Fishing Across the Centuries: What Prospects for the Venice Lagoon?

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Fishing has always been an important activity for those Venetians who live near the Lagoon, and it still enjoys an important economic and social role in the region. Over the last few years, however, the fishing industry has been subject to a profound transformation both in the reduction of the variety and the abundance of the species found in the lagoon, and in the change from a complex and well-structured type of activity to one which has become monospecialist, that is based principally on the fishing of the bivalve *Tapes philippinarum* (Adam & Reeve). The widespread diffusion of this bivalve and its considerable commercial value have resulted in an increased harvest, initially carried out by hand but now by more sophisticated methods which are capable of obtaining much higher yields. The social, economic and environmental problems resulting from this automated fishing have stimulated research into alternative strategies to manage the alieutic resources of the lagoon which will allow fishing to become a sustainable activity without inflicting long-term environmental damage. This present work will try and prepare the foundations for a system of eco-compatible management, based on an analysis of the functioning of the lagoon's eco-system, defined as a paralic model, the observation of the traditional forms of fishing practiced over the centuries, a technical analysis of the present typology of lagoon fishing (fishing with fyke nets, "vallicoltura" and fishing of fish fry for rearing, clam fishing (*Tapes philippinarum*), mussel culture) with particular reference to the species fished, the distribution of the activity throughout the year and the technology employed, to the productivity of the various fishing methods.

Keywords: Venice Lagoon, Fyke nets, Clam Fishing management, Fish Farming

JEL Classification: Q22

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I. Traditional fishing in the Venice Lagoon

In the 1000 year history of the Venetian Republic ('Serenissima Repubblica'), fishing and hunting represented the predominant productive activities carried out to satisfy the food requirements of the population. The Venetian authorities continuously introduced checks and regulations on these activities, but they also exercised, at least for fishing, an effort to control and use the resources intelligently (Bevilacqua, 1998).

Beginning in the early 12th century a series of laws and decrees concerning the wise management of the waters were passed; these concerned both the movement of water and fish resources.

Often these two factors were developed inseparably, side by side. There was a series of institutions and colleges charged with their control, management, and regulation, such as the 'Magistrature del Proprio', 'del Piovego', 'dei Provveditori di Comun', 'dei Savi' and 'Esecutori alle acque'. In 1173 the 'Magistratura della Giustizia' was founded which oversaw all of the trades and had the power to fix measures, weights, prices, and questions relating to the 123 different trades practised in the Venetian Republic (victualling, manufacture, trading).

In 1261 the 'Giustizia' was divided into 'Giustizia Nuova' and 'Vecchia', the new and the old. The latter was charged with supervising fishing, carrying out quota checks,

checking hygiene at the retail points, and establishing the criteria, timetables, and fishing methods. The commercial laws were contained in codes or statutes initially called '*capitularia*', '*statuta*', '*ordinamenta*', and sucessively from the 13th and 14th centuries '*matriculae*', '*matricole*' or '*mariegole*'. A 'Collegio' was designated for the trades, in order to eliminate possible abuse, which was supported in 1572 by the position of a magistrate called the Inquisitore alle Arti, who acted as a supervisor.

Each trade was separate, each forming a guild ('*fraglia*') with its own statutes ('*mariegole*'), its own geographical area of influence, its own meeting place ('Scholae', 'Confraternite'), and also each with its own patron saint; each trade provided their own society donations to holy ceremonies, but also to a type of mutual benefit. Particularly well-known were the 'Corporazione di Sant'Andrea di Chioggia' and that of 'San Nicolò dei Mendicoli' in Venice; whose chief fisherman ('Gastaldo'), along with the society of fishermen, enjoyed particular privileges such as the rights to artisan boat fishing, exemption from customs taxes, the right to issue permits, etc..

The resources were allocated by area to the societies ('corporazioni') and within these to each fisherman or group of fishermen.

At the sale of the fish catch the sellers met with the society of buyers and sellers' ('Compravendi') of fish, whose actions were established in the "*Capitulare de pescaribus*" issued by the 'Giustizia Vecchia' in October of 1227. To avoid either stockpiling the fish, price speculation, or the fraudulent alteration of the product, the sellers were obliged to go to a stipulated location for selling which corresponded to the 'Palo', in Piazza San Marco (St. Mark's Square) or at the Rialto. Furthermore, the sellers were prohibited from buying fish from other than recognised fishermen, who in turn were not allowed to create associations or companies which exceeded two members, opening other stalls apart from their own, and increasing the price of the fish catch (Bevilacqua, 1998).

The checks and restrictions were very strict. For example, at the end of the 1700s the 'Giustizia Vecchia' issued a measure prohibiting the citizens from meeting by boat to buy fish before they arrived at the public fishmongers. The surveillance of the price of fish was also constant, which in the mid-1700s was fixed every two months. Such procedures were believed necessary to safeguard the fishermen as well as the middlemen, businessmen, and the consumer. It was not difficult to reach a satisfactory agreement between all of the concerned parties.

In the 14th century the 'Consiglio dei X', (the Council of Ten) and at times the Senate, when they were discussing the lagoon, the shores, harbours, and rivers, made decisions after consulting a sort of technical commission representative of certain colleges called 'Savi sopra la laguna' or 'Provveditori alle acque',ie a commissioner of the waters. The 'Consiglio dei X' created five 'savi' above the '*mariegole*'.

In 1510, following the many important questions regarding water management, a proper Supervisor of the Waters ('Magistrato alle Acque') was formed which remained in force until the fall of the Republic, to rise again in more recent times.
The fishermen themselves were called upon to be part of the commission with decision-making powers. In 1536 eight were elected, of which two were from Chioggia, and two from San Nicolò. The Republic showed particular attention to the equipment used for fishing, and especially the netting which had to be approved by the Office of the 'Giustizia Vecchia'. The netting had to conform in both length and mesh size to that deposited with the commissioner of the same office. It was prohibited to use nets which had either fine meshing, to catch fish which were too small, or to use implements which would damage the banks and canals of the lagoon.
During specific periods of the year it was prohibited to fish with certain pieces of equipment, such as seine nets, cloth or canvas, reed enclosures ('grisiole') or by hand. Fishing of certain species was limited to specific months.
With the fall of the Venetian Republic in 1797 and during the Austro-Hungarian domination which followed, new meticulous laws concerning fishing were issued. In 1835 a 'Regolamento disciplinare per la pesca di mare sulle coste del Golfo Adriatico' was produced which stated that within a mile of the coast the right to fish was granted only to the inhabitants of the coast. In 1841 a further regulation concerning the conservation of the lagoon contained arrangements for fishing in the lagoon basins, but did not consider artisan boat fishing. This regulation was quite restrictive because it prohibited any kind of remedial intervention designed to protect the basins, and also prohibited the repair of existing embankments which might possibly have been damaged.
The measures concerning the fishing sector were developed taking into account the hydrology of the lagoon. In 1866 the government of the King of Italy nominated a commission, chaired by the famous hydrologist Paleocapa, in order to "study and to propose measures designed to improve and to conserve the harbours of Venice and of the Venetian lagoons, together with their connections to the inland navigation waterways", but this commission also evaluated fish farming (Bevilacqua, 1998).
Even today it is still possible for the 'Magistrato alle Acque', in his responsibility for the hydrology of the lagoon, to issue regulations which affect fishing.

The professionalism of the fisherman's work together with its difficulty, which is hardly repaid economically, have been oft-debated subjects over the years. Bearing witness to this was a periodical of the 19th century, called the *Neptunia*, which suggested in 1894, following the proposal of Levi-Morenos, the establishment of an insurance scheme and a subsidy system which would have provided, apart from a pension scheme, help for temporary misfortune and sickness. A little later, Domenico Razza (1897) urged the intervention of the town councils, the provinces, and the state to come to the aid of the fishermen's difficulties.

Towards the end of the 1800s the cooperative movement showed promise as a possible solution of the problems associated with fishing, even if their acceptance initially aroused the natural suspicion of the fishermen themselves. The foundation of the first fishing cooperative dates back to 1896 in Burano , and many others were founded in the following years. Even today at Burano there still exists the tradition of assigning fishing zones between different consortia by casting lots, called the 'tocco', which first took place in 1896 and which still happens every six months.

Documents relating to the years preceding World War II describe the organisation in the fishing centres of the Venice lagoon. Chioggia was the main fishing centre of the entire province. The fishermen (about 6000) were grouped into two categories: those belonging to cooperatives, and those also were unionised.

There was also a significant number of fishermen who did not fit into either of these categories. The fleet consisted of about 500 vessels, of which 95 were motorised, and

the others were powered by sail or rowed. The most common type was that used for trawling with the 'tartana' net, but also used were gill nets ('menaidi') and the lift net called the 'saccaleva'.

In the other fishing centres engines were not yet in use, but only boats which employed sails or oars.

Pellestrina had 236 fishermen, belonging to the cooperative of the same name, using 27 boats of the type 'a pizzo', whilst 209 rowed 'sandoli a remi'. San Pietro numbered 300 members in its own cooperative; they used small boats propelled either by oars or by sails. The fishermen of Burano, specialised in the fish fry for rearing or fry, numbered about 700, and used sailing boats called 'caorline' (there were 140 of them) and also 'sandoli', a type of sailing boat of which they had 420. In addition, Venice had its own fishermen centred at Quintavalle and at Giudecca, all of whom were registered in cooperatives of the same name and who also had exclusive fishing rights to fishing in the lagoon using both rowing and sailing boats. Other fishing centres include Caorle, with about 400 members in the local cooperatives, who used the local 'caorline' and 'sandoli' type of boats. Cortellazzo, on the other hand, was a small centre which had a limited number of fishermen, whose speciality was the fish fry for rearing (Zolezzi, 1944).

Except for motorised boats, whose use and power were very limited, the typical types of boat used before World War II were 'coccie', 'bragozzi', 'bragozetti', 'bragagne', 'ostregheri', 'sardellare', 'battelli da pizzo', 'portolate', 'caorline' and 'sandoli'. The larger boats such as the 'coccie' and 'bragozzi' were used in the open sea, while those smaller boats were more suited for use in the waters of the lagoon (see Appendix 1).

In the 18th century the open sea fishing fleet which operated out of Chioggia employed various of types of lift net called 'tartane, pieleghi and 'sardellare' (in use until the middle of the 19th century) which were similar in their shape but differed quite a lot in their tonnage. These lift nets were also suitable for fishing in the open sea, as suggested by the name 'pieleghi', which seems to derive from *pelagus* (Brunelli G. *et al*., 1940).

The absence of engines forced the fishermen to use coupled sailing boats, which could proceed under sail or could be rowed if they were hauling a very small net. The type of tackle used for fishing ensured the maintenance of stable environmental conditions, and the absence of mechanised equipment ensured that they were low-impacting, that is they caused little or no damage to the banks and bed of the lagoon.

The equipment and systems used for fishing in the Venice lagoon include the following: nets, dredgers, traps, hooks, collection devices, and harpoons. The literature is rich with descriptions of the equipment and systems used for fishing in the lagoon (Ninni, 1940; Pellizzato, Giorgiutti, 1997). A monography written by Brunelli G., Magrini G., Milani L. and Orsi P. (1940) identified 25 types of tackle used in both the lagoon and in the sea. A more complete study by Zolezzi G. (1944) made a distinction between systems used in the lagoon and systems used in the sea. For fishing in the lagoon, two classes

were identified: fishing in the open and closed lagoons. The former was carried out using only nets, while for the latter special tackle was used.
There follows a list containing the main fishing methods used in the open lagoon in the first half of the 1900s which are classified as follows: trawl nets, fyke nets, drift nets, seine nets, special nets, and a series of other special tackle.

The column titled "Currently" reports the current state of use of the fishing tackle (taken from: Pellizzato M., Giorgiutti E., 1997, *Attrezzi e sistemi di pesca nella provincia di Venezia).* We consider "not permitted" any equipment that is not expressly permitted and regulated.

Trawling nets

These represent a fishing method which is in use throughout the year, but less used during the cold season. It comprises nets being towed on the bottom using sailing boats which move in pairs, or if the net is very small, such as a 'tartanella', the vessel can proceed alone and can be rowed. The nets may differ in their size, the material used, and the presence or not of a codend, a terminal collecting bag ('cogollo'). All of them are equipped with a line of cork floaters on the upper part, and a similar line, but of lead weight sinkers, on the lower part.

Nets with a codend ('cogollo')

Type of net	**Currently**	**Species fished**	**Period of main use**	**Main characteristics**
Tartana	*not in use (not permitted)*	*Most sea species*	*in use all year*	*It is funnel shaped with a central body (a fine mesh on the upper part and thick on the lower part), a terminal sack, the codend, (kept open by wicker rings), and two wings. The net is towed by a rowing boat which has two posts on the astern and bow to which it was secured ropes to keep the two wings open.*
Tartanella fissa (da schile, da anguele, tartanella con cogularia)	*little used (permitted)*	*common brown shrimp, atherines, gudgeon, shad*	*from November to February*	*It is about 10 to 12 m in length. It possesses a central body (with a net thicker in the lower part), two side wings, terminal codend (kept open by wicker rings). It is equipped with lines. Used in canals and in the shallow bottom of lagoons, used in the same manner as that for the tartana (see above)*
Tartanella chiara *(da sepe, da buranei)*	*little used (permitted)*	*cuttlefish, flounder, sea-bass, sole, turbot*	*Spring and Summer*	*The net has the same characteristics as those for the tartana fissa (see above), but differs from it by having a more open mesh. It was used for fishing in the lagoon canals.*

Granzera *(bragogna da granchi)*	*little used (permitted)*	*crabs, and various fish (gudgeon, eels, cuttlefish, ,flounder)*	*in the Spring*	*A net similar to that of the tartanella chiara (see above), lower and smaller in size. Used for fishing crabs on the bottom of the lagoons. It was towed by a rowing boa, which moved according to the current.*
Schiler *(strassin da buranei)*	*little used (permitted)*	*common brown, shrimp, gudgeon, atherines, crabs, eels, female shore crabs, prawns*	*from August to December*	*A net similar to that of the granzera (see above), but with a smaller mesh size. Equipped with a line of lead weight sinkers and cork floaters. It was used in lagoons without aquatic plants.*
Tratturo *(strassin da fossa, bragozzo)*	*not in use (permitted)*	*eels, cuttlefish, atherines, gudgeon, etc.*	*from August to December*	*It is perhaps the largest lagoon trawl net (about 100 m long). Sailing boats were used for this net in deep lagoon areas.*
Bragagna *(arte da masse)*	*not in use (permitted)*	*gudgeon, crabs, prawns, brown shrimps, cuttlefish, eels, flounder, atherines*	*from March to October*	*It comprises a central body, two wings, and a codend. The wings are kept open by poles ('masse'). Since it was used in areas thickly covered by marine grasses, to keep it raised it was weighed down heavily. The poles ensured that the net did not become twisted.*

Nets without a codend ('cogollo')

Type of net	Currently	Species fished	Period of main use	Main characteristics
Baicolera *(saco)*	*not in use (not permitted)*	*sea-bass, also called "baicoli"*	*Autumn to Winter*	*It is a funnel-shaped net with two wide lateral wings which join together into a central sack which collects the fish. It was used near to dykes where the fish find shelter. The net which is fixed by two lines on the astern and the bow, was towed against the current for about 50 m, and then hauled in.*
Bragotto *(tralon)*	*used (not permitted)*	*generally juvenile fish (especially fry of grey mullet)*	*Autumn and Spring*	*It is a net as long as 35 m, used by some fishermen for the shallow bottom of the lagoon. The net is towed by two people walking slowly on the sea bed. Once enough fish are enclosed the ring is closed and the fish are retrieved.*
Tratta da canal *(strazzin da porto, tratta)*	*not in use (permitted)*	*all lagoon fish species (especially grey mullet, eels, atherines, flounder, gudgeon, cuttlefish, sea bream)*	*from June to January*	*The biggest net used for the lagoon, ranging from 100 to 160 m in length. It was used in locations without marine vegetation and in lagoon trenches catching very small fish. It was used at low-tide thus using the exposed canal banks or beach.*

Fike nets

By fyke nets is meant those nets dropped to the sea floor and left there for several hours or even overnight. They are equipped with floating corks and lead weight sinkers. With this type of net, the fish remain caught in the mesh. They can be used on their own or in series.

Type of net	Currently	Species fished	Period of main use	Main characteristics
Saltarello *(sartorelo, saltorelo, vollaro)*	*not in use (not permitted)*	*especially for grey mullet, sea-bass, sea bream, mullet, shad*	*Spring and Summer*	*A composite net, which consists of a 50m long arm, vertically arranged, and supported by stakes. At the edges, stretching out in concentric cirles, there is another net topped by a tramaglio. Upon finding the arm, grey mullet flank it and finish up in the centre of the net.*
Tramaglio or bobina *(sorbera)*	*used (permitted)*	*flounder, cuttlefish, atherines, mullet, grey mullet, sole, etc.*	*from March to June*	*These are passive nets, made up of three separate super-imposed pieces of net (tramelled). The fish, passing the big external mesh, and press on the section with the smallest mesh, and form a pocket from the large meshed section, where they remain surrounded.*
Tramaglio da acquadelle	*little used (permitted)*	*atherines, prawns, common brown shrimp, gudgeon, small cuttlefish, soft crabs female*	*Spring and Summer*	*It is quite a small trammel net (8 to 10 m in length) with a fine mesh. It consists of three super-imposed nets It was used near to jetties where more atherines were found.*
Passereri	*used (permitted)*	*flounder*	*from June to December*	*It is a trammelled net with the mesh size adapted to fishing for flounder. Equipped with lead weight sinkers and cork floaters.*

Drift nets

These nets are secured to the sea bed by special devices and work by blocking the movement of the fish. The nets come in various shapes and sizes (of the order of 10 to 15 m in length). They are used for almost all of the year.

Type of net	Currently	Species fished	Period of main use	Main characteristics
Mezzaluna	*little used (permitted)*	*gudgeon, eels, grey mullet, crabs*		*Similar to the spironi (see below), the only difference being that one wingof the the net is always arranged in a semi-circle, often coming near to the shore.*

Traturi *(traturo da fraima, da posto, da ghebo, da canal, da anguele, da bisati, arte morta, bertovello con ali, cogularia grande)*	*little used (permitted)*	*fish, crustaceans, molluscs, cephalopods, and gastropods*	*from June to October*	*With the use of the name 'traturi' it is implied a large codend ('cogolli') (see above). They are funnel-shaped nets arranged in arms, whose name depends upon the size and number of poles necessary to maintain it extended. The most common 'traturo' is 15 m in length and 2 m in height, and the mesh size is variable. It is installed in canals and in smaller channels ('ghebi').*
Monchin	*little used (permitted)*	*gudgeon, crabs*	*Spring and Summer*	*It is a funel-shaped net with wings of various lengths (however, one is short, while the other varies in length depending on the particular morphology and environment of the area to be fished). It is installed at the start of canals.*
Fureghin *(furighin, rè roverso, passerer)*	*little used (permitted)*	*flounder*	*from May to December*	*This is a bag-type net composed of a large opening where the lines are held together by a hoop. By stretching the 'fureghin' against the current, the fisherman stirs the sea bed in a way to disturb the flounder which, while escaping, enter the bag.*
Seragia *(panesei)*	*not in use (prohibited)*	*flounder,grey mullet, eels, sea-bass, sea bream*	*in Spring and the beginning of Summer during high Spring tide*	*This was a net as long as 1,120 m, which during high tide was encircled. When the tide receded the fish were enlosed in the net, or tried to escape and entered the codend, or remained dry above the water and were then collected with the 'volega da seragia' (see above)*
Spironi	*used (permitted)*	*gudgeon, eels, grey mullet, crabs*	*Autumn*	*These are funnel-shaped nets, without wings, with which are combined 'paneselli' according to the particular lagoon environment.*

Special nets

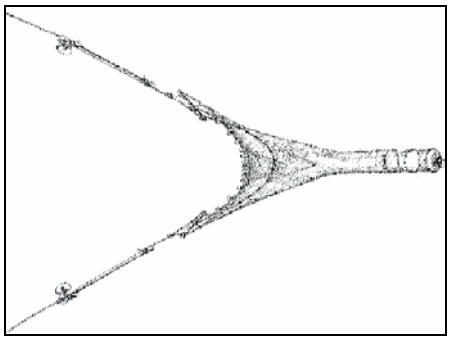
Zolezzi (1944) ascribed to this group all those nets which, because of their individual characteristics, or their manner of use, could not be classified in any of the previous groups.

Type of net	**Currently**	**Secies fished**	**Period of main use**	**Main characteristics**
Cogollo *(bertovello, bartoeo, reon, traturo, ecc.)*	*used (permitted)*	*sea, lagoon, and fresh water fish and crustaceans; sea and lagoon molluscs, cephalopods, and gastropods*	*from March to September*	*Various types of codend nets ('cogollo') exist which differ in their size, shape, and mesh size.They are used in various types of fishing equipment, particularly in fixed or anchored nets. They may be considered as a type of net trap made in the shape of a funnel, with three or more hoops.*

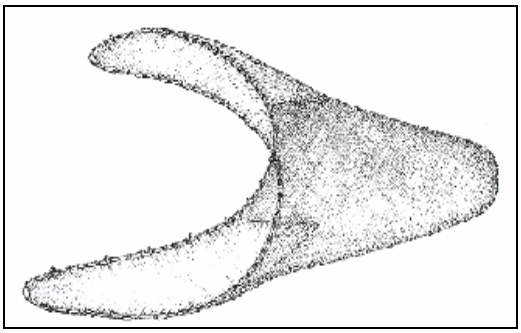
Draga o cassa *(da ostreghe e peoci)*	*used (not permitted)*	*oysters, mussels, carpet shell clam, manila clam*	*December to February*	*This is a bag-shaped net. The mouth is rectangular in shape, made of iron and has soldered to it reinforcement and ballast bars. The cage is thrown from the boat, having being previously anchored, and then retrieved from the bow.*
Cheba o nassa *(da gò o da gamberi), chebetta, cestelle*	*used (permitted)*	*gudgeon, prawns*	*March to October*	*This is a cage with a heavily-woven mesh, cylinder-shaped, and kept open with three hoops. Inside there are two cones. About 35 cm in length, it is attached to a cane which is driven into the sea-bed near to algae.*
Tele da pesce novello *(tratolina da pesse novello, bragotin da pesse novello)*	*used (permitted)*	*juvenile fish in general (especially fry of sea-bass, sea bream, grey mullet)*	*February to Autumn*	*An rectangular tool of variable height and length (canvas). At the edge there are two objects (poles) to keep it open. The tool is stretched to the edge, encircling a school of juvenile fish, and the bottom is closed with a rapid movement of rods.*
Volega *(guadino, coppo)*	*used (permitted)*	*various fish species, molluscs, and crustaceans*		*A net used to catch small-sized fish. It has a conical form and is supported by a framework which has a long handle attached. It is used to catch fish by hook or to collect other species used for fishing.*
Voleghin da conta *(bossola, bessola)*		*fry of sea-bass, sea bream, grey mullet*		*An oval-shaped implement, with a very thick mesh (1 mm), sometimes swapped with a canvas. Limited to the collection of young fry.*
Volega da granchi “pori”	*used (permitted)*	*crabs*	*during Spring and Summer*	*The 'volega' is a large net with a wide mesh. It is used for fishing from breakwater rocks which protect from the sea.*
Volega da seragia	*not in use (not permitted)*	*grey mullet, sea bream, sea-bass, eels, and other lagoon fish*		*This is a triangular implement made from a single pole. It is used for collecting fish which, with a low tide, do not enter the codends of the 'seragia' (see above) and remain above the emergent sea bed.*
Volegon da barca *(volegon da gamberi)*	*little used (permitted)*	*prawns, common brown shrimp*		*Similar to the 'paravanti da caminar' (see below). It could be towed from a boat, in order to scrape away the algae on the sea bed where small crustaceans find shelter.*
Paravanti da caminar *(raschetta, rasca)*	*little used (permitted)*	*prawns, common brown shrimp, gastropods, cocle*		*This is a particular type of of a triangular 'volega' with a thickly meshed net. Once it was made of wood. Used in the same manner as the 'volegon da barca'.*

Various equipment

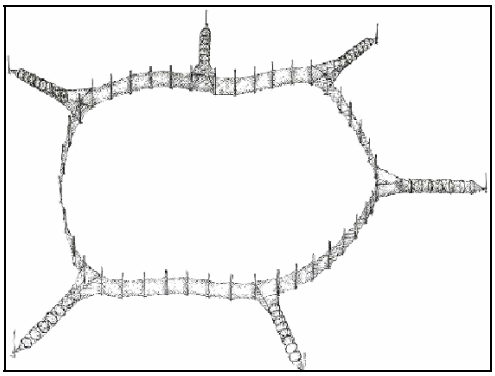
Togna	*used (permitted)*	*sea-bass, gudgeon, paganelli, turbot, flounder, eels, grey mullet*		*A hand fishing line for use in shallow waters from a boat or from the shore. Before the arrival of nylon, it was made from horse hair. At the edge,the 'master', or main, line carried lead weight sinkers and from one to three secondary lines called 'bràgole' with a terminal hook.*
Palangrese *(palangaro, corda armata, frisole, trisole, spaderno)*	*little used (permitted)*	*corb, eels, sea-bass, sea bream, flounder, turbot, gudgeon, needle fish*		*This is a long line to which are attached about every 3 m 1.5 m long fishing lines. A single 'palangrese' can carry up to 250 hooks.*



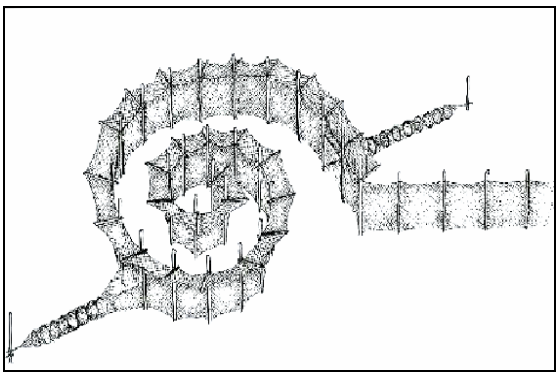
Trawling net with a codend (Tartana)



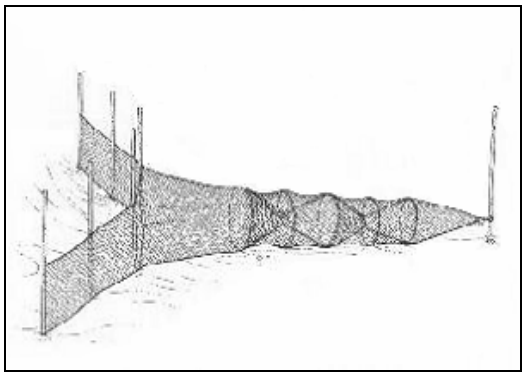
Trawling net without a codend (Baicolera)



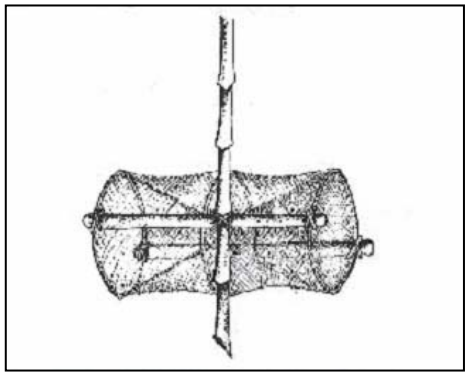
Fyke net (Seragia)



Drift net (Saltarelo)



Codend net



Nassino or Cheba

In addition to the tackle already described, simple metal tools were often used; these were often the result of modifying household utensils (spoons, knives, etc.) or those used for gardening tools (spades, small rakes). These tools were principally used for digging for bivalve molluscs (raiser shell, carpet shell clam, native clams, etc.) in shallow waters during low tide (Pellizzato, Giorgiutti, 1997).

Towards the end of the nineteenth century it was recorded that there were about one thousand fishermen of Pellestrina and Venezia (Nicolotti) who hand-fished for gudgeon directly in their lair ('brassarioli'). Hand-fishing for gudgeon was done in the shallow lagoon waters ('palùo') during low tide usually in spring when the gudgeon made their U-shaped lair with two entrances in order to lay eggs. The fisherman, once he had identified the opening, sealed one of them with his arm and inserted his other into the lair to capture the prey. In winter, when the gudgeon's lair is vertical and deep, a 'fossingolo' (three-pointed harpoon) was used. Apart from gudgeon, hand-fishing was also used to catch bivalve molluscs such as carpet shell clams, reiser shells and cockles.

Furthermore, there was also a type of 'foot-fishing' called 'zapiega' or 'sapega' (stamping with the foot) or 'peca' (kicking, footprinting). The fisherman would walk in the shallow lagoon waters ('palui') leaving behind him his footprints and muddied water. Once he had finished his walk the fisherman would retrace his steps, where he would find adult crabs inside the footprints he had previously left behind. Once collected, the crabs were placed into a net bag called 'pelela da granchi' (Pellizzato, Giorgiutti, 1997).

In order to recognise the type of sea bed, and to distinguish a muddy one from a sandy one, the fishermen would observe the types of vegetation present. The shallow waters of the lagoon were dominated by *Zostera marina,* called 'gramin', which prefers sandy-silty sediments, *Cymodocea nodosa,* called 'bioni', which prefers a sandy substrate and *Zostera noltii,* called 'lisciera' or 'lissera', which is present mostly in a silty substrate. At

the beginning of the 1960 the fishermen came across the first signs of a phenomenon which would acquire increasing significance; *C. nodosa* ('bioni') was dying on the lagoon sea bed, *Z. marina* ('gramin') was being uprooted from the soil, and there was a remarkable abundance of *Z. noltii* ('lisciera') (Vianello, 1993).

Appendix II describes the typical working day of a fisherman who practised fyke net fishing in the middle of the twentieth century (Vianello, 1993).

II. Main fishing systems and rearing techniques used in the Venice Lagoon

In 2001 a sample group of fishermen were surveyed in order to collect data about their socio-cultural characteristics (age, education, particular training) and fishing activities (species fished, fishing grounds, annual activity, technology used, and the fishing systems used).

Many of the fishing enterprises that currently operate in the Venice lagoon have been established comparatively recently. In fact 45% of them commenced activity after 1990 while only 9% of them declared that they had been in operation for more than 40 years. The percentage of the businesses which declared that they had commenced between 1970 and 1980 was 14%.

This relatively low figure can be explained by the widespread abandonment of the fishing industry in this period, when fishermen sought employment in other sectors such as manufacturing. A low percentage of operators, 9%, indicated that the decade1980-1990 was a period when fishing in the lagoon became unstable for environmental reasons (dystrophic events, environmental crises, macroalgae blooms, etc.), forcing the fishermen to choose the sea, instead of the lagoon, as the center for their activities (Table 1).

Whilst the majority of those who run land-based businesses are over 50 years of age, no fewer than 73% of those who direct fishing concerns are under 50 (Table 2).

Furthermore, 65% of those interviewed foresaw the possibility of changing the family business being handed down from son to father, or to someone from the same family.

The average level of training of the workers is quite high with respect to the average of the primary sector. In fact, only 25% declared they had only followed a basic level of training while on the other hand 20% had received a secondary education. The direct connections between the entrepreneur and the production network are very important for starting a company. Thus 55% of the fishermen acquired their knowledge of fishing techniques directly from their families while for the rest the necessary fundamental experience was learned from their colleagues. Only 5% reported that they had taken a training course. The possibility to combine professionalism, which this sector requires, with an economically and environmentally sustainable business requires a direct intervention of investment on a par with other sectors of equal complexity.

More than half the fishermen come from the Lagoon basin, from the port of Chioggia, which has always been the main fishing centre for the province. 22.5% come from the central basin, that is from the islands of Pellestrina, San Pietro in Volta and the historic centre; 14.9% are from the northern part of the Lagoon, the island of Burano and the ports of Carole and Cavallino, whilst the smallest group, only 3.6%, comprised those who live in the edge of the lagoon, which means the area near the lagoon where the salt water from the sea meets and mixes with the fresh water from the rivers, Table 3 (data supplied by the Province of Venice).

Year	Percentage
Before 1960	9%
1960-1970	23%
1970-1980	14%
1980-1990	9%
After 1990	45%

Table 1 *Operators in the fish industry: percentage groups per year of commencing activity.*

Age distribution	Percentage
25 years old or younger	5%
From 25 to 50 years old	68%
Older than 50 years	27%

Table 2 *Age distribution of the operators in the fish industry.*

Area of origin	Percentage
North lagoon	14,9%
Central lagoon	22,5%
South lagoon	59,0%
Edge of the lagoon	4,0%

Table 3 *The area of origin of the fishing workers.*

The assessment of future prospects of the sector (Table 4) shows that 11% of the interviewees did not express an opinion, while the remaining 90% was almost equally divided between three alternatives: weak growth, growth, and decline. The reason for this distribution is to be found in the type of activity followed by the interviewees and in the year in which they commenced working. Those who are mostly involved in *Tapes philippinarum* fishing and have recently commenced this activity generally express a belief in future growth, while those who have been active with fyke nets for some time see difficulties in their future prospects.

Future prospects for fishing activity	1997	2001
do not know	16%	11%
decline	47%	31%
growth	3%	26%
weak growth	34%	32%

Table 4 *Assessment by fishing sector workers of their future prospects: comparison between 1997 and 2001.*

Fishing activities are usually collective, in fact 64% of the survey belonged to this category. Moreover the great majority, about 95%, belonged to some sort of association, such as a cooperative.

Participation in cooperatives is primarily motivated by the assistance given for dealing with bureaucratic matters (66.7%) and the financial and the technical advice (47.1%) that this type of organization can provide (fig. 2).

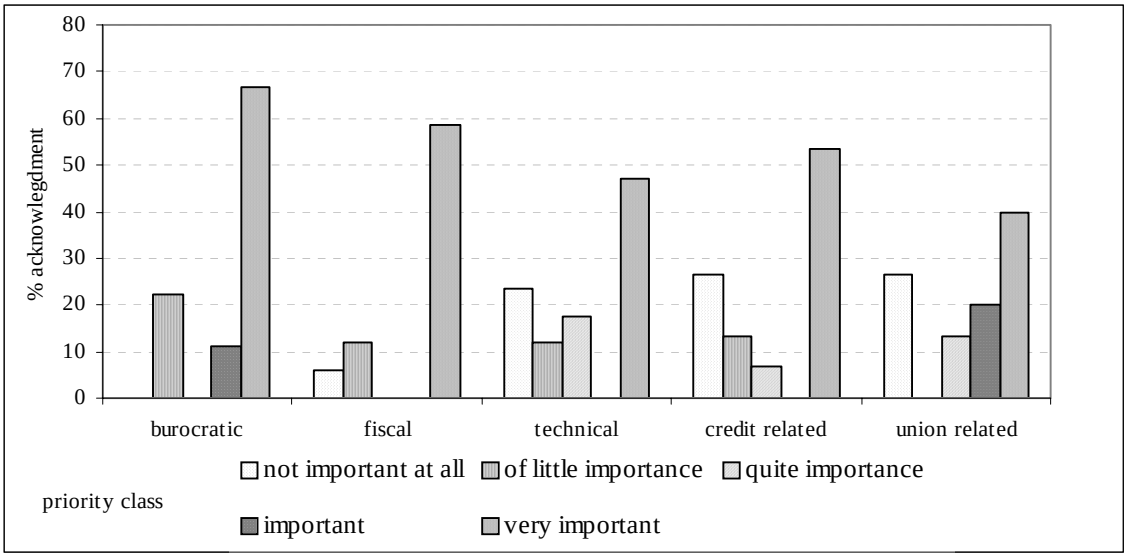


Fig. 2 *Degree of acknowledgement of the advantages given by the cooperative structure and related priority class.*

Each operator was asked to specify the type of tackle he employed, and to identify the different methods of fishing in the Venice Lagoon, and the extent of their use. In order to valuate the frequency of declared and estimated use it was considered necessary to distinguish between the tackle used to fish for the principal species found in the lagoon, and that used for the fishing of the *Tapes philippinarum*, since the latter requires totally different apparatus.

From the findings it emerged that manual tackle, such as a hand held rakes, was rarely employed in the fishing for clams, as these had been supplanted by the widespread use

of mechanical equipment which cut down on both time and manpower. Most fisherman denied admitted they used a mechanical rake, even though its use is not legally permitted.

Another piece of equipment which is widely used, in spite of the fact that is causes significant damage to the lagoon environment, is the vibrating rake. So far only 83 vibrating rakes have been recorded in the area. Even though the fishermen questioned denied having used this type of rake, they admitted that there is indeed a widespread use of this illegal equipment.

As regards the other methods of fishing carried out in the Lagoon for other species I emerged that there is a certain correspondence between the frequency of the use recorded (fig 4) and estimated (fig 5), in other words there is not much use of hooks (fishing line, *palangresi* etc), entrapment nets and trawling nets. Drifting nets and bow nets are quite commonly used; the use of fixed nets is widespread.

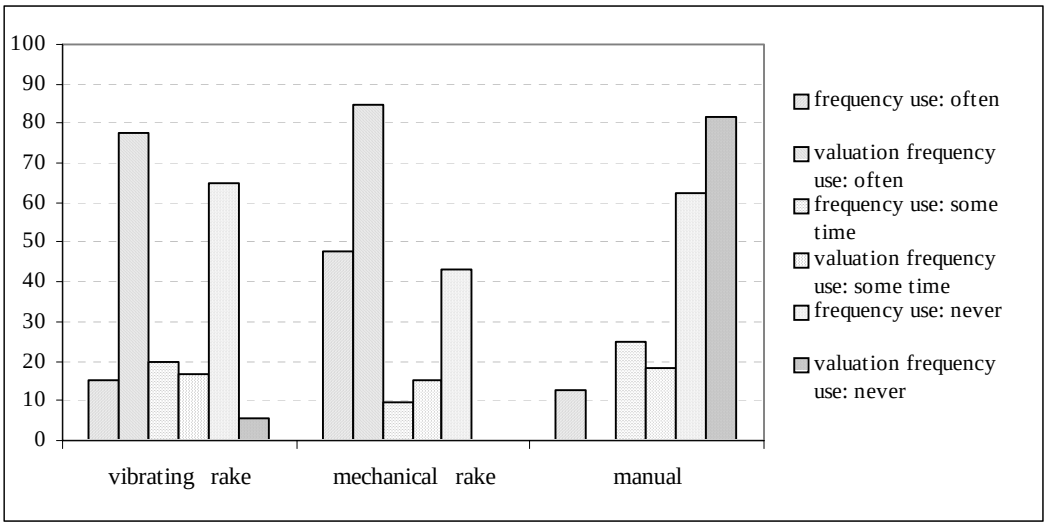


Fig. 3 *Fishing clam: own equipment used by the fishermen in lagoon.*

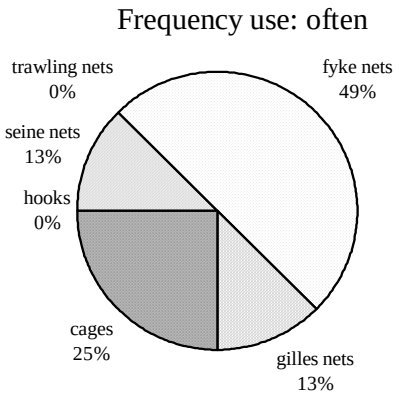


Fig. 4 *Other types of fishing tackle used by the lagoon fishermen.*

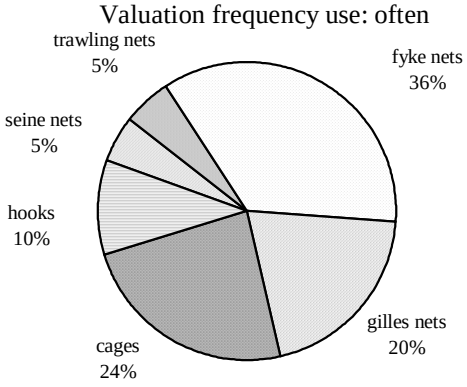


Fig. 5 *Other types of fishing tackle: estimate of the frequency of use of the tackle by the lagoon fishermen.*

Only 21% of the interviewed operators asserted that they possess structures or fixed equipment for fishing activity, such as “casoni” (warehouse for nets and other fishing tools), “buse” (for finfish fry storage), rafts (for mussel and clam selection and processing), etc. Two thirds of the interviewed operators declared that they were not supported by any structure for their working activity.

Having described the productivity of the main methods of fishing we can now move on to analyse the seasons for fishing those species with a commercial value, comparing the quantity of the catch declared by the fishermen with the biological cycle of the various species. Each fisherman was asked to assign to every species of fish caught for each month of the year an ″ index of the abundance of the catch”.
Such an index presents values ranging from 1, when the abundance of the catch was judged to be scarce or poor; 2, when the catch was thought to be mediocre; 3, when the catch was sufficient; and 4, which indicated a decent haul. Observing the accompanying graphs one can note that for certain species there emerges a marked correspondence between the findings, in that the effort required in the fishing is proportional to the biological cycle of the species. This correlation is especially evident for the fishing of fish fry for rearing (fig 6), for which, being a regulated species, there are stipulations regarding times of the year when one is allowed to fish them, that is from the middle of March, in order to safeguard those stages in which the fish are too immature and too vulnerable to the stresses of capture and transportation (Rossi, 1981), and the first ten days of May in order not to interfere with the nektonic species which reproduce in the Lagoon (Zolezzi,1941; Franzoi et al.,1989); for the fishing of cuttlefish (fig 7) there are two main harvests, one in the months of April and May, when they arrive from the open sea to lay their eggs in the lagoon, and in the period from July to September, which coincides with the development of the young which move out towards the sea in the late summer (Provincia di Venezia, 2000); as regards the fishing of the green crab (figs 8, 9), which focussed on two periods of its life, the inter-muta, which coincides with the spring and autumn when the crab obtains its new soft shell ,and the pre-reproductive phase of the females, which takes place in late summer or autumn, when they present well-developed genital organs; fishing for the flounder (fig 10), which reproduces in the Adratic in winter and swims into the lagoon in the spring and summer; the manila clam (fig 11) is characterised by a repose in its sexual activity at the end of autumn and in winter, when the water is colder and scarse in fitoplancton; gray mullet (fig 12) reproduces in August and September, and its juveniles may be present in the Lagoon even by September or October, unless they return to the sea and remain there for the winter, when they would return to the lagoon with the rest of their species to reproduce later.

The availability of certain species is not worth the effort required to catch them: for example it can be observed that for the great green goby (fig 13), a species which completes its entire-life cycle in the Lagoon and reproduces between the end of February and May-June, thus having a large number of adults in the months of July and August, is less and less caught in the months of July and August; the sand smelt (fig 14) enjoys a reproductive period which begins in the spring and continues until the autumn; during the winter it ends to swim out to the sea to avoid the lower temperatures of the lagoon, to return later in the spring.

The decrement of the catch reported in the summer months is probably also due to the increase of tourist activity which can cause problems for certain types of fishing, and to the increase affluence of the fisherman himself, and to the incentives offered by the laws governing the non-fishing periods, all of which contribute to a reduction in the fishing seasons.

There is a gap between the cycle and the intensity of the fishing for shrimp (fig 15) and gray shrimp (fig 16), which reproduce in the months of late winter and spring, the former in the lagoon, the latter in the sea, which the both swarm into the lagoon to complete their growth. Both species are fished most intensively in the autumn and winter months, as they are also used as live bait for the sea bass (Provincia di Venezia, 2000).

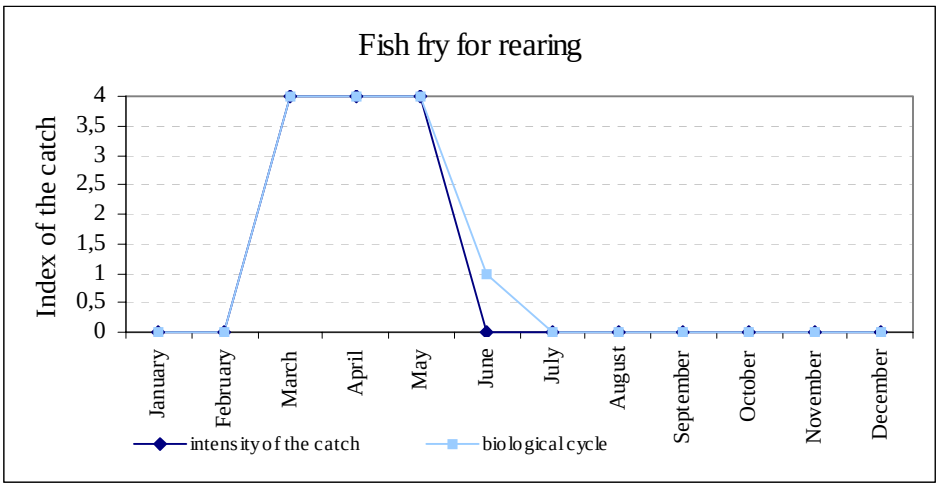


Fig. 6

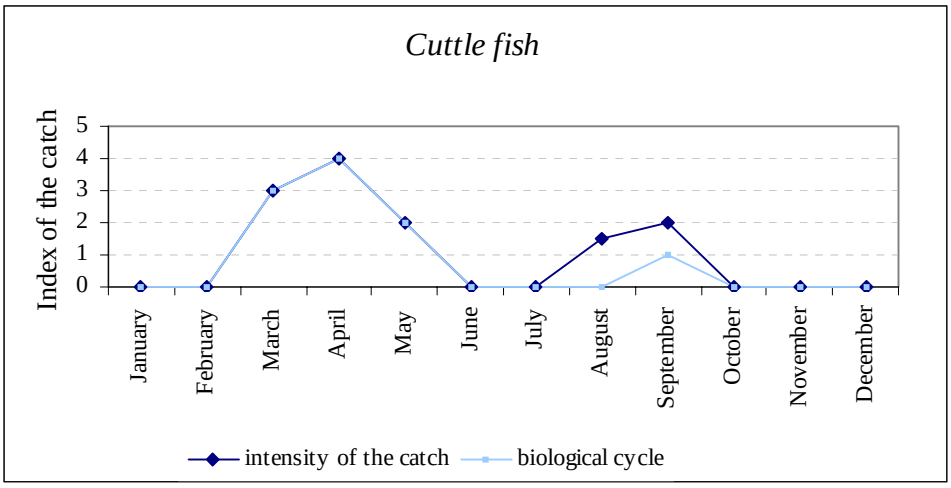
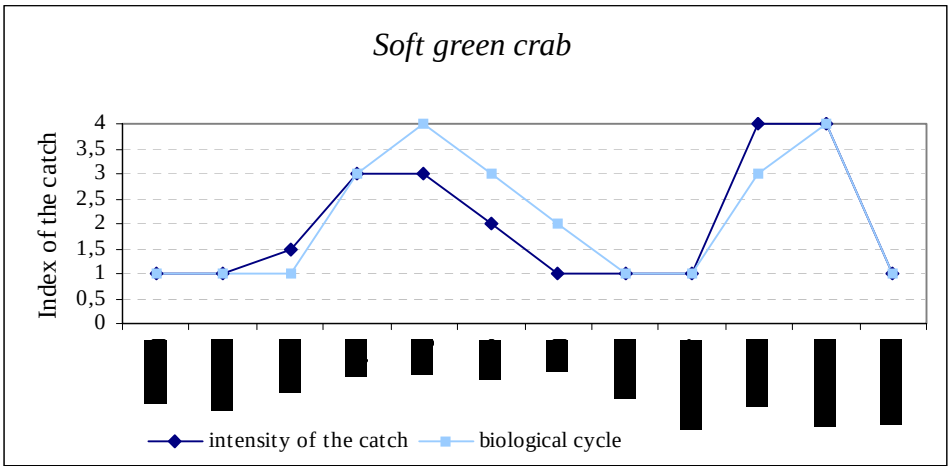


Fig. 7



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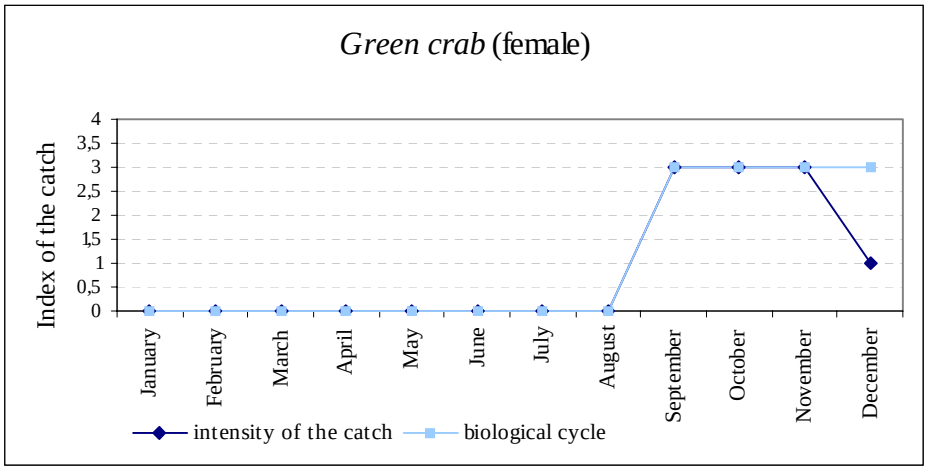

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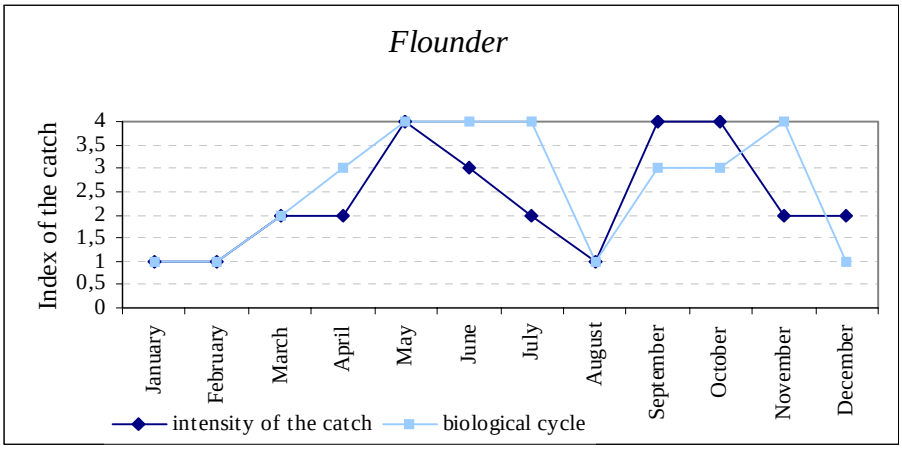

Fig. 10

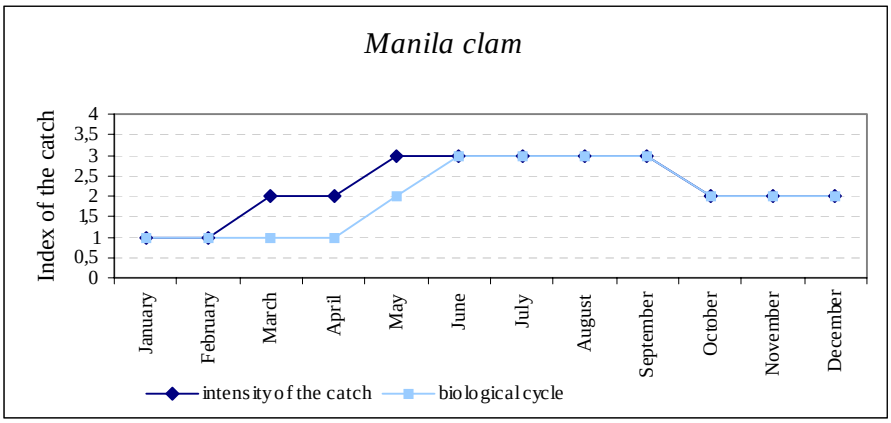

Fig. 11

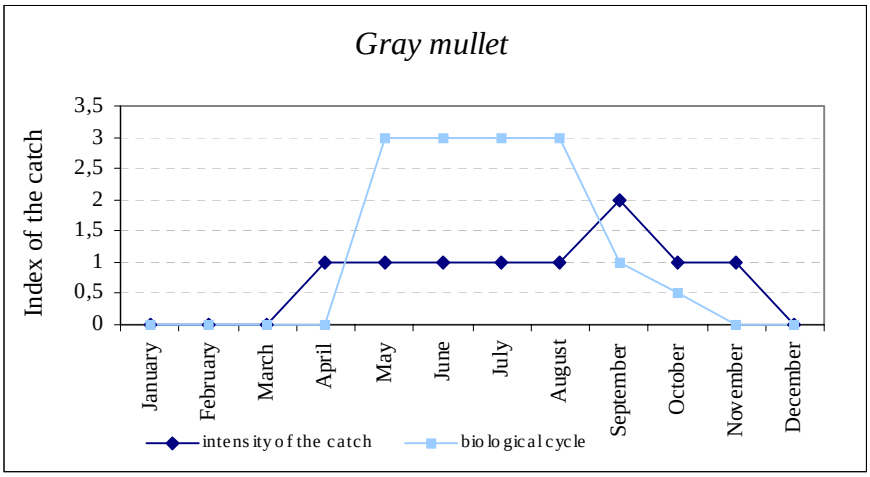

Fig. 12

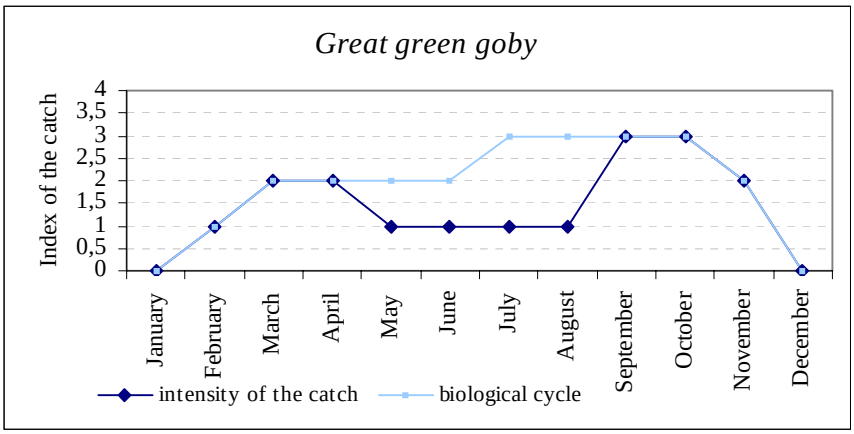

Fig. 13

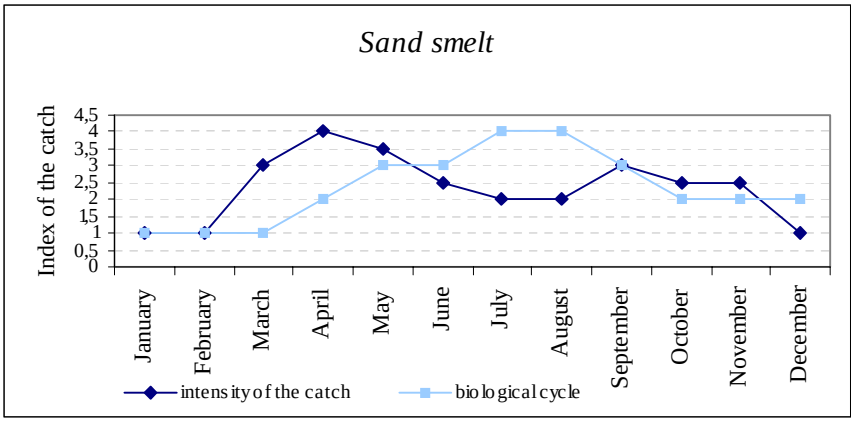

Fig. 14

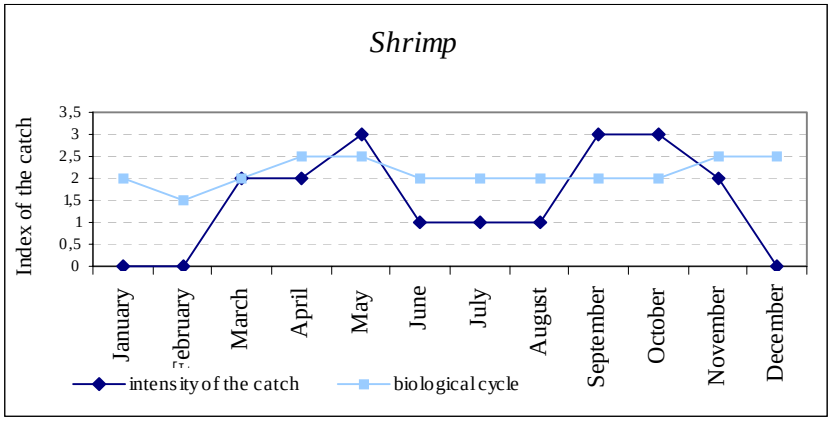

Fig. 15

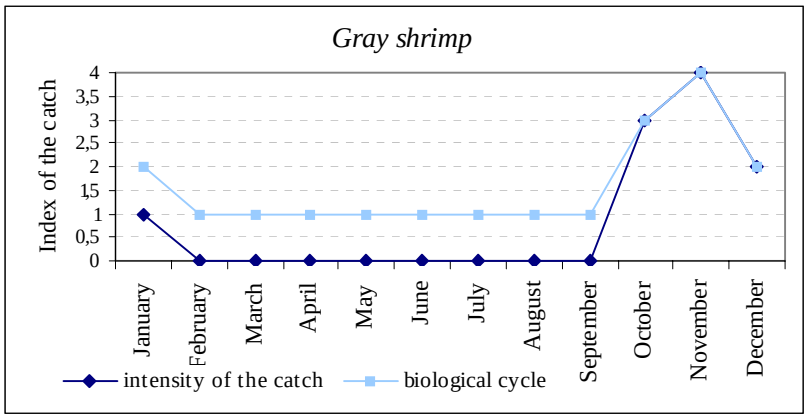

Fig.16

On the basis of the investigation the results show production values depending on the type of fishing followed.

A *Fishing with fyke nets*

This type of activity allows for the checking and management of a large lagoon area by a group of people, while the catch haul requires only the presence of a single fisherman; in this case the average productivity is about 2.5 kg harvest/fyke net/day, and it as been reported to reach up to 5 kg harvest/fyke net/day in optimal working conditions. For this type of fishing six to eight hours per day are worked. There are two main periods for fishing: from September to December, and from March to July. The fyke nets are sunk on a daily basis, the catch is recovered, and the nets are re-cleaned.

The average working days per years is about 300, dedicated to a large extent to the preparation, maintenance, and recovery of the equipment (Provincia di Venezia, 2000).

The analysis of the fyke nets distributed over the surface of the lagoon has allowed us to determine the vocation of the basin and thus deduce the typology of the fish caught in the various areas of the lagoon, as well as the entire lagoon area (fig 17).

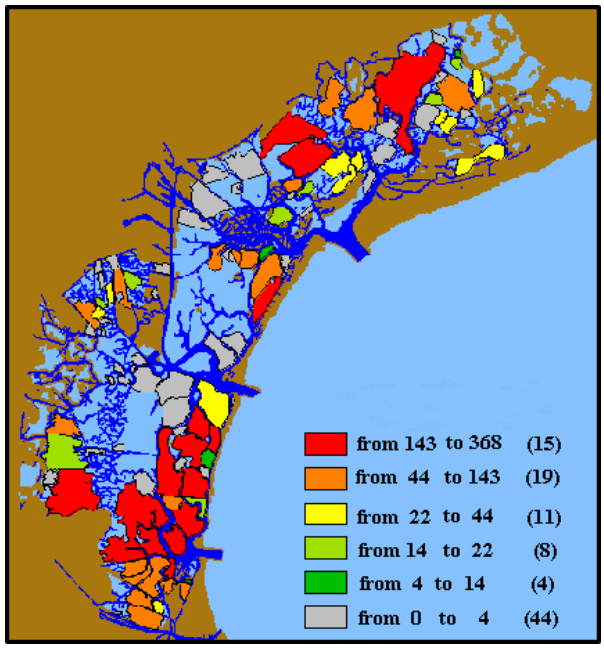

Fig. 17 I*ndex of quality and quantity of the fish population: distribution of fyke nets per homogenous fishing areas in Venice Lagoon during the month of average fishing activity (May 1998).*

On the basis of the data collected, supported and confirmed also by previous investigations undertaken by the 'Magistrato alle acque' (C.V.N., 1999), there emerged from the Venice lagoon a guide to the main species of fish caught: 36% great green goby, 20%, sand smelt, 11% cuttlefish, 8% gray mullet, 16% soft green crab, 6% gray shrimp and shrimp, and 2% flounder, and the remaining 1% other types of fish (Fig. 18).

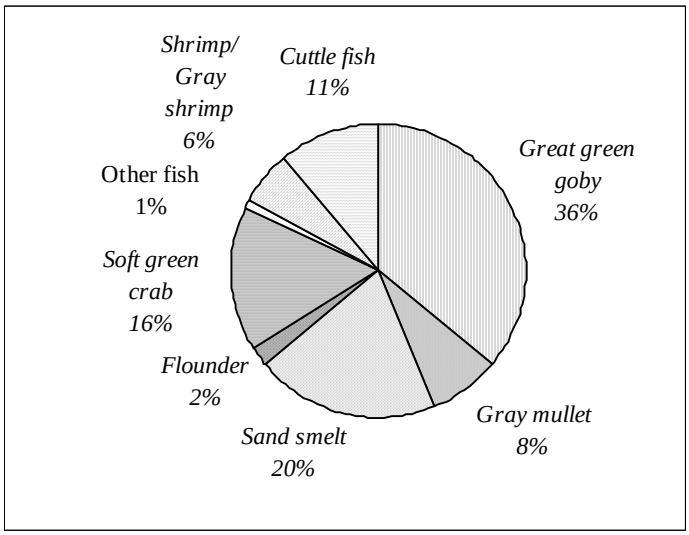

Fig. 18 *Production of the main leading fish species in the Lagoon of Venice.*

Although it is quite difficult to attribute particular productivity levels to each basin, due to the mobility of the fish fauna within the lagoon ecosystem as well as the exchange of this system with the sea, the approximate contribution of individuals basins to total catch is approximately summarised in Table 7.

Species	Northern Lagoon	Central Lagoon	Southern Lagoon
Great green goby	15,0%	65,0%	30,0%
Sand smelt	28,5%	7,0%	24,0%
Flounder	5,0%	1,0%	0,0%
Gray mullet	12,0%	11,0%	1,6%
Soft green crab	9,8%	8,6%	29,6%
Shrimp/Gray shrimp	6,1%	1,0%	9,6%
Cuttle fish	22,0%	6,0%	4,0%
Other fish	1,6%	0,4%	1,2%

Tab. 7 *Fishery contribution of the main lagoon fish species in each basin.*

B. “Vallicoltura” and fishing of fish fry for rearing

The term ‘vallicoltura’ refers to a type of fishing carried out in the ‘valli’ or enclosed basins of the Lagoon, and it could be loosely translated as marsh farm fishing.

The development of fishing management in these basins is closely connected to the role of a nursery which the lagoon environment provides in the biological cycle of some fish species.

This activity is in fact related to the seasonal migration of juveniles of the euryhaline species which swarm in from the sea to the lagoon and the coastal eco-systems where they find the optimal temperatures and trophic conditions suited for their development.

Following this migration, called a 'montata' or 'rimonta', there is a stationary period in the lagoon environment, and the juveniles and young adults of the euryhaline species migrate to the sea to complete their biological life-cycle and to reproduce (Rossi, 1986).

The form, area, and the structural organisation of the marsh fish farms have been greatly changed during the course of the centuries, due both to the adaptations to the physical changes which concern the lagoon environment itself, as well as the restrictive laws which forbid the confinement of the water areas.

In 1500 two decrees were passed ordering the destruction of about 60 of the marsh fish farms, as they were thought to "hinder the free movement of water" and might, in time, "obstruct the necessary waterways for port movement" (Bullo 1940). A census of the marsh fish farms relating to the previous century recorded 42 of them; 16 of these were banked, 10 semi-banked,7 closed with fyke nets, whilst the remaining 9 were open.

In the early 1900s, the number of marsh fish farms declined to around 34, and no open ones were present; the rest were organised as 17 banked, 13 semi-banked, 4 with fyke nets, with a total area of 13,820 hectares. The area of marsh fish farms decreased in the mid-1900s to 12,135 hectares, spread over 36 "farms" of which 20 were located in the north lagoon (Treporti-Lido basin) with an area of 6,720 hectares, and 16 with an area of 6,008 hectares in the lagoon basin of the Ports of Malamocco and Chioggia.

"Valle da pesca"	Total surface area of the "valli" (ha)		
	Bullo,1940	Boatto, Signora, 1985	ASAP, 1998
Dragojesolo	1.234	1159	1215
Fosse	172	174	172
Grassabò	1.087	860	1138
Dogà	1.685	1.650	1.688
Formenti or Caligo or Lio Mazor	140	141	27
Basegia	61		421
Cavallino or Zampenigo or Della Mora-Scarsella	350	358	
Paleazza or Spaventosa	287	378	576
La Giozza or Falconera	39	40	
Liona or Lio Piccolo	146	150-inactive	inactive
Oliviera (Olivara)	66	65	inactive
Sparesera	16	22	inactive
Mesola or Zallo	111		
Saccagnana	26	27- inactive	inactive
Lagonovo	10	9- inactive	
Sacchetta	108	118	115
St. Cristina or Squartuzzo	11	30	inactive
La cura	13		inactive
Cà de Riva grande and piccola or Perina	300	310	310
Lanzoni	265		
Serraglia	437	400	435
Averto	386	300	500
Contarina	209	353	353
Tezze or Torson di sopra	135		
Battioro	142		inactive
Cornio	288	320	372
Zappa	328	380	372
Sora	156		
Buse del Prete or Panao	27		
Figheri o Padovana	420	433	420
Pierimpiè	455	528	501
Val de Bon	249		
Barenon or Riola	405		inactive
Ghebbo Strorto	224	228	790
Morosina	566	561	
Millecampi	1.581		inactive
TOTAL	12.135	8.894	9.343
Ca' Zane*			150
Capanno*			87
La Bianca*			62
TOTAL			9.462

*corresponds to "valli" cited only by ASAP, either because they changed name or they derive from the division of other "valli".

Table 7 Total area in hectares of the marsh fish farms in the Venetian Lagoon area as reported for the years 1940, 1985, and 1999.

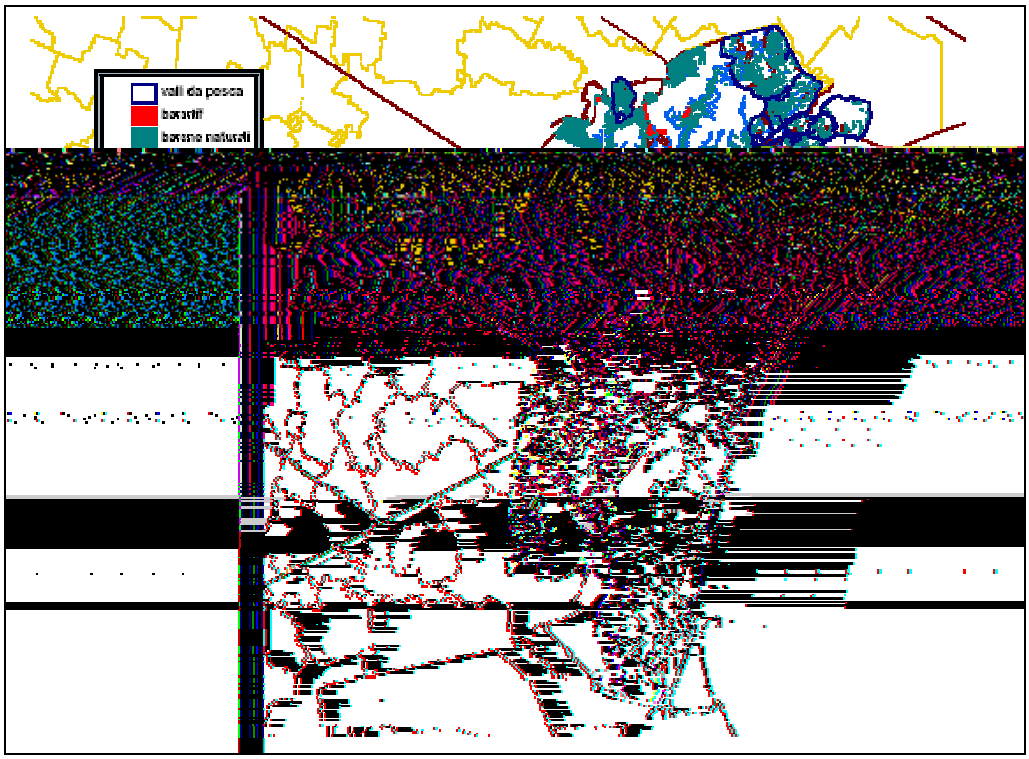

Fig. 19 *Natural and artificial salt marshes, and mars hf ish farms in the Venice lagoon. (Simplified extrapolation based on developed data from C.V.N*, taken from the website: http://www.istitutoveneto.it/)*

*C.V.N refers to the Consorzio Venezia Nuova, the sole licensee of the "Magistrato alle Acque" for the management of the Lagoon environment.

The fishing systems used in the marsh fish farms have remained largely unchanged for over 20 years, and therefore the fish yield has remained quite stable also, estimated at 75-130 kg per hectare of surface water area (Boatto, Signora, 1985; Donati *et al*., 1999). Considering that the total surface area of the marsh farms extends to 9,343 hectares, then the total production is about 700 to 1,200 tons. The composition of the fish catch hailing from these has undergone an evolution which consisted of a gradual reduction in the presence of the common eel.

60% of the fish reared were mugilids, whilst the more prestigious species such as sea-bass, sea-bream and eels accounted for about 35% of the production (Provincia Venezia,2000; Donati et al., 1999).

The fishing of fish fry for rearing is an activity that has practiced for about 7 centuries in the upper Adriatic. Currently the employees of this sector are less numerous, about 30 to 40, and they are active for less than three months per year (Franzoi, Pellizzato, 2002). A working day generally lasts at least 8 hours. Daily production of a company of

fishermen, which consists of 2-3 people, is very variable: 1,000-30,000 fish fry per day, with an average of approximately 3-4,000 head per person per day (Franzoi, Pellizzato, 2002).

Initially, fry fishing was practised to supplement the naturally-occurring 'montata', the seasonal migration, into the “valli”, following which the “valli” depended almost entirely on this annual re-supply of juveniles (Bullo, 1940; Rossi, 1981; Boatto, Signora, 1985; Franzoi, Rossi, 1992).

The species that are used in the Venice lagoon are: gilthead sea bream (*Sparus aurata*), sea bass (*Dicentrarchus labrax*) grey mullets (*Liza ramada* "botolo"; *L. aurata* "lotregano"; *L. saliens* "verzelata"; *Chelon labrosus* "bosega").

This type of fishing involves small companies, composed of 2 to 3 fishermen with motorboats and seine nets. The net is drawn by hand in the shallow bottom (inter-tidal and sub-tidal) zones and it is never lifted out off the water; the fish fry are collected with a net and put in tubs filled with water which is frequently changed. The captured fish are then putted in pounds, called "buse di deposito". The starting date for this activity is fixed each year, but it happens often in the first half of March, and ends usually within the first half of May. In the last three years, the fishing effort has concentrated on gilthead sea fish fry: on average 5 million specimens per year were captured, of which 2.3 million belong to the gilthead sea bream juveniles, 2.1 million of grey mullet juveniles, and less than half million of sea bass juveniles (Franzoi, Pellizzato, 2002).

In comparison to the past, towards the end of the 1800s, as confirmed by sales data of fish fry in Burano (Voltolina, 1898, 1902), the mugilid fry are fished less because they are less profitable compared to sea-bass and sea bream (Franzoi, Pellizzato, 2002).

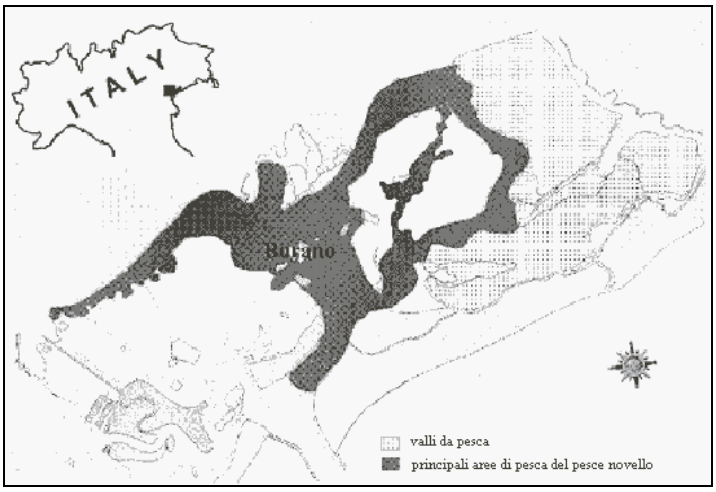

Fig. 23 *Map illustrating the location of the main fishing areas of fish fry (Franzoi, Pellizzato, 2002).*

The use of marsh fish arms as areas of seeding and growth is a system of ecologically compatible exploitation (Ardizzone *et al*., 1988; Munford, Laffoley, 1994; Rossi *et al*., 1999; Barnabè-Quet, 2000), but one which must be managed and controlled to maintain fish stocks (Rossi, 1981; Rossi *et al*., 1999; Cataudella *et al*., 1999), since the fishing of juvenile stages has a negative impact on fish resources.

Recommendations for management include the following: establishing a control which starts from the capture of the fish fry and ends at its seeding in the marsh fish farm (Franzoi, Pellizzato, 2002); establishing an commencement of activity date which is based on the analysis of environmental conditions and on directed sample observations on the fish fry development stage in order to safeguard those stages which are too immature and too vulnerable to capture and transportation stress (Rossi, 1981); fixing the date for the end of the activity in May in order not to interfere with the development of the nektonic species which need lagoon reproduction (Franzoi *et al*., 1989); reserving such activity for fishermen who possess adequate professional ability; and lastly releasing into the sea a predetermined quota of mature specimens, in order to contribute to the maintenance of the parental stocks (Cataudella *et al*., 1999).

C. *Mussel culture*

Mussel farming in 'nursery-parks' in the Venice Lagoon started in the 1930s and greatly developed in the years 1960 to 1970, reaching an annual production of 25,000 to 30,000 tonnes, and remaining so for about 20 years. For about the last 10 years this practice in the open lagoon has diminished significantly, and today only about 42 hectares of the lagoon surface area are used, which corresponds to 38 permits, and it is estimated that about 220 workers are currently employed. Either environmental or bureaucratic problems have pushed most of the sector operators to establish new plantations in the sea (off-shore). An integrated management system was then created between the two production sites, the lagoon and the sea, by improving the lagoon production methods, and then transferring the "crop" to the sea plantations, or using the structures of one plantation for the seed harvest and then transferring it to another one etc..

We estimate that the annual production of clams in the lagoon is about 4,000 tons, while the offshore plantations produce about 6-7,000 tons per year .

It would therefore appear that mussel farming in the lagoon has declined considerably: in 1993 22,100 tonnes were estimated, an amount which is five times greater than the current production. The causes of this reduction can be related to several factors. One cause may be the possible reduction of the nutrients in the lagoon; this would have increased the duration of the productive cycle in the lagoon to 18 months (versus the 9 months in the sea). Moreover, the bureaucratic route to get a permit in the lagoon is much more complex than is required to start the same activity in the sea.

The mussel farming system employed in the lagoon is the so-called "French-type nursery-park".

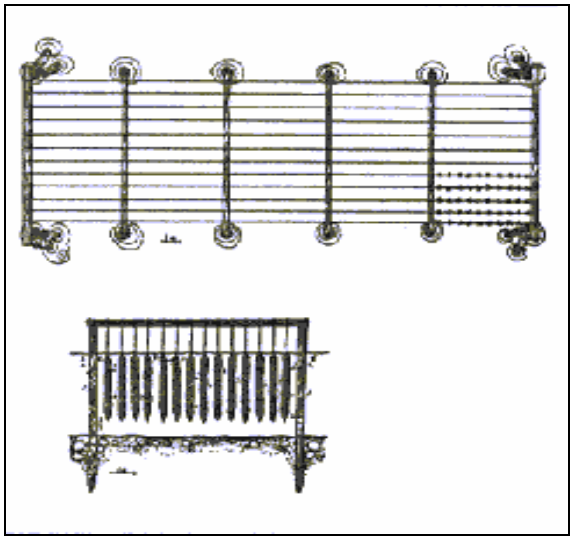

Fig. 24 *Diagram of a mussel farming nursery. The socks ('reste') are hung with zinc cables stretched between wooden poles which are fixed into the sea-bed (Pellizzato, Da Ros, 1985).*

The raising of the sea-bed which this farming system requires results in a gradual reduction of the length of the socks ('reste') and a consequent reduction in the surface yield. Production is estimated to be about 80-100 kg per square metre in particularly favourably-located nurseries. Mussel farming is spreading to many other Italian locations and the growth of the national production (over 130,000 tonnes per year) has kept the average price of the product stable, reducing the earnings of the operators in the Veneto Region (Pellizzato, Da Ros, 1983; Da Ros, Pellizzato, 1985).

D. *Clam fishing (Tapes philippinarum)*

Tapes philippinarum, called ‘caparozzoli’ in Veneto, is a rapidly growing species which was introduced to the lagoon in 1983 as a type of experiment carried out by Co.S.P.A.V. However, its use only became widespread at the beginning of the 1990s. Its maximum diffusion coincided with a reduction in the macroalgae areas due to both the availability of larger areas of the lagoon and to the subsequent reduction and disappearance of dystrophic crises associated with growth and degradation of plant matter.

Compared to native clams, such as *Tapes decussatus*, this Asian species (*T. philippinarum)* has a faster growth rate, reaches a bigger size, and has a greater tolerance of variations in temperature, salinity, and substrate quality. It lives in a more superficial habitat (Breber, 1985), and at least initially, was immune to parasites, viruses, and other diseases which have affected our native species.

Over the years the equipment used to harvest *Tapes philippinarum* has changed considerably and become more sophisticated and automated.

To conclude our summary here follows the main characteristics of the equipment used for the harvest of this bivalve (Pellizzato, Giorgiutti, 1997):

- the 'rasca': a mechanical crate armed with a rake which penetrates 5 to 15 cm into the sediment;
- the 'rusca': or 'rasca da traino': for use on motorised boats, which was subsequently modified by individual fishermen in view of their experiences. It consists of a rectangular metal frame with a V-shaped metal blade which penetrates the ground. The 'rusca' is towed by a motorised boat, and the motor also serves to disrupt the sediment, and thanks to the action of the propeller, channels the molluscs and sediment, into the fishing equipment. Towards the middle of 1998 in the lagoon there were 600 small boats of 5 to 6.5 m in length with main engines of 150/200 h.p., in addition to auxiliary engines of 15/25 h.p. During the clam harvest, the small boats cover about 750 metres per hour (Provincia di Venezia, 2000) and they are capable of penetrating the sediment to a depth of 0.15 m;
- the hydraulic dredge ('draga idraulica', or 'turbosoffiante'): during the 1980s, and from 1990 to 1996 this was used illegally in the lagoon. It consists of a parallelepipedal rigid crate with a blade to cut into the sediment and a system to send pressurised water to nozzles located at different points;
- the vibrating rake ('draga vibrante'): this was introduced in an experimental way, and it was thought that there would be five units of fishermen working each day. In reality, since 1998 the 84 known machines of this type work more or less contemporaneously and for about 150 days of the year. It consists of a crate mounted onto a sleigh, which prevents it from sinking. It is equipped with an electrical vibrating mechanism which results in the breaking-up of the collected sediment and its cleaning by the water

flowing into the crate. This type of equipment allows on average about 15 runs of 100 m each working day.

The mechanical action of this type of equipment changes the morphology and composition of the sea-beds, modifying the granular gradients and the texture, re-suspending large amounts of sediment, rendering the water turbid, and consequently hindering the development of macro-algae.

The morphological impact in the lagoon is therefore considerable. At low tide, for example, looking over the sides of the trans-lagoon bridge, it is possible to observe the furrows left behind by the fishing equipment. The furrows reach depths of 15 to 20 cm and form micro-environments which later become stagnation zones where it is possible to observe dystrophy. The geo-technical characteristics of the sediment are so altered that they are prone to erosion. The sea-bed is continuously re-mixed, due to both the movement of the fishing equipment itself, as well as the waves caused by motorised boats. This causes the fine sediment fraction, once re-suspended, to remain in suspension for long periods of time and to be re-distributed in the lagoon by sea currents, carrying away with it both nutrients and pollutants.

The mobile material then partly sediments in shallow areas (canals, channels, etc.) and increases the work required to maintain their navigability. The extent of damage, based on the speed of particle sedimentation which make up the lagoon deposits and the quantity of sediments mobilised by each piece of equipment during one year of use, is high, and is considered to be in the region of 20 billion/year (Provincia di Venezia, 2000).

Furthermore, at a depth of 20 cm in the sediment, where the hydraulic and mechanical dredgers operate, can be found the greatest concentration of pollutants, accumulated during the post-war period when there was an increase in the industrial activity at Porto Marghera. The resulting release of toxins can create sanitary-toxicological problems due to the consumption of molluscs, even if the high level of tidal water exchange means a rapid dispersion, and therefore reduces the concentration in the areas at most risk.

The continuous ploughing up of the sediment, its re-suspension, and the continuous re-settling, results in a gradual impoverishment at several levels and a simplification of both the flora and of the fauna.

Smaller macrophytes, benthic microphytes, and unicellular algae are inhibited from establishing themselves, with the result that the productive capacity of the superficial microflora is reduced and therefore the phytoplankton community that survives in that is impoverished. Phanerogams are eliminated, and these are components of the plant benthic environment that serve both as a 'nursery' for the deep fauna and as a form of protection against the erosion and re-suspension of the sea bed. Consequently, there is a breakdown of a habitat of fundamental importance for the development and diversification of the macrofauna, and the maintenance of a degree of stability of the substrate.

The Province of Venice (2000) cautiously estimated the morphological damage caused by fishermen to be an annual 10 million euro for material to be collected and disposed of, and a further 20 million euro per year for reconstruction works.
The harvest of *Tapes philippinarum* in 2001 as compared to a 1997 survey (Provincia di Venezia, 2000) resulted in total losses estimated at approximately 40%. This type of fishing necessitates working for 6 to 8 hours per day for a fishing season of approximately 200 days per year. On average, each fisherman harvests about 150 to 200 kg of clams per day.

The ecosystem has evolved towards a gradual depletion of the fish resources: estimated yields are approximately 15 to 20 g/m^2 for the Northern Lagoon, 20 to 30 g/m^2 for the Central Lagoon, and 25 to 35 g/m^2 for the Southern Lagoon. This decrease in yield is explained either by the mortality phenomena which took place in August 2001, or by the increase in the pressure of fishing, which has strengthened in the last years in conjunction with free access for the exploitation of the resources, combined with lack of a regulation which establishes catch limits.

GLOSSARY

'ALI' (WINGS OF THE NET): extreme edge of the net, usually a larger mesh size in order to channel the fish into the net bag.

'ARTE': fishing tackle, principally nets. As in 'Inquisitore alle Arti'.

BENTHIC SPECIES: species that live near the sea bed.

FYKE NETS: fishing nets which are lowered vertically, designed to surround or block areas of water in order to catch fish that swim into it.

'FRAÌMA': Autumn. The term is derived from Latin 'infra hiemes', i.e. below winter. Indicates the period which begins on Rosary Sunday (first Sunday of October) and finishes on St. Stephen's Day.

'GALLEGGIANTE' (BUOY): piece of cork, wood, or plastic which keeps the baited hook at a determined depth.

GILLES NETS: fyke net left to the actions of the wind and currents.

'LIMA' (LINE): rope or cable onto which hooks are attached

LINE OF CORK FLOATERS: upper line onto which corks or floaters in general are mounted.

LINE OF LEAD WEIGHT SINKERS: a line below the net onto which lead weight sinkers or ballast are attached.

'MENAIDA': gilles net for small sea fish.

MESH: the weave of the lines, varying in size and shape, which make up a net.

NET MESH SIZE: the distance between opposite joins of the same mesh completely stretched in the distance yielding the greatest length.

'PANESELLI': pieces of net kept between two small poles fixed into the sea bed.

PELAGIC SPECIES: species that live in the body of the water without a relationship with the sea bed.

'SPONTERI' (POLES): for boats they are horizontal poles at the edge of the bow and the stern of a boat onto which are attached the net cables to keep the separate wings open.

THE BAG OF A NET: the rear part of the net into which the fish are collected

VALLE DA PESCA: a system of canals and lock gates used for semi-intensive or extensive aquaculture in lagoon.

VALLICOLTURA: fishing management in the “valli da pesca”.

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APPENDIX I

The type of fishing boats used in the Venice lagoon during the first half of the 1900s (Associazione culturale El Fughero, 1985; Brunelli *et al*., 1940)

'*Tartana*' or '*paranza*'

This vessel was used to tow a large trawl net called a 'tartana', which was kept open by the use of a pole across the opening of the net, or by two long poles, called 'sponteri', jutting out of the boat. It drifts with the prevailing current; and in the case of a favourable wind a sail was raised, whilst if the vessel was becalmed then the fishermen used their oars.

Bragozzo (and *rete coccia*)

The boat is equipped with two masts and a lugsails, as long as 12 m, and with a tonnage of 4 to 8 t. It had a crew of 2 to 5 depending on the type of fishing practised. It is the most famous boat of the Adriatic, the symbol of the city of Chioggia with its sea-faring tradition. The 'bragozzi' were capable of fishing in pairs towing a bag-shaped net, as long as 50 m, with side wings called 'coccia' or 'cocchia'.

'Battelluccio' or *'sardellara'*

This boat was used for sardine fishing in the sea or near to harbours. It was 9 to 11 m in length and had a tonnage of 1 to 3 t. It had a crew of 2 to 3. Before sunrise, or at night-time when there was a full moon, a long net called a 'menaide' was lowered and sunk vertically to a depth of 4 to 5 m.

Caorlina

This is a typical boat used by the fishermen of Caorle and Burano and was remarkable in having a both a pointed stern and bow. It is 9 to 11 m in length, with a tonnage of 1 to 2 t, with a crew of 2 to 8. It was suitable for the transport and installation of fyke nets.

Bragagna

A thee-masted fishing boat used in Chioggia , 9 to 11 m in length with a tonnage 1 to 2 t, and crew of 2 to 4 . It fished only in the lagoon with a trawl net ('bragagna'). The three masts with their lugsails allowed the boat to proceed sideways, towing the large net whose edges were fixed to two poles ('sponteri'). In the absence of wind, the boat was pushed by hand, walking on the sea bed or rowed.

Topo ('batelo a pizzo'); variants*: 'topo mestiereto'>m7; 'topo musso' or 'musseto' <m6.80*

A boat with a rounded stern and a pointed bow, 7 to 10 m long, a tonnage of 1 to 4 t, and a crew of 1 to 5. The 'topo' was used in support of traditional fishing with 'parangali' (also called 'palangresi') and was towed to the fishing grounds by a much bigger boat (e.g. a 'tartana' or 'bragozzo'). It was generally used for attaching hooks. Once the 'topo' was used for fishing with 'a panola' (a towed line for catching mackerel).

Sandolo and *'pesca a fagia'*

A small boat with a pointed bow used in both the basins and in the lagoon itself. It was 6 to 8 m in length, and had tonnage of 0.5 to 1 t. It was crewed by 1 to 3 men. It was called by various names depending on its size and characteristics. Using a strong light directed at, and near to, the water at night-time, it was possible to act as a decoy ('pesca a fagia').

APPENDIX II

This is a description of the events of a typical working day for a fisherman who practised fyke net fishing ('seragia') in the mid-1900s (Vianello, 1993).

"Fishing with the fyke net is a tradition that has been passed down through the generations, and every chief ('padrone') of a boat bore a traditional family name. In this way at Pallestrina there was the company of 'Datti', 'Fongher', and many others, in Burano there was the famous 'Strigheta', etc.

Such a fishing method was used only in the shallow lagoon waters ('paludi') and required the use of one or more boats, usually 'caorline', which were equipped with nets. The number of boats, as well as nets, was decided upon by the 'padrone', the chief, who if he had more fishermen at his disposal, then had more boats and also more nets to use. The crew of each boat comprised of three or more men who would cast about 200 to 250 m of fyke net ('seragia').

Fishing normally took place at night-time: lengths of the shallow waters were closed off with long nets about one hour before the tide began to recede. This period was chosen because many fish species which normally live in the canals, move to the shallows with the high tide. The fyke net was fixed to the sea bed using suitable pegs at a distance of about two metres from the bank of the canal. When the tide began to recede, the fish tried to reach the canals, and in the attempt they were caught in the nets which surrounded the shallow waters. Following this, the fishermen waited until the water had fullyreceded in order to collect the fish using a net or their hands. The fish were placed into various containers, loaded onto boats ready to be transported to the fish markets of Chioggia or Venice. Sometimes it was necessary to wait a long time for the low tide, and then there was a hard night's work ahead."

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