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15. The spatial and temporal distribution of the shads in Black Sea - marine zone of Danube Delta Biosphere Reserve

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ABSTRACT. Three species of the shads (*Alosa* genus) are known to live in the north-western Black Sea including Pontic shad (*Alosa immaculata* - Bennett, 1835), Black Sea shad (*Alosa maeotica* - Grimm, 1901) and Azov shad (*Alosa tanaica* - Grimm, 1901). The paper presents actual occurrence and distribution of shad species in Black Sea, Natura 2000 site ROSCI0066 (Danube Delta - the marine zone). Fishing sampling was conducted in 2012, using fix gillnets during the night and trawl fishing throughout the day. Survey showed that in 2012 were present only two species of shads, respectively *A. immaculata* and *A. tanaica*. In the last 50 years, *A. maeotica,* that lives in Sea of Azov and occasionally reach Romanian coast, was not cited as present in Romanian marine water. The two species of shads are present in RSCI0066 all over the year. The space distribution increases from south-west to north-east and from deep sea of the 20 m isobaths to the shore, with a maximum aggregation close to the Danube River mouth. In time the presence of shads decrease from spring to autumn. The conservation status of shads appears to be in suitable condition but under the pressure of fishing and habitat loosing and degradation. Close fishing and area, sustainable fishing, monitoring and research is require for preserving shads from Black Sea - Danube river system area.

Key words: Black sea shads, temporal distribution, seasonal distribution, conservation, migration.

INTRODUCTION

Three species of shads, Alosa genus are known to live in the north-western Black Sea including Azov Sea: Pontic shad (*Alosa immaculata* Bennett, 1835), Azov shad (*Alosa tanaica* Grimm, 1901) and Black sea shad (*Alosa maeotica* Grimm, 1901). Regional populations and subspecies may migrate into the Danube, Dniester, Dnieper and Don rivers ([***1***]; [***2***]; [***4***]; [***8***]; [***9***]; [***10***]; [***19***]; [***20***]; [***21***]). These shads are fished commercially and have social economic and cultural importance in their area of distribution covering the system Black Sea - Danube Delta - Danube River.

Conducting their life cycle in two living environments (freshwater and marine), located at great distances in different periods of time, this species require knowledge on biology and conservation status of the population.

Black Sea, which is the habitat of growth and development of shads, is a vast inland sea, bordered by Ukraine to the north, Russia to the northeast, Georgia to the east, Turkey to the south, respectively Bulgaria and Romania to the west. Major rivers flowing into the Black Sea are the Danube, Bug, Dniester and Dnieper rivers. Black Sea includes Azov Sea where the Don and Kuban rivers flow.

The study aims to evaluate spatial and temporal distribution of Back Sea shads in Natura 2000 site ROSCI0066 (Danube Delta – the marine zone), to support management measures for conservation their population.

MATERIALS AND METHODS

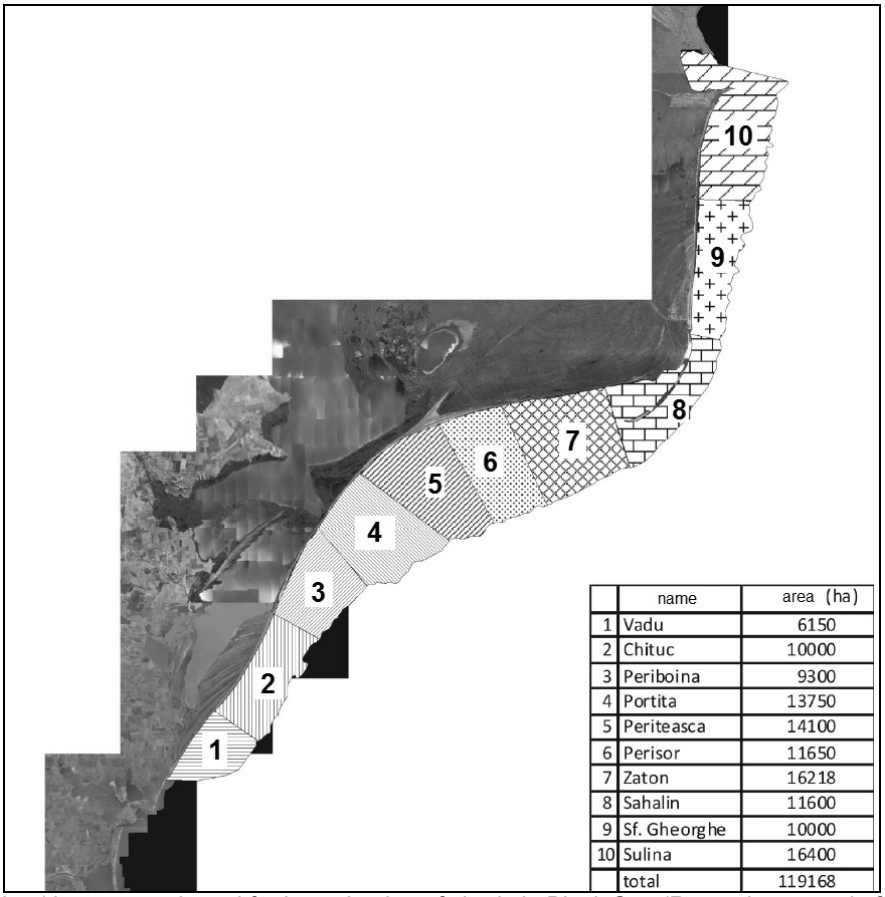
Fishing sampling was conducted in spring, summer and autumn 2012, along 9 marine sectors distributed perpendicular to coast, and three isobaths depth (0-5m, 5-10m and 10-20m) (**Figure 1**), using fix gillnets with different mesh size (a = 12÷40mm) during the night and trawl fishing (cod end 7 mm) throughout the day (**Table 1**). Sampling was performed using the operation base "Steaua de mare" research ship and trawler of the National Institute for Marine Research and Development "Grigore Antipa" Constanta, Romania.

Species identification was made after differentiating features, especially by counting number of gill rakers from first branchial arc follow the specialized publications ([***2***]; [***6***]; [***11***]; [***12***]; [***16***]; [***17***]).

Age determination was done by reading the annual growth rings on the scales using binocular microscope and sometimes documatorul ([***5***]; [***7***]; [***23***]; [***25***]).

The total length of individuals was measured with a ruler near 1 mm and the weight was recorded using an electronic field scale to near 1 g.

The level of gonadal maturation was assessed by direct observation using the VI scale stages of maturation ([***7***]).



	name	area (ha)
1	Vadu	6150
2	Chituc	10000
3	Periboina	9300
4	Portita	13750
5	Periteasca	14100
6	Perisor	11650
7	Zaton	16218
8	Sahalin	11600
9	Sf. Gheorghe	10000
10	Sulina	16400
	total	119168

Fig. 1. Distribution of the 10 sectors selected for investigation of shads in Black Sea (Romanian coast in front of Danube Delta).

RESULTS AND DISCUSSION

In identification of tree shad species it was doubt due to controversial assumptions given they are separate species status (*A. immaculata*, *A. maeotica* and *A. tanaica)* or are subspecies that previously described by the former Soviet Union and Romanian ichthyologists. The controversy continues today when after the Ukrainian scientist those three species are ecologic morphs of the same species ([***13***]; [***14***]; [***15***]). Based on genetic research they consider those three species and subspecies are migratory ecomorphs, commonly present at migratory species.

Some controversial information there is also for maxim length of *A. tanaica*. Bănărescu (1964) [***2***] gives the maximum length to 23 cm for key identification of shad, but in species description that refer to *Alosa caspia* that refers to all species and subspecies of the Black Sea and the Caspian Sea gives a maximum length of 28 cm. Moreover Bănărescu (1964) [***2***] considered *Alosa tanaica* is a subspecies of the species *Alosa caspia* living in the Azov Sea (*A. c. tanaica*) and in the northwestern Black Sea lives *A. c. nordmani* for which gives in the description of a maximum length of 20 cm.

Vasilieva (2008) [***24***] refers to *A. caspia* a maximum length of 28 cm and refers only to sub- species of Black Sea where she mention to lives more subspecies of *Alosa caspia* (*tanaica, nordmani, bulgariaco, palaeostomi*), but does not give a citation the text associated with this number and do not know if the figure comes from personal research bibliography cited in the same paper or reported the maximum size from the previous authors.

Information on the maximum length of *A. c. nordmani* (subspecies described by Antipa (1905) [***1***]) is cited by all authors who reviewed the ichthyofauna. Kottelat and Freyhof (2007) [***12***] cited the same maximum size without citing the source and giving on FishBase [***6***] the same length for *A. tanaica* as Berg (1962) [***3***].

Scientific sampling for various projects in the last 20 years record *A. tanaica* maximum size of 25 cm, for which the identification admitted this maximum size [***18***] (Năvodaru Ion, unpublished data).

In total there were sampled 958 shads individuals from what 687 Pontic shad and 271 Azov shad. Most fish were caught in gillnets and trammel nets (958 individuals) with the exception of six specimens of *A. tanaica* that were caught with trawl in July, in one haul that covered two areas, namely 7 (Zăton) and 8 (Sacalin), haul out between isobaths 10:20 m.

Black sea shad (*A. maeotica*) was not captured in the studied area, otherwise this species has not been reported / quoted in recent years in the area of the Black Sea. The most recent record of *A. maeotica* in Lake Razim was made in 1968 [***22***].

Catch recorded in fishery statistics is considered a fault, due to miss-identification of species or recording replace of *A. immaculata* with *A. maeotica* to avoid regulation in prohibition time.

In spring most of shad caught was in stage II and III of maturation gonads confirming shads just pass the area in their way towards Danube river mouth for spawning migration, but in summer and fall the shads where in stage I or VI, meaning fish where either immature in grow phase or in post-spawning fattening period.

The demographic structure of shads from Black Sea-ROSCI0066 consists of 4 generations (2 to 5 years) and is dominated by generations of three years for both shad species (**Fig. 2**). This structure from Black Sea is similar to the structure of migratory shads in Danube River, confirming again hypothesis that there are same shoals migrating up or down to or from river and Black Sea habitats are used as migratory way or feeding ground.

The weight-length relationship demonstrate an incremental growth type allometric better fitting with an exponential relationship equation an line (**Fig. 3**).

In general there is a distribution in space marked by increasing numerical abundance of shad catch from south-west (sector 1 Vadu) to north-east (sector 10th Sulina) towards the mouths of the Danube River (**Fig. 4**).

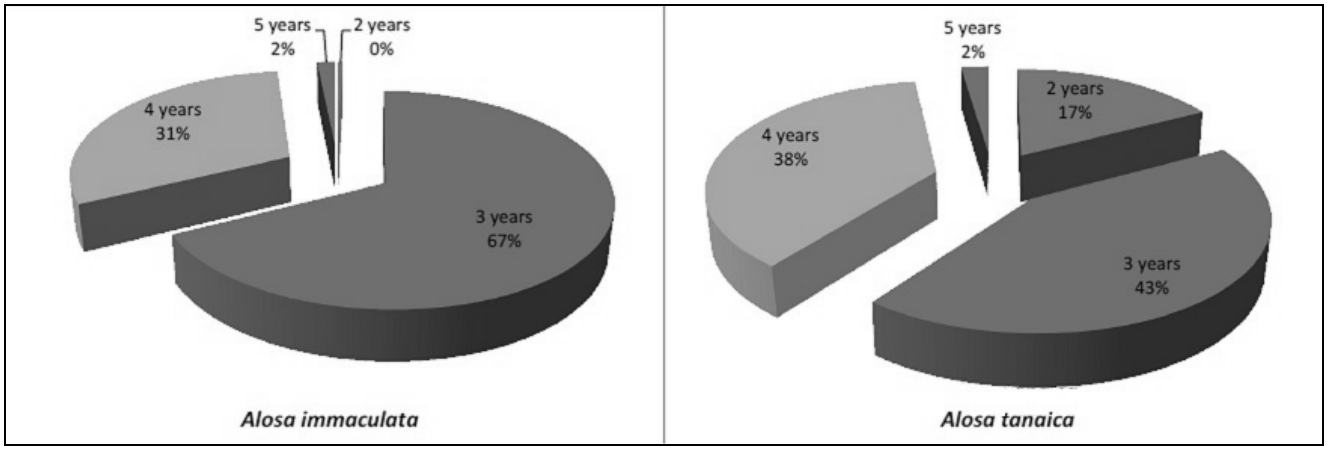


Fig. 2. Age structure of shads from Black Sea ROSCI0066 in years 2012

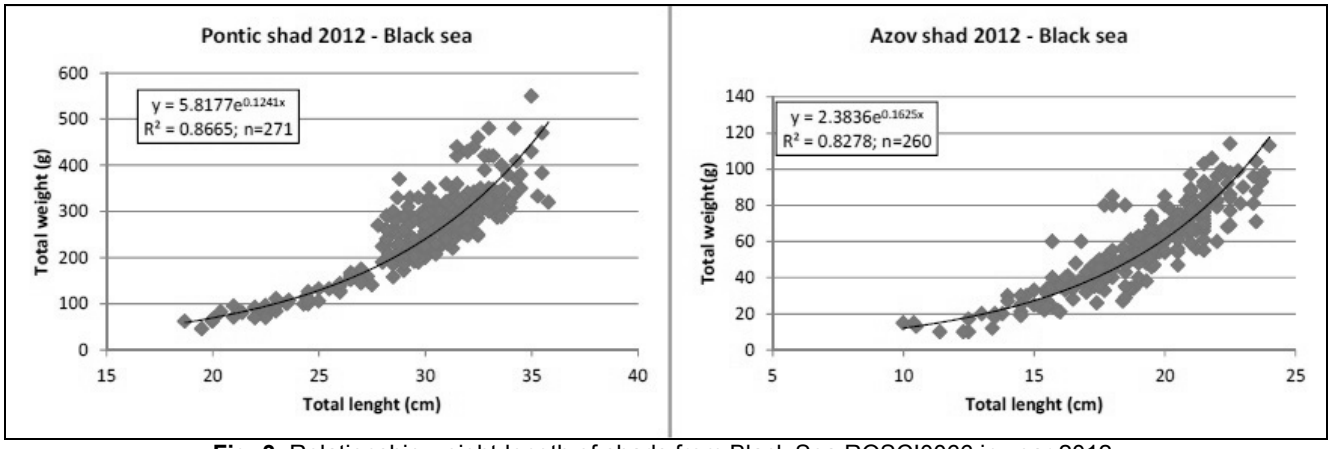


Fig. 3. Relationship weight-length of shads from Black Sea ROSCI0066 in year 2012.

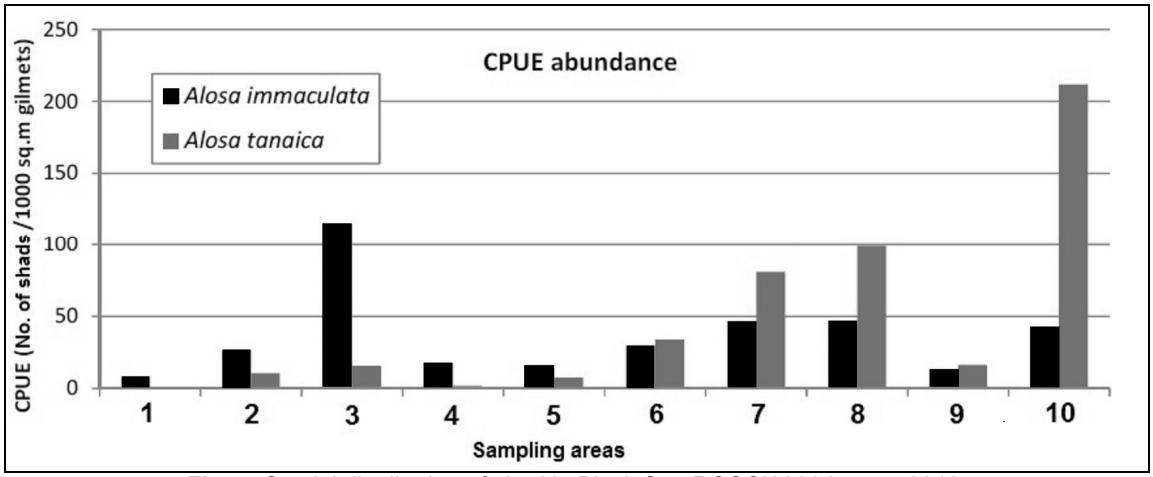


Fig. 4. Spatial distribution of shad in Black Sea ROSCI0066 in year 2012.

Note. 1 - Vadu; **2** - Chituc; **3** - Periboina; **4** - Portita; **5** - Periteasca; **6** - Perisor; **7** - Zaton; **8** - Sacalin; **9** - Sfantu Gheorghe; **10** - Sulina.

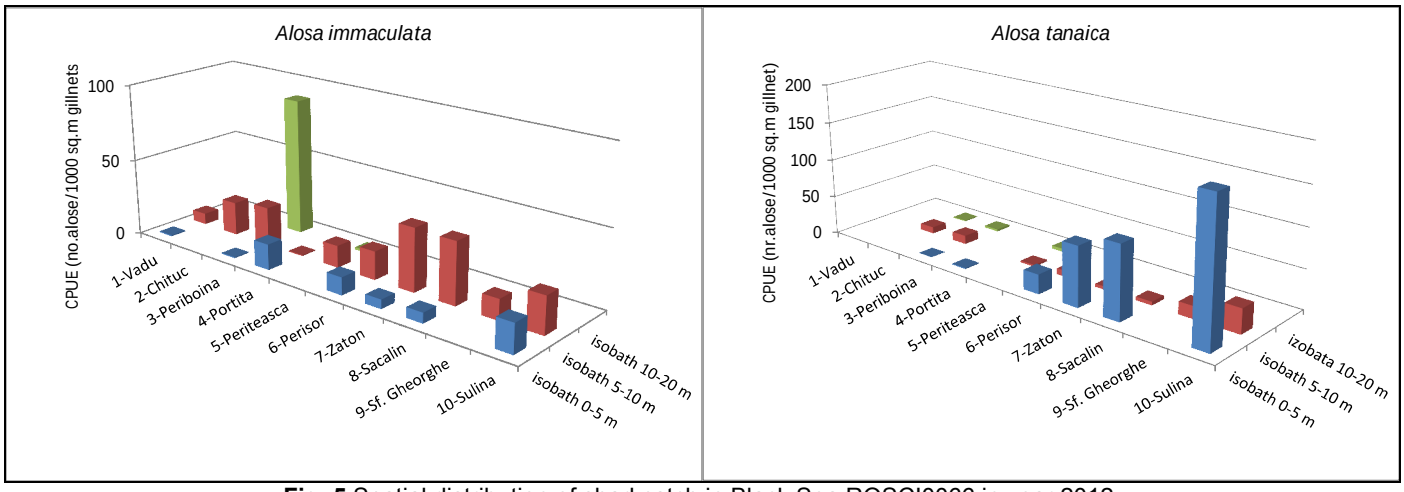


Fig. 5 Spatial distribution of shad catch in Black Sea ROSCI0066 in year 2012.

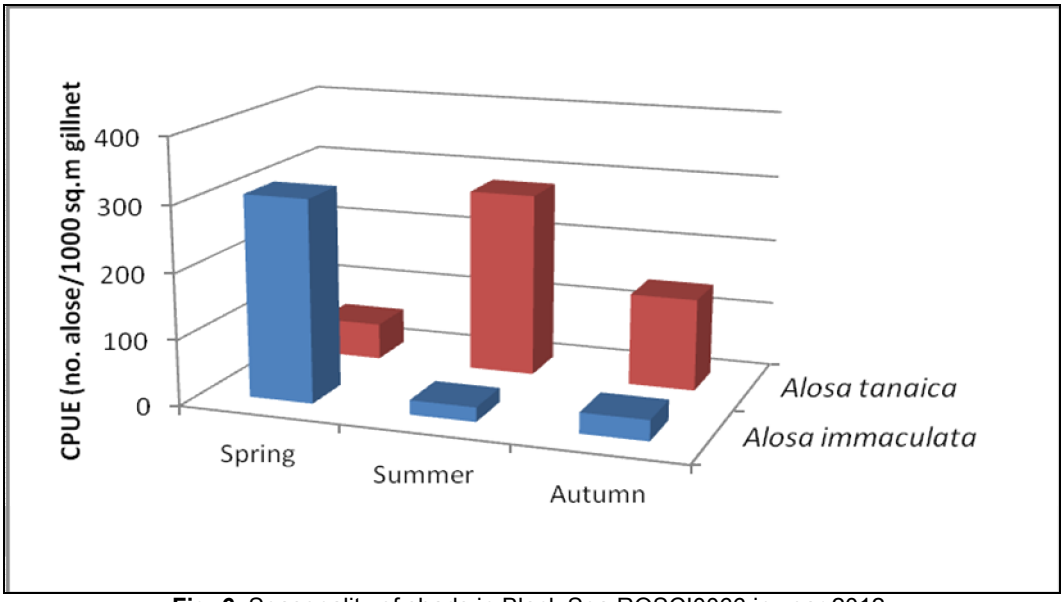


Fig. 6. Seasonality of shads in Black Sea ROSCI0066 in year 2012.

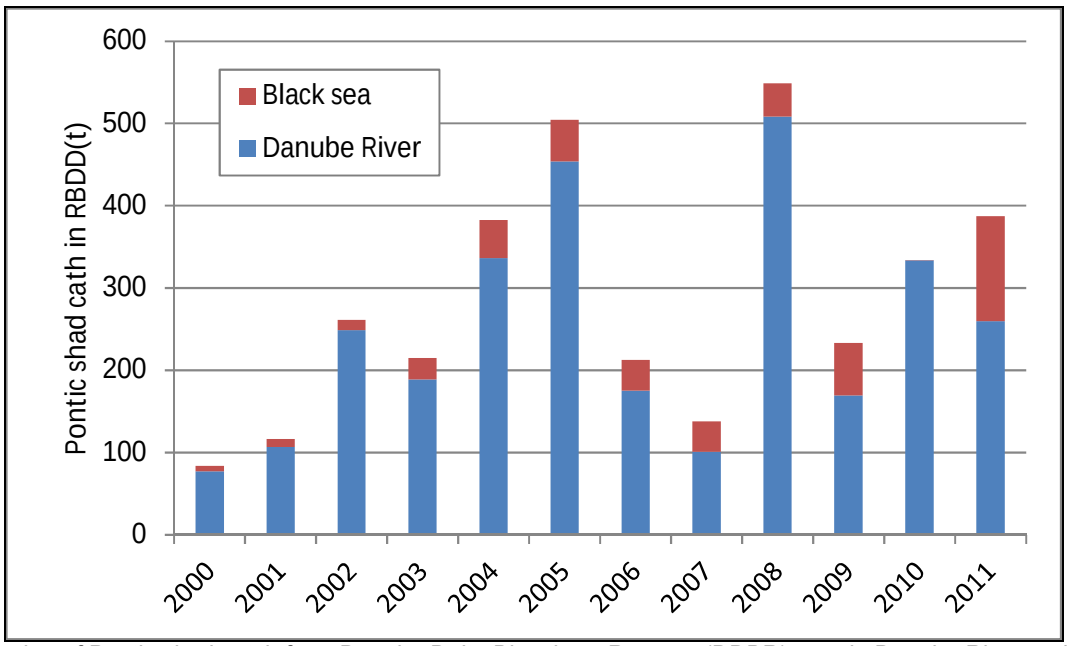


Fig. 7. Distribution of Pontic shad catch from Danube Delta Biosphere Reserve (DDBR) area in Danube River and Black Sea in 2000 - 2011 period.

A. tanaica is present especially near the shore (0-5 m isobaths) and decreases with depth, while *A. immaculata* is more in deeper watery (5-10 m isobaths), with the same trend of decreasing abundance to off shore and abundance increases of both species from south-west to north-east (**Fig. 5**).

With regard to distribution in time (seasonality), it appears that shads are present all summer season in ROSCI0066. However, *A. immaculata* are present in large numbers in spring (spawning migration), their number decreases during the summer and slightly increases again in fall, while *A. tanaica* is present in summer (July), its abundance decreases in spring and autumn (**Fig. 6**).

Form information on commercial fishing on the spatial distribution is observed that *A. immaculata* is fished in recent years, after the abolition of restrictions on fishing with fixed gill-nets in the Black Sea - ROSCI0066, the percentage of commercial catch increasing in the Black Sea, comparable previous years when shads where fished almost exclusively in the Danube River (**Fig. 7**).

The main treats for shad conservation at entire habitat level are overfishing in the sea and the river, loosing of spawning habitat by stop migratory way at Iron Gate, especially for *A. immaculata*, and loosing of brackish habitat by closing lagoons, especially for *A. maeotica* and *A. tanaica*.

The conservation status of shads appears to be in suitable condition but under the pressure of fishing and habitat degradation. To preserve good conservation status of shads is needed to protect species in the Black Sea coast by introduction of close fishing time and area regulation, at least, within ROSCI0066 during the spring breeding migration and banning reconsideration of the fishing with fixed and drifting gill nets at the shallow water marine zone up to 20 m isobaths. The sustainable exploitation of shads stocks in both living environments Danube River and Black Sea using catch and fishing effort quotas should be improved. The fishery monitoring and species research is required to include soundly scientific knowledge in management measures for sustainable use of shad stocks and population conservation.

CONCLUSIONS

Two species from tree Black sea shads, respectively migratory *Alosa immaculata* and *A. tanaica* are present In Black Sea – marine zone of Danube Delta Biosphere Reserve, Natura 2000 site ROSCI0066, in year 2012, while marine shad *A. maeotica* occasionally reach Romania Black Sea coast and fishery recording in catch statistics is considered to be a fault.

The two species of shads are present in study area all over the year, *A immaculata* is maximum in spring during spawning migration towards Danube River mouths and *A. tanaica* is present more in summer and autumn.

Space distribution of both species described by abundance shows an increasing from south-west towards north-east and from shore towards isobaths 20 respectively migration from sea towards Danube river mouths, with difference that *A. tanaica* is located more close to shore (isobaths 5-0) and *A. immaculata* prefer deeper water (isobaths 5-10).

Demographic structure of *A. immaculata* consists of generations 2-5 years similar proportion age classes with migratory shads in Danube River, concluding that therefore is part of the same breeding population of migratory species.

The study reconfirmed space and time distribution of migratory shad species in continental platform of Black Sea in front of Danube Delta, which is main rout of spawning migration towards the river and feeding habitat. Considering this marine zone is essential habitat for shads, for population conservation it is require to be protected by time and area closing fishing. Further study refer to feeding and nursing shads in this zone is needed.

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