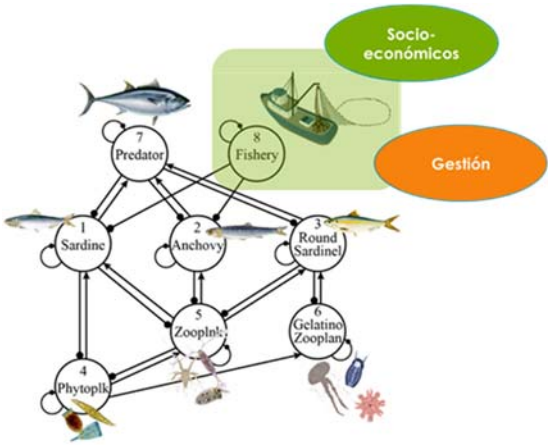
Socio-ecological analysis of the pelagic system of the northwest Mediterranean Sea, focusing on the dynamics of small pelagic fish

- Summary of the workshop –



Marta Coll, Marta Albo Puigserver, Joan Giménez, Elena Lloret Lloret & Jeff Dambacher

Institute of Marine Science (ICM-CSIC), Barcelona, Spain

February 2020

Summary of the workshop

"Socio-ecological analysis of the pelagic system of the northwest Mediterranean Sea, focusing on the dynamics of small pelagic fish"

Marta Coll, Marta Albo Puigserver, Joan Giménez, Elena Lloret Lloret, Jeff Dambacher

Workshop held on the 22nd of February 2020, Institute of Marine Science (ICM-CSIC), Passeig Marítim de la Barceloneta, nº 37-49. 08003. Barcelona. Room P74 ("Pepita Castellví" Room).

Introduction

The general objective of the workshop was to create a dialogue between stakeholders of the pelagic system of the Northwest Mediterranean Sea (fishers, managers, NGO and scientists); focusing on the dynamics of small commercial pelagic fish (targeting sardine and anchovy) and the fishing activity associated with them.

The workshop started with a scientific overview of the current knowledge derived from several research projects (e.g., EU Spelmed, Spanish Plan Estatal Pelweb). Then, factors and processes that may be affecting our understanding of the dynamics of the pelagic system were identified. Finally, stakeholders mentioned and discussed several proposals to improve the management of the fishing resources. The analysis was done from an ecological, social, economic and fisheries management perspective. All the information was integrated using qualitative network modelling techniques with the assistance of Dr. Jeffrey Dambacher, from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), (Tasmania, Australia).

Sixteen stakeholders representing the fisheries sector, scientific institutions, environmental organizations and the regional administration participated in the workshop.

Workshop agenda

10.00. Start of the workshop and attendees' presentation
10.30 - 11.00. Scientific summary of available information on small pelagic fish
11.00 -13.30. Identification of relevant factors to be considered: Ecological factors Socio-economic factors Management factors and resource management
13.30 - 14.30. Lunch

14.30 - 15.30. Identification of alternative options for the management of the fishery resource
15.30 - 16.00. General discussion and closure

Participants to the workshop

Marta Coll Montón	MC	Institute of Marine Science - CSIC
Marta Albó Puigserver	MA	Institute of Marine Science - CSIC
Valerio Sbragaglia	VS	Institute of Marine Science - CSIC
Elena Lloret Lloret	EL	Institute of Marine Science - CSIC
José Luis Arego Uriarte	JLA	Cofradía de pescadores - Castellon de la Plana
José Manuel Ramírez Martín	JMR	Cofradía de pescadores - Castellon de la Plana
Lluis Sureda Barragan	LS	Cofradía de pescadores - l'Escala
Antoni Abad Mallol	AB	Federació Nacional Catalana de Confraries de Pescadors
Josep Palaus Juan	JP	Cofradía de pescadores - Blanes
Julio Agujetas Medrano	JA	Project MEDFISH, MSC
Miquel Ortega Cerdà	MO	ENT Fundation
Jeffrey Dambacher	JD	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Alba Serrat Llinas	AS	University of Girona
Jordi Viñas de Puig	JV	University of Girona
Raquel del Rosal Gutiérrez	RR	Generalitat de Catalunya (Regional Government)
Sergi Tudela Casanovas	ST	Generalitat de Catalunya (Regional Government)

Workshop minutes and results of the day

Short introduction and welcoming of the attendees

Participants are welcomed. All attendees present themselves to the rest of stakeholders.

MC explains the objective of the workshop and the agenda to be followed. She introduces Dr. Jeffrey Dambacher, a researcher from the Commonwealth Scientific and Industrial Research Organisation (CSIRO, Tasmania, Australia), who supported by Dr. Marta Coll's research group from the Department of Marine Renewable Resources (ICM-CSIC), will be in charge of gathering all the information and knowledge we have of the pelagic system of the NW Mediterranean Sea and unify all the information to codify it into a qualitative network model.

Scientific summary of available information on small pelagic fish

MA and MC present a brief summary of the state-of-the-art of sardine and anchovy's ecology and stock status using the information collected or generated during the Spelmed (European Union) and Pelweb (Ministry of Science and Innovation) research projects.

The main highlights are:

- Sardines and anchovies have opposite breeding periods. Therefore, management measures and environmental effects will not necessarily have the same impact on the two species.

- Catches of both species have declined significantly. Sardine was defined as an overexploited species in the stock assessment of 2019 in the GSA06 and GSA07. For anchovy, despite the fact that its assessment is not yet approved, it is also considered an overexploited stock in the GSA06 area.

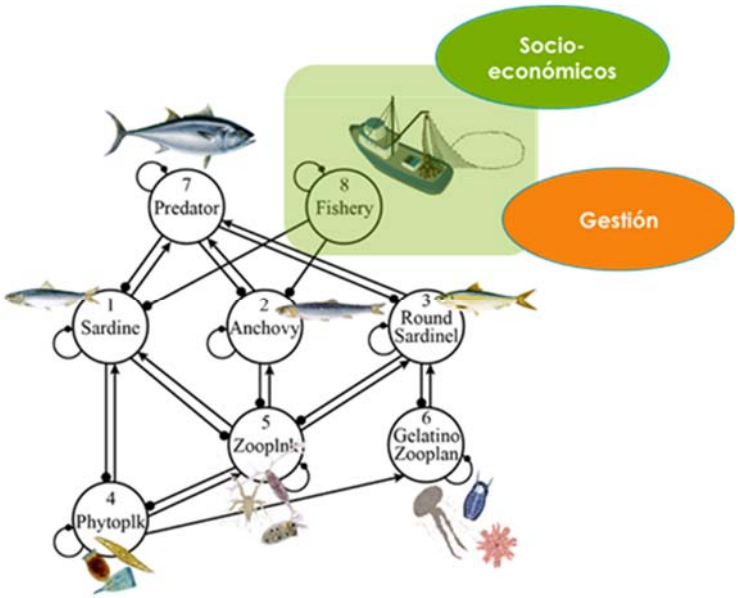
- It has been observed that both species are growing less but also that the older ages are no longer in the population. Therefore, we have some evidence of a depleted age structure as we only find small individuals.

- The size at first sexual maturity has decreased, especially in sardine. The physiological condition, although fluctuating, also shows a decrease. The changes observed are stronger in Tarragona than in Malaga, with a north to south latitudinal gradient (worse in the north than in the south).

Until now, several environmental and anthropic hypotheses have been proposed to explain this situation. In a previous study, carried out by ICM-CSIC, several of the hypotheses were tested in a qualitative ecological model (Figure 1) (Coll et al., 2019). In the model, we explored the effects of modifying the interaction of predators, fisheries, competitors (sardine and gelatinous plankton) and environmental factors (an increase of temperature) on the population of anchovy and sardine.

One of the objectives of organising this workshop was to complete the model already described above by extending the socio-economic part in order to be able to propose new management scenarios for both species.

Figure 1. Diagram (direct sign) of the qualitative ecological model already available (Coll et al., 2019). In green and orange is depicted the socio-economic and management part that was intended to be developed during the workshop. The arrows represent positive interactions and the closed circles represent negative interactions.



Identification of relevant factors to be considered: *Ecological factors, Socio-economic factors, Management factors and resource management*

The main aim of the workshop is to investigate how to "**Achieve a sustainable fishery for small pelagic fish in the central and northern western Mediterranean Sea that will sustain a healthy fishery**".

During the workshop it was decided not to include the whole community that is indirectly related to the small pelagic fish value chain. The analysis was focused on the fishing community and its direct relationships.

JD makes a brief introduction to the use of sign directed graphs to build qualitative models. This technique will be used in this session to capture all the information provided by the workshop's attendees (fishermen, scientists, managers and NGOs) and included in the form of a qualitative model.

Then, we start discussing about the different factors we want to include in the ecological model (Figure 1) to extend the socio-ecological part.

Identification of the essential components of the relationship between the pelagic ecosystem and the fishing activity relationship

We first identify all the components that comprise the sardine and anchovy fishery. The study community is also defined. It is decided that the whole North and Central system of the Northwest Mediterranean could be included as a single unit since the problems observed in one area, sooner or later, will be observed in the others. The problems are common in Castellón (JLA & JMR) and in Catalonia (JS, AB, MB, JP). However, it was noted by the fishermen and managers that, although we can generalise, separated management measures will have to be applied in each zone.

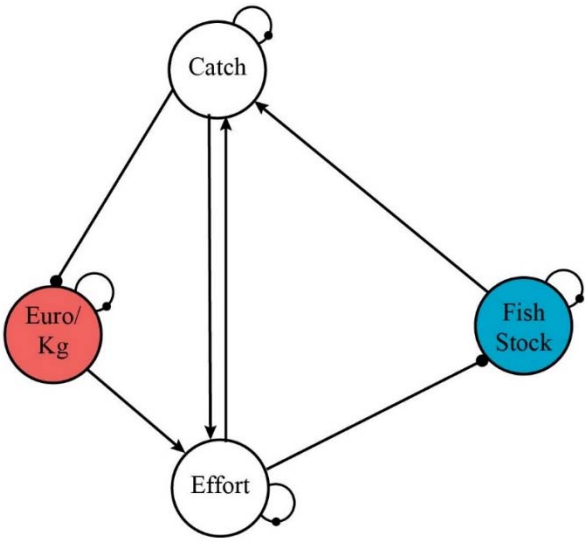
Figure 2. Pictures from the day of the workshop.

ST explains that the national fishing ground is a single unit. He also informs that Europe is carrying out a multiannual plan in the Adriatic Sea, but not yet in the Northwestern Mediterranean Sea. ST states that if it is assumed that there are problems with the national fishery, a management plan at a national scale could be proposed. There has never been a real management plan and the current situation might be a good time to start. Therefore,

different levels of management are identified and must be taken into account (European, national and regional level).

JD proposes to start by defining the relationship between the fish stock, the catch, the effort and the economic benefit (*€/Kg*) according to a previously published work (Dambacher et al., 2009). This model describes that when there are gains/benefits in a fisheries system these are reinvested in increasing effort and making fishing more efficient. This situation causes an increase in technology, thus increasing the catchability of the resource and consequently obtaining a greater catch. If there is a good catch, then it is reinvested in the effort, but the price is also influenced. This situation cannot continue indefinitely and we can reach a point where there is a change or tipping point. Therefore, more effort does not always mean more catch because if the effort increases too much, the resource will declined as a large increase in the effort will be translated into a decline of the resource (see Figure 3).

Figure 3. Diagram of the relationship between catch, effort, fish stock and commercial value. Basic socio-economic model.



Development of the market part of the base socio-economic model

With the participation of all the attendees, the economic part is discussed. As far as marketing and demand are concerned, it should be noted that the remarkable aspect of fish from the North-western Mediterranean is that it is sold fresh, which marks a commercial difference from frozen fish that may come from other markets (both national and international).

Several participants mention that in the past the market worked as follows: one part was sold as bait with a fixed price, and another part was sold to the local markets. This situation has changed. Nowadays, there are also direct contracts between ports and supermarkets (such as the contract between the big retailer “Mercadona” and the port of Tarragona). These large supermarkets set a fix price, which in the long term can be harmful as the price is not reflecting the quality of the product (e.g. whether the fish is

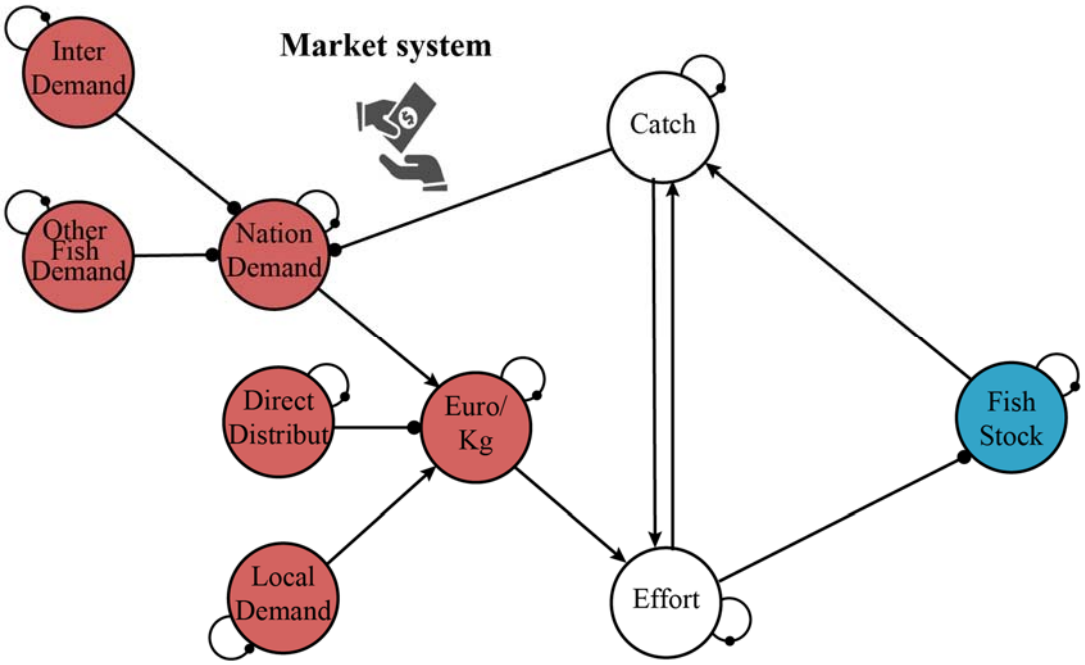
small or large). This can favour the catch of small individuals. Large supermarkets have broken the value chain since they sell directly from the boat to the supermarket and can control the demand. This translates into a negative effect of the direct distributor on the demand-supply relationship.

During the discussion it is also mentioned how the catch of other fish species can affect the price of small pelagic fish, since these small fresh pelagic fish are used as a lure, but other species are actually sold. This relationship is translated into the model as a negative effect of other fisheries on the demand for small pelagic fish (Figure 4).

The global market also affects the economic part, but in a more complicated way. For example, all the anchovy in Portugal is sold in Spain as Portuguese people have a selective preference for sardines.

If we add all these considerations into the base model (Figure 3), we obtain a modified model that includes three differentiated markets; the local, the national and the international market. We also add the direct distributors, such as the large supermarkets and other fisheries that bring product on the market and can negatively affect the demand for small pelagic fish. The model is modified to take into account these market system factors (Figure 4).

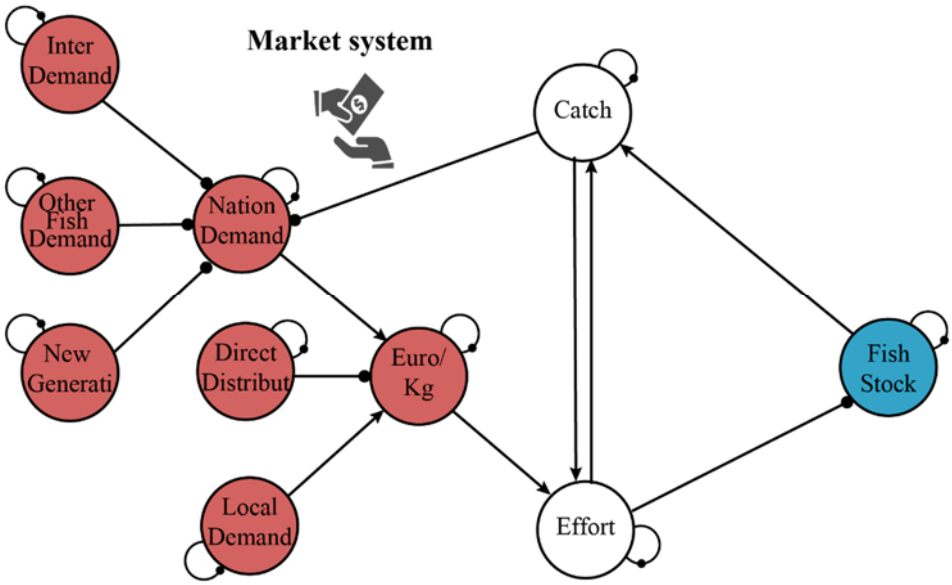
Figure 4. Socio-economic model of the Northwest Mediterranean small pelagic fish fishery system extended with elements of the market system.



Consumer preference and intergenerational differences in relation to the consumption of small pelagic fish are also mentioned during the discussion. It is described that other species such as mackerel and horse mackerel were previously caught. Nowadays, mackerel is no longer available and horse mackerel has no value assigned in the market. If horse mackerel had an economic value, it would be fished, too. This situation has

caused that in the last decade only sardine and anchovy are fished, losing the opportunity to diversify the exploited resource. It also shows that the feeding habits of younger generations have changed and they do not want to eat small fish like sardine and anchovy, so the demand has decreased. In summary, there is no demand for fresh fish. To capture this information, the model includes a negative effect of the young generations on the demand (Figure 5).

Figure 5. Socio-economic model of the Northwest Mediterranean small pelagic fishing system extended with elements of the market system and the demand of the young generations.



Development of the management part of the model

We continued the discussion by focusing on **fisheries management**. JLA comments that the changes in management have had negative effects on the entire ecosystem and there has been a lack of biological protection for both species (sardine and anchovy). Juvenile areas where fishing was previously not allowed have disappeared due to the present fishing effort in those areas (for example, in Castellón shelf and the southern part of the Ebro Delta). Comments on the effect of the fleet mobility are introduced. In the Gulf of Sant Jordi, 80% of the fleet concentrated in the past, as in the Gulf of Lion producing the depletion of the resource. Advances in telecommunications, such as the widespread use of smartphones, have greatly increased the fishing effort as information is now transmitted very quickly.

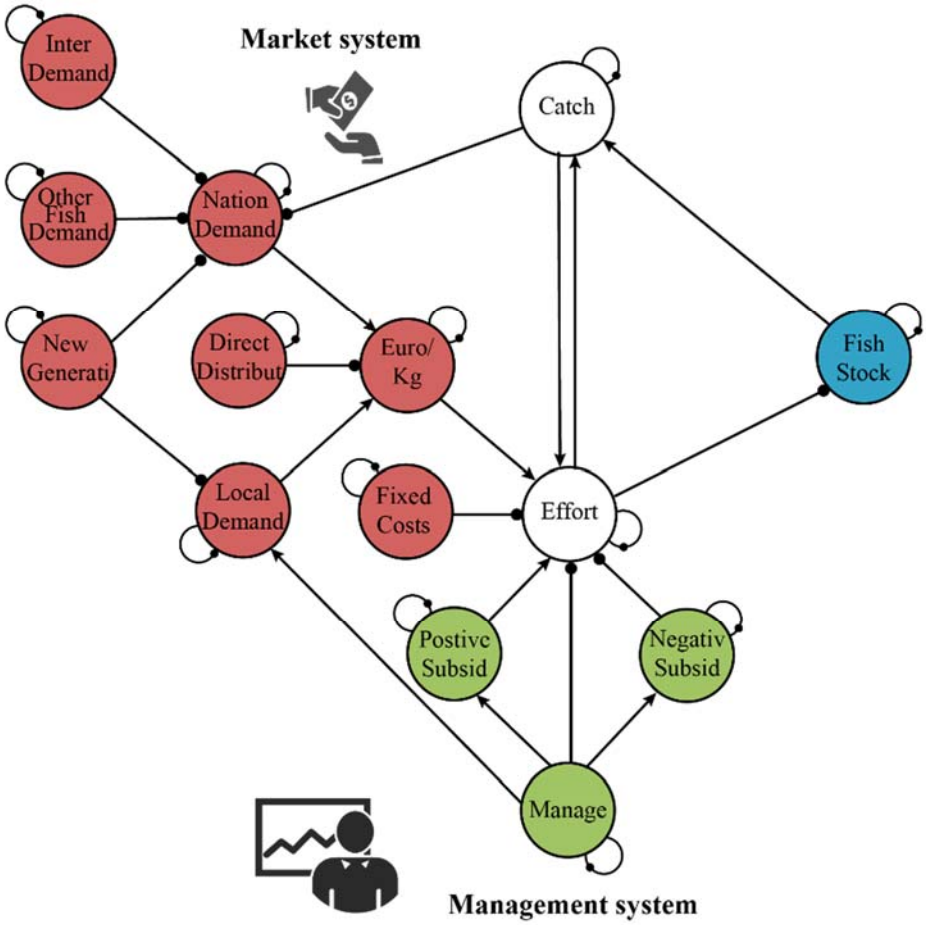
ST points out that the EU wants to eliminate **subsidies for seasonal closures**. **Subsidies for breaking up of fishing boats** had a very important effect in Tarragona, where the fleet was greatly reduced. These subsidies may be reintroduced. Therefore, it is decided that the model will test the effect of those measures.

After some discussion, the term management is added with a negative relation/link to the effort, since management is trying to rationalize and reduce the fishing effort. On the other hand, another way to manage fisheries is through subsidies, which can have a

positive or negative effect towards the effort depending on the specific measures. Closure subsidies tend to reduce effort, therefore, they have a negative effect towards effort. On the other hand, subsidies favouring technological improvement help to increase effort, and are represented with a positive relationship in the new model (Figure 6). It should be noted that closures subsidies normally alternate in different ports and this has an impact on ports that have not stopped fishing. With these closures, as the supply is reduced in certain ports, the local demand increases.

Traceability, the value of fish according to its size or origin, is another aspect discussed. Fishermen comment that the traceability of small pelagic fish does not seem to be of interest. Large retailers do not want this information to be public. One measure to increase the value of fish would be to reinforce this traceability, as local demand does value (or may value) fresh and local fish. This leads us to include a positive link from management to local demand. Nowadays, what has been done in this regard has not worked, so this link is included as a future scenario (Figure 6) that will be taken into account in the section about possible management measures.

Figure 6. Socio-economic model of the fishing system for small pelagic fish in the Northwest Mediterranean extended with elements of the market system, the demand of the young generations and the fisheries management system.

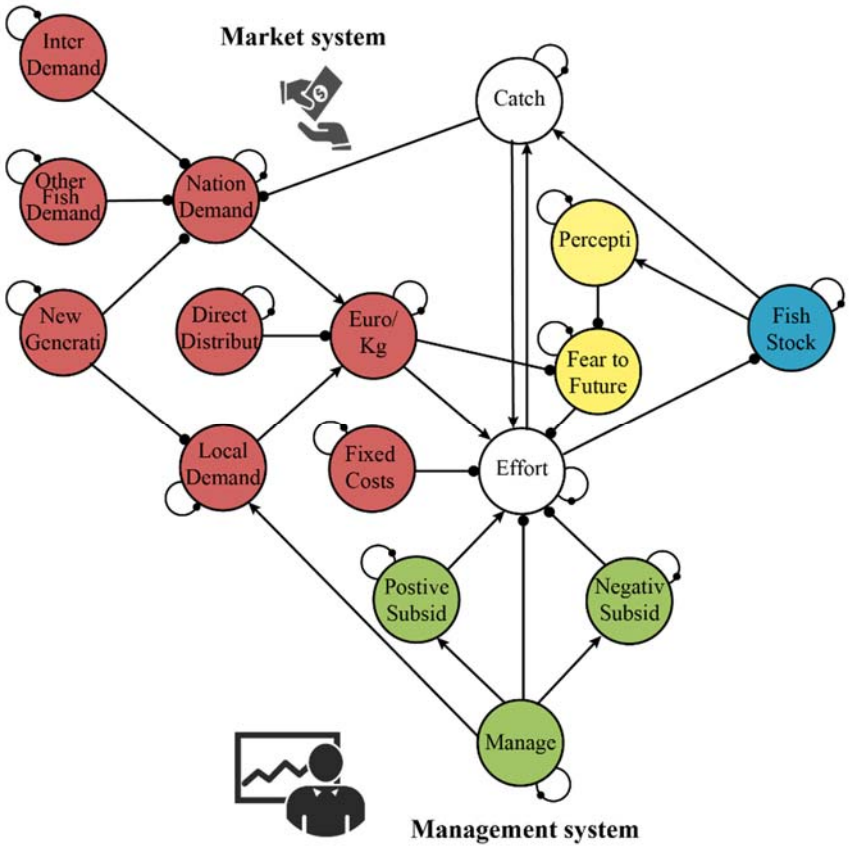


Dynamics associated with the perception of the future and emotions

The discussion continues to focus on aspects related to the perception of the state of the resource, the future of the fishery and their emotions. Fishermen emphasize that qualified workers are lacking. This is due to the fact that profits are low and therefore there are not enough people to transitioning the business to the next generations.

A recurrent factor in the discussion is the fear of the future. The fear that the business will not be viable due to the collapse of the stock. This fear is related to the perceived abundance of the resource. When fishermen perceive that there are more fish in the water the fear of a collapse and an uncertain future is low. The fear may increase when the size of the target fish is observed to be small. Normally, big fish have a higher price, but we decided not to divide the catches into big and small to avoid over complication of the model. These factors are incorporated within the price: if the price is high, the fear goes down, and if the price is low, the fear goes up. In summary, we added two new variables; the perception that is affected by what we observe at sea, and that in turn is affecting the fear, which is also affected by the market price. Finally, the fear of the future will have consequences on the effort (Figure 7).

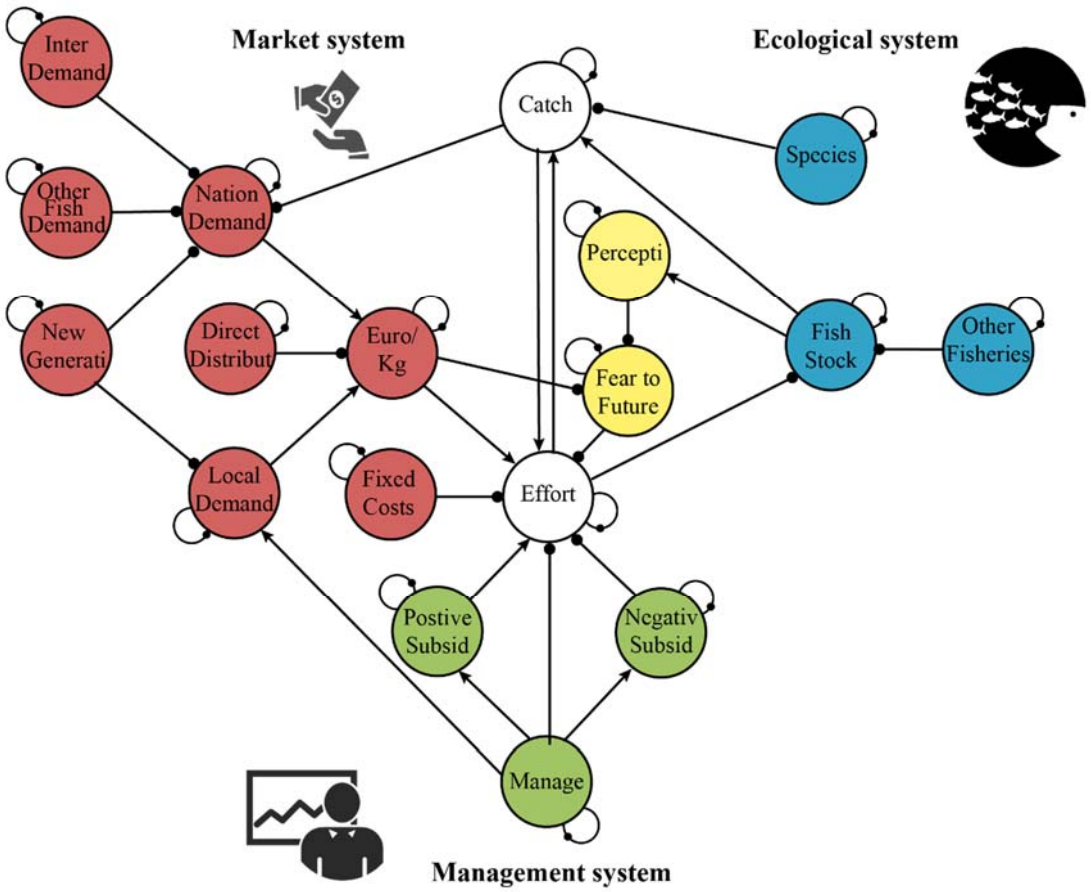
Figure 7. Socio-economic model of the fishing system for small pelagic fish in the Northwest Mediterranean extended with elements of the market system, the demand of the young generations, the fisheries management system and factors of perception of the future and emotions



Development of the ecological system part of the base model

Management in the last 25 years has been very variable. There has been a lack of protection of areas that were previously protected, even related to bottom trawling. The negative effect of the demand for small fish in Portugal, which had a negative impact on the resource, is also mentioned by the stakeholders. In the Castellon area there was a lot of pressure on small pelagic fish from both purse seiners and bottom trawlers. It is mentioned that both sardine and anchovy are in deeper waters during the day and consequently are affected by the bottom trawling fleet as well. Furthermore, bottom trawling activity also modifies the essential habitat for this species. JLA mentions that in the Castellon area a fishing depth limit for purse seiners of 45 m was included, nevertheless simultaneously the trawling fleet was allowed to fish closer to the coast. As a conclusion, it is agreed to include other types of fishing fleets that negatively affect the fishing stock of small pelagic fish (Figure 8). Other pelagic species are also added as an alternative to sardine and anchovy, taking into account that they are currently under-priced.

Figure 8. Socio-economic model of the Northwest Mediterranean small pelagic fish fishing system extended with elements of the market system, the demand of the young generations, the fisheries management system, factors of perception of the future and emotions and additional elements to the base ecological model (Figure 1).

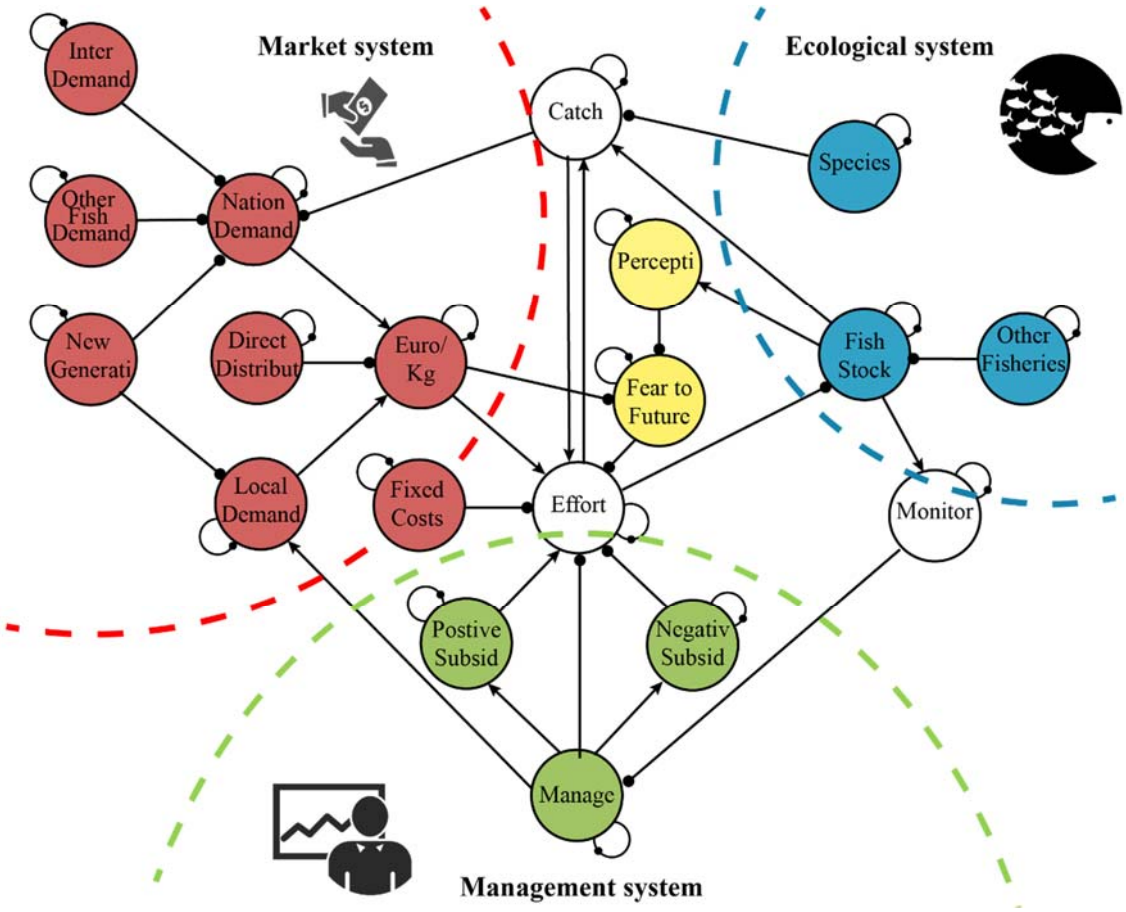


We discuss how to analyse future changes on sizes and age structure for sardine and anchovy. In the model we can only test the disappearance of individuals of older ages, but not the decrease in size for the same age.

Finally, we have to include the monitoring that is currently carried out, which at least in theory, would have to inform management according to how the fish stock is progressing, using fisheries independent data (Figure 9).

It is concluded that the current model that we have described together, and JD has drawn, is capturing the main dynamics of the socio-economic part affecting the stock of small pelagic fish (anchovy and sardine) in the northwestern Mediterranean (photographs of the original model drawn on the blackboard are shown in the annex of this document).

Figure 9. Socio-economic model of the Northwest Mediterranean small pelagic fish fishing system extended with elements of the market system, the demand of the young generations, the fisheries management system, factors of perception of the future and emotions, additional elements to the basic ecological model (Figure 1) and independent monitoring.



Identification of alternatives for the management of the fishery resource

The last part of the day is devoted to discussing possible fisheries management options for small pelagic fish in the northwestern Mediterranean Sea that are sustainable and support a healthy fishery.

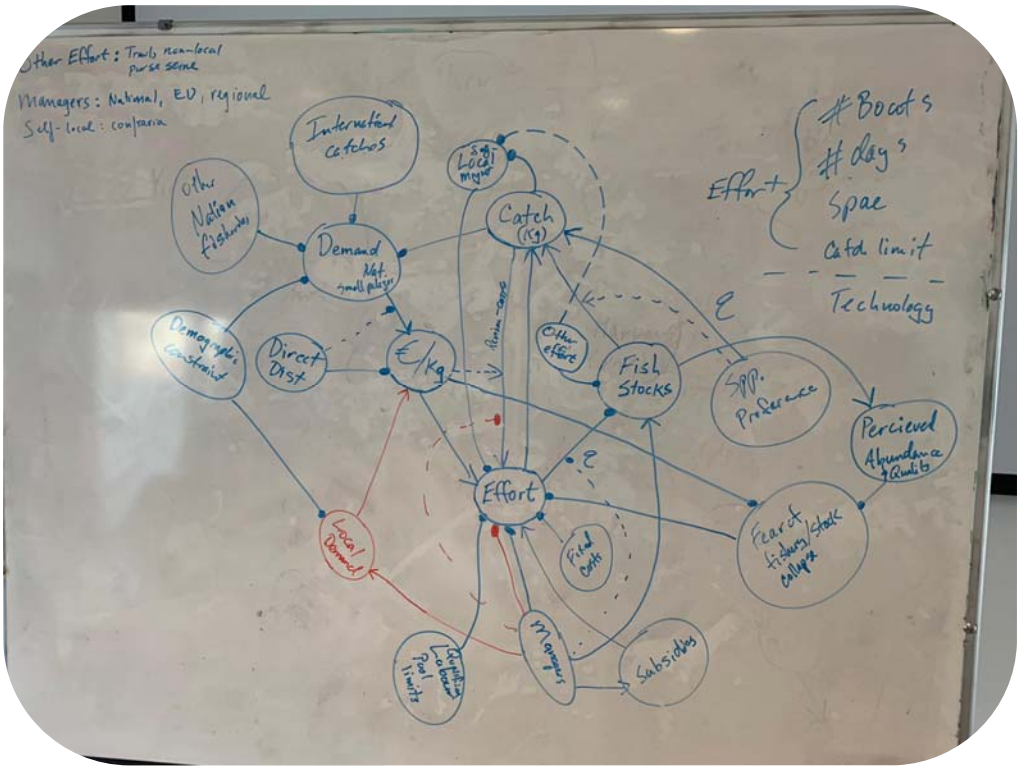
The management measures that are discussed and proposed to be tested in future model simulations are the followings:

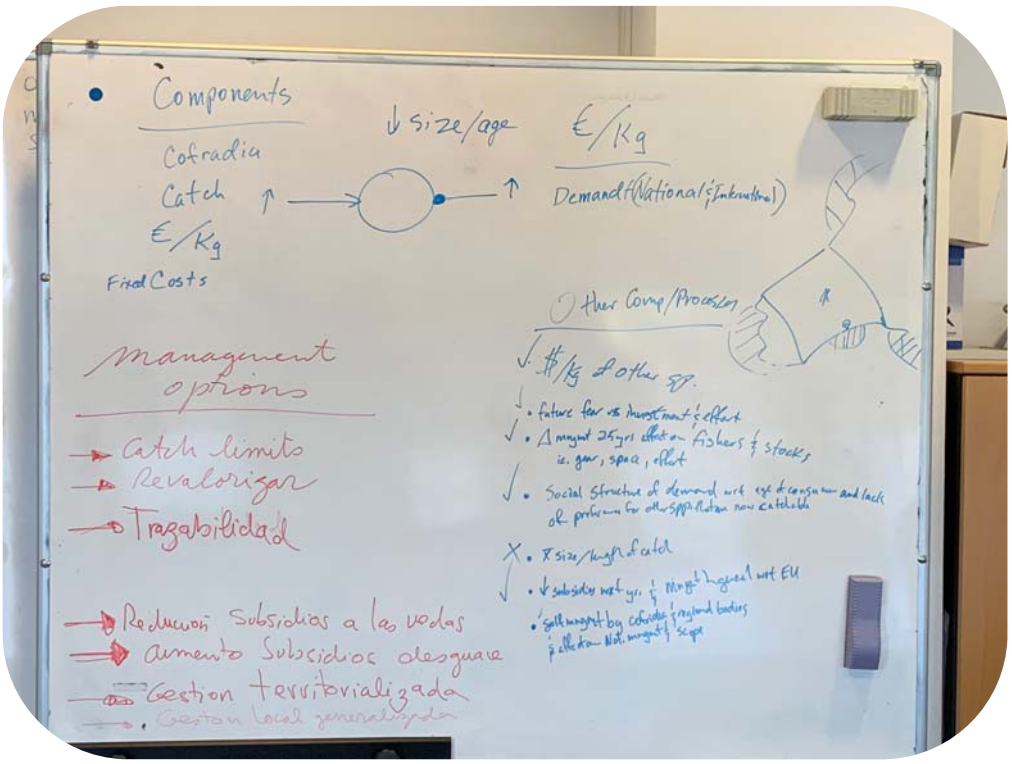
- Establishing annual catch limits
- Encouraging the revaluation of the local product
- Increasing the traceability of local products as a way of increasing their value
- Testing the impact of reducing closure subsidies
- Addressing the impact of increasing breaking up subsidies
- Addressing the impact of increasing subsidies for technological improvements
- Testing the impact of a regional management of the system (Plan Castellon)
- Testing the impact of a widespread local management

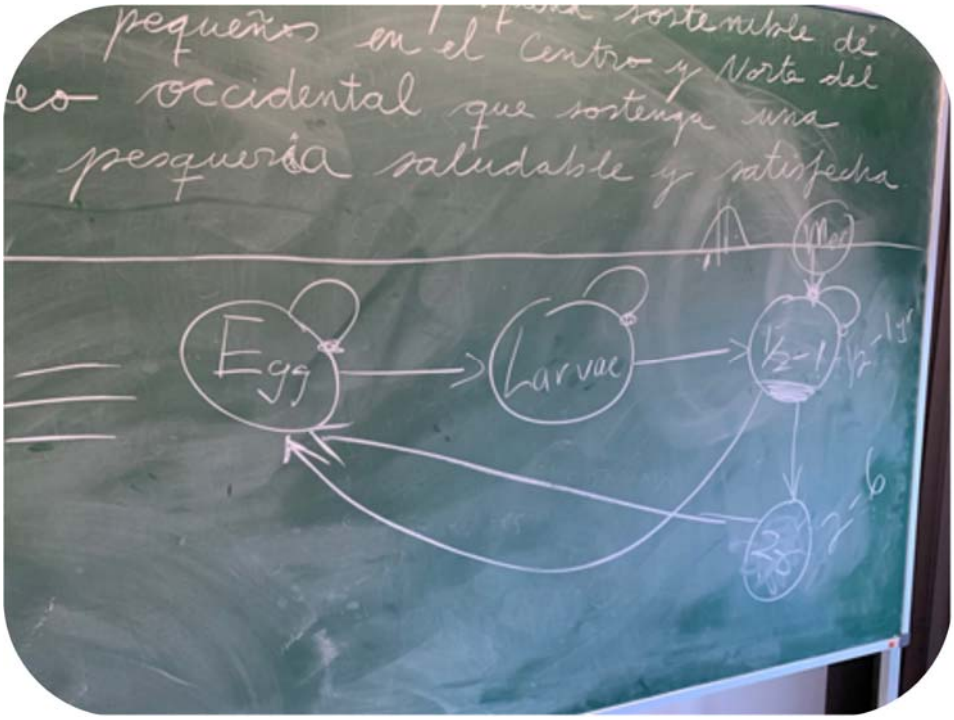
JD and MC inform all the participants that the next step is to code the model on the computer and analyse its stability properties. The model developed in this workshop (Figure 9) will be coupled with the ecological model presented at the beginning (Figure 1). The coupled model will then be used to test fishery management alternatives for small pelagic fish, taking into account scenarios of environmental change.

The results of testing these measures will be distributed to all participants of the workshop.

Annex I. Photos of model drawn by hand during the workshop,







Acknowledgments

We would like to thank all the participants for attending this workshop and Alba Serrat for sharing her notes with us. This workshop is a contribution to the project PELWEB (CTM2017-88939-R) and PELCAT (CAT 152CAT00013, TAIS ARP059/19/00005).

Literature cited

Coll, M., Albo-Puigserver, M., Navarro, J., Palomera , I., Dambacher, J., 2019. Who is to blame? Plausible pressures on small pelagic fish population changes in the NW Mediterranean Sea. Marine Ecology Progress Series 617-618, 277-294.

Dambacher, J.M., Gaughan, D.J., Rochet, M.J., Rossignol, P.A., Trenkel, V.M., 2009. Qualitative modelling and indicators of exploited ecosystems. Fish and Fisheries 10, 305-322.