 and 4 summarise for Santander and Santoña, respectively, the sources, characteristics and spatial and temporal resolution of the data used for each variable.

Temperature and Salinity

Justification: Temperature is a critical factor for the development and survival of bivalve larvae. In warmer waters larvae grow faster, the planktonic phase is shorter and a greater proportion of larvae metamorphose successfully. Recent global warming has increased the chances of spawning, recruitment and survival in established populations at the outer edge of their current distribution, accelerating the rate of species proliferation and spreading to new areas.

Salinity patterns, in turn, affect productivity, population distribution, community composition, species relationships and food web structure within the estuary. All species are physiologically limited to a specific salinity range and fluctuation (euryhaline and stenohaline), which are accentuated in estuarine environments.

Sources of information: The behavior of water surface temperature (ºC) and salinity (UPS) over time has been analyzed from data measured *in situ* under the Water Bodies Monitoring Programme (2005-2018) at 17 sampling sites in the Bay of Santander and 11 sites in the Santoña Marshes (4 annual campaigns). The selected sites have continuous records throughout that period (Figure 9).

Depth

Justification: Bathymetry, and tidal action, allow distinguishing two environments within coastal and estuarine aquatic systems: intertidal and subtidal. Each of these environments is differentiated not only by the physical-chemical conditions (aerial exposure, waves, light, etc.), but also by the biological communities. The subtidal zone is permanently submerged and the intertidal zone alternates periods of submersion-emersion as a consequence of the tides. During emersion periods, the intertidal substrate is exposed to the air and, therefore, some physical factors that condition the distribution of benthic communities show wide ranges of variation. In the intertidal environment, on the one hand, the possibility of desiccation and, on the other hand, the ranges of temperature, salinity and pH are increased, compared to the subtidal zone.

Sources of information: In Santander Bay we worked with a 25x25m spatial resolution bathymetry from the Spress project referenced to the zero of Santander harbor. In Santoña, the bathymetry was created from charts prepared by the Army Hydrographic Institute and from a field campaign carried out in 1992.

Recovery time

Justification: Ecologically, the function of the turnover time is related to the turnover of nutrients and oxygen essential for life.

Sources of information: Recovery time is defined as the time required to fully reduce the concentration of a conservative tracer introduced into a cell. The cell is assumed to behave as a continuously stirred tank (CSTR) and no initial amount of conservative tracer is introduced into any other cell. The recovery time for the two study areas is calculated by numerical modelling. However, in order to reduce the computational cost, the recovery time is set to be equal to the time required to reduce the initial concentration in the cell to 0.1%.

Current velocity

Justification: Current is an indicator of energy flows. The ecological role of current velocity is linked to the drag force it exerts on the bottom and organisms anchored to it and particularly, habitats with low currents are preferred by *O.edulis*.

Sources of information: To obtain the mean velocities (m/s) in Santander Bay and Santoña, hydrodynamic modelling of both estuaries has been carried out. In the simulations, the astronomical tide recorded in the period from 01/01/2016 to 31/12/2016 has been modelled, allowing us to capture the variability in the predominant tidal dynamics. The tidal dynamics data are those corresponding to the Santander tide gauge supplied by the Area of Knowledge of the Physical Environment of Puertos del Estado. For the hydrodynamic modelling, the hydrodynamic module of the Delft3D numerical model (Hydraulics, 2014; Roelvink and Van Banning, 1995) has been used to generate the high-resolution currents.

Quality of water bodies

Justification: The quality of water bodies provides general information on the biological, physico-chemical and chemical conditions of the estuary.

Sources of information: The trend of the ecological status and potential of the transitional water bodies of the Bay of Santander and Santoña marshes in the period 2010-2017 is used. The metrics and reference levels used are described in the Hydrological Plan of the Western Cantabrian Hydrographic Demarcation (Royal Decree 1/2016) and in Royal Decree 817/2015.

Sediment quality

Justification: The chemical conditions of the sediment provide at an ecological level indication of the suitability of the substrate for the cultivation of bivalve molluscs.

Sources of information: Sediment quality has been established from the ROM 5.1 (2013) chemical contamination index. This index, applied at sampling station level, assesses the concentration of heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) and compares the concentration recorded with the action levels established by CEDEX (1994), for the management of dredged material.

Classification of shellfish production areas

Justification: The criteria for the classification of shellfish production areas include (i) limit values and methods of analysis for marine biotoxins; (ii) virus testing procedures and virological standards; and (iii) sampling plans and the analytical methods and tolerances to be applied to check compliance with the requirements. Class A areas are areas from which live bivalve molluscs may be harvested for direct human consumption. Live bivalve molluscs harvested from these areas must comply with the relevant health standards. Class B areas are areas from which

live bivalve molluscs may be collected and placed on the market for human consumption only after treatment in a purification centre or relaying in such a way as to meet health standards. Live bivalve molluscs from these areas must not exceed 4 600 E. coli per 100 g of flesh and intrashells liquid in a five-tube, three dilution "most probable number" test. Class C areas are areas from which live bivalve molluscs may be harvested and placed on the market only after relaying over a long period, so as to meet the health standards referred to in point 3. Live bivalve molluscs from these areas must not exceed 46 000 E. coli per 100 g of flesh and intrashells liquid in a five-tube, three dilution "most probable number" test (REGULATION (EC) No 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption).

Sources of information: For the two estuaries, the classification made by the Government of Cantabria (Order MED/6/2017) has been used.

Toxicity of discharges

Justification: The presence of urban and industrial discharges, and the synergistic effects between them, are of particular relevance to the growth and survival of filter-feeding species.

Sources of information: The simulation of the area affected by diffuse emissions in the study area (information only available for the Bay of Santander) has been carried out under the most unfavourable possible conditions. The results are expressed in qualitative terms: no impact (0), low (1), medium (2), high (3) and very high (4). The potential areas for growing correspond to values 0, 1 and 2.

VARIABLE	Fecha inicio	Fecha fin	Resolución Temporal	Resolución espacial	Método	Fuente
Idoneidad biológica						
Temperatura (ºC)	2005	2018	Estacional	Est. muestreo	*In situ*	Gobierno de Cantabria
Salinidad (UPS)	2005	2018	Estacional	Est. muestreo	*In situ*	Cantabria
Idoneidad del hábitat						
Batimetría (m)	-	-	-	0,00025º	Sonar	IHCantabria
Granulometría	1993	2012	-	0,00025º	*In situ*	IHCantabria
Tiempo de recuperación (días)					Modelado	IHCantabria
Corrientes (m/s)	1988	2003	Horaria	0,00025º	Modelado	IHCantabria
Calidad de las masas de agua	2005	2018	Anual	Masa de agua	Índices	Gobierno de Cantabria
Calidad del sedimento	2009	2017	Anual	Est. muestreo	*In situ*	Gobierno de Cantabria
Clasificación zonas de producción de moluscos	2018	2018		Polígonos		Gobierno de Cantabria
Toxicidad Vertidos	2018	2018			Modelado	IHCantabria

Table 3. Sources of information, spatial resolution, temporal resolution and available time period of the physico-chemical, meteo-oceanic and physiographic variables used in Santander Bay.

VARIABLE	Fecha inicio	Fecha fin	Resolución Temporal	Resolución espacial	Método	Fuente
Idoneidad biológica						
Temperatura (ºC)	2005	2018	Estacional	Estacion muestreo	In situ	Gobierno de Cantabria
Salinidad (UPS)	2005	2018	Estacional	Estacion muestreo	In situ	Gobierno de Cantabria
Idoneidad del hábitat						
Batimetría (m)	-	-	-	0,00025º	Sonar	Instituto Hidrográfico del Ejército
Granulometría	1993	2012	-	0,00025º	*In situ*	IHCantabria
Corrientes (m/s)	1988	2003	Horaria	0,00025º	Modelado	IHCantabria
Calidad de las masas de agua	2005	2018	Anual	Masa de agua	Índices	Gobierno de Cantabria
Calidad del sedimento	2005	2005	Anual	Masa de agua	*In situ*	Gobierno de Cantabria
Clasificación zonas de producción de	2018	2018	Anual	Polígonos		Gobierno de Cantabria

Table 4. Sources of information, spatial resolution, temporal resolution and available time period of the physico-chemical, meteo-oceanic and physiographic variables used in Santoña.

4.3.5 Data analysis

Spatial dimension analyses were performed in ArcGis 10.1. For all variables and indicators, the homogenization of the raster layers has required unifying the cell size (34 m, Santander Bay; 32 m Santoña estuary) by linear interpolation applied in ArcGIS (Kriging) and projecting the coordinates to the European Datum 50 UTM 30N system.

The behavior of the variables differs substantially from one variable to another. While some variables show highly stable behavior over time, others exhibit significant temporal variability (hourly, daily, seasonal, annual or interannual). The use of long time series makes it possible to reduce this variability and to characterize their spatio-temporal dynamics more precisely.

4.4 Results for the Bay of Santander

4.4.1 Biological Suitability

The flat oyster shows well-defined spatial gradients of biological suitability. Figure 10 shows for each sampling site the probability to achieve the optimal conditions for temperature and salinity and the final Biological Suitability. The results show that for *Ostrea edulis* the biological suitability is highly conditioned by temperature. While the probability values for salinity show a low spatial variability, for the temperature it is possible to observe a spatial gradient which increases from the inner sites (54%) to the sites closest to the mouth of the estuary (83%).

Accordingly, the biological suitability also increases from the inner of the Bay, towards the outermost and deepest.

4.4.2 Habitat Suitability

Figure 10 shows the exclusion area obtained for each variable (red colour). The most limiting variable in the bay of Santander is bathymetry, while current speed, recovery time, water bodies quality, sediment quality, shellfish production areas and toxicity of discharges are the most permissive. The habitat suitability for the flat oyster obtained after excluding these areas is 4,457,174 m^2.

4.4.3 Potential areas for restoration

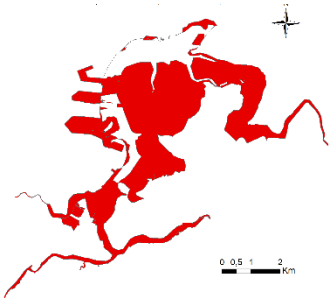
The potential areas for restoration in the Bay of Santander are identified by overlaying the biological suitability on the habitat suitability map (Figure 11). The biological suitability map shows the probability of finding optimal conditions to grow and the habitat suitability map, obtained from the sum of the individual results obtained for each variable, delimit areas not optimal for the species.

Considering both elements together, we observe that in the Bay of Santander, there is an extensive area in the mouth of the Bay with very good conditions for the restoration of *Ostrea edulis* which is contiguous with another area with moderate conditions for restoration. Nevertheless, it should be noted that both areas are included in the navigation channel of the port of Santander. In the face of a possible restoration project, this would be an important handicap that would have to be solved.

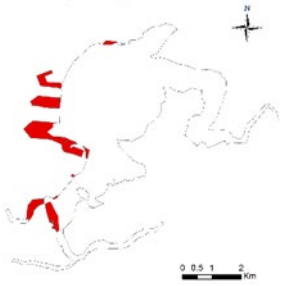
a) Biological Suitability (IB)

	Ostra plana		
	Sal (UPS)	SST (ºC)	IB
AB-BS02S	99,9	83,2	83,2
AB-BS03S	99,8	79,6	79,6
AB-BS04S	99,8	76,6	76,6
AB-BS02	100,0	75,4	75,4
AB-BS05S	99,3	71,8	71,8
AB-BS06S	98,6	72,4	72,4
AB-BS13	98,0	61,4	61,4
AB-BS15S	100,0	77,0	77,0
AB-BS18S	100,0	77,1	77,1
AB-BS20	99,6	75,5	75,5
A-BS07	100,0	82,1	82,1
A-BS09	85,7	67,4	67,4
A-BS10	100,0	54,5	54,5
A-BS11	98,0	60,5	60,5
A-BS21	100,0	81,6	81,6
AM-BS08	93,2	79,2	79,2
AB-BS01S	99,7	83,6	83,6
AB_BSZZ	98,8	77,0	77,0
AB_BSYY	99,7	77,0	77,0
AB_BSXX	99,2	77,0	77,0

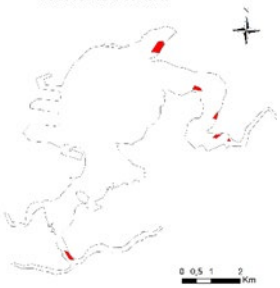
b) Bathymetry



c) Recovery time

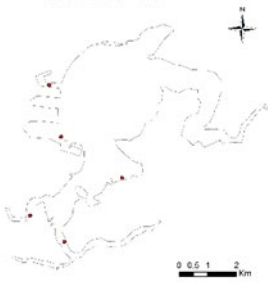


d) Current velocity

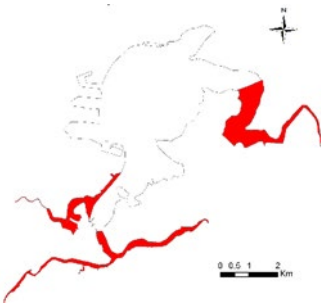


e) Water Bodies quality

f) Sediment quality



g) Shellfish production areas



h) Toxicity of discharges

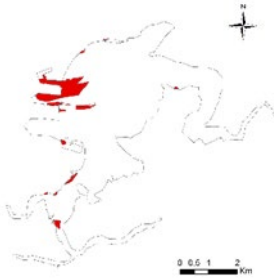


Figure 10. Analyses at the Bay of Santander: a) Probability (%) of optimal conditions for Temperature (TSS) and Salinity (Sal), and Biological suitability (IB) at each sampling site; b-h: Delimitation of exclusion areas (red colour) for the development of the species according to habitability criteria defined on the basis of bathymetry, granulometry, recovery time, current velocity, quality of water bodies, sediment quality, classification of shellfish production areas and toxicity of discharges.

-Flat Oyster- *Ostrea edulis* (Santander)

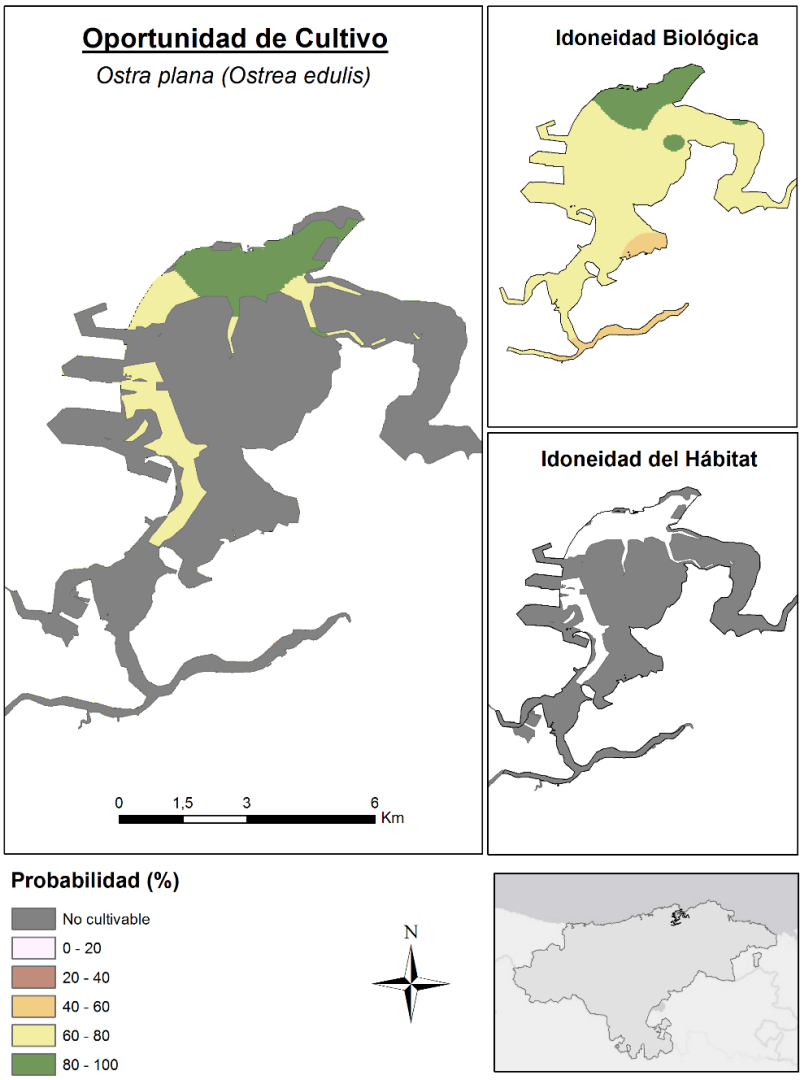


Figure 11. Biological Suitability and Habitat Suitability for the flat oyster at the bay of Santander: a) Biological suitability map for Santander, expressed as the Probability (%) of optimal conditions for Temperature (TSS) and Salinity (Sal); b) Habitat Suitability map. Not optimal and optimal sites are indicated.

4.5 Results for Santoña

4.5.1 Biological Suitability

The results of the analysis carried out in Santoña are presented in Figure 12. The sites are arranged from the area closest to the mouth (stations MS01 and MS02) to the inner part of the estuary (station MS10). The only exception is station MS11 located in the area of El Dueso (Bengoa).

In this estuary both salinity and temperature are relevant in the biological suitability analysis and both predictors show a spatial gradient in the probability values that increases from the inner to the outer estuary.

4.5.2 Habitat suitability

Unlike the study carried out in Santander, the calculation of habitat suitability in Santoña has not incorporated the recovery time, nor the toxicity study (Figure 12). Variables such as the current velocity, the quality of the water bodies and the quality of the sediment, recognise the entire surface as suitable. On the other hand, bathymetry and particularly the classification of shellfish production areas (areas classified as C) consider unsuitable an important surface area of the estuary.

4.5.3 Potential areas for restoration

The potential areas for restoration in Santoña are identified by overlaying the biological suitability on the habitat suitability map (Figure 13).

The biological suitability values are above 60% in most of the estuary and shows a gradient that increases from the inner (Rada and Asón) to the mouth of the estuary. The habitat suitable is 7,355,776 m^2. This optimal area for the development of the species occupies the middle of the estuary, coinciding with the areas where the highest values of biological suitability have been recorded.

a)

	Ostra plana		
	Sal (UPS)	SST (ºC)	IB
A-MS01	100,0	73,3	73,3
A-MS02	97,7	71,1	71,1
A-MS03	96,9	67,6	67,6
A-MS04	93,8	61,5	61,5
A-MS05	100,0	71,1	71,1
A-MS06	97,9	71,1	71,1
A-MS07	91,5	73,3	73,3
A-MS08	72,9	64,4	64,4
A-MS09	57,8	63,6	57,8
A-MS10	15,9	51,1	15,9
A-MS11	94,3	54,1	54,1

b) Bathymetry

a) Current velocity

Water Bodies quality

e) Sediment quality

f) Shellfish production areas

Figure 12. Analyses performed at Santoña: a) Probability (%) of optimal conditions for Temperature (TSS) and Salinity (Sal), and Biological suitability (IB) at each sampling site; b-f: Delimitation of non-optimal areas (red color)) for the

development of the species according to habitability criteria defined on the basis of bathymetry, current velocity, quality of water bodies, sediment quality and of shellfish production areas.

-Flat Oyster- *Ostrea edulis* (Estuary of Santoña)

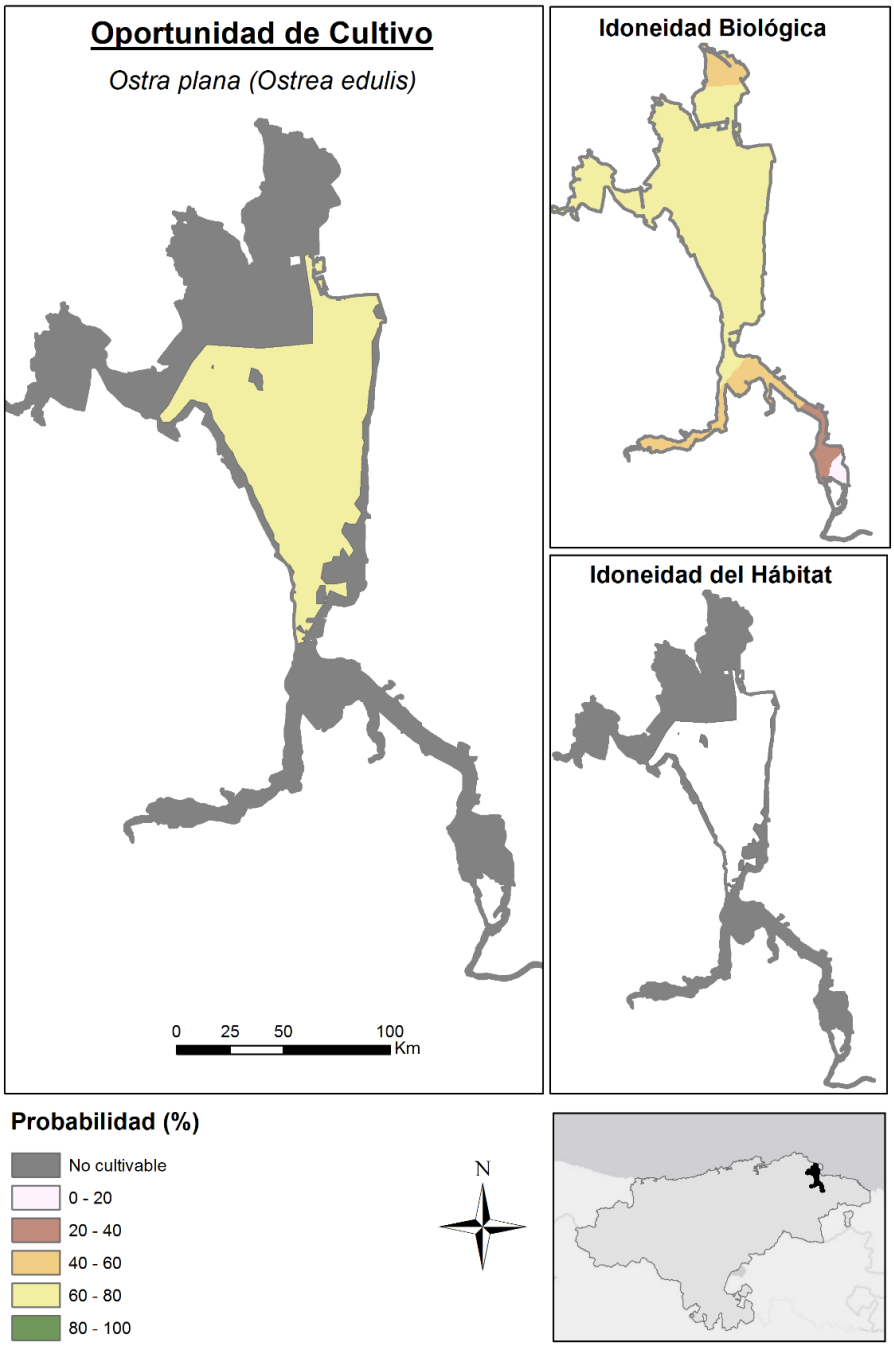


Figure 13. Biological Suitability and Habitat Suitability for the flat oyster at the Estuary of Santoña: a) Biological suitability map for Santoña, expressed as the Probability (%) of optimal conditions for Temperature (TSS) and Salinity (Sal); b) Habitat Suitability map. Not optimal and optimal sites are indicated.

5 CONCLUSIONS

The present document has analysed the potential restoration of the European flat Oyster in the Atlantic Coast of the Iberian Peninsula (Spain and Portugal).

The identification of areas in the Atlantic coast of the Iberian Peninsula colonized in the past by *O. edulis* reefs and drivers of loss: Historical ecology approach has documented the historical ecology of the flat oyster in the Iberian Peninsula. Through the revision of scientific and grey literature and historical archives and the consultation to local stakeholders, the sites where historically the species was present, the extractions techniques used throughout the history, the uses of the species as well as the national and international trade networks, the landing prices and regulations and the cultivation have been documented. The review has shown that at some historical moment, at least 50 estuaries in the Atlantic coast of the Iberian Peninsula reported the presence of *O. edulis*. *O.edulis* has been exploited and consumed since the Prehistory to the current times. At the end of the 1700s some towns, aware of the risk of extinction, regulated the extraction of oysters (Sañez Reguart, 1793). This is relevant, because for the first time in northern Spain, the need to regulate and limit the exploitation of oysters was recognized. Although likely occurred long before this, overexploitation was first recognized and addressed in 1869 by Graells. He concluded that most of the beds in the north of Spain were exhausted due to overexploitation and the only abundant bed in Galicia was located between Rivadeo and Castropol. However, the main cause of its disappearance in the 2000s is *Bonamia ostreaes* a protozoa that causes tissue perforation and high mortality, especially in oysters older than 18 months. As a consequence of this disease, today this species is present only in 13 estuaries.

The selection of potential estuaries for restoration in the Atlantic Iberian coast has been obtained through a two-step approach. The first step has recognized those estuaries where *Ostrea edulis* is currently present and the second has identified estuaries where the species were historically present (more than one historical citation) and today meet favourable conditions for the species settlement. The final selection includes 23 estuaries suitable for restoration from Spain and Portugal.

The identification of areas in the Iberian Peninsula where *O. edulis* could be restored at local scale has analysed two of the estuaries selected in the Atlantic Iberian coast scale: Bay of Santander and Estuary of Santoña. In the Bay of Santander there is an extensive area near the mouth with very good conditions for the restoration of *Ostrea edulis* which is contiguous with another area with moderate conditions for restoration. Nevertheless, both areas are included in the navigation channel of the port of Santander. In the face of a possible restoration project, this would be an important handicap that would have to be solved. In Santoña the optimal area for the development of the species occupies the middle of the estuary, coinciding with the areas where the highest values of biological suitability have been recorded, and partially occupied by a shipping channel.

6 ANNEX 1: HISTORICAL ECOLOGY

Throughout history *Ostrea edulis* has been widely present and used in the Atlantic coast of the Iberian Peninsula.

Annex 1 describes the story telling of the species reviewing the sites where historically the species was present, the national and international trade networks, the landing prices and regulations, the extractions techniques used throughout the history, the different uses that have been given to the oysters, as well as oysters aquaculture.

6.1 Identification of areas colonized in the past by *Ostrea edulis*

Both the original references and the English translation are included.

6.1.1 Mesolithic and Paleolithic

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

Oyster shells accumulations always appear in direct relation to estuaries where there are or have been natural beds. Oyster is not the most abundant mollusk found in the prehistoric sites of the Cantabrian Sea, but when it appears it does in large proportions and sometimes forming enormous shells accumulations always close to rivers or springs.

Los concheros de ostra aparecen siempre en los yacimientos en relación directa con rías donde hay o han existido bancos naturales. De los moluscos hallados en los yacimientos prehistóricos del Cantábrico no es la ostra el más abundante, pero se da la particularidad de que cuando aparece lo hace en grandes proporciones y formando en ocasiones enormes concheros siempre próximos a ríos o manantiales.

Gutierrez Zugasti, I. 2008. The exploitation of molluscs and other littoral resources in the Cantabrian region during the late Pleistocene and the early Holocene. Doctoral Thesis. University of Cantabria, 570 pp

Studies show deposits with abundant exploitation of *Ostrea edulis* in the: Mesolithic (Arenillas, La Trecha, La Fragua, El Perro, La Chora, Mazaculos, Coberizas, La Pila, Kobeaga II) and Neolithic (Kobaederra, Pico Ramos, Santimamiñe, Les Pedroses).

6.1.2 Middle ages

Gomes, I. 2013. Cultivo, Biología reproductiva y Bioquímica de la Ostra japonesa Crassostrea gigas en la Ría de Arousa. Tesis Doctoral. Universidad de la Coruña.

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In Spain, in the Middle Ages we have references on the use and exploitation of oyster richness.

En España, en la Edad Media tenemos referencias sobre el aprovechamiento y explotación de la riqueza ostrícola.

6.1.3 17th Century (1600s)

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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During the 17th century, no reference to this species is made in any of the contracts on pickling, so it seems that its extraction was not very relevant.

Durante el S XVII no se hace alusión a esta especie en ninguno de los contratos sobre escabeche, por lo que parece que su extracción no fue muy relevante.

6.1.4 18th Century (1700s)

Cornide Saavedra, J. 1788. Ensayo de una historia de los peces y otras especies marinas de la Costa de Galicia, arreglado al sistema del caballero Carlos Linneo. Con un tratado de las diversas Pescas, y de las redes y aparejos que se practican. En la oficina de Benito Cano.

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In Galicia they are very abundant in the Rias of Vigo, Arosa and Ferrol, but I fear that the greed and the persistence with which they are pursued will extinguish them, as is already happening in the Ría del Burgo.

En nuestras Galicia son abundantísimas en las Rias de Vigo, Arosa y el Ferrol, pero recelo que la codicia y el empeño con que se las persigue llegue a extinguirlas, como ya se verifica en la Ría del Burgo.

SAÑEZ REGUART, Antonio. 1793. Diccionario Histórico de las artes de pesca nacional. Tomo Quarto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1791. In Galicia there are places that are the most productive of this species of valuable shellfish, and since ancient times there has been a certain praiseworthy police force worthy of being imitated in other places where it is appropriate. Past the Barra del Barquero to the site of La Barca there is an oyster bed.

En Galicia hay parages los mas productivos de esta especie de marisco apreciable y desde tiempos remotos cierta policía laudable y digna de ser imitada en otros donde convenga. Pasada la Barra del Barquero al sitio de la Barca hay una Ostrera.

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Year 1791. The same can be said for some others on the coasts of Asturias and Cantabria. Experience leads to propose it, since in the Port of San Vicente de la Barquera, the large amount of stone that shelters the spat of its magnificent and ancient bridge serves as a perfect deposit (...).

Lo mismo se puede decir por algunos otros de las Costas de Asturias, y las de Cantabria. La experiencia induce a proponerlo, pues queden el Puerto de San Vicente de la Barquera, la mucha piedra que abriga las cepas de su magnífico y antiguo Puente sirve de perfecto depósito (…).

6.1.5 19th Century (1800s)

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

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Year 1854. In France, Spain and Great Britain, the beginning of research on fishery biology (marine biology applied to fisheries and aquaculture) was due to the decrease in catches of highly valued coastal species, such as oysters and salmon.

En Francia, España y Gran Bretaña, el inicio de las investigaciones sobre biología pesquera (biología marina aplicada a la pesca y acuicultura) se produjo por el descenso de las capturas de especies litorales muy valoradas, como la ostra y el salmón.

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1860. Some voices accused the French of being the direct cause of the depletion of the natural beds due to their abusive extraction carried out in past times, withdrawing the spats to harvest them in their sandy areas (…), leaving the beds exhausted and annihilated.

Algunas voces acusaban a los galos de ser los causantes directos del agotamiento de los bancos naturales por su abusiva extracción realizada en épocas pasadas, retirando las semillas para cultivarlas en sus arenales con las que posteriormente se beneficiarán, dejando los bancos poco menos que exhaustos y aniquilados.

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Year 1866. The Permanent Commission of Fisheries was in charge of initiating a series of works to know, first-hand, the situation of the State's natural parks. To this end, different inquiries were sent to the heads of the three Maritime Departments which, once received, were transmitted to Mr. Paz Graells so that he could make a report. The conclusions drawn leave no room for doubt about the existing poor activity, even qualifying its status as "regrettable", pointing at the same time to a series of means that would promote this activity, taking it out of that decaying state in which it was.

The answers about the Cantabrian coast reveal the existing natural beds as well as their status. In the district of the capital, very abundant oyster beds are listed from Pedreña to Punta Cotrejón; another on the San Salvador bridge; another scarce in the stream of Heros; several of little importance in the port of Boo; two in Camargo and Castillo not very abundant, but that promise; one in the Campogiro stream and a deposit adjacent to the walls of this possession. In the Santoñés district it is indicated that there is only a scarce one in Treto, which is used by registered workers making use of rakes for their extraction. In the district of Castro Urdiales, the oyster ring of the Oriñón estuary is pointed out, also very scarce, although the possibility is pointed out that if it were exploited with intelligence it could give products much superior to those that are extracted. Finally, in the Barquereño district, it is mentioned a good number of beds that, according to the informant, have excellent conditions for their development, which is hampered by the abuses that are committed there. He concludes that he should reserve for seedlings the bed of the Bulga de Cuncio in Pesués (Val de San Vicente); the one at the foot of Monte Lloza in San Vicente; in the bay the NE of the Zapedo bridge and in La Vuelta Ostrera, Suances.

La Comisión Permanente de Pesca se encargó de iniciar una serie de trabajos para conocer, de primera mano, la situación de los parques naturales del Estado. Para ello se enviaron distintos interrogatorios a los responsables de los tres Departamentos Marítimos que, una vez recibidos, fueron trasmitidos al Sr. Paz Graells para que realizara un informe al respecto (Graell, 1870). Las conclusiones extraídas no dejan lugar a dudas de la pobre actividad existente, llegando a calificar su estado como "lamentable", apuntando a la vez una serie de medios que impulsarían esta actividad sacándola de ese estado decadente en la que se encontraba.

Las respuestas sobre la costa cántabra nos descubren los bancos naturales existentes así como su estado. En el distrito de la capital se enumeran unas ostreras muy abundantes desde Pedreña a Punta Cotrejón; otra en el puente de San Salvador; otra escasa en el regato de Heros; varias de poca importancia en el puerto de Boo; dos en Camargo y Castillo poco abundantes, pero que

prometen; una en el regato de Campogiro y un depósito contiguo a las tapias de esta posesión. En el distrito santoñés se indica que sólo existe una escasa en Treto, que utilizan los matriculados haciendo uso de rastrillas para su extracción. En el distrito de Castro Urdiales se señala la ostrera de la ría de Oriñón, también muy escasa si bien se apunta la posibilidad de que si se explotara con inteligencia podría dar productos muy superiores a los que se sacan. Por último en el distrito barquereño se hace mención a un buen número de bancos que según el informante poseen excelentes condiciones para su desarrollo, el cual se ve frenado por los abusos que en él se cometen. Concluye que convendría reservar para semilleros el banco de la Bulga de Cuncio en Pesués (Val de San Vicente); el del pie del Monte Lloza en San Vicente; en la bahía el del NE del puente de Zapedo y en Suances la vuelta ostrera.

Pérez-Rubín, J. Mariano P. Graells (1809-1898): Entre la pesca 'científica' y la ciencia pesquera en España. Actas IX Congreso de la Sociedad Española de Historia de las Ciencias y de las Técnicas, 2006;2: 1045-55.

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Year 1869. (Graells) Developed his practical oyster research in 1869, when he was commissioned for two months to carry out a detailed study of the beds of this mollusk along the north coast of the country (from the border of Portugal to France), expanding his research with the cataloging and study of another 50 species of mollusks in the area (Published as Graells, 1870).

(Graells) Desarrolla sus investigaciones ostrícolas prácticas en 1869, cuando es comisionado durante dos meses para realizar un detallado estudio de los bancos de ese molusco en toda la costa norte del país (desde la frontera de Portugal hasta la de Francia), ampliando sus investigaciones con la catalogación y estudio de otras 50 especies de moluscos del área (Published as Graells, 1870).

PAZ GRAELLS, Mariano de la. 1870. Exploración científica de las costas del departamento Marítimo del Ferrol verificada de orden del Almirantazgo por el vocal de la Comisión Permanente de Pesca D. Mariano de la Paz Graells en el verano de 1869, Est. Tipográfico de T. Fortanet, Madrid. http://biblioteca.galiciana.gal/pt/consulta/registro.cmd?id=4847

Galicia:

Bayona: Two beds very abundant. From Punta de Buey to Tenaza (9/10 cables = 1800/200 meters); Monte Ferro cape (length 4 cables = 600 meters)*.

Bayona: Dos bancos muy abundantes: Punta de Buey hasta Tenaza (9/10 cables; 1800/200 metros); Punta monte Ferro (longitud 4 cables; 600 metros). Propuesta como parque natural de repoblación.

**1 spanish cable is equivalent to 120 spanish brazas = 200,628 metros.*

Ría de Vigo: Scarce beds.

Ría de Vigo: Los bancos naturales son escasos.

Ría de Pontevedra: Natural beds in Marin and Bueu. Most of the oysters sold and pickled in Vigo comes from these two beds. Natural beds at Cabo Udra (800 x 400 fathoms*=1337x668 metres), Punta Manrisca, Punta Robaleira, Punta Cabeceiro, Punta de Rajo.

*A Spanish fathom is worth 1.6718 metres.

Ría de Pontevedra: Existen bancos natuales, a pesar de haber disminuido notablemente. Bancos naturales en Marin y Bueu. La mayor parte de lo que se vende y escabecha en Vigo procede de estos dos bancos. Bancos naturales en Cabo Udra (800 x 400 brazas=1337x668 metros), punta Manrisca, punta Robaleira de gran extensión, punta Cabeceiro, punta de Rajo.

**Una braza española vale 1,6718 metros.*

Ría de Arosa: One of the most oyster estuaries in Galicia. Although almost extinct. There are 30 beds in the estuary. The town of Carril is the one most dedicated to the oyster industry. Grove Cove: Santa Eugenia, Islets (Tojas, Touris, Marma, Beiro); Cambados.

Ría de Arosa: Una de las rías más ostríferas de Galicia. Aunque casi extinguida. Precio de la ostra: 24-30 reales/100 ostras. Se contabilizan 30 bancos en la ría. El pueblo de Carril el que más se dedica a la industria de la ostra. Ensenada de Grove: Santa Eugenia, Islotes (Tojas, Touris, Marma, Beiro); Cambados.

Ría de Muros/Noya: Six beds in the estuary (Isla Quiebra; Punta Cons/Punta Coira; Punta Cabalo de Baixo, Punta Corbeira, Islas dos Coros y San Cosme), scarse and decaying.

Ría de Muros/Noya: Bancos naturales más escasos que en las rías anteriores y en decadencia. Seis bancos en la ría: Isla Quiebra; Punta Cons/Punta Coira; Punta Cabalo de Baixo, Punta Corbeira, Islas dos Coros y San Cosme.

Camariñas: Two magnificent beds. Proposed as a natural repopulation park. Punta de Lgo/Roda; La Basa (Camariñas wharf).

Camariñas: Dos magníficos bancos. Propuesta como parque natural de repoblación. Punta de Lgo/Roda; La Basa (muelle de Camariñas).

Ría de Coruña: The scarceness of the shellfish explains the high price of 4/5 reals/12 oysters.

Ría de Coruña: La gran escasez del molusco explica el elevado precio que alcanza 4/5 reales/12 ostras. La ostra es escasísima.

Ría de Ares y Sada (Betanzos). In Sada none oyster bed is found. In Ares one bed of half a mile long (900m). La magdalena/playa río Saden.

Ría de Ares y Sada: En el brazo de Sada/Betanzos no existen bancos de ostra. En Ares un banco en Punta Sopasos/Sentroña de medio milla de largo (900m); La magdalena/playa río Saden.

Ferrol: No oysters were found or collected on any of the old beds.

Ferrol: No se encontraron ni recogieron ostras en ninguno de los antiguos bancos.

Cedeira: In the past was very oyster-producing. It is mentioned that a permit was granted to a private individual who extracted 40,000 oysters from a bed and completely depleted it.

Cedeira: Fama en el pasado de muy ostrífera. Se menciona que se concedió un permiso a un particular que extrajo 40.000 ostras de un banco, tras lo cual queda agotado.

Ortigueira: One natural bed in las Salinas/Punta Leixa. Graells calls it the Arcachon of Galicia. In 1869 they were paid at 5 reales/12 oysters. In 1864 the natural beds were still abundant and oysters were sold for half real/100 oysters.

Ortigueira: Graells la llama la Arcachon de Galicia. En 1864 todavía eran abundantes los bancos naturales y la ostra se vendía a medio real/100 ostras. En 1869 se pagan a 5 reales/12 ostras. Un único banco natural las Salinas/Punta Leixa.

Ría del Barquero: Ruined its only bed.

Ría del Barquero: Arruinado su único banco muy celebrado a finales del siglo pasado.

Rivadeo: Between Rivadeo and Castropol, the only abundant bed in Galicia. The reason they have not disappeared is explained by the control of abuses and the compliance with the closed season. It is only allowed to fish with Angazo, which respects the legal size.

Rivadeo: Entre Rivadeo y Castropol un banco formado por lechos poblados el único de Galicia. El que no hayan desaparecido se debe a un control de los abusos y al cumplimiento de la veda y solo puede pescarse con Angazo, que respeta el tamaño legal.

Asturias:

Avilés: There are oysters in Lera. Their richness has almost completely disappeared.

Avilés: Hay ostras en Lera. Su riqueza casi completamente ha desaparecido.

Villaviciosa: Its richness has almost completely disappeared.

Villaviciosa: Canal del río. Su riqueza casi completamente ha desaparecido.

Rivadesella: Its richness has almost completely disappeared.

Ribadesella: Su riqueza casi completamente ha desaparecido.

Cantabria:

Tina Mayor: No oysters are present due to the low temperature of the Deva.

Tina Mayor: No hay presencia de ostras por la baja temperatura del Deva.

Tina Menor: Very good conditions. The whole estuary is oyster-producing, but especially the left bank, from the village (Pesués) towards the gola. Oysters are still abundant and to protect them Graells proposes their declaration as "Beds of mother oysters reserved for the repopulation of the extinct ones in the Asturian shores".

Tina Menor: Muy buenas condiciones. Todo el estuario es ostrífero, pero sobre todo el margen izquierdo, desde el pueblo (Pesués) hacia la gola. Aún abundan las ostras y para protegerlas Graells propone declararla como la de Camariñas "Banco de ostras madres reservado para la repoblación de las extinguidas en las riberas asturianas".

San Vicente de la Barquera: There are several natural spats, but they do not form true beds because the extraction of the mollusk does not allow them to grow.

San Vicente de la Barquera: Los criaderos naturales son varios, sin formar verdaderos bancos porque la extracción del molusco no los deja prosperar.

San Martín de la Arena (Suances): They are caught in considerable quantities. From Punta de Plata to the mouth of the river, the whole of the right bank is populated with oysters, forming real beds in some places. The largest bed is found here in vueltra ostrera. Extraction of the previous year (Cudón, Mar, Bárcena and Suances): 1,200,000 oysters / 6,000 hard; 10 reals / 100 ysters. There are 29 boats dedicated to oyster fishing. The registered ones complain that the terrestrials produce more damages.

San Martín de la Arena: En mejor estado que las anteriores rías. Se cogen en bastante cantidad. Desde punta de Plata hasta la desembocadura, toda la orilla derecha está poblada de ostras, formando en algunos sitios verdaderos bancos. El banco más grande se encuentra en vuelta ostrera. Extracción del año anterior (Cudón, Mar, Bárcena y Suances): 1.200.000 ostras/6.000 duros; 10 reales/100ostras. Hay 29 lanchas dedicadas a la pesca de la ostra. Los matriculados se quejan de que los terrestres son los que más daños producen.

Santander: Poor beds and nurseries. Oyster beds in the Maliaño cove and spats in Campogiro, Heros, Los Molinos, El Astillero, Pontejos, Cubas and Pedreña.

Santander: Bancos y criaderos pobres. Suelos ostríferos en la ensenada de Maliaño y criaderos en Campogiro, Heros, Los Molinos, El Astillero, Pontejos, Cubas y Pedreña.

Santoña: Use of the iron rake to remove rocks and attached oysters. Price 3-5 reals/dozen.

Santoña: Uso de la rastrilla de hierro para extraer las rocas y las ostras adheridas. Precio 3-5 reales/docena.

Oriñon: One natural bed.

Oriñón: Existe un banco natural.

Vizcaya:

Mundaka: Near the bar at 3-4 fathoms depth there is a fairly regular oyster hatchery of spats.

Mundaka: Cerca de la barra a 3-4 brazas de profundidad hay un criadero de ostras bastante regular.

Portugalete. One hatchery at the base of the quay wall at the Bolisa Tower.

Portugalete: Otro criadero en los cimientos del murallón del muelle a la torre de Bolisa.

Ondárroa: Oyster beds in Saldupe and Churrierreva.

Ondárroa: Ostreras en Saldupe y Churrierreva.

Guipúzcoa:

Zumaya: Small beds at various points.

Zumaya: Forman rodales en varios puntos.

Orio. More abundant formations than Zumaya. One oyster bed in San Pablo-pea.

Orio: Formaciones más abundantes que Zumaya. En San Pablo-pea hay un banco de ostras.

San Sebastian. Scarce. Do not form beds.

San Sebastián: Escasas. No forman bancos.

Pasajes: No beds or hatcheries.

Pasajes: No hay bancos ni criaderos.

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1874. After his trip (Graells, 1870) he wrote and published a memoir in which he set out the great expectations that, in his opinion, many of the marshes of the North coast of Spain offer, although he places more emphasis on the possibilities of the Galician estuaries than on the rest of the Cantabrian Sea. Attending to these indications and continuing with what is stipulated in the Royal Order, another document of the same nature is raised dated March 24, 1874, in which a series of natural beds exhausted by an abusive exploitation, where the collection of oysters is forbidden, are allocated exclusively for reproduction. Among the many sandy areas that he mentions there are only four in the Cantabrian area: one on the Coruña coast and the rest in the Cantabrian, corresponding to the areas of the Tina Menor estuary, San Vicente de la Barquera and San Martín de la Arena. The non-inclusion of the Santoña estuary among the chosen ones is notorious.

Tras su viaje (Graells, 1870) redacta y publica una memoria en la que expone las grandes expectativas que a su parecer ofrecen muchas de las marismas de la costa Norte de España, si bien hace más hincapié en las posibilidades de las rías gallegas que en las del resto del Cantábrico. Oyendo estas indicaciones y prosiguiendo con lo estipulado en la Real Orden, se eleva otro documento de la misma índole con fecha 24 de marzo de 1874, en el que se enuncian una serie de bancos naturales, agotados por una abusiva explotación, en los que se prohíbe su recolección, destinándolos exclusivamente para su reproducción. Entre los muchos arenales que cita tan sólo apunta cuatro en la zona cantábrica, uno en la costa coruñesa y los restantes en la cántabra, correspondiendo a las zonas de la ría de Tina Menor, San Vicente de la Barquera y San Martín de la Arena, en lo que en la actualidad se conoce como Suances, siendo notoria la no inclusión de la ría de Santoña entre las elegidas.

6.1.6 20th Century (1900s)

Project OYSTERECOVER (https://observatorio-acuicultura.es/comunicacion/actualidad/el-proyecto-oysterecover-hace-publico-su-informe-sobre-los-avances-en-la)

Period 1900-1950. In the first half of the 20th century, episodes of high mortality and overfishing decimated the European and Spanish populations of *O. edulis*.

En esta primera mitad del siglo XX, los episodios de alta mortalidad y la sobrepesca diezmaron las poblaciones europeas y españolas de O. edulis.

Pérez-Camacho, A. 1987. The culture of mussels (Mytilus edulis) and Oysters (Ostrea edulis) in Spain. Proc. Aquaculture research in Latin America. Ed. J.A.J. Verreth; M. Carillo; S. Zanuy and E.A. Husiman. Lima, Peru, 19pp.

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Period 1930-1950. Species spread mainly through the Cantabrian Sea and Galicia, being very abundant in the latter, from whose estuaries more than 50 million specimens were extracted annually in 1935 (Sánchez, 1936, Andreu 1968). Production dropped notably in the following years, and by the early 1950s the natural oyster beds had disappeared from the Galician coast. The causes of this disappearance are not entirely known, although may be attributed to parasites, diseases, predators, lack of genetic conditions to adapt, etc., without forgetting the exhaustive shellfish that this species was subjected to since ancient times, mainly in the period 1930-1950.

Especie (…) que se extendía fundamentalmente por el Cantábrico y Galicia, siendo muy abundante en esta última, de cuyas rías se extraían en 1935 más de 50 millones de ejemplares por año (Sánchez, 1936, Andreu 1968). La producción descendió notablemente en los años siguientes, hasta el punto de que a comienzos de los años 50 los bancos naturales de ostra habían

desaparecido de las costas gallegas. Las causas de esta desaparición no son del todo conocidas, aunque bien pueden atribuirse a parásitos, enfermedades, predadores, falta de condiciones genéticas para adaptarse, etc, sin olvidar el exhaustivo marisqueo al que desde muy antiguo se sometió a esta especie, fundamentalmente en el período 1930-1950.

Gomes, I. 2013. Cultivo, Biología reproductiva y Bioquímica de la Ostra japonesa Crassostrea gigas en la Ría de Arousa. Tesis Doctoral. Universidad de la Coruña

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Period 1950-1960. In Galicia, (…) between the years 1950 and 1960 the natural beds of the Rías de Vigo, Arousa and Muros practically disappeared due to overexploitation.

En Galicia (…) debido a una explotación fuera de control entre los años 50 y 60, los bancos naturales de las rías de Vigo, Arousa y Muros prácticamente desaparecieron.

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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Period 1960-1970. The natural oyster beds that once were frequent in the estuaries of Oriñón, Treto, Suances, Cudón, Santoña and Santander are currently reduced to their minimum expression and some of them are exhausted. The main cause of their disappearance must be attributed to industrial pollution (Suances) and, to a lesser extent, to the impurities of the estuaries and ports due to rubbish and the emptying of tanks and bilges from ships (…). Let us cite as an example the area where the Campsa deposits are located, whose docks present a high mortality of fixed oysters due to the effects of gas oil.

(...) In the estuaries of Santoña, Ajo and San Salvador there are still deep oyster beds that have resisted harvesting and the harmful effects of foreign substances or industrial waste. In the estuary of San Salvador (Santander) there is an oyster bed of *O. edulis and Griphea angulata*, that has an important stock. Unfortunately, the installation of a mineral washing installation in its proximity makes it practically unusable from the bromatological point of view.

Los ostreros naturales que en otra época fueron frecuentes en las rías de Oriñón, Treto, Suances, Cudón, Santoña y Santander se encuentran en la actualidad reducidos a su mínima expresión y algunos de ellos agotados. La causa principal de su desaparición hay que achacarla a la polución industrial (Suances) y en menor escala a las impurezas de las rías y puertos por basuras y vaciado de tanques y sentinas de los barcos (…). Citemos a título de ejemplo la zona donde se hallan los

depósitos de Campsa cuyos muelles presentan una gran mortandad de las ostras fijadas a causa de los efectos del gas oil.

(…) En las rías de Santoñá, Ajo y San Salvador existen todavía ostreros profundos que han resistido el marisqueo y los efectos nocivos de sustancias extrañas o de desecho industrial. En la ría de San Salvador (Santander) hay un ostrero de O. edulis y Griphea angulata, que cuenta con un stock importante. Por desgracia la instalación de un lavadero de mineral en su proximidad, le hace prácticamente inaprovechable desde el punto de vista bromatológico.

6.1.7 21th Century (2000s)

Project OYSTERECOVER (https://observatorio-acuicultura.es/comunicacion/actualidad/el-proyecto-oysterecover-hace-publico-su-informe-sobre-los-avances-en-la)

Period 2000-2020. The disease caused by the parasite *Bonamia ostreae* continues affecting oyster populations since, despite being perfectly identified, all the strategies aimed at fighting the parasite have failed.

La enfermedad causada por el parásito Bonamia ostreae continúa afectando a las poblaciones de ostra ya que, a pesar de estar perfectamente identificada, todas las estrategias dirigidas a luchar contra el parásito han fracasado.

Ibisate, R. 2011. Alteraciones en C. gigas debidas a la presencia de Tributilestaño. Estudio comparativo e implicaciones diagenéticas en ostras del límite Aptiense inferior-superior (Cuenca Vasco-Cantábrica). Tesis Doctoral. Universidad del Pais Vasco. 290 pp.

<u>País Vasco:</u>

Period 2000-2020. Presence in Urdaibai, Muskiz, Estuary of Bilbao (Zierbena, Getxo), Plentzia and Gorliz. *Presencia en Urdaibai, Muskiz, Estuario de Bilbao (Zierbena, Getxo), Plentzia y Gorliz.*

Personal Communication María Perez Mora. Government of Cantabria. Directorate General of Fisheries.

<u>Cantabria</u>:

Period 2000-2020. *Ostrea edulis* has practically disappeared from Cantabria and it is punctually present in the Bay of Santander (outer of Raos pier, Astander and Pedreña wall), Quejo estuary and Helgueras.

Ostrea edulis prácticamente ha desaparecido de los estuarios de Cantabria y tiene una presencia puntal en la Bahía de Santander (Salida de Raos , Astander y Muro de Pedreña), Ría de Quejo y en Helgueras.

Ibisate, R. 2011. Alteraciones en C. gigas debidas a la presencia de Tributilestaño. Estudio comparativo e implicaciones diagenéticas en ostras del límite Aptiense inferior-superior (Cuenca Vasco-Cantábrica). Tesis Doctoral. Universidad del Pais Vasco. 290 pp.

Cantabria:

Period 2000-2020. Presence in San Vicente de la Barquera. *Presencia en San Vicente de la Barquera.*

Doménech, J.J., 1995.Captación y cultivo de las ostras, Crassostrea gigas y Ostrea edulis, en la ría de Villaviciosa (Asturias).: Boletín de Ciencias de la Naturaleza, ISSN 0211-0326, Nº. 43, 1993-1995, págs. 1-12

Asturias:

Period 2000-2020. Presence in Villaviciosa. *Presencia en Villaviciosa.*

Comunicación personal Damián Costas. Universidad de Vigo. Centro de investigación marina.

Galicia:

Year 2012. Presence in Bueu, Noia y Ortigueira. No beds. *Presencia Bueu, Noia y Ortigueira. No forman reefs.*

Year 2019 y 2020. Presence in Barallobre (Ría de Ferrol), Ría de Ribadeo, Redondela y Arcade. *Barallobre (Ría de Ferrol), Ría de Ribadeo, Redondela y Arcade. No forman reefs.*

6.2 National and international Trade Networks

Gomes, I. 2013. Cultivo, Biología reproductiva y Bioquímica de la Ostra japonesa Crassostrea gigas en la Ría de Arousa. Tesis Doctoral. Universidad de la Coruña

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Various Roman writers speaks about the transfer of oysters from Galicia to the capital of the Roman Empire.

Diversos escritores romanos hablan del traslado de ostras desde Galicia a la capital del Imperio Romano.

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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17th Century. In the territory of Cantabria there are hardly any data referring to the trade and extraction of oysters until the 17th century. Its extraction was not very relevant, although part of what was extracted in Cantabria was taken to Madrid to be consumed in the Court.

En el territorio de Cantabria apenas existen datos referentes al comercio y extracción de ostra hasta el S XVII. Su extracción no fue muy relevante, aunque parte de lo que se extraía en Cantabria se llevaba a Madrid para ser consumido en la Corte.

Year 1792. News are collected about the extraction of oysters in the sandy areas of Adal-Treto for the court of Carlos IV, which allows us to know the high quality of the mollusc that was collected in the area. It is known that the Royal supplier Manuel Oxeda, requests terrestrials to be employed in the collection tasks in order to supply the royal tables. This request was rejected for going against the Navy Ordinance that only allowed fishing to those registered for the Navy service.

Se recogen noticias sobre la extracción de ostras en los arenales de Adal-Treto para la corte de Carlos IV, lo cual nos permite conocer del mismo modo la gran calidad del molusco que se recogía en la zona. Por el documento en cuestión se sabe que el arriero Manuel Oxeda, proveedor Real, solicita que se autorice a los terrestres a emplearse en las faenas de recolección para así poder surtir las mesas reales. Esta solicitud fue desestimada por ir en contra de la Ordenanza de Marina que sólo permitía la pesca a los matriculados para el servicio de Marina.

1800. (…) Quote that confirms the departure of oysters from Cantabrian marshes to the Court in Madrid. (…) Ramón de Ojeda, also a supplier of the Monarch, brought from Laredo with five cattle males, 18 barrels of oysters of two arrobas(*). each barrel (414 kg), pointing out that the trip was intended to be done in 12 days maximum, what in his opinion was tolerated by the oyster in the barrel.

Cita que nos confirma y reafirma en la salida de ostras desde las marismas cántabras para la corte madrileña. (…) Ramón de Ojeda, igualmente proveedor del Monarca, llevó desde Laredo con su recua de cinco machos, 18 barriles de ostras de dos arrobas cada barril (414 kg), apuntando que el viaje lo pretendía realizar en 12 días como máximo, que es lo que a su entender aguantaba la ostra en el barril.

* The arroba was equivalent to a quarter of a quintal, or 25 Castilian pounds (approximately 11.502 kg). *La arroba equivalía a la cuarta parte del quintal, lo que supone 25 libras castellanas (aproximadamente 11,502 kg).*

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Year 1874. The Spanish oyster farms needed to buy mother oysters in Arcachon without many of the buyers noticing the need to place harvesters for oyster hatchery, i.e. they were imported for fattening and subsequent sale to the markets.

Los parques españoles necesitaban comprar ostras madres en Arcachon sin que muchos de los compradores reparen en la necesidad de colocar recolectores para la cría de la ostra, es decir, se importaban para su engorde y posterior venta a los mercados.

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Year 1887. It was only empowered so that foreign oysters destined for hatcheries are landed and recognized at the time of arrival at the port, prior obligation to comply with the corresponding tariff rights. In a new report drawn up in 1887 he refers again to the aforementioned taxes and the imbalances existing in the Trade Treaty in force in those years. Although in the first years, after its signature (February 6, 1882), were reciprocal (oysters imported from that country (*France*) contributed 3 pts. per 100 kg and 3 francs for those exported there) with the signing of the treaty between Spain and Portugal, France enforced a clause that gave it the right to use the franchises that the Spanish State granted to other countries, so it managed to earn its oysters only 1 peseta.

Tan sólo se facultó para que las ostras extranjeras destinadas a los criaderos se desembarquen y se reconozcan en el momento de la llegada al puerto del buque que las conduzca, previa obligación de cumplir con los derechos de Arancel correspondiente. Tal es así que en un nuevo informe redactado en 1887 vuelve a referirse a los citados gravámenes y a los desequilibrios existentes en el tratado de Comercio vigente en aquellos años, que si bien en los primeros años, tras su firma (6 de febrero de 1882), eran recíprocos (las ostras importadas de aquel país contribuían con 3 pts. cada 100 kg y con 3 francos las exportadas allí) con la firma del tratado

entre España y Portugal, Francia hizo valer una cláusula que le daba derecho de uso de las franquicias que el Estado español concediera a otros países, por lo que consiguió que sus ostras devengaran sólo 1 peseta.

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Year 1884. The natural markets for these molluscs were national. With the construction of Boo station (*Bay of Santander*), the intention was to facilitate the expedition to the domestic markets of the country, especially to Madrid. It was requested and got that the Northern Railway Company to make some reduction in the high costs involved in the transport of this mollusk. Thus, according to its own calculations, The Oyster Company of Santander supplied 80% of the oysters consumed in Spain in 1884, followed by Arcachon with 15% and the remaining 5%, came from natural beds. Consignments were also sold, by sea, to other European places that consume this product, such as Arcachon (France) and London (England).

Los mercados naturales de estos moluscos eran los nacionales. Con la construcción del depósito en la estación de Boo se pretendía facilitar la expedición a los mercados interiores del país, sobre todo a Madrid. Para ello se solicitó y consiguió que la Compañía del Ferrocarril del Norte hiciera alguna rebaja en los elevados costes que suponía el trasporte de este molusco. Así, según sus propios cálculos, la Compañía Ostrícola de Santander suministraba el 80% de las ostras que se consumían en el país en 1884, siguiéndole Arcachon con un 15% y el 5% restante de los bancos naturales. También se expendían partidas, vía marítima, a otros lugares europeos consumidores de este producto, como por ejemplo Arcachon (Francia) y Londres (Inglaterra).

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Year 1885. In those years, this incidence was a great inconvenience because, despite the fact that the national market continued to be the main recipient, the quantity of oysters that were exported to that country (*France*) was increasing. The data managed by that company indicated that from September 1886 to May 1887 approximately 3,500,000 oysters had been shipped, 1,500,000 going to Arcachon and the rest to the country's markets.

En esos años esta incidencia era un gran inconveniente pues a pesar que el mercado nacional seguía siendo el principal receptor, cada vez era mayor la cantidad de ostras que se exportaban a aquel país. Los datos manejados por esa compañía apuntaban que desde septiembre de 1886 a mayo de 1887 se habían expedido aproximadamente 3.500.000 de ostras yendo 1.500.000 a Arcachon y el resto a las plazas del país.

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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Year 1969. This mollusc is sent to markets in Spain, preferably Madrid and Barcelona, where it achieve a higher price, making the flat oyster a luxury foodstuff.

Este molusco se envía a los mercados del resto de España, preferentemente Madrid y Barcelona, donde su venta alcanza una cotización más alta, lo que hace de la ostra plana un alimento de lujo.

6.3 Landing and price trends

6.3.1 Prices

PAZ GRAELLS, Mariano de la. 1870. Exploración científica de las costas del departamento Marítimo del Ferrol verificada de orden del Almirantazgo por el vocal de la Comisión Permanente de Pesca D. Mariano de la Paz Graells en el verano de 1869, Est. Tipográfico de T. Fortanet, Madrid 1870.

Graells (1970) uses the increase in the price of the oyster as an indicator of the decrease in the abundance of beds.

Year	Site	Price	Source
1864	Ortigueira	0.5 reals/100 oysters	Graells, 1870
1869	Arosa	24-30 reals/100 oysters	Graells, 1870
1869	Ría Coruña	4-5 reals/12 oysters	Graells, 1870
1869	Ortigueira	5 reals/12 oysters	Graells, 1870
1869	San Martín de la Arena	10 reals/100 oysters	Graells, 1870
1869	San Martín de la Arena	6.000 duros/1.200.000 oysters	Graells, 1870
1869	Santoña	3/5 reals/dozen	Graells, 1870
1882	Exported to France	3 francs/100kg	Escudero, 2006
1882	Imported from France	3 pts/100kg	Escudero, 2006
1887	Imported from France	1pts/100KG	Escudero, 2006
1934	Santander	2,7 miles pesetas/3,1 Tn oysters	Madariaga, 1969
1965	Cantabria	300 pesetas/dozen	Madariaga, 1969

Table 5. Prices and landing sites and from 1864 to 1965 (Source: own elaboration).

6.3.2 Landing and Captures

PAZ GRAELLS, Mariano de la. 1870. Exploración científica de las costas del departamento Marítimo del Ferrol verificada de orden del Almirantazgo por el vocal de la Comisión Permanente de Pesca D. Mariano de la Paz Graells en el verano de 1869, Est. Tipográfico de T. Fortanet, Madrid. http://biblioteca.galiciana.gal/pt/consulta/registro.cmd?id=4847

Year 1869. Vizcaya:The oyster industry in Vizcaya is very small. The catch amounts to 4,700 dozen oysters annually.

La industria ostrera en Vizcaya es muy pequeña. La pesca asciende a 4.700 docenas anuales de ostras.

Andreu, B. (1968). Pesquería y cultivo de mejillones y ostras en España. Publ. Tec. Junta. Est. Pesca, 7:303-320.

Period 1958-1968. Average production of *Ostrea edulis* in Spain: 600 Tn

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Pérez-Camacho, A. 1987. The culture of mussels (Mytilus edulis) and Oysters (Ostrea edulis) in Spain. Proc. Aquaculture research in Latin America. Ed. J.A.J. Verreth; M. Carillo; S. Zanuy and E.A. Husiman. Lima, Peru, 19pp.

Period 1935-1982. Period 1935-1982. In 1935 the oyster spread throughout the Cantabrian Sea and Galicia, being still abundant in the latter, from whose estuaries more than 50 million specimens were extracted per year from natural populations (Sanchez, 1936, Andreu 1968) of which 30 million were collected in the Vigo estuary and between 10 and 20 in the Arousa estuary (There were also natural beds in Noya). Production since 1935 has dropped significantly and at the beginning of the 1950s the natural oyster beds had disappeared from the Vigo, Noya and Arousa estuaries. According to official statistics in 1982 the oyster catch occupies one of the last places, with a production <1 Tn, while the cultivated species reached the 5th place U590 Tn and 335 million pesetas / year.

En el año 1935 la ostra se extendía por el cantábrico y Galicia, siendo todavía abundante en esta última, de cuyas rías se extraían en 1935 más de 50 millones de ejemplares al año de poblaciones naturales (Sanchez, 1936, Andreu 1968) de los cuales 30 millones se recogían en la ría de Vigo y entre 10 y 20 en la Ría de Arousa (También había bancos naturales en Noya). La producción desde 1935 descendió notablemente y a comienzos de los años 50' los bancos naturales de ostra habían desaparecido de las rías de Vigo, Noya y Arousa. Según las estadísticas oficiales en el año 1982 la captura de ostra ocupa uno de los últimos lugares, con una producción <1 Tn, mientras que las especies cultivadas alcanzan el 5 lugar 590 Tn y 335 millones de pesetas/año.

Personal Communication María Perez Mora. Government of Cantabria. Directorate General of Fisheries.

Year 2020. In Cantabria Recreational and commercial fishing of *O. edulis* is permitted, but commercial oyster fishing is restricted through licensing. The oyster shellfish was not a professional activity until the end of the 1980s. Before the 1980s its trade did not go through the fish market. Today the species that is exploited is Crassostrea gigas (*Magallana gigas*) and aliens species introduced in 1970-1970 from Japan. In the natural environment there are also another alien species, Crassostrea angulata introduced in the 16th century to Portugal from Taiwan. There are sales data records from 2016. In 2019 there is a rebound in the extraction of oysters for consumption. 80,000 Kg / year were extracted from *Crassotrea gigas*, mainly from

Santoña. The disappearance of the fine and Japanese clam from the estuaries of Cantabria has led *C. gigas* being one of the main shellfish resources, thus avoiding a social conflict.

En Cantabria actualmente en el medio natural además de O. edulis hay dos especies importadas: C. angulata (importada en el S XVI a Portugal procedente de Taiwan) y Crassostrea gigas (Magallana gigas; importada en 1970-1970 procedente de Japón). El marisqueo de ostra no es una actividad profesional hasta finales de los años 80. No pasaba por Lonja. Las especie que se explota es Crassostrea gigas. Hay registros de datos de venta a partir del año 2016. En el año 2019 se produce un repunte en la extracción de ostra para el consumo. Se extrajeron 80.000 Kg/año de Crassotrea gigas principalmente de Santoña. La desaparición de la almeja fina y japonesa de los estuarios de Cantabria ha conducido a que la C. gigas sea uno d ellos principales recursos marisqueros en la provincia, evitando de esta manera un conflicto social.

Year	Site	Capture in natural beds* (Kg)	Source
1869	San Martín de la Arena	1.200.000	Graells, 1970
1928/1928/1930	Santander	6.092	Madariaga, 1969
1934	Santander	3.100	Madariaga, 1969
1935	Galicia	50 millions *	Perez Camancho, 1987
1958-1968	Spain	Average production 600 Tn	Andreu, 1968
1969	Santander	250 oysters/week	Madariaga, 1969
1982	Galicia	< 1.000*	Perez Camancho, 1987
2011	Spain	16.000	*MAAMA, 2016
2012	Spain	56.000	*MAAMA, 2016
2013	Spain	25.000	*MAAMA, 2016
2014	Spain	65.000	*MAAMA, 2016

*Table 6. Summary of catches of Ostrea edulis between 1969 and 2014 (Source: own elaboration). Datos de capturas de Ostrea edulis entre 1869 y 2014. *Ministerio de Agricultura, Alimentación y Medio Ambiente (MAAMA).*

6.4 Uses of *Ostrea edulis*

6.4.1 Human Food

Mesolithic and Paleolithic

Gutierrez Zugasti, I., Personal Communication, 2020

Oysters were used in Prehistory, however, their use is very scarce during the Upper **Paleolithic** (40 - 11 ka-thousand years) and increases considerably during the **Mesolithic** (11-7 ka-thousand years) and the **Neolithic** (7- 5 ka-thousand years), because from the Holocene the current configuration of estuaries occurs. During the glacial periods (before 11 ka) the coastline was quite to the north, so the archaeological sites that would be located near the estuaries would be under water today, however, we are not very clear what those estuaries were like nor if they harbored mollusks as abundantly as today. In some deposits from these times we have appreciable amounts of limpets and periwinkles, but not oysters or other estuarine species, so with the data we currently have, the idea is that estuarine species do not begin to be exploited until improvement Holocene climate, coinciding with the Mesolithic (Zugasti; Pers. Com.).

Gutierrez Zugasti, I., Cuenca, D., Rasines del Río, P., Muñoz, E., Santamaría, S., Morlote, J.M. 2013. The role of shellfish in hunter–gatherersocieties during the Early Upper Palaeolithic: A view from El Cuco rockshelter, northern Spain. Journal of Anthropological Archaeology Volume 32, Issue 2, June 2013, Pages 242-256. doi.org/10.1016/j.jaa.2013.03.001

Neanderthal subsistence strategies and settlement patterns, especially for coastal settlement and use of marine resources, have been found not only in northern Iberia, but also in Atlantic Europe. Evidence of systematic shell collection has been found at El Cuco (see Gutierrez-Zugasti et al., 2013a for a detailed study of the shells assemblages). The increasing abundance of sites with evidence of coastal resource exploitation shows not only that these resources were not exclusively utilized by anatomically modern humans but also that they were extensively exploited by Neanderthals. From a more general point of view, the available evidence shows that in addition to terrestrial mammals, other resources such as small game, birds, molluscs, fish and marine mammals were present in the diet of Middle Paleolithic and EUP humans in Iberia **Neanderthal** subsistence strategies and settlement patterns, especially for coastal settlement and use of marine resources, not only in northern Iberia, but also in Atlantic Europe. Evidence of systematic shell collection has been found at El Cuco (see Gutierrez-Zugasti et al., 2013a for a detailed study of the shells assemblages). The increasing abundance of sites with evidence of coastal resource exploitation shows not only that these resources were not exclusively utilized by anatomically modern humans but also that they were extensively exploited by Neanderthals. From a more general point of view, the available evidence shows that in addition to terrestrial

mammals, other resources such as small game, birds, molluscs, fish and marine mammals were present in the diet of Middle Paleolithic and EUP humans in Iberia (Gutierrez-Zugasti et al., 2013b;), which suggests the presence of dietary diversity in both periods and therefore, to some extent, the use of similar subsistence strategies.

5th -3rd Centuries before Christ

Nadal, L. 2017. Conchylia y cocleae: transformaciones en la percepción culinaria de los moluscos durante la romanización del Noreste peninsular. Archaeofauna 26 (2017): 103-114

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With the Iberians, the exploitation of marine molluscs is limited to the coast and very rarely to pre-coastal areas. In the Iberian communities that developed between the 5th and 3rd centuries BC - there is a clear link between the appearance of malacofaunistic remains and the proximity of the sites to the coastline. The numerical importance of these elements decreases gradually and at distances greater than 20-30 km with respect to the coastline they no longer appear in the record. The appearance of shells in coastal Iberian settlements indicates an exploitation of maritime resources, whether or not for food purposes, and that these elements become rare as we move inland.

En el mundo ibérico la explotación de moluscos marinos se limita a la costa y muy escasamente a zonas prelitorales. En las comunidades ibéricas que se desarrollan entre los siglos V y III a.C.– existe una clara vinculación entre la aparición de restos malacofaunísticos y la proximidad de los yacimientos a la línea de costa. La importancia numérica de estos elementos decrece paulatinamente y en distancias superiores a los 20-30 km respecto a la línea de costa dejan de aparecer en el registro. Sea como fuere, la aparición de conchas en los poblados ibéricos costeros indican un aprovechamiento de los recursos marítimos, sea o no con finalidad alimentaria, y que estos elementos se enrarecen a medida que nos adentramos al interior.

The Romans

Nadal, L. 2017. Conchylia y cocleae: transformaciones en la percepción culinaria de los moluscos durante la romanización del Noreste peninsular. Archaeofauna 26 (2017): 103-114

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In the Roman Period, the consumption of marine mollusks is linked to the proximity to the coast and oysters become the most consumed species. The most abundant species is Ostrea edulis, which is also the one with the greatest presence in the interior areas and further from the coast. Although, the importance of marine mollusks is reduced inland, their presence represents a change of uses compared to the Iberian world. This implies not only this transformation in the perception of said foods for gastronomic purposes but also the technical and political

possibilities (pacification of territories) so that marine resources reach the interior in an acceptable time for their consumption in good condition.

En el mundo romano, el consumo de moluscos marinos se desliga de la proximidad a la costa y las ostras (Ostrea edulis) se vuelven la especie más consumida. La especie más abundante es Ostrea edulis que, además, es la que experimenta una mayor presencia en las zonas interiores y más alejadas de la costa. Aunque, la importancia de los moluscos marinos se reduce hacia el interior, su presencia supone un cambio de usos frente al mundo ibérico. Ello implica no solamente esta transformación en la percepción de dichos alimentos con finalidad gastronómica sino las posibilidades técnicas y políticas (pacificación de territorios) para que los recursos marinos lleguen al interior en un tiempo aceptable para su consumo en buen estado.

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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The first colonizing peoples of the Iberian Peninsula felt a great attraction for this food, especially the Romans (Remains of Roman shell from Castillo de la Riera, Covadonga, etc).

Los primeros pueblos colonizadores de la Península Ibérica sintieron una gran atracción por este alimento, sobre todo los romanos (Restos de conchero romano del Castillo de la Riera, Covadonga, etc).

17th and 18th Centuries

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Since ancient times, the oyster has been considered an elitist species and it is true that, for much of history, this mollusc was destined almost exclusively for the privileged tables of the aristocracy, and it was not very common for common people markets. Both the Habsburgs in the 17th century and the Bourbons in the 18th century enjoyed this delicacy both pickled and fresh, and even the clergy themselves enjoyed this mollusc during these. Although it is true that we do not have abundant documentation on the subject, it seems that during the 17th century it appeared with some frequency in markets of Castilla, normally from the Galician coast. However, during the following century there are hardly any references to its consumption in these markets.

La ostra ha sido considerada desde tiempos remotos como una especie elitista y bien es cierto que, durante buena parte de la Historia, este molusco estaba destinado casi exclusivamente a las mesas privilegiadas de la aristocracia, no siendo muy usual su aparición por los mercados del pueblo llano. Tanto los Austrias en el siglo XVII, como los Borbones en el XVIII gustaban de ese manjar tanto en escabeche como en fresco, e incluso los propios religiosos disfrutaban de este molusco durante estos siglos (Cubillo de la puente, 1998). Aunque es cierto que no contamos con abundante documentación al respecto, parece ser que durante los años del siglo XVII aparecía con cierta asiduidad por los mercados castellanos, normalmente originario de las costas gallegas. Sin embargo, durante la siguiente centuria apenas existen referencias de su consumo en esos mercados, estimación que es aplicable a lo ocurrido durante buena parte del siguiente siglo.

Year 1791. The expert Antonio Sáñez Reguart, Royal Commissioner of Marine and Fisheries recommends the placement of oysters (pens where water is retained at low tides) in Cantabria, specifically in the port of San Vicente de la Barquera, citing the bridge among the sites more appropriately, since the amount of stone sheltered served as a perfect deposit. The quality of the oysters here was already exalted by the author.

"(...) where oysters are so tasty and of such a good size that a load of them were brought in their shells to Madrid in 1785, and they were presented and celebrated by natives and foreigners who occupied the first tables ".

El experto Antonio Sáñez Reguart, Comisario Real de Marina y Pesca en esas fechas, recomienda la colocación de ostreras (especies de corrales donde permanece retenida el agua en las mareas bajas) en suelo cántabro, concretamente en el puerto de San Vicente de la Barquera, citando entre los sitios más a propósito el puente, dado que la cantidad de piedra que abrigan sus cepas servía de perfecto depósito. La calidad de la ostra aquí criada era ya ensalzada por dicho autor:

" (…) donde se crian Ostras tan superiormente sabrosas y de buen tamaño, como que habiéndose conducido una carga de ellas en sus conchas á Madrid en 1785, se presentaron y fueron muy celebradas de naturales y extrangeros en las primeras mesas de la Corte" (Sáñez Reguart, 1791).

Cornide Saavedra, J. 1788. Ensayo de una historia de los peces y otras especies marinas de la Costa de Galicia, arreglado al sistema del caballero Carlos Linneo. Con un tratado de las diversas Pescas, y de las redes y aparejos que se practican. En la oficina de Benito Cano.

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Both ancient and modern people have regarded them as one of the most exquisite delicacies: the famous glutton Apicius possessed the art of preserving them for a long time, as he sent them

from Italy to the Emperor Trajan, when he was in Persia: I have heard that by taking care to place them fresh in their own shell, and placed in such a way in a barrel or bucket, that they cannot be opened or receive the outside air, the same is achieved as Apicius did, and I have also seen that they keep for many days, but they must be fried or boiled (...) otherwise they become corrupt.

Although the oyster in its raw state is less harmful, the repugnance that some people find in eating them in this way has led to the invention of various condiments according to the diverse tastes of modern cookers; one of the simplest and most common in our stalls, although no less tasty for that reason, is to serve them fried in oil, coated with cornflour, and where there is none, with any other, or with grated breadcrumbs and a little lemon juice.

Also among the various stews, it is particularly delicious when it is cooked in a scallop shell and is made with oil, lemon, parsley, pepper and breadcrumbs, which are put on top to form a delicate crust.

Although many oysters are consumed in this way on the coast of Galicia, the most regular way is to reduce them to pickled oysters; by which means they are preserved and can be transported, as is the practice over long distances.

Tanto los antiguos como los modernos la han mirado como uno d ellos manjares más exquisitos: el célebre glotón Apicio poseía el arte de conservarlas largo tiempo, pues desde Italia se las enviaba al emperador Trajano, cuando estaba en Persia: yo he oído que cuidando de colocarlas frescas en su misma concha, y acomodadas de tal suerte en un barril o cubeto, que no pueda abrirse ni recibir el aire exterior se consigue lo mismo que practicaba Apicio, y también he visto que embarriladas con su mismo caldo, y cerradas con toda exactitud se guardan muchas días, pero es preciso freírlas o recocerlas (…) pues sino se corrompen.

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Aunque la Ostra en l estado de cruda es menos nociva, la repugnancia que hallan algunas gentes en comerlas así, ha hecho inventar varios condimentos según los diversos gustos de los modernos cocineros; uno de los más sencillos y más comunes en nuestros puestos, aunque no por eso menos sabroso es servirlas fritas en aceite, rebozadas con harina de maíz, y donde no la hay con cualquiera otra, o con miga de pan rallada y un poco de limón.

También entre los diversos guisos tiene particular gracia cuando se la hace con en una concha de Vieira y se compone de aceite, limón, perejil, pimienta y pan rallado, que se pone encima para que forme una delicada costra.

Aunque de este modo se consumen muchas ostras en la costa de Galicia, lo más regular es reducirlas a escabeche; por cuyo medio se conservan y se pueden conducir, como se practica a largas distancias.

SAÑEZ REGUART, Antonio. 1793. Diccionario Histórico de las artes de pesca nacional. Tomo Quarto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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In foreign countries, many people of good taste particularly appreciate the so-called green oysters. It should be noted that these are not fished with such a colour, and that to obtain them, they are deposited in certain oyster beds along the sea shores, which are three feet deep, bathed by the living tides on full and new moons, leaving ducts or channels through which the water that entered is refluxed, until it is left in the middle. These ditches are filled with green algae, and in the space of three to four days the oysters, which were purposely thrown in, begin to take on a "greenish look": however, they remain for six weeks in such places. The most priced green oysters are those prepared in England. They are traded extensively on the Normandy coast (...).

If, in imitation of this, some of us were to dedicate ourselves to the preparation of oyster beds in places where they would in no way prejudice free navigation, we would have oysters in untold abundance: they would be cheaper than at present; and not only would they be able to supply Madrid and other inland cities with fresh and pickled oysters, but they would also provide a branch of trade with some foreign countries.

En los Paises extrangeros muchas personas de buen gusto aprecian particularmente las Ostras llamadas verdes. Conviene advertir, que estas no se pescan con semejante color, y que para dársele se depositan en ciertas Ostreras á lo largo de las orillas del mar , jas, las quales constan de la profundidad de tres pies, bañándolas las mareas vivas en las lunas llenas y en las nuevas; dexando conductos ó canales por los que refluye el agua que entró, hasta quedar en la mitad. Estas zanjas se llenan de verdín, y en el espacio de tres á quatro dias las Ostras, que de propósito se echaron, empiezan á tomar un viso verde: no obstante se dexa permanezcan por espacio de seis semanas en semejantes parages. Las Ostras verdes mas estimadas son las que se preparan en Inglaterra. Con ellas se hace un comercio grande en las Costas de Normandía (…).

Si, á imitación de esto, algunos de entre nosotros se dedicasen á formar Ostreras en sitios donde de ningún modo perjudicasen la libre navegación , tendriamos Ostras con indecible abundancia: valdrian mas baratas que en el dia ; y no solo podrian surtir en fresco y en escabeche á Madrid y demás Ciudades interiores, sino que ademas se proporcionaría un ramo de comercio con algunos paises extrangeros.

19th Century

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1860. From 1860 onwards, it seems that its arrival in shops and fishmongers' shops was progressively greater, perhaps due to the number of concessions that were made and granted during the final period of the nineteenth century, and fundamentally due to the improvement in transport (railways) and communication routes that made it possible to shorten the distances between the harvesting areas and the points of sale, this being one of the main disadvantages that prevented its sale in the markets of the interior of Spain.

Ya a partir de 1860 parece ser que su llegada a los comercios y pescaderías fue progresivamente mayor, quizás amparada por la cantidad de concesiones que se formularon y concedieron durante el periodo final del ochocientos, y fundamentalmente por la mejora de los transportes (ferrocarril) y vías de comunicación que permitieron acortar las distancias entre las zonas de recolección y los puntos de venta, siendo éste uno de los principales inconvenientes que retraía su colocación en las plazas del interior de España.

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Year 1890. Although most of this shellfish market was fresh, another small part was brought to the market processed, both canned and, above all, pickled, the latter being the main production of the processing industry in this town (Santoña).

Aunque la mayor parte de este molusco se comercializaba en fresco, otra pequeña parte era introducida en las plazas de forma elaborada, tanto en conserva como sobre todo en escabeche, siendo ésta ultima la elaboración principal de los industriales del sector transformador en esa villa (Santoña).

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

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Year 1869. In Carril, mussels cooked in water and pickled mussels were consumed in large quantities, and some barrels of these were sold in Madrid under the misleading trade name of mussel oysters.

En Carril localmente se consumían en gran cantidad los mejillones cocidos en agua y los escabechados, y algunos barrilitos de estos se vendían en Madrid con el engañoso nombre comercial de ostras mejilloneras.

20th Century

Madariaga, B. 1969. La ostricultura en España ensayos de repoblación ostrícola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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Year 1965. Oysters are an expensive delicacy, only accessible to certain people who can pay 300 pts / dozen, which was the last price reached in December 1965.

Las ostras constituyen un manjar caro y solo asequible a ciertos "gourmet" que pueden pagar 300 pts. la docena que ha sido el precio último alcanzado en diciembre de 1965.

Year 1969. Oysters when eaten raw are not to everyone's taste. (…) The preference of regular consumers is for the flat oyster, of better quality than the Portuguese.

Las ostras a causa de comerse crudas no son apetecidas por todas las personas. (…) La preferencia de los consumidores habituales es por la ostra plana, de mejor calidad que la portuguesa. (...) La riqueza del plancton de las rías gallegas favorece no sólo el crecimiento sino también la calidad de las ostras, que son apreciadas incluso por los franceses.

6.4.2 Health

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

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Year 1870. Oyster farming gained a great deal of popular publicity (…), especially from the pages of the prestigious magazine La Ilustración Española y Americana. The curative properties of fresh oysters from Lisbon, which were fished at the mouth of the Tagus and artificially fattened, were highlighted. They were recommended for their richness in iodine and bromine to cure "scrofula and even consumption". The gourmets of the time particularly valued the Belgian oysters from Ostend, from whose parks "they come out fat and juicy; and thanks to certain care they acquire a greenish tint that gives them that succulent flavour". Unscrupulous counterfeiters tried to artificially imitate this colour and, before sale, the molluscs were dipped in a bath of dissolved copper salt.

La ostricultura consiguió gran publicidad popular (…), sobre todo, desde las páginas de la prestigiosa revista La Ilustración Española y Americana. Se destacaron las propiedades curativas de las ostras frescas de Lisboa, que eran pescadas en la desembocadura del Tajo y engordadas artificialmente. Eran recomendadas por su riqueza en yodo y bromo para curar "las escrófulas y aun las tisis". Los gastrónomos de la época valoraban especialmente las ostras belgas de

Ostende, de cuyos parques "salen gordas y jugosas; y merced a determinados cuidados adquieren un tinte verdoso que les da ese sabor suculento". Falsificadores sin escrúpulos intentaban imitar artificialmente ese color y, antes de la venta, introducían a los moluscos en un baño con una sal de cobre en disolución.

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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Year 1969. Dr. Le Gall, referring to the therapeutic value of the oyster, makes a fairly complete summary of the medical works in which its use is alluded to or prescribed in the most diverse ailments. Thus, he advises its consumption in cases of malnutrition, anemia, tuberculosis and diseases, in general, of the digestive system in which other types of food are not tolerated. In modern times, the defenders of this mollusk go further and speak that oysters are a protective food against cancer and that intervalvar water has an antibiotic power that passes to people who use this food. But, apart from all this, we must consider its appreciable nutritional value, which makes the oyster a food comparable to milk or eggs and superior to many foods due to its richness in vitamins and mineral salts.

El doctor Le Gall al referirse al valor terapéutico de la ostra, hace un resumen bastante completo de las obras de medicina en la que se alude o prescribe su utilización en las más diversas dolencias. Así, aconseja su consumo en los casos de desnutrición, anemia, tuberculosis y afecciones, en general, del aparato digestivo en que no se tolera otro tipo de alimento. Modernamente, los defensores de este molusco llegan más lejos y hablan de que las ostras constituyen un alimento protector contra el cáncer y que el agua intervalvar posee un poder antibiótico que pasa a las personas que utilizan este alimento. Pero, aparte de todo esto, hay que considerar su apreciable valor nutritivo que hace de la ostra un alimento comparable a la leche o a los huevos y superior a muchos alimentos por su riqueza en vitaminas y sales minerales.

6.4.3 Shell tools

Cuenca, D., Clemente, I., Gutiérrez, I. 2010. Using shell tools in Mesolithic and early Neolithic coastal sites from Northern Spain: experimental program for use wear analysis in malacological materials. Trabajos de prehistoria, 67, N.º 1, enero-junio 2010, pp. 211-225, ISSN: 0082-5638. doi: 10.3989/tp.2010.10037

One of the most common debates surrounding the Mesolithic and early Neolithic periods in northern Spain focuses on the scarcity of lithic and osseous technologies identified in large shell midden contexts. Currently, several hypotheses have been proposed that attribute this

phenomenon to differences in site spatial organization, increases in perishable material use, or changes in subsistence strategies. However, recently shell tools have been identified in the early Neolithic levels at Santimamiñe cave located in the Basque Country of northern Spain. These artifacts are the first evidence of shell tools to be identified in Northern Spain in an early Neolithic shell midden context. This paper proposes the hypothesis that shell tools were being used in subsistence activities. To test this hypothesis, the authors developed an experimental programme using different types of mollusc shells to examine evidence of functional use on wood, dry/fresh animal skin and non-woody plants. The experimental results were then used to examine the patterns of use on the seven shell tools from Santimamiñe. The results of the comparisons indicate that the seven shell tools have similar use patterns as the experimental shells. This evidence supports the proposed hypothesis that shell tools may have been used frequently in shell midden contexts during the Mesolithic and early Neolithic for the working of wood, plants or animal skin.

6.4.4 Animal Food

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

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Year 1969. Ría de San Salvador (Santander). *O. edulis* and *Griphea angulata* beds used for the supply of shells for domestic animal feed. Despite its continuous exploitation by tonnage, it has an important stock.

Ría de San Salvador (Santander). Se trata de un ostrero de O. edulis y Griphea angulata utilizado para el suministro de conchillas con destino a la alimentación de animales domésticos. A pesar de su continuo aprovechamiento por toneladas, cuenta con u n stock importante.

6.5 Extraction tools

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

Prehistory. In Prehistory, oysters were collected using shellfish picks or sea pebbles that were abundant on the coast. It is also likely that there were storage places in natural shelters on the coast in contact with the sea, where they were kept when the excess did not allow for total consumption or transport.

*En la Prehistoria, las ostras se recogían utilizando "**picos marisqueros" o cantos marinos** abundantes en la costa. También es de suponer que existieran lugares de almacenamiento en refugios naturales de la costa en contacto con el mar en donde se guardaban cuando el exceso no permitía el consumo total o el transporte.*

SAÑEZ REGUART, Antonio. 1791. Diccionario Histórico de las artes de pesca nacional. Tomo Segundo. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1791. In various parts of Galicia, and other parts of the north, the portions of certain bends, where the free course of ships is not impeded, because there is not even a slight berth, were taken advantage of, the corrals, besides serving to catch fish as the first object, could give enough produce to those inhabitants by using them also as oyster beds or shellfish hatcheries.

Si en varias partes de las de Galicia, y demás de nuestro septentrión se aprovechasen las porciones de ciertos recodos, donde en modo alguno pueden impedirse el libre curso de las naves, porque no hay ni siquiera un leve atracadero, los Corrales , ademas de servir á coger peces como primer objeto, podrían dar bastante producto á aquellos habitantes usándolos también como Ostreras ó criaderos de marisco.

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(...) for which purpose they look for the smallest and most well-formed fish that can be found on the beaches themselves. These young, placed in such pens, grow to a corresponding size after two or three years and are of exquisite flavour.

(…) á cuyo efecto se buscan las mas pequeñas y bien configuradas que pueden hallarse en las mismas playas. Estas crías, echadas en semejantes Corrales, al cabo de dos ó tres años crecen á un tamaño correspondiente y son dé un sabor exquisito.

SAÑEZ REGUART, Antonio. 1793. Diccionario Histórico de las artes de pesca nacional. Tomo Quarto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1793. (Los Corrales) A type of deposit made on the sea shores as oyster hatchery, in the same way that the corrals were used to catch fish, being retained when the tides went out; with the difference that the oyster beds are much smaller, arbitrary and irregular in shape, or sometimes semicircular or semi-square, as the land and the position of the beaches allow, but always built in places where there is no lack of salt water;. They are made of dry stone walls, giving them the height that is considered most convenient, according to the position of the ground on which the oyster bed is built.

(Los Corrales) Especie de depósito hecho destinadamente á las orillas del mar para criar Ostras, al modo que por su término se discurrieron los Corrales para coger peces, quedando retenidos al baxarlas mareas; con la diferencia de que las Osíreras son mucho mas pequeñas , arbitraria é irregular la figura, ó á veces semicircular ó semiquadrada , conforme permiten los terrenos ^ posiciones de las playas; pero siempre construyéndolas en parages donde n0 falte la agua salada, Fórmanse de paredón de piedra seca , dándole la altura que se considera mas conveniente, según la posición del suelo en que se quiere construir la Ostrera.

SAÑEZ REGUART, Antonio. 1795. Diccionario Histórico de las artes de pesca nacional. Tomo Quinto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1795. Raño. In some parts of Galicia this name is given to a certain kind of iron hook, with its competent handle, intended only to pull up the oysters stuck to the rocks; but this instrument is forbidden there in all seasons, under the fine of thirty reales de vellón.

Raño. En algunos parages de Galicia dan este nombre á cierta especie de gancho de hierro, con su competente mango, destinado únicamente á arrancar las Ostras pegadas á las peñas; pero este instrumento está allí prohibido en todas estaciones, baxo la multa de treinta reales de vellón.

PAZ GRAELLS, Mariano de la. 1870. Exploración científica de las costas del departamento Marítimo del Ferrol verificada de orden del Almirantazgo por el vocal de la Comisión

Permanente de Pesca D. Mariano de la Paz Graells en el verano de 1869, Est. Tipográfico de T. Fortanet, Madrid. http://biblioteca.galiciana.gal/pt/consulta/registro.cmd?id=4847

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Year 1866. In Galicia, Rastro is the most commonly used gear. It is used in sandy bottoms with little vegetation. It consists of an iron or wooden cutting board one metre and ten centimetres long and about fifteen centimetres wide and of a proportionate thickness. From one end of the plate to the other, a ring is raised where the hemp net flake is fixed. (…). In this way, the trail is walked for varying lengths of time over the oyster beds, which are traversed in different directions, and the mollusc falls into the codend (...).

Tangas (Ría de Arosa): this consists of two iron rods armed with two long poles joined together in the form of a pincer.

Angazo ostrero (Rivadeo): consists of two long carales 15 or 20 feet long, crossed and fixed at the lower part in the form of a pincer, the same as the thong and each perch armed at this end of a three-foot long cross, in each of which is fitted a series of wooden teeth in the same direction as the axis.

Los Raños (Vivero): triple or quadruple iron hooks, enmeshed in a long rod of three or four fathoms, to reach greater depths and remove the molluscs from the banks, scratching the bottoms.

The Trentón (San Martín de la Arena): a large spiked legon, like those used by farmers to remove manure, on a 20-foot long pole. It is all made of iron; each spike will be about 0.37 long, separated from each other by spaces 3 centimetres long, so that oysters with a smaller diameter cannot be removed. It is used to scrape the (stone) bottoms, especially on the large shoal of the oyster tour.

Knife and piquetilla. With these very simple tools, oysters and morrunchos are removed from the rocks, or they are taken out of the cracks of the stones in which they are stuck.

Arnel. Finally, in the Arosa estuary (...), it is used to collect the young of this mollusc. This instrument is no more and no less than a shrimp trap, whose oval-shaped frame is made of strapping or of a thin iron sheet on its edge, to scrape with it the rocks where the young are stuck, which then fall into the bag.

En Galicia, el Rastro es el arte más utilizado. Se utiliza en fondos arenosos con poca vegetación. Consiste en una plancha de hierro o madera de un metro y diez centímetros de largo y unos quince centímetros de ancho y de un grosor proporcionado. De un extremo a otro de la plancha se levanta un anillo donde se fija el copo de red de cáñamo. (…). De este modo, se recorre durante

más o menos tiempo el lecho de las ostras, que se recorre en diferentes direcciones, y el molusco cae en el copo (...).

Tangas (ría de Arosa): consiste en dos raños de hierro armados en dos largos varales unidos a modo de tenaza.

Angazo ostrero (Rivadeo): consiste en dos largos carales de 15 o 20 pies de largos, cruzados y fijos en suparte inferior a manera de tenaza, lo mismo que la tanga y armada cada percha en este extremo de un crucero de tres pies de largo, en cada uno de los cuales está encajada una serie de dientes de madera en el sentido mismo del eje.

Los Raños (Vivero): triple o cuádruple gancho de hierro enmangado en un largo varal de tres o cuatro brazas, para alcanzar mayor profundidad y sacar de los bancos el molusco, arañando los fondos.

El Trentón (San Martín de la Arena): un gran legon de púas como los que usan los labradores para remover estiércoles, en mangado en un varal de 20 pies de largo. Es todo de hierro; cada puar tendrá sobre 0,37 de largo, separadas entre ´si por unos interespacios de 3 centímetros de largo; de modo que las ostras de menor diámetro de éste no pueden sacarse. Se usa rascando los fondos (de piedra) sobre todo en el gran banco de la Vuelta ostrera.

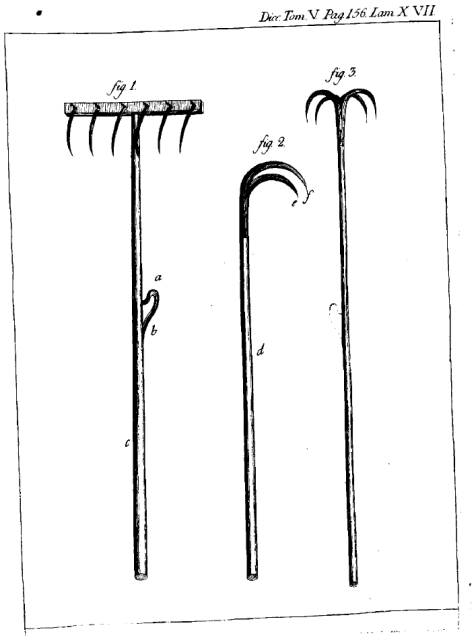
Cuchillo y piquetilla. Con estos sencillísimos instrumentos desprenden de las rocas las ostras y morrunchos, o las sacan de las rendijas de las piedras en que están metidas.

Arnel. Por fin en la ría de Arosa (…), les sirve para recoger la cría de dicho molusco. Este instrumento no es ni más ni menos que una camaronera, cuyo cerco de forma oval es fleje o de una lámina de hierro delgada en su borde, para rascar con ella las peñas donde están adheridas las crías, que así caen en la bolsa.

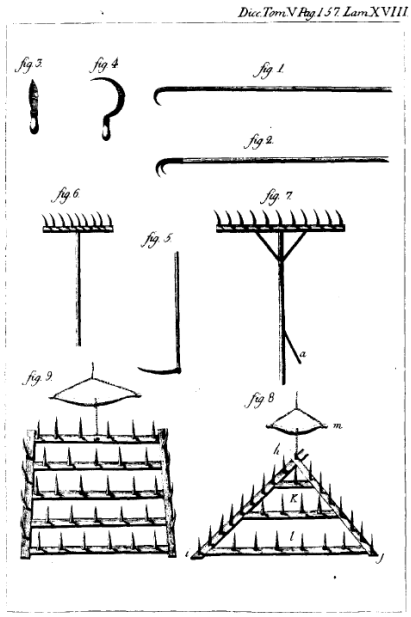
Personal Communication María Perez Mora. Government of Cantabria. Directorate General of Fisheries.

Currently, in Cantabria, oyster fishing according to the Orden de tallas mínimas y vedas del marisqueo 2019-2020 allows the use of small masonry piqueta gear for the extraction of oysters, with a wooden handle and two opposing mouths, one flat like a hammer and the other sharp like a pick.

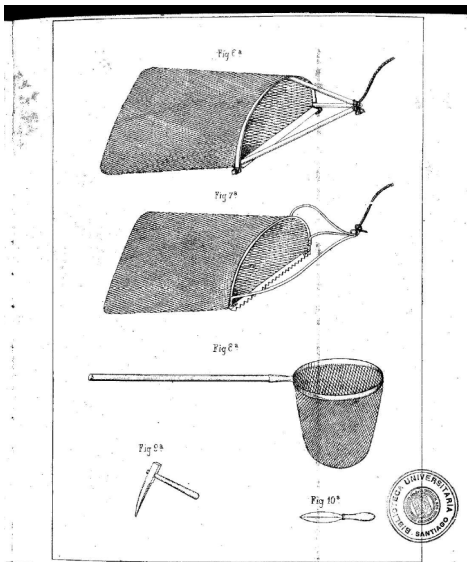
*Actualmente, en Cantabria, La pesca de la ostra según la Orden de tallas mínimas y vedas del marisqueo **2019-2020** permite el uso del **arte piqueta** pequeña de albañilería para la extracción de la ostra, con mango de madera y dos bocas opuestas, una plana como de martillo y otra aguzada como de pico.*



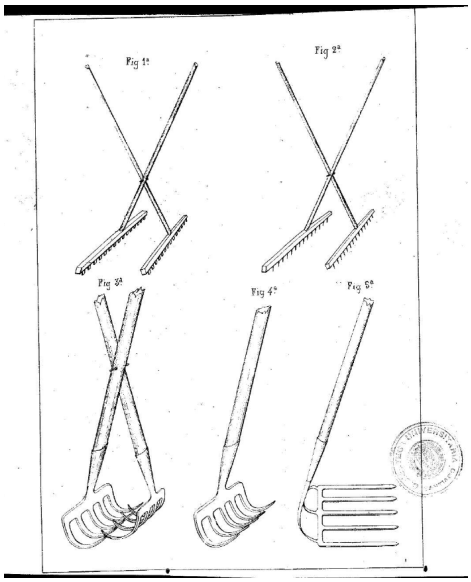
Drawing XVII (Sañez Reguart, 1795; pg 156). Figures 2 and 3: Raños. *Lámina XVII (Sañez Reguart, 1795). Figuras 2 y 3: Raños.*



Drawing XVIII (Sañez Reguart, 1795; pg 157). Figure 2: Garabato*; Figures 6 and 7:To gather seaweed and oyster. *Graells (1870) indicated that this instrument is actually similar to the Raños of Vivero. *Lamina XVIII (Sañez Reguart, 1795). Figura 2: Garabato*; Figuras 6 y 7: Recoge algas y ostra. *Graells (1870) indicó que este instrumento es en realidad similar a los Raños de Vivero.*



Drawing XVI (Graells, 1970; pg 549). Figures 6 and 7: Rastro; Figure 8: Arnel; Figure 9: Pick or hook; Figure 10: knife. *Lámina XVI (Graells, 1970). Figuras 6 y 7: Rastro; Figura 8: Arnel; Figura 9: Pico o gancho; Figura 10: cuchillo.*



Drawing XV (Graells, 1970 pg 550). Figure 1: Anganzo for oyster; Figure 3: Tanga; Figure 5: Trenton. *Figura 2. Lamina XV (Graells, 1970). Lámina XV. Figura 1: Angazo ostrero; Figura 3: Tanga; Figura 5:Trentón.*

6.6 Regulations

SAÑEZ REGUART, Antonio. 1795. Diccionario Histórico de las artes de pesca nacional. Tomo Quinto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

-P166-169-

Year 1768. The document of Sañez Reguart includes the Ordinances of the Province of the Navy of Pontevedra of 1768. Treatise XII. Titles V and XIV.

El documento incluye la Ordenanzas de la Provincia de Marina de Pontevedra de 1768. Tratado XII. Titulos V y XIV.

Del Trat. XII. tit. V.

1.°

"La pesca de Ostras tendrá su principio en »pri-

(a) Ordenanzas de la Provincia de Marina de Pontevedra de 1768.

ART. XXIV. »Item, se declara, que tambien hay, para pescar la »Ostra, el Instrumento del *Rastro*; pero este no debe ser de hier»ro, sino de palo, ó pescar con *Tangas*, segun se practica en Rianjo, »ó con *Angazo*, segun se usa en el Puente San-Payo, y al que usare »de *Rastro* de hierro, se le sacarán de multa mil maravedis, y se »tomará por perdido dicho Instrumento.

ART. XXV. »Item, se declara, que en los quatro meses de Mayo, »Junio, Julio y Agosto; no se debe andar á la pesca de Ostra, por »ser el tiempo en que este género se halla en la cria, y al que execu»tare lo contrario, se le saquen seiscientos maravedis de multa.

ART. XXVI. »Item, se declara, que la pesca de la Ostra debe prin»cipiar desde primero de Diciembre hasta último de Abril; pero en »el Puente San-Payo, y Puertos inmediatos, se permite, que pue»dan principiar desde primero de Septiembre hasta último del expre»sado mes de Abril, por no tener aquellos Naturales otra pesca para »mantenerse.

ART. XXVII. »Item, se priva, que en las mareas baxas ninguno »pase á coger la cria de la Ostra, que queda arrimada á la tierra, »antes bien procurarán todos echarla la mar adentro para que se crie, »crezca, y pueda ser útil; y respecto de que para coger dicha cria, »es preciso entrarse á pie en el agua salada, celarán los marineros, »que ninguno del Gremio de tierra entre á sacarla, ni á pescar con »Fisgas, Sollas y otros pescados; y si alguno lo executare, darán »cuenta al Subdelegado, para que lo ponga preso y tome la corres»pondiente providencia al escarmiento en lo succesivo.«

SAÑEZ REGUART, Antonio. 1793. Diccionario Histórico de las artes de pesca nacional. Tomo Quarto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1793. For this consignment the consent of the illustrious Town Council of that maritime town (San Vicente de la Barquera) intervened; because it does not allow oysters to be taken from such a site, except in certain seasons; and when extracting them, only the largest ones are chosen, and in no way are any small ones taken. It is certain that even if precautions were not taken for the conservation of the species, it seems impossible that it could be exhausted, because there is no animal that grows in such a short time, and that multiplies so prodigiously.

According to accurate and truthful observers, it takes no more than twenty-four hours for an oyster egg to develop its first shell.

Para esta remesa intervino la anuencia del ¡lustre Ayuntamiento de aquella Villa marítima (San Vicente de la Barquera); porque no permite se saquen Ostras de semejante parage sino en determinadas temporadas; y en el hecho de extraerlas, solo se escogen las mas crecidas , y en modo alguno se saca ninguna pequeña. Es cierto que aun quando no se tomasen precaucionen para la conservación de la especie, parece imposible pueda llegar á agotarse, porque no hay animal que crezca en tan breve tiempo, y que tan prodigiosamente se multiplique. Según Observadores exactos y veraces , no es menester mas que veinte y quatro horas para que un huevecillo de Ostra llegue á revestirse de su primera concha.

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However, for oyster fishing, as for all other fisheries, it is essentially advisable to have its own rules, or a certain police force, to repress and even prevent the abuses that the greed of many people easily commits to the serious detriment of the multiplication of the species itself. Governments, vigilant in the best regime of fisheries, whose interest transcends great political advantages, only allow oyster fishing in certain months of each year, and this is the way it is done among us (®). Moreover, as there are often twenty or more oysters attached to a single stone or shell, it is established that the fishermen must throw them back into the water. If in the same act of catching oysters the fishermen take, as often happens, some stones in which there are seeds, or newborn oysters, they are obliged to put them in the shelter of some rocks, or in oyster beds where they grow, fatten, and within three years reach a perfect state of seasoning.

No obstante para la pesca de Ostras, lo mismo que para todas las demás, conviene esencialmente haya sus reglas , ó cierta policía ^ que reprima y aun evite los abusos que la codicia de muchas gentes, comete con facilidad en grave perjuicio de la misma multiplicación de la especie. Los Gobiernos vigilantes en el mejor régimen de las Pesquerías, cuyo interés trasciende á grandes ventajas políticas, solo permiten la pesquera de Ostras en ciertos meses de cada afio, y así se verifica entre nosotros (®). Ademas, como muchas veces sobras una sola piedra, una sola concha , suelen hallarse pegadas veinte ó mas Ostritas , está establecido^ que los pescadores hayan de volver á echarlas al agua. Si en el mismo hecho de coger Ostras toman los pescadores, como sucede freqüentemente, algunas piedras en que haya semilla, ú Ostras recien nacidas, están obligados á ponerlas en el resguardo de entre algunas peñas, ó en Ostreras donde se crian, engordan, y antes de tres años llegan á perfecto estado de sazón.

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In Galicia there are places that are the most productive of this species of valuable shellfish, and since ancient times there has been a certain praiseworthy police force worthy of being imitated in other places where it is appropriate. Past La Barra del Barquero to the site of La Barca there

is an oyster bed, and a fine of thirty reales de vellón is imposed on anyone found taking oysters there from the first of May to the end of August. The time when such fishing is permitted is from September to April; but if even in this season any of the registered fishermen use a certain iron hook, which the people of the country call Rano, the same fine is demanded. As well as a fine of twenty-five ducats for anyone who, not being a member of the Navy, is found to be fishing at any time. In addition to these statutes peculiar to each territory or jurisdiction, in the new general Ordinances, as a single rule, it is foreseen: That as far as oyster fishing is concerned, fishermen may take advantage of it, provided that they are not in enclosed areas, such as bridge stocks, or oyster beds built expressly by some private individuals, who have owned them since time immemorial, and who have built them with Royal permission.

En Galicia hay parages los mas productivos de esta especie de marisco apreciable , y desde tiempos remotos cierta policía laudable y digna de ser imitada en otros donde convenga. Pasada la Barra del Barquero al sitio de la Barca hay una Ostrera, y está impuesta la multa de treinta reales de vellón á qualquiera que se hallare cogiendo Ostras en ella desde primero de Mayo hasta fin de Agosto. El tiempo en que se permite semejante pesca son los meses de Septiembre hasta Abril; pero si aun en esta estación alguno de los pescadores matriculados usare de cierto garabato de hierro, que las gentes del Pais llaman Rano, se le exige la misma multa. Como asimismo la de veinte y cinco ducados al que no siendo individuo de la Marina, se le encontrare haciendo la referida pesca en qualquiera tiempo. Ademas de estos estatutos peculiares de cada territorio ó jurisdicción, en las nuevas Ordenanzas generales, por regla única se previene: Que en quanto á la pesca de Ostras podrán aprovecharse de ella los pescadores^ siempre que no estuvieren en parages acotados, como cepas de puente , ú Ostreras construidas expresamente por algunos particulares, que de tiempo inmemorial las posean, 6 las construian con Real permiso.

SAÑEZ REGUART, Antonio. 1795. Diccionario Histórico de las artes de pesca nacional. Tomo Quinto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

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Year 1795. It is true that this multitude of traces with which the surface of the sandbanks is scraped, raised, and disturbed in so many and diverse ways is not in some way pernicious, and much more so if the long intervals to which the periodic order of the tides obliges the periodic order of the tides were not to be mediated; but nevertheless in our Coasts, wisely years ago, the way to avoid the damages that may result in this part is foreseen: and according to the same spirit, with subsequent local examination of the objects of that institution, the new general

Ordinances of fishing foresee the convenient in Treaties XII. V. and XIV. tit. and XIV. tit. L as the following extract shows.

Es verdad no dexa en algún modo de ser perniciosa esta multitud de Rastros con que se rasca, levanta, y transtorna la superficie de los arenales de tantas y tan diversas maneras, y mucho mas sería sino mediasen los intervalos largos á que obliga el orden periódico de las mareas; pero sin embargo en nuestras Costas sabiamente años hace se previo el modo de evitar los daños que pueden resultar en esta parte (^): y según el propio espíritu, con posterior examen local de los objetos de aquella institución, previenen las nuevas Ordenanzas generales de pesca lo conveniente en los Tratados XII. tít. V. y XIV. tít. L como manifiesta el siguiente extracto.

PAZ GRAELLS, Mariano de la. 1866. Reglamento para el régimen de la ostricultura en España. España Ministerio de Marina 23pp.

-P11-

Year 1866. Article 1. All natural oyster beds on the coast, estuaries or estuaries of the Kingdom, which do not at present belong to the State, and which are included within the marine zone of its coasts, are hereby declared to be the property of the State.

Art. 2. Of these banks, the Government shall designate those which are to serve exclusively as seed beds and those which may be used for the exploitation of shellfish for consumption.

Artículo 1.° Quedan declaradas propiedad del Estado todas las ostreras naturales que en el litoral, rías ó esteros del reino, no pertenezcan en el dia á dominio])articular, y se hallen comprendidas dentro de la zona marina de sus costas.

Art. 2.° De estos bancos señalará el Gobierno (os que exclusivamente hayan de servir de semilleros y los que puedan destinarse á la esplotacion del marisco para el consumo.

Reglamento de Ostricultura (Graells, 1866), contains 49 articles for oysters, in which he drafted a first survey that was completed by local shellfish gatherers in the Marine Commanderies under the title of Research of the oyster industry in Spain. As a result of his research and technical promotion, there were a large number of applications from private individuals for the concession of land to test oyster farms in the period 1869-1875 (Rubin, 2010).

En las publicaciones iniciales de Graells, se le dedica especial atención a las ostras. Destaca el Reglamento de Ostricultura (Graells, 1866), con 49 artículos para los mejillones se autorizaron

las empalizadas o bouchots–, donde redactó una primera encuesta que cumplimentaron en las comandan- cias de Marina los mariscadores locales bajo el título de In vestigación sobre el estado de la industria ostrera en España. Como fruto de sus investigaciones y promoción técnica, se produjeron un número elevado de solicitudes de particulares para la concesión de terrenos para ensayar los cultivos ostrícolas en el período 1869-1875 (Rubin, 2010).

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1876. Regulations for the propagation and exploitation of shellfish. It replaces and extends that of 1866, which only referred to oysters. The new regulation definitively regulates barnacles and 63 species of national molluscs and awards prices to those who manage to acclimatize "exotic marine species of recognised utility as food or for their industrial interest", such as "coral and fine sponges from Syria". It introduced important health regulations, such as the prohibition of the sale of shellfish attached to copper-lined hulls and that "oyster beds, artificial hatcheries and shellfish depots be harmed by unclean and deleterious sewage discharged in their vicinity".

Reglamento para la propagación y aprovechamiento de los mariscos. Sustituye y amplia el de 1866 que solamente hacia referencia a las ostras. La nueva normativa regula definitivamente al percebe y a 63 especies de moluscos nacionales y se ofrecen premios a los que consiguen aclimatar "especies marinas exóticas de reconocida utilidad como alimento o por su interés industrial", como "el coral y esponjas finas de Siria". Introdujo importantes normas de salubridad, como por ejemplo la prohibición de la venta de mariscos adheridos a cascos de buques forrados de cobre y que de "las ostreras, criaderos artificiales y depósitos de mariscos sean perjudicadas con desagües inmundos y deletéreos, que viertan en sus inmediaciones".

Year 1881. Rules are decreed to avoid abuses in oyster beds. The local marine authorities were to reserve the natural banks until their complete repopulation and the surveillance was to be carried out with the collaboration of the vessels of the maritime guardhouse. These acts indicate the government was sufficiently concerned about the state of oyster beds and that declines in stock were likely to be noticeable....

Se decretan reglas para evitar abusos en los criaderos de ostras. Las autoridades locales de Marina debían reservar los bancos naturales hasta su completa repoblación y en la vigilancia colaborarían las embarcaciones del resguardo marítimo. These acts indicate the government was sufficiently concerned about the state of oyster beds and that declines in stock were likely noticeable…

6.7 Letters and published news

Royal cédula to Rodrigo de Bastidas, bishop of Venezuela and Cabo de la Vela, in which he is asked for information on the introduction of canoes and Indians in the oyster fisheries of Cabo de Vela and the convenience of placing there a person who was in charge of justice. Edit. P.N.M.: I.A.C., vol. 1, doc. nº 99, p. 173

http://pares.mcu.es/ParesBusquedas20/catalogo/description/237391?nm

Year 1541. Producer: Council of the Indies. Notes on the side: To the bishop of Beneçuela. So that it contains a list of the status of the pearl fishery.

Título: Real cédula a Rodrigo de Bastidas, obispo de Venezuela y Cabo de la Vela, en la que se le pide información sobre la introducción de canoas e indios en las pesquerías de ostras de Cabo de Vela y la conveniencia de poner allí una persona que tuviese cargo de justicia.

Productor: Consejo de Indias.

Notas al margen: al obispo de Beneçuela. Para que enbíe relación del estado en que está la pesquería de las perlas'.

Méritos y servicios: generales Bartolomé y Francisco Carreño. PATRONATO,254,N.3,G.5,R.1

http://pares.mcu.es/ParesBusquedas20/catalogo/description/126893?nm

Year 1604. Merits and services: general Bartolomé and Francisco Carreño. Producer: Council of the Indies (Spain).

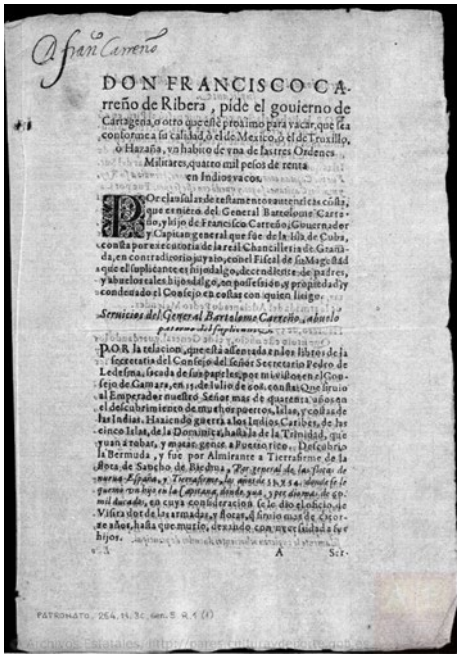
Scope and content: Printed list of the merits and services of Generals Bartolomé and Francisco Carreño, father and son. It is known that Bartolomé Carreño served more than 40 years in the discovery of many ports, islands and coasts of the Indies. He discovered Bermuda; He was admiral of Sancho Biedma's fleet to Tierra Firme, and general of the fleets of New Spain and Tierra Firme in the years 1553 and 1554, where he burned a son in the captaincy and lost more than 6,000 ducats, for whose services he gave him the office of inspector of navies and fleets, in which he served more than 14 years, until his death. Francisco Carreño went to Peru with Viceroy Blasco Núñez Vela, where he served many years in the company of his grandfather in discovering pearl oysters and conquering the islands of Cape Verde and the South Sea. He was captain against the Maroon Indians, seizing the King from him, and persecuted the tyrant Lope de Aguirre in Veragua. He was lieutenant general of the Kingdom of Tierra Firme, and served as captain in the army of the advanced Pedro Meléndez. There are other services for which he was given the office that his father had of visiting navy and fleets.- There are also two requests [Valladolid, July 16, 1604].

C3.4.Report of the results of the scoping activities

Productor: Consejo de Indias (España).

Alcance y contenido:

Relación impresa de los méritos y servicios de los generales Bartolomé y Francisco Carreño, padre e hijo. Consta que Bartolomé Carreño sirvió más de 40 años en el descubrimiento de muchos puertos, islas y costas de Indias. Descubrió Bermuda; fue almirante de la flota de Sancho Biedma a Tierra Firme, y general de las flotas de Nueva España y Tierra Firme los años de 1553 y 1554, donde se le quemó un hijo en la capitana y perdió más de 6.000 ducados, por cuyos servicios se le dio el oficio de visitador de armadas y flotas, en el que sirvió más de 14 años, hasta su muerte. Francisco Carreño pasó al Perú con el virrey Blasco Núñez Vela, donde sirvió muchos años en compañía de su abuelo en ***descubrimientos de ostras de perlas y conquista de islas de Cabo Verde y Mar del Sur****. Fue capitán contra los indios cimarrones, prendiendo a su Rey, y persiguió al tirano Lope de Aguirre en Veragua. Fue teniente general del Reino de Tierra Firme, y anduvo como capitán en la armada del adelantado Pedro Meléndez. Constan otros servicios por los que se le dio el oficio que tuvo su padre de visitador de armadas y flotas.- Hay también dos peticiones [Valladolid, 16 de julio de 1604].*



DON FRANCISCO CA-
rreño de Ribera, pide el gouierno de
Cartagena, o otro que esté proximo para vacar, que sea
conforme a su calidad, ó el de Mexico, ó el de Truxillo,
ó Hazaña, vn habito de vna de las tres Ordenes
Militares, quatro mil pesos de renta
en Indias vacos.

POr la fauorable testamento autentica cõsta,
que el mieco del General Bartolome Carre-
ño, y hijo de Francisco Carreño, Gouernador
y Capitan general que fue de la Isla de Cuba,
consta por certeza de la real Chancilleria de Granã-
da, en contradictorio juyzio, con el Fiscal de su Magd.
que el suplicante es hijo dalgo, decendiente de padres,
y abuelos reales hijos dalgo, en possession y propiedad, y
condenado el Consejo en costas con quien litigo.

Seruicios del General Bartolome Carreño, abuelo paterno del suplicante.

POR la relacion, que está asentada en los libros de la
Secretaria del Consejo del señor Secretario Pedro de
Ledesma, (escala de sus papeles) por mi visto en el Con-
sejo de Camara, en 15 de Iulio de 1604. consta, que siruio
al Emperador nuestro Señor mas de quarenta años en
el descubrimiento de muchos puertos, Islas, y costas de
las Indias. Haziendo guerra a los Indios Caribes, de las
cinco Islas, de la Dominica, hasta la de la Trinidad, que
yuan a robar, y matar gente a Puerto rico. Descubrio
la Bermuda, y fue por Almirante a Tierra firme de la
flota de Sancho de Biedma, *Por general de las flotas de
nueva España, y Tierra firme, los años de 1553, y 54. donde se le
quemo vn hijo en la Capitana, donde yua, y perdiamos de go-
mil ducados*, en cuya consideracion se le dio el oficio de
Visitador de las armadas, y flotas, el siruio mas de cator-
ze años, hasta que muriò, dexando con vxor (viuda) a su
hijos.

A Sur.

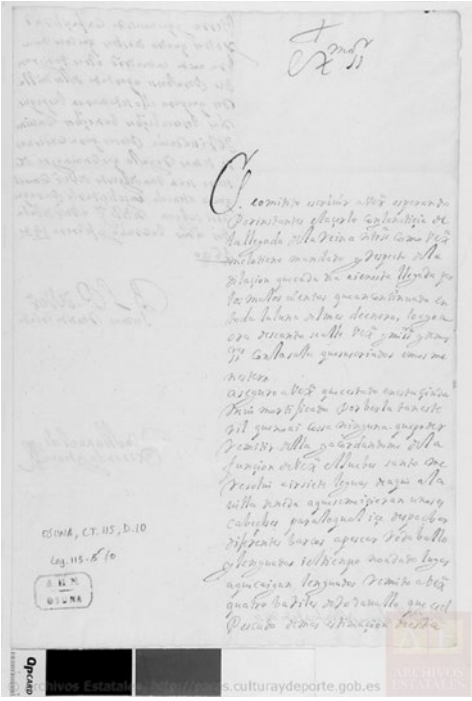
PATRONATO, 254.14.3C. Gen. 5 R.4 (1)

Cartas de Manuel Xironda y Torres [Gregorio de Silva Mendoza, X] duque del Infantado, donde relata la llegada de la reina a La Coruña, regalos recibidos (ostras, pescado en escabeche, un reloj) y de los festejos que se hicieron en su honor. OSUNA,CT.115,D.10-3

http://pares.mcu.es/ParesBusquedas20/catalogo/description/3936196?nm

Year 1690. Letters from Manuel Xironda y Torres [Gregorio de Silva Mendoza, X] Duke of Infantado, where he recounts the arrival of the Queen to La Coruña and the gifts received (oysters, pickled fish, a watch) and the festivities that took place in her honour.

Cartas de Manuel Xironda y Torres [Gregorio de Silva Mendoza, X] duque del Infantado, donde relata la llegada de la reina a La Coruña, regalos recibidos (ostras, pescado en escabeche, un reloj) y de los festejos que se hicieron en su honor.



Carta de Fray Manuel Pimentel a su pariente el Conde de Benavente para que recomendase en el Consejo un asunto del Padre Muerta. Quien le había hecho Abad de Celanova, y anunciándole el envío de doce barriles de ostras?. OSUNA,CT.252,D.88

http://pares.mcu.es/ParesBusquedas20/catalogo/description/3924848?nm

Year 1697. Producer: Condado-ducado de Benavente. Letter from Fray Manuel Pimentel to his relative, the Count of Benavente, to recommend a matter of Padre Muerta to the Council? Who had made him Abad of Celanova, and announced the shipment of twelve barrels of oysters?.

Productor: Condado-ducado de Benavente. Ducado de osuna.

Título: Carta de Fray Manuel Pimentel a su pariente el Conde de Benavente para que recomendase en el Consejo un asunto del Padre Muerta? Quien le había hecho Abad de Celanova, y anunciándole el envío de doce barriles de ostras?.

El Correo de Ultramar : Parte literaria é ilustrada reunidas: Tomo V Año 14 Número 105 – 1855

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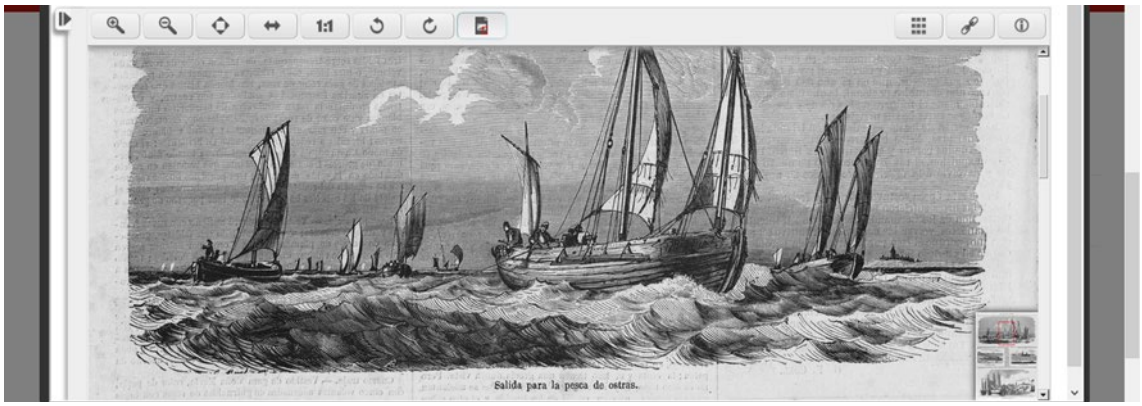
https://prensahistorica.mcu.es/es/consulta/registro.do?id=11000254938
https://prensahistorica.mcu.es/es/consulta/resultados_ocr.do

Year 1855. Oyster fishing techniques in France, fishing zones, value, quantity extracted. “The oyster is an exciting appetite that opens the desire to eat. In France, oysters are highly valued: Montaigne wrote the following lines: "Being subject to colic or depriving yourself of eating oysters are two ills for one, since it is necessary to choose between the two."

Técnicas de pesca de ostra en Francia, zonas de pesca, valor, cantidad extraída. “la ostra es una excitante del apetito que abre las ganas de comer. En Francia las ostras son muy estimadas: Montaigne escribió las siguientes líneas: “Estar sujeto a tener un cólico o privarse de comer ostras, son dos males por uno., puesto que es preciso elegir entre los dos”.


Salida para la pesca de ostras.

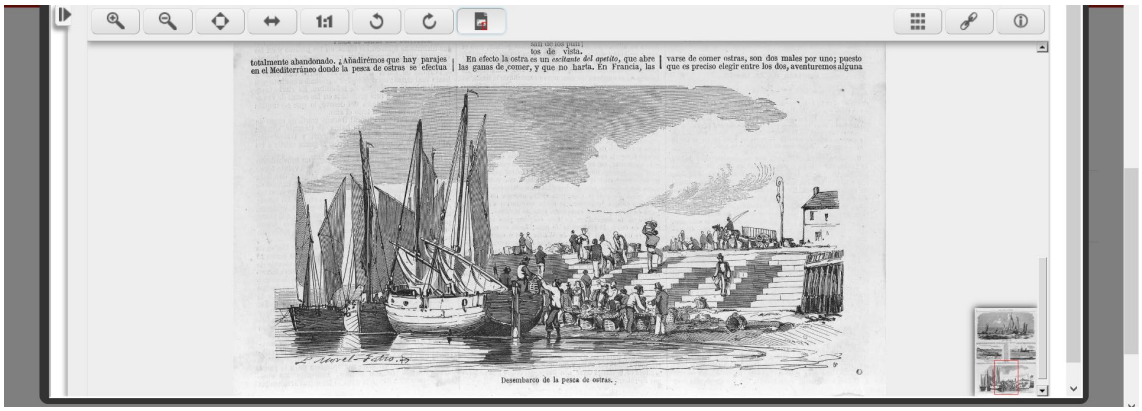

en la superficie del banco; pero este método que no puede practicarse sino cuando hay poco fondo, se halla totalmente abandonado. ¿Añadirémos que hay parajes en el Mediterráneo donde la pesca de ostras se efectua por medio de buzos que esponen su vida para arrancarlas de las rocas submarinas?

¿Hablarémos de las ostras de perlas, que son el objeto de los peligrosos trabajos de los pescadores del golfo Pérsico? Pero esta segunda pesca no puede tratarse ligeramente en algunas líneas, y aquí escribimos bajo el *punto de vista* gastronómico, como dirian los hombres de estado, que tanto usan y abusan de los puntos de vista.

En efecto la ostra es un *excitante del apetito*, que abre las ganas de comer, y que no harta. En Francia, las ostras son muy estimadas: Montaigne escribió las siguientes lineas: « Estar sujeto á tener un cólico ó privarse de comer ostras, son dos males por uno; pu que es preciso elegir entre los dos, aventuremos al

Pesca de ostras con barredera.

Pesca de ostras con rastro.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En efecto la ostra es un excitante del apetito, que abre las ganas de comer, y que no harta. En Francia, las
varse de comer ostras, son dos males por uno; puesto que es preciso elegir entre los dos, aventuremos alguna
Desembarco de la pesca de ostras.


Mujeres escojiendo las ostras.


DU PARC AUX HUITRES
Parque de las ostras en Cancale.

Estos hombres arreglan primeramente las ostras en los parques, pero esto no basta; durante los primeros tiempos que siguieron á la pesca, las sacan del agua tres ó cuatro veces por dia, con unos rastrillos de hierro. Cada vez que las sacan las examinan; separan las que están muertas, y colocan de nuevo á las otras en las zanjas. La ostra que está en la zanja se hace muy delicada, y no puede pasar sin peligro, de la vida salvaje de los bancos, á la existencia doméstica. ¡Pero tambien cuando sale de allí es bien apetitosa!

Las ostras que han permanecido en San Vaast, donde están los parques mayores que se conocen, para pasar de allí á otros mas pequeños, no necesitan tan-

Carro acelerado para el trasporte de ostras al camino de hierro de Paris.

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https://prensahistorica.mcu.es/es/consulta/resultados_busqueda_restringida.do?idOrigen=163311&tipoResultados=PAG&busq_anyopublicacion=1874&descrip_anyopublicacion=1874

year 1874. According to Me Payen, sixteen dozen oysters represent the 315 grams of azotic substance necessary for the daily nutrition of a man of medium height: consequently, to feed one hundred people during a day, only with these mollusks, nineteen are needed one thousand two hundred.

"Según Me Payen, diez y seis docenas de ostras representan los 315 gramos de sustancia azótica necesarios a la nutrición diaria de un hombre de mediana estatura: por consecuencia para alimentar a cien personas durante un día, solamente con estos moluscos, hacen falta diez y nueve mil doscientas".

6.8 Oyster aquaculture

6.8.1 18th Century (1700s)

SAÑEZ REGUART, Antonio. 1793. Diccionario Histórico de las artes de pesca nacional. Tomo Quarto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

-P292, 293-

Year 1791. On our coasts, oyster beds are not established with the same care as in other countries, where the money invested in a work of this kind, places the owner in a very profitable estate, because the abundance and better quality of the oysters, derived from the seasoning that they acquire in such hatcheries or receptacles, provide a safe fishery in the appropriate season, and the consequent advantageous sale.

In some parts of Galicia, whose seas produce exquisite oysters, there are large harvests that the lay of the seabed or some bridge provides, and from them a small trade is made in pickle, which could perhaps be much larger, if some sites were taken advantage of in which there is no remote prejudice to navigation, inviting them to build oyster beds.

The same can be said for some others on the coasts of Asturias and Cantabria. Experience leads to propose it, since in the Port of San Vicente de la Barquera, the large amount of stone that shelters the spats of its magnificent and ancient bridge serves as a perfect deposit (...).

En nuestras Costas no se hallan establecidas determinadamente Ostreras con el esmero qe en otros paises, donde el expendio invertido en una obra de esta especie, posesiona al propietario en finca de mucho rédito porque sobre la abundancia y mejor calidad de las Ostras \ dimanada de la sazón que adquieren en semejantes criaderos ó receptáculos , le facilitan una pesquería segura en la oportuna estación, y la venta consiguientemente ventajosa.

En algunos pargues de Galicia, cuyos mares producen exquisitas Ostras, hay grandes cosechas que la disposición del terreno ó algún puente proporciona , y de ellas se hace un pequeño ramo de comercio en escaveches, que acaso pudiera ser mucho mayor, si se aprovechasen algunos sitios en que no habiendo remoto perjuicio á la navegación , convidan á que se construyan en ellos Ostreras.

Lo mismo se puede decir por algunos otros de las Costas de Asturias, y las de Cantabria. La experiencia induce a proponerlo, pues queden el Puerto de San Vicente de la Barquera, la mucha piedra que abriga las cepas de su magnífico y antiguo Puente sirve de perfecto depósito (…).

6.8.2 19th Century (1800s)

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

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Year 1854. In France, Spain and Great Britain, the beginning of research into fisheries biology (marine biology applied to fishing and aquaculture) was triggered by the decline in catches of highly valued coastal species such as oysters and salmon. Acclimatisation of all kinds of useful exotic animal and plant species developed around the French Zoological Acclimatisation Society (created in 1854). During the first 14 years of its bulletin, nearly 90 articles on aquaculture were published, including those by the Spaniards Álvaro Reinoso (Nota para servir a la historia de la piscicultura, 1856) and Ramón de la Sagra (Informe al Consejo de Agricultura de Madrid, sobre la introducción de la piscicultura en España, 1857). In the European Atlantic, the best aquaculture installations were located in France (Arcachon Bay, Aiguillon Inlet, Ile de Ré, Concarneu), while in the Mediterranean they were more developed in Italy (Comacchio Lagoon, Lake Fusaro and Taranto Sea). Most of these installations were taken as reference models in Spain for the different aquaculture techniques.

Year 1862. In Spain, King Francisco Asís de Borbón encouraged the first steps for the development of modern aquaculture techniques. After visiting Novelda (Alicante) in 1862 and seeing "the first trials of artificial fish farming", he commissioned the Riojan doctor and naturalist Mariano P. Graells Agüera (1809-1898) to study the feasibility of establishing this novel technique on the Crown's land in the Segovian town of La Granja de San Ildefonso.

Year 1864. In July 1864, the necessary Manual de Piscicultura or Prontuario was published to serve as a guide for fish farmers in Spain (...), in our fresh and salt waters. Its author can be described as the first modern fisheries biologist in the country, as he was able to plan and develop coherent applied research into aquatic re-courses, promoting the modernisation of extraction techniques and the introduction of modern aquaculture, made up of molluscs, crustaceans and fish. He was responsible for the development of the national maritime industry in the 19th century and was also responsible for the overall management of the entire sector, comprising fishing, shellfishing and aquaculture.

Year 1854*. En Francia, España y Gran Bretaña, el inicio de las investigaciones sobre biología pesquera (biología marina aplicada a la pesca y acuicultura) se produjo por el descenso de las capturas de especies litorales muy valoradas, como la ostra y el salmón. Se desarrollaron tareas de aclimatación de todo tipo de especies exóticas útiles, animales y vegetales, en torno a la francesa Sociedad Zoológica de Aclimatación (creada en 1854). Durante los 14 primeros años de su boletín se publicaron cerca de 90 artículos sobre acuicultura, incluyendo los de los españoles*

Álvaro Reinoso (Nota para servir a la historia de la piscicultura, 1856) y Ramón de la Sagra (Informe al Consejo de Agricultura de Madrid, sobre la introducción de la piscicultura en España, 1857). En el Atlántico europeo las mejores instalaciones de acuicultura se ubicaban en Francia (bahía de Arcachon, ensenada del Aiguillon, isla de Ré, Concarneu), mientras que en el Mediterráneo estaban más desarrolladas en Italia (laguna de Comacchio, lago Fusaro y mar de Tarento). La mayoría de esas instalaciones se tomaron como modelo de referencia en España para las diferentes técnicas de acuicultura.

***Year 1862**. En España, el rey Francisco Asís de Borbón propició que se dieran los primeros pasos para el desarrollo de las modernas técnicas de acuicultura. Tras visitar en 1862 Novelda (Alicante) y comprobar "los primeros ensayos de piscicultura artificial", encargó al médico y naturalista riojano Mariano P. Graells Agüera (1809-1898) el estudio de la viabilidad de establecer esa novedosa técnica en los terrenos que la Corona tenía en la localidad segoviana de La Granja de San Ildefonso.*

***Year 1864**. En julio de 1864 se editó ese necesario Manual de Piscicultura ó Prontuario para servir de guía al Piscicultor en España (...), en nuestras aguas dulces y saladas. A su autor podemos calificarle como el primer biólogo pesquero moderno del país, pues fue capaz de planificar y desarrollar una coherente investigación aplicada de los re- cursos acuáticos, al impulsar la modernización de las técnicas extractivas y la implantación de la moderna acuicultura, compuesta por moluscos, crustáceos y peces. De su mano se desarrolló la industria marítima nacional decimonónica y, además, fue responsable de la ordenación global de todo el sector compuesta por pesca, marisqueo y acuicultura.*

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1860. In the 60', French industrialists wanted to exploit this activity in various points along the northern coast of the state, pointing out the good conditions offered by the estuaries and bays in this part of Spain, and above all the lack of regulations that would hinder its implementation. It seems that they were already aware of the quality of the oysters found in these areas.

-P182-

Year 1866. The report of the Permanent Fishing Commission confirms the "privileged natural conditions for the reproduction of the oyster" that the estuaries of northern Spain have in comparison with those of the rest of Spain, with special emphasis on the Galician, Basque and Cantabrian estuaries. For all these reasons, a Royal Order was drawn up, dated 15 July 1869, in

which the aforementioned gentleman (Mariano Graells) was instructed to go to the Maritime Department of Ferrol so that he could travel along the coast for two months to observe the most suitable place to establish a model park. At the same time, he was to report on the situation of the parks that had been granted up to that moment, as well as the banks for communal use, indicating which, in his opinion, should be closed to exploitation and used for breeding in order to supply the artificial parks. At the same time, a set of rules will be proposed to the Administration to establish the appropriate surveillance according to what has been observed on French soil.

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Year 1867. At this time there are already several reports, not very specific, on the interest in the cultivation of this mollusc or its fishing. The first mention is in 1867, in a Royal Order of 27 February of that year in which Guillermo de Lopategui, a resident of Bilbao, requests that he be allowed to fish for oysters off the coast of Santander and any other coast, using land where there are no registered fishermen or where they do not wish to engage in this activity. This claim is authorised, although with several conditions. Another Royal Order of 17 December of the same year authorised Máximo Goi- curia, a wealthy landowner, and the canning industrialist Mateo Llantada Barandica, both residents of Castro Urdiales, to establish an oyster farm in the Sámano estuary, provided that the dossier was formalised in accordance with the regulatory terms.

Año 1860. En los años sesenta industriales franceses pretendían explotar esta actividad en varios puntos de la costa norte del estado, señalando las buenas condiciones que ofrecen las rías y bahías de esta zona de España, y sobre todo la carencia de reglamentación que dificultase su implantación. Y es que, según parece ser, ya tenían conocimiento de la calidad de la ostra que se daban por estos parajes.

Año 1866. **E**l informe de la Comisión Permanente de Pesca confirma las “privilegiadas condiciones naturales para la reproducción de la ostra” que presentan las rías del norte de España con respecto a las del resto del estado, haciendo especial énfasis en las gallegas, las vascas y las cántabras. Por todo ello se redactó una Real Orden, con fecha 15 de julio de 1869, en la que se encargaba al citado señor (Mariano Graells) que se trasladase al Departamento Marítimo del Ferrol para que durante dos meses recorriera su costa con el fin de observar el lugar más adecuado para establecer un parque modelo. Al mismo tiempo, deberá de informar de la situación de los parques hasta ese momento concedidos así como de los bancos de uso procomunal indicando cual, a su entender, debería cerrarse a la explotación, destinándolo a la cría para surtir a los parques artificiales. Paralelamente se propondrá a la Admi- nistración una serie de normas para establecer la vigilancia adecuada según lo observado en suelo francés.

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Año 1867. Así en estas fechas se recogen ya varias noticias, no muy concretas, sobre el interés por el cultivo de este molusco o por su pesca. La primera cita se recoge en 1867, en una Real Orden del 27 de febrero de ese año en la que Guillermo de Lopategui, vecino de Bilbao solicita que se le permita dedicar- se a la pesca de ostra en las costas de Santander y cualquier otra, valiéndose de terrestres donde no haya matriculados o no quieran éstos dedicarse a tal actividad. Se le autoriza tal pretensión aunque con varias condiciones[22]. Otra Real Orden de 17 de diciembre de ese mismo año, autoriza a Máximo Goi- curia, acaudalado propietario, y al industrial conservero Mateo Llantada Barandica, ambos vecinos de Castro Urdiales para establecer un criadero de ostras en la ría de Sámano, siempre que se formalice el expediente en los tér- minos reglamentarios.

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

-P39-

Year 1868. In the Basque Country, the Provincial Council had prepared a regulation for the oyster nurseries that were to be set up in Zumaya in 1868. For the exploitation and marketing of oysters, the Compañía Ostrícola de Santander was created in Santoña and oyster deposits were set up in the Bilbao estuary. The oysters arrived at these latter facilities in hatcherty-boats from the Galician estuary of Camariñas and were kept alive until they were exported.

Year 1875. The State approved the creation of three practical oyster farming schools and in 1875, in the Madrid Gazette, it was decreed the "installation of the oyster farming school-park in the Vigo estuary", although it is not known if it ever worked.

Year 1876. The oyster park in Santa Marta de Ortigueira (1876-1887) (considered the Arcachon of the Galician estuaries; Fraga 1996) was chosen to set up the first model park in the estuary of Ortigueira in A Coruña. Its aims were to "disseminate education, supply mothers and seeds to the private parks and attend to the repopulation of the depleted banks of common use". Its inauguration coincided with the publication of the Regulation for the propagation and exploitation of shellfish.

-P40-

Year 1877. In Guipúzcoa, it seems that the first authorisations for oyster farms were granted to private individuals on the banks of the river Deva (in 1877 and 1878). In that province, interest in developing large-scale marine farming began with the opening in San Sebastian of a Zoological Station with ponds and nurseries, led by the Count of Peracamps, who had managed to overcome the administrative formalities and created the so-called Sociedad General para

Explotaciones Científico-Industriales de Piscicultura [Aquaculture], which operated between 1891-1899.

-P39-

Year 1868. En el País Vasco, la Diputación Foral había preparado un Reglamento para los viveros de ostras que se iban a instalar en Zumaya en 1868. Para la explotación y comercialización de las ostras se creó la Compañía Ostrícola de Santander en la bahía de Santoña y se instalaron depósitos ostreros en la ría de Bilbao. A estas últimas instalaciones llegaban las ostras en barcos-viveros procedentes de la ría gallega de Camariñas y se mantenían vivas hasta el momento de su exportación.

Year 1875. El Estado aprobó la creación de tres Escuelas prácticas de Ostricultura y en 1875, en la Gaceta de Madrid, llegó a decretarse la "instalación del parque-escuela de ostricultura en la ría de Vigo", aunque se desconoce si llegó a funcionar.

Year 1876. Para la puesta en marcha del primer parque modelo se eligió la coruñesa ría de Ortigueira Parque de Ostricultura de Santa Marta de Ortigueira (1876–1887) (considerada el Arcachon de las rías de Galicia; Fraga 1996). Sus fines fueron "divulgar la enseñanza, suministrar madres y semillas a los parques particulares y atender a la repoblación de los esquilmados bancos de aprovechamiento común". Su inauguración coincide con la publicación del Reglamento para la propagación y aprovechamiento de los mariscos (1876).

-P40-

Year 1877. En Guipúzcoa parece que las primeras autorizaciones para criaderos de ostras se concedieron a particulares en la ribera del río Deva (en 1877 y 1878). En esa provincia, el interés por desarrollar los cultivos marinos a gran escala se inició con la inauguración en San Sebastián de una Estación Zoológica con estanques y viveros, liderada por el conde de Peracamps. Éste había conseguido superar los trámites administrativos y creó la denominada Sociedad General para Explotaciones Científico-Industriales de Piscicultura [Acuicultura], que funcionó entre 1891–1899.

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Year 1874. In the same way, the idea of setting up a school-park that would serve as a model for the other parks continued, and the aforementioned Mr. Paz Graells was entrusted with the task. To this end, he went to the French coast and the Swiss lakes to see *in situ* how this activity was evolving in these European countries, especially in the neighbouring country where this industry

was so well developed. In this way, and culminating all these actions aimed at implementing and developing this industry, and observing the progressive request for parks by private individuals, which in 1874 reached the figure of 41 establishments in the whole of Spain, the Spanish parks needed to buy oysters.

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Year 1875. However, it seems that the first trials did not bear the desired fruit, with little success. The concessionaires applied for land where this mollusc was already growing, dedicating themselves to exploiting and plundering what was spontaneously raised there for their own benefit and building wasteful constructions that did nothing to help the intended purpose: oyster farming.

Año 1874. Del mismo modo se continúa con la idea de instalar un parque-escuela que sirva de modelo a los restantes parques, encargándole la labor al citado Sr. Paz Graells. Para ello marcha a recorrer las costas francesas y los lagos suizos para conocer in situ como iba evolucionando esa actividad en esos países europeos, sobre todo en el país vecino donde tan desarrollada estaba esta industria. De este modo, y culminando todas estas acciones encaminadas a implantar y desarrollar esta industria, y observando la progresiva solicitud de parques por parte de particulares, que ya en 1874 alcanzaba la cifra de 41 establecimientos en todo el Estado.

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Año 1875. Sin embargo, los primeros ensayos parece ser que no dieron el fruto desea- do, obteniendo escaso éxito. Los concesionarios solicitaban terrenos donde ya se daba este molusco, dedicándose a explotar y esquilmar lo que espontáneamente se criaba en ellos para su propio beneficio y realizando baldías construcciones que en nada ayudaban al fin proyectado: la cría de la ostra.

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

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Year 1879. When (the King) Alphonse XII travelled to Arcachon in August 1879, he included in his programme of visits the aquarium, several points of the bay by boat and its famous oyster parks. These had generated a profit of 200 million reais the previous year.

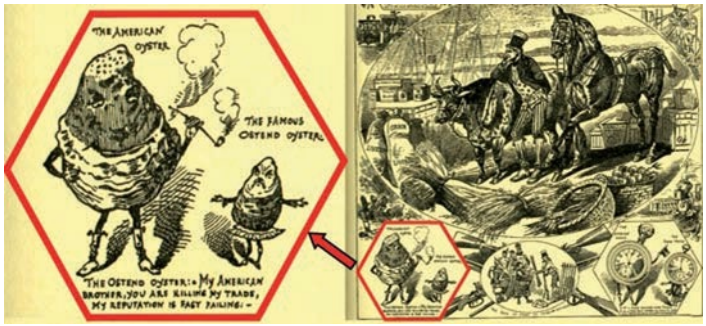
Cuando en agosto de 1879 Alfonso XII viajó a Arcachon, incluyó en su programa de visitas el aquarium, varios puntos de la bahía en barca y sus célebres parques ostreros. Éstos habían generado el año anterior un beneficio de 200 millones de reales.

Spanish Oyster Park in Arcachon:

|2| Libro popular con nociones de acuicultura marina (Vega, 1862).
|3| Parque ostrero español en Arcachon (1879).

-P37-

Advertising for North American Oysters (1877).



Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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Period 1880-1885. It was not until 1880 that the oyster farming industry really began in the Bay of Biscay and I might even venture to say in Spain. The real driving force behind this was Arsenio Isidoro de Igual y Fol, a native of Arnuero who in 1857 decided to emigrate to Mexico and the USA and later returned to Cantabria and settled in Santander. It was he who, in 1879, had the happy idea of establishing this industry and putting his knowledge of the subject into practice, as he had previously practised this industry in the United States and had also travelled and observed how it was developing in the main oyster-growing areas of Europe.

Thus, on 3 October 1880, he asked the Town Council for two pieces of land, one of 2 ha in the Boo estuary (in what would now correspond to the area of the new dock and the Bengoa marshes) and another larger one of 4 ha between the Jorge and Colindres channels, which were granted to him by Royal Order dated 8 March 1881. He acted quickly and three months later he

had already placed a million and a half mother oysters brought from Arcachon and 60,000 tiles, as well as presenting all the necessary tools for this activity.

(...) After several conversations, he prepared to leave for the French town of Arcachon, where he hired one of the most famous oyster farmers in the area to travel along the Cantabrian coast with him in order to determine which bay offered the greatest advantages for the purpose, finally deciding in favour of Santoña and Santander27. Once the location had been chosen, the next step was to formalise a company called Compañía Ostrícola de Santoña, in which Pedro Asúa y Barturen and Ricardo Igual Lavín became partners, and then apply for the land to begin their activity. Thus, on 3rd October 1880, it asked the Town Council for two pieces of land, one of 2 hectares in the Boo estuary.

In 1881 Ricardo Lavín Igual began the exploitation of 6 hectares of emerging land in what was known as Cicero beach, between the Colindres estuary to the east and the Jorge canal to the west.

In 1882, he began to build constructions to facilitate both conservation and shipping. Thus, on an islet near the small park, he built a dwelling house and a warehouse with a storage area for export. At the same time, he set up a hut with another export depot at Boo station in order to make it easier to dispatch consignments to national markets by rail.

In 1884, the Compañía Ostrícola de Santander supplied 80% of the oysters consumed in the country, followed by Arcachon with 15% and the remaining 5% from the natural banks. Consignments were also shipped by sea to other European consumers of this product, such as Arcachon (France) and London (England).

Year 1885. The lack of important natural parks in the state obliged the industrialists to import mother oysters from abroad, specifically from Arcachon. Shipments of oysters measuring more than 5 cm, which was the minimum size allowed by French legislation for export, were sent by sea. These oysters owed customs duties in the ports of Santander and San Sebastian, as the customs office in San Sebastian was not authorised for such merchandise. For this reason, Mr. Igual, together with another industrialist in the sector, requested the authorisation of the Santoña customs office for the direct import of oysters from abroad.

With the above data, it can be seen that the mortality rate was around 20%. In the first year, the mortality rate was higher due to the long number of days that the cargoes had to spend as they were unable to enter directly through the customs office in Santoña. The result obtained in June 1884 was attributed by the Director of the company to the heavy snowfall in the winter of 1883 in the area of origin, which caused the thaw to flood the large bay of Arcachon with fresh water. Of this percentage, it was accepted that three quarters came from the difficult task of separating the oysters from the collectors, a very delicate operation, and the remaining quarter came from

placing them in the crates. The missing oysters included those that could not cling to the tiles and were carried away by the currents.

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He suggested the idea of repopulating the bay of Santander with a large number of oysters (20,000,000) and introducing 1,000,000,000 shingles in order to ensure reproduction, without the need to bring mother oysters from French territory. They also asked for extreme vigilance to ensure that no oyster that was not 6 cm long was taken from any park. This last request was heard, the other requests did not bear the desired fruit.

TABLA 2. *RESULTADOS FINALES DE LAS OSTRAS IMPORTADAS EN LOS AÑOS 1881-1883 EN LAS FECHAS CORRESPONDIENTES (%).*

	1881		1882		1883
	31/12/1881	31/12/1882	Junio 1883	Junio 1884	Junio 1884
Muertas.....	27	14	17	13	75
Desaparecieron.....	14	9	12	10	–
Obtuvieron de 8 a 9 cms.....	10	25	9	27	–
Obtuvieron de 7 a 8 cms.....	15	35	17	36	–
Obtuvieron de 6 a 7 cms.....	24	10	30	9	15
Obtuvieron de 5 a 6 cms.....	10	7	15	5	10

Fuente: Ver Tabla 1

Table 6. imported oysters from 1881-1883 (%) of dead, disappearance, achieved 8-9 cm; 7-8 cm; 6-7 cm; 5-6 cm.

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Período 1880-1885. No será hasta 1880 cuando se inicie realmente la industria de la ostricultura en el Cantábrico e incluso me podría arriesgar a decir que en España. El verdadero propulsor de ello fue Arsenio Isidoro de Igual y Fol, un indiano natural de Arnuero que en 1857 decidió emigrar a México y EE.UU. para posteriormente regresar a Cantabria y avecindarse en Santander. Él fue quien en 1879 tuvo la feliz idea de establecer esta industria y poner en practica sus conocimientos en la materia, pues ya con anterioridad había practicado esta industria en los Estados Unidos y además había viajado y observado cómo se venía desarrollando dicha industria en las principales zonas ostrícolas de Europa.

Así, el 3 de octubre de 1880 pide al Ayuntamiento dos trozos de terrenos, uno de 2 ha en la ría de Boo (en lo que en la actualidad correspondería a la zona de la dársena nueva y marismas de Bengoa) y otro mayor de 4 ha entre los canales de Jorge y Colindres, los cuales le fueron concedidos por Real Orden de fecha 8 de marzo de 1881. Actúa con rapidez y tres meses después

tiene ya colocadas millón y medio de ostras madres traídas de Arcachon y 60.000 tejas, además de presentar todos los útiles necesarios para dicha actividad.

(…) Tras varias conversaciones mantenidas se preparó para partir rumbo a la localidad francesa de Arcachon donde contrató a uno de los ostricultores de más fama de esa zona para, junto a él, recorrer la costa del Cantábrico con el fin de disponer qué bahía ofrecía las mayores ventajas para el fin busca- do, decantándose al final por Santoña y Santander[27]. Elegido el lugar, el siguiente paso fue formalizar una sociedad titulada Compañía Ostrícola de Santoña, en la que entraban como socios Pedro Asúa y Barturen y Ricardo Igual Lavín, y tras ello solicitar los terrenos para comenzar su actividad. Así, el 3 de octubre de 1880 pide al Ayuntamiento dos trozos de terrenos, uno de 2 ha en la ría de Boo.

Año 1881. Ricardo Lavín Igual, inicia la explotación de 6 ha de terreno emergente en lo que se conoce como playa de Cicero, entre la ría de Colindres por el este y el canal de Jorge por el oeste.

En 1882 empieza a levantar construcciones que facilitarán tanto la conservación como su expedición. Así construye en una isleta próxima al parque menor una casa vivienda y un almacén con un parque depósito para la exportación. Paralelamente instala una caseta con otro depósito para la exporta- ción en la estación Boo con el fin de expender más cómodamente las remesas a los mercados nacionales por vía férrea.

Year 1884. la Compañía Ostrícola de Santander suministraba el 80% de las ostras que se consumían en el país, siguiéndole Arcachon con un 15% y el 5% restante de los bancos naturales. También se expendían partidas, vía marítima, a otros lugares europeos consumidores de este producto, como por ejemplo Arcachon (Francia) y Londres (Inglaterra).

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Year 1885. La falta de parques naturales de consideración en el estado obligaba a los industriales a importar las ostras madres del extranjero, concretamente de Arcachon. Se remitían vía marítima cargamentos de ostras de medida superior a 5 cm, que era la talla mínima que permitía la legislación francesa para su exportación, las cuales, adeudaban los derechos de aduana en las plazas de Santander y San Sebastián ya que la aduana santoñesa no estaba habilitada para tal mercancía. Por este motivo el Sr. Igual junto a otro a industrial del ramo solicitaron la habilitación de la aduana de Santoña para la importación directa de ostras del extranjero.

Con los datos expuestos se puede apreciar que la mortandad rondaba el 20%. En el primer año apuntado, ésta fue mayor debido al elevado número de días que tuvieron que sufrir los cargamentos al no poder entrar directa- mente por la aduana santoñesa. El resultado obtenido en junio de 1884, el Director de la sociedad lo achacaba a las grandes nevadas que en el invierno de 1883 cayeron en la zona de origen provocando que el deshielo inundara de agua dulce la amplia bahía de Arcachon. De ese porcentaje se aceptaba que 3/4 partes procedía de la difícil tarea de separar las ostras de los colectores, operación que conllevaba mucha delicadeza y el

1/4 restante al colocarlas en las cajas. Entre las desaparecidas se contabilizaban las que no pudieron aferrarse a las tejas siendo arrastradas por las corrientes.

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Se sugiere la idea de repoblar la bahía de Santander con un gran número de ostras (20.000.000) e introducir 1.000.000 de tejas para, de esta forma, tener asegurada la reproducción, no necesitando traer ostras madres ya de territorio francés. También solicitan que se extreme la vigilancia para que no se saque de ningún parque ostra que no tenga 6 cm. Esta última solicitud fue oída, el resto de peticiones no obtuvieron el fruto deseado.

6.8.3 20th Century (1900s)

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

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20th Century. In the first decades of the 20th century, producers once again insisted on the need to "plant" the emerging land with mother oysters. The patience required to carry out such a project clashed head-on with commercial interests seeking a short-term return on the capital invested. The care required for reproduction influenced the decision to opt for rearing, and it is not surprising that, for this reason, the work aimed at their multiplication was abandoned.

Years 1912-1914. In the Bay of Santander, the catches fell sharply during 1912-1914. Statistical sources blamed two phenomena as the main causes of these falls. On the one hand, and applicable only to the Bay of Santander, the aforementioned water from the mineral washings, and on the other hand, and in a special way, the effects produced among the population by the alarming and scandalous journalistic campaign propagated during the first months of 1912, which advised against the consumption since they were the spreaders of typhoid fever (…).

During 1913, it is reported that the unfounded reports continued to cause losses, although it was hoped that consumption would return to its usual state with the installation of new systems to ensure immunity. As early as 1914, the panic seems to have subsided, although consumers were still somewhat withdrawn. This attitude was also attributable to the shortage of money in the second half of that year due to the special circumstances in the country and throughout the Old Continent (World War I), which would undoubtedly have a limiting effect on sales (…).

These two conjunctural reasons seriously affected the weak health of this industry, although another chronic problem would be the one that, together with them, would certify its terminal state.

Year 1930. In 1930, the Compañía Ostrícola de Santander still had the Boo deposit, with a staff of four employees. The Company was never able to stop depending on the supply of spats from Arcachon. The Great War of 1914-18, the flat oyster epizootic of 1919-22, and the general

monetary and commercial disturbances of the inter-war period hindered or prevented supplies from the French town and the Santander Oyster Company languished.

1970 -1980. In the 1970s, in parallel with the disappearance of the natural oyster beds in Galicia, oyster farming began to develop, and during the peak of production around 300 oyster rafts(/bateas) were installed.

20th Century. En las primeras décadas del S XX, los productores vuelven a insistir en la necesidad de sembrar con ostras madres los terrenos emergentes. La paciencia exigible para llevar a cabo dicho proyecto chocó frontalmente con los intereses mercantiles que buscaban una amortización a corto plazo del capital invertido. Los cuidados que requiere la reproducción influirán a la hora de decantarse por la recría, no extrañándonos que, por dicho motivo, se fueran abandonando los trabajos encaminados a su multiplicación.

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En la Bahía de Santander los resultados descienden de forma pronunciada durante 1912-1914.

Las fuentes estadísticas responsabilizaban a dos fenómenos como los principales causantes de tales caídas. Por un lado, y aplicable solamente a la bahía santanderina, las ya comentadas aguas provenientes de los lavaderos de mineral, y por otro lado y de manera especial, los efectos que produjo entre la población la alarmante y escandalosa campaña periodística propagada los primeros meses de 1912 que desaconsejaba el consumo de estos acéfalos por entender que eran los propagadores de fiebres tifoideas.

Durante 1913 se indica que aquellas noticias infundadas siguen cau- sando pérdidas, si bien se esperaba que el consumo volviera a su estado habi- tual con la instalación de nuevos sistemas que aseguraban su inmunidad. Ya en 1914 se especifica que ese pánico parece ser había remitido, si bien toda- vía continuaban los consumidores algo retraídos. Esta actitud fue también imputable a la escasez de dinero que se observaba en el segundo periodo de ese año debido a las especiales circunstancias por las que atravesaban el país y todo el Viejo Continente (I Guerra Mundial) que sin lugar a dudas estran- gularía y limitaría su venta.

Estos dos motivos coyunturales afectaron gravemente a la débil salud de esta industria, si bien otro problema de tipo crónico será el que junto a ellos, certifique su estado terminal.

Año 1930. En 1930 la Compañía Ostrícola de Santander todavía mantenía el depósito de Boo, contando con una plantilla de cuatro empleados. La Compañía nunca pudo dejar de depender del suministro de cría de Arcachon. La Gran Guerra de 1914-18, la epizootia padecida por la ostra plana en 1919-22, y en general las perturbaciones monetarias y comerciales del período de entreguerras obstaculizaron o impidieron el abastecimiento desde la localidad francesa y la Ostrícola de Santander languideció .

Década de 1970. En la década de los 70', paralelamente a la desaparición de los bancos de ostra naturales en Galicia, comienza a desarrollarse su cultivo para el que llegaron a instalarse en la época de mayor producción alrededor de 300 bateas.

Project OYSTERECOVER (https://observatorio-acuicultura.es/comunicacion/actualidad/el-proyecto-oysterecover-hace-publico-su-informe-sobre-los-avances-en-la)

Period 1970-1980. In the early 1970s and throughout the 1980s, two diseases (caused by the parasites *Marteilia refringens and Bonamia ostreae*) spread, drastically reducing production in practically all the traditional aquaculture areas.

A principios de los 70 y a lo largo de los 80 dos enfermedades (producidas por los parásitos Marteilia refringens y Bonamia ostreae) se propagaron reduciendo drásticamente la producción en la práctica totalidad de las áreas tradicionales de cultivo.

Gomes, I. 2013. Cultivo, Biología reproductiva y Bioquímica de la Ostra japonesa Crassostrea gigas en la Ría de Arousa. Tesis Doctoral. Universidad de la Coruña

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Year 1991. The introduction of the Japanese oyster *C. gigas* in Galicia in 1991 meant a great advance in the oyster sector, due to its greater resistance and speed of growth in comparison with the flat oyster *O. edulis*, traditionally cultivated and native to this area. This situation, like any introduction of a foreign species, creates a great need for more detailed studies on the reproductive biology and culture cycle of *C. gigas*, under the environmental characteristics of the Spanish coasts, with special emphasis on the Galician production areas.

La introducción en Galicia de la ostra japonesa C. gigas en 1991 supuso un gran avance en el sector ostrícola, por su mayor resistencia y rapidez de crecimiento en comparación con la ostra plana O. edulis, de cultivo tradicional y autóctona de esta zona. Esta situación, como toda introducción de una especie foránea, crea una gran necesidad de estudios más detallados acerca de la biología reproductiva y del ciclo de cultivo de C. gigas, bajo las características ambientales en las costas españolas, con especial énfasis en las zonas de producción gallegas.

7 REFERENCES

Andreu, B. 1968. Pesquería y cultivo de mejillones y ostras en España. Publ Tec Jun.Pesca, 7: 302-320

ANSOLA FERNÁNDEZ, Alberto. 1996. Cambio económico y modo de vida en las comunidades pescadoras cántabras. Siglos XIX y XX. Tesis doctoral pre sentada bajo la dirección de José Sierra Alvarez (1889/1991), Departamento de Geografía, Urbanismo y Ordenación del Territorio, Universidad de Can- tabria, Santander 1996.

CUBILLO DE LA PUENTE, Roberto. 1998. El pescado en la alimentación de Castilla y León durante los siglos XVIII y XIX, Universidad de León, León. , p. 453.

Cuenca, D., Clemente, I., Gutiérrez, I. 2010. Using shell tools in Mesolithic and early Neolithic coastal sites from Northern Spain: experimental program for use wear analysis in malacological materials. Trabajos de prehistoria, 67, N.º 1, enero-junio 2010, pp. 211-225, ISSN: 0082-5638. doi: 10.3989/tp.2010.10037

Cornide Saavedra, J. 1788. Ensayo de una historia de los peces y otras especies marinas de la Costa de Galicia, arreglado al sistema del caballero Carlos Linneo. Con un tratado de las diversas Pescas, y de las redes y aparejos que se practican. En la oficina de Benito Cano.

Escudero, L.J. 2006. Ostricultura en las marismas de Cantabria: la eclosión de una actividad efímera. Monte Buciero 12: 175-223. ISSN 1138-9680.

Fernández, A. 2008. Cultivar ríos y mares: la acuicultura española en el siglo XX. Revista Internacional de Ciencias Sociales. Nº 27. Un siglo de pesca en España: nuevas perspectivas, nuevas aportaciones: 81-92.

Gomes, I. 2013. Cultivo, Biología reproductiva y Bioquímica de la Ostra japonesa Crassostrea gigas en la Ría de Arousa. Tesis Doctoral. Universidad de la Coruña

Gutierrez Zugasti, I. 2008. The exploitation of molluscs and other littoral resources in the Cantabrian region during the late Pleistocene and the early Holocene. Doctoral Thesis. University of Cantabria, 570 pp

Gutierrez Zugasti, I., Cuenca, D., Rasines del Río, P., Muñoz, E., Santamaría, S., Morlote, J.M. 2013. The role of shellfish in hunter–gatherersocieties during the Early Upper Palaeolithic: A view from El Cuco rockshelter, northern Spain. Journal of Anthropological Archaeology Volume 32, Issue 2, June 2013, Pages 242-256. doi.org/10.1016/j.jaa.2013.03.001

Ibisate, R. 2011. Alteraciones en C. gigas debidas a la presencia de Tributilestaño. Estudio comparativo e implicaciones diagenéticas en ostras del límite Aptiense inferior-superior (Cuenca Vaswco-Cantábrica). Tesis Doctoral. Universidad del Pais Vasco. 290 pp.

Madariaga, B. 1969. La ostricultura en España ensayos de repoblacion ostricola en la provincia de Santander. Consejo General de Colegios Veterinarios de España. Ed. San Francisco de Asís, Madrid. 118pp

Nadal, L. 2017. Conchylia y cocleae: transformaciones en la percepción culinaria de los moluscos durante la romanización del Noreste peninsular. Archaeofauna 26 (2017): 103-114

PAZ GRAELLS, Mariano de la. 1866. REGLAMENTO para el régimen DE LA OSTRICULTURA EN ESPAÑA. España Ministerio de Marina 23pp.

PAZ GRAELLS, Mariano de la. 1870. Exploración científica de las costas del departamento Marítimo del Ferrol verificada de orden del Almirantazgo por el vocal de la Comisión Permanente de Pesca D. Mariano de la Paz Graells en el verano de 1869, Est. Tipográfico de T. Fortanet, Madrid 1870.

Pérez-Camacho, A. 1987. The culture of mussels (Mytilus edulis) and Oysters (Ostrea edulis) in Spain. Proc. Aquaculture research in Latin America. Ed. J.A.J. Verreth; M. Carillo; S. Zanuy and E.A. Husiman. Lima, Peru, 19pp.

Pérez-Rubín, J. 2010. Los primeros 100 años de acuicultura española: divulgación e investigación (1855-1955) Capítulo I: Siglo XIX. Revista del Instituto Español de Oceanografía, 15: 34-41

Pérez-Rubín, J. Mariano P. Graells (1809-1898): Entre la pesca 'científica' y la ciencia pesquera en España. Actas IX Congreso de la Sociedad Española de Historia de las Ciencias y de las Técnicas, 2006;2: 1045-55.

Sánchez, M., 1936. La ostricultura en la Ría de Vigo. Industrias Pesqueras, nº 230.

SAÑEZ REGUART, Antonio. 1791-1795. Diccionario Histórico de las artes de pesca nacional. Tomos primero-quinto. Ed., Viuda de Ibarra, Hijos y Compañía - fl. 1785-1804. http://bdh.bne.es/bnesearch/Search.do?

Villena, Marqués de, 1766. Arte Cisoria o Tratado del arte de cortar del cuchillo. Biblioteca Real de San Lorenzo de El Escorial.

8 DATA SOURCES CONSULTED

1. LIBRARY DATABASES
   - Biblioteca Digital Hispánica: http://www.bne.es/es/Catalogos/BibliotecaDigitalHispanica/Inicio/index.html http://www.bne.es/en/Catalogos/HemerotecaDigital/

     Biblioteca nacional proyecto chef: https://bnelab.bne.es/proyecto/chef-bne/
   - Europeana: https://www.europeana.eu/es/
   - Biblioteca virtual Miguel de Cervantes: http://www.cervantesvirtual.com/
   - WorldCat: https://www.worldcat.org/
     Search: ostra, ostra plana, ostrea edulis, ostrícola, mariano de la paz graells
   - Portal de Archivos Españoles (PARES): http://pares.culturaydeporte.gob.es/inicio.html
     Búsqueda: ostras, ostra plana, ostrea, ostrea edulis
   - Biblioteca virtual CSIC: https://csic-primo.hosted.exlibrisgroup.com/primo-explore/search?search_scope=ALL_RESOURCES_scope&vid=34CSIC_VU1
     Search: Graells
   - Hispana: https://hispana.mcu.es/es/inicio/inicio.do
     https://hispana.mcu.es/es/consulta/busqueda.do#

     Búsqueda: ostra, ostra plana, ostrícola, Graells
   - Galiciana: https://biblioteca.galiciana.gal/gl/inicio/inicio.do
     Search: Mariano Paz Graells.
   - Biblioteca virtual prensa histórica: https://prensahistorica.mcu.es/es/inicio/inicio.do
     Search: ostras, bancos de ostra (93), miticultura (5 resultados)
   - The Sifter. Search the World of Food A TOOL FOR FOOD HISTORY RESEARCH: https://thesifter.org/

     Search: oyster recipes: https://thesifter.org/Home/Search?tab=search
   - Gbif Data base: https://www.gbif.org/species/2286060
   - Fondo Grewe de alimentación y gastronomía: https://mdc.csuc.cat/digital/collection/fonsgrewe
   - Repositorio IEO: http://www.repositorio.ieo.es/e-ieo/
   - Dialnet: https://dialnet.unirioja.es/servlet/revista?codigo=6792

     Search: ostricultura cantábrico, ostricultura Cantabria, ostricultura, País Vasco, ostricultura Galicia, ostricultura Asturias, ostra cantábrico, bancos naturales ostra (11) ostrea edulis (56 documentos), ostrea edulis culture, ostrea edulis biscay bay, ostra plana (34) Alejandro perez Camacho (36).

2. PHOTOS DATABASES:
   - Fototeca del Patrimonio Histórico: https://ipce.culturaydeporte.gob.es/documentacion/fototeca.html http://www.mcu.es/fototeca_patrimonio/search_fields.do?buscador=porCampos

Search: ostra, ostra plana, oyster.

3. SOCIETIES, UNIVERSITIES AND SURVEYS
   - The Royal Society: https://royalsociety.org/collections/catalogue-search/
   - Sociedad Española de malacología: http://www.soesma.es/; Revista Iberus: http://bionames.org/issn/0212-3010
   - Sociedad española de historia de las Ciencias y de las técnicas: https://sehcyt.es/; Llull: Revista de la Sociedad Española de Historia de las Ciencias y de las Técnicas: https://dialnet.unirioja.es/servlet/revista?codigo=1511
   - Archivo Histórico Provincial de Cantabria: https://www.culturadecantabria.com/archivo-historico
   - Centro de estudios montañeses: http://centrodeestudiosmontaneses.com/
     Search: Madariaga, Ostras, Moluscos, ostricultura

4. SCIENTIFIC JOURNAL ARTICLES
   - Web of Science
     Search: "oyster reefs" Spain, "oyster reefs" presence Spain, "oyster reefs" distribution Spain
   - GOOGLE ACADEMICS
     Search: bancos naturales" ostra España (400 results)

5. VIEWERS
   - Acuivisor: https://servicio.pesca.mapama.es/acuivisor/
   - Sigremar: capa de Bancos/bancos por recurso y te salen los bancos de ostra plana Bancos Cartografiados: http://ww3.intecmar.gal/Sigremar/
   - Visor acuícola: http://www.juntadeandalucia.es/agriculturaypesca/sia/index.xhtml

6. NAUTICAL CHARTS
   - Instituto hidrográfico de la marina: http://ideihm.covam.es/visor.html
   - Open sea map: http://map.openseamap.org/
   - Gps nautical ports: http://fishing-app.gpsnauticalcharts.com/i-boating-fishing-web-app/fishing-marine-charts-navigation.html#8.75/43.2452/-3.7107

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   - Paloma Carvallo. Spanish Ministry of Fisheries.
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   - Damián Costas (dcostas@ecimat.org). Universidad de Vigo. teléfono +34 986 815 711. Persona de contacto A través de Emilio Suárez.
   - Sergio Benitez. In Charge of the IEO National library and repository of Spanish Institute of Oceanography (IEO): sergio.benitez@ieo.es