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Management Plan for Mechanised Dredges in Andalusia, Spain (STECF-17-01)

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Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. This report deals with a management plan (MP) for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, Spain.

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Ulrich, C., Abella, J. A., Andersen, J., Arrizabalaga, H., Bailey, N., Bertignac, M., Borges, L., Cardinale, M., Catchpole, T., Curtis, H., Daskalov, G., Döring, R., Gascuel, D., Knittweis, L., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Prellezo, R., Raid, T., Sabatella, E., Sala, A., Scarcella, G., Soldo, A., Somarakis, S., Stransky, C., van Hoof, L., Vanhee, W., Vrgoc, Nedo.

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Background documents provided by the Commission

[1] Draft Management Plan for Dredges and Mechanised Dredges in the Mediterranean fishing area of the Autonomous Community of Andalusia- Evaluation and Monitoring Report Amendment and Extension Proposal (MARE-2016-689-0-0-EN-TRA-0.docx). This report is hereby referred to as EMRA. **[2]** Term of References of the ad-hoc contract for reviewing the EMRA and final report of the *ad-hoc* contract

Request to the STECF

The STECF is requested to:

TOR 1. Advice and assess whether the management plan for mechanised dredges in Andalusia contains adequate elements in terms of:

1.1. The description of the fisheries

- Recent and historical data on catches (landings and discards) of the species concerned, fishing effort and abundance indices such as catch-per-unit-effort (or CPUE). Advices whether catch and effort data should be assessed at the level of the Autonomous Region of Andalusia or by meta-populations.
- Data on length-frequency distribution of the catches, with particular reference to the species subject to minimum sizes in accordance with Annex III of the MEDREG[1].
- An updated state of the exploited resources.
- Information on economic indicators, including the profitability of the fisheries.

1.2. Objectives, safeguards and conservation/technical measures

- Objectives consistent with article 2 of the CFP[2] and quantifiable targets, such as fishing mortality rates and total biomass.
- Measures proportionate to the objectives, the targets and the expected time frame.
- Safeguards to ensure that quantifiable targets are met, as well as remedial actions, where needed, including situations where the deteriorating quality of data or non-availability places the sustainability of the main stocks of the fishery at risk.
- Other conservation measures, in particular measures to fully monitor catches of the target species, to gradually eliminate discards and to minimise the negative impact of fishing on the ecosystem.

1.3. Other aspects

- Quantifiable indicators for periodic monitoring and assessment of progress in achieving the objectives of the plan.
- Estimate the level of dependency of the fleet on the target stocks (i.e. *Donax trunculus*, *Callista chione*, *Acanthocardia tuberculata* and *Chamelea gallina)*.
- Advice whether the proposed modifications in terms of total annual catches and limit reference points of the plan would ensure a sustainable exploitation of the target stocks.

TOR 2. If deemed necessary, provide any recommendations and guidance on how to obtain improved scientific/technical supporting material for the plan. This could be done in terms of

[1] Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94. OJ L 409, 30.12.2006, p. 11–85.

[2] Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. OJ L 354, 28.12.2013, p. 22–61.

collection of data, evaluation of the status of the target stocks, evaluation of conservation measures, impact on the marine ecosystem and monitoring programme.

STECF response

A management plan (MP) for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia was implemented in 2014 (Order of 24 March 2014), which applied until 31 December 2016. STECF has previously reviewed earlier versions of the MP in 2010 (STECF PLEN-10-03) and 2013 (STECF PLEN-13-03)

The objectives of the submitted EMRA report were to: 1) evaluate compliance with the biological and conservation reference points set out in Articles 4 and 5 of the Order of 24 March 2014; 2) submit the scientific fishery evaluation and monitoring reports carried out by the Spanish Oceanography Institute and the Andalusian Agricultural and Fisheries Management Agency, dating from the entry into force of this management plan; and 3) forward the Commission the proposed amendment and extension of the Management Plan (MP). The EMRA report aims at justifying the extension of the 2014 Order until 2019. The EMRA analyses the period of implementation of the plan, from April 2014 to 15 September 2016, including the analysis of the CPUE time series over 2001-2015. Results are based on fishery-dependent data only.

The submitted EMRA (without annexes) has been revised through an *ad-hoc* contract (see section Background documents). The ad-hoc report answered the ToRs that were assessable, given that part of the ToRs were not taken into account in the objectives specified in the EMRA.

STECF agrees with the comments of the ad-hoc report.

STECF notes that the following points in the ToRs have not been addressed:

For ToR 1.1 (Description of the fishery) (i) historical data on discards of the species concerned have not been presented. According to the information presented to STECF PLEN-13-03, discard survival is however assumed to be substantial; (ii) There is no information presented on absolute fishing effort (e.g. number of vessels and fishing days), which would have indicated whether effort has increased or decreased since the implementation of the MP. STECF notes however that this information is available in the SLSEPA system. STECF notes furthermore that provisions for regulating the number of vessels, the numbers of fishing days and the numbers of fishing hours per day are included in the MP itself. Finally, STECF notes that the spatial information of the fishing effort by species presented in the maps is of poor quality and has a low spatial resolution, making it difficult to draw conclusions regarding changes over time. Additional summary metrics on the effective effort should be provided. (iii) Regarding the advice whether catch and effort data should be assessed at the level of the Autonomous Region of Andalusia or by meta-populations, the EMRA does not contain any biological information regarding stock structure and the possible existence of sub-populations in the area. The Ad-hoc report notes that according to the maps presented in the EMRA, the catch areas are rather continuous; STECF notes however that this does not seem to be always the case and that some fishing areas for some stocks seem more geographically isolated. Additionally, region 3 on the maps is not contiguous with region 2 for *C. gallina* and for *D. trunculus.* According to Marie et al. (2016), there is however no clear genetic differentiation of *D. trunculus* at different sampling sites within Andalucia, and therefore no evidence of isolated sub-populations in the region. Given that all the species are largely coastal and sedentary, it remains unclear whether single stock assessments at the level of the Autonomous Region of Andalusia are appropriate or larger/smaller areas should be considered. STECF considers that stocks' identity should be investigated further to validate or better define the stock unit of the species included in the MP. (iv) Finally, information on economic indicators, including the profitability of the fisheries are not present in the management plan.

For ToR 1.2 (Objectives, safeguards and conservation/technical measures) Potential measures which can be used to eliminate discards and minimise the negative impact on the ecosystem are not described. Nevertheless, information was presented to STECF in 2013 (PLEN-13-03) arguing that the fishery can be considered to have a low impact on the ecosystem.

For ToR 1.3 (other aspects). The dependency of the fleet on the target species is not presented.

STECF notes that a major element of the EMRA is the revision of some of the target TACs and limits CPUEs for some species (i.e. TAC decreases for *D. trunculux* to 35 t; TAC increases to 216 t/year for *C. chione*; TAC increases to 1290 t/year and average minimum catch increases to 325 kg/boat/day for *A. tubercolata*; average minimum catch decreases to 23.8 kg/boat/day for *C. gallina*). These revisions are based on updated analyses of surplus production models fitted to landings and CPUE time series, tested using both ASPIC and BioDyn software. The ad-hoc report considers that these adjustments, proposed as amendments to the Article 4 of the Order of 24 March 2014, seem to be reasonable in the light of the trends in CPUE observed during the period 2014-2016. STECF endorses this comment. As also noted by the ad-hoc contract, STECF considers nevertheless that the reliability of the stock assessment would be greatly improved by collecting fisheries-independent density estimates.

Ultimately, the growth and mortality of bivalves are known to be strongly conditioned by environmental conditions such as e.g. temperature, turbidity or chlorophyll. STECF suggests that further investigations including some environmental explanatory variables could be performed, as can be done with e.g. BioDyn.

STECF conclusions

STECF concludes that the revised MP presented in the EMRA includes many elements supported by scientific data, but notes that some ToRs are only partially addressed.

STECF concludes that the revision of some of the target TACs and limits CPUEs for some species is appropriate.

STECF concludes that economic indicators, including the economic viability of the fisheries, should be assessed.

STECF agrees with the guidance under ToR 2 of the ad-hoc contract regarding the needs to carefully monitor the status of *C. gallina* in the near future and to supplement the stock assessment with fisheries-independent estimates of biomass density.

STECF considers that the stock structure of the different species should be investigated further, and the relevance of performing single stock assessments at the level of the Autonomous Region of Andalusia are appropriate or larger/smaller areas should be considered.

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[1] - Information on STECF members' affiliations is displayed for information only. In any case, Members of the STECF shall act independently. In the context of the STECF work, the committee members do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

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Background documents

1. Draft Management Plan for Dredges and Mechanised Dredges in the Mediterranean fishing area of the Autonomous Community of Andalusia- Evaluation and Monitoring Report Amendment and Extension Proposal (MARE-2016-689-0-0-EN-TRA-0.docx).

2. Term of References of the ad-hoc contract for reviewing the EMRA and final report of the ad-hoc contract

GOVERNMENT OF ANDALUSIA

MANAGEMENT PLAN FOR DREDGES AND MECHANISED DREDGES IN THE MEDITERRANEAN FISHING AREA OF THE AUTONOMOUS COMMUNITY OF ANDALUSIA

- EVALUATION AND MONITORING REPORT AMENDMENT AND EXTENSION PROPOSAL –

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Preparation	✓ Spanish Institute of Oceanography (*Instituto Español de Oceanografía*, IEO) Malaga Oceanographic Centre (Centro Oceanográfico de Málaga). ✓ Fisheries Inspection Department *(Departamento de Inspección Pesquera)* Subdirectorate-General for Agri-food Inspection – Resources and Infrastructure *(Subdirección de Inspección Agroalimentaria Recursos e Infraestructuras)*. Agency for the Management of Agriculture and Fisheries of Andalusia (*Agencia de Gestión Agraria y Pesquera de Andalucía,* AGAPA) ✓ Fishery and Aquaculture Resources Management Service *(Servicio de Ordenación de Recursos Pesqueros y Acuícolas)*. Directorate-General for Fisheries and Aquaculture (*Dirección General de Pesca y Acuicultura* (DGPA)).
Review	Fishery and Aquaculture Resources Management Service, Directorate-General for Fisheries and Aquaculture
Approval	Head of the Directorate-General for Fisheries and Aquaculture

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1. BACKGROUND

Since 2010, the Directorate-General for Fisheries and Aquaculture has been working on the Management Plan for Dredges and Mechanised Dredges off the Mediterranean coast of the Autonomous Community of Andalusia, in order to comply with the provisions of Article 19 of *Council Regulation (EC) No 1967/2006 of 21 December concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94,* which establishes that:

> *'Article 19: Management plans for certain fisheries in territorial waters.*
> *1. Member States shall adopt, by 31 December 2007, management plans for fisheries conducted by trawl nets, boat seines, shore seines, surrounding nets and dredges within their territorial waters. Article 6(2) and (3) and Article 6(4) first subparagraph of Regulation (EC) No 2371/2002 shall apply to those management plans.*
>
> *2. Member States may subsequently designate other management plans on the basis of new relevant scientific information.*
>
> *3. Member States shall ensure adequate scientific monitoring of the management plans. In particular, certain management measures for fisheries exploiting short-life species shall be revised each year to take into account changes that are likely to occur in the recruitment strength.*
>
> *4. Management plans may include measures which go beyond the provisions of this Regulation for the purpose of:*
> *a) increasing the selectivity of fishing gear;*
> *b) reducing discards;*
> *c) limiting the fishing effort.*
>
> *5. The measures to be included in the management plans shall be proportionate to the objectives, the targets and the expected time frame, and shall have regard to:*
>
> *a) the conservation status of the stock or stocks;*
> *b) the biological characteristics of the stock or stocks;*
> *c) the characteristics of the fisheries in which the stocks are caught;*
> *d) the economic impact of the measures on the fisheries concerned.*
>
> *6. Management plans shall provide for the issuing of special fishing permits in accordance with Regulation (EC) No 1627/94. Notwithstanding the provisions of Article 1(2) of Regulation (EC) No 1627/94, vessels of an overall length of less than 10 m may be required to have a special fishing permit.*
>
> *7. Management plans referred to in paragraph 1 shall be notified to the Commission by 30 September 2007 for it to present its observations before the plan is adopted. Management plans referred to in paragraph 2 shall be notified to the Commission six months in advance of the foreseen date of entry into force. The Commission shall communicate the plans to the other Member States.*
>
> *8. Where a management plan is likely to affect the vessels of another Member State, it shall be adopted only after consultation of the Commission, the Member State and the Regional Advisory Council concerned in accordance with the procedure set out in Article 8(3) to (6) of Regulation (EC) No 2371/2002.*
>
> *9. If the Commission, on the basis of the notification referred to in paragraph 7 or of new scientific advice, considers that a management plan adopted pursuant to either paragraph 1 or paragraph 2 is not sufficient to ensure a high level of protection of resources and the environment, it may, after having consulted the Member State, ask it to amend the plan or may propose to the Council appropriate measures for the protection of the resources and the environment."*

Finally, on 31 March 2014 the Official Gazette of the Government of the Autonomous Community of Andalusia (Junta de Andalucía) (BOJA No 61) published the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia* (Annex, Document No 1).

On 14 May 2014, the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, Ms Carla Montesi, sent a written communication (Ref.: MARE/D2/SPM/sfb D(2014)1531718) to the Director-General for Fisheries Resources and Aquaculture of the Spanish Ministry of Agriculture, Food and Environment, Mr Ignacio Escobar Guerrero, requesting clarifications and making some corrections to the final text of the management plan approved by the Order of 24 March 2014 (Annex, Document No 2).

On 20 May 2014, the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment, forwarded to this Directorate-General (Ref.: 411/AGG), the written communication of the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, dated 14 May 2014 (Annex, Document No 3).

On 12 June 2014, in reply to the request made by the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, in her letter dated 14 May 2014, this Directorate-General sent a written communication (Ref.: EC0/2014/732717) to the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment, forwarding the requested clarifications and communicating the intention to submit the corresponding amendment proposal regarding the *Order of 24 March 2014* (Annex, Document No 4) to the Legal Services of the Regional Ministry of Agriculture, Fisheries and Rural Development.

On 20 June 2014, the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment, wrote to the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, attaching the letter received from the Directorate-General of Fisheries and Aquaculture of the Government of Andalusia, dated 12 June 2014.

On 11 July 2014, the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, sent a letter (Ref. MAR-D2/SPM (2014)2318137) to the Director-General for Fisheries Resources and Aquaculture of the Spanish Ministry of Agriculture, Food and Environment, consisting of a series of comments on the communication submitted by the Directorate-General for Fisheries and Aquaculture of the Government of Andalusia, dated 12 June 2014 (Annex, Document No 5).

On 14 July 2014, the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment, forwarded to this Directorate-General (Ref. 411/AGG), the letter of the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries, dated 11 July 2014 (Annex, Document No 6).

On 16 July 2014, this Directorate-General sent a written communication to the Director for the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs and Fisheries (EC0/2014/754762), and the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment (EC0/2014/753425), accepting the comments made by the Director for
the Mediterranean and the Black Sea of the European Commission Directorate-General for Maritime Affairs, in its letter dated 11 July 2014 (Annex, Document No 7).

On 26 July, a draft Order amending the Order of 24 March 2014, which established a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia (Annex, Document No 8), was sent to the Legal Services of the Regional Ministry of Agriculture, Fisheries and Rural Development (Ref.:EC0/2014/760396).

On 12 January 2015, the Official Gazette of the Government of Andalusia (BOJA No *D*6), published *the Order of 29 December 2014, which amended the Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia* (Annex, Document No 9).

On 12 January 2015, this Directorate-General sent a letter (Ref. ECO/2015/858343) to the Director-General for Fisheries and Aquaculture Resources of the Spanish Ministry of Agriculture, Food and Environment (Annex, Document No 11), informing him of the publication in the Official Gazette of the Government of Andalusia (BOJA No 6), of the Order of 29 December 2014, which amended the Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, in order that he, in turn, could inform the European Commission (Annex, Document No 10).*

2. OBJECTIVE

This document aims to:

1. Evaluate compliance with the biological and conservation reference points set out in Articles 4 and 5 of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia.*

> *'Article 4: Biological reference points.*
>
> *For the purposes of applying this Order, the main species susceptible of being caught by means of a mechanised dredge are, according to the Spanish Institute of Oceanography, deemed to be within safe biological limits and, therefore, exploited in a sustainable manner, when the following requirements are met:*
>
> *Abrupt wedge shell (Donax trunculus):*
> *Total annual catch not more than 49 t/year.*
> *Minimum average annual catch of at least 17.5 kg/vessel/day.*
>
> *Smooth clam (Callista chione):*
> *Total annual catch not more than 182 t/year.*
> *Minimum average annual catch of at least 92 kg/vessel/day.*
>
> *Rough cockle (Acanthocardia tuberculata):*
> *Total annual catch not more than 1 128 t/year.*
> *Minimum average annual catch of at least 321 kg/vessel/day.*
>
> *Striped venus clam (Chamelea gallina):*
> *Total annual catch not more than 22 t/year.*
> *Minimum average annual catch of at least 25.6 kg/vessel/day."*
>
> 'Article 5: Conservation reference points.
>
> 1. *If the total annual catch values set out in Article 4 are exceeded, the fishery for that species must be closed for the remainder of that year, following a reasoned resolution by the Directorate-General for Fisheries and Aquaculture.*
>
> 2. *If the minimum average annual catch values are not reached for the aforementioned species, an analysis of the fishery data and situation must be carried out, in order to determine the reasons for those values.*
>
> *In the event that this situation is considered to be a consequence of a decrease in exploitable populations, whatever its cause, fishing for the threatened species must be reduced from five authorised fishing days per week to four fishing days per week in the following year.*
>
> 3. *If the measure described in the previous paragraph fails to re-establish values above the minimum average annual catch, the fishery must be closed by means of a resolution by the Directorate-General for Fisheries and Aquaculture, until such time as the results of the scientific monitoring, established in Article 15 of this Order offer sufficient technical assurances to allow fishing to resume.'*

2. In accordance with Article 19.3 of *Council Regulation (EC) No 1967/2006 of 21 December concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea*, the scientific fishery evaluation and monitoring reports carried out by the Spanish Oceanography Institute and the Andalusian Agricultural and Fisheries Management Agency, dating from the entry into force of this management plan, must be submitted to the Commission.

> *'Article 19: Management plans for certain fisheries in territorial waters.*
>
> *3. Member States shall ensure adequate scientific monitoring of the management plans. In particular, certain management measures for fisheries exploiting short life species shall be revised each year to take into account changes that are likely to occur in the recruitment strength.'*

3. In accordance with Articles 16 and 19 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia,* the proposed amendment and extension of the Management Plan is forwarded to the Commission.

> *'Article 16: Adjustment of fishing effort*
>
> *On the basis of the results of the scientific evaluation and monitoring reports of the fishery, the Ministry responsible for fishing and shellfish shall decide on the need to adopt additional measures, through the modification of this Management Plan, for the adjustment and control of fishing effort and, where appropriate, for the annual total catch or the average annual minimum catch values, the percentages of effort reduction necessary, as well as the period during which these reduction targets must be met.*
>
> *Article 19. Validity of the Management Plan.*
>
> *The Plan shall apply from the date of entry into force of this Order until 31 December 2016 and shall be reviewed and modified, if appropriate in view of the scientific reports, annually.*
>
> *Without prejudice to the provisions of the preceding paragraph, and with the agreement of the European Commission, the period may be extended, where necessary, on the basis of the scientific reports on the evolution of resources.'*

3. EVALUATION OF COMPLIANCE WITH BIOLOGICAL AND CONSERVATION REFERENCE POINTS

Article 4 of *the Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia* provides that:

> 'Article 4: Biological reference points.
>
> For the purposes of application of this Order, the main species susceptible to being caught by means of a dredge or mechanised dredge are deemed, according to the Spanish Oceanography Institute, to be within safe biological limits and, therefore, exploited in a sustainable manner, when the following requirements are met:
>
> *Abrupt wedge shell (Donax trunculus):*
> *Total annual catch not more than 49 t/year.*
> *Minimum average annual catch of at least 17.5 kg/vessel/day.*
>
> *Smooth clam (Callista chione):*
> *Total annual catch not more than 182 t/year.*
> *Minimum average annual catch of at least 92 kg/vessel/day.*
>
> *Rough cockle (Acanthocardia tuberculata):*
> *Total annual catch not more than 1 128 t/year.*
> *Minimum average annual catch of at least 321 kg/vessel/day.*
>
> *Striped venus clam (Chamelea gallina):*
> *Total annual catch not more than 22 t/year.*
> *Minimum average annual catch of at least 25.6 kg/vessel/day.*

In this sense, the following table shows the total catch values obtained annually since the entry into force of the management plan:

Table 1: Total annual catch (tonnes) of the abrupt wedge shell, smooth clam, rough cockle and striped venus clam species.

	Total annual catch (tonne/year)			
	2014[(1)]	**2015**	**2016[(2)]**	**Limit**
Abrupt wedge shell *(Donax trunculus)*	18.34	24.16	19.46	49
Smooth clam *(Callista chione)*	190.63	242.93	172.85	182
Rough cockle *(Acanthocardia tuberculata)*	705.20	1 116.54	1 007.19	1 128
Striped venus clam *(Chamelea gallina):*	19.51	13.64	3.87	22

(1) Total yields (kg) from April to December 2014, i.e. since the entry into force of the *Order of 24 March 2014.*

(2) Dated 15 September 2016.

The following table shows the average annual catch per boat and per day obtained since the entry into force of the management plan:

Table 2: Average annual yields (kg/vessel/day) of the abrupt wedge shell, smooth clam, rough cockle and striped venus clam species.

	Catch (kg/vessel/day)			
	2014 [1]	**2015**	**2016[2]**	**Limit**
Abrupt wedge shell *(Donax trunculus)*	16.14	15.80	-	17.5
Smooth clam *(Callista chione)*	93.14	98.28	-	92
Rough cockle *(Acanthocardia tuberculata)*	934.32	808.46	-	321
Striped venus clam *(Chamelea gallina):*	26.68	21.48	-	25.6

[1] Average yields from April to December 2014, i.e. since the entry into force of the *Order of 24 March 2014*
[2] Data not available.

Article 5 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia* provides that:

> 'Article 5: Conservation reference points.
>
> 1. *Should the total annual catch values set out in Article 4 be exceeded, the fishery for that species shall be closed for the remainder of that year, by means of a reasoned resolution by the Directorate-General of Fisheries and Aquaculture.*
>
> 2. *If the minimum average annual catch values are not reached for the aforementioned species, an analysis of the fishery data and situation must be carried out, in order to determine the reasons for those values.*
>
> *In the event that this situation is considered to be a consequence of a decrease in exploitable populations, whatever its cause, fishing for the threatened species must be reduced from five authorised fishing days per week to four fishing days per week in the following year.*
>
> 3. *If the measure described in the previous paragraph fails to re-establish values above the minimum average annual catch, the fishery must be closed by means of a resolution by the Directorate-General for Fisheries and Aquaculture, until such time as the results of the scientific monitoring, established in Article 15 of this Order offer sufficient technical assurances to allow fishing to resume.'*

3.1. ABRUPT WEDGE SHELL *(Donax trunculus)*

In accordance with Article 4 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, the abrupt wedge shell *(Donax trunculus),* is considered to be within safe biological limits and, therefore, sustainably exploited, according to the Spanish Oceanography Institute, when the following requirements are met:

- Total annual catch not more than 49 t/year.
- Minimum average annual catch of at least 17.5 kg/vessel/day.

The results of these parameters are given below.

Table 3: Total annual catch (tonnes) of the abrupt wedge shell species (Donax trunculus).

	Total annual catch (tonne/year)			
	2014[(1)]	**2015**	**2016[(2)]**	**Maximum limit**
Abrupt wedge shell *(Donax trunculus)*	18.34	24.16	19.46	49

[(1)] Total yields (kg) from April to December 2014, i.e. since the entry into force of the *Order of 24 March 2014.*
[(2)] Dated 15 September.

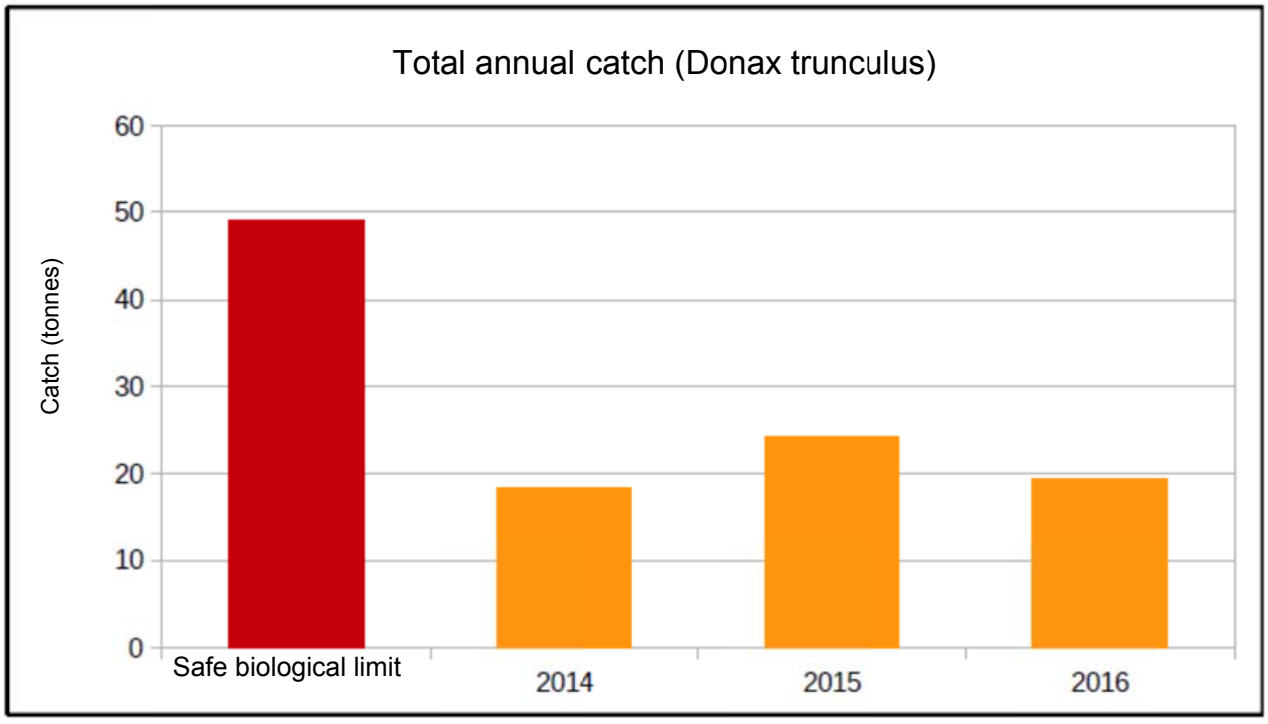


Figure 1: Visual representation of total annual catch (tonnes) of the abrupt wedge shell species (Donax trunculus)

Table 4: Average annual yields (kg/vessel/day) of the abrupt wedge shell species

	Catch (kg/vessel/day)			
	2014	**2015**	**2016[1]**	**Minimum limit**
Abrupt wedge shell *(Donax trunculus)*	16.14	15.80	-	17.5

[a]Data not available.

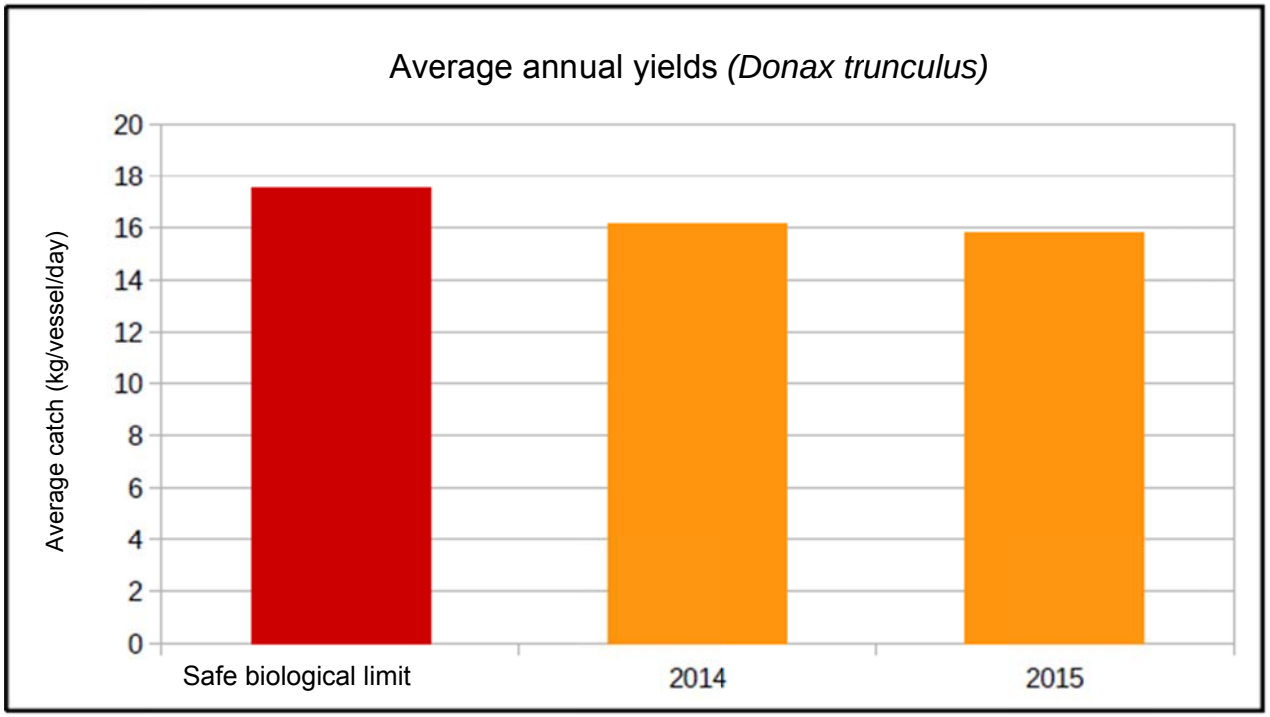


Figure 2: Visual representation of average annual yields (kg/vessel/day) of the abrupt wedge shell species (Donax trunculus).

The total annual catch data obtained since the entry into force of the *Order of 24 March 2014* for the abrupt wedge shell species have not exceeded the established annual limit of 49 t/year (2014: 18.34 t; 2015: 24.16 t; 2016: 19.46 t). The highest annual catch was obtained in 2015, reaching a total of 24.16 t, which is still 50.76% lower than the maximum value established by the Spanish Oceanography Institute as a safe biological limit. With regard to this parameter, the abrupt wedge shell species is being exploited in a sustainable way.

Regarding the average annual yield data (kg/vessel/day), these were calculated based only on fishing trips made by vessels included in the Shellfish Census, during which the catch was exclusively made up of abrupt wedge shells, while fishing trips during which abrupt wedge shells had been caught together with other species were not taken into account; we consider that the inclusion of the latter would distort the calculation of the average annual yield. In this regard, of the total number of fishing trips made by Mediterranean shellfish fleets that caught abrupt wedge shells (2014: 1 180 fishing trips; 2015: 1 563 fishing trips), 973 of them met this requirement in 2014 and 1 364 in 2015.

The analysis of these fishing trips shows that the average annual yield (kg/vessel/day) obtained since the entry into force of the *Order of 24 March 2014* for the abrupt wedge shell species was 16.14 kg/vessel/day in 2014 and 15.80 kg/vessel/day in 2015, which in both cases is slightly below the minimum annual average threshold established in the *Order of 24 March 2014* as a safe biological limit (17.5 kg/vessel/day).

Therefore, since the minimum average annual catch (17.5 kg/vessel/day) has not been reached either in 2014 or in 2015, in accordance with Article 5(2) of the *Order of 24 March 2014*, as amended by the *Order of 29 December 2014,* the data must be analysed in order to determine whether this situation is the result of a 'decline in exploitable populations'. In this regard, the results of the scientific study carried out by the Spanish Oceanography Institute (section 4.3.3.4) show that:

- In all sampling months the average size obtained was above the minimum size of catch, fluctuating between 1.3 mm and 5.6 mm above this size.

- The main results obtained from the application of the ASPIC model show that the resource is in good condition and that there is even a probability of increasing its exploitation, yielding MSY values of 44.5 tonnes and Bcur almost 1.67 times higher than the value of B_{MSY} and F 0.6 times lower than that of F_{MSY}.

- The population trajectory in terms of B/B_{MSY} and F/F_{MSY} shows that the stock is in good condition and has not been overfished, nor are there any other signs of overfishing over the period studied.

Therefore, it was concluded that the failure to reach the minimum average annual threshold during the years 2014 and 2015 **was not a consequence of a 'decline in exploitable populations'**, which is why it has not been necessary to reduce the five authorised fishing days per week to four fishing days per week for the following year for that species, as provided for in the second subparagraph of Article 5(2) of the *Order of 24 March 2014.*

3.2. SMOOTH CLAM *(Callista chione)*

In accordance with Article 4 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, the smooth clam*(Callista chione),* is considered to be within safe biological limits and, therefore, sustainably exploited, according to the Spanish Oceanography Institute, when the following requirements are met:

- Total annual catch not more than 182 t/year.
- Minimum average annual catch of at least 92 kg/vessel/day.

The results of these parameters are given below.

Table 5: Total annual catch of the smooth clam species (Callista chione)

	Total annual catch (tonne/year)			
	2014[1]	**2015**	**2016[2]**	**Maximum limit**
Smooth clam *(Callista chione)*	190.63	242.93	172.85	182

[1] Total catch (kg) from April to December 2014. Since the entry into force of the Order of 24 March 2014.
[2] Dated 15 September 2016.

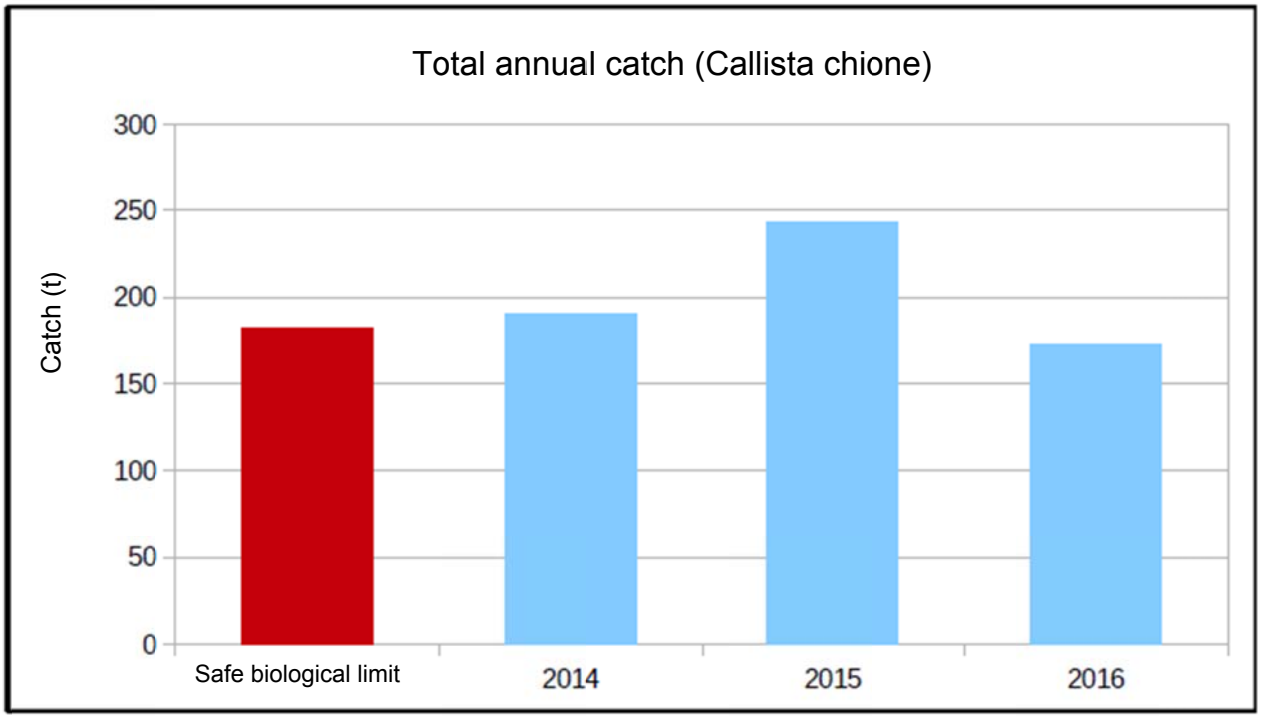


Figure 3: Visual representation of total annual catch (tonnes) of the smooth clam species (Callista chione)

Table 6: Average annual yields (kg/vessel/day) of the smooth clam species (Callista chione).

	Catch (kg/vessel/day)			
	2014[1]	**2015**	**2016[2]**	**Minimum limit**
Smooth clam *(Callista chione)*	93.14	98.28	-	92

[1] Total catch (kg) from April to December 2014. Since the entry into force of the Order of 24 March 2014.
[2] Data not available.

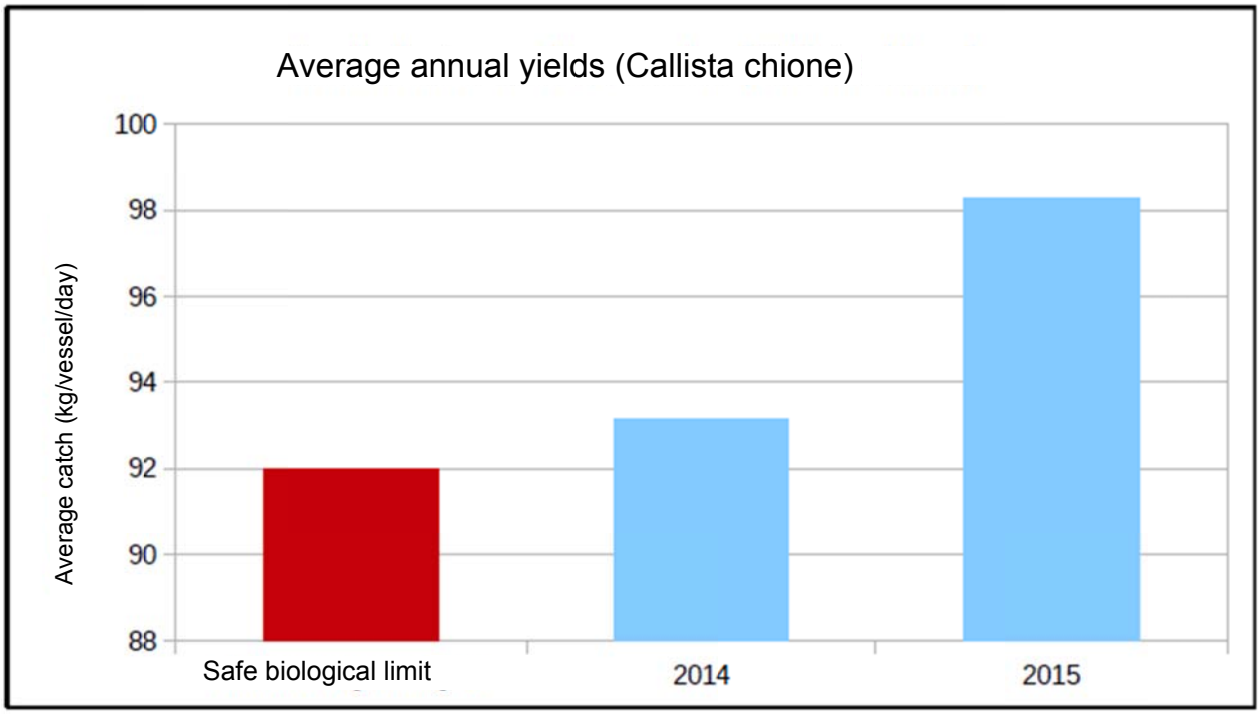


Figure 4: Visual representation of average annual yields (kg/vessel/day) of the smooth clam species (Callista chione).

The total annual catch data obtained since the entry into force of the *Order of 24 March 2014* for the smooth clam species, exceeded the established maximum limit of 182 t/year established by the Spanish Oceanography Institute as a safe biological limit in 2014 and 2015.

The following tables show the monthly evolution of the total catch data for the years 2014 and 2015.

Table 7: Monthly evolution of the smooth clam catch data (2014).

	Total catch during 2014 (t)								
	April	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Smooth clam *(Callista chione)*	31.41	54.66	95.12	112.91	140.08	158.71	171.15	180.98	190.63

Table 8: *Monthly evolution of the smooth clam catch data (2015).*

				Total catch during 2015 (t)								
	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Smooth clam *(Callista chione)*	13.85	13.85	13.85	31.48	71.35	122.75	171.55	220.06	242.93	242.93	242.93	242.93

In 2014 the total annual catch (190.63 t) slightly exceeded, by 4 %, the maximum limit of 182 t/year. However, in view of the monthly evolution of the catches, it can be seen that this limit was only exceeded in the month of December, specifically on Monday, 15 December 2014. Taking into account, firstly, that fish auction centres are obliged to send the sales notes electronically within 24 hours to the competent authority of the Autonomous Community, a deadline that is not always complied with; that during the month of December there are several holidays; and lastly, that the incorporation and processing of the data sent by the auction centres is carried out weekly, this Directorate-General was informed that the maximum total annual catch had been exceeded during the week of 22 December, and thus, did not have sufficient time to approve, publish and communicate the closure of the fishery to the fishing sector concerned, as provided for in Article 5(1) of the *Order of 24 March 2014.*

In 2015 the total annual catch (242.93 t) exceeded the maximum limit of 182 t/year by 33 %. The limit was exceeded, and in accordance with the provisions of Article 5(1) of the *Order of 24 March 2014,* the fishery was closed by resolution of the Directorate-General of Fisheries and Aquaculture (16/09/2015) (Annex, Document No 11).

As a consequence of the precautionary closing of the fishery ordered by Resolution of the Directorate-General of Fisheries and Aquaculture, dated 16 September 2016 (Annex, Document No 12), the maximum limit established for the total annual catch (182 t) has not surpassed been during this year, 2016, with the total annual catch remaining at 172.85 t. This precautionary closure prior to exceeding the annual maximum limit corrects to some extent the overfishing that occurred in 2014 and 2015.

Regarding the average annual yield data (kg/vessel/day), these were calculated based only on fishing trips made by vessels included in the Shellfish Census, during which the catch was exclusively made up of smooth clams, while fishing trips during which smooth clam were caught together with other species were not taken into account; we consider that the inclusion of the latter would distort the calculation of the average annual yield. In this regard, of the total number of fishing trips made by Mediterranean shellfish fleets that caught smooth clams (2014: 2 021 fishing trips; 2015: 2 386 fishing trips), 1 780 of them met this requirement in 2014 and 2 212 in 2015. The analysis of these fishing trips shows that in 2014 (93.14 kg/vessel/day) and in 2015 (98.28 kg/vessel/day) the minimum average annual threshold established in the *Order of 24 March 2014* as a safe biological limit (92 kg/vessel/day) was met, and therefore, the smooth clam species is being exploited, according to the Spanish Oceanography Institute, in a sustainable way.

3.3. ROUGH COCKLE *(Acanthocardia tuberculata)*

In accordance with Article 4 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, the rough cockle *(Acanthocardia tuberculata),* is considered to be within safe biological limits and, therefore, sustainably exploited, according to the Spanish Oceanography Institute, when the following requirements are met:

- Total annual catch not more than 1 128 t/year.
- Minimum average annual catch of at least 321 kg/vessel/day.

The results of these parameters are given below.

Table 9: Total annual catch of the rough cockle species.

	Total annual catch (tonne/year)			
	2014[(1)]	**2015**	**2016[(2)]**	**Maximum limit**
Rough cockle *(Acanthocardia tuberculata)*	705.20	1 116.54	1 007.19	1 128

(1) Total catch (kg) from April to December 2014. Since the entry into force of the Order of 24 March 2014.
(2) Dated 15 September 2016.

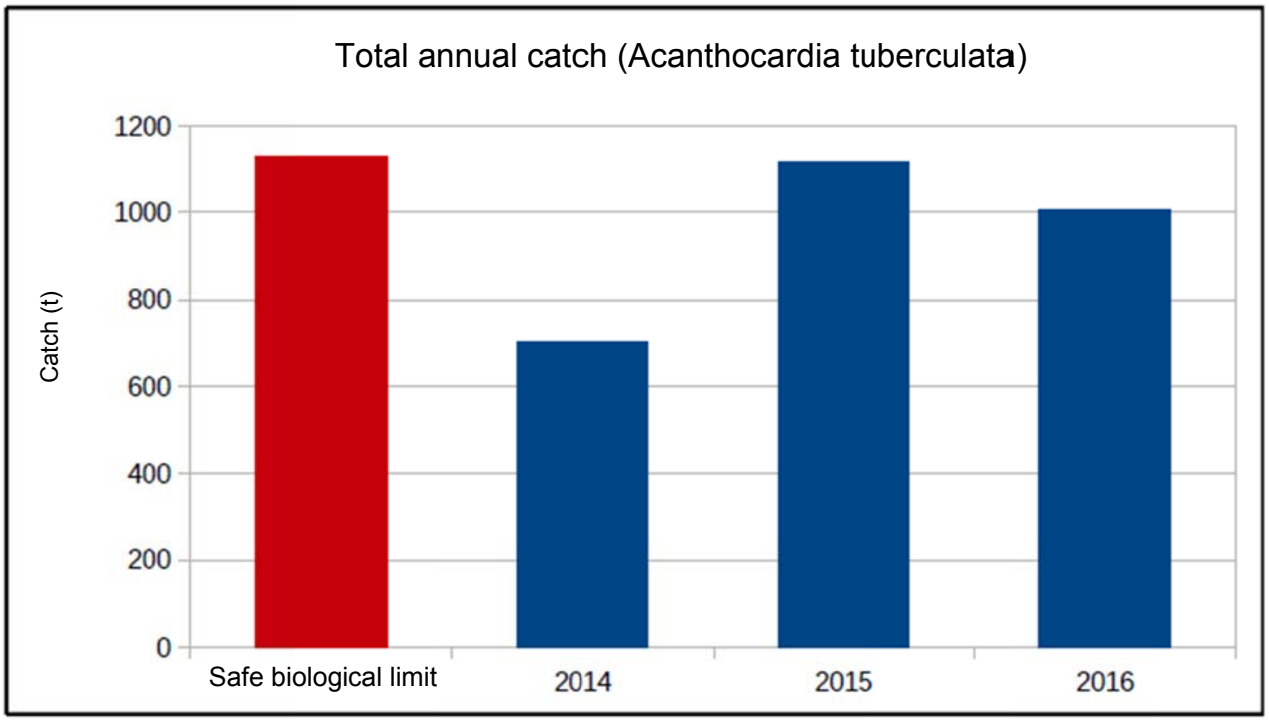


Figure 5: Visual representation of total annual catch (tonnes) of the rough cockle species (Acanthocardia tuberculata).

Table 10: Average annual yields (kg/vessel/day) of the rough cockle species.

	Catch (kg/vessel/day)			
	2014	**2015**	**2016(1)**	**Minimum limit**
Rough cockle *(Acanthocardia tuberculata)*	934.32	808.46	-	321

[1] Data not available.

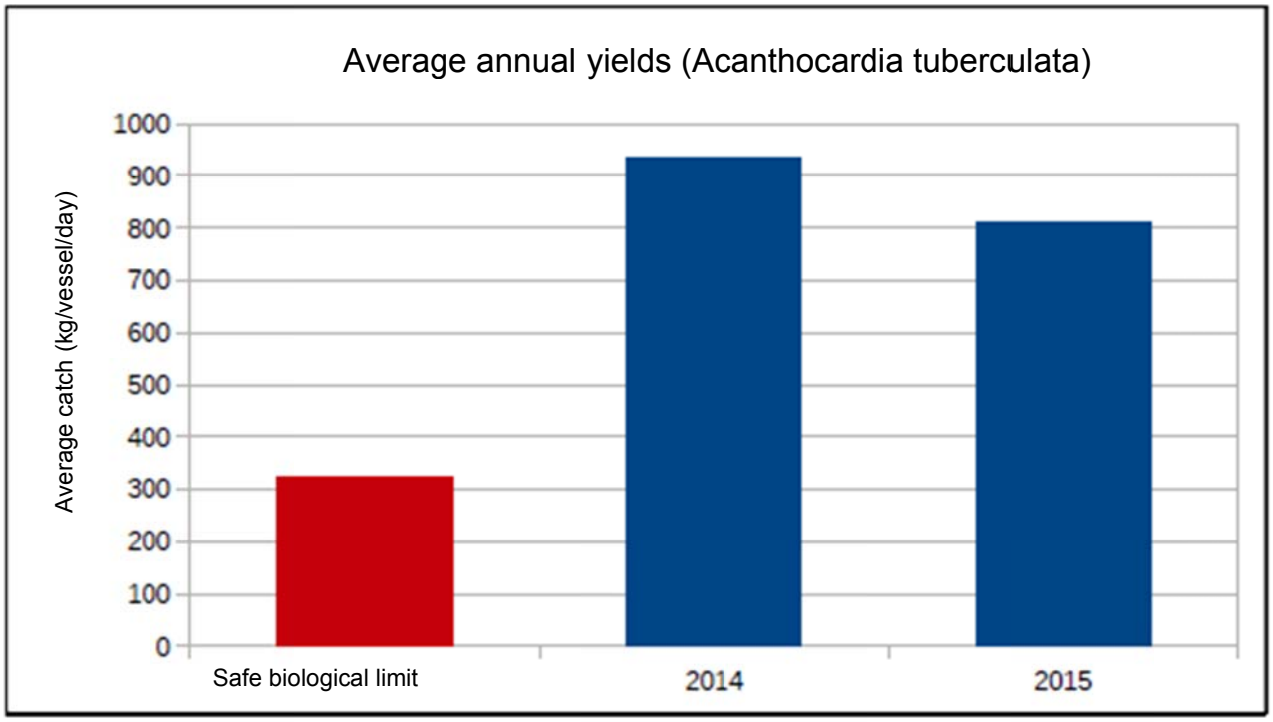


Figure 6: Visual representation of average annual yields (kg/vessel/day) of the rough cockle species (Acanthocardia tuberculata).

The total annual catch data obtained since the entry into force of the *Order of 24 March 2014* for the rough cockle species have not exceeded, in any year (2014: 705.20 t; 2015: 1 116.54 t; 2016: 1 007.19 t), the maximum established limit of 1 128 t/year. These fishing activities are carried out at the request of the company that receives these catches, UBAGO GROUP MARE, SL, which agrees together with the sector annually on the amount that it needs. This means that the limit is not exceeded in any year because the total catch that will be achieved during each year is previously determined. Therefore, as set out in Article 4 of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, the rough cockle species *(Acanthocardia tuberculata)* is deemed, in terms of the total annual catch, to be within safe biological limits and, therefore, exploited in a sustainable way according to the Spanish Oceanography Institute.

The shellfish sector plans to use the rest of the quota available for this year (120.81 t) before the end of 2016.

As for the other species, the average annual yield (kg/vessel/day) was calculated based only on fishing trips made by vessels included in the Shellfish Census, during which the catch was exclusively made up of rough cockles, while fishing trips during which rough cockles had been caught together with other species were not taken into account; we consider that the inclusion of the latter would distort the calculation of the average annual yield. In this regard, of the total number of fishing trips with a rough cockle catch made by Mediterranean shellfish fleets (2014: 687 fishing trips; 2015: 1 297 fishing trips), 603 fishing trips met this requirement in 2014 and 1 225 in 2015. The analysis of these fishing trips shows that the catch in 2014 (934.32 kg/vessel/day) and in 2015 (808.46 kg/vessel/day), was above the minimum average annual catch stipulated in the *Order of 24 March 2014* as a safe biological limit (321 kg/vessel/day). Therefore, as set out in Article 4 of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*, the rough cockle species *(Acanthocardia tuberculata)* is deemed, in terms of the minimum annual average catch, to be within safe biological limits and, therefore, exploited in a sustainable way according to the Spanish Oceanography Institute.

3.4. STRIPED VENUS CLAM *(Chamelea gallina):*

In accordance with Article 4 of the *Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast* of Andalusia, the striped venus clam *(Chamelea gallina)* is considered to be within safe biological limits and, therefore, sustainably exploited, according to the Spanish Oceanography Institute, when the following requirements are met:

- Total annual catch not more than 22 t/year.
- Minimum average annual catch of at least 25.6 kg/vessel/day.

The results of these parameters are given below.

Table 11: Total annual catch of the striped venus clam species.

	Total annual catch (tonne/year)			
	2014[1]	**2015**	**2016[2]**	**Maximum limit**
Striped venus clam *(Chamelea gallina):*	19.51	13.64	3.87	22

[1] Total catch (kg) from April to December 2014. Since the entry into force of the *Order of 24 March* 2014.

[2] Dated 15 September 2016.

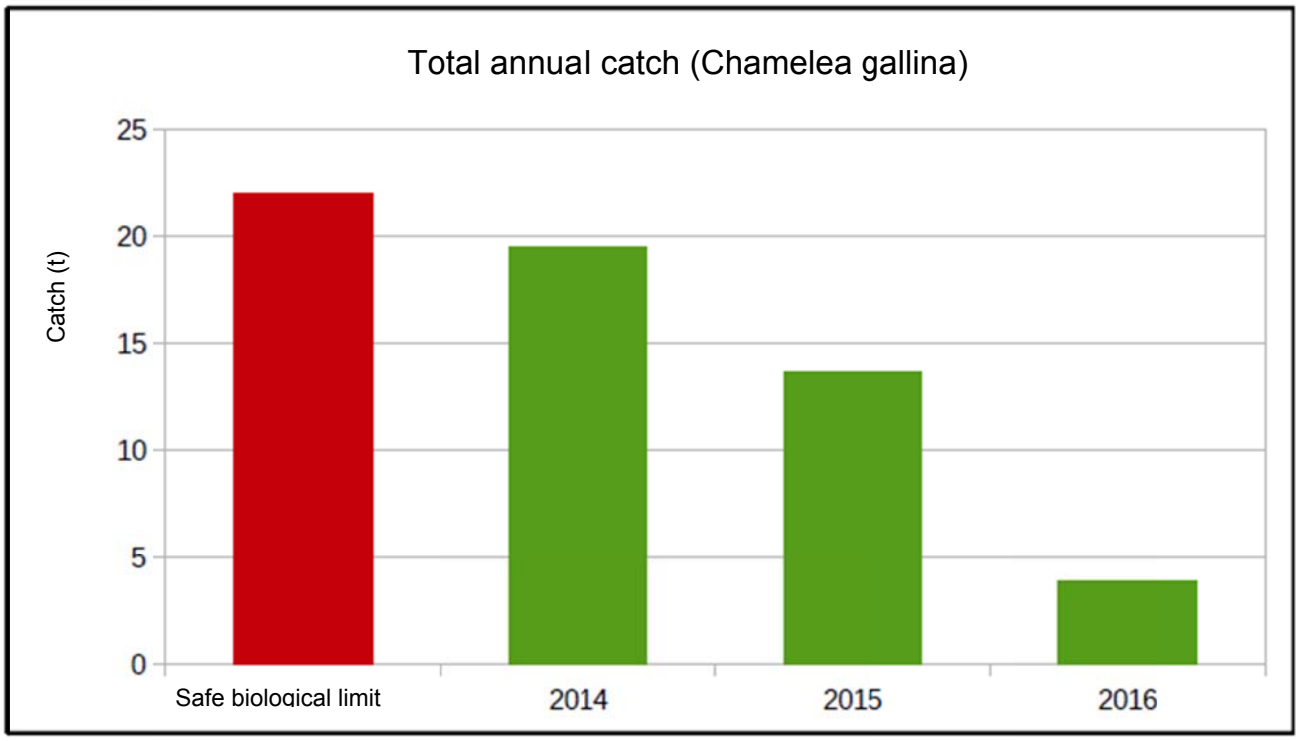


Figure 7: Visual representation of total annual catch (tonnes) of the striped venus clam species (Chamelea gallina)

Table 12: Average annual yields (kg/vessel/day) of the striped venus clam species.

	Catch (kg/vessel/day)			
	2014	**2015**	**2016**[1]	**Minimum limit**
Striped venus clam *(Chamelea gallina)*	26.68	21.48	-	25.6

[1] Data not available.

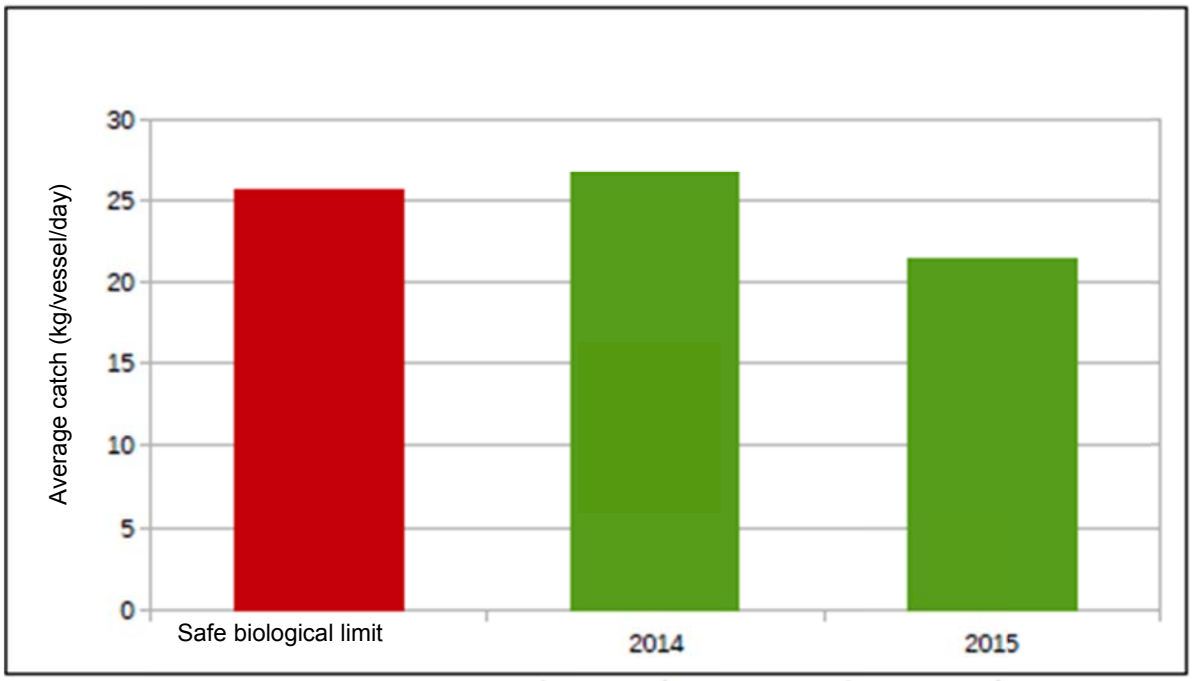


Figure 8: Visual representation of average annual yields (kg/vessel/day) of the striped venus clam species (Chamelea gallina).

The total annual catch data obtained since the entry into force of the *Order of 24 March 2014* for the striped venus clam species have not exceeded, in any year (2014: 19.51 t; 2015: 13.64 t; 2016: 3.87 t) the maximum of 22 t/year, established by the Spanish Oceanography Institute as the safe biological limit.

As for the other species, the average annual yield (kg/vessel/day) was calculated based only on fishing trips made by vessels included in the Shellfish Census, during which the catch was exclusively made up of striped venus clams, while fishing trips during which striped venus clams had been caught together with other species was not taken into account; we consider that the inclusion of the latter would distort the calculation of the average annual yield. In this sense, of the total number of fishing trips made by Mediterranean shellfish fleets that caught striped venus clams (2014: 818 fishing trips; 2015: 715 fishing trips), 611 fishing trips met this requirement in 2014 and 524 in 2015. The analysis of these fishing trips shows that the catch in 2014 (26.68 kg/vessel/day) was above the minimum average annual catch established in the *Order of 24 March 2014* as a safe biological limit (25.6 kg/vessel/day).

However, in 2015 the average annual catch (21.48 kg/vessel/day) did not reach the minimum annual average catch indicated in Article 4 of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia,* as a safe biological limit.

Therefore, in accordance with Article 5(2) of the *Order of 24 March 2014*, as amended by the *Order of 29 December 2014,* it is necessary to analyse these data in order to determine whether this is a consequence of a decline in exploitable populations. In this regard, the results of the scientific study carried out by the Spanish Oceanography Institute (section 4.3.3.4) show that:

- The evolution of the average size of the commercial catch for the entire period from the start of the study in March 2013 and in the subsequent monitoring of the fishery up to December 2015 has remained practically above the minimum legal catch size, fluctuating between 25 and 30 mm.

- The CPUE estimated by the BioDyn model shows few differences compared to the observed CPUE. The model estimates an MSY value of 35 t, very far from the current catch. The B/B_{MSY}, B/B0.1, Fc/F_{MSY} and Fc/F0.1 reference values show signs of slight overfishing, while the relative biomass trajectories and the sustainable exploitation rate are slightly elevated as well.

- As the MSY obtained was higher than the current catch, a 10-year projection was made by testing a precautionary strategy in which the catch is kept constant at a value corresponding to 65% of the estimated MSY. The projection shows this strategy would result in a rapid recovery and return to sustainable exploitation values, as well as an increase in sustainable yields and a rising trend towards MSY values.

Therefore, from the scientific point of view, there are signs that this species is slightly over-exploited, so that, pursuant to Article 5(2) of the *Order of 24 March 2014,* as amended by the *Order of 29 December 2014,* it is necessary to reduce fishing of this species from five authorised fishing days per week to four authorised fishing days per week during 2016.

An analysis of the number of fishing days per week worked by the fleets targeting striped venus clam in 2016 shows that of the 155 fishing trips with striped venus clam catches analysed (from January 2016 to 15 September 2016), which were carried out by a total of 36 vessels, only three of those vessels reached a total of five fishing days per week directed at catching striped venus clam during the entire year. The average number of days of fishing per week for striped venus clam catches has been 2.05, and therefore, very far from the 5 authorised days per week. In fact, of the total number of weeks per year (37 weeks), only four of them saw five fishing days used in the same week for striped venus clams (weeks 29, 30, 31 and 36).

Therefore, given that the vessels during 2016 have voluntarily reduced the striped venus clam fishing days, we consider that it is not necessary to reduce the authorised days per week to four during 2016. If the scientific monitoring of the fishery carried out in 2016 should indicate that this voluntary reduction in the number of fishing days per week has not been sufficient to ensure recovery of the exploitable population, the fishery will be closed temporarily in 2017.

4. SCIENTIFIC EVALUATION AND MONITORING REPORTS

Since the approval of the Management Plan for Dredge and Mechanised Dredge Fishing off the Mediterranean coast of the Autonomous Community of Andalusia, the Directorate-General for Fisheries and Aquaculture has carried out the evaluation and monitoring of the management plan through the scientific studies carried out by the Spanish Oceanography Institute and the Agency for the Management of Agriculture and Fisheries of Andalusia (AGAPA). The results of these studies are given below.

4.1. BACKGROUND

In accordance with the requirements of the Directorate-General for Fisheries and Aquaculture of the Government of Andalusia, the Spanish Oceanography Institute and the Agency for the Management of Agriculture and Fisheries of Andalusia (AGAPA) initiated the process of scientific monitoring in 2010. During the period between March 2013 and April 2014, the necessary information was extensively collected, enabling a first approximation of the exploitation pattern of mechanised dredge fishing. To this end, a programme of on-board observers was established, which enabled the collection of information related to:

- Characteristics of fishing fleet activity.
- Catches and real effort expended.
- Determination of the catch sizes.
- Collection of samples from the commercial and discarded catch.

The information collected was used to determine the size distributions of both the commercial and discarded specimens, identify the growth patterns of the target species, monitor the reproductive cycle, assess allometric relationships, and carry out qualitative and quantitative analyses of the discards. This in turn enabled a first determination of the impact of the fishing gear on the target and bycatch species of the fishery. Finally, we established a protocol for the preparation and adaptation of the historical series of the catch and effort data derived from the fishery statistics produced by the Andalusian Information System on Fisheries Production and Marketing Data (*Sistema de información andaluz sobre datos de comercialización y producción pesquera*, IDAPES) of the Directorate-General of Fisheries and Aquaculture of the Regional Government of Andalusia. This information, together with the application of value-in-use assessment models, helped establish the values or biological reference points necessary for developing fishery management measures that favour the maintenance of the biomass level below the mentioned reference points, and therefore, for ensuring exploited populations are kept within safe biological limits.

As a result of the results obtained, the management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia was published in March 2014 (*Order of 24 March, 2014, BOJA No. 61, 31/03/2014).*

Following the publication of the management plan, the monitoring of the status of exploited populations was carried out using different indicators: catch, effort, CPUE, effective effort, analysis of size distributions of the retained catch, and evolution of its average size over time.

4.2. MATERIAL AND METHODS

4.2.1. Sampling during fishing operations with on-board observers

Sampling points have been established for an on-board observer programme, within the customary fishing grounds of vessels with home ports that have the highest levels of shellfish activity, based on the volume of landings of the target species recorded during the period 2006–2010. The ports are those of La Atunara, in the province of Cadiz, and Estepona, Fuengirola and Caleta de Vélez, in the province of Malaga (see Table 13). For the period March 2013–April 2014, two biweekly samplings were established per port and per target species, with a total of twelve samples per month. The ports of Fuengirola and Caleta de Vélez were selected for abrupt wedge shells and striped venus clams, while the ports of La Atunara, Fuengirola, and occasionally Estepona, were selected for smooth clams. As for the rough cockle, its exploitation is due to the existing demand for the product by canning companies, which is the only way of marketing the species, so the samples were taken during the fishing season. As of April 2014, for the follow-up of the size distributions of the retained catch and determination of the evolution of the average size of the retained catch over time, the number of samples has been reduced to six samples per month. However, at specific times of the year fishing activities may be subject to closures of certain fishing grounds in response to technical measures established for the protection of the species (fishing bans) or for an undetermined time period due to technical and sanitary reasons (biotoxins, fecal contamination, etc.). For this reason, the proposed sampling scheme contemplates the hiring of fishing vessels belonging to the shellfish fleet census to carry out observation trips during those closure periods; nevertheless, the established periodic sampling schedule has not always been maintained.

Table 13: Home ports of vessels selected for sampling by species.

	Striped venus clam	Smooth clam/Rough cockle	Abrupt wedge shell
La Atunara		X	
Fuengirola	X	X	X
Estepona			
Caleta de Vélez	X		X

During fishing operations, the methodology seeks to obtain the following data on fishing activity:

- Morphometric study of the dredges: width of mouth, number of teeth, distance between teeth, codend length and mesh size, total number of dredges used.

- Characterisation of the sets: GPS coordinates of the fishing manoeuvres (firing up and turning of the slip hook and dredges) and depth of work.

- Catch data: weight of retained catch, commercial catch and discards. Structure of all target species of the study and all commercial species.

The study timeframe (Tables 14, 15 and 16) reflects the sampling planned for the years 2013, 2014 and 2015.

Table 14: Samplings planned for 2013.

	2013											
Samplings port/species	JANUARY	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Fuengirola striped venus clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Fuengirola abrupt wedge shell		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Fuengirola smooth clam/rough cockle		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
La Atunara smooth clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Caleta de Vélez striped venus clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Caleta de Vélez abrupt wedge shell		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

Smooth clam fishing ban according to the Order of 25 March 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

Rough cockle fishing ban according to the Order of 25 March 2003, establishing minimum catch sizes and closed seasons for |bivalves and gastropods of the Autonomous Community of Andalusia.

Striped venus clam and abrupt wedge shell fishing ban according to the Resolution of 26 March 2013, of the Directorate-General of Fisheries and Aquaculture, modifying closed seasons for striped venus clam (Chamelea gallina) and abrupt wedge shell (Donus trunculus) off the Mediterranean Coast of the Autonomous Community of Andalusia during 2013.

Table 15: Samplings planned for 2014.

	2014											
Samplings port/species	JANUARY	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Fuengirola striped venus clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Fuengirola abrupt wedge shell		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Fuengirola smooth clam/rough cockle		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
La Atunara smooth clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Caleta de Vélez striped venus clam		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
Caleta de Vélez abrupt wedge shell		1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

Smooth clam fishing ban according to the Order of 25 March 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

Rough cockle fishing ban according to the Order of 25 of March 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

Striped venus clam and abrupt wedge shell fishing ban according to the Order of 25 March 2003, establishing minimum catch sizes and closed seasons for |bivalves and gastropods of the Autonomous Community of Andalusia.

Table 16: Samplings planned for 2015.

	2015											
Samplings port/species	JANUARY	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
Fuengirola striped venus clam		1	1	1	1	1	1	1	1	1	1	1
Fuengirola abrupt wedge shell		1	1	1	1	1	1	1	1	1	1	1
Fuengirola smooth clam/rough cockle		1	1	1	1	1	1	1	1	1	1	1
La Atunara smooth clam		1	1	1	1	1	1	1	1	1	1	1
Caleta de Vélez striped venus clam		1	1	1	1	1	1	1	1	1	1	1
Caleta de Vélez abrupt wedge shell		1	1	1	1	1	1	1	1	1	1	1

Smooth clam fishing ban according to the Order of 25 *March* 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

Rough cockle fishing ban according to the Order of 25 March 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

Striped venus clam and abrupt wedge shell fishing ban according to the Order of 25 of March 2003, establishing minimum catch sizes and closed seasons for bivalves and gastropods of the Autonomous Community of Andalusia.

For the sampling, a previous coordination project was developed with the different fishermen's associations, in order to have a list of cooperating vessels available by port. This list has been under constant change because the vessels are part of the small-scale fishing fleet and therefore can alternate their fishing activity with other fishing gear (net, hook or traps), directing their fishing effort to the species that interests them most depending on the time of year.

The final samplings were carried out in the second half of 2013 and are shown in Table 17.

Table 17: Samplings carried out during 2013, 2014 and 2015.

		2013												2014												2015											
Port	Species	J	F	M	A	MY	J	JL	A	S	O	N	D	J	F	M	A	MY	J	JL	A	S	O	N	D	J	F	M	A	MY	J	JL	A	S	O	N	D
Fuengirola	Striped venus clam				1	2	2		2	2	1			1	1	1	1	1	2	1									1	1	1							
	Abrupt wedge shell					2	2	2	2	2	2	1			1	1	1	2	2	2		1	1	1					1	1					1	1		
	Smooth clam/rough cockle			1	1	2	2	1	2	2	2	1	1	1	2	1	2	2	2	1								1		1						1	
La Atunara	Smooth clam/rough cockle			2	2	2	1		1		2	1				1		1								3	1			1					1	
	Striped venus clam		2	1	2	2	2	1	2	1	2		1			1		2	2							1	1	1	1	1	1		1		1	
	Abrupt wedge shell		2	2	2	2	1		1	1	1	1	1			2				1									1	1		1				

The total number of samplings made was 148, of which 79 were made in 2013, 41 in 2014 and 28 in 2015.

If the work is analysed carefully by port and species, it is notable that in Fuengirola the sampling of striped venus clams began in April of 2013, coinciding with the temporary fishing ban on the species, without completing the two samplings during that month because they did not have a cooperating vessel. The sampling objective for this species was reached during the rest of 2013, except during July, because the cooperating vessels directed their fishing effort towards another species, specifically octopus.

In November it was not possible to carry out all samplings needed due to bad weather, and in December due to closure of the production areas. During 2014, this species was continuously sampled until July, although only a monthly shipment was made during this year, due to the lack of available vessels. In 2015, the sampling was concentrated on the months of April, May and June.

In this same port, the abrupt wedge shell was continuously sampled from the beginning in May 2013, but without reaching the established number of samplings in November due to bad weather and in December 2013 and January 2014 due to closure of the production areas. During the rest of 2014 it was sampled continuously, at least once a month. It is the only species and the only port for which samplings were possible from September to November 2014. During 2015, sampling was only carried out in May and June, coinciding with the closed season for this species, and in October and November.

On the other hand, in the port of Fuengirola, smooth clams were sampled continuously from the beginning of the samplings in March 2013 until July 2014, and at least one of the two established samplings was always carried out. From August 2014 to March 2015 sampling was not possible due to the lack of cooperating vessels, coinciding with the closed season for the species.

In November of 2015 there was a sampling of rough cockles, with an on-board observer.

In the port of Atunara, the smooth-clam sampling began in March 2013, coinciding with the closure of the season for the species, continuing until the first half of June. Sampling began in the port of Estepona at this time. Thanks to this, it was possible to carry out smooth clam samplings in August and October. In November 2013 and May 2014, new samplings were carried out in La Atunara. In 2014, smooth clam was only sampled twice, in March and May. Only three samplings were carried out in 2015, two during the closed season for the species, in February, and one in July. Rough cockles were sampled in November.

In Caleta de Vélez, samples of both striped venus clam and abrupt wedge shell began in February 2013. In both cases, there was continuity of sampling until October 2013, but not all the samples established were carried out due to a lack of cooperating vessels, bad weather or a change in the target species of the boats. In 2014, both species were sampled in March, and striped venus clam was also sampled in May and July. It should be mentioned that it was not possible to carry out the sampling planned for the closed season for the abrupt wedge shell, due to the lack of boats that fulfilled the requirements to carry the species on board. During 2015, striped venus clams were sampled from February to July, as well as in September and November. Abrupt wedge shells were sampled in May, June and August. The lack of continuity in 2014 and 2015 was due to the fact that the cooperating vessels directed their efforts at other target species.

If the total number of sampling outings made is analysed in detail (Figure 9), we can see that: during 2013, 47 of these were made with observers on board (59%) and 32 were targeted samplings (41%); during 2014 there was a significant decrease in the number of sampling outings made, with 15 samplings being carried out with on-board observers (38%) and 26 being targeted samplings (62%). The number of samplings decreased further in 2015, with a total of 28, namely 17 with on-board observers (61%) and 11 targeted ones (39%).

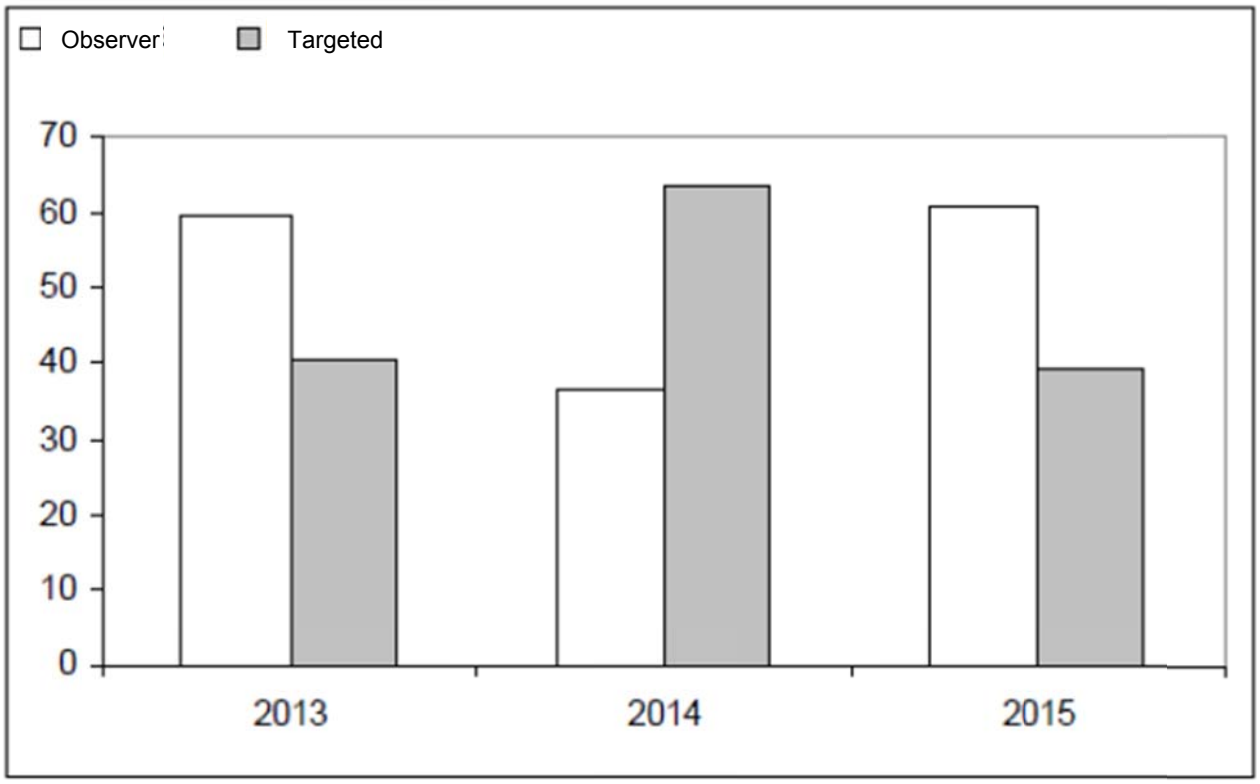


Figure 9: Number of samplings carried out in 2013, 2014 and 2015.

During all samplings, discard samples were collected for each species, labelled *in situ* for later transfer to the Campanillas Fisheries and Aquaculture Resources Laboratory (AGAPA). These samples were preserved by freezing on the day they were collected.
All the information collected on board, manoeuvre data, catches, sizes and faunal data was entered into the database designed by the Spanish Oceanography Institute (SOI) and sent to the SOI on a monthly basis for further processing of the data and information.

4.2.2. IDAPES

Data on the daily landings of striped venus clam *(Chamelea gallina),* abrupt wedge shell *(Donax trunculus),* soft clam *(Callista chione)* and rough cockle *(Acanthocardia tuberculata)* were obtained during the years 2014, 2015 and 2016, through the Andalusian Information System on Fisheries Production and Marketing data of the Directorate-General of Fisheries and Aquaculture of the Government of Andalusia (IDAPES).

4.2.3. SLSEPA

In order to carry out the spatial analyses, the data of the Location and Track System for Andalusian Fishing Vessels (*Sistema de Localización y Seguimiento de Embarcaciones Pesqueras Andaluzas,* SLSEPA) and the auction sales data for the different vessels registered in the IDAPES Database of the Ministry of Agriculture, Fisheries and Rural Development was used. On the one hand, the SLSEPA data were filtered for speeds between 0 and 2 knots, which corresponded to the speed range of the fishing fleet, and were integrated into the Geographic Information System (ArcGIS 10.0 of ESRI).

In addition, the geographical location of the catch was assigned to each auction sale using the first auction sale information from the IDAPES database.

For this study, an effective effort unit was used: Number of hours per fishing trip, defined as hours of work performed during the fishing day. Due to the characteristics of the study area, it was divided into a grid, where each grid square had a surface of 0.25 nautical miles, and the number of fishing trips made during the study period was calculated for each grid square. The average effort in hours per fishing trip was calculated by dividing the sum of the hours spent in each grid square by the number of fishing trips in the grid square.

4.3. RESULTS AND DISCUSSION

4.3.1. Size-frequency distribution

The determination of the sizes through catch sampling aimed to provide knowledge of their frequency distribution and thus help determine the structure of the exploited population and its evolution over time.

During the period from March 2013 to April 2014 the size distributions were calculated for all catches made. The retained catch is the part of the catch that is selected for marketing. The specimens of the target species that are not selected for marketing, as well as specimens of other species caught together with the target species are returned directly to the sea. The characteristics of this type of shallow fishing, the short duration of the fishing manoeuvres, the species that it targets, as well as the small bathymetric variation in the course of a fishing trip, contribute to the discarded specimens being returned to the same place where they were caught in a short period of time. This contributes to the high probability of survival of the specimens *(Royo 1997, 1999; Royo y Carmona, 1999; Malaquias et al., 2006; Pranovi et al, 2001).*

A precision gauge of 0.1 mm was used to determine the size of the exploited specimens. During the period from March 2013 to April 2014 a total of 82 198 specimens (45 143 belonging to the retained catch and 37 055 to the discarded catch) were measured. The length was determined for *C. chione, C. gallina* and *D. trunculus* specimens, and the height for *A. tuberculata specimens.* The size of the retained or commercial catch of the four target species started being monitored as of April 2014; 25 073 specimens were used for this purpose.

Table 18 shows the main statistical results of the monthly sampling of the retained catch carried out in the period between March 2013 and December 2015.

Month	Number of Specimens	Average Size	Interval (Min-Max)	Standard Deviation	Number of Specimens	Average Size	Interval (Min-Max)	Standard Deviation	Number of Specimens	Average Size	Interval (Min-Max)	Standard Deviation	Number of Specimens	Average Size	Interval (Min-Max)	Standard Deviation
	Acanthocardia tuberculata				*Callista chione*				*Chamelea gallina*				*Donax trunculus*			
Mar_2013	-	-	-	-	1 016	62.4	27-89	7.6	658	25.6	17-35	2.4	972	29.3	24-39	2.6
Apr_2013	-	-	-	-	1 611	66.6	25-95	7.2	1 247	26.8	19-34	2.9	1 329	28.2	24-35	2.3
May_2013	-	-	-	-	1 135	65.2	55-89	5.9	2 599	26.6	21-35	2.3	2 825	29.7	22-43	3.4
Jun_2013	-	-	-	-	765	73.2	63-89	4.1	2 322	25.8	18-37	2.7	1 793	29.4	24-39	2.9
Jul_2013	-	-	-	-	551	69.7	43-89	7.0	510	26.0	22-32	1.4	1 117	28.1	23-39	2.2
Aug_2013	-	-	-	-	1 159	70.0	54-91	6.3	2 277	24.8	19-36	2.7	1 725	28.6	21-38	2.5
Sep_2013	-	-	-	-	451	66.9	60-80	3.4	1 641	27.7	20-37	2.8	1 538	29.9	23-38	2.7
Oct_2013	-	-	-	-	1 805	63.1	39-92	9.8	1 701	28.0	20-38	3.1	2 213	29.2	21-43	3.4
Nov_2013	-	-	-	-	804	60.7	35-87	10.6	436	27.8	22-37	2.3	984	29.2	23-37	3.2
Dec_2013	928	52.2	40-63	3.9	-	-	-	-	638	24.2	19-32	2.3	688	27.1	19-37	3.6
Jan_2014	514	51.3	43-61	3.7	-	-	-	-	496	26.8	22-34	2.2	-	27.8	20-40	3.5
Feb_2014	-	-	-	-	377	71.6	58-85	5.8	407	27.0	23-35	2.1	495	29.0	23-40	2.7
Mar_2014	-	-	-	-	656	67.5	54-85	6.1	1 015	27.5	22-39	2.8	1 745	28.4	21-37	3.1
Apr_2014	-	-	-	-	795	69.8	58-87	8.3	433	27.6	23-35	3.1	1 078	29.1	23-.41	3.0
May_2014	731	53.2	40-69	4.0	254	67.1	56-87	7.4	1 502	27.0	23-35	2.5	589	27.8	23-37	3.1
Jun_2014	-	-	-	-	494	68.5	57-87	7.6	1 351	26.8	23-35	2.4	996	28.8	23-40	3.2
Jul_2014	-	-	-	-	-	-	-	-	678	26.1	21-37	2.3	951	27.7	23-41	3.4
Aug_2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sep_2014	-	-	-	-	-	-	-	-	198	27.2	23-36	2.9	297	27.2	23-35	3.2
Oct_2014	-	-	-	-	-	-	-	-	-	-	-	-	496	26.3	22-35	3.6
Nov_2014	-	-	-	-	-	-	-	-	-	-	-	-	396	27.4	23-36	3.3
Dec_2014	291	53.6	42-68	4.3	73.0	69.7	51-92	10.5	-	-	-	-	-	-	-	-
Jan_2015	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
Feb_2015	402	49.5	42-61	3.7	-	-	-	-	795	26.1	21-35	2.7	-	-	-	-
Mar_2015	603	50.7	42-68	3.9	293	72.1	57-84	11.4	594	29.3	22-38	4.9	-	-	-	-
Apr_2015	-	-	-	-	-	-	-	-	895	26.5	21-35	2.5	170	29.6	24-40	3.6
May_2015	-	-	-	-	525	67.1	45-82	7.3	1 097	28.6	20-39	4.4	980	30.6	24-42	3.1
Jun_2015	-	-	-	-	626	66.6	51-82	7.1	1 126	27.1	20-37	3.2	1 103	28.7	23-38	2.6
Jul_2015	-	-	-	-	-	-	-	-	890	27.1	21-39	3.2	-	-	-	-
Aug_2015	-	-	-	-	-	-	-	-	131	27.0	24-32	2.4	520	30.5	24-40	2.3
Sep_2015	-	-	-	-	-	-	-	-	237	27.5	22-32	2.2	-	-	-	-
Oct_2015	-	-	-	-	-	-	-	-	-	-	-	-	693	27.7	22-38	3.0
Nov_2015	523.0	56.3	40-67	4.6	-	-	-	-	660	26.7	22-35	2.1	587	27.0	22-36	2.4
Dec_2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**3 992.0**	**52.7**	**40-69**	**4.7**	**13 390**	**65.7**	**25-95**	**8.0**	**26 534**	**26.5**	**17-39**	**2.8**	**26 280**	**28.7**	**19-43**	**3.0**

4.3.1.1. Size distribution of smooth clam *(Callista chione)*

For all of the period studied, the *C. chione* commercial catch sizes oscillated between 25 and 95 mm. Commercialised specimens were found, in all months, with an average size above the minimum reference size for conservation purposes, set at 60 mm *(Order of 25 March 2003, BOJA No 65, 04/04/2003).* Only 17% of the landings were made up of individuals with a size below the aforementioned legal size (60 mm). Almost no specimens below the first maturity size (SFM = 35 mm) form part of this retained catch (Figure 10).

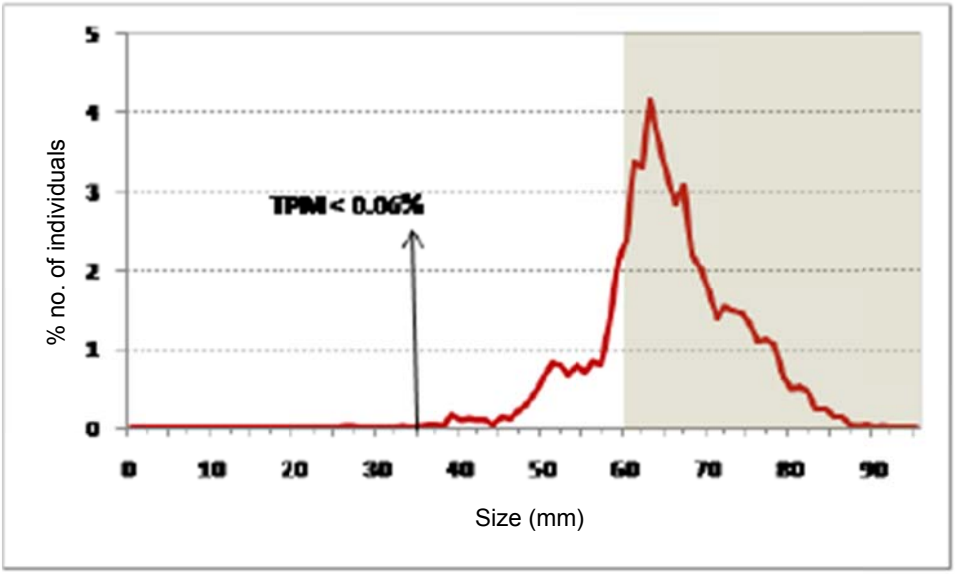


Figure 10. Size distribution of the commercial catch of C. chione for the period between March 2013 and December 2015. (SFM: Size at First Maturity; shaded rectangle represents the legal size range).

Figure 11 shows the monthly size distribution obtained for retained and discarded catch of *C. chione* in the period between March 2013 and March 2014. The distribution mode for retained catch sizes is above the minimum sizes in all months. In March 2013, the mode moves slightly to the left of the minimum size. This larger proportion of smaller-sized individuals can be accounted for by the greater number of yields for this species in February and April (Tirado et al., 2002a,b). In Table 18 and Figure 12, the evolution of the average commercial catch size can be seen for the period between March 2013 and December 2015. At the beginning of the period, in which there was greater regularity in the samples taken, a tendency for rising regularity is noticeable until summer, which can be related to the period of fast growth in spring-summer, described for populations of this species in the Atlantic and near to the Strait of Gibraltar (Cano Pérez, 1981; Moura et al., 2009).

Almost all of the discards were made up of specimens below the minimum size. One of the main factors influencing discards of species is minimum size regulations (Sánchez et al., 2004). In August 2013, 45 % of the discard weight comprised specimens below the minimum catch size.

The discarding of specimens above the minimum size did not exceed 20%.in catch weight, except in August, when a level of 24% was reached. Market factors have an influence on the discarding of specimens above the legal size, which are a response to the non-acceptance of individuals with shell deterioration caused in the course of catch handling, and the search for large-sized specimens that would ensure a greater sale value.

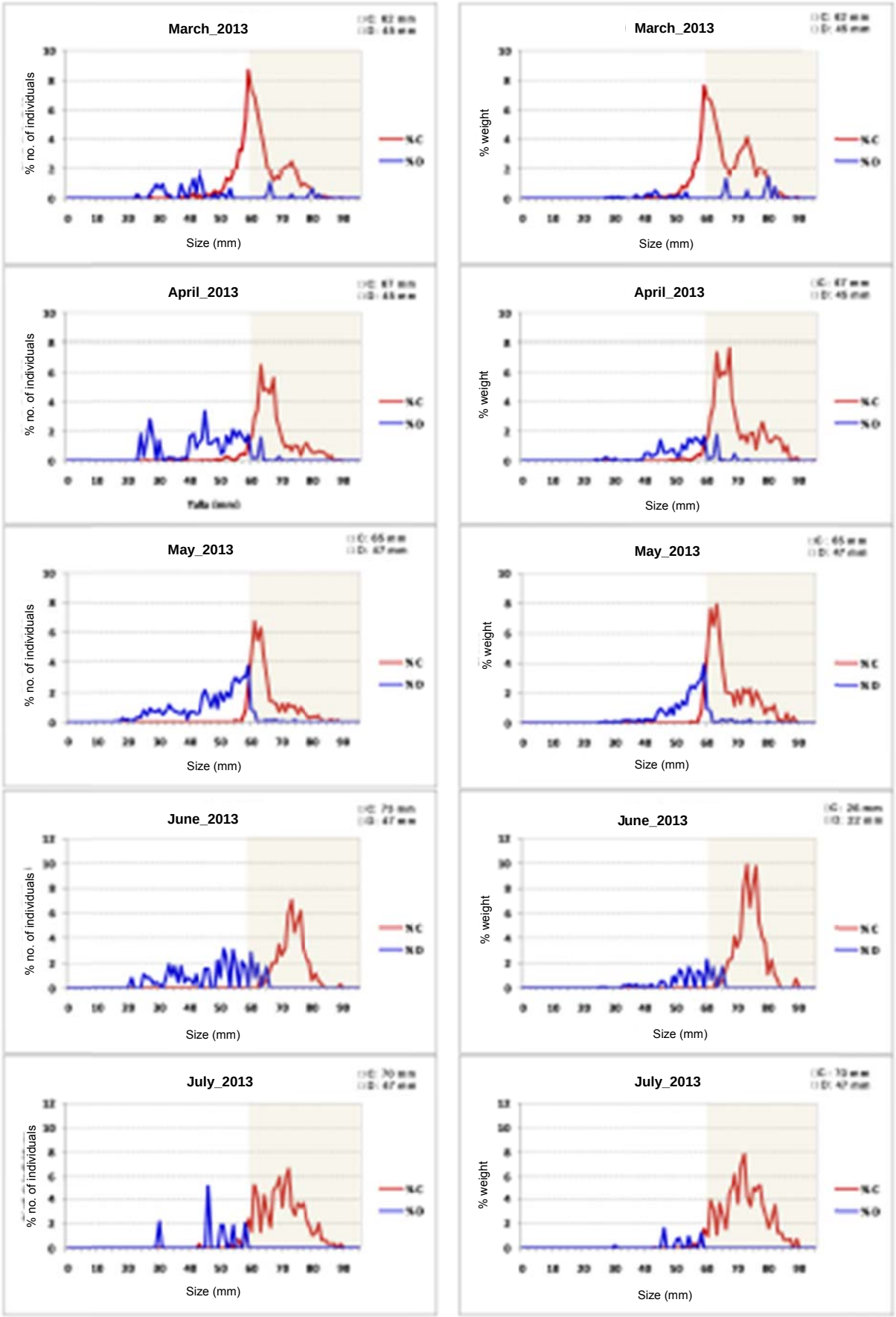


Figure 11: Monthly size distribution of the commercial catch (C) and discarded catch (D) of C. chione for the period between March 2013 and March 2014. The data are represented as the proportion of the number of individuals (first column) and the proportion of individuals' weight (second column). The shaded rectangle represents the legal size

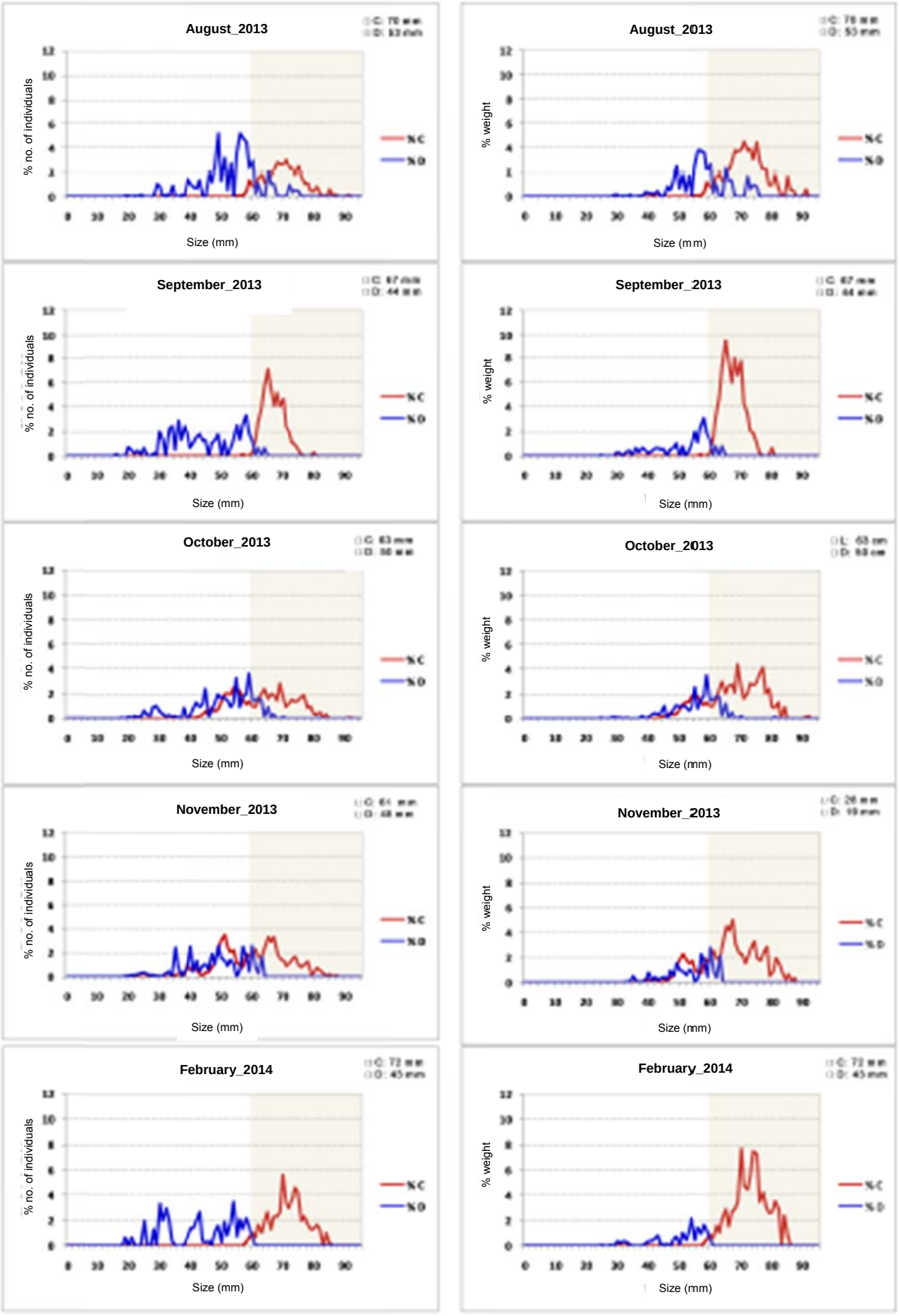


Figure 11 continued.

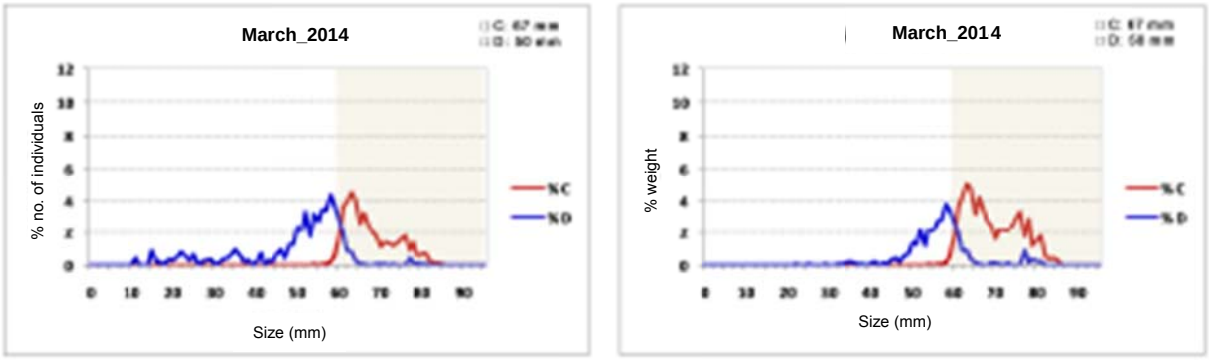


Figure 11 continued.

The evolution of the average size for all of the period, from the start of the study and subsequent monitoring of fisheries (Figure 12), shows the spread of the distribution obtained in some months, as well as maintenance of the average size above the minimum reference size for conservation purposes.

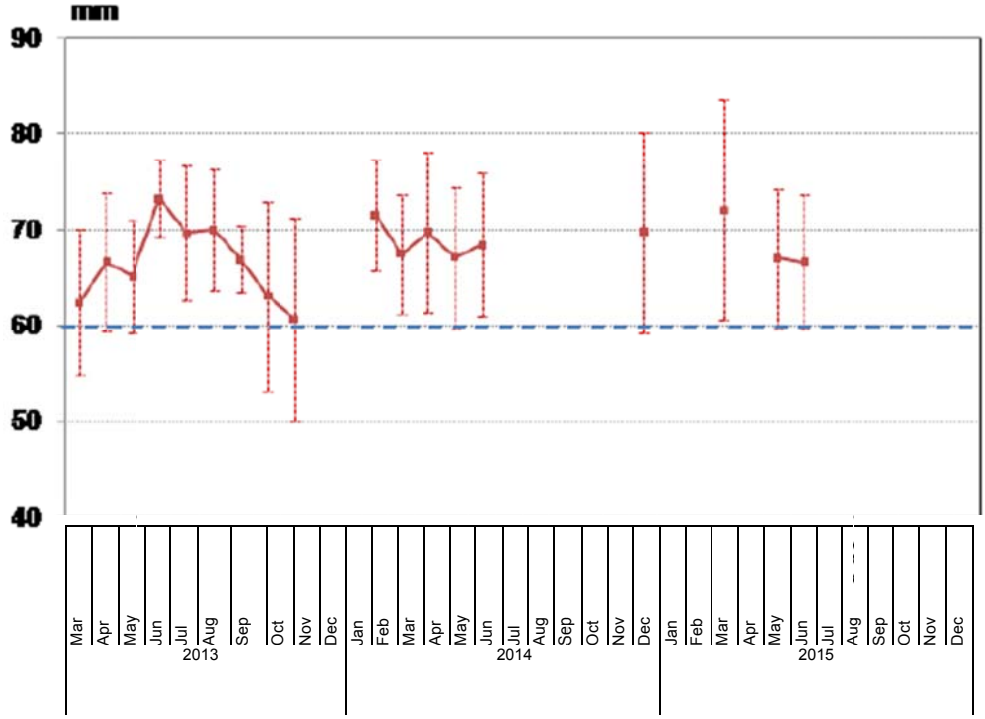


Figure 12: Evolution of the monthly size distribution of C. chione for the period between March 2013 and December 2015. The blue dotted line represents the minimum conservation reference size (MCRS)

4.3.1.2. Size distribution of Striped venus clam (Chamelea gallina)

The commercial catch sizes for *C. gallina* were distributed between a minimum of 17 mm and a maximum of 39 mm. 19 % of striped venus clams retained for the period between March 2013 and December 2015 were below the minimum catch size, set at 25 mm *(Order of 25 March 2003, BOJA no. 65, 04/04/2003).* Almost no specimens below the first maturity size (SFM = 12.5 mm) form part of this retained catch (Figure 13). The average size fluctuated between a minimum value of 24.2 mm and a maximum value of 29.3 mm. Only in the months of August and December 2013 was the average size value slightly below the legal size (Table 18, Figure 14). 90 % of the discarded weight for this species is made up of specimens below the minimum size, with the main reason for the occurrence of discards being the minimum size regulations in force.

The monthly distribution of retained catch sizes for this target species for the period between March 2013 and March 2014 (Figure 14) shows that the mode for this is above the minimum size, with the exception of March 2013. During June, July, August and December 2013, and January, February and March 2014, the proportion of small-sized specimens is above 50%, reaching a value of around 80% for the presence of these specimens in the last month of the period of study. This greater presence of smaller-sized specimens means that there were more discarded individuals than commercialised ones. The presence of small specimens, shown in the progressive increase in frequencies of smaller size classes since the end of the year, underlines the importance of recruitment during this period (Tirado et al., 2002a).

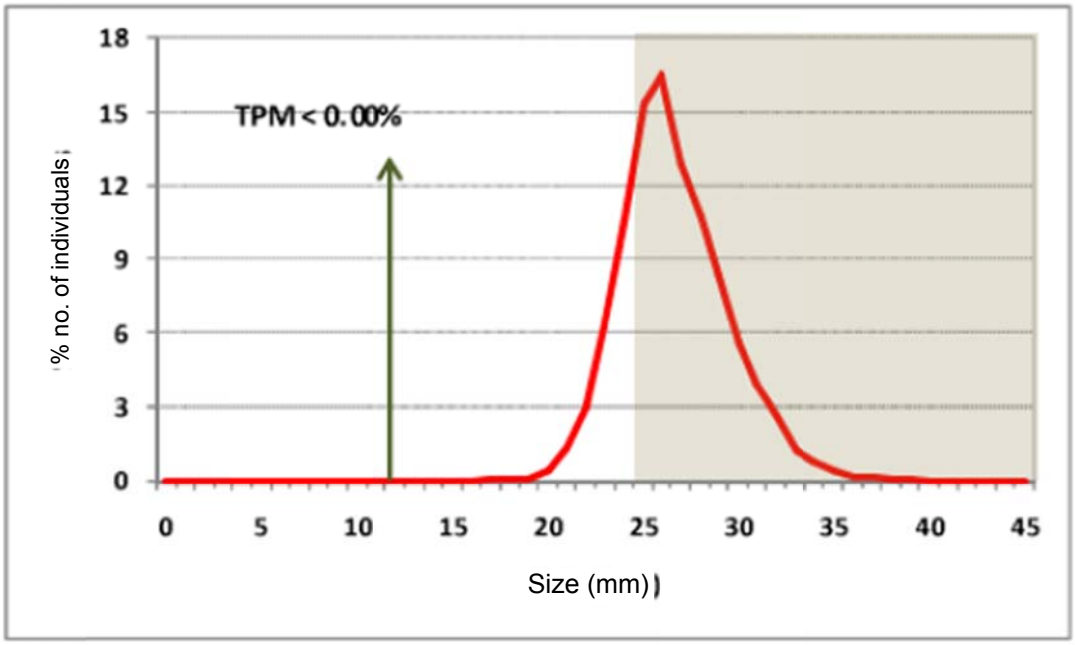


Figure 13: Size distribution of the commercial catch of C. gallina for the period between March 2013 and December 2015 (SFM: Size at First Maturity; shaded rectangle represents the legal size range).

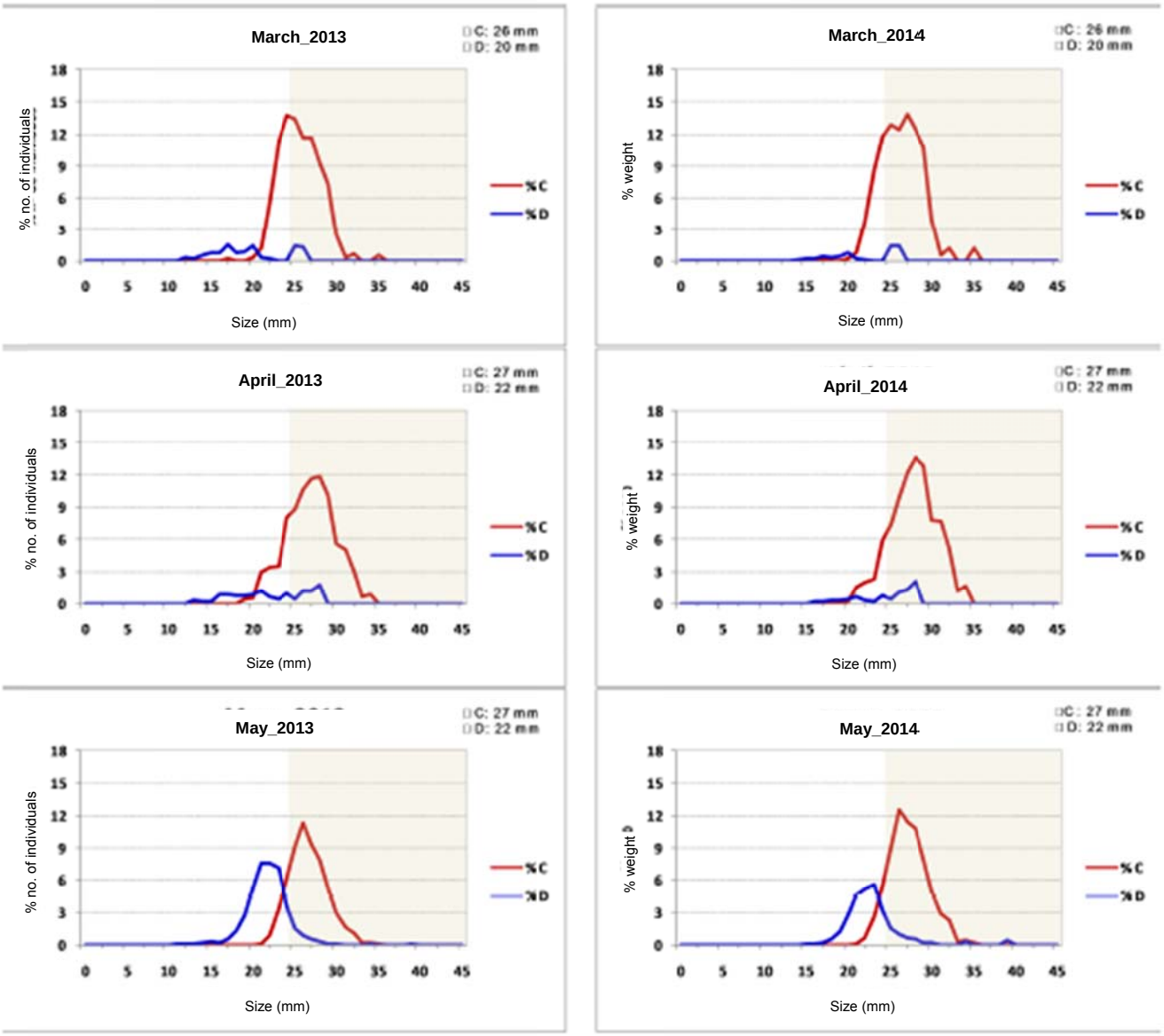


Figure 14: Monthly size distribution of the commercial catch (C) and discarded catch (D) of C. gallina for the period between March 2013 and March 2014. The data are represented as the proportion of the number of individuals (first column) and the proportion of individuals' weight (second column). The shaded rectangle represents the legal size.

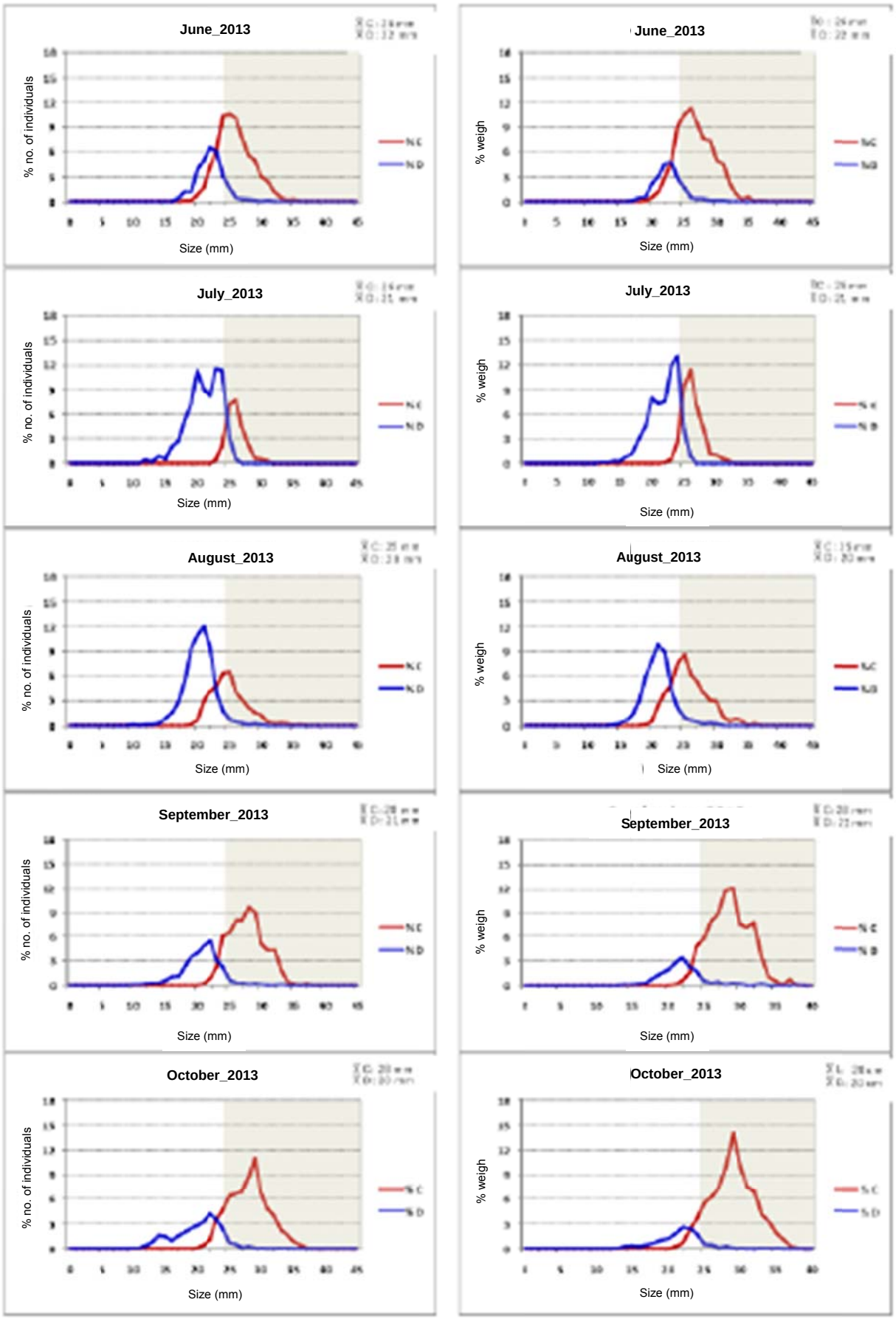


Figure 14 continued.

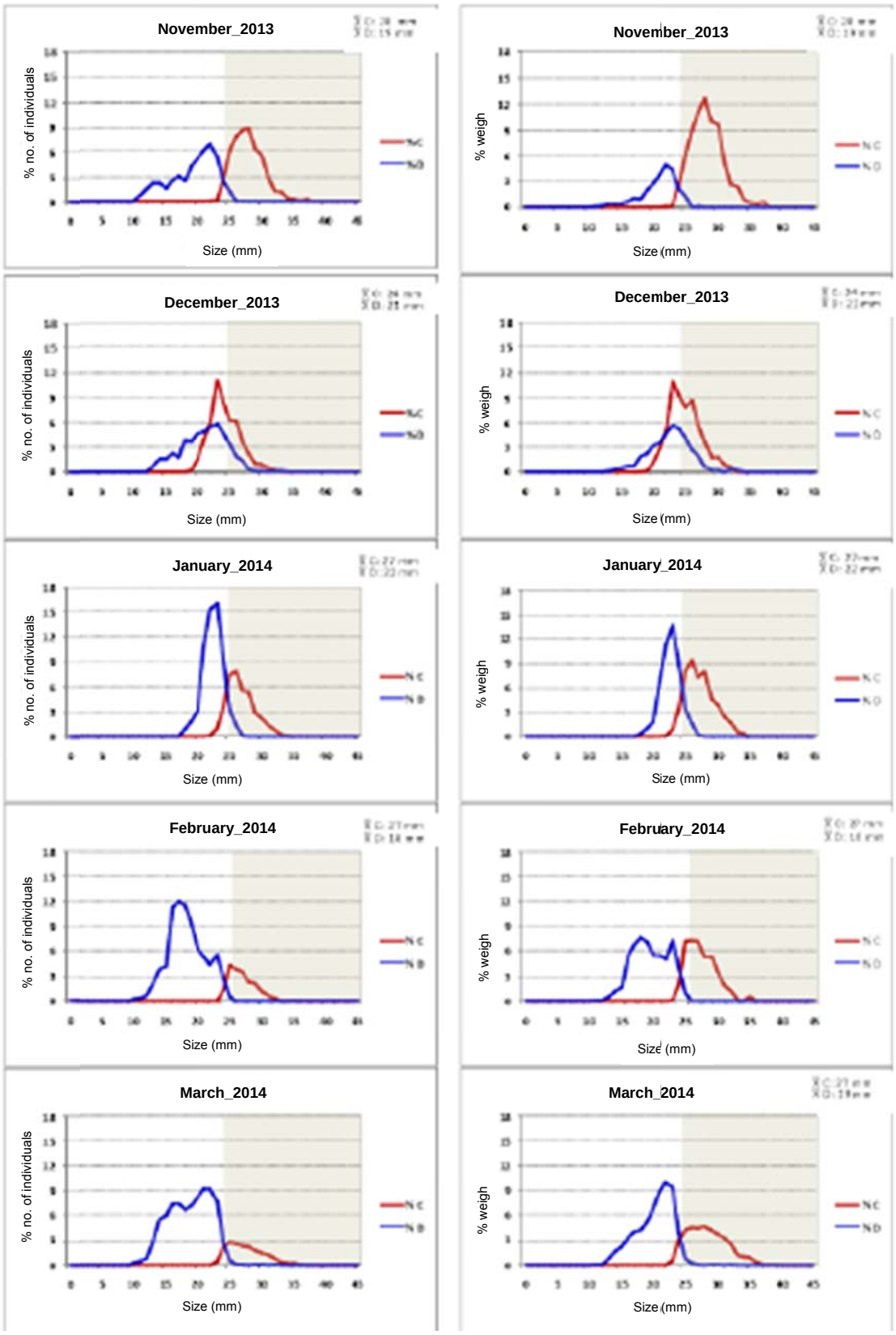


Figure 14 continued.

The evolution of the average size of the commercial catch for the entire period from the start of the study in March 2013 and in the subsequent monitoring of the fishery up to December 2015 (Figure 15; Table 18) has remained practically above the minimum legal catch size, fluctuating between 25 and 30 mm.

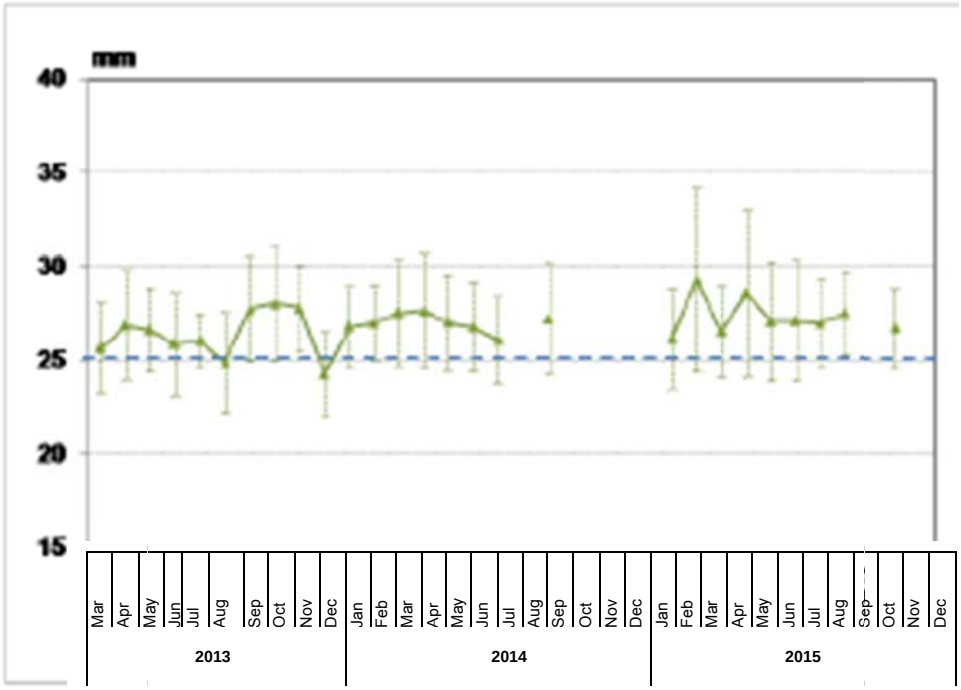


Figure 15: Evolution of monthly size distribution of C. gallina for the period between March 2013 and December 2015. The blue dotted line represents the minimum conservation reference size.

4.3.1.3. Size distribution of abrupt wedge shell (Donax trunculus)

For *D. trunculus,* the commercial catch sizes oscillated between 19 and 43 mm. For the total number of trips considered, only 3.8 % of the retained specimens (Figure 16) were smaller than the legal catch size, set at 25 mm (BOJA No. 195, 30/09/2008). The trend for monthly distribution sizes for the period between March 2013 and March 2014 (Figure 18), has always been above legal catch size. In December, two modal averages were detected: the first of 24 mm and the other of 30 mm. This may be explained by the winter recruitment that takes place between December and February (Ramón et al., 1995). From August, there is an increase in the weight proportion for specimens below the legal size in the discarded fraction. This proportion reaches a maximum of 92 % in October. The smaller-sized discarded specimens were from 19 mm in December. The analysis of the size distributions obtained shows that a comprehensive selection of specimens to be subsequently marketed was carried out on this species. 80 % of the discard by weight consisted of specimens below the legal size.

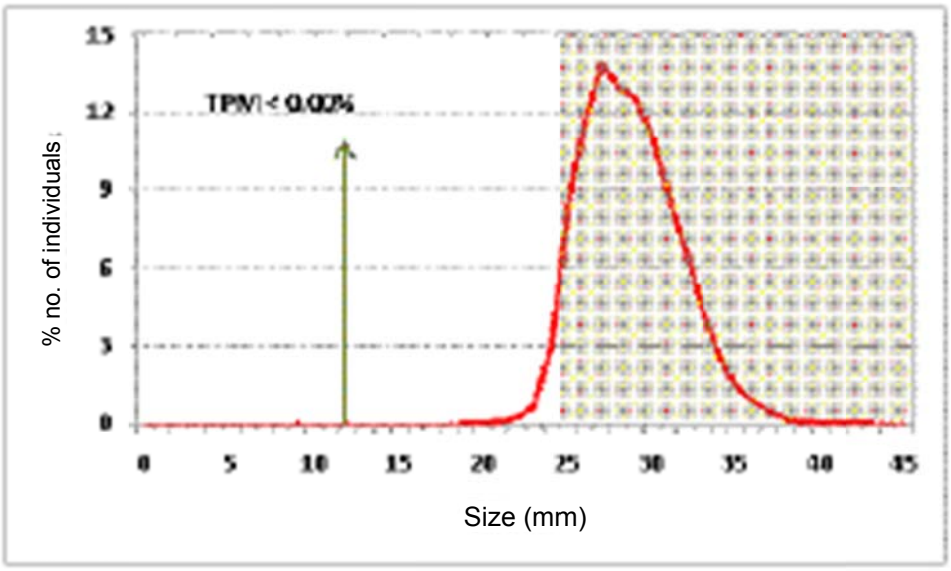


Figure 16: Size distribution of the commercial catch of D. trunculus. for the period between March 2013 and December 2015 (SFM: Size at First Maturity; shaded rectangle represents the legal size range).

Monitoring the evolution of the average size of the commercial catch from April 2014 is represented in Figure 17 and Table 18. The maximum average size was obtained in May 2015, with a length of 30.6 mm; in all sampling months the average catch size was above the minimum catch size, fluctuating between a minimum of 1.3 mm and 5.6 mm above this size.

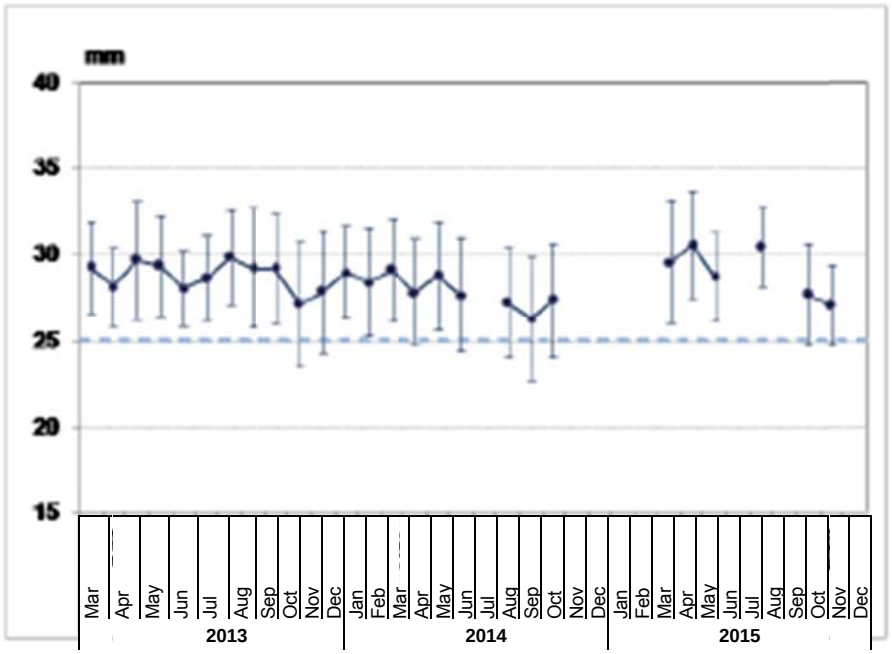


Figure 17: Evolution of monthly size distribution of D. trunculus for the period between March 2013 and December 2015. The blue dotted line represents the minimum conservation reference size (MCRS).

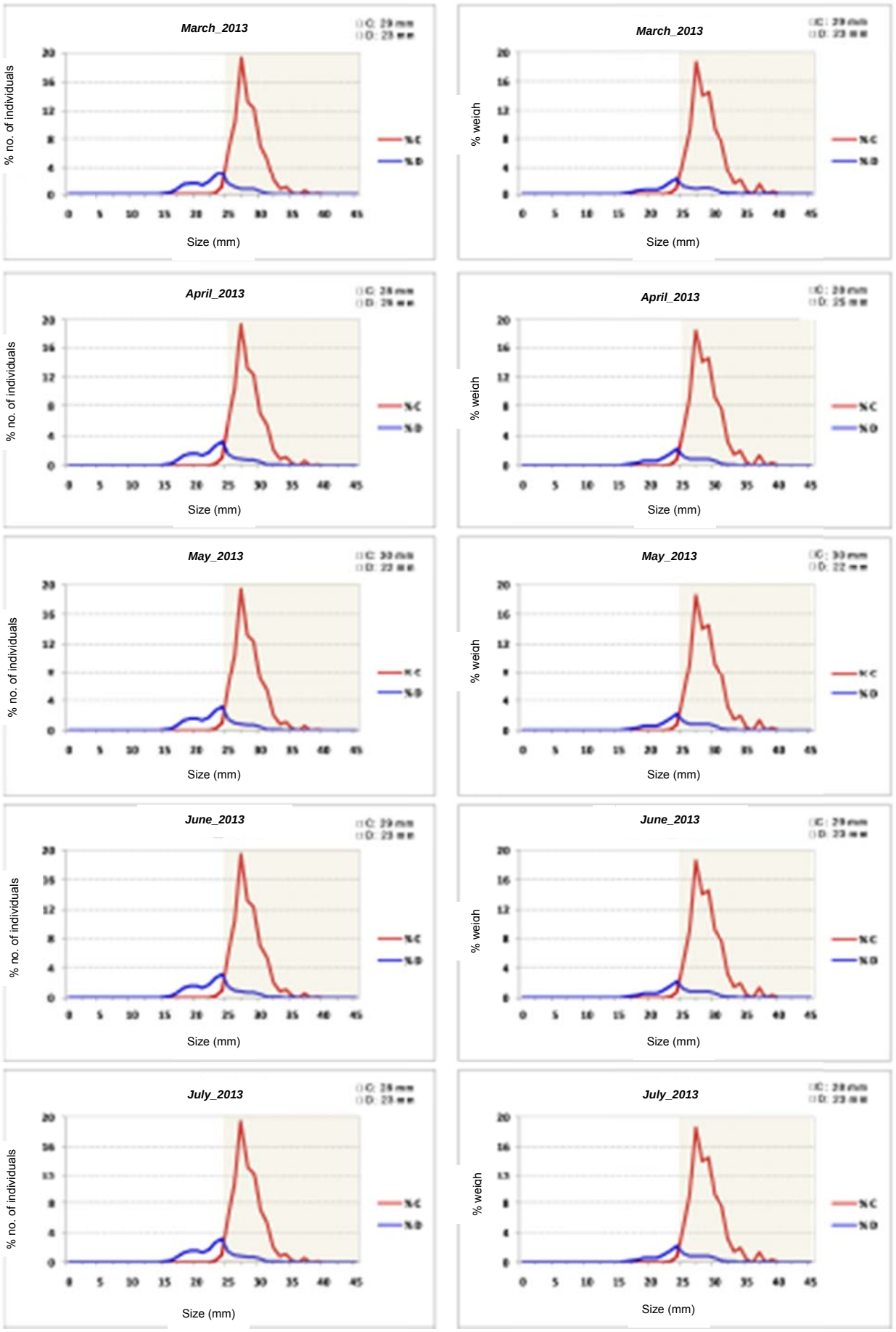


Figure 18: Monthly size distribution of the commercial catch (C) and discarded catch (D) of D. trunculus for the period between March 2013 and March 2014. The data are represented as the proportion of the number of individuals (first column) and the proportion of individuals' weight (second column). The shaded rectangle represents the legal size.

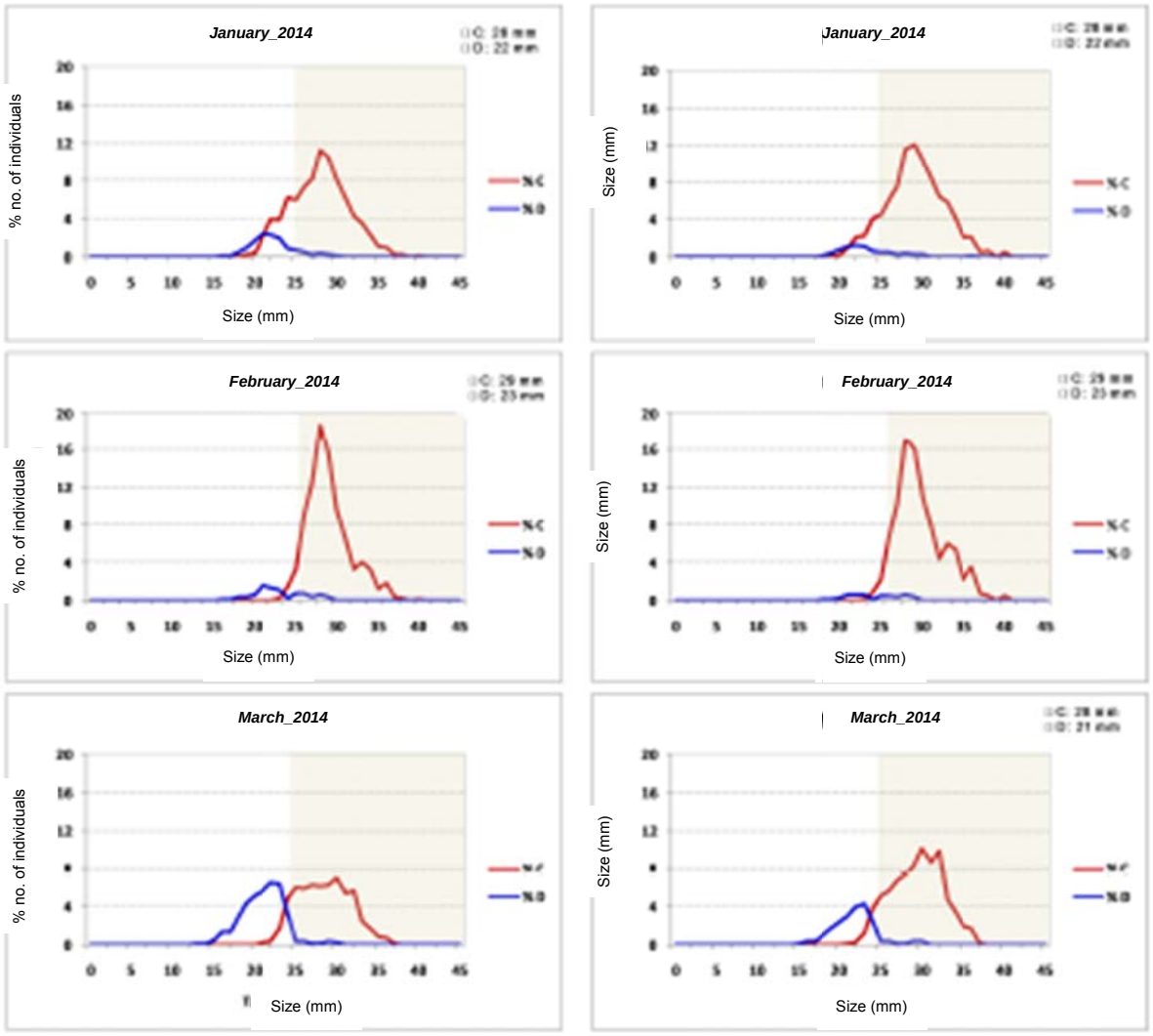


Figure 18 continued.

4.3.1.4. Size distribution of rough cockle (Acanthocardia tuberculata)

The exploitation of *A. tuberculata* is due to demand for the product by the canning companies, with this being the only way of marketing the species. That entails an exploitation that is not continuous through time, presenting huge difficulty in terms of monitoring the evolution of the sizes of the species. The minimum catch size is fixed at 45 mm (BOJA 65, 04/04/03). Figure 19 shows the sizes of the commercial catch exploited between March 2013 and December 2015, taken during 7 months of that period. The sizes ranged from 40 to 69 mm, with only 4.3 % of the specimens forming part of the commercial catch having a size smaller than that established as the minimum catch size, and in this commercial catch no individuals had a size below that of first maturity.

During the period between March 2013 and March 2014, commercial exploitation was only carried out in December and January. In spite of there being no commercial exploitation continued over time, monitoring was performed on the sizes present in the total catches of rough cockle obtained in fisheries aimed at other species, catches that were later returned to the sea (Figure 20) . The distributions of the commercial catch sizes exploited in the months prior to those mentioned show that the modal height for specimens exploited was at 53 and 52 mm respectively, far above the minimum conservation reference size. Only 2.7 % of specimens exploited were found to be below the first catch size.

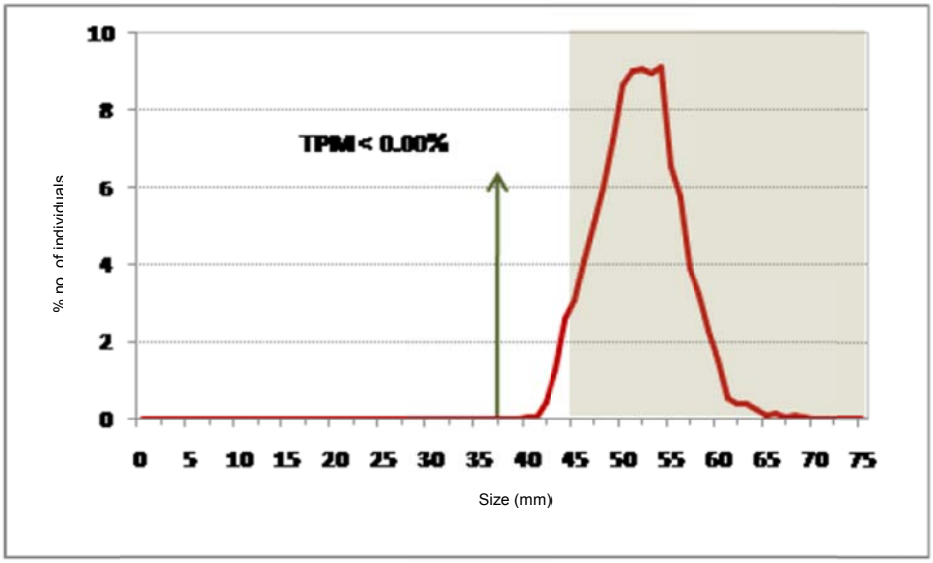


Figure 19: Size distribution of the commercial catch of A. tuberculata for the period between March 2013 and December 2015. (SFM: Size at First Maturity; shaded rectangle represents the legal size range).

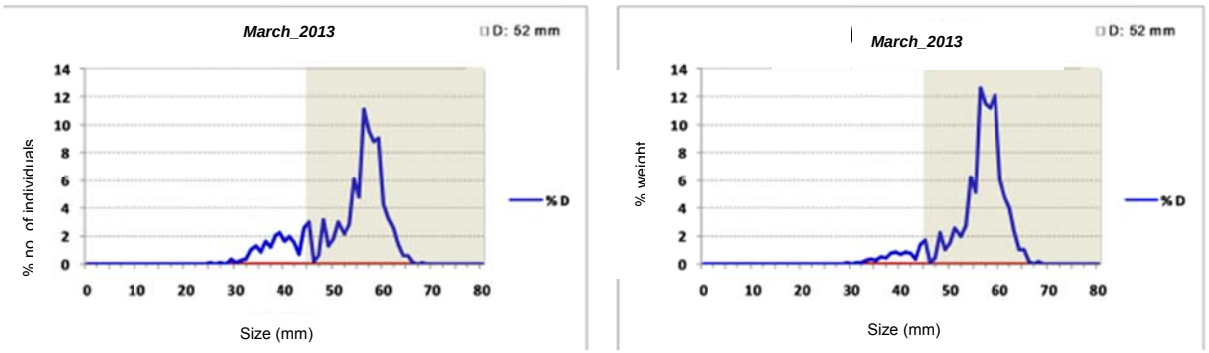


Figure 20: Monthly size distribution of the total catch of A. tuberculata for the period between March 2013 and March 2014, and of the commercial catch (C) and discarded catch (D) in the months of December 2013 and January 2014. The data are represented as the proportion of the number of individuals (first column) and the proportion of individuals' weight (second column). The shaded rectangle represents the legal size.

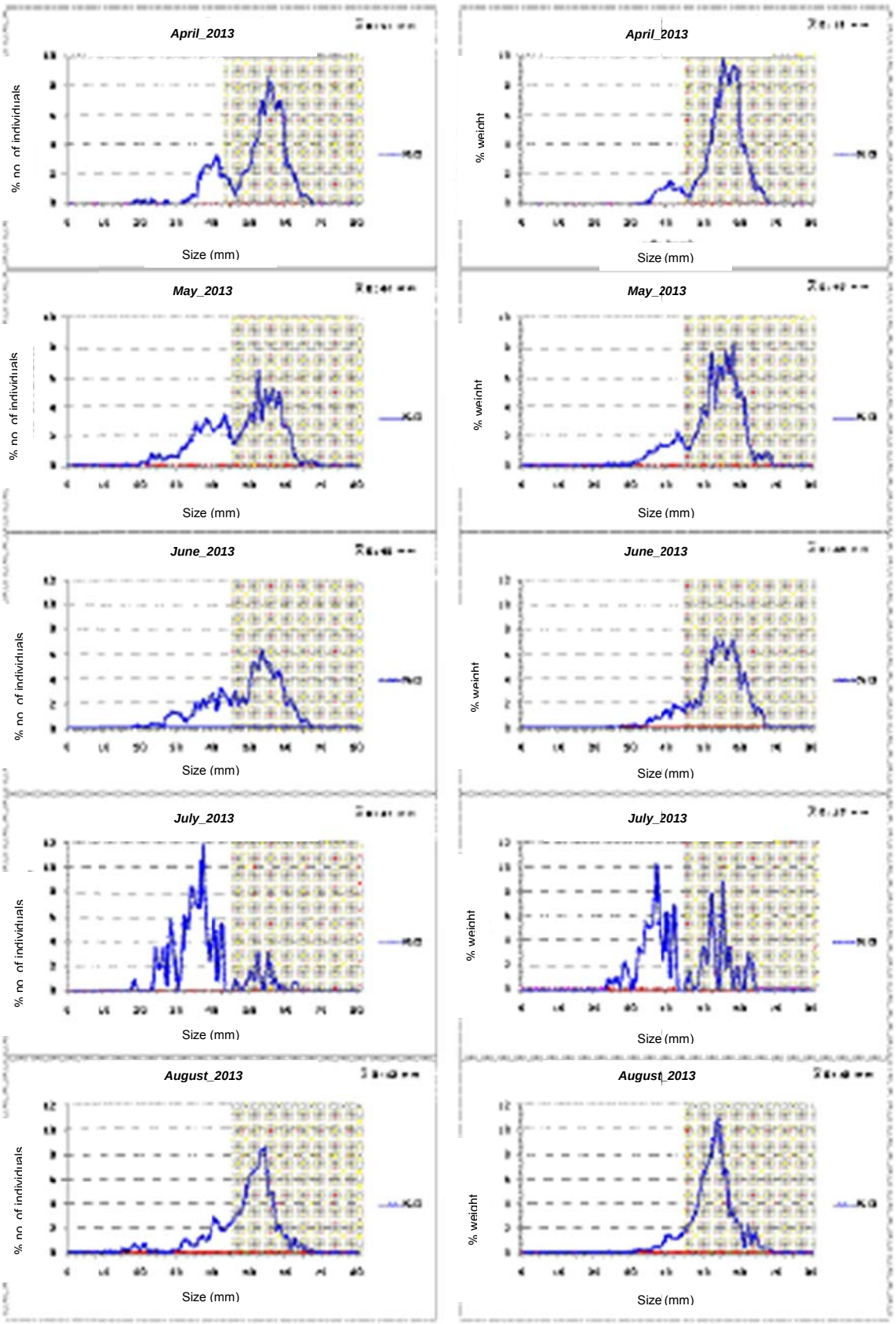


Figure 20 continued.

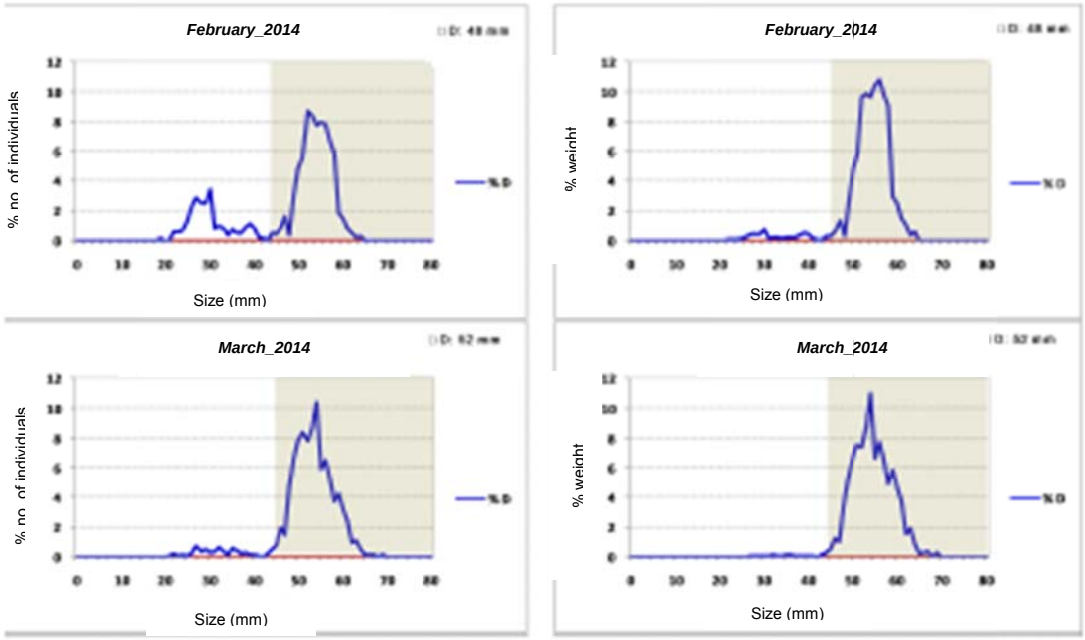


Figure 20 continued.

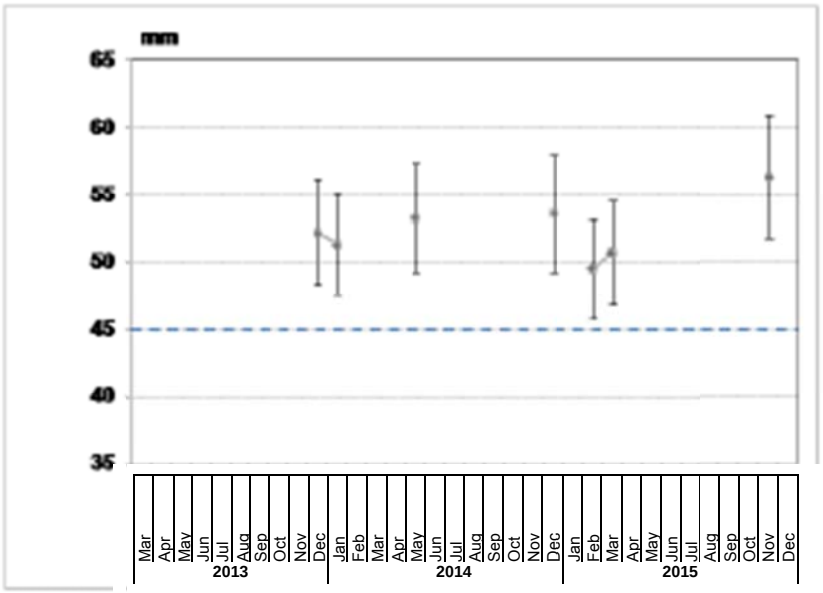


Figure 21: Evolution of monthly size distribution of A. tuberculata for the period between March 2013 and December 2015. The blue dotted line represents the minimum conservation reference size.

The extensive period of sexual activity between January and August, described by Tirado et al., (2002a), in which several peaks of emission and therefore several recruitments occur over time, explain the existence of trends in certain months, which, in turn, may be associated with different peaks of recruitment. The bulk of the population is made up of individuals above the minimum catch size.

As has been noted, it was only possible to make 7 samples in order to determine distribution of the exploited fraction size for A. tuberculata, with the average size found to be well above the legally established first catch size (Figure 21; Table 18).

4.3.2. SLSEPA

Analysis of the data obtained using the Location and Tracking System of Andalusian Fishing Vessels (*Sistema de Localización y Seguimiento de Embarcaciones Pesqueras Andaluzas* - SLSEPA) enabled the location of the fleet at all times to be analysed and represented, obtaining data on the fishing effort that the fleet makes in fisheries, express as:

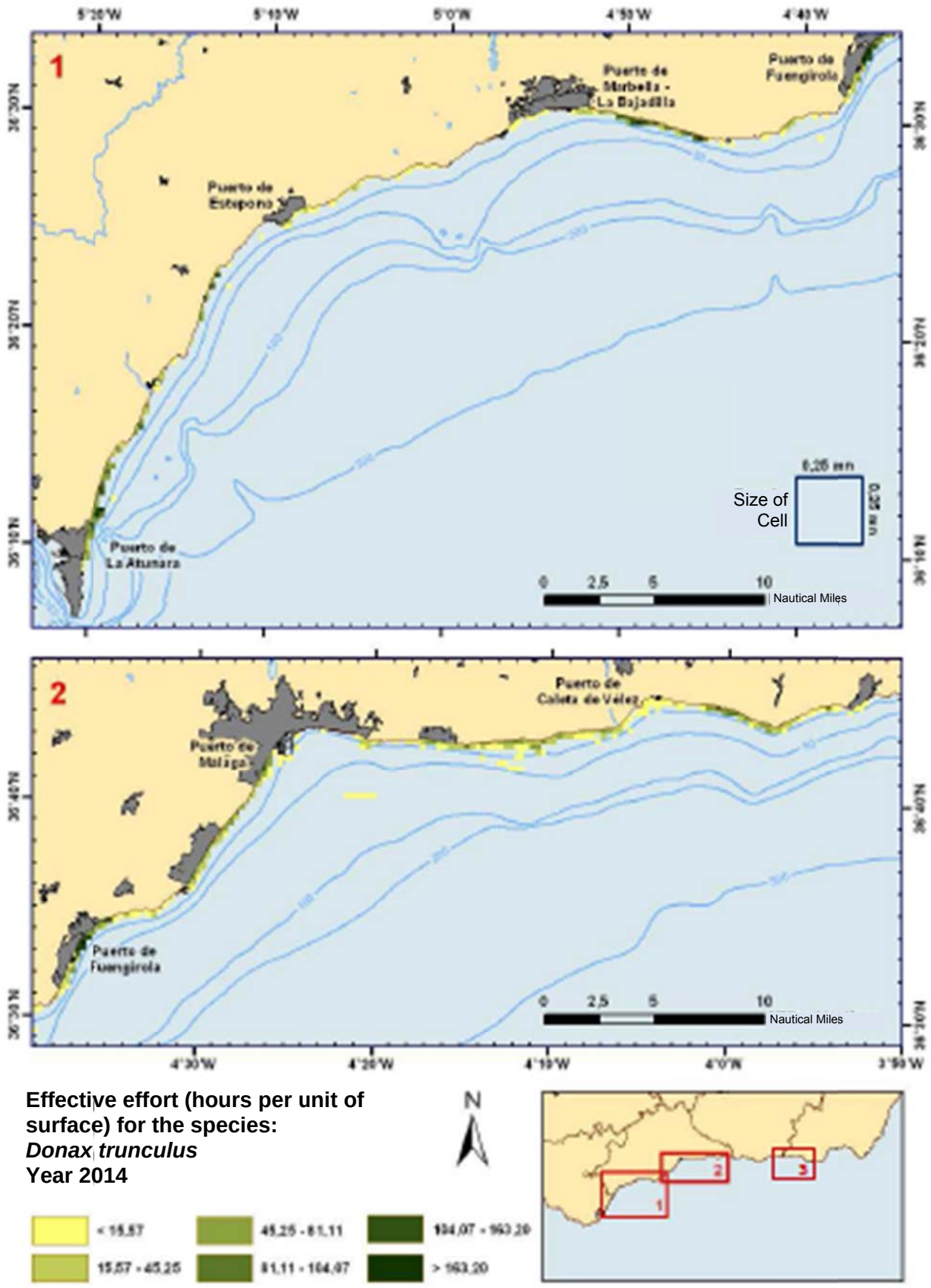
- Number of trips.
- Hours per trip.

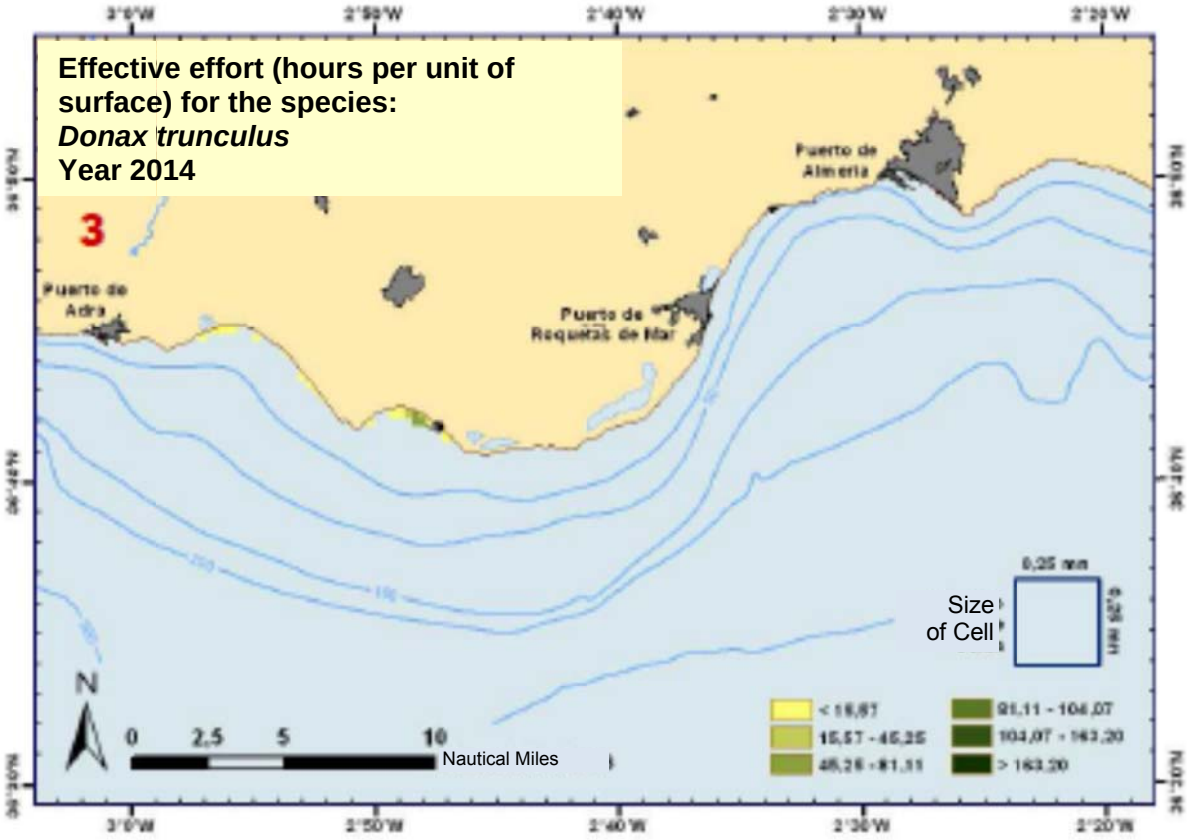
The information collated using SLSEPA is particularly useful for determining where effort is concentrated for each species landed in port and, thus, marking out the banks of the various species.

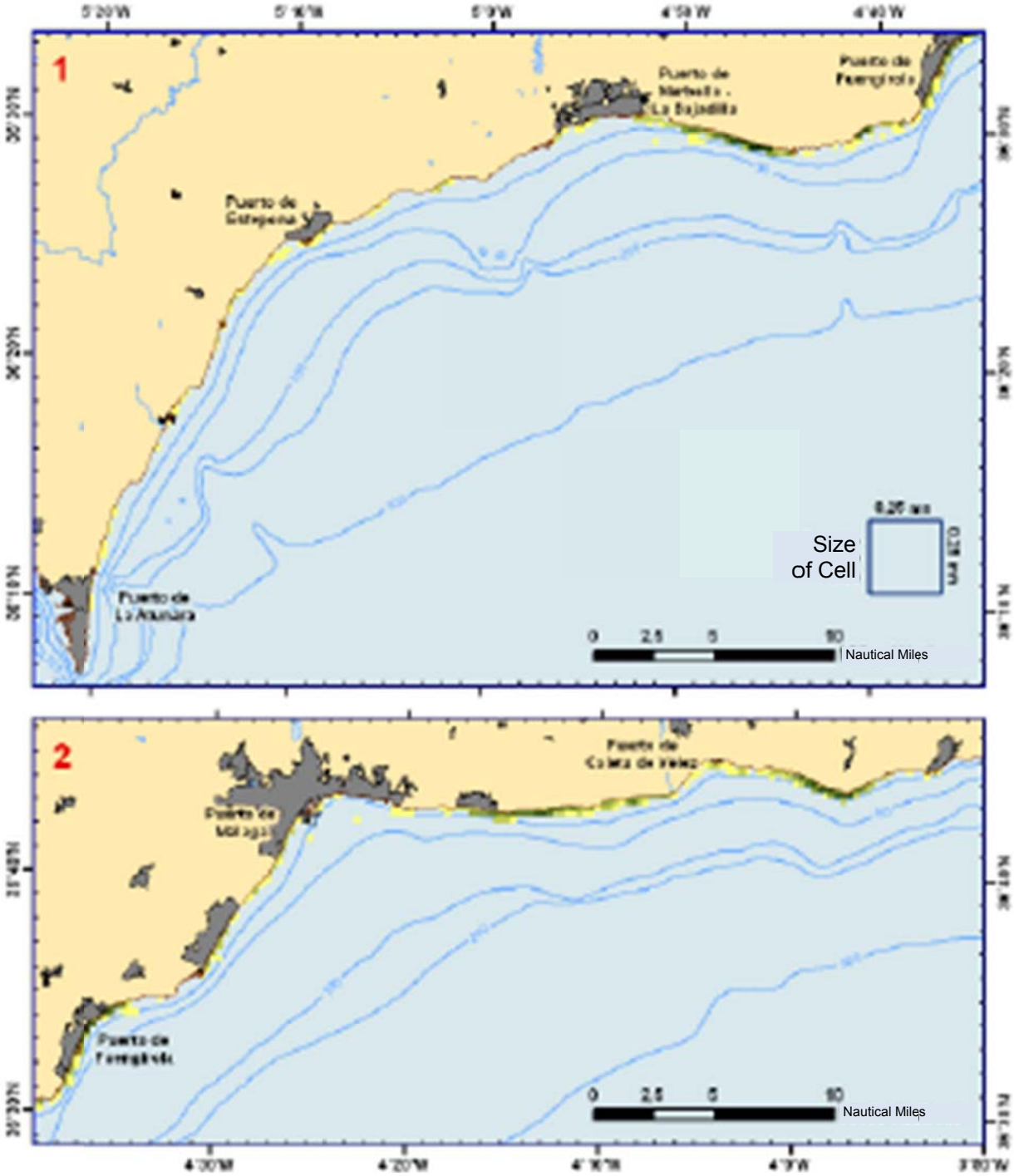
This information shows that shorter fishing days and greater yield were obtained for the rough cockle. However, longer fishing days were held for catching the smooth clam, while the lowest average yields were for the abrupt wedge shell.

The effective effort (hours of fishing activity per surface unit) during the years 2014 and 2015 for the four species studied are given in the graphs below.

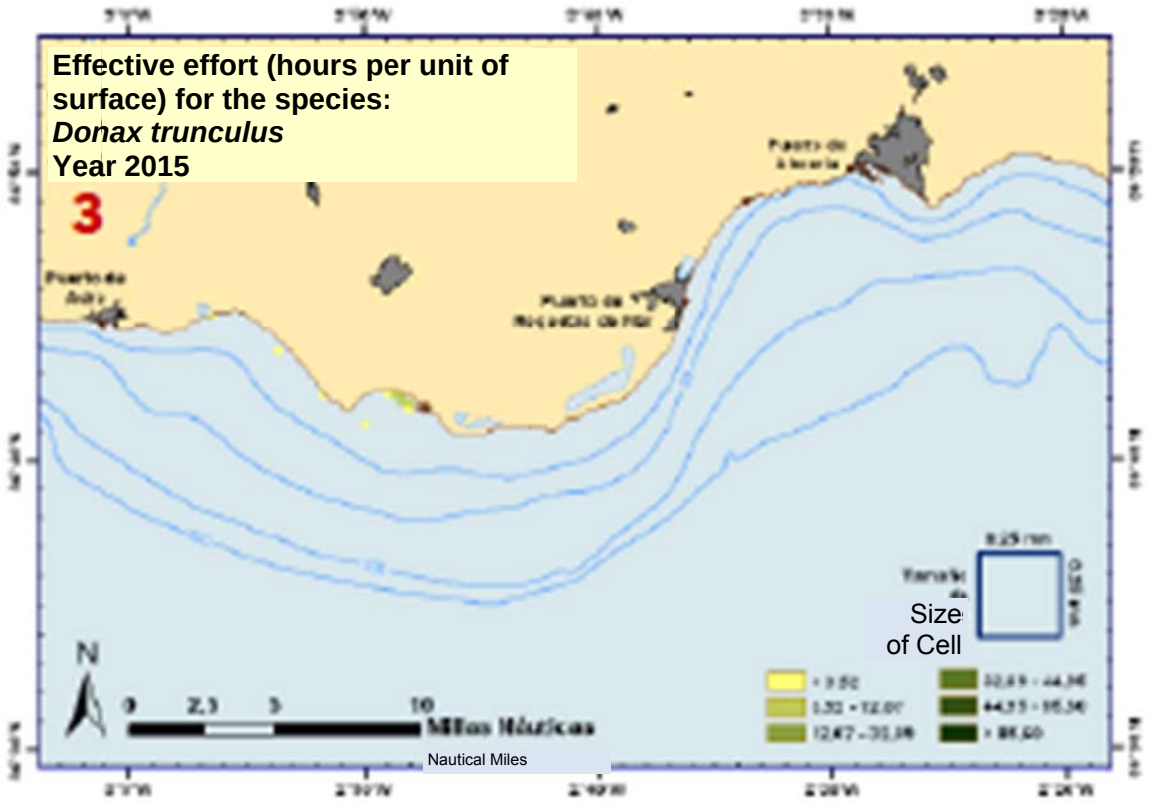
4.3.2.1. Effective fishing effort for the abrupt wedge shell species *(Donax trunculus)*




Effective effort (hours per unit of surface) for the species:
Donax trunculus
Year 2014
3
Puerto de Almería
Puerto de Adra
Puerto de Roquetas de Mar
Size of Cell
0,25 nm
6,29 nm
N
0 2,5 5 10
Nautical Miles
< 15,57
15,57 - 46,26
46,26 - 91,11
91,11 - 104,07
104,07 - 163,20
> 163,20

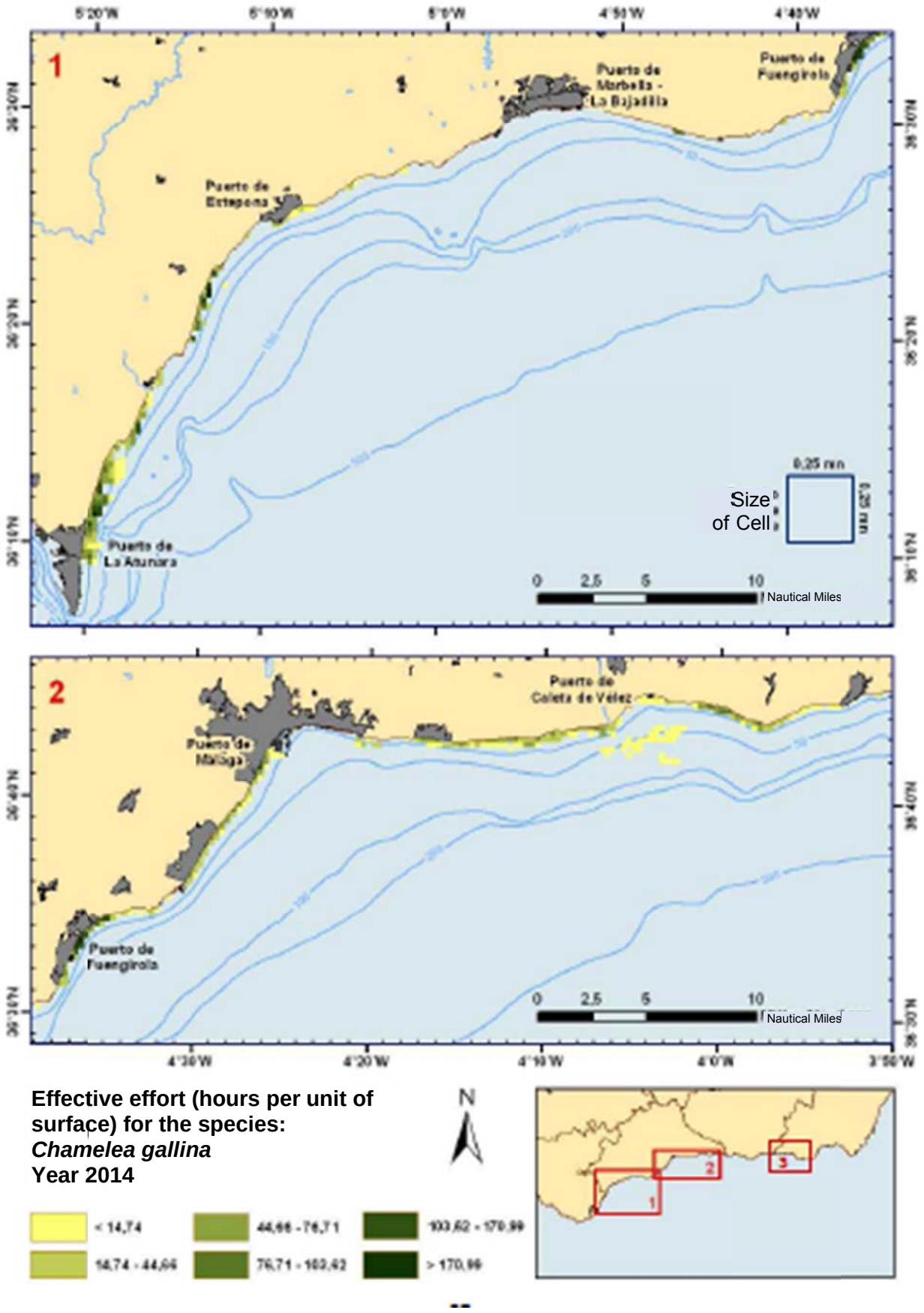


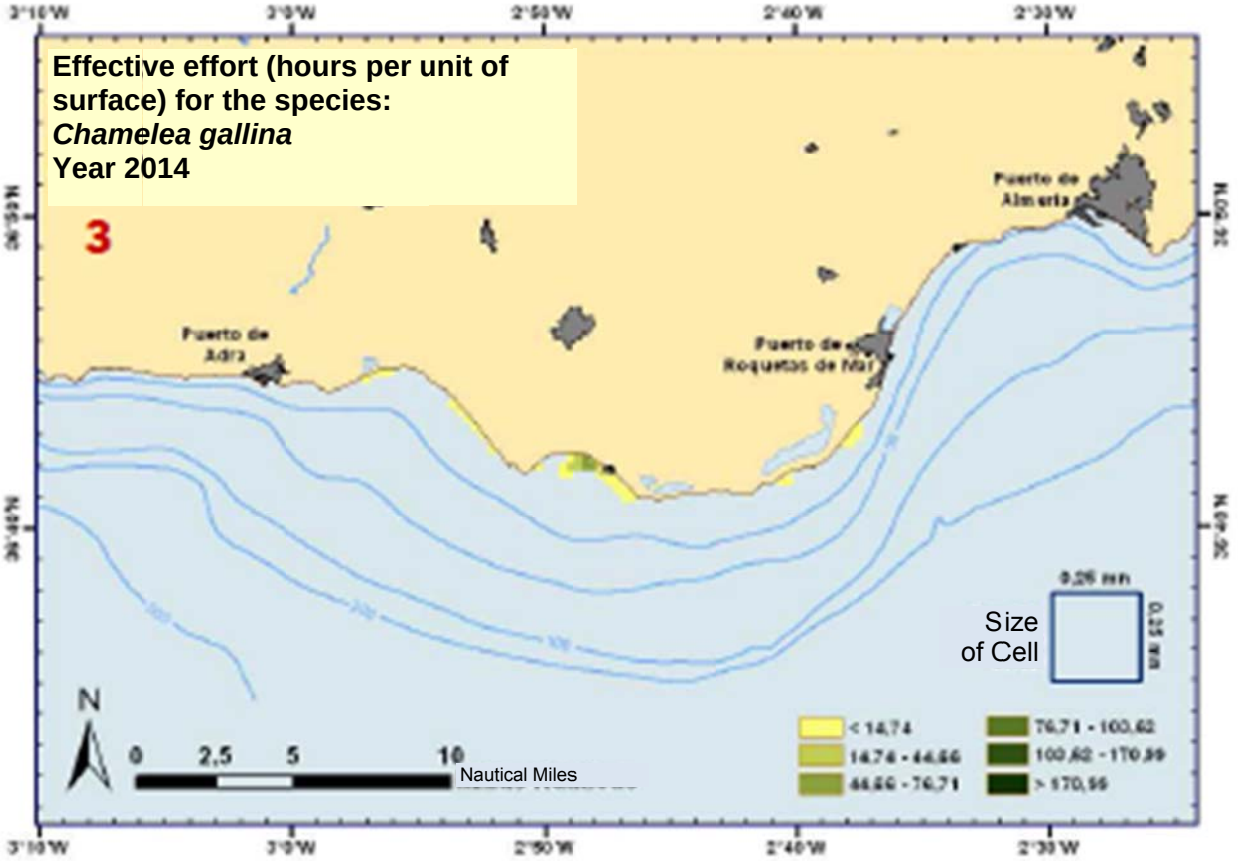
Effective effort (hours per unit of surface) for the species:
Donax trunculus
Year 2015

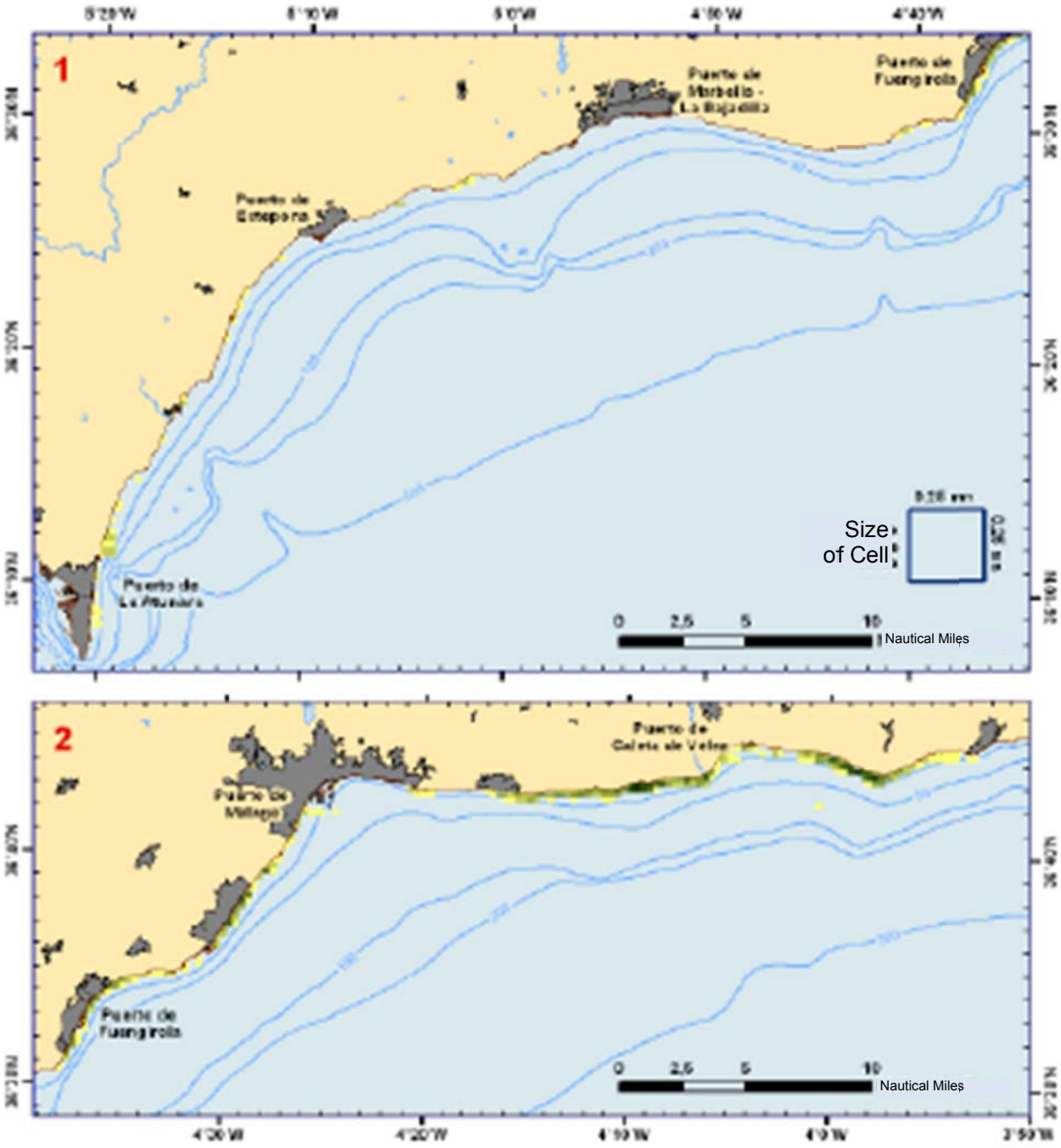


The effort of the mechanised dredge fleet, fishing for the abrupt wedge shell in the Mediterranean coast of Andalusia, concentrates its efforts in the areas surrounding the ports of La Atunara, Estepona, Marbella, Caleta de Vélez and the Bay of Almerimar (Almería). Nevertheless, in the maps shown, it can be seen how, in 2015, the fleet reduced effort off the entire coast, particularly in the areas surrounding the ports of La Atunara, Estepona, Marbella and la Bahía de Almerimar.

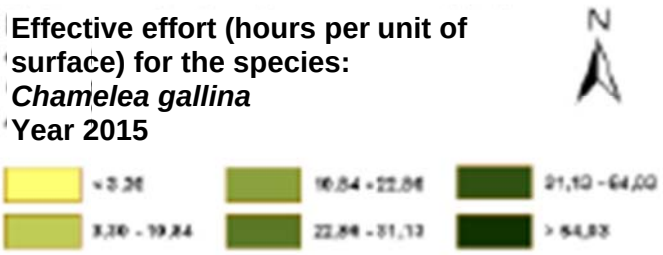
4.3.2.2. Effective fishing effort for the striped venus clam species *(Chamelea gallina).*

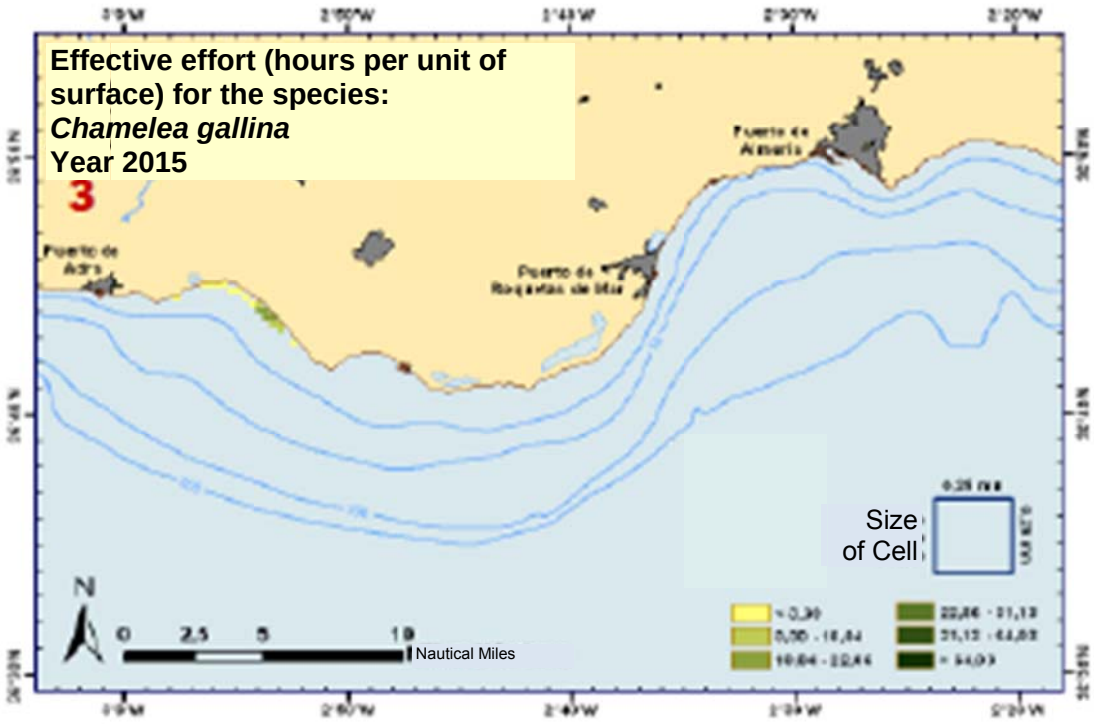



Effective effort (hours per unit of surface) for the species:
Chamelea gallina
Year 2014
3
Puerto de Almería
Puerto de Adra
Puerto de Roquetas de Mar
Size of Cell
0,25 nm
0,25 nm
N
0 2,5 5 10
Nautical Miles
< 14,74
14,74 - 44,66
44,66 - 76,71
76,71 - 100,62
100,62 - 170,99
> 170,99



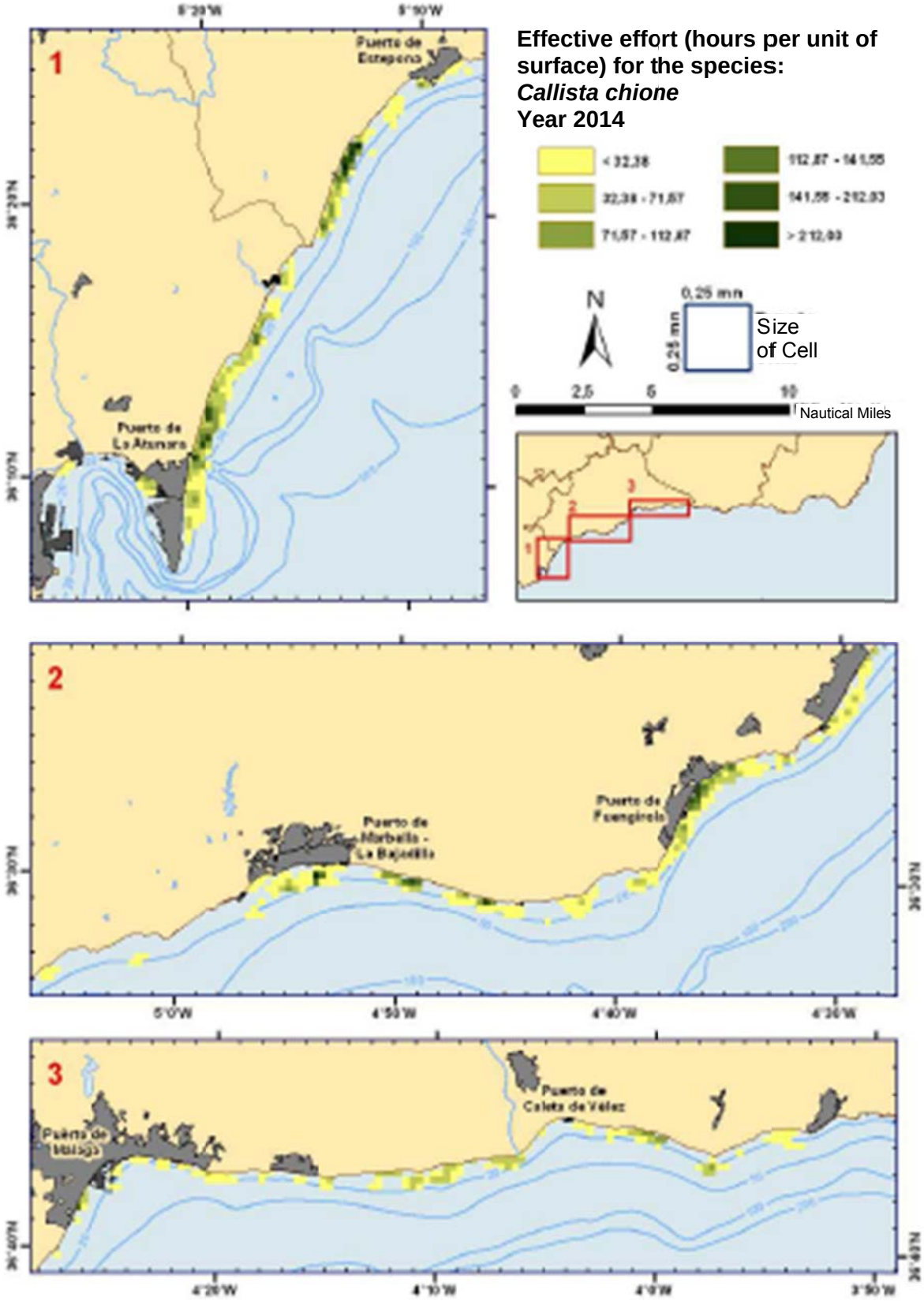
Effective effort (hours per unit of surface) for the species:
Chamelea gallina
Year 2015

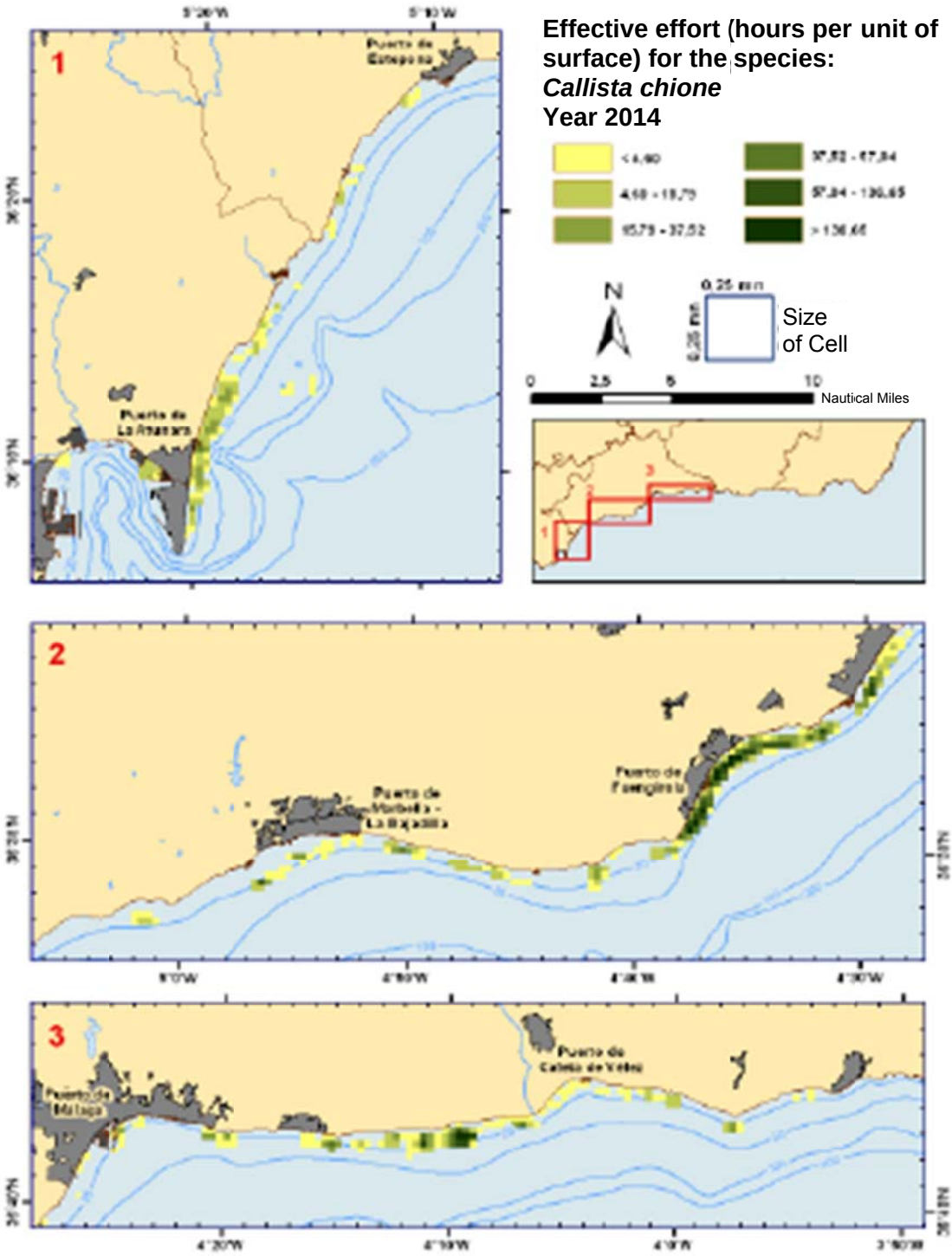




The striped venus clam appears to follow the same effort pattern as the abrupt wedge shell, with the banks situated at the same sites, and as has also happened in the case of the abrupt wedge shell, the effort on the striped venus clam appeared to fall throughout the entire coast in 2015, particularly in and around the ports of La Atunara, Estepona, Marbella and Alemerimar.

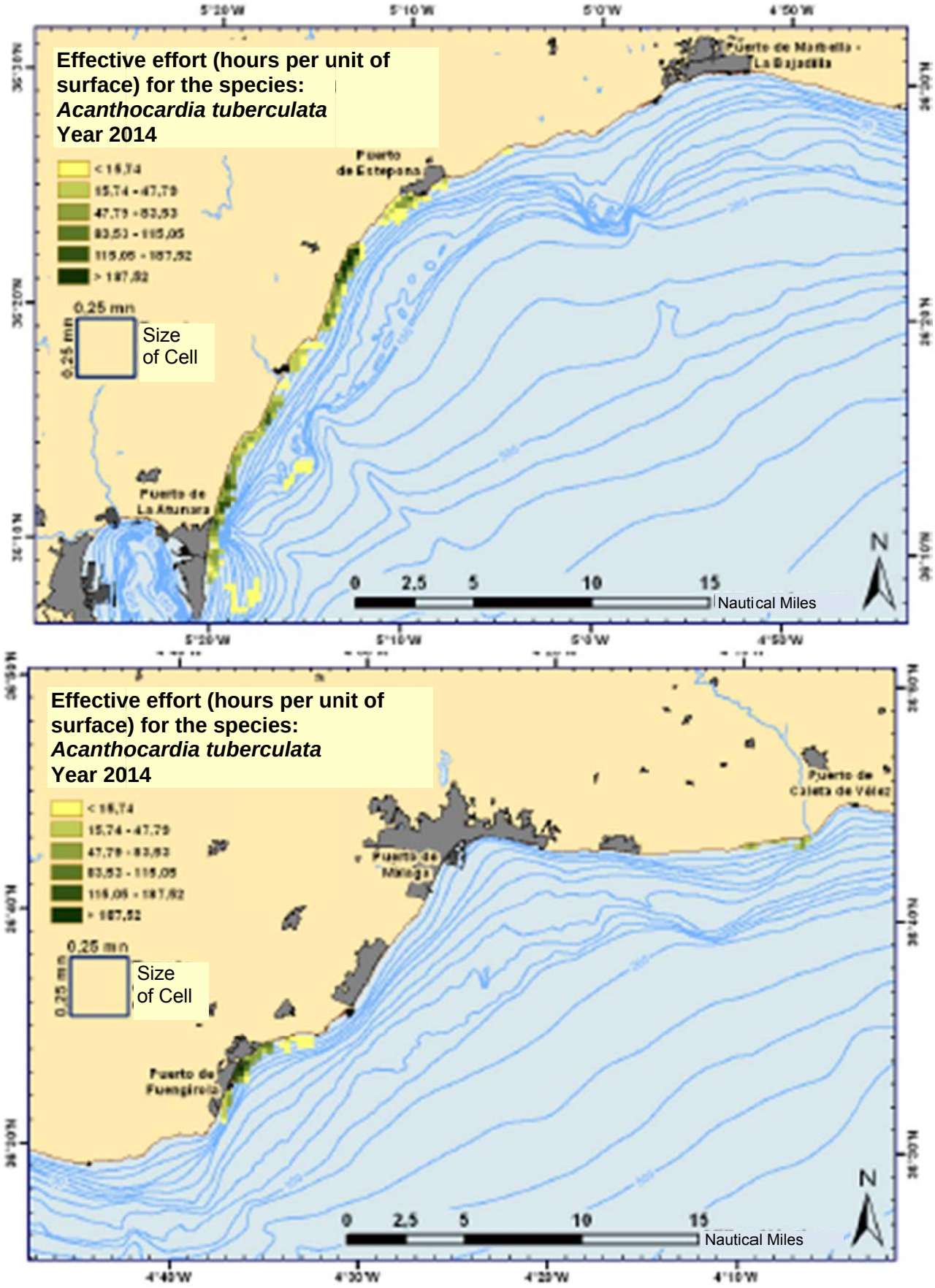
4.3.2.3. Effective fishing effort for the smooth clam species *(Callista chione)*

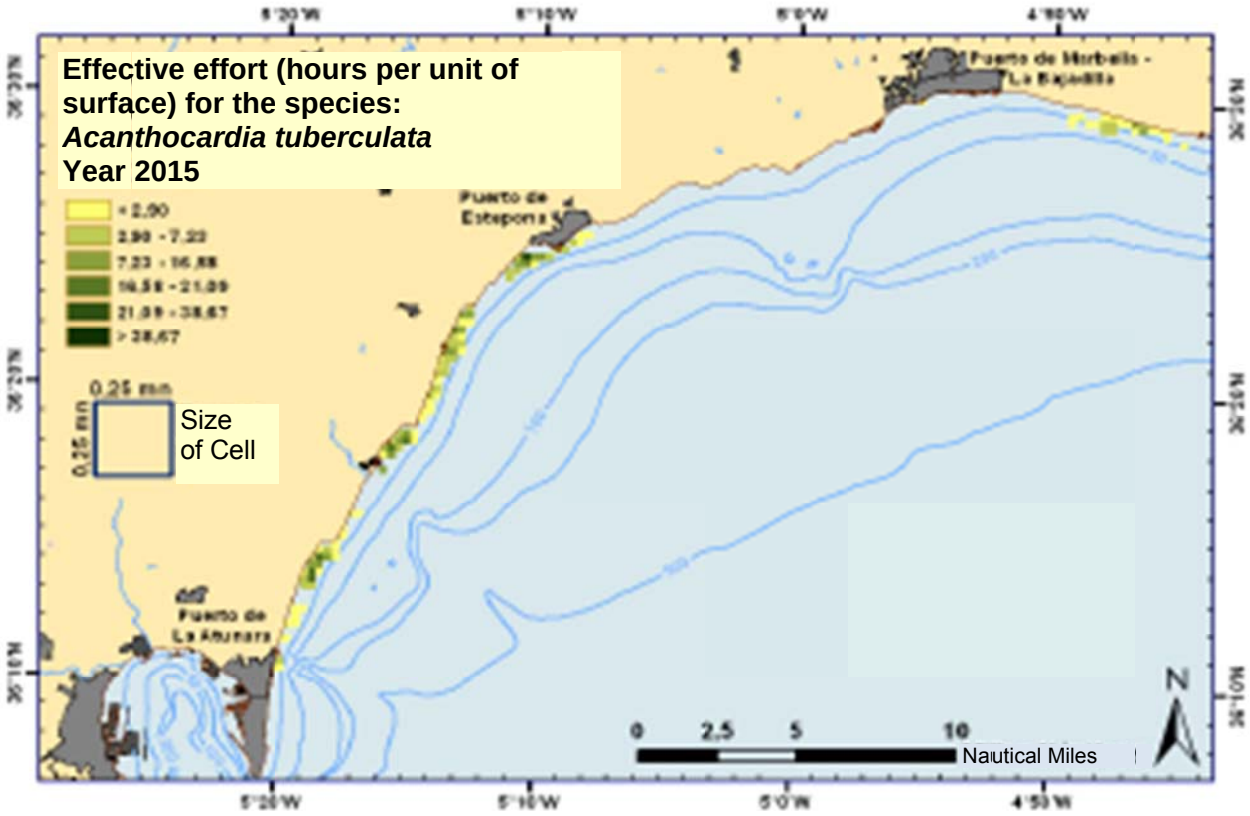


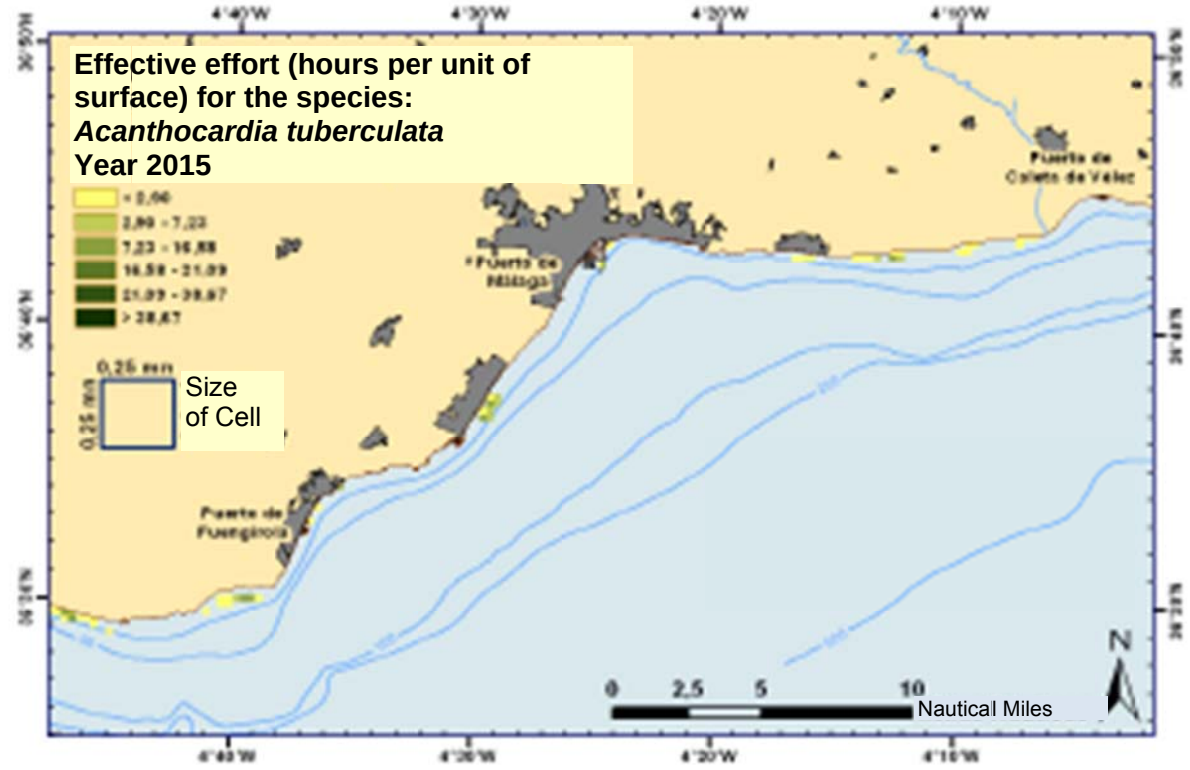


As with other species, smooth clam banks appear to be well defined throughout the mechanised dredge fleet. However, with the short seasonal series available, an increase in effort on banks near to the port of Caleta de Vélez over the last two years seems to have been observed.

4.3.2.4. Effective fishing effort for the rough cockle species *(Acanthocardia tuberculata)*







Effort for the rough cockle was spread out between the most western area of the Mediterranean Andalusian coast (La Atunara, Estepona and Marbella) and the most central area (Fuengirola and Caleta de Vélez-Málaga).

4.3.3. Stock evaluation

In order to attempt to determine the current states of exploited stocks, daily CPUE averages per vessel and target species (kg*day^{-1}), for the period between 2001 and 2015, were analysed. Prior to the use of the production models tested, the CPUE series were standardised by applying GLMs according to year, gross register tonnage (GRB), CV power (HP) and length (LOA) of vessels. The possible correlations between the different variables used in CPUE with GLM modelling have been analysed using the Spearman's correlation coefficient. The values have been represented using graphs showing the corresponding cloud of points, the possible trends and signs of these. In order to analyse whether there are differences between the standardised and non-standardised annual average CPUEs, a Mann-Whitney U-Test was used for two independent samples.

In order to obtain information on reference values, a simple production model was used, where possible, by means of a spreadsheet based on information on the annual average CPUE of the 2001 to 2015 series. The reference values obtained were used, in certain species, as initial estimates for the use of a non-equilibrium production model ASPIC (A Surplus Production Model Incorporating Covariates), so as to obtain the population's trajectory in terms of relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) (Prager, 1994; 2004). In addition, to verify the results, the BioDyn production model based on the Schaefer model was used, which also offers the possibility of analysing the population's trajectory on the same terms as ASPIC, as well as making projections taking into account changes in the catch or effort. This model was implemented using an MS Excel spreadsheet distributed by FAO (FAO, 2006). The model uses four input parameters: biomass load capacity (K), intrinsic rate of population growth (r), Biomass of the stock at the beginning of the data series, as a proportion of the Virgin Biomass (BI/K) and catchability coefficient (q). As biological reference points of stock status, those adopted by the GFCM were taken into consideration. The ranges of overexploitation (overfishing) were based on the Fc/F0.1 and Fc/F_{MSY} ratios. As catch limits, values based on MSY were estimated based on the degree of exploitation of the fishery. As a minimum reference threshold, the 33rd percentile of the CPUE series analysed was used as the empirical value below which relative abundance was considered low and stock overexploited.

4.3.3.1. Rough Cockle (Acanthocardia tuberculata).

Standardisation of CPUE

CPUE correlates positively with GRB, HP, and LOA (Figure 22), even though the Spearman's correlation coefficient values, although significant, are very low, with no pronounced positive or negative trends reported (Table 19). As expected, there is a considerable degree of collinearity among the variables that represent the technical characteristics of the vessels, which do show a strong correlation (Table 19).

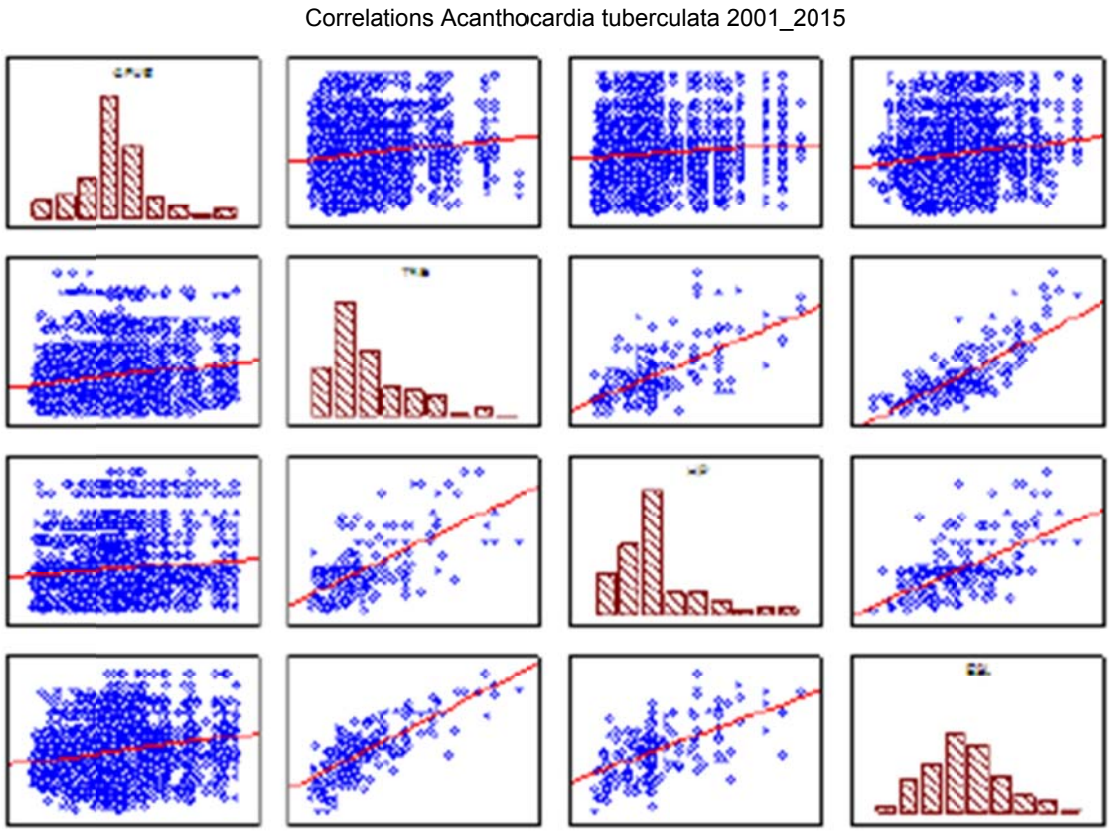


Figure 22: Scatterplots between the different variables taken into account for CPUE standardisation. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

Table 19: Spearman's rank correlation coefficient values between the different variables examined. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

Variable	Spearman's Rank Order Correlations *A. tuberculata* MD pairwise deleted Marked correlations are significant at p <.05000				
	CPUE	GRB	HP	LOA	
CFUE	1.000000	0.106333	0.056783	0.187198	
GRB	0.166333	1.000000	0.485523	0.695640	
HF	0.056783	0.485523	1.000000	0.481205	
LOA	0.187198	0.695640	0.481205	1.000000	

Table 20: Significance (p-value) and AIC value of the different combinations of explanatory variables for GLM model adjustment to the CPUE data for Acanthocardia tuberculata (2001-2015).

Step	CPUE - Model building results *Acanthocardia tuberculata* Distribution NORMAL Link function LOG							
	Var 1	Var 2	Var 3	Var 4	Degr of Freedom	AIC	L Ratio Chi^2	P
1	LOA	YEAR			15	64 593.09	5 339.434	0.000000
2	GRB	LOA	YEAR		16	64 595.05	5 339.483	0.000000
3	HF	LOA	YEAR		16	64 595.07	**5 339.463**	0.000000
4	GRB	HF	LOA	YEAR	17	64 597.04	5 339.491	0.000000
5	GRB	YEAR			15	**64 654.88**	5 277.649	0.000000
6	GRB	HF	YEAR		16	64 655.70	5 278.823	0.000000
7	HF	YEAR			15	64 700.19	5 232.342	0.000000
8	YEAR				14	64 751.61	5 178.921	0.000000
3	GRB	HF	LOA		3	69 712.29	196.236	0.000000
10	GRB	LOA			2	69 713.79	192.743	0.000000
11	LOA				1	69 716.86	187.669	0.000000
12	HF	LOA			2	69 718.34	188.184	0.000000
13	GRB				1	69 766.52	138.007	0.000000
14	GRB	HF			2	69 768.05	138.474	0.000000
15	HF				1	69 849.52	55.007	0.000000

The GLM result shows that the best fit is the inclusion of the explanatory variables LOA and YEAR, although other options are also acceptable (Table 20). In any case, the mean annual values of the standardised CPUE are practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 95> 0.05), in such a way that one or the other may be used without distinction.

Stock diagnosis

Figure 23 shows the evolution of catches and CPUE for the period 2001 to 2015. Catch data is extremely variable between years, presenting a maximum of 2 300 tonnes in 1996 and registering abrupt oscillations to the end of the series. The exploitation of the species is completely dependent on demand for the product from canning manufacturers, the only marketing opportunity for this species. The oscillations observed are therefore due to varying demand according to the season.

A closer view of the relative abundance of the species is offered by CPUE evolution (Figure 23). Here, a steady increase since 2003 is observed with maximum values from 2010 to 2015, with more than 400 kg/fishing day, reaching 730 kg/fishing day in the last year of the series.

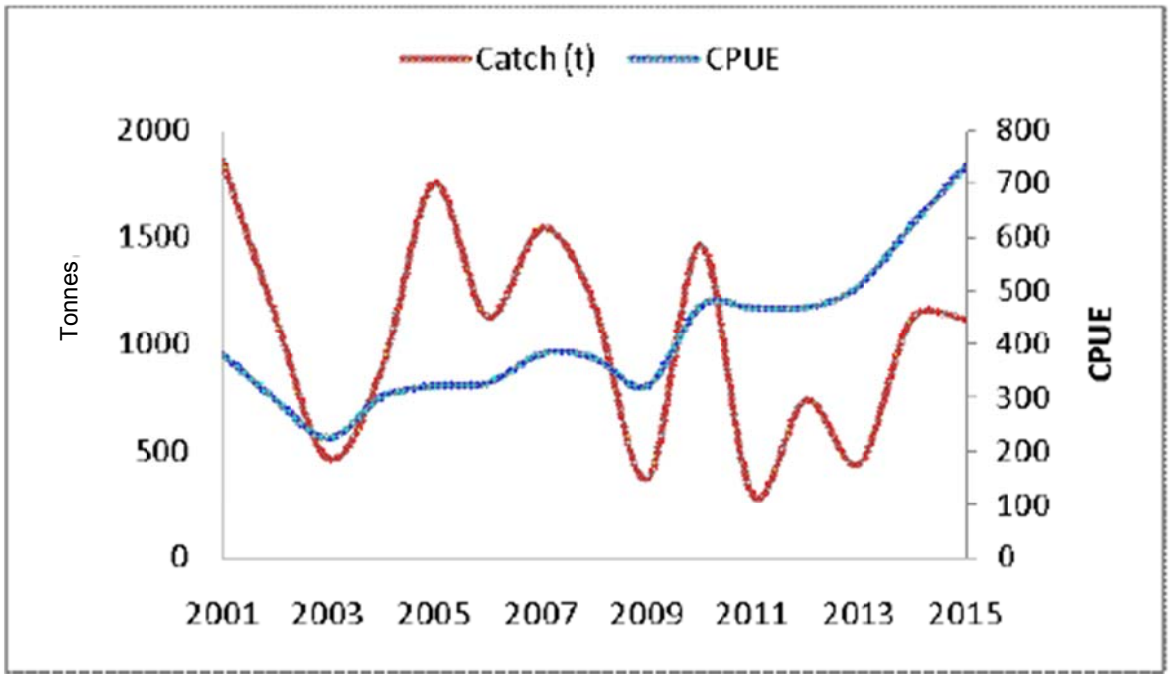


Figura 23: Evolution of catch and CPUE for rough cockle (Acanthocardia tuberculata) between 2001 and 2013.

Considering the series 2001 to 2015, and so as to gain an overview of the trajectory of exploited stock, a production model with ASPIC was carried out, using a bootstrap adjustment through 1 000 iterations. The estimated CPUE via ASPIC shows few differences from that observed (Figure 24). The evolution of the indexes considered as biological reference limit points - relative biomass (B/B_{MSY}) and relative fishing mortality rate (F/F_{MSY}) (Figure 25) - shows a progressive increase of biomass, even exceeding the value of biomass needed to reach MSY. Although some oscillation in F/F_{MSY} values can also be seen, in recent years and since 2010, there has been a significant improvement in the exploitation of the resource and a situation whereby stock does not appear to be overexploited or overfished.

The value of MSY obtained with ASPIC amounts to approximately 1 670 t, with the current values of the Boundary Reference Points (B/B_{MSY} and F/F_{MSY}) showing that the resource has a good state of health with a relative biomass rate 1.13 times greater than that of the biomass required to obtain maximum sustainable yield, and a fishing mortality rate that is only 60% of that required to obtain the MSY (Table 21).

Table 21: Estimates of biological reference points obtained from a bootstrap analysis via ASPIC (biomass data in k) carried out for the rough cockle (Acanthocardia tuberculata).

Parameter	Estimate
MSY (Maximum sustainable yield)	1.67E+06
B_{MSY} (Stock biomass giving MSY)	1.03E+07
F_{MSY} Fishing mortality rate at MSY	1.62E-01
$B(2016)/B_{MSY}$	1.13E+00
$F(2015)/F_{MSY}$	6.06E-01
$F_{MSY}/F(2015)$	1.650E+00
$Y.(F_{MSY})$ Approx. yield available at F_{MSY} in 2016	1.866E+06
as proportion of MSY	1.118E+00
Ye. Equilibrium yield available in 2016	1.642E+06
as proportion of MSY	9.834E-01

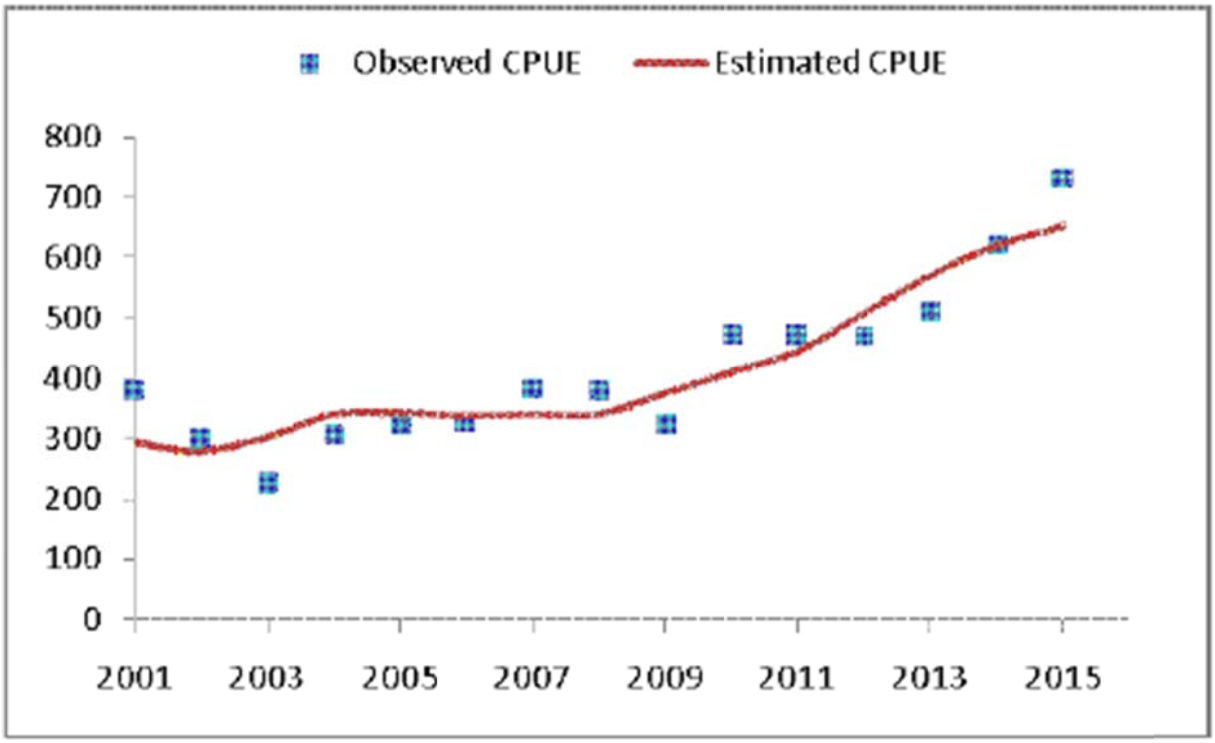


Figure 24: Annual evolution of CPUE observed and estimated using the ASPIC model (kg/day) for rough cockles (A. tuberculata) in the period 2001-2015.

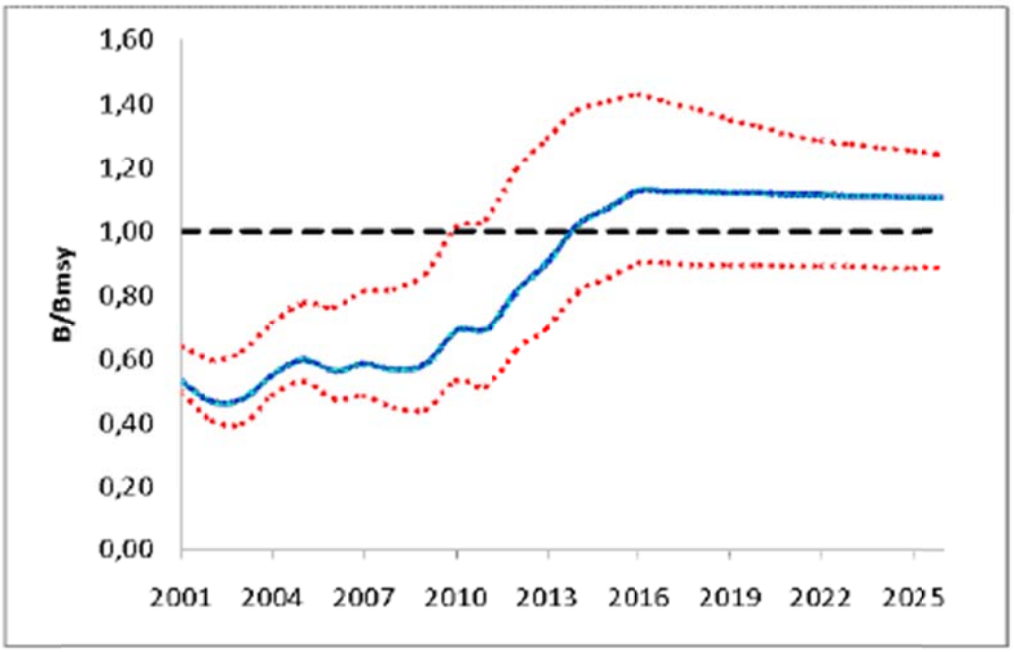


Figure 25: 10-year projection of the B/B_{MSY} index value for rough cockles (A. tuberculata), maintaining the MSY value estimated by the ASPIC model. Dotted lines represent the confidence limits at an 80 % confidence interval

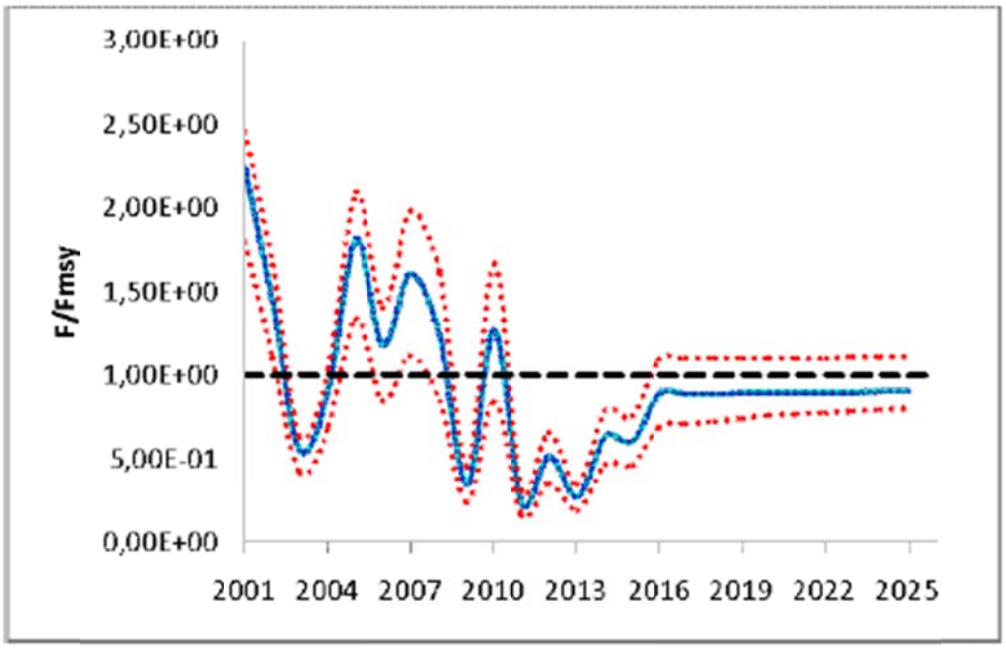


Figure 26: 10-year projection of the F/F_{MSY} index value for rough cockles (A. tuberculata), maintaining the MSY value estimated by the MSY model constant. Dotted lines represent the confidence limits at an 80 % confidence interval

In the evaluation performed with BioDyn, the results are slightly different from those obtained with the ASPIC model, estimating a lower MSY value (1 359 t) than that obtained with ASPIC (1 670 t). However, the perception of the state of the resource is similar, with current values of relative biomass being 1.4 times greater than that required to reach MSY biomass and an F/F_{MSY} value of 0.6 (Table 23). The trend of the resource in terms of relative biomass is even better than in the case of ASPIC. After a series of years in which the resource appeared to have been overexploited, the situation has improved in the last period and it can be seen that the values of B/B_{MSY} and F/F_{MSY} are in areas which are suitable for the maintenance of the resource, although the growth of the stock seems to have a very slight tendency to decline according to the estimated value of Fcur/FSYcur. (Figure 27).

Table 23: Estimates (t) of the model parameters obtained via BioDyn for Acanthocardia tuberculata

Stock Parameters	
MSY	1 359
BMSY	5 437
B0.1	5 981
Cur Stock	7 790
B/B_{MSY}	143 %
B/B0.1	130 %
Cur_SustProd	1105
Cur_PercProd	81 %
CurY	1117
FMSY	0.25
F0.1	0.23
FCur	0.14
Fcur/FMSY	57 %
Fcur/F0.1	64 %
FSYCur	0.14
Fcur/FSYCur	101 %
DBCur	-12
DBCUr/Bcur	0 %
CurY/MSY	82 %

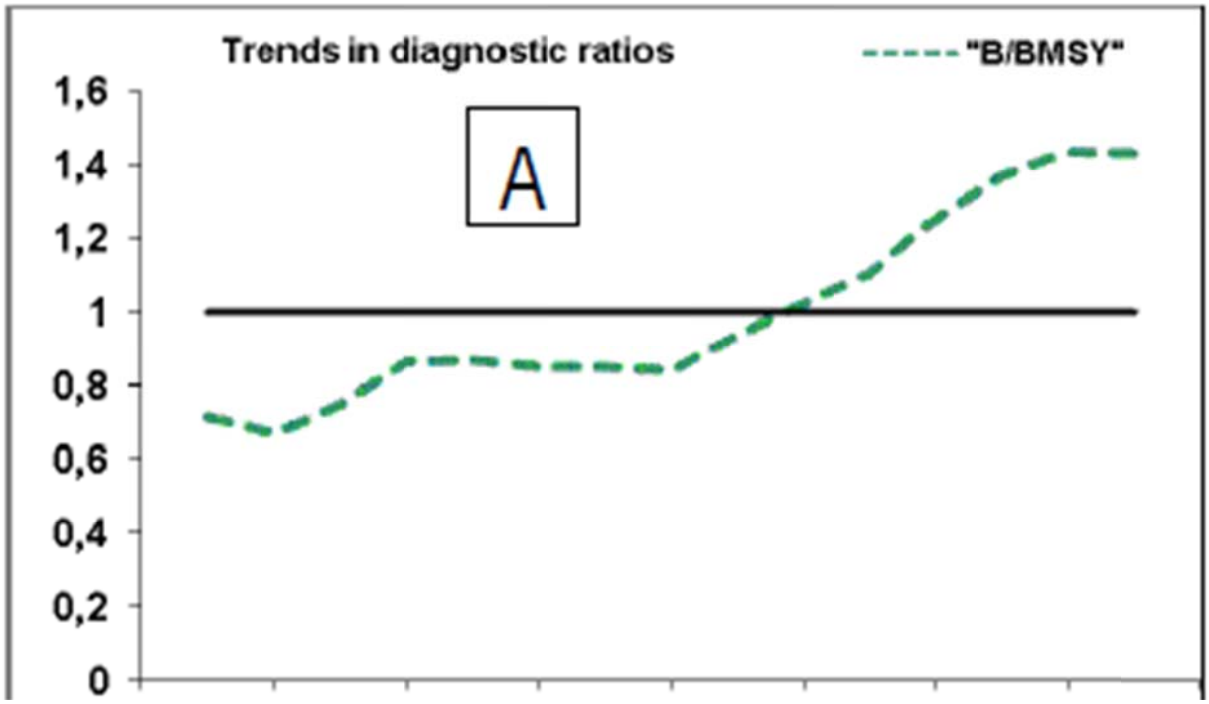


Figure 27: A: Trajectory of the rough cockle population (A. tuberculata) in terms of relative biomass (B/B_{MSY}) and B: in terms of relative fishing mortality (F/F_{MSY}) according to Biodyn results.

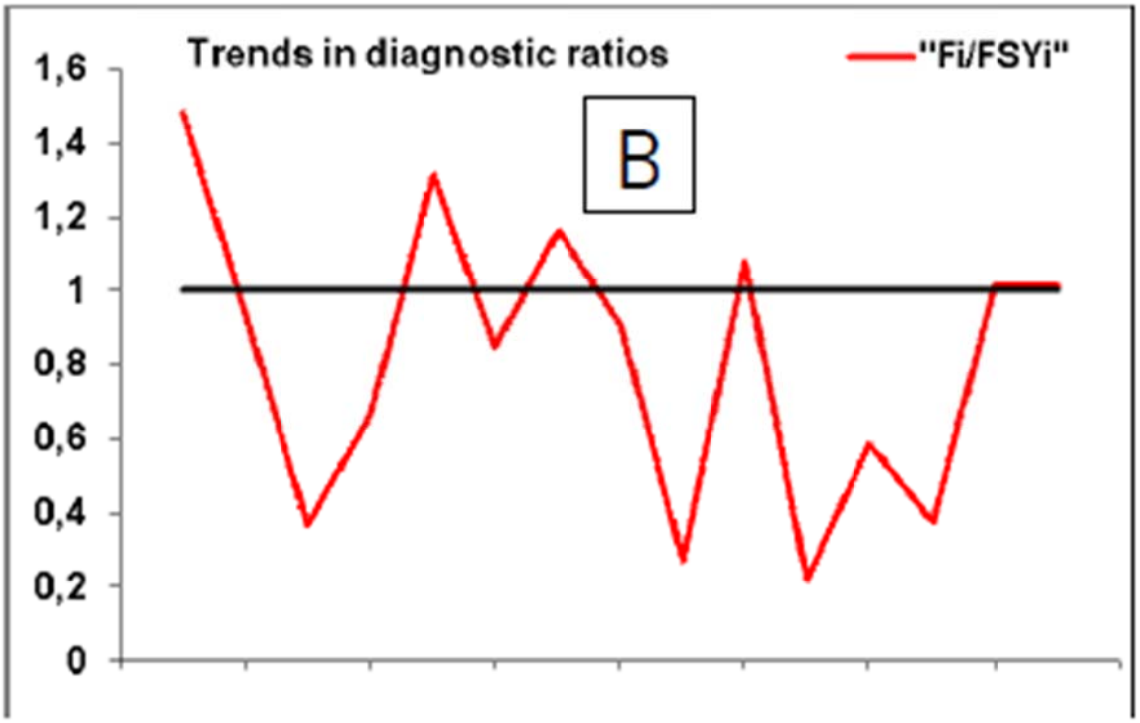


Figure 27 continued.

With the values estimated by BioDyn, a 15-year projection has been made, keeping the catch at 5 % lower than the estimated MSY value, since the trend of Fi/FSYi is set to increase. The result shows a slight decrease in the relative abundance of stock in the first five years of projection, as suggested by the estimated value of Fcur/FSYCur, which later stabilises (Figure 28). The projection of values is never lower than the reference value for the precautionary exploitation rate U0.1 (Figure 28). On the other hand, the maintenance of catch values would improve sustainable yield, bringing this near to the estimated MSY value (Figure 29).

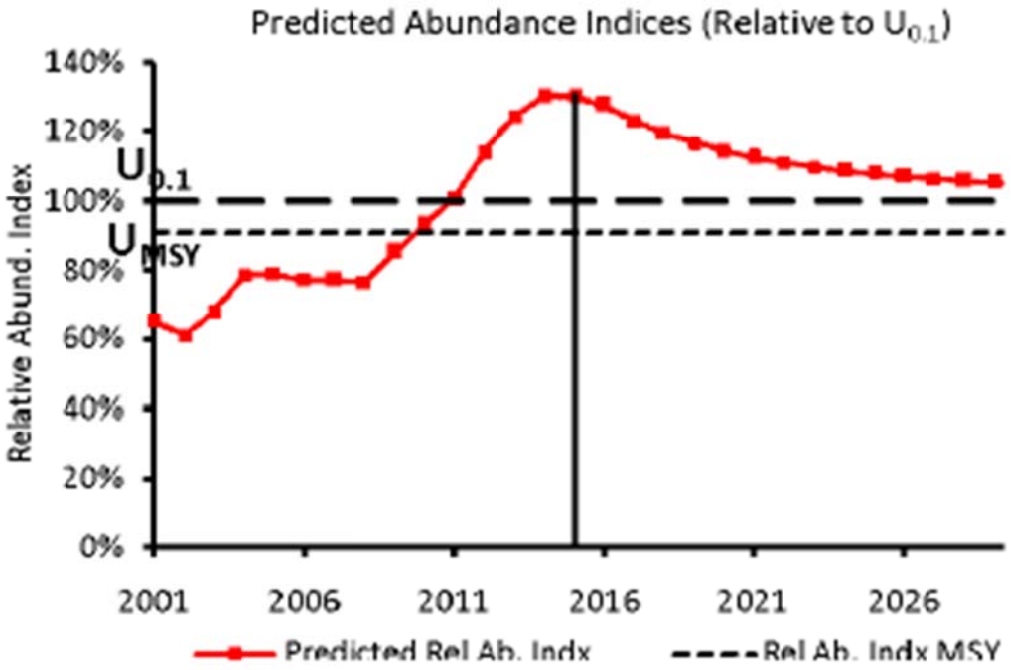


Figure 28: 15-year projection of the B/B_{MSY} index value for rough cockles (A. tuberculata), maintaining the catch 5 % lower than that estimated by the MSY model.

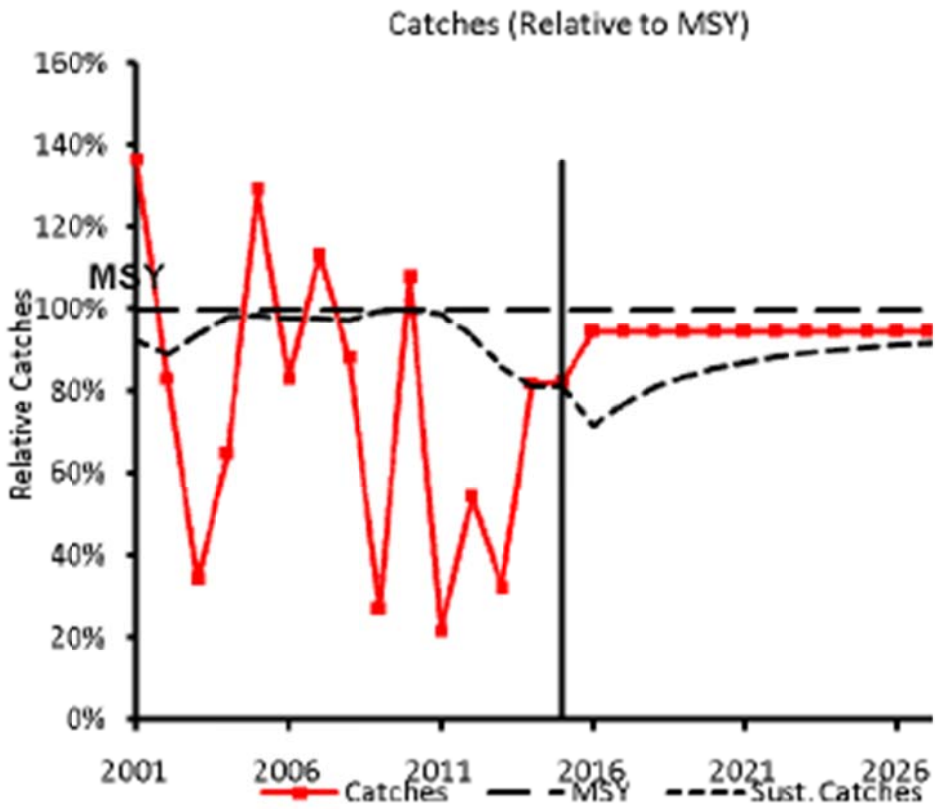


Figure 29: 15-year projection of the B/B_{MSY} index value for rough cockles (A. tuberculata), maintaining the catch 5 % lower than the estimated MSY value

The current state of exploitation of stock is sustainable, according to the results obtained in the models. However, as a precautionary measure, it is suggested that the catch limit is kept at 1 290 t, corresponding to 95 % of the MSY value estimated by BioDyn, which is also significantly lower than that estimated with ASPIC. As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of the abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 325 $k*day^{-1}$.

4.3.3.2. Smooth clam (Callista chione)

Standardisation of CPUE

CPUE appears to correlate negatively with GRB and LOA (Figure 30). However, the Spearman's correlation coefficient values, although significant, are very low, with no pronounced positive or negative trends reported (Table 24). The technical characteristics of vessels certainly display a strong mutual correlation.

Correlations *Callista chione* 2001-2015

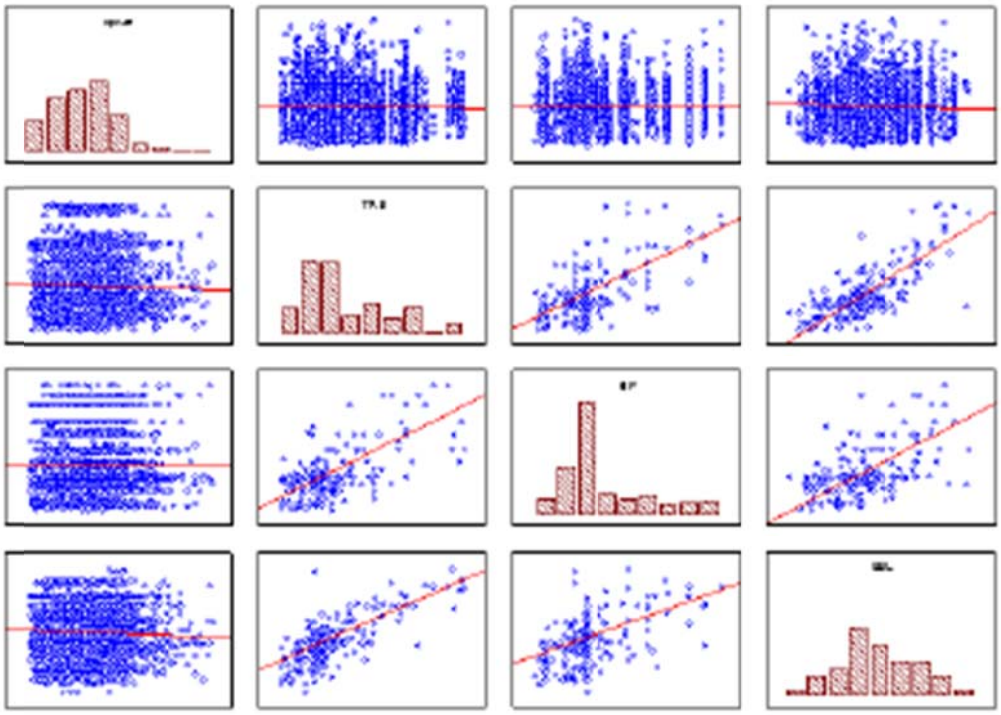


Figure 30: Scatterplots between the different variables taken into account for CPUE standardisation. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat

Table 24: Spearman's rank correlation coefficient values between the different variables examined. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

	Spearman's Rank Order Correlations (corrected statistics) MD pairwise deleted Marked correlations are significant at p <.05000				
Variable	cpue	GRB	HF	LOA	
cpue	1.000000	-0.047948	-0.017991	-0.042691	
GRB	-0.047948	1.000000	0.591608	0.719951	
HF	-0.017991	0.591608	1.000000	0.607817	
LOA	-0.042691	0.719951	0.607817	1.000000	

Although the variables representative of the technical characteristics are clearly correlated with each other and very little with CPUE, a generalised linear fit (GLM) was made taking these all into account. A preliminary analysis of CPUE, GRB, HP and LOA showed that these variables follow a log-normal distribution (Chi-square P <0.001), so the function used for the response variable was *log* with a Gaussian distribution function.

The GLM result shows that the best fit is that which takes into account the inclusion of all the explanatory variables: GRB, HP, LOA and YEAR, although other options are also acceptable (Table 25). In any case, the mean annual values of the standardised CPUE are practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 97> 0.05), in such a way that one or the other can be used without distinction.

Table 25: Significance (p-value) and AIC value of the different combinations of explanatory variables for GLM model adjustment to the CPUE data for Callista chione (2001-2015).

Step	CPUE - Model building results (Callista2001_2015) Distribution : NORMAL Link function: LOG							
	Var. 1	Var. 2	Var. 3	Var. 4	Freedom	AIC	L.Ratio Chi^2	p
1	GRB	HP	LOA	YEAR	16	49 819.60	122.6840	0.000000
2	GRB	HP	YEAR		15	49 822.31	117.9797	0.000000
3	GRB	LOA	YEAR		15	49 823.94	116.3472	0.000000
4	YEAR				13	49 825.55	110.7363	0.000000
5	GRB	YEAR			14	49 825.57	112.7170	0.000000
6	LOA	YEAR			14	49 825.92	112.3649	0.000000
7	HP	YEAR			14	49 827.18	111.1083	0.000000
8	HP	LOA	YEAR		15	49 827.77	112.5119	0.000000
9	GRB	HP	LOA		3	49 902.09	14.1992	0.002646
10	GRB	HP			2	49 904.37	9.9171	0.007023
11	GRB				1	49 908.02	4.2633	0.038944
12	GRB	LOA			2	49 909.13	5.1551	0.075959
13	LOA				1	49 912.04	0.2481	0.618442
14	HP				1	49 912.16	0.1275	0.721010
15	HP	LOA			2	49 913.84	0.4423	0.80 1577

Stock diagnosis

Figure 31 shows the smooth clam catch evolution for the period 2001 to 2015, during which a maximum production was seen in 2003 (306 t), and a minimum one in 2001, when the least catches (67 t) were recorded; although this low reading could also have been due to shortcomings in the collection of landing data. Since 2008, catches have become more or less stable, at around 200 tonnes.

The evolution of CPUE shows a negative trend until 2009, when it seems to stabilise until 2012, and subsequently the sign of the trend changes, increasing progressively, in the same way as occurs with the catches.

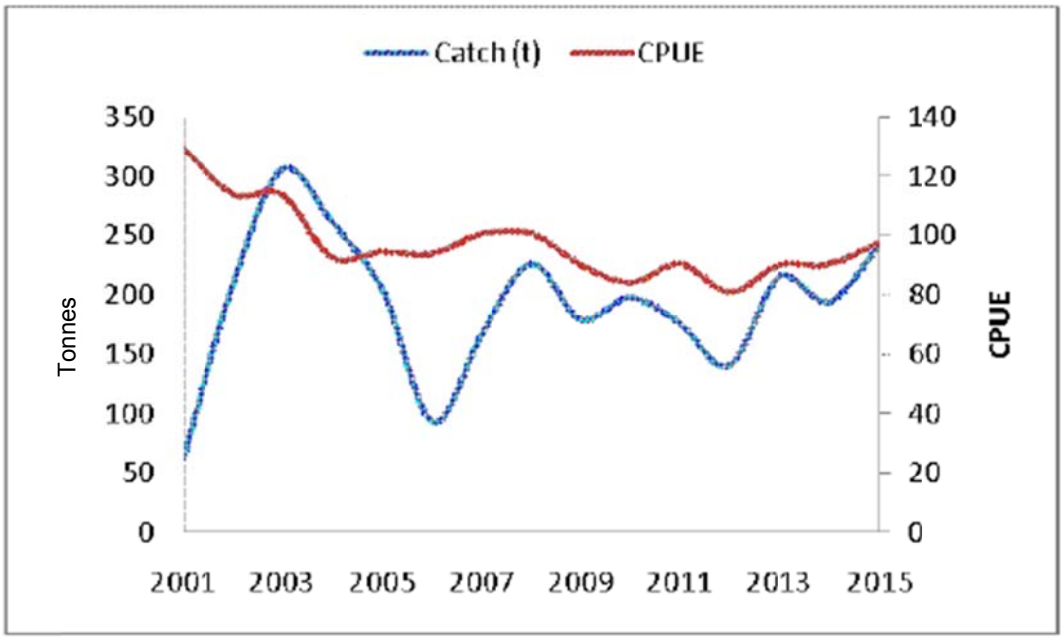


Figure 31: Evolution of smooth clam (Callista chione) catch and CPUE between 2001 and 2015

In order to obtain useful points of reference for resource management, the catch data was adjusted using bootstrap (1000 iterations) and CPUE was standardised to a logistical model (Schaefer) using the ASPIC software for this. The estimated CPUE via ASPIC shows few differences from those observed (Figure 32). The main results obtained from the application of the model are given in Table 26. The population trajectory in terms of B/B_{MSY} and F/F_{MSY} shows that stock has not been overexploited (overfished) at any point (Figure 33). The situation over the last year is summarised in Table 26, which highlights the MSY value of 216 t and the values of $B/_{MSY}$ and F/F_{MSY}, indicating a sustainable exploitation of stock with a biomass 1.3 times higher than the maximum yield point, and a F_{MSY} 1.2 times higher than the F level currently experienced.

Table 26: Estimates of biological reference points obtained from a bootstrap analysis via ASPIC (biomass data in k).

Parameter	Estimate
MSY (Maximum sustainable yield)	2.16E+008
B_{MSY} (Stock biomass giving MSY)	9.83E+008
F_{MSY} Fishing mortality rate at MSY	2.20E+002
$B(2016)/B_{MSY}$	1.34E+003
$F(2015)/F_{MSY}$	8.21E+002
$F_{MSY}/F(2015)$	1.22E+003
Y.(F_{MSY}) Approx. yield available at F_{MSY} in 2016	2.34E+05
as proportion of MSY	1.08E+003
Ye. Equilibrium yield available in 2016	1.90E+008
as proportion of MSY	8.81E+002

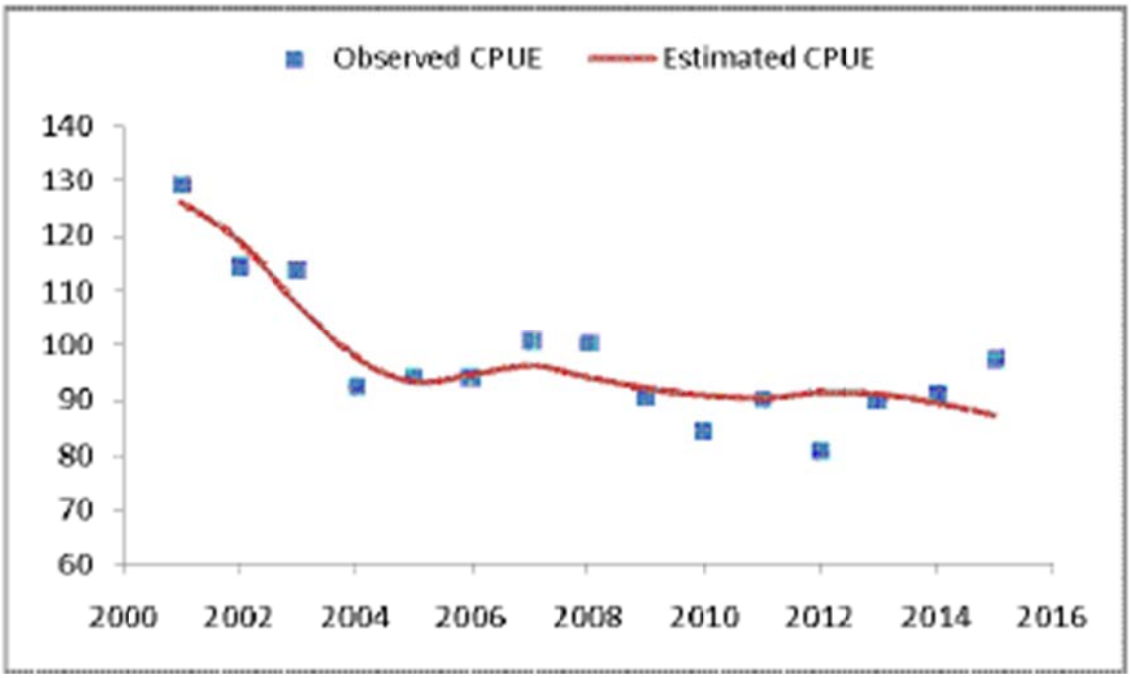


Figure 32: Yearly evolution of CPUE observed and estimated through the ASPIC model (kg/day-1) for smooth clams during the period 2001-2015.

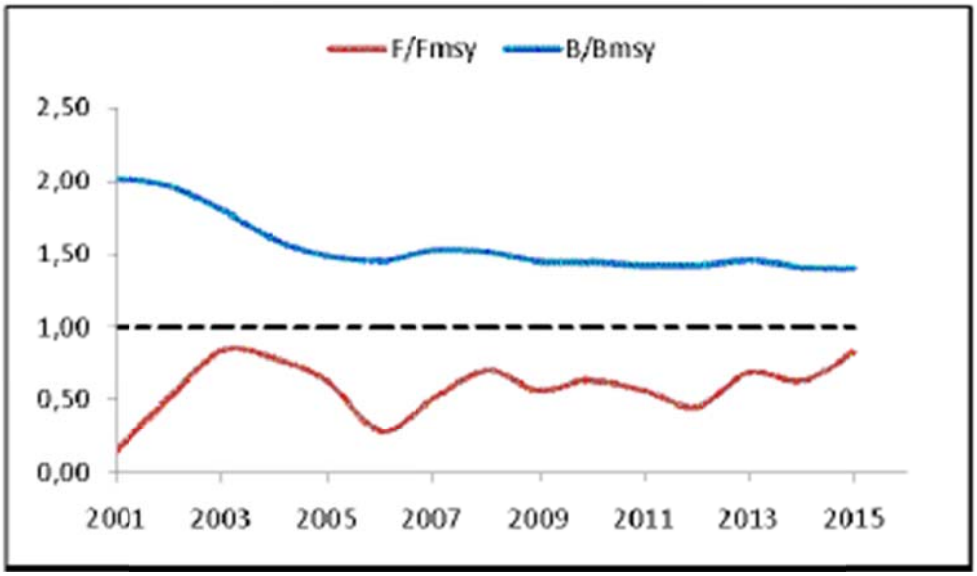


Figure 33: Trajectory of the smooth clam (C. chione) population in terms of relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) according to ASPIC.

A 10-year projection was tested using the results obtained with ASPIC, taking into account a catch limit equal to the estimated MSY value (216 t) and constant for the period. In this case, maintenance of catches at the level of the estimated MSY seems to ensure not only maintenance of biomass but also a marked increase in biomass (Figure 34).

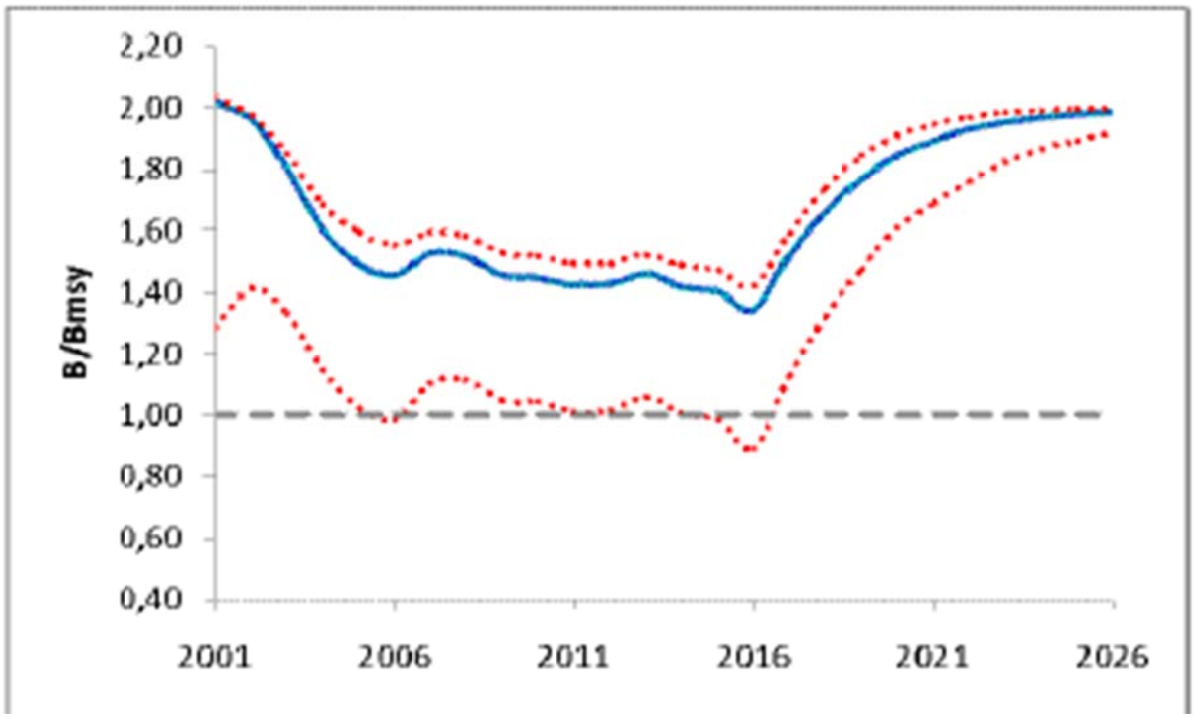


Figure 34: 10-year projection of the B/B_{MSY} index value for smooth clams (Callista chione), maintaining the MSY value estimated by the ASPIC model constant. Dotted lines represent the confidence limits at an 80 % confidence interval

The resource was also analysed using BioDyn. The results of the model show a situation similar to that obtained by ASPIC, although more optimistic with respect to the sustainable yield value, which is estimated at 272 t and with stock in good condition, with a current biomass (B/B_{MSY}) 1.5 times higher than the MSY could provide, although the value of FCur/FSYCur seems to indicate a scenario of a slight decrease in stock. In the current state of the stock, there are no signs of overfishing with an $Fc/F_{0.1}$ value of 0.65 (Table 27 and Figure 35).

Table 27: Estimates (t) of the model parameters obtained via BioDyn for Callista Chione.

Stock Parameters	
MSY	272
BMSY	1 283
B0.1	1 411
Cur Stock	1 968
B/B_{MSY}	153.00%
B/B0.1	139.00%
Cur_SustProd	194
Cur_PercProd	72.00 %
CurY	243
FMSY	0.21
F0.1	0.19
FCur	0.12
FCur/FMSY	0.58
FCur/F0.1	64.79%
FSYCur	0.10
FCur/FSYCur	125.00%
DBCur	-49
DBCur/BCur	-2.00%
CurY/MSY	89.00%

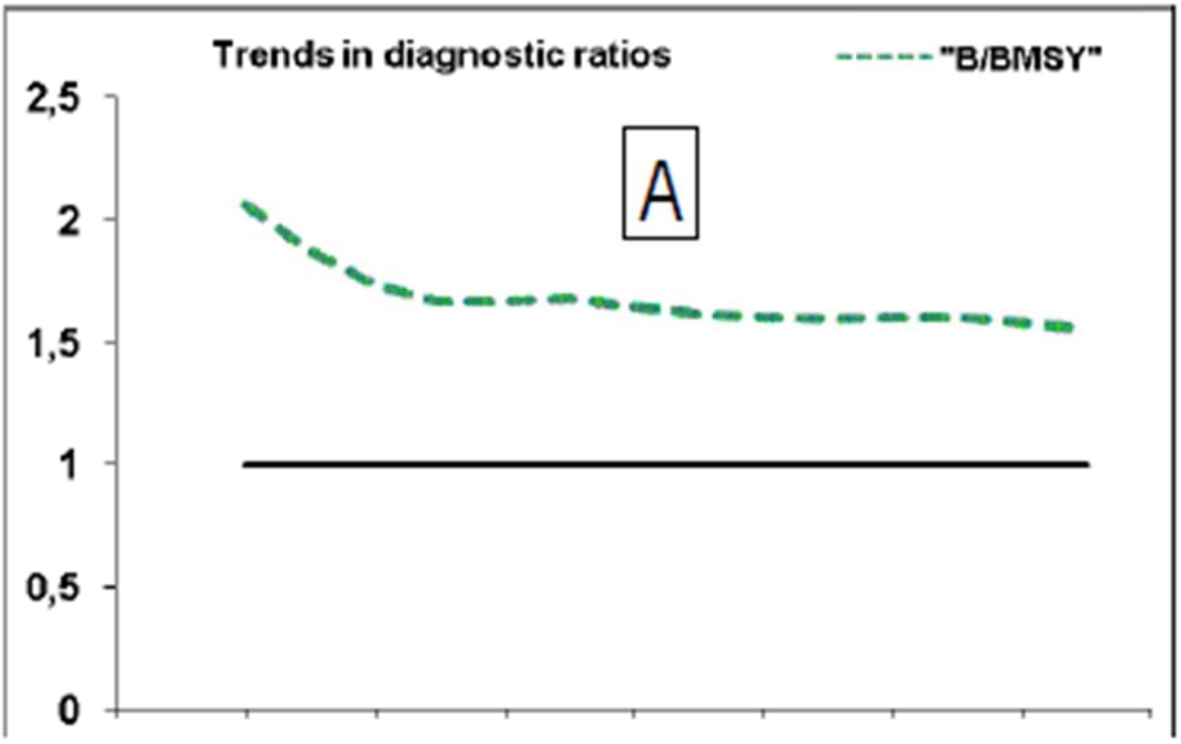


Figure 35: A: Trajectory of the smooth clam (C. chione) population in terms of relative biomass (B/B_{MSY}) and B: in terms of relative fishing mortality (F/F_{MSY}) according to Biodyn results.

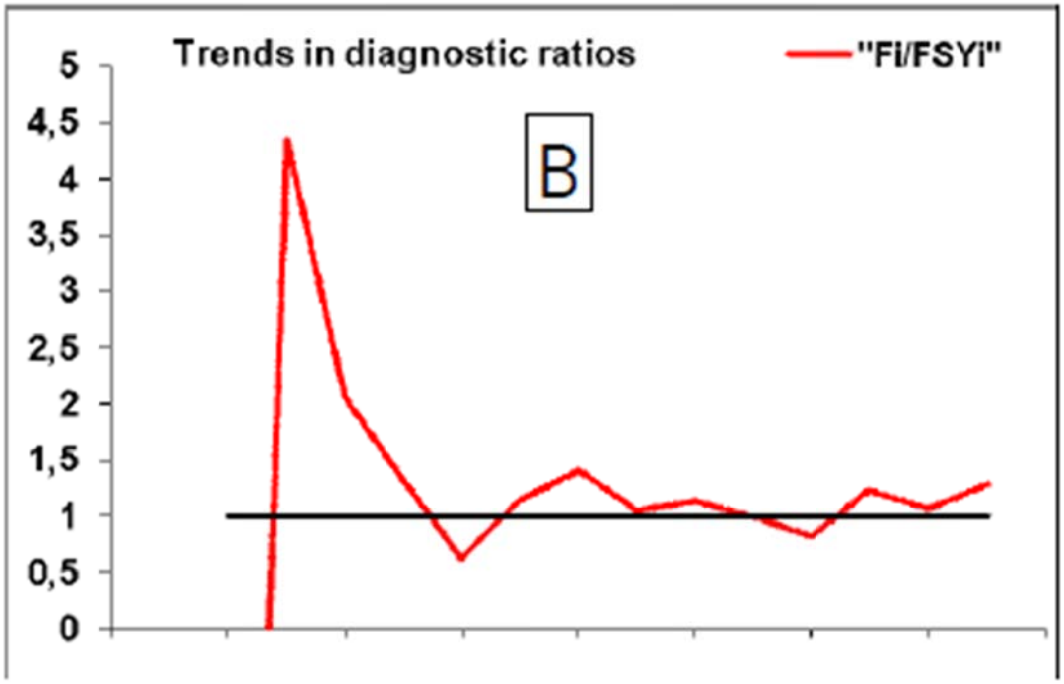


Figure 35 continued

Since the MSY obtained by Biodyn was much higher than that estimated with ASPIC, a 20-year projection was made, keeping the catch at its current value (243 t). The result shows a decrease in the relative abundance of stock in the first five years of projection, as suggested by the estimated value of Fcur/FSYCur, which stabilises later (Figure 36). The projection of values is never lower than the reference value corresponding to the precautionary exploitation rate (U0.1). On the other hand, maintaining the catch values would improve sustainable yield for a fairly short period of time (Figure 37). The general situation is that the current catch rate could rise 10 % (to 267 t), keeping stock within safe limits.

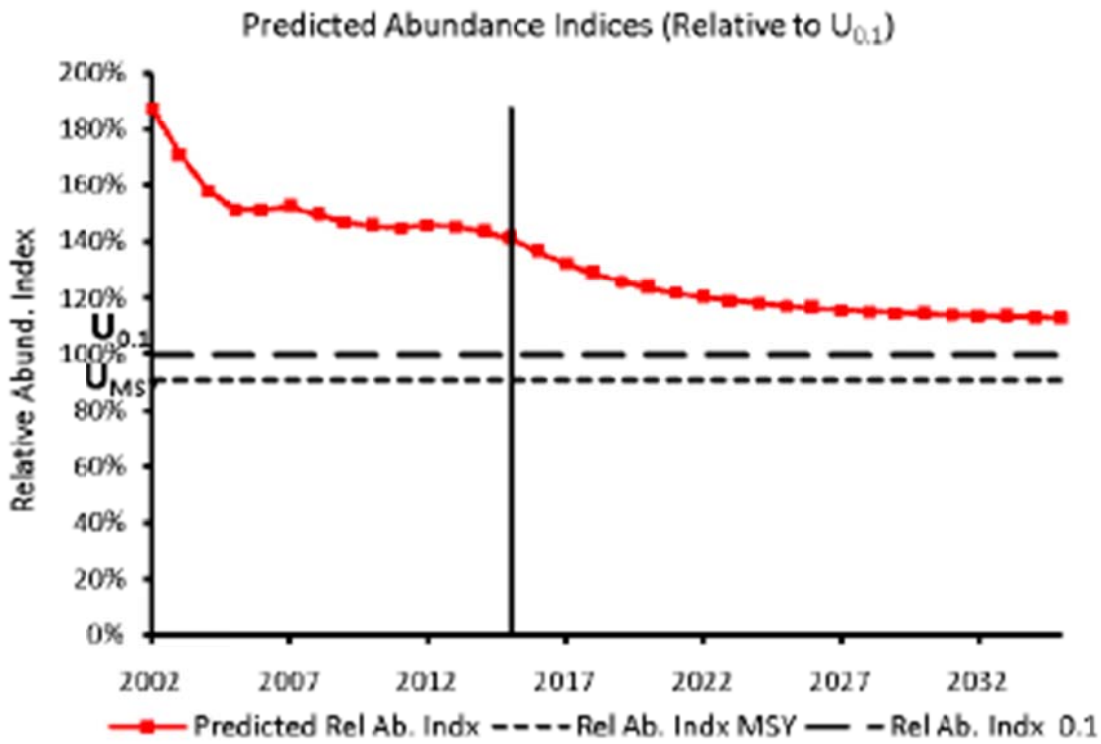


Figure 36: 15-year projection of the relative abundance index value for smooth clams (Callista chione), keeping the catch at the current levels.

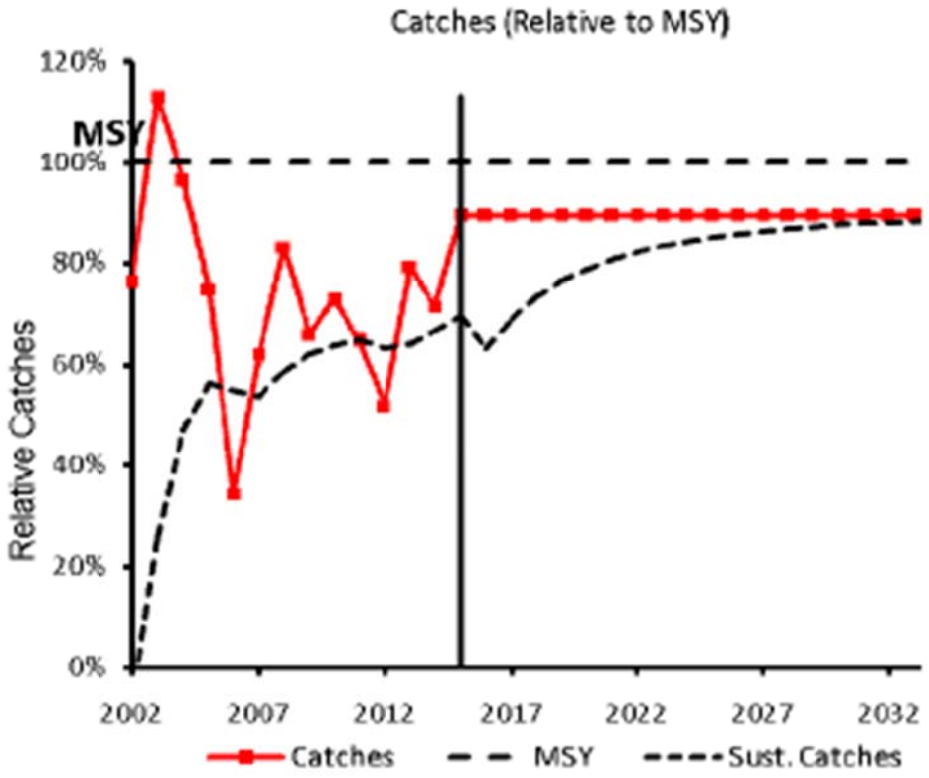


Figure 37: 15-year projection of sustainable catch levels for smooth clams (Callista chione), keeping the catch at the current levels.

Although there is a significant difference in the estimated MSY value between both models (52 t), the projections in both cases - both maintaining the MSY in ASPIC and the current catch in BioDyn - demonstrate no tendency towards overfishing, but rather maintenance of the reference points within safe limits. In this case, the most precautionary solution could be the adoption of a more conservative catch limit (MSY in ASPIC). As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of the abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 92 $k*day^{-1}$.

4.3.3.3. Striped venus clam (Chamelea gallina)

Standardisation of CPUE

There are no trends in CPUE in accordance with the explanatory variables GRB, HP and LOA (Figure 38), since although the Spearman's correlation coefficient values are significant, they are low, showing no pronounced positive or negative trends (Table 28). As in the previous cases, the technical characteristics of the vessels do show a strong correlation, especially in terms of length (LOA) with the other two variables.

Correlations (*Chamelea gallina* 2001 -2015)

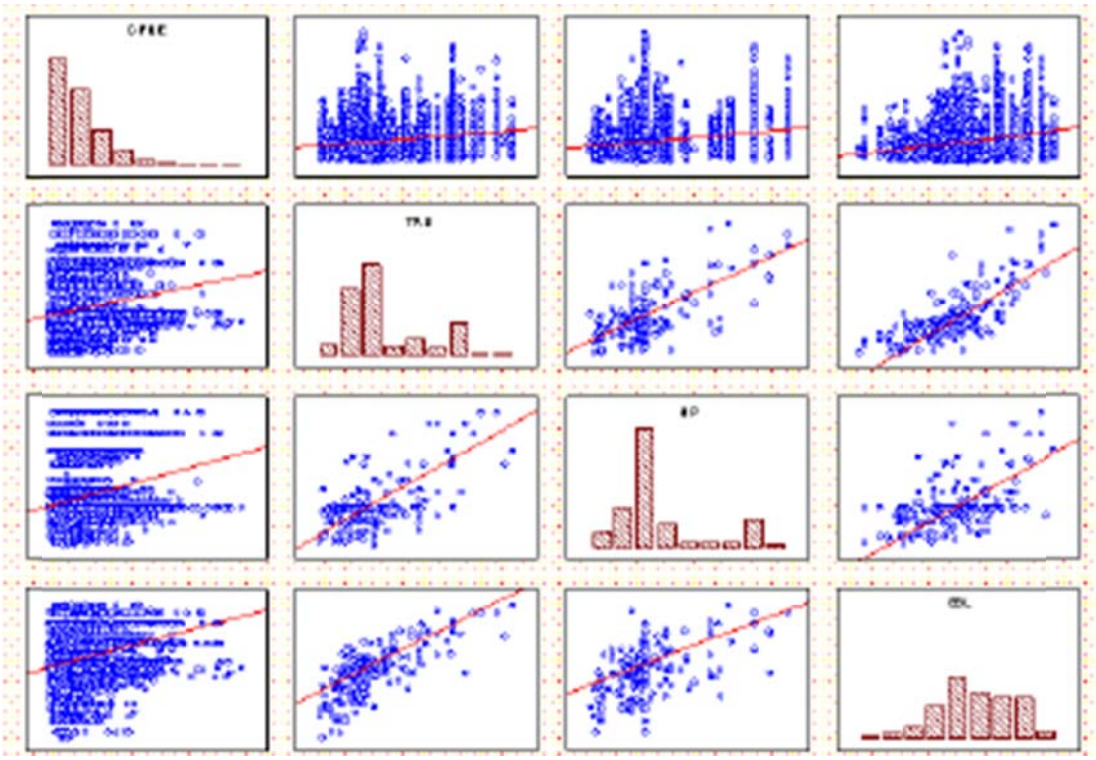


Figure 38: Scatterplots between the different variables taken into account for CPUE standardisation. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

Table 28: Spearman's rank correlation coefficient values between the different variables examined. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

	Spearman's Rank Order Correlations (striped venus clam) MD pairwise deleted Marked correlations are significant at p <.0500			
Variable	CPUE	GRB	HP	LOA
CPUE	1.000000	0.186378	0.216490	0.273696
GRB	0.186378	1.000000	0.480235	0.802487
WF	0.216490	0.480235	1.000000	0.604870
LOA	0.273696	0.802487	0.604870	1.000000

Table 29: Significance (p-value) and AIC value of the different combinations of explanatory variables for GLM model fit to the CPUE data for Chamelea gallina (2001-2015).

Step	CPUE - Model building results (striped venus clam) Distribution: NORMAL Link function: LOG							
	Var. 1	Var. 2	Var. 3	Var. 4	Degr of Freedom	AIC	L Ratio Chi^z	p
1	GRB	HP	LOA	YEAR	17	71 559.21	1 749.363	0.00
2	GRB	LOA	YEAR		16	71 643.68	1 662.891	0.00
3	HP	LOA	YEAR		16	71 690.52	1 616.054	0.00
4	LOA	YEAR			15	71 700.35	1 604.228	0.00
5	HP	YEAR			15	71 852.17	1 452.407	0.00
6	GRB	HP	YEAR		16	71 854.13	1 452.443	0.00
7	GRB	YEAR			15	71 969.34	1 335.230	0.00
8	YEAR				14	72 184.73	1 117.841	0.00
9	GRB	HP	LOA		3	72 586.08	694.499	0.00
10	HP	LOA			2	72 686.42	592.156	0.00
11	GRB	LOA			2	72 696.46	582.117	0.00
12	LOA				1	72 719.86	556.710	0.00
13	GRB	HP			2	72 856.94	421.637	0.00
14	HP				1	72 858.88	417.690	0.00
15	GRB				1	72 988.12	288.456	0.00

Despite the positive correlation between the variables, a GLM was tested in order to standardise the CPUE as a function of these. The result (Table 29) shows that the best adjustment is that which takes into account inclusion of the explanatory variables GRB, HP, LOA and YEAR, although other options are also acceptable. In any case, the mean annual values of the standardised CPUE are practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 109> 0.05), in such a way that one or the other can be used without distinction.

Stock diagnosis

For the striped venus clam, together with the abrupt wedge shell, the lowest catch values for the bivalve species exploited in the region are recorded, with catches in the last fifteen years oscillating between the minimum in 2003, at only 7.3 t, and the maximum in 2006, at 53 t.

During the period between 2001 and 2015, CPUE suffered some oscillations, fluctuating between 48.7 and 19.8 kg day-1, with the lower values observed at the beginning and the end of the period. The evolution of the catch records is similar to that of CPUE, with increases observed when the catch is higher (Figure 39), although there is no general trend in one direction or another covering the entire period analysed.

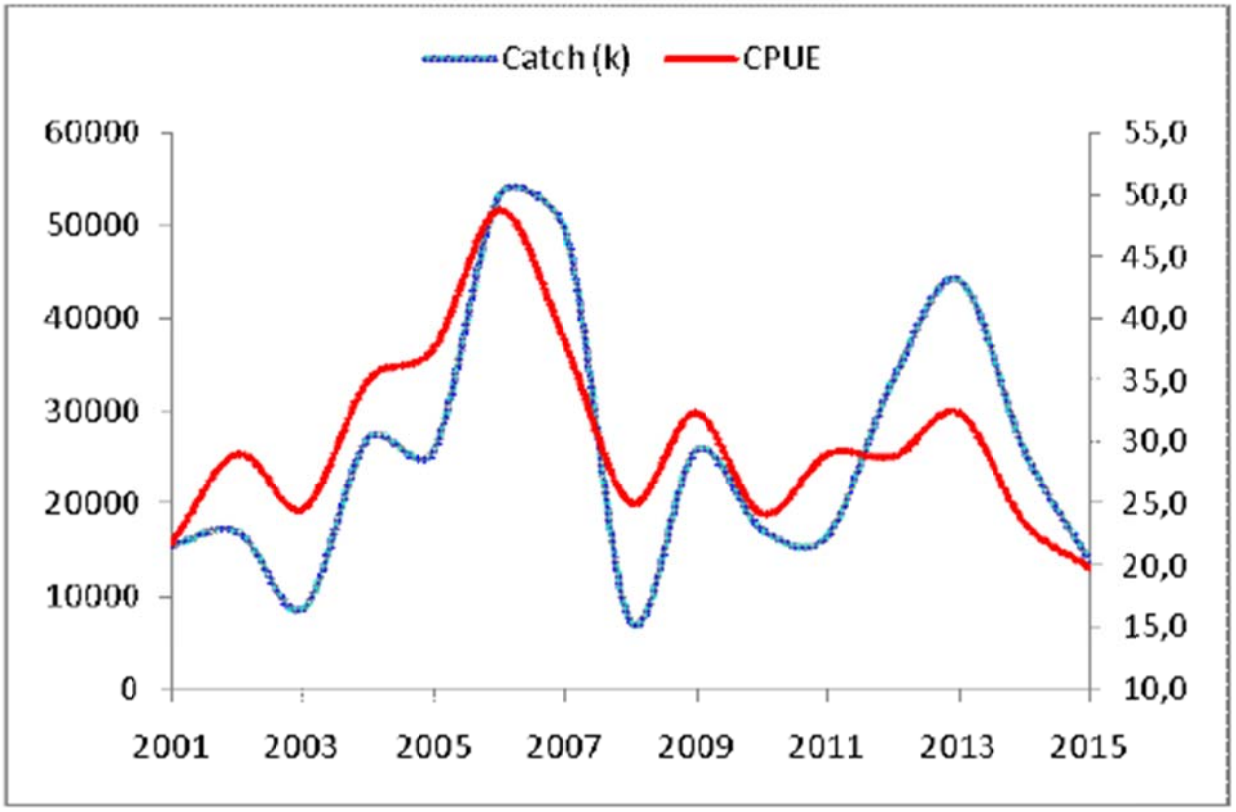


Figure 39: Evolution of striped venus clam (Chamelea gallina) catch and CPUE between 2001 and 2015.

It has not been possible to fit a production model with ASPIC. Therefore, only the results obtained with BioDyn are presented. The estimated CPUE shows few differences against those observed (Figure 40). The model estimates an MSY value of 35 t, very far from the current catch. The B/B_{MSY}, B/B0.1, Fc/F_{MSY} and Fc/F0.1 reference values show signs of slight overfishing (Table 30), while the relative biomass trajectories and the sustainable exploitation rate are slightly elevated as well (Figure 41)

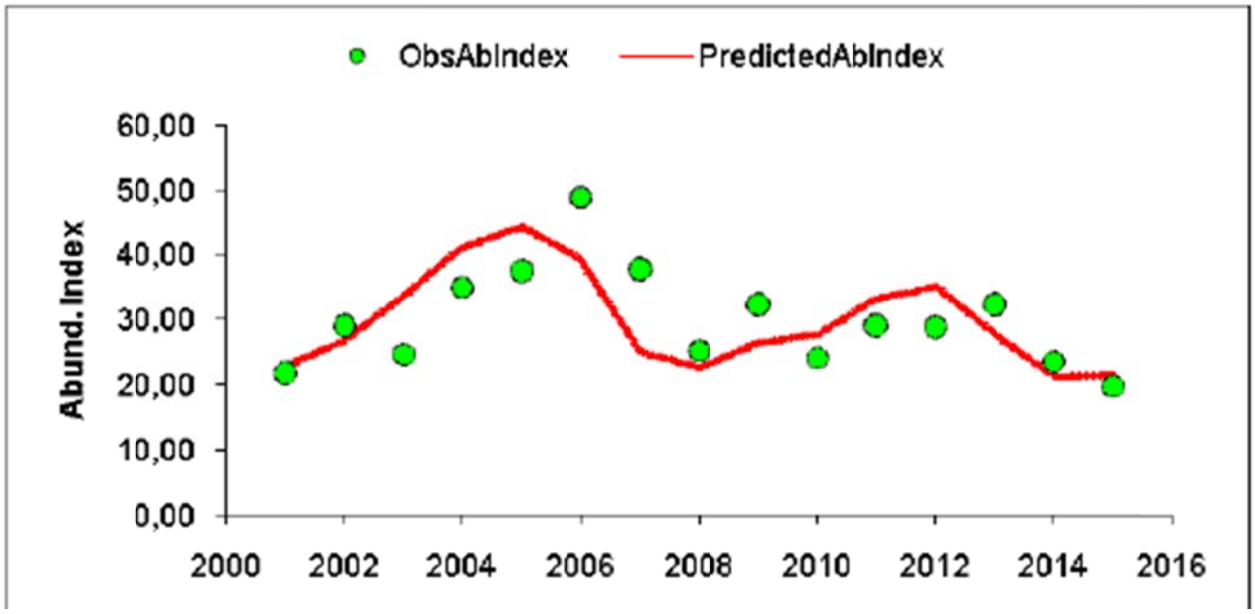


Figure 40: Yearly evolution of CPUE observed and estimated by the BioDyn model (kg/day-1) for striped venus clams during the period 2001-2015.

30. Table: Estimates (t) of the model parameters obtained via BioDyn for Chamelea gallina.

Stock Parameters	
MSY	35
BMSY	102
B0.1	113
Cur_Stock	40
B/B_{MSY}	39.00%
B/B0.1	36.00%
Cur_SustProd	22
Cur_PercProd	63.00%
CurY	14
FMSY	0.34
F0.1	0.31
FCur	0.34
Fcur/FMSY	100.00%
Fcur/F0.1	111.00%
FSYCur	0.55
Fcur/FSYCur	62.00%
DBCur	8
DBCUr/Bcur	21.00%
CurY/MSY	39.00%

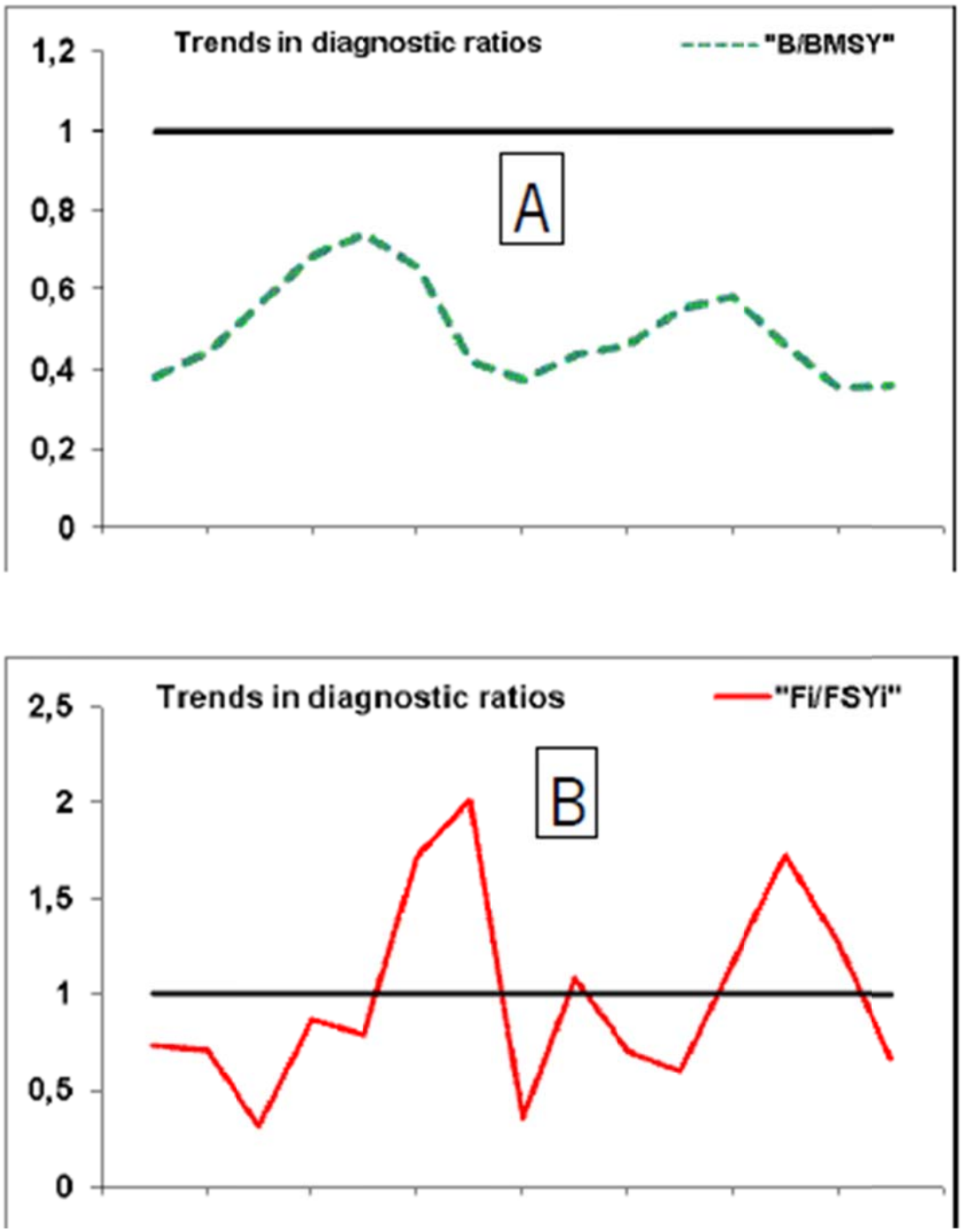


Figure 41: A: Trajectory of the striped venus clam (C. gallina) population in terms of relative biomass (B/B_{MSY}) and B: in terms of relative fishing mortality (F/F_{MSY}) according to Biodyn results.

As the MSY obtained is higher than the current catch, a 10-year projection was made by testing a precautionary strategy in which the catch is kept constant at a value corresponding to 65% of the estimated MSY. The projection shows this strategy would result in a rapid recovery and return to sustainable exploitation values (Figure 42), as well as an increase in sustainable yields and a rising trend towards MSY values (Figure 43).

In this situation, it appears suitable to maintain a catch limit of 22 tonnes and a minimum reference threshold of 23.8 kg*day.

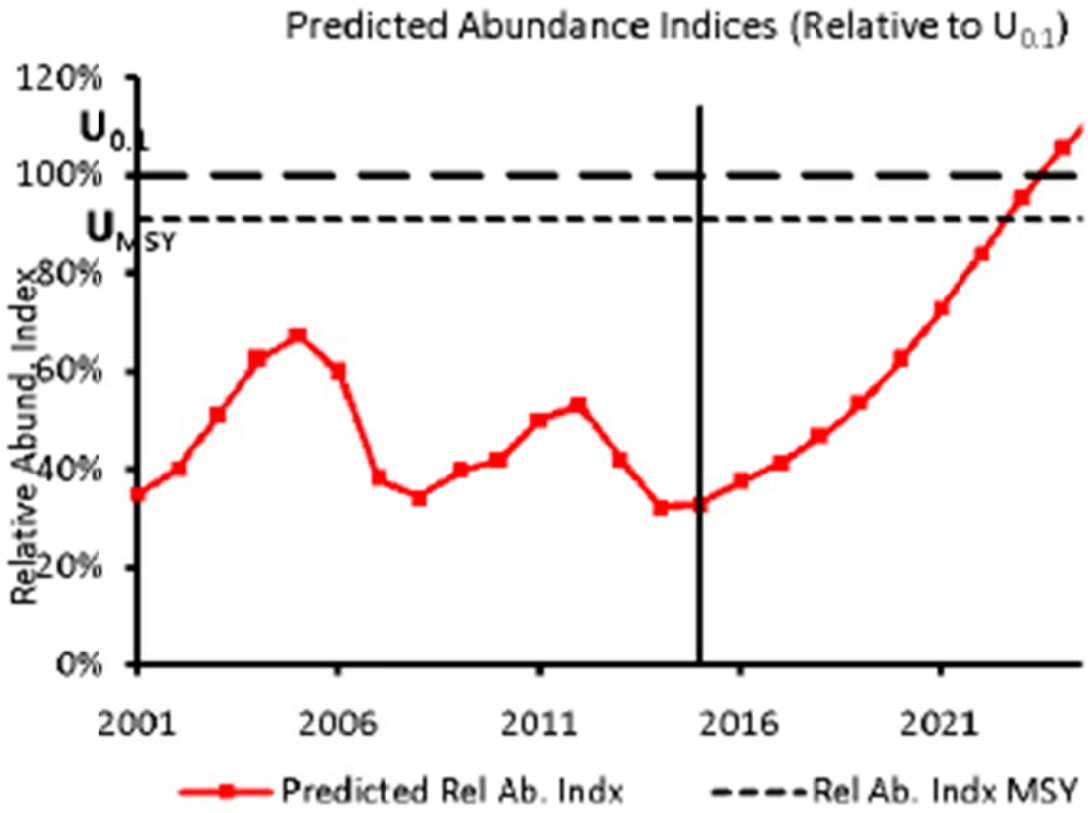


Figure 42: 15-year projection of the relative abundance index value for striped venus clams (Chamelea gallina), maintaining the catch level 35% lower than the estimated MSY.

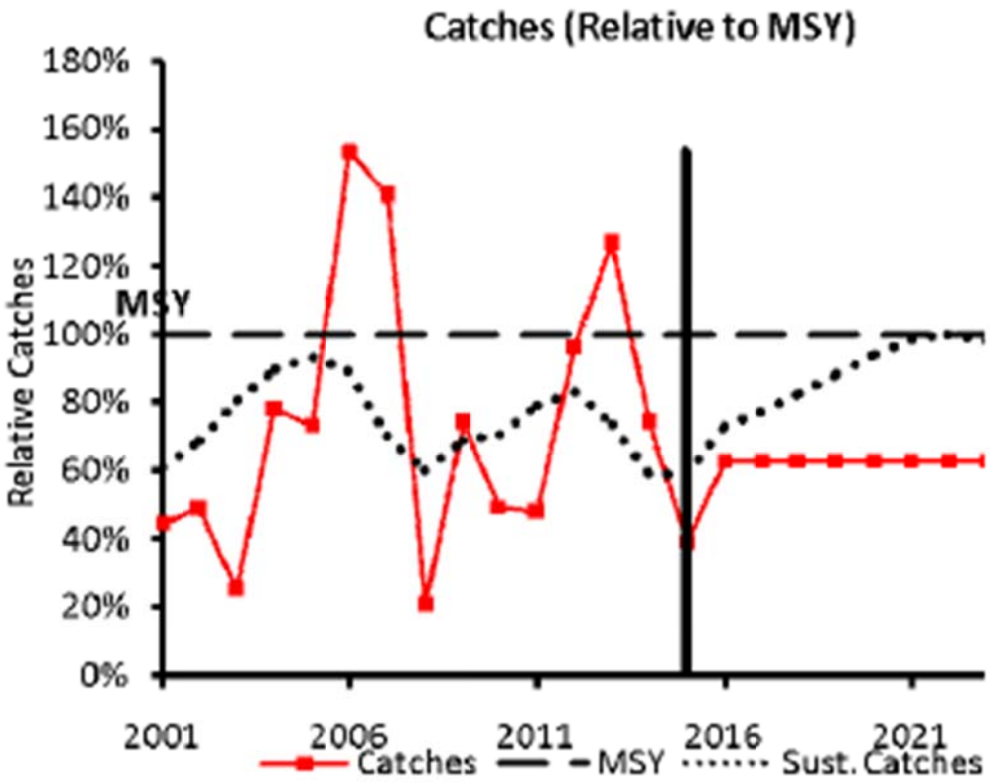


Figure 43: 15-year projection of sustainable catch levels for striped venus clams (Chamelea gallina), maintaining the catch level 35% lower than the estimated MSY.

4.3.3.4. Abrupt wedge shell (Donax trunculus):

Standardisation of CPUE

There are no trends in CPUE in accordance with the explanatory variables GRB, HP and LOA (Figure 44), since although the Spearman's correlation coefficient values are significant, they are extremely low, showing no pronounced positive or negative trends (Table 31). As in the previous case, the technical characteristics of the vessels do show a strong correlation, especially in terms of LOA with the other two variables.

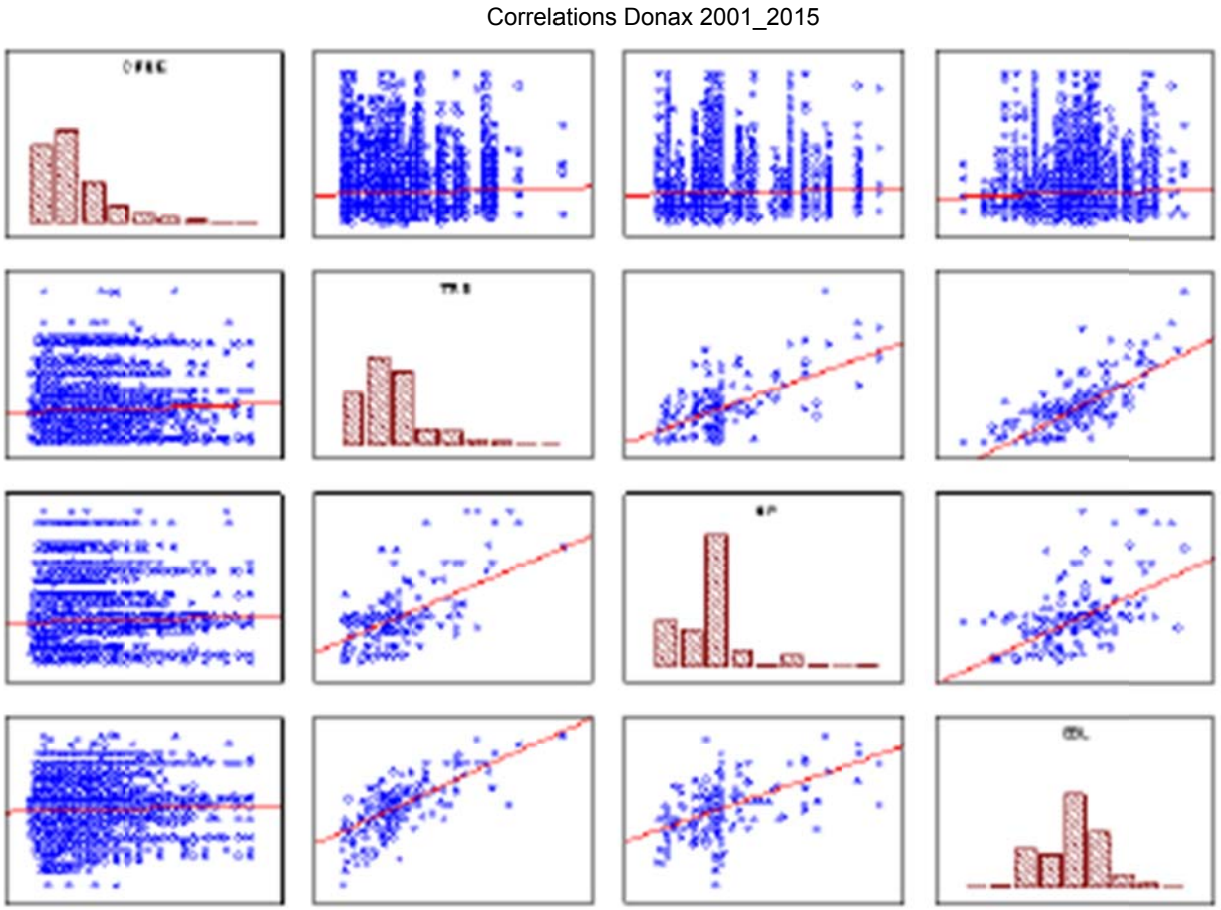


Figure 44: Scatterplots between the different variables taken into account for CPUE standardisation. CPUE: Catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

Table 31: Spearman's rank correlation coefficient values between the different variables examined. CPUE: catch per unit effort; GRB: gross register tonnage; HP: horsepower measured in CV; LOA: length overall of the boat.

Variable	Spearman's Rank Order Correlations (Donax 2001_2015) MD pairwise deleted Marked correlations are significant at p <.05000			
	CPUE	GRB	HP	LOA
CPUE	1.000000	0.049477	0.106657	0.111740
GRB	0.049477	1.000000	0.337984	0.617783
HP	0.106657	0.337984	1.000000	0.544381
LOA	0.111740	0.617783	0.544381	1.000000

Table 32: Significance (p-value) and AIC value of the different combinations of explanatory variables for GLM model fit to the CPUE data for Donax Trunculus (2001-2015).

Step	CPUE - Model building results (Donax) Distribution: NORMAL Link function: LOG							
	Var. 1	Var. 2	Var. 3	Var 4	Degr of Freedom	AIC	L.Ratio Chi^2	p
1	GRB	HP	YEAR			104 274.4	555.2734	0.000000
2	GRB	HP	LOA	YEAR	17	104 274.7	557.0083	0.000000
3	GRB	YEAR			15	104 276.9	550.7842	0.000000
4	GRB	LOA	YEAR		16	104 278.4	551.2383	0.000000
5	HP	YEAR			15	104 278.9	548.7828	0.000000
6	HP	LOA	YEAR		16	104 280.8	548.8548	0.000000
7	LOA	YEAR			15	104 290.7	536.9624	0.000000
8	YEAR				14	104 295.9	529.7581	0.000000
9	GRB	LOA			2	104 762.2	39.4364	0.000000
10	GRB	HP	LOA		3	104 762.3	41.4324	0.000000
11	GRB	HP			2	104 763.7	37.9559	0.000000
12	HP	LOA			2	104 765.2	36.4478	0.000000
13	GRB				1	104 765.5	34.2292	0.000000
14	LOA				1	104 767.9	31.7616	0.000000
15	HP				1	104 776.9	22.8164	0.000002

The GLM result (Table 32) shows that the best fit is that which takes into account inclusion of the explanatory variables GRB, HP and YEAR, although other options are also acceptable. In any case, the mean annual values of the standardised CPUE are practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 95> 0.05), in such a way that one or the other may be used without distinction.

Stock diagnosis

For the striped venus clam, together with the abrupt wedge shell, the lowest catch values for the bivalve species exploited in the region are recorded, with catches in the last fifteen years oscillating between the minimum in 2011, at only 17 t, and the maximum in 2003, at 37 t.

CPUE undergoes slight oscillations, fluctuating in values between 14.2 and 23.5 kg day^{-1}, with a decrease observed at the end of the period. The negative trend for the catch, from the high in 2003 to the low of 2011, is not reflected in the evolution of CPUE, which remains more or less stable in this period. In recent years, there has been a decrease in both catches and CPUE (Figure 45), although there are no general trends covering the period analysed.

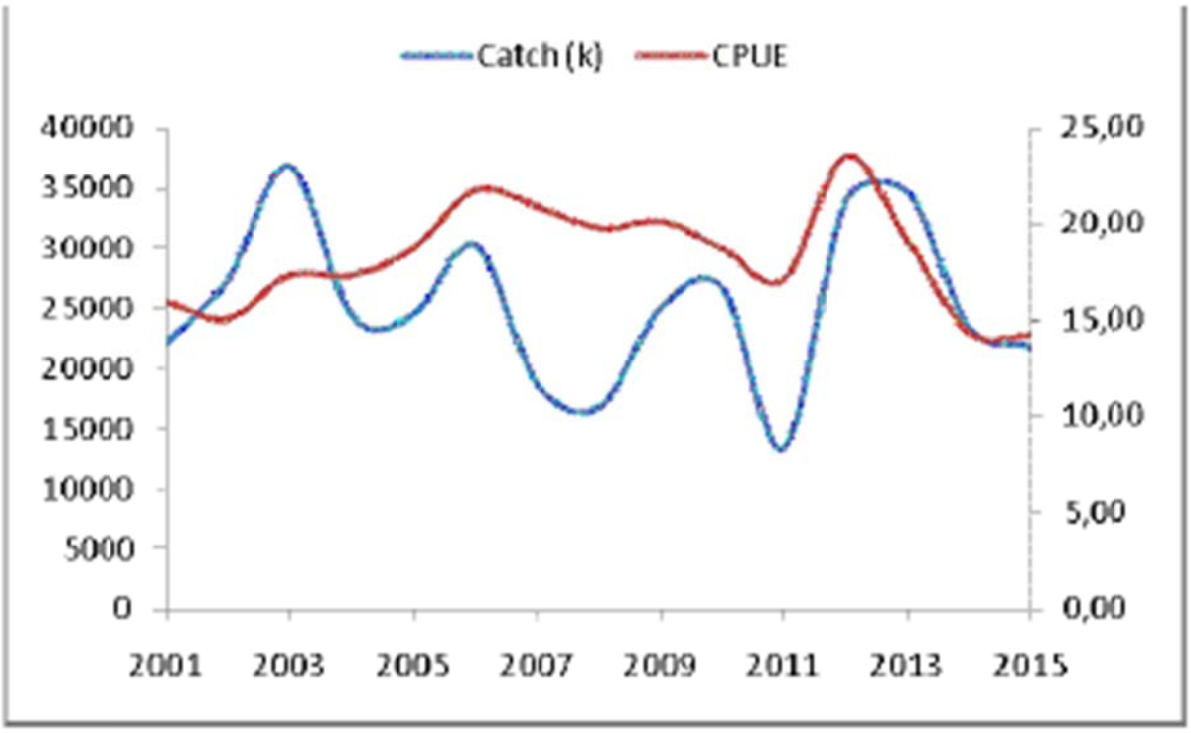


Figure 45: Evolution of catch and CPUE for abrupt wedge shells (Donax trunculus) between 2001 and 2015.

The main results obtained from the application of the ASPIC model are given in Table 33. The values obtained show that the resource is in good condition and that there is even a probability of increasing its exploitation, yielding MSY values of 44.5 tonnes and Bcur almost 1.67 times higher than the value of B_{MSY} and F 0.6 times lower than that of F_{MSY}.

Table 33: Estimates of biological reference points obtained from a bootstrap analysis via ASPIC (biomass data in k).

Parameter	Estimate
MSY (Maximum sustainable yield)	4.445E+04
B_{MSY} (Stock biomass giving MSY)	8.299E+04
F_{MSY} Fishing mortality rate at MSY	5.356E-01
$B(2016)/B_{MSY}$	1.671E+00
$F(2015)/F_{MSY}$	2.977E-01
$F_{MSY}/F(2015)$	3.359E+00
$Y.(F_{MSY})$ Approx. yield available at F_{MSY} in 2016	6.482E+04
as proportion of MSY	1.458E+00
Ye. Equilibrium yield available in 2016	2.445E+04
as proportion of MSY	5.501E-01

The differences between the CPUEs observed and the estimations using the ASPIC model are small (Figure 46). The population trajectory in terms of B/BMSY and F/F_{MSY} shows that the stock is in good condition and has not been overexploited (overfished), nor are there any other signs of overexploitation (overfishing) for the period studied (Figure 47).

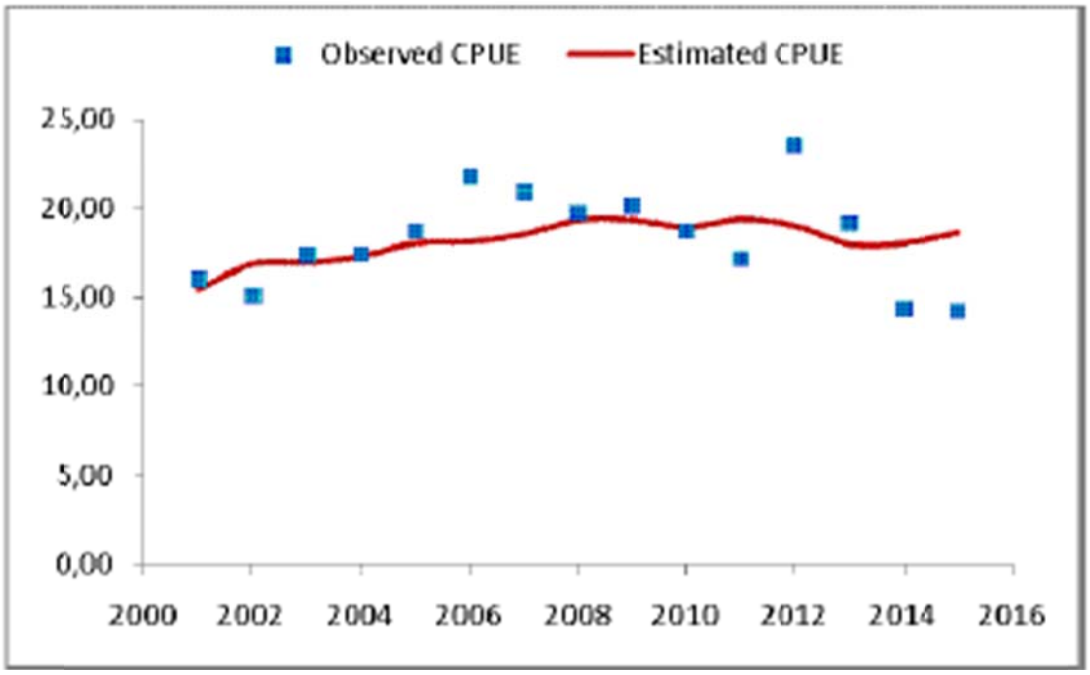


Figure 46: Yearly evolution of CPUE observed and estimated through the ASPIC model (kg/day-1) for abrupt wedge shells during the period 2001-2015.

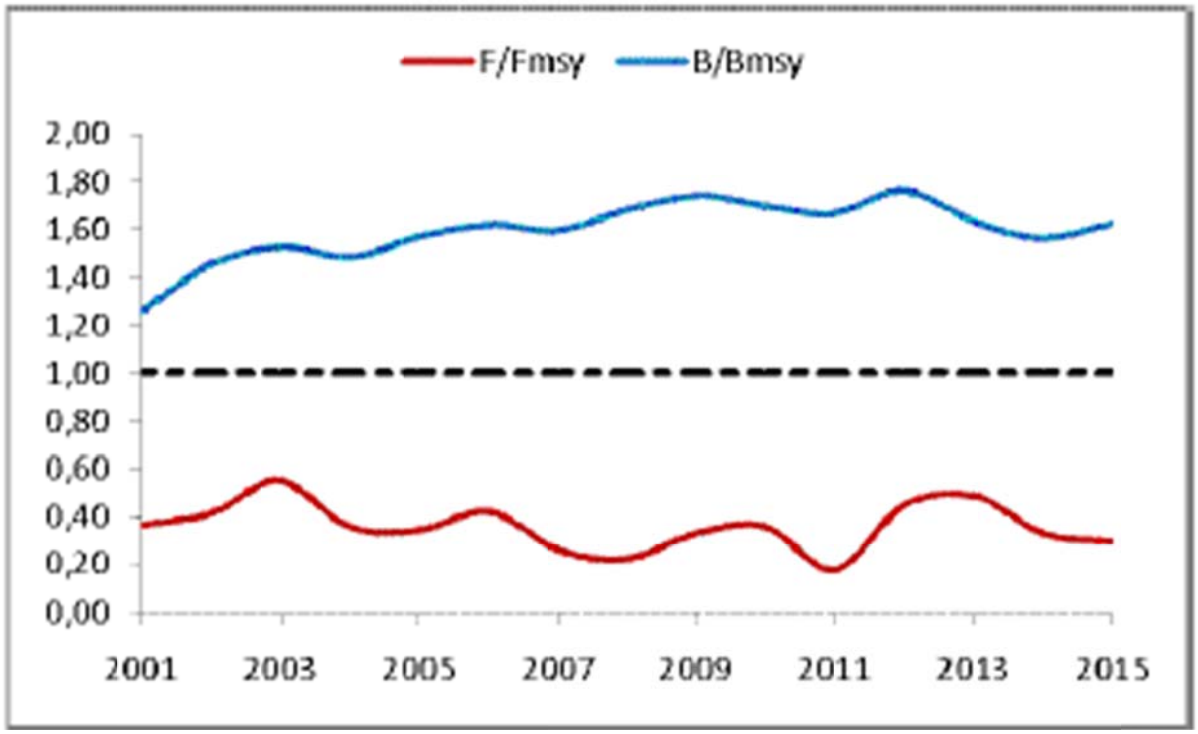


Figure 47: Population trajectory of abrupt wedge shells (D. trunculus) in terms of relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) according to ASPIC.

With the aim of estimating how the abrupt wedge shell stock might evolve, a 10-year projection was tested with ASPIC, taking into account a constant MSY value for the course of exploitation and equal to that obtained in the bootstrap analysis (44.5 tonnes). The projection results in terms of biomass and relative effort can be seen in Figures 48 and 49. The evolutions of B/B_{MSY} and F/F_{MSY} never exceed the reference level that would lead to the adoption of more restrictive management measures (a TAC less than MSY) for the maintenance of the resource, although they do approach this level at the end of the projection. However, the value of 80 % for the lower limit of confidence for the B/B_{MSY} index and the upper one for F/F_{MSY} rapidly move away from the estimated values (blue line) to areas where confidence is very low.

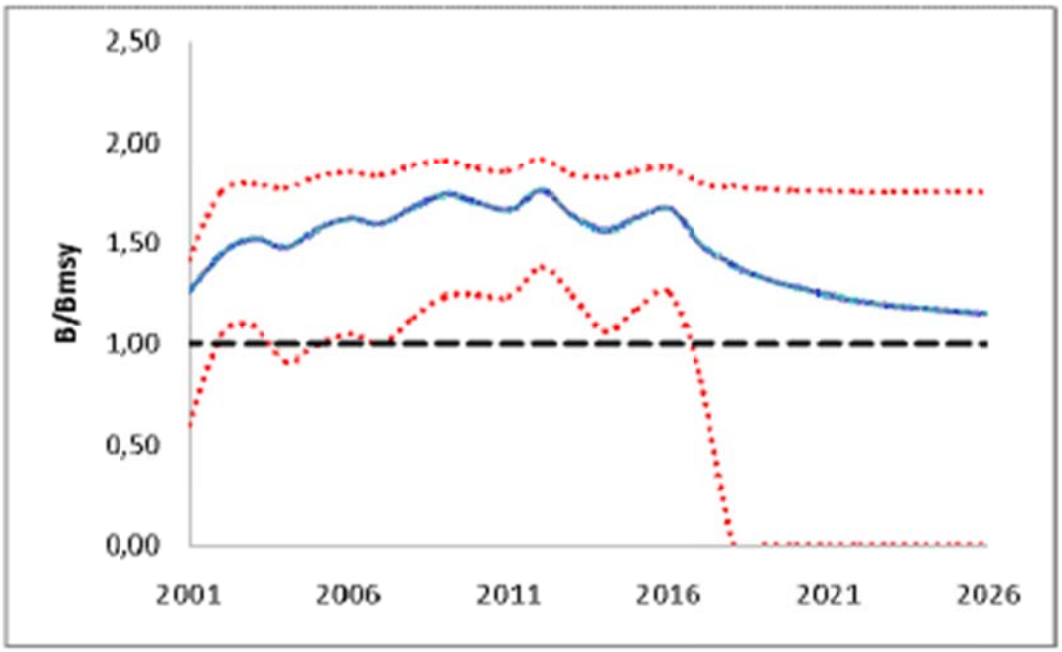


Figure 48: 10-year projection of the B/B_{MSY} index value for abrupt wedge shells (D. trunculus), maintaining the MSY value estimated by the ASPIC model. Dotted lines represent the confidence limits at an 80 % confidence interval

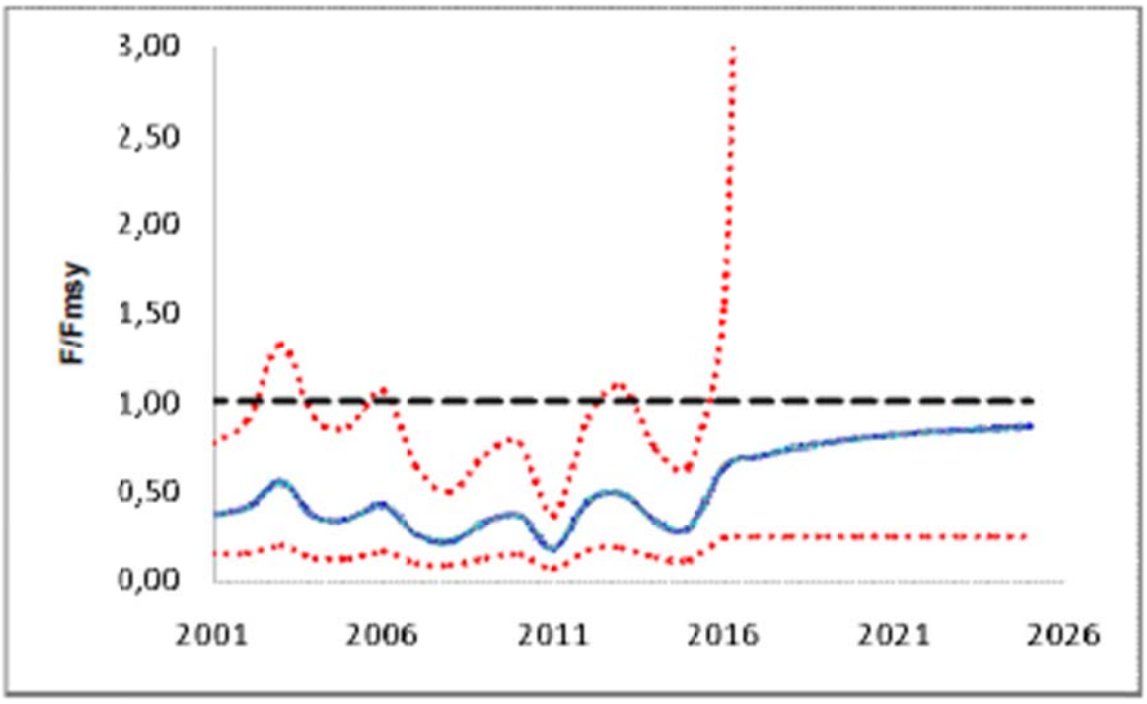
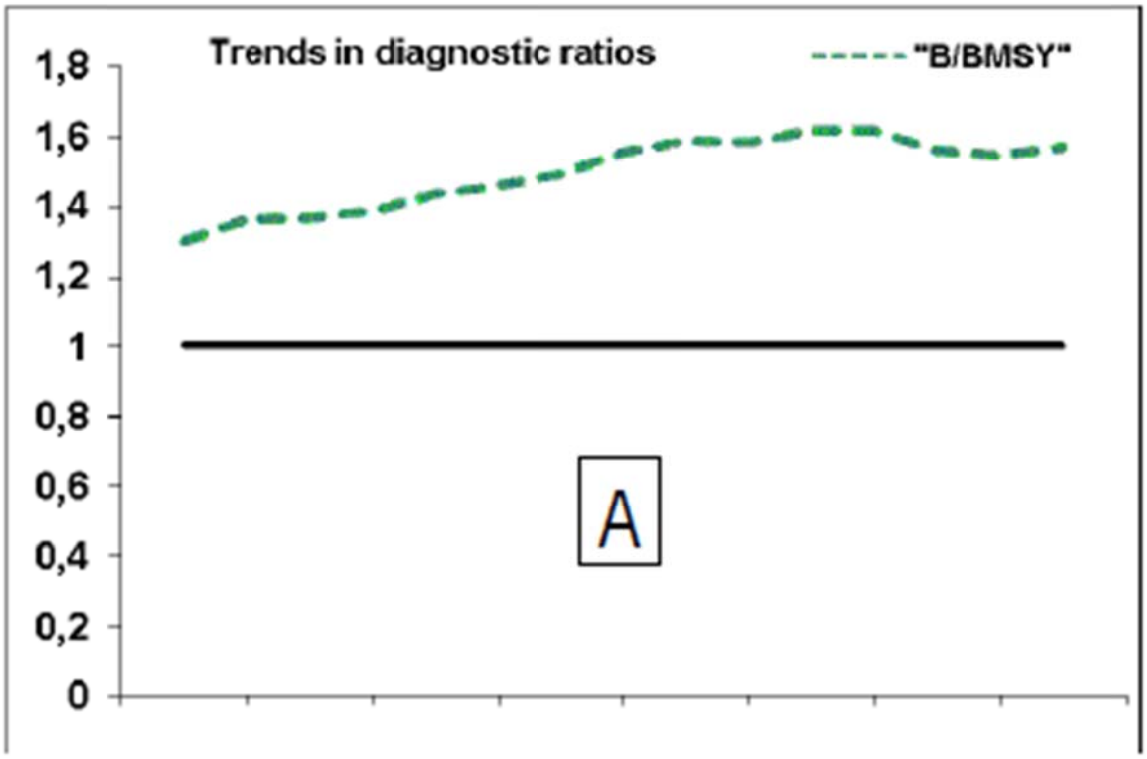


Figure 49: 10-year projection of the F/F_{MSY} index value for abrupt wedge shells (D. trunculus), maintaining the MSY value estimated by the ASPIC model. Dotted lines represent the confidence limits at an 80 % confidence interval

A model fit was also carried out with BioDyn. The results of the model show a similar situation to that obtained by ASPIC, although less optimistic with respect to the sustainable yield value, which is estimated at 39 t with stock in good condition, with a current biomass(1/BMSY) almost 1.6 times higher than the MSY could provide. In addition, the FCur/FSYCur value suggests a stock increase scenario (Table 34 and Figure 50).

Table 34: Estimates (t) of the model parameters obtained via BioDyn for Donax trunculus.

Stock Parameters	
MSY	39
BMSY	154
B0.1	170
Cur_Stock	244
B/B_{MSY}	158%
B/B0.1	144 %
Cur_SustProd	25
Cur_PercProd	66 %
CurY	22
FMSY	0.25
F0.1	0.23
FCur	0.09
Fcur/FMSY	36 %
Fcur/F0.1	40 %
FSYCur	0.10
Fcur/FSYCur	86 %
DBCur	4
DBCUr/Bcur	1%
CurY/MSY	57 %



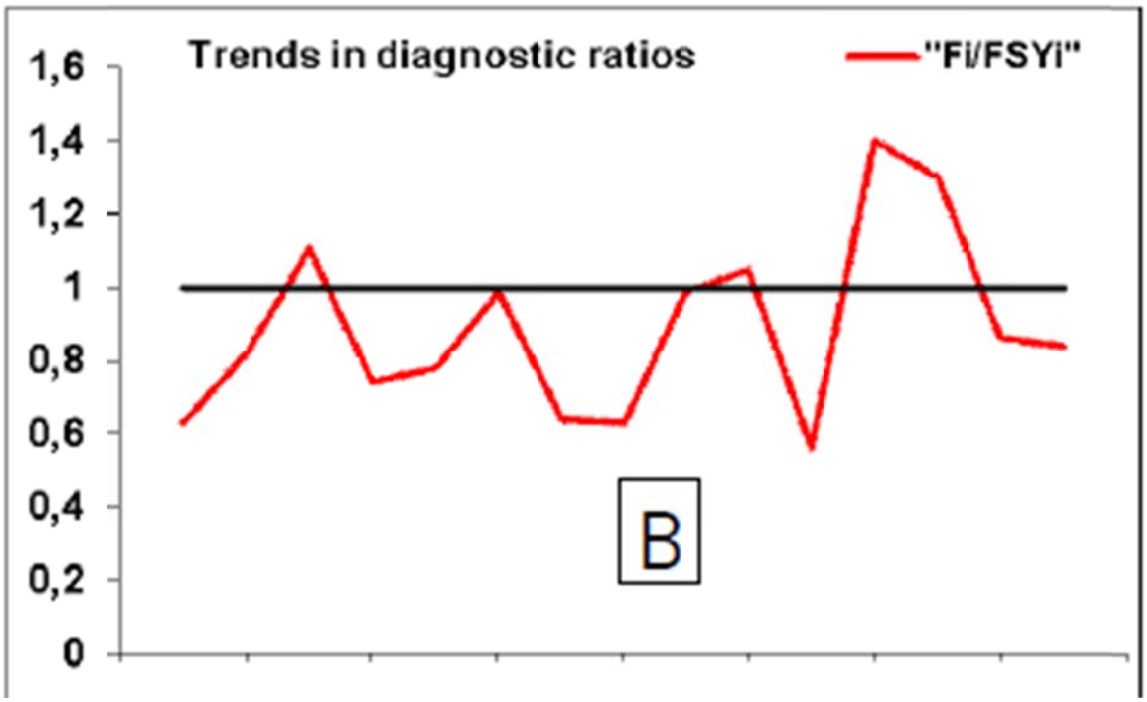


Figure 50: A: Trajectory of the abrupt wedge shell (D. trunculus) population in terms of relative biomass (B/B_{MSY}) and B: in terms of relative fishing mortality (F/F_{MSY}) according to Biodyn results.

Given the uncertainty in the confidence intervals of the reference indices in the estimated ASPIC projection, a 15-year projection with BioDyn was performed, keeping the catch at the estimated MSY value (39 t). The result shows a progressive decrease in the relative abundance of stock until it exceeds the precautionary exploitation rate in the final years (Figure 51). In accordance with this result, new tests have been carried out, keeping the catch constant at values below the estimated MSY. A projection with a constant catch 10% lower than the estimated MSY (35 t) offers a more moderate evolution of biomass levels. Although these fall, they stabilise above the precautionary level (Figure 52) and significantly improve sustainable yield (Figure 53).

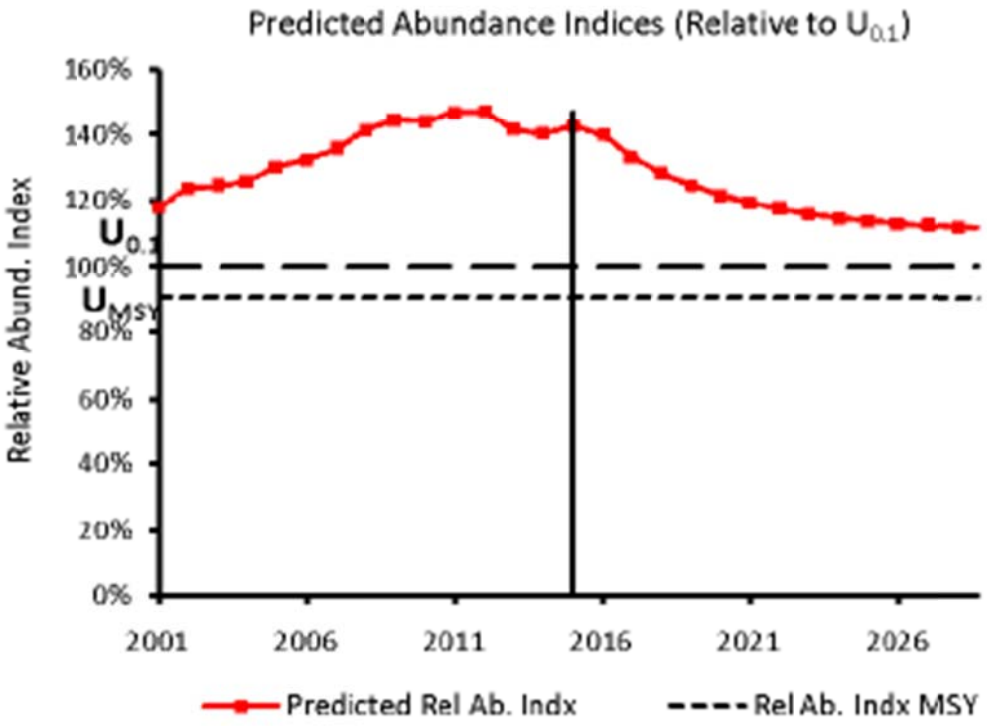


Figure 51: 15-year projection of the relative abundance index value for abrupt wedge shells (D. trunculus), maintaining the catch level 10% lower than the MSY value estimated via BioDyn.

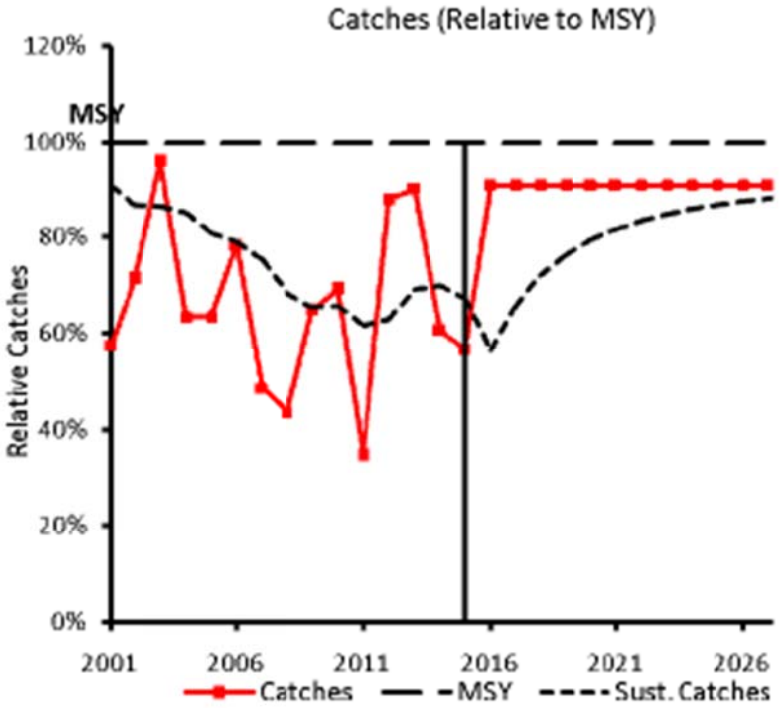


Figure 52: 15-year projection of sustainable catch levels for abrupt wedge shells (D. trunculus), maintaining a catch level 10% lower than the MSY value estimated via BioDyn.

On the basis of the results obtained, we can conclude that the general condition of the stock is good. The difference observed in the MSY value obtained using one model or another, as well as in the result of the projections, suggests that, as a more precautionary measure, a catch limit corresponding to 90 % of the estimated MSY using BioDyn (35 t) should be established. Once this value is reached in landings (if this occurs), the fishery must stop in order to maintain production in sustainability terms. As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of the abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 17.5 k*day^{-1}.

4.3.3.5. General points

Table 35 shows the reference values taken into account for each of the species, indicating the estimated maximum sustainable yields (MSY) with the application of each of the models (ASPIC and BioDyn), and the proposed catch limit values and average annual minimum threshold (33rd percentile of CPUE series ($k*day^{-1}$)). In addition, for all stocks, the target exploitation state should be that which ensures that Fc is equal to less than F0.1.

Table 35: Recommended reference values to be used for A. tuberculata, C. chione, C. gallina and D. trunculus.

	MSY (t) ASPIC	MSY (t) BioDyn	Catch limit	Minimum $k*day^{-1}$ threshold
Acanthocardia tuberculata	1670	1 359	1290[a]	325
Callista chione	216	272	216[b]	92
Chamelea gallina		35	22[C]	23.8
Donax trunculus	44	39	35[d]	17.5

A. 95 % of estimated MSY using BioDyn.
B. MSY obtained using ASPIC.
C. 65 % of estimated MSY using BioDyn.
D. 90% of estimated MSY using BioDyn.

5. PROPOSAL FOR AMENDMENT AND EXTENSION OF MANAGEMENT PLAN

Article 19 of Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/1993 and repealing Regulation 1626/1994, establishes the obligation for Member States of the European Union to draw up management plans for certain fishing methods within their jurisdictional waters, including fishing with dredges and mechanised dredges. Similarly, measures taken in these management plans should be consistent with measures for the conservation and sustainable exploitation of marine biological resources set out in Part III of Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013, on the Common Fisheries Policy.

On 31 March 2014, the Order of 24 March 2014 was published, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, fulfilling the obligation established in the Article 19 of Council Regulation (EC) No 1967/2006 of 21 December.

Article 5 of this management plan establishes conservation reference points, which allow the development of a strategy for the conservation of fishery resources. In addition, the management plan establishes annual scientific monitoring, which allows up-to-date information to be available, so that appropriate decisions may be taken in the implementation of new management mechanisms in order to continue keeping fishery resources exploitable within the limits of biological safety .

On 12 January, at the request of the European Commission, the Order of 29 December 2014, amending the Order of 24 March 2014, was published, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, including an amendment to Article 5(2) of the Order of 24 March 2014, and including a new Article 19 regarding the validity of the Plan, stating that ‘The Plan shall apply from the entry into force of this Order until 31 December 2016 and shall be reviewed and amended annually, where appropriate, in the light of scientific reports. Without prejudice to the provisions of the preceding paragraph, and with the agreement of the European Commission, the period may be extended, where necessary, on the basis of the scientific reports on the evolution of resources’.

In addition, Article 16 of the Order of 24 March 2014 establishes that ‘On the basis of the results of the scientific evaluation and monitoring reports of the fishery, the Ministry responsible for fishing and shellfish shall decide, through the amendment of this Management Plan, on the need to adopt additional measures for the adjustment and control of fishing effort and, where appropriate, for the annual total catch or the average annual minimum catch values, the percentages of effort reduction necessary, as well as the period during which these reduction targets must be met.’.

Therefore, what follows are the main conclusions obtained in the scientific monitoring of the Management Plan, as well as the proposals for its amendment.

5.1. ABRUPT WEDGE SHELL (Donax trunculus)

5.1.1. Conclusions of scientific studies

What follows are the most relevant conclusions of the different scientific studies carried out on this species in the evaluation and monitoring of the Management Plan:

- The modal monthly size distribution for the period between March 2013 and March 2014 was always above the legal minimum catch size (25 mm).
- The analysis of the size distributions obtained shows that a comprehensive selection of specimens to be subsequently marketed was carried out on this species. 80 % of the discard by weight consisted of specimens below the legal size.
- In all sampling months the average catch size was above the minimum catch size (25 mm), fluctuating between 1.3 mm and 5.6 mm above this size.
- The mean annual values of the standardised CPUE were practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 95> 0.05), in such a way that one or the other may be used without distinction.
- For the striped venus clam, together with the abrupt wedge shell, the lowest catch values for the bivalve species exploited in the region are recorded, with catches in the last fifteen years oscillating between the minimum in 2011, at only 17 t, and the maximum in 2003, at 37 t.
- CPUE undergoes slight oscillations, fluctuating in values between 14.2 and 23.5 kg day^{-1}, with a decrease observed at the end of the period. The negative trend for the catch, from the high in 2003 to the low of 2011, is not reflected in the evolution of CPUE, which remains more or less stable in this period.
- In recent years, there has been a decrease in both catches and CPUE, although there are no general trends covering the period analysed.
- The main results obtained from the application of the ASPIC model show that the resource is in good condition and that there is even a probability of increasing its exploitation, yielding MSY values of 44.5 tonnes and Bcur almost 1.67 times higher than the value of B_{MSY} and F 0.6 times lower than that of F_{MSY}.

- The differences between the CPUEs observed and the estimations using the ASPIC model are small. The population trajectory in terms of B/B_{MSY} and F/F_{MSY} shows that the stock is in good condition and has not been overexploited (overfished), nor are there any other signs of overexploitation (overfishing) for the period studied.
- With the aim of estimating how the abrupt wedge shell stock might evolve, a 10-year projection was tested with ASPIC, taking into account a constant MSY value for the course of exploitation and equal to that obtained in the bootstrap analysis (44.5 tonnes). The evolutions of B/B_{MSY} and F/F_{MSY} never exceed the reference level that would lead to the adoption of more restrictive management measures (a TAC less than MSY) for the maintenance of the resource, although they do approach this level at the end of the projection. However, the value of 80 % for the lower limit of confidence for the B/B_{MSY} index and the upper one for F/F_{MSY} rapidly moves away from the estimated values (blue line) to areas where confidence is very low.
- A model fit was also carried out with BioDyn. The results of the model show a similar situation to that obtained by ASPIC, although less optimistic with respect to the sustainable yield value, which is estimated at 39 t with stock in good condition, with a current biomass (1/BMSY) almost 1.6 times higher than the MSY could provide. In addition, the FCur/FSYCur value suggests a stock increase scenario.
- Given the uncertainty in the confidence intervals of the reference indices in the estimated ASPIC projection, a 15-year projection with BioDyn was performed, keeping the catch at the estimated MSY value (39 t). The result showed a progressive decrease in the relative abundance of stock until it exceeded the precautionary exploitation rate in the final years. In accordance with this result, new tests were carried out, keeping the catch constant at values below the estimated MSY. A projection with a constant catch 10 % lower than the estimated MSY (35 t) offers a more moderate evolution of biomass levels. Although these fall, they stabilise above the precautionary level and significantly improve sustainable yield.
- On the basis of the results obtained, we can conclude that the general condition of the stock is good. The difference observed in the MSY value obtained using one model or another, as well as in the result of the projections, suggests that, as a more precautionary measure, a catch limit corresponding to 90 % of the estimated MSY using BioDyn (35 t) should be established. Once this value is reached in landings (if this occurs), the fishery must stop in order to maintain production in sustainability terms. As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of the abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 17.5 $k*day^{-1}$.

5.1.2. Management Plan amendment proposal

In view of the above, the modification of the maximum annual total catch is proposed for the abrupt wedge shell *(Donax trunculus)* from 49 t/year to 35 t/year (amendment to Article 4 of the *Order of 24 March 2014).*

5.2. SMOOTH CLAM (Callista chione)

5.2.1. Conclusions of scientific studies

What follows are the most relevant conclusions of the different scientific studies carried out on this species in the evaluation and monitoring of the Management Plan:

- Commercialised specimens were found, in all months, with an average size above the minimum reference size for conservation purposes, set at 60 mm.
- The distribution mode for retained catch sizes was above the minimum sizes in all months (60 mm).
- Almost all of the discards were made up of specimens below the minimum size. One of the main factors influencing discards of species was minimum size regulations.
- The discarding of specimens above the minimum size did not exceed 20 %.in catch weight, except in August, when a level of 24 % was reached. Market factors have an influence on the discarding of specimens above the legal size, which are a response to the non-acceptance of individuals with shell deterioration caused in the course of catch handling, and the search for large-sized specimens that ensure a greater sale value.
- The evolution of the average size for all of the period, from the start of the study and subsequent monitoring of fisheries, shows the spread of the distribution obtained in some months, as well as maintenance of the average size above the minimum reference size for conservation purposes.
- The mean annual values of the standardised CPUE were practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 97> 0.05), in such a way that one or the other could be used without distinction.
- In the evolution of catches of the smooth clam for the period of 2001 to 2015, maximum production was seen in 2001 (306 t), and minimum production in 2003, when the least catches (67 t) were recorded, although this low reading could also have been due to shortcomings in the collection of landing data. Since 2008, catches have become more or less stable, at around 200 tonnes. The evolution of CPUE shows a negative trend until 2009, when it seems to stabilise until 2012, and subsequently the sign of the trend changes, increasing progressively, in the same way as occurs with the catches.

- The estimated CPUE via ASPIC shows few differences against those observed. The population trajectory in terms of B/B_{MSY} and F/F_{MSY} shows that stock has not been overfished and neither has overfishing occurred in the past. Over the last year, the MSY value of 216 t and the values of B/B_{MSY} and F/F_{MSY} are of note, indicating a sustainable exploitation of stock with a biomass 1.3 times higher than the maximum yield point, and a F_{MSY} 1.2 times higher than the F level currently experienced.
- A 10-year projection was tested using the results obtained with ASPIC, taking into account a catch limit equal to the estimated MSY value (216 t) and constant for the period. In this case, maintenance of catches at the level of the estimated MSY seems to ensure not only maintenance of biomass but also a marked increase in biomass.
- The resource was also analysed using BioDyn. The results of the model offer a situation similar to that obtained by ASPIC, although more optimistic with respect to the sustainable yield value, which estimates 272 t with stock in good condition, with a current biomass (1/BMSY) 1.5 times higher than the MSY could provide, although the value of FCur/FSYCur seems to indicate a scenario with a slight decrease in stock. In the current state of the stock, there are no signs of overfishing with an Fc/F0.1 value of 0.65.
- Since the MSY obtained by Biodyn was much higher than that estimated with ASPIC, a 20-year projection was made, keeping the catch at its current value (243 t). The result shows a decrease in the relative abundance of stock in the first five years of projection, as suggested by the estimated value of Fcur/ FSYCur, which later stabilises. The projection of values is never lower than the reference value corresponding to the precautionary exploitation rate (U0.1). On the other hand, maintaining the catch values would improve sustainable yield for a fairly short period of time. The general situation is that the current catch rate could rise 10 % (to 267 t), keeping stock within safe limits.

- Although there is a significant difference in the estimated MSY value between both models (52 t), the projections in both cases - both maintaining the MSY in ASPIC and the current catch in BioDyn - demonstrate no tendency towards overfishing, but rather a maintenance of the reference points within safe limits. In this case, the most precautionary solution could be the adoption of a more conservative catch limit (MSY in ASPIC). As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 92 $k*day^{-1}$.

5.2.2. Management Plan amendment proposal

In view of the above, modification of the maximum annual total catch is proposed for the smooth clam *(Callista chione)* from 182 t/year to 216 t/year (amendment of Article 4 of the *Order of 24 March 2014).*

5.3. ROUGH COCKLE (Acanthocardia tuberculata)

5.3.1. Conclusions of scientific studies

What follows are the most relevant conclusions of the different scientific studies carried out on this species in the evaluation and monitoring of the Management Plan:

- The exploitation of *A. tuberculata* is due to demand for the product by the canning companies, with this being the only way of marketing the species. That entails an exploitation that is not continuous through time, presenting huge difficulty in terms of monitoring the evolution of the sizes of the species.
- During the period between March 2013 and March 2014, commercial exploitation was only carried out in December and January. The size distributions of the commercial catches exploited in the aforementioned month show that the height trend for specimens exploited was at 53 and 52 mm respectively, far above the minimum conservation reference size (45 mm).
- The bulk of the population was made up of individuals above the minimum catch size (45 mm).
- The size distribution of the exploited catch of *A. tuberculata,* indicates that the mean size is well above the legally established first catch size.
- The mean annual values of the standardised CPUE were practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 95> 0.05), in such a way that one or the other may be used without distinction.
- Catch data was extremely variable between years, presenting a maximum of 2 300 tonnes in 1996 and reporting abrupt oscillations until the end of the series. The exploitation of the species is completely dependent on demand for the product from canning manufacturers, the only marketing opportunity for this species. The oscillations observed are therefore due to varying demand according to the season. A closer look at the relative abundance of the species is offered by CPUE evolution, in which a steady increase since 2003 is observed with maximum values from 2010 to 2015, with more than 400 kg/fishing day, reaching 730 kg/fishing day in the last year of the series.

- Considering the series 2001 to 2015, and so as to gain an overview of the trajectory of exploited stock, a production model with ASPIC was carried out, using a bootstrap adjustment through 1 000 iterations. The estimated CPUE via ASPIC shows few differences against those observed. The evolution of the indexes considered as reference biological limit points - relative biomass (B/B_{MSY}) and relative fishing mortality rate (F/F_{MSY}) - show a progressive increase of biomass, even exceeding the value of biomass needed to reach MSY. Although some oscillation in F/F_{MSY} values can also be seen, in recent years and since 2010, there has been a significant improvement in the exploitation of the resource and a situation whereby stock does not appear to be overexploited or overfished.
- The value of MSY obtained with ASPIC amounts to approximately 1 670 t, with the current values of the Boundary Reference Points (B/B_{MSY} and F/F_{MSY}) showing that the resource has a good state of health with a relative biomass rate of 1.13 times greater than that of the biomass required to obtain maximum sustainable yield and a fishing mortality rate that is only 60% of that required to obtain the MSY.
- In the evaluation performed with BioDyn, the results are slightly different from those obtained with the ASPIC model, estimating a lower MSY value (1 359 t) than that obtained with ASPIC (1 670 t). However, the perception of the state of the resource is similar, with current values of relative biomass being 1.4 times greater than that required to reach MSY biomass and an F/F_{MSY} value of 0.6. The trend of the resource in terms of relative biomass is even better than in the case of ASPIC. After a series of years in which the resource appeared to have been overexploited, the situation has improved in the last period and it can be seen that the values of B/B_{MSY} and F/F_{MSY} are in areas which are suitable for the maintenance of the resource, although the growth of the stock seems to have a very slight tendency to decline according to the estimated value of Fcur/FSYcur.
- With the values estimated by BioDyn, a 15-year projection was made, keeping the catch at 5 % lower than the estimated MSY value, since the trend of Fi/FSYi is set to increase. The result shows a slight decrease in the relative abundance of stock in the first five years of projection, as suggested by the estimated value of Fcur/FSYCur, which later stabilises. The projection of values is never lower than the reference value for the precautionary exploitation rate (U0.1). On the other hand, the maintenance of catch values would improve sustainable yield, bringing this near to the estimated MSY value.

- The current state of exploitation of stock is sustainable, according to the results obtained in the models. However, as a precautionary measure, it is suggested that the catch limit is kept at 1 290 t, corresponding to 95 % of the MSY value estimated by BioDyn, which is also significantly lower than that estimated with ASPIC. As minimum reference values, it should be established that Fcur is equal to or less than F0.1 and that the minimum threshold of the abundance index is never lower than that corresponding to the 33rd percentile of the CPUE series, in other words 325 $k*day^{-1}$.

5.3.2. Management Plan amendment proposal

Taking into account what is stated in the previous paragraph, the amendment of the maximum annual total catch for rough cockle *(Acanthocardia tuberculata)* from 1 128 t/year to 1 290 t/year, and of the average annual minimum catch threshold from 321 kg/boat/day at 325 kg/boat/day *(amendment to Article 4 of the Order of 24 March 2014) is proposed.*

5.4. STRIPED VENUS CLAM (Chamelea gallina)

5.4.1. Conclusions of scientific studies

What follows are the most relevant conclusions of the different scientific studies carried out on this species in the evaluation and monitoring of the Management Plan:

- Almost no specimens below the first maturity size formed part of this retained catch.
- The average size fluctuated between a minimum value of 24.2 mm and a maximum of 29.3 mm. Only in the months of August and December 2013 was the average size value slightly below the legal size.
- 90 % of the discarded weight for this species is made up of specimens below the minimum size, with the main reason for the occurrence of discards being the minimum size regulations in force.
- The monthly distribution of retained catch sizes for this target species for the period between March 2013 and March 2014 shows that the modal average was above the minimum size, with the exception of March 2013.
- The evolution of the average size of the commercial catch for the entire period from the start of the study in March 2013 and in the subsequent monitoring of the fishery up to December 2015 remained above the minimum legal catch size in practical terms, fluctuating between 25 and 30 mm.
- The mean annual values of the standardised CPUE are practically no different from those of the non-standardised CPUE, according to the result of the Mann-Whitney U test (p U = 109> 0.05), in such a way that one or the other can be used without distinction.
- For the striped venus clam, together with the abrupt wedge shell, the lowest catch values for the bivalve species exploited in the region are recorded, with catches in the last fifteen years oscillating between the minimum in 2003, at only 7.3 t, and the maximum in 2006, at 53 t.

- During the period between 2001 and 2015, CPUE suffered some oscillations, fluctuating between 48.7 and 19.8 kg day-1, with the lower values observed at the beginning and the end of the period. The evolution of the catch records was similar to that of CPUE, with increases observed when the catch was higher, although there was no general trend in one direction or another covering the entire period analysed.
- The CPUE estimated by the BioDyn model shows few differences compared to the observed CPUE. The model estimates an MSY value of 35 t, very far from the current catch. The B/B_{MSY}, B/B0.1, Fc/F_{MSY} and Fc/F0.1 reference values show signs of slight overfishing, while the relative biomass trajectories and the sustainable exploitation rate are slightly elevated as well.
- As the MSY obtained was higher than the current catch, a 10-year projection was made by testing a precautionary strategy in which the catch is kept constant at a value corresponding to 65 % of the estimated MSY. The projection shows this strategy would result in a rapid recovery and return to sustainable exploitation values, as well as an increase in sustainable yields and a rising trend towards MSY values.
- In this situation, it appears appropriate to maintain a maximum catch of 22 tonnes and a minimum reference threshold of 23.8 $kg*day^{-1}$.

5.4.2. Management Plan amendment proposal

On the basis of what is stated in the previous paragraph, the amendment of the average annual catch minimum threshold from 25.6 kg/boat/day to 23.8 kg/boat/day (amendment to Article 4 of the *Order of 24 March 2014*) is hereby proposed for the striped venus clam *(Chamelea gallina).*

5.5. EXTENSION OF THE MANAGEMENT PLAN

On 12 January, at the request of the European Commission, the Order of 29 December 2014, was published, amending the Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, *including a new Article 19 relating to the entry into force of the Plan:*

> Article 19. Validity of the Management Plan.
> 'The Plan shall apply from the date of entry into force of this Order until 31 December 2016 and shall be reviewed and modified, if appropriate, based on the scientific reports, annually.
>
> Without prejudice to the provisions of the preceding paragraph, and with the agreement of the European Commission, the period may be extended, where necessary, on the basis of the scientific reports on the evolution of resources.'

Therefore, and in accordance with the outcome of the scientific studies relating to the resources assessment, it is proposed to extend the plan until 31 December 2019.

5.6. PREVENTIVE CLOSURE OF FISHERY

As a result of the experience gained by this Directorate-General since the entry into force of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia,* and in particular in relation to the monitoring of the biological reference points set out in Article 4, it is deemed necessary to amend the Order in order to enable the incumbent of the Directorate-General for Fisheries and Aquaculture to declare the precautionary closure of the fishery when the catch data (total catch values close to the annual maximum allowed) and/or effort (yields well below the average annual minimum catch threshold), make it advisable.

In this regard, it is proposed that a new paragraph 4 within Article 5 be added, as follows:

> 'If, according to the catch data available to the Directorate-General with competences for shellfish, it is verified that the consumption of the total annual catch is close to being achieved, the Directorate-General for Fisheries and Aquaculture shall issue a resolution ordering the precautionary closure of that fishery'.

5.7. REDUCTION OF AUTHORISED WORKING DAYS PER WEEK

Article 5.2 of the Order of 24 March 2014 establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia *provides that:*

> 'Article 5 Conservation reference points.
>
> 2. If the minimum average annual catch values are not reached for the aforementioned species, an analysis of the fishery data and situation must be carried out, in order to determine the reasons for those values.
>
> In the event that this situation is considered to be a consequence of a decrease in exploitable populations, whatever its cause, fishing for the threatened species must be reduced from five authorised fishing days per week to four fishing days per week in the following year.

In this regard, it is deemed necessary to make an amendment to this paragraph, in order to enable the mechanism that allows the Directorate-General for Fisheries and Aquaculture to reduce the authorised weekly days, from five to four, in the case contained in the aforementioned paragraph.

6. PROPOSAL FOR REGULATORY TEXT

Order of_____, amending that of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia.

PREAMBLE

Article 19 of Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/1993 and repealing Regulation 1626/1994, establishes the obligation for Member States of the European Union to draw up management plans for certain fishing methods within their jurisdictional waters, including fishing with dredges and mechanised dredges. Similarly, measures taken in these management plans should be consistent with measures for the conservation and sustainable exploitation of marine biological resources set out in Part III of Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013, on the Common Fisheries Policy.

On 31 March 2014, the Order of 24 March 2014 was published, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, fulfilling the obligation established in the Article 19 of Council Regulation (EC) No 1967/2006 of 21 December.

Article 5 of this management plan establishes conservation reference points, which allow the development of a strategy for the conservation of fishery resources. In addition, the management plan establishes annual scientific monitoring, which allows up-to-date information to be available, so that appropriate decisions may be taken in the implementation of new management mechanisms in order to continue keeping fishery resources exploitable within the limits of biological safety .

Article 16 of the Order of 24 March 2014, establishes that 'On the basis of the results of the scientific evaluation and monitoring reports of the fishery, the Ministry responsible for fishing and shellfish shall decide, through the amendment of this Management Plan, on the need to adopt additional measures for the adjustment and control of fishing effort and, where appropriate, for the annual total catch or the average annual minimum catch values, the percentages of effort reduction necessary, as well as the period during which these reduction targets must be met.'

On 12 January, at the request of the European Commission, the Order of 29 December 2014, amending the Order of 24 March 2014, was published, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia, including an amendment to Article 5(2) of the Order of 24 March 2014, and including a new Article 19 regarding the validity of the Plan, stating that 'The Plan shall apply from the entry into force of this Order until 31 December 2016 and shall be reviewed and amended annually, where appropriate, in the light of scientific reports. Without prejudice to the provisions of the preceding paragraph, and with the agreement of the European Commission, the period may be extended, where necessary, on the basis of the scientific reports on the evolution of resources'.

In order to attempt to determine the current states of exploited stocks, daily CPUE averages per vessel and target species ($kg*day^{-1}$), for the period between 2001 and 2015, were analysed. In addition, to obtain information on the reference values, the non-equilibrium production model ASPIC (A Surplus-Production model Incorporating Covariates) was used so as to obtain the trajectory of the population in terms of relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}), and in order to verify the results, the BioDyn production model based on the Shaefer models was used, which also offers the possibility of analysing the trajectory of the population in the same terms as ASPIC, as well as making projections taking into account changes in catch or effort.

The results of the scientific studies carried out by the Spanish Institute of Oceanography, in its monitoring of these fisheries, show that the abrupt wedge shell, smooth clam, rough cockle and striped venus clam populations are in a healthy condition, as reflected in the values obtained at the biological reference points studied (relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) associated with the modelling of these fisheries. In addition, application of the ASPIC and BioDyn production models to the catch data permitted a re-estimation of the MSY values and the 33rd percentile of the CPUE series, which served to establish the biological reference points contained in the Order of 24 March 2014. The analysis of these values suggests a need for their revision, and in particular, an amendment to the maximum annual total catch for the abrupt wedge shell, smooth clam and rough cockle, and an amendment to the average annual minimum catch threshold for smooth venus clam and rough cockle.

Lastly, as a result of the experience acquired by this Directorate-General since the entry into force of this Order, and in particular in relation to the monitoring of the biological reference points contained in its Article 4, it is deemed necessary to make an amendment to the said Order to enable a mechanism for ordering the precautionary closure of the fishery when the total catch data makes it advisable, as well as to enable the amendment of the authorised work days per week in the event that the circumstances described in Article 5.2 occur.

Due to all of the above, at the proposal of the Director-General of Fisheries and Aquaculture, and in the use of the powers attributed to me under Article 44.2 of Law 6/2006, of 24 October 2006, of the Government of the Autonomous Community of Andalusia , And Decree 215/2015, of 14 July 2015, establishing the organic structure of the Ministry of Agriculture, Fisheries and Rural Development,

I HEREBY ORDER

Sole article. Amendment of the Order of 24 March 2014.

The Order of 24 March 2014, establishing a management plan for dredge or mechanised dredge fishing off the Mediterranean coast of Andalusia, is amended in the following manner:

One. Article 4 reads as follows:

For the purposes of application of this Order, the main species susceptible to being caught by means of a dredge or mechanised dredge are deemed, according to the Spanish Oceanography Institute, to be within safe biological limits and, therefore, exploited in a sustainable manner, when the following requirements are met:

- *ABRUPT WEDGE SHELL* (Donax trunculus)
  Total annual catch not more than 35 t/year.
  Minimum average annual catch of at least 17.5 kg/vessel/day.

- *Smooth clam* (Callista chione)
  Total annual catch inferior not more than 216 t/year.
  Minimum average annual catch of at least 92 kg/vessel/day.

- *ROUGH COCKLE* (Acanthocardia tuberculata)
  Total annual catch not more than 1 290 t/year.
  Minimum average annual catch of at least 325 kg/vessel/day.

- *Striped venus clam* (Chamelea gallina)
  Total annual catch not more than 22 t/year.
  Minimum average annual catch of at least 23.8 kg/vessel/day.

Two. Article 5.2 is amended to read as follows:

If the minimum average annual catch values are not reached for the aforementioned species, an analysis of the fishery data and situation must be carried out, in order to determine the reasons for those values.

In the event that this situation is considered to be a consequence of a decrease in exploitable populations, whatever its cause, fishing for the threatened species must be reduced from five authorised fishing days per week to four fishing days per week in the following year.

Three. A new paragraph 4 is added to Article 5, which reads as follows:

Where, according to the catch data available to the Directorate-General for Fisheries and Aquaculture, it is verified that the consumption of the annual catch is close to being achieved or the average daily yield is well below the average annual minimum established, the Directorate-General of Fisheries and Aquaculture must issue a resolution ordering the precautionary closure of the said fishery.

Four. Article 19 reads as follows:

The Plan shall apply from the date of entry into force of this Order until 31 December 2019 and shall be reviewed and modified, if appropriate, based on the scientific reports, annually.

Without prejudice to the provisions of the preceding paragraph, and with the agreement of the European Commission, the period may be extended, where necessary, on the basis of the scientific reports on the evolution of resources.

Sole final provision. Entry into force.

This Order shall enter into force on the day following its publication in the Official Gazette of the Autonomous Government of Andalusia.

Seville,_____ December 2016

MARIA DEL CARMEN ORTÍZ RIVAS

Regional Minister for Agriculture, Fisheries and Rural Development

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SCIENTIFIC REPORT on

"MANAGEMENT PLAN FOR DREDGES AND MECHANISED DREDGES IN THE MEDITERRANEAN FISHING AREA OF THE AUTONOMOUS COMMUNITY OF ANDALUSIA.

- Evaluation and monitoring report amendment and extension proposal -

This revision has been proposed to assist the European Commission as an independent expert, by providing a scientific report to support STECF, which has been asked to deliver scientific advice on "Management Plan for dredges and mechanised dredges in the Mediterranean Fishing Area of the autonomous Community of Andalusia, Spain".

The contractor is requested to

TOR 1. Advice and assess whether the management plan for mechanised dredges in Andalusia contains adequate elements in terms of:

1.1. <u>The description of the fisheries</u>

- Recent and historical data on catches (landings and discards) of the species concerned, fishing effort and abundance indices such as catch-per-unit-effort (or CPUE). Advices whether catch and effort data should be assessed at the level of the Autonomous Region of Andalusia or by metapopulations.
- Data on length-frequency distribution of the catches, with particular reference to the species subject to minimum sizes in accordance with Annex III of the MEDREG.
- An updated state of the exploited resources.
- Information on economic indicators, including the profitability of the fisheries.

1.2. <u>Objectives, safeguards and conservation/technical measures</u>

- Objectives consistent with article 2 of the CFP and quantifiable targets, such as fishing mortality rates and total biomass.
- Measures proportionate to the objectives, the targets and the expected time frame.
- Safeguards to ensure that quantifiable targets are met, as well as remedial actions, where needed, including situations where the deteriorating quality of data or non-availability places the sustainability of the main stocks of the fishery at risk.
- Other conservation measures, in particular measures to fully monitor catches of the target species, to gradually eliminate discards and to minimise the negative impact of fishing on the ecosystem.

1.3. <u>Other aspects</u>

- Quantifiable indicators for periodic monitoring and assessment of progress in achieving the objectives of the plan.
- Estimate the level of dependency of the fleet on the target stocks (i.e. *Donax trunculus*, *Callista chione*, *Acanthocardia tuberculata* and *Chamelea gallina)*
- Advice whether the proposed modifications in terms of total annual catches and limit reference points of the plan would ensure a sustainable exploitation of the target stocks.

TOR 2. If deemed necessary, provide any recommendations and guidance on how to obtain improved scientific/technical supporting material for the plan. This could be done in terms of collection of data,

evaluation of the status of the target stocks, evaluation of conservation measures, impact on the marine ecosystem and monitoring programme.

General observations

The objectives of the Management Plan are the establishment of complementary measures to control the bivalves (*Acanthocardia tuberculata*, *Callista chione*, *Chamelea gallina*, and *Donax trunculus*) fishery carried out with the mechanised dredges in the Andalusian Mediterranean coast, together with a series of measures to control fishing effort. The aim of the MP is to maintain the level of target species biomass above the selected biological reference points, and thus maintain stocks within defined safe biological limits.

The submitted document, specifically addressed by the present report, contains the evaluation and monitoring report based on the MP and the amendment proposal. In particular, it aims to:

- evaluate compliance with the biological and conservation reference points set out in Articles 4 and 5 of the *Order of 24 March 2014, establishing a management plan for dredge and mechanised dredge fishing off the Mediterranean coast of Andalusia*;
- submit the scientific fishery evaluation and monitoring reports carried out by the Spanish Oceanography Institute and the Andalusian Agricultural and Fisheries Management Agency, dating from the entry into force of this management plan;
- forward to the Commission the proposed amendment and extension of the Management Plan.

According to all of this, some of the proposed TORs resulted not assessable, since the related topic is not referred in the present report.

Observations in relation to each of the elements outlined in the Terms of Reference

1.1 "Description of the fisheries"

"Recent and historical data on catches (landings and discards) of the species concerned, fishing effort and abundance indices such as catch-per-unit-effort (or CPUE). Advices whether catch and effort data should be assessed at the level of the Autonomous Region of Andalusia or by metapopulations".

Data on total annual catches (2001- 2015) and catches per unit of effort (CPUE, 2001- 2015) are reported for all the four species exploited by the mechanized dredges. In addition, the spatial distribution of the effective effort (in terms of hours of fishing activity per surface unit), based on the Location and Tracking System of Andalusian Fishing Vessels, is also reported for 2014 and 2015. On the contrary, no information about discarded species are reported.

Given the importance of the standardization procedure of the effort when using CPUE as indicator for deriving limit and target catches for a fishery, in the report this issue is discussed for all the target species, describing the applied methods and obtained results. The CPUE has been standardized against the gross register tonnage (GRB), CV power (HP) and length (LOA) of vessels. No significant deviation between the standardized and non-standardized values have been recorded. The maps about the spatial distribution of the fishing effort (hours/0.06 NM) showed a general trend of effort reduction in 2015 in comparison with 2014 for *D. trunculus* and *C. gallina*; whereas a slight increase in some areas was recorded for *A. tuberculata* and *C. chione*. Based on the effort distribution maps, banks of all the exploited species showed a contagious distribution. This would suggest the opportunity to move towards an assessment at metapopulation level, instead of the regional level. Within this context, however, also taking into the account the observed contagious distribution, it would be necessary to base the stock assessment on the

biomass density (i.e. kg/m^2) obtained by fishery-independent data. In alternative, also fishery-derived data could be useful allowing to compare present values with a predefined baseline, estimated from unfished areas or from data obtained in the past, assuming that they represent a more pristine status of the stock. In this case, a value comprised between the 30% and 40% of the density estimated from unfished areas or from data obtained in the past might be suitable as reference points to evaluate the stock status (Cardinale et al., 2012). At present, no indication about this issue are reported in the Report. Finally, it is not clear from the Report if each vessel is allowed to only use one dredge at the time.

"Data on length-frequency distribution of the catches, with particular reference to the species subject to minimum sizes in accordance with Annex III of the MEDREG".

Three of the species specifically addressed in the Management Plan (namely *Acanthocardia tuberculata*, *Callista chione*, , and *Donax trunculus*) are not listed in the Annex III of the Council Regulation (EC) No 1967/2006. However, the MP proposes a 'minimum landing size' (mls) for each of them, that are considered appropriate for all species exploited by mechanised dredges on the Mediterranean fishing grounds of the Andalusia Regional Government. All this is also confirmed by the results of the monitoring activities carried out since the approval of the MP by the Directorate-General for Fisheries and Aquaculture of the Government of Andalusia. The Report referred results of the on-board monitoring activity, carried out, on a monthly basis, from March 2013 to December 2015.
For *C. chione*, during the analysed period, only 17% of the landings was composed by individuals below the minimum landing size (60 mm), and almost no specimens below the first maturity size (35 mm) have been recorded. About discarded fraction, about 20% is composed by specimens above the mls (shell-damaged individuals and/or market preference for large-sized more valuable specimens.
For *C. gallina*, during the analysed period, only 19% of the landings was composed by individuals below the minimum landing size (25 mm), and almost no specimens below the first maturity size (12.5 mm) have been recorded. It is worthy to not that in some period the discarded fraction (composed by specimens below the mls) greatly exceed the retained commercial fraction (50-80%). Taking into consideration that most of the individuals discarded have a high probability of surviving as they are generally thrown back in the same area where they have been caught, this could not represent a major criticality, but suggest be more deeply investigate in the next future.
For *D. trunculus*, during the analysed period, only 3.8% of the landings was composed by individuals below the minimum landing size (25 mm). The same considerations made in the previous case, could be proposed for this species, since in some periods the discarded fraction (composed by specimens below the mls) greatly exceed the retained commercial fraction (till 92%).
In the case of A*. tubercolata*, being the exploitation completely driven by canning companies demand, it resulted to be quite scattered through the time. Data collected showed that only 4.3% of the landings was composed by individuals below the minimum landing size (45 mm).

"An updated state of the exploited resources"

The state of the exploited resources has been updated to 2015 (CPUE time series from 2001 to 2015). The methods are the same presented in the MP, with the evaluation based on an analytical assessment (i.e. ASPIC production model based on catches and effort). Within this context it worthy to note that, as reported by several authors (e.g. Defeo and Caddy, 2001), the production models based on relative short time-series resulted to be quite sensitive to the initial values, with important effects on the modelling outputs. The assessment identifies an MSY value for exploitation rate (i.e. fishing mortality, F) and stock

biomass, and estimates the current status of the stock compared to these. Therefore, the status of the resource with reference in particular to long-term yields and low risk of stock collapse is given in the document. In order to cope with the problem of using the CPUE as reference threshold (33rd percentile of the CPUE time series) the Report described methods used to standardize the effort (see section above), so improving the quality of the assessment. As previously stated, it would be necessary to base the analysis on stock density data, in order to obtain a more robust assessment.

"Information on economic indicators, including the profitability of the fisheries"

Data about economic indicators are not among the aims of the Report

1.2 "*Objectives, safeguards and conservation/technical measures*"

On the basis of the monitoring activities, biological reference points were estimated, in relative terms (i.e. F/Fmsy and B/Bmsy), for all the four target species (*Acanthocardia tuberculata*, *Callista chione*, *Chamelea gallina*, and *Donax trunculus*). For each target species recommended reference values have been reported, as MSY Catch limit (TAC), and minimum kg/boat/day threshold. These data, partially revised thresholds previously assessed in the Management Plan (in details: TAC decrease for *D. trunculux* to 35 t; TAC increase to 216 t/year for *C. chione*; TAC increase to 1290 t/year and average minimum catch increase to 325 kg/boat/day for *A. tubercolata*; average minimum catch decrease to 23.8 kg/boat/day for *C. gallina*). All these adjustments, proposed as amendments to the Article 4 of the *Order of 24 March 2014*, seem to be reasonable in the light of the evaluation report results regarding recorded trends for the period 2014-2016.
Finally, the Report proposed some amendments to the formal harvest control rules, defining what kind of management measures should be implemented in the future if the stock falls below Bmsy or if F exceeds Fmsy. On one side, the precautionary closure of fishery, ordered by the Directorate-General for Fishery and Aquaculture, at the achieving of the TAC for that target species (Article 5); on the other, the reduction of authorized fishing days from 5 to 4 per week, ordered by the Directorate-General for Fishery and Aquaculture, in relation to the fact that the non-achievement of the average minimum catch could be considered as consequence of a decrease of the exploitable population (Article 5.2).

1.3. "*Other aspects"*
The evaluation and monitoring programme put in place by the Management Plan seems to be adequate and effective, ensuring the capability to assess through the time proposed reference points.
No elements are available in the Report to estimate the level of dependency of the fleet on the target stocks (i.e. *Donax trunculus*, *Callista chione*, *Acanthocardia tuberculata* and *Chamelea gallina*), but this is not among its aims.

Proposed modifications in terms of total annual catches and limit reference points of the plan are supported by scientific data reported and would ensure a sustainable exploitation of the target stocks.

2 "*If deemed necessary, provide any recommendations and guidance on how to obtain improved scientific/technical supporting material for the plan. This could be done in terms of collection of data, evaluation of the status of the target stocks, evaluation of conservation measures, impact on the marine ecosystem and monitoring programme*"

Within the context of the 'Management Plan' and the 'Evaluation and monitoring report amendment and extension proposal', a couple of criticalities remain still open.

The first is the question about the recorded reduction of *Chamelea gallina* stock, that must be carefully monitored in the next future, and for which the recommendation to take into consideration the opportunity to move from a regional to a metapopulation assessment is expressed.

The second refers to the need to base the stock assessment on fishery independent surveys, or as secondary option on biomass density (i.e. kg/m^2) data, in order to improve quality of obtained results.

Final conclusions

The "Evaluation and monitoring report amendment and extension proposal" presented by the Government of Andalusia, within the context of the "Management Plan for dredges and mechanised dredges in the Mediterranean Fishing Area of the autonomous Community of Andalusia, Spain" well supports the implementation of the MP itself. It demonstrated, indeed, to be adequate and effective with reference to the main objectives of the Plan. The proposed amendments, comprised the extension to 2019, are feasible and supported by results.

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