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E DELL'ACQUACOLTURA

DISCARD MANAGEMENT PLAN FOR VENUS CLAM *CHAMELEA GALLINA* (ART. 15 EU REG. 1380/2013)

REPORT OF THE ACTIVITY CARRIED OUT AFTER THE ENTRY INTO FORCE OF THE COMMISSION DELEGATED REGULATION 2016/2376 (2017-2018)

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Summary of results

- **Application of the measures envisaged in the discard plan**
  - The bivalve mollusc management consortia have applied the measures envisaged in the discard plan:
    - systems for detecting vessel position
    - restocking areas
    - introducing a certification system to verify conformity of the product to the Minimum Conservation Reference Size (MCRS) at the landing sites
- **Biology**
  - Given the adjustment of the Minimum Conservation Reference Size to 22 mm, compared to 25 mm established in Reg. EC1967/2006, some details have been provided on the biology of the species.
    - The results obtained with regard to sexual maturity and growth confirm the scientific findings of other authors in previous years. In the samples obtained from surveys in both 2017 and 2018 it was possible to determine the sex of individuals of 8-10 mm and observe mature gametes in both sexes from a length of 11-12 mm.
    - The period May - July corresponds to the reproductive peak
    - A size of 22 mm is 22-38% higher than the size in the first stage of maturity (L50 = 16-18 mm) and is therefore aligned with and in full respect of sexual maturity, guaranteeing the sustainability of exploitation of this resource.
    - Data relative to growth, on the other hand, have shown that clam size increases by about 1 mm/month. This means that a clam takes just under 2 years to reach a size of 22 mm and that the clams of 22 mm or slightly less, once released back into the sea, reach a size of 25 mm in about 3 months.
- **Survivability**
  - Studies on survivability of clams after release are ongoing both in captivity and in commercial situation (end of projects December 2019). Previous studies carried out on calms caught and sorted by the sieve on board demonstrated that clams survived and were able to actively rebury.
- **Fishing effort reduction**
  - potential fishing days per year have decreased (four days per week instead of the previous five days per week);
  - significant reduction of daily fishing effort for two reasons:
    - The reduction of the maximum daily quota (from 600 to 400 kg)
    - the possibility to market specimens smaller than 22 mm (although it is currently rare to find clams smaller than 23 mm on the market) have together made it possible to reach the quota set more quickly (on average 1 – 1.5 fishing hours per day)
    - The reduction of the daily fishing effort (the mean is actually 2 hours/day compared to 4.5 hours/day in 2016) has meant that the consortia could better manage the fishing activities with the rotation of the exploitable areas. This resulted in a longer time closure for the areas closed to fishing activities (rotation of areas) and to an increase in fishing days with a benefit in terms of economic revenues.
    - this has also resulted in a reduction in the areas dredged, thus reducing the environmental impact of dredging gear. It is clear that the effects will need to be assessed over time. The reduction in the time spent on fishery operations means that this fishery also has implications of a socially useful nature.

- **Selectivity**
    - With the entry into force of the Discard Plan, the characteristics of the size-selective gear on board (mechanical vibrating sieves) have not been modified. The sieving grids themselves have not been modified either. A recent study on the selectivity of Adriatic dredgers demonstrated unequivocally that, where compliant vibrating sieves are employed (hole diameter 21 mm), the number of specimens under 22 mm is negligible. The length-frequency distribution of the clams sampled directly from the collecting box (before sorting) shows a wide range of sizes with a large number of undersized specimens (< 22 mm). However, on considering size distribution after sieving, it is possible to observe that there are very few specimens under 22 mm, sometimes almost none (<1%).
    - It is clear from the results obtained from monitoring activities that, as a consequence of the sorting operations on board with a sieve that is compliant with the regulations in force, there are not sufficient quantities of clams retained on board to allow for reasonable seeding operations for restocking purposes. This explains why, in many Maritime Districts, restocking areas have only been used marginally. In the light of the selective properties described above, the quantity of clams under 22 mm kept on board was often so low that it was completely impractical and unprofitable to discard these specimens in the restocking areas. It will, however, be possible to use these areas to test rotational seeding as envisaged in Ministerial projects that have already been approved.
    - The cage (dredge) towed on the bottom is responsible of the first and effective selection phase. The L50 obtained from the process is equal to the MCRS for this species. Therefore, most of the small clams did not reach the sieving process on board but directly return to the bottom.
    - 10 projects dealing with improvement of gear selectivity (both sieve and cage) are ongoing. Final results December 2019.
- **Biomass**
    - The standardised monitoring activities carried out in 2017 and 2018 demonstrate that, in almost all the consortia, the resource has recovered, with biomass and densities that are higher than the values registered for previous years. At the end of August 2018, however, clams died in very large numbers in the central-northern Adriatic Sea, probably due to a sudden, exceptional climatic phenomenon and this may have negatively affected the surveys carried out from September onwards.
    - The surveys have demonstrated that good levels of spawning stock have been maintained, which is confirmed by the large quantities of juveniles in all the areas, proving that recruitment has been excellent and will be able to sustain the future population of commercial clams.
    - The area within 0.3 nautical miles from the coast is forbidden to fishing with hydraulic dredges. Surveys have shown that this area is rich in both adults and youth and therefore represents a useful basin for maintaining the reproductive potential of the stock.
    - The vessel position detection system has enabled the sector to participate in control operations, considerably improving management activities.
    - The vessel position detection system will be used to plan fishing activities in relation to the effort applied: growth studies highlight that when clams of 20-22 mm are rejected, they can reach 24-25 mm in three months. Vessel position system will be used to manage the rotation of fishing areas.
- **Impact**
    - The biological communities present in the fishing areas are those typical living in low-depth and high-energy environments. Vatova found similar communities in the famous study conducted in 1949. These communities are already naturally subjected to constant environmental stress due to exceptional phenomena (in particular, significant wave movements, strong currents), and for this reason, they demonstrate rapid recovery (resilience). The rotations of fishing areas (typical of the clam management) enable long rest periods that allow the macrobenthic community to recover for periods of 2-6 months. The ecological effects and the recovery of the benthic community after the action of hydraulic dredge gear can therefore be equated to the recovery that takes place following natural

disturbances. No species are caught that present problems related to conservation or which are protected.

- **Economy**
  - The adoption of the Discard Plan for clam has produced evident economic benefits. The reduction of daily fishing hours has reduced costs for fuel while it enabled to better manage the rotation of fishing areas.
  - The revenues from clams between 22 and below 25 mm accounted for around 80% of the total. This means that in the same period, the maintaining of 25 mm as MCRS would have implied significant economic loss. To maintain revenues, fishermen would strongly increase fishing effort to catch bigger quantity of clams of 25 mm. This would leave to a possible excessive exploitation of the resource.
- **Controls**
  - Inspection activities carried out by control bodies were regular and intense (663 controls in 2017 and 661 in 2018). However, the possible non-compliance with the minimum reference size for conservation (22 mm) and fishing within the restocking areas concerned less than 1% of the controls carried out
- **Conclusions**
  - In the light of the studies carried out during the first two years of implementation of the Discard Plan, it is possible to affirm that maintaining the Minimum Conservation Reference Size at 22 mm appears to be a fundamental element towards guaranteeing a positive future for the fisheries sector operating with hydraulic dredges, as it is sustainable from an ecological point of view (the biology of the species and the low environmental impact support this argument) and also from a socio-economic point of view.

Foreword

This report represents a summary of the monitoring carried out from the entry into force of the discard management plan for venus clam *Chamelea gallina*. The work summarizes the results achieved in the first year and a half of application of the Plan, which, as noted, will end on 12/31/2019. Some results are therefore partial, but unequivocally indicate the good results achieved by the application of the Plan and also show the studies in progress to achieve the set objectives. In fact, some provisions, such as the system for the control of the vessel position, are new, therefore a period of adaptation was necessary for the Consortia, but also for the scientific institutes for deciphering the data and its analysis.

The venerid clam (*Chamelea gallina* L., 1758), known locally in Italy as “cappola”, “lupino”, “cocciola” etc., is widely distributed throughout the Mediterranean, in the eastern Adriatic and in the Black Sea; in Italy it is particularly abundant along the central and northern Adriatic coast (noteworthy quantities are also caught in the mid and lower Tyrrhenian Sea) and is one of the most commercially important molluscs.

C. gallina is found in high density shoals in the coastal area up to a depth of 12 m on sandy sea beds in which it burrows, leaving only the two siphons protruding on the outside, with which it draws in (inhalant siphon) and expels (exhalant siphon) water. The growth of the clam, as well as other fossorial species, is influenced by various biotic and abiotic factors such as temperature, water trophism, the nature of the sediments and population density. In the presence of high densities (> 500 individuals m^2), phenomena such as increased natural mortality have been demonstrated (especially in the summer when hypoxia can occur more frequently in the area close to the coastline), as well as a reduced growth rate and a slowing down of recruitment. It is therefore not rare for this species to suffer mass deaths, which on several occasions have led to critical periods for the relative fishing industry, these deaths can be caused by changes in the coastal environment due to natural and other causes (anoxia, quantities of fresh water river run-off, storms, pollution, etc.); it would appear, however, that the clam possesses a remarkable capacity for recovery following stressful conditions and its reproductive biology appears naturally predisposed to react to phenomena of sudden mass deaths with subsequent intense recruitment.

The reform of the Common Fisheries Policy, as defined in Regulation (EU) 1380/2013 (hereinafter referred to as the "Basic Regulation"), envisages the progressive introduction of a discard ban into EC law and the consequent landing obligation for certain target species. The obligation is introduced gradually according to the fishing gear employed and the relative target species, in other words the timing is staggered according to the fishery.

On the contrary to Northern European seas, in the Mediterranean area the landing obligation is applied according to a schedule defined in the Basic Regulation for species that have minimal conservation reference size in the Mediterranean Sea, pursuant to Annex III of Regulation (EC) 1967/06.

Where the clam *Chamelea gallina* is concerned, as this is a species that "defines the fishery" (article 15.1 letter d of the Basic Regulation) the landing obligation comes into force on "1st January 2017 at the latest".

With Delegated Regulation (EU) 2016/2376 of 13th October 2016, the EC established a discard plan for mollusc bivalve Venus spp. in the Italian territorial waters. This plan, by way of derogation from the minimum conservation reference size established in Annex III to Regulation (EC) No 1967/2006 set the minimum conservation reference size of *Chamelea gallina* in Italian territorial waters at 22 mm.

The Italian Ministerial Decree of 27th December 2016 implements the Regulation EU 2376/2016, adopting the National Discard Management Plan for the clam *C. gallina*, establishing a series of additional technical measures.

This document aims to analyse the preliminary results of the implementation of the so-called Discard Plan and to evaluate its possible extension.

In the general part, after a brief chapter on the regulatory framework touching both on the reform and on some aspects relative to the introduction of the landing obligation, the reasons for a discard management plan are clarified. The general part continues with a description of the gears involved, with particular reference to the hydraulic dredger. An analysis of the main biological aspects of the species involved follows, drawing both on bibliographical studies and on *ad hoc* research carried out in the last year. Mention is then made of the size of the stock and its distribution in the various Italian GSAs.

The preliminary results are reported in the text (the Discard Plan is still in progress) relative to the implementation of the Plan itself. Lastly, reference is made to the sustainability of the fishery activities and the selectivity of the vibrating sieves, the impact of dredges and fishing effort.

The legislative framework and the management of fisheries employing dredges

EC Measures

- Regulation (EU) 1380/2013: Article 15 of Reg.(EU) 1380/2013, in force since 1st January 2014, establishes that all catches of species subject to catch limits [1] and in the Mediterranean catches of species subject to minimum sizes as defined in Annex III to Regulation (EC) No 1967/2006, are carried and kept on board the fishing vessels, registered, landed and charged to the quotas, if appropriate, unless they are used as live bait. Therefore, for the Mediterranean EC countries, the obligation is in force:
  a) at the latest from 1st January 2015 for:
  — small pelagic fisheries: Anchovy (*Engraulis encrasicolus*), Sardine (*Sardina pilchardus*), Atlantic mackerel (*Scomber spp.*), Horse mackerel (*Trachurus spp.*) [because they have a minimum landing size in Reg.1967/06];
  - large pelagic fisheries: Bluefin tuna (*Thunnus thynnus*) [because it is subject to a catch limit – quota]
  b) by 1st January 2017 for those species that define the fishery.
  c) by 1st January 2019 for all the other species targeted by fishery activities that are not covered by letter a) [that have a minimum landing size in Reg.1967/06] and that is:
  Demersals: Sea bass (*Dicentrarchus labrax*), Annular seabream (*Diplodus annularis*), Sharp snout seabream (*Diplodus puntazzo*), White seabream (*Diplodus sargus*), two-banded seabream (*Diplodus vulgaris*), Grouper

(*Epinephelus spp.*), Sand steenbras (*Lithognathus mormyrus*), Hake (*Merluccius merluccius*), Mullet (*Mullus spp.*), Axillary seabream (*Pagellus acarne*), Blackspot seabream (*Pagellus bogaraveo*), Atlantic wreckfish (*Polyprion americanus*), Common sole (*Solea vulgaris*), Gilthead seabream (*Sparus aurata*), unless scientific evidence demonstrates high survival rates, "taking into account the characteristics of the gear, of the fishing practices and of the ecosystem; (art. 15, para. 4, letter b);

Crustaceans: Norway lobster (*Nephrops norvegicus*), European lobster (*Homarus gammarus*), Spiny lobster (Palinuridae), Mediterranean deep water rose shrimp (*Parapenaeus longirostris*), unless scientific evidence demonstrates high survival rates, "taking into account the characteristics of the gear, of the fishing practices and of the ecosystem; (art. 15, para. 4, letter b);

Bivalve molluscs: Scallop (*Pecten jacobaeus*), Carpet clam (*Venerupis spp.*), Venerid clam (*Venus spp.*) unless scientific evidence demonstrates high survival rates, "taking into account the characteristics of the gear, of the fishing practices and of the ecosystem; (art. 15, para. 4, letter b).

Paragraph 4 of article 15 defines the cases in which the landing obligation is not applicable:

a) species in respect of which fishing is prohibited and which are identified as such in a Union legal act adopted in the area of the CFP;

b) species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem;

c) catches falling under de minimis exemptions.

Recently with article 9 of Regulation (EU) 2015/812, so-called "Omnibus Regulation", the following letter was also introduced

d) fish damaged by predators.

Paragraph 5 establishes that the details for implementation of the landing obligation in the single States must be specified in specific multi-annual plans, with particular reference to the different fishing activities, the species to which the landing obligation applies, including an indication of exemptions from the landing obligation for species with recognised high survival rates.

For the species subject to the landing obligation the use of catches of species below the minimum conservation reference size (Annex III reg. (CE) 1967/2006) shall be restricted to purposes other than direct human consumption, including fish meal, fish oil, pet food, food additives, pharmaceuticals and cosmetics.

Vice versa for species not subject to the landing obligation referred to in paragraph 1 (e.g. those entering into force from 1st January 2019) catches of species below the minimum conservation reference size are not stored on board, they must be immediately discarded at sea.

Finally, to monitor compliance with the landing obligation, Member States shall ensure detailed and accurate documentation of all fishing trips and adequate capacity and means, such as observers, closed-circuit television (CCTV).

- Article 4 of Reg. (CE) 1967/2006 bans the use of hydraulic dredges within 0.3 nautical miles of the coast, over seagrass beds of *Posidonia oceanica* or other marine phanerogams, coralligenous habitats and mäerl beds.
- Delegated Regulation (EU) 2016/2376 of 13 October 2016 that establishes a discard plan for mollusc bivalve Venus spp. in the Italian territorial waters, by way of derogation from the minimum conservation reference size established in Annex III to Regulation (EC) No 1967/2006, set the minimum conservation reference size of *Chamelea gallina* in Italian territorial waters at 22 mm.

- On the basis of the characteristics of the dredges and the towing method, art. 2 of EC Regulation 1967/2006 recognises four key types of dredger:
  - Boat dredge, towed by the vessel, this means gear which are actively towed by the main vessel engine (which corresponds to the Italian term "traino per molluschi" pursuant to DM 26/07/1995);
  - Mechanised dredge, hauled by a motorised winch from an anchored vessel (which corresponds to the Italian term "rastrello da natante" pursuant to DM 26/07/1995);
  - Hydraulic dredge, which are vessels with hydraulic equipment, commonly known as suction dredges;
  - Hand dredge, pulled by hand or by manual winch in shallow waters with or without the support of a vessel.

National measures

- The maximum daily quantity clams that each vessel can fish was set at 600 kg by DM 22/12/2000 but was recently amended to 400 kg by DM 27/12/2016.
- DM 22/12/2000 established the following characteristics for hydraulic dredges *i)* maximum cage width 3 m *ii*) maximum water pressure from the nozzles 1.8 bar *iii*) maximum gear weight 600 kg. The dredge on vessels targeting clams is also subject to the following limitations: the distance between the metal rods on the lower part of the cage must not be less than 12 mm. Instead of the rods, a metal grid with square mesh not less than 17 mm/side or rectangular mesh with sides of 12 and 25 mm respectively are allowed, or a perforated sheet of metal with holes with a diameter of not less than 21 mm and a full/ empty ratio of less than ½. Once hauled, the contents of the cage are turned out into the collection box then separated with sieves that have grids with the same characteristics as the cage described above.

- The "National Discard Management Plan for clam stocks *(Chamelea gallina)*" of 27/12/2016 (OJ N.8 11/1/2017) established*:*
    - forfeiting the 5% weight tolerance on the minimum conservation reference size;
    - a maximum of 40 sacks per day (400 Kg) per vessel, in order to reduce production by 20%;
    - applying the plan to all clams selected using the sieving gear and kept on board;
    - landing all clams from every fishing vessel at the landing points, where the relative bivalve mollusc consortia will have installed an appropriately-sized sieve;
    - a second inspection in optimal conditions at the landing point, returning all the clams above the new minimum conservation reference size to the fishing vessel (under the control of the clam fisheries management consortia, hereafter referred to by the Italian acronym CoGeVo), issuing the fishing vessel with a certificate confirming the successful second screening with respect to the minimum conservation reference size for the quantity of clams submitted;
    - the CoGeVo collects all specimens below the new minimum conservation reference size that are present in the landed product, before transferring them back to areas of the sea designated for repopulation

- DM 27/12/2016, transposing EU Regulation 2376/2016,
    - adopted the National Discard Management Plan for clam stocks *Chamelea gallina*;
    - blocked the number of vessels at September 2009 levels (DM 28/09/2009);
    - set the maximum number of fishing days per week at 4;
    - reduced maximum catch quantities to 400 kg/vessel/day;
    - made the vessel position detection and monitoring system mandatory;
    - introduced a system of certification of the minimum conservation reference size through the management consortia;
    - introduced the requirement to identify restocking areas in which the undersized specimens landed can be relocated.

For the purpose of preparing this management plan, the legislative procedure to be followed can be found in Regulation (EU) 2015/812, where Article 3 adds an additional article (art.15 b) to Regulation (EC) 1967/2006 (the so-called "Mediterranean Regulation"), which defines the procedure for establishing new minimum conservation reference sizes in the framework of the discard plans and by way of derogation from the provisions of Annex III of the aforementioned Mediterranean Regulation.

This plan therefore follows the same procedure, which led, pursuant to Article 18 of the Basic Regulation, to the drafting of the joint recommendation relative to the discard management plans for small pelagics, acknowledged by the European Commission through the adoption of delegated regulation 1392/2014: in 2014 this recommendation was scientifically motivated by the advisory council (MEDAC) and sent to the national administrations, which, after the text had been shared and approved, sent it to the European Commission for the necessary evaluation.

In the delegated regulation, the new minimum conservation reference size for the clam would be defined together with all the management measures for the implementation of the landing obligation and the consequent actions in support of the environment and sustainability.

Management by Consortia

The management measures included in this Management Plan define the framework within which the Consorzi di Gestione dei Molluschi will carry out their activities. The measures are proportional to the aims, the objectives and the planned schedules and take into account the following factors:

a) maintaining a high productivity of one or more species;

b) the biological characteristics of one or more species;

c) the characteristics of management and harvesting activities;

d) the economic impact of the measures.

The management of Chamelea gallina harvesting with hydraulic dredges is entrusted to the Consortia established pursuant to ministerial decrees no. 44/1995 and no. 515/1998 and recognised by the Ministry of Agriculture and Forestry; the operational procedures and the prerogatives of the Consortia are defined by the Ministerial Decree of 22 December 2000 that amends D.M. 21.7.1998, that regulates the fishing of bivalve molluscs. The principle that inspired this regulation, introduced in the 1990s by national policies, was to make it possible to adopt management systems that could make it possible to increase the added value for operators produced by the resource through management-related actions in relation to management of fishing zones entrusted directly to specific consortia, so as to ensure a balance between the fishing effort, stock dimensions and seeding as well as regulation of harvesting. Twenty years of experience with this management by the National Administration and the District Consortia and the excellent results achieved in terms of economic returns, make it possible to confirm the current management system for the hydraulic dredges sector for the coming years.

Rights-based management – RBM, in accordance with all that has been reported in the Commission's Communication, can improve the efficiency of fishing management, while facilitating achievement of the basic objectives pursued by the Community and the member States within the framework of the common fisheries policy (CFP), such as conservation of fish stock, preservation of the "relative stability" of fishing activities in member States and a competitive fishing industry. In the case of bivalve molluscs, management is effectively based on territorial fishing rights similar to those that exist in other Member States (in English TURF, Territorial Use Rights for Fishing). The introduction of territorial rights envisaging the full transfer of responsibility to the holders of such rights is appropriate in cases where the resources are sedentary; it is in this case only, in fact, that there is no competition between the parties who hold territorial rights and those who practice fishing outside the borders. The management of hydraulic dredges is very similar to this system, where each fishing district operates and has fishing rights exclusively in its own territory (maritime district). However, there are in Italy innovative and highly successful situations, as is the case of OP "Bivalvia Veneto" and OP "I Fasolari", that are an example of joint management and supra-district cooperation that is unique on the entire Italian fishing scene and a source of pride, achieving social and economic sustainability that is constant over time and a reduction in product fluctuations in terms of both space and time, supporting profitable and long-lasting fishing activities.

In Italy, there are at the moment the following 17 Management Consortia: *CoGeMo Monfalcone*, *CoGeVo Venice*, *CoGeVo Chioggia*, *CoGeMo Ravenna*, *CoGeMo Rimini*, *CoGeVo Pesaro*, *CoGeVo Ancona*, *CoGeVo Civitanova Marche*, *CoVoPi San Benedetto del Tronto*, *CoGeVo Abruzzo*, *CoGeVo Frentano*, *CoGeVo Termoli*, *CoGeMo Manfredonia*, *CoGeMo Barletta*, *CoGeMo Naples*, *CoGeMo Gaeta*, *CoGeMo Rome*. The number of consortia has increased over the years: the Barletta, Ortona and Gaeta ones are among the most recent.

Almost the entire fleet is associated with the different consortia and this proves that members have a strong desire to belong to the Management Consortia. In particular, the slight difference between vessels authorised to harvest bivalve molluscs with hydraulic dredges and those that belong to the Consortia is due to the fact that, in the case of CoGeVo

Abruzzo, 8 vessels do not belong to the Consortium. The other vessel not registered with the Consortium comes from Barletta, but it is not clear whether or not it is actually active. Special mention must be made of CoGeMo of Gaeta where in addition to the hydraulic dredgers, boat-operated clam rakes used for abrupt wedge clams harvesting also belong to the Consortium. Although all 4 authorised hydraulic dredgers belong to the Consortium, only 5 of the 11 boat-operated clam rakes belong to it, while the remaining 6 (the majority) do not operate under the Consortium's directives. Therefore, in actual fact, a number of vessels that is less than 75% of the ones authorised to harvest bivalve molluscs belong to the Consortium.

The current management system is the result of a lengthy development process that involved the central Administration and the Management Consortia, on the basis of the decree dated 22 December 2000. In some areas, for specific needs, ad hoc provisions have been introduced for a type of management better linked to local needs, as in the case of smooth clam fishing in the Veneto region.

The consortia are especially focused on managing and organising fisheries and seek, as far as possible, to safeguard fishing businesses while at the same time not reducing the natural product beds. The framework and the general rules are decided at the central level by the Directorate General for Fisheries and Aquaculture, while the Consortia can regulate activities in particular in the areas described below, naturally internally, adopting more restrictive measures within the boundaries set by national and community legislation.

Different Consortia have adopted different management measures to safeguard resources and maintain good social and economic sustainability. In addition to the different bureaucratic activities (e.g. approval of financial statements, appointment of the Board, etc.) and actions to control and monitor members' activities, the Consortia have been involved, albeit in different ways, in defining different management measures.

- **Maximum daily quantities allowed and fishing days**
  Maximum daily quantities, in line with the Regulation, are almost always lower than those established by the legislation in force. In some cases (e.g. North Adriatic Consortia) the quantities are set according to the size of the crew. Weekly fishing days are also established in connection with resource conditions (Reference points) and market demand.
- **Technical and voluntary resting periods**
  In addition to the two summer resting months envisaged by law, most Consortia generally have other months of voluntary resting. In most cases, voluntary no-fishing periods are prompted by resources shortages resource resulting from natural fluctuations in the stocks of the target species or, in more tragic cases, a high mortality rate.

Table 1 reports the fishing closures decided in the last 12 years according to the state of resources based on the reference points. It is possible to observe that according to the state of the resources the different Consortia have decided for even long time closures, until the recovering of clam densities. Long period of closured might also be caused by sudden events of massive natural mortality due to environmental factors.

Table 1. Fishing closures (in months) decided by the Consortia in relation to the clam densities and reference points.

	Consortia								
Year	**Ancona**	**Civitanova**	**San Benedetto**	**Frentano**	**Chioggia**	**Venezia**	**Ortona**	**Ravenna**	**Pesaro**
2006	2	4	2	1	1	1	-	-	7
2007	2	2	3	2.5	1	1	-	-	2
2008	2	2	2	4	0	0	-	-	2
2009	6	5	3	3	4	4	3	-	3
2010	3	2	2	2.5	4	4	2.5	-	2
2011	2	5	4	3	3	3	4	-	3
2012	4	2	2	3	2	2	2	-	5
2013	4	5	4	9	3	3	8	5	6
2014	4	3	4	5	4	4	5	7	5
2015	4	4	4	9	4	4	9	7	6
2016	4	3	4	12	3	3	12	2	2
2017	6	4	3	6	3	3	6	3	3
2018	5	3	3	2.5	-	-	2.5	7	3

- **Selectivity of the gear**
  Some Consortia of the middle-lower Adriatic, thanks to scientific support, have studied and introduced a number of changes to dredges to reduce their impact by changing the position of the nozzles and increase the flow of water inside the dredge so as to better expel the sand and juvenile specimens. This indicates that fishermen are careful about safeguarding the resource (especially the younger fraction) as well as the benthic habitat on which they live and grow.

- **Monitoring the resource**
  Constant and uninterrupted monitoring of the resource over the years, performed both on behalf of the Consortium members and in cooperation with research bodies, is essential for obtaining a clear overview of both the resource's spatial distribution and its abundance, as well as the commercial and juvenile fractions. Resource monitoring is preparatory to seeding, repopulation, rotation and closure of fishing activities. The continued monitoring of the resource carried out by individual Consortia, under the supervision of the chosen Scientific Institute (required by the National Management Plan for fishing using hydraulic dredges and boat-operated rakes), is not regularly performed by all Consortia.

- **Monitoring the fishing effort**
  Vessel position detection systems nowadays enable the Consortia to constantly monitor the fishing effort applied to the areas of reference. Once it has been fully implemented, this tool will make it possible to plan harvesting activities ensuring fishing-grounds rotation.

- **Seeding, restocking and rotation**
  These are the most important management actions in relation to preserving resource stocks as well as fishing activities. They are actions nowadays undertaken by most Consortia and supported by scientific opinion. The cases where these activities are best managed have been found to be in the northern Adriatic (Veneto Consortia) where through seeding, restocking and the rotation of fishing activities, a regular availability of the resource has been ensured, with reduced fluctuations and mortality.

- **Scientific support**
  Each consortium relies on the technical-scientific opinion of a research body of reference. There are many cases of productive and efficient cooperation in relation to both maintaining stocks and adopting selective gear with a

lower impact. The results of the studies and monitoring performed in cooperation with research bodies have increased interest and provided a positive stimulus in the fishing sector regarding fishing activities increasingly managed and aided by scientific support, as proven by the participation of Consortia in different research projects for personnel training, improvement of product quality and environmental protection. The documents clearly show that, where fishing activities are carried out in close cooperation with a scientific institute, the state of the resource, and hence fishing activities, are improved.

- **Commercial policies**
  The commercial policies introduced by the Consortia are vitally important because they can make it possible for fisheries to be profitable even when the resource is not abundant. Opening up new commercial avenues, new export destinations, "celebrating" the product locally through events and fairs are undoubtedly part of a strategy to be pursued as shown by some Adriatic Consortia.

- **Management beyond the districts**
  This is exclusive to the Northern Adriatic Consortia and is at the forefront as one of the most interesting management methods in the entire Italian national fishing industry. The Chioggia CoGeVo and the Venice CoGeVo manage fishing in two different districts but in actual fact refer to a single Management Plan unanimously shared by all the members of both Consortia, to which the 163 vessels of the Veneto Region belong. After an initial phase that presented organisational difficulties, for many years now an atmosphere of cooperation between the two Consortia has developed and has resulted in the establishment of two important producer organisations, OP "Bivalvia Veneto" and OP "I Fasolari". The management of smooth clams harvesting represents the apex of beyond-border management, involving also the Monfalcone CoGeVo, for shared havesting jointly managed by as many as 3 different Consortia belonging to two different regions.

Critical issues in the management of fishing with hydraulic dredges

Several Consortia have raised different issues, some common to all and others that instead present some specificity limited only to some cases. The different problems, associated with both regulatory and management issues or environmental or anthropogenic factors (e.g. urbanization and infrastructures), are listed below:

Reduced fishing grounds as a result of Reg. (EC) 1697/2006

The following are the critical issues that the bivalve mollusc fishing sector employing hydraulic dredges has faced following the entry into force of Reg (EC) 1967/2006 (Mediterranean Regulation) and the consequences after four years of implementation.

These are critical issues at national level and have been detected in all the Italian Maritime Districts where fishing with hydraulic dredges is present and in all the different management Consortia, albeit in different degrees where the impact is concerned depending on the nature of the coastal area involved and the target species.

The entry into force of the new limit from the coast (0.3 nm), within which fishing activities with hydraulic dredges cannot be carried out, has significantly reduced the exploitable areas, as already highlighted, the impact differs in the various management consortia but is always significant and give rise to difficulties in fleet operations in relation to the sustainability of resource harvesting. In general, the application of Art.13 has led to significant reductions in the fishing grounds for this resource, penalising management consortia and reducing the authorised operating areas.

In the following Table 2 the impact at regional level of Reg. EC 1967/2006 on the fishing grounds for hydraulic dredges is quantified.

Table 2. Fishing areas per Italian region and the areas no longer available for fisheries activities after Reg. EC 1967/2006 came into force.

Region	Fishing area (Km^2) before Reg 1967/2006	Fishing area (Km^2) after Reg 1967/2006	% reduction fishing area
Friuli Venezia Giulia	88,0	56,4	35,9
Veneto	148,2	64,7	56,3
Emilia Romagna	127,2	57,8	54,6
Marche	252,2	163,1	35,3
Abruzzo	208,5	139,1	33,3
Molise	51,1	32,3	36,8
Puglia	102,5	10,2	90,0
Lazio	78,2	2,5	96,8
Campania	52,1	0,2	99,6
Total	**1108,0**	**526,3**	**52,5**

Source: first management plan for hydraulic dredgers 2010.

These reductions have resulted in operational and management difficulties for the Consortia, with repercussions on catches and profitability for the operators. As the specific characteristics of the Mediterranean were not taken into account, fisheries activities were further penalised and this continues to create problems both from an economic and a political-social point of view.

Environmental factors

Water quality directly influences bivalve molluscs, given that they are filter feeder organisms. Any deterioration in water quality can have negative repercussions on the mollusc fishing industry, because of the possible declassification of the production areas (Reg. EC 854/2004). The lower environmental quality of the water can generate problems in terms of health and product hygiene with a resulting suspension of fishing and subsequent marketing. Clearly, in these cases, the professional hydraulic dredges sector suffers commercial as well as eco-biological damage.

Furthermore, the absence of adequate quality control of the water that flows from rivers into the stretches of sea of all the coastal regions has in recent years caused restrictions on fishing grounds that could instead potentially be productive. The problem of water classification is typical of some Tyrrhenian areas, as is the case of the Salerno, Naples and Gaeta districts.

Other environmental factors affecting the state and distribution of the resource are linked to waters transported by rivers into the sea, as is the case of the Ravenna District, that can affect the biogeochemistry of sediments and the coastal seabed sediment characteristics (for instance muddy instead of strictly sandy sediments), making them less favourable for the survival of molluscs of commercial importance. By reducing the optimal habitats for their survival, these factors reduce the area of distribution of the target species.

High mortality and stock fluctuations

In recent years there have been local cases of high and even massive mortality, in some cases chronic and in others of a seasonal nature. These conditions of inactivity are the main threat in some Districts. The most extreme cases have affected the Ravenna, Rimini, Ortona Districts and the Apulia region as regards clams, a species that in recent years has seen a drastic drop in abundance also in the Monfalcone District. As regards razor shells, the resource has now been below the fishing threshold for many years in the Chioggia and Venice Districts. In this connection, actions to reactivate the resources are being undertaken.

Man-made infrastructure and beach replenishments

In this regard the problems that hinder fishing are to be attributed mainly to the strong presence of urban centres, as is the case of districts with a strong seaside tourism industry (e.g. the Rimini district), and to the different man-made infrastructures that exist along the coastline. At times the fishing grounds are further reduced by the presence of other specificities as in the case of the Ravenna district where one area has been allocated for military use (Military Shooting Range of the Military Command of the Defence Ministry) and in the Pescara District where the Torre del Cerrano protected area has recently been established. Added to that, the coastal area is a fishing ground to be shared also with small-scale fishing (drift nets, pots, etc.) and with mollusc farming facilities (e.g. mussels), that further limit the range of activity of hydraulic dredges during some seasons of the year.

Along the Veneto coastline instead there are periodic beach replenishments and other port engineering activities (e.g. creation of underwater dams at Lido of Venezia and Pellestrina, Mo.S.E project, etc.) that over time permanently and constantly reduce areas that were traditionally used as fishing grounds. Critical issues faced by the hydraulic dredging sector following the implementation of Reg (EC) 1967/2006.

Description of the fishery

Fishing techniques

Dredges are fishing gear with a fixed mouth, they are towed on the sea bed by hand or by vessel and are employed to catch bivalve molluscs. All dredges operate in shallow waters (generally less than 15 m) because it is at these depths that it is possible to find the bivalve molluscs that burrow into the sediment. The most important from a commercial point of view, as they permit the most abundant catches, are hydraulic dredges and dredges towed by vessels. On the basis of the new gear classification included in the Italian Ministerial Decree of 26 January 2012, hydraulic dredges are defined by the HDM reference code as ("Mechanical dredges including suction dredges").

Since the 1960s, hydraulic dredges have been used for fishing, in particular targeting venerid clams, razor clams and smooth clams, which live resting on or burrowed into the sediment (Gramitto, 2001). On the basis of the species captured it is possible to identify three types of hydraulic dredger and in Italian the names given to the vessels reflects this: the "vongolara" (Figure 1), to catch Venerid clams (*Chamelea gallina*), Carpet shell clams (*Venerupis aurea*) and Cockles (*Acanthocardia spp* and *Cardium spp*); the "fasolara" to catch Smooth clams (*Callista chione*), mainly used in the central and northern Adriatic; the "cannellara" mainly used along the coasts of the Campania and Lazio regions as well as the northern Adriatic coasts to catch razor clams (*Ensis spp, Solen spp*).

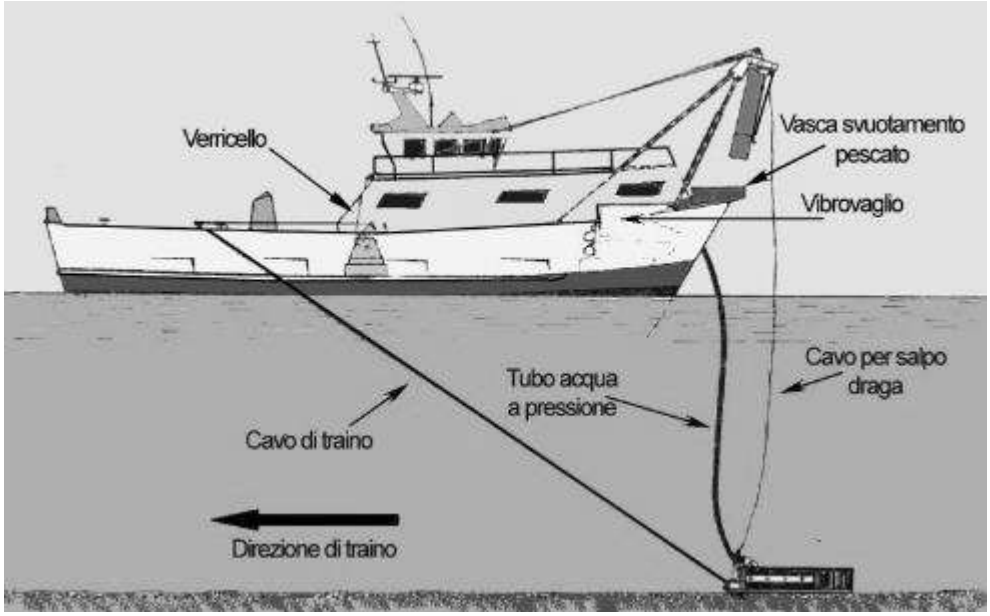


Figure 1. Illustration of a clam fishing vessel (suction dredger) and the fishing system (source: Lucchetti and Sala, 2012).

The hydraulic dredger for clam fisheries has “blade” dredge gear, i.e. on the lower part in contact with the sea bed there is a sharp metal blade that protrudes under the sledge runners a few cm (4-6 for the “vongolare” dredger), which favours the removal of the top part of the sediment, which is conveyed into the gear along with the bivalves that are in the sediment (Figure 1). The dredge consists of a sort of parallelepiped-shape metal cage, the lower, upper and rear parts of which are made of metal rods. This part of the gear makes the first selection of the molluscs by size. According to Italian legislation, the rods must be spaced at least 12 mm apart to allow the juvenile specimens to escape (Ministerial Decree 22/12/2000). The cage rests on two skid-sledge runners that facilitate the sliding motion on the sea bed; different types of nozzles are mounted on the dredge, arranged in parallel rows, which inject water under pressure, hence the name “hydraulic dredge”. There are further nozzles at the mouth of the dredge which spray water downwards in order to dissolve the sediment in such a way as to make the bivalves emerge that are burrowed into it while at the same time assisting the movement of the dredge in the substrate. Further back there are “washing” nozzles which clear the cage of materials such as sand, mud and debris that could otherwise clog it. The pressurised water pump is almost always located on board the vessel and the water is conveyed into the cage via a rubber hose.

For this kind of fishery, the dredge is at the bow, to avoid obvious interference between the cage and the propeller of the fishing vessel during hauling, and accordingly the vessel moves backwards during towing. Until a few years ago, the fishing vessels used for this activity were less powerful than nowadays, so the dredge was towed by applying force on the anchor, which was dropped into the sea before the gear and at a safe distance behind the vessel. Fishery operations took place at the time the anchor cable was retrieved. Currently, the towing methods (with the propeller or pulling on the anchor) are established by the Management Consortia, once the agreement of the Ministry has been obtained, which means that towing takes place practically everywhere using the propeller. However, those vessels that that do not belong to one of the Management Consortia must tow the dredge using the anchor.

After towing the “cage”, is hauled on board and the material gathered is transferred to the sieves on board (there are usually two, one made of metal rods, the other from a perforated metal sheet), which carry out a further selection of the marketable sizes. The sieves, like the dredge, must comply with the legislation that requires a set distance between the rods and specific size for the holes in the case of a perforated metal sheet (DM 22/12/2000).

Recent and historical data

In Italy, fishery operations with hydraulic dredges are carried out in the following regions and for the species indicated in Table 3.

Table 3. Bivalve mollusc fisheries in the various Italian regions.

Region	Venus clam	Razor clam	Smooth clam
Friuli Venezia Giulia	●	●	●
Veneto	●	●	●
Emilia Romagna	●		
Marche	●		
Abruzzo	●		
Molise	●	●	
Puglia	●	●	
Lazio	●	●	
Campania	●	●	

The fleet of hydraulic dredgers authorised to harvest bivalve molluscs in Italian territorial waters has 706 units, the breakdown is shown in the table below (Table 4).

Table 4. Hydraulic dredgers authorised to harvest bivalve molluscs in Italian territorial waters.

Bivalve mollusc fisheries in Italy		
Region	*Management consortium*	*Number clam vessels*
Friuli Venezia Giulia	Co.Ge.Mo. Monfalcone	42
Veneto	Co.Ge.Vo. Venezia Co.Ge.Vo. Chioggia	163
Emilia Romagna	Co.Ge.Mo. Ravenna Co.Ge.Mo. Rimini	54
Marche	Co.Ge.Mo. Pesaro Co.Ge.Vo. Ancona Co.Ge.Vo. Civitanova Marche Co.Vo.Pi. San Benedetto del Tronto	221
Abruzzo	Co.Ge.Vo. Abruzzo Pescara Co.Ge.Vo. Frentano Ortona	103
Molise	Co.Ge.Vo. Termoli	9
Puglia	Consorzio Molluschi Nord Gargano Co.Ge.Mo. Il Colosso di Barletta	76
Campania	Co.Ge.Mo. Napoli	14
Lazio	Co.Ge.Mo. Gaeta Co.Ge.Mo. Roma	24
Total		**706**

636 fishing vessels are authorised to harvest *Chamelea gallina* and 70 fishing vessels from the Italian regions of Friuli Venezia Giulia and Veneto are authorised to harvest *Callista chione* (smooth clam) and they are also managed by the Management Consortia.

Venus clam is fishery is focused in the Adriatic Sea, with 588 vessels. The first Adriatic hydraulic dredges were launched in the early 1970s and within a few years these new gears replaced the traditional hand manoeuvred gears (Gaudenzi, 2008) because catches and economic yields were much higher. In 1974 the hydraulic clam dredges numbered 383 (of which 240 were modified traditional dredges) along the entire Italian Adriatic coast and ten years later they had

increased in number to 607 in the same area. In the late 1980s authorised vessels started towing the dredges by inverted propellers so that their operational speed approximately doubled (up to 2.0-2.2 knots; Morello et al., 2005). The fleet is concentrated along the Adriatic coast, with significant production centres in the Marche region (31% of hydraulic dredgers operating in Italy) and in the Veneto region (23%). The dredgers that operate in the Tyrrhenian sea (about 40) only target razor clam (*Ensis minor*) and Venus clam is an ancillary activity.

Dredgers peaked at 778 in 1993 and then the fleet started decreasing. Within the EU-funded reduction plans, fishing capacity dropped to 665 in 1998 and 585 in 2002, to subsequently remain nearly unchanged (Table 5).

Hydraulic dredges, depending on the spatial and bathymetric distribution of the target species, operate at depths that rarely exceed 12-15 m.

Fisheries employing hydraulic dredges are carried out along about 1400 km of coastline over a total length of about 8000 km of Italian coasts. The clam is only present in areas with a sandy seabed.

The fleet of hydraulic dredgers is currently uniform in terms of technology and dimensions. The total number of crew members on board is estimated at around 1500, which is equivalent to an average crew of two operators per vessel (Table 6).

The average number of fishing days per year is around 85.

In economic terms, hydraulic dredgers as a segment contribute about 5.7% to the value of the gross commercial production of the whole Italian fisheries sector. Overall production in 2017 and 2018 was respectively 21 796 tonnes, representing 10.36% of all fisheries production by the Italian fleet.

Table 5. Number of hydraulic dredges targeting venus clam.

	Year													
Maritime districts	1974	1979	1985	1987	1993	1997	1998	2002	2012	2013	2014	2015	2016	2017
Friuli Venezia Giulia	5		38	38		88	42	17	31	29	29	29	23	14
Veneto	78		156	156		183	170	127	103	105	105	105	111	120
Emilia Romagna	2		15	15		54	54	54	54	54	54	54	54	54
Marche	174		193	193		221	221	221	221	221	221	221	221	221
Abruzzo	75		128	148		150	112	108	103	103	103	103	103	103
Puglia	49		77	80		79	66	58	76	76	76	76	76	76
TOTAL	383	560	607	630	778	775	665	585	588	588	588	588	588	588

Table 6. Number of fishermen employed in dredges targeting venus clam.

	N. of fishermen					
Region	2012	2013	2014	2015	2016	2017
Abruzzo	234	307	302	282	246	293
Campania	31	29	46	35	28	28
E. Romagna	108	116	108	108	108	104
F.Venezia Giulia	84	89	84	84	84	86
Lazio	41	53	48	48	48	49
Marche	448	457	458	442	464	459
Molise	29	21	18	20	18	20
Puglia nord	152	49	152	152	152	148
Veneto	326	398	326	322	322	332
Total	1453	1519	1541	1493	1470	1520
Mean Number of Fishermen	**2.06**	**2.15**	**2.18**	**2.12**	**2.08**	**2.15**

Biology of the target species (*Chamelea gallina*)

Given the adjustment of the Minimum Conservation Reference Size to 22 mm, compared to 25 mm established in Reg. EC1967/2006, some details have been provided on the biology of the species. This information was gathered following careful review of the available literature (as already demonstrated in the first opinion on the Discard Plan) together with new biological research.

The results obtained with regard to sexual maturity and growth confirm the scientific findings of other authors in previous years. In the samples obtained from surveys in both 2017 and 2018 it was possible to determine the sex of individuals of 8-10 mm and observe developping gametes in both sexes from a length of 11-12 mm. From the results of the studies, from March to June it is possible to determine the sex of a large number of individuals, with the lowest percentage of undetermined individuals in the months of May and June, these two months correspond to the reproductive peak with the highest number of mature individuals found. This reproductive peak is followed by a resting stage until November, which is when the gametogenic cycle begins again for both sexes.

Data relative to growth, on the other hand, have shown that clam size increases by about 1 mm/month. This means that a clam takes just under 2 years to reach a size of 22 mm and that the clams of 22 mm or slightly less, once released back into the sea, reach a size of 25 mm in about 3 months

Studies on the biology and growth of the clam will continue in 2019.

Habitat

Chamelea gallina is an infaunal clam of the Veneridae family (Bivalvia: Lamellibranchiata: Veneridae), locally known in Italy as 'vongola' or 'lupino' that inhabits the particulate sands of the infralittoral and circalittoral zones (Froglia, 1989). In the Adriatic Sea, *C. gallina* inhabits the fine well-sorted sand biocoenosis described by Pérès & Picard (1964) and is so abundant and dominant as to constitute a 'facies a *C. gallina*'. A study by Barillari et al. (1979) on the presence of *C. gallina* in relation to the nature of the sediment in the north-western Adriatic Sea, near Venice, showed that *C. gallina* does not extend to substrata having a redox potential below +50 mV (i.e. does not tolerate reduced conditions) and a percentage composition of sand below 90%.

The *C. gallina* clam lives on sandy and sandy-muddy sea beds along the coastal strip at depths ranging from 1 to 18 meters. It does not live on muddy, pebbly or rocky sea beds nor those covered with Posidonia meadows. The depth limit of 18-20 meters is theoretical because the distribution area extends from the shoreline, where coarse sand is present, up to a distance of 1-2 km from the coast. In Italy the species is present in the Adriatic from the Trieste Maritime District to Barletta-Molfetta in the south, as well as in some limited areas of the Lazio and Campania coasts (Tyrrhenian sea). It has been observed that, over the years, the distribution areas of clams generally follow the distribution of sandy sea beds. In the Adriatic there is spatial continuity of clams, and due to extensive displacements in the larval and planktonic stages, it is believed that there is one single population, even if the biological parameters are different over space and time. As far as the Adriatic is concerned, the direction and intensity of the marine currents play an important role in the distribution of clams and these factors condition where the clams that are carried in the larval and planktonic phase will burrow.

The venerid clam *Chamelea gallina* (L. 1758), is a bivalve mollusc (Lamellibranchiata) which filters using syphons, belonging to the Veneridae family. There are several kinds of bivalve mollusc which have the name "clam": the Cross-cut carpet shell clam (*Tapes decussatus)*, the Carpet clam (*Tapes semidecussatus*), Golden venus clam (*Tapes aureus*) and other similar but less common species.

Reproduction

The results obtained with regard to sexual maturity confirm the scientific findings of other authors in previous years. In the samples obtained from surveys in both 2017 and 2018 it was possible to determine the sex of individuals of 8-10 mm

and observe mature gametes in both sexes from a length of 11-12 mm. The 22 mm MCRS is 22-38% higher than the size in the first stage of maturity (L50 = 16-18 mm). The period May - July corresponds to the reproductive peak.

Bivalves in general have an annual reproductive cycle with a period of both male and female gametogenesis followed by one or more release periods. Spermatogenesis in males starts with repeated mitosis of the primordial germ cells giving rise to spermatogonia from which spermatocytes originate (after meiosis), from these spermatids will produce spermatozoa flagellum. Oogenesis in females also starts from the primordial germ cells, from which, after a series of mitotic divisions, the primary oogonia originate, and, after repeated mitosis, give rise to the secondary oogonia that begin meiosis. This process stops at prophase, to be completed in the event of fertilisation. By vitellogenesis, the oocytes accumulate reserve material, such as lipid cells and small amounts of glycogen. The oocytes may undergo lysis throughout the gonadal cycle, however this process seems particularly marked at the beginning of the release phase and at the end of the reproductive cycle. Fertility is related to size and age and is influenced by environmental factors. The age of first reproduction is species-specific.

The juveniles grow rapidly and somatic growth completely absorbs all available energy, on approaching maturation of the gonads there is a gradual passage of energy towards conversion in reproduction, this explains the more rapid growth observed in many organisms before reaching the reproductive age. The term reproductive effort is used to indicate the fraction of "energy" channeled to reproduction, this value is expressed as a percentage of total secondary production.

$$RE = Pg / (Pg + Ps)$$

Where: *Pg* is gametes production and *Ps* is somatic production.

C. gallina is a gonochoristic species with external fertilisation, although Corni et al. (1985), amongst others, reported cases of hermaphroditism, both rudimentary and functional. The sex ratio has been reported to be approximately equal (1:1) in all studied populations (Valli and Zecchini- Pinesich, 1981, 1982; Froglia, 1989) and this agrees with Ansell (1961) on the Atlantic equivalent of C. gallina, C. striatula. Chamelea (= Venus) striatula was formerly thought to be of the same species but has recently been proved to be a separate species (Backeljau et al., 1994).

C. gallina has a lenticular equivalent shell, with thick valves and marked concentric lines. The two valves are held together by elastic ligaments and a hinge mechanism with an interlock that has three teeth in each valve. The oval-lenticular valves are characterised by numerous concentric, irregular ribs (Fischer et al., 1987) and externally are brown-whitish or grey in colour with stripes and darker spots. The Smooth clams (*C. chione*), on the other hand, are oval in shape, with brownish, yellowish and marbled colours, with a raised stripe on the shell. The inner surface of the valves of the Venus clam, on the other hand, is smooth and has a yellowish-white colour with purple spots at the insertion points of the adductor muscles. The function of these muscles is to keep valves closed, opposing the force exerted by an elastic ligament which tends to make the two valves open. The clam can reach a maximum size of 45 mm at 8 years of age. It can be distinguished from the other species due to its rounder shape and for variegated grey colouring.

The biological cycle of the clam involves two distinct phases; a planktonic larva phase, called a veliger, when it is suspended in the water mass and a benthic adult phase, below the surface of the sandy substrates. The fertilised eggs form a larva less than a tenth of a millimeter in size, which lives suspended in the water and is transported by the currents. As the days pass by, the larva increases in size and begins to secrete the substances that form the shell. As the shell formation proceeds, while it is still less than 1 mm in size, the shell which is still transparent increases in weight, making it more and more difficult to remain suspended in the water, so the clam slowly descends towards the sea bed. When it reaches the bottom, with an extremely fragile shell, the clam slips between the grains of sand and begins to behave like an adult clam, placing itself vertically in the sediment, with two small openings, the siphons, which remain on the surface. From this moment the filtration of the water begins, and the clam retains the organic substances and small planktonic organisms thus beginning growth.

As the mollusc grows, its shell increases in size and thickness, becoming progressively more robust. The clams are ready to reproduce even before reaching one year. Each clam produces a very large quantity of eggs and this amount

increases significantly as the clams grow, they can exceed a few hundred thousand eggs per clam. Reproduction does not take place throughout the year; it is seasonal and is linked to the thermal cycle of the water. In the Adriatic, reproduction occurs in the late spring - summer period and, in general, eggs are released in July - August.

However, the biological cycle of this species is significantly influenced by the environmental conditions, in particular the temperature, significant differences in the deposition period can therefore be observed in the various geographical areas. In 2016, for example, mature specimens were found from the month of February. Growth is also influenced by various factors such as temperature, water trophism, the nature of sediments and population density. In the Adriatic the clam generally takes one year to reach a size of 16-18 mm and two years to reach the commercial size of 22 mm. The species appears to be mature within the first year of age. The maximum size in the past (in the first years after 2000) could reach 5 cm, with a maximum age of about 8 years.

It is therefore not rare for this species to suffer mass deaths, which on several occasions have led to critical periods for the relative fishing industry, these deaths can be caused by sudden changes in the coastal environment (anoxia, quantities of fresh water river run-off, storms, pollution, etc.); it would appear, however, that the clam possesses a remarkable capacity for recovery following stressful conditions and its reproductive biology appears naturally predisposed to react to phenomena of sudden mass deaths with subsequent intense recruitment.

In *C. gallina*, sexual differentiation takes place after an initial juvenile stage when the follicles are undifferentiated (Corni et al., 1980). Macroscopic and histological studies of the gonads enabled the determination of the different developing stages during the reproductive cycle of the species. Indeed, during the two surveys period (2017-2018) maturity stages were assessed taking 10 specimens for each length class (2 mm). Once the valves had been opened with a cutter or scalpel the gonads were examined. This organ is located in the visceral mass above the foot and hepatopancreas (Figure 2).

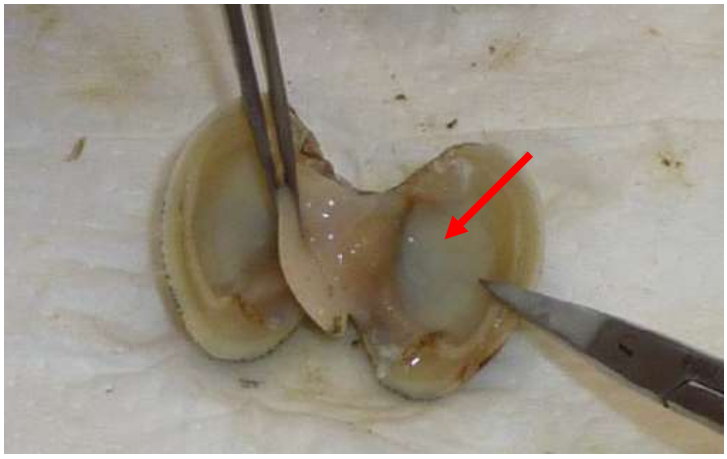


Figure 2. Gonads of *Chamelea gallina*.

Using tweezers, a small incision was made at the base of the gonad and a small amount of gonadal material was removed, a smear was then applied to a slide moistened with sea water.

The material was observed under an optical microscope using 100x and 250x magnification for females and greater magnification for males (400x and 630x). Once the valves were open, the material extracted was observed in a short time (about 15 minutes max), because in the case of male specimens the spermatozoa are distinguishable thanks to the flagellar movement and this mobility is quickly lost (Figure 3). In females, on the other hand, the presence of egg cells could be observed at different stages of development according to the month of the year, for example in the reproductive period bigger mature oocytes can be identified within the follicles (Figure 4).

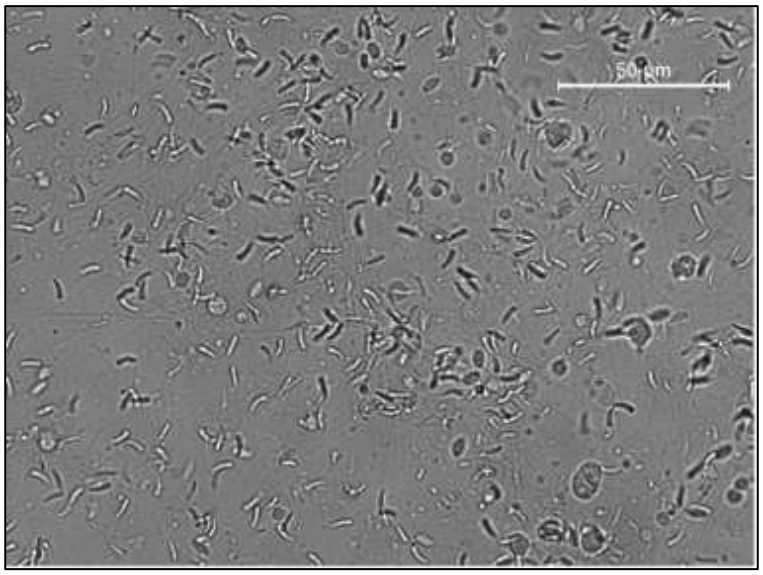


Figure 3. Male spermatozoa during the reproductive period (LT = 20 mm).

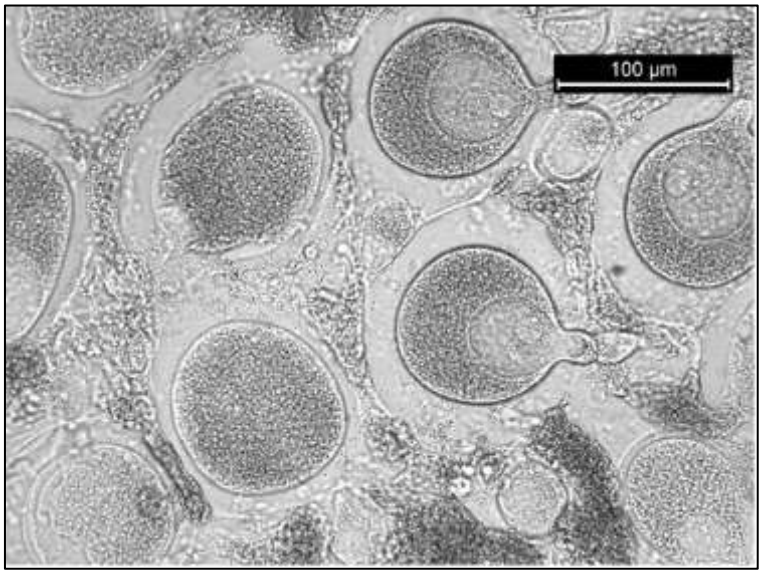


Figure 4. Ovary with mature oocytes (LT = 22 mm).

Additional information on the weight-length relationship was also investigated during the sampling periods. For some of the stations sampled during the 2017-2018 surveys, clam specimens were measured and weighed individually, including those above the commercial size and those below it, to establish the type of growth that characterises the population of the area.

For 2017, based on the equation obtained with a linear model, growth was found to have negative allometry (slope b <3). This means that the weight of the clams increases more slowly than the length, although in this case, as b = 2.84, this type of growth is not easily visible from the graph (Figure 5).

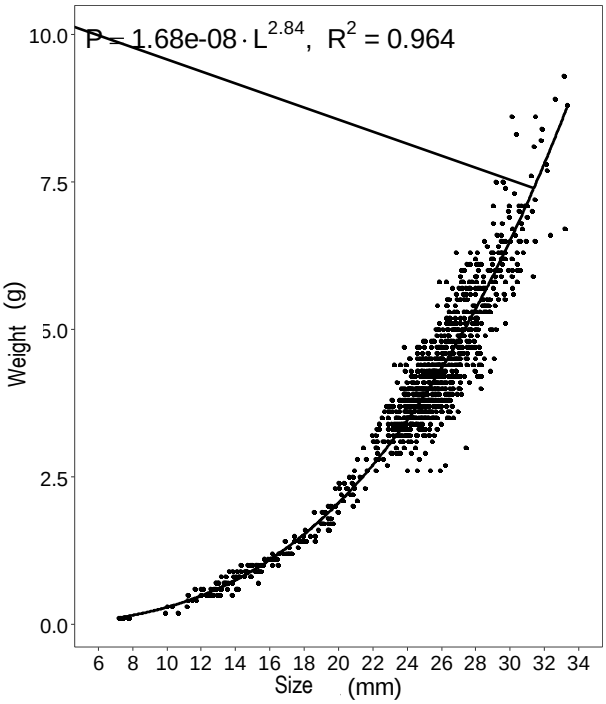


Figure 5. Length weight curve of clam specimens measured and weighed individually from some stations distributed between the Maritime Districts of Ancona and San Benedetto del Tronto. The equation highlighted represents the trend line in black.

Also, during the sampling carried out in the period April-June 2017 in the Maritime Districts of Ancona and San Benedetto the sex ratio and the percentage of individuals with developing gametes were identified; this allowed the identification of the reproductive peak of the species, which in the Adriatic is generally from May to September**. In the samples it was possible to determine the sex of specimens from a length of 10 mm and observe developping gametes in both sexes at a length of 11-12 mm** (Figure 6).

In the reproductive period the ovary appears highly uniform with mature oocytes recognisable within the follicles. Macroscopic recognition of the other stages of maturity for both sexes is much more difficult, especially outside the reproductive period, in this case sex determination is only possible by means of a histological analysis of the gonadal tissue.

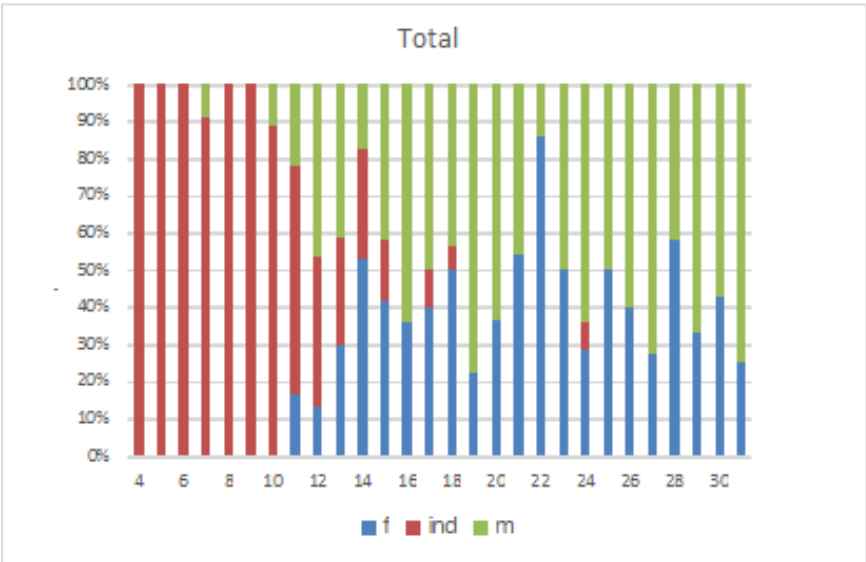


Figure 6. Variation in the proportion of the specimens in which it was possible to determine the sex during the sampling period (April – June 2017).

In 2018 based on the equation obtained with a linear model, growth was found to have negative allometry (slope b <3 t-test p<0.05). This means that the weight of the clams increases more slowly than the length, although in this case, as b = 2.77.

From March to November 2018, a sample of clams above and below the reference size was monthly analysed to define the relationship between the sexes and the stage of maturity across different months (Figure 7). The species is known to reproduce in the Adriatic during the late spring-summer period with a resting stage between September and November when the gametogenic cycle starts again for both sexes. The results show a high number of individuals whose sex can be determined from March to June, with the lowest percentage of indeterminate individuals in the months of May and June. These last two months correspond to the reproductive peak with the highest number of mature individuals found. In July, the highest number of indeterminate individuals is observed, following the spawning phase of the previous months, the gonads appear empty with no germ cells. The resting period is followed by an obvious recovery of the gametogenic cycle in November.

In the samples it was possible to determine the sex of individuals of 8-9 mm (in the month of June) and observe developing gametes in both sexes from a length of 10-11 mm (Figure 8). In the months outside the reproductive period, sex determination was much more difficult, especially for small specimens, in such cases it is only possible by means of a histological analysis of the gonadal tissue.

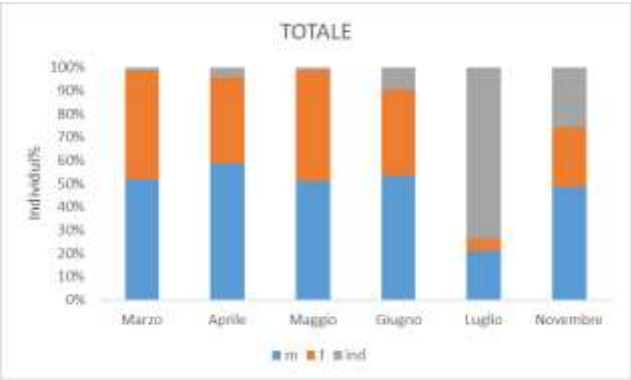


Figure 7. Variation in the proportion of the specimens in which it was possible to determine the sex during the sampling period.

Figure 8. Variation in the distribution of the sexes in the specimens of different size class during the sampling period (March-November 2018)

Below in Table 7 are summarized different results found by other authors in different areas regarding the reproductive cycle of *C. gallina* are synthesized. In summary, this scientific literature indicates that the reproductive period of the clam is between April and October, with multiple deposition for the same individuals during the reproductive period.

Reproduction has also been reported in different periods such as late autumn and winter. The period can also be linked to temperature trends above 14°C or to stressful situations.

The size at which gametogenesis begins has been considered differently by the authors, the growth and development processes of the gametes can begin before 10 mm and continue according to seasonality. Gametes were detected at sizes less than 15 mm during the reproductive season. It can be argued that clams of 13-15 mm are in reproduction.

The number of eggs that are released depends on the size of the clams during the reproductive season. The size-fecundity ratio has not been studied in depth. The fecundity of the clams is however very high, according to Delgado et al. 2013, fertility between 11 mm and 29 mm would go from 77.000 to 797.000 oocytes and a 30 mm clam would

produce 4.5 times more eggs than a 20 mm clam; this element can be useful in estimating the reproductive potential of the clam population.

It should be remembered that, according to some observations, there are differences in growth and that for the purposes of fertility it would appear to be the age that influences the number of oocytes produced and not just the size.

Table 7. Main bibliographical sources and data on reproduction.

Author	Year	Area	Period of sampling	Females TL at first maturity	Females TL during full maturity	Size class (if available)	Peak of spawning (if available)	Method
Salvatorelli	1967	in front of Chioggia	not obtainable	na	na		July-August	hystological
Poggiani et al.	1973	Northern and Mid Adriatic	July 1968-March 1970	16-18	na		July-August	hystological
Froglia	1975	Mid Adriatic	January-December 1978	na	na		May-July and September-October	macroscopic
Marano et al.	1980	Gulf ofManfredonia	January-December 78/79	na	na	mean	end of March to August/September	hystological
Marano et al.	1982	Gulf ofManfredonia	April 1975-1976	na	na		July-October	hystological
Valli e Zecchini-Pinesich	1981(1982)	Grado	September-December 1982	na	na	marketable	June-August	hystological
Corni et al.	1985	Cesenatico	September 81/82	na	na	starting from 20 mm	post-emission	hystological
Valli et al.	1985	Grado	2000-2001, 2003	na	na	marketable	March-July	hystological
Cordisco et al.	2005	Molise and Puglia Regions along the Tyrrhenian Sea		na	na	12,5-38,3	March-July	macroscopic
IZS Abruzzo e Molise	2006	C.M. Pescara		12	na			
Romanelli et al.	2009	Adriatic Sea		13-15	20-25			
Rizzo et al.	2010	Chioggia	June 2009-February 2010	na	na		June-July and December-February	macroscopic
Franceschini e Bernarello	2013	Veneto		13-15	20-25		March-September	
Scopa et al.	2014	Molise	2003-2012	13-15	20-25		March-October	
MIPAAF	2015	CC.MM. Nazionali		15	20		from March/April to October/November	
Ràmon Herrero	1990	Gulf of Valencia	May 1988-May 1990	nd	na	>20	June-August	macroscopic
Rodriguez de la Rùa et al.	2003	Altantic-Mediterranean	June 1999-May2000	16	na	5.7-35,2	April-July	hystological
Delgado et al.	2013	Gulf of Cadiz (Atlantic)	May 2010-April 2011	10,29	na	from 3 to 32	March-September	hystological
Erkan	2009	Southern Black Sea	July 2016			>20	June-July	hystological

Growth

Data relative to growth have shown that clam size increases by about 1 mm/month. This means that a clam takes just under 2 years to reach a size of 22 mm and that the clams of 22 mm or slightly less, once released back into the sea, reach a size of 25 mm in about 3 months.

Among the more commercially important bivalve molluscs, the clam *Chamelea gallina* is distributed on well-calibrated fine sand bottoms along the coastline in several areas of the Mediterranean Sea and the Black Sea and along the coasts of the eastern Atlantic (Fischer *et al*. 1987, Poppe and Goto, 1993).

In Italy, changes in the environmental conditions in the Adriatic coastal areas and the exploitation of the resource have caused a reduction in the quantities of commercial stocks in some areas over the last 20 years, with clear repercussions in economic terms (Relini *et al*., 1999; al., 2009).

On the other hand, optimal conditions for clam growth depend on a series of often fluctuating environmental factors (temperature, salinity, dissolved oxygen, hydrology, substrate nature, trophism, inter- and intraspecific competition, etc.) (Barillari *et al*., 1979), which must achieve positive synergy with the biological recruiting peaks that occur during the extensive reproductive season described for the species (Poggiani *et al*., 1973; Froglia, 1975; Valli and Zecchini-Pinesich, 1982; 1983; Froglia and Fiorentini, 1988; Ramon and Richardson, 1992; Gaspar *et al*., 2004; Rizzo *et al*., 2011).

Therefore, a knowledge of the biological and ecological aspects, as well as the environmental and anthropic pressure to which the populations are subjected, is extremely important for the sustainable exploitation of *C. gallina*, especially when, as in the case in question, management measures exist for fishery activities and a fixed minimum size has been set for the species in order to market it legally under EC Reg. 1967/2006 (25 mm corresponding to 2 years of age).

In particular, a detailed knowledge of the growth methods of the species and of the growth parameters estimated for localised populations are fundamental in order to construct management models on a local scale, especially in areas where fisheries activities have historical value and where they represent a keystone of the local economy, such as in the Adriatic Sea (Padella and Finco, 2009).

In the varied scenario of methods applied and consequent results obtained for this long-studied species, *C. gallina* (e.g. Relini *et al*., 1999 and included bibliography), it was considered appropriate to proceed with a systematic synopsis of aspects related to age determination and to the estimation of growth parameters that contemplates possible interpretative scenarios, including comparisons.

In recent years, most scientific research conducted to estimate the growth parameters of *C. gallina* have seen the application of different methods to determine age. Consulting the ample bibliography on the subject, it is possible to identify the three main methodologies applied:

- analysis of modal components in length-frequency distribution;
- analysis of growth rings on the outside of the shell;
- analysis of the growth lines on the inside of the shell.

There are also studies in which marking methods and energy budget modeling has been applied to the physiology of *C. gallina*, as well as the methods for observing variations in the isotopic composition of the shell (Keller *et al.,* 2002).

The analysis of the progression of the modal components or pseudo cohorts (Bhattacharya, 1967) in length-frequency distributions is well-known as an indirect method for the estimation of growth parameters according to the von Bertalanffy model, as implemented in the FISAT II software (Gayanilo *et al*., 2005). In particular, this methodology that associates an age with the different pseudo cohorts identified in the size distributions and observed in progression over a defined

period of time, was widely used in older studies for the estimation of growth parameters of *C. gallina* in the Mediterranean and Atlantic (Froglia, 1975, 1989, 2000; Ramón, 1993); more recently it has been applied comparatively with other methodologies to allow for appropriate comparison and corroboration (Ramón and Richardson 1992; Gaspar *et al.,* 2004).

Indeed, problems can occur in the variability of the growth parameters estimated for *C. gallina* with this method, due to the relatively long biological recruitment period and/or the highly variable individual growth rates within the pseudo cohorts identified in the length- frequency distributions (Seed, 1976; Cerrato, 1980; Kautsky, 1982).

As an alternative to this indirect method, clam growth parameter estimations can also be obtained through the macroscopic observation of the succession of growth lines on in the outer part of the shell, or by microscopic observation of the stripes inside the shell (Figure 9).

In general, for bivalve molluscs the formation of the rings on the outside of the shell takes place annually during the winter period when growth slows down (Lutz and Rhoads, 1980). The methodology that envisages the observation of the outer rings of the shell has often been used for *C. gallina* because it is a rapid technique (Vives and Suau, 1962; Massé, 1972; Poggiani *et al*., 1973; Marano *et al*., 1982 ; Royo, 1984; Cano and Hernández, 1987; Ramón, 1993; Deval and Oray, 1998; Gaspar *et al.,* 2004).

However, the main problem with this methodology is that exposure of the surface of the shell to the action of agents that can erode its margins make the traces of deposition indistinguishable or equivocal.

Moreover, in this case it is always possible that the growth rings are irregular due to drastic environmental changes, which make it impossible to decipher the age. This occurs mainly in bivalve molluscs in highly unstable environments such as tropical marine areas rather than in temperate areas. In the same way, the annual growth rings on the outer shell of *C. gallina* could be superimposed with other lines that are formed in periods of reproductive stress, or due to harvesting, dredging and predation attempts by other carnivorous species (for more information see Richardson, 2001).

This interpretative difficulty is partially overcome when we proceed with studies of the deposition lines inside the shell of *C. gallina* under a microscope, counting the annual clefts (Barker, 1964). The advantage in observing the microscopic growth lines is that the structures are not affected by environmental perturbations, which consents greater accuracy in age determination (Richardson 1987, 1989 and 1990; Anwar *et al*. 1990, Bourget and Brock 1990). However, in consideration of the fact that the clefts represent an increase in the density of the micro-lines of growth, coinciding physiologically with the passing of time or with the possible moments of stress for the clam, it is not possible to remove the possible effects of fishing activity, which may affect the estimates.

In any case, although it is more expensive in terms of costs and involves more work, there have been numerous applications of this methodology for age determination and the estimation of growth parameters in *C. gallina* populations in different areas of the Mediterranean. (Arneri *et al*., 1995, 1997; Ramón and Richardson, 1992; Polenta, 1993; Ramón, 1993; Deval, 2001; Dalgic *et al*., 2010; Biondi and Del Piero, 2012).

To date, most of the work that has focused on investigating the growth dynamics of clams and other bivalves has tended to use the methods described above simultaneously, in order to compare the results obtained, as well as to compare recent work with past research in which only one of the aforementioned methods was employed. In general, compared to the use of direct observation methods, the need arises to correlate the formation of rings or micro-lines with environmental variables, such as temperature, to achieve an improved understanding of these influences.

In other words, the situation is similar to the investigation of the age of other organisms, where the reading of the rings on the shell is similar to the reading of bands on otoliths or scales, vertebrae or bones.

In general, each technique demonstrates a certain variability in growth, both between different specimens living together and when comparing growth over several years.

For various species, in particular bivalve molluscs of commercial interest, the different methods to evaluate growth have been compared with the results from breeding hatcheries in which each specimen can be followed in its growth over time.

In mussels, for example, which do not receive artificial food and which grow using the natural environmental and trophic conditions, it has been noted that to reach the size of 6 cm they can take from 10 months to over 24 months. Growth of the Manila clam is equally variable, in the same lot coming from artificial breeding there are specimens that reach 20 mm in a few months while others take more than a year, therefore the commercial values of the clam seed are different between those that grow rapidly and those that grow slowly.

This significant variability in growth is also present in *C. gallina* clams and the parameters reported by the various authors for different areas and different years demonstrate this.

It should be considered that, through the whole reproductive period, there is already a large difference in size with the same number of rings, linked to the slowdown of growth.

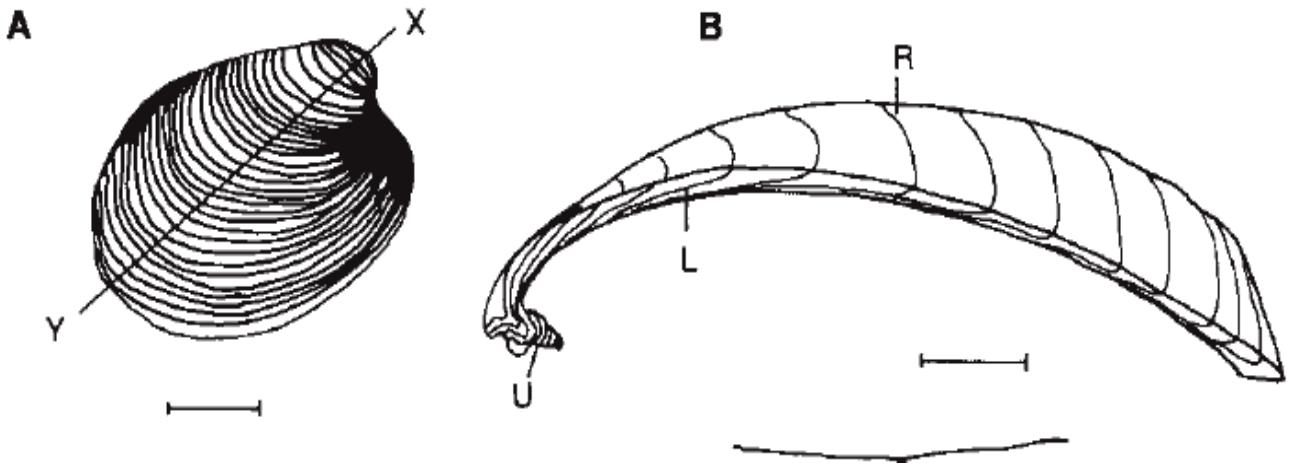


Figure 9. Diagrammatic representation of a) the external growth rings and the radial shell section taken along the X-Y axis to reveal the internal growth rings (L) in the outer shell layers and umbone (U) surface growth rings (R) (modified from Gosling, 2003).

Growth of bivalve molluscs is allometric and is characterised by a progressive change in the proportions of the shell along a radial axis. Specifically, in *C. gallina* a negative allometric growth relationship was observed in the Atlantic along the coasts of Portugal (Gaspar *et al*., 2001) and in the Mediterranean (Froglia, 1975; Cano and Hernández, 1987; Deval, 2001; Çolakoğlu and Tokaç; Table 8).

Table 8. Size/age ratio estimated for *C. gallina* in different geographical areas.

Area	a	b	r	Bibliographical reference
Mid Adriatic	0,555	2,780		Froglia *et al*., 1975
Manfredonia district (north Gargano area)	0,000646	2,733	0,982	Vaccarella *et al*., 1996
Manfredonia district (south Gargano area)	0,000541	2,780	0,997	Vaccarella *et al*., 1996

Upper Adriatic	0,62	2,300	0,816	Valli *et al*., 1982
Upper Adriatic	0,000715	2,747		Pellizzato and Vendramini, 2002
Central Tyrrhenian sea	0,00092	2,701	0,940	Costa *et al*., 1987
Atlantic (Portugal)	0,0007	2,801		Gaspar *et al.*, 2001
Marmara Sea (Turkey)	0,3593	2,8908	0,98	Çolakoğlu and Tokaç, 2014

As far as the length-age relationship is concerned, a wide list of estimated values for the growth parameters is reported, obtained from various studies conducted on samples of *C. gallina* gathered in Mediterranean and Atlantic areas and published from 1962 to 2010 (Table 9). Comparing the results obtained with the application of the different methods, it results that the estimated length/age using external growth rings is greater than that obtained with other techniques (Ramón and Richardson, 1992) (Figure 10). In particular, Ramón and Richardson (1992) demonstrate that the sizes estimated at age 1 and 2 correspond to about 18 and 25 mm, respectively. However, the sizes estimated at more advanced age appear to be underestimated and undermined by a flattening trend of the growth curve.

Regardless of the different methodological aspects, the main divergences between the various results obtained in the different scientific studies considered are found above all in the first year of age. Therefore, reaching the commercial size of 25 mm takes place in a range that varies between the second and the fourth year of age, depending on the geographical area and the method used to estimate growth.

The local differences in the growth dynamics of *C. gallina* are attributable to a series of endogenous factors, such as metabolism and life cycle, and exogenous, such as environmental agents and the impact of human activities.

The growth rate of the clam tends to decrease with age, showing annual variations attributable to the synergic action of various factors. In particular, periods of slowing down and interruption of growth coincide with reproductive events in the summer period, which however determine conditions of stress (Ramón and Richardson, 1992; Gaspar *et al*., 2004).

These results are also supported by the studies conducted by Keller *et al.* (2002) on changes in oxygen isotopes that confirm both seasonal variations in growth and a reduction of calcium carbonate deposition with increasing age (Ramón and Richardson, 1992; Gaspar *et al*., 2004).

Fishing pressure also seems to have a negative influence on growth, since greater speed of growth has been demonstrated in areas not affected by fisheries with hydraulic dredges compared to those targeted in the Black Sea (Dalgiç *et al*., 2010). Effects of mechanical impact on *C. gallina* were also studied in the Northern Adriatic Sea (Moschino *et al*., 2003), identifying the different types of damage suffered by the shells and the disturbance in growth.

Lastly, among the anthropogenic disturbances with a potential effect on the growth of *C. gallina*, water acidification should be considered (Fabry *et al*., 2008) which has been shown to contribute to a reduction in shell thickness (Bressan *et al*., 2014).

The variability of growth between different areas can be partly explained by very different productivity situations, which is demonstrated for mussels and Manila clams bred in hatcheries, but there are also elements that cause growth to vary between different years in the same area.

The fact that the clams live in a narrow coastal strip, subject to anthropic impact and the ecological variations associated, for example, with different annual amounts of fresh water with nutrients that affect productivity. This is at the root of the different growth rates between clams of the upper Adriatic and those of the Tyrrhenian coast.

Another element that conditions the growth of clams where food is equally available is the density of clams; there are areas in which the density of clams exceeds 1000 specimens per m² and other areas with dozens of clams per m². In areas with greater competition for food, slower growth is observed. The fact that the growth takes place at a different speed in the course of the year also indicates that ecological factors influence growth, among which water temperature has an important role, causing growth to slow both when temperatures are coldest and when they are highest at the end of summer.

On the whole it can be said that clams demonstrate fairly variable growth rates between different areas and different years and that growth is strongly influenced by numerous ecological parameters and this variability must be kept in mind for management purposes. In addition, it is often the case that the value assumed by parameters of the von Bertalanffy growth model, indicates that the analyses mainly aimed at estimating the $L\infty$ and k parameters in the growth curve, were conducted leaving the fitting algorithm to guide the procedure, without any kind of critical constraint, often providing perfect estimates from the point of view of simple mathematical calculation, since they minimise the data gap, but at the cost of unrealistic values, especially in t_0.

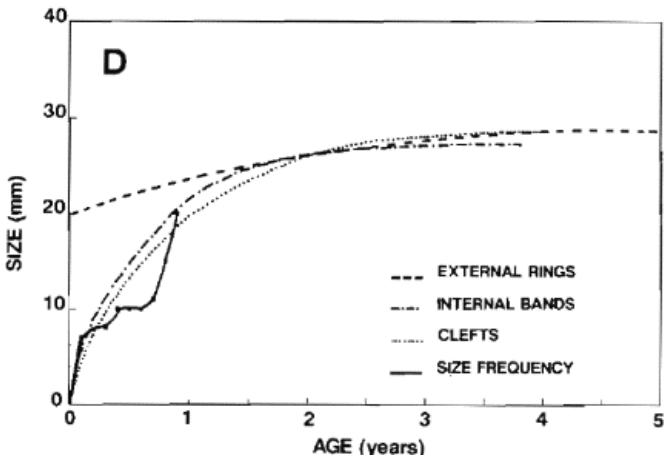


Figure 10. Comparison of growth curves obtained with different methods and estimated using the von Bertalanffy equation (modified by Ramón and Richardson, 1992).

A clear indication of the size at which sexual maturity is reached is available in a study Rodriguez de la Rua *et al*. (2003), which shows that 50% of individuals are sexually mature around a size of 16 mm in length (Figure 11). At 22 mm the percentage of mature individuals rises to 85%, reaching 93% at 25 mm.

Table 9. Growth parameters (length-age, k e L_{inf}) of *C. gallina* obtained using different methods in different geographical areas.

Area	Method	L_{max}	L_{inf}	k	Age (L_{25mm})	t_0	Bibliographical reference
Eastern Adriatic, mouth of the Neverta (Croatia)	Thin section	46,0	39,50	0,52	-	-0,13	Arneri *et al.*, 1997
Mediterranean, Gulf of Marseille (France)	Length frequency distribution	23,00	-	-	-		Bodoy, 1983
Mediterranean, Gulf of Marseille (France)	External rings	32,00	-	-	2		Massè, 1972
Tyrrhenian sea		-	39,11	0,50	-	-0,30	Costa et al., 1987
Central Adriatic, Ancona (Italy)	Length frequency distribution	50,00	-	-	2		Froglia, 1975, 1989, 2000
Central Adriatic, Ancona (Italy)	Acetate peel	49,00	52,20	0,21	2	-0,97	Polenta, 1993
Central Adriatic, Ancona (Italy)	Thin section	-	41,60	0,48	-	-0,01	Arneri *et al.*, 1995
Central Adriatic, Fano - Pesaro (Italy)	External rings	46,00	-	-	3		Poggiani *et al.*, 1973
Southern Adriatic, Bari (Italy)		-	42,82	0,79	-	-0,03	Vaccarella *et al.*, 1996
Southern Adriatic, Bari (Italy)	External rings	47,00	-	-	3		Marano *et al.*, 1982
Atlantic, Algarve coast (Portugal)	Length frequency distribution	40,00	37,55	0,71	2		Gaspar *et al.*, 2004
Atlantic, Algarve coast (Portugal)	External rings	40,00	38,95	0,47	2	-0,24	Gaspar *et al.*, 2004
Atlantic, Algarve coast (Portugal))	Acetate peel	40,00	42,15	0,32	3		Gaspar *et al.*, 2004
Western Mediterranean, Ebro (Spain)	External rings	41,00	-	-	3		Vives and Sau, 1962
Western Mediterranean, Valencia (Spain)	Acetate peel	-	36,12	0,35	2		Ramón and Richardson, 1992
Western Mediterranean, Valencia (Spain)	Length frequency distribution	-	40,05	0,40	-		Ramón, 1993
Atlantic, Huelva (Spain)	External rings	-	-	-	3		Royo, 1984
Mediterranean, Bay of Mazarrón (Spain)	External rings	-	-	-	2		Cano and Hernández, 1987
Northern Black Sea (Turkey)	Thin section	27,10	27,50	0,61	-	-0,14	Boltachova and Mazlumyan, 2001
Northern Marmara Sea (Turkey)	External rings	34,50	34,17	0,43	3	-0,49	Deval and Oray, 1998
Marmara Sea (Turkey)	Thin section	34,30	33,46	0,37	4	-0,69	Deval, 1995
Northern Marmara Sea (Turkey)	Acetate peel	34,30	33,46	0,37	4	-0,69	Deval, 2001
Western Marmara Sea (Turkey)	Length frequency distribution	39,00	33,00	0,39	-	-0,43	Çolakoğlu and Tokaç, 2010
Black Sea – areas not dredged (Turkey)	Thin section	31,50	28,88	0,21	-	-1,29	Dalgic *et al.*, 2010
Black Sea - areas dredged (Turkey)	Thin section	28,70	26,0	0,16	-	-1,96	Dalgic *et al.*, 2010
Black Sea – areas where fisheries are banned (Turkey)	Thin section	29,10	26,6	0,22	-	-1,21	Dalgic *et al.*, 2010

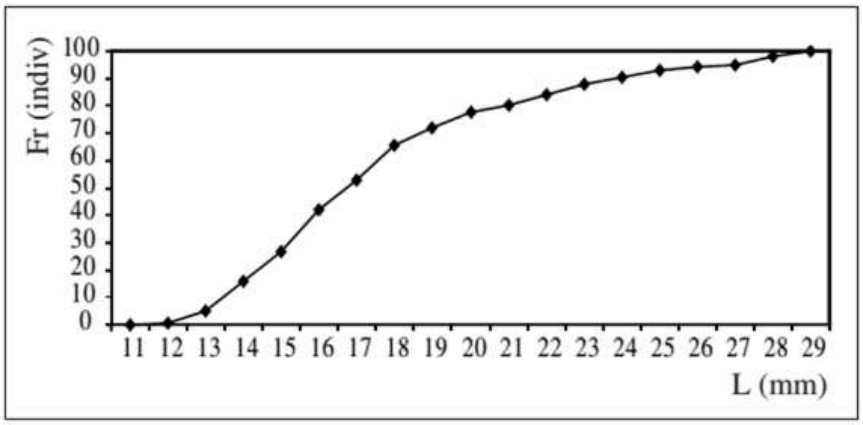


Figure 11. Frequency of mature specimens in relation to the length.

To make the inverse calculation, in order to obtain an estimate of the reproductive potential from the size distribution, the same curve was used, correcting it where necessary to make the relation monotonic.

In this regard it should be underlined that data on the populations in Italian waters are not available in a similarly structured form, although the sources available seem to provide slightly different indications from those of Rodriguez de la Rua *et al*. (2003). These researchers, *inter alia*, provide data on a geographical area that is not directly comparable with the Adriatic. However, these authors provide the only example of a curve or function that expresses the fraction of sexually mature individuals in relation to their size that is currently available in literature. For this reason, despite the limits mentioned above, this source has been adopted as a reference in this study. As the estimates available for Italian waters seem to indicate greater reproductive potential depending on size, the use of the curve reported by Rodriguez de la Rua *et al*. (2003) also appears to respond to the precautionary principle.

Furthermore, as reported in the Italian Management Plan for dredge fisheries and also in the European Parliament (PECH Committee) study on the Clam Fishing sector (2016), the results confirm that *Chamelea gallina* reaches sexual maturity at dimensions that vary between 13 mm and 18 mm. Adult clams are defined as specimens that are larger than 18 mm in size (pages 14, 42, table 1, source: European Parliament study on the Clam Fishing sector - the case of the Adriatic Sea, January 2016).

A size of 22 mm is therefore 22% higher than the size at the first stage of maturity (18 mm) and is therefore in line with and in respect of sexual maturity, ensuring the sustainability of the exploitation of these resources.

Clams survivability

Despite the lack of studies on the striped venus clam survivability returned at sea after the sieving process, Morello et al. (2006) carried out a laboratory study in experimental tanks to study the rebury capacity of the clams. In the study two factors were considered: 1) the disturbance due to fishery activity splitted into two categories “Dredge” (“D” – specimens harvested in the collecting box) and dredge + Sieve (“S” specimen harvested before the return at sea); 2) temperature (12°C and 20°C). The harvested specimens were kept separated in different tanks with the same physical condition accordingly to the type of disturbance (D or S); and the experiment was replicated for three times. A total of 4 tanks (40x40x30) were used with 20 specimens inside each. Two tanks were set at 12°C (20 “D” and 20 “S”) and the other two at 20°C (20 “D” and 20 “S”). After 4 hours the unburied clams were counted. The study showed that any significant difference between treatments occurs both for the percentage of unburied individuals after 4 hours (< 35%) and for the

time required to 50% individuals to rebury (< 10000 seconds). So, that clams were mainly able to rebury independently from temperature and the type of disturbance D or S.

A study on the survival of venus clams was carried out by ISPRA during the construction of the LNG terminal at Porto Viro (Rovigo), analyzing the clams fished and screened on board a hydraulic dredger.

The specimens of *C. gallina* destined for the survival test (40 for each station) were placed in plastic tanks on the bottom of which is a layer of absorbent paper saturated with moisture. The tanks are kept at a constant temperature in a thermostatic cell at 18±0.5°C.

Every day there are dead individuals, which can be recognized by the open valves and by the fact that they do not respond to mechanical stimuli.

Survival data were processed using the Kaplan and Meier method (1958), thanks to which it is possible to calculate the value of LT 50, i.e. the number of days in which 50% of organisms die. The data were represented graphically via cumulative survival curves. The comparison of the trend of the curves was made through the Cox F test. The differences were considered not significant for p>0.05.

The average values of LT 50, with relative standard deviation, are shown in the following Figure 12.

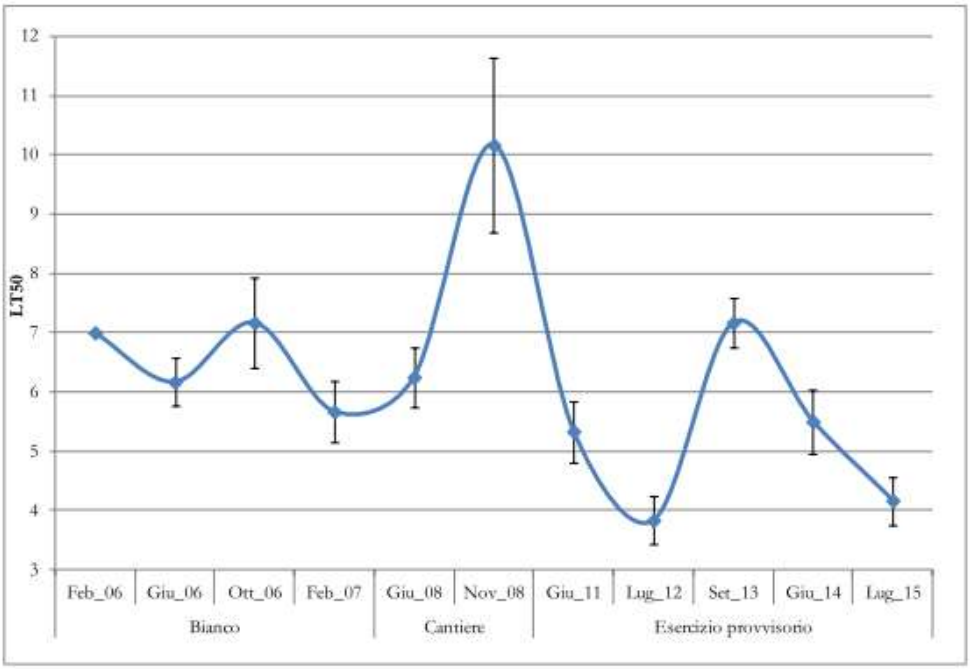


Figure 12. Survivability of clams in the ISPRA study LT 50 is. the number of days in which 50% of organisms die.

In this test it is observed that the value of LT50 varies from 3.8 to 10.2 days, with an average of 6.2 days. In each monitoring campaigns it can be noted that the LT50 value generally tends to decrease in the Terminal operating phase (infrastructural work), remaining below the average in 4 out of 5 samples.

Periodicity, together with other biotic and abiotic factors, influences the condition of organisms (Boscolo et al., 2003) and therefore survival in the air. The differences observed in terms of the average of LT 50 between white and exercise are partly attributable to the fact that in the latter the useful data refer only to medium-warm seasons (spring and summer), when organisms naturally tend to have a minor resistance to air exposure (Boscolo et al., 2003). It is also to be considered that the LT 50 is strongly influenced negatively by changes in salinity and anoxias: the resistance to

exposure to air of clams in laboratory tanks with salinity of 28 and 40 significativamente decreases significantly, and the values of LT 50 go from 7 (to 34) to 4 (28 ‰) and 5 days (40 ‰) (Matozzo et al., 2005; Matozzo et al., 2007). The area in which the stations are located (in particular the C035 and the C036) is certainly subject to the fresh water supplies of at least one branch of the Po (Po di Maistra), especially since an outlet to the sea was opened (winter 2007-2008).

Furthermore, fishing can also increase the stress to which organisms are subjected due to the shaking action inside the dredger cage (Ballarin et al., 2003; Marin et al., 2003). During the construction phase, it can be assumed that the interruption of fishing due to the laying of the pipeline in the area may have resulted in less stress conditions for individuals and therefore greater resistance.

Another study was carried out with venus clams placed in airtight boxes, in saturated humidity conditions and at a temperature of 18 ° C (Eertman et al., 1993).

As for *M. galloprovincialis*, also for *C. gallina* the p-value comparison of the Kruskal-Wallis ANOVA was performed by testing Fisher combinations for independent tests. Salinity was significantly influencing the value of LT50. Values of 34 psu and 28 psu are the conditions with a greater survival (LT50 of 6 days) compared to 40 psu (LT50 of 4 days). Comparing the response obtained to the different combinations of temperature and pH at each salinity, with respect to the control, no comparison was significantly different.

Moschino et al. (2008) studied the shell damage to the clam Chamelea gallina captured by hydraulic dredging in two sites along the north-western Adriatic coast (Lido and Jesolo). They detect and quantify shell damage caused by fishing operations on both captured and discarded clams. The mortality of dredging at high water pressure (inlet pressure ~2.5 bar) ranges between 2-20% with an average around 10 %. This corresponds thus to a survival rate of at least 80%. However, the study above was performed with a jet pressure of 2.5 bar, whereas the fisheries operate now with lower pressure (1.8 bar), which may infer lower mortality.

Ongoing studies

The Italian Ministry for Food, Agriculture, Fisheries and Tourism Policies (MiPAAFT) recently financed projects to improve the selectivity of dredging fishery and to study the survivability of clams rejected after sorting.

Basing our knowledge on this previous study the CNR-IRBIM of Ancona will carry out, by 31th December 2019, two survival experiments: one in experimental tanks and the other at sea.

In the experimental thanks natural sea conditions will be recreated as much as possible using natural sand as sediment, keeping the water oxygenated, the temperature constant similar to the sea water one, and by feeding the clams on microalgae. A minimum period of 21 days of survival will be examined to assess survivability. Specimens under the minimum landing size discarded after sieving process will be used as test.

At sea fixed metal cage designed not to allow clams escapement will be adopted as well to assess survivability. The inferior side of the fixed cage will be covered with sand and specimens under the minimum landing size will be used as test again.

In both the experiments it will be even possible to investigate the survival potential of specimens stressed and damaged by the dredge and/or the sieve.

Another project on the survival of clams will be carried out by Agriteco in the northern Adriatic sea to evaluate the survival of the clams after the passage of a dredger on the bottom. This study will be carried out with underwater cameras and will also focus on evaluating the time required for clams to rebury.

State of implementation of the discard plan

This chapter provides a summary of the state of implementation of the National Discard Management Plan for the Venerid clam (*Chamelea gallina*) adopted with DM 27/12/2016 "Adoption of the National Discard Management Plan for the Venerid clam (*Chamelea gallina*)", an in-depth analysis is provided in Annex II.

Verification of the state of implementation was carried out by verifying documentation produced by the single Management Consortia and through the communications received from the Port Authorities, specifically, compliance with the schedule of the actions indicated in D.M. 27/12/2016 was analysed.

The activities to be carried out by the Management Consortia that are necessary to achieve the general objective are:

- **within ninety days** of the entry into force of the National Discard Management Plan for stocks of the Venerid clam (*Chamelea gallina*):
    - all units authorised to harvest clams must be equipped with a system to monitor and record vessel position at sea (VMS - AIS - GPS);
    - at the designated landing sites, the equipment for the selection of the product must be operational, fixed or mobile structures, on land or floating can be used;
    - the management consortia must introduce a certification system to certify conformity of the product to the minimum conservation reference size.
- **within one hundred and eighty days** of the entry into force of the National Discard Management Plan for stocks of the Venerid clam (*Chamelea gallina*):
    - restocking areas must be identified, in order to relocate the undersized specimens previously caught. In these areas appropriate measures shall be taken to limit and regulate clam fisheries (*C. gallina*) as well to ensure the rotation of the areas for the repopulation of the species;
    - a continuous scientific monitoring system must be adopted for the restocking areas to monitor survival and growth of the specimens transferred there; scientific assessment must take place on a regular basis and in any case in the three months following the repopulation period of the undersized specimens;
    - A control plan must be implemented in cooperation with the European Fisheries Control Agency (EFCA).
- **within twelve months** of the entry into force of the National Discard Management Plan for stocks of the Venerid clam (*Chamelea gallina*):
    - a pilot project will be implemented with the aim of increasing the selectivity of the sieving gear, which will be carried out in two maritime districts designated for this purpose.

Lastly, **on a yearly basis**, in order to evaluate the Plan, a monitoring programme will be implemented in order to evaluate the state of the clam stocks, the efficiency of the technical measures adopted and the state of implementation of the national control programme.

The state of implementation of the measures carried out by the Italian Consortia for the Management of Bivalve Molluscs is reported hereafter.

The system to monitor and record vessel position at sea (VMS - AIS - GPS)

D.M. of 27/12/2016, relative to the adoption of the National Discard Management Plan for Venerid clam stocks (*Chamelea gallina*), states in art. 3 letter a): "all the units authorised to harvest clams are equipped with a system to monitor and record vessel position at sea (VMS-AIS-GPS)".

As shown in brackets, the system can be based on data transmission by means of traditional VMS systems, blue box, or AIS, (Automatic Identification System), which use radio wave transmission, or with the use of GPS systems that rely on data transmission via GSM, similar to those that are used to transmit data with mobile phones.

Some Consortia have adopted *ad hoc* systems, others used existing systems, such as AIS or those used for vehicle tracking.

Regardless of how data is transmitted and acquired, the systems adopted have some common basic characteristics, to which additional features can be added, summarised as follows:

- the system must operate independently from the will of the fisher(s). Activation therefore occurs when the vessels starts and ends when engines are switched off. This is to ensure that it is always active during fishing operations;
- the data transmitted include the following, at least:
    - Vessel number, EU number or other identification code;
    - Date
    - Time (hour, minutes, seconds)
    - GPS position in geographical coordinates
- The transmission of data to the receiving station that has the recording system takes place with a frequency of between 60 and 120 seconds;
- The receiving station records the data and stores them for the duration of the experimentation (about 3 years);
- The Consortium can view the position of the vessels operating in the entire district on a special map as well as the relative data in real time;
- The visualisation map shows the perimeter of the discard zones where fishing is prohibited;
- When the discard area is violated, this is automatically and immediately reported to the Consortium managers;
- The system allows access to data, on a read-only basis, by technicians appointed by the Consortium to monitor the progress of fishery activities periodically.

Depending on the type of system adopted, additional functions are possible that allow further observations and checks on fishing activities. In some specially-designed systems, it is possible to assign different colors to the vessels in relation to a certain speed range, for example red if it is in navigation, green if it is fishing. On the map it is possible to manage the areas in which fishing is prohibited, create, rename, delete or enable/disable areas of interest. Circles, rectangles or polygons can be created. Graphics tools are provided for the correct positioning and sizing of the areas.

When a vessel enters a prohibited area at a speed compatible with fishing activities, the system records the infringement keeping track of it in the database. Information on any infringements is shown in chronological order in a dedicated table, which shows: the name or code of the vessel, the name of the area infringed, the date and time of infringement began and the date and time it ended. It is also possible to display the vessel's route within the prohibited area by clicking on the infringement line.

A daily report is also issued detailing any infringements, which is sent by e-mail to the Consortium's managers, in addition to the generation of alarms sent via email, text message, etc.

The state of implementation of the monitoring and recording systems relative to vessel position at sea present on board hydraulic dredgers is provided below (Table 10).

Table 10. Type of vessel position detection system adopted by the various Management Consortia.

Monitoring system and of position at sea (VMS-AIS-GPS)			
Management consortium	*n. vessels*	*VMS-AIS-GPS*	*Notes*
Co.Ge.Mo. Monfalcone	42	yes	All units have GPS systems
Co.Ge.Vo. Venezia	86	yes	All units have AIS systems
Co.Ge.Vo. Chioggia	77	yes	All units have AIS systems
Co.Ge.Mo. Ravenna	18	yes	All 18 vessels that are members of the consortium have GPS geolocalisation systems
Co.Ge.Mo. Rimini	36	yes	GPS system provided by Visirun
Co.Ge.Mo. Pesaro	65	yes	All 65 vessels have GPS registration systems
Co.Ge.Vo. Ancona	74	yes	73 vessels have GPS and12 vessel has an AIS system
Co.Ge.Vo. Civitanova Marche	25	yes	23 vessels have GPS and 2 vessels have AIS systems
Co.Vo.Pi. San Benedetto del Tronto	57	yes	46 units have GPS systems, 11 vessels have AIS
Co.Ge.Vo. Abruzzo Pescara	82	yes	All 82 vessels have AIS or GPS systems.
Co.Ge.Vo. Frentano Ortona	21	yes	3 vessels have AIS systems and 18 vessels have GPS systems
Co.Ge.Vo. Termoli	9	yes	All 9 vessels have GPS MOPE systems
Consorzio Molluschi Nord Gargano	51	yes	48 vessels have GPS systems
Co.Ge.Mo. Il Colosso di Barletta	25	yes	All 25 vessels have GPS systems
Co.Ge.Mo. Napoli	14	no	They will be equipped in the future
Co.Ge.Mo. Gaeta	4	no	
Co.Ge.Mo. Roma	20	no	

Landing sites

There are 63 landing sites along the coasts of the Maritime Districts involved in clam fisheries.

Table 11. Landing sites.

Landing sites		
Consortium	*n.landing sites*	*Location*
Co.Ge.Mo. Monfalcone	2	Grado (banchina Riva Dandolo c/o Mercato Ittico) Marano Lagunare (Banchina Nord-Ovest c/o mercato ittico)
Co.Ge.Vo. Venezia	5	Caorle (zona Sansonessa lungo riva fiume Livenza) Cortellazzo (riva adiacente ponte di Cortellazzo) Porto di Piave Vecchia (banchina vicino alla ditta Azzurra pesca) Punta Sabbioni (località Saccagnana - riva della ricevitoria) Malamocco (loc. S. Pietro in Volta - strada comunale dei Murazzi 1250)
Co.Ge.Vo. Chioggia	5	Chioggia (zona Punta Poli banchina Nord) Chioggia (zona Punta Poli (banchina Est) Porto Tolle (Porto Barricata località Scardovari) Pila di Porto Tolle (approdo laguna di Barbamarco) Porto Levante (banchina antistante caserma GDF)
Co.Ge.Mo. Ravenna	6	Porto di Cervia (Banchina portuale Nord) Porto di Ravenna/Marina di Ravenna (Darsena pescherecci) Porto di Portogaribaldi (banchina portuale Mercato ittico) Porto di Goro (banchina portuale c/o mercato ittico) Riva Sud del Po di Volano
Co.Ge.Mo. Rimini	4	Porto di Cesenatico (banchina dei pescatori lato di Ponente) Porto di Cattolica (Tratto della banchina dalla Madonnina al ponte) Porto di Rimini (banchina piazzale Boscovich) Porto di Bellaria-Igea Marina
Co.Ge.Mo. Pesaro	3	Fano (Banchina 11 e testata Banchina 12) Pesaro (Banchina "Filippini Maria") Gabicce-Cattolica (Molo Madonnina)
Co.Ge.Vo. Ancona	3	Senigallia (Darsena Nino Bixio) Ancona (Banchina 18) Civitanova Marche (Banchina Martello)
Co.Ge.Vo. Civitanova Marche	1	Porto di Civitanova Marche (Banchina Martello)
Co.Vo.Pi. San Benedetto del	2	Porto di San Benedetto del Tronto (Banchina di Riva Malfizia)

		Landing sites
Tronto		Porto di San Giorgio (Molo Sud)
Co.Ge.Vo. Abruzzo Pescara	3	Giulianova (radice molo Laudadio) Roseto (banchina Est) Pescara (banchina Sud)
Co.Ge.Vo. Frentano Ortona	2	Porto di Ortona (banchina commerciale molo Nord) Porto di Vasto (banchina di Levante)
Co.Ge.Vo. Termoli	1	Porto di Termoli (banchina del molo Nord-Est e del molo Sud-Est)
Consorzio Molluschi Nord Gargano	4	Porto Punta Pietre Nere Porto Canale di Capoiale Porto di Peschici Porto di Manfredonia
Co.Ge.Mo. Il Colosso di Barletta	2	Porto di Barletta (porto commerciale, molo di Tramontana) Porto Canale di Margherita di Savoia (molo di ponente)
Co.Ge.Mo. Napoli	1	località Monte di Procida - Porto di Acquamorta
Co.Ge.Mo. Gaeta	7	Fiume Garigliano Porto di Formia Porto di Gaeta Porto di Sperlonga Porto di Terracina Porto di San Felice Circeo Canale Rio Martino Sabaudia Latina
Co.Ge.Mo. Roma	13	Passoscuro (stabilimento Paloma) Maccarese (spiaggia tra stabilimenti Isola e Eco Mare) Fregene (spiaggia tra gli stabilimenti Singita e Onda Anomala) Fiumicino (molo Nord altezza Torre Piloti) Ostia Lido (canale dei pescatori) Torvajanica (SP 601 km 11.600) Torvajanica (lungomare delle Meduse) Torvajanica (Viale Spagna) Ardea (via Avellino) Ardea (passo a mare n. 25 lungomare dei Troiani 75/77) Ardea (consorzio Lido Tor San Lorenzo) Anzio (porto di Anzio) Nettuno (porto di Nettuno)

Restocking and monitoring areas

Overall, 27 restocking areas have been identified by 13 Management Consortia.

Table 12.Restocking areas.

Restocking areas to relocate undersized specimens landed and monitoring			
Management Consortium	*n. restocking areas*	*location*	*Monitoring of the areas*
Co.Ge.Mo. Monfalcone	2	Lignano Sabbiadoro Grado	Foreseen but not applied, because the areas have not been used. Agriteco sc is in charge of monitoring
Co.Ge.Vo. Venezia	3	Caorle Jesolo Lido di Venezia	Three-monthly monitoring is carried out in collaboration with Agriteco sc
Co.Ge.Vo. Chioggia	3	Chioggia Levante Port Pila di Porto Tolle	Three-monthly monitoring is carried out in collaboration with Agriteco sc
Co.Ge.Mo. Ravenna	3	Tagliata di Cervia-Porto Canale di Cervia Marina di Ravenna-Punta Marina The area off scanno di Goro	Monthly monitoring in collaboration with the Marine Biology and Fisheries Laboratory of the University of Bologna – located in Fano (PU). Monitoring will be carried out if the areas are used.
Co.Ge.Mo. Rimini	1	About one mile north of the port of Rimini at about one Km from the coast	Three-monthly monitoring is carried out in collaboration with MARE scarl
Co.Ge.Mo. Pesaro	2	Near Fano Port Cattolica Port	At least twice a year with the Marine Biology and Fisheries Laboratory of the University of Bologna – located in Fano (PU).
Co.Ge.Vo. Ancona	3	Senigallia Ancona Porto Recanati	Monitoring is every two months in collaboration with CNR-IRBIM Ancona
Co.Ge.Vo. Civitanova Marche	1	Civitanova Marche	Three-monthly monitoring is carried out in collaboration with CNR-IRBIM Ancona
Co.Vo.Pi. San Benedetto del	2	San Benedetto del	*Ad hoc* survey if needed, carried out by CNR-IRBIM Ancona. Three-

Restocking areas to relocate undersized specimens landed and monitoring			
Tronto		Tronto Port; Porto di San Giorgio	monthly monitoring system.
Co.Ge.Vo. Abruzzo Pescara	3	Giulianova Roseto Pescara	Three-monthly monitoring system in collaboration with the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise
Co.Ge.Vo. Frentano Ortona	2	South of Ortona port North of Vasto port	Foreseen but not implemented as the restocking areas are not active
Co.Ge.Vo. Termoli	1	Termoli near the port	Monitoring carried out in collaboration with ASREM – Regional Prevention Department – animal hygiene and foodstuffs of animal origin
Consorzio Molluschi Nord Gargano	0	Not yet identified	Not present
Co.Ge.Mo. Il Colosso di Barletta	0	Not yet identified	Not present
Co.Ge.Mo. Napoli	1	Castel Volturno località Lavapiatti	carried out in collaboration with CNR Ancona
Co.Ge.Mo. Gaeta	0	Not yet identified	Not present
Co.Ge.Mo. Roma	0	Not yet identified	Not present

Certification system to confirm product compliance with the minimum conservation reference size

12 Consortia have an Operational Plan to certify product compliance with the minimum conservation reference size.

Table 13. Certification system.

Certification system to confirm product compliance for sale		
Management Consortium	*System present*	*Reference documentation*
Co.Ge.Mo. Monfalcone	yes	Discard Management Plan for the species *Chamelea gallina* in the Maritime District of Monfalcone - Organisation of the Management and Control System. Definition of the methods to certify product compliance with the minimum conservation reference size
Co.Ge.Vo. Venezia	yes	Experimental Discard Management Plan for the species *Chamelea gallina* in the Maritime District of the Veneto region- Organisation of the Management and Control System. Definition of the manual of procedures for the certification of product compliance with the minimum conservation reference size

Certification system to confirm product compliance for sale		
Co.Ge.Vo. Chioggia	yes	Experimental Discard Management Plan for the species *Chamelea gallina* in the Maritime District of the Veneto region- Organisation of the Management and Control System. Definition of the manual of procedures for the certification of product compliance with the minimum conservation reference size
Co.Ge.Mo. Ravenna	yes	Operational - Procedural Plan for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Mo. Rimini	yes	Operational - Procedural Plan for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Mo. Pesaro	yes	Operational - Procedural Plan for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Vo. Ancona	yes	Procedural document for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Vo. Civitanova Marche	yes	Procedural document for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Vo.Pi. San Benedetto del Tronto	yes	Procedural document for the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Vo. Abruzzo Pescara	yes	Operational methods adopted by the Co.Ge.Vo. Abruzzo of the Pescara Maritime District implementing DM 27/12/2006 relative to the adoption of a certification system confirming product conformity to the minimum size of 22 mm
Co.Ge.Vo. Frentano Ortona	no	The minimum size of 25 mm is observed (DM 22/12/2000)
Co.Ge.Vo. Termoli	yes	Operational Plan of the Termoli Co.Ge.Vo.
Consorzio Molluschi Nord Gargano	no	
Co.Ge.Mo. Il Colosso di Barletta	no	
Co.Ge.Mo. Napoli	yes	Operational Plan for discards of *Chamelea gallina* stocks of the Naples Co.Ge.Mo.
Co.Ge.Mo. Gaeta	no	
Co.Ge.Mo. Roma	no	

With regard to the traceability of the product caught, the system adopted in Veneto is given as an example.

In the "Experimental plan for the management of discards of the Chamelea gallina species in the maritime compartments of the Veneto region" drawn up in synergy with the 2 Co.Ge.Vo. the control protocol for the certification of the compliance of the product caught at the minimum commercial size is divided into the following points:

• The management system of clam fishing.

• The product traceability system.

• The system of management of discards with the self-certification protocol of the suitability for the sale of the product caught.

• Monitoring the critical points of the discard management system.

• Corrective measures.

• Preservation of documents.

• The relationship with the supervisory authority.

The phases that most closely concern the actions of this project are the first three that also include the self-certification protocol.

The management system for clam fishing

Currently the Co.Ge.Vo. of Venice and Chioggia control the fishing of *C. gallina* managing the system by organizing the fishing day set on a process of conferring of product already sold (booked in advance by the buyers). In this way the Consortia communicate to the associated companies on the evening prior to the fishing day:

- Fishing companies interested in collecting clams
- Starting time
- Fishing area
- Daily quantity (kg) of fishing
- Active landing points

The product traceability system

During each day of fishing the company collects the quantity of clams communicated and, after having screened it, stocks it in bags on the net of 10 kg each, marked with a complete label with all the information needed to trace the product.

An example is the printing of the labels directly on board the motopesca using a small printer. Other examples are labels, notes, barcodes, QR codes, etc. with the obligation to allow the controllers and the consumer a complete traceability of the product (Figure 13).

With this procedure all the clams caught are identifiable and can be subjected to the fishing company and to the fishing boat that collected them and to the person responsible for the self-certification of their suitability for sale.

Figure 13. Labeller and label for on-board traceability.

Trend in biomass

The clam resource is managed at the district level and the management activity often involves massive interventions aimed at redistributing the smaller clams from one area to another. This is functional to the reduction of mortality caused by the high density of clams (even thousands of specimens per square meter). Furthermore, the management activity involves the rotation of the fishing areas to allow the discarded product to grow and reach commercial sizes after sorting. In light of all this, it is essential to conduct standardized surveys, mainly aimed at:

- knowing the status of the resource in relation to historical reference points based on clam density;
- knowing the annual recruitment to give management indications

The development of standardized surveys has also been essential to evaluate the effectiveness of the discards plan after two years from its application.

Standardized surveys

Assessment of the state of the clam population in the various maritime districts involved a series of sampling activities, in both years, in the spring-summer period. On board there were crew, at least 2 people, and two scientific operators with the task of gathering fisheries data and coordinating the activities. The sampling operations were carried out with the support of two vessels used for professional clam fisheries with hydraulic dredges.

For the sampling operations a professional hydraulic dredge was used both years, with a front skid runner and two small side skid runners. The mouth had a width of about 3 m (variable from Consortium to Consortium), while the grid had a space between the rods of 12 mm. For the purposes of the research, the commercial sieve with hydraulic movement on board was modified. The various metal grills used during commercial fishing operations were replaced by a single 19 mm grill.

All information on the catch quantities, coordinates and depth of each haul were reported on specially-prepared forms. Each individual haul was tracked and recorded with GPS equipment and then analysed after landing by computer. Sampling took place with fishing operations on equidistant transects and perpendicular to the coast, with stations at 0.25, 0.50, 0.75 and 1 nautical mile from the coast and, where necessary, even further, in relation to the presence of clams.

According to the operational protocol, the dredge was lowered when the vessels was almost at a standstill and after the water pump had started, the starting position of the haul was recorded as soon as the two lateral warps tightened. The end of the haul was recorded when the water pump shut down, the propeller stopped and when there was no longer any

tension in the two side warps. Attempts were made at each haul to explore exactly the same area (the length of the area swept by the dredge was 100 m). To this end, considering that the speed of the vessel was not a reliable parameter to define the length of the haul precisely (operating at a speed of 1-2 knots it is easy to make mistakes even of a few dozen metres), the researchers opted for the use of GPS equipment, which was able to mark 100 metres accurately. The data detected with the GPS allowed for standardiation of the catches a precise manner, even if the haul lasted longer than established in the protocol. At each station, at the end of the haul the dredge was opened over the collection box and the product was rinsed to remove the mud. Once washed, the catch was screened using a single sieve with 19 mm holes. All the clams held in the sieve at each haul were weighed on board with motion compensation marine scales (Marelec W50 / 50-D4 marine scales with precision 50 g and maximum load 50 kg). When catches were abundant, a sub-sample (about 2 kg) was taken for subsequent analysis of the size distribution.

One of the purposes of biological sampling was to study the fraction of juvenile clams that would have reached commercial size in the following months, and their distribution. To sample the juveniles of 8-16 mm (1 year of age, commonly called seed) and 17-24 mm (2nd year of age), it was necessary to use a sampling net, consisting of a stainless-steel frame and a nylon net with a 12 mm opening. The sampling net frame size is shown in Figure 14. The net was fixed inside the dredge with ties and the catch (benthic organisms, other fauna and clams of all sizes) was weighed and, when it exceeded 10 kg, sub-sampling was carried out.

Figure 14. Sampling net made of a stainless-steel frame (40 cm internal length, 20 cm internal width with a thickness of 1 cm) and a nylon net with 12 mm mesh.

The samples from the dredge and from the sampling net were marked with labels placed inside watertight tubes, showing the code indicating the relative maritime district, the transept number and the station number. At the end of the fishing trip the samples were transported in a refrigeration unit (-18° C) awaiting the biometric measurements in the laboratory. After having been defrosted, each sample was weighed again, the clams were sorted and measurements were taken.

The biometric analysis was carried out by video. Details of the procedures are reported in Stagioni (2010). The clam samples were then divided into groups and positioned one at a time on an illuminated photographic table over which (at the same height for all the assessments) a digital camera was mounted (Canon EOS Digital 20D) with 8.2 Megapixel resolution and a 28/80 mm lens.

The photos were processed using video analysis software *ImageJ* (Rasband, 2010), that is able to determine the maximum width of the single clams, which is described using the Feret X parameter (*the longest distance between any two points along the selection boundary, also known as maximum caliper*). The calibration was carried out each time on

the central clam, measured manually with a laboratory caliper to limit error as far as possible, due to the distortion of the lens. The biometric readings were made with an accuracy of 0.5 mm and subsequently, during data processing, they were rounded up to the next unit.

The monitoring activities were carried out with a fishing vessel with the Co.Ge.Vo. of Venice and Chioggia, equipped with gear with set dimensions, prepared commercial fishing operations, pursuant to the Ministerial Decree of 22nd December 2000.

The fishing operations were carried out along 26 transects in the Venice district and 17 transects in that of Chioggia, spaced about every 2 nautical miles and were conducted starting at a depth of 2 metres (where possible) and ending where the resource was very scarce, or where the safety conditions on board the fishing vessels were not guaranteed (possible presence of submerged rocky outcrops or fixed structures such as dams), or where there were important environmental elements (e.g. seagrass meadows). The catches were carried out parallel to the shoreline, while reversing and towing the dredge that had been lowered onto the seabed, using the system currently employed by the vessels that harvest *C. gallina*, as manoeuvres are simplified and safety on board is greater.

Each haul, which lasted for about 4 minutes at a speed of 2-3 knots, was geo-referenced with a GPS system, while the depth of the seabed was recorded using the on-board instrumentation (Echosounder). At the end of each haul, the same transept was followed to reach the next station, located at greater depth.

The harvested product was conveyed to the selection area consisting of a rotating steel screw conveyor and a vibrating sieve that is set up in all vessels as follows:

- Metal rods at 21 mm to separate the commercial fraction (≥ 22 mm).
- Metal rods at 18 mm to select the sub-commercial fraction (approximately 20-21 mm).

Using the coordinates at the beginning and the end of the fishing operations, the length of the haul was calculated, which, when calculated together with the width of the gear, provides an estimate of the dredged area. This makes it possible to report a biomass value in grams per square metre of the commercial (≥22 mm) and sub-commercial (approximately 20-21 mm) fractions.

To have a historical biomass trend, the biomass estimates obtained from the 2017-2018 surveys were compared with the estimates obtained from previous surveys.

Case study: North Adriatic

To assess the effectiveness of the entry into force of the Discard Plan, also considering the resource, comparative results are reported of the surveys carried out between 2003 and 2018 in the two Maritime Districts in Veneto.

Data analysis shows that the sourface of suitable areas for clam fishery in the in the last 15 years are on average of 108,8 km^2, with a decreases of about 25% when important death phenomena occur while in an optimal situation of natural beds the surface of the suitable area can increase more than 20% compared to the average value (max 125 km^2).

The monitoring of *Chamelea gallina* allow to provide an estimation of the overall biomass of the adult size (≥20 mm individuals), that on average, for the period 2003-2018, in Veneto is around 7,000 t / year (min. 2,307 t - max. 12,954 t).

The figure for 2018 is influenced by the death events and extreme hydrometeorological condition occurred in autumn 2018.

The trend of the capture data allows to obtain an average value of about 3,000 t / year, with peaks of almost 5,000 t and minimum values slightly below 1,000 t.

The ratio between the trend of the catches (t), on an annual basis, and the estimated amounts of *C. gallina* on the suitable areas, determined by the monitoring activities, shows that on average the amounts gathered are just over 40%

of those naturally present larger than 20 mm, with the exception of years in which phenomena of death occurred, in which this ratio is about 52% (2009 and 2018).

Table 14: Data on biomass estimation and amount of C. gallina in Veneto

Year	*Suitable area (km²)*	*biomass (g/m²) ≥20 mm in suitable area*	*Commercial Catch (t)*	*Estimated amount in suitable area (t)*	*ratio catch/ estimated amount*
2003	114,55	61,82	3.258,7	7.081,5	0,460
2009	83,52	37,07	1.606,5	3.096,4	0,519
2010	83,52	27,62	931,1	2.307,2	0,404
2011	104,71	52,91	1.450,7	5.540,5	0,262
2016	125,16	83,74	4.236,6	10.481,4	0,404
2017	125,16	103,50	4.969,6	12.954,1	0,384
2018	125,16	62,38	4.026,5	7.807,1	0,516
Media	**108,8**	**61,29**	**2.925,7**	**7.038,3**	**0,416**

The following graph shows the biomass trend in 2003/2018, divided into commercial and sub-commercial biomass and total biomass.

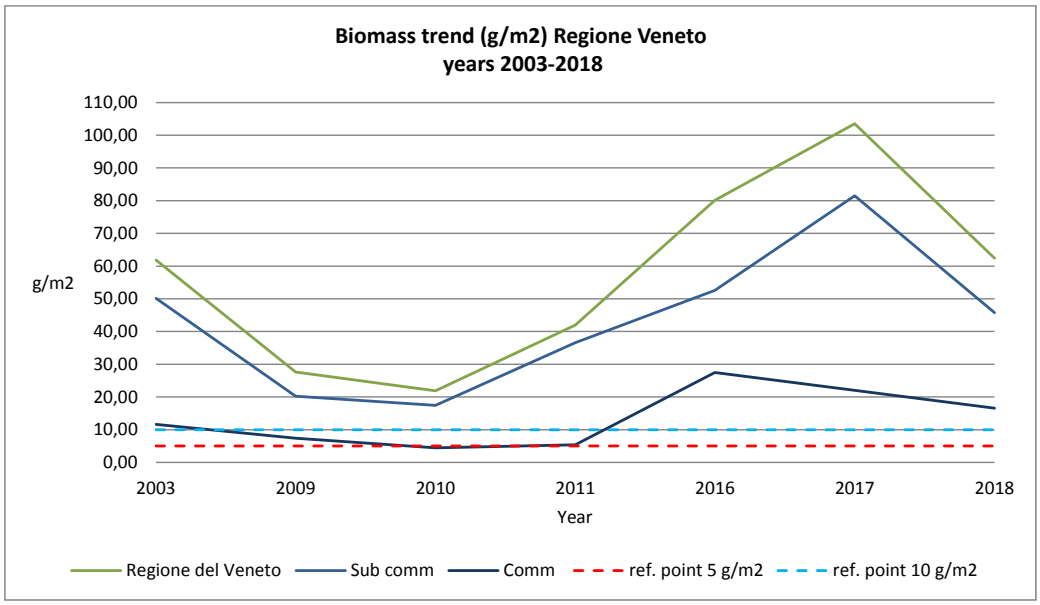


Figure 15: Biomass trend of *C. gallina* (≥20 mm) in 2003/2018 in Veneto

The data analysis evidence that the discard plan had no significant negative results on the state of the adult population (≥ 20mm), in fact the average biomass value during 2018, after two years of Discard Plan application, can be compared with the average value of the last 15 years and its fluctuations are due to common density variations of a population.

Case study: Central Adriatic

Marche Region

To assess the effectiveness of the entry into force of the Discard Plan, also considering the resource, comparative results are reported of the surveys carried out in 2017 and 2018 in some sampled areas. In Table 15, the sub areas of

the Ancona compartment are compared. The density data clearly showed an increase in 2018 respect to 2017. According to the Italian Reference points, in 2017 a very few transects showed densities compatible with fishing, and in fact, for several months the dredging activities have been interrupted. In 2018, the situation completely overturned, with densities extremely higher than the previous year. Although the commercial fraction in 2017 was not so high, the undersized fraction was, on the contrary very high and this may have contributed to the recruitment in the subsequent year, increasing the commercial fraction. Similar observations were made also in the area covered by the Civitanova Marche Consortium, with an increase in the commercial fraction in 2018 (Table 16).

In the San Benedetto del Tronto district, the densities in 2017 were not as ugly as in Ancona, although a decrease in the landings were recorded by fishermen. In any case, even here in 2018 an increase in the commercial fraction was observed (Table 17).

Table 15. Ancona maritime district: total catches standardised by area explored in [g/m^2] by dredges and sampling net for each station (ID).

		2017				2018	
Area	ID	Catch [g/m^2]		Area	ID	Catch [g/m^2]	
		Dredge	Net			Dredge	Net
AN2	AN04A	6.1	557.2	AN1	AN01A	142.9	352.4
	AN04B	11.8	19.8		AN01B	159.8	879.1
	AN04C	13.8	14.4		AN01C	80.9	1148.5
	AN04D	1.2	0.3		AN01D	18.3	662.2
	AN05A	15.7	27.3		AN02A	94.5	563.5
	AN05B	4.9	9.2		AN02B	153.8	809
	AN05C	3.7	8.5		AN02C	49.5	904.1
	AN05D	3.6	21.2		AN02D	13.6	822.4
	AN06A	3.1	3.1		AN03A	196.6	757.1
	AN06B	0	0.1		AN03B	202.4	642.2
	AN06C	0	0		AN03C	46.8	1061.6
	AN06D	0	0		AN03D	15.1	872.3
AN1	AN07A	5.9	196.9		AN04A	137.9	495.1
	AN07B	17	874.4		AN04B	102.2	935
	AN07C	6.2	552.5		AN04C	173.3	780.2
	AN07D	8.7	148.6		AN04D	24.2	857.2
	AN08A	27.2	105.3	AN2	AN05A	80.4	189.8
	AN08B	13.8	237.8		AN05B	0.4	12.6
	AN08C	4.1	30.6		AN06A	9.3	72.2
	AN08D	2.1	33.4		AN06B	39.3	111.5
	AN09A	20.3	209.2		AN06C	7.5	126.1
	AN09B	16.6	653.5		AN06D	18.1	39.7
	AN09C	19.2	47.9		AN07A	82.6	744.7
	AN09D	4.1	14.6		AN07B	59.2	78
	AN10A	60	378.8		AN07C	46.5	328.9
	AN10B	13.8	671.5		AN07D	49.2	83.5
	AN10C	6.2	85.2		**Mean**	**77.1**	**551.1**
	AN10D	10	2.3				

	Mean	**10.7**	**175.1**

Table 16. Civitanova Marche maritime district: total catches standardised by area explored in [g/m^2] by dredges and sampling net for each station (ID).

		2017				**2018**	
Area	**ID**	**Catch [g/m^2]**		**Area**	**ID**	**Catture [g/m^2]**	
		Dredge	**Net**			**Dredge**	**Net**
CIV	AN01A	24.6	616.8	CIV	AN08A	88.2	502.1
	AN01B	4.6	185		AN08B	102.3	265.1
	AN01C	12.2	20		AN08C	149.2	319.2
	AN01D	14.4	148.7		AN08D	90.8	152.1
	AN02A	7.5	630.1		AN09A	259.3	715.3
	AN02B	9	123.1		AN09B	181	356.7
	AN02C	8.2	9.7		AN09C	170.6	787.6
	AN02D	1.8	12.4		AN09D	126.3	349.8
	AN03A	6.6	779.9		AN09E	281.6	447.9
	AN03B	2.2	83.1		AN09F	26.7	39.3
	AN03C	7.7	21.1		AN10A	192.1	134.3
	AN03D	3.1	4.3		AN10B	109.3	351.5
	Mean	**8.5**	**219.5**		AN10C	25.5	27
					AN10D	25.8	27.6
					Mean	**130.6**	**319.7**

Table 17. San Benedetto del Tronto maritime district: total catches standardised by area explored in [g/m^2] by dredges and sampling net for each station (ID).

		2017				**2018**	
Area	**ID**	**Catch [g/m^2]**		**Area**	**ID**	**Catch [g/m^2]**	
		Dredge	**Net**			**Dredge**	**Net**
SBT2	SBT01A	16.3	142.2	SBT1	SBT01A	374.5	292.9
	SBT01B	6.7	23.9		SBT01B	409.8	1030.2
	SBT01C	1	8.4		SBT01C	94.8	61.7
	SBT01D	1.5	108.6		SBT01D	31.8	16.6
	SBT02A	14.2	25.8		SBT02A	215.8	293.3
	SBT02B	20.9	56.9		SBT02B	266.8	477
	SBT02C	3.4	12.7		SBT02C	148.8	62.8
	SBT02D	0.8	4		SBT02D	0.8	1.5
	SBT03A	17.9	50.7		SBT03A	231.4	461
	SBT03B	26.4	51.2		SBT03B	226.1	536.2
	SBT03C	17.5	99.6		SBT03C	149.1	438.5
	SBT03D	44.8	152.6		SBT03D	114.3	225.3
	SBT03E	12.6	59.7		SBT03E	22	9.3
	SBT04A	62.3	182.3		SBT04A	103	330.4

	SBT04B	24.4	72.5
	SBT04C	18.6	68.9
	SBT04D	3.7	25.3
	SBT05A	118.9	197.2
	SBT05B	13.7	506
	SBT05C	34.1	111.4
	SBT05D	42.5	78.5
	SBT05E	69.9	135.7
	SBT05F	16.6	32.4
	SBT06A	2	65.2
	SBT06B	25.8	58.2
	SBT06C	239.4	258.1
	SBT06D	30.6	42.1
	SBT06E	6.8	7.6
SBT1	SBT07A	2.2	6.7
	SBT07B	4	7.6
	SBT07C	19.8	25.9
	SBT07D	12.7	31.4
	SBT07E	144.2	165.7
	SBT07F	6	43.7
	SBT08A	5	19.5
	SBT08B	18.1	23.8
	SBT08C	73.5	88.8
	SBT08D	54.9	55.3
	SBT08E	10.6	11.4
	SBT09A	20.7	49.5
	SBT09B	23.9	46.7
	SBT09C	12.2	27.5
	SBT09D	0.2	2.5
	SBT10A	29.8	237.5
	SBT10B	14.1	31.5
	SBT10C	5.7	14.8
	SBT10D	9.6	21.3
	Mean	**28.9**	**75.5**

	SBT04B	414.2	566.5
	SBT04C	326.6	918.9
	SBT04D	83.7	172.4
	SBT04E	119	196.4
	SBT04F	5.8	8
	SBT05A	286.2	272.5
	SBT05B	112.6	202.5
	SBT05C	99	156.3
	SBT05D	33.8	79.8
SBT2	SBT06A	163.2	83.9
	SBT06B	526.7	1184
	SBT06C	361.1	871
	SBT06D	202.3	869.2
	SBT06E	291.1	641.3
	SBT06F	51.7	64.8
	SBT07A	128.1	298
	SBT07B	282.4	1116.8
	SBT07C	91.8	1105.9
	SBT07D	393	443
	SBT07E	47.2	84.7
	SBT08A	208.5	599.7
	SBT08B	241.8	1039
	SBT08C	207.8	1125.2
	SBT08D	356.6	1097.4
	SBT08E	74.2	109
	SBT08F	31.7	35.2
	SBT09A	180.4	735
	SBT09B	119.1	761.1
	SBT09C	173.3	967.8
	SBT09D	70.6	1395.3
	SBT09E	205.8	372.2
	SBT09F	0.6	0.6
	SBT10A	231.2	415.4
	SBT10B	424.4	236
	SBT10C	215.6	256.9
	SBT10D	15.2	3.9
	Mean	**183.3**	**454.4**

The biomass estimates at sea obtained by the surveys for these two compartments, from 1984 to 2018, are reported in Table 18.

Table 18. Striped venus clam biomass (tons) at sea estimated by surveys over the period 1984-2018 in the Ancona and San Benedetto districts. Both biomass of commercial (L ≥ 25 mm) and total individuals (L ≥ 10 mm) are reported. The ratio between commercial and total population biomass is reported as percentage.

	L ≥ 25 mm		L ≥ 10 mm			
Years	Ancona	San Benedetto	Ancona	San Benedetto	Ancona Ratio Commercial/Total [%]	San Benedetto Ratio Commercial/Total [%]
1984	4427	5902	5353	21688	82.70	27.21
1985	8255	7483	10154	19228	81.30	38.92
1986	3918	1303	7012	1868	55.88	69.75
1987	3788	2076	8405	7606	45.07	27.29
1988	-	-	-	-	-	-
1989	-	-	-	-	-	-
1990	-	-	-	-	-	-
1991	475	639	1057	6808	44.94	9.39
1992	1103	1689	4349	6572	25.36	25.70
1993	1069	1445	2052	2325	52.10	62.15
1994	1936	309	27752	468	6.98	66.03
1995	5775	1506	24638	3357	23.44	44.86
1996	6842	2726	25532	47766	26.80	5.71
1997	3944	1194	9806	15024	40.22	7.95
1998	3456	1798	50467	96160	6.85	1.87
1999	11951	2582	97270	30671	12.29	8.42
2000	12351	2344	35224	11355	35.06	20.64
2001	3127	671	11151	1876	28.04	35.77
2002	-	-	-	-	-	-
2003	-	-	-	-	-	-
2004	-	-	-	-	-	-
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	-	-	-	-	-	-
2008	-	-	-	-	-	-
2009	-	-	-	-	-	-
2010	-	-	-	-	-	-
2011	2411.16	338.2	-	-	-	-
2012	2708.2	7451.1	8564.6	16756.3	31.62	44.47
2012	-	-	-	-	-	-
2013	-	-	-	-	-	-
2014	-	-	-	-	-	-
2015	-	-	-	-	-	-

2016	-	-	-	-	-	-
2017	1020.6	5003.2	24246.3	24000.3	4.21	20.85
2018	15974.6	25304.6	193852.7	223025.8	8.24	11.35

It is evident a fluctuation in the biomass estimates for the commercial portions of the striped venus clam populations, as well as for the entire population considering also the undersized individuals. An impressive biomass at sea were estimated in 2018 in both Ancona and San Benedetto. It is possible that after 2017 the resource widely recovered with a massive recruitment, helped also by the restocking and fishing closures (6 months in the Compartment of Ancona in 2017). From the ratios between commercial and total population biomass it is evident a decrease in the fraction of commercial sizes. This decrease is not to be imputed to a diminished quantity of the commercial size, but to an increase in smaller fraction of the population, and this trend seems almost constant over the years.

In Figure 16, the densities of the commercial portion of the population observed during the surveys over the years (1984-2018) in the areas of the Ancona, Civitanova Marche and San Benedetto del Tronto districts showed high fluctuations. The highest densities were observed in Ancona and Civitanova districts. The densities fluctuated according to the biomass estimated to be present at sea. Although with different magnitudes, it is clear that the biomasses recover and collapse almost similarly in the three districts.

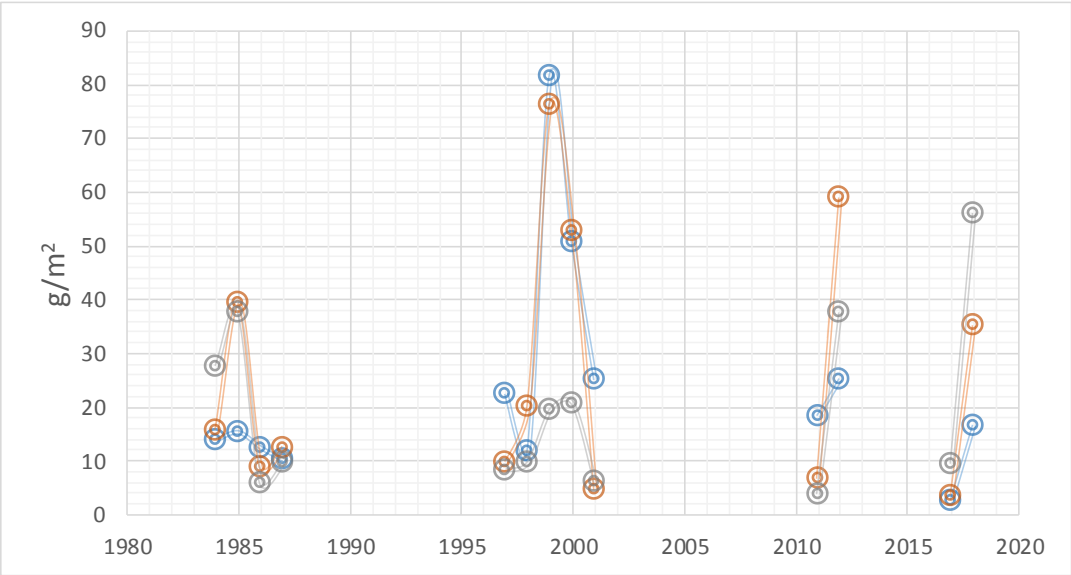


Figure 16. Biomass densities of the commercial fraction (L ≥ 25 mm) of the striped venus clams observed over the years during the surveys in the areas of Ancona, Civitanova Marche and San Benedetto del Tronto.

Considering the biomass of clams estimated from the available surveys (some of them were carried out back in 1990) and the monthly landings it was possible to produce the following exploitation graph, were the ratio between clams removed from fishing activity (landings) and the clams bigger than 25 mm is shown. It is possible to estimate that the rate of exploitation in 2012 and 2017 was quite similar to that observed at the end of 1990s. However, in 2018 the exploitation rate dropped, due to the huge density of clams. Therefore the situation greatly improved in 2018.

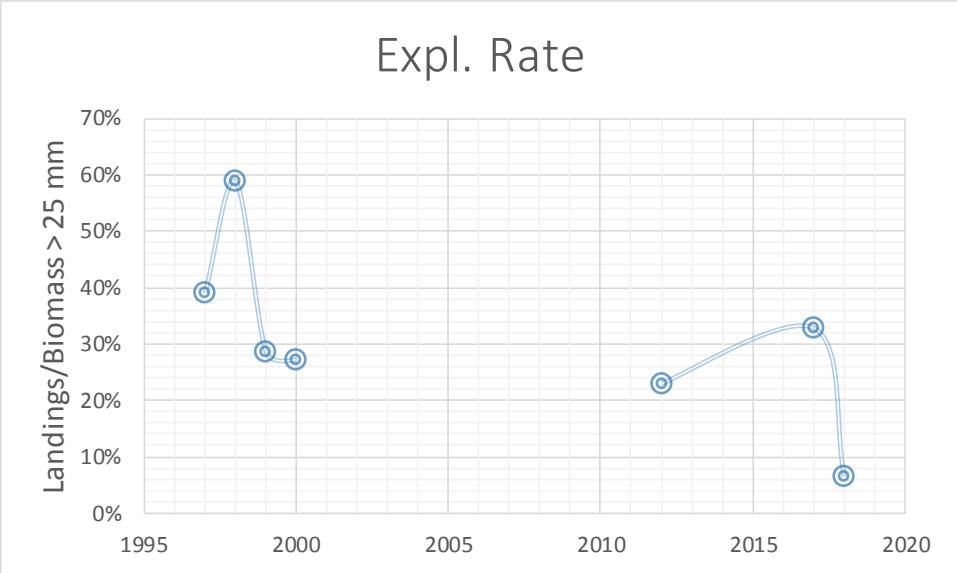


Figure 17. Exploitation rate landings / biomass of clams bigger than 25 mm obtained from surveys.

Unfortunately, the lack of surveys between 2001 and 2011 and between 2012 and 2017, as well as reliable landing values before 2005, make it difficult to ascertain clear trends between densities observed during the surveys and the landings produced over the years.

Abruzzo Region

Data that emerged from the field survey emphasises above all how all along the coast of the Pescara maritime district, the distribution of the *Chamelea gallina* is quite inhomogeneous and at times irregular, but basically indicates a good presence of these resources with figures that are similar in both surveys.

Product density assessed in terms of biomass is certainly higher in the areas between the distances of 0.25 nautical miles 0.75 nautical miles that include the hauls A, B and C (Table 19 and Table 20).

Table 19. Catch values and densities per haul in the survey of 2017.

Transect	Haul	Dredge [g]	Dredge Densities [g/m²]	Net [g]	Net Densities [g/m²]
1	PE01A	5.395,92	11.629	5.395,92	11.629
1	PE01B	1.080,00	2.477	1.080,00	2.477
1	PE01C	0	-	0	-
1	PEO1D	0	-	0	-
2	PE02A	880,55	1.914	880,55	1.914
2	PE02B	18.690,41	37.989	18.690,41	37.989
2	PE02C	27.647,87	48.676	27.647,87	48.676
2	PE02D	30.332,83	56.591	30.332,83	56.591
2	PE02E	735,00	1.557	735,00	1.557
3	PE03A	13.209,66	25.8	13.209,66	25.8
3	PE03B	18.356,55	33.744	18.356,55	33.744
3	PE03C	14.555,00	28.428	14.555,00	28.428
3	PE03D	0	-	0	-
4	PE04A	6.010,90	13.298	6.010,90	13.298
4	PE04B	11.503,13	26.143	11.503,13	26.143
4	PE04C	23.779,50	60.049	23.779,50	60.049
4	PE04D	4.682,20	10.94	4.682,20	10.94
5	PE05A	4.338,31	10.429	4.338,31	10.429
5	PE05B	18.752,34	50.41	18.752,34	50.41
5	PE05C	20.146,11	46.635	20.146,11	46.635
5	PE05D	15.515,07	36.941	15.515,07	36.941
5	PE05E	5.811,10	13.207	5.811,10	13.207
6	PE06A	4.490,57	10.692	4.490,57	10.692
6	PE06B	7.601,62	18.099	7.601,62	18.099
6	PE06C	7.767,73	18.854	7.767,73	18.854
6	PE06D	282,19	603	282,19	603
6	PE06E	9,70	17	9,70	17
7	PE07A	1.687,50	3.545	1.687,50	3.545
7	PE07B	4.715,84	10.342	4.715,84	10.342
7	PE07C	8.352,40	16.187	8.352,40	16.187
7	PE07D	197,1	385	197,1	385
8	PE08A	5.518,02	12.541	5.518,02	12.541
8	PE08B	6.336,77	13.896	6.336,77	13.896
8	PE08C	845,00	1.576	845,00	1.576
8	PE08D	99,90	225	99,90	225
9	PE09A	3.101,57	6.862	3.101,57	6.862
9	PE09B	3.344,00	7.085	3.344,00	7.085
9	PE09C	4.356,33	9.001	4.356,33	9.001
9	PE09D	38,80	80	38,80	80

Table 20. Catch values and densities per haul in the survey of 2018.

Transect	Haul	Dredge [g]	Net Densities [g/m²]	Net [g]	Net Densities [g/m²]
1	PE01A	45.251	14.912	7.630,39	18.168
1	PE01B	7.25	2.509	1.244,96	3.112
1	PE01C	843	265	0	-
1	PEO1D	0	-	0	-
2	PE02A	36.963	11.843	194,55	450
2	PE02B	48.743	15.333	21.899,51	49.772
2	PE02C	36.108	10.412	21.422,69	44.631
2	PE02D	9.681	3.045	16.046,06	36.468
2	PE02E	5.318	1.534	601,37	1.253
3	PE03A	22.701	6.831	15.783,03	34.311
3	PE03B	29.011	9.126	25.238,66	57.361
3	PE03C	41.97	12.102	17.913,99	37.321
3	PE03D	1.803	624	0	-
4	PE04A	20.986	6.982	9.141,12	21.974
4	PE04B	23.27	7.668	9.987,96	23.781
4	PE04C	14.013	4.532	19.601,53	45.798
4	PE04D	4.37	1.35	3.313,39	7.396
5	PE05A	24.683	8.292	6.298,90	15.289
5	PE05B	38.161	13.205	28.624,66	71.562
5	PE05C	28.169	9.025	23.645,48	54.735
5	PE05D	10.854	3.414	13.156,29	29.901
5	PE05E	1.978	585	6.750,37	14.424

6	PE06A	10.913	3.666	6.581,66	15.975
6	PE06B	11.121	3.848	9.089,75	22.724
6	PE06C	5.578	1.892	5.284,27	12.952
6	PE06D	207	66	446,88	1.034
6	PE06E	0	0	0	-
7	PE07A	6.325	1.99	2.511,57	5.708
7	PE07B	6.057	1.977	6.468,59	15.256
7	PE07C	9.071	2.706	8.517,44	18.357
7	PE07D	0	0	0	-
8	PE08A	16.53	5.72	8.027,99	20.07
8	PE08B	12.961	4.153	7.733,61	17.902
8	PE08C	646	193	696,50	1.501
8	PE08D	0	0	0	-
9	PE09A	5.765	1.864	4.039,56	9.438
9	PE09B	15.851	4.986	4.761,15	10.821
9	PE09C	4.104	1.315	2.679,66	6.203
9	PE09D	1.119	387	70,34	176

Clam density falls drastically when adding the nautical mile distance (haul D) and in some cases falls to zero. Density figures for the evaluated produce in the two campaigns that are the subject of the report were superior compared to data registered in a previous survey carried out in 2014.

At a geographical level, there is clearly a greater presence and consistency of beds, both of commercial and smaller sizes for the first 5 transects, corresponding to stretches of the coast between Martinsicuro (north) and Roseto degli Abruzzi, amounting to about 25 km of coastline, while south of Roseto, in transepts between Pineto and Pescara, the presence of clams is lower both according to data collected with the dredge and with the sampler.

The analysis of medium-sized clams in product sampled with dredges over the two-year period, emphasises how the larger clams are found in the transects south of the Pescara district, affected by lower fishing pressure also in relation to the presence of areas in which clam fishing is forbidden, such as the Protected Marine Area of Torre Cerrano, between transepts 6 and 7.

The medium-sized clams seen in the data collected by the sampler do not indicate trends between the various transepts with more varied figures between transepts and distance from the shore.

Figures observed by the sampler highlight, both for 2017 and 2018, indicate a positive presence of the *Chamelea gallina,* bearing witness to a correct balance between fishing and protecting the resources, probably linked to the adoption of a National Management Plan for the releasing of clam stocks and the fact that fishing within 0.3 nautical miles from the coast is forbidden.

As far as the distribution of size is concerned, data processed both for 2017 and 2018 highlights an average size of about 24 mm for dredges and of about 18 mm for the sampling clams. Size distribution curves both for the dredge and the sampler underlines a move towards the right for 2018, bearing witness to a greater presence of larger-sized clams.

With the sample collection programme planned for 2019, it will be possible to validate or not the trends and figures found in the first two years.

Data collected highlights that distribution of *Chamelea gallina* in the Ortona maritime district is intense along the coast and not homogeneous. Greater density is registered at 0.25 nautical miles from the coast with only one station in the portion assessed registering figures of 115 g/m^2 even at 0.50 nautical miles (Table 21 and Table 22).

Table 21. Standardised yields (g/m^2) for the dredge.

cala/transetto	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A-0,25mn	0,00	115,38	76,92	0,00	0,00	26,92	107,69	0,00	0,00
B-0,50mn	0,00	10,77	115,38	0,46	7,69	12,31	30,77	0,00	0,00
C-0,75mn	0,00	0,77	0,77	0,38	1,92	1,15	30,00	0,00	0,00
D-1,00mn	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 22. Standardised yields (g/m^2) for the net sampler.

cala/transetto	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A-0,25mn	6,70	91,50	53,08	2,50	0,25	34,43	23,98	0,30	0,00
B-0,50mn	7,75	23,75	3,00	0,00	0,00	3,60	22,70	2,50	0,00
C-0,75mn	0,00	0,00	0,00	0,00	0,00	0,00	0,25	0,00	0,00
D-1,00mn	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

The population of adult and juvenile clams overlap and there is a portion of juvenile specimens that fuels the stock of commercial product.

Case study: South Adriatic

In the south of Italy the survey confirmed that in this area clams are confined in well identified areas.

In the Barletta maritime district, the abundance of commercial clam stocks appeared inferior to 4 g/m^2 during the 2018 summer summer sampling session

Table 23.

Table 23. Catch (g) and densities (g/m^2) in the summer period in the Barletta district. Bold values are “good management” densities; underlined values are “attention intervals”; italic values are “prohibition of fishing”.

Area	ID	Catch (g)		Densities (g/m^2)	
		Dredge	Net	Dredge	Net
BL1	BL01a	0.0	13.6	0.0	0.0
	BL01b	0.0	0.0	0.0	0.0
	BL01c	0.0	0.0	0.0	0.0
	BL01d	0.0	0.0	0.0	0.0
	BL02a	0.0	65.0	0.0	0.2
	BL02b	0.0	7.2	0.0	0.0
	BL02c	0.0	0.0	0.0	0.0
	BL02d	0.0	0.0	0.0	0.0
	BL03a	0.0	3.2	0.0	0.0
	BL03b	0.0	2.3	0.0	0.0
	BL03c	0.0	1.1	0.0	0.0
	BL03d	0.0	0.0	0.0	0.0
	BL04a	0.0	1.5	0.0	0.0
	BL04b	0.0	0.0	0.0	0.0
	BL04c	0.0	0.0	0.0	0.0
	BL04d	0.0	0.0	0.0	0.0
	BL05a	0.0	0.0	0.0	0.0
	BL05b	0.0	0.0	0.0	0.0
	BL05c	0.0	0.0	0.0	0.0
	BL05d	0.0	0.0	0.0	0.0
	BL06a	0.0	3.3	0.0	0.0
	BL06b	0.0	0.0	0.0	0.0
	BL06c	0.0	0.0	0.0	0.0
	BL06d	0.0	0.0	0.0	0.0
BL2	BL07a	0.0	0.0	0.0	0.0
	BL07b	0.0	0.0	0.0	0.0
	BL07c	0.0	0.0	0.0	0.0
	BL07d	0.0	0.0	0.0	0.0
	BL08a	0.0	0.0	0.0	0.0
	BL08b	0.0	0.0	0.0	0.0
	BL08c	0.0	0.0	0.0	0.0
	BL08d	0.0	0.0	0.0	0.0
	BL09a	0.0	0.0	0.0	0.0
	BL09b	0.0	0.0	0.0	0.0
	BL09c	0.0	0.0	0.0	0.0
	BL09d	0.0	0.0	0.0	0.0
	BL10a	10692.0	905.4	**18.5**	1.5
BL2	BL10a	10692.0	905.4	**18.5**	1.5
	BL10b	13878.6	752.2	**24.6**	1.3
	BL10c	0.0	23.3	0.0	0.0
	BL10d	0.0	0.0	0.0	0.0
	BL11a	892.2	120.3	*2.2*	0.3
	BL11b	488.2	64.4	*1.1*	0.1
	BL11c	0.0	0.0	0.0	0.0
	BL11d	0.0	0.0	0.0	0.0
	BL12a	356.7	34.5	*0.7*	0.1
	BL12b	0.0	0.0	0.0	0.0
	BL12c	0.0	0.0	0.0	0.0
	BL12d	0.0	0.0	0.0	0.0

In the autumn of 2018 (Table 24) a greater availability of clams was observed, albeit restricted to some sampling stations in which standardised yields measured were well above reference points (51.09 ±78.16 g/m^2).

Table 24. Catch (g) and densities (g/m^2) in the autumn period in the Barletta district. Bold values are "good management" densities; underlined values are "attention intervals"; italic values are "prohibition of fishing".

Area	ID	Catch (g)		Catch (g/m^2)	
		Dredge	Net	Dredge	Net
BL1	BL01a	0.0	5.9	0.0	0.0
	BL01b	0.0	0.0	0.0	0.0
	BL01c	0.0	0.0	0.0	0.0
	BL01d	0.0	0.0	0.0	0.0
	BL02a	0.0	1.4	0.0	0.0
	BL02b	0.0	4.3	0.0	0.0
	BL02c	0.0	0.0	0.0	0.0
	BL02d	0.0	0.0	0.0	0.0
	BL03a	0.0	1.8	0.0	0.0
	BL03b	0.0	0.0	0.0	0.0
	BL03c	0.0	0.0	0.0	0.0
	BL03d	0.0	0.0	0.0	0.0
	BL04a	0.0	17.0	0.0	0.0
	BL04b	0.0	6.0	0.0	0.0
	BL04c	0.0	0.0	0.0	0.0
	BL04d	0.0	0.0	0.0	0.0
	BL05a	0.0	287.9	0.0	0.2
	BL05b	0.0	3.8	0.0	0.0
	BL05c	0.0	143.3	0.0	0.2
	BL05d	0.0	0.0	0.0	0.0
	BL06a	0.0	8.6	0.0	0.0
	BL06b	0.0	128.7	0.0	0.2
	BL06c	0.0	0.0	0.0	0.0
	BL06d	0.0	0.0	0.0	0.0
BL2	BL07a	-	-	-	-
	BL07b	-	-	-	-
	BL07c	-	-	-	-
	BL07d	-	-	-	-
	BL08a	14868.6	1383.6	**35.1**	3.3
	BL08b	27030.0	2841.3	**60.8**	6.4
	BL08c	122655.0	5007.2	**268.0**	10.9
	BL08d	0.0	723.8	6.3	2.3
	BL09a	30743.9	866.0	**66.8**	1.9
	BL09b	102288.0	3955.6	**198.7**	7.7
	BL09c	0.0	1640.0	**14.9**	6.8
	BL09d	0.0	393.9	0.0	1.5
BL2	BL10a	11382.8	515.0	**28.4**	1.3
	BL10b	0.0	957.3	0.0	2.1
	BL10c	0.0	0.0	0.0	0.0
	BL10d	0.0	0.0	0.0	0.0
	BL11a	8676.8	1542.0	**23.7**	4.2
	BL11b	19960.8	2661.6	**44.1**	5.9
	BL11c	0.0	0.0	0.0	0.0
	BL11d	0.0	0.0	0.0	0.0
	BL12a	6533.4	389.0	**19.5**	1.2
	BL12b	0.0	547.0	0.0	1.5

BL12c	0.0	0.0	0.0	0.0
BL12d	0.0	0.0	0.0	0.0

This is not an overall revival of resources in the area near Barletta, but rather of defined areas populated by a high density of clams that should instead be preserved as spawning stock to fuel a later and more stable renewal of resources in the district of Barletta. This management hypothesis corroborates scientific evidence linked to the fact that significantly large beds of young *C. gallina* (measuring between 4 and 8 mm) were found in sampling carried out in the autumn precisely in the area near Barletta.

In the maritime district of Manfredonia, the abundance of stocks of commercial clams appeared to be below 4 g/m^2 in all sub-areas investigated in both sampling surveys. Average standard yields (4.10 ±11.89 g/m^2) estimated in the autumn were slightly higher than the threshold for suspending commercial fishing (Table 25).

Table 25. Standardised yields in g/m^2 estimated for the catches of clam obtained with dredger and net sampler for sub-detection area (code Margherita di Savoia=BL1; Barletta=BL2; Lesina=MF1, Varano=MF2; Manfredonia=MF3). The mean value with standard deviation (sd) per sub-area is reported, highlighting in bold the abundance indicating "good management"

	Summer				Autumn			
Area	Dredge		Net		Dredge		Net	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
BL1	0,00	0,00	0,02	0,04	0,00	0,00	0,04	0,08
BL2	*3,62*	8,08	0,26	0,53	**51,09**	78,16	3,80	3,09
MF1	*1,57*	3,18	1,48	1,55	*0,73*	1,48	0,49	0,52
MF2	0,00	0,00	0,26	0,51	4,10	11,89	1,52	2,40
MF3	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,02

In this case, the extreme variability of catches at individual sampling stations advises an extremely cautious approach. This is not a generalised revival of resources in the area near Varano, but rather limited areas populated by a high density of clams that should instead be preserved as spawning stock to fuel a later and more stable renewal of stock in the district of Manfredonia. This management hypothesis is corroborated by scientific evidence linked to the fact that significant numbers of young *C. gallina* (measuring between 6 and 16 mm) were found in samplings carried out during the summer and the autumn in the sub-areas of Lesina and Varano.

Excluding the area south of the district of Barletta, in which there appears to be a weak but fragile revival of resources, biomass data suggests putting a stop to fishing activities in the Apulia districts and implementing a reactivation of resources and management of fishing areas.

The historical knowledge on the distribution and abundance of the banks of clam, in the Middle and Lower Adriatic derive mainly from the research conducted by the Laboratory of Marine Biology of Bari, through the execution of different programs. In particular, it should be noted that this scientific research lasted until 2001, with interruptions in the years 1988, 1989, 1993 and 1996. The survey area extended from Pescara to Barletta, covering the compartments of Pescara, Termoli, Manfredonia and Molfetta. The whole area was subdivided into 9 sub-areas indicated by the letters I for the compartment of Pescara; G and H for the compartment of Termoli; A, B, C, D and E for the compartment of Manfredonia and F to the compartment of Molfetta. Experimental campaigns for the evaluation of the clam resource were carried out in July-August and July-September in the three years 1997-1999 and in the two years 2000-2001 respectively. The sampling stations were located along 64 transepts perpendicular to the coast in 1997 and 1998 and along 63 transepts in 1999, 2000 and 2001. The transepts were spaced about 4 km apart. The dredged were conducted parallel to the coast for 50 m of length, investigating each meter of depth, from 2 m up to 10 m, maximum depth at which, in the Lower Adriatic, there are commercially exploitable quantities of clams. The position of the stations was

determined by GPS when they were taken. All the collected material was transported to the laboratory and stored in the freezer, in the case of large quantities sub-samples were taken.

In the Table 26 and Table 27 the biomass indices (total and commercial) of striped venus clams expanded to the surfaces covered by all the sampled stations with positive results in each compartment are reported.

Table 26. Average biomass and densities in the districts covered for individuals of length ≥ 25 mm.

District		1997	1998	1999	2000	2001
Pescara	Tons	1423.5	1728.5	4322.9	6498	427.9
	km²	181.4	176.3	161.4	150	110
	t/km²	7.8	9.8	26.8	43.3	3.9
Termoli	Tons	485.2	194.1	139.5	58.1	62.1
	km²	27.5	21.2	20	19	18
	t/km²	17.6	9.2	7	3.1	3.5
Manfredonia	Tons	271.9	1552.9	1315.5	800.6	122
	km²	124.2	105.5	91.3	85	70
	t/km²	2.2	14.7	14.4	9.4	1.7
Molfetta	Tons	154.6	156	33.2	155.4	7.6
	km²	5	6.3	6	5.8	4
	t/km²	30.8	24.6	5.6	26.8	1.9

Table 27. Average biomass and densities in the districts covered for individuals of length ≥ 15 mm.

District		1997	1998	1999	2000	2001
Pescara	Tons	5120.6	33638.1	71877.3	17070	679.8
	km²	181.4	176.3	161.4	150	110
	t/km²	28.2	190.8	445.4	113.8	6.2
Termoli	Tons	1527.4	414.2	259.2	124.6	82.1
	km²	27.5	21.2	20	19	18
	t/km²	55.4	19.6	12.9	6.6	4.6
Manfredonia	Tons	1375.1	9258.9	3995	1026	147.8
	km²	124.2	105.5	91.3	85	70
	t/km²	11.1	87.8	43.8	12.1	2.1
Molfetta	Tons	275.4	313.6	109.3	309.1	10.1
	km²	5	6.3	6	5.8	4
	t/km²	54.8	49.5	18.3	53.3	2.5

In conclusion, the surveys carried out in the three years 1997-1999 and in the two years 2000-2001 highlighted that the clam banks in the mid and lower Adriatic coastline showed a different density and a very variable biomass from one year to the next. In fact, very consistent biomass changes have been observed over time even though the overall trend has shown a steady contraction of the biomass of clams, and in some cases, has shown a collapse of stocks. From the

examination of the distribution of the frequencies of size in the historical surveys, it was not always possible to observe the bimodal trend typical of this bivalve, that is a first peak around 13-16 mm and a second around 22-25 mm, corresponding to organisms of the first and second years respectively. Often, on the other hand, a unimodal distribution has been observed with only one-year organisms and even worse with a significant reduction in the number of young individuals. The maximum size collected was around 36-37 mm while the smallest organisms measured 4-5 mm. The phenomenon of depletion of the clam resource has been observed mainly in the Molfetta compartment, slightly less evident in that of Termoli.

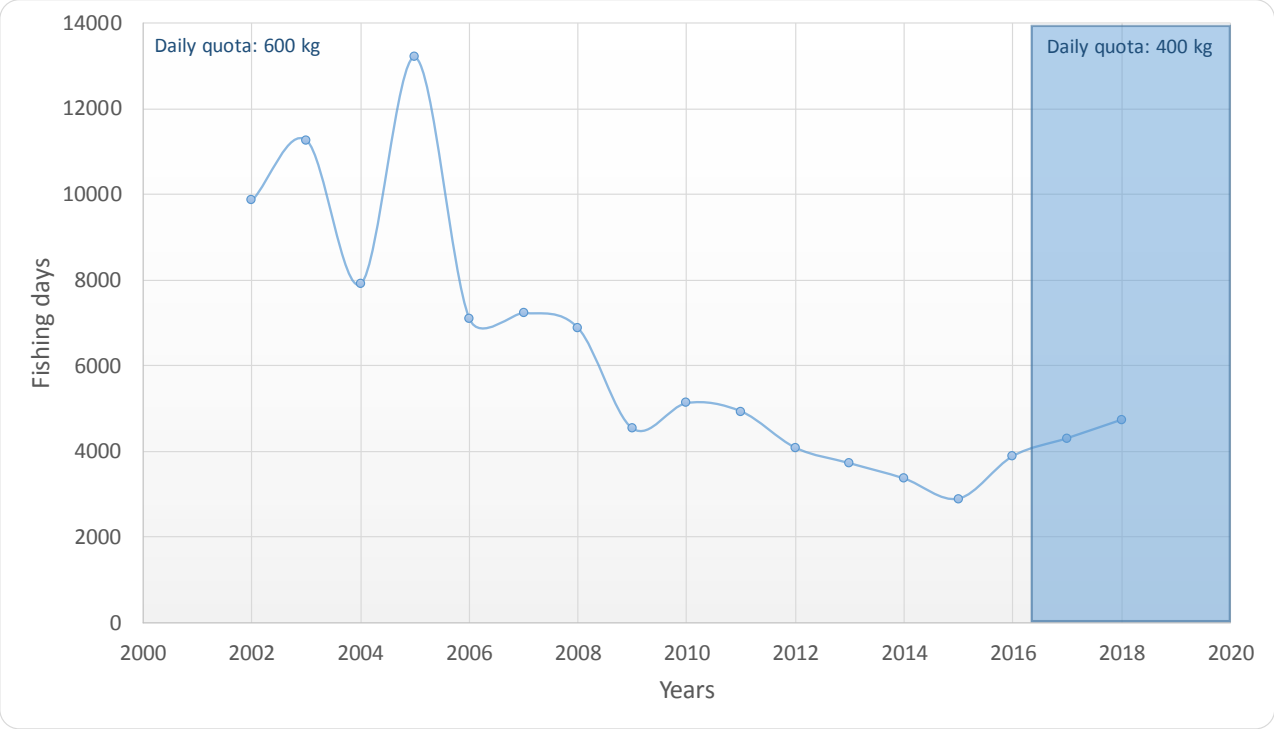
Fishing effort

Implementation of the National Discard Management Plan for clam resources (*Chamelea gallina*) (DM 27/12/2016, OJ N.8 11/1/2017) brought about a significant reduction in daily fishing effort, applied through two measures:

- the effective reduction of fishing days/week: partial modification of art. 5 paragraph 2 of Ministerial Decree 22/12/2000, the units authorised to fish clams must suspend fishing activities on Saturday, Sunday and set holidays plus another day established by the Consortia, so as not to exceed 4 fishing days/week. This effectively implied a reduction of potential fishing days of about 20%, given that Ministerial Decree 22/12/2000 art. 5 set a maximum of 5 fishing days/week;
- the reduction of catch quantities per day: art. 7 of Ministerial Decree of 22/12/2000 set the daily fishing limit at 600 kg/vessel. The Ministerial Decree of 12.27.2016 reduced the daily catch limit per vessel to 400 kg, approximately 33%.

The effects of the measures contained in the Discard Plan, therefore, resulted in a considerable reduction in the daily fishing effort exerted hydraulic dredgers. The reduction in the maximum daily quota (from 600 kg to 400 kg) and the possibility to market clams smaller than 25 mm (although it is currently rare to find clams smaller than 23 mm on the market) have together made it possible to reach the daily quota set more quickly, which implies a reduction of the areas dredged. The reduction of the daily fishing effort has meant that the consortia could better manage the fishing activities with the rotation of the exploitable areas. This resulted in a longer time closure for the areas closed to fishing activities (rotation of areas) and to an increase in fishing days with a benefit in terms of economic revenues.

For hydraulic dredging the number of fishing days is a good indicator of the status this type of fishery. In fact, the more are the fishing days the better is the situation of the resource. As an example, the following Figure 18 shows the average situation in different Consortia. It is possible to observe that with the entry to force of Discard plan the situation does not change consistently, with a slight increase in the number of fishing days, which is a sign of a positive trend for the fishing sector. This is also supported by the results of CPUE, that remained constant. The general decrease in the CPUE (kg/day/vessel) observed in the last years is due to the reduction of daily quota from 600 kg to 400 kg vessel. Unfortunately, the time series of fishing effort do not imply the effective hours of fishing, so that the CPUE cannot be used for stock assessment models.



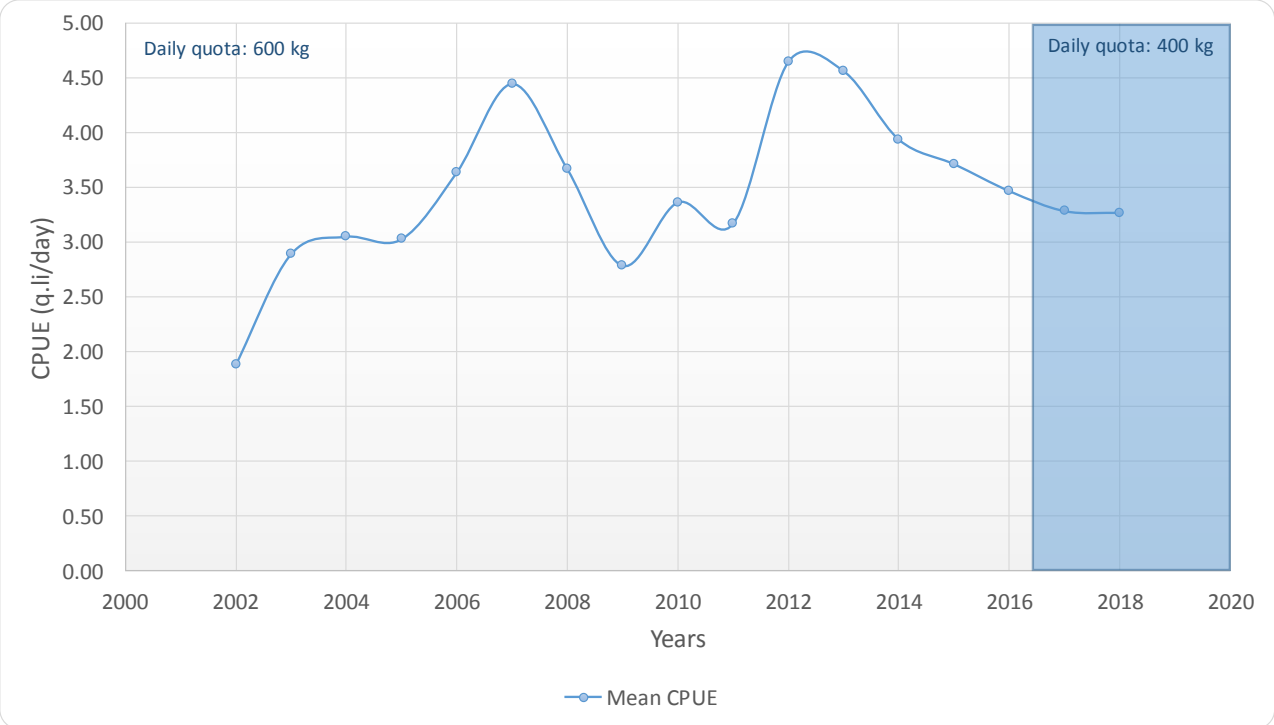


Figure 18. Fishing effort (total number of fishing days) and CPUE (kg/vessel/day) exerted by 4 Consortia in the Marche Region.

However, considering the fishing effort in terms of actual daily fishing hours it is possible to find a clear reduction, a trend that is still decreasing, for a daily average that is less than 2 hours of fishing (Figure 19).

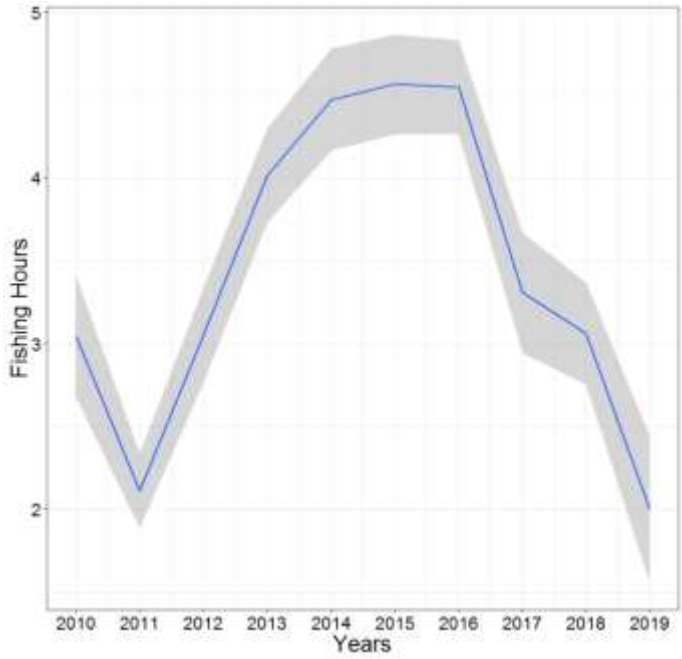


Figure 19. Daily fishing hours and confidence interval in the Central Adriatic.

Furthermore, all vessels authorised to fish for clams with hydraulic dredges are currently equipped with a vessel position detection system which allows fishing effort to be verified from a spatial point of view, and also makes it possible for appropriate management measures to be adopted based on the degree of exploitation of the areas (e.g. rotation of fishing areas.

In the next future, the use of data from vessel position detection system will enable to calculate CPUE by using real fishing effort in terms of effective hours of fishing.

Case study: North Adriatic

Clam fishing with hydraulic dredges differs from other fishing systems as is drawn with a maximum quota imposed by law and an effective fishing quota that is established daily by the Management Consortia based on market requests.

With the entry into force of the legislation referable to the Discard Plan, the maximum quota that can be fished daily is changed from 600 kg to 400 kg. From 2016 (the last year at 600 kg) to 2017 and 2018 (period in which the 400 kg quota applies) we observe a constant decrease in the average quota caught daily by a single vessel due to the reduction in the maximum quota and the different market demand.

year	n. of dredge	Average catches (kg/day)
2016	111	418,1
2017	120	370,4
2018	121	355,4

Trend of average catch per vessel - years 2016-2018

The variable that can affect the status of the resource is the real fishing time that each vessel takes to reach the sales quota:

- the shorter the fishing time the greater the presence of the target species of commercial size;

- the longer the fishing time the lower the presence of the target species.

To define the fishing time for each vessel, the data acquired by the geolocation system (AIS), supplied to the hydraulic dredges of the Veneto region from the year 2015 before the entry into force of the Discards Plan (1 January 2017), was used. AIS data allowed the determination of the real fishing time for a representative number of hydraulic dredges (15 of 110) in the different fishing areas and in all the months of activity of the evaluated years.

Overall analysis of the data before and after application Discards Plan shows that:

• The average daily fishing time has varied from almost 4 hours to around 2.5 hours, with a reduction of about 37% in fishing action.

• In 2017, compared to the previous year, the total fishing hours of all Veneto hydraulic dredges decreased by around 6.5% despite an increase of about 10% in the number of boats.

• In 2018 there was a further decrease in fishing hours (-30% compared to 2016 and -25.5% compared to 2017).

• The calculation of the effective tool usage time (real fishing time) shows that from about 2h40 'of 2016 the time has been reduced to 1h39 of 2018, with a net reduction of one hour.

• The hourly yield (kg/hour) shows an increase of around 36% in the year 2018 compared to the period before the adoption of the Discard Plan.

year	n. of dredges	n. total fishing days	Fishing time (hours)	Average time of fishing day (hours)	Real time fishing/day (hours)	catch (t)	hourly yield (kg/ hour)
2016	111	10.133	40.229	3h58’	2h39'	4.237	105,3
2017	120	13.418	37.572	2h48’	1h53'	4.970	132,3
2018	121	11.331	27.988	2h28’	1h39'	4.027	143,9

Time of fishing of hydraulic dredges in Veneto

Fishing effort, as defined by the EU, represents the product between some characteristics of fishing vessels (GT or kW) compared to fishing time, usually indicated in days. In the case of *C. gallina* fishing with hydraulic dredger, as the vessel characteristics are substantially unchanged maintaining GT or kW practically constant, it is considered as most representative unit of time the actual hours of the fishing action.

After the entry into force Discards Plan, the CPUE (catch per unit effort), calculated on the actual fishing hours, is constantly increasing, with a percentage increase of 20,2% in 2018 compared to 2016.

year	n. of dredge	GT	average fishing days	Fishing effort (GT*fishing hours)	CPUE	% variation
2016	111	1.169	91	47.027.594	9,009E-05	-
2017	120	1.266	112	47.565.544	1,045E-04	+13,8
2018	121	1.275	94	35.684.152	1,128E-04	+20,2

Hydraulic dredge fishing effort data in Veneto

With the introduction of the discards Plan, and the consequent decrease in fishing times, it is possible to define the reduction of the areas affected by the action of hydraulic dredges. Considering that the average width of the tool used is 2.70 meters and that a single fishing action is carried out at an average speed of 2 knots for a time of about 6-7 minutes, the surface affected by the action of the hydraulic dredger it is around 1000-1200 m^2.

Considering that:

• before Discards Plan for each fishing boat (600 kg / day and minimum size 25 mm) the actual fishing period included about 22—25 fishing actions for a dredged area of 27,500 m^2;

• with the discards plan for each fishing boat (400 kg / day and minimum size 22 mm) the actual fishing period includes about 14-16 fishing actions for a dredged area of 17,600 m^2;

it is noted that the area affected by the fishing action is reduced by about 35%.

Selectivity of hydraulic dredges

General characteristics

The knowledge of the selectivity of a fishing gear, on different species and on different sizes, represents a crucial point to guarantee rational management of marine resources. The selectivity of gear has, for half a century now, been one of the main technological aspects considered indispensable by modern population dynamics, to achieve correct levels of exploitation of fishery resources (Sala, 2011).

Control and improvement of selectivity, in synergy with responsible management of fishing effort, represent the necessary, but the only, conditions to achieve the aim of correct management of resources.

The main aim of technical measures for the conservation of fish stocks is to increase the selectivity of fishing gears and reduce the capture of juveniles and other juvenile phases (Sala, 2011, Sala and Lucchetti, 2010, 2011). The term **selectivity** defines the selection process of a fishing gear or of the process that leads to the catch, the composition of which shall differ from the composition of all the organisms actually present in the area where fishing is carried out (Sala, 2011; Sala *et al.,* 2006; 2007; 2008). In other words, selectivity is the probability that the different sizes and species of fish will be caught by the fishing gear.

In practice, with this term we can express both the capacity of a gear to catch only certain sizes of a given species, and the selection of the different species present at sea. In the first case, in order to have gear that allows the juvenile forms of a given species to escape, meshes of appropriate opening and shape are generally used. In the second case, however, the selectivity of a gear cannot be improved just by the use of appropriate mesh sizes and shapes, since it depends mainly on how the vessels and the gear are structured and any devices installed on the gear that modify its functioning (Sala *et al*. 2007; 2011).

Therefore, selectivity is a function both of the technical characteristics of a given fishing gear and of the ethological properties of the species to be captured. Since the clam, being a bivalve, cannot actively escape capture by the dredge, the selection process can take place either on the sea bed by the dredge itself or on board with sieves that separate the catch mechanically. As in trawl fisheries, where the selection process is mainly a function of the mesh opening, in the case of the dredge, selectivity depends on the distance between the rods or the diameter of the holes in the case of the perforated grid of the sieve. **Since the material collected by the dredge is subsequently selected by the vibrating sieve, this can be considered to be the main selection process for clams.**

Some studies have demonstrated that even minute variations in the diameter of the sieve holes result in significant changes in selectivity (Froglia and Gramitto, 1981). According to the D.M. of 22/12/2000 the sieves must respect certain

characteristics, in order to allow the specimens below the minimum size for first capture and marketing to escape, which for the clam (*C. gallina*) is 22 mm.

The sieves, according to the regulations, can be made of metal rods, with characteristics similar to those of the cage, or of a perforated metal grid. It should be borne in mind that, in the case of the rods in the dredge or in the sieves, selection takes place on the basis of the thickness of the clams, while with the perforated grid selection is mainly due to the diameter of the clams. For this reason, the rods and the holes are subject to different regulations: 12 mm minimum distance between the rods and 21 mm minimum hole diameter (D.M. 22/12/2000). The latter (perforated grid with a minimum diameter of 21 mm for the holes) is the solution that is adopted almost everywhere.

The material collected by the dredge is transferred on board and emptied into a stainless-steel collection box at the bow, then by means of a rotating screw conveyor it is dropped onto the plates of a vibrating sieve that is on a slight slope. The vibrations make the clams move down slowly from one sieve to another. These sieve plates can be different depending on the vessels, they are sometimes made by local artisans. In general, however, all the vibrating sieves have a series of plates one above the other with decreasing hole sizes. The top layer of this filter, onto which water is sprayed, receives all the material and this one has large holes, usually over 32 mm, through which all the clams and organisms of similar diameter pass. From the second sieve onwards, the fisher is free to use sieves with different hole sizes, but pursuant to the D.M. of 22/12/2000 they must have a diameter of not less than 21 mm. in some cases, the Management Consortia set the minimum diameters of the sieve holes to ensure uniformity of sampling between the boats in the same district and sometimes they then fasten and seal the sieve so that it is not possible to replace the sieve plates.

In the Discard Plan, the characteristics of the vibrating sieves have not been modified.

Selectivity of mechanical vibrating sieves

A recent study conducted in the Adriatic (Sala *et al*., 2017) made it possible to verify the selectivity of mechanical vibrating sieves currently in use.

The screening process was carried out with the vessel at a standstill, the catch held in each container was screened using each of the single sieves that made up the complete on-board vibrating sieve equipment. As illustrated in Figure 20, following selection, the contents of each collection box (*P0*) was separated into 6 fractions (*debris, r1-r5* and *P5*), which were then weighed and, when quantities were abundant as usually was the case for the *P5* fraction, a sub-sample (about 3 kg) was removed for subsequent analysis of the size distribution: 1) *debris*: the fraction retained by the first filter (32.5 mm holes) containing coarse material and some large specimens of clam; 2) *r1*: the fraction retained by the first sieve (holes of 21.5 mm) containing commercial-size clams; 3) *r2*: fraction retained by the second sieve (holes of 21.1 mm) contained sub-commercial size clams; 4) *r3*: fraction retained by the third sieve (holes of 20.3 mm, not used for commercial purposes but useful for research); 5) *r4*: fraction retained by the final filter with metal bars (slats) 10.5 mm apart; 6) *P5*: the fraction not retained by any of the sieves.

All 54 sieving selection operations analysed (*e.g.* 3 hauls x 2 collection boxes x 3 speeds x 3 sieves, see Table 28. Number of repetitions obtained for each sieve assessed *(e.g. 3 hauls x 2 collection boxes)* at the three different speeds: 1180, 1210 and 1230 RPM.) were deemed valid and used in the assessment of mean selectivity of each sieve. From Table 29 to Table 31 the selectivity parameters are reported for the single sieving operations replicated for each of the three sieves, obtained with the *Covered Codend method.* An accurate analysis of the robustness of each of the logistic models (*p*-value and derivation vs. DOF) indicates that no problems were encountered with the adoption of the logit curves to describe the data on materials retained at each sieving operation, based on the adoption of the procedures dictated by the *Covered Codend method*.

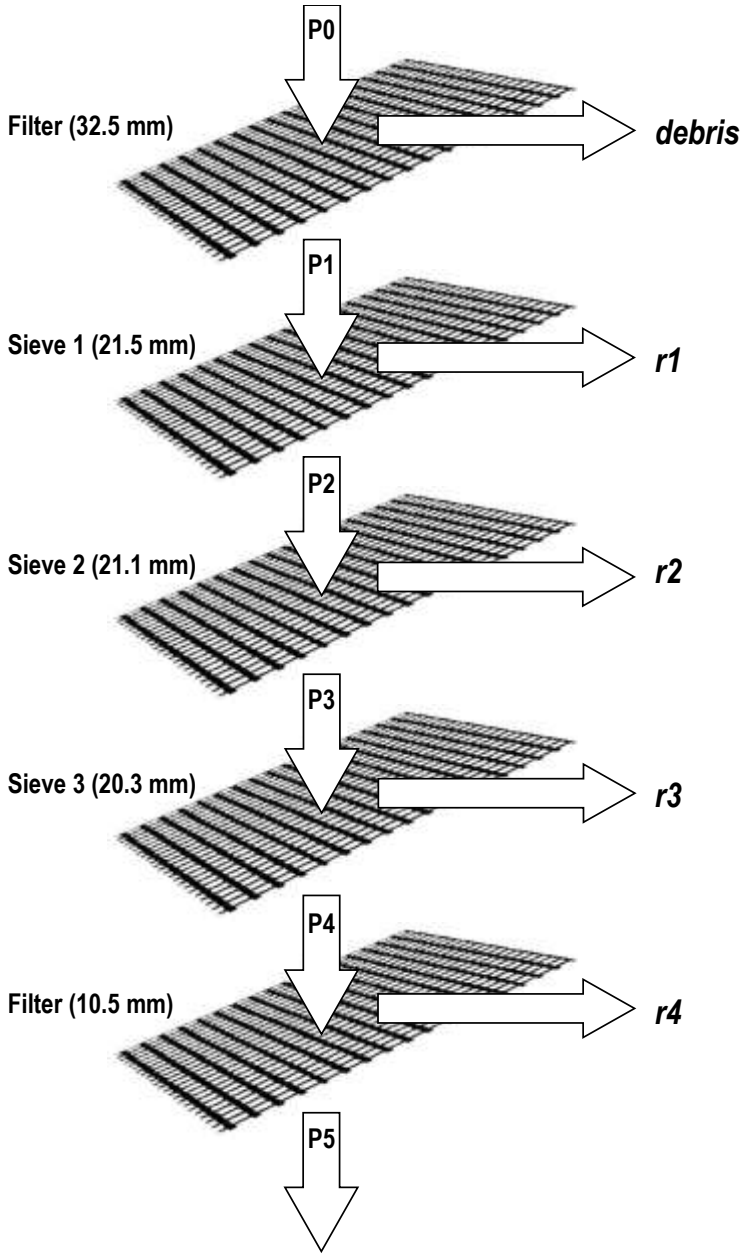


Figure 20. Selection process of the clams using the three sieves and filters that make up the system of vibrating sieves on board. The samples obtained following sieving of a single collection box were: *debris*: the fraction retained by the first filter (32.5 mm holes) containing coarse materials and a few large clam specimens; *r1*: fraction retained by the 1st sieve (21.5 mm holes) containing commercial size clams; *r2*: fraction retained by the 2nd sieve (21.1 mm holes) containing sub-commercial size clams; *r3*: fraction retained by the 3rd sieve (20.3 mm holes); *r4*: fraction retained by the last filter made of metal bars (slats) 10.5 mm apart; *P5*: fraction not retained by any of the sieves or filters.

The rotation speed of the screw conveyor was also included in the study, a parameter that could influence selective properties. The estimated selectivity parameters were significant for all the screenings carried out at all three rotation speeds of 1180, 1210 and 1230 RPM.

For a description of the statistical methodology applied to the selectivity study please refer to Sala *et al*. (2017).

Table 28. Number of repetitions obtained for each sieve assessed *(e.g. 3 hauls x 2 collection boxes)* at the three different speeds: 1180, 1210 and 1230 RPM.

Sieve n. *(diameter of the holes)*	**Speed (RPM)**			**Total screenings**
	1180	**1210**	**1230**	
Sieve 1 (21.5 mm)	3 x 2	3 x 2	3 x 2	**18**
Sieve 2 (21.1 mm)	3 x 2	3 x 2	3 x 2	**18**
Sieve 3 (20.3 mm)	3 x 2	3 x 2	3 x 2	**18**
Total screenings	**18**	**18**	**18**	**54**

The mean selectivity parameters, calculated for each sieve according to the methodology proposed by Fryer (1991), which takes into account, in this case, the variability between the screening operations (between-haul variation), are reported in Figure 21 and Table 32. In this case, the mean values of each sieve were calculated both as an average at each sieving rate and with all the sieving operations aggregated without taking into account the speed parameter. The highest mean value of L50 was found to be that of the 2nd sieve (L50=25.30 mm), which however was not significantly different from that of the 1st sieve (24.91 mm), on the contrary the best SR (lowest value) was that of the 1st sieve with 1.12 mm against 1.76 mm of the 2nd sieve. The mean value of L50 relative to the 3rd sieve (L50=22.87 mm) was significantly lower than the other two ($p < 0.001$; Figure 22).

The comparative analysis of the selectivity parameters of the three sieves, illustrated in the graph *L50*-versus-*SR* in Figure 22 makes it possible to appreciate better that, although there has been an increase in both the retention length (L50) and the selection interval (SR) passing from the first to the second sieve, these increases are not significant as the projections of the two ellipses, which represent the confidence intervals of L50 and SR, overlap in both the x and y dimensions. On the contrary, observing the ellipse relative to the third sieve, it can be seen that there was a significant decrease in the retention length, which fell to 22.87 mm from 24.91 and 25.30 mm of the first and second sieves (Figure 23).

From the results of the study, and in particular from the mean selectivity curves, it is possible to observe that with the legally compliant sieve size (Grid 2 in the study) retention of specimens under 22 mm is irrelevant (Figure 23).

Table 29. Selectivity parameters estimated for the 1st sieve, D1(215), with hole diameter 21.5 mm. the individual values were calculated at the three different speeds of 1180, 1210 and 1230 RPM. The data were analysed using the methodology proposed by Fryer (1991). Retention length at 50%, 25% and 75% (L50, L25 and L75), selection interval (SR), test Akaike's Information Criterion (AIC), degrees of freedom (DOF), *p*-value, confidence interval of L50 and SR (±DelL50, ±DelSR), standard deviation of L50 and SR (SdL50, SdSR), between-haul variation {D}, minimum and maximum retention length (MinL, MaxL), total number of clams screened, retained and released (NrTot, NrTes, NrCov).

Code	Speed	Diam	L50	SR	L25	L75	AIC	*p-value*	Deviance	DOF	R2	DelL50	SdL50	DelSR	SdSR	D11	D12	D13	MinL	MaxL	NrTot	NrTes	NrCov
Sieve-Spe-Haul	[RPM]	[mm]	[mm]	[mm]	[mm]	[mm]						[mm]	[mm]	[mm]	[mm]				[mm]	[mm]			
D1(215)-1230-1	1230	21.5	25.05	0.94	24.58	25.51	1139.83	0.969	11.40	22	0.999	0.07	0.03	0.09	0.04	0.0010	0.0001	0.0020	20.5	32.0	1886	909	977
D1(215)-1230-1	1230	21.5	25.25	1.07	24.72	25.78	1654.04	0.191	26.42	21	0.997	0.07	0.03	0.09	0.05	0.0010	0.0004	0.0020	20.5	32.0	2412	885	1527
D1(215)-1210-1	1210	21.5	24.95	1.01	24.45	25.46	991.26	1.000	3.22	19	1.000	0.08	0.04	0.11	0.05	0.0014	0.0002	0.0030	21.0	31.0	1424	694	730
D1(215)-1210-1	1210	21.5	24.92	1.12	24.36	25.48	1366.53	0.972	9.75	20	0.999	0.07	0.03	0.11	0.05	0.0012	0.0001	0.0028	21.0	33.0	1834	927	907
D1(215)-1180-1	1180	21.5	24.96	1.24	24.34	25.58	1590.92	0.880	13.75	21	0.998	0.07	0.04	0.12	0.06	0.0012	0.0002	0.0035	20.5	32.5	1878	904	974
D1(215)-1180-1	1180	21.5	25.05	1.03	24.53	25.56	1267.46	0.993	8.51	21	1.000	0.07	0.03	0.11	0.05	0.0011	0.0002	0.0026	20.5	31.5	1715	843	872
D1(215)-1230-2	1230	21.5	25.01	1.11	24.45	25.56	975.57	0.965	8.76	18	0.998	0.09	0.04	0.13	0.06	0.0017	0.0006	0.0040	20.5	30.0	1288	515	773
D1(215)-1230-2	1230	21.5	24.88	1.10	24.33	25.43	667.38	0.077	28.34	19	0.936	0.10	0.05	0.16	0.07	0.0023	0.0001	0.0055	20.5	31.0	914	454	460
D1(215)-1210-2	1210	21.5	24.93	1.27	24.30	25.56	1291.63	0.317	20.29	18	0.998	0.09	0.04	0.14	0.07	0.0016	0.0005	0.0043	20.5	30.0	1582	677	905
D1(215)-1210-2	1210	21.5	24.78	1.39	24.09	25.48	1085.38	0.213	23.58	19	0.964	0.10	0.05	0.17	0.08	0.0023	0.0005	0.0065	20.5	31.0	1243	581	662
D1(215)-1180-2	1180	21.5	24.80	1.12	24.24	25.36	1026.51	0.985	7.48	18	0.999	0.09	0.04	0.13	0.06	0.0016	0.0005	0.0038	20.5	30.0	1372	566	806
D1(215)-1180-2	1180	21.5	24.78	1.70	23.93	25.63	1100.20	0.395	18.95	18	0.991	0.12	0.06	0.24	0.11	0.0034	0.0013	0.0130	21.0	31.5	1089	485	604
D1(215)-1230-3	1230	21.5	24.75	1.03	24.24	25.27	1230.51	0.981	9.83	21	0.999	0.07	0.03	0.10	0.05	0.0011	0.0001	0.0024	20.5	32.0	1770	869	901
D1(215)-1230-3	1230	21.5	24.70	1.13	24.14	25.27	1777.07	0.572	18.24	20	0.997	0.06	0.03	0.10	0.05	0.0009	0.0001	0.0022	20.5	31.0	2327	1175	1152
D1(215)-1210-3	1210	21.5	24.88	1.14	24.31	25.45	1612.63	0.759	15.31	20	0.999	0.07	0.03	0.11	0.05	0.0011	0.0002	0.0026	20.5	31.0	2033	963	1070
D1(215)-1210-3	1210	21.5	24.90	0.83	24.48	25.31	1041.28	0.142	26.77	20	0.999	0.06	0.03	0.09	0.04	0.0009	0.0001	0.0017	20.5	33.0	1722	857	865
D1(215)-1180-3	1180	21.5	24.81	0.97	24.32	25.29	1150.92	0.867	13.23	20	0.999	0.07	0.03	0.10	0.05	0.0011	0.0002	0.0022	20.5	32.0	1788	828	960
D1(215)-1180-3	1180	21.5	24.96	1.18	24.37	25.55	1470.60	0.165	24.86	19	0.997	0.07	0.04	0.12	0.06	0.0013	0.0003	0.0031	20.5	30.5	1851	807	1044

Table 30. Estimated selectivity parameters for the 2nd sieve, D2(211), with a hole diameter of 21.1 mm.

Code	Speed	Diam	L50	SR	L25	L75	AIC	*p-value*	Deviance	DOF	R2	DelL50	SdL50	DelSR	SdSR	D11	D12	D13	MinL	MaxL	NrTot	NrTes	NrCov
Sieve-Spe-Haul	[RPM]	[mm]	[mm]	[mm]	[mm]	[mm]						[mm]	[mm]	[mm]	[mm]				[mm]	[mm]			
D2(211)-1230-1	1230	21.1	25.78	2.72	24.43	27.14	928.66	0.373	10.81	10	0.951	0.47	0.21	0.76	0.34	0.0445	0.0629	0.1158	20.5	26.0	975	204	771
D2(211)-1230-1	1230	21.1	25.79	1.55	25.02	26.57	949.83	0.334	11.31	10	0.984	0.25	0.11	0.30	0.13	0.0126	0.0127	0.0177	20.5	26.0	1518	186	1332
D2(211)-1210-1	1210	21.1	25.26	1.43	24.54	25.98	573.76	0.973	2.75	9	0.998	0.23	0.10	0.34	0.15	0.0107	0.0115	0.0225	21.0	26.0	727	136	591
D2(211)-1210-1	1210	21.1	25.13	1.24	24.52	25.75	688.22	0.352	9.98	9	0.988	0.16	0.07	0.24	0.11	0.0052	0.0050	0.0111	21.0	26.0	903	179	724
D2(211)-1180-1	1180	21.1	25.46	1.58	24.67	26.25	781.74	0.921	4.52	10	0.995	0.23	0.10	0.34	0.15	0.0109	0.0126	0.0236	20.5	26.0	967	179	788
D2(211)-1180-1	1180	21.1	25.43	1.37	24.74	26.11	666.37	0.369	10.85	10	0.978	0.21	0.09	0.30	0.13	0.0089	0.0095	0.0176	20.5	26.0	869	155	714
D2(211)-1230-2	1230	21.1	25.13	1.77	24.25	26.01	715.70	0.273	12.19	10	0.973	0.24	0.11	0.41	0.19	0.0119	0.0148	0.0343	20.5	26.0	771	180	591
D2(211)-1230-2	1230	21.1	24.80	2.18	23.72	25.89	496.14	0.862	5.41	10	0.868	0.30	0.14	0.64	0.29	0.0183	0.0232	0.0829	20.5	26.0	459	144	315
D2(211)-1210-2	1210	21.1	25.55	2.28	24.41	26.69	814.56	0.742	6.83	10	0.910	0.37	0.16	0.57	0.26	0.0269	0.0350	0.0658	20.5	26.0	904	183	721
D2(211)-1210-2	1210	21.1	24.93	1.27	24.30	25.57	522.82	0.109	15.70	10	0.953	0.18	0.08	0.27	0.12	0.0064	0.0058	0.0144	20.5	26.0	661	146	515
D2(211)-1180-2	1180	21.1	24.99	1.29	24.35	25.63	569.71	0.892	4.98	10	0.995	0.19	0.09	0.27	0.12	0.0073	0.0070	0.0142	20.5	26.0	803	143	660
D2(211)-1180-2	1180	21.1	25.24	1.73	24.38	26.10	522.89	0.064	16.12	9	0.932	0.29	0.13	0.46	0.20	0.0167	0.0195	0.0409	21.0	26.0	602	127	475
D2(211)-1230-3	1230	21.1	25.28	2.39	24.09	26.48	880.38	0.149	14.56	10	0.631	0.35	0.16	0.60	0.27	0.0253	0.0353	0.0734	20.5	26.0	900	207	693
D2(211)-1230-3	1230	21.1	25.09	1.75	24.21	25.96	1026.55	0.088	16.44	10	0.952	0.21	0.09	0.33	0.15	0.0089	0.0106	0.0223	20.5	26.0	1150	250	900
D2(211)-1210-3	1210	21.1	25.33	2.09	24.28	26.37	1030.50	0.820	5.95	10	0.985	0.27	0.12	0.46	0.21	0.0147	0.0199	0.0428	20.5	26.0	1068	247	821
D2(211)-1210-3	1210	21.1	26.05	1.87	25.12	26.99	522.26	0.778	6.43	10	0.935	0.54	0.24	0.59	0.26	0.0586	0.0582	0.0693	20.5	26.0	865	91	774
D2(211)-1180-3	1180	21.1	25.27	2.00	24.27	26.27	835.62	0.638	7.91	10	0.932	0.30	0.14	0.46	0.21	0.0184	0.0227	0.0423	20.5	26.0	960	189	771
D2(211)-1180-3	1180	21.1	25.86	2.82	24.45	27.27	985.65	0.070	17.23	10	0.513	0.49	0.22	0.79	0.35	0.0490	0.0694	0.1250	20.5	26.0	1040	214	826

Table 31. Estimated selectivity parameters for the 3rd sieve, D3(203), with a hole diameter of 20.3 mm.

Code	Speed	Diam	L50	SR	L25	L75	AIC	*p-value*	Deviance	DOF	R2	DelL50	SdL50	DelSR	SdSR	D11	D12	D13	MinL	MaxL	NrTot	NrTes	NrCov
Sieve-Spe-Haul	[RPM]	[mm]	[mm]	[mm]	[mm]	[mm]						[mm]	[mm]	[mm]	[mm]				[mm]	[mm]			
D3(203)-1230-1	1230	20.3	22.79	2.52	21.53	24.05	864.32	0.275	13.28	11	0.790	0.29	0.13	0.61	0.28	0.0174	-0.0254	0.0776	20.5	26.5	773	532	241
D3(203)-1230-1	1230	20.3	22.29	2.45	21.06	23.51	1247.98	0.057	20.57	12	0.719	0.31	0.14	0.48	0.22	0.0197	-0.0254	0.0479	20.5	27.0	1335	1048	287
D3(203)-1210-1	1210	20.3	22.92	3.44	21.20	24.64	743.62	0.144	14.68	10	0.679	0.43	0.19	1.27	0.57	0.0369	-0.0764	0.3275	21.0	26.5	592	374	218
D3(203)-1210-1	1210	20.3	22.57	4.51	20.32	24.83	921.41	0.055	16.63	9	0.726	0.61	0.27	1.93	0.86	0.0730	-0.1849	0.7313	21.0	26.0	724	463	261
D3(203)-1180-1	1180	20.3	22.78	2.99	21.29	24.28	916.66	0.001	33.79	13	0.434	0.57	0.27	1.30	0.60	0.0704	-0.1191	0.3615	20.5	27.5	791	541	250
D3(203)-1180-1	1180	20.3	22.75	4.13	20.69	24.81	893.66	0.002	30.15	11	0.575	0.94	0.43	2.71	1.23	0.1831	-0.4274	1.5157	20.5	26.5	716	469	247
D3(203)-1230-2	1230	20.3	22.97	2.40	21.78	24.17	683.95	0.050	18.29	10	0.944	0.28	0.12	0.63	0.28	0.0155	-0.0206	0.0809	20.5	26.0	591	381	210
D3(203)-1230-2	1230	20.3	24.00	2.81	22.60	25.40	389.97	0.141	16.01	11	0.671	0.36	0.16	1.05	0.48	0.0269	0.0241	0.2263	20.5	30.0	316	135	181
D3(203)-1210-2	1210	20.3	23.25	1.96	22.27	24.23	810.81	0.473	9.63	10	0.979	0.18	0.08	0.40	0.18	0.0069	-0.0058	0.0329	20.5	26.0	721	437	284
D3(203)-1210-2	1210	20.3	20.11	4.84	17.69	22.53	472.13	0.007	25.88	11	0.199	3.26	1.48	4.63	2.10	2.1966	-3.0050	4.4253	20.5	26.5	516	425	91
D3(203)-1180-2	1180	20.3	22.54	3.22	20.93	24.15	804.15	0.221	13.04	10	0.922	0.37	0.16	0.97	0.43	0.0270	-0.0464	0.1881	20.5	26.0	660	422	238
D3(203)-1180-2	1180	20.3	23.58	3.70	21.73	25.43	628.27	0.520	9.13	10	0.894	0.36	0.16	1.46	0.65	0.0263	-0.0164	0.4277	21.0	26.5	477	248	229
D3(203)-1230-3	1230	20.3	22.79	3.21	21.18	24.39	862.67	0.219	14.25	11	0.893	0.35	0.16	1.00	0.45	0.0247	-0.0462	0.2053	20.5	26.5	694	436	258
D3(203)-1230-3	1230	20.3	21.72	6.03	18.70	24.73	1133.71	0.099	17.31	11	0.130	1.02	0.46	3.04	1.38	0.2157	-0.5808	1.9020	20.5	26.5	901	599	302
D3(203)-1210-3	1210	20.3	22.63	3.60	20.84	24.43	1001.22	0.055	17.97	10	0.448	0.44	0.20	1.15	0.52	0.0386	-0.0785	0.2684	20.5	26.0	821	544	277
D3(203)-1210-3	1210	20.3	22.57	3.19	20.98	24.17	898.84	0.077	16.89	10	0.862	0.42	0.19	0.94	0.42	0.0350	-0.0614	0.1783	20.5	26.0	774	534	240
D3(203)-1180-3	1180	20.3	22.71	2.88	21.26	24.15	929.37	0.157	14.37	10	0.910	0.30	0.14	0.78	0.35	0.0187	-0.0313	0.1241	20.5	26.0	771	497	274
D3(203)-1180-3	1180	20.3	22.74	2.58	21.45	24.03	920.44	0.150	15.76	11	0.925	0.29	0.13	0.61	0.28	0.0176	-0.0255	0.0756	20.5	26.5	830	574	256

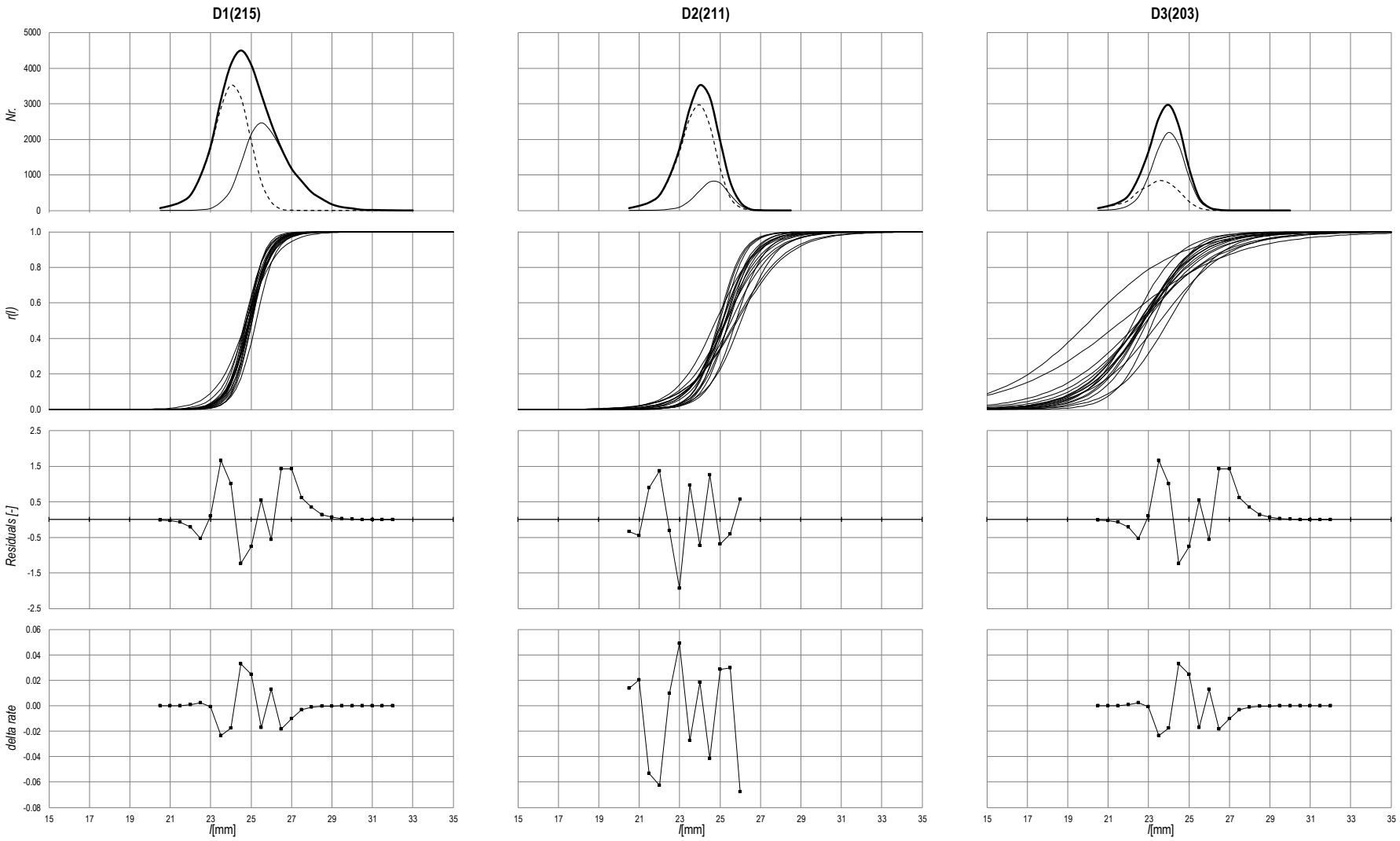


Figure 21. Size distribution of the screened clams: total (▬), retained (—) and released (---) from the 1st sieve D1(215) with a hole diameter of 21.5 mm, 2nd sieve D2(211) hole diameter 21.1 mm and 3rd sieve D3(203) hole diameter 20.5 mm; selectivity curve of the individual sieves; graphs of the residuals and delta rate. These last two graphs represent the robustness of the approximation of the logistic model given the set of experimental observations obtained during the sieving tests.

Table 32. Mean selectivity parameters estimated for the 1st sieve, D1(215), with hole diameter 21.5 mm, the 2nd sieve D2(211) hole diameter 21.1 mm and 3rd sieve D3(203) hole diameter 20.5 mm. The individual values were calculated using the methodology proposed by Fryer (1991) at the three different speeds of 1180, 1210 and 1230 RPM and with all of the

speeds combined *pooled data* (*All.P.*), highlighted in grey. Retention length at 50%, selection interval (SR), with mean values (estimated), standard error (S.E.), confidence interval at 95% (C.I.95%) and *p*-value, selection factor (SF), curve estimators that best approximate the data *(v_1, v_2)*, within-haul variation *{R_i} (WHV),* between-haul variation *{D} (BHV)*, test Akaike's Information Criterion (AIC), delta Log-Likelihood (Delta).

Sieve	**Speed**	**L50**				**SR**				SF	$\upsilon 1$	$\upsilon 2$	WHV			BHV			log-likel.	AIC	*Delta*
		Estimate	S.E.	C.I.95%	*p* -value	Estimate	S.E.	C.I.95%	*p* -value				R_{11}	R_{12}	R_{22}	D_{11}	D_{12}	D_{22}			
D1(215)	1180	**24.89**	0.046	*(24.78-25.00)*	1.99E-17	**1.20**	0.099	*(0.96-1.43)*	6.08E-06	1.16	-45.72	1.84	0.0021	-0.0016	0.0098	0.0112	-0.0097	0.0544	4.01	1.978	3.82E-15
	1210	**24.89**	0.021	*(24.84-24.94)*	7.93E-20	**1.12**	0.082	*(0.93-1.31)*	2.58E-06	1.16	-48.81	1.96	0.0004	-0.0008	0.0067	0.0013	-0.0048	0.0367	8.98	-7.951	9.72E-15
	1230	**24.94**	0.083	*(24.74-25.13)*	1.20E-15	**1.06**	0.031	*(0.98-1.13)*	4.98E-09	1.16	-51.83	2.08	0.0069	-0.0007	0.0010	0.0401	-0.0045	0.0030	7.01	-4.012	6.72E-15
D2(211)	1180	**25.33**	0.105	*(25.08-25.58)*	5.48E-15	**1.69**	0.163	*(1.31-2.08)*	1.65E-05	1.20	-32.84	1.30	0.0110	0.0098	0.0265	0.0432	0.0323	0.1066	-2.62	15.24	6.41E-15
	1210	**25.33**	0.136	*(25.01-25.65)*	3.48E-14	**1.64**	0.170	*(1.23-2.04)*	2.74E-05	1.20	-34.01	1.34	0.0186	0.0131	0.0289	0.0930	0.0582	0.1370	-3.75	17.51	6.17E-15
	1230	**25.29**	0.148	*(24.94-25.64)*	6.06E-14	**2.02**	0.173	*(1.61-2.43)*	7.61E-06	1.20	-27.54	1.09	0.0218	-0.0031	0.0298	0.1117	-0.0423	0.1264	-5.52	21.05	8.39E-15
D3(203)	1180	**22.90**	0.155	*(22.53-23.27)*	1.74E-13	**2.98**	0.206	*(2.49-3.47)*	1.79E-06	1.13	-16.89	0.74	0.0241	0.0068	0.0424	0.1117	0.0821	0.0604	-5.67	21.34	7.48E-09
	1210	**22.87**	0.146	*(22.53-23.22)*	1.13E-13	**2.86**	0.490	*(1.70-4.02)*	6.43E-04	1.13	-17.58	0.77	0.0213	-0.0551	0.2403	0.0772	-0.2331	1.1045	-10.65	31.31	9.96E-15
	1230	**22.94**	0.232	*(22.39-23.49)*	2.88E-12	**2.58**	0.138	*(2.25-2.91)*	3.15E-07	1.13	-19.53	0.85	0.0540	0.0027	0.0191	0.3004	0.0428	0.0061	-9.22	28.45	7.52E-09
D1(215)	*All.P.*	**24.91**	0.032	*(24.84-24.97)*	5.62E-74	**1.12**	0.040	*(1.04-1.20)*	4.81E-25	1.16	-48.85	1.96	0.0010	-0.0004	0.0016	0.0167	-0.0066	0.0254	15.9	-21.8	3.23E-15
D2(211)	*All.P.*	**25.30**	0.072	*(25.16-25.45)*	3.43E-62	**1.76**	0.101	*(1.56-1.97)*	1.69E-18	1.20	-31.57	1.25	0.0051	0.0025	0.0102	0.0753	0.0244	0.1445	-14.29	38.58	8.64E-15
D3(203)	*All.P.*	**22.87**	0.112	*(22.64-23.09)*	4.04E-54	**2.76**	0.144	*(2.47-3.06)*	8.87E-20	1.13	-18.19	0.80	0.0125	-0.0037	0.0208	0.1843	-0.0104	0.1563	-31.43	72.86	7.96E-15

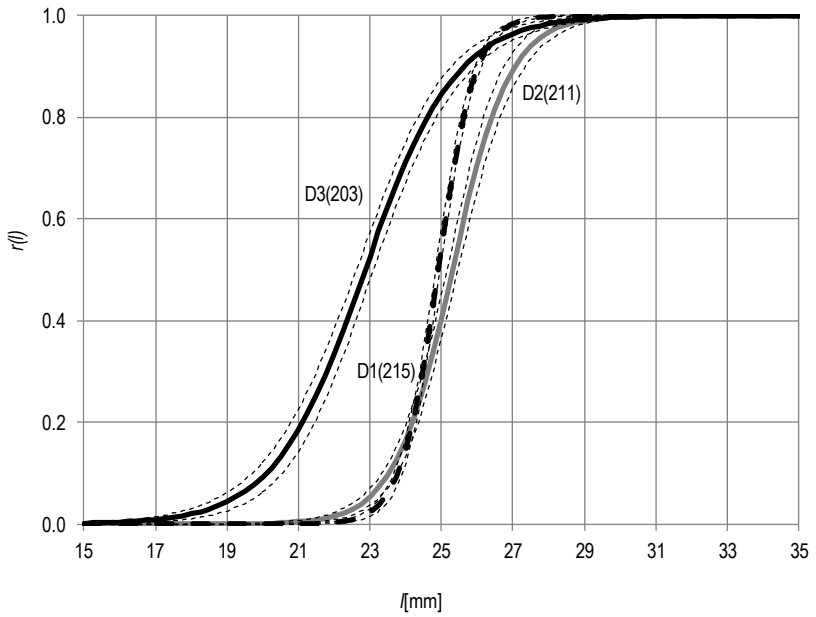


Figure 22. Mean selectivity curves estimated for the 1st sieve D1(215) with hole diameter 21.5 mm, the 2nd sieve D2(211) hole diameter 21.1 mm and 3rd sieve D3(203) hole diameter 20.5 mm. The individual values were calculated using the methodology proposed by Fryer (1991) with all the speeds combined. The dotted curves represent the confidence intervals in graphic form.

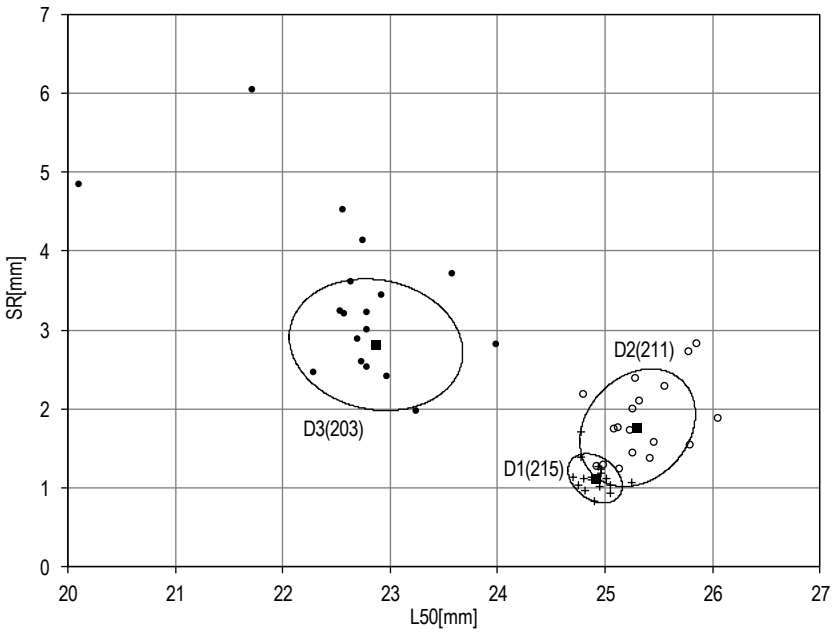


Figure 23. *L50* versus *SR*, the ellipses were calculated on the basis of the variation of the parameters estimated and represent graphically the confidence intervals of both *L50* and *SR* of each sieve: 1st sieve D1(215) with hole diameter 21.5 mm, the 2nd sieve D2(211) hole diameter 21.1 mm and 3rd sieve D3(203) hole diameter 20.5 mm.

Selectivity of dredge

The first selection process in the clam fishery occurs when clams enter the dredge. The space between bars enables the small clams to escape directly from the cage. The sea trials to assess the selectivity of a hydraulic dredge were performed with a standard dredge with 12 mm bar spacing. To collect the entire clam population in the dredged area a sampling net, consisting of a stainless-steel frame and a nylon net with a 12 mm opening, was used. This net was fixed inside the dredge with ties. Therefore, a classical covered-codend method used to study the selectivity of trawl codend was applied.

For each haul, the retention probability *r(l)* in the dredge was modelled by means of the logistic selectivity curve:

$$r(l) = \frac{e^{\upsilon_1 + \upsilon_2 l}}{1 + e^{\upsilon_1 + \upsilon_2 l}},$$

where *r(l)* is the probability that a fish of length *l* is retained, given that it entered the dredge (Wileman et al., 1996), and $\hat{\upsilon} = (\upsilon_1, \upsilon_2)^T$ is the vector of the selectivity parameters. The model proposed by Fryer (1991) was then used to investigate the between-haul variation of the selectivity parameters υ_1 and υ_2, allowing a mean curve to be estimated.

The results of selectivity analysis are shown in Figure 24 and Figure 25. The selectivity parameters estimated were:

L50 = the 50% retention length

SR = Selection Range (L75 – L25)

The selectivity parameters calculated by pooling the data obtained from the single curves are:

L50 = 22.29 ± 0.95

SR = 2.13 ± 1.04

Fryer model enabled to consider the between haul variation. The results were:

L50 = 22.39 ± 0.17

SR = 1.79 ± 0.14

The dredge towed on the bottom is responsible of the first and effective selection phase. The L50 obtained from the process is equal to the MCRS for this species. Therefore, most of the small clams did not reach the sieving process but directly return to the bottom.

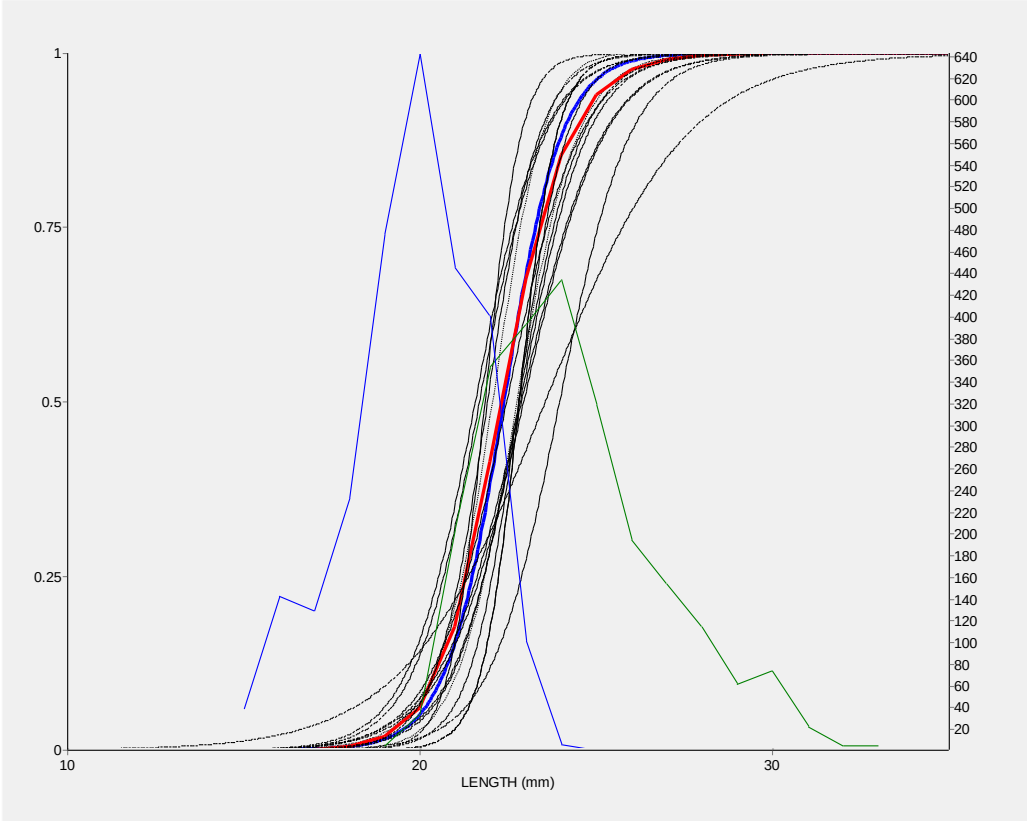


Figure 24. Selectivity curves for individual hauls (thin lines) and mean selectivity curves obtained with pooled data and Fryer model (1991, red and blue respectively. In green and blue, the retained and the escaped population.

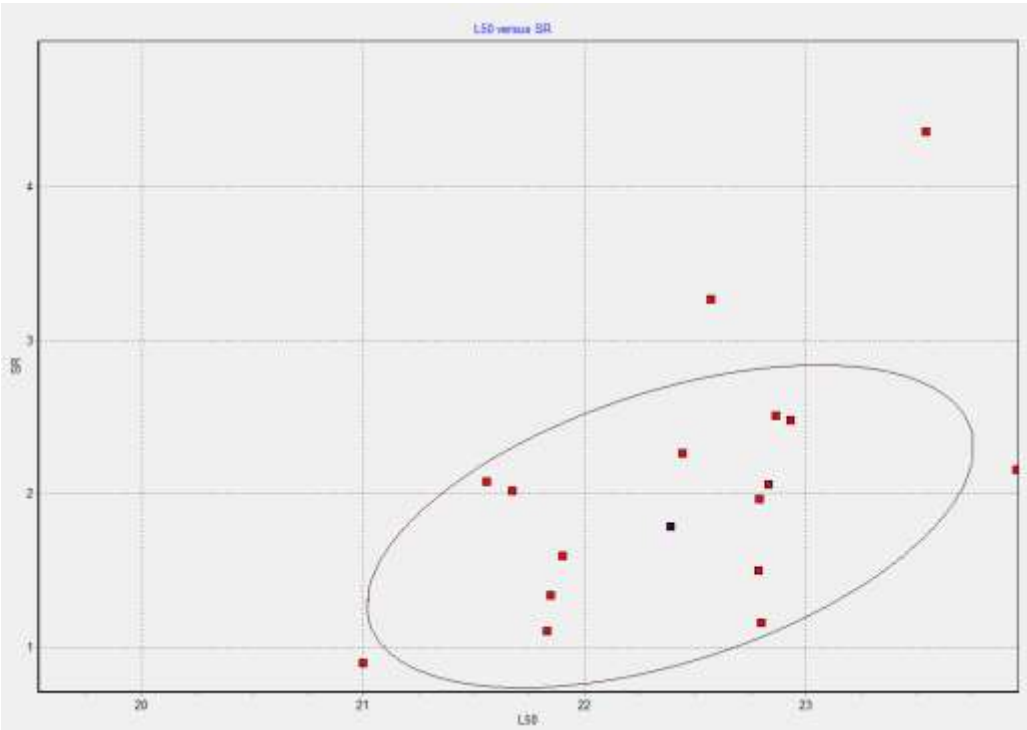


Figure 25. The relationship between L50 and SR of the experimental data.

Ongoing Pilot projects to increase the selectivity of the gear (sieve and cage)

The Italian Ministry for Food, Agriculture, Fisheries and Tourism Policies (MiPAAFT) recently financed projects to improve the selective performance of the gear as whole: the cage, where the first selection of the product occur, and the vibrating sieve, where most of the section occur.

To achieve this, the European Maritime and Fisheries Fund (EMFF), with specific reference to art.39 of Reg. (EU) 508/2014 "Innovation linked to the conservation of marine biological resources", may support interventions aimed at developing or introducing new technical or organisational knowledge that reduce the impact of fishery activities on the environment, including more effective and increased selectivity of fishing gear.

In order to pursue the objectives defined in the CFP and in particular those related to the implementation of conservation measures and the development of sustainable models of stock exploitation, the MiPAAFT has financed 15 initiatives for the realisation of project proposals, aimed at increasing the selectivity of screening equipment in relation to the national discard management plan for clam resources, adopted with DM 03/12/2018.

These projects are ongoing.

The following table shows the Consortia authorised to carry out the projects proposed to increase the selectivity of screening equipment, financed by MiPAAFT through Measure 1.39 "Innovation linked to the conservation of marine biological resources" of the EMFF 2014-2020.

Table 33. Pilot projects to increase the selectivity of the on-board screening equipment financed by MIPAAFT.

Pilot project to increase the selectivity of the on-board screening equipment		
Management Consortium	*Protocol reference*	*Amount eligible for funding*
Co.Ge.Mo. Monfalcone	n. 15650 of 13/07/2018	EUR 298 872.46
Co.Ge.Vo. Venezia	n. 15648-15649 of 13/07/2018	EUR 600 00.00
Co.Ge.Vo. Chioggia	n. 15647-15651 of 13/07/2018	EUR 600 00.00
Co.Ge.Mo. Ravenna	n. 15732 of 16/07/2018	EUR 282 950.00
Co.Ge.Mo. Rimini	n. 15731 of 16/07/2018	EUR 239 600.00
Co.Ge.Mo. Pesaro	n. 15730-15733 of 16/07/2018	EUR 510 800.00
Co.Ge.Vo. Ancona	n. 15635 of 13/07/2018	EUR 299 817.00
Co.Ge.Vo. Civitanova Marche	x	x
Co.Vo.Pi. San Benedetto del Tronto	n. 15588 of 12/07/2018	EUR 136 000.00
Co.Ge.Vo. Abruzzo Pescara	n. 11340 of 23/05/2018	EUR 299 493.00
Co.Ge.Vo. Frentano Ortona	x	x
Co.Ge.Vo. Termoli	n. 15632 of 13/07/2018	EUR 298 312.00
Consorzio Molluschi Nord Gargano	x	x
Co.Ge.Mo. Il Colosso di Barletta	n. 15774 of 17/07/2018	EUR 300 00.00
Co.Ge.Mo. Napoli	x	x
Co.Ge.Mo. Gaeta	x	x
Co.Ge.Mo. Roma	n. 15634 of 13/07/2018	EUR 298 312.00

Discards

Since the Discard Plan entered into force, to assess the effectiveness of the selection process and to verify that the product complied with the minimum conservation reference size (MCRS - 22 mm) periodic sampling on the commercial clam catch was carried out, also to check the discarded fraction of clams. In particular, random sampling was carried out (samples collected from different Maritime Districts): a sample was taken before the selection process, directly from the collection box at the bow of vessel, in which all the catch was transferred immediately after the haul. Then from the same haul, a commercial sample was also taken after the selection process with the mechanical vibrating sieve.

The length-frequency distributions of the clams sampled directly from the collection box (non sorted catch) demonstrate a wide range of sizes, with a considerable quantity of undersized specimens (< 22 mm; Figure 26). This means that the population present in the areas sampled was well structured. In terms of weight this undersized portion of the catch represents from 16% to a maximum of more 75%, with average value of 43.27±0.21%.

However, taking the size distributions after screening, it is possible to observe that the number of specimens under 22 mm was extremely small and sometimes almost zero (< 1%; Figure 27 and Table 34). In terms of weight, as the clams were small in size, their contribution to the total commercial catch quantity was not relevant. In fact, after screening undersized portion had a weight of 0.2% to 5% with an average value of 2.02±0.02%.

Furthermore, it was possible to observe that the commercial catch (after sieving) was mainly made up of clams of 24-25 cm (modal classes).

The results obtained from the monitoring activities demonstrate that, as a consequence of the screening operations on board with a legally compliant sieve, the quantities of clams currently retained are not sufficient to allow practical seeding operations for restocking purposes. Over 95% of undersized clams (<22 mm) are immediately returned to sea following the selection process. Considering the growth rates of the species, described in the chapter dedicated to the biology *C. gallina*, it can be envisaged that clams of 22 mm or similar can reach commercial sizes of 24-25 mm within 3-4 months.

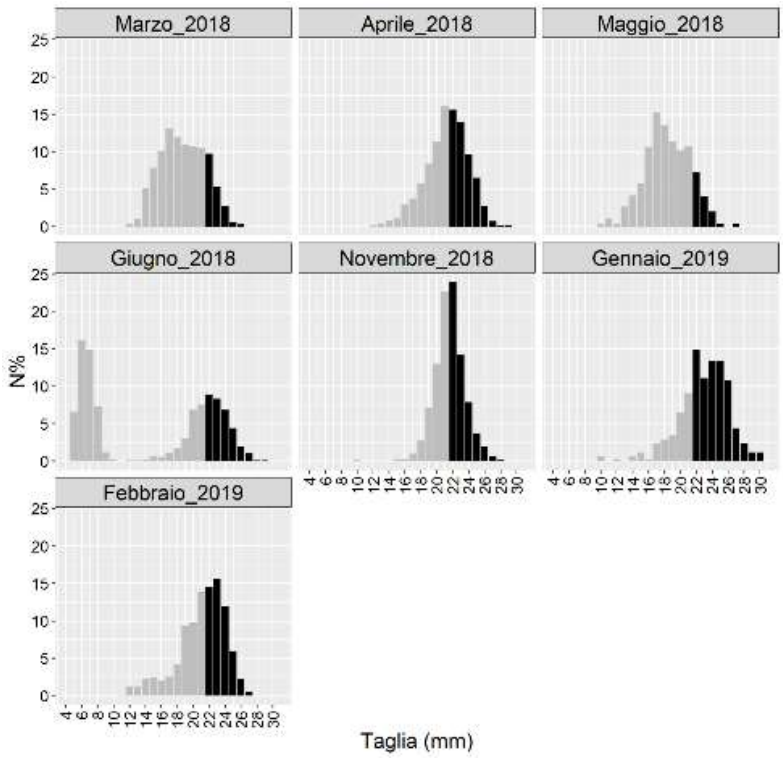


Figure 26. Density of specimens of *C. gallina* caught with hydraulic dredgers and not subjected to on-board screening operations in order to retain the undersized specimens. The specimens above the commercial size are indicated in black. Samples gathered at random from the Maritime Districts of Ancona, Civitanova and San Bendetto del Tronto.

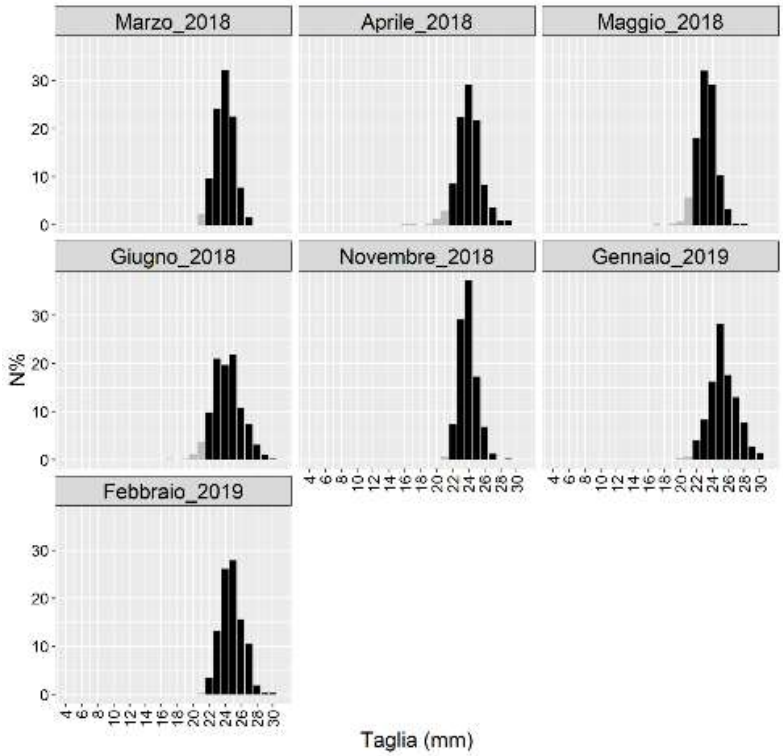


Figure 27. Density of specimens of *C. gallina* caught with hydraulic dredgers and subjected to on-board screening operations. The specimens above the commercial size are indicated in black. Samples gathered randomly from the Maritime Districts of Ancona, Civitanova and San Bendetto del Tronto.

Table 34. Percentage of specimens in number (N) and weight (Gr) under the minimum conservation reference size observed during monitoring. The percentages are given both for the commercial sample obtained following on-board selection operations and for the portion that was not screened. Samples obtained randomly from the Maritime Districts of Ancona, Civitanova and San Bendetto del Tronto.

		Mar-18	Apr-18	May-18	Jun-18	Nov-18	Jan-19	Feb-19
Not screened	**N < 22mm**	81.34%	50.60%	85.92%	68.47%	47.34%	27.11%	49.12%
	Gr < 22mm	69.44%	37.55%	75.64%	31.35%	38.04%	15.98%	34.92%
Screened	**N < 22mm**	2.30%	4.66%	6.98%	5.19%	0.68%	1.16%	0.35%
	Gr < 22mm	1.6%	2.92%	5.03%	3.26%	0.47%	0.65%	0.22%

Some cases are reported below of samples of *C. gallina* selected on board the fishing vessels using sieves with a 21 mm grill (single sieving operation), as normally used for commercial fisheries.

The cases reported refer to the years 2017 and 2018 (Veneto region)

<u>Selection with a 21 mm grill</u>

On the next table are shown the percentage ratio of clams (divided by size) after the first sieving on board.

Table 35: Size ratio (%) with sieve of 21 mm

Sieving with 21 mm sieve (1 on board)						
	Before DP		During DP			
Size	2015	2016	2017a	2017b	2018a	2018b
	%	%	%	%	%	%
16-21 mm	2,60	3,31	0,58	0,78	0,12	0,00
22-24 mm	35,93	39,16	31,38	58,07	41,53	41,35
≥25 mm	61,47	57,53	68,04	41,15	58,35	58,65
tot	100,00	100,00	100,00	100,00	100,00	100,00

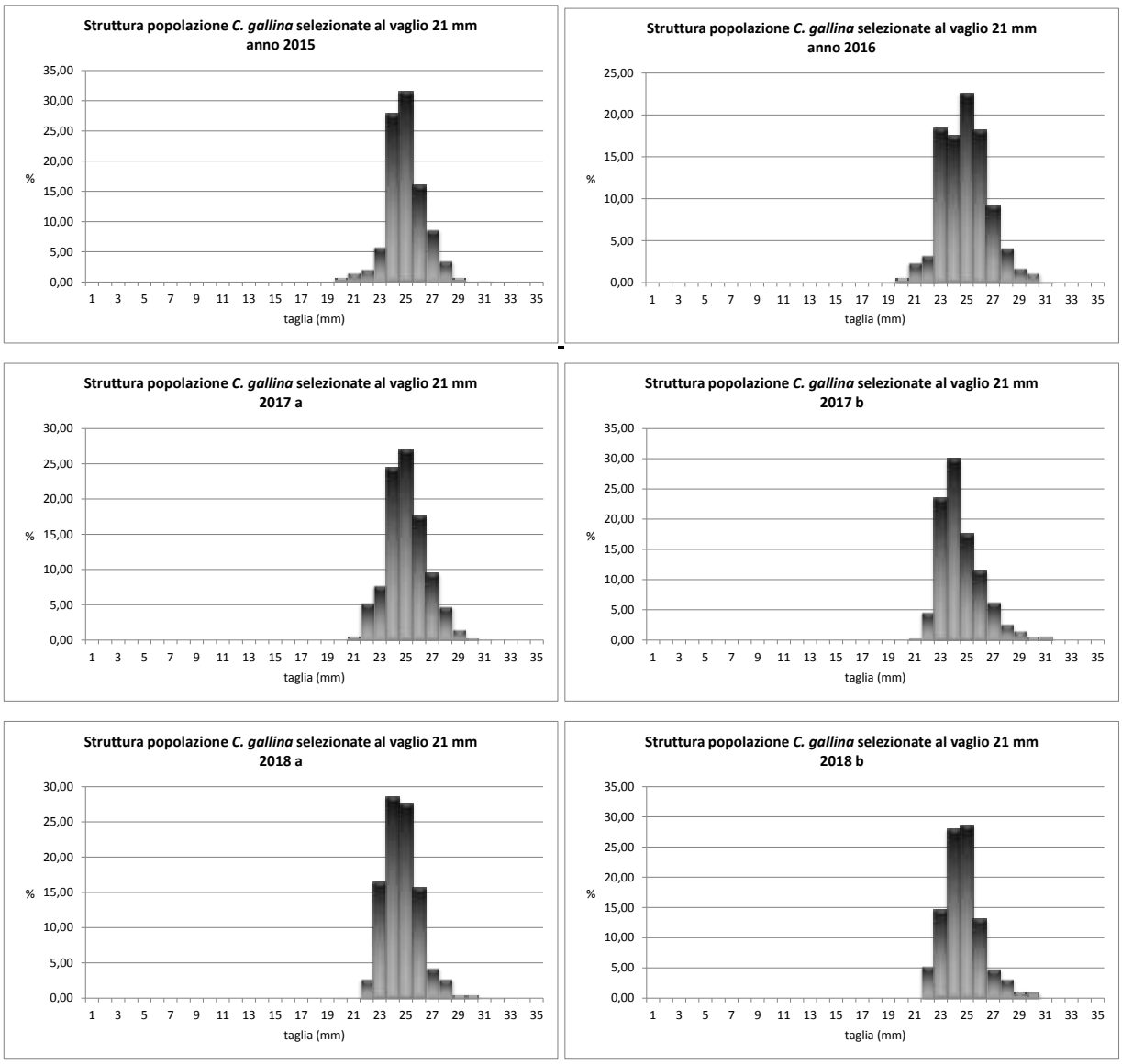


Figure 28: Population structure selected by 21 sieve - 2016/2018

The data analysis shows that the fraction between 22-24 mm is about 40% of fishery; this fraction, before the discard plan, was released to the sea with the risk to be fished more and more time by other vessels. The fishery impact on this clam fraction was reduced by the application of the discard plan.

After the introduction of the Discard Plan, it can be observed that the fraction of C. gallina <22 mm following selection with a 21 mm grid is very small, roughly estimated at 0.5%. This percentage, albeit low, is completely eliminated with the second screening procedure.

Restocking areas

The local management consortia to respect the minimum size adopted this protocol:

- a double sieve on board with 21 mm sieve with the release in loco of undersize clams;
- a further sieve on landing points with the recovery of undersize clam to be released on the restocking areas.

Indeed, using the legally compliant 21 mm sieves (hole diameter), the under-sized part of the catch retained on board after the selection process was so small that any reseeding operations would not be economically viable and would ultimately be of little use.

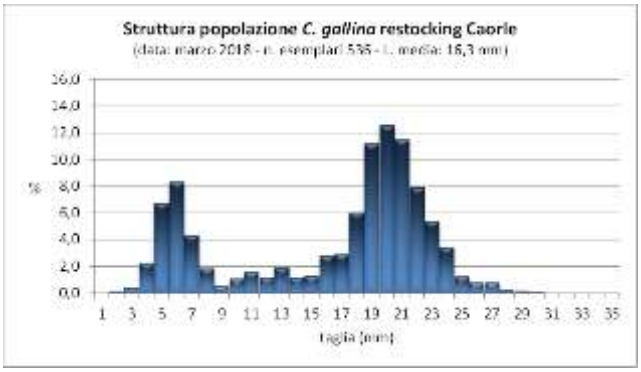
It can be added, however, that in the short time available it was possible to observe growth in the clams in the restocking areas, in line with the growth rates already described in the chapter on the biology of the species.

Pilot study: restocking areas in Veneto

Six restocking areas were identified in Veneto, which have not been used to date for the release and reseeding of undersized specimens caught; they have, however, been the subject of protection and periodic monitoring activities, the results are reported below.

Table 36. Caorle restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring.

Caorle area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	5,4	17,0
1° quarter 2018	4,4	15,4
2° quarter 2018	4,2	11,9
3° quarter 2018	6,4	7,7
4° quarter 2018	10,9	14,5



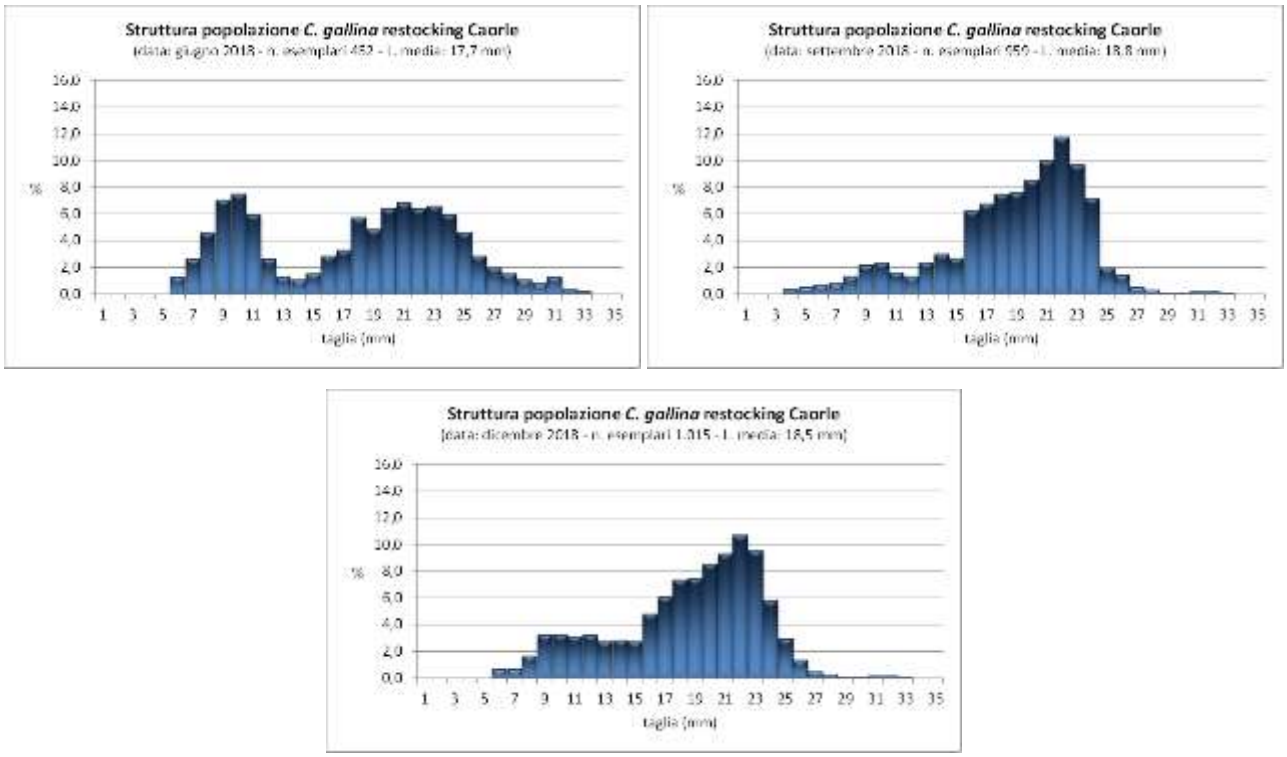
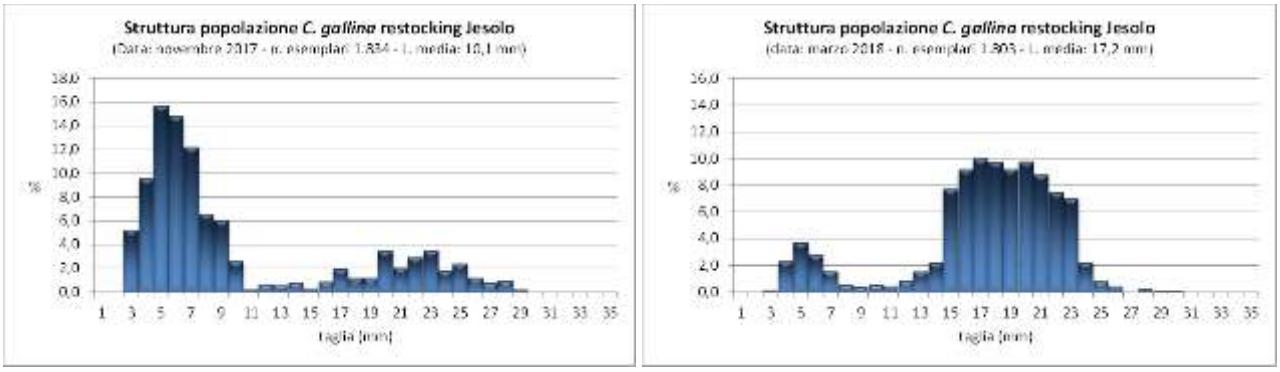


Figure 29. Size distribution found in the Caorle restocking area.

Table 37. Jesolo restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring.

Jesolo area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	16,0	37,5
1° quarter 2018	16,7	33,4
2° quarter 2018	19,8	36,0
3° quarter 2018	21,7	30,1
4° quarter 2018	24,2	20,9



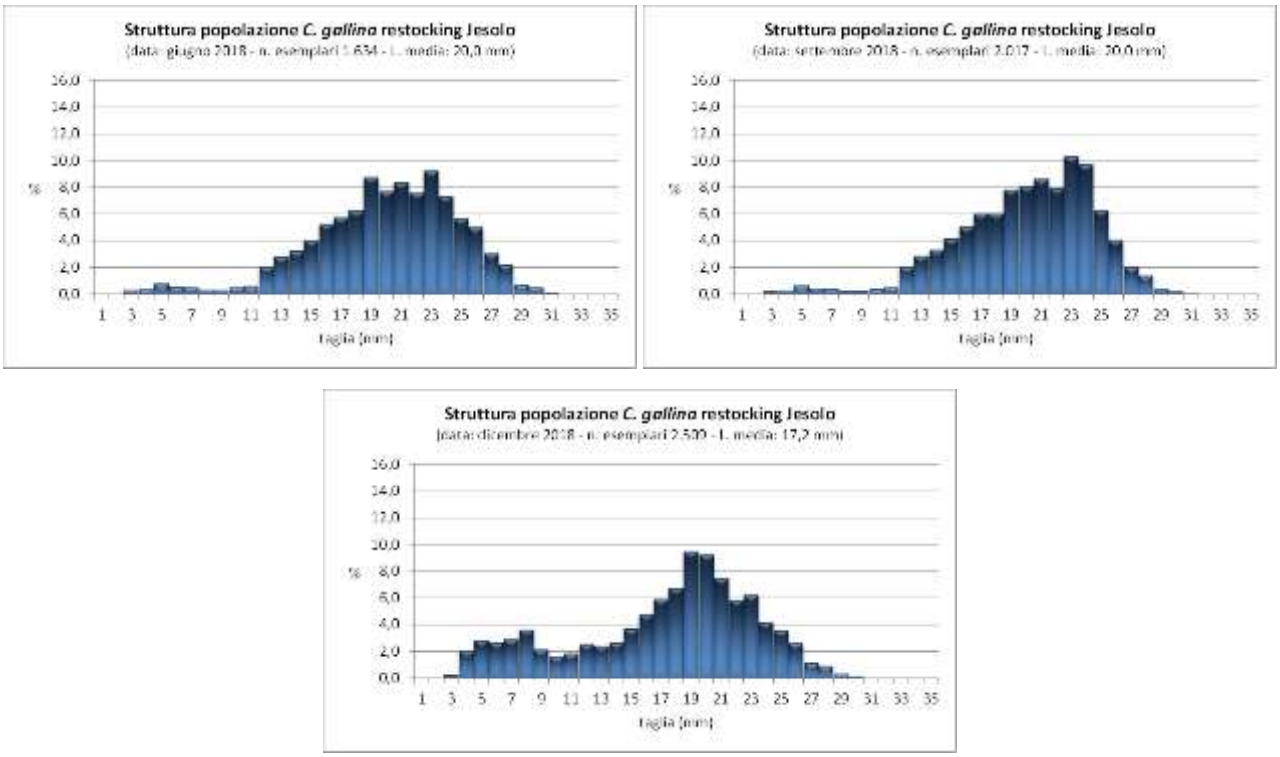
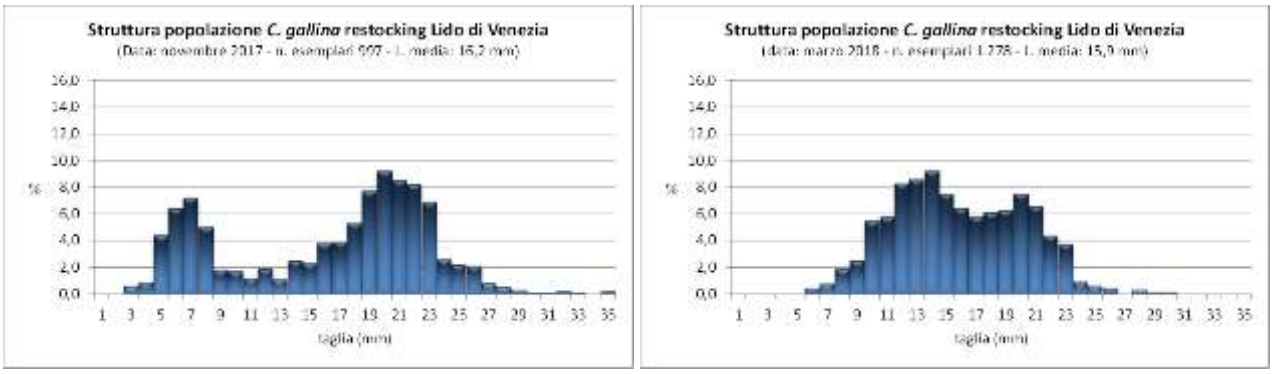


Figure 30. Size distribution found in the Jesolo restocking area.

Table 38. Lido di Venezia restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring.

Lido di Venezia area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	29,5	18,7
1° quarter 2018	13,2	34,1
2° quarter 2018	20,6	44,4
3° quarter 2018	31,3	35,8
4° quarter 2018	42,7	27,6



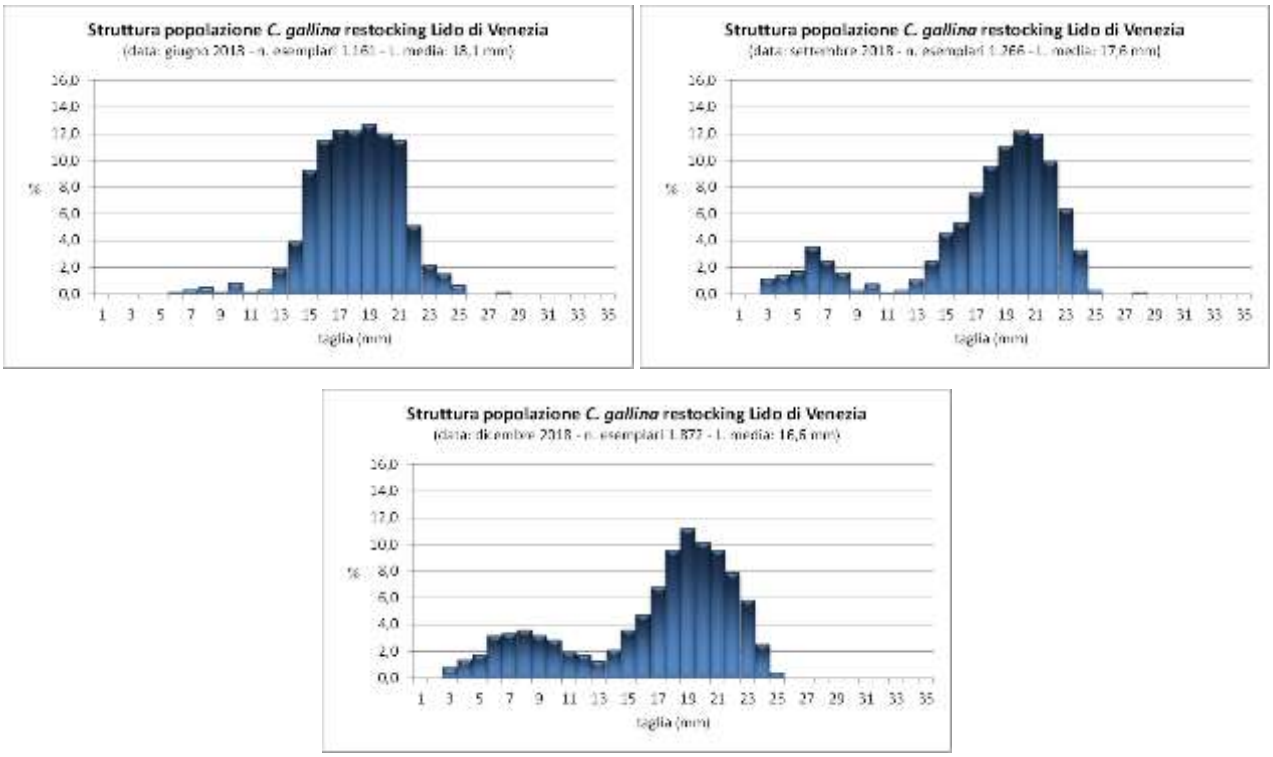
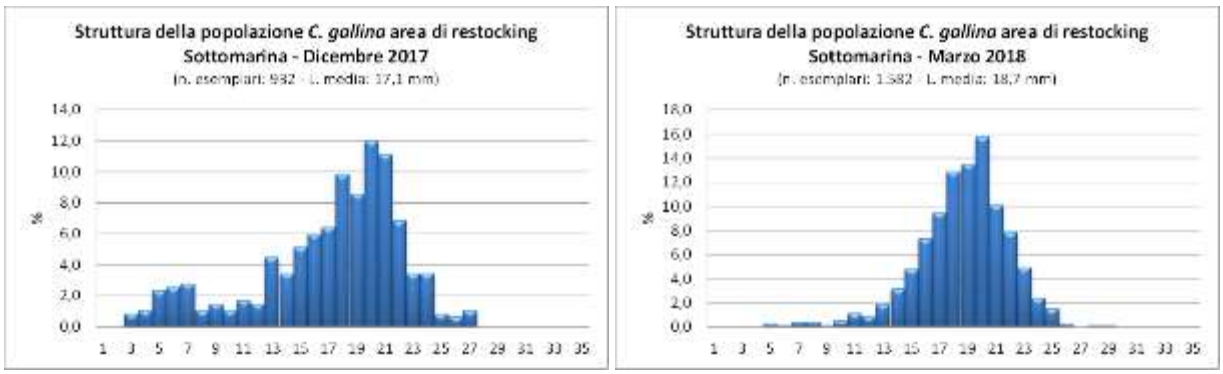


Figure 31. Size distribution found in the Lido di Venezia restocking area.

Table 39. Sottomarina restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring.

Sottomarina Area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	25,3	49,1
1° quarter 2018	37,8	57,1
2° quarter 2018	23,1	40,9
3° quarter 2018	21,5	36,8
4° quarter 2018	17,5	36,9



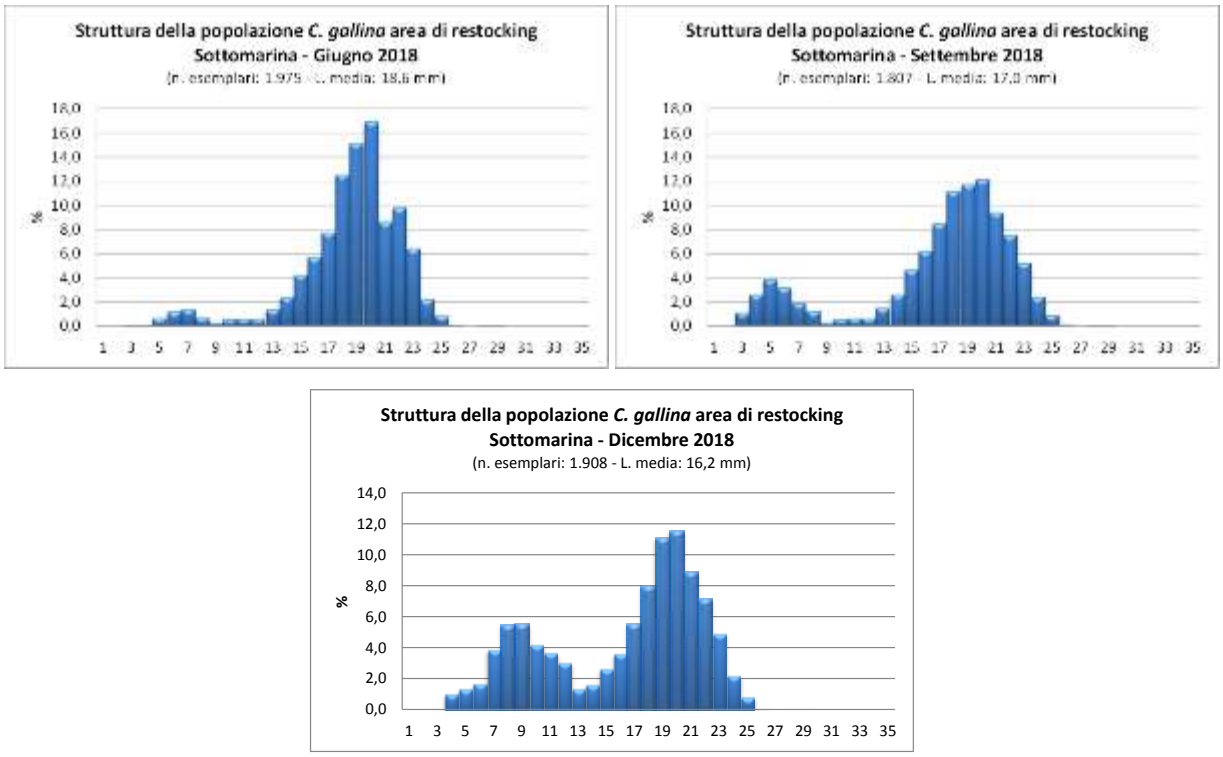
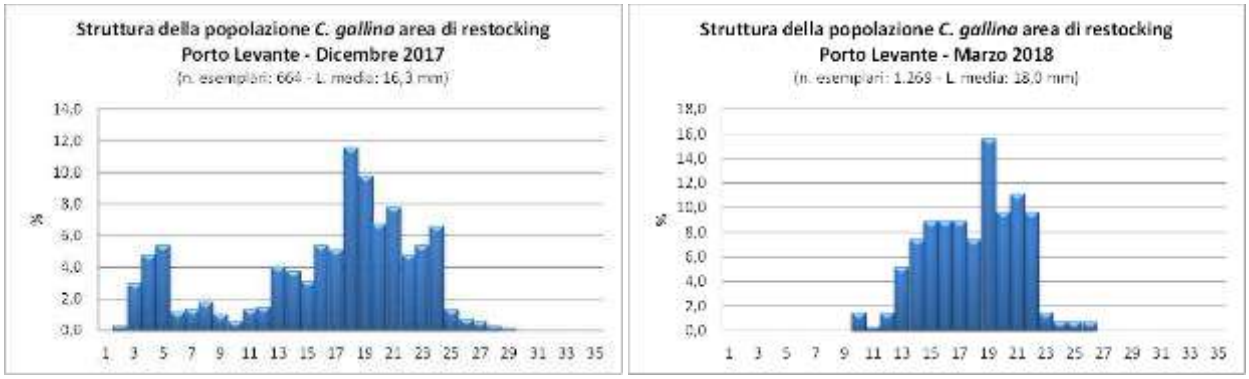


Figure 32. Size distribution found in the Sottomarina restocking area.

Table 40. Porto Levante restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring.

Porto Levante Area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	22,1	66,4
1° quarter 2018	18,5	56,2
2° quarter 2018	8,7	49,9
3° quarter 2018	17,8	49,8
4° quarter 2018	32,0	56,2



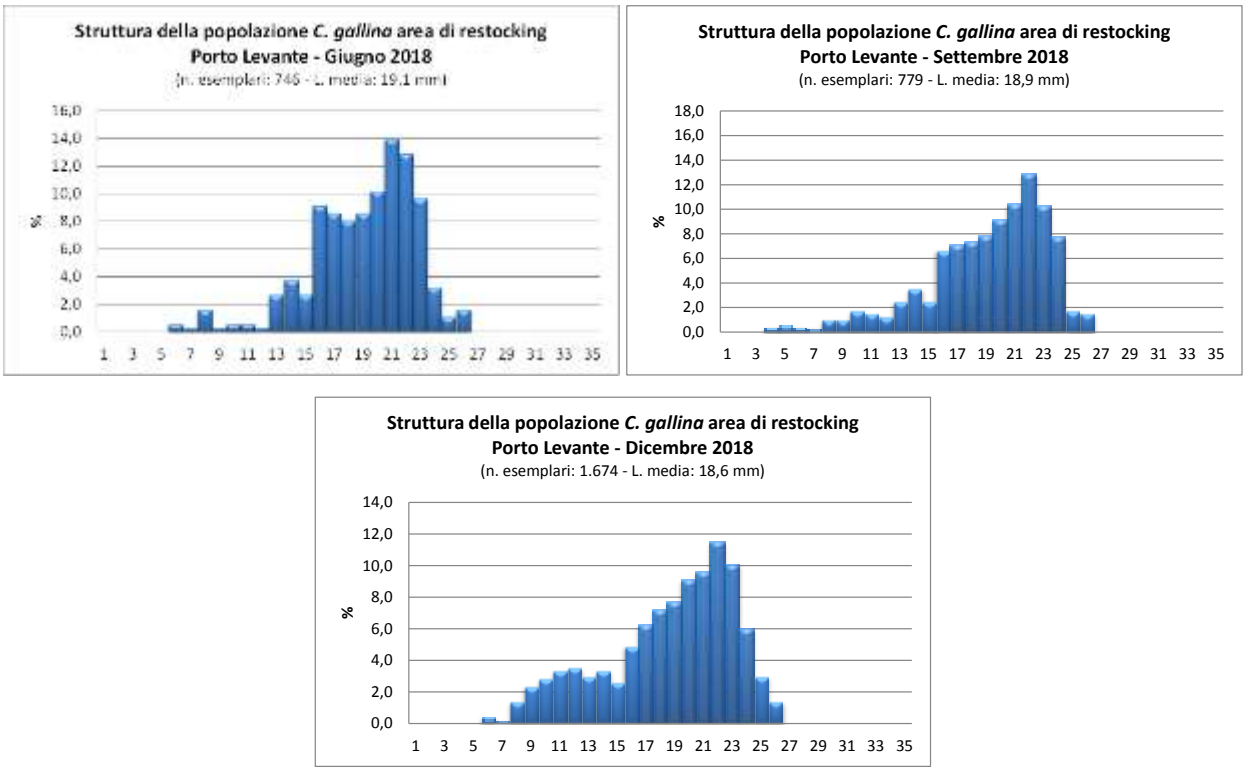
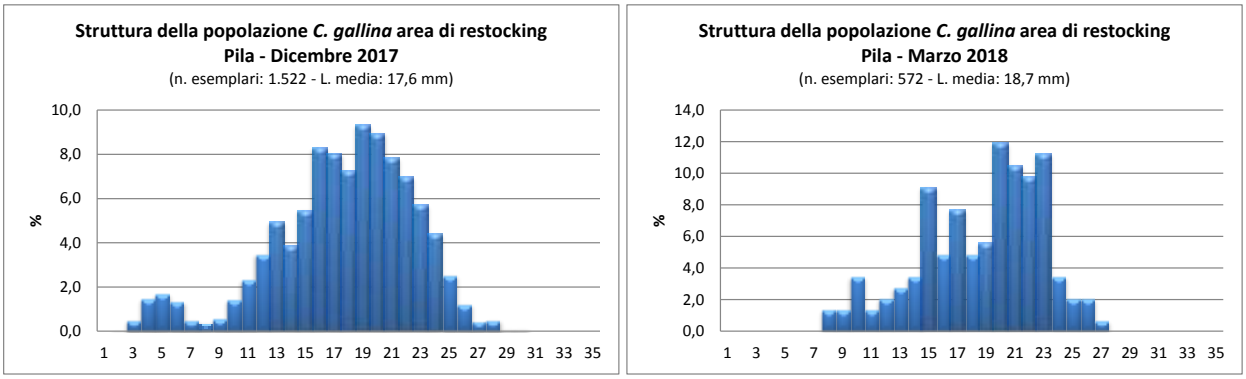


Figure 33. Size distribution found in the Porto Levante restocking area.

Table 41. Pila di Porto Tolle restocking area: biomass values for *Chamelea gallina* detected during periodic monitoring

Pila di Porto Tolle Area	Biomass (g/m2) ≥22 mm	Biomass (g/m2) 18-21 mm
Initial state	35,7	43,8
1° quarter 2018	29,1	44,7
2° quarter 2018	27,0	75,5
3° quarter 2018	31,2	70,3
4° quarter 2018	Not sampled	Not sampled



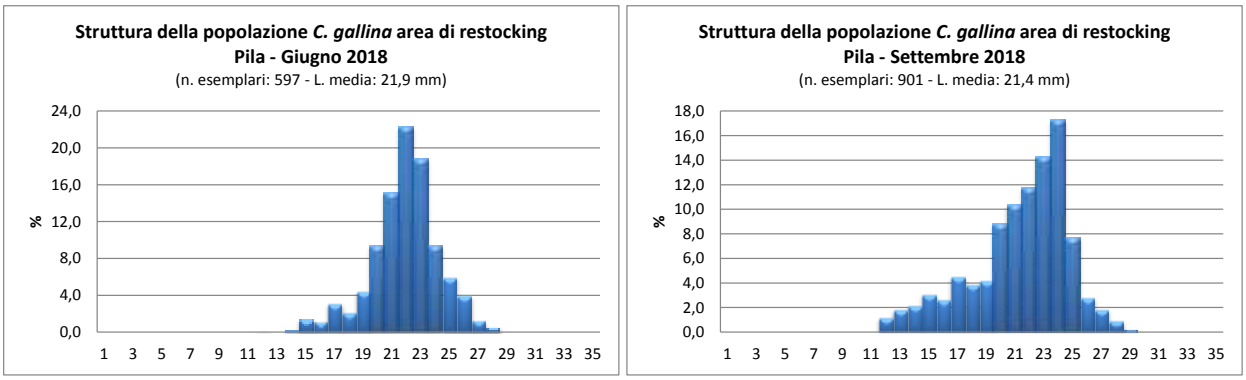


Figure 34. Size distribution found in the Pila di Porto Tolle restocking area.

Monitoring of the restocking areas along the Veneto coast highlighted that the areas, in which fishery activities are prohibited, maintain abundance levels of *C. gallina*. The only significant changes can be attributed to external factors, in particular the Lido di Venezia area, which in March 2018 was monitored in non-optimal marine conditions (the day before a deterioration in the weather conditions with south-easterly winds); the Porto Levante area where monitoring in June 2018 was hampered by the presence of pots, and the Pila di Porto Tolle area, in which the last controls (December 2018) were not carried out because the substrate was covered with muddy sediments following flooding in late October 2018.

Final considerations

In the light of the investigations conducted in the first two years of application of the Discard Plan, it has been possible to observe that the Management Consortia have applied the measures envisaged in the Discard Plan adequately, adopting systems to detect the position of vessels, defining the restocking areas according to the established schedule, introducing a certification system attesting the conformity of the product to the minimum conservation reference size at the landing sites. There are a few exceptions, but the consortia which have not fully implemented the Discard Plan have very low levels of the resource in question.

Where the minimum conservation reference size of 22 mm is concerned, it was considered appropriate to investigate some aspects of the biology of the species. This information was gathered following careful review of the available literature together with new biological research. The results obtained with regard to sexual maturity and growth confirm the scientific findings of other authors in previous years. In the samples obtained from the survey it was possible to determine the sex of individuals of 8-10 mm and observe mature gametes in both sexes from a length of 11-12 mm. The reproductive peak for the species would appear to be in the months of May and June, this period is followed by a resting stage until November, which is when the gametogenic cycle begins again for both sexes

A size of 22 mm is therefore larger than the size in the first stage of maturity (L50 = 16-18 mm) and is therefore aligned with and in full respect of sexual maturity, guaranteeing the sustainability of exploitation of this resource. Data relative to growth, on the other hand, have shown that clam size increases by about 1 mm/month. This means that a clam takes just under 2 years to reach a size of 22 mm and that the clams of 22 mm or slightly less, once released back into the sea, reach a size of 25 mm in about 3 months.

The technical measures included in the Discard Plan have brought about a reduction in fishing effort by hydraulic dredges. The potential fishing days per year have decreased, the maximum daily quota per vessel has been reduced (from 600 to 400 kg) and lastly the possibility to market specimens from a minimum length of 22 mm has been conceded (although it is currently rare to find clams smaller than 23 mm on the market). As a direct result has been possible for vessels to reach the daily quota more quickly, this has also resulted in a reduction in the areas dredged, thus reducing

the environmental impact of dredging gear. The reduction in the time spent on fishery operations means that this fishery also has implications of a socially useful nature.

With the entry into force of the Discard Plan, the characteristics of the selection gear on board have not been modified. Therefore, the properties of the sieving grids themselves have not been modified either. The research carried out has demonstrated that with the use of the correct vibrating sieves (hole diameter 21 mm), the number of specimens below 22 mm retained is irrelevant. Therefore, the number of individuals under 22 mm in the catch after selection is usually so low that it is often impractical and unprofitable to return these specimens to the restocking areas. This explains why in many Districts the areas of restocking have only been used marginally.

The standardised monitoring activities carried out 2017 and 2018 demonstrate that in almost all the Consortia the resource has recovered, with higher biomass and density values recorded in comparison with previous years. At the end of August 2018, however, there was an episode of sudden mass death in the central north of the Adriatic, probably due to a severe climatic event that may have negatively affected the surveys conducted from September onwards.

The surveys demonstrate high levels of spawning stocks, with a large number of juveniles in all areas, proving that recruitment has been excellent and this will ensure the future quantities of commercial clams.

The vessel position detection system has enabled the sector to participate in control activities, significantly improving its management activities. This tool can be used to plan fishing activities in relation to the effort applied.

The results of the first two years of the investigation show that the adoption of the clam discard plan has unequivocally led to benefits in economic terms. The portion of clams between 22 and 25 mm represents the main commercial portion, with modal classes at 23-24 mm. In the same period and with the same fishing effort a MCRS of 25 mm would have led to commercial losses of around 80%. **This means that a possible return to the 25 mm size would imply a considerable increase in fishing effort to guarantee an acceptable level of revenue, with likely an overexploitation of the resource**.

Hydraulic dredges have a physical impact on the seabed. However, it should be noted that communities living in low-depth, high-energy environments are already naturally subjected to constant environmental stress due to exceptional events (in particular large wave movements, strong currents), and they demonstrate resilience with rapid recovery, also depending on the duration of the event. The areas of the shoreline affected by *Chamelea gallina* fishing activities are not chronically disturbed as management planning differentiates harvesting activities by area, closing areas in rotation, or reducing fishing effort. In advanced management planning, large areas of the coast are subject to bans on fishing activities for average periods of 4-5 months, up to a maximum of 8-9 months (also applied by means of Orders issued by the local Port Authorities). These rest periods for the production areas allow the macrobenthonic community to recover over a 3-6-month period as indicated by Pranovi and Giovanardi (1994), or over about 2 months for areas with predominantly sandy characteristics used for commercial fishing (Pranovi *et al*.,1998). According to Goldberg *et al*., 2012, in a specific assessment of the effects of the hydraulic dredger used to harvest *Mercenaria mercenaria* in Connecticut, it appears that the ecological effects and recovery of the benthic community after the action of hydraulic dredgers can be assimilated to those which intervene after natural disturbances.

Keeping the Minimum Conservation Reference Size at 22 mm therefore appears to be a crucial to guarantee a positive future for the sector operating with hydraulic dredges, because it is sustainable from an ecological point of view (the biology of the species and the low environmental impact support this theory) but also from a socio-economic point of view.

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