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The Study of the Existing Interactions between the Wild Fish and the Farming Sea Cages of Marine Aquaculture in the Bay of Vlora

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Abstract

Marine aquaculture in Albania is also becoming a considerable factor for the recent social and economic developments. The aim of this study is the evaluation of the wild fish abundance and biomass close to one of the marine aquaculture farms in the Bay of Vlora, though these studies are rare in the Mediterranean basin. The accumulation of the wild fish close to the fish farms is happening on spatial and temporal scales and the relative structure could be subject to variations in the species presence. The abundance and the dimensions structure of the wild fish species close to a sea cage farm was evaluated and later compared to the control areas near the farm. The Alb-Adriatico 2013 farm is located about 100-350 m from the rocky coast of Bay of Karaburun (Vlorë), where gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) are growing inside the 40 sea cages. The accumulation of the fish was evaluated by using visual registrations and doing underwater photos. The relative species composition showed to be different in the composition between the control area and the sea cages farm, where it was registered the presence of 11 wild fish species close to the sea cages and none of them in the control area. The most abundant species families were represented by Sparidae, Pomacentridae and Mugilidae.

Keywords: Visual registrations; Adriatic Sea, Bay of Karaburun.

1. Introduction

The aquaculture is representing one of the most attracting sectors of the Blue Economy in Europe recently. Globally, it is considered as one of the most rapid development sub-sectors of Agriculture by the social and economic point of view. In Albania, the most profitable sector of Aquaculture is represented by growing European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) by using floating seacages in the coastal areas of Albania. Based on the reports by the Ministry of Agriculture and Rural Development, the value of the sectorial production at the national and international markets (exclusively represented by aquaculture farms located in the Ionian and south Adiatic Seas coasts, respectively) is about 6.1 milion Euro; it results to be a promising sector for providing incomes dhe emplyments toward the coastal communities and the economical developments in Albania [1].

Albania is rich country in water resources, which are represented by coast extended about 370 km, fresh water basins, artificial lakes, rivers and lagoons. Actually, there are present about 16 aquaculture farms specialized on growing gilthead seabream and European seabass. Most of these farms are located in the Bay of Vlora (Karaburun peninsula), Sarandë (in Ksamil) and Himarë (Porto Palermo). The same productions systems used in Greece and Turkey are installed in these farms, which are represented by floating sea cages for fingerlings adaptations with dimensions of 3 m × 3 m and on-growing floating sea cages with a diameter of 13 m and 19 m, respectively. The minimal depth where are installed the sea cages is about 20 m. Generally, the density varies from 10-15 kg/m^3 in this floating sea cages. The food convertion ration (FCR) is lower than 2.0 and in some farms it is about 1.6. This shows that experienced experts and managers are working in these marine aquaculture farms.

In the Bay of Vlora, the production started on 2004 and it belonged to seven licensed companies with 63 sea cages, which resulted on total production of 220

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tonnes. The Bay of Vlora represents the most productive region regarding the gilthead seabream and the European seabass. On 2017, the Bay of Vlora production was 8 folds higher than the production in Sarandë and Himarë. In the Bay of Vlora, the company "Orata" reached the maximal production capacity for both species in 2013. Generally, the production of gilthead seabream resulted 2 folds higher than the production of European seabass in the last 10 years. The preference to grow gilthead seabream instead of European seabass is related to the problems coused by the diseases which are affecting mostly European seabass in comparison to gilthead seabream. In the Bay of Vlora, the farmers are preferring the growing of gilthead seabream, while in Sarandë and Himarë, the farmers prefer to grow the other species, the European seabass [2].

Several studies have been published recently about the aquaculture production environmental impact in the Mediterranean basin, based on the rapid developments happening within the marine aquaculture [3]. The pelagic fish species have been shown to be attracted by floating structures in the water column. The floating sea cages farms are attracting fish species and othe marine marine organisms, where these structures are used as shelters for them, while the uneated fish feed could help on reching the attractive effects [4]. As a consequence of the physiological processes linked to the development of aquaculture, some of the contaminants (mainly represented by the organic substances coming from the uneated fish feed and feces) are reported to be present in the surrounding environment by stimulating the biological activities close to the areas, where are installed the sea cages. The contribution of the organic material is supposed to be the cause of crowding of wild fish species around the sea cage farms in several countries: Mediterranean Sea, Red Sea, Canary Islands, Norway, Australia and Indonesia.

The aim of this experimental and field works was to analyse in details the interactions created between the marine organisms, including fish species and the sea cages. This study is the first to be conducted not only in the Bay of Vlora, but also in all over the Albanian territory and it is based on the methodology used previously in other countries of Mediterranean, like Spain and Italy [5-7].

2. Material and Methods

2.1. Area of study

This study was conducted in a marine aquaculture farm, which is represented by Alb-Adriatico 2013, located along the Bay of Karaburun,Vlorë (Figure 1). This aquaculture farm is composed of around 40 floating sea cages, grouped in 10 and 20 sea cages in each panel. This farm is specialized on growing gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*). The fish individuals are feeded twice a day by using extruded fish feed between 8:00 and 16:00. The farm is located 100-350 m from the coast at a depth of 35 - 50 m. Close the the aquaculture farm there were present other sea cages corresponding to other marine aquaculture farms.

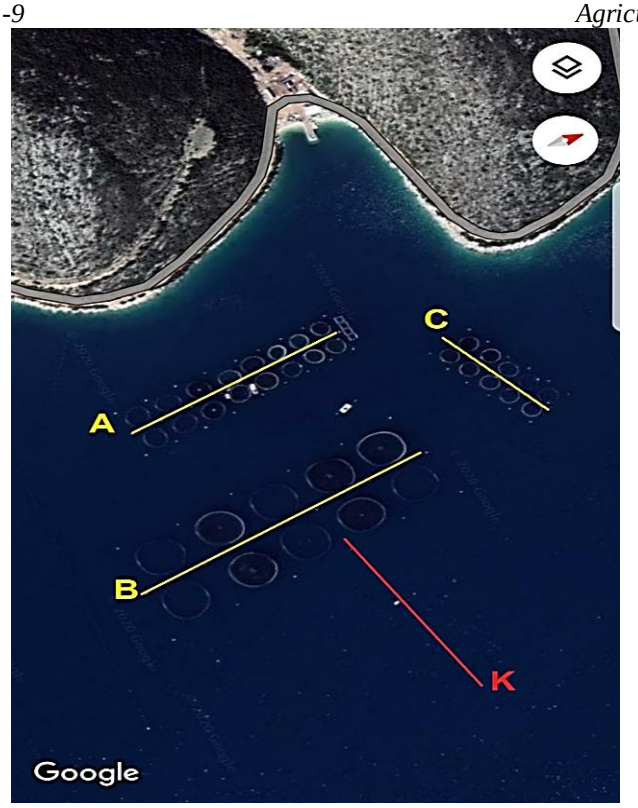

Figure 1. The monitoring areas in the Bay of Vlora. Zone A, Zone B and Zone C represents the monitoring areas close to the floating sea cages, and Zone K represents the control area.

2.2. Experimental modeling and visual survey

The visula registration represents a fast and *non-invasive* method, which permits a large scale of doing replicated observations. Furthermore, the visual counting offer better estimations of the abundance in comparison to other techniques in a space, where the moving fish species represent an important component of it. The visual counting were conducted by the divers. The main diver registered the fish (other marine organisms) species and the relative abundance by following the methodology of Harmelin-Vivien [8]. The information reported by the diver was checked after every visual counting in order to minimize the error margins on collecting the data. At the same time, it was performed the visual counting, the video registration or the underwater photoshooting of the relative species. After completing the diving surveys, it was conducted the identification of the registered species by a detailed observation of the relative marine organisms in the videos and photos, while contemporary checking the visual counting and looking about any consistency with videos and photos [4].

The experimental design of the study included three factors: the presence of the sea cages (close to the farm, control), months (July, August, September) and days (three in each month). The accumulation of wild organisms (including fish species) were evaluated by using visual registration and doing photos in three different days, each of the survey months. During these underwater survey it was used an underwater professional camera ThiEYE T5 Edge 4K.

Every day of doing the surveys, it was conducted the visual counting by the diver, which was repeated 5 times and each counting process lasted 5-6 minutes, 3 of them were conducted close to the sea cages (ZoneA, Zone B and Zone C) and 2 of them were conducted by the diver the control area by doing a trip to the Zone K, which is located 200m from the marine aquaculture farm.

The diver was diving close to the sea cages and casually was doing the photoshooting and registration of the marine organisms with a visuality conditions in 15 m depth x 15 m width × 50 m length. The time of doing the video registrations of the organisms coincided with the time of feeding the fish inside the floating sea cages.

The surveys started at 8:00, previous to fish feeding, while at 11:00, when the aquaculture farm was totally functional (the intensity of fish feeding was high – about 30% of the sea cages were contemporary provided with fish feed). Later, at 16:00 it was conducted another underwater survey, when the farm was totally functional [4]. The environmental

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parameters together with the production paramteres were taken into account based on the hypothesis that the related factors could influence the physiology and behavior of the fish crowded close the sea cages. The water temperature was measured by a digital thermometer and it was registered every day at a depth of 10 m, while it ranged 26-27 °C[4]. Two controlling point were previously fixed at a distance of 200 m from the sea cages and the presence of marine organisms was evaluated by the divers in three casual days, each month.

3. Results and Discussion

Totally, by the visual observations and registrations with the underwater camera, it was identified the presence of 3059 individuals including 11 marine organism species, which correspond to different families. All the identified species have been present around the farm, while in the control areas, it was not possible to observe any species. Sparids represented the most representative individuals with 3 species, saddled seabream (*Oblada melanura*), bogue (*Boops boops*), and common two-banded seabream (*Diplodus vulgaris*). After the detailed analyses of the observations obtained by registering videos and doing photos during the underwater survey, it was possible to identify the number of individuals corresponding to each species of family Sparidae: 1118 individuals of *O. melanura*, 2 individuals of B. boops and 14 individuals of *D. vulgaris* (Figure 2). The presence of the other species is represented by 934 individuals of flathead grey mullet (*Mugil cephalus*), 920 individuals of Mediterranean chromis (*Chromis chromis*), 13 individuals of common dolphinfish (*Coryphaena hippurus*), 40 individuals of European pilchard (*Sardina pilchardus*), 5 individuals of garfish (*Belone belone*), 9 individuals of bluefish (*Pomatomus saltatrix*), 1 individual of Tompot blenny (*Parablennius gattorugine*) and 3 individuals of barrel jellyfish (*Rhizostoma pulmo*).

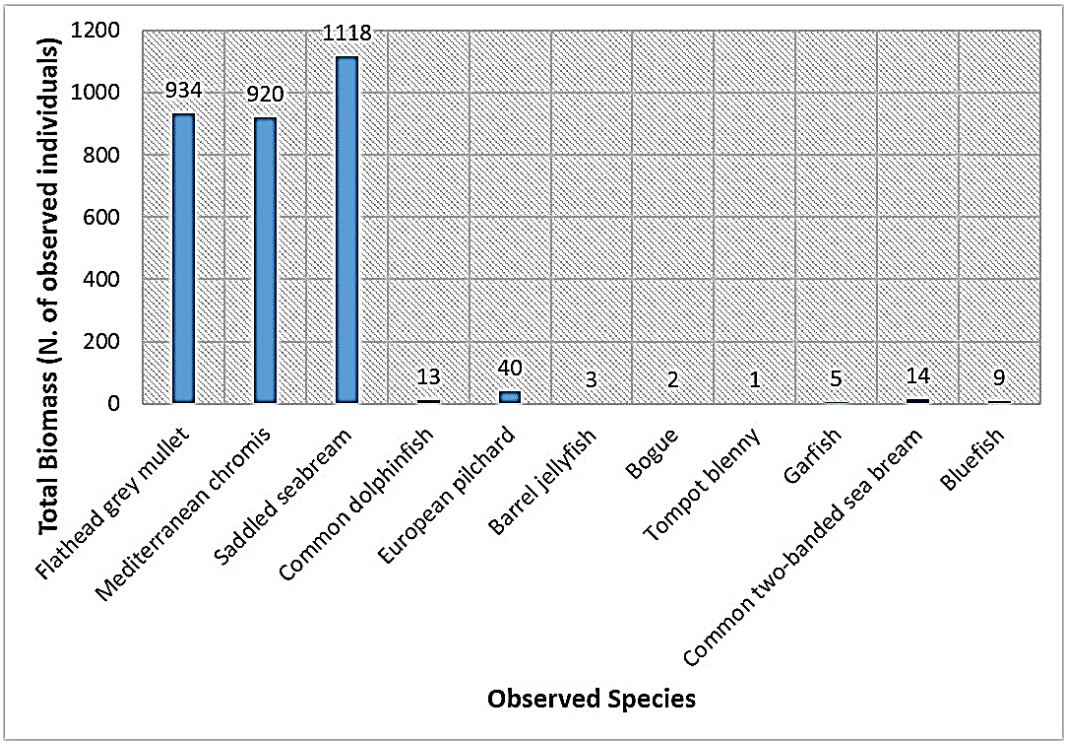

Figure 2. Graphical presentation of the total biomass of the wild organisms observed during the performed underwater survey close to the floating sea cages of Alb-Adriatico 2013 farm.

As, it is shown in Figure 3, the Zone C was characterized by the highest number of individuals with 596 individuals, while the Zone A abundance was 512 individuals and Zone B abundance was 404 individuals. The Zone K, which represent the control area, was characterized by 0 individuals.

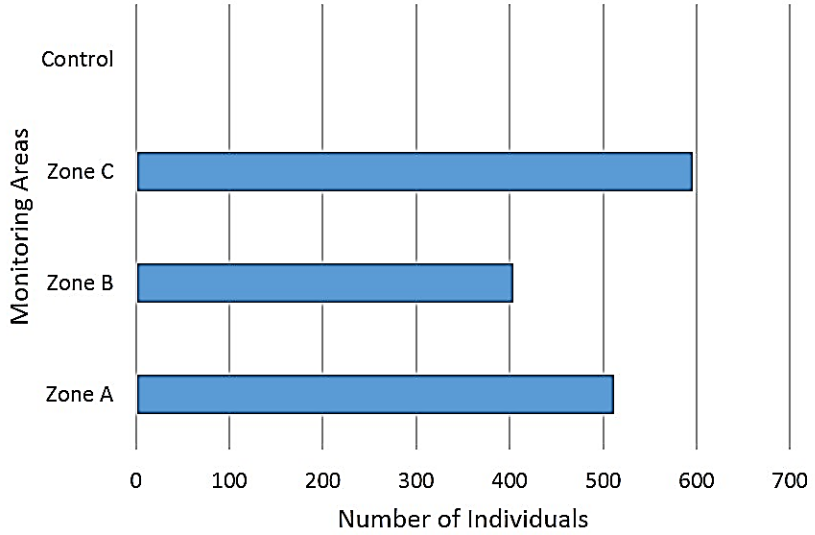

Figure 3. Graphical presentation of the comparisons of the registered abundance between the 4 Zone (monitoring areas and area of control).

From these results, it emerged out that the sea cages accumulated nearby more wild marine species than the control area in the three surveyed months. Furthermore, as it is shown in Figure 4, during the September underwater surveys, it was registered the highest number of individuals, 805 individuals, while the minimal number of observed individuals close to the sea cages was registered during August, 340 individuals. On July, it was registered the presence 356 individuals close the marine aquaculture farm, with a difference of just 16 individuals from the observations performed during the underwater surveys during the month of August.

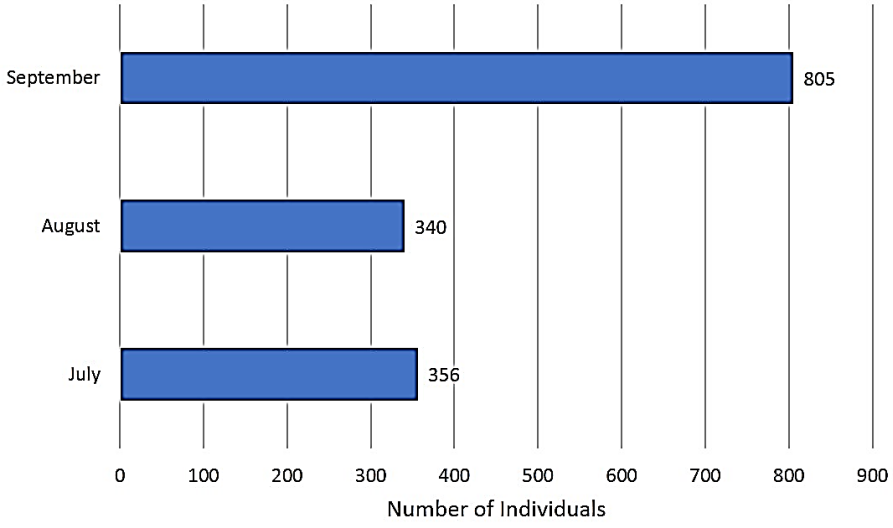

Figure 4. Graphical presentation of the comparisons of the registered abundance between the months (July, August and September 2019).

As it is shown in Figure 5, during the survey on July, in the Zone A was observed the presence of flathead grey mullet, Mediterranena chromis and saddled seabream individuals, which constituted the most abundant species in this area. In this monitoring area, it was not observed the presence of European pilchard and common dolphinfish individuals. Even in the Zone B was observed the presence of the same marine organisms. In the Zone C, it was observed the presence of European pilchard and common dolphinfish together with the previously mentioned species. In all the Zones, it was not registered the presence of common

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two-banded seabream, garfish and bluefish individuals, respectively.

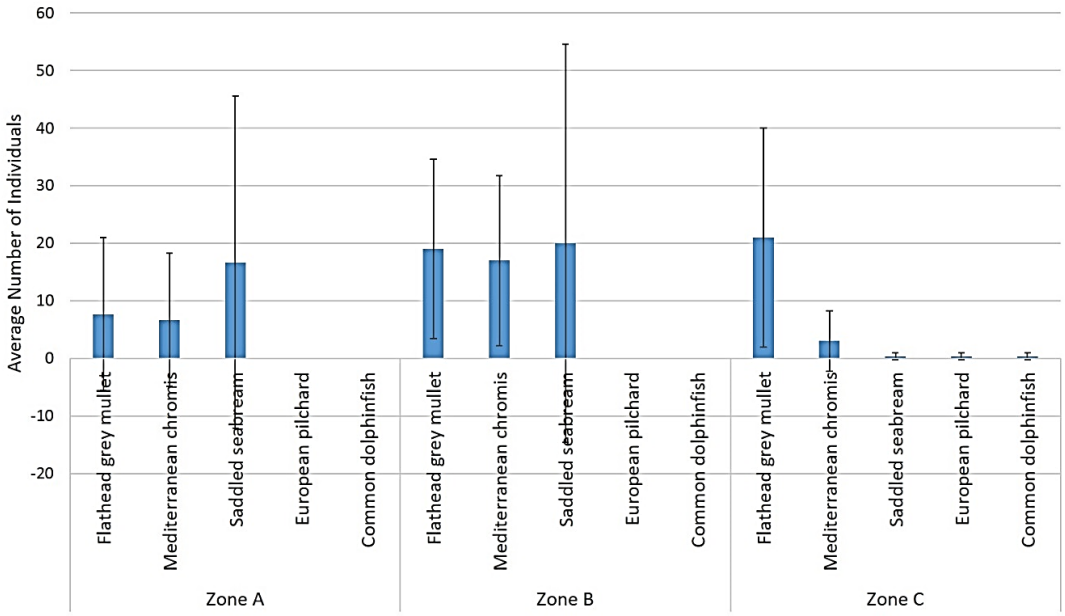

Figure 5. Graphical presentation of abundance comparisons between the species and the three monitoring areas during the month of July.

During the month of August (Figure 6), in the Zone A, it was registered the presence of flathead grey mullet, Mediterranean chromis and saddled seabream individuals. In the Zone B, it was registered just a low presence of flathead grey mullet, common dolphin and barrel jellyfish. Similarly to Zone A, in the Zone C was registered the presence of flathead grey mullet, common dolphin and barrel jellyfish, while the presence of the other species was not registered in all the three monitoring areas.

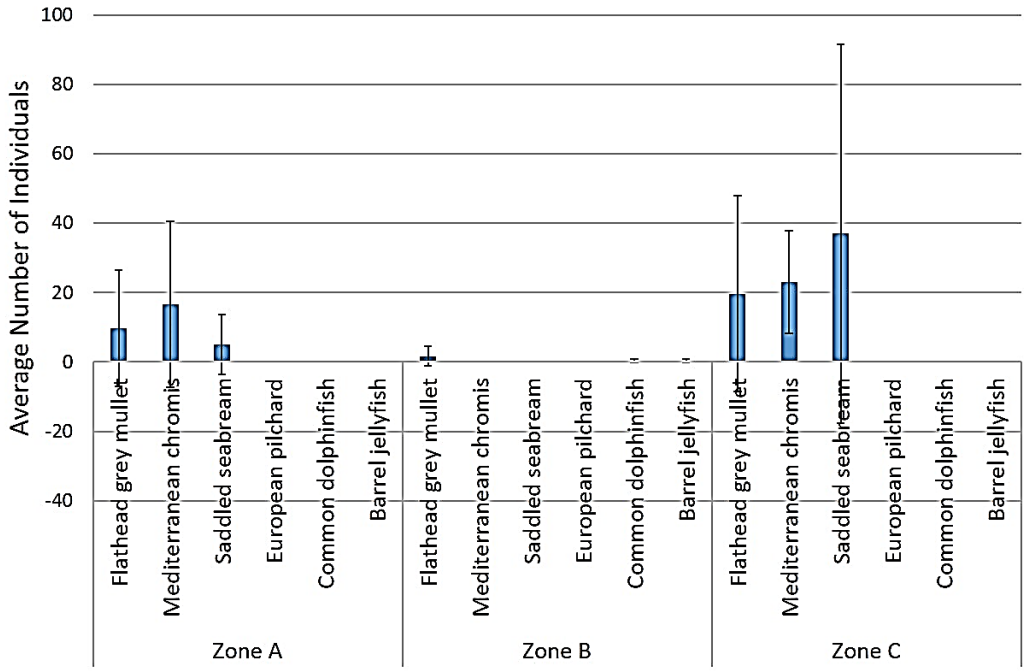

Figure 6. Graphical presentation of abundance comparisons between the species and the three monitoring areas during the month of August.

In all the three monitoring areas (Figure 7; Zone A, Zone B and Zone C) during the underwater surveys conducted on September, it was registered an high presence of flathead grey mullet, Mediterranean chromis and saddled seabream, where the abundance in each areas was nearly the same.

During the month of September it was registered the presence of some individuals (not present in the graphic of Figure 7) of common two-banded seabream, garfish, bluefish and common dolphinfish. The dolphinfish appeared in different days of the month of September, while the females appeared lonely, the males formed small groups of fish individuals.

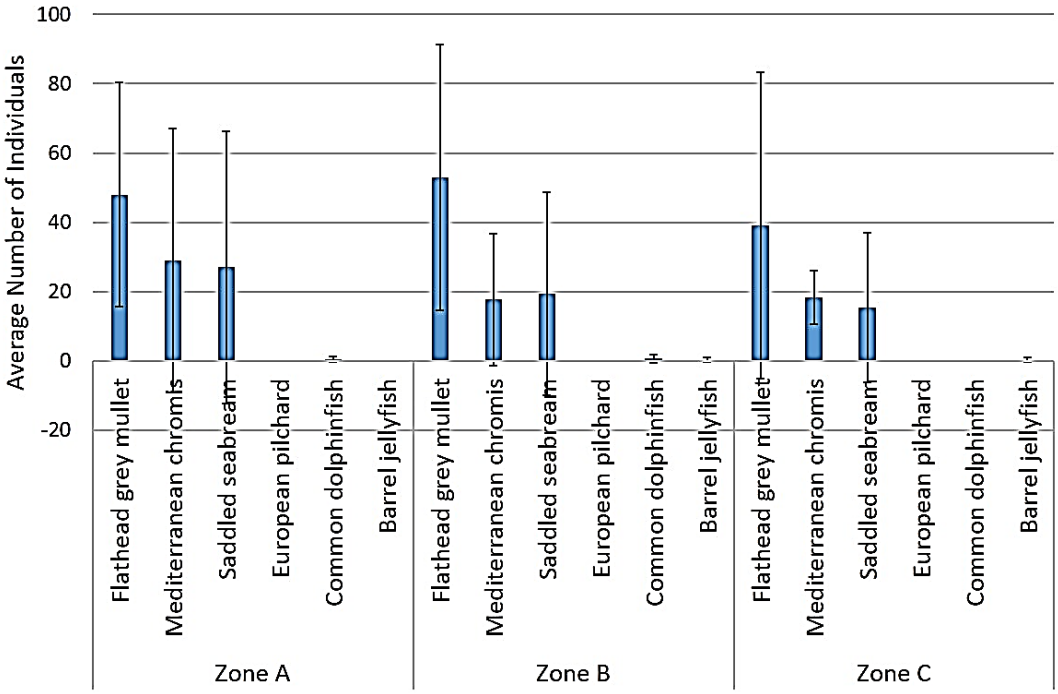

Figure 7. Graphical presentation of abundance comparisons between the species and the three monitoring areas during the month of September.

The number of observed species close to the sea cages (Figure 5, 6 and 7) varied in the comparisons between the surveyed months. Flathead grey mullet (*M. cephalus*) was present during all the surveyed months, July, August and September, while saddled seabream together with the Mediterranean chromis (*C. chromis*) were mostly observed during the months of August and September, respectively.

During all the months, the bogue was not registered to create fish schools, while common two-banded seabream, garfish and bluefish individuals created small schools.

Furthermore, as it is shown in Figure 8, in the Zone A during the month of July, the average number of observed individuals was 6.2, while in the same monitoring area, the averge number of observed individuals was doubled and it was 11.2. In the month of September, the average number of individuals was 5. In the Zone B, during the month July, the average number of individuals was 11.2, while the during the month of August, the average number of individuals was the lowest of all the monitoring areas (0.39). In the Zone B, during the month of September it was registered the highest average number of individuals close to the sea cages and it was 15.2. In the Zone C, during the month of July, the average number of individuals was 5, while on August and September, the average number of individual was 13.3 and 12.2, respectively.

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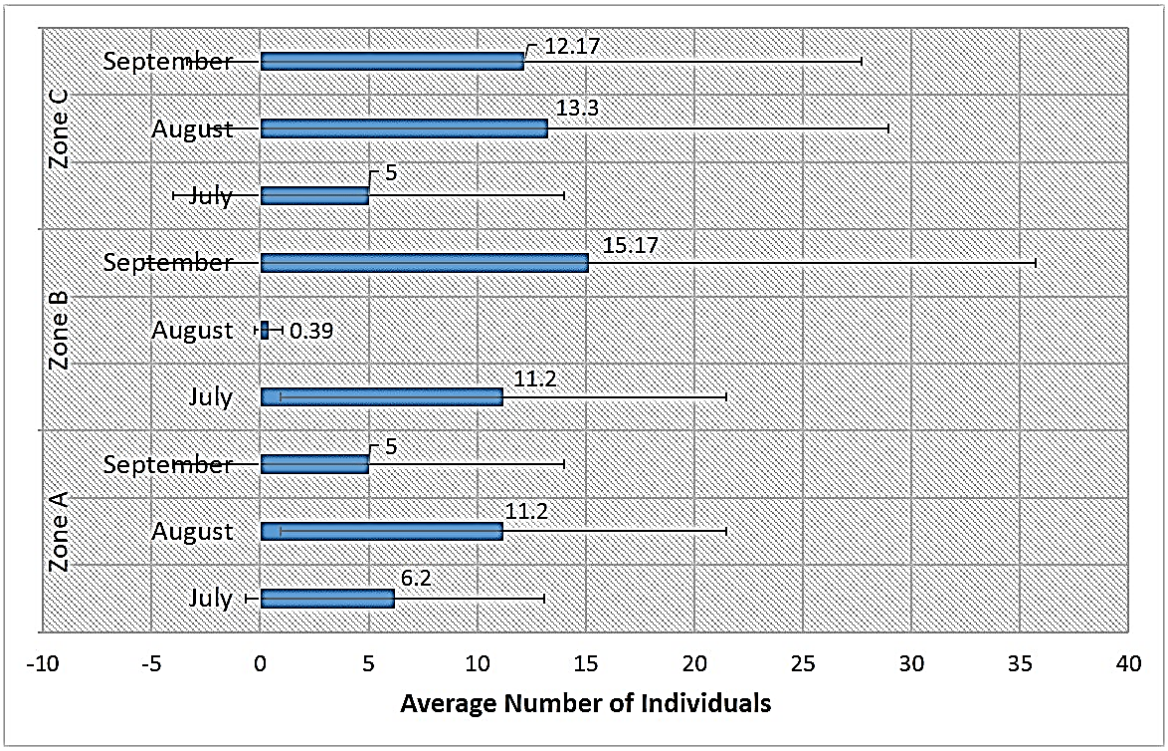

Figure 8. Graphical presentation of the comparisons between each monitoring areas in the different months.

In Mediterranena Sea, the creation of fish schools close to the floating sea cage farms appeared to create spatial and time differences in the content and structure. The spatial variability have been studied in different locations, depths and distances from the farms. Generally, the farms closest natural habitats are characterized by the highest abundance and richest on the marine organisms, though the time variability have less studies. The fish species represents poichilotermic organisms, while the temperature and the photoperiods affect the distribution and the relative behavior. These factors could create the conditions to split the schools of the different species, consequently affecting the strucuture of fish accumulation with time [4].

Dempster [6] suggested that the variability in the fish schools close to the sea cages could be related to the variability of the geographical and environmental conditions, or the interactions between the fish species [7]. Furthermore, Fernandez-Jover [7] suggested that the wild fish schools around the marine aquaculture farms could be highly influenced by the environmental variabels, like depth, coastal geomorophology and distance from the coast. Some growing features, like the fish feed, the farmed fish biomass or the number of the accumulated wild organisms (including fish species) could be the promoters of the temporal variability close to the fish farms [7]. Only the study of Bacher [9] has considered the activity of fish feeding in the sea cages as factor highly influencing the crowding of wild fish species around the sea cages of the marine aquaculture farm. The activity of fish feeding is subject to variations during the days and consequently its intensification could have effects on the temporal availability of the wild fish species [9].

According to the results shown in the comparsions between the months (Figure 8), in the case of the September month surveys, it was observed a high variability of abundance in all the monitoring areas (shown by the high level of variance). The abundance, total biomass and the number of species in this study resulted to be the highest in the Zone A and Zone C, which correspond to the sea cages panels closer to the rocky coast and it could be realted to the attraction of the wild individuals even by the rocky coastal habitats and the *Posidonia* medows in the coast.

Generaly, the observed fish species close to the marine aquaculture farms are represented by big or adult

individuals, which could present a high reproductive capacity. Consequently, the marine aquaculture farm area could be serve as nursery area and create a "reserve" effects on providing the surrounding areas with larvae and fingerlings. It can create good conditions for stimulating the development of artisanal fisheries close to the marine aquaculture farm. It could suggest the creation of the No Take Zone (NTZ) close to these farms. In this study the most abundant species represent species, which are subject of fishing activities and with low economic value (like bogue, flathead grey mullet and saddled seabrea), but their accumulation around the sea cages could attract valuable commercial species like bluefish and tuna. The continuous feeding of the farmed fish with fish feed highly riched with proteins could mean that the surrounding wild fish could have even bigger dimensions in comparison to the individuals swimming far away from the marine aquaculture farms. It could mean that these fish species could have higher reproductive capacity and highly valuable for increasing the profits of the local artisanal fishers.

4. Conclusions

Unluckily, in this study (for logistic reasons) the relative observations were conducted just close to one marine aquaculture farm in the Bay of Vlora. In the future, it would be really interesting to conduct a similar study by including other marine aquaculture farms. In the last years, it has been observed an increased frequency of the small-scale and sport fishing activities close to the farms and it could suggest that the marine aquaculture farm could provide more fish to catch for the professional and recreational fishers. It could be required a further study for evaluating the extention of this effect and the contribution on the relative exploited fish species abundance.

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