

## **Balearic Islands boat seine fisheries: the transparent goby fishery an example of co-management**

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An economically important, small-scale fishery operates during the winter months in Mallorca. Using a special surrounding net that is hauled over the sand and gravel bottoms of bays at depths reaching 30 m, it primarily targets *Aphia minuta* and *Pseudaphya ferreri*, but other goby species and juveniles of the *Pagellus* spp are also caught. Similar fisheries are operated on the Spanish coast and in Italy. This fishery is run with specific licenses, equipment controls, and closed seasons (based on species availability). In cooperation with local fishermen, the administration has in recent years established a daily quota for sustaining the sales prices of the species caught. A management plan was set up in 2013 in accordance with European Union rules to ensure the sustainability of the fishery. Its sustainable quotas have been set at 30 kg/day/boat for *A. minuta* and 50 kg/day/boat for *P. ferreri*, and the by-catch cannot exceed 10% of the total catch. Landings are permitted in 11 fixed ports and only 35 boats can fish with the regulated nets from December 15<sup>th</sup> to April 30<sup>th</sup>. A co-management committee was created with the participation of the public administration, fishermen's associations, researchers, and certain non-governmental organizations (NGOs). The co-management process was revised and fishermen's opinions were obtained in a successful enquiry that was answered by the majority of the operating fleet, and their views on the management rules will be considered in future regulations. The co-management of the small-scale boat seine fishery in the Balearic Islands is thus an ongoing collaborative and communicative process in a local community that continues to evolve over time. Although the fishermen are represented by their port guilds, communication efforts are necessary in the near future to ensure the success of the co-management process.

**Keywords:** W Mediterranean, *Aphia minuta*, fisher's guilds, fishermen' interviews, MINOUW project

### **Introduction**

The transparent goby (*Aphia minuta*, Risso 1810) is a pelagic neritic goby common in the European Atlantic (ranging from Gibraltar to the Norwegian coast in the Baltic Sea) and in the Mediterranean, including the Black and Azov seas (Tortonese, 1975). However, this species is not found along the North African coasts (La Mesa *et al.*, 2005). It is a small pelagic species (< 60 mm in the Mediterranean Sea) with a lifespan of approximately one year (Buen, 1931). This progenetic species gathers in bays to spawn from December to April in shoals close to the bottom (5 to 40 m depth), while a second spawning season occurs in

autumn (September- October) in deeper areas (40- 90 m depth) outside of bays (Iglesias and Morales-Nin, 2001). The breeders quickly die after spawning (La Mesa *et al.*, 2005).

Despite its small size, the transparent goby is the target species of a small-scale fishery that specifically operates in the western and central Mediterranean. The commercial exploitation of the transparent goby occurs during one fishing season each year, generally from December to March, concurrent with the transparent goby coastal migration and shoaling in winter. This traditional seasonal fishery uses a special purse-seine net over sand and gravel bottoms inside bays (Iglesias *et al.*, 1994). Similar fisheries are operated in Spain, just off Murcia (Martínez-Baño *et al.*, 1993), in the Ligurian Sea (Relini *et al.*, 1996), in the north Tyrrhenian Sea (Serena *et al.*, 1990; Baino *et al.*, 1996) and in the Adriatic Sea (Frogliia and Gramitto, 1989; Ungaro *et al.*, 1994).

The exploited *A. minuta* population in Mallorca Island consists of fish from 2 to 8 months old (Iglesias *et al.*, 1997). Another two gobies, which share the pelagic life style of *A. minuta* and its morphological and evolutive traits (Kon and Yoshino, 2002), are by-catches of the fishery; these gobies include *Pseudaphya ferreri* (De Buen and Fage, 1908) and *Cristallogobius linearis* (von Düben, 1845). Transparent gobies are popular in the Mediterranean region and can command high market prices (from 20 to 40 € per kg depending on the *A. minuta* and the by-catch proportion in the landing). The transparent goby fishery is considered by the Commission of the European Communities (EU) as a “special fishery” (Anonymous, 2004) involving artisanal fishing fleets from Spain and Italy. “Special fisheries” are managed locally and in derogation of general European rules. These fisheries are permitted in restricted areas in which the resource is particularly abundant and traditionally exploited (La Mesa *et al.*, 2005). Moreover, a special management plan has been in place since 2006 (CE1967/2006) in which the fishery stakeholders participate. These types of plans have been implemented in Mallorca Island for *A. minuta* and in Ibiza Island for *Spicara smaris* (Linnaeus, 1758).

This paper describes the co-management of this small-scale fishery and evaluates the vision of the participating fishermen because the fishermen themselves changed the incentives regarding maximizing catches by maximizing profit. Co-management is defined as the collaborative and participatory process of regulatory decision-making among representatives of user-groups, government agencies, and research institutions (Jentoft *et al.*, 1998). Although EU regulations have established the co-management of the fishery, it is relevant to know the fishermen’s perceptions because the legitimacy of regulations and enforcement must include user groups in the decision-making process. This belief has spurred a growing interest in co-management, which involves cooperation among participants in the fishery and government regulatory agencies.

## **The fishery**

The fishing vessels engaged in the fishery range from 5 to 12 m and between 20 and 155 HP; their number varies depending on the year (Table 1). The seine-net fishery is responsible for 6% of the island’s fishing activity (Alarcon-Urbistondo, 2001). The schools of *A. minuta* are found inside of bays; their aggregations are detected using echo sounder devices and are easily identified because their schools do not disaggregate. The haul with the boat-seine net is performed around the school. A selectivity study on the purse seine yielded a by-catch percentage of only 1% of the number of individuals caught (Brunet-Quetglas, 2004).

The regulation allows only boats based in 11 specific ports to be registered for the fishery and excludes all others, which results in 35 to 48 boats fishing for *A. minuta* in Mallorca Island or *S. smarís* in Ibiza Island. The activities of these boats are limited to waters shallower than 30 m to protect maerl bottoms. The daily sales registers by boat in the central Fish Wharf provided the data necessary for following the evolution of the landings from 2002 to 2015 (Fig. 1), and these data show quite stable seasonal landings. Despite the limited effort of the *A. minuta* fishery (“jonquillera”) (an effort of 7890 days, 4.5% total effort) and low landings in kg (190,495 kg, 3.8% total landings), the gains (3,293,985 €, 7.1% total income first sale) were still relatively high because of the previously discussed high prices for the species.

Interannual catch variability (Figure 1) depends on annual recruitment abundance because the population consists of a single year class. Applying Leslie models (Leslie and Davies, 1939; Bairo *et al.*, 2001) to catch and fishing-effort data for the two main target species together, the biomasses of the stocks at the beginning of the fishing seasons of 1982/83 and 1985/86 were estimated to be approximately 119 and 90 tons, respectively; these values might represent the biomass of the whole recruitment. However, in recent years, the estimated stock is lower (Table 1). There are many unknown aspects to the population dynamics of the species, including stock-recruitment relationships. Additionally, the landings include two species in varying proportions and the amount of the catch is determined by the previous day’s price, resulting in uncertain estimates. Moreover, there is also a weak relationship with climatic variables in this regard (Aguilar, DGPMM, ump.dat.).

Since the 1986/87 fishing season, the Directorate General for Fisheries of the Balearic Islands (DGPMM), in conjunction with the fishermen guilds, has fixed a maximum daily catch per vessel (or quota) to maintain prices and in accordance with the changing paradigm of maximizing catches for maximizing profit (Morales-Nin *et al.*, 2010). The landings are auctioned in the Palma Fishing Wharf following an automatized decreasing bidding system typical of the Spanish Mediterranean (Kaplan, 2000).

### *The EU regulation*

According to EC Regulation 1967/2006, boat seine and shore seine fisheries are severely restricted (articles 4.1 and 9.1), although they are allowed (articles 4, 9, 18 and 19) if a multi-annual management plan for the fisheries is developed and approved by the state member and the EU. Therefore, the “Plan de Gestión para la Pesca con Artes de Tiro Tradicionales en Aguas de Baleares” (decree 17/2009 and decree 44/2013) has been developed and is enforced in the Balearic Islands for the two fisheries targeting *A. minuta* and *Spicara smarís*. The objectives of this management plan are as follows:

(i) to provide long-term high yields consistent with the historic maximum registered yields and to guarantee a low risk of *Aphia minuta* and *Spicara smarís* stock collapse; (ii) to maintain the effort level and to avoid exploiting other species targeted by other fishing gears; and (iii) to maintain a seasonal summer closure of the goby fishery to protect the May-December spawning season.

Within this context, the fishery is regulated by annual permits issued by the DGPMM to small-scale boats that have operated at least 5 years in this fishery and with certain restrictions on their size and engine power. Their landings must be located on one of the 11 permitted ports, their fishing must be conducted in waters of less than 30 m depth, and their target species can include the following: “jonquillera” seine *A. minuta*, *Pseudaphya ferreri*,

*Gymnamodytes cicerellus*, and *Crystallogobius linearis* as well as “artet” seine *Spicara smaris*. The closed season extends from May 1 to December 14. The catch limits, closed season, and boat permits are reviewed periodically.

The threshold to manage the fishing effort (fishing days) is based on daily catch limits by month that are established at the beginning of the fishing season, which are equivalent to the first quartile of the catch by boat and day for the month calculated from the historic data series beginning in 2002. If the monthly threshold is not reached, the fishing effort is reduced (closing days). Because the production is calculated on a daily basis (kg/boat-day), the effort reduction does not affect the calculations for future periods.

The DGPMM has established a Survey Commission (SC) that consists of the following stakeholders: sector partners, including representatives from the Formentera and Ibiza Islands (where the *S. smaris* fishery is the traditional fishery), the responsible parties for the Balearic Fishers Guild, Alcudia harbor, and the Fishing Wharf; technical and scientific partners, including DGPMM and IMEDEA (CSIC/UIB); and social partners, including ONG (WWF). The Fishing Wharf is a fishermen’s association in charge of the commercialization of captured stock. The SC began working in January 2014 and has successfully avoided conflicts and maintained landings and prices. Its management rules are summarized in Fig. 2.

## Results

### *Hands-on: 2013/14, 2014/15, 2015/16 A. minuta fishing seasons*

Boats licensed to use seines for transparent goby fishing are required to keep log-books that record daily catches and to deliver these logs to the institutional authorities. The logs contain the dates, the daily catches of transparent goby, and the fishing areas utilized. In the monthly SC meeting, the values of the landings (both as reported and from the sales at the Fishing Wharf) are checked against the minimum threshold for the daily capture by boat, which is fixed annually prior to the beginning of the fishery season. If the average yield per boat and day remain above this threshold (see Table 1), there are no changes in the permissible activity. However, if the threshold is not reached, some reduction in effort must be adopted, such as reducing the fishing days to four days per week or, if the monthly yield is again under the threshold, the fishery must be closed. During the 2014/15 fishing season, low landings in February led to a reduction in the number of fishing days per week (from Monday to Friday, one day of no fishing was chosen by the fishermen). Despite this measure, the mean capture in March did not reach the threshold and the fishery was closed, except for 3 boats (7% of authorized boats) that continued monitoring the resource. The data from these boats allowed for the monitoring of the stability of the landings during April.

The two sources of information on landings (daily sales registers from the Fishing Wharf) and catches (mandatory daily registers from the fishermen) showed some disagreement. Not all fishermen reported to the DGPMM, resulting in lower catches and effort in days (i.e., 13 tons from the fishermen reports against 17 tons from sales registers for 2013/14). This tendency has not changed during the most recent 3 years, and the possibility of not renewing the fishing permits to the boats/skippers who consistently did not report their data was contemplated by the SC.

### *Stakeholder’s perceptions*

To evaluate the stakeholder’s perception, a framework survey was organized at the end of the 2015/16 fishing season for the *A. minuta* fishery. A structured review was designed with

11 primary open-ended questions, organized in blocks, to determine the fishermen's knowledge concerning i) fishing regulations (their own perception of their knowledge and specific questions to test their knowledge); ii) fishing operations; iii) capture handling; iv) their perception regarding economic revenues; and v) their satisfaction with the SC. An additional 6 questions addressed their preferences regarding management options (ranked from 1 to 10). The enquiry was sent by the DGPM to SC members and the fishermen guilds, and some in-person interviews were also performed. A total of 22 respondents answered the questionnaire, representing 62.85% of the fleet for the year considered. The answers are summarized in Tables 2 and 3.

All the respondents confirmed that they were well informed, with the exception of one respondent who did not answer the question concerning his knowledge of the regulations. All correctly answered the question regarding the daily quota, but they did not know the permitted landing ports, probably because they always land in their port of origin. The target species were well known, and the less precise answers probably were due to a lack of interest in answering correctly (Table 2a).

The excess quota catch was reported to be returned to the sea (90.91%) or if the fish were dead, the catch was shared between boats already fishing that had not met their quota (18.18%) (Table 2b). Regarding the fishing operations to identify the *A. minuta* schools with regard to avoiding the capture of non-target species, the use of the school image in the sonar screen was the most frequently used procedure (54.55%), albeit other operations such as hauling slowly to allow non target species to escape (13.64%) were also employed (Table 2b). Although a wide variety of finfish by-catch was reported, the most common by-catch consisted of cuttlefish and squid (Table 2b). Handling the capture was mostly performed by collecting the target species with a hand net with the seine still in the water (68.18%), followed by putting the catch in a water container to sort the species (50%).

Most respondents were satisfied with the management measures (63.64%) and felt well-represented in the SC (45.45%). However, representation in the SC was the most unanswered question (18.18%) and had numerous negative answers (27.27%). Most respondents had not experienced better economic revenue since implementation of the management plan (Table 2b). Regarding the preferences for management measures, there was disparity in the answers (Table 3). Several fishermen suggested a reduction in the daily quota to 20 kg, in addition to beginning the fishing season in January to avoid catching small fishes. There was consensus on the need for an extended daily timetable because the fishing operations were slow and required more time. This measure was supported by the existence of a daily quota. The number of fishing licenses was also considered to eliminate those boats that do not report or that do not catch the allowed quota.

## **Discussion**

The legitimacy of the regulations and enforcement might be improved by transferring more responsibility to the user-groups by including them in the decision making process. Such inclusion would result in co-management, which involves agreements between participants in the fishery and government regulatory agencies. The fundamental issues are the institutional arrangements that are required for the sustainable utilization and management of common pool resources that are removable and suffer the effects of environmental variability and uncertainty. A common tool used to regulate fisheries is limiting access by issuing licenses and permits (i.e., rights to fish). However, the social aspects of fisheries and

fishermen behavior should be considered in designing management systems. The essence of co-management is that the government and user-groups share responsibility for managing the resource. The main actors represented include the following: society (ONG), scientists (Research Institute), fishermen (Fishermen Guilds), commercialization (Fishing Wharf) and managers (DGPM). The approach chosen is adaptive management in which changes in the regulations depend on fishing results. However, the exploitation of a resource based on a short-lived species (<1 year) and reproduce at 4-5 months of age (Iglesias and Morales-Nin, 2001) depends on recruitment success, which is subject to annual variability (Figure 1). The Leslie model (Leslie and Davis, 1939) provides rough estimates of abundance and is calculated at the end of the fishing season, thereby not taking part in the management measures. The exploitation levels appear to be high but the time-series data do not show definitive conclusions.

The complete set of management measures is the result of efforts taken to limit the number of fishing licenses and the fishing hours and days, to limit spatial access (fishing at less than 30 m depth), and to limit landings (fixed quotas). The SC meets monthly to determine the effort (fishing days) of the next month based on the maintenance of the landings according to a fixed quota calculated from the historical data series. In one case, the SC reduced effort and closed the fishery one month early for one season. The system used to manage the *A. minuta* fishery uses daily fishing activity to monitor the state of the resource. Two sources of information are available: the self-reporting of the fishermen and the sales registries. Moreover, the DGPM regularly monitors the fishery to obtain data on fishing practices, landings, discards, and target species biology. During the implementation plan, a consistent trend of lack of reporting has emerged, resulting in varying catch estimates.

The mean first sale price/kg showed a higher value at the beginning of the fishing season because the transparent goby species is a staple of Mallorca's cuisine. After this initial interest, the price decreased slightly and fluctuated inversely with the landings. The high mean price was maintained following the strategy of maximizing profit instead of landings, which began in the 1980s with the fishermen initiative. However, the fishermen concluded that the new management had not improved their revenues, which depend on the commercialization process. A common suggestion was to reduce the daily quota to raise the first sale price.

The fishermen were mostly satisfied with the management regulations. However, when asked for their preferred management measures, there was a disparity of criteria (Table 3). The most controversial were licenses and the beginning of the fishing season. A main issue involved representation on the SC. This question had the highest no response rate and, considering the negative and mid-term answers, the fishermen showed that they were mildly satisfied. Only 11 ports are allowed to participate in the fishery, and these 11 ports correspond to eight Guilds, which are directly represented by the head of the association of Guilds and the head of one main harbor Guild (25% of the SC constituents) and indirectly represented by the head of the Fishing Warf. Increasing their presence on the SC through the port guilds (a very old self-organization structure) might unbalance the SC. As McCay (1995) stated, the specific management models in each country reflect the broader institutional patterns and practices that prevail because fishery management institutions do not originate in an institutional vacuum and must generally comply with their external political environment. In our case, the EU policies determine the current management approach, albeit better communication between the fishermen and their representatives is necessary. A good example of co-management in a Mediterranean fishery

is the Catalanian sand eel fishery that established a co-management committee in 2012 (LLeonart *et al.*, 2014). This successful management framework has been used as a current case study. A similar type of management has been implemented for the *A. minuta* fishery regulation in the southeast of Spain (Murcia), although there is no SC in place. In the management plan that is currently in negotiations with the EU, an SC will be included (Peñalver Regional Ministry of Water Agriculture and Environment, Murcia, pers.comm.).

The success of the enquiry among the fishermen (62.86% of the registered fleet answered) itself showed that there was a positive attitude toward the management. However, the co-management implemented since the 2013/14 fishing season would require a more active dissemination and divulging among the fishermen because a sizeable portion of these fishermen did not feel well-represented (Table 1) or were not even aware that a co-management commission had been set up (one answer). Some management measures could be refined in the future based on the answers to our questionnaire, which for the first time gathered the fishermen's opinions. In summary, the balanced relationship between the fishermen's initiative and the administrative regulatory capacity is necessary to maintain the community voice of the fishermen for the collective purpose of keeping the fishery sustainable.

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## **Figure Legends**

**Figure 1.** Evolution of the annual catch of the target species for the transparent goby fishery.

**Figure 2.** Summary of the regulation measures developed to follow the EU regulations.