Chapter 4

Capture fisheries

4.1 Fishing systems and technology

Ferretti M.

Fishing is an activity thousands of years old. The human search for sustenance has always included the sea. Technologies naturally developed over time and fishing systems became more sophisticated, as understanding of the habits and behaviours of the various species available in the sea gradually increased.

Fishing gear has changed over time, becoming increasingly adapted to catch the most desirable species. This evolution is still in progress, since technological development goes on.

In recent times there is greater awareness of environmental problems and when new fishing methods are developed, attention is paid to their impact on resources and on the environment. Fishing regulations have likewise become stricter and more specific.

The time of technological development disregarding the environmental issue has passed and now there is a keen sensitivity, of both fishermen and managers towards sustainability and fishing systems with an acceptable impact, thereby making fisheries more responsible.

Evolution over the last century

From World War II onwards, the world of fisheries, which was rooted in tradition and resistant to innovation, has made giant leaps in the use of technology. There have been more innovations in the last hundred years than in the previous twenty centuries.

The nets used by St. Peter in the Sea of Galilee were not very different from those used in the early 20th century. The materials used for fishing gear, the working methods, the risks and the effort involved in fisheries were more or less the same. Some technological evolutions from other sectors were then tried out in fishing, with surprising results, and they very rapidly transformed a sector that had been resistant to change. Some of the most important factors that enabled these changes and led to rapid progress, both in regard to fishing gears and methods, and to the quality of fishermen's life and the profitability of their work, are examined below.

Engines

Until the early 20th century, fishing was practised from boats powered by sails or oars. The physical effort involved in this activity, the risks that were taken and the unpredictability of the work, due to sea weather conditions and winds, can be easily understood.

A typical example is trawl fishing. Trawl nets were also used with sailing boats, but were either nets with fixed openings, such as beam trawls, or the nets were pulled by two vessels to ensure the horizontal spread of the net. Achieving this spread through hydrodynamics was unthinkable, given that the power was fuelled only by the wind.

With the spread of engines, the nets could be towed at a constant speed and so otter boards could now be used to ensure the horizontal spread of trawl nets. Pair trawling was abandoned and replaced by otter trawling.
Within a few years, practically all trawling boats had become motorised. The motorisation of fishing vessels was rapid, chaotic, and pioneering, and fisheries totally changed its characteristics, resolving many problems as well as creating or encountering new ones. At present, the problem is not to motorise fishing vessels, making them safer and more profitable, but often one of excess motorisation, due to the use of highly powerful motors that are out of proportion to the fishing needs, with repercussions on natural resources and production costs.

Synthetic fibres

Most fishing gear is made from textile fibres. Natural fibres were used for fishing gears until the middle of the last century. These were normally plant fibres, particularly hemp, cotton, manila, sisal and coconut. Plant fibres could easily be used in the manufacture of fishing nets. Each of the fibres mentioned above has its own particular qualities that make it suitable for certain parts of fishing nets. All of them, however, have one disadvantage: they decay. They therefore had to be frequently treated, and even more frequently laid out to dry to avoid or delay decay. Moreover, although plant fibres are quite strong compared to other natural fibres, they are not as strong as the synthetic fibres that began to be produced in those years. Hence, fairly large twine had to be used in the manufacture of nets, which then created problems when fishing.
The appearance of synthetic fibres on the market, particular polyamide fibre, provided a solution to many problems. Synthetic fibres do not decay, they only undergo a limited form of ageing caused by light, they are much stronger than plant fibres and they are (or at least polyamide fibre is) very resistant to abrasion and therefore have a much longer working life.
In a few years, synthetic fibres completely replaced plant fibres, which have now virtually disappeared from Italian fisheries. A very small quantity is still used to make ropes, but no natural fibre nets are still produced. The use of synthetic fibres has also led to the development of manufacturing processes for the production of woven net panels that are quite different from traditional ones. Knotless net, for example, was produced on a loom that was developed for embroidery. Knotless net is currently the material commonly used for bottom trawl nets.

Deck equipment

Until the introduction of motors on fishing vessels, gear was hauled manually, requiring much time and often great effort. Motors enabled the introduction of deck equipment such as winches, net haulers, line haulers, bridle haulers and net drums. This equipment, very often hydraulic, speeded up operations and drastically reduced human labour, also permitting deep sea fishing down to 700-800 metres depth for catching species such as red shrimps.

Electronic equipment

The huge development of electronics has also radically changed fishing, with the introduction of electro-acoustic instruments including echo sounders, sonar, net sounders, positioning instruments, such as radar and GPS (geographical position system), and navigational instruments, such as autopilots.The first two groups in particular, electroacoustic and positioning instruments, have had a very strong impact on fisheries, providing information to make fishing safer, more abundant and more facilitated.

With electro-acoustic instruments it is possible to assess the advantage of setting the gear in a particular location, to locate schools of pelagic fish and to regulate the correct operation of pelagic trawl. For pelagic fishing, therefore, both with purse seine and towed nets (mid-water trawl), echo sounders and sonar provide valuable data regarding the location and size of fish schools as well as their species.
Net sounders are useful instruments for mid-water trawling, as they provide information on the behaviour of the net, on the working depth, on the fish that enter the net and on those that escape either above or below it. This instrument is not widely used in Italian fishing communities.
Positioning instruments also enable work to be carried out more safely and quickly, facilitate the location of passive gear left at sea and allow the avoidance of obstacles, which would make trawling hazardous in certain areas.
The introduction of electronic instruments has therefore led to an increased catch capacity with greater profits, as well as to a considerable increase in fishing effort.

Processing the catch

The use of engines on board, the constant improvements in refrigeration equipment, and ice-making machines enabled a better treatment of the catch and fish conservation. Whereas in the past it was necessary to frequently go back to the port to bring the catch to market, with the new techniques it became possible to remain at sea at longer (even for a few months, for fishing vessels with freezers), and to thereby exploit areas far from the base ports.
This was a huge revolution that led to an increase in fishing capacity and effort, with the product offered for sale in good conditions even after a relatively long time after capture.

Division of the fleet

According to the Italian provisions of Presidential Decree 1639/1968, the regulation implementing Law 963/1965, the fleet is divided into coastal (at times subdivided into *local* and *near-distance*), *Mediterranean* and *Overseas* vessels (which fish beyond the Mediterranean Straits). Operators are more often divided, however, into small-scale or artisanal fishing fleets and larger-sized fleets.
The general meaning of the three categories mentioned above is quite clear. Some difficulties arise when a precise, clear and easily applicable definition is required, because Italian and European legislation include various definitions; some of these use size as the decisive parameter (still, at times, gross tonnage), others use overall length, while others again refer to the type of fishing system used.
In general, however, small-scale or artisanal fishing refers to fishing practised with small boats, mainly in trips from morning until evening and with a minimal crew (one or two fishermen).

Fishing systems

The practice of professional fishing requires a fishing license indicating the fishing system that can be used. Under Ministerial Decree 26/07/95, commonly known as the License Decree, there are 13 possible licenses, one for each of the listed fishing systems. A vessel can have more than one gear allowed in the licence, and can therefore use a selection of more than one fishing system from those indicated on the license.
It should be noted that the term “fishing systems” refers to a group of gears that are similar, but not identical; thus “static gear” refers to both static nets (trammel nets, gillnets and combined

nets), as well as pots and fixed nets (fyke nets, etc.). EC regulations, however, always concerns gears rather than systems and therefore the distinction must be made between one gear and another.
One of the 13 original fishing systems was cancelled and the respective licenses withdrawn: drift nets for sword fish and albacore have in fact been outlawed and their use is now prohibited. Twelve fishing systems therefore remain currently in force, practically all of which are used by Italian fishermen, even though only some of them are of general interest.
Starting from the License Decree and following the order given in Article 11, the first fishing system listed is that indicated by the term "surrounding net system", which includes all surrounding nets, both those that close mechanically, such as purse seines, and those without closure, whether for catching pelagic fish or for tuna.
These nets are used together with fishfinder devices and attraction and concentration systems.
The most widely used system for attracting and concentrating schools of fish is that based on a light source, as purse seine nets used for small pelagic species (anchovy and sardine). Once the artificially formed school of fish is considered large enough, the nets are then set for the catch.
The second fishing system listed in the License Decree is the seine system, both from the shore and from boats. This is a historical fishing system practised for several centuries; the Italian term "*sciabica*" comes from Arabic and has remained in the Italian language since the time of the Arab domination of southern Italy. The seine is a bottom net that is always used with a weighted ground line on the seabed. It is normally used from small boats, at times even without a motor.
The next system indicated in the License Decree is bottom trawling and includes all bottom trawl nets, including bottom otter trawls, beam trawls, and bottom pair trawls (which have practically disappeared from Italy). Bottom trawl nets allow multiple species of high economic value to be landed in considerable quantities.
The *rapido* is a type of net that is used only since a few decades. It is a fixed-opening net fitted with a table that acts as a depressor and a toothed bar that forces the fish up from the seabed. The target species include sole, other flatfish, great scallop and queen scallop. The net, or rather nets, since a fishing vessel normally uses more than one at a time, are pulled at considerable speed, hence the name *rapido*; the higher the speed, the more the depressor keeps the gear firmly against the seabed. The row of iron teeth on the lower portion, controlled by runners that prevent them from penetrating deeper than necessary, prevent the fish from clinging to the seabed, thereby obliging them to rise and enter the net. The *rapido* has now definitively replaced the older beam trawl from which it was derived.
While bottom trawl nets are towed nets that operate on the seabed, midwater trawl nets, listed next in the License Decree, operate in the body of water. They therefore target completely different species than bottom trawl nets. They have, however, one common characteristic with bottom trawl nets: their use involves heavy fuel consumption. A high-powered engine is required to tow them at fishing speed, which obviously consumes significant quantities of fuel.
Midwater trawl nets generally target small pelagic fish and therefore often come into conflict with surrounding nets. Fishing with midwater trawls, however, is generally carried out at a shallow depth (less than 100 m) and during the day, whereas fishing with surrounding nets is practised at night and at greater depths.
The systems indicated next in the License Decree are those for catching burrowing bivalve molluscs. These are "hydraulic dredges", "towed mollusc gear" and "boat rakes". Each of these three gear groups, or systems, has a specific licence.

These are gears that penetrate the marine sediment to root out and retain molluscs, separating them from the sand and mud. They are generally used by vessels of moderate size that operate close to the coast, where the mollusc beds are found. They always make daytime trips, normally lasting a few hours. There are very strict national and EC regulations for these gears, as they inevitably have a certain impact on the seabed.

The “static gear” licence includes the most traditional gears and probably those with the least impact in use today. Boats with static gear licences can use all static nets, including gillnets, trammel nets and combined nets, and all types of traps, both static and mobile.

Static traps worthy of mention include fyke nets and *serragie*, while mobile traps include pots of all types, with the most varied shapes, made from a wide range of materials and used for specific target species. These are gears that have been used for centuries, or even millennia; they were the first devices used by humans to catch marine organisms.

Today, the use of synthetic fibres and nautical equipment has enabled fishing to become more abundant and, above all, less arduous. The use of synthetic fibres, however, has caused a few problems. Since they do not decay, if a net is lost, which happens fairly often, it continues to catch fish and to therefore cause damage, with no benefit to the fishermen.

Catches with any type of static net occur through one of the mechanisms described in figure 4.1 i.e. gilling, meshing, tangling or bagging.

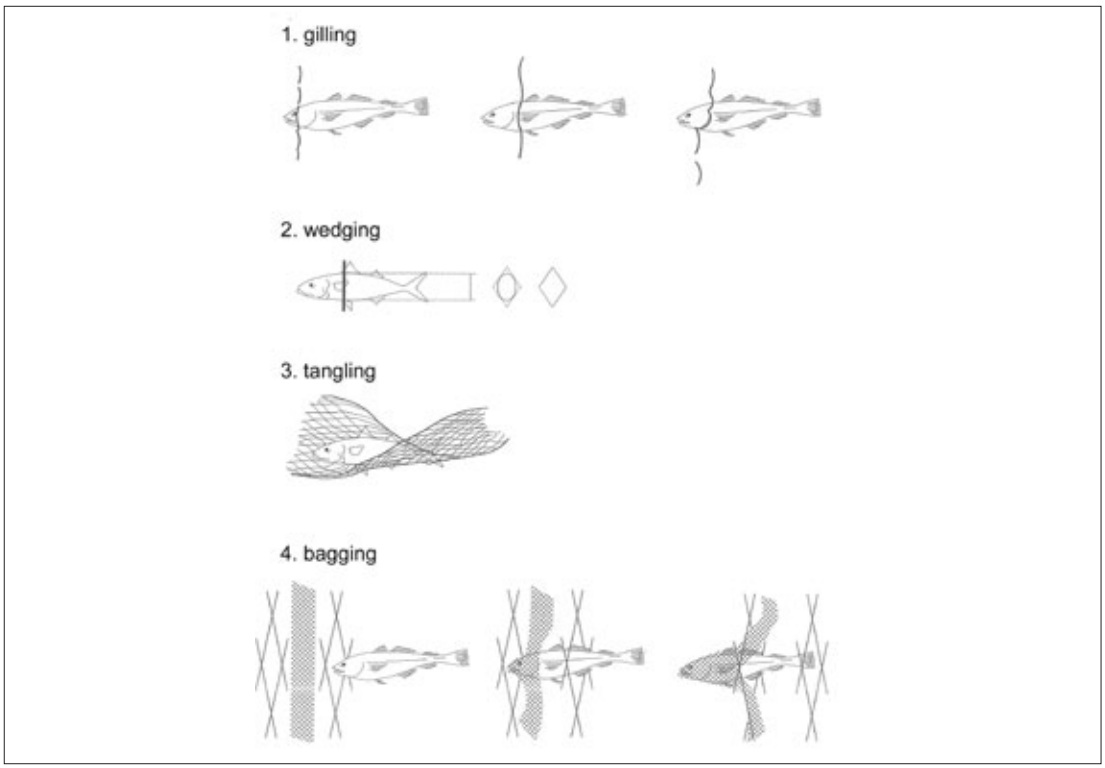

Figure 4.1 - Catch methods with static nets.

As mentioned before driftnets (for swordfish and albacore) have been outlawed and all licences have been withdrawn due to unintentional but potential catches of protected species, particularly

cetaceans. Fishing with these nets also had a long tradition and with the arrival of synthetic fibres, which allowed the use of several kilometres of net, they brought large profits. The "*ferrettara*" licence (for driftnets with finer mesh) is still issued to various vessels, but the limitations, in terms of both mesh and permitted target sizes and species, are so restrictive that it is not very profitable. The "longline" licence permits the use of both drifting and static longlines. Longlines are quite frequently used and consist of a series (hundreds or even thousands) of baited hooks, attached by clips to a main line known as the "*madre*" (mother) or "*trave*" (beam). They are now normally set using special winches known as "line haulers". Like static gear and *ferrettara* nets, longlines are passive gear and their use does not therefore require great power. A second licence for fishing with hooks is the "line" licence. This covers various types of gears, all of which are equipped with hooks or jigs. Lines usually use few hooks (around ten) and can also be towed, whereas longlines are always left anchored, semi-anchored, or drifting with the currents, in the case of drifting long lines, therefore static in relation to the body of water. Unlike longlines, which are left at sea as long as necessary for the fish to bite, lines are mainly kept under human control, even if there are cases of lines being left to themselves.
The final licence in the License Decree is the "harpoon" licence. Holders of this license can use genuine harpoons, spears or mirrored poles for catching sea urchins. The most interesting equipment, however, is the genuine harpoon. It is still used professionally in the area of the Strait of Messina to catch swordfish from "*feluche*", specially rigged ships for sighting and harpooning swordfish. This is obviously a very ancient and highly selective fishing system: the harpoon is only fired when the prey is sighted and the species and size have been identified. If the fish is too small or of the wrong species, the harpoon is not fired.

Most commonly used fishing gear

After the brief overview of the fishing systems and gear permitted for use by fishermen, it is now worth examining the gears most commonly used in our fishing communities at a professional level (Ferretti, 1983), and which provide the greatest revenues.
The surrounding nets that are best known and most widely used, even from vessels of considerable size, are mechanically closing nets most frequently known as *purse seines* (figure 4.2). These nets are used for both small pelagic fish, almost always by attracting the fish with a light source (hence the term "*lampare*", which is very widely used in Italian fishing communities), and for catching large pelagic fish, particularly tuna, in which case they are known as *tuna seines*.
Tuna seines are the largest and heaviest nets in use: they can exceed 1,500 m in length and 400 m in height, with a weight of a few dozen tonnes.
Other widely used gear are *trawl nets,* both *bottom trawls* and *midwater trawls* (figures 4.3 and 4.4). For bottom trawl nets, a further subdivision can be made between bottom otter trawls (figure 4.5) and those with a fixed opening, or *rapidi* (figure 4.6).
In addition to traditional Italian nets (figure 4.7), which are used by most trawlers, other nets called *volantine* have also been introduced (figures 4.8 and 4.9). These maintain contact with the bottom but have a larger vertical opening that also allows the capture of species that are not always in close contact with the seabed.

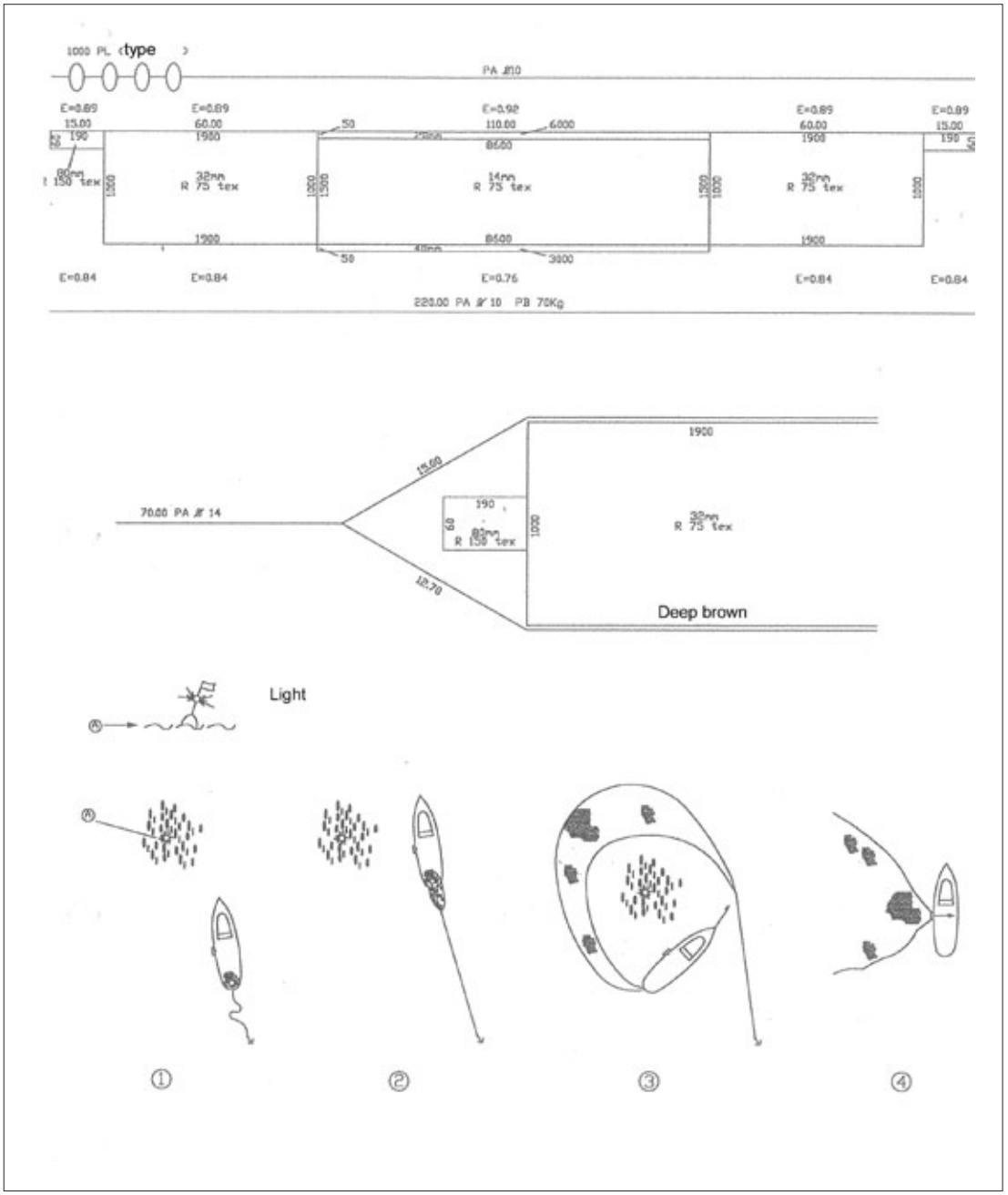

Figure 4.2 - Design of surrounding nets for sardines, Atlantic mackerel and dolphinfish used in the Southern Tyrrhenian Sea (purse seine).

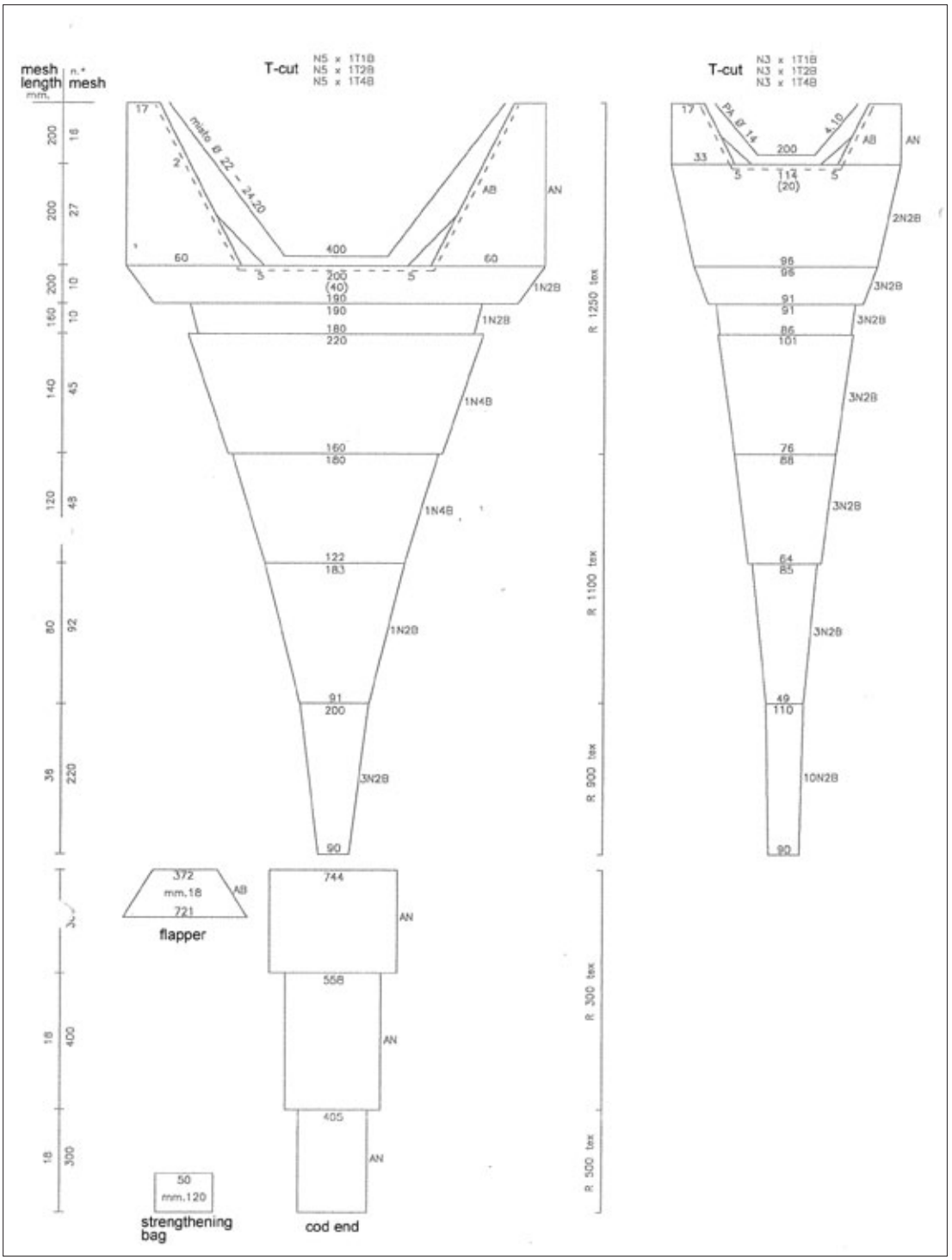

Figure 4.3 - Plan of a pelagic trawl net for small pelagic fish.

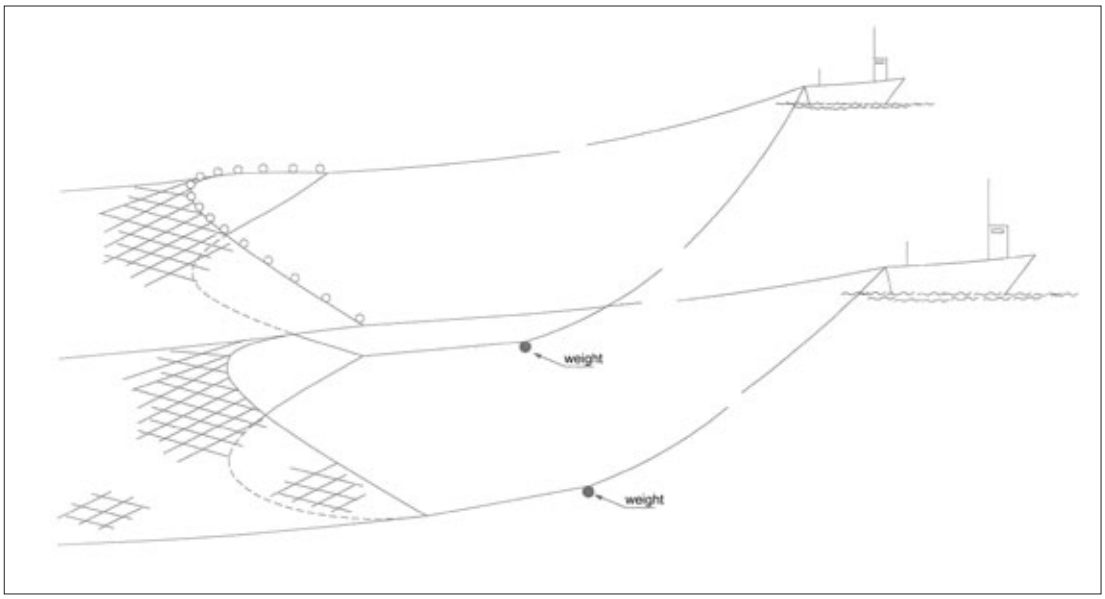

Figure 4.4 - Rig used in the Adriatic Sea for towing midwater trawl nets. Each vessel operates with two warps.

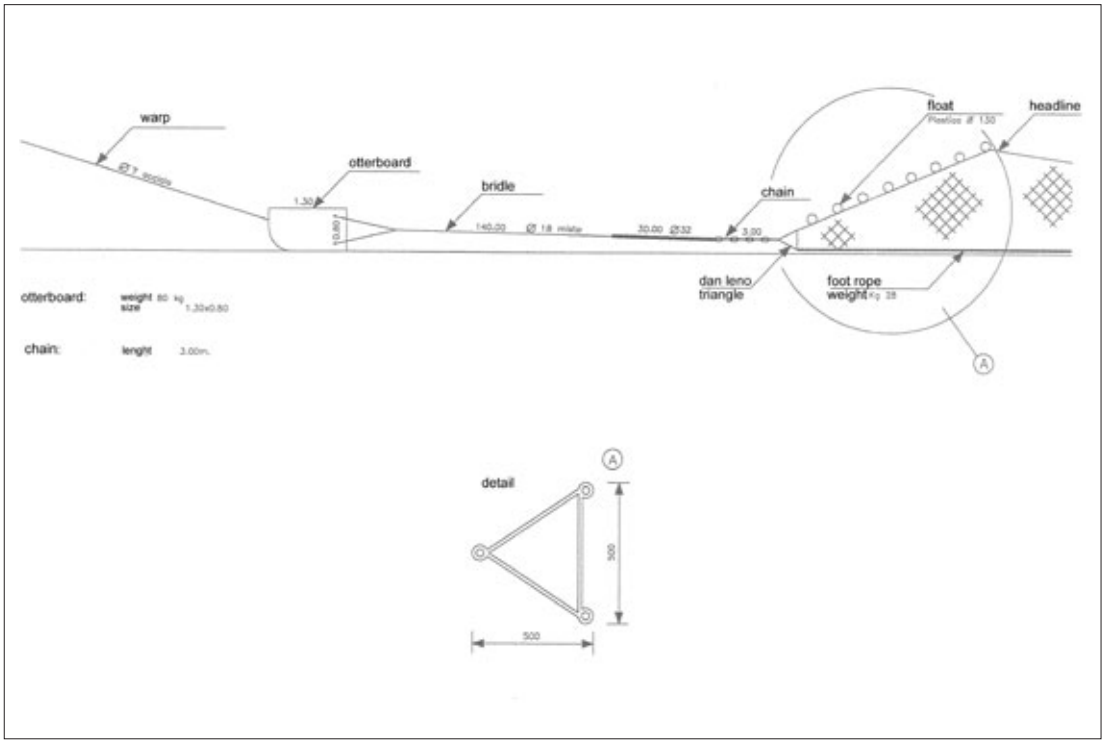

Figure 4.5 - Design of an otter trawl.

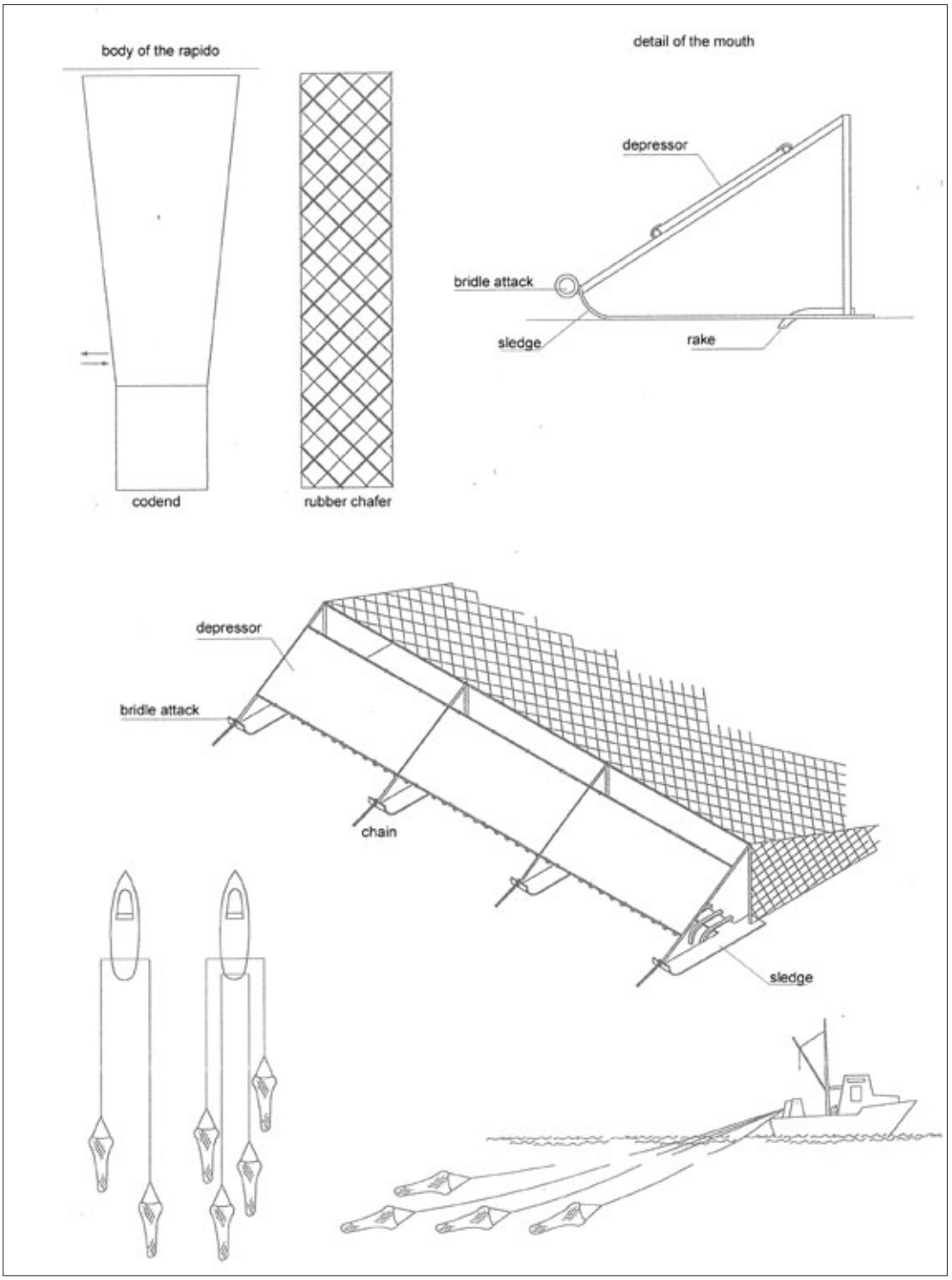

Figure 4.6 - Design of a toothed beam trawl: *rapido*.

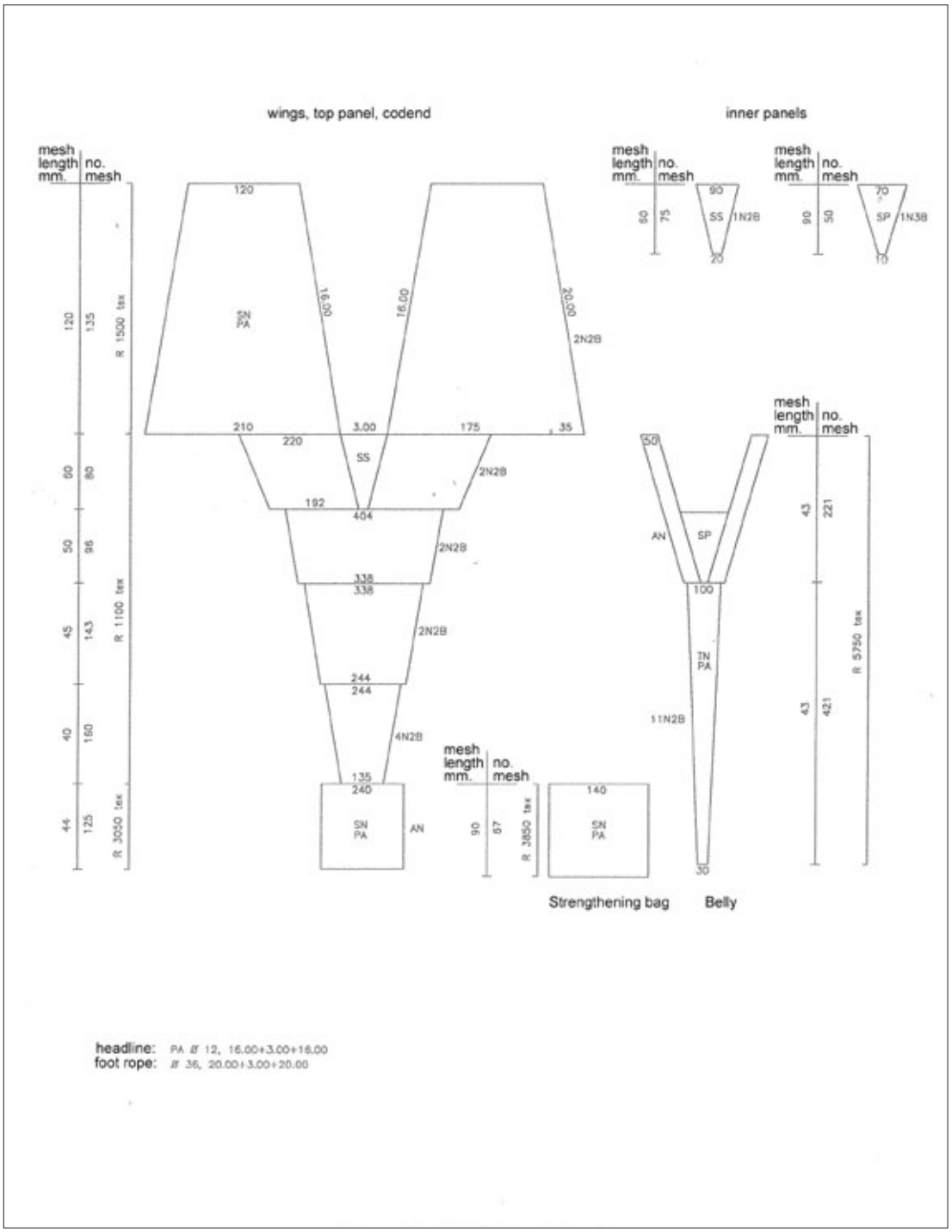

Figure 4.7 - Design of a traditional bottom trawl net.

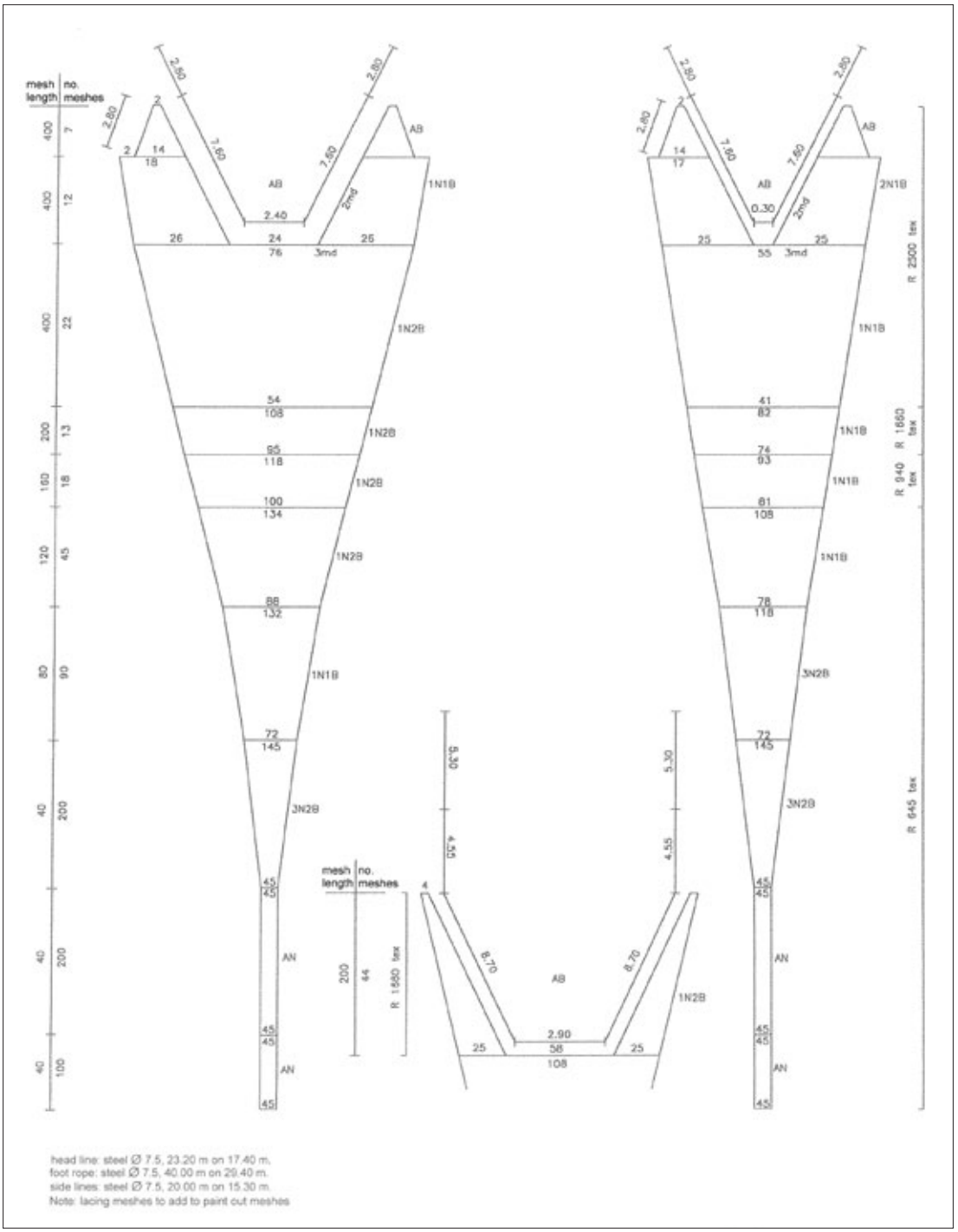

Figure 4.8 - Design of a four-part semi-pelagic net.

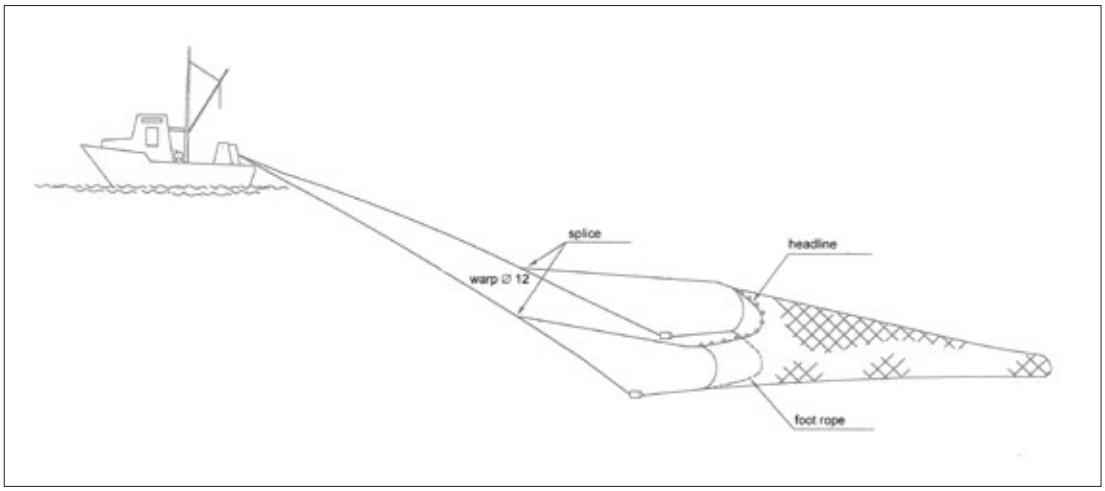

Figure 4.9 - *Volantina*.

The best known and most widely used *dredge* is the hydraulic dredge, often called the *turbosoffiante* in Italy, which permits good catches in short time periods. It is an excellent piece of equipment with great catch efficiency, although it has a considerable impact on the seabed; on the other hand, the seabed has to be disturbed in order to catch bivalve molluscs.
The most widely used static gear is the *trammel net* (figure 4.10), followed by the *anchored gillnet*. These are gears that allow limited catches, but mainly of valuable fish, and therefore many boats continue to use them, particularly smaller vessels.
In regard to longlines, *drifting longlines* (figure 4.11) are widely used today to catch large pelagic fish, particularly bluefin tuna, swordfish and albacore. A per *capita* quota is already in force for bluefin tuna and new quotas will no longer be available in the future.
With albacore and swordfish, the difficulties arise from unwanted catches of juveniles, which can often be abundant in the autumn. This led to the ban of swordfish fishing for a few months each year and possibilities are being examined concerning longer ban periods, limitations on minimum hook sizes and even the introduction of quotas for swordfish, as for bluefin tuna.

Technology

Fishery technology has advanced rapidly and decisively since the end of World War II. In addition to the introduction of motors and synthetic fibres, which transformed fishing, there has also been a cultural transformation among fishermen, who have changed their means of work, both in terms of vessels and gear, often with the help of incentives. At times this has been done in a trailblazing way, involving error and excess, and now fishing vessels are too large and too efficient for the available resources.
The fisherman's life at sea is hard and at times it is difficult to find crews. For this reason, much has been done to automate operations on board in order to reduce the number of crew members.

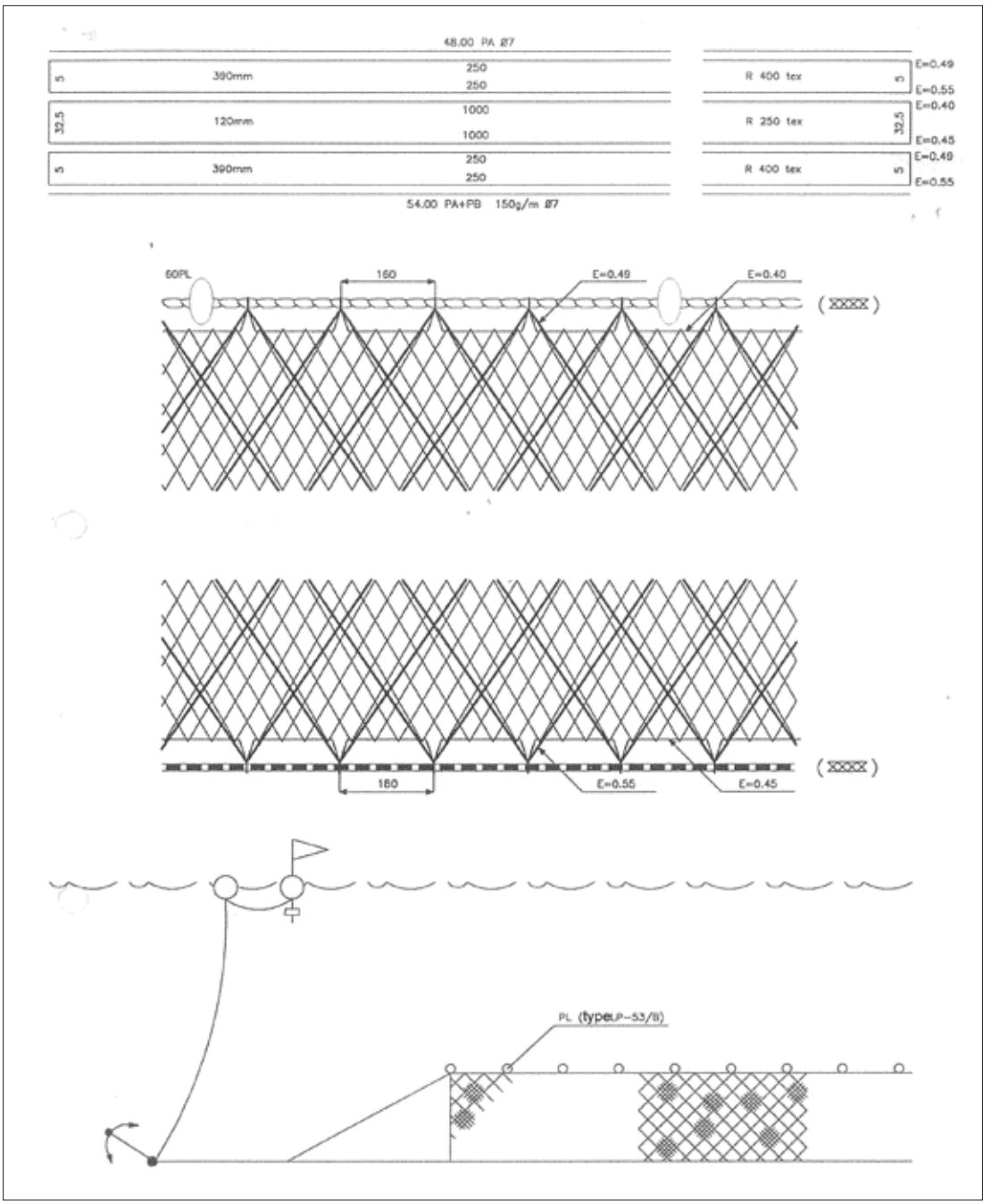

Figure 4.10 - Static trammel nets.

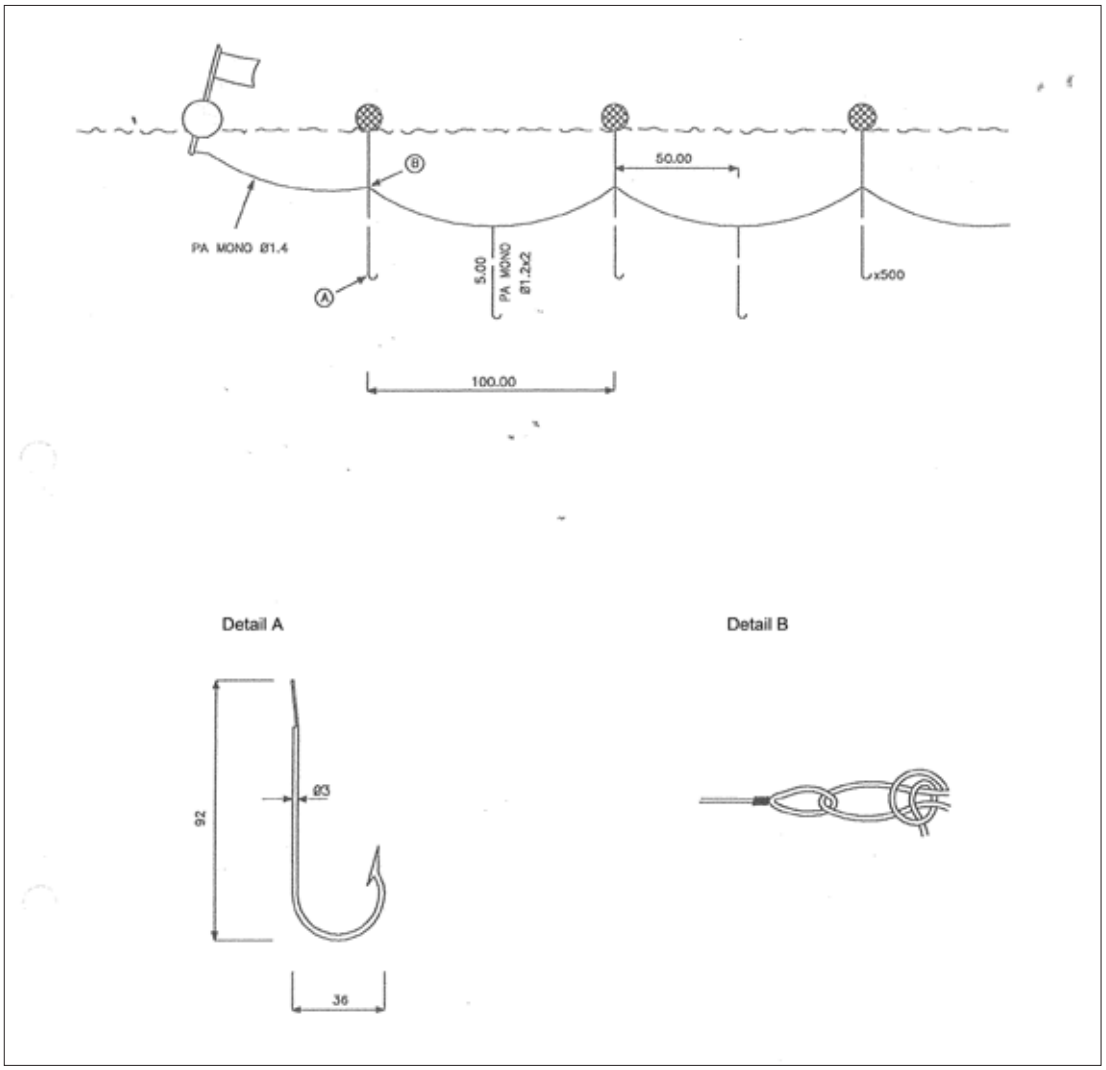

Figure 4.11 - Drifting longline.

Fishing vessels have become larger, both in order to adequately treat and preserve catches and to have larger and more comfortable spaces for life on board. Living conditions on fishing vessels have been greatly improved, to make the time spent at sea more comfortable and acceptable.
Fishing gear has been modified, simplified and made more efficient through the use of high-strength synthetic fibres. All of this has inevitably led to an increase in the fishing effort. Although measures have been taken to limit the parameters of tonnage and power, which are considered as indices of fishing capacity, other factors that influence fishing effort have not been taken into consideration and the problem of the renewal of fishery resources has arisen.
Even though the number of fishing vessels has decreased in recent years, this does not necessarily mean that the fishing effort has been reduced, and therefore the poor state of living resources may well be due to excess activity.

Concluding remarks

Italian fleet has been modernised, it includes large and powerful vessels, the life of fishermen has improved, but the problems are not over.

Gear has become more selective, also due to the introduction of larger meshes, required by regulations and often accepted by fishermen, who have understood the need to safeguard juvenile fish. Despite this, resources are excessively exploited and catches need to be reduced.

If this is the case, it is also true that the number of fishing vessels has been greatly reduced, and so there is no alternative but to lay the blame on technological development, which has increased the fishing effort. The pioneering spirit with which the technology has been developed has perhaps also led to negative results. Technological development obviously cannot be stopped, particularly when it makes work safer and less strenuous, reduces downtime and makes life on board more bearable, but the consequences that it has on living resources, which are only renewable if their biological limits are respected, should be kept in mind.

Technological development should be carefully monitored, introducing further fishery management measures wherever necessary, or else we will have development with undesirable negative results.

References

- Decreto del Ministero delle risorse agricole, alimentari e forestali, 26 luglio 1995, “Disciplina del rilascio delle licenze di pesca”.
- D.P.R. 2 ottobre 1968, n. 1639, “Regolamento per l’esecuzione della legge 14 luglio 1965 n. 963 concernente la disciplina della pesca marittima”.
- Ferretti M. (1983) - *Inventario degli attrezzi da pesca usati nelle marinerie italiane*. Ministero della Marina Mercantile, Direzione Generale della Pesca: 95 p.
- Legge 14 luglio 1965, n. 963, “Disciplina della pesca marittima”.

4.2 Gear and selectivity

Sala A.

The term selectivity refers to the measurement of the selection process of fishing gear, i.e. the process that produces a catch with a composition different from the range of organisms present in the area where fishing is carried out. The term can refer to both the capacity of a gear to predominantly catch only certain sizes of a species and the selection of the various species found at sea. In the first case, meshes of a suitable size and shape are normally used so that the gear can allow the juvenile forms of a determined species to escape. In the second case, however, the selectivity of a gear cannot be improved through the use of suitable meshes alone, since it mainly depends on the equipment and on devices installed on the gear to modify its behaviour (Sala *et al.*, 2011).

Selectivity of trawl nets

Trawl nets have a catch system defined as active gear because they are pulled through the sea to catch marine organisms as they move forward. With this type of net the selection process occurs in various parts of the fishing gear. There is a common conviction that the process mainly occurs inside the cod-end. Various studies have shown that a substantial portion of selection can also occur outside the net (Sala *et al.*, 2006) or within the body of the net (figure 4.12) before the fish reach the cod-end (Dremière *et al.*, 1999).

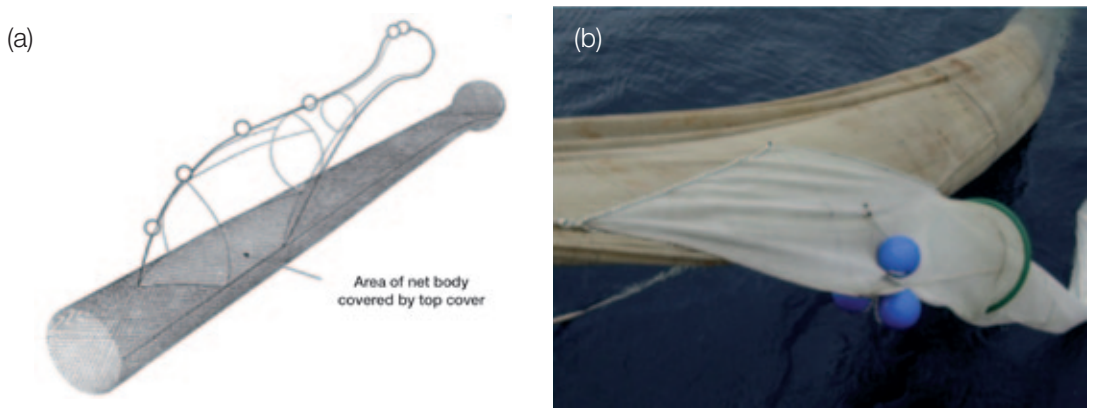

Figure 4.12 - Assessment of the selection that occurs in the body of trawl nets. Special bags (top covers) are designed (a) and fitted on the net body (b) in order to quantify the escape of marine organisms through the net body mesh.

There are various procedures for studying the selectivity of trawl fishing gear, based on two main method types (Pope *et al.*, 1975):

- paired-gear methods, which include alternate hauls, parallel hauls, twin trawls and trouser trawls. This type of approach involves comparing the catch from a test net with that of a control net capable of catching all the individuals present in the area;
- covered cod-end methods, which specifically measure cod-end selectivity (figure 4.13).

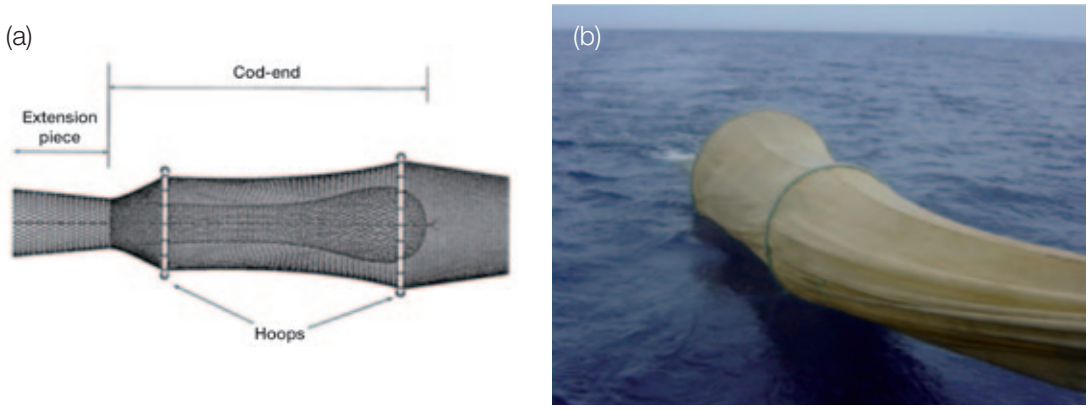

Figure 4.13 - Covered cod-end method for measuring the selectivity of trawl nets. Detail of the cover with hoops (a) in order to avoid the masking effect; (b) retrieval of a trawl net during an experimental test at sea, detail of a cover with aluminium hoops.

The parameters with the greatest effect on the selectivity of trawling gear are the size and shape of the cod-end mesh but other factors may affect selectivity, at times considerably. One to be mentioned is the ratio between the circumference of the cod-end and that of the extension piece, which affects the opening of the cod-end mesh. In general, if the cod-end circumference is larger

than that of the extension piece, the mesh tends to remain more closed, thereby decreasing selectivity. Other important parameters affecting selectivity are the characteristics of the mesh twine, such as its material, thickness, colour and stiffness (Sala *et al.*, 2006; 2007; 2008, Sala & Lucchetti, 2010; 2011).

Statistical analysis of trawl net selectivity

In selectivity studies, the retention probability of trawl net cod-ends can be represented by various mathematical models. One of the most commonly used is the logistic model:

$$r(l) = \frac{e^{v_1+v_2 l}}{1+e^{v_1+v_2 l}}$$

where *r(l)* represents the probability of a fish of length *l* being retained once it has entered the cod-end (Wileman *et al.*, 1996). The selectivity curve shown above provides the two most commonly used parameters for identifying the selectivity of fishing gear: L50 and *SR*. *L50* is the length at which a specimen of a given species has a 50% probability of being retained. This value is defined as $L50=-v_1/v_2$ and is obtained through the equation *r(l)*=0.5. The selectivity ratio *SR,* defined as *SR=L75-L25*, is calculated through the formula: $SR=2\ln(3)/v_2$.

With the introduction of the Fryer method in 1991, it became possible to represent haul data replicated through a model that accounts for between-haul variation and allows for random variation in the selectivity curves of each single haul around a mean selectivity curve. Fryer then extended his model, allowing assessment of both the influence and specific contribution of the effects of monitored variables or fixed effects and the between-haul variation on the selectivity parameters.

Selectivity of driftnets

Catch types with gillnets and trammel nets vary depending on the technical characteristics of the net, which directly affect the selection process. Gillnets capture fish by three principal methods (Baranov, 1914):

- Wedging: the net mesh tightens around the bodies of the fish, thereby trapping them;
- Gilling: the fish are captured when the gillnet mesh becomes lodged under their opercula;
- Tangling: the fish are held by mesh that is tangled on various parts of their bodies, such as spines, pre-opercles, dorsal fin rays, jaws or teeth.

The first two methods depend mainly on the size of the mesh, whereas the third is negligible with gillnet fishing but more common with trammel nets.

In addition to these three types, there is a fourth which is exclusive to trammel nets:

- Pursuing: the fish passes through the external layer of netting, with larger mesh, encounters the central layer, which has finer mesh, and becomes trapped in a sort of bag-shaped hernia as it struggles to escape.

Catches by wedging and gilling depend essentially on the net mesh size. There is a strict relationship between the size of the mesh and the circumference or girth of the fish intended to be caught; this relationship is known as the Fridman formula (1973): *MO=TL/K*, where *MO* is the mesh opening, *TL* is the fish length and *K* is a coefficient that varies according to the species and therefore according to the fish shape. In general: *K* = 5 for long, narrow fish; *K* = 2.5 for deep bodied, wide and round fish; and *K* = 3 for average fish.

Capture by tangling depends on the amount of slack, i.e. the extent to which the net fluctuates in the water. This technical characteristic is expressed by the *hanging ratio* (*E*), i.e. by the ratio

between the length of the float line (*Ls*) and the extended net length (*Lr*, number of meshes multiplied by the mesh size): *E=Ls/Lr*. If the net is very long in relation to the lines, the hanging ratio will be very low (<0.5 for example), the net will be very voluminous and will fluctuate in the water. The hanging ratio for gillnets is generally 0.5 and an *E* between 0.6 and 0.7 normally combines a good mesh opening with a large explored area.

Methods for determining the selectivity of driftnets

For catches by wedging and gilling, the selectivity curves of driftnets are bell-shaped and can be described through normal distribution (Holt, 1963). This bell-shape curve can be explained intuitively as follows: small juveniles pass through the net meshes and escape, then, as fish sizes increase, so does the efficiency of the net up to the apex (modal length), which is the length at which the fish have the highest probability of being retained; at this point the curve descends once more because the fish reach sizes that make penetration of the mesh difficult, and so they simply "rebound" off the net and escape.

The width of the curve represents the selection interval, while the height represents the efficiency with which a given net catches fish of an optimal size. The peak of the curve expresses the length at which 50% are retained (L50). The selectivity of driftnets can be determined with various methods based on three main types:

- Methods not requiring knowledge of the population present in the area and based on a comparison of net panels of similar size but with different mesh openings;
- Methods that require knowledge of the size distributions of the population present in the fishing area and essentially based on comparison between a catch made with a driftnet (test), and that with a poorly selective net, such as a trawl net, which serves as a control;
- Methods not requiring knowledge of the population present in the area and based on the ratio of the maximum circumference of captured fish to the size of the mesh used.

Sechin method

The Sechin method is a selectivity evaluation method which does not require knowledge of the size distribution of the population. This method does not allow for capture by tangling into account but can include correction coefficients to allow for fish girth compressibility and variations in mesh size due to the elasticity of the material.

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4.3 Technical evolution of the fishing vessels

Messina G.

The beginning of the Italian fishing vessels technical evolution dates back to 1912 when the first motor fishing vessel was built in San Benedetto del Tronto (AP). After the pause imposed by the WW I, mechanical fishing started its continuous development: firstly, the diesel engine was installed on board sailing boats, then fishing vessels were built *ex novo* introducing also otter boards to make the trawling net opening easier. After WW II, the fishing fleet underwent a technological change, due to the development of diesel engines, of the electronic and hydro-acoustical development, to the introduction of the oleodynamic and, finally, to new materials.

This caused an increased fishing efficiency, a greater safety in the working environment on board and improved living conditions at sea.ć

Unfortunately, several political interventions, unaware of the renewal capability of fisheries resources, encouraged the construction of larger fishing boats which increased fishing effort and overfishing.

An analysis of the evolution of the fishing fleet over the last decade allows the following considerations:

- both the installed power and the overall number of fishing boats is decreasing
- there is a considerable presence of small boats, primarily devoted to coastal fisheries (longline, set and drifting nets, pots) which could replace trawlers, at least in some areas
- many fishing boats are oversized in relation to their fishing activity; therefore, their management costs are very high against a poor production;
- the equipments aboard many fishing vessels do not allow the crew to work safely.

The Atlantic fishing fleet, born in the 1950s and 1960s and mainly represented by the fishing boats of S. Benedetto del Tronto, underwent a heavy decline to almost disappear.

Hulls: In the construction of fishing vessels, a greater awareness was gained on the fact that optimum performance can be obtained through the application of marine engineering. Then, the propulsive efficiency and the marine boat sea-kindness have improved. In many cases, the cruiser stern was replaced by a transom stern also because of better propulsive results. For a long time, wood has been the most important material to build fishing boats. Due to the subtraction of volume by the thicker plating required to face the same strain, almost all fishing vessels are now made of steel and stainless steel. The smaller fishing vessels hulls, generally devoted to set nets, are planing or semi-

planing type and therefore can achieve very high speeds with beneficial effects on the social life of the fishermen. Catamarans have been also made as support vessels in some mariculture activities.

Deck machineries: Fishing vessels were initially equipped with two-drum winches and warping ends, directly driven by the main engine. Later on, both drums were driven by a hydraulic motor, first at low pressure and then at high pressure, with flexible and lower diameters piping. Winch drums number was increased from two to four (two for steel cables and two for bridles) and a spooling gear was installed, firstly mechanically and then oleo-dynamically driven. In the seventies, the use of *net drum* spread to trawlers and pelagic fishing boats to hold bridles and the net. The derrick was replaced by a crane or by a gantry, the upper beam of which can be fixed or extensible (i.e. hydraulically movable) for a regulation of the distance between pulleys. Recently, on some Adriatic "*rapidos*", some hydraulic servomechanisms were mounted to open the lateral boots while on the trawlers fishermen have successfully tested some mechanical devices for sorting the catch and for waste disposal.

Propulsive plants: Diesel engines were initially rotating at low speed, in order to develop high torques at the same power, with the advantage of a direct coupling to the propeller, but required large spaces. In particular, the working deck was interrupted by the engine room casing to the detriment of space for fishing operations. Delivered engine powers were much less than the present ones. For instance, a trawler 30 m long for oceanic fisheries was equipped with a 600 HP diesel engine running at 420 rpm. Today, a similar fishing vessel has a propulsive power of 1,000 HP. Even though the present four-stroke diesel engines have a greater rotational speed (and then a reduction gear is to be put between the engine and the propeller), they result in smaller size and lighter weight and in increased efficiency. At present, almost all fishing vessels engines are overcharged and deliver a doubled power, in comparison with the naturally aspirated engines. In order to increase propulsive efficiency, propulsive apparatus are equipped with slow running propellers with large diameters or with ducted propellers which give increase bollard pulls for a same engine power. Moreover, some fishing boats are equipped with controllable pitch propellers which allow the engine to run at its maximum speed, both in trawling and in cruising conditions and then developing its maximum power. Finally, increased fuel costs and reduced catches lead to check the fuel consumption by a flow-meter. The capacity of the propulsive apparatus of a fishing vessel, in terms of thrust, greatly depends on its propeller characteristics and it is therefore quite wrong not to take into account how the engine power is developed, when speaking of fishing effort.

Electronic equipment: Fishing vessels were gradually equipped with increasingly sophisticated tools for fish finding and sighting obstacles on the seabed. Today, sonar, radar, echo sounder, autopilot, VHF, GPS and the computerized nautical charts allow the skipper:

- to be exempted from continuous watch keeping
- to find schools and to explore the sea at different depths and beds
- to know both the boat position and speed
- to communicate with the crew of the boats around at sea and with the mainland

On many newly built vessels, the most important areas (engine room, aft main deck etc.) are controlled and monitored by cameras from the bridge.
The technical development of fishing vessels is to be considered still *in fiery* because the definition of a fishing vessel by area and fishing metier is still waiting to be realized. Moreover,

hydro-dynamically well designed hulls certainly contribute to save energy, are adequately stable (according with International rules) and provide fishermen an as safe as possible working environment.

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4.4 Fishing techniques and traditions in Italian administrative regions

4.4.1 The Northern Adriatic Sea

Giovanardi O., Fortibuoni T., Raicevich S.

The industrialisation of fisheries in the Northern Adriatic Sea gradually became consolidated starting from the 1950s, having begun in the period between the two world wars with the first experiments with engines. At the same time, as the use of engines took hold, the period following World War II was characterised by marked changes concerning the use of both new equipments and new technologies, which significantly improved the strenuous working conditions for fishermen. Motors and the use of progressively larger ships allowed fishing areas to be expanded and larger and heavier gears to be towed, while the use of winches clearly facilitated net hauling operations. In the mid 1980s, the introduction of LORAN (*Long Range Navigation*) and subsequently the video plotter and GPS (*Global Positioning System*) greatly improved navigation precision, allowing the exploitation of areas that were previously inaccessible because of their proximity to unsuitable trawling sites.

The first of the major innovations in fishing equipment to be introduced was the "*saccaleva*" or "*cianciolo*" surrounding net. It became widespread in the 1940s and it is still used in the Gulf of Trieste for fishing small pelagic fish with a light source, gradually replaced all other methods of fishing oily fish (such as the traditional "*menaide*" drift net). The saccaleva is a rectangular or trapezoidal net with a mesh size that varies according to the target species (minimum mesh-size 14 mm). It is a very high net (it can reach up to 120 m in the centre) and can be up to 800 m long.

This purse seine is cast from a boat around a school of fish attracted by light sources, and prior to being hauled it is closed by a rope that passes through the iron rings in the lower "purse line". The 1960s saw the introduction of the "*volante*" net (a mid water pelagic trawl net towed from 2 boats), mainly used for catching oily fish, especially sardines, anchovies, mackerels and sprats, which replaced the "*saccaleva*" in many marine communities in the Northern Adriatic Sea. The net is trawled close to the surface or in mid-water, depending on the length of the threaded rope and the speed of the boat. It is equipped with floats and weights, with 2 large weights on the towing rope to ensure the vertical aperture is kept open. The meshes are larger towards the mouth (200-400 mm) and gradually decrease in size towards the bag (20 mm). Having identified the school with the echosounder, one of the two boats casts the net. Next, the second boat pulls up alongside it to receive the end of the towing rope. At this point the two fishing boats move away from each other but remain connected by a rope and start to tow the net.

In the 1960s the "*rapido*" trawl (a sort of beam-trawl, rigged with 10 cm long iron teeth) was introduced to fish demersal species such as queen scallop, great Mediterranean scallop, oysters, spottail mantis squillid, prawns, common cuttlefish, common sole, etc. "*Rapido*" trawling is the result of the technological evolution of the "*ostreghero*"[1], which in turn was derived from the *sfogliara*[2], both of which are no longer used. In the "*rapido*", compared to the "*ostreghero*" and "*sfogliara*", the metal structure was further strengthened and metal teeth were introduced with the function of penetrating the surface of marine sediment to raise target organisms, which are then collected in the codend of the net (minimum regular mesh-size: 50 mm when diamond shaped or 40 mm when square shaped). A wooden board (depressor) is attached to the upper part of the frame, which keeps the gear in contact with the seabed through hydrodynamic effect, allowing high towing speeds (around 5-7 knots). The presence of runners prevents the teeth from penetrating the sediment more than necessary. When it first became popular, boats towed 1 or 2 "*rapido*" trawls with a breadth of around 2 m. With the progressive increase in tonnage and power of boats over time, fishermen began using larger "*rapido*" trawls (up to 4 m width), towing a total number of 4 gears (or sometimes even 6).

In the 1970s, hydraulic clam dredgers were introduced to fish marine bivalve molluscs (carpet shells, sword razor shells, smooth callista, etc.). Until the 1950s, clam fishery was one of the least profitable activities in the Adriatic Sea, but after the introduction of this gear it quickly became one of the most profitable. Hydraulic dredgers consist of a metal cage equipped with a horizontal opening (mouth) that is dragged along the seabed and uses a front blade to penetrate the sediment, capturing the target species. During fishing, the gear sinks several centimetres into the substrate and high-pressure water jets facilitate towing by helping sieve the sediment.

The "*coccia*" or "*tartàna*" is a bottom trawl net used throughout the whole Northern Adriatic Sea for centuries, especially by Chioggia fishermen. It consists of a cone-shaped bag with two side wings formed of pieces of net and it can reach overall dimensions of 50 m. The trawl doors ensure the side opening is maintained, as they tend to enlarge the net horizontally outwards during

[1] The "*ostreghero*" (or "*carpasfoglie*") was a 5 m long trawled fishing gear made up of a net (6 cm mesh-size) fixed to a semi-circle rigid mouth made of iron or wood called "*massa*", which kept the net open with the help of a wooden beam fixed to the mouth. Sometimes iron spikes were attached to rake the seabed better. Usually, 2 or 3 "*ostreghero*" trawls were used at the same time, depending on the size of the vessel.

[2] The "*sfogliara*" (or "*scassadiavolo*") was a trawled fishing gear formed of a metal frame attached to 2 runners that allowed it to glide along the seabed. The net was attached to this metal structure. A mixed groundrope was found in the lower part of the net, weighed down by a series of weights that cause the mouth to interact firmly with the seabed, increasing catch efficiency. Each vessel towed 2 gears at the same time.

towing. The net is formed of various pieces with meshes that decrease towards the codend (the same minimum measures given for the "*rapido*"), where the captured fish is held.
Gillnets and fish traps have also been used along the coastal areas of the North Adriatic Sea for centuries (small-scale fishery). The "*barracuda*" is a gillnet made of pieces of monofilament nylon net, which is extremely resistant and practically invisible in water. It is a very selective net, and its mesh size changes according to the target species. The "*nassa*" is a fish trap with a funnel-shaped inlet constructed so that it allows the prey to enter (generally when attracted by bait) but not to exit. Until a decade ago, fish traps were mainly made by hand. They had a parallelepiped shape and were made of wicker, whereas now they are built out of synthetic netting and plastic and close in a concertina-like manner so that they take up less space on board. Target species include the Common cuttlefish that are caught when the species approaches the coast during the reproductive season by placing sprigs of laurel inside the traps (or frayed plant material or synthetic materials such as cords and nets), on which the cuttlefish lay their eggs. Various other species can be caught depending on the bait used and the season, including spottail mantis squillid, gobies, etc.

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4.4.2 Liguria

Repetto N.

The thin stretch of land that comprises Liguria lands would suggest that this region, which has a coastline along its entire length, has a long tradition of fishing. However, commercial fishing has never been important to the Ligurian economy. The Ligurian Sea is a deep sea that is battered by the north wind, its continental shelf is very limited and the fishing areas are close to the coast, meaning that shore fishing, as they like to call it in Noli, is still typical of the area today. At least until the arrival of the railway in the second half of the 19th century, the dominant form of fishing was limited, subsistence fishing for local consumption because of the difficulties in transporting the product over the long and impenetrable routes. The Ligurian Sea has entirely unique features, and is even defined as a small ocean model. The steep sea beds, the canyons and the seamounts amplify the effect of the waves, the wind and the currents, creating a complex pelagic ecosystem that generates favourable conditions for cetaceans and large migratory fish such as tuna, swordfish and sharks. However, the Ligurians preferred to migrate to work in pelagic fisheries throughout the Mediterranean, leaving a mark that remains today in the red coral trade first and foremost, followed by bluefin tuna (Repetto, 2010). Fishing only had a significant economic and social value for the small coastal villages, which established rules and regulations governing not only the sale of its products but also the species to be caught and the rotation of the net drops. These rules were so firmly established in the area that they far surpassed today's more generalised regulations. Traditional fishing mainly involved purse seines, cast by hand from land and especially used in summer to catch small oily fish (figure 4.14 a - b).

Figure 4.14a - Use of seine nets in the mid-20th century (Historical Photographic Archive, Varazze).

Figure 4.14b - Use of seine nets in Varazze (Photo by N. Repetto).

Then as now, in the winter gillnets, traps and longlines were used to catch modest quantities of fish, but with extraordinary biodiversity in terms of the species composition. An important change in fishing methods took place between 1925 and 1930. Sail trawlers, which fished at a depth of between 50 and 130 metres, were replaced by motor fishing boats, which could drag nets at greater depths. The fishing community of Santa Margherita Ligure was one of the first in Italy to exploit the fishing potential of the continental slopes, which are over 200 metres deep. With the discovery of new fishing zones, many economically important species previously unknown to the Ligurian Sea arrived on the market, such as Norway lobster (*Nephrops norvegicus*) and above all red shrimp (*Aristeus antennatus* and *Aristaeomorpha foliacea*).
Around 1960 the first motor trawlers appeared from Tuscany, equipped with "*ciancioli*", large seine nets for catching small pelagics, which replaced the small lampara nets (Cattaneo Vietti, 1985).

The 1960s also saw an economic boom, the abandonment of the hinterland and mass coastal urbanisation. Heavy industry (represented by companies such as Ansaldo, Italcantieri, etc.) and tourism, including the construction of marinas, took away portions of land and sea from fisheries, triggering a process that has not yet stopped. Thus began the slow but steady abandonment of the sector, as can be seen in table 4.1.

Table 4.1 - Number of vessels registered with the departments of Liguria from 1961 to 2009 (data from Irepa/MiPAAF, modified).

Year	Number of vessels
1961	1,534
1971	1,291
1981	1,250
1991	1,144
2001	788
2005	565
2009	543

In 2009 there were less than 1,000 professional fishermen. Of the total number of vessels, 12% were used for trawl fishing, 7% caught small pelagics, and 81% practiced small-scale or coastal fishing. The most abundant species was found to be the anchovy (*Engraulis encrasicolus*) for seine fishing and hake (*Merluccius merluccius*) for trawling, while the most significant from an economic perspective were Norway lobster and red shrimp. Overall, the produce sold in 2009 totalled around 4,150 tonnes, with a value of approximately 33 million euro, plus around an additional 800 tonnes of produce (bass/sea bass, sea bream and mussels) farmed in 4 Ligurian fish farms, showing a steady *trend* in recent years. These quantities represent 4% of the national product, but with a high commercial value, reaching an average of 7.85 euros per kilo, compared to the national average of 5 euros[3]. With the definitive implementation of reg. (EC) 1967/06, on 1st June 2010, the fishing fleet in Liguria has shown accentuated fragmentation, with increasingly reduced spaces at sea and no adequate commercial policy. Intermediation by wholesalers, who manage the sales of almost the entire catch, gives preference to a limited number of species, raises retail prices and does not guarantee consumers transparency in relation to the origin of the product. The lack of entrepreneurship of the fishing cooperatives does not, except in rare cases, allow them to take control of the situation, which is characterised by profound changes and a growing awareness of local products and short supply chains on the part of consumers. To support the sector, the Region of Liguria approved Regional Law 37/2007, “Disciplina delle attività agrituristica, del pescaturismo e ittiturismo” (Regulation for agritourism, recreational fishing and fishing tourism), Directive 1415/2007 “Disciplina sull’acquacoltura marittima” (Regulation for maritime aquaculture) and Regional Law 50/2009, “Disposizioni regionali per la modernizzazione del settore pesca e l’Acquacoltura” (Regional provisions for the modernisation of the fishing sector and aquaculture). Reg. (EC) 776/00 establishes the PGI (Protected Geographical Indication) specifications for “Marinated anchovies from the Ligurian Sea”. The *Slow Food* protection of fish products for Liguria concerns fishing of the Mediterranean sand eel in Noli and “*tonnarella*” net fishing in Camogli (figure 4.15).

[3] Data from Irepa, 2010.

Figure 4.15 - Atlantic horse mackerel and Atlantic mackerel in the "*tonnarella*" in Camogli (Photo by N. Repetto).

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4.4.3 Tuscany

Bartoli A., Rossetti I.

Fisheries have always contributed to sustain the economy of the coastal populations of Tuscany, a region open to maritime contacts and traffics. As far back as the Roman era, there were numerous pools along the coast in which live fish were farmed to be sent to the various markets throughout the empire. In the Middle Ages, fisheries was one of the greatest resources for the survival of coastal populations, allowing important trades with inland areas together with the exploitation of coastal salt pans. Professional organisation of fishermen started since the Renaissance onwards, when lagoon production started to be exploited in the Orbetello area and several small ports were created along the coast. The development of fisheries therefore underwent a series of evolutionary stages over the centuries, transforming an activity that was predominantly linked to subsistence into an economic activity with a sound commercial basis.

The origin of fisheries in Tuscany can be dated several centuries back with small-scale fisheries, which found in this area a suitable environment. This can be seen in the "special fisheries" (such as transparent goby and picarel fisheries) which have been practiced in Tuscany for centuries.

Moreover in the past fisheries were practised with a greater diversity of gears and activities ("*tonnara*" and "*tonnarella*" for tuna fishing, "*menaide*" and "*agugliara*" nets, coral fishing, etc.). Fishermen implemented a sort of "self-management", following the seasonality of resource availability, alternating the most appropriate fishing gear at different times.
The influence of fishermen coming from other regions of Italy was fundamental for fisheries development. In Livorno in 1800 the local fishermen community was completely devoted to the work on merchant ships, with better working conditions and salaries. This aspects created important working possibility for many fishermen families coming from the south of Italy. The Neapolitans, known as "Pozzolani", arrived first from Torre del Greco and Procida, followed by fishermen from Molfetta and Trani (Apulia). At first these migrations were seasonal, but over time fishermen stayed and went on to form stable local nuclei, thanks to their skills at fishing in high seas. During those years, the first *paranzella* and *bilancella* sailing boats started to fish far away from the coast.
According to a census carried out in 1850, in Tuscany 21 vessels were exclusively dedicated to fisheries (2 *bestinare*, 16 *castardelle*, 2 *felughe* and 1 *leuto*), 21 vessels to coral fisheries (1 *feluga*, 3 *leuti* and 17 *paranzelle*) and 221 vessels to both transport of goods and fisheries, 9 of which were *tartane* and 62 *paranzelle*. The *bestinare* and *costardelle* were boats propelled by rows but equipped with removable broad-sails, intended for coastal fisheries. The former were fitted with longlines and the latter with a seine.
Viareggio was certainly one of the most important fishing fleets in Tuscany. It played a leading role in this area and introduced many technological innovations and *know how* to other locations nearby, such as Bocca di Magra, and far away, such as Castiglione della Pescaia. The origins of trawl fishing in Viareggio go back to the beginning of the last century, when a group of fishermen from San Benedetto del Tronto on board of "*trabaccoli*" (vessels with broad-sails adapted for trawling) settled in this area.
The original lineage of the Livorno trawling community also comes from the Adriatic Sea and more precisely from Ancona. This happened during the post-war period: the semi-destroyed city of Livorno attempted to recover by investing, particularly in the port area. The sea needed to be cleared of unexploded devices, mines and aerial bombs, requiring specialised means and personnel, and the Ancona fishermen, with their experience gained in the Adriatic Sea, were perfect for the task.
The only fishermen community with Tuscan origins is that of Porto Ercole. Even though Porto Santo Stefano is currently a basis of an important fishermen community, initially its "seafaring" habits were linked to trade ships. Today, the fishing vessels with the greatest gross tonnage are concentrated at the ports of Argentario.
An historically important fishing method for Tuscany, targeting anchovies and sardines, known as "*menaide*", was brought by fisherman from Campania and Sicily in 1700. For centuries, this activity was the source of income and sustenance for many local fishermen. It was carried out in several areas of Tuscany, such as San Vincenzo, Giglio Island and the Argentario promontory, using a special net with fine meshes. The fish caught were marinated and put in barrels. In San Vincenzo a small pelagics canning industry, called "*friggera*", helped local fishermen with their business. This fishery was widespread in the ports of Argentario until the second half of the 1900s, especially in Porto Ercole.
At present anchovy and sardine fisheries, which is mainly carried out with purse seine, is only important in a few areas, mainly in the North of the Island of Elba and Viareggio. Portoferraio is the maritime district with the greatest number of "lampara boats". Another historical fishing activity

mainly present in the area around Elba and the nearby Baratti (Piombino) was the "*tonnara*" (net traps for tuna). The first "*tonnara*" developed rapidly from the 17th century, although a tuna trap had already been set up in the waters of Portoferraio by Francesco de' Medici. The most successful structure based in Elba, in terms of catches, was the *tonnara* of Enfola, which remained active until the 1970s. On 24 June 1958, the last cull took place in Enfola with a catch weighing 22 tonnes. An important role for the development of this fishery in the Island of Elba was due by the fishermen families arrived from Ponza and Campania, who began to exploit the waters of the Tuscan Archipelago at the end of the 1800s, and then moved with their families to the various coastal villages of Elba (Marina di Campo and Marciana Marina above all), creating several artisanal fleets using set nets, traps and longlines.
The other important centre for tuna fisheries was the Argentario, on both sides, with the neighbouring islands (Giglio and Giannutri).
There were anyway completely different situations, such as that of Maremma, where the absence of a local marine fishing tradition led the population and the local authorities (see Castiglione della Pescaia) to exclusively exploit the resources of the inland brackish waters and wetlands. In Castiglione della Pescaia brackish waters were exploited using nets and traps to catch both marine (e.g. grey mullet and sea bass) and fresh water fish (eels). Another fishery was practiced using the "*lavoriero*" (a system of sequential closures with cane barriers to concentrate the fish migrating back to sea). This gear was introduced following the experience of fishermen coming from Comacchio and Fogliano lake.
In recent decades, the economic crisis produced a continuous decrease in the fishing fleets and in the number of fishermen, especially for trawling and purse seine fisheries.
Finally, the increasing role of marine tourism reduced the number of mooring facilities for fishing vessels, with serious problems relating the lack of adequate space for such activities.

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4.4.4 The Central Adriatic Sea

Piccinetti C.

When analysing the fishing activities of an area, it is necessary to consider not only the current situation, but also the evolution of the fishing methods that led to the development of specific knowledge and experience in that environmental context.
In the Adriatic Sea, fisheries have a long tradition that is also highly diversified in that it has been influenced by the political, administrative and socio-economic circumstancesthat have characterised the Adriatic area. The existence of natural coves and harbours has caused the naval vessels to be concentrated in just a few, predominantly merchant areas, and has given fishing a marginal role in terms of availability of space: small vessels were often dry docked on beaches when they returned from fishing.

In addition to these situations, it should be noted that the coastal areas of the Central Adriatic Sea had rivers that were not dammed until the last century and contained coastal marshes that were not particularly suitable for the establishment of permanent communities. Until 1830, the waters of the Adriatic Sea were frequented by pirate ships, which captured fishermen at sea to sell them to slave markets in Tunis. The local historical archives contain many pleas from the families to the local authorities to pay the ransom.

Within this context, fishing had a punctiform development around several inhabited centres and using very simple techniques such as manual dredges for bivalve molluscs, traps for inshore fishing, beach seines, entangling nets and drifnets for pelagic fish. The technological development of equipment has strongly influenced fishing activities, and the quantity and quality fished in relation to the environment. Fishing strictly consisted of coastal fishing that was often seasonal, with fishermen always in financial difficulties related to the local commercial network, in which high volume catches had no possibility of absorption. The creation of ports of refuge, the drainage of marshy coastal areas, the transfer of economic activities towards the coast, the creation of infrastructures (railways and coastal roads), the production of ice and the cold chain are elements that led experience and capital towards fishing and allowed gradual changes to be made.

Trolling with sail boats was replaced with steam fishing boats with increasingly powerful engines, with mechanical, then hydraulic winches, with refrigerated sections to preserve the catch, nets made with plant fibres moved on to synthetic fibres, and with increasingly varied fishing techniques. Communication between fishermen originating from different areas helped spread experiences and technologies. In particular, the rapid development of a fleet from San Benedetto to fish in the Atlantic Ocean made it possible to acquire and develop new technologies that were then applied to other types of local fishing. In the Adriatic Sea, fishing activities were gradually shifted to greater distances from the base ports, from the coasts to greater depths. This led to increased catch of non-coastal species, such as hake, Norway lobster, deep-water rose shrimp and flying squid. The increased size of motor fishing boats and the use of equipment, especially electronic devices for navigation, communication and fish search, allowed the whole Adriatic Sea area to be worked continuously to catch species that provided a better income.

The growing pressure on certain species with long life cycles and slow development (sharks, rays, anglers etc.) reduced the consistency of some species, with a decline in fishing profitability linked to annual recruitment with strong fluctuations in catches and yield. The decline of fisheries began with the disappearance of the less-profitable techniques or those that required more work. Motor fishing boats are still active for some special fisheries where forms of participatory management by fishermen allowed biological resources and profits to be maintained, as in the case of clam fisheries. In a cyclical manner, the development of alternative economic activities to fishing, such as tourism and catering, for example, has led to a reduction in fishing workers and the abandonment of the sector. This flow fluctuates and is attracting workers to fisheries even from very distant areas, leading to a greater combination of traditions.

The results of fishing activities and their development also had an impact on processing and production activities. For instance, in the years between 1960 and 1975, highly developed clam processing activities were carried out by companies employing many workers for the preparation of crates of shelled clams to be used in sauces, with a consumption of over 50,000 tonnes of clams from the Adriatic Sea. This provided a market for part of the fleet of clam boats that, despite still operating with iron and wooden poles and dragging the boats onto the beach every day, managed to catch several tonnes of (often small) clams a day. Increase in prices and

fishing regulations reduced its cost-effectiveness, so many processing industries closed or were transferred to other areas, in spite of the presence of developed fishing technologies that would allow greater catches. A similar process took place with small pelagics.
In the last century, *menaide* net fishing played a primary role in the employment of fishermen. This type of fishing was replaced by seine nets with light sources, which produced a greater catch and profit, using fishing boats that employed 8-10 people. In the North Adriatic Sea, this activity was replaced by fishing with pelagic trawl nets that operate during the day, even when sea conditions were not calm, and caught a wider range of species. All this is reflected in the preservation activities: the salting industries, which were previously indispensible for preserving large catches, shrank as small pelagics began to be preserved in deep-freezers.
Currently, international regulation results in further rapid changes to fishing equipment, which is no longer selected by fishermen to catch more fish, but regulated to reduce catches. During the current phase, traditions are disappearing and equipment being developed on the basis of its ability to catch selectively.

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4.4.5 Campania

Casola E.

The coastal morphology of Campania mainly extends across the two gulfs of Naples and Salerno, with different characteristics due to the bathymetric trends and coastal terrain.
The alluvial plain of Salerno has places of particular interest because of the coastal settlements primarily located in the Amalfi Coast, where the features of the natural ports allowed the creation of fishing villages that evolved into veritable crossroads for maritime transport. A good example of this is the Maritime Republic of Amalfi, which began as a small village of fishermen and then became a powerful trading city.
In the case of the Gulf of Naples, its unique coastal formation and its oceanographic characteristics meant that it was home to settlements formed as villages dependent on the sea, as demonstrated by the myth of the town foundation, which traces back to the siren Parthenope.
Until modern age, fishing villages upheld specialisations that allowed them to develop technological and industrial traits along the Gulf of Naples. These capabilities were handed down from father to son and are still identifiable in the particular specialisations of the various areas today. For example, the peculiarity of Borgo di Santa Lucia was mussel farming, which was rediscovered and re-valued nearly a decade ago, whereas Borgo di Mergellina had a fleet specialised in fishing with gillnets, and the fishing community at Torre del Greco was heavily reliant on boats with towed gear, i.e. the current trawlers, and on coral fisheries with processing on site.
This remained unchanged until the period following World War II, and along the Gulf of Naples there are villages that were culturally and socially separated from the hinterland and which were the source of fish supplies for the whole region. All this demonstrates the richness of the fishery resources offered by the Gulf of Naples.

The fishing vessels in Campania are subdivided into the four Maritime Districts of Naples (which extend from the river Garigliano to Naples, including the islands of the Gulf, and are subdivided into 12 maritime offices), Torre del Greco (which is subdivided into the maritime offices of Torre del Greco and Portici), Castellammare di Stabia (which extends from Castellammare up to Massalubrense and is subdivided into 7 maritime offices) and Salerno (which covers the entire Gulf of the same name, including the coasts of Cilento and reaching the administrative borders of Basilicata, subdivided into 15 maritime offices). The fishing fleet of Campania in December 2009 was composed of 1,130 vessels, with a total tonnage of 19,981 GT, equipped with a total motor power of 119,309.15 kW.
The *trend* of fleet size in the last decade, i.e. from 2000 to 2009, resulted in a net downsizing with a steady decrease in the number of vessels, which fell from 1,584 in 2000 to the current 1,130, with a decrease of 454 units, equal to 28.5% of the total (figure 4.16).
If regional data are compared to national ones, the Campania fishing fleet in December 2009 represents around 8.3% of the national fleet.

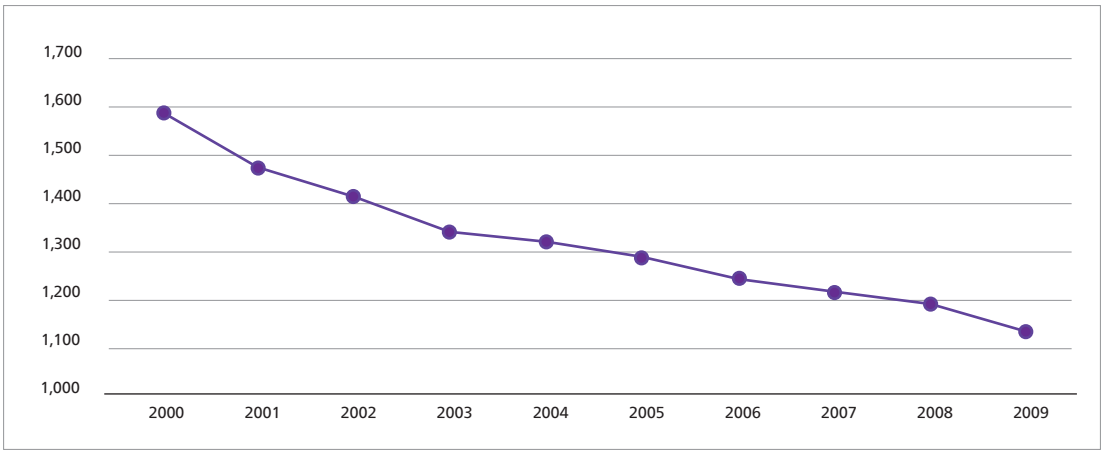

Figure 4.16 - Trend in the number of fishing vessels in the Campania region from 2000 to 2009 (Source: MiPAAF-Unimar).

The distribution of the fleet among the various fishing systems is quite uneven, as the 805 boats within small-scale fisheries makes up as much as 71.2% of the whole fleet in terms of number of vessels, whereas the remaining 325 boats, making up 19.5% of the total, can be included in the polyvalent sector.
The trawling sector represents 5% of the fleet, seine fishing 2.8%, hydraulic dredges 1.2% and finally there are 3 vessels that fish with gillnets but have on overall length greater than 12 m, which comprise 0.3% of the fleet numerically (table 4.2).

Table 4.2 - Technical specifications of the Campania fishing fleet according to fishing systems, absolute values and incidence % (Source: Unimar).

Campania	N. of vessels	%	GRT	%	GT	%	kW	%
Bottom trawl	56	5.0	1,546.64	13.6	2,203	16.9	10,964	13.7
Purse seine	32	2.8	1,434.13	12.6	1,759	13.5	8,359	10.5
Dredges	14	1.2	127.17	1.1	141	1.1	2,157	2.7
Polyvalents	220	19.5	5,721.36	50.4	7,368	56.5	36,544	45.8
Passive gear	3	0.3	25.42	0.2	35	0.3	349	0.4
Small-scale fishery	805	71.2	2,493.08	22.0	1,533	11.8	21,431	26.9
Total	**1,130**	**100.0**	**11,347.80**	**100.0**	**13,039**	**100.0**	**79,806**	**100.0**

From these data we can also calculate the average technical specifications of the fleet as a whole and also for the individual fishing systems (table 4.3).

Table 4.3 - Average technical specifications of the Campania fishing fleet according to fishing systems (Source: Unimar).

Campania	N. of vessels	Mean Loa	Mean GRT	Mean GT	Mean kW	Mean creaw	Mean age of the vessels (years)
Bottom trawl	56	17.3	27.6	39.3	195.8	4	25.6
Purse seine	32	20.4	44.8	55.0	261.2	5	24.5
Dredges	14	11.6	9.1	10.1	154.1	2	28.9
Polyvalents	220	14.0	26.0	33.5	166.1	3	26.6
Passive gear	3	13.7	8.5	11.7	116.5	2	25.0
Small-scale fishery	805	7.0	3.1	1.9	26.6	1	30.9
Total	**1,130**	**9.3**	**10.0**	**11.5**	**70.6**	**2**	**29.6**

It is evident from these data that the average specifications of the Campania fleet can be summed up as small, old boats with few workers. This is explained by the numerical preponderance of small-scale fishing boats that significantly affect the trend of the average data. More analytically, the average boat has an overall length of just over 9 m, tonnage of 11.5 GT, motor power of just over 70 kW, a crew of just 2 persons and aged just below 30 years.

Within the different fleet segments of the Campania fleet there are marked differences in the values of the average dimensional parameters, and this is due to the techniques used for carrying out fishing activities.

The vessels used for small-scale fisheries have very low tonnage and motor power values, a very high average age (almost 31 years) and just one person on board, whereas the seine boats are bigger and more powerful, with an average of 5 crew members and less than 35 years old.

With regard to the geographical distribution of the fleet as a whole, there are large numerical differences between the various districts, with that of Salerno, which is home to the greatest number of vessels, equal to 44.3% of the entire Campania fleet, followed by that of Naples, with 33.9% of the fleet, and the Maritime Districts of Castellammare di Stabia and Torre del Greco, which are much smaller and represent 15.4 and 6.4% of the fleet respectively (figure 4.17).

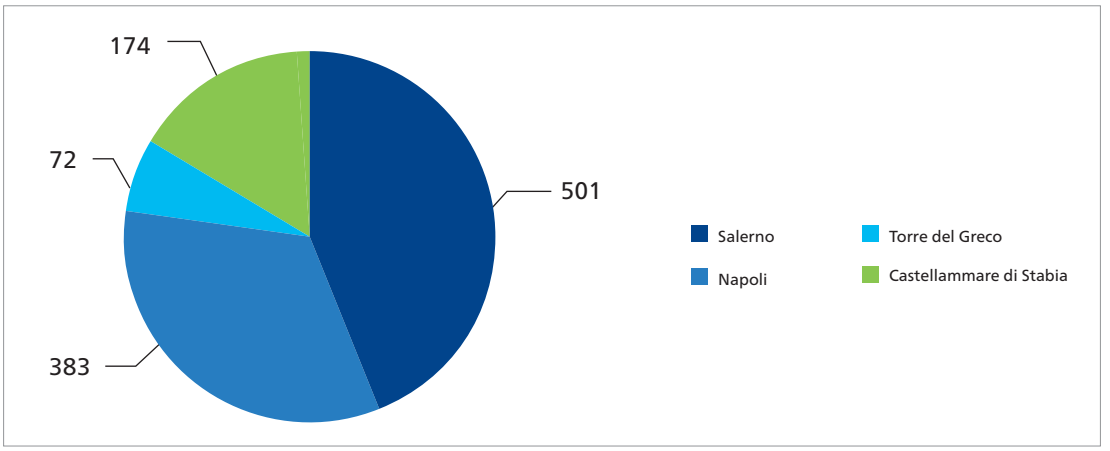

Figure 4.17 - Number of vessels in the Maritime Districts of Campania (Source: Unimar).

In relation to the distribution of the fishing systems across the various fishing communities, traces still remain of the particular fishing activities that the communities developed over time so they became part of their cultural heritage (table 4.4).

Table 4.4 - Geographic distribution of the Campania fishing fleet subdivided by fishing systems authorised by licences (Source: Unimar).

Maritime District	Bottom trawl	Purse seine	Dredges	Polyvalents	Passive gear	Small-scale fishery	Total
Napoli	12	18	14	66	1	272	383
Torre del Greco	18	0	0	18	0	36	72
Castellammare di Stabia	0	8	0	52	1	113	174
Salerno	26	6	0	84	1	384	501
Campania	56	32	14	220	3	805	1,130

In particular, throughout all the districts small-scale fisheries is the most represented sector, and in some communities, such as Monte di Procida, Meta di Sorrento, Positano and Marina di Pisciotta, it makes up the entire fleet.
The District of Castellammare di Stabia is mainly active in the polyvalent sector, which makes up 30% of the whole fleet, reaching 50% in the fishing community of Sorrento. Mechanical dredging only takes place in the District of Naples, and is mainly concentrated in the fishing community of Castelvolturno (around 79%) with the remaining 21% in Pozzuoli.
More than half of the vessels used for seine fishing are concentrated in the Maritime District of Naples, with a significant presence in the fishing communities of Naples, Pozzuoli, Procida, while Torre Annunziata and Salerno in other districts. Finally, we note the absence of a trawling sector in the District of Castellammare di Stabia, although it is highly concentrated in Torre del Greco, where it makes up a quarter of the entire fleet.

4.4.6 Apulia

Spedicato M. T.

The coasts of the Apulia peninsula extend for around 784 km across the South Adriatic and the North Ionian Seas. The sea has played a remarkable influence on the history and economy of Apulia, a strategically located region for communicating with the rest of the Mediterranean. As such, communities developed in the shelter of coastal areas turning the sea into a place of trade, communication and work. Together with agriculture and maritime traffic, fishing has long been one of the main activities of the populations based on the Apulian coastline, which gathered raw materials and products from the sea and the land as the basis for their economies. Offshore fishing was a typical activity in communities such as Molfetta, whose boats went as far as the coasts of North Africa on seasonal fishing trips. In Bari, ship-owner companies are still in operation for fishing beyond Mediterranean waters, albeit very few remain compared to the past.

Trawling semi-industrial fisheries evolved during the economic boom of the 1960s and the related processes of industrial development, which altered the appearance and practice of rural and marginal activities such as fisheries. Taranto, where fishing has gradually become a residual activity in the face of pressure from industrial activities, is perhaps an emblematic case of this, although aquaculture manages to maintain space to operate at sea, in spite of the pressure from industrial activities. Until the 1980s, the Ionian city was home to one of rarest and most sought after group of experts in the sector, namely the fishermen specialising in juvenile fish, the "*pescenovellanti*" who were able to recognise and catch fry of various species such as grey mullet, sea bass, sea bream, shi drum, glass eels and elvers, to be stocked in coastal lagoons, extensive rearing ponds or farms. In 1962 the regional fleet numbered 1,467 motor vessels with overall gross tonnage of 14,274, and production around 29,000 tonnes (Taberini, 1969). In 1982 the experimental PESTAT programme (Bazigos *et al*., 1984; Cingolani *et al*., 1986) that combined a considerable sampling effort with census statistics, estimated a presence of 2,460 motor vessels within the region, with overall gross tonnage of 22,885 and a production of approximately 38,670 tonnes.

Irepa figures for 2002 indicated the presence 1,992 vessels with gross tonnage of 23,293 tonnes and production of 68,911 tonnes. The current situation (2010, data from Irepa) shows a further decrease in the number of vessels (1,962 units) with a total capacity of 19,072 gross tonnage and production of 29,648 tonnes. By using crude capacity/impact indicators (number of vessels x tonnage) and productivity or abundance of resources (catch per unit effort, where the effort is given by the capacity indicator), which are the only measurable metrics for the whole time period under examination, it can be seen that (figure 4.18) the lower capacity in 1962 corresponds to one of the highest CPUE (catch per unit effort) values, with an increasing level of production for the following years. However, production increased only slightly in 1982, when the capacity of the fleet was around 160% that of 1962, while the CPUE decreased. These were the years in which the need to intervene with specific management instruments emerged, and in fact the first Regional Law on fisheries (Regional Law 57/1981) and National Law 41/82 came into effect at this time. During the next 20 years, measures were implemented to contain and withdraw the fleet that led to a reduction in capacity, as shown by the figures from 2002. Production and CPUE expanded as a likely effect of greater fleet efficiency, in terms of catch power, an efficiency that no longer showed the same *performance* in the following years, when the dip in CPUE could be a sign of reduced system productivity in terms of abundance of fishery resources.

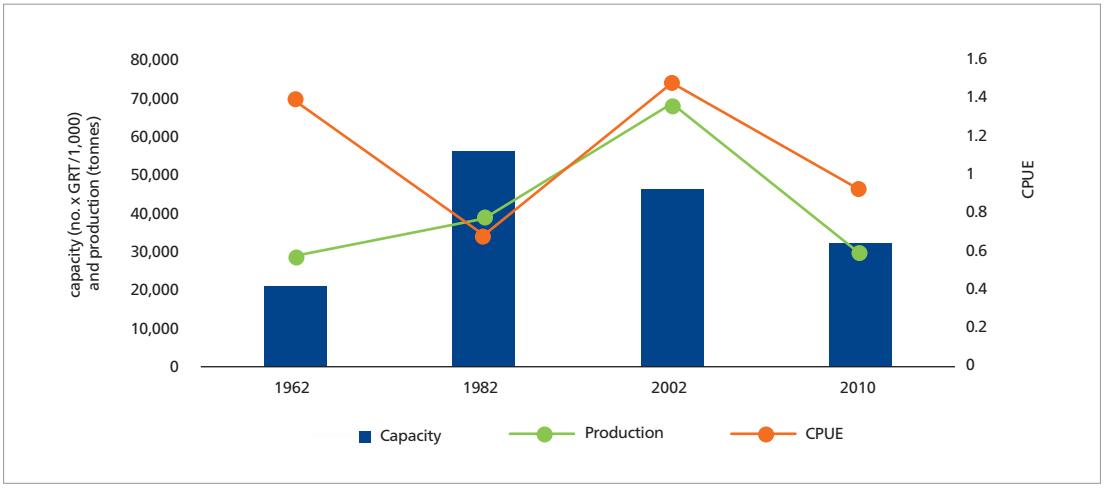

Figure 4.18 - Values for the capacity (number of vessels × gross tonnage/1000), production and catch per unit effort (CPUE = production/capacity) of the Apulian regional fleet in 1962 (Source: Taberini, 1969; PESTAT, 1982; Irepa, 2002 and 2010).

Overall, the distinctive traits of the main fishing communities in the region have not changed over time: Molfetta largely remains a place of traditional offshore fishing, whereas in the coastal settlements of Salento, such as Gallipoli and Porto Cesareo, as well as along the Gargano, are the places of small-scale fisheries. These areas, together with Manfredonia, which has the most important fleet in number within the region, Mola di Bari and Monopoli, make up around 80% of the regional fleet capacity (Lembo & Donnaloia, 2007; table 4.5 and figure 4.19).

Table 4.5 - Structural indicators of the regional fleet by maritime district (Source: Lembo & Donnaloia, 2007).

	Unit (no.)		Tonnage (GRT)		Power (kW)	
Maritime District	**a.v.**	**%**	**a.v.**	**%**	**a.v.**	**%**
Bari	296	16.8	3,564	17.5	31,469	19.9
Brindisi	112	6.4	436	2.1	5,269	3.3
Gallipoli	417	23.7	2,204	10.8	22,086	14.0
Manfredonia	532	30.2	5,367	26.3	42,213	26.7
Molfetta	223	12.7	7,947	39.0	45,318	28.7
Taranto	181	10.3	871	4.3	11,593	7.3
Puglia	**1,761**	**100.0**	**20,388**	**100.0**	**157,949**	**100.0**

Apulia substantially contributes to the capacity and productivity of the national fleet, with quotas of around 13% and 16% respectively (data from Irepa, 2010). The district with the greatest number of boats is Manfredonia, but the District of Molfetta has a higher capacity.

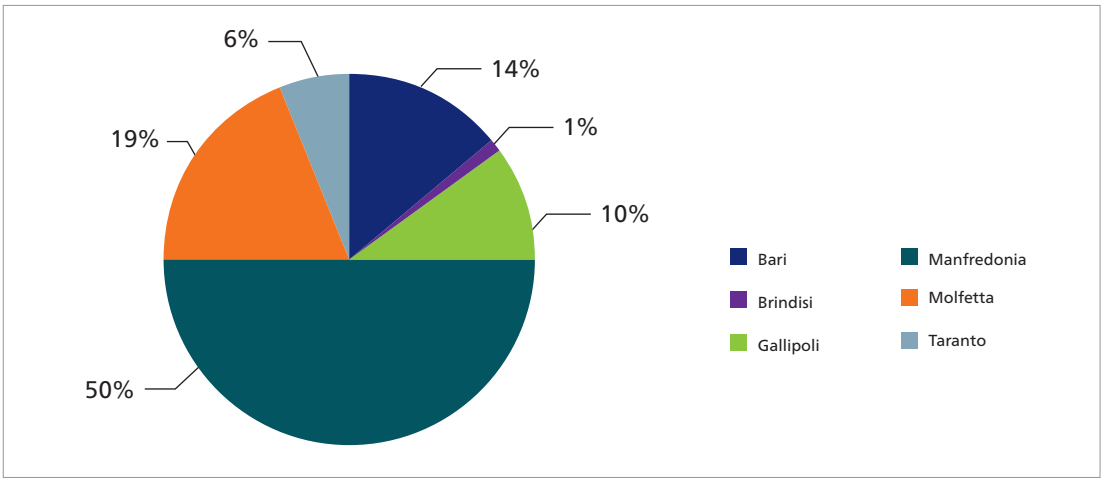

Figure 4.19 - Percentage distribution of capacity (number of boats x gross tonnage) of the Apulian regional fleet by maritime district (Source: Lembo & Donnaloia, 2007).

Old traditions, the variety of the aquatic environments in the region – particularly if the coastal marine environment is considered together with the extended lagoon systems of Lesina and Varano and the Alimini Lakes – created an impressive variety of catch systems, especially within small-scale fisheries. For example, fishing with *paranza* boats and fyke nets, and barriers and traps to catch eels is typical of the lagoon of Lesina.

The *trabucco* is an old fishing gear that was normally located on protrusionsof the coast and which used large drop nets. This fishing method was widespread in the South Adriatic, the North of Apulia and along the Abruzzi coast, and is now protected in Apulia as a monument to its heritage by the Gargano National Park.

An ancient fishing technique typical of the Bari coast, where it is still widely practiced, is that of the harpoon and a metal tube with a mirrored bottom to catch sea urchins and octopuses.

In Manfredonia, cuttlefish is typically captured in late spring (May-June). In this period sections of the coast are assigned to fishermen not without conflict. Once this fishery was regulated by ministerial decrees (Taberini, 1969), while it is now under the control of local fishing cooperatives together with the Harbour Master's Office.

In Gallipoli and Porto Cesareo, conversely, tuna fisheries was one of the main activities, and was practiced with *tonnara* nets until the end of the 1960s and then abandoned (Taberini, 1969). Fishing with so-called *squadrara* nets (Parenzan, 1983) to catch lobster, rays and sharks also gradually disappeared over the years. Since then, large pelagic fishing has been practiced with longlines and *ferrettara* nets.

Today Gallipoli and a large part of the fishing communities of Salento, such as the nearby Porto Cesareo, typically practice small-scale inshore fishing with various types of specific gillnets for catching certain species, such as *pupiddi* (picarel). In Gallipoli over the past 20 years, the trawling sector has specialised in deep-sea fishing in the bathyal zone to catch red shrimp and *Aristeus antennatus* in particular. At present, trawler fishing is predominant in terms of the capacity of vessels, whereas gillnets are still used by the greatest number of boats (figure 4.20) even though there is now a smaller variety of fishing techniques used than in the past.

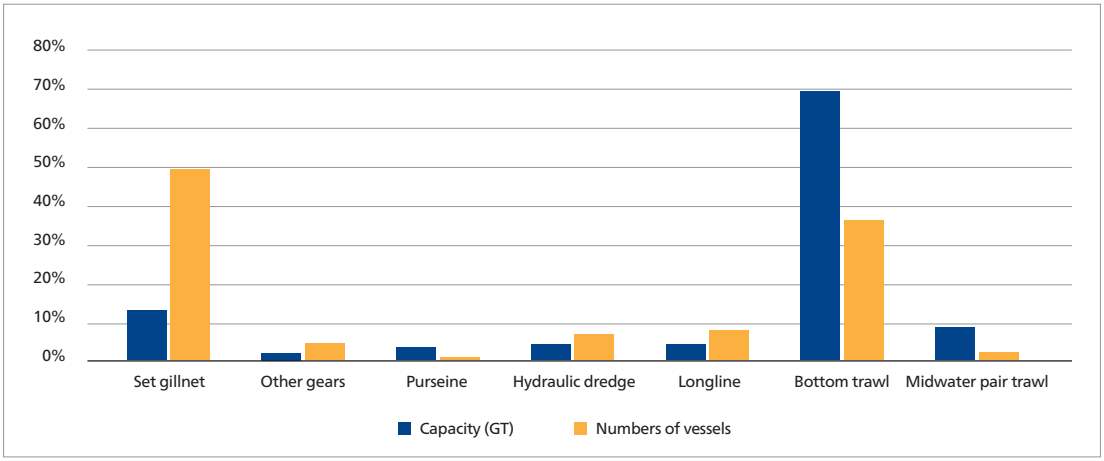

Figure 4.20 - Distribution (%) of the fleet in terms of number and capacity (GT) per fishing system (modified from Lembo & Donnaloia, 2007).

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4.4.7 Calabria

Ponticelli A.

The history of fishing in Calabria is often little known, though it contains aspects with significance that extends beyond Italy. The importance of Calabrian fisheries, which currently account for only 4% of the total national production, was much greater in the past, especially before the introduction of trawl fishing systems and the motorisation of fishing vessels in general. In the South Tyrrhenian Sea in particular, specifically the area between the Strait of Messina and Vibo, the morphology of the coast, its hydrodynamism and the high contrast of the currents provided the opportunity to develop methods for catching large pelagic fish, particularly tuna and swordfish. Historical documents testify to the economic importance of these fishing activities in past centuries. In 1700 rights to fishing zones were still feudally controlled, and property of a section of coast also included the adjacent portion of sea and the exclusive right to fish. This ownership of the sea extended as far as the eye could see. In practice, the right to fish was in upheld in various ways until the early 20th century.
Calabrian fishermen did not normally fish exclusively, but also carried out agricultural activities, especially those related to vines and olives. This was closely linked to the history of the coastal communities of Calabria, where the settlements along the coastline have only recently undergone significant development. Indeed, in Calabria, because of both the historical incidence of raids

by the Barbary corsairs, and the significance of malaria outbreaks in the lowlands, inhabited areas historically developed far away from the coast. It was only in the 19th century that maritime hamlets and fishing villages gradually developed to become more densely populated than the hillside municipalities they belonged to, as they are now. Evidence of the cultures practiced by fishermen communities includes, for example, terraces for cultivating grapevines, typical of the area of Bagnara Calabra on impervious rocky walls and directly overlooking the sea. These terraces were also used to sight large pelagic fish. Between the late 19th century and early 20th century, the crisis caused by a Phylloxera infestation and the subsequent destruction of the vines brought about mass emigration from Calabria to the Americas, which came as a heavy blow to the fishing-agricultural communities. Many of the descendants of these emigrants remain in Argentina, and in Mar del Plata some of them own the most important fishing companies and fish product processing plants. In Bahia Blanca the most active crews fishing langostino, the Argentine red shrimp, include the great-grandchildren of the immigrants from Calabria.

The fishing techniques of Calabria were historically divided between the Ionian and Tyrrhenian coasts. Indeed, the two seas share some characteristics but differ completely in others. One aspect they have in common is the oligotrophic condition of the waters and the presence of a bathymetric gradient. The seabed rapidly reaches great depths, with some areas only a few miles from the coast featuring depressions reaching depths of more than 700 metres. However, the southern part of the Tyrrhenian coast near the Strait of Messina has very intense water circulation, and the narrow passage between Sicily and Calabria acts as a sort of “trap” for the large migratory pelagic fish coming from the Strait of Sicily along the Calabrian coasts. These special conditions encouraged the development of large pelagic fishing over the centuries. By contrast, despite often reaching significant depths, the Ionian coast saw the development of small-scale inshore fishing, which was mainly practiced along the shore. It was only the introduction of motor fishing boats that allowed trawl fishing to be developed in certain areas where the continental shelf extends further out.
A thousand year-old fisheries developed in the section of coast between the Strait of Messina and Bagnara Calabra, namely the swordfish hunt. The swordfish hunt in the area around the Strait was based on the use of lookouts positioned on the terraces overlooking the sea. Using audible and visual signals, the lookouts could direct the boats towards the swordfish. The boat used in ancient time was the “*galea*”, of Byzantine origin, but from the 14th century the “*luntro*” (figure 4.21) was more commonly used. Its name was probably derived from the Roman *linter*, a flat-bottomed boat used for transport and fishing. A typical *luntro* was around 7 metres long and could be operated by up to eight rowers.

Figure 4.21 - The "*luntro*" used for hunting swordfish.

A mast around three metres high stood at the centre of the vessel, which allowed the on board lookout to give directions to the harpooner. Other features of the *luntro* included its black colouring, which made it less visible to the prey, and the particular shape of its hull, which had two bows at the end. Once the fish was sighted by the lookout on land, this structural formation allowed the boat to be guided towards the swordfish quickly without being forced to change its course, which would have slowed down the rapid rowing as it approached.
Around 1500 a ballasted and moored boat known as the "*feluca*" (*felucca*) was introduced. It had a tall mast with a lookout at the top. The felucca was laid up, in that it had no means of

propulsion. With the introduction of motors to boats, the *felucca* began to be provided with independent propulsion and over time it was used directly in the swordfish hunt. The *luntro*, which could not be fitted with a motor given its modest dimensions, gradually fell into disuse. The evolution that took place in the second half of the 20th century included the introduction of a long gangplank at the front of the felucca with for the harpooner to stand on, and a 20 metre high observation antenna for the lookout, who could issue commands and so act as helmsmen by immediately directing the boat towards the sighted prey. The boat derived from the felucca took the name "*passerella*"over time. In more recent years, swordfish fishing saw the introduction of a system of driftnets or long "*spadara*" driftnets that could reach up to 40 kilometres. This form of fishing was banned because of its lack of selectivity, but continued illegally until recent times and now seems to have definitively stopped at last.
The migration of large pelagics also concerned tuna, which followed the same coastal route as the swordfish before approaching the coasts near Vibo Valentia and especially Pizzo. The fixed Calabrian "*tonnara*" net was characterised by a blocking net called a "*pedale*" that was around 1,800 metres long and a fleet of scows arranged around a rectangular water area, divided by a series of set gillnets formed of several chambers leading to the final chamber in which blue fin tuna were captured. The fishing season lasted from spring to September, and the product collected was immediately processed on land through salting or cooking. The produce from the Calabrian *tonnara* was then sent all over Italy and even abroad. The Calabrian tonnara nets have not been used for many decades, but it is significant that in Vibo Valentia companies specialised in tuna processing are operating, and their excellence is not only recognised nationally but also further afield.
Of the other fishing methods still practiced, the "*cianciolo*", a type of seine fishing that uses fishing lamp, should be mentioned, the historical evidence of which dates back to the early 19th century. The mothership with the net on board remains still, while a boat ("*u bozzetto*") approaches with a lit lamp. When the small pelagic fish has gathered around the boat, the mothership casts the net, surrounding the school, which is then caught.
Another widely practiced fishing system, particularly by small-scale inshore fishermen in addition to the gill nets, known as the "*rizzilli*", is the longline, a tool comprised of a hemp rope over 500 metres long, to which two metre end lines ending in a hook are attached. The longline (which is now made from nylon) is widely used in both deep-sea fishing (hake, dentex, groupers, etc.) and surface fishing.
Inshore fishing is practiced using a purse seiner, which is cast from a boat in the identified coastal area. It consists of a large net equipped with two wings and bag, with a fine mesh that closes up during the retrieval stage, trapping medium sized fish. Similar to a purse seiner, but smaller and with tighter mesh, is the "*sciabachello*", which was mainly used for fishing whitebait.
From the 1930s onwards, the gradual introduction of motors to fishing allowed an important trawling community to develop. As mentioned, the areas in which trawler fishing mainly developed were around Crotone and the Gulf of Corigliano, to the extent that the overall output of the Tyrrhenian coast, which was once marginal, is now the biggest contributor to the Calabrian fishing industry.

The Calabrian fleet gradually increased to 1,200 units in the mid 1990s, but has declined in the last decade. At present (2011) there are around 900 fishing boats in Calabria, but this figure is set to decrease further following the adoption of the adaptation plans, which include measures to definitively stop trawl fishing.

Traditional whitebait fishing, which includes more than 154 vessels (17% of the Calabrian fleet - Source Aquatech 2010), is in particularly critical situation following the enforcement of the specific regulations issued by the European Union. The boats used for it are small in size and belong to small-scale inshore fishing (over 90% are smaller than 12 metres) and all are used for numerous types of fishing except trawling (figure 4.22).

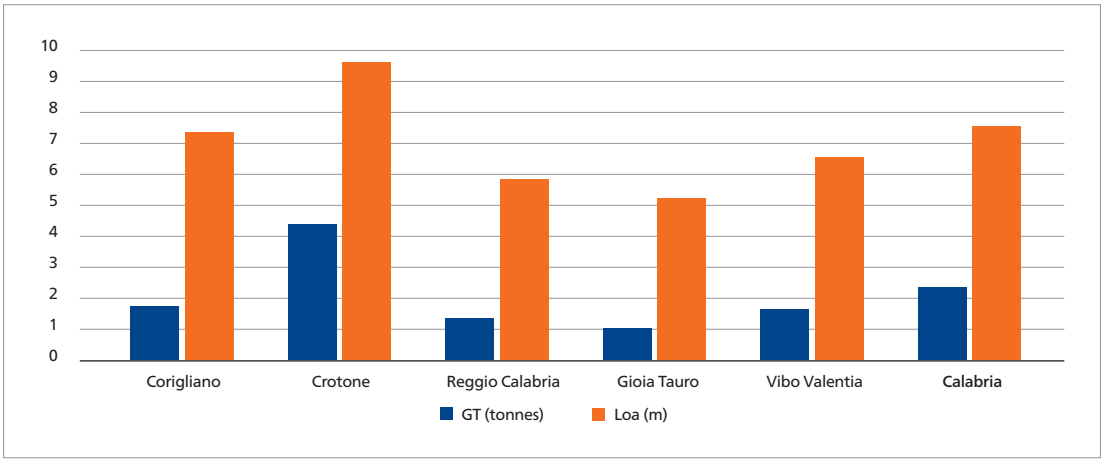

Figure 4.22 - Characteristics of the Calabrian fleet used in "special fisheries" by maritime district – mean values (Source: Aquatech, 2010).

For the more than 400 fishermen who catch juvenile sardines, this is the opportunity to make the biggest profit of the year. Whitebait fishing is also linked to the tradition of processing "rosa marina", which involves over 20 companies in Calabria, many of which are family run, and all known for their excellence. It should also be noted that the traditions of the various coastal fishing communities seem to lend themselves well to the new European Union policy for the development of fishing areas. This is an excellent opportunity for Calabria, particularly in relation to the recovery of the fishing villages and their use for high quality purposes (fish tourism, *diving*, sport fishing). Today, the presence of tourists tends to extend beyond the traditional summer months. This is also because of the increasingly important impact of North European tourists, who seek out places to stay, sometimes permanently, by purchasing vacation homes located close to the most distinctive maritime communities. On the other hand, traditional processing of fish products could also be boosted by developing small, domestic-type processes that would provide an opportunity to supply a product that meets quality and food safety criteria.

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4.4.8 Sicily

Andaloro F.

The profound environmental changes that occurred between 10,000 and 8,200 B.C. led humans in many Mediterranean areas to modify their means of subsistence. This phenomenon, defined by archaeologists as the "tardiglacial paradigm" and attested by the fishing activity in Greece during the Mesolithic, can be extended to Sicily as there is evidence of fish preparation (Iovino, 2000) and littoral catch of molluscs. This primordial fishing allowed prehistoric man to abandon nomadism, giving rise to the process of neolithisation. More than fishing, marine organisms were gathered above the tide line, in tidal pools or deposited on the beach, though the apotropaic carvings of tuna and other marine animals in the Genovese cave in Levanzo island show an unexpected knowledge of sea organisms as early as 3000 B.C. Evidence of stone harpoons and bone hooks, replaced by metal in the bronze age, show a subsequent interest in fishing. However it was not until Greek colonisation that it underwent significant development and people were first able to catch marine, inshore and deep water species, which accounts for the widespread presence of *salsamentum* (fish in brine), *tharicos* (dried fish) and subsequently *garum*, a sauce produced by fish fermentation. Considerable visual evidence, such as the cupid fishermen of the mosaics in the villa del Casale in Piazza Armerina (Enna), shows us that fishing in the 3rd century A.D. already used subactual techniques and equipment was only limited in relation to the fishing of the last century by the available materials and means, but not by ingenuity. The inventory of tools used in Magna Graecia and ancient Rome was, in some ways, superior to that used today, having been eroded by the monocratisation of semi-industrial fisheries and the decline of target species (Andaloro, 2006).

From antiquity to the 20th century, despite the succession of rulers, the community of fishermen remained unchanged and fishing did not undergo radical alterations, but rather evolved. The techniques of the fishermen from various fishing communities were similar to one another but with some differences, such as the size of the mesh and the weights, the number of corks, the ratio of rigging, the knot on the hook and the bait used, which allowed them to adapt fishing gears to the nature of the bottom and the behaviour of the prey. The fishermen learned all this day-by-day, modifying their fishing gear and attempting to keep it a secret. The essential changes that took place in the last century only concerned the nature of the cord, which were previously made of coloured coconut, manila hemp or cotton coloured with nut husks, the floats, which were previously made of cork and the weights (known in Italian as "piombi", meaning lead) made from stone materials.

Much of the historical fishing gears is still in use in Sicily, including *tratte* and *menaidi* (small driftnets with different meshes), *rizzelle* (gillnets), *pusticedde* (combined nets for seasonal fish), *sciabicuni*, *tartaruni* and *ravastine* (seine nets), *conzi di funnu* and *di summu* (bottom and floating longlines). Dolphin fish is still fished with *cannizzati (Fishing Aggregating Devices)*, which have been used since 1800 and are made with palm leaves fixed to floats and anchored at the bottom, under which the so-called "pesci d'ombra" (shadow fish) gather. Forgotten fishing methods include octopus fishing with the *quartare* (earthenware pots), sea bream fishing with *suvari* (corks), garfish fishing with harpoons, sea urchin and bullseye (*Haliotis* spp.) with the *manuzza* (a type of harpoon), *cinciri* mullet fishing with entangling net deployed around school of fish, and male of cuttlefish fishing using, as actaction, a live female. The continued use of other equipment

was, however, compromised by legislation prohibiting its use, such as the beach seines, the *bardassuna* (correntine driftnets), lamps for harpoon fishing along the coast. Abandoned or modified fishing techniques worthy of attention for their cultural value include acient tonnare (tuna traps) and swordfish hunting with a harpoon.

Irrespective of the debatable possibility of earlier activities, systematically conducted bluefin tuna fisheries with anthropological and economic value may only date back to the time of Greek colonisation in Sicily. In the classical era (Purpura, 1982), tuna were sighted from the wooden towers on land and were diverted by blocking nets positioned at that moment towards the inlets, where they were closed off at the shore by seine nets and killed with harpoons and rods. The appearance of the *tonnara* with the "camera della morte" (chamber of death) was an innovation, possibly of Arabic origin, dating back to around the first half of the 9th century A.D., which significantly increased the yield of the systems. The consequent need to preserve the catch and harbour the boats and equipment, which became progressively larger and more expensive, necessitated the construction of buildings which took on an increasingly important architectural complexity over the centuries, until reaching maximum development in the 17th century: the *tonnara*. None of the 82 *tonnare* that operated on the island between the 18th and 19th centuries has been active since the last *mattanza* (tuna cull) in Favignana in 2008 (Sarà, 1998). This marked the end of tuna culture in Sicily.

In the 2nd century B.C., Oppiano and Polybus described swordfish hunts with the use of harpoons. This form of fishing slowly evolved in the Strait of Messina by exploiting the behaviour of the fish according to the environmental characteristics of the area, using a system that led to the construction of fast boats driven by oars ("*luntri*") in the 15th century. They were guided by the cries of the spotters on land first and then those on board the vessels ("*feluche*"), as described in 1658 by Reina. The most recent testimony (Sisci, 2005) of swordfish fishing with harpoons described the modern motorised fishing boats that replaced the feluca. These were a few Sicilian and Calabrian vessels equipped with a gangplank of around 25 m long, on which the harpooner or "*lanzaturi*" would be positioned, and an equally tall sighting antenna from which the boat was manoeuvred and the fish sighted. These boats had places for 2 to 4 spotters ("*ntiinneri*"). Fishing took place at the end of spring and in the summer, when the swordfish reproduce. From 1902 onwards, lots were drawn at the Harbour Master's office of Messina and Reggio Calabria for the poste small fishing areas into which the Strait was divided, which were assigned to the fishermen without the possibility of straying into other areas.

Though eel was favoured by the Ancient Greeks and was captured until the 20th century, there is now no more professional fishing in freshwater. Eel fishermen were called *ciumaroli* and their activities were associated with surveillance of rivers. They used cylindrical willow and cane traps and did not use boats and moved on foot, carrying the eels "stitched" together with a blade of grass. In addition to eels, tench and carp were also caught.

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4.4.9 Sardinia

Cannas A.

Max Leopold Wagner, linguist and unsurpassed scholar of the Sardinian language, observed in the last century that most of the Sardinian word relating to the marine world were actually of "non Sardinian" origins. This vocabulary was predominantly of Arabic, Spanish, Genoese or Campanian origin, or from other areas of the Mediterranean region. This observation, together with the theory that language is also an indicator of history in addition to being a cultural form, highlights the difficult relationship that Sardinia has always had with the sea and with traditional activities connected to it.

Sardinians are not fishermen people and this is confirmed by the traditional activities into which fisheries can be divided: coastal fisheries, mainly practiced for local consumption, and marine fisheries, developed because of economic interest in the island's most precious marine resources – especially coral and tuna – on the part of the various peoples that colonised Sardinia over the centuries.

In coastal lagoons areas, such as those around Cagliari and Oristano, Sardinians developed forms of lagoon fisheries over the centuries, with equipment that is still used today, albeit with a few modifications. The carousel or "*mantra*" used in ponds is a small fish barrier, originally made from swamp reeds, which have since been replaced with more modern, durable materials. At the *stagno* in Cabras (OR) it is still possible to admire the original carousel and enjoy the products that tradition has distinguished as genuine island specialities: "*sa merca*", salted mullet preserved in marsh grass, and mullet roe.

Gillnets were often used for "*pesca vagantiva*" (fishing with no defined aim), especially to catch grey mullets. These nets were fitted with cloth netting parallel to the water surface to catch the fish that jumped over the barrier. At present the same nets (made from synthetic materials) are also used to catch many sparids, more abundant then in the past because of the gradual increase in water salinity. Reed traps were generally used for fishing eels, gobies and crabs, but are made of plastic-coated iron. They also play a more marginal role in lagoon fisheries, as they were replaced by the more efficient "*bertovello*" trap introduced to Sardinia in the 1960s by fishermen from Lesina. It is still in use, but regional legislation imposed limits on it because of its poor selectivity. Fishing with harpoons was another method used in the lagoon waters for centuries, but which has almost disappeared.

Marine fisheries mainly originated with the arrival of fishermen families from Sicily, Liguria and Campania for tuna and coral fisheries at various times. A scholar of the history of Sardinian fisheries, Giuseppe Doneddu, reports that bluefin tuna fishery was practiced in early times with rowboats or sail boats, then was greatly expanded at the end of the 16th century with the set tonnara nets. In the early 17th century, there were 12 *tonnara* along Sardinian coasts; now, the few that are still active are concentrated in the south-western coast. In 2011, only those of Carloforte and Portoscuso (CI) were cast.

Another traditional fisheries in Sardinia is coral fisheries, which was carried out with tools that are now forbidden, such as the St. Andrew's cross and the "*ingegno*", formed of wooden or metal bars fitted with nets that caught the coral branches as the tool was lowered and pulled or dragged across the seabed. Like tuna, for centuries coral was one of the main Sardinian fisheries resources and, according to some historians, this precious product was the real cause of the Catalan invasion in the Middle Ages. Now only around 30 operators are licenced to fish coral,

and they may only do so from the first of May to 15 October at a depth of at least 80 m and only using an axe.
Groups of fishermen from Campania, Sicily and Liguria came to Sardinia for the coral and tuna season, but around the 19th century they settled on the island with the families, slowly becoming Sardinian for all intents and purposes through their offspring. These men developed small-scale inshore fisheries with rowboats or boats with lateens, using various sized reed traps depending on the target species, with larger traps up to 1.50 m long for lobster, and smaller ones for picarel, muraena, conger and other species. Today the descendants of these families continue their activities, but the reed traps have been replaced by other equipment that is alternated during the different fishing seasons, namely set and drift gillnets and longlines.
Finally, sea urchin fishing is another traditional activity permitted to scuba divers who harvest sea urchins by hand, and to professional fishermen who operate from a boat using a bathyscope and a "*coppo*" net or long cane "*cannuga*" open at both ends. Sea urchin fishing is permitted from November to May.
To summarise, these are the main forms of traditional fisheries in Sardinia; small-scale fisheries are in strong competition with trawling, which is practiced both by large fishing boat, for which it is practically the exclusive method, and other, smaller boats ranging from 10 to 30 tonnes, which also use other equipment. These latter often cross over into restricted areas, creating conflicts within the fishing community that have not yet been resolved.

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