

MULLETS AND THE IMPACT OF THE ENVIRONMENTAL STATUS OF BURGAS BAY ON THEIR POPULATIONS

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Abstract: An ecosystem approach has been chosen for an assessment of the status of the populations of three mullet species in Burgas Bay. The complex data requirements for all three species and physicochemical parameters plus sediment are the basis for a comparative assessment of the population status of mullets in Burgas Bay. An assessment of the local anthropogenic impact was also made using hydrochemical analyses. The present study aims to extend and deepen the knowledge of the population- biological characteristics of three species of mullets (*Mugil cephalus*, *Chelon auratus* and *Chelon saliens*) from Burgas Bay by using an ecosystem scale research to determine the degree of contamination with biogenic substances and their impact on the mullet populations.

INTRODUCTION

Environmental changes due to anthropogenic factors affect all parts of the plant and animal world in inland waters, seas and oceans. The Black Sea is close to the so-called "red line" beyond which ecosystem degradation processes may become irreversible. Commercial fishing is the most unfavorable factor as it directly destroys a significant part of the populations of certain species, which in terms affects all other species that are in strictly specific relationships with the intensely exploited ones. The mullets as species with rapid growth rate are sensitive to various anthropogenic impacts and changes. The dynamics of the stocks of these species is highly dependent on both the size of catches and the changing ecological status of the Black Sea over the years (Prodanov *et al.* 1997).

The golden grey mullet (*Chelon auratus*, Risso, 1810) and leaping mullet (*Chelon saliens*, Risso, 1810) usually lives inshore, enters lagoons and estuaries, and rarely moves into freshwater. Additionally, they are widely distributed in the Mediterranean Sea and the Black Sea, Atlantic coasts from the Azores and Madeira northward to the British Isles, and the southern coasts of Norway and Sweden. The flathead grey mullet (*Mugil cephalus* L.) is cosmopolitan species, occurring in tropical, subtropical and temperate coastal waters in all major oceans (Bruslé, 1982; Quignard and Farrugio, 1981). This species occupies a wide variety of marine, estuarine and freshwater environments, but spawning occurs in the sea (Karapetkova and Zhivkov, 2006; Ghaninejad *et al.*, 2010). As expected with the above distribution pattern, *M. cephalus* is a strongly euryhaline species capable of living in waters ranging from fresh to hyperhaline (Koutrakis, 2011; Minos *et al.*, 1994). The flathead grey mullet is also found in both clear and turbid areas, sandy and muddy habitats, and can survive in waters with a wide range of dissolved oxygen levels (Minos *et al.* 1994, 1995).

The golden gray mullet is the most common among mullet fish along the Bulgarian Black Sea coast (Stefanov *et al.* 1963, Karapetkova and Zhivkov, 2006). The golden grey mullet is the most abundant mullet species, which catches highly predominate over that of the other two species for the period 1966 - 1970 (Alexandrova 1973). Like flathead gray mullet, it is a pelagic, shoaling and highly mobile fish. The leaping mullet, like the golden gray mullet, is a pelagic, shoaling and extremely agile fish. In summer flathead gray mullet make significant leaps over the water. All three species slightly tolerate changes in water salinity and are somewhat sensitive to temperature decrease (Minos *et al.* 1994, 1995; Pavlovskaya, 1969). The differences in the ratio between these three species are due to the different salinity levels in the nearshore lakes. The grey mullet sustains better the lower salinity in the nearshore lakes, while the golden mullet prefers waters of higher salinity, so it rarely enters the lakes except for young individuals (Alexandrova 1973, Prodanov *et al.* 1997).

Flathead grey mullet, leaping grey mullet and golden grey mullet enter the lakes along the Bulgarian Black Sea coast for feeding. Catches vary in a wide range over the years. The survival of these species in lakes and bays is closely related to the thermal regime during the winter months and the ecological status of these basins. Lately, the catches of mullets in the Bulgarian section of the Black Sea and the coastal lakes exhibit a clear downward trend (Bekova and Raikova-Petrova, 2011). In recent years, no catches of mullets have been recorded in the Burgas lakes (except the Pomorie Lake), and the catches in the Burgas Bay were extremely low (NAFA data, Bekova and Raikova-Petrova, 2011).

MATERIALS AND METHODS

Mullet specimens were collected during the period May 2010 – September 2018 from the areas of Burgas Bay (Fig. 1). The samples were collected by cast nets fishing – the size of the eye 22-38 mm, length 50 m and height of the nets between 1.5 and 2 m.

A total of 2131 individuals were used to study the size-age structure and the growth rate of the mullet specimens.

For each specimen standard length ($L \pm 1$ mm). The age was determined by the scales at a magnification of 17.5X with Projector Dokumator, Lasergeret (Carl Zeiss, Jena).

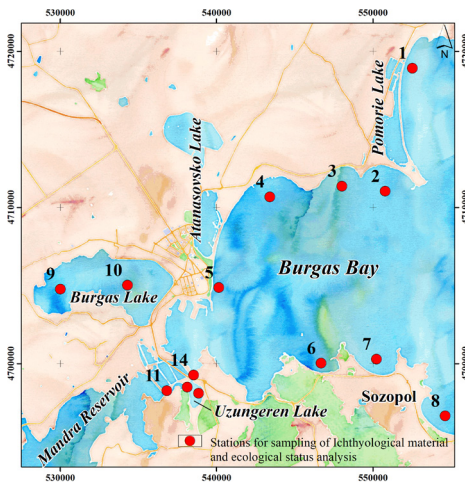
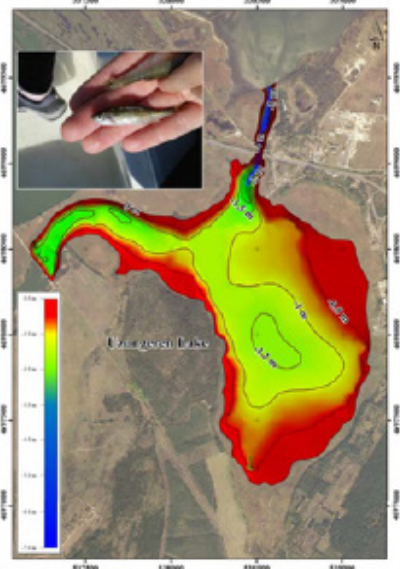


Fig. 1 Stations for a sampling of Ichthyologic material and ecological status analysis

Fig. 2 Bathymetric map of the Uzungeren Lake (Poda locality) (Bekova et al. 2018)



The monitoring, as well as the assessment of the ecological status of the coastal marine waters for the given period were carried out by the Institute of Oceanology - BAS according to the Agreement № Д-33-5 / 28.01.2016 between the MoEW and the Institute in implementation of Art. 171, para. 2, it. 3 of the Water Act

RESULTS AND DISCUSSION

The main objective was to extend and deepen the knowledge of the population- biological characteristics of the three species of mullets as in the case the ecological status of Burgas Bay was defined under the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD) and an ecosystem scale approach was used to determine the level of contamination with nutrients and their impact on the mullet populations.

An analysis of the age composition of the caught ichthyologic material for the period 2015-2018 was made. (Fig. 3).

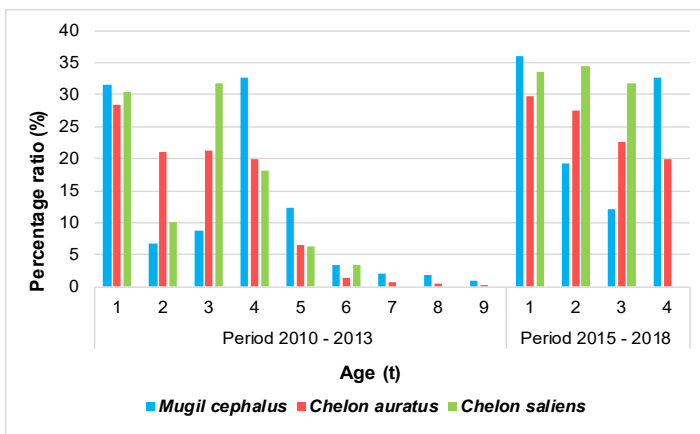


Fig. 3 Age distribution of mullets from Burgas Bay for two periods

These results were compared with a previous survey for the period 2010 - 2013. Four age groups were determined for the period 2015-2018, with the absence of five age groups compared to the previous period for flathead grey mullet and golden grey mullet. Three age groups were determined for the period 2015-2018 for leaping mullet. These results are with two age groups less, compared with the previous period. This is probably due to the loss of mullets' natural winter habitats, such as Lake Burgas, Lake Mandra (currently Mandra Dam) and overexploitation of their populations. Dimensional structure analysis showed something similar (Fig. 4).

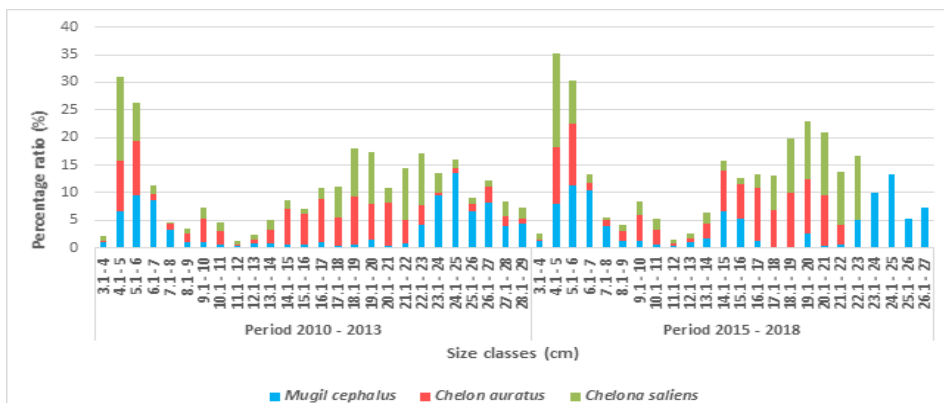


Fig. 4 The size structure of mullets from Burgas Bay for two periods

For the three species of family Mugilidae for the period 2010-2013 the size classes are from 3.1 cm to 29 cm. For the period 2015-2018 the registered specimens of the golden grey mullet were up to 22 cm and of the leaping mullet – up to 23 cm. Seven size classes were missing for the golden grey mullet and six for the leaping mullet. This result may indicate over-exploitation of the catches or the loss of habitats has a substantial impact on the state of the populations of species from family Mugilidae as well as the worsened environmental state of the habitat in recent years (Table 1 and Table 2). After analysis it was found that the habitats were extremely shallow and inappropriate for wintering of mullets. During the investigation (period 2015-2018), hypoxia and high phytoplankton blooms were registered (for spring – autumn period 2018), resulting in the mass extinction of the ichthyofauna. In Burgas and Atanasov lakes no mullets were registered. The collected material from Pomorie region is still to be analyzed. The collection of material will continue in the coming year and the database that has been accumulated so far will be improved and updated.

An analysis of the trend in the change of the ecological status of Burgas Bay was made (Table 1 and Table 2).

Table 1. Trends in the changes in the ecological status of the coastal water bodies in Burgas Bay.

2011	2012	2013	2014	2015	RBMP 2016-2021	2016
					BG2BS000C1208	moderate
					BG2BS000C1308	poor
moderate	poor	moderate	not assessed	not assessed	BG2BS000C009	
poor	poor	moderate	moderate	moderate	BG2BS000C1010	moderate
moderate	moderate	poor	not assessed	not assessed	BG2BS000C1011	moderate

Table 2. Assessment of the chemical status of the water bodies in Burgas Bay for 2016

Name of the station	Assessment of chemical elements - water matrix	Assessment on organic pollutants matrix water	Matrix biota	Assessment of the chemical status of the water body
Koketraiz	Not good standing - Cd	Good		Not good standing
Pomorie	Good*	Not good standing - Tributyltin compounds		Not good standing
Rosenets	Not good standing - Cd, Pb	Not good standing - Tributyltin compounds		Not good standing
Burgas Bay	Good	Good		Good
Cape "Maslen nos"	Good	Good		Good
Sozopol	Good	Good	Not good standing - PBDE content, Heptachlor and Heptachlor-epoxide, Hg	Not good standing

Over the years, the environmental status varied from good to bad, with the area covered by the study being in poor condition according to the majority of biological quality and chemical elements (according to WFD and MSFD). An analysis of the catches of mullets was also made (according to NAFA data, Fig. 5). A sharp drop in the catches of flathead grey mullet, golden grey mullet and leaping mullet was observed.

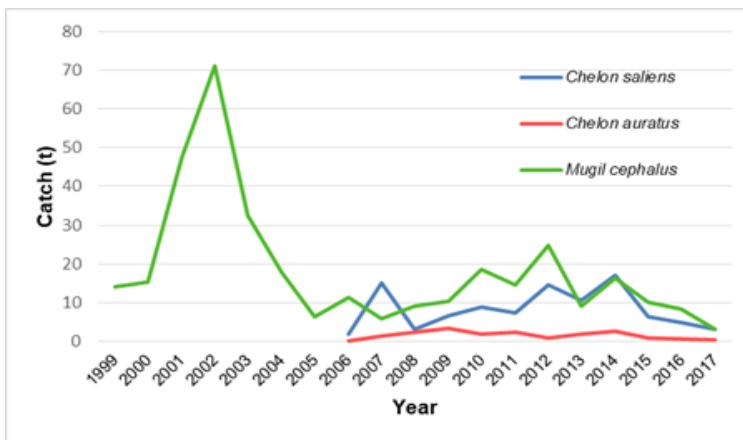


Fig. 5 Catches of mullets from the Bulgarian Black Sea water area

CONCLUSION

The lack of certain age and size classes for the period 2015-2018 compared to 2010-2013 speaks for worsening environmental conditions and the durable fishing press leading to a sharp decline in the stock of mullets. Over the years, the environmental status varies from good to bad, with the area covered by the study being in poor condition according to the majority of biological quality elements. According to the NAFA data, catches of mullets fish have fallen sharply in recent years.

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DECLARATION OF INTEREST

The authors declare no existing conflict of interest.

AUTHORS CONTRIBUTION STATEMENT

RB collected the data, analyzed the biological data, wrote the manuscript. BP collected the data, analyzed the bathymetric data, wrote a part of “Materials and Methods”. TL collected the data.

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