Final Project Evaluation Report

Your Details	
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Project Title	Strongholds for Groupers in Iskenderun Bay, Grouper Fishery, Conservation and Management Practices
Application ID	23780-2
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1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
The target or bycatch grouper species of different fishing methods				We detected which type of fishing gear or method catch grouper species as target or bycatch by way of interviews with fishers and local people. We validated this data with field observations.
The amounts of grouper catch of different fisheries				We collected the best days catch data based on the fishers' statement. Catch data should regularly be monitored in fishery ports so that more reliable analyses can be performed.
The size distribution of grouper catches of different fisheries				We detected which type of fishing gear catches which sizes of groupers separately for each species by way of interviews with fishers and local people. We validated this data with field and market observations.
Grouper fishery season of each gear				We obtained species and gear-specific data showing fishing seasons of each grouper species. We collected this data by way of interviews with fishers and local people. Future research is needed to validate this data.
Grouper fishery area of each gear				We could collect this information based on the statements of fishers roughly.
The impact of new fishing regulations on fishing behaviours				We met with fishers and talked about the changes of their fishery routines because of the new regulations.
Fishers' opinion about the most effective conservation option for groupers				We met with fishers and talked about their opinions on how groupers should be protected.
Spawning areas of groupers				We could not obtain satisfying results from the genetic analysis of grouper

				larvae. However, we managed to verify identification of *Serranus* genus, larval *Epinephelus* did not reveal similarity with Mediterranean congeners. A local genetical data base is required to make reliable comparisons.
Create public awareness about the importance of groupers and to reduce demand on small sized fishes				We organised new meetings with the representatives of each fishery cooperative, fishery managers and controllers operating around the bay. We updated the flyers and posters of our previous project and printed a total of 2000 copies. To increase public awareness, we keep our website updated in Turkish. To reduce demanding the small sized groupers, we also left posters and flyers to the fish markets and restaurants showing the most recent legal regulations. However, this task should be continuous to fully achieve rising the public awareness.
Impact and value added with this project				We made two oral presentations about the results of our works on groupers. Additionally, we presented our results and conservation advises to stakeholders in a workshop held in Cukurova University. We also submitted a paper to a peer reviewed international journal indexed in SCI. We are planning to produce other publications about spawning and nursery areas after we enrich present data with further efforts.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

Just after our first project started in 2016; catching, landing and selling of white (*Epinephelus aeneus*) and dusky (*Epinephelus marginatus*) groupers were declared to be banned until 2020 by the Turkish fishery management authority. Fishers strongly objected to this regulation and demanded repeal of legislation. Therefore, we had critical problems on trust building. Communication was the strongest tool in tackling this difficulty. We met with fishers as frequent as possible in the course of our projects and convinced them on the importance of groupers for the ecosystem. After we established a trust-based network, we started to interact with fishers in the way that

imposing the importance of the conservation by resource users and participation of resource users to data collection and management systems. By this way, we acquired significant amount of data on the biodiversity (20449-1) and fishery practices (with this project). This data provided a significant baseline in management and conservation of groupers in the eastern Mediterranean.

Towards the end of our second project, in October 2018, the prohibition on white groupers has been repealed. Therefore, a new critical question has risen what the fishers reacted to the new regulation. This question was directly related with our purposes in this project. In order to tackle this problem, we had to design a new survey to have information about the changes of fishing behaviours after white grouper fishery has been legalised.

Identification of spawning areas is a tough challenge in marine species. Results of ichthyoplankton surveys performed in context of the second project provided additional arguments showing that the spawning area of *Mycteroperca rubra* is in the northern coasts of the Iskenderun Bay. However, identification of larval specimens was employed using classical morphological methods. Results of genetic analysis indicated that the samples belonged to the sub-family Epinephelinae but did not give any reliable information at the species level. We believe that the cause of non-decisive results was lack of proper literature in the global databases. Therefore, a database specifically consider genetical structure of local grouper populations should be gathered using adult samples in future projects/attempts.

3. Briefly describe the three most important outcomes of your project.

The main goal of this project was to acquire supplementary data for grouper conservation. For this purpose, we found answers for the following questions; (a) what the main characteristics of grouper fishery are, (b) how fishers react with the changes of legal regulations and (c) how alternative management strategies can be advanced. Regarding to first two questions, we used a community based approach and we met with more than 300 fishers in the fishery ports, recreational fishing gear markets, sport fishing and free diving groups and coffees where fishers gathering. Meetings were held in three cities and 10 fishery ports around Iskenderun Bay. In these meetings a total of 120 interview forms were filled. Before interviews we had conversations explaining our purposes and telling the importance of groupers for coastal ecosystems. Additionally, we discussed what fishers suggested for the conservation of grouper species. Eventually, we showed a catalogue of all grouper species, then directed questions about their fishery practices.

a) Characterization of grouper fishery in Iskenderun Bay

Longliners constitute the main fishery pressure

Based on fishers' statements, near threatened white groupers are the primary target species in Iskenderun Bay. The main cause of this is that the white groupers inhabit in sandy and muddy habitats while the others mostly distribute around reefs. Sandy habitats are usually considered as better fishery grounds since fishing around rocky bottoms causes' loss of fishing gears and consequently brings extra costs.

According to the respondents, groupers are exploited by six different fishing gears. Longliners, traps and spear guns particularly target grouper species, whereas trawls and nets can unintentionally capture them. The median best days' catch (BDC) values were found to be higher in longliners in comparison with the other fishing gears for all grouper species (Figure 1). According to Turkish Fishery Statistics, there were 698 recorded longliners fishing adjacent to all the Mediterranean coasts of Turkey by 2016. More than half of these (467 boats) are operating around the Iskenderun Bay. This was inevitable because Iskenderun Bay and adjacent areas have the widest continental shelf along the eastern Mediterranean. Therefore, the most developed coastal fishery fleet operates here not only for longliners but also all other fishery methods.

Juveniles are under strong pressure of fishery

Although its usage has long been prohibited, 2% of fishers reported the usage of traps in grouper fishery, and from which the second highest best day's catch was reported. However, trap fishers claim that they do not catch small individuals (Figure 2), scientific investigations argue against. Additionally, fishers using other gears consistently assert that trap fishery particularly catch juvenile individuals. Most of the fishers find the trap fishery ban is necessary for conservation.

Bottom trawlers constituted the second important source of fishing pressure for white groupers. Since, bottom trawling is not possible around the rocky bottoms, other species are quite rarely encountered by this fishery (Figure 1). On the other hand, bottom trawlers catch high amounts of small sized individuals according to reports of fishers and field observations (Figure 2). Small-scale fishers perceive that the industrial fishery, bottom trawling is the most important threat on white grouper populations. Therefore, further efforts are required to assess the effect of bottom trawlers on white grouper populations and advance new methods to reduce this pressure.

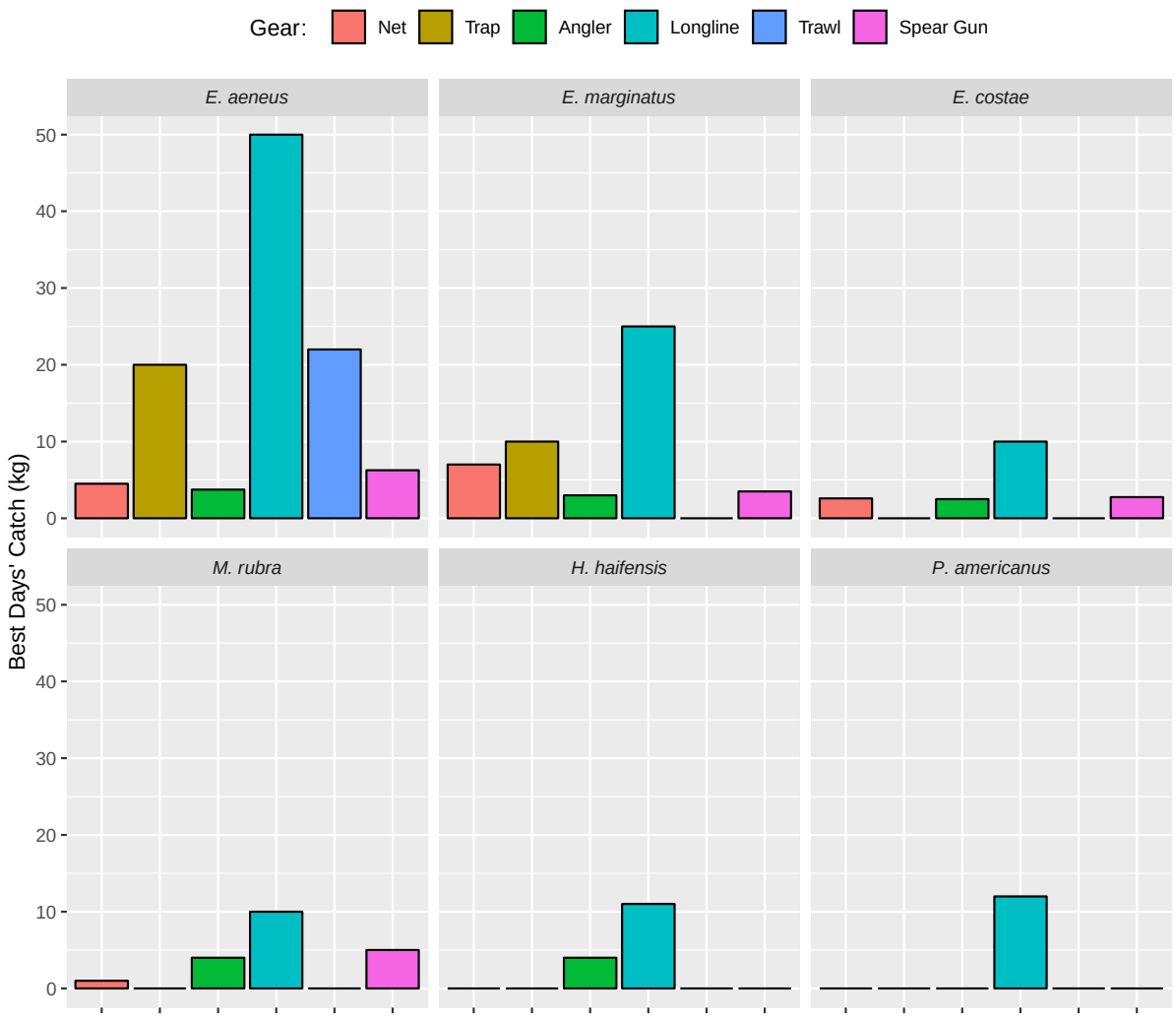

Figure 1. Fishing pressure on grouper populations in Iskenderun Bay

Catch amounts of recreational fishery appear to be lower than those of commercial and subsistence fishery (Figure 1). Nevertheless, the size of fish caught by anglers appears to be smaller than the other methods. This is probably because of that they fish close to shore where small sized groupers inhabit. The ability of spear gun fishers is also limited by depth since fishing using a scuba diving equipment is prohibited. However, fishers report that this ban is frequently broken around the Bay. Understanding the effect of this illegal fishery is challenging and requires further joint efforts of fishers, NGOs, universities and fishery management authority.

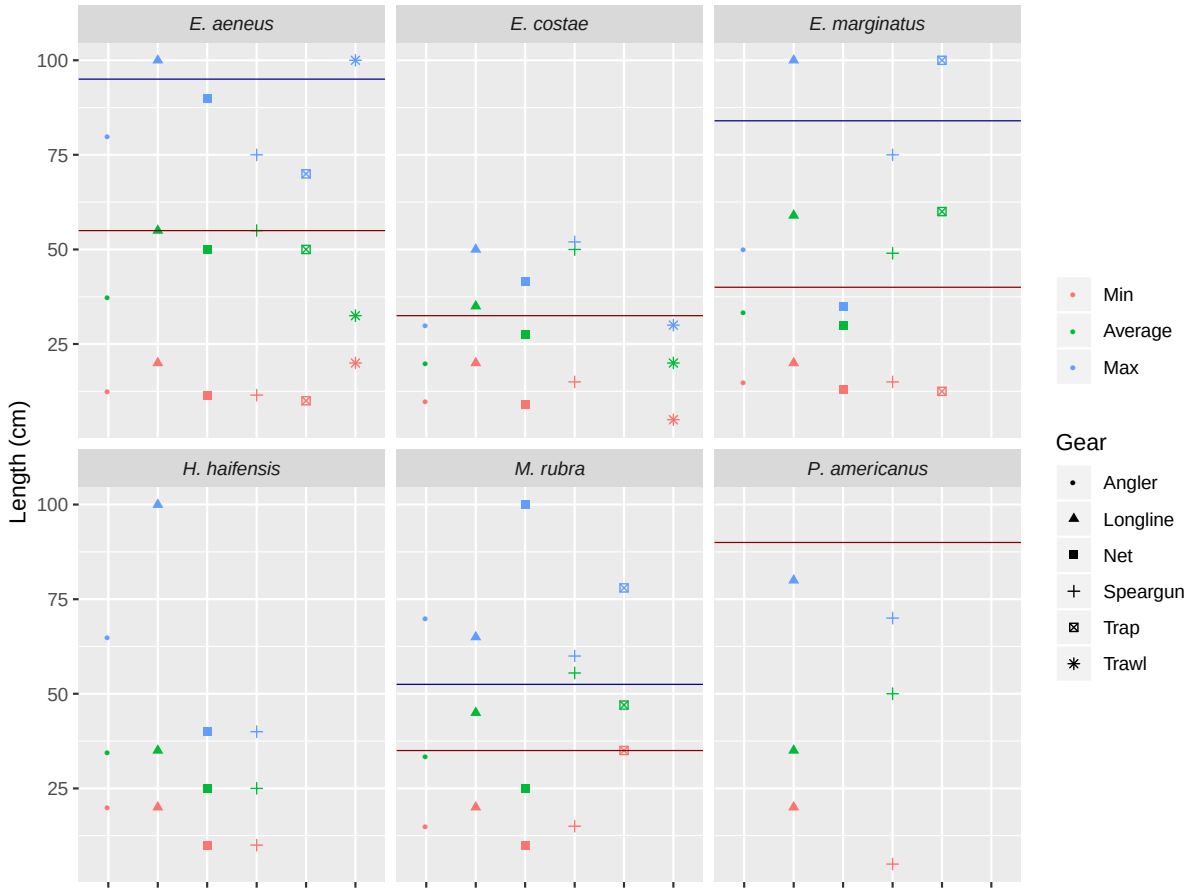

Figure 2. Minimum, average and maximum lengths of groupers by species and fishing methods. Horizontal lines show the length at first maturity (red) and sex reversal (blue).

Grouper fishery is highest in Spring and Autumn

Fishery pressure on grouper populations varied among seasons. The grouper fishery became remarkably higher towards spring and autumn for all fishing gears, except for anglers who reported higher catches during the winter months. This may be a contributory factor in the provision of safe spawning habitats for summer spawner groupers such as *E. aeneus*, *E. marginatus* and *E. costae*. In contrast, the spawning season of *M. rubra* is during the spring period, with a peak in April and May, when the fishery pressure was also reported in its maximum level. Therefore, a closure during the spring season may be beneficial for conservation of *M. rubra*.

The reason of the seasonal variations of fishery effort varies among fishing gears and areas. For instance, trawl fishery is forbidden from April to September. Spear gun fishermen also reported a seasonal pattern depending on turbidity and water temperature. Some of the longliners reported that the grouper fishery was not economically reliable during the summer period due to the seasonal presence of sharks, which either remove the bait or cut the hooks and lines. Additionally, longliners are artisanal fishermen and they usually change their fishing gear and target species seasonally. They usually use sole trammel nets in winter and shrimp trammel nets in summer months because of higher profit gained from them.

Since summer months are the spawning season of groupers, their whereabouts is an important knowledge. Fishers usually answer this question for white groupers because it is the main target species of grouper fishery. Two different answers emerge from the perceptions of fishers. A group of fishers believe that they are still inhabit in the Bay, but longliners cannot catch them because they do not attack the baits since they are under spawning stress. On the contrary, we did not find any eggs or larvae in Iskenderun Bay in the ichthyoplankton samplings during summer months. The other groups claim that groupers migrate out of the Bay in summer months, but they do not give a distinct location. We found this claim more reasonable since (1) the absence of early life stages in the Bay during summer months and (2) the all fishery groups give the same season as they rarely catch groupers. But further effort should be concentrated to clarify the migration patterns of groupers particularly in summer months because information on their spawning aggregations can be quite useful for advancing a better conservation strategy.

b) How policy changes affected fishing behaviours

Over the course of our two projects, legislations on grouper fishery have been changed two times. Before 13.08.2016; the landing size in Turkey was restricted to a minimum 45 cm for white and dusky groupers, and there was a temporal closure from 15 June to 31 July. Following catch statistics highlighted abrupt declines in populations of *E. aeneus*, policy-makers introduced a regulation providing for the permanent prohibition of the catch of these two species until 2020. Fishers strongly objected to this regulation and demanded repeal of legislation claiming that the trend of landing statistics are unreliable. These objections resulted in the way fishers demand and fishery management authority repealed the legislation for white grouper in 09.10.2018. Recently, white grouper fishery is regulated with a minimum landing size restriction of 50 cm, and a temporal closure from 1 June to 31 August.

Fishery statistics are in accordance with population trends

To start with, we challenged fishers claim about the grouper fishery statistics. This was a necessary step to understand the true status of groupers and share evidences with fishers. For this purpose, we reached available time series data sets; catch per unit effort (CPUE) from coastal bottom trawl time series (2004-2018) of Cukurova University, officially reported grouper catch statistics (2002-2017) and microdata set (2012-2016) gathered by Turkish Statistical Institute (TUIK). All three data sources revealed that the decline in fishery statistics reveal the true trend in grouper populations. There was no statistically significant difference between the direction and magnitude of slopes of landings and CPUE trends (Figure 3).

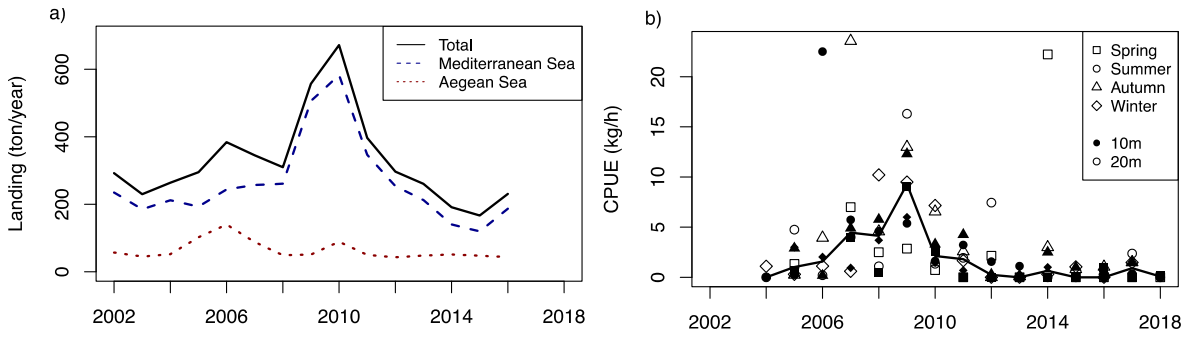

Figure 3. Landings of white grouper fishery statistics (a) and catch per unit effort (CPUE) values of juvenile groupers from a coastal bottom trawl time series.

Illegal fishing continued after the ban

Subsequent changes in grouper fishery policy, provided us a unique opportunity to understand the reflexes of fishers against critical changes in fishery management applications. To acquire information in this context, we met with trusted fishery leaders since talking about illegal fishery activities irritate fishers. Reaction of fishers after grouper fishery was banned varied among different fishing methods. Trawl and net fishers report that they do not target groupers in all circumstances. Groupers are by-catch for these gears which are incidentally caught. Most of the individuals caught by these gears are reported to be already dead when the gear collected back. Therefore, bottom trawler and net fishers did not change their fishing behaviour and continued selling groupers illegally after the ban.

The reflex of recreational fishers changed depending on the cultural and educational level. Amongst the spear gun fishers and anglers, there were two different groups. As a preliminary observation, the ones who had higher socio-economic status were well aware of the importance of conservation of groupers for the coastal ecosystem and they were law-abiding. They report that they did not catch, or they released banned groupers after they took a photograph. On the other hand, some of the anglers and spear gun fishers report that recreational grouper fishing illegally continued even after the ban.

The ban particularly effected longliners

Longline fishery is the most effected one from the legislation changes because groupers are their primary target. To understand their reflexes, some details should be mentioned about the characteristics of longline fishery. Two types of longline fishing have been practiced in Iskenderun Bay. Thick longlines are the prevalent one which particularly targeting white groupers using 7 and 8 number hooks. Eventually, longliners are artisanal fishers and they usually do not use only one type of gear throughout a year. Thick longline fishery is employed during two different periods, one is from March to June and second is from September to December when sole or shrimp fishery is over. When we directed our questions about their behavioural changes regarding to new legislations, a lot of fishers reported that they started to use sole and shrimp trammel nets. But this is their usual fishing behaviour unconnected with the legislation change. Thus, we concentrated our questions specifically on the grouper fishery seasons.

Based on reports of fishers, the reactions of longliners can be grouped under three different categories. A couple of fishers reported that they completely left fishing because if they continued longlining, groupers would inevitably be caught. Fishers in this group was usually operating around the northern coasts of Iskenderun Bay, where there were industrial facilities providing alternative employment opportunities. The second group of fishers was the ones who reported that they change using thick longlines to gill nets or thin longlines during the grouper fishery season. The main target of gill nets were goatfishes (*Mullus* spp.) or Sparids (Sparus aurata, *Diplodus* spp., *Pagrus* spp., Dentex spp. etc.). Particular attention should be given thin longlines here. This gear is similar with the thick longlines but only differ with smaller hook sizes. Fishers operating İskenderun Bay use 11 to 14 number hooks in thin longlines and this means they target smaller individuals. Based on fishers' reports, thin longline fishery is employed in both sandy and rocky bottoms. In sandy bottoms, its main target is an invasive species *Nemipterus randalli* and fishers state that they can catch 80 to 100 kg of *N. randalli* for 1000 hooks in each fishing day. This seems a positive effect of grouper ban because it directed an important amount of fishery effort to an invasive species. On the other hand, thin longlines also catch groupers even at the smaller sizes. According to fishers, when this gear is operated on the rocky bottoms, they frequently encounter goldblotch groupers (*Epinephelus costae*) and mottled groupers (*Mycteroperca rubra*). It can easily be assumed that dusky groupers (*Epinephelus marginatus*) are also subject to fishery in this circumstance, even though fishers do not mention about it. White groupers (*Epinephelus aeneus*) can also be caught by thin longlines on the sandy bottoms. Market observations are also support all these inferences. Small sized goldblotch and mottled groupers can be seen in Figure 4. The hooks of thin longlines were still present on some of the individuals (Figure 4-c).

Figure 4. Sightings of small sized groupers in the fish markets in İskenderun, Dortyol and Adana.

The last group of fishers honestly confessed that they continued thick longlining targeting white groupers even during the fishery ban. We tried to collect information about the rate of illegal fishing activity in order to guess an approximate value. For this purpose, we communicated with cooperatives, fish market owners and fishery controllers. The rate of illegal fishing given by all three respondent groups were roughly between 20% and 40%.

All fishers will return the old fishery routines after the repeal

In October 2018, the prohibition on white groupers has been repealed by Turkish fishery management authority. After this regulation we met with grouper fishers again and tried to collect information about their reactions. When meetings were performed most of the fishers did not start thick longlining yet. This was primarily because they had already done their plans and investments for the fishing season. We also asked if they will start thick longlining by the next season. All fishers stated that they will return thick longlining without any exception. But this survey should be repeated in April or May during the main fishing season of groupers, in order to reach more accurate conclusions.

c) Results of ichthyoplankton samplings

To achieve the third task, we collected data about the spawning areas of groupers by way of ichthyoplankton samplings and imply this data to fishery management. For this purpose, we performed a meso-scale ichthyoplankton survey at 30 stations covering the whole İskenderun Bay in April 2018 because samplings of our previous project showed that *Mycteroperca rubra* spawns in this period. Only one-year data of larval distribution was not enough to claim certain spawning areas. By this way we strengthened our evidences and become giving conservation suggestions confidently.

In context of ichthyoplankton samplings in April, 30 stations were sampled covering all Iskenderun Bay. During these samplings we detected a total of 15 individual of pre and postlarval stages of Mottled grouper, *Mycteroperca rubra*. Collected larval individuals were identified morphologically. Then we tried to validate our results using

molecular techniques, but we could not obtain satisfying results. According to sequencing results, one of our individuals gave 94% similarity with *Epinephelus radiatus* and *Epinephelus episticus*. The both species has not yet been recorded in the eastern Mediterranean. The other sample gave 94% similarity with *Epinephelus episticus* and 93% similarity with hybrids of *Epinephelus lanceolatus* and *Epinephelus fuscoguttatus* and *Epinephelus moara*. Firstly, we suspected our methods, and to validate them, we performed these genetic analyses also on the known larval specimens. For example, we successfully obtained 98% similarity in larval *Engraulis encrasicolus* and 97% similarity in larval *Dussumieria elopsoides* samples. We believe that, these results indicate that the failure in larval groupers was not because of our methods. We rather need a local genetic data base covering the genetical information of local populations to make our comparisons. This data base should be established using adult specimens.

In context of samplings, mottled groupers were detected at the 23% of all stations. The abundance of mottled grouper larvae ranged from 0 to 57.77 individual per m^2. The overall log-normal average abundance and its standard deviation was calculated as 1.92 individual per 10 m^2 and 3.43 individual per 10 m^2 respectively. The results of binomial generalized linear model revealed that, the probability of presence of larval mottled groupers positively correlated with only longitude. We did not detect any connection with environmental parameters in the survey performed in April 2018. The larval distribution pattern was in accordance with the previous year. The abundance and probability of presence of larval mottled groupers increased towards the northern coasts of Iskenderun Bay (Figure 5). This survey remarkably strengthened our arguments showing that *Mycteroperca rubra* spawn in the northern coasts of Iskenderun Bay, where and when the fishery pressure on grouper populations was highest. By, this results we confidently suggest that, Mottled grouper fishery should be restricted in April and May when the highest spawning activities were observed.

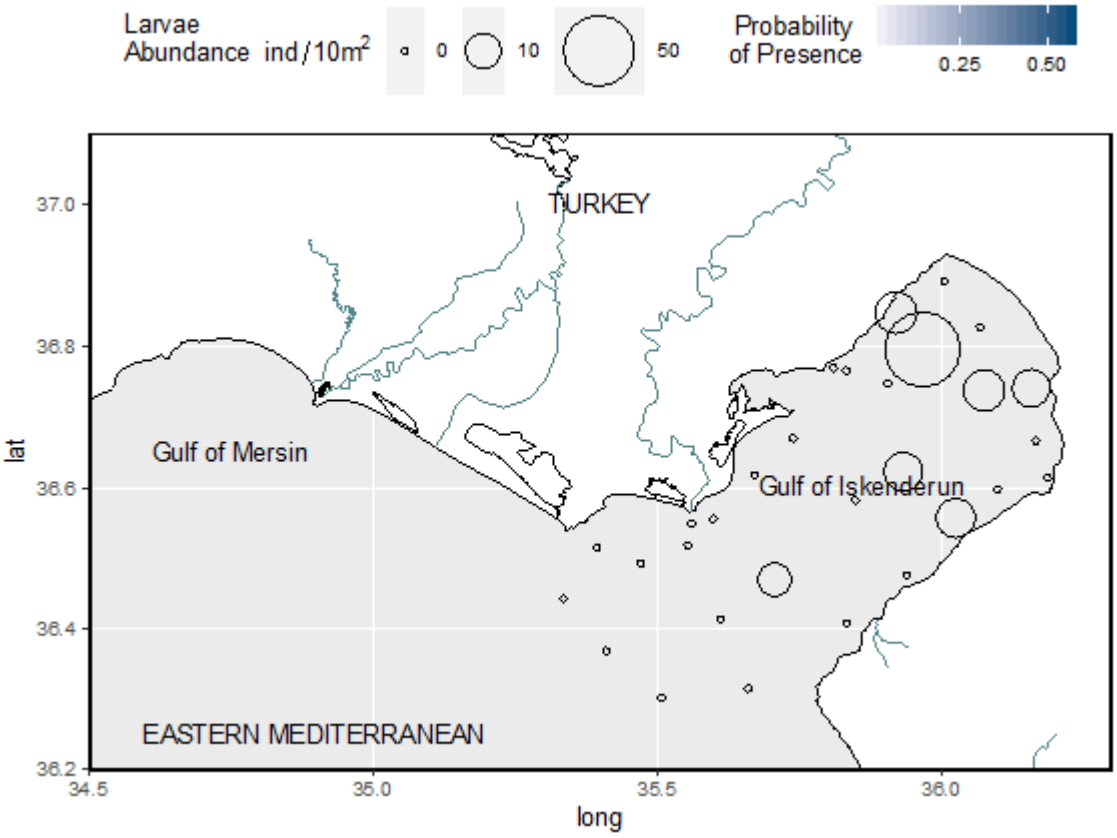

Figure 5. The abundance and probability of presence of larval mottled groupers in Iskenderun Bay in April 2018.

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

Our project used the Local Ecological Knowledge approach as the main source of data. In this approach, local community and particularly resource users actively contribute to the data collection system. Accordingly, we performed all data collection procedures with the participation of local community. During the meetings we found opportunity to interview more than 300 fishers face to face in the fishery ports and recreational fishing gear markets. Along with acquiring the data, we also utilized these meetings to build a trust-based network and share our knowledge and conservation goals with fishes.

Additionally, we made a presentation in the Thick Longline Fishery and Problems Workshop held in Akif Kansu Conference Hall of Çukurova University with the participation of employees from the local fishery management authority, universities, fishery cooperatives and several non-governmental organizations concerning nature conservation. The workshop was directly related with the management of grouper fishery in the north-eastern Mediterranean and therefore provided us a significant opportunity to share our knowledge, impressions and opinions about grouper fishery.

One of the most important stakeholders are consumers in the conservation of fishery resources. Therefore, our effort was not limited with fishers, also reached out the fish markets and restaurants. Fish are usually consumed freshly cooked as a whole body in the Turkish tradition. According to sellers, consumers mostly prefer serving size fish from 500 gr to 2-3 kg. Therefore, the market demand and price of these sizes are higher. Unfortunately, favourite sizes are smaller than the length at first maturity for the most of grouper species. Therefore, raising awareness to reduce demand on small sized groupers is necessary for a successful conservation plan. On the other hand, breaking the routines is a tough challenge and requires continuous efforts. To achieve this task, we prepared and distributed flyers and posters to the restaurants and fish markets in context of this project. Additionally, our web site is up and running in Turkish, spreading information about the biology, ecology and importance of grouper species. Our web site can be reached from the following link https://orangerproject.wixsite.com/grouper.

5. Are there any plans to continue this work?

Yes, there are. In the course of our two projects, we acquired significant information which are necessary for the management and conservation of groupers. In addition, we gathered information on the local problems and knowledge gaps. An effective conservation policy requires significant amount of data not only about bio-ecological dynamics of the populations but also about the sociological dynamics of the resource users. This task should be achieved step by step with the participation of local fishery community.

Based on fishers' opinions, there is a significant amount of unreported mortality of the grouper populations. This mortality mainly results from two sources; illegal fishing activities (trap fishery, mass catching of small sized individuals by bottom trawls, spear gun fishing with scuba equipment) and washing ashore events due to unknown reasons. In our further step, we are planning to proceed with resolving the illegal and unreported sources of mortality in order to develop precautionary approaches. Finding actual amount and reason of total mortality enhances the prediction of anthropogenic impacts on the populations from the point of conservation view.

Additionally, we were successful in defining spawning habitats of *Mycteroperca rubra* in our two projects. However, there are six more grouper species inhabiting in the North-eastern Mediterranean. We are planning to continue our ichthyoplankton samplings in a wider spatial extent in order to describe potential spawning areas of other grouper species.

6. How do you plan to share the results of your work with others?

In the course of this project, we made a presentation in the Thick Longline Fishery and Problems Workshop held in Akif Kansu Conference Hall of Çukurova University. Then, we made another oral presentation in the III. National Marine Science Symposium which was held in İzmir, Turkey in May 2018. In our presentation, we discussed the reliability of grouper fishery statistics and its utility in policy making. Its abstract can be reached from the following link

(http://3udbk.deu.edu.tr/assets/3udbkkitap.pdf). During the course of the project, we made another oral presentation at the Larvalfish Conference which was held in Victoria, Canada in June 2018. Our presentation was about the potential fishery pressure on the spawning aggregations of *Mycteroperca rubra* in the North-eastern Mediterranean. Its abstract can be reached from the following link (http://lfc-2018.com/downloads/Abstract%20Booklet%202018%20LFC%20FINAL%20VERSION%2023-06-2018.pdf). Additionally, we submitted a peer reviewed article to a prestigious journal indexed in SCI about the trends and reliability of white grouper fishery statistics. It is under review at the time final report has been presented.

Besides, our web site is up and running in Turkish. By this way, we spread information about the biology, ecology and importance of groupers. We keep it updated with the recent policies and our activities. It can be reached from the following link https://orangerproject.wixsite.com/grouper. We also share our results via social media. Finally, we are going to share our final report with the management and controlling authorities of Turkey.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

As anticipated, our project started with the meetings in December 2017. During these meetings, we hang posters and distribute flyers about groupers. Additionally, we continued scuba diving and snorkelling to monitor the status of grouper populations and collect visual material (Figure 6). Our ichthyoplankton samplings were also completed as planned. We performed a meso-scale ichthyoplankton survey covering all Iskenderun Bay in April, when *Mycteroperca rubra* spawns.

Due to the policy changes, we had to use two months more in order to achieve objectives of the project. In October 2018, the prohibition on white groupers has been repealed. In this circumstance, how fishers reacted to this change was arisen as an important question directly related with the objectives of our project. Therefore, we designed one more fishery survey in order to collect information about the changes of fishing behaviours after white grouper fishery ban was repealed. This additional survey also provided us opportunity to share our results with fishers. Additionally, we attended longlining and trawling operations to observe grouper fishery after the ban repealed and we collected visual materials.

Figure 6. Frames from visual censuses (a: juvenile *Epinephelus costae*, Yanışlı, Mersin; b: juvenile *Epinephelus costae*, Akyar, Mersin; c: Serranus scriba, Yumurtalık, Adana; d: *Seranus scriba*, Gölovası, Adana; e, f: *Epinephelus marginatus*, Gölovası, Adana)

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Projection Materials (Device and Screen)	300	300		
Printing Material	450	600	+150	Because of the legislation changes we had to update our published materials
Genetic Analysis	900	800	-100	Because we could not collect eggs and larvae of groupers in summer months, we kept summer

				ichthyoplankton surveys in small spatial extents.
Ichthyoplankton Samplings	1050	600	-450	Because we could not collect eggs and larvae of groupers in summer months, we kept summer ichthyoplankton surveys in small spatial extents.
Travels	800	1000	+200	Because of the legislation changes we had to design one more fishery survey.
Accommodation	1500	1800	+300	Because of the legislation changes we had to design one more fishery survey.
TOTAL	**5000**	**5100**	**+100**	

9. Looking ahead, what do you feel are the important next steps?

Our two projects derived important insights on biodiversity and fishery of groupers in the north-eastern Mediterranean. During the projects, our main focus was advancing an effective conservation strategy for grouper populations. For this purpose, we focused on resolving main source of threats on groupers. According to small-scale fishers' perceptions, the most important threat on the white groupers is bottom trawling because trawlers can catch high amount juvenile fish. Field observations also confirms this perception. Therefore, understanding the effect of bottom trawling on the sustainability of white grouper populations would be an important next step to advance a better conservation strategy.

Advancing an effective conservation strategy requires detailed information on the bio-ecological properties of populations. However, far too little attention has been paid to this point particularly in the Eastern Mediterranean. Seven grouper species inhabit in the area. But, conservation status of only three of them (*Mycteroperca rubra*-LC, *Epinephelus marginatus*-En, *Epinephelus aeneus*-NT) have been assessed so far. The others are classed under the "Data Deficient" category in IUCN's Red List. These species should particularly be taken into consideration in the next steps. Because of insufficient data, there is no regulation on their fishery. Unfortunately, this does not mean the status of their populations are in a sustainable level. These species may be under even higher extinction risk than the ones that classed under "Endangered" category by IUCN.

Classical stock assessment methods are quite difficult to apply in grouper fishery since they require detailed data such as length structured population status, catch and effort amounts. This data is absent in the North-Eastern Mediterranean. A more realistic approach on the stock management of groupers would be spatial or temporal restrictions on their fishery. For this purpose, defining spawning periods and areas are of great importance. Accordingly, we tried to find evidences of spawning aggregations in İskenderun Bay, in the course of our two projects. Our ichthyoplankton samplings clearly revealed that *Mycteroperca rubra* spawns in April and May in the northern coasts of Iskenderun Bay. On the other hand, we did not

find such an evidence for other groupers. Therefore, spawning sites of the other grouper species should be seek in a wider spatial extend in further efforts.

Another important question to answer is the natural mortality events of multiple grouper species. During the conversations of our two projects, fishers and local people consistently mentioned that they encounter dead or unconsciously drifting groupers in shores. Such mortality events have been documented in the Western Mediterranean because of grouper nodavirus epidemics. But observers tell that they rarely encounter lesions on the fish, which is an important sign of nodavirus infection. Therefore, the magnitude and causes of mass mortality events, and their effects on the grouper populations should be clarified and integrated to conservation plans with the future investigations.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

We used The Rufford Foundation logo and acknowledged the name in all published materials. Additionally, The Rufford Foundation receives publicity in our web site (https://orangerproject.wixsite.com/grouper). Posters hung on the fishery boats, fish markets and restaurants, and flyers distributed to local community.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Project leader, **Sinan Mavruk**, actively attended all work packages of project and made data analyses and visualisations with **Fethi Bengil, Ismet Saygu** and Sinan Mavruk also organised meetings with fishermen. Presentations were performed by Sinan Mavruk, Ismet Saygu and Fethi Bengil. Interviews were performed by all project members. Ichthyoplankton samples were collected by Sinan Mavruk and Vahit Alan, and Sinan Mavruk did the taxonomical analyses. Sinan Mavruk, Vahit Alan and İsmet Saygu organized and performed diving.

12. Any other comments?

In the course of our two projects, we acquired significant information which are necessary for the management and conservation of groupers. Fishermen's knowledge allowed us to gather new data on the status of grouper populations and their fishery along the Turkish coasts, providing a practical complement to traditional surveys. These findings will hopefully contribute to stimulate participatory processes, which are particularly needed for developing effective measures for the conservation of groupers in the study area.

Remarks on Conservation

An effective conservation policy is only possible with the intentional participation of all stakeholders. This is the most challenging task of the policy making, and it can only be accomplished with convincing all stakeholders on the necessity of the legislations. Resource users, in our case fishers, have the key role here, because any regulation in the legislation directly interests their livelihood. Their perception about

the status of fishery resources, the fish populations, create also their opinion on the conservation policies. This point of view encouraged us; because, although we did not get positive feedbacks from all fishers we interacted, we believe that we could raise awareness which will designate their perceptions and eventually their opinions about conservation.

The opinions of fishers on the regulations are critically important on the applicability of the new legislation. Therefore, we asked fishers' opinions on the current policy. Whereas, the ban on white groupers has been repealed in autumn 2018, catch of dusky groupers is still banned. Most of the fishers find the current policy on dusky groupers is proper. Fishers find 50 cm minimum landing size restriction on white groupers is unnecessary because groupers are usually caught with barotrauma and their post release survival is not possible. According to fishers, increasing hook size does not reduce the catch of small sized fishes. Therefore, they request reconsider the minimum landing size restriction. In our opinion, this restriction can remain until local data on the length at first maturity gathered which is unknown yet for the eastern Mediterranean. Additionally, we believe that a minimum landing size restriction is necessary to prevent selling small sized individuals in the market.

Ichthyoplankton samplings of our two projects show that *Mycteroperca rubra* spawn in the northern coasts of Iskenderun Bay in spring, where and when the fishery pressure on grouper populations is highest. Based on these results, we confidently suggest that, Mottled grouper fishery should be restricted in April and May when the highest spawning activities are observed. We will report our results and supporting arguments to the Turkish fishery management authority on this case.

The data gap on the information about groupers classed under "Data Deficient" category still remains. However, the status of their populations is unknown, fishers' reports and market observations reveal that there is a significant amount of fishery pressure on them. Therefore, the necessary information should immediately be collected in order to advance an effective conservation strategy on these populations. Until that, some conservatory precautions can be considered.