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Fish and Fisheries
Prespa Lake

Implementing the EU Water Framework Directive in South-Eastern Europe

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Conservation and Sustainable Use of Biodiversity at Lakes Prespa, Ohrid and Shkodra/Skadar (CSBL)

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Michael Pietrock, Project Manager, Institute of Inland Fisheries, Potsdam, Germany

Disclaimer

Content

List of Abbreviations

ALB	Albania
BPUE	catch (in biomass /m^2 of net) per unit of effort
conduct.	conductivity
CPUE	catch per unit of effort
CSBL	Conservation and Sustainable Use of Biodiversity at Lakes Prespa, Ohrid and Shkodra / Skadar
HIO	Hydrobiological Institute Ohrid
ind.	individuals
LFI	Lake Fish Index
MARDWA	Ministry of Agriculture, Rural Development and Water Administration (Albania)
MEFWA	Ministry of Environment, Forestry and Water Administration (Albania)
MK	Macedonia
MMG	multi-mesh gillnet
MoE	Ministry of Environment
NPUE	catch (in numbers /m^2 of net) per unit of effort
SB	sub-basin
TACQ	total allowable catch quota
temp.	temperature
WFD	Water Framework Directive

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Foreword

The fish fauna of the three great lakes of the Western Balkans is one of the richest and most diverse in Europe. Lake Prespa, the most isolated lake, is home to thirteen indigenous fishes, including endemics such as Prespa barbel. In addition, eight non-native species are believed to have been introduced into the lake, either deliberately or through negligence. Some of these alien species, e.g. carp, are of high commercial value while others impress by their sheer abundance more than by their economic potential (e.g. bitterling).

The management and sustainable use of the lake's fishes poses manifold challenges to competent authorities and small-scale fishers alike. First, vulnerable species are protected under national and EU nature conservation legislation and require special conservation efforts. Second, economic species such as carp or bleak are exploited haphazardly and sometimes illegally with little if any knowledge on the status of stocks and maximum sustainable yields. Third, fisheries regulations differ among countries and are, in any case, poorly implemented. Lastly, fishes are one of four so-called biological elements – or indicators – that determine the ecological status of lakes according to the EU Water Framework Directive. The Directive requires that good ecological status, i.e. the status of the fish fauna (and other biota) under nearly undisturbed conditions, has to be maintained or restored, and that specific measures are to be taken to fulfil this requirement.

However complex and variable these challenges may be, they have one thing in common: the need for data and up-to-date information on the status of the fish fauna of the lake. Yet sampling fish is anything but a small undertaking in terms of both effort and finance. The last comprehensive stock assessments had been made during communist times in both countries. In those days, annual catch statistics were collated by fishing authorities, providing a fairly sound basis for the management of stocks. Unfortunately, such statistics are no longer collected, let alone data from independent monitoring campaigns.

It is from this perspective that German Development Cooperation supported partner countries in conducting multi-annual fish sampling pursuant to fishing standards set by the European Committee for Standardization, of which Albania is an affiliate and Macedonia a full member. Standardized sampling was carried out in three consecutive years jointly by Albanian, German and Macedonian experts, yielding a prolific data base on more than 63,000 specimens of fish, and an outline of the present-day composition and abundance of fish assemblages in Lake Prespa. For species such as bleak data sets were sufficiently large to derive immediate management recommendations while other species of economic and/or conservation importance require further monitoring as well as employment of different fishing gear before firm conclusions on their management can be drawn. Furthermore, a Lake Fish Index was derived to define tentative reference conditions and assess the ecological status of the lake according to the Water Framework Directive, using fish as biological element.

In any case, the present investigation generated the most comprehensive data set since communist times. Investigators and authors are acknowledged not only for gathering and analysing this wealth of information but also for doing it collaboratively and compliant with recognized methods. Fishing authorities in turn are encouraged to make best use of the data, and to ensure that adequate resources are allocated for future monitoring, including collation of catch statistics.

Dr Ralf Peveling
Program Manager CSBL

1 SUMMARY

Prespa Lake[1] is a large (but relatively shallow) natural waterbody located on the Balkan Peninsula. The exact age of the lake is still under discussion but it is considered an ancient lake more than one million years old. A special feature of the lake is the occurrence of many endemic species, which make it a highly valuable environment in terms of biodiversity and species conservation. Prespa Lake is an important part of Europe's natural heritage and is shared by the riparian countries Albania, FYR of Macedonia[2], and Greece.

Starting in 2012, the Technical Assistance program *Conservation and Sustainable Use of Biodiversity at Lakes Prespa, Ohrid and Skadar/Shkodra* (CSBL) has been implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry of Economic Cooperation and Development. A main objective of this program has been to foster transboundary management of the natural resources of the three Balkan lakes in accordance with the EU's environmental and biodiversity protection objectives. On this account, fish sampling campaigns were conducted compliant with the requirements of the EU Water Framework Directive (WFD). While the data generated primarily address questions related to the WFD, they also provide insights into current composition of the fish community, as well as on spatial distribution of species in the lake, their relative share in terms of abundance and biomass (catch per unit of effort) and length classes of fishes.

During the fall of 2013, 2014 and 2015, multi-mesh gillnet (MMG) fishing was performed in various parts of Prespa Lake and in line with the European standard EN 14757. In total, 528 nets (composed of twelve panels each with mesh sizes ranging from 5 to 55 mm) were randomly set in seven sub-basins located at Albanian and Macedonian territories. Sampled fish were identified to species and length and weight of collected specimens were taken. Additionally, for a preliminary analysis of the ecological status of the lake compliant to WFD, suitable metrics were identified and class boundaries set.

Based on a sample size of over 63,000 fish, the main results of the fish sampling campaigns were as follows:

- The collected fish belong to 15 species: carp (*Cyprinus carpio*), Prespa bleak (*Alburnus belvica*), Prespa roach (*Rutilus prespensis*), Prussian carp (*Carassius gibelio*), Prespa barbel (*Barbus prespensis*), Prespa nase (*Chondrostoma prespensis*), spirlin (*Alburnoides prespensis*), Prespa chub (*Squalius prespensis*), bitterling (*Rhodeus amarus*), stone moroko (*Pseudorasbora parva*), tench (*Tinca tinca*), Prespa minnow (*Pelasgus prespensis*), Prespa spined loach (*Cobitis meridionialis*), Prespa trout (*Salmo peristericus*) and pumpkinseed (*Lepomis gibbosus*). The caught specimens thus represent 75 % of the fish species known to currently inhabiting the lake.
- Differences in species occurrence exist primarily between pelagic and littoral habitats, but were not that obvious between Albanian and Macedonian sampling sites. For example, the open water (pelagial) is largely populated by Prespa bleak and roach (and pumpkinseed), while the shoreline areas (stratum 0-3 m) are populated by bitterling, stone moroko and spirlin.
- In terms of biomass, the Prespa Lake fish community is dominated by five species: bleak, spirlin, roach, bitterling and stone moroko.
- Alien species (especially bitterling and stone moroko) are widely distributed across the lake and, in terms of numbers, combined represent more than 50 % of all fish.

[1] Prespa Lake consists of two connected lakes (Lake Macro Prespa and Lake Micro Prespa), of which only Lake Macro Prespa is in focus of the current report.

[2] Upon decision of the General Assembly of the United Nations in 1993, Macedonia is provisionally referred to as "The former Yugoslav Republic of Macedonia", pending settlement of the difference that had arisen over its name. For the ease of reading and without prejudice, henceforth the name Macedonia is used.

- In all three years of sampling, Prespa bleak formed a significant part in the catches at all sampling sites. Additionally, the bleak population was made up of juveniles and potential spawners (i. e. adult fish) at all sites indicating, in combination, that the population of Prespa bleak seems to be relatively stable. Similarly, the high number of both large and small Prespa roach individuals found at all sites and throughout all sampling years suggests high stock stability also for this species.
- The number of carp individuals in the catches was low relative to other species and, in terms of biomass, in the current study carp contributed only moderately to overall biomass values. It is conceivable that maximum mesh size used in the sampling campaigns (55 mm) was not sufficient to catch larger specimens, which supports findings from former studies in other European waters.
- A preliminary system to assess the ecological status based on fish according to the WFD showed a moderate status of Prespa Lake.

In summary, as a standardized fish monitoring across territorial borders has never been performed at Prespa Lake, current results provide both qualitative *and* quantitative information on fish populations of Prespa Lake.[3] Fishing with MMG provides reasonably good information on fish assemblage regarding composition, relative abundance and biomass (CPUE), and size structure of the individual fish populations (Appelberg 2000, Emmrich et al. 2012). Nonetheless, for monitoring purposes sampling should be complemented by additional nets of larger mesh sizes as well as by other gear to sample species that can typically not be caught by gillnets (like e.g., European eel).

Moreover, future fish monitoring should ideally include littoral and pelagic sampling sites to account for habitat-specific differences in numbers of species and individuals. Current quantitative data furthermore show that not all fishes of Prespa Lake are under significant pressures and, therefore, generalizations are treated with caution and a species-specific view is recommended instead. Ideally, a coordinated transboundary management is advised to preserve ecologically important (endemic) species and to sustainably use the economically interesting ones.

[3] For similar reports on Lakes Ohrid and Shkodra/Skadar, see Spirkovski et al. (2017) and Mrdak et al. (2017), respectively.

2 INTRODUCTION

Prespa Lake (also known as Macro Prespa) is located on the Balkan Peninsula in south-eastern Europe. It is of tectonic origin and, although the lake's exact age is still under debate (Cvetkoska et al. 2015, Wagner & Wilke 2011) it is considered an ancient lake (Jovanovska et al. 2015) likely being more than one million years old (Wagner & Wilke 2011). Prespa Lake is blessed with an extraordinary high diversity of animal and plant species, many of which are endemic either to the lake or to the region (Oikonomou et al. 2014). Out of the 25 fish species that have been reported from this waterbody, eight species are endemics (Spirkovksi et al. 2012).

In the Prespa area, fishery has always been playing an important role for provision of food to local people. Nowadays, fishing still contributes significantly to the household income of people from the nearby villages (Ceroni 2013, Grazhdani et al. 2010, Spirkovksi et al. 2012) and about 120 professional fishers (Albania and Macedonia combined) currently make their living from these aquatic resources. Exact data are difficult to obtain, but it is estimated that present catches of Albanian and Macedonian fishermen sum up to approximately 370 t per year (information from the Albanian MEFWA).

Sustainable management of living (aquatic) resources in Prespa Lake and its surroundings depend on sound data and information. Over the last decade many conservation projects of different scale have been undertaken in the Prespa region which, in general, aimed to maintain biodiversity and to protect local habitats and species for current and future generations. Importantly, reports derived from those projects as well as scientific articles often stress the scarcity or even lack of recent information related to Prespa Lake fish stocks (Anonymous 2005, Hartman 2008).

In 2012, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry of Economic Cooperation and Development started implementing a Technical Assistance program (CSBL) in the European Union (EU) candidate countries Albania, Macedonia and Montenegro targeting, among others, improvement of the ecological status of Lakes Prespa, Ohrid and Shkodra/Skadar compliant to requirements of the Water Framework Directive (WFD) (Anonymous 2000). In the course of this programme, fishing was conducted on Macedonian and Albanian territories of Prespa Lake by use of multi-mesh gillnets (MMG) in accordance with the standard EN 14757 (European Committee for Standardization 2015), which is an accepted method to collect fish in the context of WFD investigations and beyond. This procedure provides a whole-lake estimate for species occurrence, quantitative relative fish abundance, biomass (expressed as catch per unit effort, CPUE) and size structure of fish assemblages. These data can as well be important from a fisheries perspective as they shed light on the status of fish stocks. The current report is based on these MMG fishing campaigns. It provides the most recent and comprehensive information on the state of Prespa Lake fishes and derives knowledge-based measures for a sustainable use of these biological resources.

Additionally, using fish as a biological quality element, an assessment of the ecological status of Prespa Lake according to WFD standards is presented. The WFD aims at establishing or preserving a good ecological status in all water bodies (Anonymous 2000). As a prerequisite, the current ecological status has to be evaluated in order to estimate the necessity of measures. The evaluation needs to be done on the basis of so called biological quality elements, with fish being one element (the others are phytoplankton, macrophytes and macrozoobenthos). The fishing campaigns during the CSBL project provided data obtained with a standardized and comparable methodology. Based on this data, a system for the assessment of the ecological status of Prespa Lake based on fish could be developed (Lake Fish Index - LFI). The development of the LFI followed the principles of the WFD, accompanying documents and existing systems (CIS 2003 a, b, 2011, Gassner et al. 2014, Olin et al. 2014, Ritterbusch et al. 2017 a). It, however, needs to be outlined that the LFI presented here is highly preliminary. It provides a first basis for future actions to adopt the WFD, but is not approved as yet by competent authorities.

3 PRESPA LAKE, ITS FISHES AND FISHERY

3.1 Prespa Lake

The Prespa Lakes Basin is a high altitude system (850-2,600 m) with a catchment area of over 2,500 km^2. It includes Lakes Macro and Micro Prespa and covers parts of the territories of Albania, Macedonia and Greece. Lake Macro Prespa (Figure 1), which is in focus of the current report and henceforth called Prespa Lake, is a subtropical dimictic lake. According to Matzinger et al. (2006) it has a surface area of currently about 254 km^2 with a maximum water depth of 48 m (mean 14 m). Micro Prespa is of much smaller size (surface area 47 km^2) and has a maximum water depth of 9 m. Prespa Lake has four tributaries: Agios Germanos (Greek part), Brajcinska, Kranska and Golema Reka (Macedonian part). At the Albanian territory there are no perennial streams feeding the lake. In a recent study commissioned by CSBL, the drainage basin comprising Macro and Micro Prespa has been divided into four main sub-basins or hydrogeomorphological areas (Blinkov et al. 2017).

Nearly 30,000 people live in the region with the majority residing in Macedonia. There is extensive industry in the area and the main source of income is agriculture which is estimated to employ about 75% of the work-force (Popovski 2006).

Figure 1. Sampling at Prespa Lake

As a result of intensive agricultural activities, since the late 20th century the ecosystem of the Prespa Lakes has been subject to excessive nutrient inputs and subsequent dramatic over-abundant plant growth (eutrophication) (Patcheva 2005, Matzinger et al. 2006, Trajanovska & Talevska 2016). The trophic state of the lake developed from oligotrophic in the mid-70's to mesotrophic in the following two decades and to eutrophic status (Peveling et al. 2015) from the turn of the century. Changes in trophic conditions are demonstrated by physico-chemical water parameters and the development of phytoplankton communities (Levkov et al. 2007, Petrova et al. 2008, Jovanovska et al. 2015). Concurrent with an increase in nutrient loading, reduced water levels resulting from over-exploitation of lake water for irrigation purposes also contributed to significant changes in environmental conditions of the lake. Water transparency, for example, is now substantially lower than it was only some decades ago (Stankovic 1929, Löffler et al. 1998). Similarly, average water temperatures during winter have decreased by approximately 4° C over the last 20 years as a result of reductions in the water level (Matevski et al. 2013). Reduced temperatures, in turn, have led to the freezing of the lakes' littoral zones during cold season. The dissolved oxygen concentrations now found in the Prespa lakes are typical of eutrophic lakes. The presence of anoxic areas with limited or no oxygen in the water column below 15 m (Spirkovski 2004) is nowadays a regular phenomenon during the stagnant summer period. In addition to substantial changes in water quality occurring over the last few decades, Prespa Lake also experienced a dramatic decline in water levels (Popovska & Bonacci 2007).

The diverse biota of the region is worth special mention. The geography, soil types and climate coupled with the relatively low human population and moderate anthropogenic impact on the basin resulted in high species diversity and a significant proportion of endemic species. The Prespa Lake region has been recognized as a European and global hotspot of biodiversity (Stankovic 1960), not only because of the sheer number of species and habitats present, but also due to their quality, such as rarity and conservation significance. The total number of animal species, recorded in Macedonia's part of Prespa Lake watershed is over 2.500, of which 375 are vertebrates. Today one National Park in Albania (Prespa NP) and two in Macedonia (NP Galicica and Pelister NP) protect animal and plant diversity in the area.

3.2 Fish fauna of Prespa Lake

Twenty-five fish taxa have been identified in the Prespa Lakes (Table 1). With the exception of catadromous European eel, *Anguilla anguilla*, none of them is a migratory species.

Out of determined 13 native fishes, 8 species are endemics: Prespa spirlin, Prespa bleak, Prespa barbel, Prespa nase, Prespa minnow, Prespa roach, Prespa trout and Prespa chub (Spirkovski et al. 2012 a).

At first sight, the proportion of endemism in the fish populations of the Prespa Lakes seems remarkable. It should be mentioned however, that, according to Crivelli et al. (1990, 1997), the taxonomic position of a number of taxa occurring in the Prespa Lakes remains doubtful. At present, only the barbel would appear to be undoubtedly endemic to (Micro and Macro) Prespa Lakes (Dupont & Lambert 1986, Economidis 1989, Catsadorakis et al. 1996, Crivelli et al. 1996). Prespa barbel also presents species with some economic importance in the Prespa watershed (Kapedani et al. 2009).

According to Economidis (1992), two endemic species (Prespa barbel and Prespa trout) are classified as "endangered", which is an important criterion used for identification of priority species for conservation of animals in Prespa Region. Both species are listed as "vulnerable" species on the IUCN Red List of Threatened Animals (Globally threatened species and Regional-European threatened species) (Freyhof & Brooks 2011). Further, Prespa barbel is present in all three countries (Macedonia, Albania, Greece) sharing Prespa Lake, which is important for transboundary collaboration in terms of species conservation. Pelister stream trout (*Salmo peristericus*), on the contrary, can be only found in Macedonian and Greek rivers (River Braychinska and its tributaries, Agios Germanos stream, and others) of the Prespa basin (Crivelli et al. 2008).

While the status of some non-indigenous fishes is currently not clear, a recent survey by Shumka et al. (2015) reported about occurrence of six non-indigenous species (Prussian carp, carp, stone moroko, bitterling, tench and pumpkinseed) in Prespa Lake.

Table 1. Fish species of Prespa Lake

Latin name	Common name	native species	alien species introduction	alien species last record
Cyprinidae				
Alburnoides prespensis	Prespa spirlin	+		
Alburnus belvica	Prespa bleak	+		
Barbatula sturanyi	Stone loach	+		
Barbus prespensis	Prespa barbel	+		
Carassius gibelio	Prussian carp		1970's	
Chondrostoma prespensis	Prespa nase	+		
Ctenopharyngodon idella	Grass carp			1980's
Cyprinus carpio	Carp		+	
Hypophthalmichthys molitrix	Silver carp			1980's
Pelasgus prespensis	Prespa minnow	+		
Phoxinus lumaireul	Minnow	+		
Parabramis pekinensis	Bream			1970's
Pseudorasbora parva	Stone moroko		1970's	
Rhodeus amarus	Bitterling		1990's	
Rutilus prespensis	Prespa roach	+		
Squalius prespensis	Prespa chub	+		
Tinca	Tench		1980's	
Centrarchidae				
Lepomis gibbosus	Pumpkinseed		1995/96	
Poeciliidae				
Gambusia holbrooki	Mosquito fish		1960's	
Salmonidae				
Salmo peristericus	Prespa trout	+		
Salmo letnica	Lake Ohrid trout			1950's
Oncorhynchus mykiss	Rainbow trout			1970's
Siluridae				
Silurus glanis	Catfish		1980's	
Anguillidae				
Anguilla anguilla	European eel	+		
Cobitidae				
Cobitis meridionalis	Spined loach	+		

The spawning season for most of the fish species present in the lake is within the period of April to June, with exception of the salmonids (trout) which spawn in the connected rivers from November to March. Another exception is the alien pumpkinseed (*Lepomis gibbosus)* (Figure 2) which spawns twice a year – in spring and autumn. Different habitats within the lake are preferred by the fish for reproduction. For example, lithophilous species (such as spirlin) deposit their eggs on gravel and stony substrates whereas phytophils (such as carp) require submerged vegetation for spawning (Spirkovski et al. 2012 a).

Figure 2. Pumpkinseed (*Lepomis gibbosus*) (© L. Stefanov)

Stocking of Prespa Lake was performed only with autochthonous carp fingerlings starting from 1971 from the state-owned hatchery in the village of Zvezda (Albania). From 1990 onwards, only Macro Prespa has been stocked using fry and fingerlings (Figure 3) (Spirkovski et al. 2012 b).

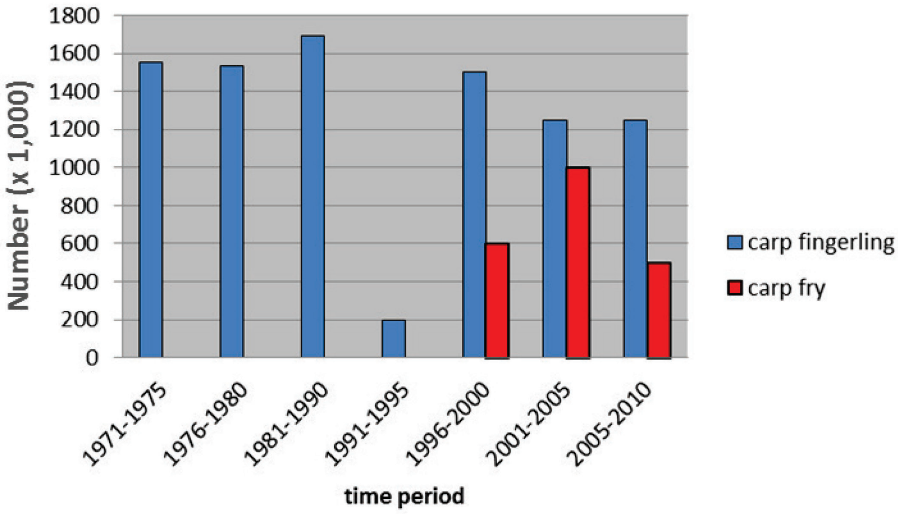


Figure 3. Number of carp fingerlings and fry stocked in Prespa Lake between 1971 and 2010 (Spirkovski et al. 2012 b)

3.3 Fisheries

Fishery activities at Prespa Lake have been undertaken since ancient times. At present, fishing is allowed in all three riparian countries sharing this waterbody (Albania, Macedonia and Greece). Fishing is performed in a traditional way, i. e. at small-scale, with low capital and technology investments, and undertaken by fishermen from individual households (as opposed to large fishing companies).

3.3.1 Albania

At present there are 50 professional fishermen conducting fishery at Prespa Lake (Shumka et al. 2009). These fishermen, however, are also engaged in other agricultural activities in their home villages during times they are not on the lake. Statistics on Albanian catches of Prespa Lake exist from 1954 (Figure 4). Beginning in the 1970s, a distinct increase in total catches was noted but dropped again towards the end of last century.

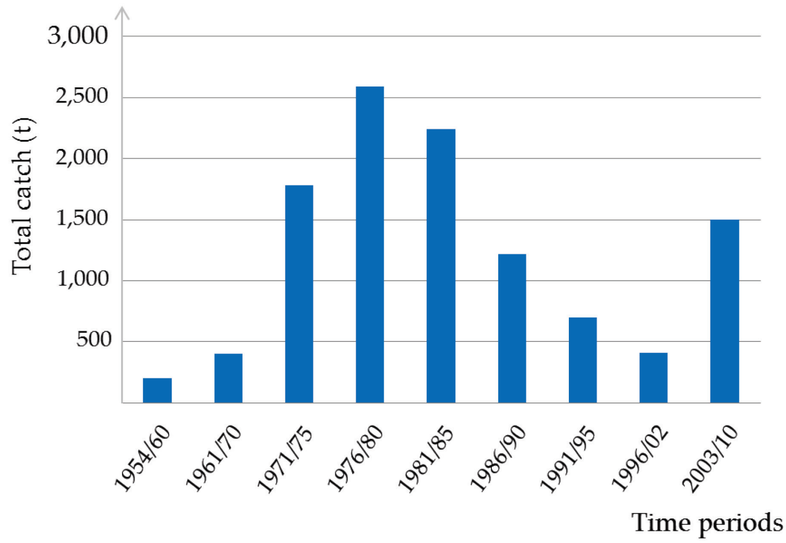


Figure 4. Temporal course of Albanian fish catches at Prespa Lake (modified from Spirkovski et al. 2012 b).
Note: time periods shown on y-axis differ in length

In view of catch composition, Prespa bleak in particular and carp contribute most to overall catches (Table 2).

Table 2. Composition of fish catches at the Albanian side of the Prespa Lakes 1954-2010 (modified from MEFWA-Fishery)

Period	Bleak (%)	Carp (%)	Nase and others (%)*	total catch (t)	Yield (kg/ha)**
1954-1960	67	20	13	150	28.7
1961-1970	82	13	5	370	70.9
1971-1975	91	3	6	1,807.2	346.2
1976-1980	95.5	0.5	4	2,598.9	497.9
1981-1985	96.5	0.5	3	2,241.5	429.4
1986-1990	91	4	5	1,217.7	233.3
1991-1995	87	5	8	693.3	132.8
1996-2000	92	6	2	620.0	118.8
2001-2010	94	4	2	630.0	120.7

* Nase and other species after 1991, ** 5,220 ha water surface

Fish data collection is based on the Law 7908 dated 05/04/1995 as well as on the Regulation No. 1 dated 26/03/1997. The declaration of statistical data is one of the fundamental prerequisites for the renewal of fishing licenses. In the context of the further improvement of the data collection system for fisheries and of approximating Albanian legislation to that of the EU, preparatory work has begun on the improvement of the data collection system in the fisheries sector. It consists in the consideration given to the EC Regulations No. 1543/2000 dated June 29, 2000 which determines the "Community structures for the collection and processing of necessary data in order to follow common policies in fisheries", as well as the EC Regulation No. 1639/2001 dated July 25, 2001 that establishes a "minimal program and a broad program for data collection in the fisheries sector and determines the ways to apply the Regulation (EC) 1543/2000". These regulations provide the basis for the establishment of an efficient system of data collection as well as the development and funding of monitoring programs.

In reality, however, the system can hardly be considered as reliable because of several reasons: (i) large number of illegal fishermen; (ii) no location for inspection of catches; (iii) low awareness level and responsibility of fishermen, and (iv) complicated marketing approaches.

Environmental monitoring in Albania was first stipulated in the Decision of the Council of Ministers (DCM) No. 103, 31 March 2002. This DCM was abrogated by the DCM No. 1189 of 2009, for the development and implementation of environmental monitoring in Albania. The overall structure and main components of a monitoring system were outlined by the EU funded project "Strengthening of the Environmental Monitoring System in Albania" (StEMA, 2006-2008). This Project designed a nationwide, modern and cost-effective Integrated Environmental Monitoring System (IEMS) covering all major environmental topics. It was based on EU requirements and EEA recommendations for monitoring and reporting to ensure harmonization and comparability of data. There are two integrated stations foreseen for Prespa Lake including monitoring of fish and fishery. For various reasons it has not been implemented so far.

The adopted Law No. 10341 dated June 9, 2011 on Environmental Protection sets out the framework for providing a high level of protection for the environment, its preservation and improvement, prevention and reduction of the human health associated risks and improvement of the life quality of today and next generations as well as ensuring sustainable development. Amongst others, it includes: (i) prevention and control of pollution, (ii) environmental monitoring and (iii) environmental information. Currently National Environmental Agency (NEA) is responsible for environmental monitoring and thus for the IEMS and the Environmental Information Management System. Further to that, in the period of 2011-2014, the EU IPA project "Consolidation of the Environmental Monitoring System in Albania" was implemented, with the specific objective to support the Ministry of Environment, Forestry and Water Administration to implement a National Monitoring Program through the expansion and consolidation of an operational Integrated Environmental Monitoring. There are still several gaps to fill until the system becomes operational with all its components, including fish and fishery as a crucial biological element in WFD assessments.

There is a joint priority species conservation plan for Prespa barbel, prepared in the frame of UNDP project with defined overall conservation goals and strategy, institutional setup, threats and efficient conservation actions (DEKONS-EMA 2009). Other national laws, including fisheries related laws in Albania, are giving a full set of actions to secure species protection, such as:

- Law no. 7664, dated 21.01.1993, concerning environmental protection
- Law no. 7875, dated 23.11.1994, concerning protection of wild fauna and hunting
- Law no. 7908, dated 05.04.1995, on fishing and aquatic life
- Law no. 8870, dated 21.03.2002, amended by the law no. 7908 dated 5.04.1995, on fishing and aquaculture
- Law no. 7, dated 15.01.2008, on fishery and aquaculture
- Law no. 64 dated 31.05.2012, on fishery
- Decision no. 80, dated 18.02.1999, designation of Prespa as "National Park" and of Pogradeci as "Protected Landscape Area"
- Law no. 8763, dated 02.04.2001, concerning amendment of the law no. 7908, dated 05.04.1995, on fishing and aquaculture
- Law no. 8906, dated 06.06.2002, on protected areas
- Law no. 8934, dated 05.09.2002, on environmental protection
- Law no. 9103, dated 10.7.2003, on protection of transboundary lakes
- Law no. 9587, dated 20.07.2006, on biodiversity protection
- Order no. 262, dated 15.05.2006, approving the status of "Fishery Management Organizations (FMO)"
- Decision no. 146, dated 08.05.2007, on approving the "Red List of Flora and Fauna"
- Law no. 87, dated 15.07.2008, on water.
- Law no. 10341 dated 09.06. 2011, on environmental protection
- Law no. 111, dated 15.12.2012, on integrated water resources management.

In March 2015 the fishery sector moved from the Ministry of Environment to the Ministry of Agriculture, Rural Development and Water Administration (MARDWA) and the Directory of Fishery is administratively functioning as a part of General Directory of Politics. Within this body exist the sectors of Fishery Policy, and Aquaculture and Inland Water Policy.

This Ministry prepares the strategy for the lake fishery sector, the fisheries management plans and acts accordingly. For example, this Ministry is responsible for issuing the fishing licenses for the lake and for the number of persons allowed to fish in the lake. There are in force also these legislative acts: Law No. 7908, dated 5.4.1995, on fishery and aquaculture, amended and Regulation No. 1 date 29.3.2005, for application of the legislation on fishery and aquaculture, which determine the various regulating aspects for Prespa Lake (MEFWA 2009).

Regarding the enforcement of the law and of the activities a fishing inspector responsible for the Korça district has the power and responsibility to control their enforcement. Other important aspect of this law is the set of the Fishing Inspectorate as the responsible and competent body in executing fishery laws, bylaws and regulations. The coordination of the inspection activities is responsibility of the Ministry, and the Fishing Inspectorate is included as a division in the Directorate of Fishery Policy. The Inspector also reports on monthly basis in the Ministry for the status of the fishery activities in the lakes and the measures and penalties taken.

Specific details (as outlined in the current Albanian fishery legislation) related to the fisheries management at Prespa Lake are as follows:

a) To achieve sustainable fish exploitation, the Directory of Fishery Policy has to prepare an administrative and development plan for the fishery and aquaculture sector.
b) To have a booking right in the Professional Fishermen Register, the requested person should practice professional or seasonal fishing within a Fishery Management Organization.
c) In inland waters, the license may be given to one or several boats, but the number have to be specified in the license.
d) The interruption of the fishing license is a competency of the fishing inspectors.
e) Catches by nets and hooks in Prespa have to be landed and traded first in centers approved by competent Veterinarian Authorities.
f) It is forbidden to fish, carry on board or transit on the boat, purposed landing and trading with whatever means and tools all fish species in Prespa Lakes for a period of one month per year.
g) It is forbidden to fish and sell water organisms with dimensions less than: *Alburnus* spp. 10 cm, *Chondrostoma* spp. 15 cm, *Rutilus* 12 cm, *Leuciscus* 15 cm, *Cyprinus carpio* 30 cm, *Carassius* spp. 15 cm (Table 6).
h) It is prohibited to change water quality and the flow direction.
i) It is prohibited to cut water vegetation without the approval of responsible bodies.
j) It is forbidden to carry in boats or use nets by mesh size less than 66mm for carp in Prespa Lake.

Several fish and fishery activities are subject of "Management Plan of Prespa National Park 2014-2024", already in implementation stage. Within plans, different zones can has identified, reflecting the specific ecological particularly in terms of spawning grounds, zones of the protected area within aquatic surface, social or economic objectives being pursued in specific areas. Further to that plan it appeals for strong control and respect of fishery ban period, number of licensed fishermen, type of nets, etc.

3.3.2 Macedonia

Prespa Lake's meso- to eutrophic character enables a relatively high fish production. Annual fish catches differ from year to year and varied from 173 t in the 60's to only about 20 t towards the end of the last decade (Spirkovski et al. 2012 b). The price of fish was relatively low through decades and in the period before the moratorium moved from a minimum of 0.5 €/kg for bleak up to 3.5 €/kg for carp. Since 2013, there is a concessioner managing Prespa Lake fish stocks. At present, there are about 45 professional fishers working for the concessioner at the Macedonian part of Prespa Lake.

Fishery statistics for Prespa Lake dates back to the year of 1946 (Annex III Table 27). Different species are predominant in the annual catches (Figure 5) depending on market demand and fishing gears used. In the period after Second World War trawls and seine nets were used, than in the beginning of 1960's purse seine net was introduced as a new fishing gear which results with higher percentage of bleak in the annual catch with 55 tons per year. Market demand for the same species in the 1990's derived with presence of more than 80% of the bleak in the commercial catch with 65 tons per year.

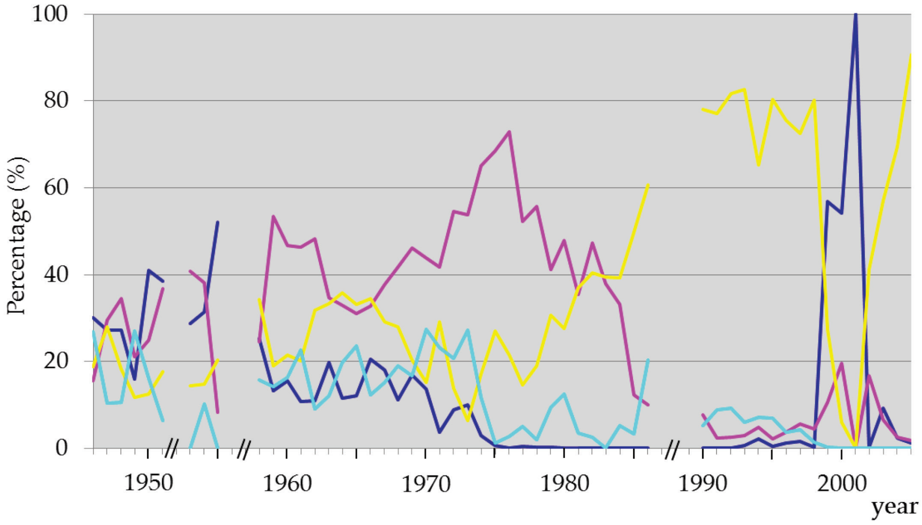


Figure 5. Percentage of carp (dark blue), bleak (yellow), nase (purple) and roach (light blue) in annual fish catches of 1946-2006 at the Macedonian part of Macro Prespa Lake (Spirkovski et al. 2012 b)

In 2007 the existing "Law on Fishery" (from 1993) has been replaced with the "Law on Fishery and Aquaculture" (LFA) Official gazette7/2008 date 15.01.2008. This law has eight amendments: one in 2010 - Official gazette 67/10, two in 2011: Official gazette 47/11 and 53/11, in 2012 - Official gazette 95/12, in 2013 - Official gazette 164/13, in 2014 - Official gazette 116/14 and two in 2015: Official gazette 154/15 and 193/15.

The following documents are complimentary to the Law on Fishery and Aquaculture:

- „Law for the protection of Ohrid, Prespa and Dojran Lake", Official gazette 45/1977 date 09.09.1977. This law has four amendments: one in 1980 Official gazette 08/1980, one in 1988 Official gazette 51/1988 and one in 1990, Official gazette 10/1990 and one in 1993, Official gazette 62/1993.
- „Law for nature protection", Official gazette 67/2004 date 04.10.2004 This law has five amendments: one in 2006 Official gazette 14/2006, one in 2007 Official gazette 84/2007, one in 2010 Official gazette 35/2010,and two in 2011 Official gazette 47/2011 and Official gazette 148/2011.
- „Law for the environment", Official gazette 53/2005 date 05.07.2005, This law has seven amendments: one in 2005 Official gazette 81/2005, one in 2007 Official gazette 24/2007, one in 2008 Official gazette 159/2008, one in 2009 Official gazette 83/2009, two in 2010 Official gazette 48/2010 and 124/2010 and one in 2011 Official gazette 51/2011.
- Fishery Master Plan for Prespa Lake for the period 2011-2016. Official gazette 145/2011. (The new Fishery Master Plan for the period of 2017-2023 is in preparation.)

Regulations

- Regulation on the form, content and the way of performing evidence of fish production as for the amount of the sold fish per species (2008)
- Regulation for performing the fish guarding service, the form and the content of the fish guardian legitimation, as the way of its issuing and withdrawing (2008)
- Regulation of the content of the Program for examining, the form and content of the certificate, as the cost for issuing certificate for commercial fishery (2008)
- Regulation on the form and the content of the evidence formulary in the fishing regions (2008)
- Regulation of the content of the Fishery Master Plan (2008)

- Regulation of the content of the annual plan for protection and exploitation of the fish and the content of the annual report of realization of the plan (2008)
- Regulation on the technical requirements for the lending sites (2008)
- Regulation on the quality, size and weight, as also the way of declaring the fish for traffic market (2008)
- Regulation on the way of marking of the boats and tagging and evidencing of the fishing gear (2008)
- Regulation on the form and the content of the document for the origin of the fish and the way of its issuing and fulfilling (2010)
- Regulation on the way of issuing licenses for recreational fishing, the required documentation for issuing, the form and content of the evidence formulary, the way of evidencing and delivering the data (2010)
- Regulation on the form and the content of the legitimation for recreational fishing and the way of its issuing (2010)
- Regulation on the allowed fishing gears and equipment and their use for commercial and recreational fishing (2011)
- Regulation on the length of the fish under which they cannot be fished for commercial and recreational fishing (2011)
- Regulation on the quality, size and weight, as also the way of declaring the fish for traffic market (2013)
- Regulation for amendments of regulation on the allowed fishing gears and equipment and their use for commercial and recreational fishing (2013)
- Regulation for changes of the regulation on the length of the fish under which they cannot be fished for commercial and recreational fishing (2013)

Within the Master Plan for the Macedonian Part of Prespa Lake (Official gazette of R. M. 145/211 and 18/2013 – issued by the Ministry of Agriculture, Forestry and Water Management), protection of the fish and their habitats are of highest priority. For these issues fishing bans per species have been determined. At the same time total allowable catch quota (TACQ) per fish species was estimated based on their minimum catchable length (MCL). The number of required fishermen and fish guardians was stated also. Types of fishing and number of days and fishing gears per fisherman per species were determined. Commercial and recreational fisheries are allowed on the lake, while on the rivers only recreational fishing is possible. Aquaculture activities within the lake are not allowed at all, while in the watershed only on autochthonous fish species of Prespa Basin. Total allowable catch quota for commercial and recreational fishery on Prespa Lake is presented in the following Table 3 and Table 4.

Table 3. Commercial fishery at Prespa Lake (total allowable catch quota, TACQ)

Common name	Latin name	Total allowable catch quota per species (in kg)
carp	*Cyprinus carpio*	30,000
nase	*Chondrostoma prespense*	15,000
roach	*Rutilus prespensis*	20,000
bleak	*Alburnus belvica*	100,000
Prussian carp	*Carassius gibelio*	unlimited
TOTAL		165,000

Maximum daily allowable catch for recreational fishing per angler at the recreational zone is 3 kg. The number of the caught specimens per species cannot exceed the allowed number per species. In the total catch of 3 kg, bleak, roach and other species are included (Table 4).

Table 4. Recreational fishery TACQ

Common name	Latin name	Total allowable catch quota per species per day (in specimens)
catfish	*Silurus glanis*	1
carp	*Cyprinus carpio*	up to 2
nase	*Chondrostoma prespense*	up to 20
roach	*Rutilus prespensis*	up to 25
Prussian carp	*Carassius gibelio*	unlimited

Fishing gear for commercial fishing is limited to 15 bottom standing nets (one net has a maximum length of 50 meters and a maximum height of 5 meters with minimum mesh size of 45 mm) per fisherman for carp and 20 bottom-standing nets (one net has maximum length of 45 meters and maximum height of 3 meters with minimum mesh size of 16 mm) per fisherman for bleak. For other commercial fish species like chub, roach and Prussian carp 15 bottom-standing nets (one net has maximum length of 45 meters and height of 3 meters with minimum mesh size of 20 mm) per species per fisherman, as well as trawling nets with maximum length of 500 meters and maximum height of 3 meters with mesh size of minimum 10 mm are allowed for use. For catfish fishing, a line with a maximum of 50 hooks per fisherman is allowed.

In terms of recreational fishing angling for all fish species is possible. Recreational fishing can be conducted with either two rods (with one line with three hooks) or three rods (with one line and one hook).

3.3.3 Comparative overview of fishery rules in Albania and Macedonia

Fishing ban season per species for Macedonian part of Prespa Lake is 30 days during the spawning period, which can differ from year to year, but has to be in the period stated in the following Table 5.

Table 5. Fishing ban season by species and by countries

Common name	Latin name	ALBANIA		MACEDONIA	
carp	*Cyprinus carpio*	1st May	30th May	15th April	15th June
chub	*Squalius prespensis*	1st May	30th May	1st May	15th June
roach	*Rutilus prespensis*	1st May	30th May	1st April	15th May
bleak	*Alburnus belvica*	1st May	30th May	1st May	15th June

In Table 6 the minimum body length of various species is shown which must be reached before the fish is allowed to be taken by fishermen and anglers, respectively.

Table 6. Minimum allowable length for fishing of some commercial species

Common name	Latin name	ALBANIA	MACEDONIA
carp	*Cyprinus carpio*	30 cm	40 cm
chub	*Squalius prespensis*	15 cm	30 cm
roach	*Rutilus prespensis*	12 cm	17 cm
bleak	*Alburnus belvica*	10 cm	12 cm
Prussian carp	*Carassius gibelio*	15 cm	unlimited
pumpkinseed	*Lepomis gibbosus*		unlimited

As can be seen from the two tables above there are differences in fishing ban periods and minimum allowable landing sizes of fishes between Albania and Macedonia. Clearly, these differences make a sustainable fishery at Prespa Lake difficult and call for the transboundary management of aquatic resources.

3.4 Valuable fish habitats

The "Transboundary Fish and Fisheries Management of the Prespa Lakes Basin" (Spirkovski et al. 2012 b) identified various spawning sites of Prespa bleak, Prespa roach, carp, Prespa barbel and pumpkinseed. According to that document, named species (especially bleak, roach and pumpkinseed) spawn at almost any stretch along the shores of the lake. Similarly, spawning sites of carp and Prespa barbel also cover many parts of the shorelines. While this may or may not be true it needs to be kept in mind that certain areas are more vulnerable to environmental stressors than others and, in consequence, survival of developing fish embryos as well as hatching success and further growth of larval fish may differ from site to site. For this reason, some habitats are shown in the figures below which for various reasons (e.g., conservation of endemic species, good fish nursery grounds, exceptional spawning sites) are considered to be particularly valuable (Figure 6 and Figure 7).

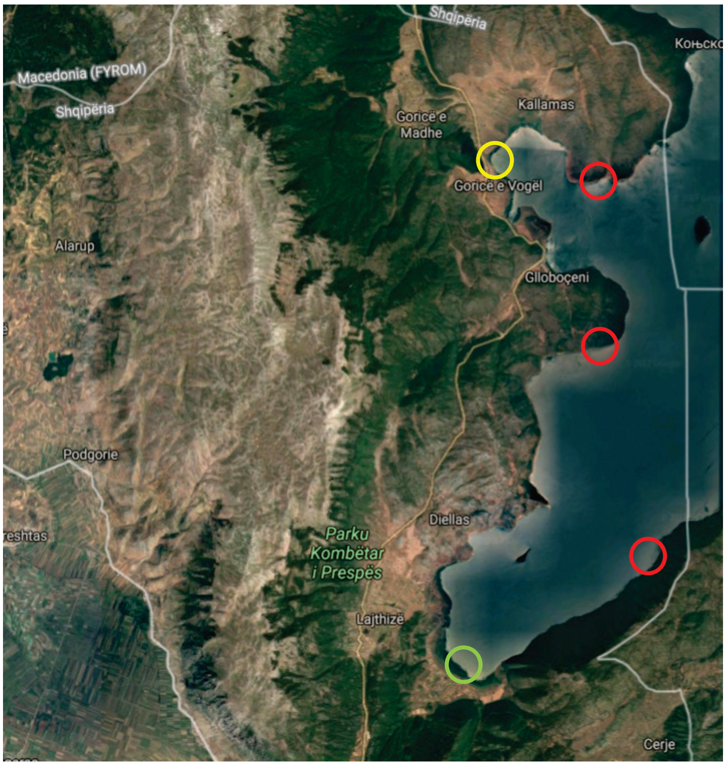


Figure 6. Valuable spawning and nursing habitats on Albanian territory of Prespa Lake for carp and roach (yellow), bleak (red) and carp, barbel and nase (green) (Map source: Google)

Further information on potential littoral spawning and nursing habitats is given by Blinkov et al. (2017) who studied the shorezone functionality of Prespa Lake. The study distinguishes five shorezone typologies and 45 homogeneous stretches of shorezone (Greek part excluded). For each stretch, including those shown in Figures 6 (all areas) and 7 (northernmost area only) a description is given of shoreline features including shorezone and littoral vegetation.

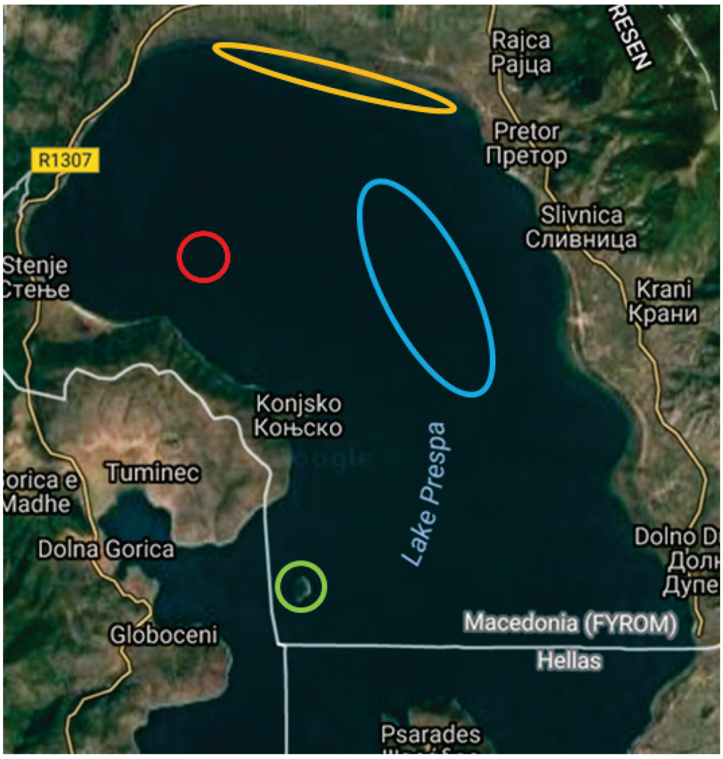


Figure 7. Valuable spawning and nursing habitats on Macedonian territory of Prespa Lake for carp (yellow), carp, barbel, nase and roach (green), roach and barbel (red) and bleak (blue) (Map source: Google)

4 MATERIAL AND METHODS

4.1 Fish sampling

The European standard EN 14757 (European Committee for Standardization 2015) was used to collect fish at Albanian and Macedonian territories taking into account that Prespa Lake is a large water body with different habitats.

For sampling, the lake was divided into seven sub-basins (SB) with SB 1 and SB 2 being at the Albanian territory and SB 3-7 at Macedonian territory (Figure 8). Sampled SB reflected different ecological conditions with regard to bathymetry, habitat differentiation, wind exposure etc. In short, sampling sites are characterized as follows:

Figure 8. Sampling sites at Prespa Lake (SB 1-SB 7)

- SB 1 (Kallamas, ALB): Littoral SB with corresponding biological communities. Rocky bottom along the shoreline.
- SB 2 (Liqenas, ALB): Littoral SB with corresponding biological communities. Rocky bottom along the shoreline.
- SB 3 (Asamati, MK): From the lake shore up to 1.5 m depth there is a fine muddy substrate and the whole area is covered with *Phragmites* (reed belt). From the reed belt on up to 3 m depth *Potamogeton* and *Myriophyllum* are present; muddy substrate. From 3 to 6 m depth; muddy area. This locality is under direct influence of the tributary of river Golema Reka, which is the main source of nutrient load from the agricultural area in the watershed (Matevski et al. 2013).
- SB 4 (Otesevo, MK): Similar habitat characteristics as SB 3, except that there is no tributary present. Moreover, this lake area does not border to an agricultural zone of Prespa Lake watershed.
- SB 5 (Konjsko, MK): From the lake's shore up to 2.5 meters depth, the substrate consists of rocks and gravel; vegetation in this area is composed of *Phragmites* and *Myriophyllum*. In the zone of 2.5 to 4 m depth, the substrate is made of rocks and gravel; no vegetation. From 4 to 12 m depth there is sandy substrate.

- SB 6 (Central Plate, MK): Average depth of this pelagic central area is 14-16 m. The bottom consists of fine sandy substrate all over.
- SB 7 (Kazan, MK): The deepest area of Prespa Lake, with maximum depth of 36 m. Stones and rocky substrate are present along with submerged vegetation composed of *Najas* and *Myriophyllum*. Sampling site is relatively close to the shore of the lake.

Sampling procedures in all three years were based on stratified random sampling. Specifically, periods of fish grouping (formation of shoals for e.g., spawning or wintering) were avoided. In addition, sampling sites were chosen with the help of e.g., a bathymetric map (i. e., topographic map 1 : 25,000 with grids of 250 x 250 m). The grids were numbered starting from the first stratum (0-3 m) to the second (3-6 m) and to the third (6-12 m) stratum. This division over the map produced a number of potential, non-overlapping sampling sites (Figure 9). All grids (including whole and partial grids), were assigned their own unique number. Final determination of actual sampling sites was subsequently conducted with the help of a random numbers table. Lastly, individual nets were set in different directions relative to the shoreline. For example, some nets were set from the shore starting with the panel of mesh size 43 mm while others were placed starting with panel of mesh size 29 mm. Similarly, in some cases nets were put either perpendicular, parallel or in an angle of 45° or 60° relative to the shore.

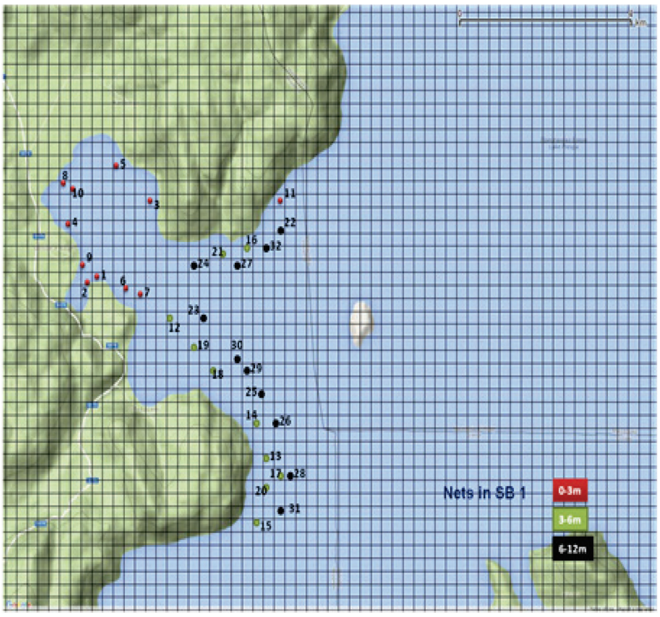


Figure 9. Placement of nets in sub basin 1 (Kallamas, ALB)

4.2 Multi-mesh gillnetting

Fish collection took place in Prespa Lake during fall of 2013, 2014 and 2015, following the recommendations of the CEN 14757 protocol (European Committee for Standardization 2015). Specifically, benthic multi-mesh gillnets (MMG) composed of 12 panels with different mesh sizes ranging from 5 mm to 55 mm (knot to knot) in the following order: 43 mm, 19.5 mm, 6.25 mm, 10 mm, 55 mm, 8 mm, 12.5 mm, 24 mm, 15.5 mm, 5 mm, 35 mm and 29 mm were employed. Each benthic MMG was 30 m long and 1.5 m deep. In addition, pelagic MMG, 27.5 m in length and 6 m in height were used as well (Table 7). Pelagic MMGs were composed of 11 panels with same mesh sizes as the benthic ones (except for the 5 mm panel which was not included). Thread diameters were 0.10 mm (5-8 mm meshes), 0.12 mm (10 and 12.5 mm meshes), 0.15 mm (15.5 and 19.5 mm meshes), 0.17 mm (24 and 29 mm meshes), 0.20 (35 and 43 mm meshes) and 0.25 mm (55 mm mesh) (Figure 10).

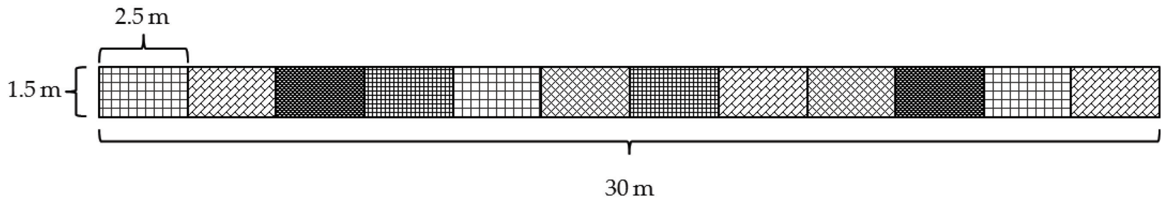


Figure 10. Schematic view of a benthic multi-mesh gillnet

All sites were sampled in 2013, 2014, and 2015 with the exception of SB 7, which was sampled in 2014 and 2015 only. Nets were set before dusk, stayed overnight and were taken out after dawn (12 hours of sampling) to cover both highest activity circadian peaks. The Prespa Lake Station Monitoring boat was used for setting and lifting the nets on the Macedonian side of Prespa Lake. Total number of nets set per sampling site and year are given in Table 7.

Table 7. Number of multi-mesh gillnets set at various sub-basins (Kallamas, Liqenas, Asamati, Otesevo, Konjsko, Central Plate and Kazan) in 2013, 2014 and 2015.

SUB-BASIN	Total no. of nets per sub-basin	Stratum	Nets/stratum 2013	Nets/stratum 2014	Nets/stratum 2015
SB 1 (Kallamas)	96	0-3	11	11	11
		3-6	10	10	10
		6-12	11	11	11
SB 2 (Liqenas)	96	0-3	11	11	11
		3-6	10	10	10
		6-12	11	11	11
SB 3 (Asamati)	95	0-3	5	16	16
		3-6	5	16	16
		6-12	5	8	8
SB 4 (Otesevo)	92	0-3	4	16	16
		3-6	4	16	16
		6-12	4	8	8
SB 5 (Konjsko)	92	0-3	5	16	16
		3-6	3	16	16
		6-12	4	8	8
SB 6 (Central Plate)	41	14-16	25 [a]	8 [b]	8 [b]
SB 7 (Kazan)	16	0-36		8 [c]	8 [c]

[a] benthic nets, [b] pelagic nets - individual, [c] pelagic nets - cascade

GPS coordinates for each net, net setting depth, setting position to the shore, air and water temperature, pH, oxygen concentration and transparency (Secchi depth) were determined for all Albanian (Annex I, Table 13 to Table 18) and Macedonian (Table 19 to Table 24) sites.

4.3 Data analysis

All captured fish were identified to species level, counted and weighed in grams. If less than 50 individuals were caught per individual panel, all caught specimens were measured. In cases where several hundreds of one species were caught per panel, 50 individuals were measured by length and weight and the total weight and number of individuals of the rest was recorded. Weight was measured on a portable balance with accuracy of 0.1 g. Standard and total length were measured to the closest mm and for data processing just total length was used and averaged to the nearest cm.

Data analysis was performed with regard to fish species composition per sub-basin and species abundance per depth stratum in the respective SB. For benthic nets, catch per unit effort (CPUE) expressed as biomass of species per depth stratum (g/m^2) per net surface (1.5 m x 30 m = 45 m^2, BPUE) and individuals of species per depth stratum (ind./m^2) per net surface (1.5 m x 30 m = 45 m^2, NPUE) was calculated. For pelagic nets, CPUE expressed in biomass of species per depth stratum (g/m^2) per net surface (6 m x 27.5 m = 165 m^2, BPUE) and individuals of species per depth stratum (ind./m^2) per net surface (6 m x 27.5 m = 165 m^2, NPUE) was determined.

The mean CPUE value for each species in each stratum (0-3m, 3-6m and 6-12 m) was calculated as a sum of each the CPUE value of species *N* / number of nets in the respective stratum.

4.4 Preliminary Lake Fish Index

The development of a preliminary Lake Fish Index (LFI) for Prespa Lake was mostly achieved during two meetings of Albanian, Macedonian, and Montenegrin fishery experts participating in the CSBL project. The index development was accompanied by a member of the Institute of Inland Fisheries having long-time experience in the European harmonization of fish based systems.

Generally, an LFI compliant with the requirements of the WFD includes a typology, a selection of metrics and a certain scoring procedure. A typology summarizes lakes with comparable geographic, morphometric or physico-chemical characteristics. Possible factors for characterization are ecoregion, altitude, depth, size, geology, water residence time, temperature, or mixing characteristics (Annex II of the WFD). Lakes of a common type should have a comparable fish communities, at least under undisturbed conditions. Metrics are traits of the fish community that are likely to be influenced by human impact. For example, certain cyprinids might be more abundant in eutrophic water bodies. If eutrophication is of anthropogenic origin, the abundance of these cyprinids can be used as a metric. An LFI needs multiple metrics in order to be robust against accidental results. Usually, 5 to 10 metrics are used. The WFD provides normative descriptions of what high, good and moderate status means in terms of fish traits. Three categories of traits are used in this description: fish abundance, species composition and development/ reproduction. To follow the WFD as close as possible, fish metrics of each of these categories should be part of the index. To obtain total index values, each metric is first scored individually. The ranges for metric scoring are not prescribed. However, scores are frequently set in accordance with the WFD classification of 1 to 5. In this case, 1 corresponds to very high impact (bad status) and 5 to no or negligible impact (high status). Finally, individual metrics are combined to a total score, e.g. as sum or mean. This final score needs to be transferred to the range from 0 to 1 in order to be comparable with other systems. The final score is termed EQR (ecological quality ratio), and a five-step normative category is assigned: high, good, moderate, poor, or bad.

A major problem in the development of an LFI was the uniqueness of Prespa Lake and its fish community in combination with the lack of comparable data. There was no dataset that could have served as a basis for essential steps like establishing a typology or testing the pressure-impact relationship between anthropogenic impact and metrics. For this reason, most steps had to be based on expert judgement.

The literature available for the development of WFD compliant assessment systems is nearly infinite. A selection is:

- for typology: Ecostat (2004), Poikane (2009), Ritterbusch et al. (2014);
- for the theoretical background of system development and scoring: Birk et al. (2013), CIS (2003 a, b, 2009, 2011, 2015), Lyche-Solheim et al. (2013), Poikane et al. (2015);
- for overviews of existing systems with descriptions of typology, metrics, and scoring: Argillier et al. (2013), Gassner et al. (2014), Olin et al. (2014), Ritterbusch et al. (2017 a, b).

5 RESULTS

5.1 Prespa Lake total

During the three years of sampling more than 63,000 fish were collected and analysed. Using MMG, 15 fish species were found during the sampling campaigns (Table 8).

Table 8. Fish species of Prespa Lake caught in the course of the project (2013-2015)

Taxon (family)	Species name
Cyprinidae	Carp (*Cyprinus carpio*) Prespa bleak (*Alburnus belvica*) Prespa roach (*Rutilus prespensis*) Prussian carp (*Carassius gibelio*) Prespa barbel (*Barbus prespensis*) Prespa nase (*Chondrostoma prespensis*) Spirlin (*Alburnoides prespensis*) Prespa chub (*Squalius prespensis*) Bitterling (*Rhodeus amarus*) Stone moroko (*Pseudorasbora parva*) Tench (*Tinca tinca*) Prespa minnow (*Pelasgus prespensis*)
Cobitidae	Prespa spined loach (*Cobitis meridionialis*)
Salmonidae	Prespa trout (*Salmo peristericus*)
Centrarchidae	Pumpkinseed (*Lepomis gibbosus*)

Generally, the fish community of Prespa Lake is composed predominantly of five species: Prespa bleak, Prespa roach, spirlin, bitterling and stone moroko. Numerically, other species add to a little degree to the overall fish assemblage (Figure 11).

In 2013, a total of 15 species was recorded in the catches at Albanian and Macedonian parts of the lake, of which in terms of fish numbers (abundance) 71 % were represented by the alien species bitterling, stone moroko and pumpkinseed (Figure 12).

In 2014, a total of 14 species were caught (Figure 13), with 42% of aliens (same species as above) and 58% of native species (bleak, roach and spirlin).

In 2015, the total catch comprised 15 species and was composed of 57% of alien species (mainly bitterling and stone moroko) while 43% belonged to the group of native fish (bleak, roach and spirlin (Figure 12).

Taken together, in terms of absolute fish numbers, alien species dominated in the catches and clearly outnumbered native fishes. Roughly speaking, every second fish was non-native.

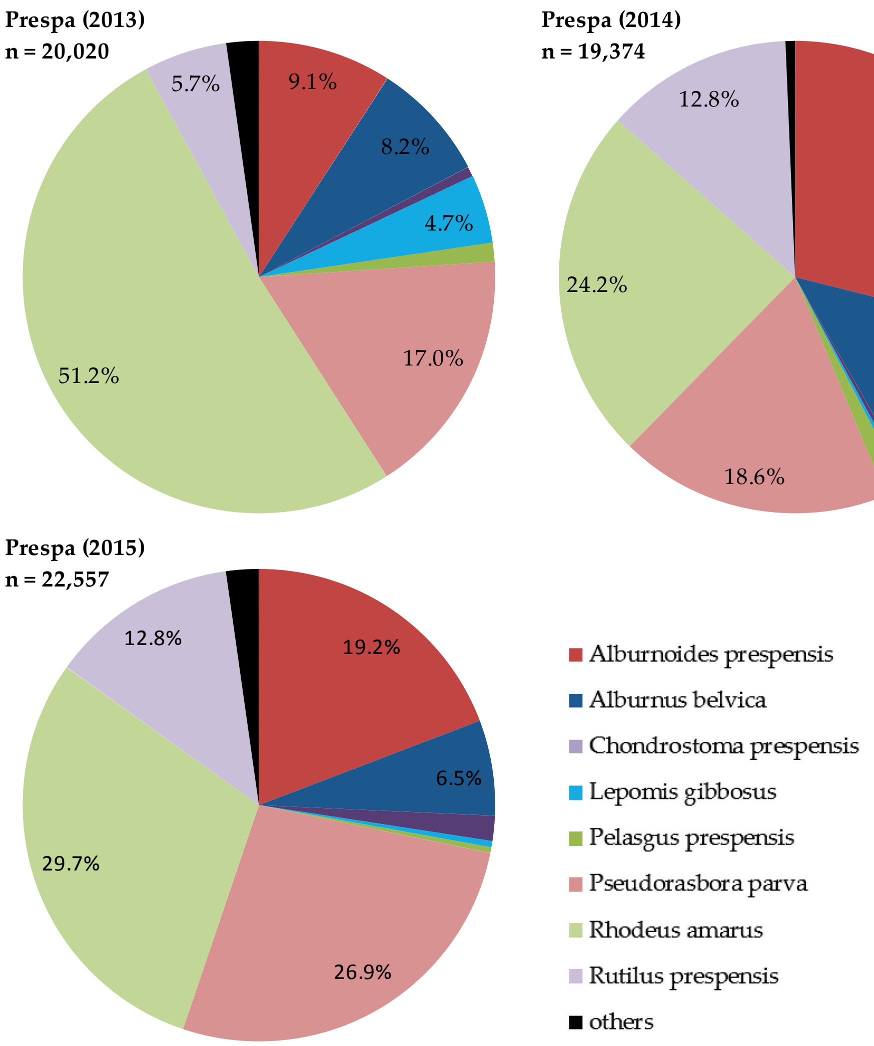
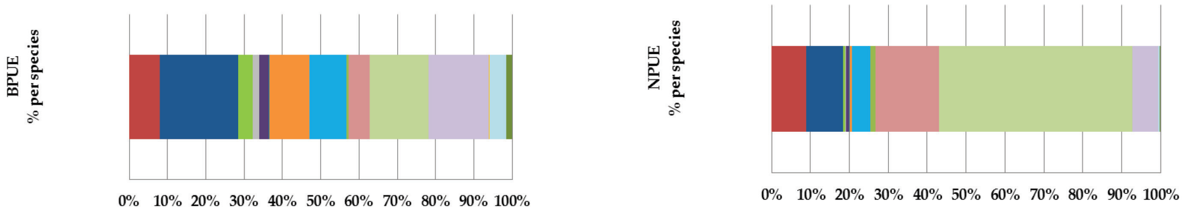


Figure 11. Relative fish species composition based on number of individuals in the annual catches in Prespa Lake. The data comprise the catches with benthic nets in sub-basins 1-5 and are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others': barbel, Prussian carp, spined loach, carp, Prespa trout, chub, and tench

In terms of biomass (BPUE), two native fishes (bleak and roach) and two alien species (pumpkinseed and bitterling) dominated in the combined Albanian and Macedonian catches of 2013. For example, per square meter of net on average 6.60 g of bleak (*A. belvica*) were caught. Regarding number of fish / m² of net, the aliens bitterling and stone moroko represented more than 60% of the NPUE in 2013 (Figure 12).

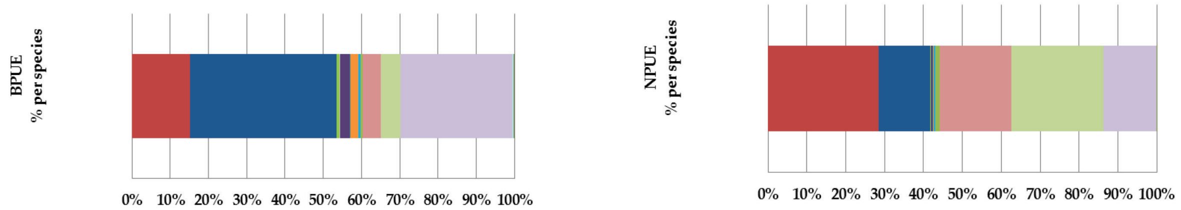


	2013
Alburnoides prespensis	2.56
Alburnus belvica	6.60
Barbus prespensis	1.22
Carassius gibelio	0.54
Chondrostoma prespensis	0.79
Cobitis meridionalis	0.06
Cyprinus carpio	3.39
Lepomis gibbosus	3.06
Pelasgus prespensis	0.19
Pseudorasbora parva	1.80
Rhodeus amarus	4.95
Rutilus prespensis	5.05
Salmo peristericus	0.04
Squalius prespensis	1.44
Tinca tinca	0.47

	2013
Alburnoides prespensis	0.39
Alburnus belvica	0.43
Barbus prespensis	0.03
Carassius gibelio	0.01
Chondrostoma prespensis	0.03
Cobitis meridionalis	0.01
Cyprinus carpio	0.03
Lepomis gibbosus	0.21
Pelasgus prespensis	0.06
Pseudorasbora parva	0.73
Rhodeus amarus	2.21
Rutilus prespensis	0.30
Salmo peristericus	0.00
Squalius prespensis	0.01
Tinca tinca	0.01

Figure 12. Standardized catches per unit of effort (CPUE) for Prespa Lake during the sampling campaign of October 2013. Data based on benthic nets in the sub-basins 1 to 5. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species.

In the 2014 sampling campaign three native species bleak, roach and spirlin contributed more than 80 % to the total catch biomass of fish caught on Macedonian and Albanian territories. Regarding the number of fish / m² of net, the aliens bitterling and stone moroko represented app. 40 % of the NPUE in 2014 (Figure 13).

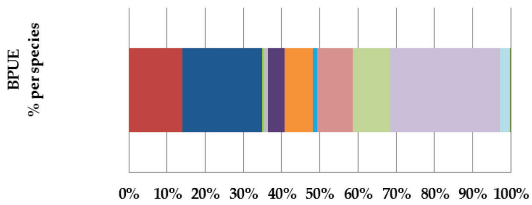


	2014
Alburnoides prespensis	2.74
Alburnus belvica	6.89
Barbus prespensis	0.13
Carassius gibelio	0.03
Chondrostoma prespensis	0.45
Cobitis meridionalis	0.03
Cyprinus carpio	0.38
Lepomis gibbosus	0.11
Pelasgus prespensis	0.08
Pseudorasbora parva	0.87
Rhodeus amarus	0.91
Rutilus prespensis	5.24
Salmo peristericus	0.00
Squalius prespensis	0.07
Tinca tinca	0.04

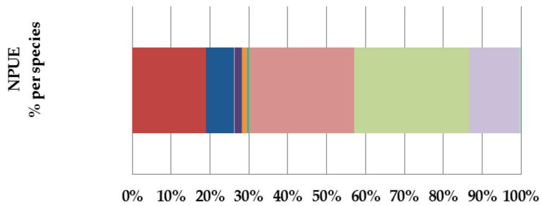
	2014
Alburnoides prespensis	0.68
Alburnus belvica	0.31
Barbus prespensis	0.00
Carassius gibelio	0.00
Chondrostoma prespensis	0.01
Cobitis meridionalis	0.01
Cyprinus carpio	0.00
Lepomis gibbosus	0.01
Pelasgus prespensis	0.03
Pseudorasbora parva	0.44
Rhodeus amarus	0.57
Rutilus prespensis	0.32
Salmo peristericus	0.00
Squalius prespensis	0.00
Tinca tinca	0.00

Figure 13. Standardized catches per unit of effort (CPUE) for Prespa Lake during the sampling campaign of November 2014. Data based on benthic nets in the sub-basins 1 to 5. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species.

During the 2015 sampling campaign bleak, roach and spirlin were present again and represented about 64 % of the total biomass (BPUE). Stone moroko and bitterling represented about 56 % of the NPUE in 2015 (Figure 14).



	2015
Alburnoides prespensis	2.56
Alburnus belvica	3.80
Barbus prespensis	0.07
Carassius gibelio	0.19
Chondrostoma prespensis	0.79
Cobitis meridionalis	0.02
Cyprinus carpio	1.34
Lepomis gibbosus	0.20
Pelasgus prespensis	0.03
Pseudorasbora parva	1.67
Rhodeus amarus	1.80
Rutilus prespensis	5.16
Salmo peristericus	0.05
Squalius prespensis	0.48
Tinca tinca	0.03



	2015
Alburnoides prespensis	0.52
Alburnus belvica	0.19
Barbus prespensis	0.00
Carassius gibelio	0.01
Chondrostoma prespensis	0.05
Cobitis meridionalis	0.00
Cyprinus carpio	0.04
Lepomis gibbosus	0.01
Pelasgus prespensis	0.01
Pseudorasbora parva	0.73
Rhodeus amarus	0.81
Rutilus prespensis	0.36
Salmo peristericus	0.00
Squalius prespensis	0.01
Tinca tinca	0.00

Figure 14. Standardized catches per unit of effort (CPUE) for Prespa Lake during the sampling campaign of November 2015. Data based on benthic nets in the sub-basins 1 to 5. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species

5.2 Albania

5.2.1 Abundance and species composition

During the 2013 fish sampling campaign at SB 1 (Kallamas) and SB 2 (Liqenas) the following 15 fish species were found: Prespa bleak, Prespa spirlin, Prespa barbel, Prespa nase, Spined loach, Prespa minnow, Prespa roach, Prespa trout, Prespa chub, carp, Prussian carp, pumpkinseed, bitterling, stone moroko and tench. In 2013, bitterling represented the numerically dominant species. In terms of numbers it accounted for 52% of the individuals in the Albanian catches. The second most common species in terms of numbers was stone moroko, which amounted to about 15 % in total catches (Figure 15).

In fall of 2014 a total of 15 fish species were sampled again at Albanian territories, of which bitterling, stone moroko, and spirlin were the most common species. Bleak and roach also added in significant numbers to the catch while all other species caught (tench, Prespa barbel, Prespa nase, spined loach, Prussian carp, carp, pumpkinseed, Prespa minnow, Prespa trout, Prespa chub) contributed distinctly less than 5 % to total annual catch numbers (Figure 15).

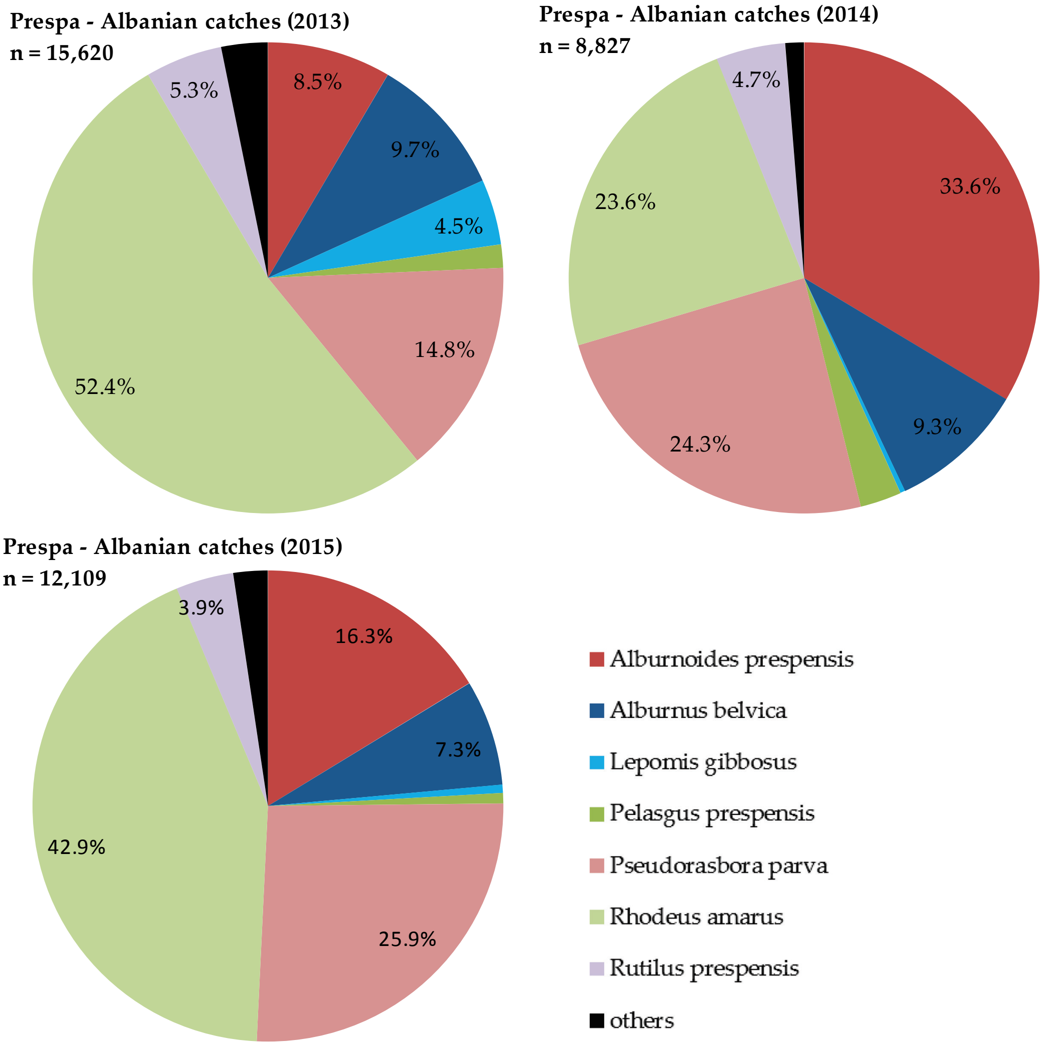
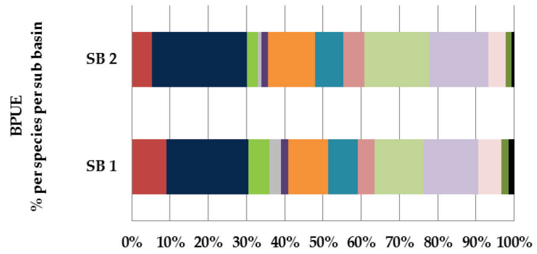


Figure 15. Relative fish species composition based on number of individuals in the annual catches at the Albanian Part of Prespa Lake. The data comprise the catches in the sub-basins 1 and 2 and are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others': barbel, nase, Prussian carp, spined loach, carp, Prespa trout, chub, and tench

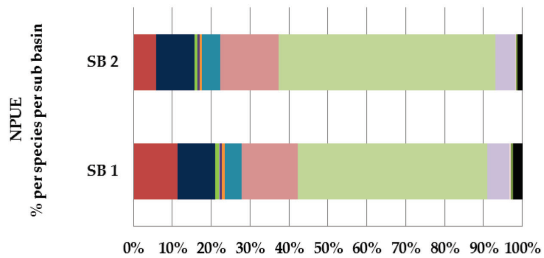
In 2015, 69 % of caught individuals were either stone moroko or bitterling. Both of them were particularly prevalent in the 0-3 and 3-6 m strata. Similar to previous years, in terms of numbers bleak represented about 8 % of overall catch at SB 1 and SB 2 combined (Figure 15). For maximum and minimum numbers of sampled specimens per net, see Annex III (Table 25).

5.2.2 CPUE (Albanian territory)

In the year of 2013, a higher amount of biomass per m² of net (BPUE) was collected at SB 1 than at SB 2. Relative biomass and numerical contributions of each species to catches at SB 1 and SB 2, respectively, were however, very similar (Figure 16). The bitterling was the most abundant species in 2013 with recorded amount of 2.5 and 3.2 individuals per m², respectively, in SB 1 and SB 2, followed by stone moroko, Prespa bleak and Prespa spirlin.



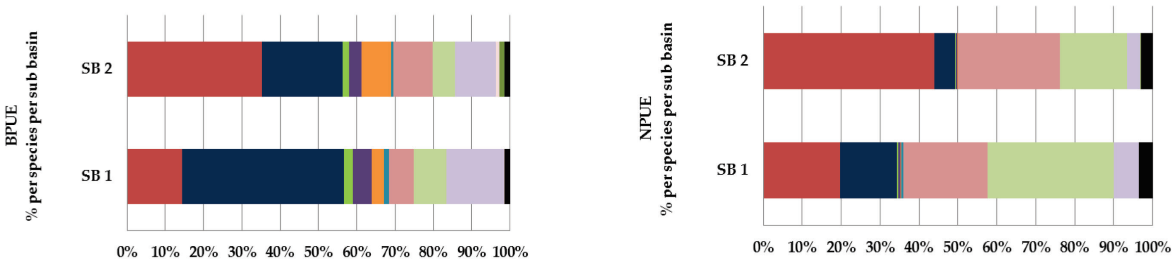
	SB 1	SB 2
Alburnoides prespensis	4.07	2.13
Alburnus belvica	9.69	10.16
Barbus prespensis	2.50	1.16
Carassius gibelio	1.35	0.40
Chondrostoma prespensis	0.89	0.70
Cyprinus carpio	4.70	5.04
Lepomis gibbosus	3.51	3.04
Pseudorasbora parva	1.95	2.29
Rhodeus amarus	5.88	6.98
Rutilus prespensis	6.43	6.25
Squalius prespensis	2.70	1.89
Tinca tinca	0.90	0.61
others	0.63	0.27



	SB 1	SB 2
Alburnoides prespensis	0.59	0.33
Alburnus belvica	0.49	0.56
Barbus prespensis	0.05	0.03
Carassius gibelio	0.01	0.01
Chondrostoma prespensis	0.03	0.03
Cyprinus carpio	0.04	0.03
Lepomis gibbosus	0.22	0.26
Pseudorasbora parva	0.74	0.86
Rhodeus amarus	2.52	3.17
Rutilus prespensis	0.29	0.29
Squalius prespensis	0.02	0.01
Tinca tinca	0.02	0.02
others	0.13	0.07

Figure 16. Standardized catches per unit of effort (CPUE) for the Albanian Part of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the sub-basins. Species with less than 1 % of biomass in the overall catch are summarized as 'others': spined loach, Prespa minnow, Prespa trout

In 2014, Prespa bleak and spirlin dominated the catches in terms of biomass per m² of net in SB 1 and SB 2, respectively. However, while Prespa bleak was the most contributing species in SB 1, spirlin contributed most in SB 2 (Figure 17). In SB 1, Prespa barbel added as well to overall BPUE. In 2014 similar NPUE values were recorded in SB 1 and SB 2, respectively. Bitterling and stone moroko were the most abundant species per m² of net in both SB. Native species (Prespa bleak, Prespa roach, spirlin and others) combined made up for about 45 % of collected individuals per m² of net (Figure 17).

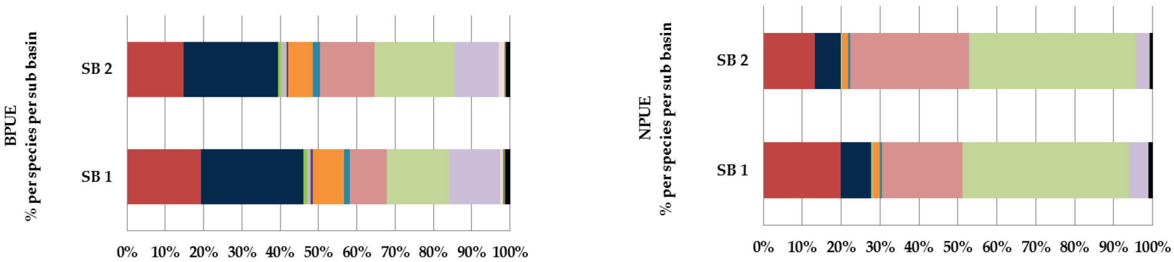


	SB 1	SB 2
Alburnoides prespensis	2.52	6.60
Alburnus belvica	7.49	3.93
Barbus prespensis	0.38	0.30
Carassius gibelio	0.02	0.00
Chondrostoma prespensis	0.86	0.59
Cyprinus carpio	0.58	1.46
Lepomis gibbosus	0.20	0.13
Pseudorasbora parva	1.16	1.91
Rhodeus amarus	1.49	1.10
Rutilus prespensis	2.67	1.97
Squalius prespensis	0.01	0.18
Tinca tinca	0.01	0.23
others	0.27	0.29

	SB 1	SB 2
Alburnoides prespensis	0.51	1.55
Alburnus belvica	0.38	0.19
Barbus prespensis	0.01	0.01
Carassius gibelio	0.00	0.00
Chondrostoma prespensis	0.01	0.01
Cyprinus carpio	0.00	0.01
Lepomis gibbosus	0.02	0.01
Pseudorasbora parva	0.56	0.92
Rhodeus amarus	0.84	0.61
Rutilus prespensis	0.17	0.12
Squalius prespensis	0.00	0.00
Tinca tinca	0.00	0.01
others	0.09	0.10

Figure 17. Standardized catches per unit of effort (CPUE) for the Albanian Part of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the sub-basins. Species with less than 1 % of biomass in the overall catch are summarized as 'others': spined loach, Prespa minnow

In 2015 overall BPUE values in SB 1 and SB 2, as well as relative contribution of each species to overall biomass at these sites was almost identical (Figure 18). Prespa bleak and spirlin again contributed significantly to overall BPUE, but also bitterling added noteworthy amounts to overall biomass per m² of net. Alien bitterling and stone moroko again numerically dominated the catches in SB 1 and SB 2 and contributed most to overall NPUE values in 2015. Combined these two species represented 64 and 73 % of caught individuals of SB 1 and SB 2, respectively. As in previous years, percentage of native species (in terms of numbers) on entire number of sampled individuals in BS 1 and SB 2 was less than 35 %.



	SB 1	SB 2
Alburnoides prespensis	4.03	3.33
Alburnus belvica	5.64	5.58
Barbus prespensis	0.17	0.17
Carassius gibelio	0.21	0.34
Chondrostoma prespensis	0.13	0.09
Cyprinus carpio	1.70	1.45
Lepomis gibbosus	0.32	0.46
Pseudorasbora parva	2.03	3.21
Rhodeus amarus	3.41	4.72
Rutilus prespensis	2.80	2.62
Squalius prespensis	0.15	0.32
Tinca tinca	0.09	0.10
others	0.29	0.25

	SB 1	SB 2
Alburnoides prespensis	0.78	0.59
Alburnus belvica	0.31	0.30
Barbus prespensis	0.01	0.01
Carassius gibelio	0.01	0.01
Chondrostoma prespensis	0.01	0.00
Cyprinus carpio	0.06	0.06
Lepomis gibbosus	0.02	0.03
Pseudorasbora parva	0.81	1.37
Rhodeus amarus	1.68	1.93
Rutilus prespensis	0.19	0.15
Squalius prespensis	0.00	0.00
Tinca tinca	0.00	0.00
others	0.04	0.04

Figure 18. Standardized catches per unit of effort (CPUE) for the Albanian Part of Prespa Lake during the sampling campaign of November 2015. See Figure 17Figure 17 for additional information. Species with less than 1 % of biomass in the overall catch are summarized as 'others': spined loach, Prespa minnow, Prespa trout

5.3 Macedonia

5.3.1 Abundance and species composition

In 2013, the total catch all of sub-basins 1-6 sampled at Macedonian territory was composed of 4,400 specimens belonging to 12 species, which equals 60 % of the fish species currently known to inhabit the lake. The most dominant fishes in 2013 were the two alien species bitterling and stone moroko. The alien pumpkinseed had major shares on the total number too. The total abundance of native species was 23%. The results are shown in Figure 19, not including sub-basins SB 6 (Central Plate) and SB 7 (Kazan) because these pelagic sites exhibited a very distinct species composition (Figure 22, Figure 23). For further details on SB 6 and SB 7, see Annex II.

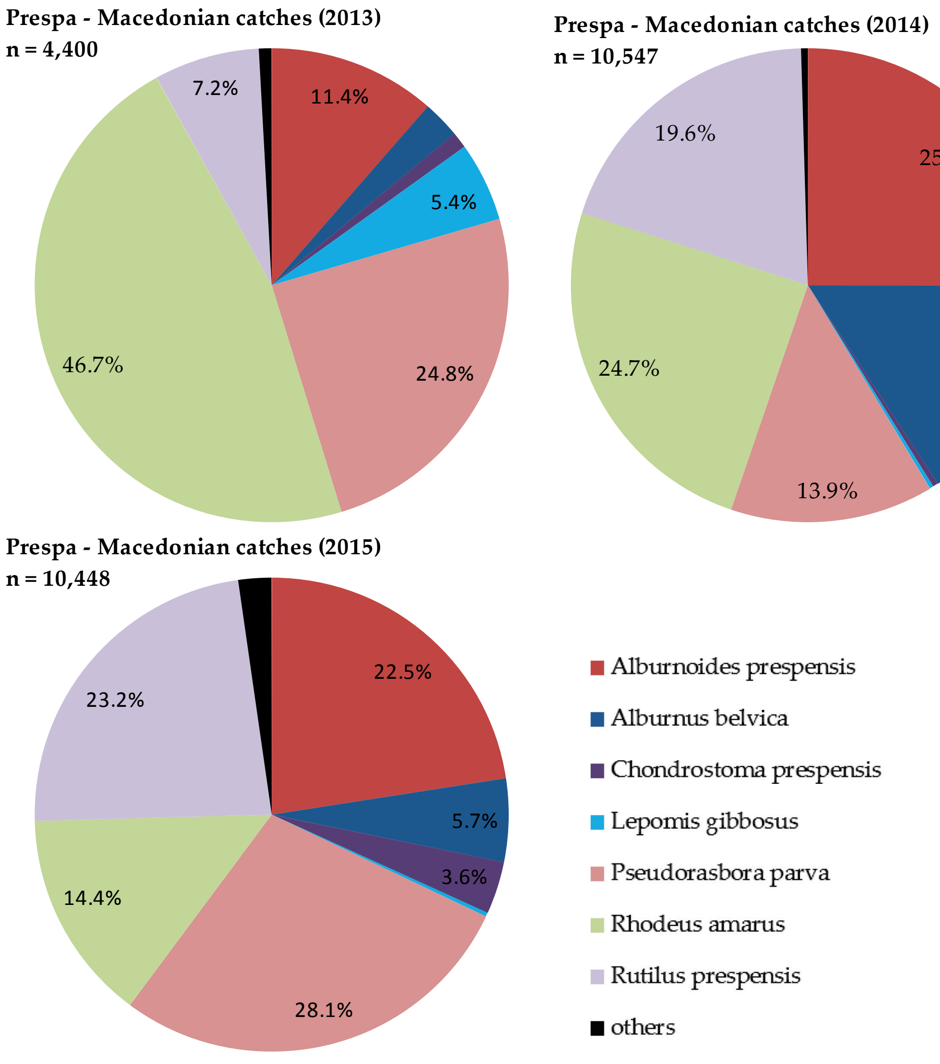


Figure 19. Relative fish species composition based on number of individuals in the annual catches at the Macedonian part of Prespa Lake for the benthic nets in the sub-basins 3-5. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others': barbel, carp, chub, minnow, Prussian carp, and spined loach

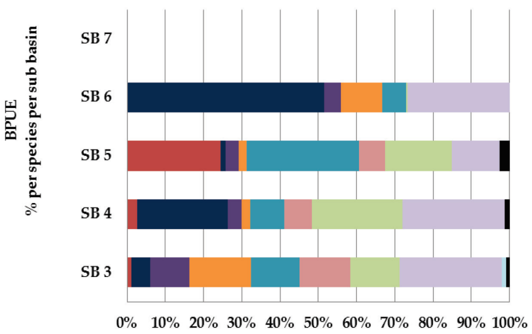
In 2014, 13 species of fish with a total of 10,547 individuals were sampled. The fish composition in that year was in favor of the native species with a numerical dominance of bleak, roach and spirlin. Total abundance of the individuals of native species was 61 %. The relative numbers of bitterling, stone moroko, and pumpkinseed had decreased compared with the previous year, but still were close to 30 % (Figure 19).

During the MMG sampling campaign of 2015 a total of 10,448 fish individuals were collected, which represented 13 species. As in the year before, roach, spirlin and bleak were the most abundant fishes in the catch (51 %) while relative abundances of the alien species were more than 40 % (Figure 19). For maximum and minimum numbers of sampled specimens per net, see Annex III (Table 26).

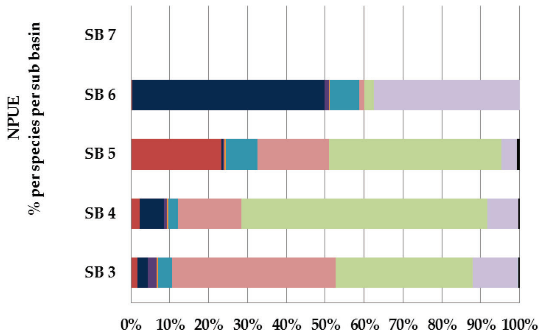
5.3.2 CPUE (Macedonian territory)

In 2013, BPUE and NPUE showed wide distribution of alien species (stone moroko, bitterling, pumpkinseed) at all Macedonian sampling sites (SB 3 - SB 6). Although small in body size, these species are taking more than 30% of the BPUE in the three littoral sub-basins. Native Prespa spirlin was present in all sampled sub basins but showed distinct differences in occurrence. Like carp it was predominant in areas linked with its spawning grounds. Prespa roach revealed similar distribution in all sub-basins whereas native Prespa bleak was the most dominant species at the pelagic sub basin. In terms of relative abundances (NPUE) in the year 2013 bitterling (Figure 20) was the most abundant species, followed by stone moroko, Prespa bleak and Prespa roach (Figure 21).

Figure 20. Bitterling (*Rhodeus amarus*) (© L. Stefanov)



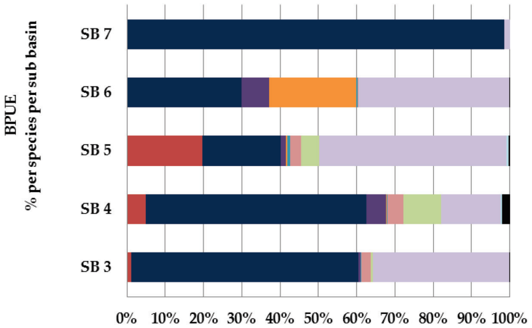
	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.14	0.31	4.97	0.01	
Alburnus belvica	0.59	2.72	0.27	5.87	
Chondrostoma prespensis	1.20	0.42	0.68	0.49	
Cyprinus carpio	1.90	0.26	0.46	1.24	
Lepomis gibbosus	1.49	1.02	5.95	0.70	
Pseudorasbora parva	1.57	0.83	1.39	0.01	
Rhodeus amarus	1.52	2.73	3.57	0.04	
Rutilus prespensis	3.15	3.07	2.54	3.04	
Squalius prespensis	0.13	0.00	0.00	0.00	
others	0.11	0.14	0.51	0.00	



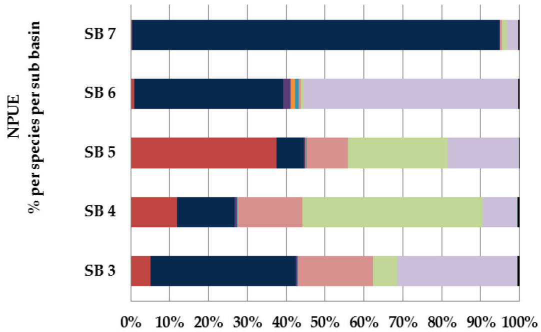
	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.03	0.05	0.84	0.00	
Alburnus belvica	0.05	0.13	0.01	0.30	
Chondrostoma prespensis	0.04	0.02	0.02	0.01	
Cyprinus carpio	0.01	0.01	0.01	0.00	
Lepomis gibbosus	0.07	0.05	0.30	0.05	
Pseudorasbora parva	0.80	0.35	0.67	0.01	
Rhodeus amarus	0.68	1.35	1.61	0.02	
Rutilus prespensis	0.22	0.17	0.14	0.23	
Squalius prespensis	0.00	0.00	0.00	0.00	
others	0.01	0.01	0.03	0.00	

Figure 21. Standardized catches per unit of effort (CPUE) for the Macedonian Part of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/ m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the sub-basins. Species with less than 1 % of biomass are summarized as 'others': Prespa barbel, spined loach, Prespa minnow

In 2014, in terms of biomass native species dominated in the samples although stone moroko and bitterling both were numerically highly abundant in the catches. Moreover, biomass was distinctly higher in 2014 than in 2013. At pelagic site (SB 7), bleak heavily dominated in the catches (Figure 22). In terms of relative abundance of species (NPUE), different species dominated in the various sub-basins. Overall, however, spirlin, Prespa bleak, stone moroko, bitterling and Prespa roach accounted for most of the catches at all littoral sites (SB 3-SB 5), while Prespa roach and Prespa bleak, in particular, occurred in high numbers at the pelagic sampling sites.

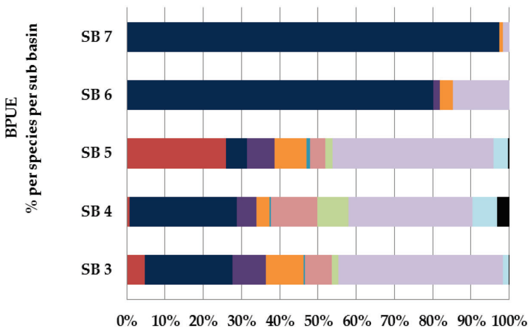


	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.24	0.43	4.61	0.03	0.01
Alburnus belvica	12.76	5.02	4.76	6.52	20.92
Chondrostoma prespensis	0.12	0.46	0.31	1.58	0.00
Cyprinus carpio	0.00	0.01	0.10	4.95	0.00
Lepomis gibbosus	0.05	0.02	0.16	0.11	0.00
Pseudorasbora parva	0.53	0.36	0.64	0.01	0.01
Rhodeus amarus	0.13	0.87	1.12	0.01	0.02
Rutilus prespensis	7.65	1.36	11.39	8.63	0.30
Squalius prespensis	0.00	0.03	0.16	0.00	0.00
others	0.04	0.17	0.06	0.02	0.00

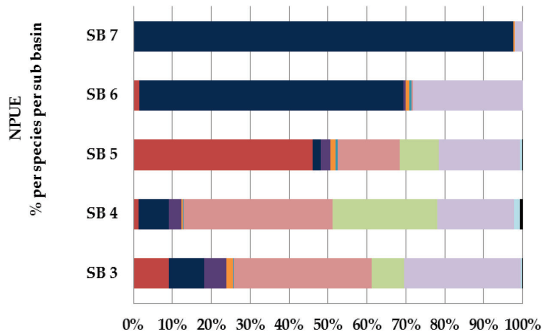


	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.07	0.13	1.26	0.01	0.00
Alburnus belvica	0.53	0.16	0.24	0.34	0.92
Chondrostoma prespensis	0.00	0.01	0.01	0.02	0.00
Cyprinus carpio	0.00	0.00	0.00	0.01	0.00
Lepomis gibbosus	0.00	0.00	0.01	0.01	0.00
Pseudorasbora parva	0.27	0.18	0.36	0.01	0.01
Rhodeus amarus	0.09	0.50	0.86	0.01	0.01
Rutilus prespensis	0.44	0.10	0.62	0.49	0.03
Squalius prespensis	0.00	0.00	0.00	0.00	0.00
others	0.01	0.01	0.01	0.00	0.00

Figure 22. Standardized catches per unit of effort (CPUE) for the Macedonian Part of Prespa Lake during the sampling campaign of November 2014. See Figure 21 for details. Species with less than 1 % of biomass are summarized as 'others': Prespa barbel, Prussian carp, spined loach, Prespa minnow



	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.74	0.09	5.05	0.03	0.00
Alburnus belvica	3.68	3.77	1.04	10.39	15.77
Chondrostoma prespensis	1.39	0.66	1.42	0.22	0.00
Cyprinus carpio	1.56	0.47	1.60	0.43	0.16
Lepomis gibbosus	0.05	0.04	0.19	0.01	0.00
Pseudorasbora parva	1.12	1.62	0.77	0.00	0.00
Rhodeus amarus	0.28	1.09	0.39	0.00	0.00
Rutilus prespensis	6.86	4.36	8.16	1.91	0.27
Squalius prespensis	0.25	0.84	0.75	0.00	0.00
others	0.01	0.44	0.06	0.00	0.00



	SB 3	SB 4	SB 5	SB 6	SB 7
Alburnoides prespensis	0.15	0.02	1.14	0.01	0.00
Alburnus belvica	0.15	0.13	0.05	0.38	0.67
Chondrostoma prespensis	0.09	0.06	0.06	0.00	0.00
Cyprinus carpio	0.03	0.01	0.03	0.01	0.00
Lepomis gibbosus	0.00	0.00	0.01	0.00	0.00
Pseudorasbora parva	0.58	0.65	0.40	0.00	0.00
Rhodeus amarus	0.13	0.46	0.24	0.00	0.00
Rutilus prespensis	0.49	0.34	0.52	0.16	0.01
Squalius prespensis	0.00	0.03	0.01	0.00	0.00
others	0.00	0.01	0.01	0.00	0.00

Figure 23. Standardized catches per unit of effort (CPUE) for the Macedonian Part of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). See Figure 21 for details. Species with less than 1 % of biomass are summarized as 'others': Prespa barbel, Prussian carp, spined loach, Prespa minnow

In 2015 a similar distribution of native species was recorded as in 2014, although aliens became more abundant again (Figure 23). Overall CPUE (BPUE) was less than in 2014. In 2015 at SB 3 and SB 4 alien species stone moroko and bitterling were found in high numbers, while at SB 5 (Konjsko), Prespa spirlin was the dominant species again. At the pelagic sub-basins, similar to 2014 Prespa bleak and Prespa roach were the most abundant.

In summary, certain fluctuations in species occurrence were noted between the years. However, native Prespa roach and the two aliens bitterling and stone moroko were present with high numbers at all littoral sub basins, while bleak showed a predominance at pelagic sites (SB 6 and SB 7, in particular). Highest BPUE and NPUE values for Prespa spirlin were noticed at SB 5 (Konjsko) in all three years.

5.4 Preliminary Lake Fish Index

5.4.1 Typology

A typology for Lakes Ohrid, Prespa and Shkodra could not be established. The lakes are unique with outstanding surface areas, depths and a very ancient genesis. They are not comparable with other lakes in the surroundings. Additionally, no comparison between the lakes is possible. Lake Shkodra is located at lower altitude and is much shallower than Lakes Prespa and Ohrid. The latter are both located at higher altitudes but differ considerably in area and depth. The fish communities are characterized by endemic species. Therefore, using similar metrics for all three lakes would be ill-founded. It was decided that individual assessments of every lake would be necessary. This decision is supported by the thresholds supposed for typologies in Annex II of the WFD.

5.4.2 Metrics and metric scoring

Long-time series of comparable fish data were not present. The dataset consisted of fishing campaigns in three consecutive years without the possibility of comparisons with results from other lakes. Therefore, metrics were selected by expert judgment. They were mainly based on the catches of benthic multi-mesh gillnets according to a standardized procedure EN 14757 in 2013, 2014 and 2015 (abbreviated MMG).

- **%N Prespa spirlin –** the numerical percentage of spirlin in the catches with MMG. The Prespa spirlin is an endemic species which should be common. Low percentages indicate a replacement of this species. This is an indication of major anthropogenic impact on the lake ecosystem.
- **%N Prespa minnow** - the numerical percentage of minnows in the catches with MMG. See %N spirlin for rationale.
- **%W Prespa bleak** - the weight percentage of bleak in the catches with MMG. See %N spirlin for rationale.
- **%N rheophilic species –** the numerical percentage of rheophilic species in the catches with MMG. The presence of rheophilic species indicates connection with adjacent rivers and brooks. Low percentages show that fish passage is impaired and that the ecological integrity is degraded. Rheophilic species in Prespa Lake are barbel, nase, minnow and chub.
- **%W native species** - the percentage of weight of native species in the catches with MMG. If native species are replaced by non-native species, a deterioration of the natural fish composition takes place. As non-natives are or were introduced by humans, this means an anthropogenic ecological degradation of the lake. The status of the fish species (native/alien) is shown in Table 1.
- **%N of juvenile Prespa spirlin –** the percentage of juvenile spirlin with juveniles being smaller than 10 cm. In an intact ecological situation, smaller individuals should be found in high numbers compared to bigger individuals. If mortality or lack of reproductive success lead to an underrepresentation of small individuals, a degraded ecological status can be assumed. The metric is not scored quantitatively but derived from length-frequency distributions (Annex II).
- **%N of juvenile Prespa bleak –** the percentage of juvenile bleak with juveniles being smaller than 10 cm. See juvenile spirlin for rationale.

The percentages of specific species, of rheophilic and of natives are metrics for the WFD category 'composition'. The percentages of juveniles belong to the metrics for 'reproduction and development'.

Preliminary class boundaries were set by expert's decisions based on data (Table 9). Three classes were assigned: high/good (5 points), moderate (3 points) or poor/bad (1 point). The reference values shown in the table are the expected values for a theoretical situation without anthropogenic impacts. Metric values above the good/moderate boundary are scored with 5 point, values between the boundaries score with 3 point and values below the moderate/poor boundary get 1 point.

Table 9. Metrics and class boundaries selected for a preliminary assessment LFI for Prespa Lake

Metric	Reference[a]	good/moderate	moderate/poor
%N Prespa spirlin	25	20	5
%N Prespa minnow	3	2	0.5
%W Prespa bleak	65	50	20
%W rheophilic	3	2	0.5
%W native	100	95	50
%N juvenile Prespa spirlin	high	low	absent
%N juvenile Prespa bleak	high	low	absent

[a] Reference shows a theoretical value for an un-impacted situation, the boundaries good/moderate and moderate/poor are relevant for scoring

5.4.3 Total scoring

The metric scores were combined by summation to a total score. The total score was transformed to an EQR between 0 and 1 with the following equation:

$$EQR = (X-X_{min})/(X_{max}-X_{min})$$

X is the sum of the scores, X_{min} is the smallest possible sum (all metrics score 1 point) and X_{max} is the highest possible sum (all metrics score 5 points).

Finally, the five ecological status classes of the WFD were assigned to the EQR values. As a first approach, an equidistant division was chosen: High: ≤ 1.0 / Good: ≤ 0.8 / Moderate: ≤ 0.6 / Poor ≤ 0.4 / Bad ≤ 0.2.

5.4.4 Preliminary assessment results

The preliminary LFI for Prespa Lake was calculated on the basis of the catches with MMG in the years 2013, 2014 and 2015. Pelagic nets were not included in the calculations. The data from Albania and Macedonia were combined. Sub-basins 6 and 7 (on Macedonian territory) were not included because of the special fishing method (pelagic MMG). The preliminary assessment results are shown in Table 10. The values were mostly calculated from the fishing data. Only the %N of juveniles were visually estimated from length-frequency distributions (see Annex II). Prespa spirlin below 10 cm were abundant in all sub-basins and in all years. Prespa bleak below 10 cm was underrepresented in the sub-basins 3 to 7 in all three years, thus a lower score was given.

Table 10. Results of a preliminary LFI for Prespa Lake. Columns with "MMG" show the corresponding values of the metrics for the three years of multi-mesh gillnetting (MMG). The columns with "Score" show the scores of the specific metrics. Lower lines show the total assessment results for each year and the corresponding ecological status

Metric	MMG 2013	MMG 2014	MMG 2015	Score 2013	Score 2014	Score 2015
%N Prespa spirlin	9.1	28.9	19.2	3	5	3
%N Prespa minnow	1.3	1.3	0.4	3	3	1
%W Prespa bleak	20.5	38.3	20.9	3	3	3
% rheophilic	11.3	4.1	7.6	5	5	5
%W native	66.3	89.1	78.6	3	3	3
%N juvenile Prespa spirlin	high	high	high	5	5	5
%N juvenile Prespa bleak	low	low	low	3	3	3
			EQR	**0.64**	**0.71**	**0.57**
			Status	**Moderate**	**Moderate**	**Poor**

6 DISCUSSION

Previous reports on Prespa Lake fishes primarily provide qualitative information (presence/absence) of different species (Spirkovski et al. 2012 b, Fremuth & Shumka 2014, Crivelli et al. 1997, Milošević & Talevski 2015, Spirkovski et al. 2012 a, Talevski et al. 2009) while quantitative information exists in form of catch data (Shumka et al. 2009, Spirkovski et al. 2012 b). In rare cases, CPUE values are presented (Crivelli 2010, SPP 2012, Shumka et al. 2015) which may enable comparisons among studies when methods are standardized. In any case, however, previous investigations and catch data are confined to national territories and no transboundary studies on fishes of Prespa Lake have been conducted so far. For the first time, therefore, the present report provides large-scale information on fish of Prespa Lake encompassing the territories of the riparian countries Albania and Macedonia. Additionally, the present report is founded on standardized fishing techniques (EN 14757) applied over a period of three years and thus gives insights into inter-annual trends of fish community development.

MMG fishing has been developed for the implementation of the WFD and is a widespread fishing procedure used across Europe for comparable scientific fish investigations. The gillnetting procedure provides a whole-lake estimate for species occurrence, quantitative relative fish abundance, biomass (expressed as catch per unit of effort, CPUE) and size structure of fish assemblages in temperate lakes. Applying the MMG technique at Prespa Lake resulted into a catch comprised of 15 species, which represent 75 % of the fish species known to currently inhabit the lake. This method, therefore, provides sound knowledge in terms of species diversity. In order to also get information on other species, such as European eel (*Anguilla anguilla*) or catfish (*Siluris glanis*), different gears need to be employed. Furthermore, MMG fishing has occasionally been criticized for not providing a “real” picture about certain fish community descriptors (Deceliere-Vergès & Guillard 2008, Prchalová et al. 2009). In the current study, based on expert knowledge, some fish size classes were underrepresented, such as big individuals of carp. It is, therefore, recommended for future monitoring to also use panels having larger mesh sizes (e.g. 70 or 90 mm knot to knot) than those employed here. Nonetheless, the current data on species richness are in good agreement with recent investigations conducted, among others, in the Greek part of Lake Micro Prespa (Petriki et al. 2017), where MMG fishing resulted into catches composed of 15 species.

Small differences in species composition and relative abundance of species were noted between years (Figure 11) but not so much between Albanian and Macedonian sampling sites (Figure 15 and Figure 19). Generally speaking, the fish community of Prespa Lake is numerically dominated by five species (Prespa bleak, Prespa roach, Prespa spirlin, bitterling, stone moroko). All of these are cyprinids which is in accordance with the eutrophic state of the lake. Current data furthermore show that alien species (especially bitterling, stone moroko and pumpkinseed) are very well established in the lake. At present, more than 50 % of the Prespa fishes are aliens which, most probably, compete with native species for food resources and habitats, and may also prey upon indigenous fish (Spirkovski et al. 2012 a). Potential direct and/or indirect effects of alien species on native fishes in Prespa Lake are, however, still poorly understood. Despite this there is ample evidence from other waters that non-indigenous (alien) species can have manifold effects on native fauna (Adams & Maitland 2001).

Variations in species composition and relative abundance of species did occur between pelagic and littoral sampling sites (Figure 22 and Figure 23). The pelagic habitat is inhabited by roach and bleak, in particular. During all surveyed periods, bleak was most abundant in the depth strata of 6-12 m (i. e. in the pelagic SB Central Plate and Kazan) where its dominance in the catches reached values of up to 98%. Such habitat-specific differences in species occurrence, thus, need to be taken into consideration in future fish monitoring programs.

From the three sampling campaigns, 15 fish species were recorded at Prespa Lake which represents 75% of inhabiting fish fauna. At SB 1 and SB 2 in all three years 15 species in both SB were recorded, and for the other SB this number fluctuated somewhat, mainly because of the appearance of rare species in the catches, such as Prespa barbel, Prespa minnow, Prussian carp and spined loach (Figure 39, Figure 44, Figure 49 and Figure 54). Obviously, a higher sampling effort is needed (or use of alternative gear) to also catch fishes that occur in low numbers. On the other hand, MMG fishing is a random sampling method and low numbers of individuals of a particular species in the catch obviously also reflect their low abundance in the whole fish community. A positive correlation between MMG fishing effort and number of fish species caught in other Mediterranean lakes was noticed by Petriki et al. (2017), although these authors pointed out that, in their studies, sampling effort could be reduced in the deepest zones of the lakes.

While MMG fishing according to standard EN 14757 was developed to assess the ecological status of a lake on the basis of the fish communities, this technique may also allow tentative statements regarding status of selected fish populations. At Prespa Lake, **Prespa bleak** *(Alburnus belvica)* is a major target species of commercial fishermen and local people. Additionally, it also is major prey of fish eating birds, such as Dalmatian pelican and cormorants (Spirkovski et al. 2012 a, Liordos & Goutner 2007). Despite these pressures, current investigations suggest that the population of bleak is relatively stable (Figure 12, Figure 13 and Figure 14). At any year of sampling, bleak represented somewhat less than 10 % of the collected individuals at both Macedonian and Albanian parts of the lake (Figure 16-Figure 18 and Figure 21-Figure 23). Importantly, fish of all size classes, i. e. juveniles and spawners, were caught throughout the years. In view that bleak start spawning at Prespa Lake after reaching approximately 90 mm in size, current data show that proportion of adult fish (i. e. share of potential spawners) has always been comparatively high at all sampling sites (Figure 29, Figure 34, Figure 39, Figure 44, Figure 49, Figure 54 and Figure 60). Nonetheless, as Prespa bleak is a relatively short-lived species and fish numbers were decreasing in the final year, its status should be monitored regularly.

In addition to Prespa bleak, **carp** (*Cyprinus carpio*) is also highly sought after by fishermen and local people (Ceroni 2013). In terms of biomass, in the current study carp contributed moderately to overall BPUE values, while the number of carp individuals in the catches was low relative to other species (Figure 16-Figure 18 and Figure 21-Figure 23). It is worth mentioning though that, on average, only small carp were sampled by use of MMG (Figure 29, Figure 34, Figure 39, Figure 44, Figure 49, Figure 54 and Figure 60) and only a few specimens were larger than the minimum allowed length of 30 (Albania) and 40 (Macedonia) cm, respectively (Table 6). Presumably, maximum mesh sizes used in the sampling campaigns (55 mm) were not sufficient to catch larger individuals. Previous research suggests that application of standard MMG (with mesh sizes ranging from 5-55 mm) do not provide a representative picture of fish sizes for larger species and use of additional net panels of 70, 90, 110 and 135 mm has been proposed (Šmejkal et al. 2015). The current results with low number of large carp in the catches, therefore, support these proposals.

The **Prespa spirlin** (*Alburnoides prespensis)* is a common species in the lake, especially in the depth strata of 0-3 m and 3-6 m. It occurs in all littoral SB with abundances of 9% in 2013, 29% in 2014 and 19% in 2015, respectively. High numbers of spirlin were recorded in particular at SB 1, SB 2 and SB 5. In view of body length, many individuals of small, medium and large size, respectively, were caught during the sampling campaigns (Figure 29, Figure 34 and Figure 49) which, in combination with high abundances, indicate that the Prespa Lake spirlin population is relatively stable.

Prespa roach (*Rutilus prespensis)* was widely spread in all sampled SB and throughout all sampling years (Figure 11). Moreover, the roach population is represented by both a high numbers of individuals and length classes, which in combination with the widespread occurrence of this species is indicative of a high stock stability.

Bitterling (*Rhodeus amarus*) and **stone moroko** (*Pseudorasbora parva)* are introduced species which are of no commercial value. Since introduction, both species have formed stable populations and can now be found at any littoral habitat. According to Spirkovski et al. (2012 a), the population of bitterling is low, which, however, is in contrast to results from current fishing campaigns (Figure 11, Figure 12, Figure 13 and Figure 14).

The endemic **Prespa barbel** (*Barbus prespensis*) (Figure 24) is only of minor relevance for fishery (Spirkovski et al. 2012 a) although it is occasionally caught because of its "fine flavour" (Ceroni 2013). Occurrence of barbel typically varies from year to year as this species faces several threats (such as lack of spawning grounds due to oscillations in water level, droughts and water abstractions) (Popovska & Bonacci 2007, Spirkovski 2004, Spirkovski et al. 2012 a). In the course of the CSBL project only a few Prespa barbel were collected (Figure 12, Figure 13 and Figure 14) which suggests that this species needs continuing support to increase the abundance of this vulnerable fish (Smith & Darwall 2006).

Figure 24. Prespa barbel (*Barbus prespensis*)

Other recorded species, such as **tench** (*Tinca tinca*) seem to not have established large populations in Prespa Lake. During the sampling campaigns this species was caught only with comparatively low numbers on the Albanian side of the lake. About the reasons can only be speculated but it is possible that tench becomes outcompeted by other species, such as carp or Prussian carp.

Only single individuals of **Prespa trout** (*Salmo peristericus*), which is considered "endangered" by IUCN (Smith & Darwall 2006), were sampled in the course of the current project (Figure 12 and Figure 14). This result is not surprising as *S. peristericus* is very sensitive towards suboptimal environmental conditions. Current physico-chemical situation and biological conditions at Prespa Lake (Peveling et al. 2015) obviously favour cyprinid fishes resulting into a rare presence of salmonids. Additionally, *S. peristericus* is also known to primarily occur in the headwaters of four adjacent streams (Rivers Agios Germanos, Brajcinska, Kranska and Leva Reka stream) which have limited connection to Prespa Lake (Koutseri et al. 2010). Therefore, the restricted distribution of Prespa trout may as well have contributed to low catches in the course of this study.

At various sub-basins and years, native species like bleak and roach as well as the non-indigenous carp formed significant parts of biomass in the annual catches (shown as high BPUE values), but in terms of numbers (NPUE) their contribution was much smaller (e.g., Figure 36, Figure 38, Figure 41, Figure 42 and Figure 43). Such differences were due to the natural characteristics of the fishes, i. e. larger body size of these species relative to stone moroko and bitterling. A recent study performed with MMG nets in eleven natural lakes in Greece (Petriki et al. 2017) resulted into mean biomass values (BPUE) of the sampled mesotrophic and eutrophic waters of about 15 to 110 g /m^2 of net, with most lakes showing BPUE values of around 30-40 g /m^2. The corresponding values of Prespa Lake obtained in the current study ranged from 17-28 g/m^2 during the three sampling years, and are, therefore, at a lower range compared with findings from other Mediterranean water bodies.

The preliminary assessment system indicated a moderate ecological status of Prespa Lake. In 2015, the status was rated as poor but very close to the upper boundary. The current results are heavily influenced by the huge abundance of non-native species. These species are not only indicating ecological degradation themselves but also lead to a decrease of the relative number of native species that were used as metrics. Non-native species are a very controversial topic in the context of WFD-compliant lake assessment. They are absent in reference conditions and can have significant impacts on fish communities. However, the WFD aims at evaluating the ecological status of the lake and not the pristineness of the fish stock. Non-native species might or might not negatively affect the ecology of the lake, i. e. other organisms or the food chain. There are arguments that non-native species should be evaluated as a significant anthropogenic stressor. On the other hand, there are arguments that a fish community with significant shares of non-native species cannot be used anymore for the assessment of ecological status. The situation at Prespa Lake, therefore, has to be clarified in the course of future improvements of the fish-based assessment system.

The development of a preliminary assessment system demonstrated the general possibility to use the existing data for future ambitions towards the implementation of the WFD. Prespa Lake is more or less incomparable to other lakes concerning its geography, morphometry, and fish community. Expert judgment played a major role in the development of the assessment system, especially in the setting of class boundaries. However, comparable procedures are not uncommon in Europe (Gassner et al. 2014, Ritterbusch et al. 2017 a). Some additional metrics were promising for the future improvement of the LFI. The weight per unit of effort is a widespread metric positively correlated with eutrophication and shoreline degradation. Another one is the percentage of weight of oxygen-intolerant species. However, as experiences with values of these metrics for MMG were missing, the setting of preliminary class boundaries based on expert decisions had to be postponed.

7 CONCLUSIONS

A standardized fishing using MMG according to EN 14757 has been performed for the first time on Prespa Lake. Analysis of data in relation to lake depth shows that the greatest concentration of alien species occurred in the shallower waters, while most economically valuable species (such as bleak, roach and carp) inhabit the pelagic part of the lake. Nonetheless, littoral areas are of tremendous significance as spawning and nursery grounds, also for native fish and provide food as well as shelter from predators.

About 75 % of currently existing fish species of the lake were caught by using MMG. From the present fish fauna, only three native species (European eel, stone loach and one of the minnows – *Phoxinus lumaireul*) and two alien species (catfish and mosquito fish) remained uncaught. Using fishery catch statistics as reference, it became obvious that very large fishes (like carp and Prespa chub) were not adequately represented in MMG catches if only the standard effort is applied. Similar observations have also been made by other authors implementing the same method in large European lakes (Holmgren & Appelberg 2000, Pope et al. 2005). Selectivity of the MMG fishing seems to be one of the reasons that both of above mentioned species are scarcely presented in the catches from pelagic nets. It is, therefore, suggested to include larger mesh sizes and/or other fishing gear into future fish monitoring activities.

Distribution of fish species within the littoral parts of Prespa Lake is relatively similar with regard to species composition and abundance between Albanian and Macedonian sites. However, distinct differences in these parameters exist between littoral and pelagic habitats which need to be considered when spatial comparisons are made. These spatial differences need to be considered when choosing future fish monitoring sites.

Current data suggest that alien species (bitterling, stone moroko, pumpkinseed) are well established in the lake. Their effect on other (especially endemic) fishes, however, needs to be investigated further. The economically important bleak seems to be in good condition. Nonetheless, as this species is short-living and numbers in final sampling year were dropping (Annex II), its regular monitoring is advised. Specifically, the mean size of spawners and age at maturity should be followed to uncover potential overfishing effects. In terms of carp, further data are needed, in particular on relative numbers and condition of adult fish (see above).

A preliminary system to assess the ecological status of Prespa Lake with fish showed the general suitability of the fish data for such a WFD-compliant approach. The system resulted in a moderate status, essentially caused by a huge share of alien species. The clarification of the relevance of aliens in the ecosystem is crucial for future efforts to implement the WFD.

8 PROPOSED MONITORING SCHEME

Based on data obtained in the present investigations using MMG, as well as expert opinion of fishery scientists a fish sampling scheme (Table 11) is proposed to monitor stock development of Prespa Lake fishes. The plan includes sampling sites at both Albanian and Macedonian territories and aims at collecting data about the state of both economically interesting species (such as bleak and carp), as well as fishes that deserve special attention because of their ecology (invasive species) and/or conservation status (e.g. Prespa barbel). In consequence, depending on the information needed for management purposes or research questions asked, the corresponding fishing gear(s) should be employed at the indicated locations and at time intervals varying in dependence on the respective topic, fish species, age class etc.

By using standardized sampling methods and calculation of catch-per-unit-efforts (CPUE), inter-annual comparisons shall be made possible and assessments on development of fish populations can be undertaken. Importantly, fishing effort (e.g. number of nets, fishing hours, fished areas etc.) need to be recorded to enable comparisons between sites or years. Additionally, fishing shall be performed according to existing standards (such as MMG fishing in line with EN 14757). For example, the European Standard EN 14962: 2006 (“Guidance on the scope and selection of fish sampling methods”) provides a methodological overview of the estimation of fish abundance and evaluation of fish populations. It also informs about existing fishing methods and evaluates their suitability in relation to category of individual water bodies (European Committee for Standardization 2006). Similarly, the European Standard EN 14011: 2003 (“Sampling of fish with electricity”) is a guideline for the estimation of composition, abundance and diversity of fish using electric gear. The norm includes details on gear and methods, but also safety standards. The minimum sampling effort (i.e. the shoreline length that needs to be sampled) is described in dependence on the water body type, and information about fish handling and measurement is presented (European Committee for Standardization 2003).

Catch data (along with information on related fishing effort) shall be collected from whoever is fishing, which can be the concessioner, FMO or private fisher. Such data may not be easy to obtain but do not necessarily come at a high cost.

Table 11. Proposed sampling scheme for fish monitoring at Prespa Lakes

Method	**ALBANIA (Macro (Ma) and Micro (Mi) Prespa Lakes)**											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Benthic MMG							Ma: Kallamas Mi: ALB-GR border					
Pelagic MMG												
Fyke net[a]							Ma: Kallamas Mi: ALB-GR border					
Electrofishing transects												
Larval fish trap[a]							Ma:					
Beach seine[a]							Ma: Kallamas Mi: ALB-GR border					
Catch data	x	x	x			x	x	x	x	x	x	x

[a] fyke, beach seine, larval fish traps for specific sites (streams of Kallamas, Liqenas, and Zaroshke)

Method	**MACEDONIA (Macro Prespa Lake)**											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Benthic MMG							Asamati; Oteshevo; Konjsko			Asamati; Oteshevo; Konjsko		
Pelagic MMG							Kazan			Kazan		
Fyke net[a]								Kazan				
Electrofishing transects								Asamati				
Larval fish trap							Asamati; Oteshevo; Konjsko; pelagial					
Beach seine								Asamati; Oteshevo; Konjsko				
Catch data [b]	x	x	x	x		x	x	x	x	x	x	x

[a] fyke, beach seine, larval traps, [b] if concessioner available

9 ADDITIONAL RECOMMENDATIONS

Prespa Lake is a shared resource, and no action can be taken by one country without impacting the resources and conditions in the other riparian countries.

In terms of sustainable fish stock management it is of utmost importance to re-establish a transboundary co-management authority ("Prespa Lake Fisheries Authority or Commission"), which already existed in the previous century to manage fisheries and related resources. Representatives from national institutions, local authorities, fishermen's organizations, research institutions, civil society etc. are recommended to be considered for membership.

This authority (technical and political) could, for example, be established in the frame of the "*Agreement on the Protection and Sustainable Development of the Prespa Park Area*" (2011), or the "*Agreement between the Council of Ministers of the Republic of Albania and the Government of the Republic of Macedonia for the Protection and Sustainable Development of Lake Ohrid and its Watershed*" (2004). According to these agreements, the riparian countries will take the necessary measures, among others, to protect biodiversity (particularly endemic species), to ensure the sustainable use of natural resources, and to prevent damage to the environment. In the light of the above possible measures, it is very important that the fishing effort be regularly adjusted according the actual status of the various species to conserve biodiversity and to restore the balance of the underwater fauna in order to exploit the available resources in a sustainable manner. Additionally, among the first tasks which can relatively easily be performed by this authority is the harmonization of national regulations in terms of allowed fishing gear, fishing ban periods, minimum legal size of species and identification of no-take zones.

The unique fish fauna of Prespa Lake is considered cultural heritage and as such deserves adequate resources for its protection and continuous contribution to human wellbeing. For knowledge-based decision making, further research is needed which, among others, shall focus on

- transboundary monitoring of fish stock, spawning grounds and habitats, and
- Prespa Lake Fish stock assessment, based on time series using all necessary fishing gears and other surveying technics.

Measures and actions (Table 12) proposed in a previous Prespa Lake project targeting the improvement of fisheries management, protection of fish biodiversity and lowering pressure on fishes (Spirkovski et al. 2012 b), remain on the agenda.

Table 12. Proposed measures and actions for improved fishery management at Prespa Lake (from Spirkovski et al. 2012 b, slightly modified)

No	Measures	Actions
1	Trilateral fishery management	Establishment of a Joint Prespa Fishery Commission (JPFC)
2	Monitoring of water quality and fish stocks	Establishing local monitoring sites in the three riparian countries in cooperation with scientific institutions and other relevant stakeholders
3	Joint technical monitoring protocols	Quality assurance and data acquisition (created by designated implementing bodies in charge of fishery)
4	Improved fish statistics	Using uniform software (data exchange) Establishing fishery database
5	Fish stock assessment	Integrated actions (open cross border expeditions and surveillances with joint resources) FSA Revision and relevant changes of the actual Fishing Master Plans for Prespa Lake and Prespa Lake Watershed on the Macedonian side
6	Guarding of fish stocks	Establishing national guarding bodies (state and/or private)
7	Conservation	Conservation action plans specified for individual fish species Total ban on Prespa barbel for 6 years period Total ban on Prespa trout for 3 years period Stocking program only with autochthonous fish related to specific habitats
8	Control of alien fishes	Selective and ameliorative fishing
9	Fishing limits	Determining and harmonizing the allowable smallest catchable size per species Determining the spawning periods and harmonizing closed fishing season per species
10	Spawning grounds, habitats	Defining strict natural fish spawning grounds (where any activities without special permission of the national management bodies and JPFC are not allowed) Improving the conditions of spawning grounds (access to rivers from the lake-side for e.g. Prespa nase)
11	Catch quotas	Determining of Annual Total Allowable Fish Catch Quotas (ATAFCQ) per country / per species
12	Fishing regulations	Maximum allowed fishing gears and fishing equipment for commercial and recreational fishery
13	Fish stocking	Designing of a Joint Fish Stocking Program (JFSP) where needed, species-specific and based on monitoring data

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ANNEX

Annex I. Prespa Lake points of sampling and additional sampling data

Table 13. Sub-basin 1 (Kallamas), points of sampling at Albanian part (2013)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	F	0-3 m	N40°51´434	E20°57´404	17.10.2013	1728	630	782	2.7	16.4
2	F	0-3 m	N40°51´389	E20°56´528	17.10.2013	1738	640	782	2,7	16.4
3	A	0-3 m	N40°52´473	E20°56´446	16.10.2013	1720	610	810	2,8	16.6
4	E	0-3 m	N40°52´541	E20°55´497	18.10.2013	1725	630	785	3	16.2
5	D	0-3 m	N40°53´541	E20°56´355	16.10.2013	1735	630	815	2.8	16.6
6	F	0-3 m	N40°51´352	E20°57´414	19.10.2013	1725	620	815	2.8	16.5
7	G	0-3 m	N40°51´262	E20°58´161	19.10.2013	1735	630	815	2.8	16.5
8	C	0-3 m	N40°53´166	E20°55´438	18.10.2013	1740	645	810	3	16.2
9	F	0-3 m	N40°52´006	E20°56´348	20.10.2013	1740	620	800	2.8	16.4
10	E	0-3 m	N40°52´525	E20°55´507	20.10.2013	1730	435	665	2.8	16.4
11	K	0-3 m	N40°52´564	E20°58´143	17.10.2013	1810	710	780	2.7	16.4
12	E'	3-6 m	N40°52´292	E20°57´055	16.10.2013	1755	645	810	2.8	16.6
13	K'	3-6 m	N40°51´150	E20°58´221	21.10.2013	1800	640	760	2.5	16.1
14	B'	3-6 m	N40°50´257	E20°58´032	20.10.2013	1800	705	785	2.8	16.4
15	A'	3-6 m	N40°50´399	E20°57´592	20.10.2013	1810	715	785	2.8	16.4
16	G'	3-6 m	N40°52´474	E20°58´192	17.10.2013	1800	655	775	2.7	16.4
17	I'	3-6 m	N40°50´570	E20°58´161	19.10.2013	1800	700	780	2.8	16.5
18	C'	3-6 m	N40°51´292	E20°58´132	18.10.2013	1810	640	750	3	16.2
19	E'	3-6 m	N40°51´464	E20°57´543	18.10.2013	1820	655	755	3	16.2
20	J'	3-6 m	N40°50´496	E20°58´181	19.10.2013	1810	715	785	2.8	16.5
21	G'	3-6 m	N40°52´315	E20°58´072	16.10.2013	1810	700	810	2.8	16.6
22	H'	6-12 m	N40°53´116	E20°58´322	17.10.2013	1815	725	790	2.7	16.4
23	E'	6-12 m	N40°52´007	E20°57´195	16.10.2013	1820	715	815	2.8	16.6
24	K'	6-12 m	N40°52´142	E20°57´513	20.10.2013	1835	740	785	2.8	16.4
25	B'	6-12 m	N40°51´269	E20°58´130	20.10.2013	1855	755	780	2.8	16.4
26	A'	6-12 m	N40°51´195	E20°58´201	20.10.2013	1920	810	810	2.8	16.4
27	G'	6-12 m	N40°52´496	E20°58´212	17.10.2013	1825	740	795	2.7	16.4
28	I'	6-12 m	N40°51´157	E20°58´280	20.10.2013	1920	830	790	2.8	16.4
29	C'	6-12 m	N40°51´449	E20°57´563	18.10.2013	1855	730	795	3	14.2
30	E'	6-12 m	N40°51´539	E20°57´573	18.10.2013	1905	735	750	3	14.2
31	J'	6-12 m	N40°50´496	E20°58´210	21.10.2013	1825	705	800	2.5	16.1
32	G'	6-12 m	N40°52´270	E20°58´563	16.10.2013	1835	730	815	2.8	16.6

Table 14. Sub-basin 2 (Liqenas), points of sampling at Albanian part (2013)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	D	0-3 m	N40°47′241	E20°54′493	24.10.2013	1735	630	815	3	16
2	J	0-3 m	N40°48′254	E20°56′298	25.10.2013	1720	620	780	2.8	15.8
3	E	0-3 m	N40°47′400	E20°55′083	24.10.2013	1750	650	780	3	16
4	G	0-3 m	N40°47′493	E20°55′153	26.10.2013	1750	620	790	2.7	15.7
5	P	0-3 m	N40°49′536	E20°56′106	26.10.2013	1800	630	750	2.7	15.7
6	H	0-3 m	N40°48′000	E20°55′583	27.10.2013	1735	605	790	2.5	15.6
7	N	0-3 m	N40°49′232	E20°56′241	27.10.2013	1755	620	785	2.5	15.6
8	A	0-3 m	N40°46′296	E20°54′365	23.10.2013	1740	600	780	3.2	16.1
9	K	0-3 m	N40°48′549	E20°56′199	25.10.2013	1740	640	780	2.8	15.8
10	D	0-3 m	N40°46′446	E20°54′396	23.10.2013	1750	610	780	3.2	16.1
11	H	0-3 m	N40°47′274	E20°54′458	28.10.2013	1750	700	830	2.6	15.5
12	J'	3-6 m	N40°46′301	E20°54′591	23.10.2013	1810	620	730	3.2	16.1
13	E	3-6 m	N40°47′268	E20°55′146	23.10.2013	1825	630	725	3.2	16.1
14	H'	3-6 m	N40°48′000	E20°56′115	24.10.2013	1810	715	785	3	16
15	I'	3-6 m	N40°47′067	E20°56′291	24.10.2013	1830	735	785	3	16
16	J'	3-6 m	N40°46′281	E20°56′360	27.10.2013	1815	645	750	2.5	15.6
17	N	3-6 m	N40°49′118	E20°56′464	25.10.2013	1800	700	780	2.8	15.8
18	B'	3-6 m	N40°46′412	E20°55′074	27.10.2013	1835	705	790	2.5	15.6
19	O'	3-6 m	N40°50′081	E20°56′434	26.10.2013	1815	645	750	2.7	15.7
20	V'	3-6 m	N40°49′551	E20°56′337	26.10.2013	1830	700	790	2.7	15.7
21	O'	3-6 m	N40°49′131	E20°56′461	25.10.2013	1820	720	780	2.8	15.8
22	B'	6-12 m	N40°46′354	E20°55′232	23.10.2013	1840	645	725	3.2	16.1
23	J'	6-12 m	N40°48′435	E20°57′158	27.10.2013	1850	725	795	2.5	15.6
24	I'	6-12 m	N40°47′441	E20°56′267	27.10.2013	1910	745	755	2.5	15.6
25	O'	6-12 m	N40°48′435	E20°57′122	25.10.2013	1850	745	815	2.8	15.8
26	F'	6-12 m	N40°47′494	E20°56′274	24.10.2013	1850	755	785	3	16
27	J'	6-12 m	N40°48′381	E20°57′114	25.10.2013	1910	712	722	2.8	15.8
28	N'	6-12 m	N40°49′260	E20°57′032	28.10.2013	1830	730	780	2.6	15,5
29	O'	6-12 m	N40°49′531	E20°57′218	26.10.2013	1845	720	795	2.7	15.7
30	S	6-12 m	N40°49′158	E20°57′237	26.10.2013	1900	745	765	2.7	15.7
31	I'	6-12 m	N40°47′541	E20°56′336	24.10.2013	1905	810	785	3	16
32	F'	6-12 m	N40°47′440	E20°56′055	23.10.2013	1900	705	725	3.2	16.1

Table 15. Sub-basin 1 (Kallamas), points of sampling at Albanian part (2014)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	F	0-3 m	N40°51´434	E20°57´404	13.11.2014	1710	610	780	4	10.2
2	F	0-3 m	N40°51´389	E20°56´528	06.11.2014	1700	530	750	4	12
3	A	0-3 m	N40°52´473	E20°56´446	07.11.2014	1720	610	810	4	11.8
4	E	0-3 m	N40°52´541	E20°55´497	15.11.2014	1725	630	785	4	9.8
5	D	0-3 m	N40°53´541	E20°56´355	08.11.2014	1735	630	815	3.8	11.7
6	F	0-3 m	N40°51´352	E20°57´414	06.11.2014	1720	600	740	4	12
7	G	0-3 m	N40°51´262	E20°58´161	13.11.2014	1735	630	775	4	10.2
8	C	0-3 m	N40°53´166	E20°55´438	26.11.2014	1730	540	730	3.5	10.8
9	F	0-3 m	N40°52´006	E20°56´348	15.11.2014	1740	640	780	4	9.8
10	E	0-3 m	N40°52´525	E20°55´507	08.11.2014	1745	645	780	3.8	11.7
11	K	0-3 m	N40°52´564	E20°58´143	07.11.2014	1730	630	780	4	11.8
12	E'	3-6 m	N40°52´292	E20°57´055	13.11.2014	1755	645	770	4	10.2
13	K'	3-6 m	N40°51´150	E20°58´221	06.11.2014	1745	615	750	4	12
14	B'	3-6 m	N40°50´257	E20°58´032	07.11.2014	1800	645	745	4	11.8
15	A'	3-6 m	N40°50´399	E20°57´592	08.11.2014	1810	715	785	3.8	11.7
16	G'	3-6 m	N40°52´474	E20°58´192	15.11.2014	1800	655	775	4	9.8
17	I'	3-6 m	N40°50´570	E20°58´161	06.11.2014	1800	700	780	4	12
18	C'	3-6 m	N40°51´292	E20°58´132	07.11.2014	1810	700	770	4	11.8
19	E'	3-6 m	N40°51´464	E20°57´543	13.11.2014	1810	700	770	3.8	10.2
20	J'	3-6 m	N40°50´496	E20°58´181	15.11.2014	1810	715	785	4	9.8
21	G'	3-6 m	N40°52´315	E20°58´072	08.11.2014	1830	700	750	3.8	11.7
22	H'	6-12 m	N40°53´116	E20°58´322	08.11.2014	1845	725	760	3.8	11.7
23	E'	6-12 m	N40°52´007	E20°57´195	15.11.2014	1820	715	815	4	9.8
24	K'	6-12 m	N40°52´142	E20°57´513	06.11.2014	1835	740	785	4	12
25	B'	6-12 m	N40°51´269	E20°58´130	13.11.2014	1830	730	780	3.8	10.2
26	A'	6-12 m	N40°51´195	E20°58´201	15.11.2014	1845	730	795	4	9.8
27	G'	6-12 m	N40°52´496	E20°58´212	06.11.2014	1840	740	70	4	12
28	I'	6-12 m	N40°51´157	E20°58´280	07.11.2014	1830	715	765	4	11.8
29	C'	6-12 m	N40°51´449	E20°57´563	13.11.2014	1855	735	750	3.8	10.3
30	E'	6-12 m	N40°51´539	E20°57´573	08.11.2014	1905	735	750	3.8	11.7
31	J'	6-12 m	N40°50´496	E20°58´210	26.11.2014	1800	630	750	3.5	10.8
32	G'	6-12 m	N40°52´270	E20°58´563	07.11.2014	1845	730	815	4	11.8

Table 16. Sub-basin 2 (Liqenas), points of sampling at Albanian part (2014)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	D	0-3 m	N40°47′241	E20°54′493	19.11.2014	1735	630	815	4	10
2	J	0-3 m	N40°48′254	E20°56′298	14.11.2014	1720	620	780	4	10.4
3	E	0-3 m	N40°47′400	E20°55′083	20.11.2014	1700	610	780	3.5	9.1
4	G	0-3 m	N40°47′493	E20°55′153	14.11.2014	1750	630	780	4	10.4
5	P	0-3 m	N40°49′536	E20°56′106	21.11.2014	1730	600	750	3.5	8.6
6	H	0-3 m	N40°48′000	E20°55′583	21.11.2014	1745	615	790	3.5	8.6
7	N	0-3 m	N40°49′232	E20°56′241	22.11.2014	1700	600	780	3.5	8.7
8	A	0-3 m	N40°46′296	E20°54′365	27.11.2014	1730	535	725	3.5	10.7
9	K	0-3 m	N40°48′549	E20°56′199	20.11.2014	1720	640	860	3.5	9.1
10	D	0-3 m	N40°46′446	E20°54′396	22.11.2014	1720	620	780	3.2	8.7
11	H	0-3 m	N40°47′274	E20°54′458	19.11.2014	1750	650	780	4	10
12	J'	3-6 m	N40°46′301	E20°54′591	19.11.2014	1810	700	770	4	10
13	E	3-6 m	N40°47′268	E20°55′146	14.11.2014	1810	640	750	4	10.4
14	H'	3-6 m	N40°48′000	E20°56′115	21.11.2014	1800	630	790	3.5	8.6
15	I'	3-6 m	N40°47′067	E20°56′291	14.11.2014	1830	640	780	4	10.4
16	J'	3-6 m	N40°46′281	E20°56′360	20.11.2014	1740	650	70	3.5	9.1
17	N	3-6 m	N40°49′118	E20°56′464	19.11.2014	1830	720	770	4	10
18	B'	3-6 m	N40°46′412	E20°55′074	22.11.2014	1750	650	780	3.5	8.7
19	O'	3-6 m	N40°50′081	E20°56′434	21.11.2014	1815	645	750	3.5	8.6
20	V'	3-6 m	N40°49′551	E20°56′337	22.11.2014	1810	710	780	3.5	8.6
21	O'	3-6 m	N40°49′131	E20°56′461	20.11.2014	1820	720	780	2.8	15.8
22	B'	6-12 m	N40°46′354	E20°55′232	21.11.2014	1840	645	725	3.2	16.1
23	J'	6-12 m	N40°48′435	E20°57′158	20.11.2014	1800	705	785	3.5	9.1
24	I'	6-12 m	N40°47′441	E20°56′267	27.11.2014	1800	630	750	3.5	10.7
25	O'	6-12 m	N40°48′435	E20°57′122	14.11.2014	1850	700	730	4	10.4
26	F'	6-12 m	N40°47′494	E20°56′274	19.11.2014	1850	755	785	4	10
27	J'	6-12 m	N40°48′381	E20°57′114	22.11.2014	1830	720	770	3.5	8.6
28	N'	6-12 m	N40°49′260	E20°57′032	14.11.2014	1905	720	735	3.5	10.4
29	O'	6-12 m	N40°49′531	E20°57′218	22.11.2014	1845	745	780	3.5	8.6
30	S	6-12 m	N40°49′158	E20°57′237	20.11.2014	1820	730	790	3.5	9.1
31	I'	6-12 m	N40°47′541	E20°56′336	21.11.2014	1900	720	740	3.5	8.6
32	F'	6-12 m	N40°47′440	E20°56′055	19.11.2014	1900	805	785	4	10

Table 17. Sub-basin 1 (Kallamas), points of sampling at Albanian part (2015)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	F	0-3 m	N40°51´434	E20°57´404	06.11.2015	1710	610	780	4.5	12.8
2	F	0-3 m	N40°51´389	E20°56´528	03.11.2015	1710	530	740	3.8	13.1
3	A	0-3 m	N40°52´473	E20°56´446	04.11.2015	1720	610	810	3.5	13.2
4	E	0-3 m	N40°52´541	E20°55´497	07.11.2015	1725	630	785	4.5	12.7
5	D	0-3 m	N40°53´541	E20°56´355	05.11.2015	1735	630	815	4.8	13
6	F	0-3 m	N40°51´352	E20°57´414	03.11.2015	1720	600	740	3.8	13.1
7	G	0-3 m	N40°51´262	E20°58´161	06.11.2015	1735	630	775	4.5	12.8
8	C	0-3 m	N40°53´166	E20°55´438	08.11.2015	1730	540	730	4.5	12.8
9	F	0-3 m	N40°52´006	E20°56´348	07.11.2015	1740	640	780	4.5	12.7
10	E	0-3 m	N40°52´525	E20°55´507	05.11.2015	1745	645	780	4.8	13
11	K	0-3 m	N40°52´564	E20°58´143	04.11.2015	1730	630	780	3.5	13.2
12	E'	3-6 m	N40°52´292	E20°57´055	06.11.2015	1755	645	770	4.5	12.8
13	K'	3-6 m	N40°51´150	E20°58´221	03.11.2015	1745	615	750	3.8	13.1
14	B'	3-6 m	N40°50´257	E20°58´032	04.11.2015	1800	645	745	3.5	13.2
15	A'	3-6 m	N40°50´399	E20°57´592	05.11.2015	1810	715	785	4.8	13
16	G'	3-6 m	N40°52´474	E20°58´192	07.11.2015	1800	655	775	4.5	12.7
17	I'	3-6 m	N40°50´570	E20°58´161	03.11.2015	1800	700	780	3.8	13.1
18	C'	3-6 m	N40°51´292	E20°58´132	04.11.2015	1810	700	770	3.5	13.2
19	E'	3-6 m	N40°51´464	E20°57´543	06.11.2015	1810	700	770	4.5	12.8
20	J'	3-6 m	N40°50´496	E20°58´181	07.11.2015	1810	715	785	4.5	12.7
21	G'	3-6 m	N40°52´315	E20°58´072	05.11.2015	1830	700	750	4.8	13
22	H'	6-12 m	N40°53´116	E20°58´322	05.11.2015	1845	725	760	4.8	13
23	E'	6-12 m	N40°52´007	E20°57´195	07.11.2015	1820	715	815	4.5	12.7
24	K'	6-12 m	N40°52´142	E20°57´513	03.11.2015	1835	740	785	3.8	13.1
25	B'	6-12 m	N40°51´269	E20°58´130	06.11.2015	1830	730	780	4.5	12.8
26	A'	6-12 m	N40°51´195	E20°58´201	07.11.2015	1845	730	795	4.5	12.7
27	G'	6-12 m	N40°52´496	E20°58´212	03.11.2015	1840	740	70	3.8	13.1
28	I'	6-12 m	N40°51´157	E20°58´280	04.11.2015	1830	715	765	3.5	13.2
29	C'	6-12 m	N40°51´449	E20°57´563	06.11.2015	1855	735	750	4.5	12.8
30	E'	6-12 m	N40°51´539	E20°57´573	05.11.2015	1905	735	750	4.8	13
31	J'	6-12 m	N40°50´496	E20°58´210	08.11.2015	1800	630	750	4.5	12.8
32	G'	6-12 m	N40°52´270	E20°58´563	04.11.2015	1845	730	815	3.5	13.2

Table 18. Sub-basin 2 (Liqenas), points of sampling at Albanian part (2015)

Net no.	Sector basin	Depth stratum	Coordinates		Date	Time set	Time lift	Time effort (min)	Secchi depth (m)	Temp (°C)
1	D	0-3 m	N40°47′241	E20°54′493	10.11.2015	1735	630	815	4.5	12.8
2	J	0-3 m	N40°48′254	E20°56′298	09.11.2015	1720	620	780	4.5	12
3	E	0-3 m	N40°47′400	E20°55′083	11.11.2015	1700	610	780	4.5	12.8
4	G	0-3 m	N40°47′493	E20°55′153	09.11.2015	1750	630	780	4.5	12
5	P	0-3 m	N40°49′536	E20°56′106	12.11.2015	1730	600	750	4.8	12.5
6	H	0-3 m	N40°48′000	E20°55′583	12.11.2015	1745	615	790	4.8	12.5
7	N	0-3 m	N40°49′232	E20°56′241	13.11.2015	1700	600	780	4.5	12.3
8	A	0-3 m	N40°46′296	E20°54′365	14.11.2015	1730	535	725	4.5	12.5
9	K	0-3 m	N40°48′549	E20°56′199	11.11.2015	1720	640	860	4.5	12.8
10	D	0-3 m	N40°46′446	E20°54′396	13.11.2015	1720	620	780	4.5	12.3
11	H	0-3 m	N40°47′274	E20°54′458	10.11.2015	1750	650	780	4.5	12.8
12	J'	3-6 m	N40°46′301	E20°54′591	10.11.2015	1810	700	770	4.5	12.8
13	E	3-6 m	N40°47′268	E20°55′146	09.11.2015	1810	640	750	4.5	12
14	H'	3-6 m	N40°48′000	E20°56′115	12.11.2015	1800	630	790	4.8	12.5
15	I'	3-6 m	N40°47′067	E20°56′291	09.11.2015	1830	640	780	4.5	12
16	J'	3-6 m	N40°46′281	E20°56′360	11.11.2015	1740	650	70	4.5	12.8
17	N	3-6 m	N40°49′118	E20°56′464	10.11.2015	1830	720	770	4.5	13.1
18	B'	3-6 m	N40°46′412	E20°55′074	13.11.2015	1750	650	780	4.5	12.3
19	O'	3-6 m	N40°50′081	E20°56′434	12.11.2015	1815	645	750	4.8	12.5
20	V'	3-6 m	N40°49′551	E20°56′337	13.11.2015	1810	710	780	4.5	12.3
21	O'	3-6 m	N40°49′131	E20°56′461	11.11.2015	1820	720	780	4.5	12.8
22	B'	6-12 m	N40°46′354	E20°55′232	12.11.2015	1840	645	725	4.8	12.5
23	J'	6-12 m	N40°48′435	E20°57′158	11.11.2015	1800	705	785	4.5	12.8
24	I'	6-12 m	N40°47′441	E20°56′267	14.11.2015	1800	630	750	4.5	12.5
25	O'	6-12 m	N40°48′435	E20°57′122	09.11.2015	1850	700	730	4.5	12
26	F'	6-12 m	N40°47′494	E20°56′274	10.11.2015	1850	755	785	4.5	12.8
27	J'	6-12 m	N40°48′381	E20°57′114	13.11.2015	1830	720	770	4.5	12.3
28	N'	6-12 m	N40°49′260	E20°57′032	09.11.2015	1905	720	735	4.5	12
29	O'	6-12 m	N40°49′531	E20°57′218	13.11.2015	1845	745	780	4.5	12.3
30	S	6-12 m	N40°49′158	E20°57′237	11.11.2015	1820	730	790	4.5	12.8
31	I'	6-12 m	N40°47′541	E20°56′336	12.11.2015	1900	720	740	4.8	12.5
32	F'	6-12 m	N40°47′440	E20°56′055	10.11.2015	1900	805	785	4.5	12.8

Table 19. Points of sampling at Macedonian part (2013)

Sub-basin	Net number	Date	Depth stratum	Depth (m)	Longitude	Latitude
SB 3 ASAMATI	1	11.10.2013	3 - 6	6.0 - 6.0	E 21° 01´ 724	N 40° 59´ 210
	2		6 - 12	7.5 - 8.1	E 20° 01´ 609	N 40° 59´ 155
	3		6 - 12	10.2 - 10.5	E 20° 01´ 609	N 40° 59´ 080
	4		6 - 12	11.9 - 11.5	E 20° 01´ 572	N 40° 59´ 038
	5		6 - 12	11.9 - 11.9	E 20° 02´ 187	N 40° 58´ 840
	6	16.10.2013	6 - 12	15.3 - 12.0	E 21° 00´ 771	N 40° 59´ 141
	7		0 - 3	2.4 - 2.4	E 21° 01´ 149	N 40° 59´ 469
	8		0 - 3	2. 6 - 2.6	E 21° 01´ 194	N 40° 59´ 454
	9		0 - 3	2.6 - 2.6	E 21° 01´ 587	N 40° 59´ 341
	10		0 - 3	2.7 - 2.7	E 21° 01´ 883	N 40° 59´ 296
	11		0 - 3	2.5 - 3.5	E 21° 02´ 116	N 40° 59´ 240
	12		3 - 6	3.7 - 3.7	E 21° 02´ 357	N 40° 59´ 118
	13		3 - 6	3.5 - 3.5	E 21° 02´ 536	N 40° 59´ 075
	14		3 - 6	3. 8 - 3.8	E 21° 02´ 705	N 40° 58´ 891
	15		3 - 6	3.7 - 3.7	E 21° 02´ 772	N 40° 58´ 841
SB 4 OTESEVO	16	10.10.2013	0 - 3	1.0 - 1.0	E 20° 54´ 153	N 40° 57´ 504
	17		0 - 3	0.0 - 3.0	E 20° 54´ 119	N 40° 57´ 465
	18		0 - 3	0.0 - 3.0	E 20° 54´ 029	N 40° 57´ 372
	19		3 - 6	3.0 - 6.0	E 20° 54´ 073	N 40° 57´ 387
	20		3 - 6	3.0 - 6.0	E 20° 54´ 031	N 40° 57´ 309
	21	11.10.2013	3 - 6	6.0 - 6.0	E 20° 55´ 076	N 40° 58´ 385
	22		6 - 12	8.0 - 9.0	E 20° 55´ 139	N 40° 58´ 356
	23		6 - 12	9.6 - 9.8	E 20° 55´ 150	N 40° 58´ 301
	24		6 - 12	10.0 - 10.7	E 20° 55´ 153	N 40° 58´ 210
	25		6 - 12	11.5 - 11.9	E 20° 55´ 222	N 40° 58´ 115
	26		0 - 3	0.0 - 3.0	E 20° 55´ 260	N 40° 58´ 085
	27		3 - 6	5.0 - 6.0	E 20° 55´ 251	N 40° 58´ 030
SB 5 KONJSKO	28	12.10.2013	0 - 3	2.5 - 2.4	E 20° 59´ 219	N 40° 54´ 945
	29		3 - 6	2.8 - 3.6	E 20° 59´ 140	N 40° 54´ 953
	30		0 - 3	1.5 - 2.5	E 20° 58´ 871	N 40° 54´ 961
	31		6 - 12	7.1 - 8.2	E 20° 58´ 887	N 40° 54´ 995
	32		6 - 12	9.3 - 9.7	E 20° 58´ 932	N 40° 55´ 012
	33		6 - 12	12.1 - 8.3	E 20° 59´ 052	N 40° 55´ 001
	34		3 - 6	6.6 - 6.3	E 20° 59´ 252	N 40° 54´ 990
	35		6 - 12	11.7 - 8. 3	E 20° 59´ 354	N 40° 54´ 982
	36	15.10.2013	0 - 3	1.6 - 1.6	E 20° 59´ 317	N 40° 54´ 936
	37		0 - 3	2.2 - 2.2	E 20° 59´ 439	N 40° 54´ 887
	38		0 - 3	2.6 - 2.6	E 20° 59´ 485	N 40° 54´ 836
	39		3 - 6	4.5 - 6.0	E 20° 59´ 219	N 40° 54´ 945
SB 6 CENTRAL PLATE	40	13.10.2013	14 - 16	14.0 - 16.0	E 21° 01´ 816	N 40° 54´ 640
	41		14 - 16	14.0 - 16.0	E 21° 01´ 939	N 40° 54´ 550
	42		14 - 16	14.0 - 16.0	E 21° 02´ 101	N 40° 54´ 427

SB6 CENTRAL PLATE (contd.)	43		14 - 16	14.0 - 16.0	E 21° 02′ 281	N 40° 54′ 380
	44		14 - 16	14.0 - 16.0	E 21° 02′ 524	N 40° 54′ 321
	45		14 - 16	14.0 - 16.0	E 21° 02′ 675	N 40° 54′ 328
	46		14 - 16	14.0 - 16.0	E 21° 02′ 890	N 40° 54′ 388
	47		14 - 16	14.0 - 16.0	E 21° 02′ 928	N 40° 54′ 524
	48		14 - 16	14.0 - 16.0	E 21° 02′ 947	N 40° 54′ 692
	49		14 - 16	14.0 - 16.0	E 21° 02′ 855	N 40° 54′ 831
	50	14.10.2013	14 - 16	14.0 - 14.0	E 21° 01′ 780	N 40° 57′ 223
	51		14 - 16	14.0 - 14.0	E 21° 01′ 690	N 40° 57′ 360
	52		14 - 16	14.0 - 14.0	E 21° 01′ 580	N 40° 57′ 420
	53		14 - 16	14.0 - 14.0	E 21° 01′ 446	N 40° 57′ 522
	54		14 - 16	14.0 - 14.0	E 21° 01′ 137	N 40° 57′ 605
	55		14 - 16	14.0 - 14.0	E 21° 00′ 923	N 40° 57′ 655
	56		14 - 16	14.0 - 14.0	E 21° 01′ 640	N 40° 57′ 705
	57		14 - 16	14.0 - 14.0	E 21° 00′ 394	N 40° 57′ 727
	58		14 - 16	14.0 - 14.0	E 21° 00′ 206	N 40° 57′ 665
	59	15.10.2013	14 - 16	14.0 - 14.0	E 21° 02′ 401	N 40° 56′ 239
	60		14 - 16	14.9 - 14.9	E 21° 02′ 620	N 40° 56′ 355
	61		14 - 16	14.8 - 14.8	E 21° 02′ 540	N 40° 56′ 521
	62		14 - 16	14.8 - 14.8	E 21° 02′ 435	N 40° 56′ 696
	63		14 - 16	14.8 - 14.8	E 21° 02′ 312	N 40° 56′ 899
	64		14 - 16	14.0 - 14.0	E 21° 02′ 190	N 40° 56′ 960
PELAGIC NET	65	16.10.2013	0 – 6 surface	0.0 - 6.0	E 20° 55′ 495	N 40° 56′ 696

Table 20. Points of sampling at Macedonian part (2014)

Sub-basin	Net number	Date	Depth stratum	Depth (m)	Longitude	Latitude
SB 3 ASAMATI	1	17.11.2014	0 - 3	2.7 - 2.8	E 21° 02´ 310	N 40° 59´ 171
	2		0 - 3	3.0 - 3.0	E 21° 02´ 357	N 40° 59´ 150
	3		0 - 3	2.8 - 3.0	E 21° 02´ 436	N 40° 59´ 110
	4		0 - 3	2.7 - 3.0	E 21° 02´ 486	N 40° 59´ 041
	5		0 - 3	2.6 - 3.0	E 21° 02´ 509	N 40° 58´ 943
	6		0 - 3	3.1 - 2.7	E 21° 02´ 610	N 40° 58´ 844
	7		0 - 3	2.5 - 3.0	E 21° 02´ 708	N 40° 58´ 746
	8		0 - 3	2.9 - 3.0	E 21° 02´ 800	N 40° 58´ 718
	9		0 - 3	2.3 - 3.0	E 21° 02´ 848	N 40° 58´ 661
	10		0 - 3	3.0 - 3.1	E 21° 02´ 810	N 40° 58´ 615
	11	19.11.2014	0 - 3	2.2 - 1.8	E 21° 02´ 144	N 40° 59´ 303
	12		0 - 3	1.4 - 1.4	E 21° 02´ 192	N 40° 59´ 341
	13		0 - 3	1.3 - 1.9	E 21° 02´ 235	N 40° 59´ 330
	14		0 - 3	1.9 - 1.9	E 21° 02´ 265	N 40° 59´ 286
	15		0 - 3	1.9 - 2.1	E 21° 02´ 328	N 40° 59´ 257
	16		0 - 3	2.6 - 2.9	E 21° 02´ 326	N 40° 59´ 205
	17		3 - 6	4.1 - 4.4	E 21° 02´ 256	N 40° 58´ 987
	18		3 - 6	5.1 - 6.1	E 21° 02´ 234	N 40° 58´ 927
	19		3 - 6	6.0 - 5.8	E 21° 02´ 128	N 40° 58´ 996
	20		3 - 6	5.6 - 5.5	E 21° 02´ 062	N 40° 59´ 062
	21	21.11.2014	3 - 6	4.0 - 4.2	E 21° 02´ 572	N 40° 58´ 786
	22		3 - 6	5.0 - 5.6	E 21° 02´ 414	N 40° 58´ 729
	23	25.11.2014	3 - 6	6.0 - 5.7	E 21° 02´ 896	N 40° 58´ 532
	24		3 - 6	4.5 - 5.2	E 21° 02´ 757	N 40° 58´ 781
	25		3 - 6	5.2 - 6.1	E 21° 02´ 704	N 40° 58´ 828
	26		3 - 6	3.5 - 5.1	E 21° 02´ 620	N 40° 59´ 008
	27		3 - 6	4.0 - 4.3	E 21° 02´ 491	N 40° 59´ 055
	28		3 - 6	3.8 - 4.7	E 21° 02´ 322	N 40° 59´ 080
	29		3 - 6	5.0 - 6.3	E 21° 02´ 194	N 40° 59´ 092
	30		3 - 6	4.8 - 5.7	E 21° 02´ 154	N 40° 59´ 145
	31		3 - 6	6.0 - 4.8	E 21° 02´ 088	N 40° 59´ 166
	32		3 - 6	5.0 - 6.2	E 21° 01´ 935	N 40° 59´ 275
	33	21.11.2014	6 - 12	7.0 - 11.0	E 21° 02´ 368	N 40° 58´ 667
	34		6 - 12	11.5 - 8.0	E 21° 02´ 439	N 40° 58´ 582
	35		6 - 12	7.7 - 11.5	E 21° 02´ 471	N 40° 58´ 567
	36		6 - 12	8.0 - 11.9	E 21° 02´ 532	N 40° 58´ 520
	37		6 - 12	12.0 - 7.0	E 21° 02´ 648	N 40° 58´ 448
	38		6 - 12	6.3 - 7.6	E 21° 02´ 677	N 40° 58´ 444
	39		6 - 12	8.0 - 12.5	E 21° 02´ 679	N 40° 58´ 400
	40		6 - 12	9.0 - 12.5	E 21° 02´ 879	N 40° 58´ 280
SB 4 OTESEVO	41	11.11.2014	0 - 3	1.4 - 1.4	E 20° 54´ 177	N 40° 57´ 746
	42		0 - 3	1.4 - 2.7	E 20° 54´ 213	N 40° 57´ 764
	43		0 - 3	2.9 - 2.0	E 20° 54´ 250	N 40° 57´ 760

SB 4 OTESEVO (contd.)	44		0 - 3	1.4 - 2.0	E 20° 54′ 236	N 40° 57′ 787
	45		0 - 3	1.9 - 2.8	E 20° 54′ 391	N 40° 57′ 835
	46		0 - 3	3.5 - 2.9	E 20° 54′ 442	N 40° 57′ 852
	47		0 - 3	2.1 - 1.8	E 20° 54′ 477	N 40° 57′ 906
	48		0 - 3	1.8 - 1.8	E 20° 54′ 515	N 40° 57′ 940
	49		0 - 3	1.7 - 2.9	E 20° 54′ 596	N 40° 57′ 993
	50		0 - 3	3.0 - 1.7	E 20° 54′ 663	N 40° 58′ 023
	51	12.11.2014	0 - 3	1.4 - 1.6	E 20° 54′ 680	N 40° 58′ 073
	52		0 - 3	1.4 - 2.5	E 20° 54′ 703	N 40° 58′ 086
	53		0 - 3	2.6 - 1.7	E 20° 54′ 741	N 40° 58′ 082
	54		0 - 3	1.3 - 1.6	E 20° 54′ 743	N 40° 58′ 115
	55		0 - 3	1.5 - 2.6	E 20° 54′ 801	N 40° 58′ 172
	56		0 - 3	3.0 - 2.4	E 20° 54′ 868	N 40° 58′ 212
	57		3 - 6	3.7 - 4.2	E 20° 54′ 940	N 40° 58′ 264
	58		3 - 6	4.4 - 4.6	E 20° 55′ 011	N 40° 58′ 288
	59		3 - 6	6.0 - 5.0	E 20° 55′ 079	N 40° 58′ 355
	60		3 - 6	4.6 - 5.2	E 20° 55′ 045	N 40° 58′ 400
	61	13.11.2014	3 - 6	4.0 - 4.3	E 20° 54′ 984	N 40° 58′ 304
	62		3 - 6	5.2 - 6.0	E 20° 55′ 057	N 40° 58′ 267
	63		3 - 6	5.2 - 4.8	E 20° 55′ 010	N 40° 58′ 241
	64		3 - 6	5.1 - 6.4	E 20° 54′ 979	N 40° 58′ 180
	65		3 - 6	6.0 - 4.2	E 20° 54′ 963	N 40° 58′ 160
	66		3 - 6	4.2 - 4.2	E 20° 54′ 901	N 40° 58′ 166
	67		3 - 6	4.2 - 5.0	E 20° 54′ 864	N 40° 58′ 101
	68		3 - 6	5.0 - 6.0	E 20° 54′ 870	N 40° 58′ 050
	69		3 - 6	6.0 - 5.2	E 20° 54′ 813	N 40° 58′ 000
	70		3 - 6	4.7 - 4.6	E 20° 54′ 740	N 40° 57′ 998
	71	14.11.2014	3 - 6	4.1 - 4.2	E 20° 55′ 463	N 40° 59′ 100
	72		3 - 6	4.6 - 4.9	E 20° 55′ 571	N 40° 59′ 157
	73		6 - 12	6.0 - 6.2	E 20° 55′ 694	N 40° 59′ 188
	74		6 - 12	6.3 - 6.0	E 20° 55′ 850	N 40° 59′ 269
	75		6 - 12	6.5 - 6.9	E 20° 55′ 925	N 40° 59′ 260
	76		6 - 12	7.5 - 7.9	E 20° 56′ 000	N 40° 59′ 183
	77		6 - 12	8.6 - 9.0	E 20° 56′ 048	N 40° 59′ 074
	78		6 - 12	9.9 - 10.0	E 20° 56′ 093	N 40° 58′ 995
	79		6 - 12	11.0 - 11.5	E 20° 56′ 170	N 40° 58′ 873
	80		6 - 12	12.0 - 12.0	E 20° 56′ 171	N 40° 58′ 751
SB 5 KONJSKO	81	18.11.2014	0 - 3	1.8 - 1.9	E 20° 59′ 325	N 40° 54′ 939
	82		0 - 3	1.8 - 2.4	E 20° 59′ 160	N 40° 54′ 956
	83		0 - 3	1.9 - 2.2	E 20° 58′ 932	N 40° 54′ 954
	84		0 - 3	1.9 - 3.2	E 20° 58′ 725	N 40° 55′ 050
	85		0 - 3	1.7 - 2.0	E 20° 58′ 538	N 40° 55′ 145
	86		0 - 3	1.8 - 3.8	E 20° 58′ 099	N 40° 55′ 205
	87		0 - 3	1.8 - 2.6	E 20° 57′ 910	N 40° 55′ 319
	88		0 - 3	1.5 - 3.2	E 20° 57′ 637	N 40° 55′ 462
	89		0 - 3	1.7 - 2.0	E 20° 57′ 456	N 40° 55′ 600

SB5 KONJSKO (contd.)	90		0 - 3	2.0 - 3.5	E 20° 57´ 265	N 40° 55´ 701
	91	24.11.2014	0 - 3	1.6 - 3.2	E 20° 59´ 095	N 40° 54´ 951
	92		0 - 3	1.8 - 3.0	E 20° 58´ 734	N 40° 55´ 049
	93		0 - 3	2.9 - 1.7	E 20° 58´ 525	N 40° 55´ 156
	94		0 - 3	1.5 - 1.7	E 20° 58´ 070	N 40° 55´ 220
	95		0 - 3	2.9 - 2.2	E 20° 57´ 810	N 40° 55´ 376
	96		0 - 3	2.2 - 1.2	E 20° 57´ 611	N 40° 55´ 484
	97	15.11.2014	3 - 6	3.2 - 6.2	E 20° 58´ 376	N 40° 55´ 174
	98		3 - 6	6.4 - 4.5	E 20° 58´ 437	N 40° 55´ 183
	99		3 - 6	5.0 - 6.0	E 20° 58´ 552	N 40° 55´ 163
	100		3 - 6	5.1 - 5.0	E 20° 58´ 736	N 40° 55´ 081
	101		3 - 6	6.0 - 5.1	E 20° 58´ 831	N 40° 55´ 017
	102		3 - 6	3.4 - 3.0	E 20° 59´ 004	N 40° 54´ 956
	103		3 - 6	3.7 - 5.0	E 20° 59´ 230	N 40° 54´ 955
	104		3 - 6	4.2 - 5.1	E 20° 59´ 367	N 40° 54´ 957
	105		3 - 6	5.1 - 3.2	E 20° 59´ 441	N 40° 54´ 920
	106		3 - 6	3.2 - 5.8	E 20° 59´ 579	N 40° 54´ 851
	107	24.11.2014	3 - 6	5.3 - 5.2	E 20° 59´ 477	N 40° 54´ 645
	108		3 - 6	6.0 - 5.5	E 20° 59´ 651	N 40° 54´ 670
	109		3 - 6	5.6 - 5.8	E 20° 59´ 755	N 40° 54´ 759
	110		3 - 6	3.1 - 4.2	E 20° 59´ 388	N 40° 54´ 926
	111	22.11.2.14	3 - 6	4.9 - 5.4	E 20° 59´ 650	N 40° 54´ 703
	112		3 - 6	6.0 - 4.9	E 20° 59´ 422	N 40° 54´ 633
	113		6 - 12	6.2 - 11.3	E 20° 58´ 081	N 40° 55´ 289
	114		6 - 12	12.0 - 7.5	E 20° 58´ 360	N 40° 55´ 204
	115		6 - 12	6.5 - 9.3	E 20° 58´ 547	N 40° 55´ 182
	116		6 - 12	6.2 - 7.5	E 20° 58´ 697	N 40° 55´ 104
	117		6 - 12	7.2 - 8.9	E 20° 59´ 001	N 40° 55´ 008
	118		6 - 12	6.0 - 7.3	E 20° 59´ 316	N 40° 54´ 979
	119		6 - 12	11.2 - 8.2	E 20° 59´ 598	N 40° 54´ 881
	120		6 - 12	6.2 - 12.1	E 20° 59´ 780	N 40° 54´ 763
SB 7 KAZAN (Pelagic nets)	121	19.11.2014	0 - 36	max	E 20° 57´ 210	N 40° 56´ 240
	122			max		
	123			30 – max		
	124			24 - 30		
	125			18 - 24		
	126			12 - 18		
	127			6 - 12		
	128			0 - 6		
SB 6 CENTRAL PLATE (individual pelagic nets)	129	25.11.2014	14 - 16	14.7	E 21° 01´ 300	N 40° 57´ 859
	130		14 - 16	15.1	E 21° 01´ 560	N 40° 57´ 902
	131		14 - 16	15.4	E 21° 01´ 786	N 40° 57´ 863
	132		14 - 16	15.9	E 21° 01´ 977	N 40° 57´ 843
	133		14 - 16	14.0	E 21° 01´ 048	N 40° 57´ 811
	134		14 - 16	16.6	E 21° 02´ 194	N 40° 57´ 866
	135		14 - 16	14.0	E 21° 00´ 702	N 40° 57´ 768
	136		14 - 16	14.0 - 13.8	E 21° 00´ 348	N 40° 57´ 746

Table 21. Points of sampling at Macedonian part (2015)

Sub-basin	Net number	Date	Depth stratum	depth (m)	Longitude	Latitude
SB 3 ASAMATI	1	14.11.2015	0 - 3	1.5 - 1.6	E 21° 02´ 832	N 40° 58´ 863
	2		0 - 3	1.5 - 2.5	E 21° 02´ 858	N 40° 58´ 806
	3		0 - 3	2.5 - 1.8	E 21° 03´ 124	N 40° 58´ 436
	4		0 - 3	1.7 - 1.9	E 21° 03´ 200	N 40° 58´ 377
	5	15.11.2015	0 - 3	2.8 - 1.7	E 21° 03´ 533	N 40° 58´ 188
	6		0 - 3	1.9 - 1.9	E 21° 03´ 645	N 40° 58´ 135
	7		0 - 3	1.5 - 1.9	E 21° 03´ 837	N 40° 58´ 005
	8		0 - 3	1.6 - 1.9	E 21° 03´ 895	N 40° 57´ 903
	9	16.11.2015	0 - 3	2.7 - 2.4	E 21° 02´ 592	N 40° 59´ 118
	10		0 - 3	1.8 - 2.1	E 21° 02´ 420	N 40° 59´ 270
	11		0 - 3	2.1 - 2.4	E 21° 02´ 038	N 40° 59´ 367
	12		0 - 3	1.5 - 2.1	E 21° 01´ 886	N 40° 59´ 444
	13	17.11.2015	0 - 3	2.8 - 2.3	E 21° 03´ 908	N 40° 57´ 693
	14		0 - 3	1.8 - 1.8	E 21° 03´ 942	N 40° 57´ 670
	15		0 - 3	2.1 - 2.4	E 21° 03´ 960	N 40° 57´ 588
	16		0 - 3	1.8 - 2.3	E 21° 04´ 016	N 40° 57´ 488
	17	14.11.2015	3 - 6	3.5 - 3.9	E 21° 02´ 777	N 40° 58´ 720
	18		3 - 6	5.8 - 5.6	E 21° 02´ 688	N 40° 58´ 570
	19		3 - 6	5.8 - 5.6	E 21° 02´ 700	N 40° 58´ 487
	20		3 - 6	4.8 - 4.7	E 21° 02´ 916	N 40° 58´ 474
	21	15.11.2015	3 - 6	5.8 - 5.2	E 21° 03´ 380	N 40° 58´ 163
	22		3 - 6	3.6 - 4.0	E 21° 03´ 523	N 40° 57´ 958
	23		3 - 6	3.5 - 4.1	E 21° 03´ 775	N 40° 57´ 963
	24		3 - 6	3.1 - 3.9	E 21° 03´ 826	N 40° 57´ 852
	25	16.11.2015	3 - 6	5.3 - 4.7	E 21° 02´ 273	N 40° 58´ 941
	26		3 - 6	3.5 - 3.8	E 20° 02´ 190	N 40° 59´ 179
	27		3 - 6	3.9 - 3.9	E 20° 02´ 090	N 40° 59´ 170
	28		3 - 6	3.0 - 3.1	E 21° 01´ 836	N 40° 59´ 317
	29	17.11.2015	3 - 6	5.8 - 5.0	E 21° 03´ 733	N 40° 57´ 651
	30		3 - 6	3.7 - 3.9	E 21° 03´ 890	N 40° 57´ 642
	31		3 - 6	4.4 - 5.4	E 21° 03´ 750	N 40° 57´ 558
	32		3 - 6	3.9 - 4.3	E 21° 03´ 970	N 40° 57´ 426
	33	14.11.2015	6 - 12	10.5 - 6.6	E 21° 02´ 612	N 40° 58´ 471
	34		6 - 12	11.7 - 10.3	E 21° 03´ 109	N 40° 58´ 132
	35	15.11.2015	6 - 12	6.1 - 6.7	E 21° 03 650	N 40° 58´ 080
	36		6 - 12	6.8 - 7.5	E 21° 03´ 580	N 40° 57´ 745
	37	16.11.2015	6 - 12	8.3 - 7.0	E 21° 02´ 160	N 40° 58´ 910
	38		6 - 12	6.1 - 6.6	E 21° 01´ 728	N 40° 59´ 151
	39	17.11.2015	6 - 12	8.5 - 6.5	E 21° 03´ 650	N 40° 57´ 560
	40		6 - 12	7.5 - 11.0	E 21° 03´ 666	N 40° 57´ 379
SB 4 OTESEVO	41	18.11.2015	0 - 3	2.9 - 2.6	E 20° 56´ 885	N 41° 00´ 000
	42		0 - 3	2.5 - 2.1	E 20° 56´ 634	N 40° 59´ 972

SB 4 OTESEVO (contd.)	43		0 - 3	2.5 - 2.8	E 20° 56´ 319	N 40° 59´ 824
	44		0 - 3	2.5 - 2.6	E 20° 56´ 205	N 40° 59´ 787
	45	19.11.2015	0 - 3	2.9 - 2.5	E 20° 55´ 967	N 40° 59´ 536
	46		0 - 3	2.7 - 2.6	E 20° 55´ 918	N 40° 59´ 504
	47		0 - 3	2.9 - 2.4	E 20° 55´ 590	N 40° 59´ 255
	48		0 - 3	2.9 - 2.5	E 20° 55´ 501	N 40° 59´ 181
	49	20.11.2015	0 - 3	1.8 - 3.0	E 20° 55´ 353	N 40° 59´ 066
	50		0 - 3	1.7 - 1.8	E 20° 55´ 285	N 40° 58´ 995
	51		0 - 3	1.6 - 2.7	E 20° 54´ 910	N 40° 58´ 483
	52		0 - 3	1.4 - 1.6	E 20° 54´ 838	N 40° 58´ 339
	53	21.11.2015	0 - 3	1.5 - 2.5	E 20° 54´ 477	N 40° 57´ 933
	54		0 - 3	1.7 - 1.9	E 20° 54´ 315	N 40° 57´ 831
	55		0 - 3	2.9 - 1.6	E 20° 54´ 193	N 40° 57´ 744
	56		0 - 3	2.0 - 2.9	E 20° 54´ 056	N 40° 57´ 200
	57	18.11.2015	3 - 6	3.1 - 3.3	E 20° 56´ 816	N 40° 59´ 914
	58		3 - 6	3.2 - 3.6	E 20° 56´ 570	N 40° 59´ 850
	59		3 - 6	4.6 - 4.4	E 20° 56´ 532	N 40° 59´ 733
	60		3 - 6	3.6 - 3.9	E 20° 56´ 208	N 40° 59´ 650
	61	19.11.2015	3 - 6	4.6 - 4.6	E 20° 56´ 113	N 40° 59´ 537
	62		3 - 6	3.1 - 3.8	E 20° 55´ 890	N 40° 59´ 460
	63		3 - 6	4.1 - 4.6	E 20° 55´ 782	N 40° 59´ 342
	64		3 - 6	4.7 - 5.6	E 20° 55´ 514	N 40° 59´ 069
	65	20.11.2015	3 - 6	5.8 - 5.4	E 20° 55´ 470	N 40° 59´ 000
	66		3 - 6	4.4 - 5.1	E 20° 55´ 311	N 40° 58´ 900
	67		3 - 6	5.8 - 5.3	E 20° 55´ 170	N 40° 58´ 594
	68		3 - 6	4.0 - 4.5	E 20° 54´ 879	N 40° 58´ 156
	69	21.11.2015	3 - 6	3.2 - 4.5	E 20° 54´ 254	N 40° 57´ 793
	70		3 - 6	3.0 - 3.9	E 20° 54´ 081	N 40° 57´ 606
	71		3 - 6	5.7 - 4.1	E 20° 54´ 071	N 40° 57´ 424
	72		3 - 6	4.0 - 3.9	E 20° 54´ 042	N 40° 57´ 329
	73	18.11.2015	6 - 12	6.2 - 6.8	E 20° 56´ 657	N 40° 59´ 608
	74		6 - 12	6.2 - 6.5	E 20° 56´ 310	N 40° 59´ 499
	75	19.11.2015	6 - 12	6.1 - 7.1	E 20° 55´ 995	N 40° 59´ 316
	76		6 - 12	6.5 - 7.8	E 20° 55´ 560	N 40° 58´ 990
	77	20.11.2015	6 - 12	6.7 - 7.4	E 20° 55´ 378	N 40° 58´ 763
	78		6 - 12	7.1 - 8.5	E 20° 54´ 967	N 40° 58´ 076
	79	21.11.2015	6 - 12	6.5 - 8.5	E 20° 54´ 945	N 40° 57´ 945
	80		6 - 12	7.7 - 11.2	E 20° 54´ 101	N 40° 57´ 490
SB 5 KONJSKO	81	10.11.2015	0 - 3	2.0 - 2.3	E 20° 59´ 423	N 40° 54´ 682
	82		0 - 3	1.7 - 2.0	E 20° 59´ 486	N 40° 54´ 703
	83		0 - 3	2.9 - 1.9	E 20° 59´ 656	N 40° 54´ 797
	84		0 - 3	1.5 - 1.7	E 20° 59´ 621	N 40° 54´ 804
	85	11.11.2015	0 - 3	2.1 - 1.7	E 20° 59´ 439	N 40° 54´ 887
	86		0 - 3	2.9 - 1.4	E 20° 58´ 732	N 40° 55´ 031
	87		0 - 3	1.2 - 3.1	E 20° 58´ 650	N 40° 55´ 093
	88		0 - 3	2.1 - 2.9	E 20° 58´ 578	N 40° 55´ 137

SB 5 KONJSKO (contd.)	89	12.11.2015	0 - 3	2.2 - 2.4	E 20° 58´ 341	N 40° 55´ 164
	90		0 - 3	1.8 - 3.5	E 20° 58´ 029	N 40° 55´ 274
	91		0 - 3	3.3 - 1.7	E 20° 57´ 866	N 40° 55´ 358
	92		0 - 3	1.5 - 3.2	E 20° 57´ 748	N 40° 55´ 397
	93	13.11.2015	0 - 3	1.0 - 2.0	E 20° 57´ 441	N 40° 55´ 599
	94		0 - 3	3.0 - 1.5	E 20° 57´ 255	N 40° 55´ 715
	95		0 - 3	1.9 - 3.6	E 20° 56´ 990	N 40° 55´ 967
	96		0 - 3	1.7 - 1.7	E 20° 56´ 872	N 40° 56´ 035
	97	10.11.2015	3 - 6	4.8 - 5.3	E 20° 59´ 137	N 40° 54´ 507
	98		3 - 6	3.9 - 4.8	E 20° 59´ 286	N 40° 54´ 607
	99		3 - 6	4.3 - 4.6	E 20° 59´ 586	N 40° 54´ 700
	100		3 - 6	3.5 - 6.3	E 20° 59´ 574	N 40° 54´ 884
	101	11.11.2015	3 - 6	5.7 - 3.6	E 20° 59´ 353	N 40° 54´ 945
	102		3 - 6	3.4 - 5.8	E 20° 59´ 413	N 40° 54´ 888
	103		3 - 6	3.2 - 5.8	E 20° 58´ 719	N 40° 55´ 070
	104		3 - 6	4.5 - 4.7	E 20° 58´ 465	N 40° 55´ 180
	105	12.11.2015	3 - 6	3.2 - 5.8	E 20° 58´ 248	N 40° 55´ 178
	106		3 - 6	6.3 - 4.7	E 20° 58´ 115	N 40° 55´ 242
	107		3 - 6	4.7 - 4.8	E 20° 57´ 949	N 40° 55´ 326
	108		3 - 6	3.2 - 6.3	E 20° 57´ 718	N 40° 55´422
	109	13.11.2015	3 - 6	3.0 - 5.3	E 20° 57´ 387	N 40° 55´ 648
	110		3 - 6	3.6 - 3.8	E 20° 57´ 236	N 40° 55´ 722
	111		3 - 6	6.1 - 3.9	E 20° 57´ 056	N 40° 55´ 912
	112		3 - 6	3.5 - 5.5	E 20° 56´ 821	N 40° 56´ 086
	113	10.11.2015	6 - 12	6.3 - 7.3	E 20° 59´ 167	N 40° 54´ 467
	114		6 - 12	6.0 - 7.6	E 20° 59´ 742	N 40° 54´ 691
	115	11.11.2015	6 - 12	7.4 - 7.5	E 20° 59´ 377	N 40° 54´ 963
	116		6 - 12	9.0 - 6.8	E 20° 59´ 006	N 40° 55´ 018
	117	12.11.2015	6 - 12	9.1 - 8.3	E 20° 58´ 180	N 40° 55´ 229
	118		6 - 12	7.1 - 13.0	E 20° 57´ 711	N 40° 55´ 455
	119	13.11.2015	6 - 12	6.9 - 8.5	E 20° 57´ 379	N 40° 55´ 688
	120		6 - 12	6.1 - 8.2	E 20° 56´ 797	N 40° 56´ 154
SB 7 KAZAN (pelagic nets)	121	08.11.2015	0-36 m	max	E 20° 56´ 164	N 40° 56´ 143
	122			max		
	123			30 – max		
	124			24 - 30		
	125			18 - 24		
	126			12 - 18		
	127			6 - 12		
	128			0 - 6		
SB 6 CENTRAL PLATE (individual pelagic nets)	129	07.11.2015	13.0 - 16.5	13.2	E 21° 00´ 153	N 40° 56´ 115
	130		13.0 - 16.5	14.1	E 21° 00´ 713	N 40° 55´ 734
	131		13.0 - 16.5	14.8	E 21° 01´ 096	N 40° 55´ 518
	132		13.0 - 16.5	15.3	E 21° 01´ 747	N 40° 55´ 789
	133		13.0 - 16.5	16.5	E 21° 02´ 093	N 40° 56´ 728
	134		13.0 - 16.5	15.6	E 21° 01´ 011	N 40° 56´ 898
	135		13.0 - 16.5	14.7	E 21° 00´ 284	N 40° 56´ 996
	136		13.0 - 16.5	14.1	E 20° 59´ 632	N 40° 57´ 084

Table 22. Additional sampling data (Macedonian part, 2013)

Sub-basin	Sampling date	Air temp. (°C)	Water temp (°C)	Secchi depth (m)	pH	Oxygen ($mg \cdot l^{-1}$)	Moon
SB 3 ASAMATI	11.10.2013	15.1	16.5	5.21	8.20	10.35	First ½
	16.10.2013	15.5	17.0	3.20	8.25	10.25	½
SB 4 OTESEVO	10.10.2013	19.4	16.9	2.70	8.31	10.30	First ½
	11.10.2013	15.5	16.5	2.95	8.20	10.25	First ½
SB 5 KONJSKO	12.10.2013	18.0	16.7	3.20	8.25	10.20	First ½
	15.10.2013	15.1	17.3	3.60	8.33	11.50	½
SB 6 CENTRAL PLATE	13.10.2013	19.0	17.0	3.30	8.32	10.20	½
	15.10.2013	15.9	17.0	3.10	8.57	10.40	½

temp. = temperature

Table 23. Additional sampling data (Macedonian part, 2014)

Sub-basin	Sampling date	Air temp. (°C)	Water temp (°C)	Secchi depth (m)	pH	Oxygen ($mg \cdot l^{-1}$)	Conduct. (µS)	Moon
SB 3 ASAMATI	16.11.2014	11.5	12.8	3.20	8.30	9.5	233	no
	18.11.2014	12.8	12.2	3.20	8.20	9.5	230	no
	20.11.2014	11.5	13.0	3.20	8.25	9.7	232	no
	24.11.2014	11.0	12.2	3.20	8.20	9.5	232	no
SB 4 OTESEVO	10.11.2014	14.7	14.5	max	7.50	9.7	269	87%
	11.11.2014	11.5	13.4	4.20	8.62	9.8	214	no
	12.11.1014	12.8	13.3	4.20	8.50	10.2	215	no
	13.11.2014	12.1	13.2	3.50	8.30	8.9	234	no
SB 5 KONJSKO	14.11.2014	14.3	13.8	3.50	8.40	10.2	236	last 1/4
	17.11.2014	11.0	12.7	3.30	8.30	9.2	233	no
	21.11.2014	13.5	11.2	3.20	8.20	9.8	234	no
	23.11.2014	12.3	12.0	3.20	8.25	9.7	230	no
SB 6 CENTRAL PLATE (pelagic nets)	24.11.2014	11.0	12.2	3.20	8.20	9.5	232	no
SB 7 KAZAN (pelagic nets)	18.11.2014	11.5	12.8	3.20	8.30	9.5	233	no

temp. = temperature, conduct. = conductivity

Table 24. Additional sampling data (Macedonian part, 2015)

Sub-basin	**Sampling date**	**Air temp. (°C)**	**Water temp. (°C)**	**Secchi depth (m)**	**pH**	**Oxygen ($mg \cdot l^{-1}$)**	**Conduct. (µS)**	**Moon**
SB 3 ASAMATI	14.11.2015	15.1	14.7	3.50	8.30	8.5	221	no
	15.11.2015	13.9	14.5	3.80	8.21	8.1	223	first ¼
	16.11.2015	13.7	14.2	4.00	8.78	8.1	225	first ¼
	17.11.2015	13.7	14.3	4.60	8.50	9.25	232	first ¼
SB 4 OTESEVO	18.11.2015	13.2	14.2	3.35	8.36	8.5	230	½
	19.11.2015	14.9	14.1	3.50	8.70	9.2	245	½
	20.11.1015	13.3	14.2	3.45	8.53	8.9	236	½
	21.11.2015	13.2	14.1	3.21	8.35	8.5	234	½
SB 5 KONJSKO	10.11.2015	13.4	14.2	3.20	8.37	8.6	224	no
	11.11.2015	14.7	14.4	3.30	8.22	8.8	219	no
	12.11.2015	14.0	14.3	3.20	8.25	9.1	224	no
	13.11.2015	13.3	14.3	3.25	8.20	9.0	217	no
SB 6 CENTRAL PLATE (pelagic nets)	07.11.2015	13.7	14.5	3.25	7.52	8.3	228	no
SB 7 KAZAN (pelagic nets)	08.11.2015	13.4	14.4	5.50	8.25	9.1	217	no

temp. = temperature, conduct. = conductivity

Annex II. Details (relative fish species composition, CPUE, length-frequency distributions) of individual sub-basins

SB 1 - Kallamas

At SB 1 bitterling represented the dominant species in terms of number of individuals, particularly at the depth strata 0-3 and 3-6 meters with specific abundances reaching more than 60% (Figure 25, Figure 26) during the sampling campaign of 2013. Second most dominant species was another introduced species, stone moroko, followed by the two native species bleak and spirlin.

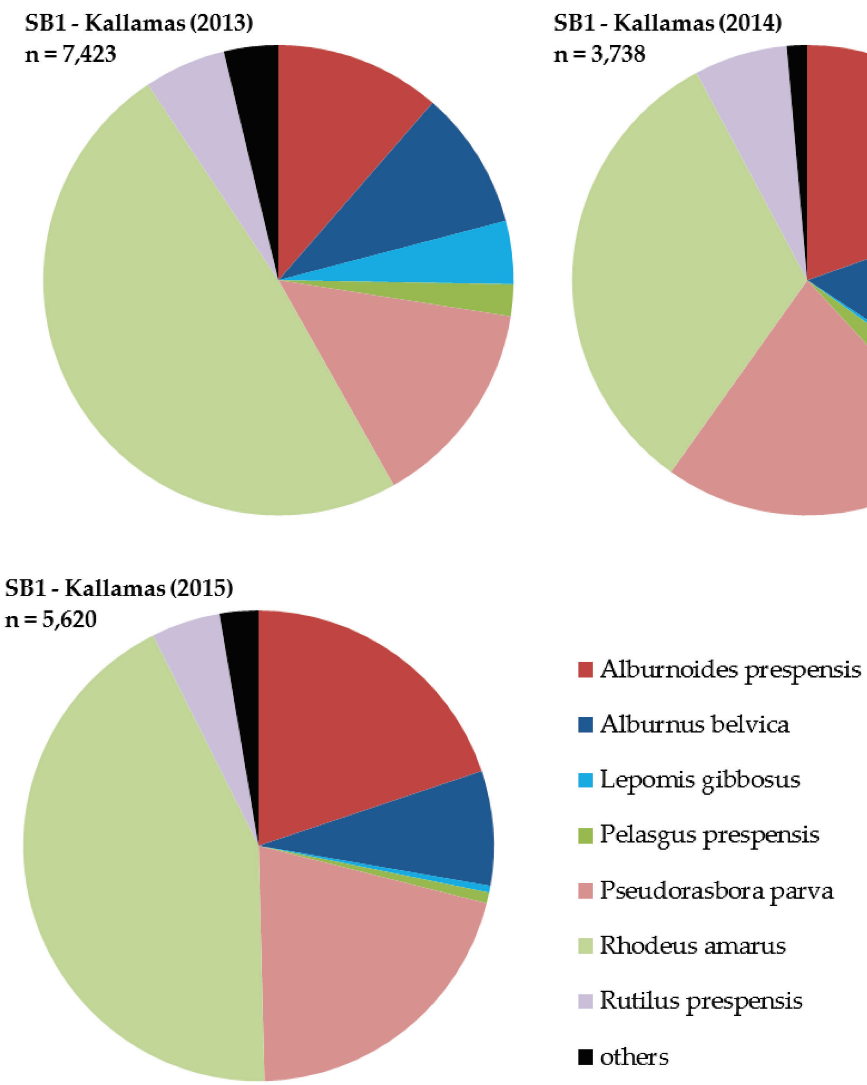
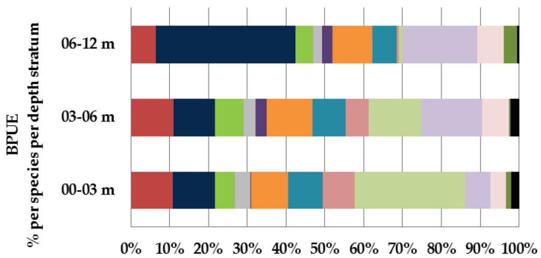


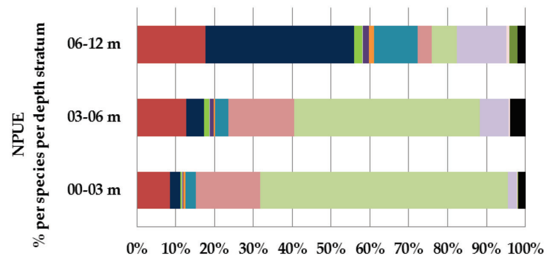
Figure 25. Relative fish species composition based on number of individuals in sub-basin 1 (Kallamas) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as ‘others’.

There was a clear difference in species dominance between the 0-3 m stratum and the 6-12 m stratum. At the deeper part the endemic species bleak and roach composed about 55% of entire CPUE (in biomass per square meter of net) in 2013. In all years, Prespa bleak was found most often in the deeper water layers (Figure 26, Figure 27, Figure 28).

As stated above, both bitterling and stone moroko were the most abundant species in terms of number of individuals, while other alien species like pumpkinseed, tench and Prussian carp were less abundant (Figure 26, Figure 27, Figure 28) at this site.

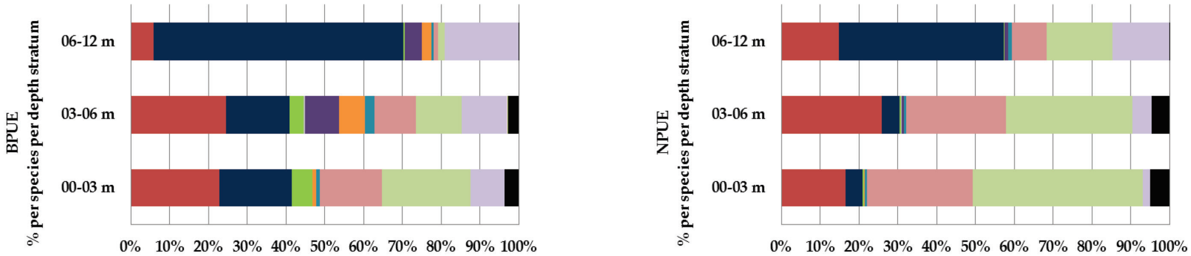


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	4.44	4.20	3.57
Alburnus belvica	4.42	4.11	20.04
Barbus prespensis	2.11	2.87	2.56
Carassius gibelio	1.65	1.19	1.18
Chondrostoma prespensis	0.09	1.06	1.52
Cyprinus carpio	3.82	4.59	5.68
Lepomis gibbosus	3.66	3.28	3.56
Pseudorasbora parva	3.37	2.24	0.26
Rhodeus amarus	11.72	5.29	0.59
Rutilus prespensis	2.62	5.96	10.66
Squalius prespensis	1.65	2.64	3.79
Tinca tinca	0.55	0.18	1.90
others	0.81	0.82	0.29



	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.67	0.62	0.47
Alburnus belvica	0.21	0.22	1.02
Barbus prespensis	0.04	0.07	0.06
Carassius gibelio	0.02	0.01	0.01
Chondrostoma prespensis	0.00	0.05	0.04
Cyprinus carpio	0.05	0.02	0.04
Lepomis gibbosus	0.20	0.17	0.30
Pseudorasbora parva	1.30	0.83	0.10
Rhodeus amarus	5.01	2.35	0.17
Rutilus prespensis	0.17	0.36	0.34
Squalius prespensis	0.02	0.02	0.02
Tinca tinca	0.01	0.00	0.05
others	0.15	0.19	0.05

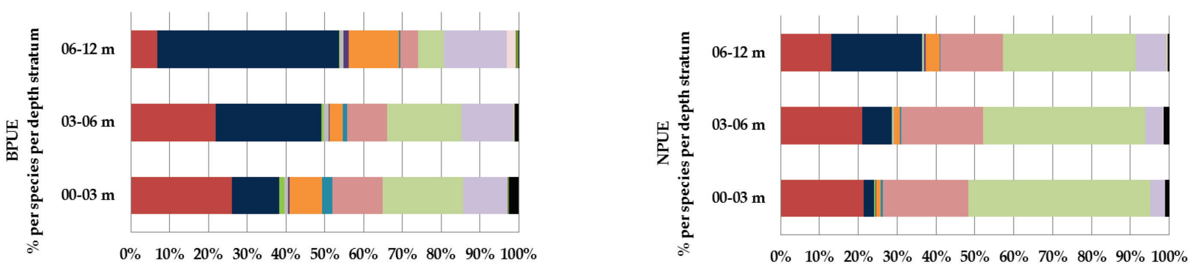
Figure 26. Standardized catches per unit of effort (CPUE) for sub-basin 1 (Kallamas) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata.



	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	2.18	3.88	1.64
Alburnus belvica	1.79	2.57	17.66
Barbus prespensis	0.51	0.56	0.10
Carassius gibelio	0.00	0.05	0.00
Chondrostoma prespensis	0.00	1.40	1.23
Cyprinus carpio	0.09	1.04	0.66
Lepomis gibbosus	0.07	0.37	0.18
Pseudorasbora parva	1.54	1.69	0.30
Rhodeus amarus	2.18	1.85	0.46
Rutilus prespensis	0.82	1.83	5.27
Squalius prespensis	0.00	0.02	0.00
Tinca tinca	0.00	0.03	0.00
others	0.36	0.44	0.01

	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.44	0.81	0.30
Alburnus belvica	0.11	0.15	0.86
Barbus prespensis	0.01	0.01	0.00
Carassius gibelio	0.00	0.00	0.00
Chondrostoma prespensis	0.00	0.02	0.02
Cyprinus carpio	0.01	0.00	0.00
Lepomis gibbosus	0.01	0.01	0.02
Pseudorasbora parva	0.72	0.81	0.18
Rhodeus amarus	1.17	1.03	0.34
Rutilus prespensis	0.05	0.15	0.30
Squalius prespensis	0.00	0.00	0.00
Tinca tinca	0.00	0.00	0.00
others	0.13	0.14	0.00

Figure 27. Standardized catches per unit of effort (CPUE) for sub-basin 1 (Kallamas) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

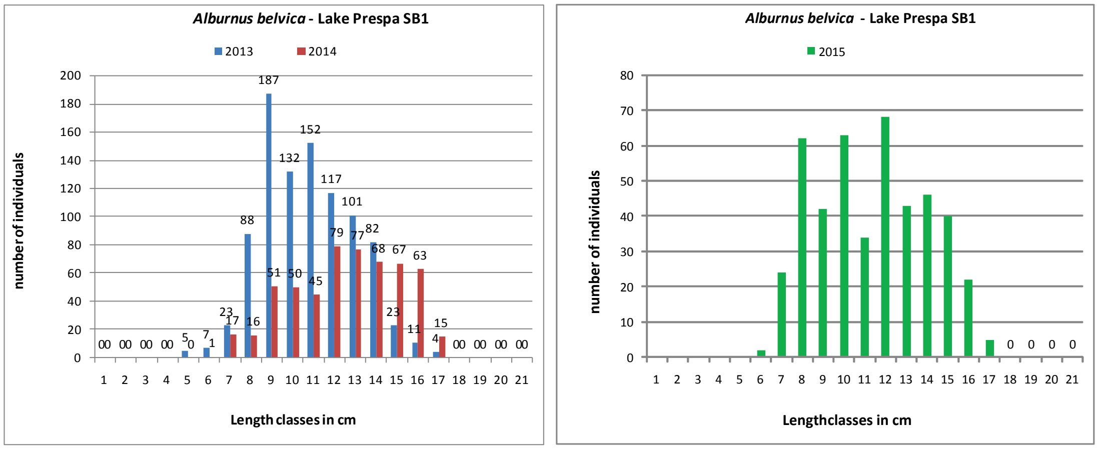


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	6.28	4.65	1.22
Alburnus belvica	2.90	5.79	8.23
Barbus prespensis	0.33	0.15	0.04
Carassius gibelio	0.21	0.26	0.16
Chondrostoma prespensis	0.11	0.06	0.22
Cyprinus carpio	2.00	0.73	2.27
Lepomis gibbosus	0.66	0.22	0.07
Pseudorasbora parva	3.08	2.20	0.82
Rhodeus amarus	5.01	4.10	1.16
Rutilus prespensis	2.75	2.80	2.85
Squalius prespensis	0.00	0.04	0.41
Tinca tinca	0.08	0.07	0.11
others	0.62	0.20	0.02

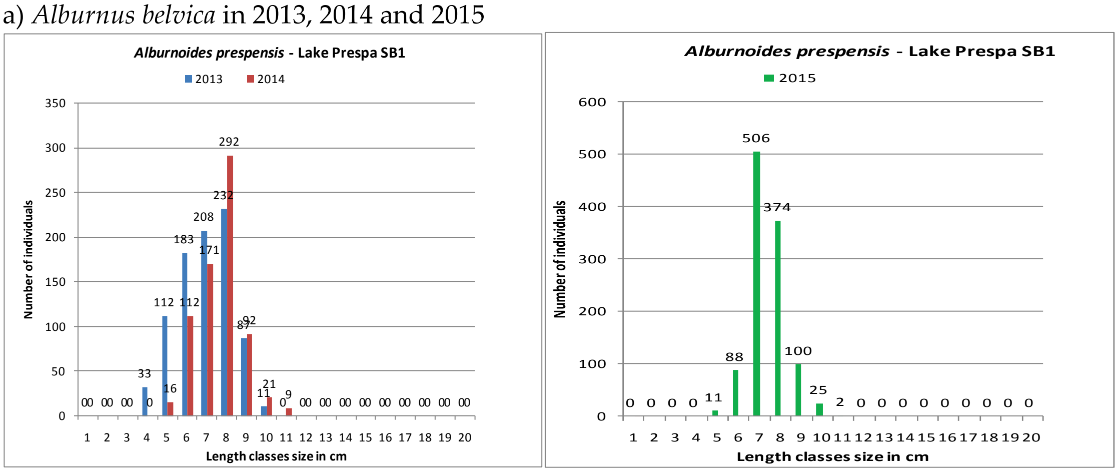
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	1.19	0.90	0.24
Alburnus belvica	0.15	0.33	0.44
Barbus prespensis	0.02	0.01	0.00
Carassius gibelio	0.00	0.01	0.01
Chondrostoma prespensis	0.00	0.00	0.01
Cyprinus carpio	0.07	0.06	0.07
Lepomis gibbosus	0.03	0.02	0.01
Pseudorasbora parva	1.22	0.91	0.30
Rhodeus amarus	2.61	1.79	0.64
Rutilus prespensis	0.21	0.20	0.15
Squalius prespensis	0.00	0.00	0.00
Tinca tinca	0.00	0.00	0.00
others	0.05	0.06	0.01

Figure 28. Standardized catches per unit of effort (CPUE) for sub-basin 1 (Kallamas) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

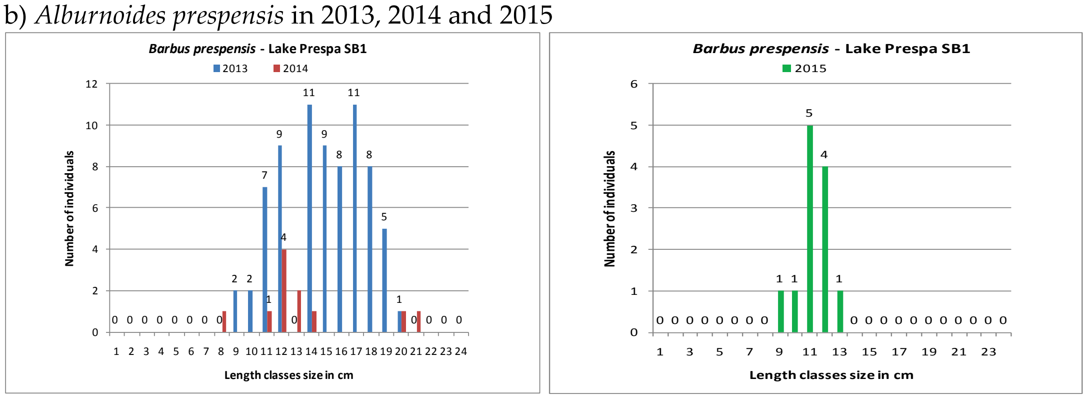
The length-frequency distributions of the fish species caught during the survey at the SB 1 for the period 2013-2015 are presented in the following Figure 29 (a-j), in either blue (2013), red (2014) or green color (2015).



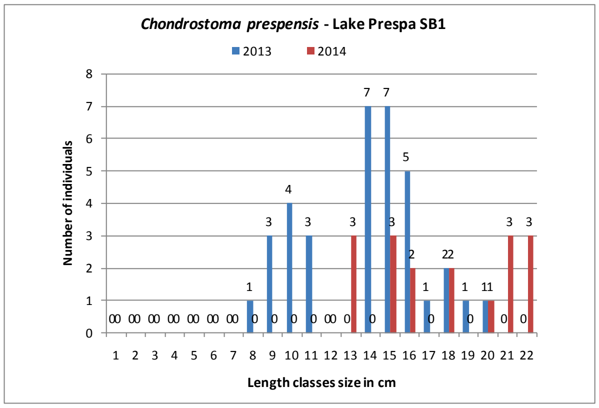
a) *Alburnus belvica* in 2013, 2014 and 2015

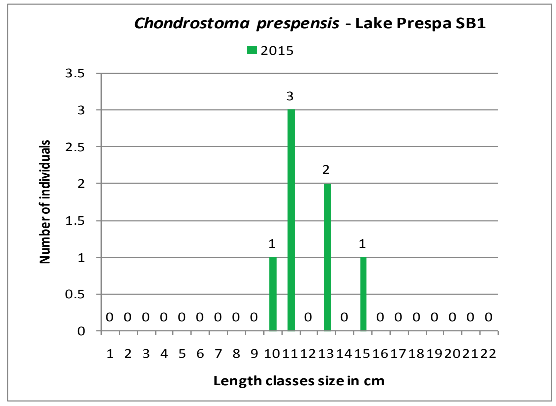


b) *Alburnoides prespensis* in 2013, 2014 and 2015

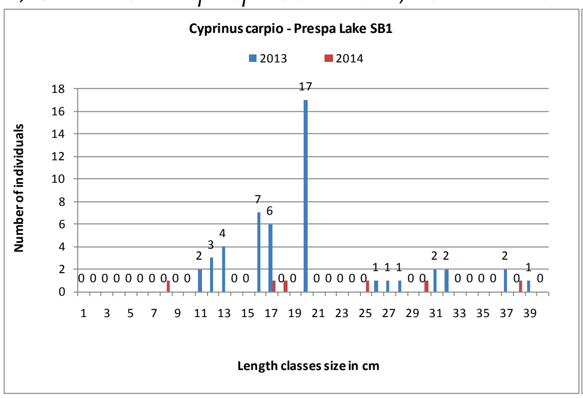


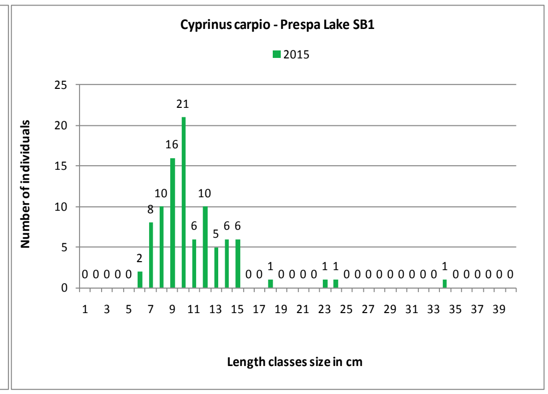
c) *Barbus prespensis* in 2013, 2014 and 2015



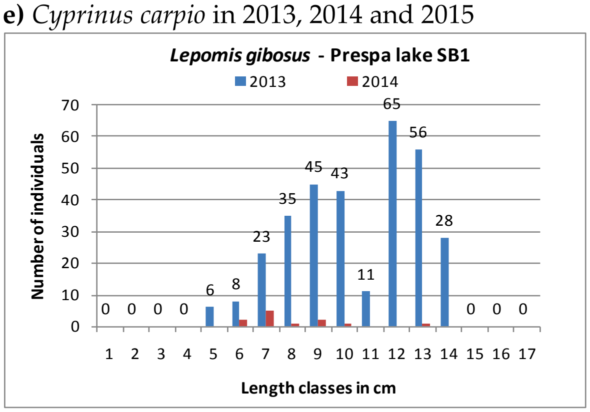


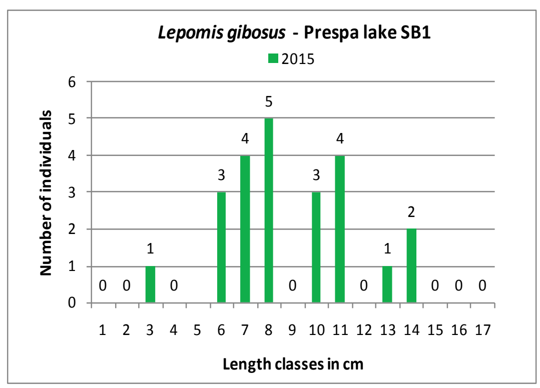
d) *Chondrostoma prespensis* in 2013, 2014 and 2015



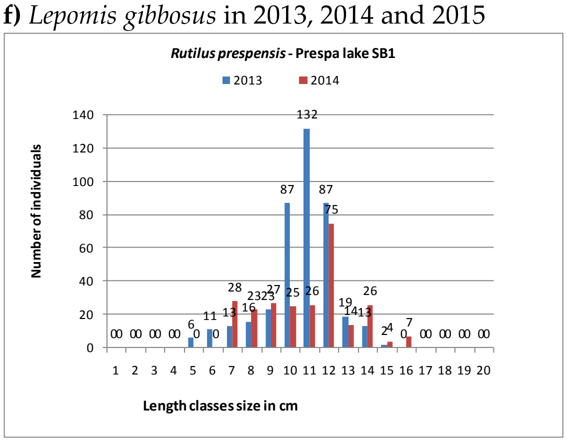


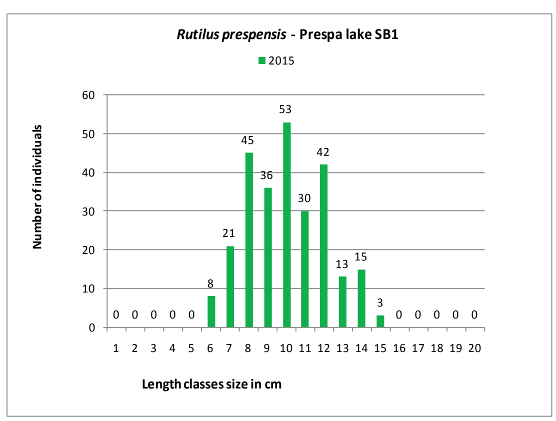
e) *Cyprinus carpio* in 2013, 2014 and 2015



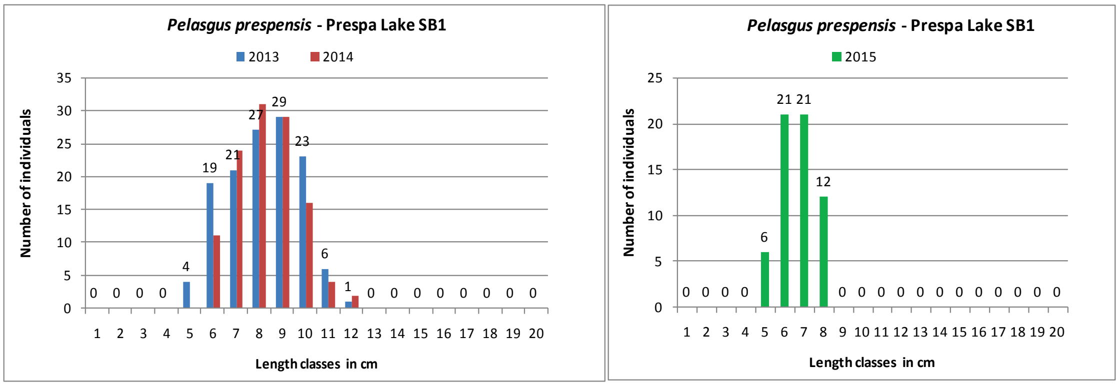


f) *Lepomis gibbosus* in 2013, 2014 and 2015

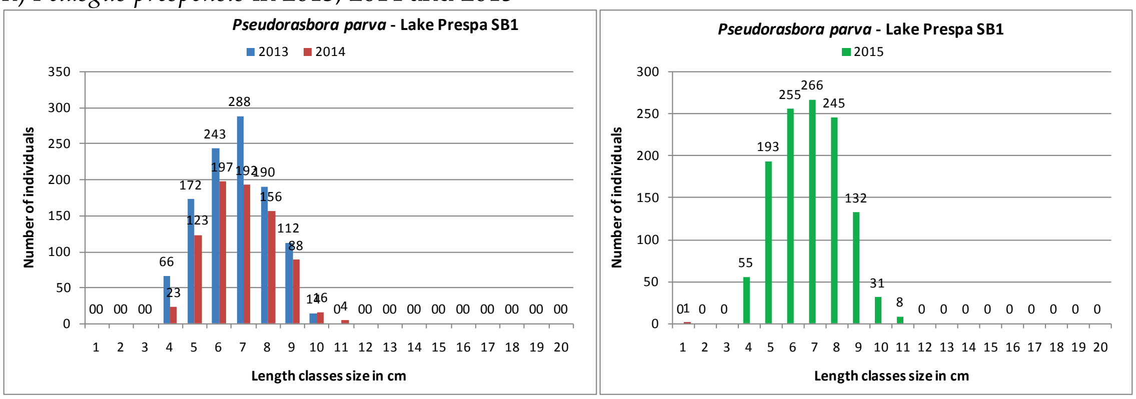




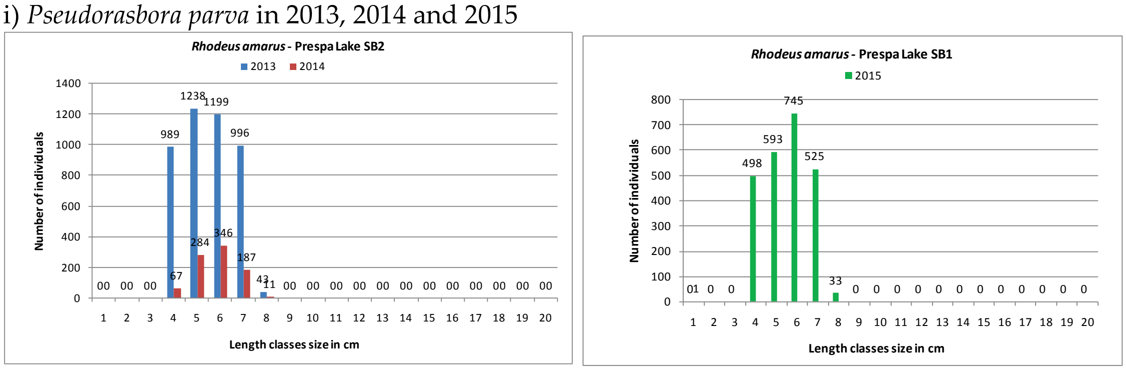
g) *Rutilus prespensis* in 2013, 2014 and 2015



h) *Pelasgus prespensis* in 2013, 2014 and 2015



i) *Pseudorasbora parva* in 2013, 2014 and 2015



j) *Rhodeus amarus* in 2013, 2014 and 2015

Figure 29. Length-frequency distributions of the fish species caught during the survey at SB 1 for the period 2013-2015 (a-j)

SB 2 - Liqenas

Similar to SB 1, at SB 2 the alien species bitterling and stone moroko were the most abundant species in terms of number of individuals with 56 and 15% respectively, while other alien species like pumpkinseed, tench and Prussian carp were less abundant (Figure 30). In 2014, spirlin became more abundant although bitterling and stone moroko showed up in high numbers too. In 2015, both named alien species accounted for about three quarters of individuals caught at this site (Figure 30).

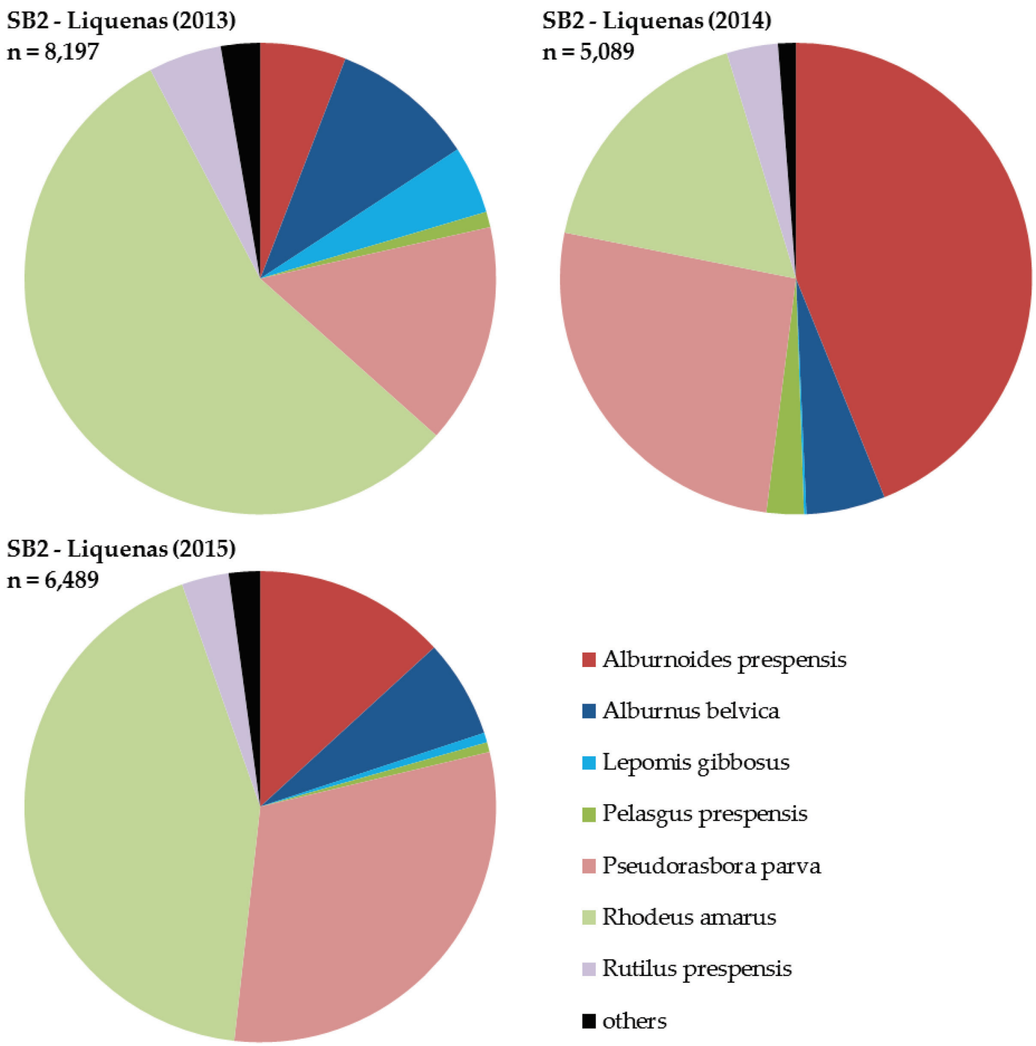
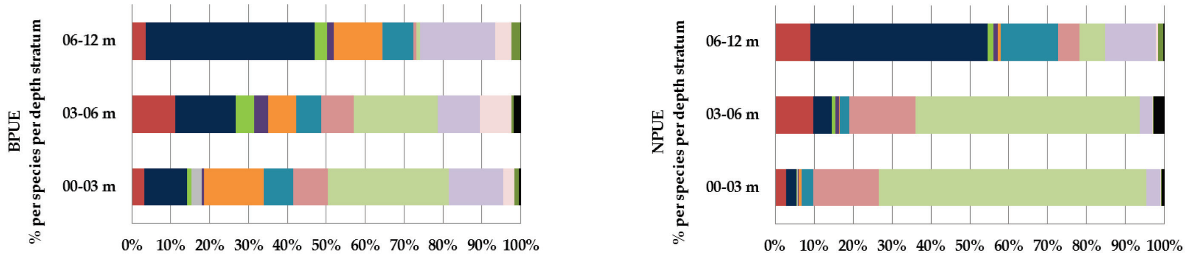


Figure 30. Relative fish species composition based on number of individuals in sub-basin 2 (Liqenas) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others'

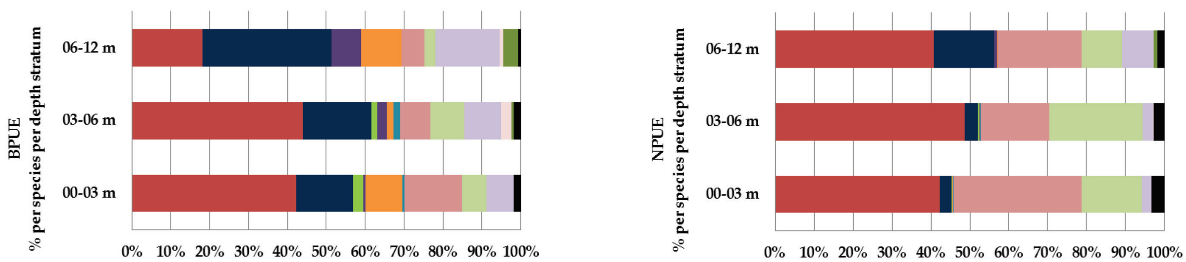
In any one year, bleak occurred in the deeper water layers in contrast to spirlin which did not show spatial preferences and inhabited all depth strata (Figure 31, Figure 32 and Figure 33).



	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	1.37	3.51	1.62
Alburnus belvica	4.89	4.83	20.27
Barbus prespensis	0.51	1.52	1.49
Carassius gibelio	1.15	0.00	0.00
Chondrostoma prespensis	0.22	1.09	0.81
Cyprinus carpio	6.79	2.29	5.80
Lepomis gibbosus	3.28	1.98	3.75
Pseudorasbora parva	3.93	2.64	0.34
Rhodeus amarus	13.68	6.74	0.48
Rutilus prespensis	6.14	3.38	8.98
Squalius prespensis	1.24	2.58	1.90
Tinca tinca	0.54	0.13	1.12
others	0.20	0.60	0.05

	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.25	0.54	0.23
Alburnus belvica	0.24	0.25	1.17
Barbus prespensis	0.02	0.05	0.04
Carassius gibelio	0.02	0.00	0.00
Chondrostoma prespensis	0.01	0.05	0.03
Cyprinus carpio	0.06	0.02	0.02
Lepomis gibbosus	0.27	0.14	0.38
Pseudorasbora parva	1.52	0.92	0.14
Rhodeus amarus	6.21	3.14	0.17
Rutilus prespensis	0.33	0.18	0.34
Squalius prespensis	0.02	0.01	0.01
Tinca tinca	0.02	0.00	0.03
others	0.06	0.16	0.01

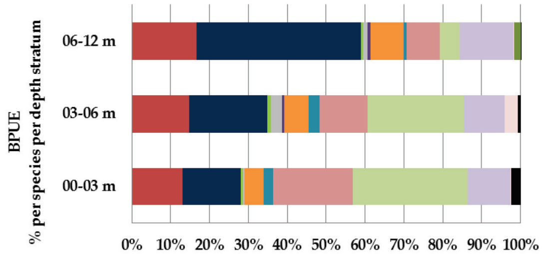
Figure 31. Standardized catches per unit of effort (CPUE) for sub-basin 2 (Liqenas) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



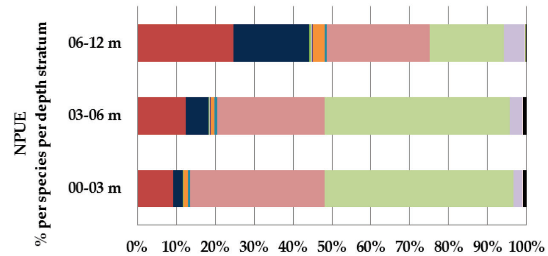
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	9.96	6.86	3.02
Alburnus belvica	3.42	2.76	5.51
Barbus prespensis	0.64	0.26	0.00
Carassius gibelio	0.00	0.00	0.00
Chondrostoma prespensis	0.13	0.37	1.25
Cyprinus carpio	2.24	0.27	1.76
Lepomis gibbosus	0.13	0.26	0.00
Pseudorasbora parva	3.48	1.24	0.96
Rhodeus amarus	1.49	1.34	0.47
Rutilus prespensis	1.63	1.50	2.75
Squalius prespensis	0.00	0.42	0.16
Tinca tinca	0.00	0.06	0.61
others	0.44	0.30	0.13

	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	2.24	1.64	0.78
Alburnus belvica	0.15	0.12	0.30
Barbus prespensis	0.01	0.01	0.00
Carassius gibelio	0.00	0.00	0.00
Chondrostoma prespensis	0.01	0.01	0.01
Cyprinus carpio	0.01	0.00	0.01
Lepomis gibbosus	0.01	0.01	0.00
Pseudorasbora parva	1.74	0.59	0.41
Rhodeus amarus	0.83	0.81	0.20
Rutilus prespensis	0.13	0.09	0.15
Squalius prespensis	0.00	0.00	0.00
Tinca tinca	0.00	0.00	0.02
others	0.18	0.10	0.03

Figure 32. Standardized catches per unit of effort (CPUE) for sub-basin 2 (Liqenas) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



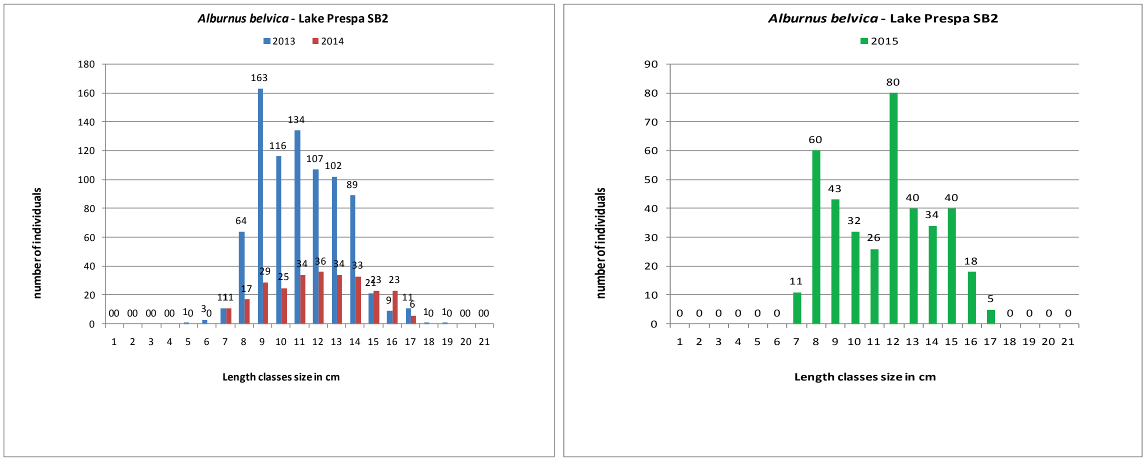
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	3.04	3.85	3.14
Alburnus belvica	3.48	5.19	8.04
Barbus prespensis	0.14	0.29	0.08
Carassius gibelio	0.09	0.72	0.24
Chondrostoma prespensis	0.00	0.14	0.14
Cyprinus carpio	1.11	1.65	1.61
Lepomis gibbosus	0.57	0.70	0.14
Pseudorasbora parva	4.80	3.22	1.61
Rhodeus amarus	6.86	6.48	0.99
Rutilus prespensis	2.57	2.70	2.60
Squalius prespensis	0.05	0.88	0.07
Tinca tinca	0.01	0.00	0.29
others	0.55	0.18	0.01



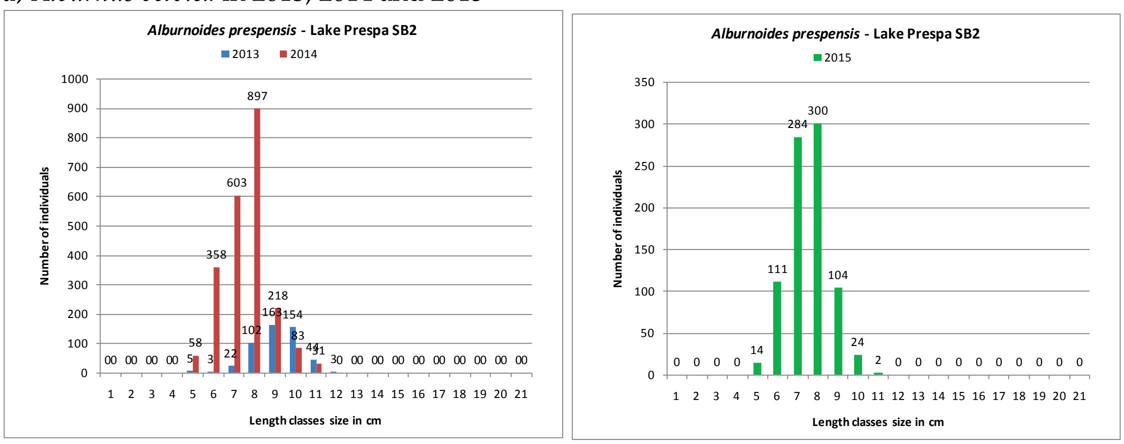
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.56	0.64	0.58
Alburnus belvica	0.15	0.30	0.46
Barbus prespensis	0.01	0.00	0.01
Carassius gibelio	0.00	0.01	0.01
Chondrostoma prespensis	0.00	0.01	0.00
Cyprinus carpio	0.07	0.05	0.07
Lepomis gibbosus	0.04	0.04	0.01
Pseudorasbora parva	2.09	1.41	0.62
Rhodeus amarus	2.94	2.46	0.45
Rutilus prespensis	0.15	0.17	0.13
Squalius prespensis	0.00	0.01	0.00
Tinca tinca	0.00	0.00	0.01
others	0.06	0.05	0.00

Figure 33. Standardized catches per unit of effort (CPUE) for sub-basin 2 (Liqenas) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

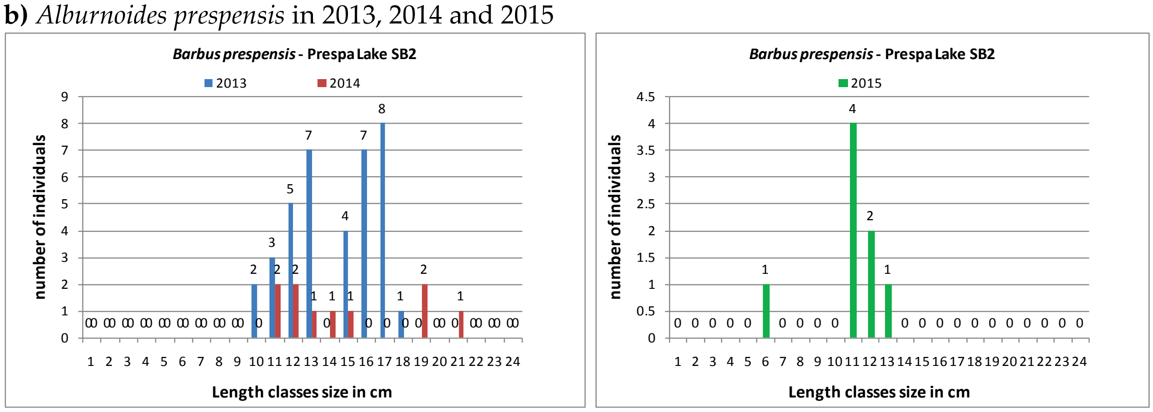
The length-frequency distributions of the fish species caught during the survey at the SB 2 are presented in the following Figure 34 (a-j), in either blue (2013), red (2014) or green color (2015).



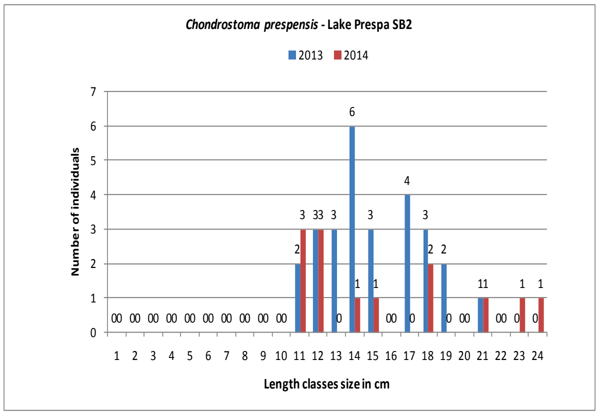
a) *Alburnus belvica* in 2013, 2014 and 2015

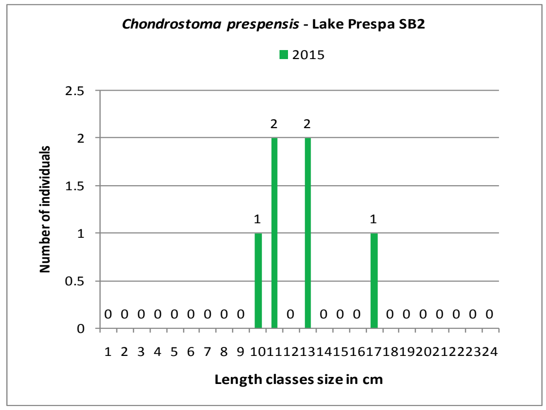


b) *Alburnoides prespensis* in 2013, 2014 and 2015

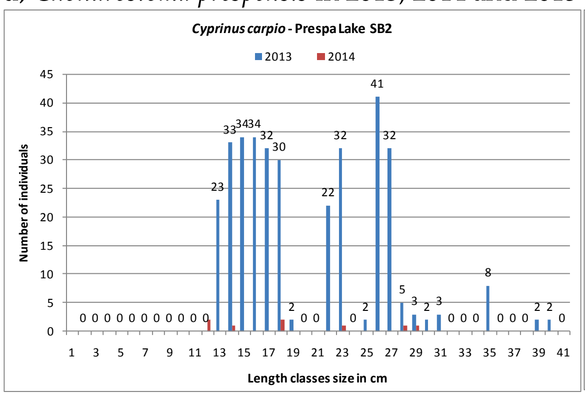


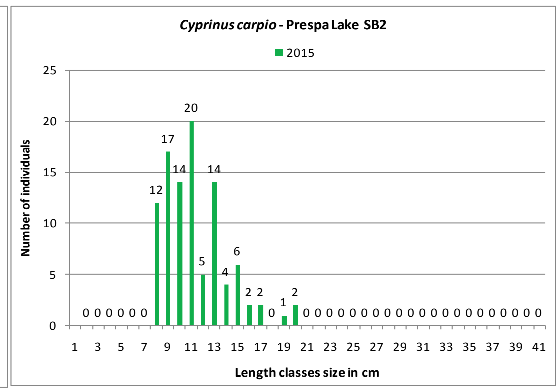
c) *Barbus prespensis* in 2013, 2014 and 2015



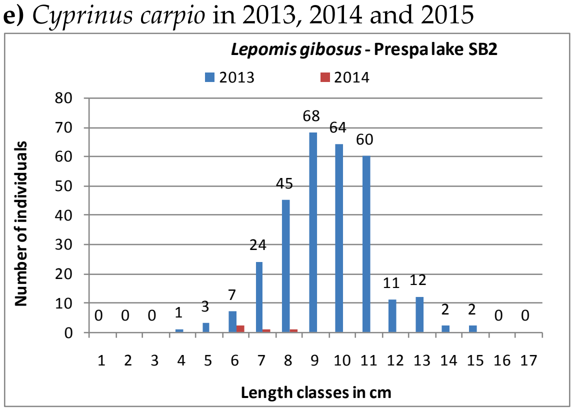


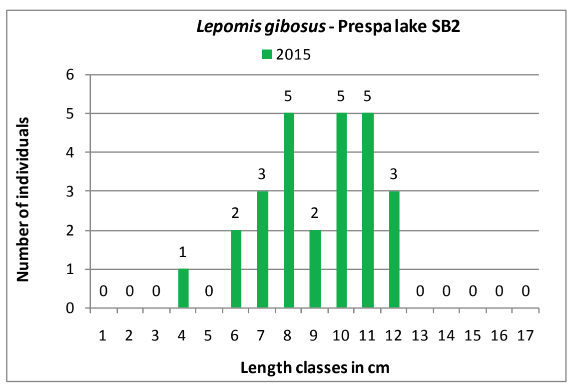
d) *Chondrostoma prespensis* in 2013, 2014 and 2015



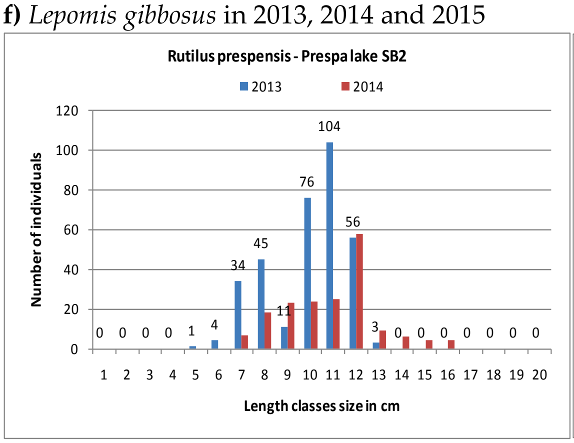


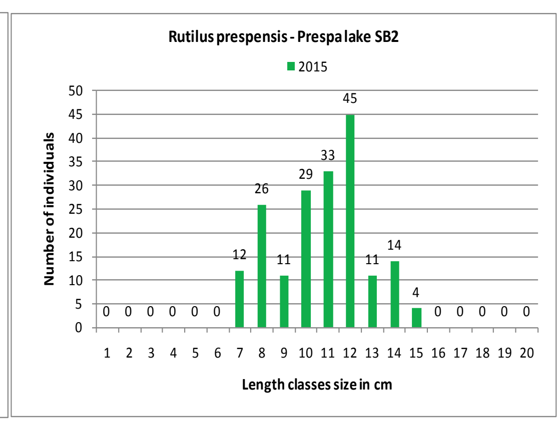
e) *Cyprinus carpio* in 2013, 2014 and 2015



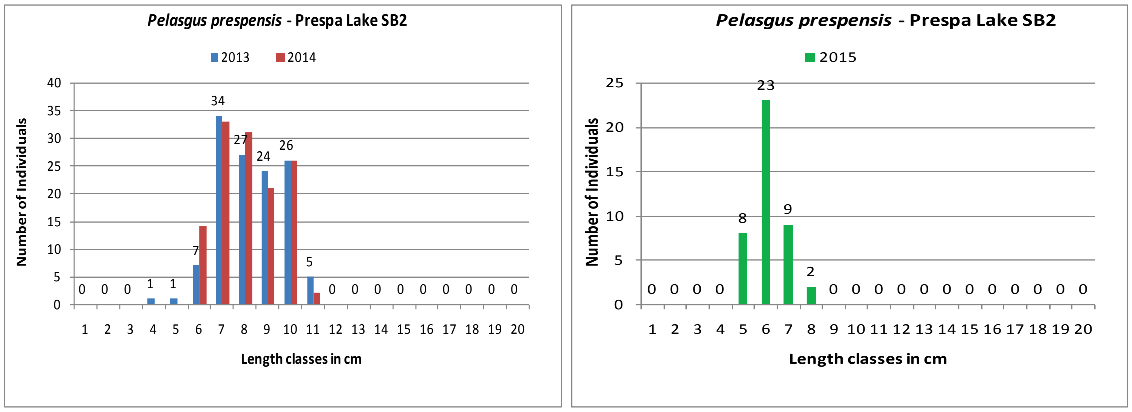


f) *Lepomis gibbosus* in 2013, 2014 and 2015

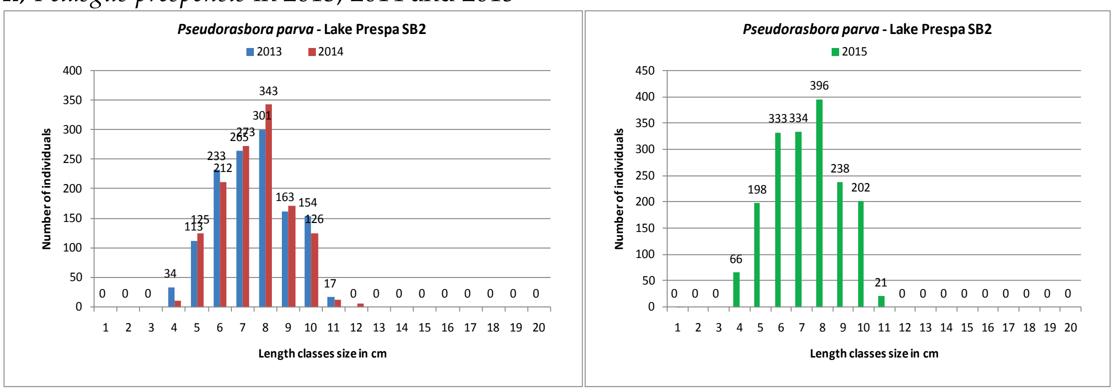




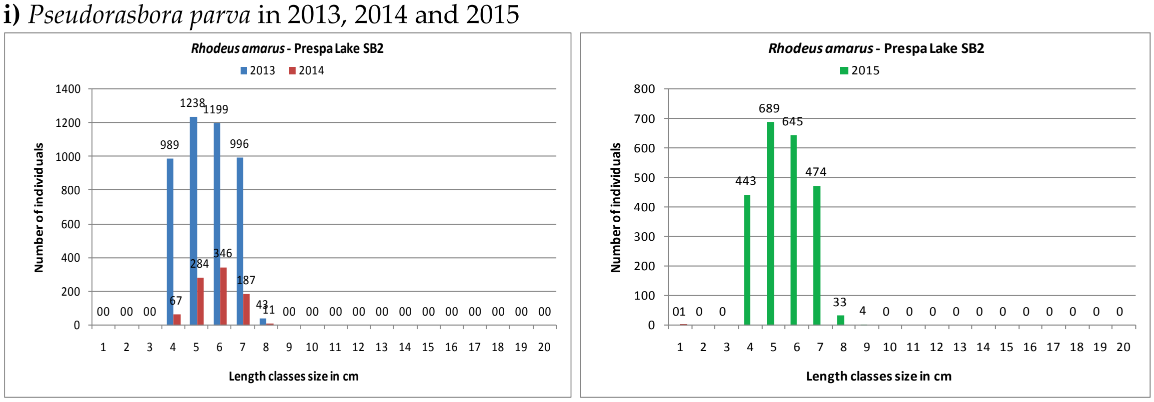
g) *Rutilus prespensis* in 2013, 2014 and 2015



h) *Pelasgus prespensis* in 2013, 2014 and 2015



i) *Pseudorasbora parva* in 2013, 2014 and 2015



j) *Rhodeus amarus in* 2013, 2014 and 2015

Figure 34. Length-frequency distributions of the fish species caught during the survey at SB 2 for the period 2013-2015 (a-j)

SB 3 - Asamati

At the SB 3 near the village of Asamati located at the northeast part of Prespa Lake, annual differences of the fish fauna composition were present. In October 2013, ten species were recorded in the total catch of 1,292 individuals, in 2014 eight species were caught with 2,548 individuals in total. In 2015, ten species were sampled again with 2,945 individuals. In contrast to 2013 when three alien species – stone moroko, bitterling and pumpkinseed – were dominant (81 % of individuals in total catch), native bleak, roach and spirlin contributed most (73 %) to the total catch in 2014. In 2015, native bleak, roach and spirlin were present with 48 % while alien species bitterling and stone moroko represented 44 % of individuals (Figure 35).

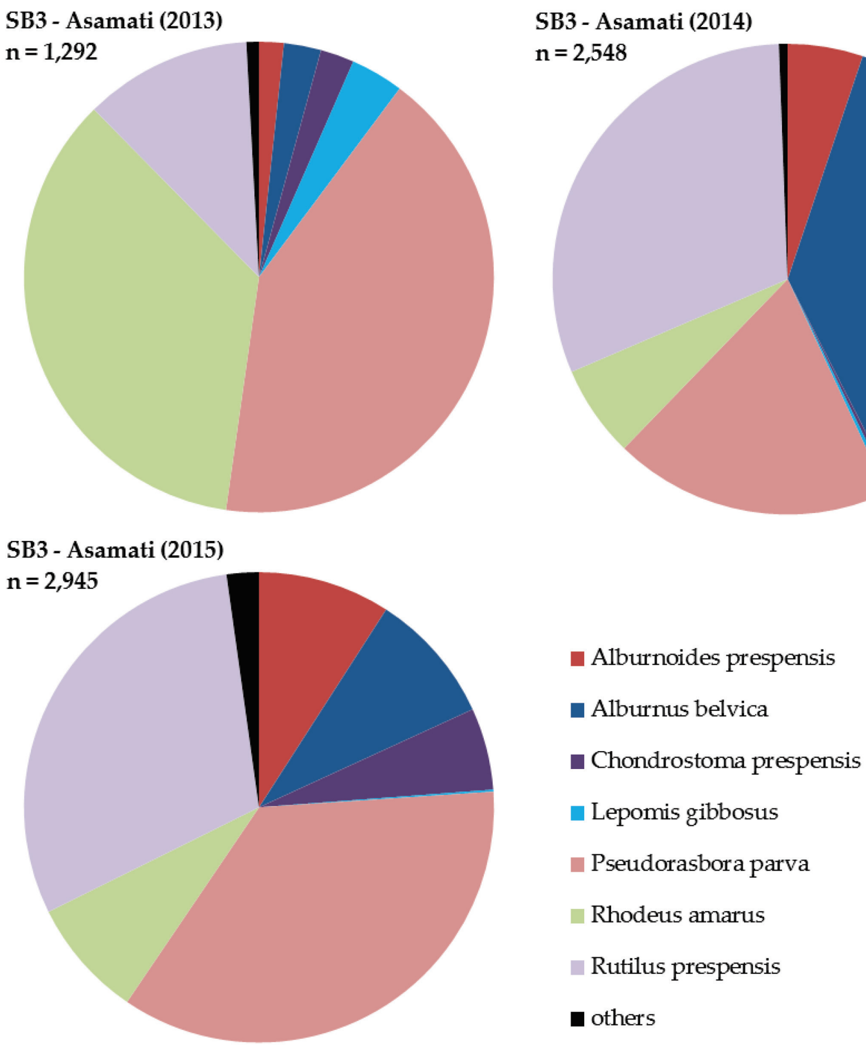
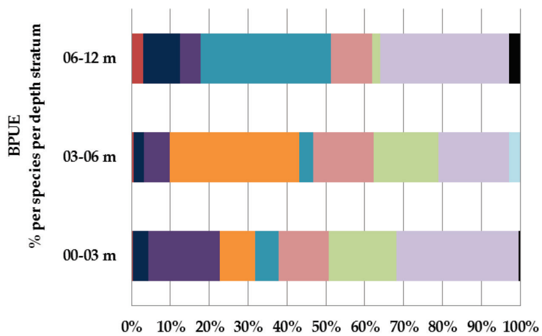
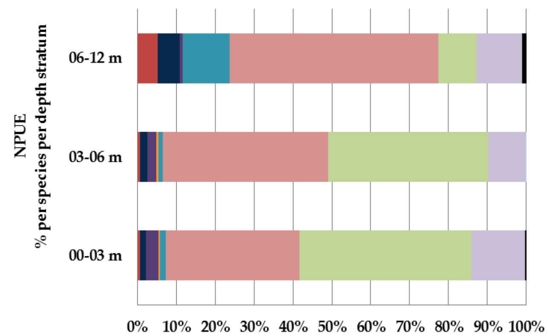


Figure 35. Relative fish species composition based on number of individuals in sub-basin 3 (Asamati) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others'

At SB 3 native species (especially carp, roach, bleak) reached high BPUE values, i.e. in terms of biomass, contributed significantly to the annual catches (Figure 36, Figure 37 and Figure 38). Nonetheless, in view of number of individuals per net area (NPUE), alien species like stone moroko and bitterling formed large parts of the catches.

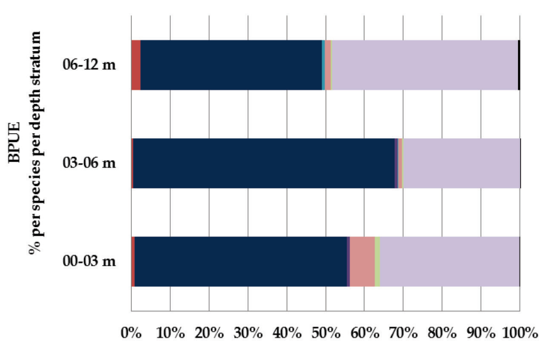


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.04	0.08	0.29
Alburnus belvica	0.47	0.36	0.93
Chondrostoma prespensis	2.16	0.92	0.52
Cyprinus carpio	1.06	4.63	0.00
Lepomis gibbosus	0.70	0.49	3.28
Pseudorasbora parva	1.53	2.14	1.04
Rhodeus amarus	2.04	2.33	0.21
Rutilus prespensis	3.70	2.52	3.24
Squalius prespensis	0.00	0.39	0.00
others	0.04	0.00	0.28

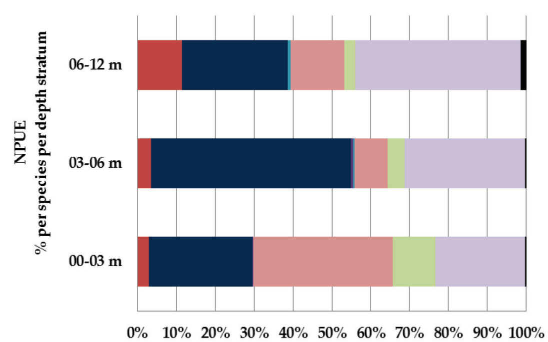


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.01	0.02	0.07
Alburnus belvica	0.03	0.04	0.07
Chondrostoma prespensis	0.07	0.06	0.01
Cyprinus carpio	0.01	0.01	0.00
Lepomis gibbosus	0.03	0.03	0.15
Pseudorasbora parva	0.70	1.04	0.67
Rhodeus amarus	0.90	1.01	0.12
Rutilus prespensis	0.28	0.24	0.15
Squalius prespensis	0.00	0.00	0.00
others	0.01	0.00	0.01

Figure 36. Standardized catches per unit of effort (CPUE) for sub-basin 3 (Asamati) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

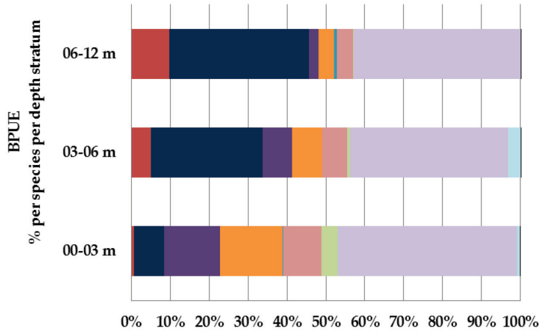


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.13	0.17	0.60
Alburnus belvica	7.32	18.80	11.55
Chondrostoma prespensis	0.09	0.21	0.00
Cyprinus carpio	0.00	0.00	0.00
Lepomis gibbosus	0.00	0.05	0.16
Pseudorasbora parva	0.86	0.25	0.42
Rhodeus amarus	0.18	0.10	0.08
Rutilus prespensis	4.81	8.40	11.82
Squalius prespensis	0.00	0.00	0.00
others	0.02	0.02	0.14

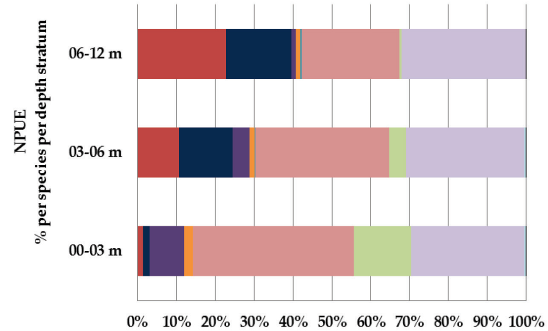


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.04	0.05	0.18
Alburnus belvica	0.33	0.78	0.44
Chondrostoma prespensis	0.00	0.01	0.00
Cyprinus carpio	0.00	0.00	0.00
Lepomis gibbosus	0.00	0.00	0.01
Pseudorasbora parva	0.44	0.13	0.22
Rhodeus amarus	0.13	0.07	0.04
Rutilus prespensis	0.28	0.47	0.68
Squalius prespensis	0.00	0.00	0.00
others	0.00	0.00	0.03

Figure 37. Standardized catches per unit of effort (CPUE) for sub-basin 3 (Asamati) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



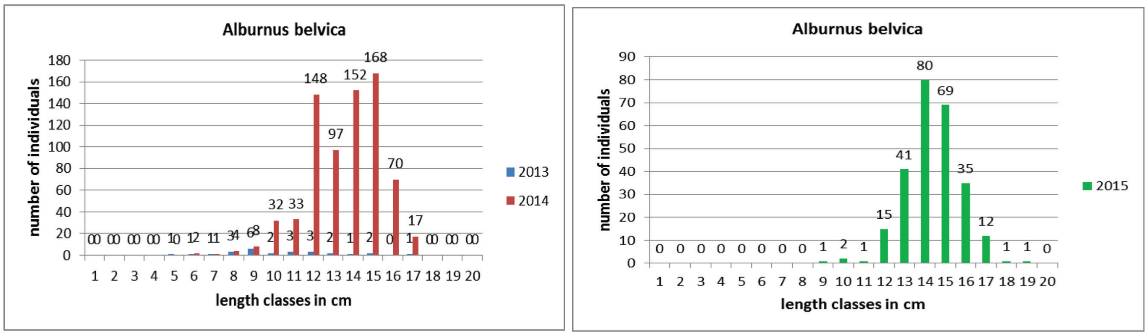
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.10	0.79	1.90
Alburnus belvica	1.09	4.60	7.02
Chondrostoma prespensis	2.03	1.19	0.48
Cyprinus carpio	2.27	1.25	0.77
Lepomis gibbosus	0.03	0.00	0.18
Pseudorasbora parva	1.38	1.01	0.81
Rhodeus amarus	0.57	0.12	0.02
Rutilus prespensis	6.51	6.47	8.37
Squalius prespensis	0.12	0.51	0.00
others	0.01	0.01	0.01



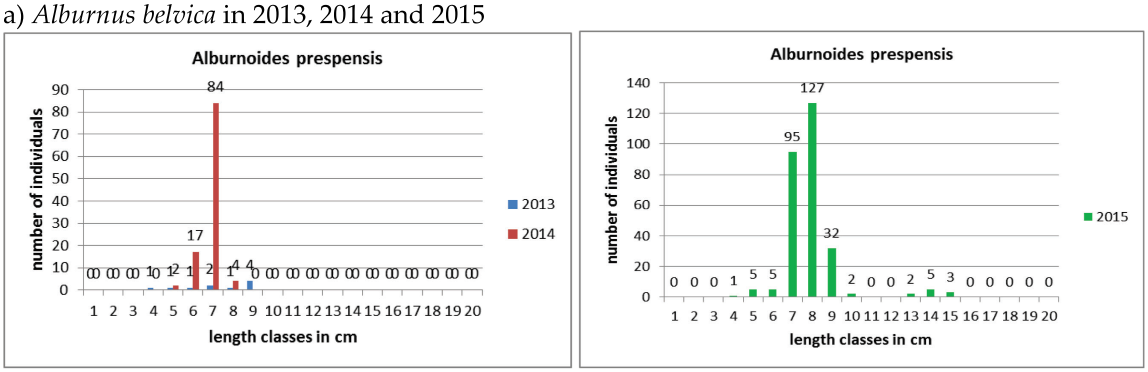
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.03	0.16	0.38
Alburnus belvica	0.03	0.20	0.28
Chondrostoma prespensis	0.16	0.06	0.02
Cyprinus carpio	0.04	0.02	0.02
Lepomis gibbosus	0.00	0.00	0.01
Pseudorasbora parva	0.74	0.50	0.42
Rhodeus amarus	0.27	0.06	0.01
Rutilus prespensis	0.52	0.44	0.53
Squalius prespensis	0.01	0.01	0.00
others	0.00	0.00	0.00

Figure 38. Standardized catches per unit of effort (CPUE) for sub-basin 3 (Asamati) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

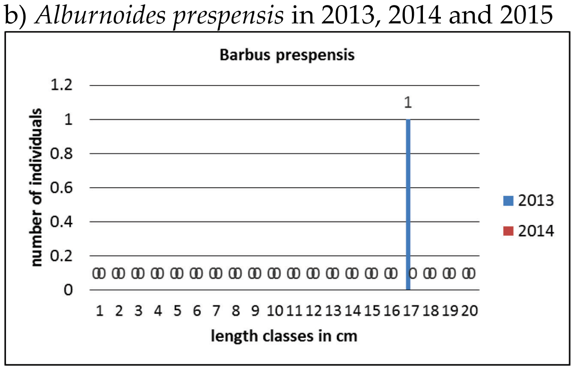
The length-frequency distributions of the fish species caught during the survey at SB 3 are presented in the following Figure 39 (a-k), in either blue (2013), red (2014) or green color (2015). Bleak, roach, nase and carp were present in several length classes. Fishes of the latter species (carp), however, were nonetheless small and did not reach the minimum allowable size of 30 cm (Albania) and 40 cm (Macedonia), respectively (Table 6).



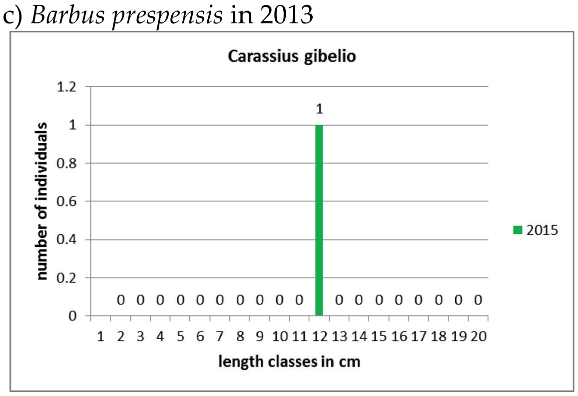
a) *Alburnus belvica* in 2013, 2014 and 2015



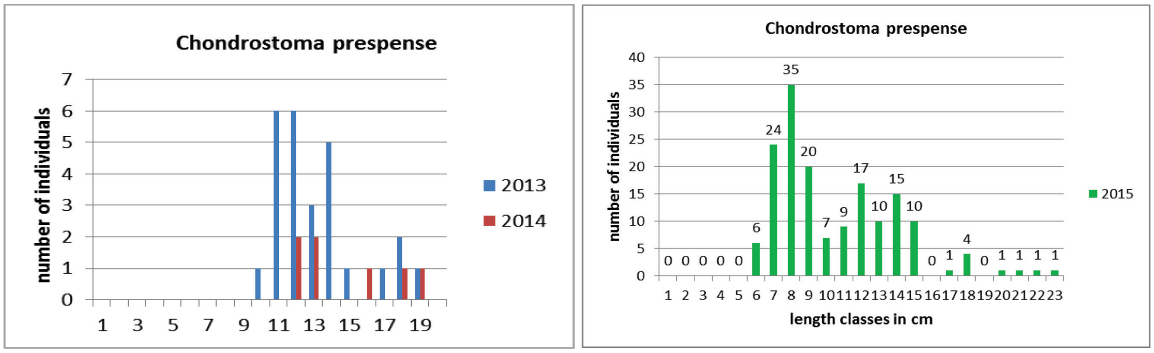
b) *Alburnoides prespensis* in 2013, 2014 and 2015



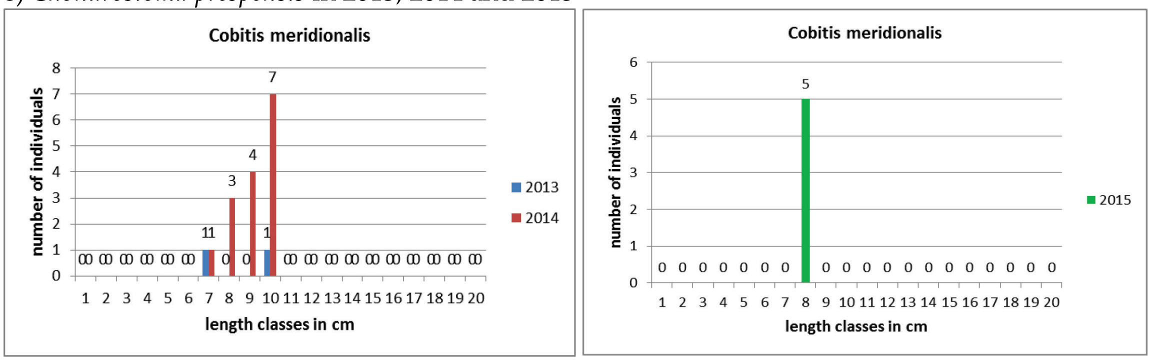
c) *Barbus prespensis* in 2013



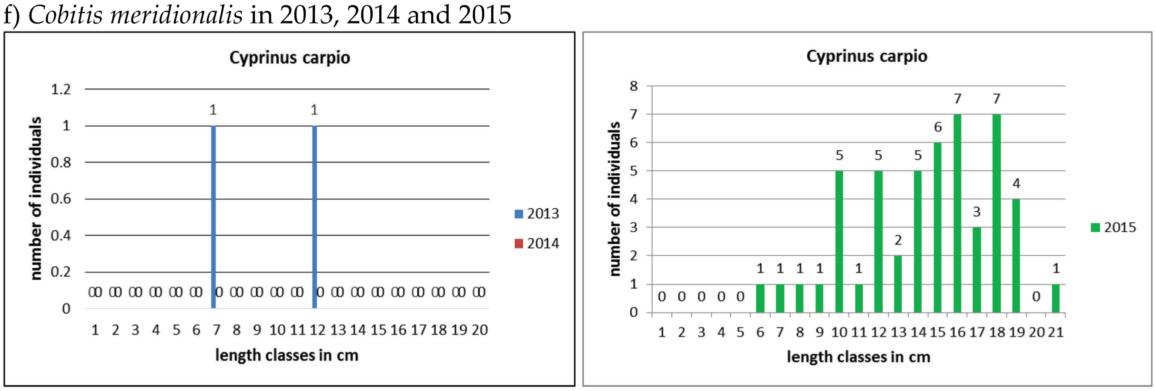
d) *Carassius gibelio* in 2013, 2014 and 2015



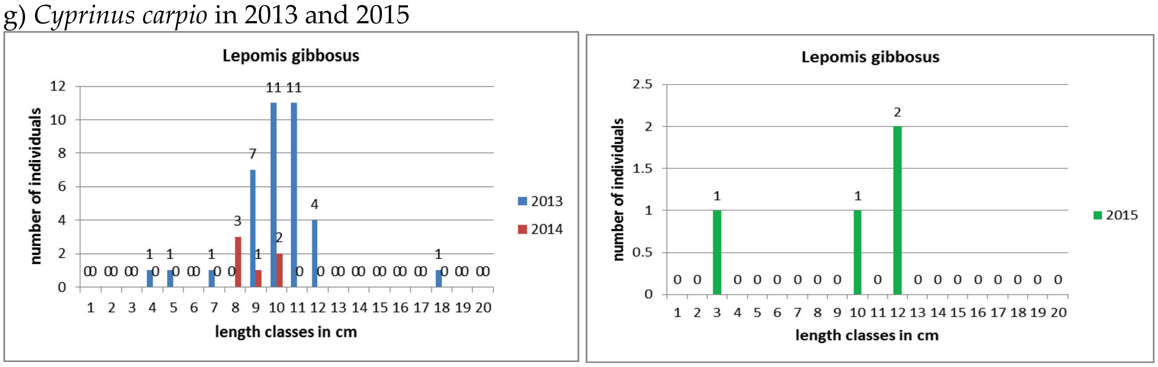
e) *Chondrostoma prespensis* in 2013, 2014 and 2015



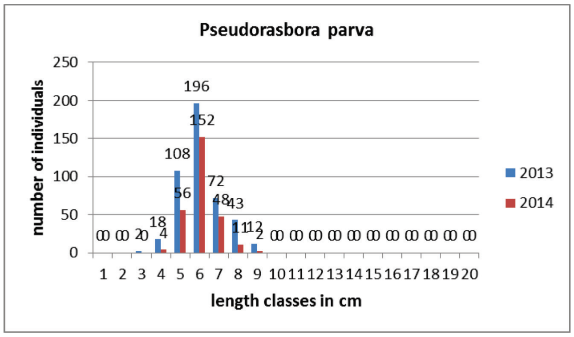
f) *Cobitis meridionalis* in 2013, 2014 and 2015

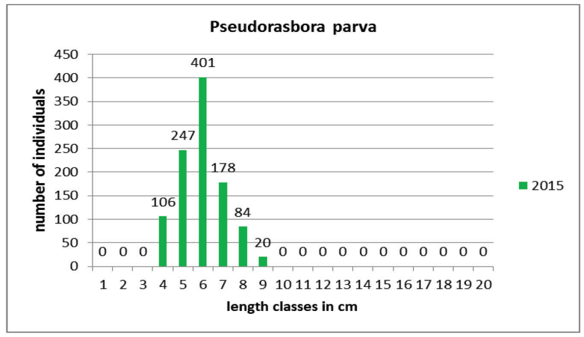


g) *Cyprinus carpio* in 2013 and 2015

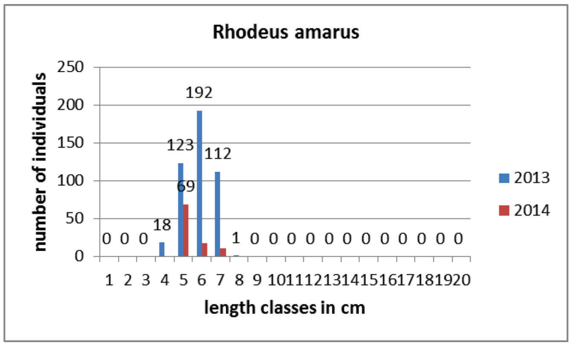


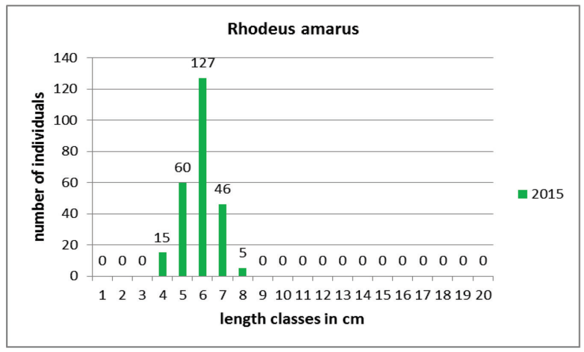
h) *Lepomis gibbosus* in 2013, 2014 and 2015



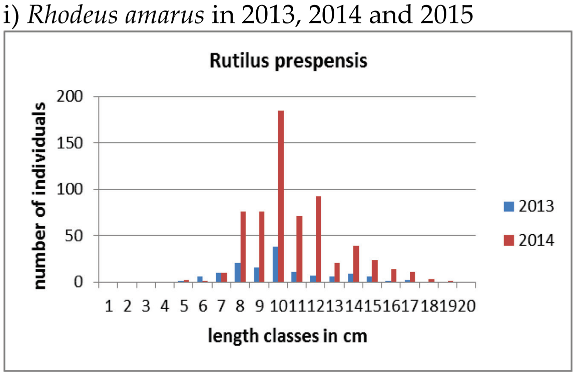


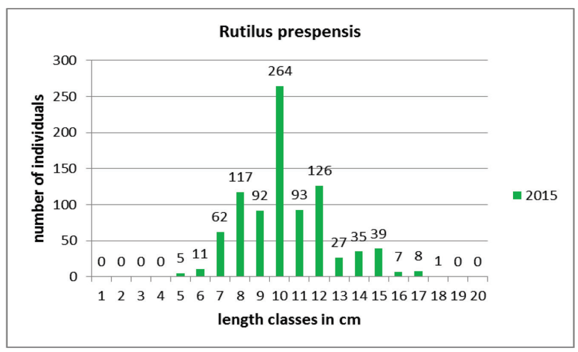
h) *Pseudorasbora parva* in 2013, 2014 and 2015



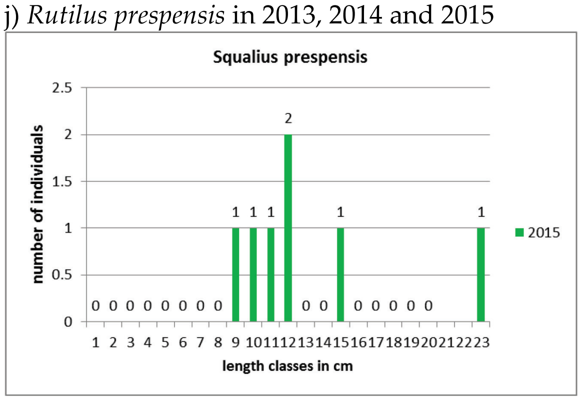


i) *Rhodeus amarus* in 2013, 2014 and 2015





j) *Rutilus prespensis* in 2013, 2014 and 2015



k) *Squalius prespensis* in 2015

Figure 39. Length-frequency distributions of the fish species caught during the survey at SB 3 for the period 2013-2015 (a-k)

SB 4 - Otesevo

At SB 4, ten to twelve species were collected in individual sampling years (ten species in 2013 and twelve each in 2014 and 2015) (Figure 40). In terms of numbers, three alien species – stone moroko, bitterling and pumpkinseed – dominated in the catches and were highly abundant.

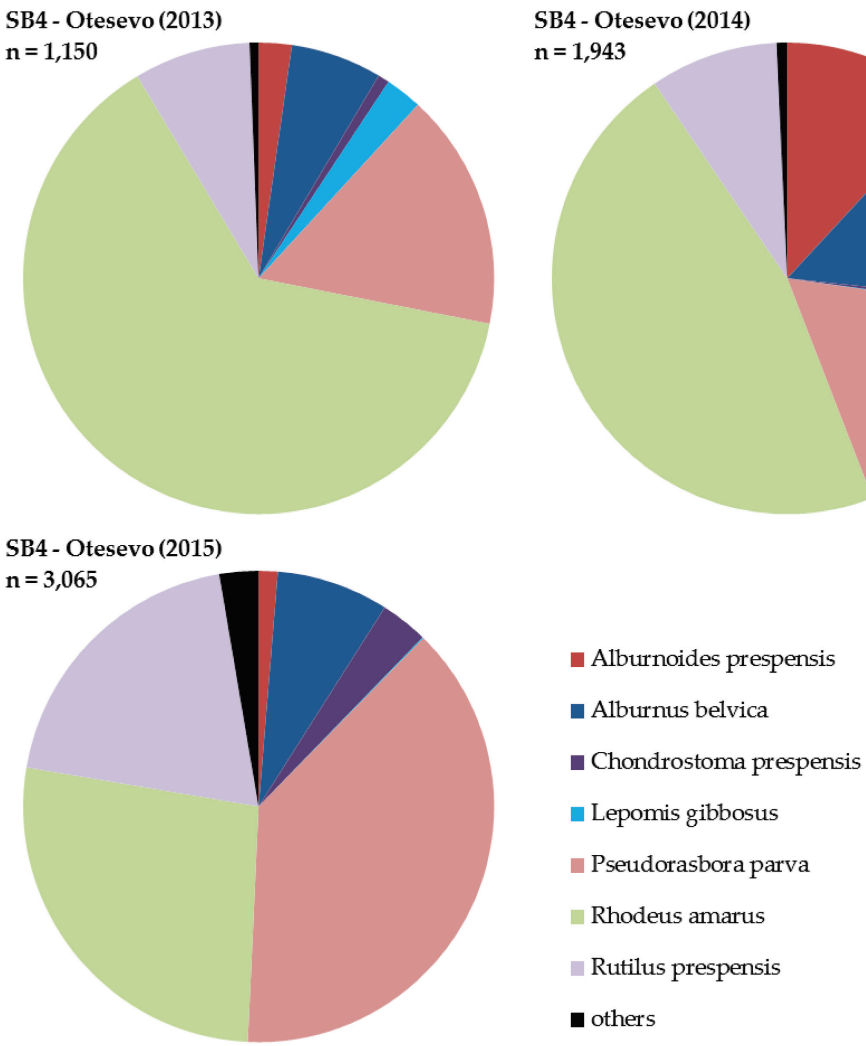
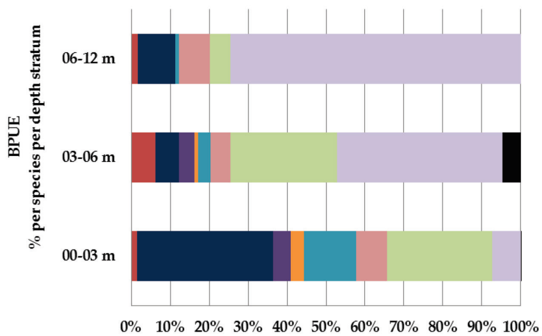


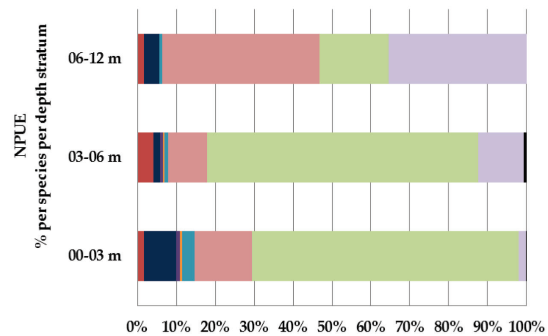
Figure 40. Relative fish species composition based on number of individuals in sub-basin 4 (Otesevo) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others'

Similar to SB 3, at SB 4 native species (bleak, roach) contributed significantly to BPUE (biomass) values, but in terms of relative abundance (NPUE), they were of less importance (Figure 41, Figure 42 and Figure 43).

Bleak showed spatial preferences for deeper water layers (6-12 m), in particular during the years 2014 and 2015. Bitterling, showed high relative abundances at the 0-3 and 3-6 m strata.

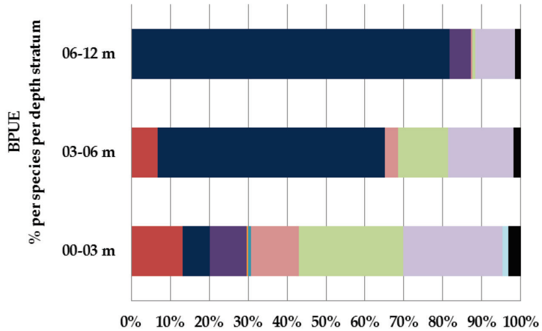


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.28	0.55	0.09
Alburnus belvica	7.11	0.52	0.52
Chondrostoma prespensis	0.91	0.35	0.00
Cyprinus carpio	0.70	0.07	0.00
Lepomis gibbosus	2.71	0.29	0.05
Pseudorasbora parva	1.61	0.44	0.43
Rhodeus amarus	5.51	2.41	0.28
Rutilus prespensis	1.47	3.72	4.04
Squalius prespensis	0.00	0.00	0.00
others	0.01	0.41	0.00

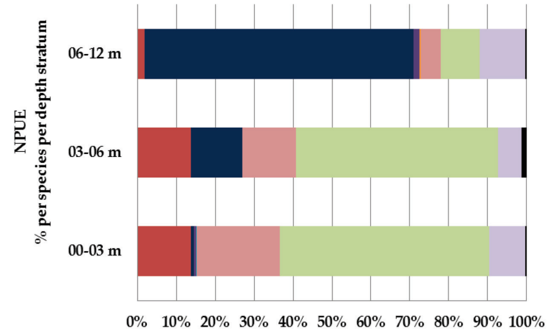


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.07	0.07	0.01
Alburnus belvica	0.34	0.03	0.03
Chondrostoma prespensis	0.04	0.01	0.00
Cyprinus carpio	0.02	0.01	0.00
Lepomis gibbosus	0.14	0.02	0.01
Pseudorasbora parva	0.60	0.16	0.28
Rhodeus amarus	2.81	1.12	0.12
Rutilus prespensis	0.08	0.19	0.24
Squalius prespensis	0.00	0.00	0.00
others	0.01	0.01	0.00

Figure 41. Standardized catches per unit of effort (CPUE) for sub-basin 4 (Otesevo) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

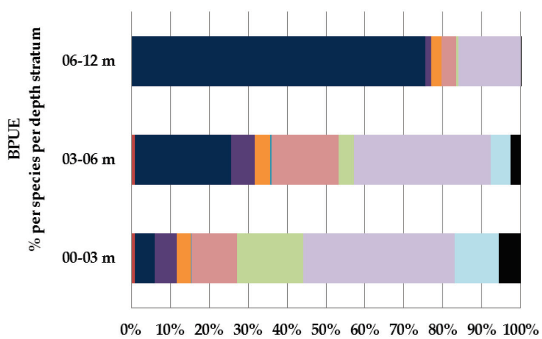


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.73	0.33	0.05
Alburnus belvica	0.38	2.85	18.66
Chondrostoma prespensis	0.52	0.00	1.24
Cyprinus carpio	0.02	0.00	0.03
Lepomis gibbosus	0.04	0.00	0.00
Pseudorasbora parva	0.68	0.16	0.09
Rhodeus amarus	1.47	0.62	0.17
Rutilus prespensis	1.41	0.82	2.33
Squalius prespensis	0.08	0.00	0.00
others	0.18	0.09	0.33

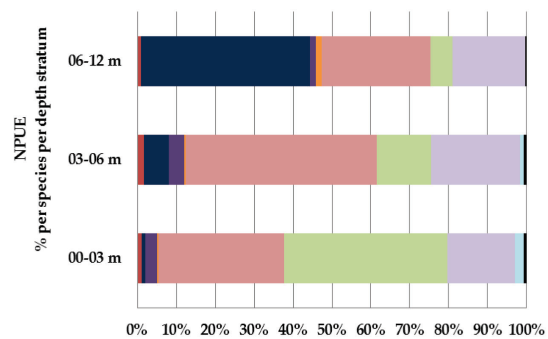


	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.22	0.09	0.02
Alburnus belvica	0.01	0.09	0.59
Chondrostoma prespensis	0.01	0.00	0.01
Cyprinus carpio	0.00	0.00	0.00
Lepomis gibbosus	0.00	0.00	0.00
Pseudorasbora parva	0.34	0.09	0.04
Rhodeus amarus	0.85	0.36	0.09
Rutilus prespensis	0.15	0.04	0.10
Squalius prespensis	0.00	0.00	0.00
others	0.01	0.01	0.00

Figure 42. Standardized catches per unit of effort (CPUE) for sub-basin 4 (Otesevo) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



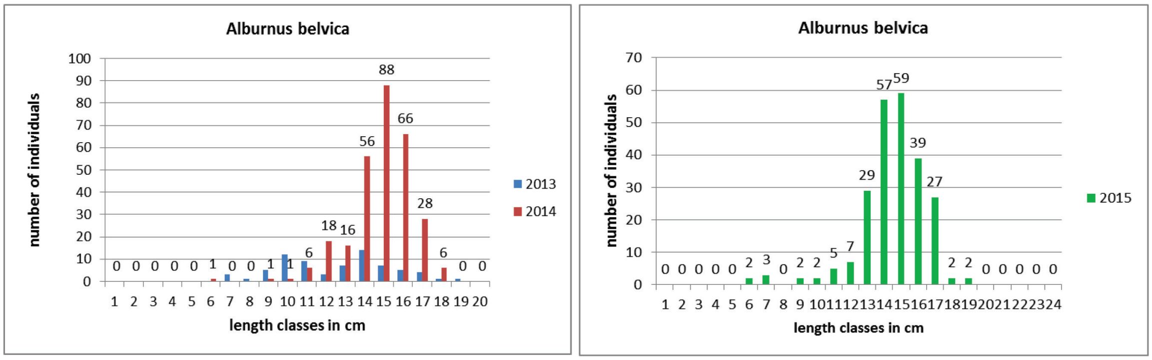
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.11	0.11	0.02
Alburnus belvica	0.66	3.34	10.84
Chondrostoma prespensis	0.73	0.82	0.22
Cyprinus carpio	0.44	0.54	0.39
Lepomis gibbosus	0.04	0.06	0.00
Pseudorasbora parva	1.48	2.31	0.52
Rhodeus amarus	2.17	0.52	0.08
Rutilus prespensis	4.99	4.74	2.31
Squalius prespensis	1.44	0.67	0.00
others	0.73	0.36	0.01



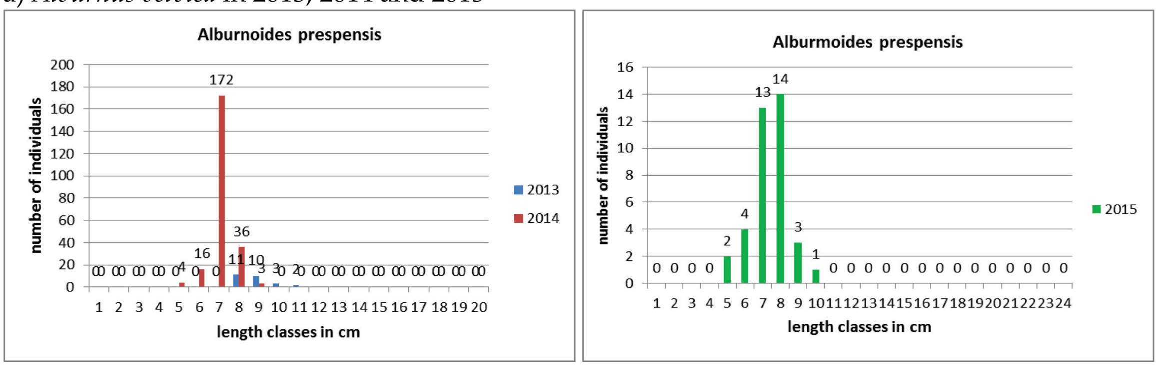
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.02	0.03	0.01
Alburnus belvica	0.02	0.11	0.40
Chondrostoma prespensis	0.06	0.07	0.01
Cyprinus carpio	0.01	0.01	0.01
Lepomis gibbosus	0.00	0.00	0.00
Pseudorasbora parva	0.67	0.83	0.26
Rhodeus amarus	0.88	0.24	0.05
Rutilus prespensis	0.36	0.39	0.17
Squalius prespensis	0.05	0.02	0.00
others	0.02	0.01	0.00

Figure 43. Standardized catches per unit of effort (CPUE) for sub-basin 4 (Otesevo) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

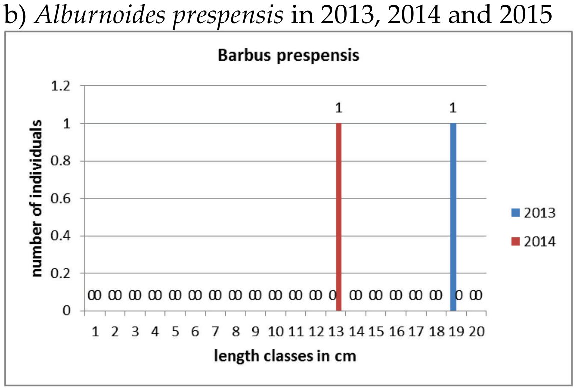
The length-frequency distributions of the fish species caught during the survey at the SB 4 are presented in the following Figure 44 (a-m), in either blue (2013), red (2014) or green color (2015).



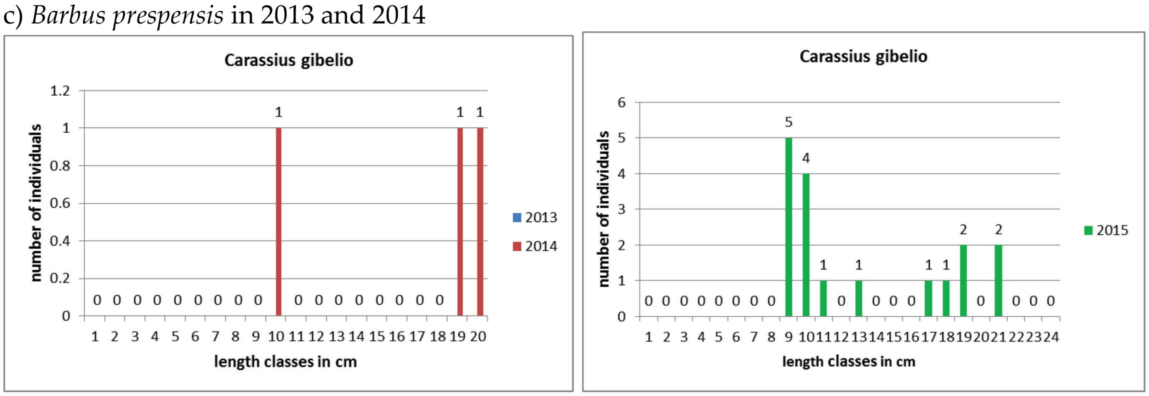
a) *Alburnus belvica* in 2013, 2014 and 2015



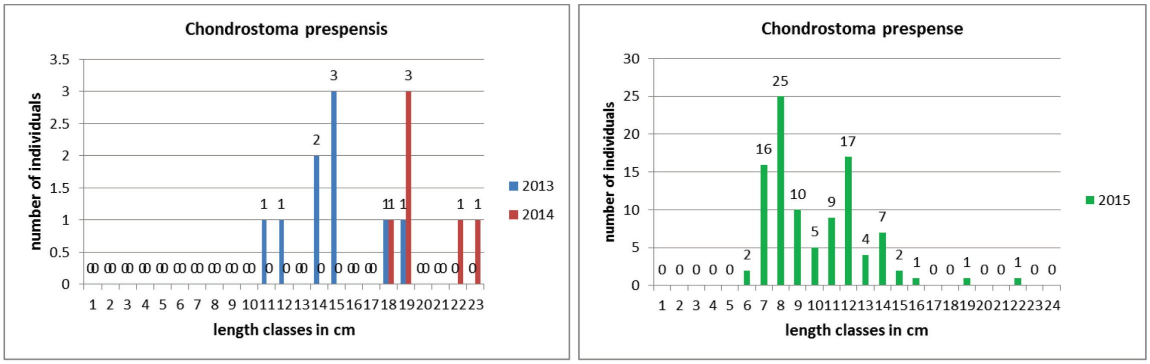
b) *Alburnoides prespensis* in 2013, 2014 and 2015



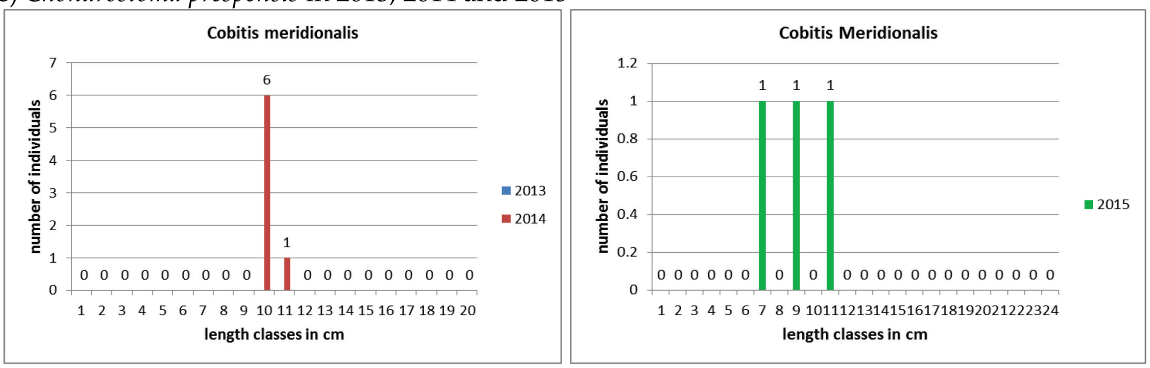
c) *Barbus prespensis* in 2013 and 2014



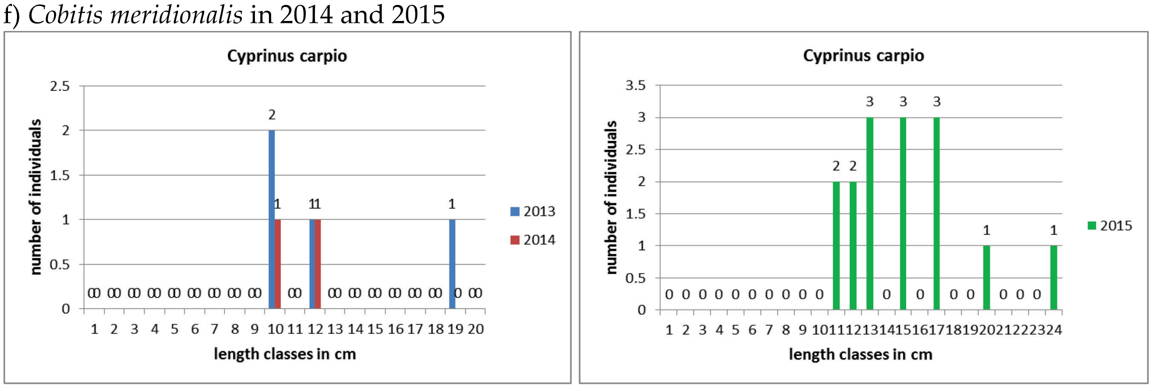
d) *Carassius gibelio* in 2014 and 2015



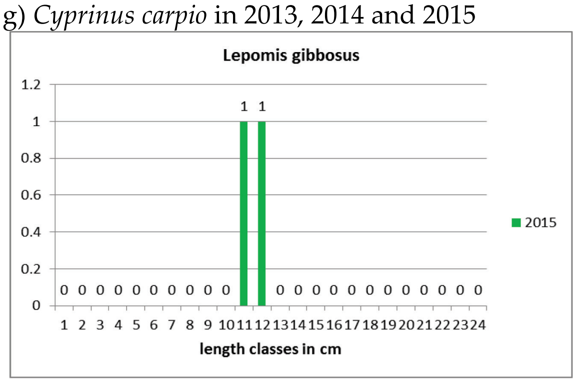
e) *Chondrostoma prespensis* in 2013, 2014 and 2015



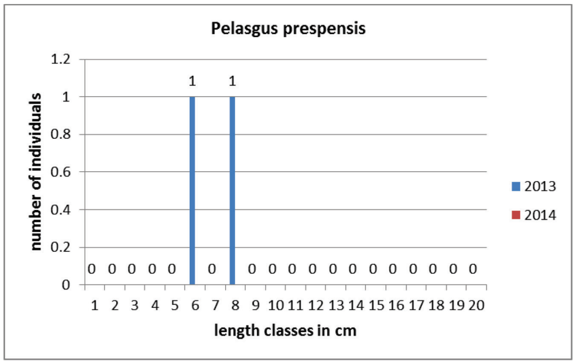
f) *Cobitis meridionalis* in 2014 and 2015



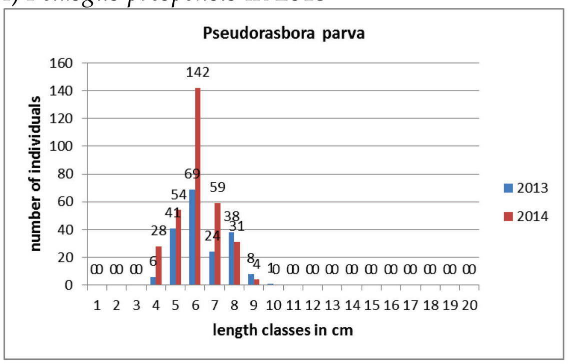
g) *Cyprinus carpio* in 2013, 2014 and 2015

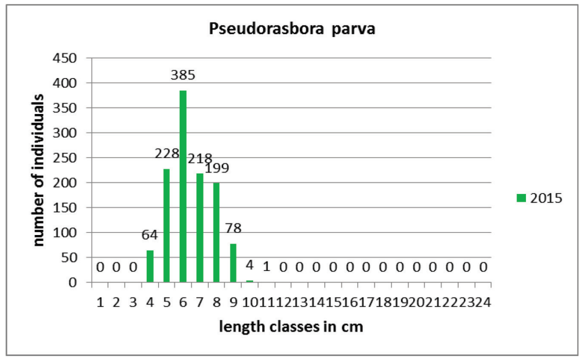


h) *Lepomis gibbosus* in 2015

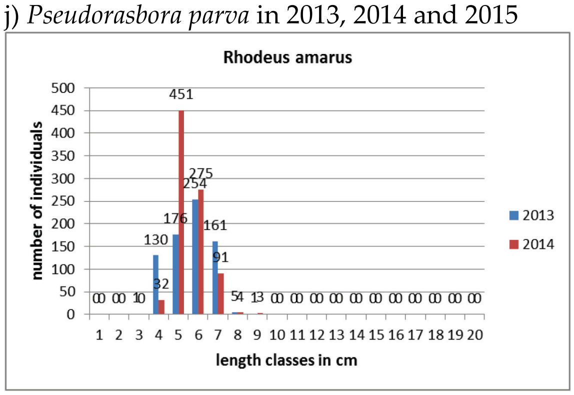


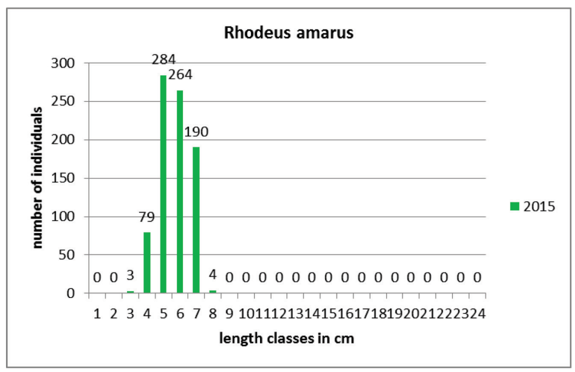
i) *Pelasgus prespensis* in 2013



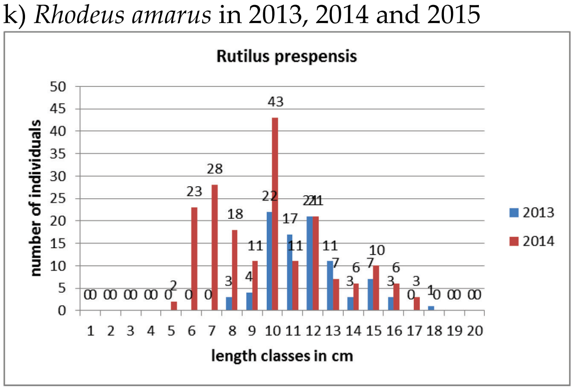


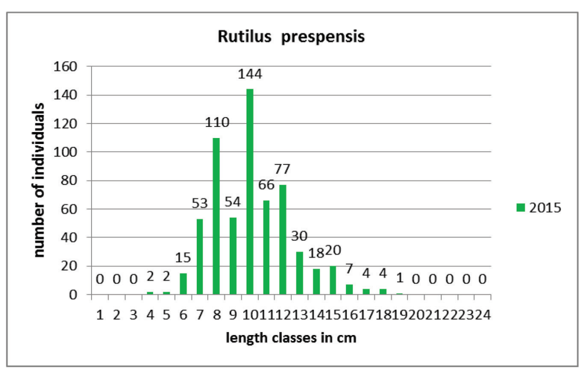
j) *Pseudorasbora parva* in 2013, 2014 and 2015



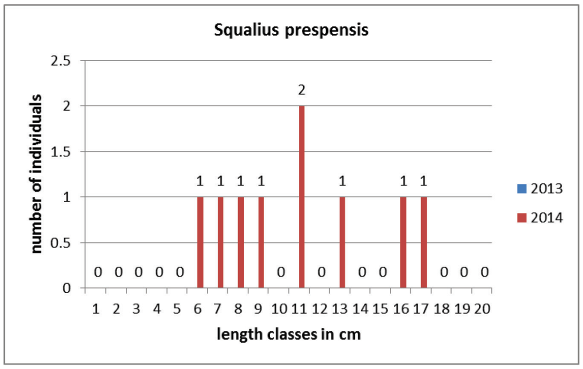


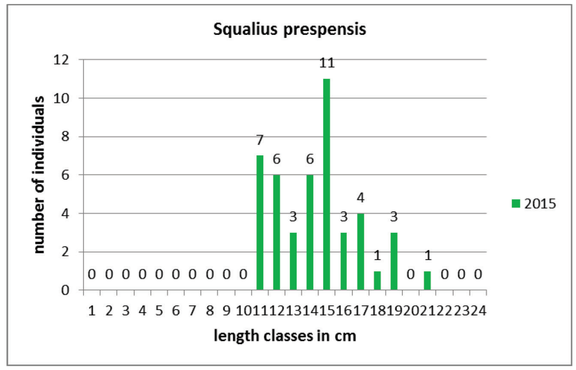
k) *Rhodeus amarus* in 2013, 2014 and 2015





l) *Rutilus prespensis* in 2013, 2014 and 2015





m) *Squalius prespensis* in 2014 and 2015

Figure 44. Length-frequency distributions of the fish species caught during the survey at SB 4 for the period 2013-2015 (a-m)

As shown from the figures above, bleak catches were made up of small and relatively large (i. e. adult) individuals throughout all sampling years. Higher numbers of fish, however, were caught in 2014 and 2015. Similarly, roach (*Rutilus prespensis*) also occurred in a wide range of length classes in any one year. Interestingly, chub was sampled over a range of eight length classes in 2014.

SB 5 - Konjsko

At SB 5 a total of 1,958 individuals belonging to 11 species were sampled in October 2013, and 6,056 fish (13 species) were collected in 2014. In 2015, the total catch was made up of 4,438 individuals (11 species) (Figure 45). During the first year, alien species (bitterling, stone moroko and pumpkinseed) were present in high numbers in the overall catch. In 2014, native species spirlin, roach and bleak were present with combined 63%. The spirlin at this locality was the most dominant native species. In 2015, the most abundant species was spirlin again (46% of sampled individuals), followed by roach (21 %) and the two alien species stone moroko and bitterling with 16 and 9 %, respectively.

Annual changes in species abundances were also noticeable in BPUE and NPUE values (Figure 46, Figure 47 and Figure 48). During the first sampling year pumpkinseed reached high values in terms of biomass and relative abundance, but during the following years, spirlin, roach and bleak became more dominant in total catches.

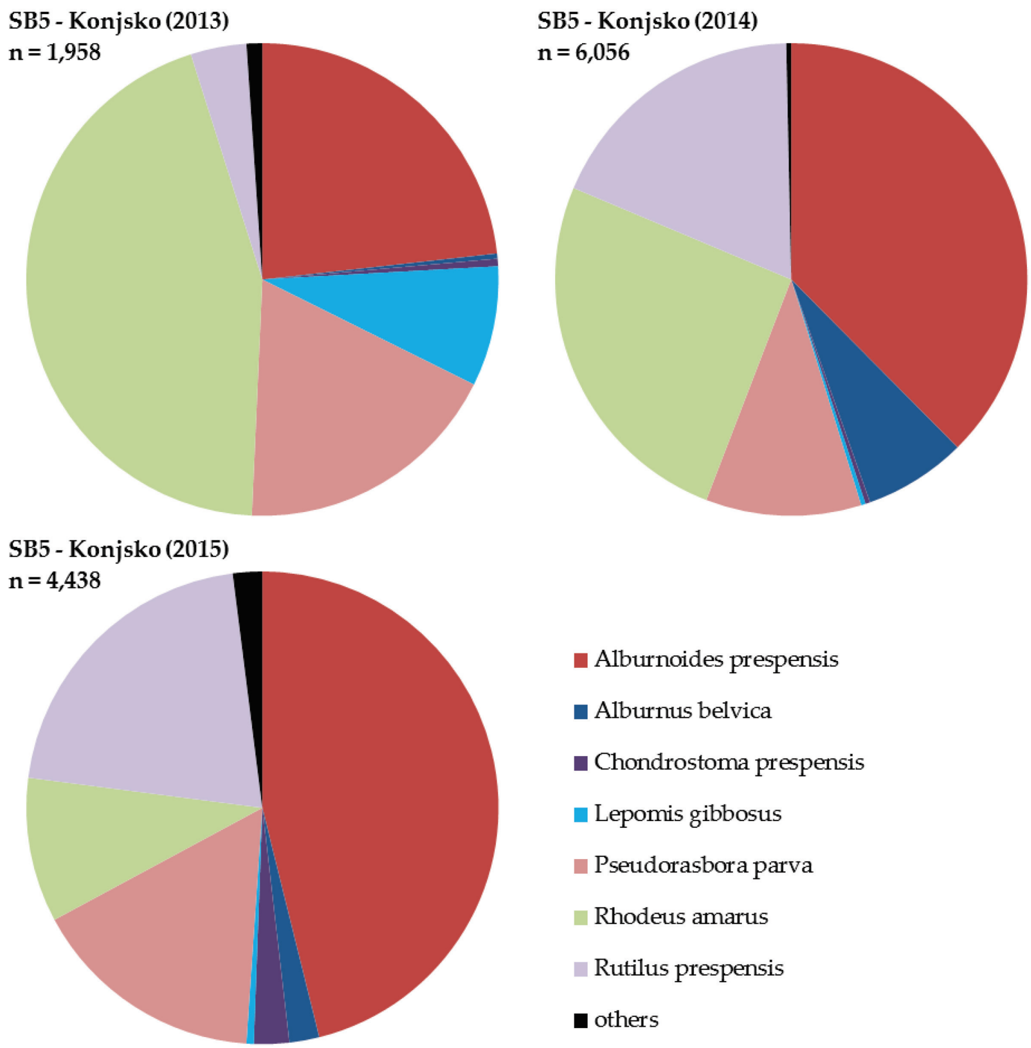
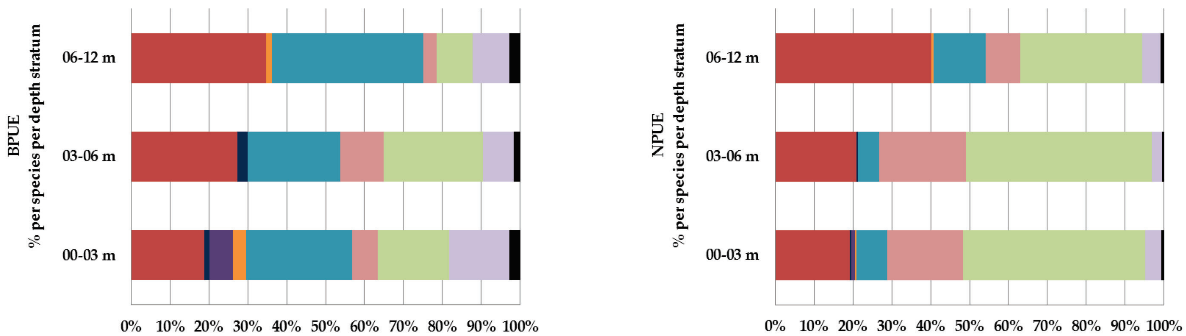


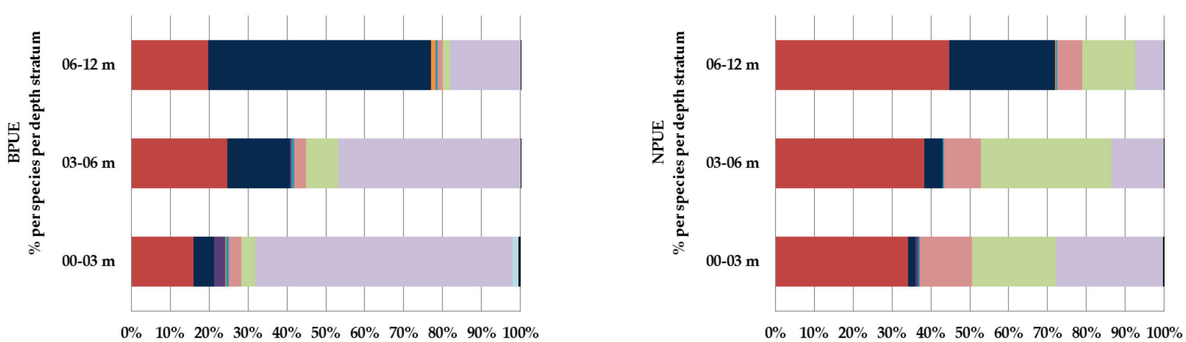
Figure 45. Relative fish species composition based on number of individuals in sub-basin 5 (Konjsko) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as ‘others’



	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	5.06	4.63	5.10
Alburnus belvica	0.35	0.47	0.00
Chondrostoma prespensis	1.62	0.00	0.00
Cyprinus carpio	0.93	0.00	0.21
Lepomis gibbosus	7.28	4.03	5.72
Pseudorasbora parva	1.80	1.90	0.50
Rhodeus amarus	4.90	4.30	1.36
Rutilus prespensis	4.16	1.36	1.39
Squalius prespensis	0.00	0.00	0.00
others	0.74	0.28	0.40

	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	0.95	0.79	0.75
Alburnus belvica	0.02	0.01	0.00
Chondrostoma prespensis	0.04	0.00	0.00
Cyprinus carpio	0.02	0.00	0.01
Lepomis gibbosus	0.39	0.21	0.25
Pseudorasbora parva	0.96	0.85	0.17
Rhodeus amarus	2.31	1.81	0.58
Rutilus prespensis	0.20	0.10	0.09
Squalius prespensis	0.00	0.00	0.00
others	0.04	0.02	0.02

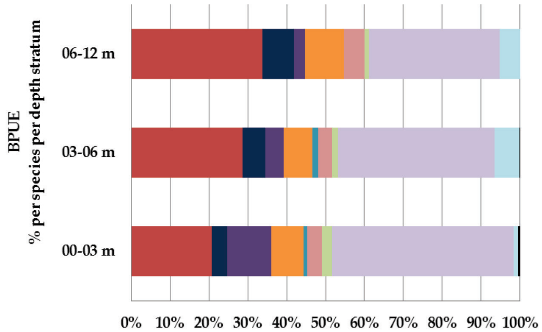
Figure 46. Standardized catches per unit of effort (CPUE) for sub-basin 5 (Konjsko) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



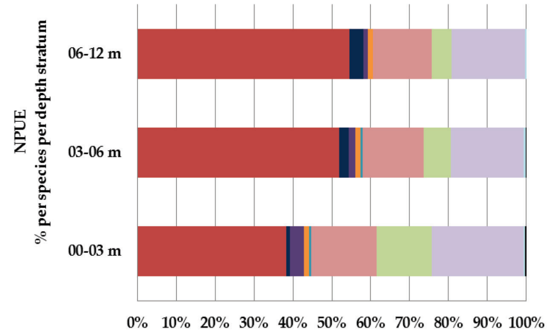
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	4.17	4.75	5.20
Alburnus belvica	1.35	3.09	14.92
Chondrostoma prespensis	0.72	0.06	0.00
Cyprinus carpio	0.08	0.00	0.33
Lepomis gibbosus	0.18	0.15	0.13
Pseudorasbora parva	0.85	0.60	0.33
Rhodeus amarus	0.95	1.58	0.52
Rutilus prespensis	17.12	9.00	4.73
Squalius prespensis	0.40	0.00	0.00
others	0.13	0.01	0.01

	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	1.21	1.36	1.18
Alburnus belvica	0.06	0.17	0.72
Chondrostoma prespensis	0.03	0.00	0.00
Cyprinus carpio	0.00	0.00	0.01
Lepomis gibbosus	0.01	0.01	0.01
Pseudorasbora parva	0.48	0.33	0.17
Rhodeus amarus	0.76	1.20	0.36
Rutilus prespensis	0.97	0.48	0.19
Squalius prespensis	0.01	0.00	0.00
others	0.01	0.00	0.00

Figure 47. Standardized catches per unit of effort (CPUE) for sub-basin 5 (Konjsko) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



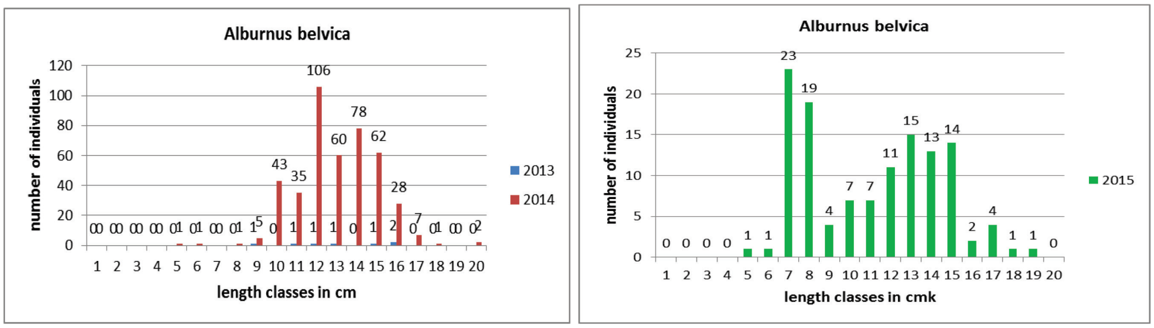
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	4.46	5.54	5.25
Alburnus belvica	0.85	1.12	1.26
Chondrostoma prespensis	2.44	0.90	0.44
Cyprinus carpio	1.79	1.43	1.55
Lepomis gibbosus	0.18	0.29	0.00
Pseudorasbora parva	0.83	0.68	0.82
Rhodeus amarus	0.59	0.29	0.18
Rutilus prespensis	10.01	7.77	5.24
Squalius prespensis	0.24	1.24	0.81
others	0.13	0.02	0.00



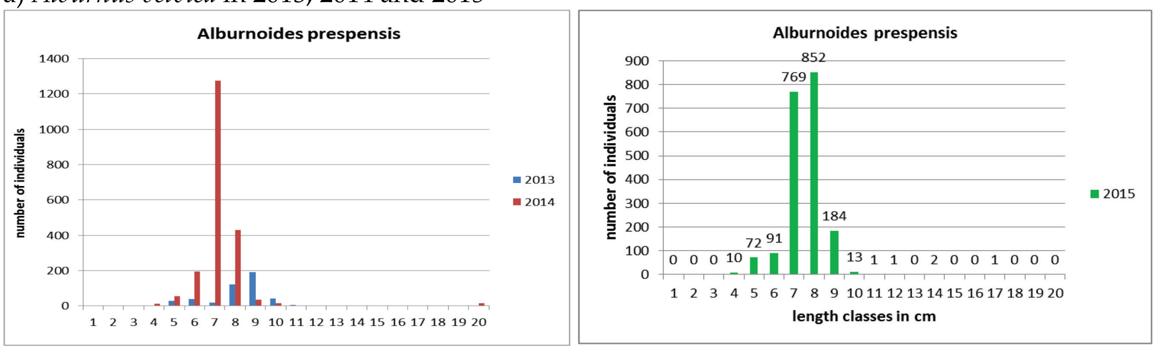
	00-03 m	03-06 m	06-12 m
Alburnoides prespensis	1.06	1.23	1.11
Alburnus belvica	0.03	0.06	0.07
Chondrostoma prespensis	0.10	0.04	0.02
Cyprinus carpio	0.04	0.03	0.03
Lepomis gibbosus	0.02	0.01	0.00
Pseudorasbora parva	0.47	0.37	0.31
Rhodeus amarus	0.39	0.17	0.10
Rutilus prespensis	0.66	0.44	0.38
Squalius prespensis	0.01	0.01	0.01
others	0.01	0.01	0.00

Figure 48. Standardized catches per unit of effort (CPUE) for sub-basin 5 (Konjsko) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

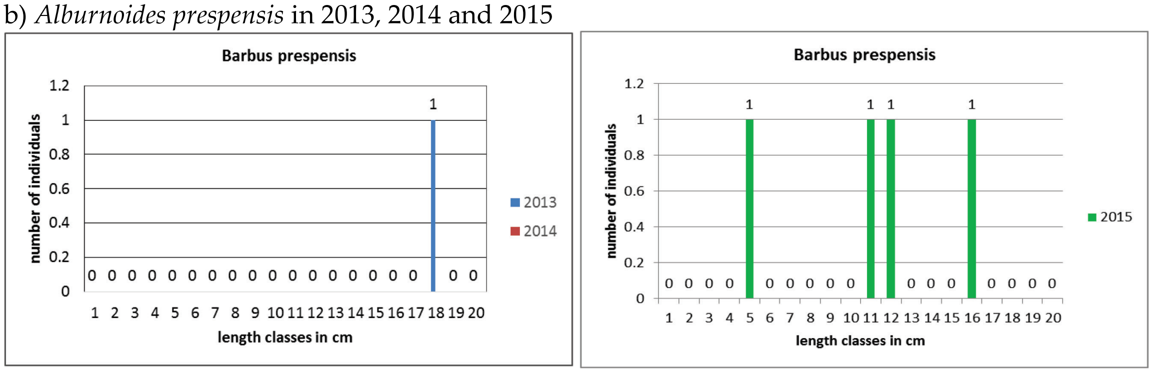
The length-frequency distributions of the fish species caught during the survey at the SB 5 are presented in the following Figure 49 (a-m), in either blue (2013), red (2014) or green color (2015).



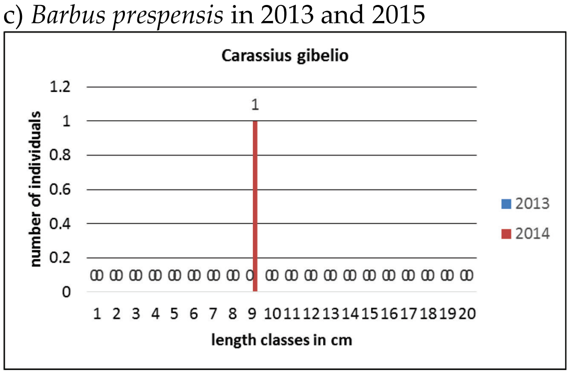
a) *Alburnus belvica* in 2013, 2014 and 2015



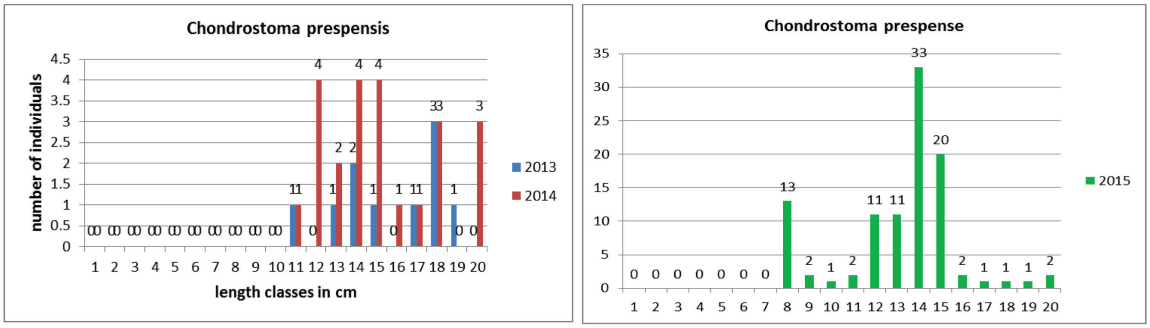
b) *Alburnoides prespensis* in 2013, 2014 and 2015



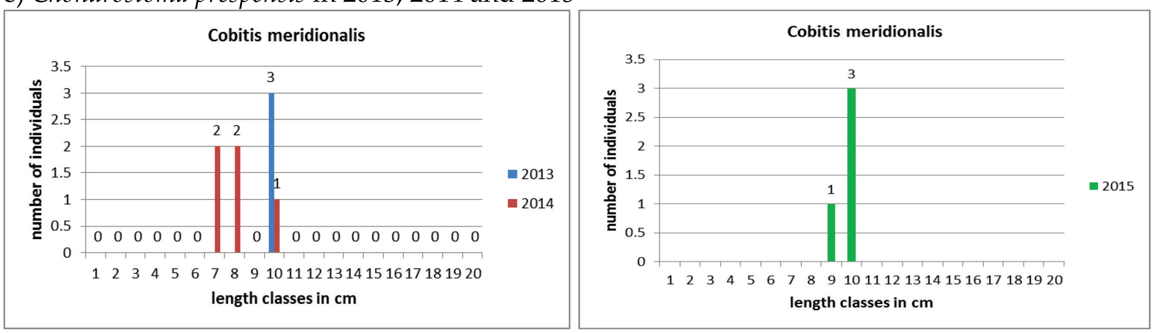
c) *Barbus prespensis* in 2013 and 2015



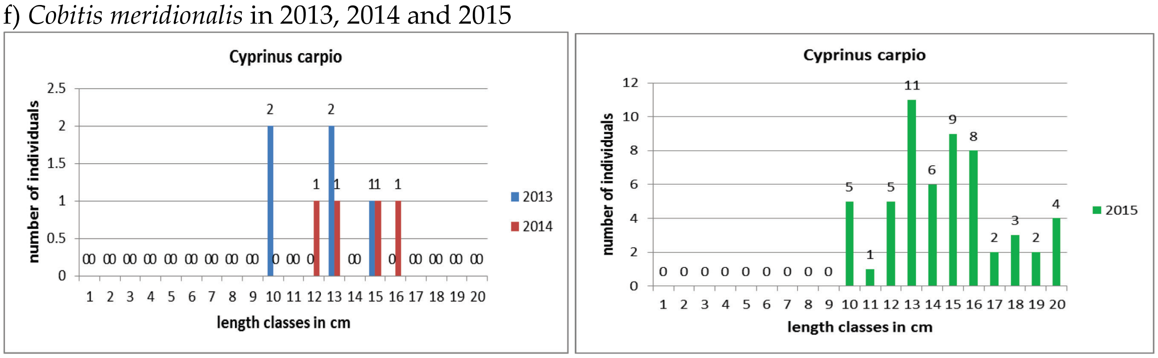
d) *Carassius gibelio* in 2014



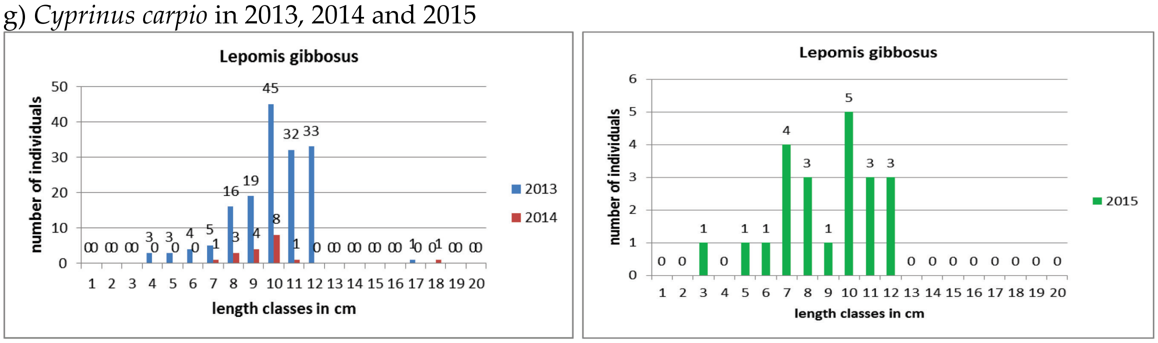
e) *Chondrostoma prespensis* in 2013, 2014 and 2015



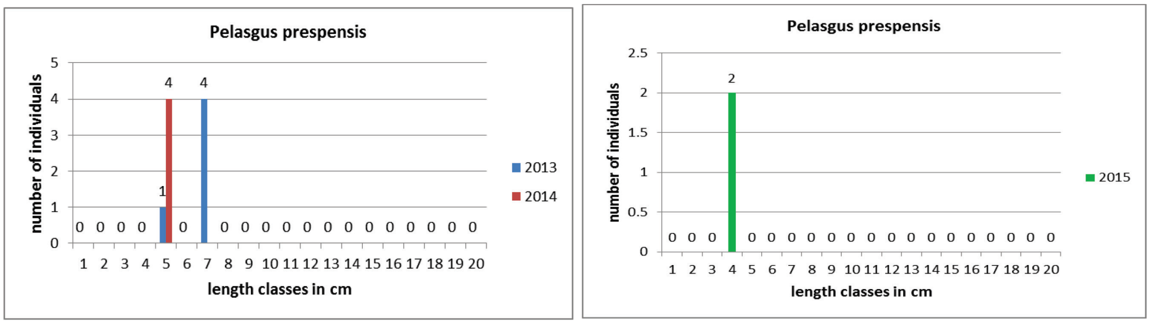
f) *Cobitis meridionalis* in 2013, 2014 and 2015



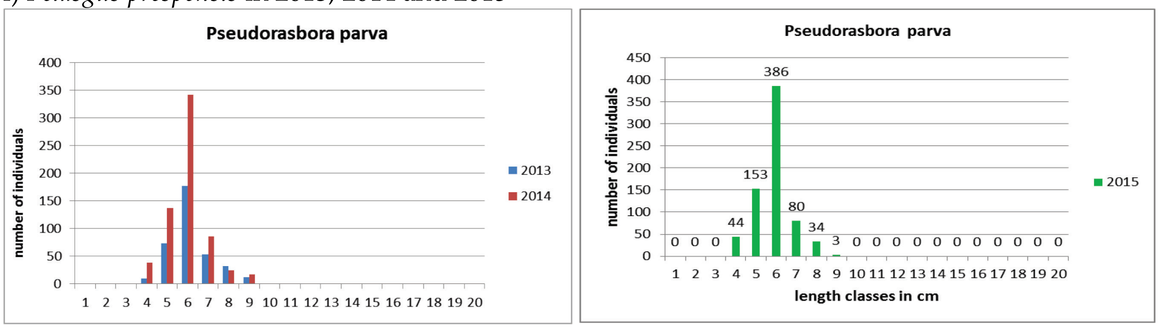
g) *Cyprinus carpio* in 2013, 2014 and 2015



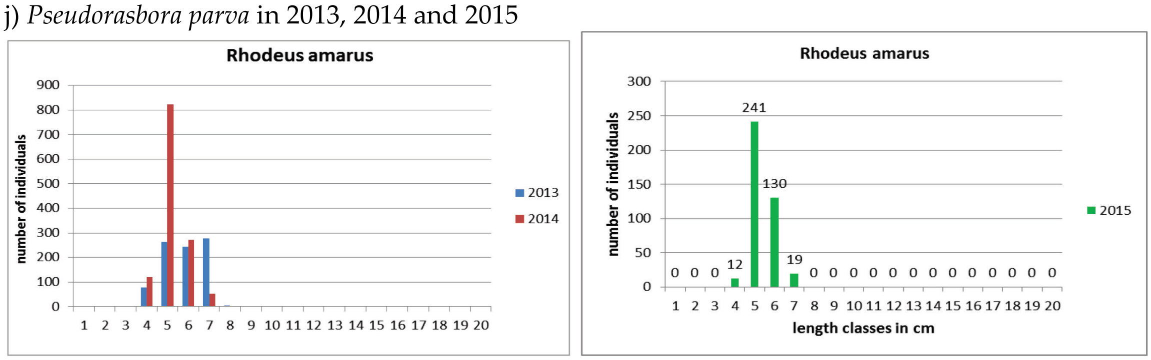
h) *Lepomis gibbosus* in 2013, 2014 and 2015



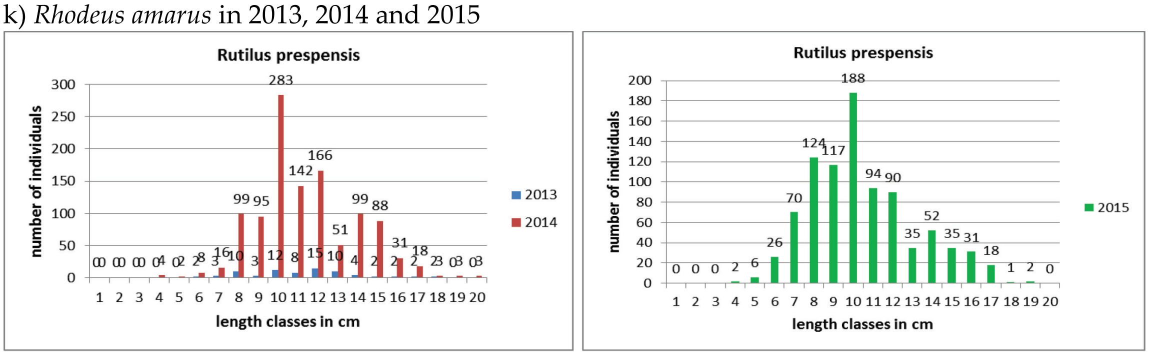
i) *Pelasgus prespensis* in 2013, 2014 and 2015



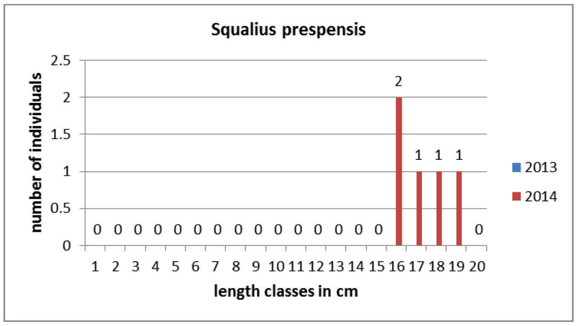
j) *Pseudorasbora parva* in 2013, 2014 and 2015

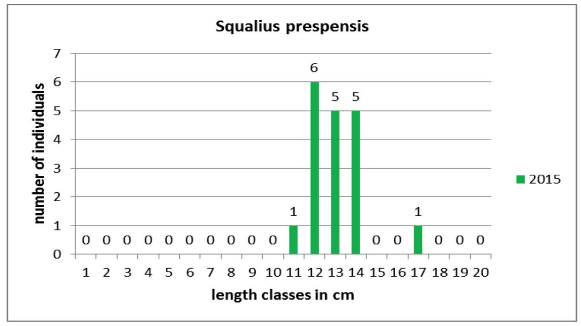


k) *Rhodeus amarus* in 2013, 2014 and 2015



l) *Rutilus prespensis* in 2013, 2014 and 2015





m) *Squalius prespensis* in 2014 and 2015

Figure 49. Length-frequency distributions of the fish species caught during the survey at SB 5 for the period 2013-2015 (a-m)

The length-frequency distributions showed a wide spread of length classes (both small and big individuals) for roach and bleak (Figure 49). In 2014, spirlin was present with 1,276 individuals belonging to a single length class (7 cm).

SB 6 - Central Plate

At the central pelagic part of Prespa Lake (SB 6), low numbers of fish were sampled relative to the other, littoral sampling sites. In 2013, a total of 685 fishes belonging to 8 species were collected, whereas in the two following years 317 fishes (9 species) and 199 individuals (6 species) were caught (Figure 50).

Native species (bleak, roach) dominated in the catches in all three sampling years. In fact, in 2013 native species comprised 89% of the sample which was composed of bleak (49%), roach (38%) and other fishes such as nase, spirlin and carp (combined 2%). In 2014, bleak and roach reflected 93% of the total catch, while carp, nase and spirlin and stone loach combined contributed another 4% of individuals to the catch (Figure 50), whereas in 2015 more than 98% of the total catch at SB 6 was comprised of native species.

Alien species (bitterling, stone moroko and pumpkinseed) occurred in low numbers in any one year (Figure 50).

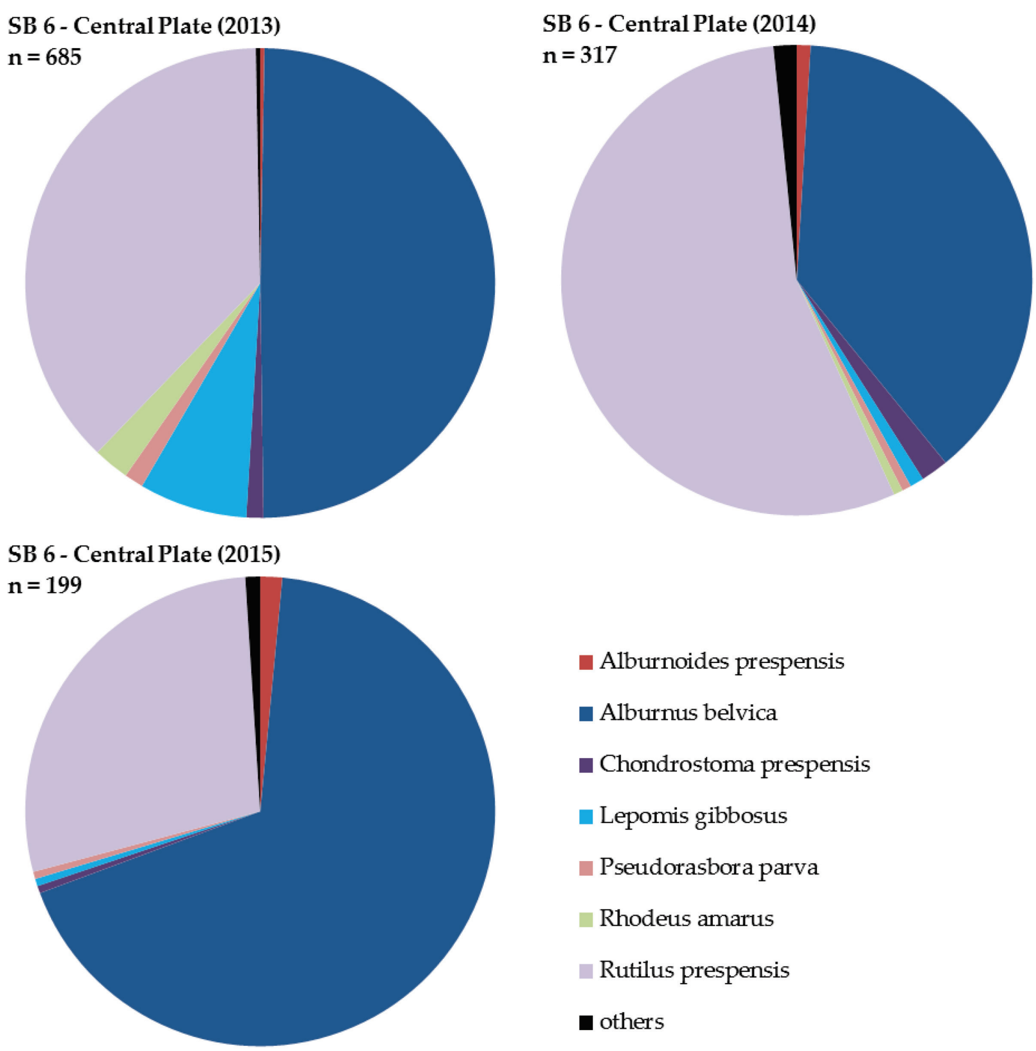
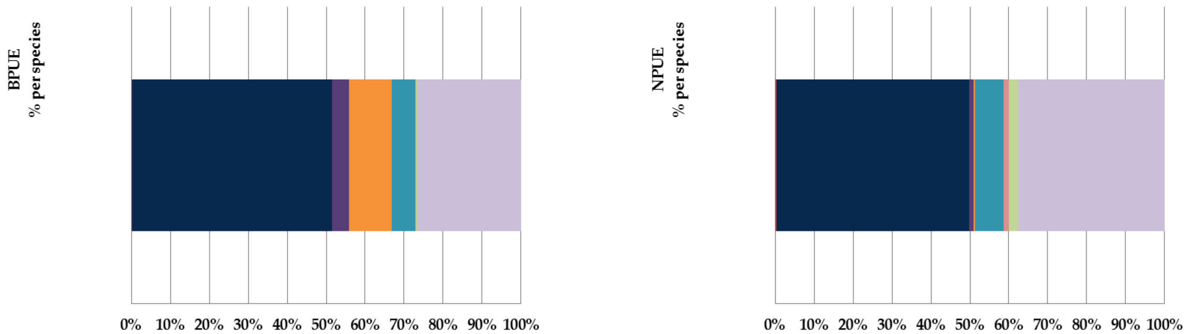


Figure 50. Relative fish species composition based on number of individuals in sub-basin 6 (Central Plate) of Prespa Lake. The data are provided for the years 2013, 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others'

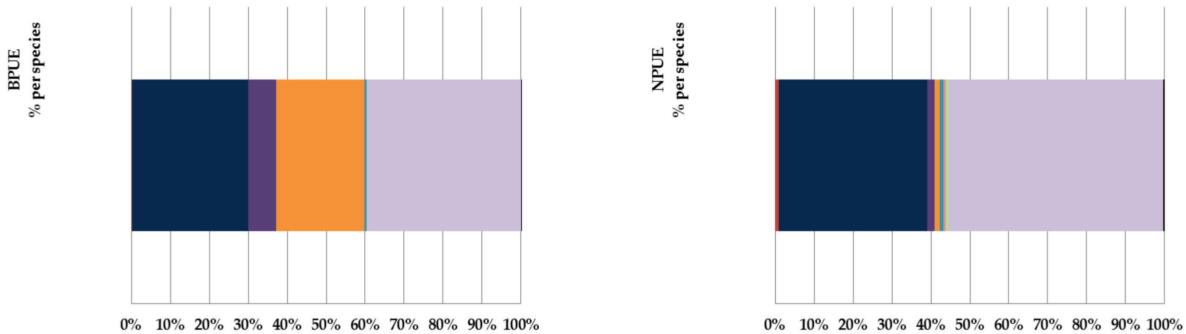
In the case of the Central Plate sub-basin in all three years of sampling, unlike the other sites close to the shore, species' contributions to CPUE (biomass, numbers) values were comparatively identical, meaning that species which occurred in high numbers (NPUE) also contributed to a high degree to BPUE (Figure 51, Figure 52 and Figure 53).



	014-016
Alburnoides prespensis	0.01
Alburnus belvica	5.87
Chondrostoma prespensis	0.49
Cyprinus carpio	1.24
Lepomis gibbosus	0.70
Pseudorasbora parva	0.01
Rhodeus amarus	0.04
Rutilus prespensis	3.04
Squalius prespensis	0.00
others	0.00

	014-016
Alburnoides prespensis	0.00
Alburnus belvica	0.30
Chondrostoma prespensis	0.01
Cyprinus carpio	0.00
Lepomis gibbosus	0.05
Pseudorasbora parva	0.01
Rhodeus amarus	0.02
Rutilus prespensis	0.23
Squalius prespensis	0.00
others	0.00

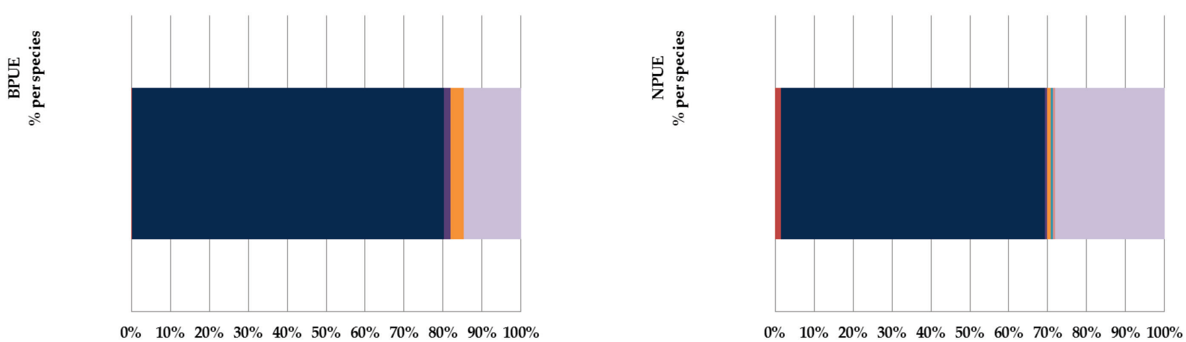
Figure 51. Standardized catches per unit of effort (CPUE) for sub-basin 6 (Central Plate) of Prespa Lake during the sampling campaign of October 2013. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata



	012-018
Alburnoides prespensis	0.03
Alburnus belvica	6.52
Chondrostoma prespensis	1.58
Cyprinus carpio	4.95
Lepomis gibbosus	0.11
Pseudorasbora parva	0.01
Rhodeus amarus	0.01
Rutilus prespensis	8.63
Squalius prespensis	0.00
others	0.02

	012-018
Alburnoides prespensis	0.01
Alburnus belvica	0.34
Chondrostoma prespensis	0.02
Cyprinus carpio	0.01
Lepomis gibbosus	0.01
Pseudorasbora parva	0.01
Rhodeus amarus	0.01
Rutilus prespensis	0.49
Squalius prespensis	0.00
others	0.00

Figure 52. Standardized catches per unit of effort (CPUE) for sub-basin 6 (Central Plate) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

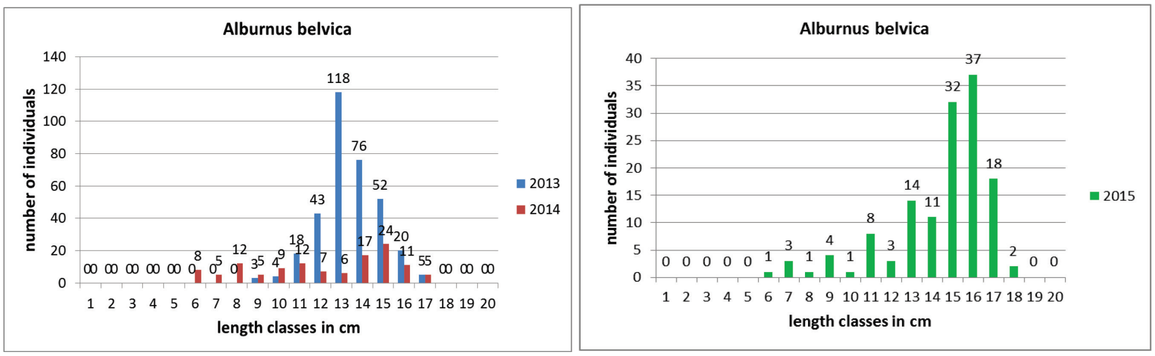


	013-016
Alburnoides prespensis	0.03
Alburnus belvica	10.39
Chondrostoma prespensis	0.22
Cyprinus carpio	0.43
Lepomis gibbosus	0.01
Pseudorasbora parva	0.00
Rhodeus amarus	0.00
Rutilus prespensis	1.91
Squalius prespensis	0.00
others	0.00

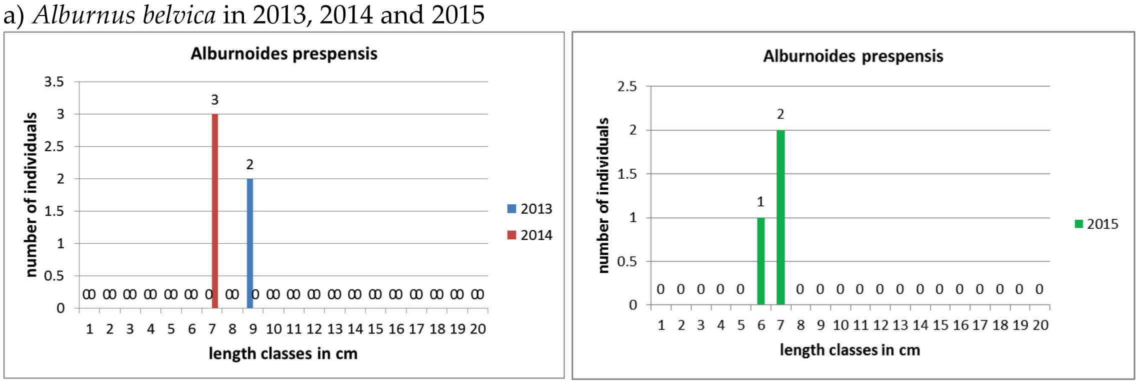
	013-016
Alburnoides prespensis	0.01
Alburnus belvica	0.38
Chondrostoma prespensis	0.00
Cyprinus carpio	0.01
Lepomis gibbosus	0.00
Pseudorasbora parva	0.00
Rhodeus amarus	0.00
Rutilus prespensis	0.16
Squalius prespensis	0.00
others	0.00

Figure 53. Standardized catches per unit of effort (CPUE) for sub-basin 6 (Central Plate) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are given separately for the depth strata

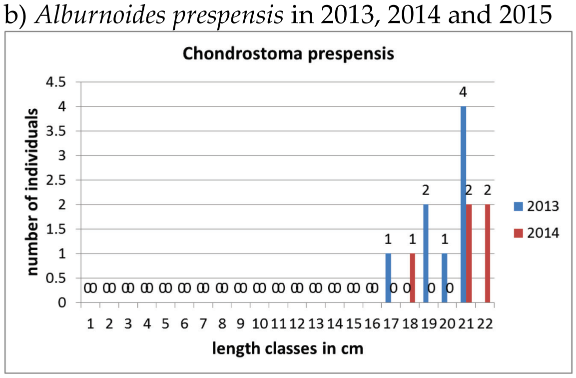
The length-frequency distributions of the fish species caught during the survey at the SB 6 are presented in the following Figure 54 (a-i), in either blue (2013), red (2014) or green color (2015).



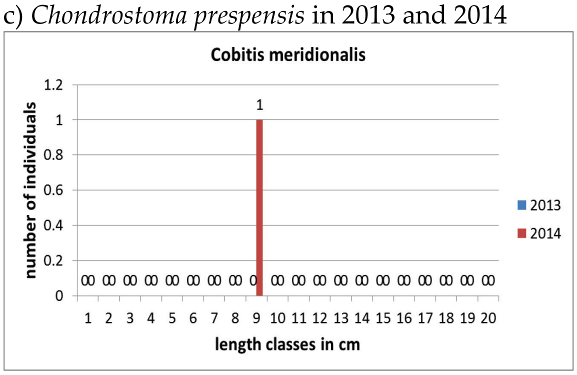
a) *Alburnus belvica* in 2013, 2014 and 2015



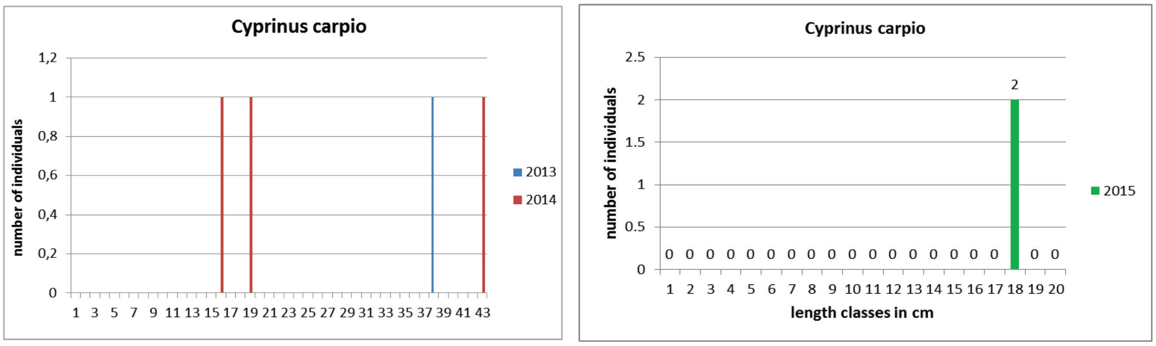
b) *Alburnoides prespensis* in 2013, 2014 and 2015



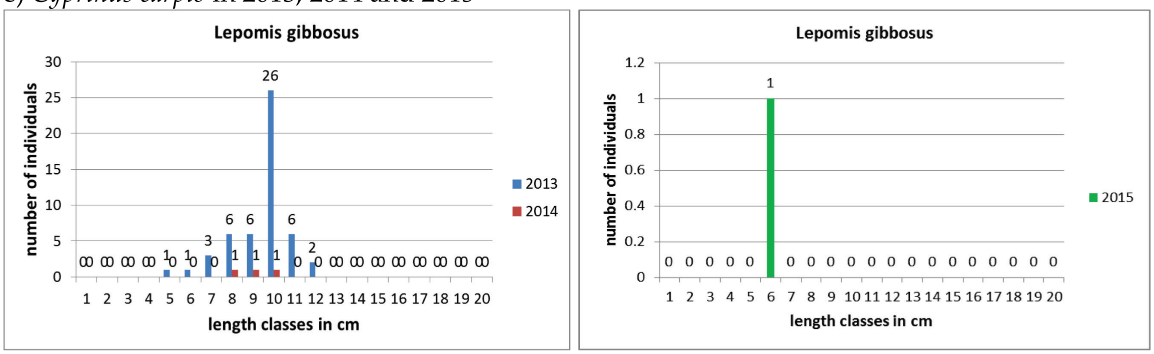
c) *Chondrostoma prespensis* in 2013 and 2014



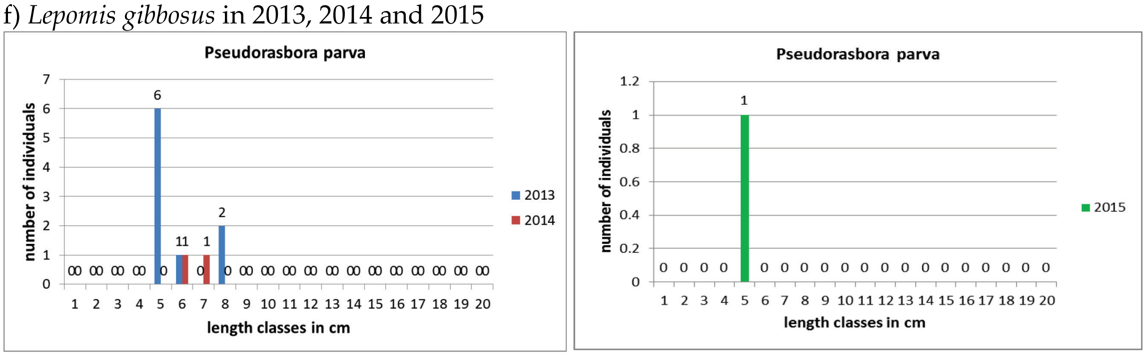
d) *Cobitis meridionalis* in 2014



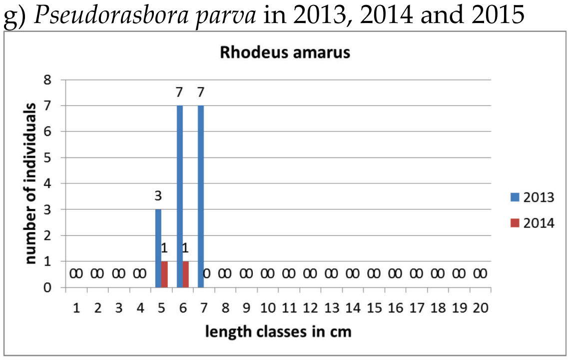
e) *Cyprinus carpio* in 2013, 2014 and 2015



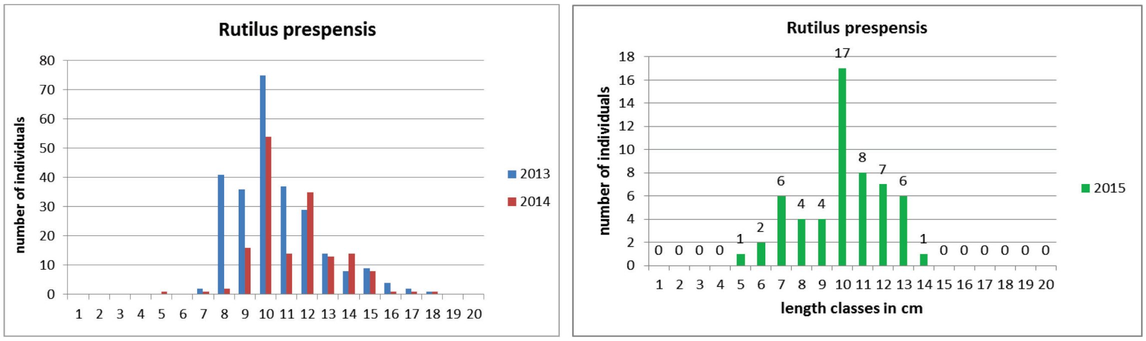
f) *Lepomis gibbosus* in 2013, 2014 and 2015



g) *Pseudorasbora parva* in 2013, 2014 and 2015



h) *Rhodeus amarus* in 2013 and 2014



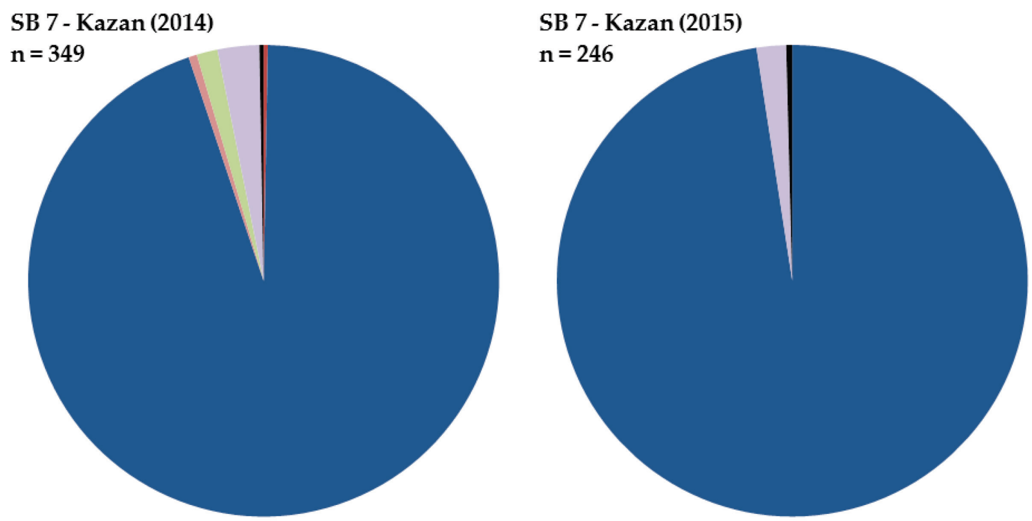
i) *Rutilus prespensis* in 2013, 2014 and 2015

Figure 54. Length-frequency distributions of the fish species caught during the survey at SB 6 for the period 2013-2015 (a-i)

Regarding the length class frequency in all three years the most dominant species both in numbers of individuals per length class as well as in total number of length classes were roach and bleak.

SB 7 - Kazan

At SB 7 a total of six species were recorded in 2014, of which four were native (bleak, roach, spirlin and stone loach) representing 98% of the catch. Nonetheless, most of the fish (95%) were bleak. Two alien species (bitterling and stone moroko) added up to 2 % of the total catch in that year. In 2015 only three species were recorded at this SB, all of which were native, like bleak (98%), roach (2 %) and a single carp (Figure 55).



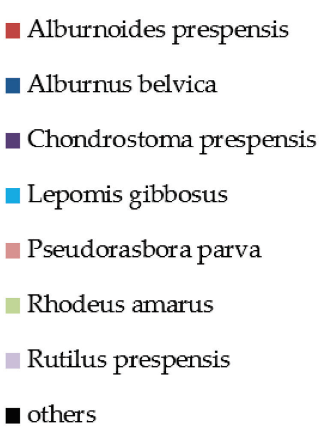
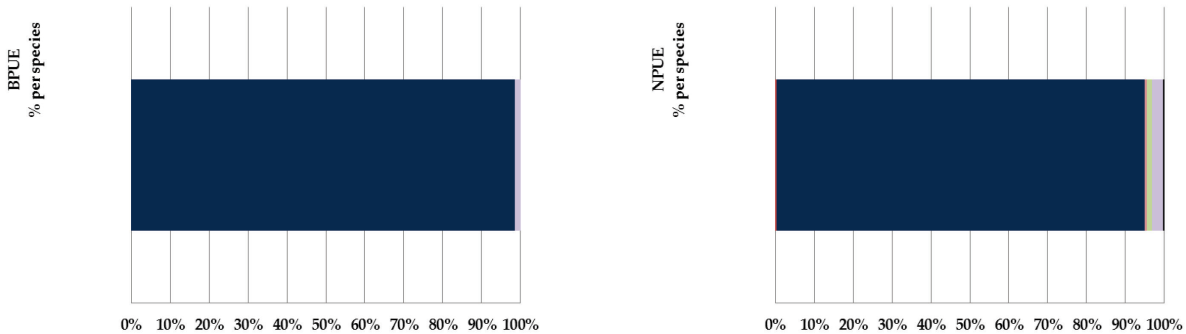


Figure 55. Relative fish species composition based on number of individuals in sub-basin 7 (Kazan) of Prespa Lake. In this basin, the nets were put in the pelagic. The data are provided for the years 2014 and 2015, along with the total number of fish caught. Fish species with less than 1 % of number in the overall catch are summarized as 'others'

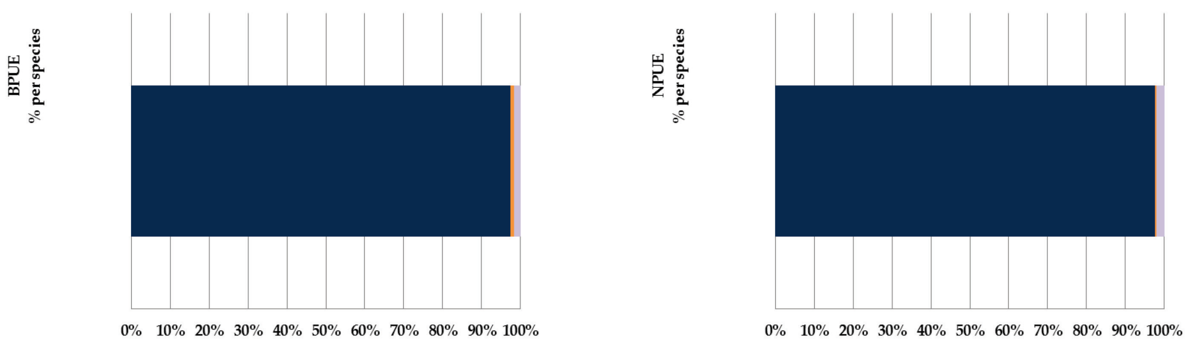
Similar to SB 6, at SB 7 (Kazan) in both 2014 and 2015, patterns of BPUE and NPUE values followed the distribution of the species composition in the total catch (Figure 56 and Figure 57).



	00-36 m
Alburnoides prespensis	0.01
Alburnus belvica	20.92
Chondrostoma prespensis	0.00
Cyprinus carpio	0.00
Lepomis gibbosus	0.00
Pseudorasbora parva	0.01
Rhodeus amarus	0.02
Rutilus prespensis	0.30
Squalius prespensis	0.00
others	0.00

	00-36 m
Alburnoides prespensis	0.00
Alburnus belvica	0.92
Chondrostoma prespensis	0.00
Cyprinus carpio	0.00
Lepomis gibbosus	0.00
Pseudorasbora parva	0.01
Rhodeus amarus	0.01
Rutilus prespensis	0.03
Squalius prespensis	0.00
others	0.00

Figure 56. Standardized catches per unit of effort (CPUE) for sub-basin 7 (Kazan) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are based on pelagic nets and given for the whole water column

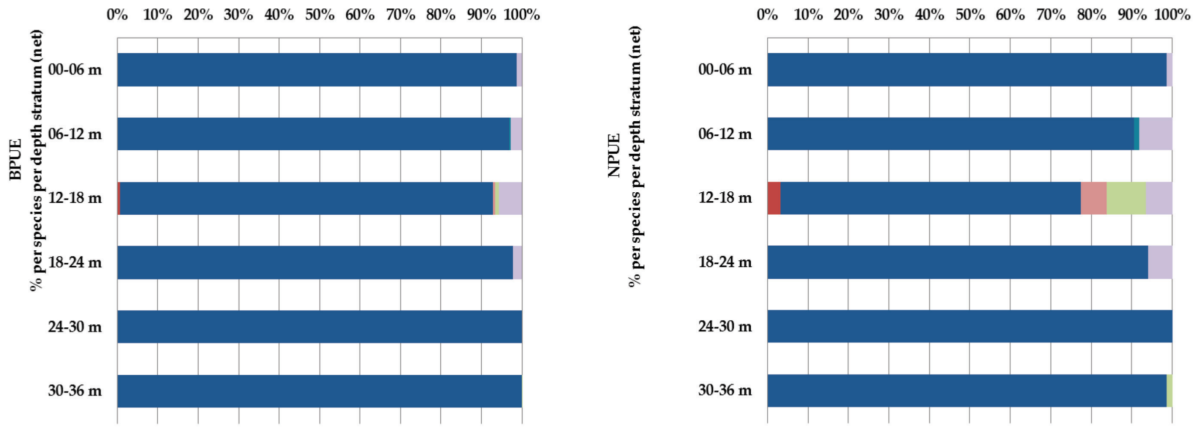


	00-32 m
Alburnoides prespensis	0.00
Alburnus belvica	15.77
Chondrostoma prespensis	0.00
Cyprinus carpio	0.16
Lepomis gibbosus	0.00
Pseudorasbora parva	0.00
Rhodeus amarus	0.00
Rutilus prespensis	0.27
Squalius prespensis	0.00
others	0.00

	00-32 m
Alburnoides prespensis	0.00
Alburnus belvica	0.67
Chondrostoma prespensis	0.00
Cyprinus carpio	0.00
Lepomis gibbosus	0.00
Pseudorasbora parva	0.00
Rhodeus amarus	0.00
Rutilus prespensis	0.01
Squalius prespensis	0.00
others	0.00

Figure 57. Standardized catches per unit of effort (CPUE) for sub-basin 7 (Kazan) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data are based on pelagic nets and given for the whole water column

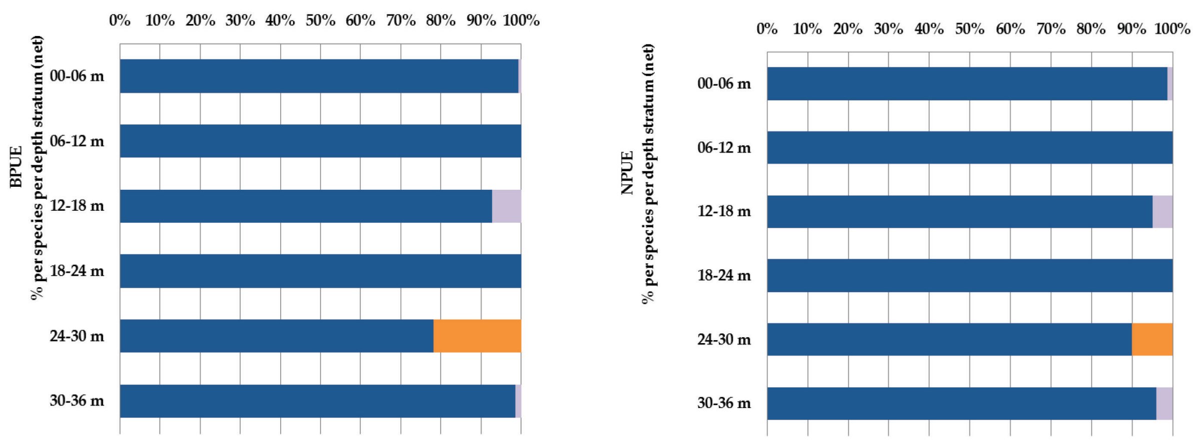
Regarding the vertical species distribution at this locality, bleak was very abundant in all depth strata from surface to bottom. Roach was present in the nets set from surface to 24 m. The alien species bitterling was present at two depth strata – one at the bottom and 12-18 m. In the latter stratum, stone moroko and spirlin were also present with few specimens (Figure 58 and Figure 59).



	30-36 m	24-30 m	18-24 m	12-18 m	06-12 m	00-06 m
Alburnoides prespensis				0.06		
Alburnus belvica	23.22	4.46	7.09	8.59	39.34	38.23
Cobitis meridionalis					0.13	
Cyprinus carpio						
Pseudorasbora parva				0.07		
Rhodeus amarus	0.03			0.07		
Rutilus prespensis			0.16	0.54	1.16	0.51

	30-36 m	24-30 m	18-24 m	12-18 m	06-12 m	00-06 m
Alburnoides prespensis				0.02		
Alburnus belvica	1.10	0.16	0.36	0.51	1.49	1.53
Cobitis meridionalis					0.02	
Cyprinus carpio						
Pseudorasbora parva				0.04		
Rhodeus amarus	0.01			0.07		
Rutilus prespensis			0.02	0.04	0.13	0.02

Figure 58. Standardized catches per unit of effort (CPUE) for sub-basin 7 (Kazan) of Prespa Lake during the sampling campaign of November 2014. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data based on pelagic nets and given separately for depth strata

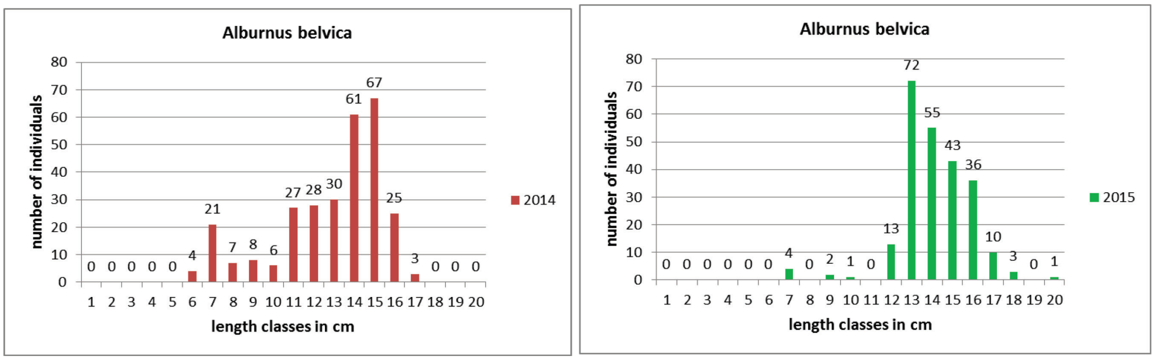


	30-36 m	24-30 m	18-24 m	12-18 m	06-12 m	00-06 m
Alburnoides prespensis						
Alburnus belvica	7.98	4.70	5.36	19.53	29.85	42.72
Cobitis meridionalis						
Cyprinus carpio		1.31				
Pseudorasbora parva						
Rhodeus amarus						
Rutilus prespensis	0.11			1.54		0.31

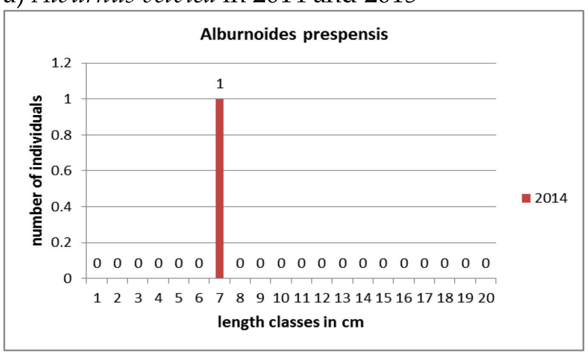
	30-36 m	24-30 m	18-24 m	12-18 m	06-12 m	00-06 m
Alburnoides prespensis						
Alburnus belvica	0.35	0.20	0.18	0.84	1.31	1.76
Cobitis meridionalis						
Cyprinus carpio		0.02				
Pseudorasbora parva						
Rhodeus amarus						
Rutilus prespensis	0.01			0.04		0.02

Figure 59. Standardized catches per unit of effort (CPUE) for sub-basin 7 (Kazan) of Prespa Lake during the sampling campaign of November 2015. Left: biomass/m² of net (BPUE in g/m²). Right: number of individuals/m² (NPUE in ind./m²). Upper bars show the respective percentage of species. Data based on pelagic nets and given separately for the depth strata

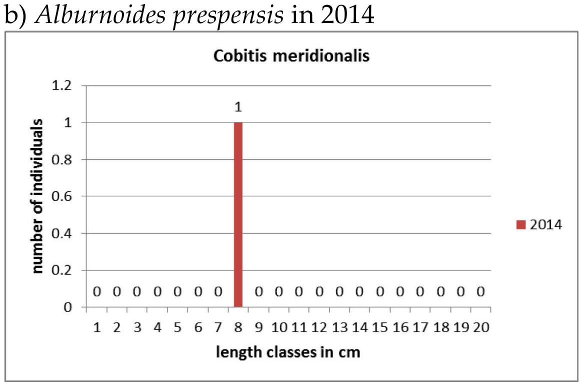
The length-frequency distributions of the fish species caught during the survey at the SB 7 are presented in the following Figure 60 (a-g), in either red (2014) or green color (2015). At this SB, bleak showed the highest number of individuals in different length classes as well as the highest number of length classes in both consecutive sampling years.



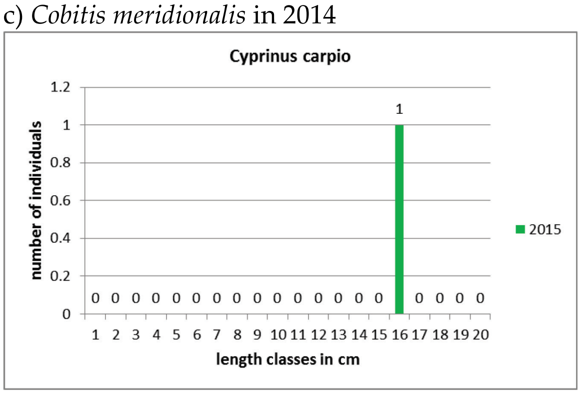
a) *Alburnus belvica* in 2014 and 2015



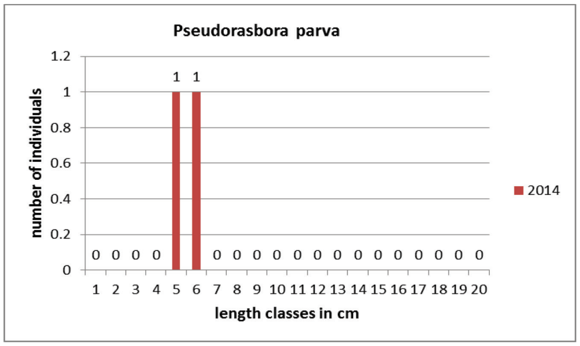
b) *Alburnoides prespensis* in 2014



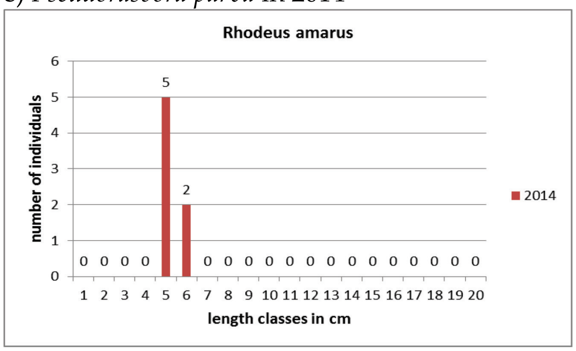
c) *Cobitis meridionalis* in 2014



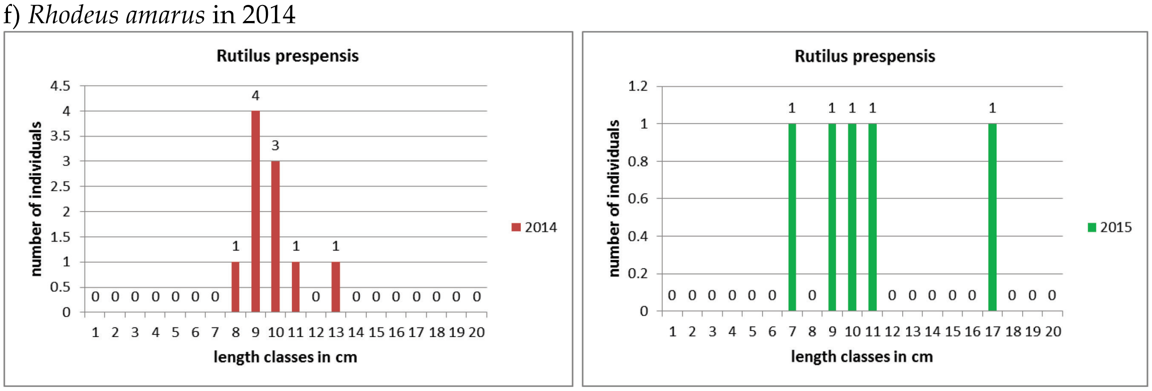
d) *Cyprinus carpio* in 2015



e) *Pseudorasbora parva* in 2014



f) *Rhodeus amarus* in 2014



g) *Rutilus prespensis* in 2014 and 2015

Figure 60. Length-frequency distributions of the fish species caught during the survey at SB 7 for the period 2013-2015 (a-g)

Annex III. Other data

Table 25. Overview of net and fish numbers at two sub-basins (Kallamas, Liqenas)

Sub-basin, sampling date	No. of nets	Maximum ind./net	Minimum ind./net	Nets / stratum	
Kallamas (SB 1) (16-21.10.2013)	32	1,552	76	0-3 m	11
				3-6 m	10
				6-12 m	11
Kallamas (SB 1) (06-26.11.2014)	32	605	64	0-3 m	11
				3-6 m	10
				6-12 m	11
Kallamas (SB 1) (03-08.11.2015)	32	396	43	0-3 m	11
				3-6 m	10
				6-12 m	11
Liqenas (SB 2) (23-28. 10.2013)	32	1,431	79	0-3 m	11
				3-6 m	10
				6-12 m	11
Liqenas (SB 2) (09-14.11.2014)	32	422	35	0-3 m	11
				3-6 m	10
				6-12 m	11
Liqenas (SB 2) (14-22.11.2015)	32	415	32	0-3 m	11
				3-6 m	10
				6-12 m	11

Table 26. Overview of net and fish numbers at five sub-basins (Asamati, Otesevo, Konjsko, Central Plate, Kazan)

Sub-basin, sampling date	No. of nets	Maximum ind./net	Minimum ind./net
Asamati (SB 3)			
(11-16.10.2013)	15	150	22
(17-25.11.2014)	40	290	0
(14-17.11.2015)	40	112	36
Otesevo (SB 4)			
(10-11.10.2013)	12	1,606	14
(11-14.11.2014)	40	223	7
(18-21.11.2015)	40	178	25
Konjsko (SB 5)			
(12-15.10.2013)	12	548	72
(15-24.11.2014)	40	345	49
(10-13.11.2015)	40	204	18
Central Plate (SB 6)			
(13-15.10.2013, benthic nets)	25	70	1
(pelagic nets - individual, 25.11.2014)	8	52	18
(pelagic nets - individual, 07.11.2015)	8	36	12
Kazan (SB 7)			
(pelagic nets - cascade, 19.11.2014)	8	91	7
(pelagic nets - cascade, 08.11.2015)	8	80	8

Table 27. Selected economically important fish species in the annual fish catch (in t) in the Prespa Lake (Source: Riboprespa – former concessioner)

Year	Carp	Prespa nase	Bleak	Roach	Others (barbel, chub) 1990-2007	Total annual catch
1946	30.02	15.50	18.86	26.83	7.76	115.272
1947	27.21	29.58	28.03	10.37	4.79	99.229
1948	27.21	34.42	18.31	10.56	2.13	135.888
1949	15.89	21.19	11.81	27.04	24.04	137.385
1950	41.05	24.97	12.55	16.10	5.33	143.052
1951	38.56	36.68	17.67	6.38	0	138.308
1953	28.78	40.69	14.41	0	16.13	130.926
1954	31.33	38.18	14.86	10.27	5.36	131.656
1955	52.03	8.28	20.35	0	19.34	138.138
1958	25.27	24.60	34.30	15.83	0	115.205
1959	13.30	53.44	18.98	14.29	0	93.716
1960	15.58	46.66	21.42	16.34	0	127.423
1961	10.79	46.37	20.20	22.63	0	151.053
1962	10.99	48.16	31.79	9.05	0	148.206
1963	19.71	34.76	33.33	12.20	0	173.416
1964	11.46	32.94	35.91	19.69	0	173.405
1965	12.11	31.10	33.21	23.58	0	165.281
1966	20.49	32.84	34.45	12.22	0	149.837
1967	18.08	37.64	29.09	15.19	0	143.566
1968	11.20	41.75	27.99	19.05	0	126.427
1969	16.97	46.09	20.31	16.62	0	108.136
1970	13.57	43.92	15.12	27.38	0	121.070
1971	3.76	41.77	29.18	23.27	2.02	80.643
1972	8.88	54.48	13.84	20.78	2.02	102.918
1973	9.99	53.80	6.34	27.28	2.59	97.911
1974	2.92	65.13	17.11	11.79	3.05	82.733
1975	0.59	68.50	26.93	1.20	2.78	87.635
1976	0.09	72.80	21.52	2.76	2.84	88.802
1977	0.39	52.26	14.70	5.12	27.53	118.344
1978	0.23	55.64	19.01	2.08	22.98	126.530
1979	0.29	41.09	30.75	9.38	18.02	113.339
1980	0.11	47.87	27.52	12.49	12.02	86.005
1981	0.04	35.47	36.99	3.61	23.90	57.926
1982	0.14	47.35	40.45	2.53	9.53	84.148
1983	0.05	37.95	39.36	0	22.64	53.394
1984	0.13	33.17	39.19	5.15	22.36	77.958

Year	Carp	Prespa nase	Bleak	Roach	Others (barbel, chub) 1990-2007	Total annual catch
1985	0.05	12.31	49.74	3.28	34.63	69.902
1986	0.06	10.01	60.62	20.25	9.06	52.747
1990	0.15	7.69	78.08	5.19	0.47 / 8.42	69.389
1991	0.05	2.47	77.14	8.84	0.32 / 11.17	75.994
1992	0.15	2.57	81.64	9.34	0.47 / 5.82	82.028
1993	0.60	2.89	82.69	5.97	0.74 / 7.11	83.814
1994	2.18	4.77	65.18	7.17	0.53 / 2.01	83.252
1995	0.56	2.11	80.42	7.02	0.17 / 9.72	64.687
1996	1.18	3.80	75.54	3.67	0.30 / 15.52	57.272
1997	1.54	5.68	72.41	4.21	0.67 / 16.12	28.516
1998	0.22	4.49	80.24	1.51	0.72 / 12.82	30.365
1999	56.77	10.50	27.36	0.35	0.41 / 4.61	7.131
2000	54.08	19.49	6.10	0	0 / 20.33	11.547
2001	100	0	0	0	0 / 0.00	3.040
2002	0.30	16.69	41.12	0	0 / 41.88	0.659
2004	9.30	6.59	57.11	0	0 / 27.01	107.317
2005	2.45	2.64	69.42	0	0 / 25.48	47.001
2006	1.16	1.83	90.74	0	0 / 6.27	17.997
2007						18.582