SELECTIVE FISHING WEIRS IN THE GULF OF CADIZ: THE "CORRALES"

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Abstract

The coastline of the province of Cadiz (SW Spain) retains a magnificent example of sustainable profitability of the sea, as much as, a natural and historical treasure: the "corrales". These structures are weirs built of stone walls whose top level allows for the entry of fish during high tide and a closed exit and easy fishing during low tide. The origins, structures and operation are described herein. Regrettably, these structures face a severe danger of disappearance due to tourist related vandalism and the ensuing abandonment of this type of fishing. According to the assistance requested by the local bodies, the Regional Council has declared the "corrales" a Natural Monument bearing the status of a specially protected area. Furthermore, given its prominence, the Ministry of the Environment has taken over the repair and reconstruction works.

Keywords and phrases: Gulf of Cadiz, corrales, fishing traps, coastal management.

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Introduction

The Gulf of Cadiz has always been well known for its maritime activity and a rich fishing industry. Historical fishing tuna (Thunnus thynnus) when migrating through the Strait of Gibraltar, and the importance of the Scomber scombrus as a main ingredient in the famous "garum gaditanum" (fashioned at the age old factories of Baelo Claudia, Tarifa), were already recorded by Plinio the Old dating back to the first century (García-Bellido [11]).

Between the Guadalquivir River mouth and the Bay of Cadiz (Figure 1), a rocky platform emerges during low tide. This Plio-Quaternary outcrop is a bioclastic conglomerate, mostly composed by oysters and pecten shells, fossilised by a continental glacis consisting of quartz rich sands. This stratum lays in disconformity on the Pliocene rocks with a quasi horizontal dip (Gutierrez-Mas et al. [14]) and the beach profiles are supported on it (Muñoz-Pérez et al. [19]; Gómez-Pina [12]; Bernabeu et al. [3]). The existence of this rocky flat, in a zone bearing a tidal range of 4 meters, has allowed for the development of a selective, economic and environmentally friendly fishing technique.

The objective of this paper is not only to share the peculiarities (idiosyncrasies) of this system, found exclusively in the proximity of Cadiz and off the coast of Isle d´Oleron (France) (Figure 1), but also the steps being taken towards the reconstruction and preservation of these structures.

"Corral" Description

Historical origins

Fishing at the zone is a tradition which goes back to the times of the Roman Empire, this being confirmed by the location of a remarkable amount of archaeological discoveries. In the town of Chipiona, one of the better known sites is that of the "El Olivar", a ceramic factory whose main production line was that of amphorae, employed for the preservation and transport of pickled fish (Lapeña Marchena [15]). However, the authors have not found any mention of these corrales in the

documented historical sources pertaining to the epoch (Avieno, Estrabon, Mela, Plinio or Ptolomeo).

Under the Muslim sovereignty, the importance of fishing activity is remarkably reduced and is reinstated in the late Middle Age, though Lapeña Marchena [15] attributes an Arabic origin to these corrales. The most ancient cite corresponds to a letter written in 1399 (Regla library) where the founder of the Monastery of Our Lady of Regla donated the fishing corrales located on his village of Rota as a alimony for the monks. Afterwards, Ruano Fernández [20] points out that the Cadastre carried out by the Marquis of Ensenada (1751) registers the existence of eight fishing corrales in Chipiona: four of which were owned by the Regla Sanctuary, while the others were of non clerical dependence. For the latter, there appear ten names of individuals running the trap on a contract basis.

The first graphic reference known of these corrales in Chipiona can be seen in Figure 2, a map of the Guadalquivir River mouth, drawn up by Samuel Chaplain in 1599-1602 before his departure to Mexico. There exists, however, one earlier reference dating from 1564 of the corrales in the Caleta Cove of the city of Cadiz (Figure 3). Detailed sketches of the corrales, names included, can be found among the XVIII century cartographic collections.

On the French Atlantic coast, the corrales of the Isle of Oleron (46°00′N, 1°2′W) in the proximity of the Garona River mouth (Figure 1), extraordinarily similar in construction and application to those found in Cadiz, are considered to belong to the Middle Age. The oldest written reference in this case dates back to 1436 (Debande and Jugieau [7]; Desse-Berset [8]). Bouchard [6] remarks that fish weirs of similar characteristics may have existed in the North of Wales, there in turn, dating back to the days of the Roman Empire. Similar methods of using the tidal flow as an instrument for trapping fish, have been observed in Bahrain, Persian Gulf (Desse-Berset [8]) differing however in the use of wooden fences as opposed to that of rocky structures. Other fishing corrales made of reeds in the Caribbean Sea (Fernández-Mendez [10]; Barreiro [2]) or stone in streams and rivers of eastern North America

(Lutins [16]) differ mainly because their lack of a remarkable tidal range. Again, another similar yet modernized idea appears on a televised video tape (TVNZ, 1995, New Zealand) of a Polynesian island, in this case the use of plastic geomeshs is applied.

Along this line, an interesting study of toponomy was carried out by Stanford University (www.linguistic.stanford.edu). The name Mitrenquen (Isle of Grande Chiloe, latitude 43ºS, off the Coast of Chile) originates from the term mutreken, which in the native Mapundungun dialect means "to put posts out for the setting up of fishing corrales". Idem Qinchao would mean "picket fence designed for trapping fish". Finally, it is worthy mentioning the mythological legend of Cuchivilu; a half swine half snake creature, said to inhabit the beaches of Chiloe. In Figure 4, a branch made corral can be seen in the background of a sketch where Cuchivilu, as according to legend, comes out by night to destroy these traps.

"Corrales" locations

The fishing corrales dealt with in this paper are to be found on the Atlantic Coast of Cadiz, mainly in the municipalities of Chipiona and Rota, though some are also to be seen in the nearby Sanlucar de Barrameda and Puerto de Santa Maria. Figure 5 depicts the actual locations of these in the Gulf of Cadiz and specifically the area influenced by the Guadalquivir River mouth.

These structures, each pertaining to independent shore locations, can be divided into five basic groups (Figure 5):

(a) Punta de Montijo: two corrales bearing the names of *Merlin* in the Sanlucar municipality and *Punta Montijo* itself in Chipiona.

(b) City of Chipiona: four corrales situated from North to South with the names of *La Longuera*, *Trapillo*, *Cabito* and *Nuevo* (see aerial snapshot in Figure 6).

(c) From Camaron Point to Cuba Point: six corrales, ordered from North to South with the names of *Camaron*, *Mariño*, *Chico*, *Canaleta*, *Hondo* and *Cuba* (Figure 7, aerial photo).

(d) Candor Point: being the northernmost the biggest and surrounded by other three smaller traps supported on it.

(e) Seawashed ruins of no longer existing corrales can be found off other shores of Rota, Puerto de Santa Maria and in the Bay of Cadiz.

The natural conditions of the zone in which these corrales lay are technically ideal. On one hand, the standard setting is on a sandy beach which in turn is supported by a rocky yet fractioned stratum with a very low dip. On the other hand, a tide that ranges between 1 (neap tides) and 4 meters (spring tides), by which the outer walls of these corrales are thoroughly inundated twice a day, allowing for the free entry of marine life.

Form and structure

A prototype corral is built of continuous flat stone wall, bearing a curved outline, and hand-made entirely by craftsmen. In longitude they reach up to two kilometers, as seen in Punta Montijo (Chipiona), one of the longest. The wall height is variable for each one, providing that the perimeter always be levelled in its entirety. Generally, these walls start at beach shore level, increasing in height as the outer contours stretch away from shallow waters. The outermost point of this slight arch can reach up to 1.5 meters, where, due to the induced wavebreaking activity, the outer wall must be sufficiently robust as to stand such force. The width on the top at this point, heavily reinforced by buttresses, is of 0.80 to 1.20 meters; permitting ample space for pedestrian access. The tightly handfitted rocks, in vertical position, give support to these structures (Figure 8). This peculiar fitting is the reason why no bonding compound, like mortar, has been applied. Large oysters (*Ostrea angulata*) and goose barnacles (*Cthamalus stellatus*) cover the surface adding a natural bonding agent to the stones. On occasion, organic build of up to 30 cm in width has been depicted.

Regrettably, certain acts of vandalism, committed by the tens of thousands of tourists visiting during each summer season, have progressively weakened the walls in general. Due to this and a lack of periodic maintenance of such, the walls have been vulnerably exposed to

the further erosion caused by breaking waves. As an outstanding occurrence, enormous stone blocks of up to 5000 kg in weight have been found along these walls, and whose transport – at the very least – must have posed certain problems. At the outermost points, we find what are known as "corralines", small circular walls built along the interior of the corrales and at a lower water level of the main wall, to facilitate the fish collecting task.

In order to allow the water to flow out from the corral, there exists a number of outlets with an average diameter of 50 cm along the basement of the walls (Figure 8). The amount of these water passages installed may vary, though they are usually abundant, between 30 and 40 per corral in order to alleviate the water pressure. Metallic or wooden stick meshes are placed inside the water outflow passages, creating a triage of fish able to escape from the corrales, according to size.

Once the tide has gone back down, large puddles of water remain among the rocks. Each of these pools has been given names by the local fishermen according to location or characteristic idiosyncrasies (e.g., the Hole, the Corner). The deeper and larger pools are divided by means of narrow and lower walls which purpose is to block the possible exit ways and limit the mobility of trapped fish. Some of these pools, which have been carved into peculiar manmade shapes, remain filled with water during the low tide and will therefore be the objective of stranded fish as the tide recedes. Within these puddles, the people with legal collection rights place large flat stones over the deeper parts of the pool leaving hollow shelters for the fish to take refuge.

Collection task and fishing gear

Fishing corrales are huge traps that run on tidal flow. The effectiveness of these traps is substantially higher during the spring tides, since that is the moment when a greater amount of fish can enter and the low tide allows for a more thorough emptying of the pools, making the collection task easier. As the tide rises, fish cross over the wall to feed (Figure 9). Certain fish, such as the *Diplodus sargus*, get into the corral as soon as the water level reaches the top of the wall, simply by sliding over the top on their sides. On the spring tides, the top of the wall

can be until 2 meters under the highest water level. Once the high tide has receded, the length of the wall crown emerges evenly along the perimeter, which is why a well maintained and levelled wall is of utmost importance, hence trapping the fish which have not managed to escape at that point (Figure 9). As the tide lowers, fishes (of sizes larger than allowed for in the mesh filters placed in each outflow passage) then accumulate in the pools in search of shelter under the aforementioned large flat stones (Figure 9d).

It is during low tide when the fisherman in charge of the collection initiates his task. Equipped with wading boots and a pitcher of leftover kitchen oil, he enters the corral and pours some oil over the surface to give a glassy effect for better visibility. Battery operated flood lamps are now used in substitute for old carbide lamps. A long and narrow swordlike knife, with a flat iron surface, a length of approximately half a meter and a blunt edge is used for batting the fish and rendering them unconscious (Figure 10). A trident shaped spear is to be applied for larger fish and squid (*Sepia officinalis*). A curved hook on the other end is ideal for lifting octopi out. Sometimes, the handle is made of wood and more adequate for nighttime activity, floating to the surface in case of being dropped. Also of common use is a sharpened cane bearing bait on one end such as may be a small crab. The crab is inserted between the cracks to lure the chosen prey out, at which point, it is then grabbed with the free hand. Finally, a circular fishnet with leaded edges which is thrown over the fish, landing in an open position and therefore trapping what is caught below. The best season for catching squid in the corrales is from January to May and from May to October for the rest of fish varieties, and also right after a storm. The best moment for claming is right at the final stage of the ebb or falling tide, the minimum low tide level and the initial stage of the rising or flow tide, lasting a total of 3 to 4 hours.

Very strict rules exist as far the corrales exploitation is concerned; the fisherman in charge has absolute priority to the collection of fish, yet not that of crabs, squid nor octopi. Other people are solely permitted to go after him and collect any fish he may have left behind. Currently, this order is no longer respected in those corrales which are still being exploited, and this poaching activity altogether with the abusive use of

fine meshed nets at the outflow passages are influential factors on the decrease of corrales activity.

Typical fauna of the corrales

Due to strategic location and proximity to the Guadalquivir River mouth, this paper deals with one of the most biodiversified zone in the South of Spain (Arias and Drake [1]). An ample variety of marine species penetrate the corrales. Great scores of fish, such as the (*Diplodus sargus*), (*Diplodus vulgaris*), (*Liza aurata*), (*Atherina boyeri*) etc. (Figure 11), find in the corrales an ideal habitat for their juveniles, being that feeding is abundant. Other advantages are safe refuge among the rocks and an ideal water temperature for growth. Therefore, fish of a larger variety, such as the (*Argvosomus regius*), (*Dicentrarcus labrax*) or the *Trachinotus ovarus* a Mediterranean variety of salmon, find the corrales quite suitable for feeding on small fry. On the other hand, different species like (*Sepia officinalis*), (*Paracentrotus lividus*), *Eriphia verrucosa* and (*Palaemon elegans*) are also abundant, seeking these corrales as grounds for laying eggs. Consequently, to attribute a fundamentally ecological role to these reef corrales in the life cycle sustainability of the autochthonous ecosystem should be taken into consideration.

Further uses

Due to the conglomerate stone nature of the corrales, bearing countless amounts of slits and cracks, an exceptionally abundant amount of invertebrates concentrate or accumulate inside, with an unusually dense population of crabs. Possibly, this area constitutes an important shelter for newly hatched fish, therefore also attracting diverse bird species as well (Bernal et al. [4]).

Furthermore, the fine beach surroundings and high density summer tourism make of these municipalities favourite recreational spots. For instance, el “muelle”, one of the most urban frequented beaches of Chipiona, is located within the La Longuera corral itself. Safe swimming for younger children is a main attraction due to the shallow nature and crab catching form of entertainment.

In recognition, another important contribution of these corrales is the

outstanding impact made on a strikingly unique landscape. As the stonewashed lacework is exposed and hidden by tidal movements, a subtle statement of human interaction with the sea, over the centuries, is made. The landscape is integrated with the impression of time and forces of nature turning these corrales into historical and touristic resources of singular order.

In addition, with the protection of these corrales, some of the more important dune systems in this part of the littoral, such as those of Punta Candor and Punta Cuba, have been sustained and sheltered from erosion (Muñoz-Pérez and Enríquez [18]; Gómez-Pina et al. [13]).

Conservation and Restoration Methods

The corrales, constructed with thin and vertically positioned slabs of stone and held together only by the friction between pieces, must be able to resist the impact of waves on a coast where storms are a common phenomenon during the Winter months (M.O.P.T. [17]). Constant maintenance, which up to date was left up to the fisherman in charge, being this his livelihood, is required nowadays for keeping them in optimal conditions. The cracking process begins with the “unimportant” extraction of some oyster shells, usually by an unaware tourist. This eliminates the natural bonding among the small stone pieces. The very next storm will extract one of the stones, causing the friction with the adjacent ones to disappear and allowing for subsequent wave activity, even of lesser height, to continue the erosion. At this point, damage is manageable and can be rapidly repaired by the fisherman in charge.

Regrettably, damaging of the stick meshes by vandalism and raiding by poachers lead the fisherman in charge to surrender to the overwhelming amount of maintenance work and the lack of economic interest. In the meantime, the crumbling of the wall progresses in both directions. This results in the disintegration of long stretches of corral wall beyond the control of patchwork maintenance.

Until quite recently, as regardless of all the uses and practical purposes they present, the state in which the corrales were kept were deplorable. Of the 16 corrales shown in Figure 5, nine were not in use,

three practically destroyed and the remaining four were highly damaged. The Camaron, Cuba and Hondo Corrales were badly affected during the 60s when the price of oysters skyrocketed. The first two had disappeared and the Hondo Corral was found to be in an advanced state of deterioration. Taking notice of this problem, the Delegation of Environmental Affairs of the Chipiona City Hall, through the action of the Junta de Andalucia (the regional government), achieved the declaration of these Corrales as Natural Monuments with a special protection status (BOJA [5]). Moreover, the General Coastal Directorate, dependent of the Ministry of the Environment, agreed to be responsible for the repairing and reconstruction of the Corrales.

Due to the above mentioned jurisdiction and for the last decade, the Corrales have undergone extensive repair and reconstruction works. The exterior aesthetic aspect of these walls is being redone in full respect to the original hand-crafted method. The stones are placed in rowloch formation (Figure 12), yet a solid concrete filling, resistant to the aggressive marine environment (EHE [9]), strengthens the body for greater durability. Some vertical iron rods are inserted to connect the different concrete layers. Moreover, a setting accelerator is used to avoid loses on the cement during the rising tide. Top part of the wall is made by putting stones into the concrete while it is not set or hard yet.

From 1993 onwards, six different and complimentary projects have been carried out. Data with description, date, term, budget and comparative costs can be checked in Table 1. It is noteworthy to point out how, along the last decade, the importance of the works and, consequently, their budgets have increased enormously due to the prominence of this type of performances inside the Ministry of the Environment and the European Community funds.

The increase in price per linear meter (from 24 to 358 euros per meter) is mainly due to a change in type of the rebuilding process. The first cheap projects were dedicated to fixing deteriorated stretches of wall, whereas, in the latter, completely disappeared stretches are built in their entirety.

These work projects are included into a more general strategy, based

on integrated management and sustainability criteria, which involves ecologist groups, users and trading organizations, local bodies, the regional government and the Ministry of the Environment.

Certain imaginative solutions are being considered for a sustainable profit of the corrales. This work would involve the local population. A citizen volunteer organization could be the key to sustainability. One organization, named Jarife, has already been founded to take care of the corrales from Chipiona. These interested and willing people would contribute to the revalorization of the trade of "cataor" (the traditional harvester-fisherman), and of the products and resources derived from the exploitation of corrals (e.g., a quality guarantee stamp for all fish captured there). This organization is supported by the local ecologist group (CANS), and each and every one of the Public Administrations. Other possibilities, such as using these enclosures as tourist attractions offering guided tours or even work camps are also taken into account.

It could be interesting to remember that, according to the Spanish Shore Act, the State is the owner of the corrales. So, any activity carried out into the corrales must get the relevant permission.

It should be pointed out, as well, that another municipality, Rota, and the Andalusian government, altogether with the Ministry of Environment, have signed last year a convention which will forward the conservation, maintenance and improvement of the corrales due to its natural monument condition. To promote recreation and environmental education will be one of the main objectives.

It is noteworthy to highlight that one of the aforementioned projects, "Rehabilitation, management and promotion of the corrales de Rota", has been included in the United Nations Best Practises Database. This database is a powerful instrument for new knowledge management tools, networking, technical cooperation through the supply of proven experience and policy development base on that works, amongst others.

Conclusions

The fishing corrals of Chipiona and Rota constitute a historical,

cultural and scenic background which is the legacy of a rural and remote fishing culture. For the real value, as well as the practical one, they are especially worthy of the attention given to them by the Official Organisms. Several steps, such as the declaration of these corrals as National Monuments by the Andalusian government, have been taken. Also worthy of mention is the restoration work being carried out by the Ministry of the Environment along the last decade but not finished yet.

The importance of this rehabilitation works has been increasing not only due to a major environmental conscience but to the European funds as well.

Interested and willing people are already joined into organizations, like Jarife in Chipiona, which aims to get a sustainability exploitation of the corrales, environmental education and promoting their recreational but controlled use. These organizations will be held, at least in the beginning, by the different Public Administrations involved in the zone (local bodies, regional government and Ministry of Environment).

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Filmography

TVNZ (1992) "Reef fish. Where have they all gone?" Directed and produced by Andrew Penniket, New Zealand TV, 50 min.

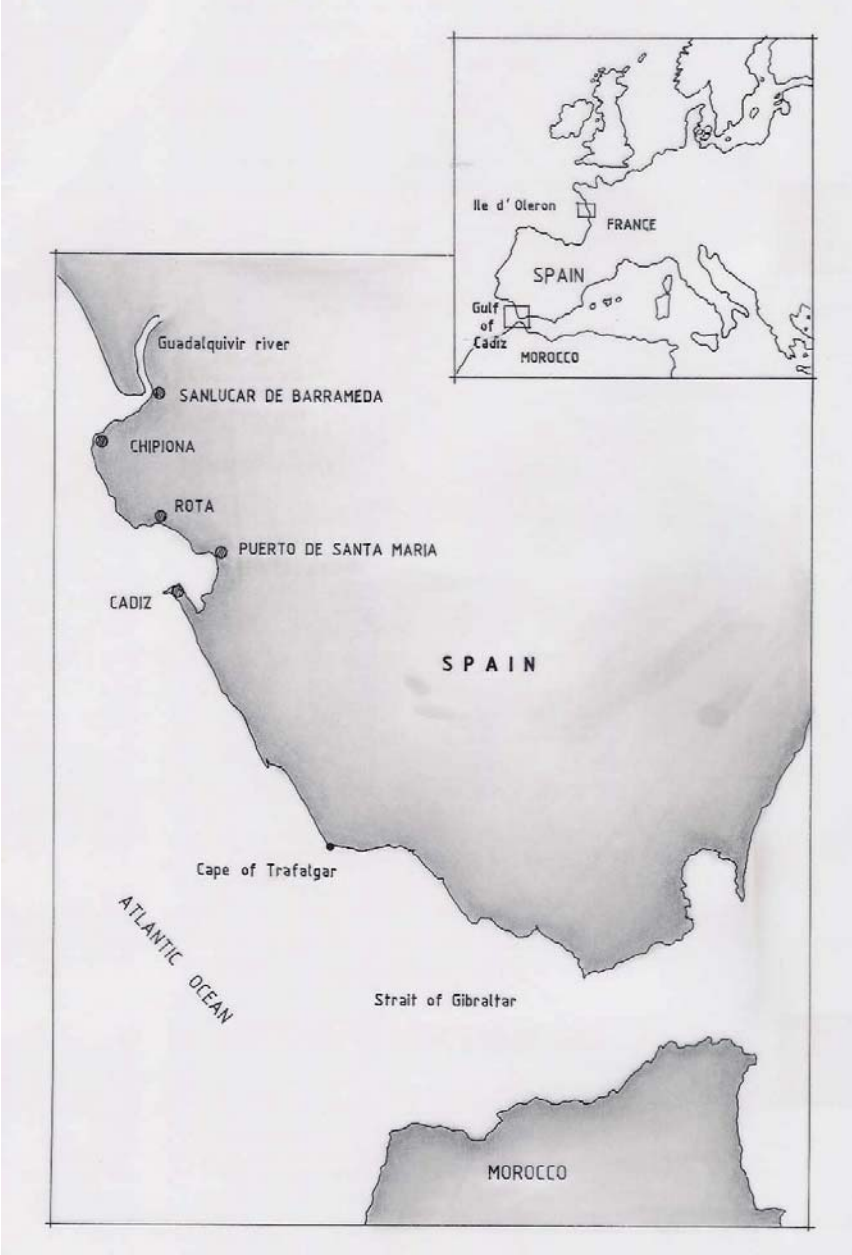

Figure 1. Map of situation with the Isle d'Oleron (south of French Bretagne) and the Bay of Cadiz from the Guadalquivir River mouth to Cortadura.

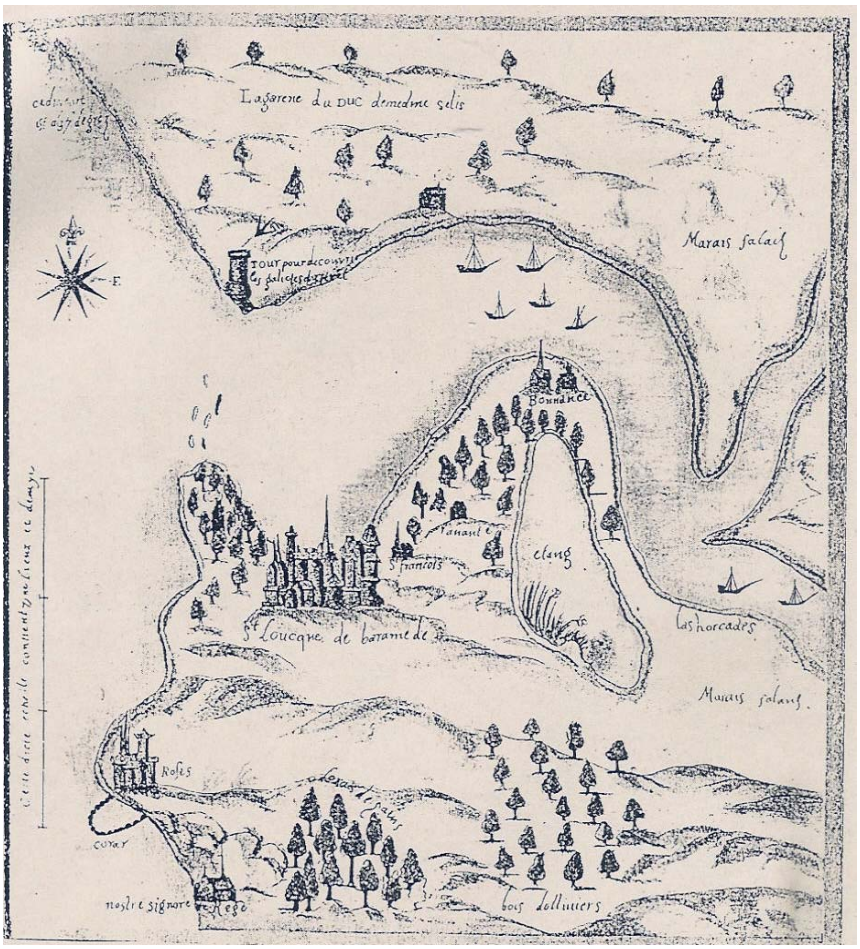

Figure 2. Map of the Guadalquivir River mouth by Samuel Chaplain (1599-1602).

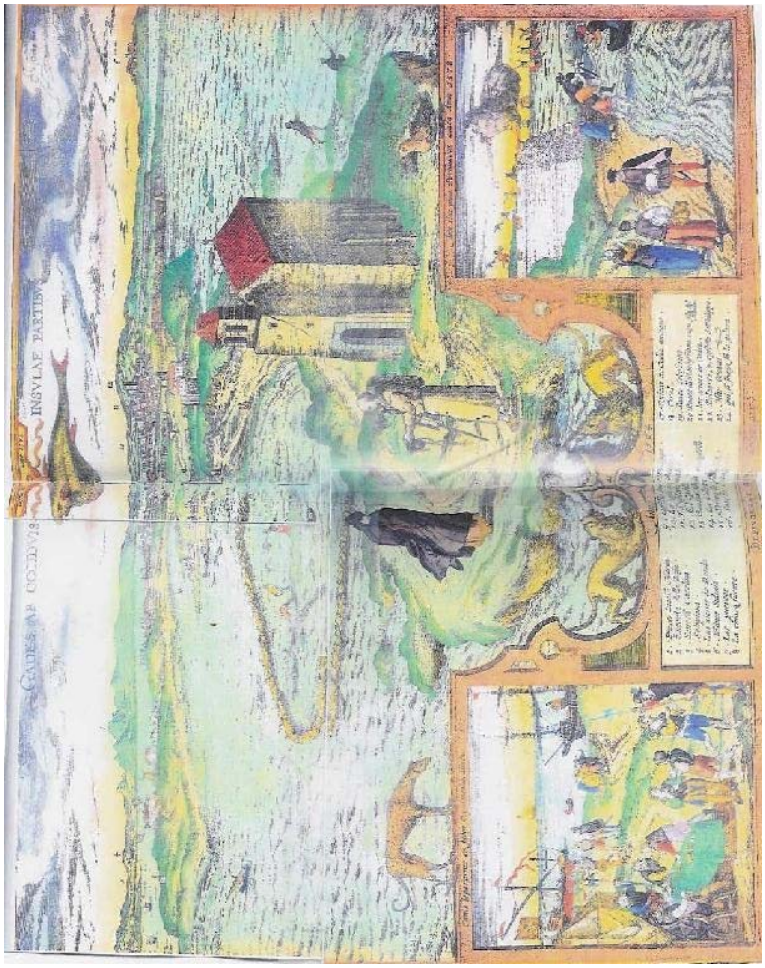

Figure 3. Map of the city of Cadiz by Georg Hoefngel (1564). Civitates Orbis Terrarum, volume n. 5. Remark corral n. 18.

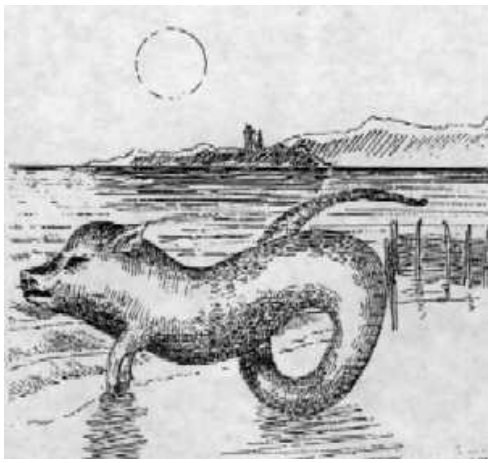

Figure 4. Sketch of Cuchivilu, a mythological monster believed to destroy thatched corrals in Chiloe (Chile).

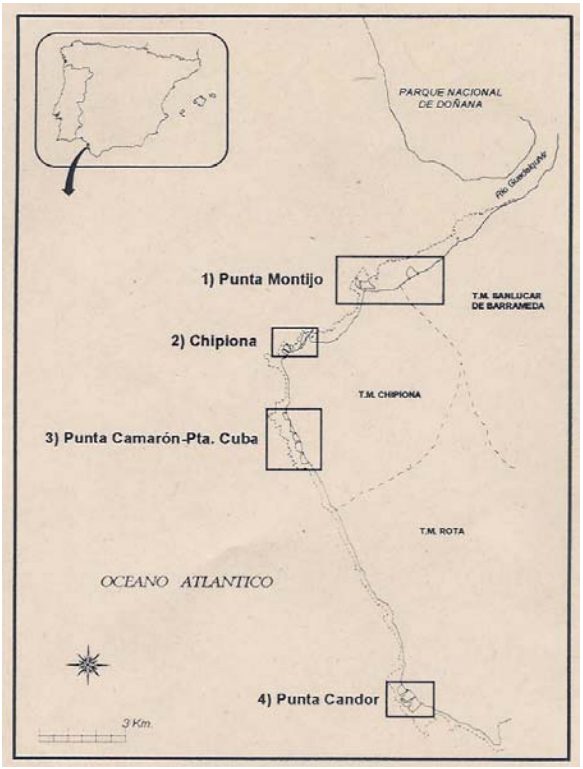

Figure 5. The four corral zones: (a) Montijo, (b) Chipiona city, (c) Tres Piedras and (d) Punta Candor.

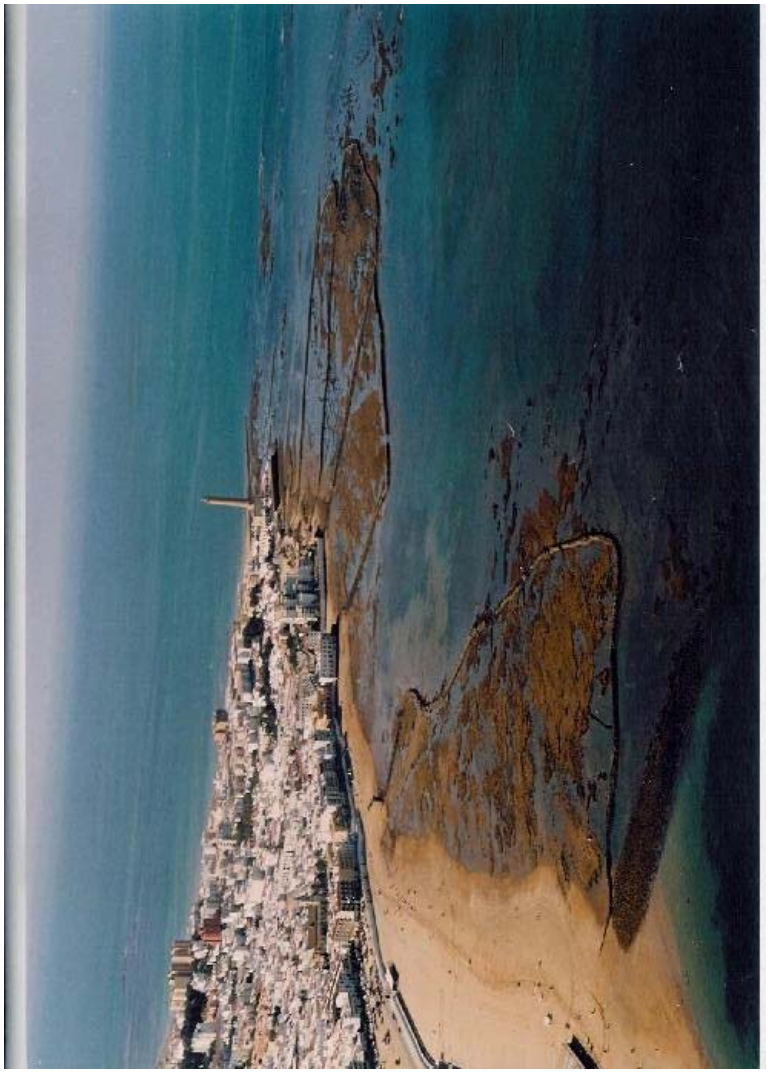

Figure 6. Aerial photograph of corrales in Chipiona city: La Longuera, Trapillo, Cabrito and Nuevo (from left to right).

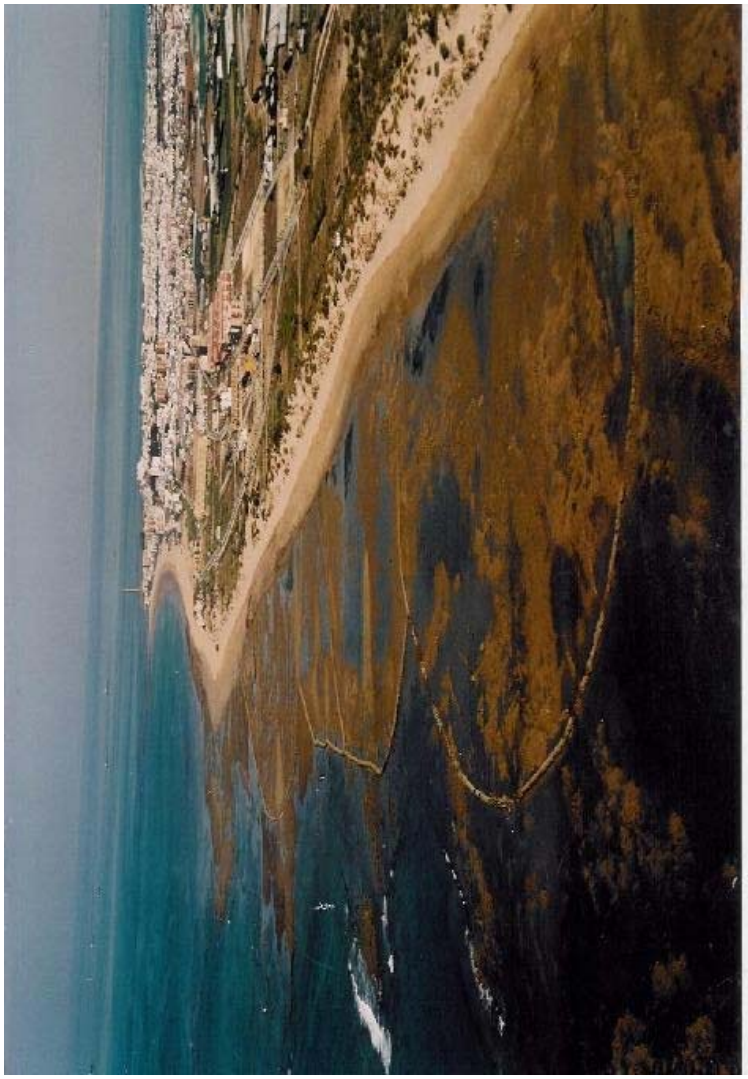

Figure 7. Aerial photograph of corrales in Tres Piedras zone: Camaron, Mariño, Chico, Canaleta y Hondo (from top to bottom).

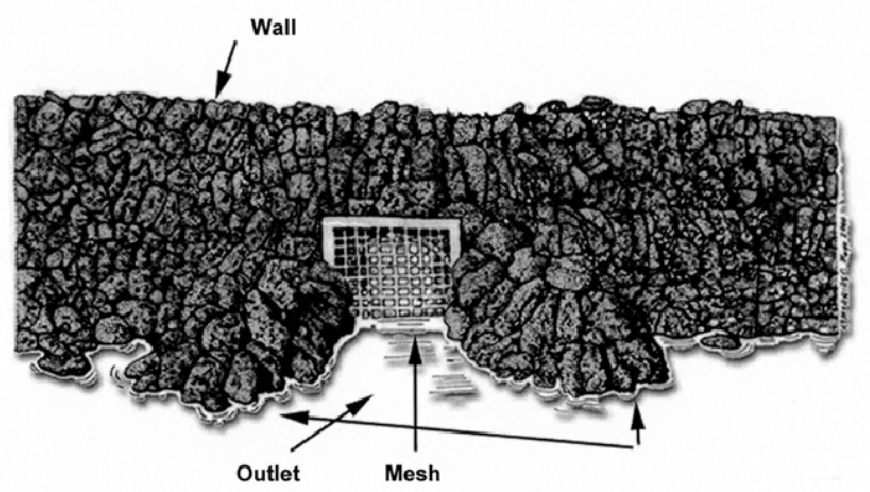

Figure 8. Frontal view of water channel used for tidal outflow with screening mesh which impedes fish escape.

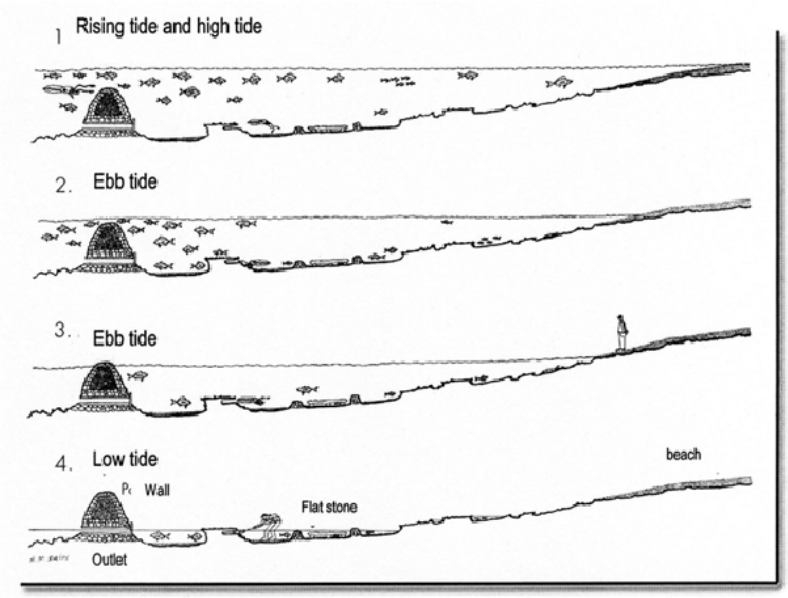

Figure 9. Cross-sections showing corral function. During flood tide (9a), fish take advantage to enter and feed. The low tide (9c), in turn, obstructs the exit, facilitating harvesting by the "cataor" (traditional fisherman).

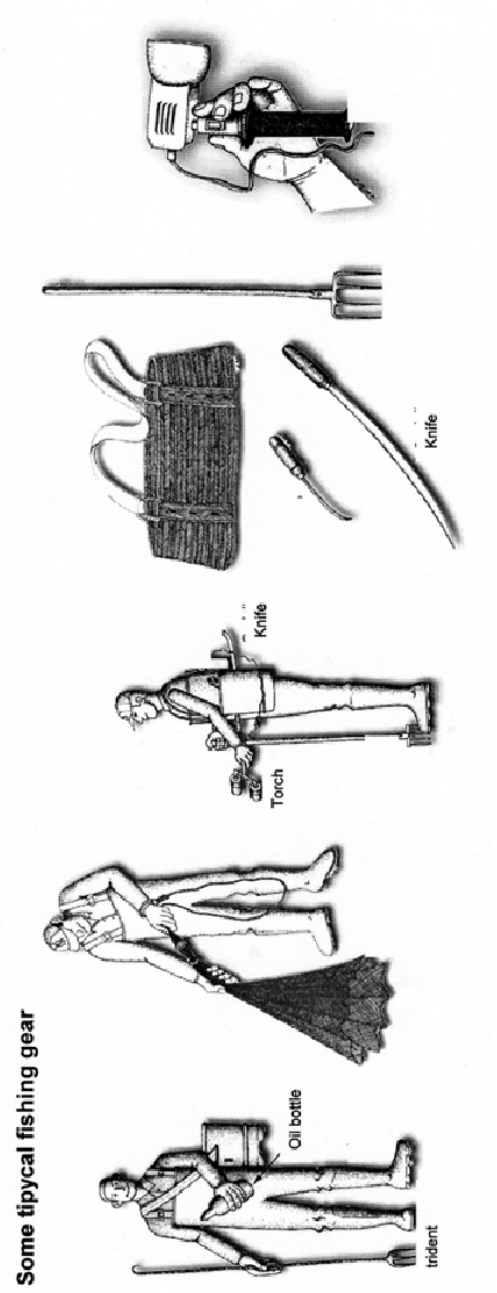

Figure 10. Traditional fishing gears.

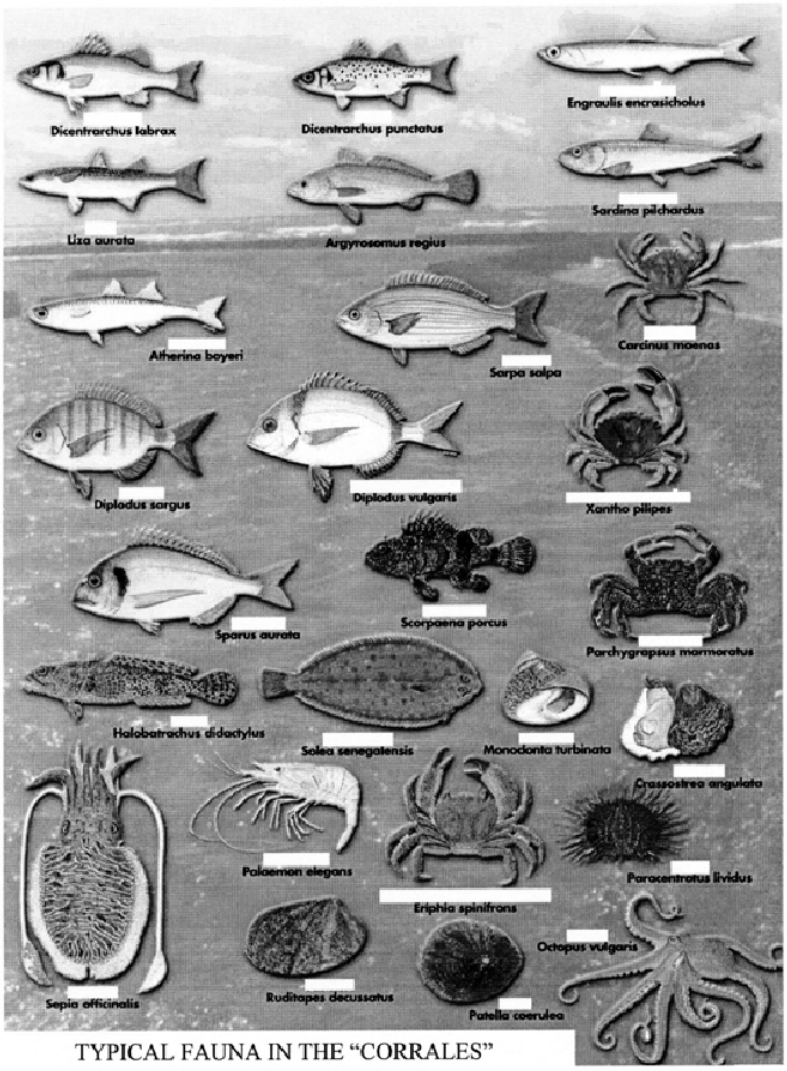

Figure 11. A variety of fauna found in the corrals.

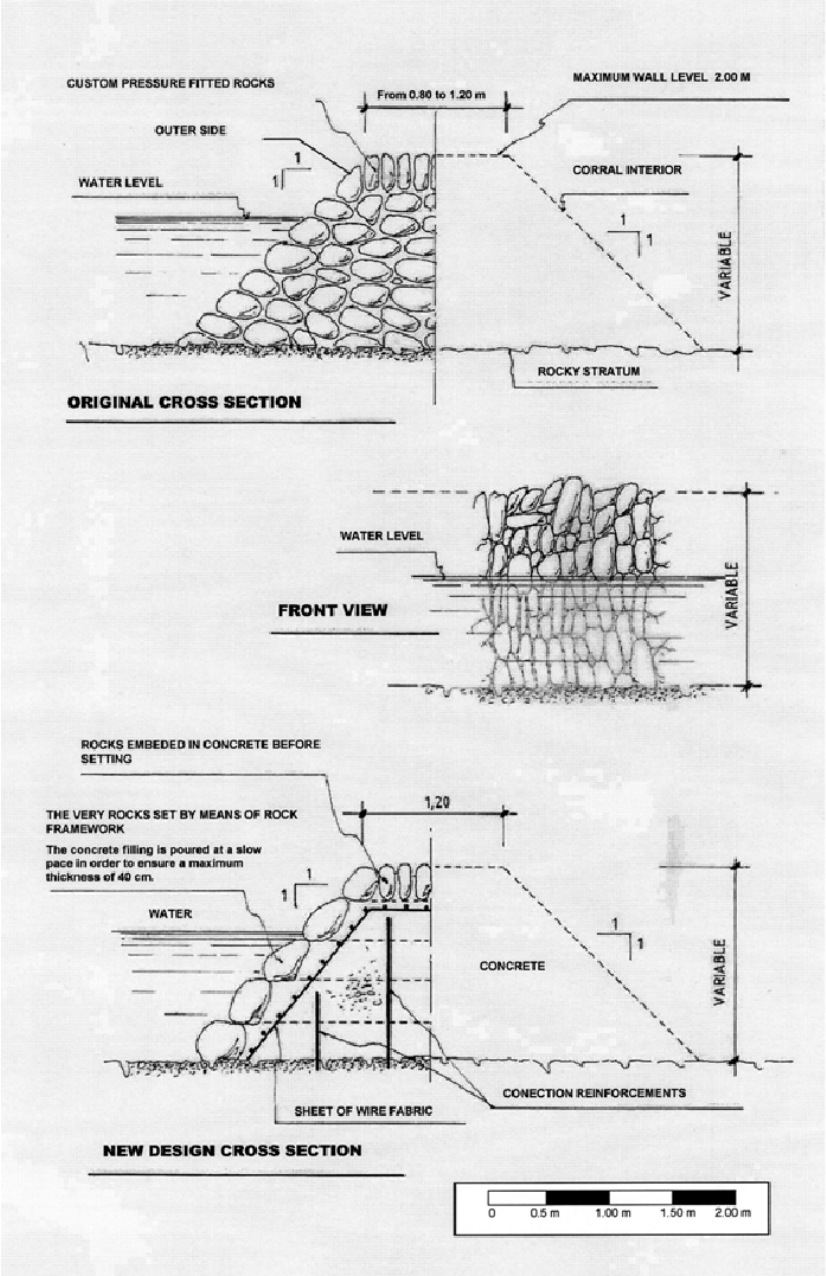

Figure 12. Traditional and modern cross-sections of the wall where is worthy to note that the concrete filling is not visible.

Table 1

Description	Year	Term (months)	Budget (€)	Length (metre)	Cost (€/metre)
Restoration of fishing corrales in Chipiona: Nuevo, Cabito, Trapillo and Longuera (Phase I)	1993	5	121.746	504	24,11
Restoration of fishing corrales in Chipiona: Nuevo, Cabito, Trapillo and Longuera (Phase II)	1994	2	44.312	502	88,27
Restoration of fishing corrales in Chipiona: Nuevo, Cabito, Trapillo, Longuera, Hondo, Chico, Canaleta and Marino (Phase III)	1999 2000	12	420.006	2.622	160,21
Restoration of fishing corrales in Chipiona damages by storm waves: Mariño, Canaleta, Chico and Hondo	2001	6	41.941	212	198,40
Restoration of Montijo Corral	2003	14	982.802	2.901	338,78
Restoration of fishing corrales in Rota	In project phase	9	1.004.926	2.977	337,56

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