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Evaluating status of European eel (*Anguilla anguilla*) in Skadar Lake

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Introduction

European eel is fish from the Anguiliidae family which consists of only one genus, so the family characters may be considered as generic characters too. The following concept of family Anguiliidae is expressed by Berg (1949): Body elongate, snake-like. Dorsal and anal fin confluent with the rudimentary caudal fin, Pectoral fine present, ventral absent. Body covered with minute scales. Lateral line well-developed. Vent remote from the head, mouth terminal; jaws not particularly elongate. Teeth small, pectinate or setiform, in several series on the jaws and the vomer. Minute teeth on the pharyngeal bones, forming an ovate patch on the upper pharyngeals. Gill openings lateral vertical, quite well developed, well separated from each other. Inner gill slits wide. Tongue present. Lips thick. Frontal bones paired, not grown together, Pelatorterygoids well-developed. Premaxilllaries not developed as distinct elements in adults. Pectoral girdle with 7 to 9 (up to 11 in the young) radial elements. Caudal vertebrae without transverse processes.

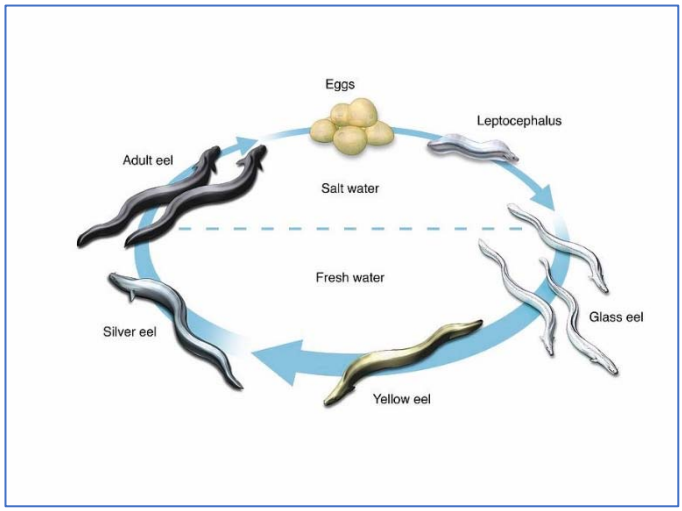
Swainson (1839) was the first to use the combination *Anguilla anguilla* although it was firstly described and name as *Muraena angulilla* by Linnaeus (1958). Linnaeus did not designate any type material, but a specimen named by him is in the British Museum (Natural History), London: Linnaeus Collection, No, 80,

Considering eel as a catadromous species, those that spent majority of their life in fresh water and migrated in marine habitat in order to breed, European eel have extremely complicated life cycle. By complicated we meant that in order to produce the next generation, all mature individuals have to undertake almost epic migration for every European river and lake which is connected to sea in to the Sargasso Sea (Western Atlantic).

Figure 1. European eel - *Anguilla anguilla*

In contrast to other fish species which become mature as they reach certain age and size, eel mature on different ages and size and what is the reason for that and how it is driven still is an unanswered question.

According to D'Ancona (1943), who studied the development of eel gonads from the elver stage onward, the gonads at first have a non-differentiated appearance, with some parts tending to show male characters, some female, and some intermediate. The sexual differentiation of the gonads take place with the development of elements of the male gametogenic series and degeneration of the female or vice versa. Differentiation of female gonads may sometimes be recognized in eels of 20 cm or even smaller. Most eels, however, remain in a condition of sexual indetermination up till lengths of 30 cm or more. During their development, a stock of eels shows a gradual series from distinct females to distinct males linked by more or less intermediate specimens. In conclusion all eels have the potential for both sexes and most likely the gender determination is driven by some other but not by genetic factors. Some scientist found out that different conditions of crowding affect sexual determination. For instance, Parsons et al., 1977 reported that dense stock (high abundance) results in a majority of males while decreasing population density increases the percentage of females.



The eel life cycle starts in Sargassum sea after breeding and eggs fertilization. Fertilized eggs are pelagic have a thin chorion and a diameter of about 1.2 mm (Boëtius, 1980). After hatching eel have been known as leptocephalus larvae which was wrongly described as new species - *Leptocephalus breviroetris* and that phase last until the young eel reach length of 75 mm. Then eel undertake first metamorphosis in to the glass eel stage. This happened by the end of their passive voyage driven by Gulf Current and small glass eel passively reach the estuaries.

Figure 2: Eel life cycle

This part of life cycle, from fertile eggs until they reach the estuary last bout one year or few months longer for the galls eels that reach most distant part of

Mediterranean Sea. As they reached the estuary the undertake the second metamorphosis and become elvers, the small free-swimming eels that undertake upstream migration and in order to inhabit the whole drainage area. The most conspicuous features of elver development are the gradual pigmentation and the reduction in length and weight (Gilson, 1908; Strubborg, 1913). This is their first not-feeding period in life and that is why they lose in weight and in length since they are constantly swimming upstream. As they settle they become small eel and start feeding and growing until they somehow decide to mature and undertake migration back to the Sargassum Sea. In this period, they are called yellow eel and they can spent 6 to almost 90 years in freshwater feeding and growing. How and what is the main trigger for the maturation of the eel still is unknown so some of theme start maturing in 7th year (males) and migrate in to marine habitat while some can stay for several decades in fresh water habitats. When the maturation starts it also start the third metamorphosis in their life cycle and adult eel prepare for the long trip to Sargassum sea. They stop feeding (second time in their lifespan), the anal opening closes out, they become silverish and black, the lateral line become intensively visible and the eyes grows in diameter and become almost double in size compered to yellow stage. This stage is known as silver eel stage. The “silvers” migrate downstream in to the sea and start they journey back to Sargassum sea where they spawn in depts of western Atlantic and died. The voyage to Sargassum Sea last bout 6 months during which they are not feeding and live on the fat they accumulate during yellow phase in fresh water.

Eel is top predatory species which feeds literary on everything what is available. Being nocturnal animals, feed mostly during the night, when they search for food but it is not rare that bigger ells feds during a daylight. Feeding takes place all over the area where eels occur and where food is available. In estuarine areas daily movements may occur to and from the foodstaples in the brackish area (Koendzinsj, 1958). In springtime, spawning areas of coarse fish may attract large numbers of eels, which feed upon the spawn. A list of species serving as food for eel has to include virtually the whole aquatic fauna (freshwater as well as marine) occurring in the eel's area. The food list might easily be augmented with animals living out of water (e.g. worms, insects etc.), while fresh meat is taken as well. Big eels are more inclined to prey on fish and crayfish they can swallow than small eels, and as eels are mainly bottom dwellers they prey dominantly on the bottom fauna but it is not unusual that they can fed even on some pelagic resources.

Their voracity is amazing. The stories about eels habits to get out of the water in order to feed on some terrestrial food items are well known and Bergmann (1970) have proved that eels may leave the water to forage, and knowing their ability to locate the nearest stretch of water, it must be that Nilsson (1860) were right about this peculiar feeding ground.

Thanks to those feeding habits eels grows relatively fast even in some scarce waters and by now the recorder for size was the 7.65 kg eel caught in Dalsland (Sweden) in the first half of the 19th Century (Svärdson, 1972). Since this region, the Lake Skadar and surrounding Balkan estuaries and lagoons are particularly good for the eels we are showing the 7 kg eel picture recently caught in Metkoivć (Croatia) in Neretva river estuary (Figure 3). Similar caught are reported for the Trebišnjica river (BiH) and for Lake Skadar but unfortunately haven't been pictured or the pictures are lost.

Figure 3: 7kg eel caught in Metkovići

Global distribution

The eel is distributed from the Atlantic (the spawning area) towards Europe and Northern Africa. It inhabits coastal areas of Europe and its islands from Pechora to the Black Sea, Mediterranean and its coastal areas of Middle-East and Africa, Atlantic shore of Morocco and Canary Isles, Azores as well as Madeira. It lives in rivers of North Atlantic, Baltic and Mediterranean seas. Boundaries in Europe are lower part of Pechora, Volga-system, and Black Sea, with occurrence in Danube, Dniester, Bug, Dnieper and sometimes Don (Figure 4)

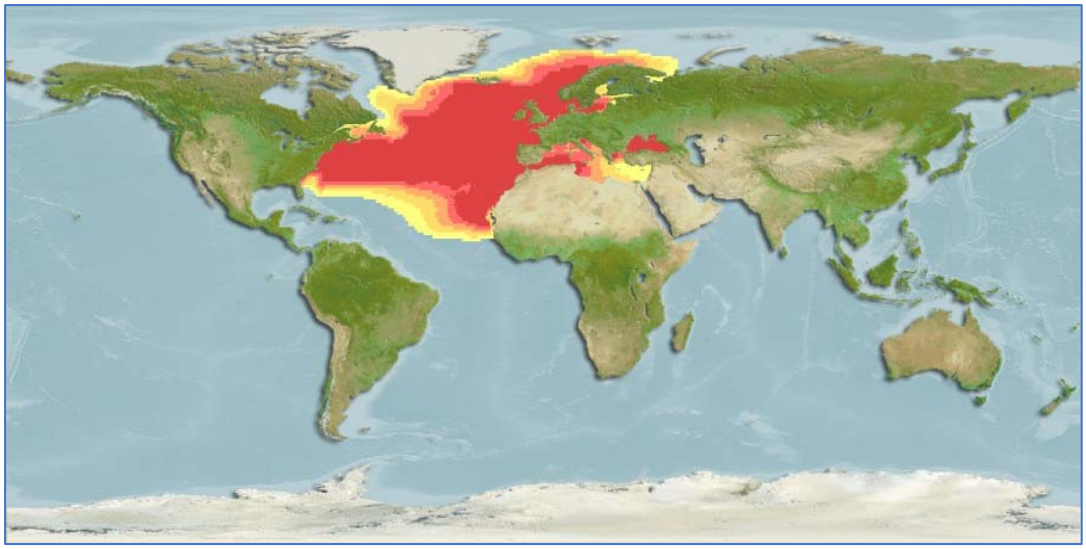


Figure 4: Global distribution of *Anguilla anguilla*

Continuous introductions to Asia and South and Central America are noticed. Recent genomic DNA studies show that the European eel exhibits isolation by distance, implying that non-random mating and restricted gene flow among eels from different location exists (Wirth & Bernatchez, 2001). The existence of 3 genetically distinct sub-populations is suggested: a Northern European subpopulation (consisting mainly of the Icelandic stocks); a Western European subpopulation (including the Baltic, the Mediterranean and Black Sea); a Southern sub-population (including stocks of Morocco).

It was the general conviction that Gulf stream and North Atlantic current primary determined the distribution of the eel larvae and in this way of the species. Due to the work of Worthington (1976), in which the existence of these flow-systems is denied, it must be assumed that the larval distribution in the Atlantic is determined by other, hitherto unknown factors, with subsequent dispersion in coastal areas after the glass eel metamorphosis assisted by possible sea-currents near and on the continental slope.

Further distribution depends on accessibility of interior water regions and on transplantations. All water-areas, be it in the interior or along the coast, which are fit for fish and offer a sufficient food supply, may contain eels. This applies from a warm saline lagoon on the Mediterranean coast to a cool fresh trout brook in a mountainous region, e.g., the eutrophication of the North Sea area along the Dutch coast not only gave rise to an increase of shrimp stock, but promoted an important eel stock as well. Local winter hardships eels are overcoming by underground hibernation. If not barred by obstacles (e.g. weirs), inland areas may

be reached by eels swimming upstream in rivers and water-courses; density of eel-stock decreases with increasing distance from the coast.

Importance

If we estimate their ecological role eel pop up as important estuary / rivers / lakes species. They are top predators which regulate numerous populations of water species on which the prays on and therefore control their abundance. They themselves are significant source of the food for number of fish species as well as for the mammals, turtles and birds.

As a food item, on every developmental stage (leptocephali, glass eel, elver, yellow and silver eel), eel is important part of complicate food chain in both, marine and freshwater ecosystems. Moreover, it is important as a vector of organic matter and nutrients transfer from highly productive freshwater to surrounding terrestrial ecosystems as well as to marine ecosystems considering the fact that numerous of silvers become pray of marine fish and mammals on their migrating route.

As scavengers, ells clean the water habitats and feeding on dead remains of not only water species but also of those that somehow get in to water. Doing that they prevent infections and development of saprobic microorganisms which can create local anoxia due to their intensive metabolism in presence of large amount or available food.

Lately eels are used as good bioindicator for pollution since they are long living animals (up to 88 years; Bobick & Peffer, 1993) and often they spent the whole yellow phase of life in the same freshwater system. Additional advantage is the presence of high percentage of fat in their body (up to 30%; Larson et al, 1990) so they bioaccumulate heave metals and some other complex organic and inorganic pollutant molecules in it. And on the end, being the top predator in river / lakes / lagoon / estuary ecosystems makes eel more than perfect for such model animals and more than suitable for detecting of pollution trough the bioaccumulation processes.

Eels are important as fishery and fish farming resource. Since it is bay now impossible to have artificial spawn of eels this means that we have to rely on natural production of this fish species and this makes a lot of pressure on their population. Eel is highly appreciated as food item as glass, and yellow and silver eel. Using of glass eels nowadays is almost absent and it could be found only in several small towns along European Atlantic coast. But in the past glass eels were significant seasonal food items for the coastal communities. This was vary pronounced in a first decade after the Second World War until 60's of previous century during so called years of post war hunger until economy was rebuilt and reestablished in post war Europe.

For several decades eel fishery was significantly important on almost all rivers which directly or indirectly run in to the sea (Mediterranean, Atlantic, Baltic, Black Sea) since the eel is highly priced and highly demanded on fish market. Due to dramatic drop of the eel abundance, which start happening in 80's of the past century, fishery on rivers / lakes / lagoons / estuaries is not so important like it was and nowadays the eel farming took the primate. Namely, because of the fact that even today it is impossible to spawn eels in captivity this farming is based on glass eels and their transfer in to the fish farms because growing. When they reach certain weight, eels are harvested and offered on market as either fresh or smoked fish. Due to high price of eel, especially of smoked eel, this economy is highly attractive since it does not require anything special. The other countries out of Europe are also extremely interested in eel farming where Japan and China are in first place. Lately, the export of glass eels and elvers are forbidden for EU countries but smugglers are still active and somehow transport big amount of it in China.

In 1980s, the number of glass eels reaching Europe has declined by 95% and lately European Commission has proposed ban on eel fishing in the Atlantic, in an attempt to recover the dwindling stock of the European eel. But despite the fact that in 2009 the EU banned all trade in eel, every year half of the total European catch of elvers and glass eels is smuggled illegally outside of Europe, mainly to China, where they farmed, fattened, and sold on as grilled eel (Figure 5).

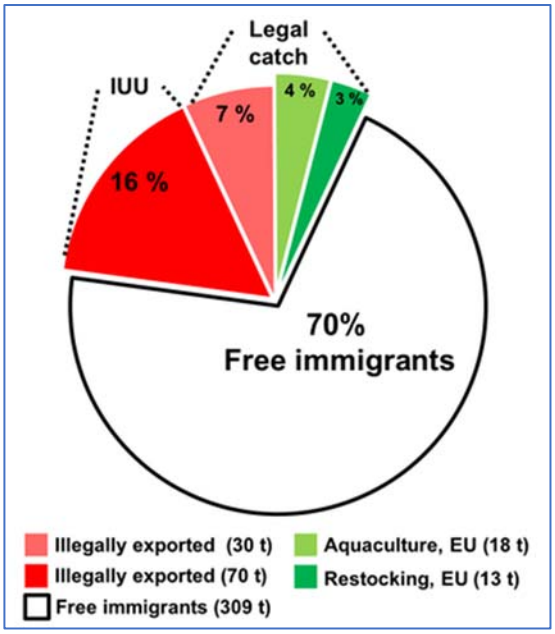


Figure 5: The destiny of young eel immigrants from the Sea (Anonymous, 2018)

Status in Skadar lake

Distribution

Eel inhabits the whole water mass of Lake Skadar, from its shoreline to its central part, form the small coastal springs to the depts of sublacustric wells called „oka“. Other word speaking eel inhabits complete ecotone of Lake Skadar. It is also present in every Lake tributary, as in smallest as well as in the big ones. It inhabits Morača river up to Međuriječje, complete watercourse of Rijeka Crnojevića, Karatuna, Plavnica, Gostiljska, Crmnička and Orahovštica rivers as well as in Cijevna river within Montenegro. It also lives in Zeta river (complete lower part flow through the Bjelopavlići valley), Ribnica, Matica, Sušica and Crkovnica rivers. In addition, it lives in all small coastal tributaries as well as in the wetland areas of Buljarica, Tivatska Solila and Ulcnjiska Solana. The whole course of Bojana river, the Lake Skadar outlet toward Adriatic Sea is also inhabited with eel. So, almost 90 % of Adriatic drainage area in Montenegro is inhabited with this unique species (Figure 6).

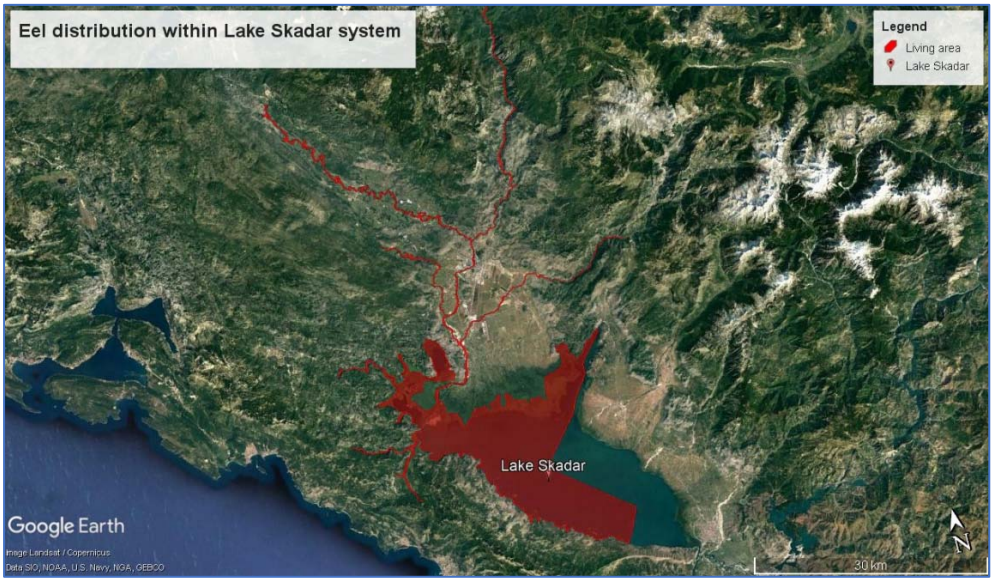


Figure 6: Eel distribution in Lake Sakdar and in Adriatic watershed

The total habitat surface in Montenegro for eel is about 316 square kilometers of which more than 95% is related only to Lake Skadar. Therefore, it is more than obvious how important this lake is for the eel. If we take in account the size of Lake Skadar, the presence of numerous dams and obstacle in eastern Mediterranean rivers and lagoons it become obvious that Lake Skadar play

significant role for the whole eastern Mediterranean part of the eel population and therefore have to be considered as one of the eel most important habitat in this part of the Europe.

Young eels swim in to this system through the relatively wide and short river Bojana which, near the city of Ulcinj, forms big delta estuary on Adriatic coast. Glass eel reach and enter in to Lake Skadar system in several waves. The first glass eels reach Bojana estuary in November and migration last until May (Hegediš, 2007). Of course, there are several waves and most massive are those in February – April period (Hegediš, 2007). As they enter in Bojana river they metamorphosed and become elvers and continue with upstream swimming in order to reach lake and riverine habitats where they will settle and transform in to young yellows. Majority of theme settle in Lake Skadar where it spent 6 years to several decades growing and waiting for the time when they will start with maturation, become silver form and undertake downstream migration toward their spawning ground in western Atlantic.

Threats

In contrast to majority of fish species, eel have to be estimated globally. Determining changes in the international stock in eels is difficult due to limited data and the poor understanding of the relationship between recruitment, freshwater populations, and escapement. Not only is there a huge time lag between the recruitment of glass eels to fresh and brackish water and the subsequent escapement of silver eels, but given that *A. anguilla* are panmictic, escapement from one area does not translate directly into returning larval recruitment at the same locality. Indeed, for all intents and purposes it is assumed that practically nothing is known about the dynamics of the oceanic phase of A. anguilla. It has been proposed that due to the relatively short time-span between spawning and recruitment that the latter is a good indicator of the past spawning stock that produced the juvenile cohort; this will depend, to an extent, on the significance of oceanic factors on larval transport.

Glass eel: Since the early 1980s, a steady and almost continent-wide decline of about 90% has been observed in the recruitment of glass eels. Recently, the WGEEL recruitment index (five-year average) fell to its lowest historical level: less than 1% for the North Sea and 5% elsewhere in the distribution area with respect to recruitment from between 1960-1979 (ICES WGEEL 2012). In the last two years however, the recruitment index has increased to 1.5% of the 1960-1979 reference level in the North Sea series, and to 10% in the Elsewhere series, but both remain far from healthy (ICES WGEEL 2013). This could possibly be in response to the closure of silver eel fisheries across Europe in 2009, although this increase is within the natural variation of historical records (ICES WGEEL 2012). Whilst data from catch returns indicate this increase in recruitment, the impact of the overall decline will likely continue to influence adult stock for at least one generation length (ICES WGEEL 2012). Furthermore, the use of fisheries data

makes it difficult to assess the full extent of this recent increase in recruitment due to a lack of effort metrics for some data sets and the introduction of quotas which, once reached and fishing ceases, provide no way of estimating subsequent arrivals to coastal freshwater habitat (according to Jacoby & Gollock, 2014).

Yellow eel: While the decline in yellow eel populations was not as severe as that of recruitment, the available data indicated that it was greater than 50% over three generations (45 years). It is very likely that the less pronounced decline will be partially due to density dependent mortality. However, it needs to be considered that the age range of yellow eels is broad and that there may very well be a time lag in knock-on population effects. As such, any increase in recruitment would not be expected to be immediately mirrored in a rise in yellow eel numbers, indeed, it is possible that this life stage may continue to decline (according to Jacoby & Gollock, 2014).

Silver eel: The data sets on silver eel escapement were from France, Norway, Ireland and Sweden and were collected from scientific surveys and fisheries. Silver eel decline was not as pronounced as yellow eel populations or recruitment but, similar to yellow eels, the indication was that the decline across the range was greater than 50% over three generations. Again, this may be due to density dependent mortality at previous life stages, but it cannot be ruled out that a decline in silver eel escapement may continue despite increases in glass eels and/or yellow eels due to the long generation time (according to Jacoby & Gollock, 2014).

One of the major threats to European Eel are barriers to upstream and downstream migration, which also includes mortality by hydropower turbines and their associated screens and water management systems. Across Europe, there are a total of 24,350 hydropower plants and this figure is set to rise in the near future (Van der Meer, 2012). Degradation and loss of available habitat is also exacerbated by development, flood control, water-level management and the abstraction of surface and ground water for both domestic and commercial (e.g. agricultural) use. In North Africa, the declines in fisheries catches of all eel life history stages have been attributed to over-exploitation, dam construction, pollution of estuaries and water abstraction for domestic use (Azeroual, 2010). It is proposed that the decline in good quality habitat and associated resources may be causing a decline in body condition of escaping silver eels in parts of the range which may have effects on the success of migration and/or spawning due this species', particularly the female's, reliance on fat stores for reproductive success. The accumulation of lipophilic chemical pollutants by maturing eels could have potentially toxic effects on migrating adults. These chemicals are stored by the fish and released when fat stores are broken down during migration which could subsequently limit the capacity of the silver eels to complete their spawning migrations due to metabolic disruption (Robinet & Feunteun, 2002; Palstra et al., 2006).

Climate change has been proposed to play a role in fluctuations of abundance in *A. anguilla* – particularly larval transport and glass eel recruitment - through its impact on the suspected breeding grounds (Sargasso Sea) and on changing oceanic conditions that can influence the recruitment of glass eels to near shore and freshwater environments. An important consideration in this discussion is the time scale over which changes are thought to occur as a result of oceanic conditions. The North Atlantic Oscillation (NAO) and the associated climate variability that this brings to the North Atlantic have been dated as far back as the Holocene (Kim et al. 2004)

The parasite nematode (*Anguillicola crassus*), introduced when the Japanese Eel (*A. japonica*) was imported to Europe for culture in the early 1980s, is also thought to impact the ability of the European Eel to reach their spawning grounds due to its negative influence on the fitness traits associated with the silvering stage of maturation (Fazio et al., 2012) in addition to swimbladder damage which impairs swimming performance (Palstra et al., 2007) and the ability to cope with high pressure during their reproductive migration (Vettier et al., 2003; Sjöberg et al., 2009).

Overfishing of glass - fisheries are primarily in France, with the UK and Spain also contributing, yellow and silver eels across Europe is also a threat to the species. Across its distribution all continental life history stages of the European Eel are currently exploited although data from different regions varies in quality and longevity. Export outside of Europe is now banned with any trade occurring within Europe (for consumption, culture and stocking) and quotas are in place, however, under-reporting, poaching and illegal trade are believed to occur throughout the range of the European eel fisheries. These activities endanger the species and make assessment of the impact of this fishery difficult, and it's associated management problematic.

Lake Skadar (local threats): Considering global problems which affects European eel population, only few of them are present in Lake Skadar and its drainage area. Since there was no glass eel fishery on Bojana estuary, not in the past and not even nowadays, all immigrant glass eel and elevers without any obstacle enter in Lake Skadar and further upstream in its catchment area. The situation with Drim river is completely different since there are several huge hydroelectric power plants and dams on it preventing upstream movement of eel elvers. Furthermore, in Montenegro there are almost no industry and therefore the only pollution comes from aluminum plant and from communal waste waters but thanks to the fact that all watermasses of Lake Skadar change almost three times during one-year cycle even those pollution is minimized. The habitats in Lake Skadar and its catchment rivers are intact and in natural shape while the Lake is characterized by high productivity similar to some Mediterranean lagoons so the environmental conditions for eel are more than excellent. The biggest threat to eel in Lake Skadar is eel fishery on both forms, yellows and silvers during autumn

migration. Due to high market demand all catch is easily sold and the price vary depending on eel size and period of the year. Unfortunately, there are no log books no the precise statistic of catch but some rough estimation is that on Lake Skadar every year fisherman caught about 50 thons of eel. Of that almost half are silver eels that are harvested during those two and half months of downstream migration. Since all eel spawn on one place, overfishing of eel in Lake Skadar is not detectable by the decreasing of immigrant glass eels and elvers but by decreasing of average body size of eels in catch. From last year we have established monitoring of eels from commercial catch under the GFCM program so in the following years we will be able to say if those overfishing happened in the Lake Skadar. Most probably is that majority of silvers are caught due to high fishing pressure on both side of the border and particularly because of the existence of fish traps in Albania on Bojana river which are placed several hundred meters downstream from Lake Skadar (Figure *7*). This fish trap operates under unknow dynamic but one thing is sure, it is most active during silver eel downstream migration since all silvers from the Lake Skadar and belonging catchment area have to pass through theme on their way down to the Adriatic Sea.

Figure 7: Fish trap on Bojana river downstream of Lake Skadar (Albania)

Protection measures

Eel Management Plans (EMP) have been developed and implemented in EU Member States since the EC Regulation 1100/2007 was created to offer protection, promote recovery and increase of silver eel biomass and enhance the sustainable management of this species. The objective of each EMP is to reduce anthropogenic mortalities so as to permit, with high probability, the escapement to the sea of at least 40% of the silver eel biomass relative to the best estimate of

escapement that would have existed if no anthropogenic influences had impacted the stock. Member States are responsible for implementing measures to achieve their targets, and these measures can include, but are not limited to: reducing commercial and recreational fisheries, restocking, improving habitats and making rivers passable, transportation of silver eels to the sea, reducing predation, amending hydro-electric power turbine schedules to reduce mortality, and developing aquaculture. According to the ICES WKEPEMP report (2013) most management actions have been for commercial and recreational fisheries, followed by hydropower pumping stations obstacles, then measures on habitat, restocking, and predator control. Other actions expected to have indirect effects, such as implementing monitoring programs and scientific studies, have been almost as common as controls on fisheries. A total of 756 management actions proposed in the EMPs have been implemented fully, 259 partially and 107 declared as not implemented at all (ICES WKEPEMP 2013).

As part of the EMPs, any Member State that allowed fishing for eels of <12 cm total length – generally referred to as glass eel fisheries - was required to reserve a minimum of 35% of their catch for restocking purposes (i.e. restocking rivers with glass eels from elsewhere) in 2010, rising to 60% from 31 July 2013. Whether restocking programmes actually enhance the population is still open to debate. Trap and transport programmes across Europe are designed to provide eels with both upstream and downstream passage and/or access to habitat that has been lost through the construction of migratory barriers. These programmes that involve catching wild eels and moving them over relatively small distances past barriers are generally working with lower numbers of fish than restocking programmes and are very location specific.

However, when applied to migrating silver eels, low in a catchment, it can have a significant and immediate effect on escapement thus potentially having a positive impact on the spawning stock. It is hoped that translocation can mitigate against the loss of habitat and positively contribute to enhanced escapement, and by association, recruitment. Continuous monitoring of eel escapement on a national or international scale is currently very rare and highly unlikely and so in addition to localized monitoring, modelling has been explored for providing estimates of escapement in eel subpopulations.

In Montenegro, although we are member of ICES WGEEL from the 2014, we haven't developed EMP for Lake Skadar as one management units since it is irrelevant to do it without Albanian partners. In situation when we have EMP for Lake Skadar and we allowed 40% of silvers to migrate and not to be fished this is completely irrelevant since all of theme will become part of the harvest on fish trap downstream of Skadar city in Albania. Therefore, only right way to implement this keystone protective measure is to develop and implement EMP together with Albanian partners since it is only sustainable way to make it.

As for any other monitoring, monitoring of immigration of glass eel/ elvers or emigration of sliver toward sea, till now there were no available funds and haven't ben established any of them. By now in Montenegro we have applied several protective measures. It is forbidden to catch eel smaller than 30cm and fishing ban season on eel starts on 1st November and end on 1st January in order to allow silvers to migrate downstream. But this last protective measure is not effective as the presence of fish trap in Albania completely suppressed this measure since all of silver that will be let to migrate form Montenegrin territory potentially will become part of harvest on those non-selective fishing gear. From this year the log books have to become obligative to fisherman and we will finally have insight in total eels caught by Montenegrin fisherman.

Flagship species

Concept of flagship species

Originally, a flagship was the leading ship in a fleet of vessels – the largest, fastest, or most heavily armed ship would fly the flag of the fleet. Now, a flagship often refers to the most important or leading member of a group. Flagship species are charismatic animals that capture the public's imagination, and encourage people to support conservation projects. Flagship species are usually used as the focal point of large conservation campaigns for their ability to get people's attention (Figure *8*). For example, campaigns to save the Bengal tiger could help preserve forests and habitat for other creatures. Some of the examples of flagship species are: panda, polar bears, sea turtles, golden eagle, bear, clownfish etc.

Figure 8: Examples of some flagship species

By focusing on, and achieving conservation of that flagship species, the status of many other species which share its habitat – or are vulnerable to the same threats - may also be improved. Flagship species are usually relatively large, or characteristic in terms of body shape or some habits in behavior and considered to be 'charismatic' in western cultures. Flagship species may or may not be keystone species and may or may not be good indicators of biological process. The best situation is when you have all in one so if we choose the flagship species which is also a keystone species and good indicators of biological process than we make do the best and we can expect best possible conservation effect not only

to this species but for the whole ecosystem which this species inhabits and for all other constituents of this particular ecosystem.

In the context of conservation, the term flagship species first appeared in academic literature in relation to Brazilian primates, which were seen as excellent examples of how charismatic animals could be „used to sell the cause of tropical conservation as a whole" (Mittermeier, 1986). In keeping with the instrumental purpose of its origins, the conservation literature on flagships has focused on two broad themes. The first concerns criteria for selecting species to promote as flagships. The range of assessment criteria proposed include geographical distribution, conservation status, visibility, body size, perceived charisma, and whether or not it is an umbrella, keystone, or cultural species (Dietz et al., 1994; Caro & O'Doherty 1999; Bowen-Jones & Entwistle, 2002; Barua et al., 2012). The second describes the different ways flagship species have been put to use and analyses their effectiveness in differing conservation roles. The list examined includes: creating a moral or cultural imperative for policy, promoting inter-institutional planning, and justifications relating to site protection (Kalland, 1993; Kinan & Dalzell 2005).

Conservation importance

The flagship species has huge importance for the conservation of certain ecosystem and all members of this particular part of nature which is inhabited with selected flagship species. Of course, this is only if the flagship species is chosen on right way and if this species satisfied all criteria for such selection. For instance, if the flagship species isn't the charismatic one or there is nothing special related to it biology (e.g life cycle, behavior, voicing etc.) it is hard to believe that people will "connect" with it.

The flagship species and its promotion, although it is matter of conservation efforts and It has conservative idea behind as overall aim, is heavily related to marketing and PR activities. The selected species have to be well known not some extremely rare species or some of small dimension for which you need microscope to spot it. Other word speaking, the future success of conservation efforts is highly dependent on which flagship species is chosen for certain ecosystem or ecotone.

If everything is done by the book and if the chosen flagship species is the right one we can expect that future conservation of this species will be successful. As all conservation measures demands some significant amount of funds it is much easier to rise it if you have the right species. For instance, donator representatives, no matter If they area some state or international or private funds, will easily understand if there is a need for conservation action which will target some big and charismatic species (e.g. mammal, bird or a fish). Sometimes specialists insist to have some endemic small invertebrate species as a flagship for some region. For theme there is no dilemma why it shouldn't be such species regarding all

biological data and importance but if this is not some colorfully butterfly or some other shine or valuable insect, such species will not play the predicted role. Since it is not well-known species it is likely that representatives and managers of the funds will not be willing to support conservative action related to those species.

Once we make a right choice for flagship species we can expect multiple benefit. Considering the fact that selected species is not highly endangered or even extinct in wild, all conservation measures will be applied *in situ* - within ecosystem where this species occurs. If we wish to support or to help selected species in order to rise its abundance, we have to have an overall or ecosystem approach. If three is problem with pollution we have to find a solution to minimize it and therefore not help only selected species but also upgrade the whole ecosystem helping all living creatures in it. We have to take in consideration the food web in which our species participates and if there are some problems in it we will be also focused on other species in order to help nature to rebuilt such food web (e.g if the species is an op predator we have to rise the abundance of its pray and therefore support other than flagship species).

In conclusion, flagship species have to have an important conservation role for the whole ecosystem and to trigger concern for the species and motivate community members to conserve such species and its habitat. Such well selected species will built strong and positive relationship among members of local communities, decision makers, NGO representatives and conservation specialists which will affect in synergy and conservation effort which will hit not only the flagship species but the whole ecosystem where such species lives

Aquarium Skadarsko jezero flagship species

For Skadarsko jezero (Lake Skadar) aquarium we have to suggest one fish species which will be its flagship species. Out of 52 fish species that inhabits Skadar lake we are suggesting to select an eel (*Anguilla anguila*) as aquarium flagship species. There are several flowing reasons for such proposal:

- Eel is fish with unusual body shape which resemble on snake which is already dramatic and characteristic and will have effect on future aquarium visitors (there is almost biblical relation among humans and snakes or snake like animals no matter if they hate or like it)
- Eel is relatively big and it doesn't demand some special conditions and it can lives for several decades in captivity
- Eel has dramatic life cycle and we can expect that we will have the "wow" effect on every visitor which read the story about eel life, migrations and metamorphosis
- Eel is relatively well-known fish (visually) and therefore there is good potential of using this species in marketing purposes (aquarium logo, printing on T-shirts etc.)
- Eel is critically endangered (CR status according to ICUN) fish species and therefore it demands strong conservative actions
- Because of such CR status and regarding to eel compex biology this species needs an overall - continental conservation approach. Therefore, it is only fish species which has it own so called "Eel Directive" (EC Regulation 1100/2007).
- Being recognized as CR endangered and existence of EC Regulation 1100/2007 make eel an ideal flagship species for fundraising activities
- Allowing upstream and downstream migration for eel will also help other anadromous and catadromous species to migrate and make Lake Skadar ecosystem more effective in terms of functionality and natural fauna exchange (hire we have to emphasize one other fish species which extinct from the Lake Skadar due to overfishing and fish trap barrier. It is the Adriatic sturgeon (*Acipenser naccarii*) for which Lake Skadar was one of the most important spawning and nursery area in whole living areal).
- Lake Skadar is one of the biggest living area for eels without any obstacle for upstream migration and therefore one of the most important eel habitats in this part of Mediterranean.
- The eel as a species has potential to be not only flagship species of Aquarium, this species could be estimated as flagship species for the whole Lake Skadar ecotone.

Conclusions and recommendations

- Eel is highly endangered fish species due to several factors (overfishing of glass eel, yellows and silvers; swimming bladder parasite which originate from *Anguilla japonica*, habitat loss, riverine connectivity loss) and still is not clear whether some of them are curtail or it is synergetic effect of all of theme or the detected dramatic decrease of eel abundance is related to some climate changes in Atlantic ocean (The North Atlantic Oscillation – NOA) which caused cyclic changes in main Gulf current which is essential for dispersal of eel larvae
- In close future, together with Albanian partners, we have to develop constant monitoring program for monitoring of glass eel immigration and sliver eel emigration from Lake Skadar and to estimate the eel biomass in this Lake in order to understand what is happening with eels in this system
- As soon as possible, together with Albanian partners and based on previously mentioned results of monitoring and findings, we have to produce the Eel Management Plan for Lake Skadar
- In order to regulate downstream migration of silver eels and to satisfied demands of "eel directive" we have to work on regulation and controlling of harvesting of fish trap on Bojana river in Albania during downstream eel migration
- In order to reduce fishing pressure on eel live stock in Lake Skadar we suggest to estimate development of eel farming and using of glass eels and elevers from Bojana delta as fish farm stocking material
- Eel has to be proposed as flagship species for the Lake Skadar Aquarium
- Taking in mind the importance of Lake Skadar as huge eel habitat, eel vulnerability, global threats, biological importance, marketing potential and eel unique and mysterious life cycle as well as unique body shape, we strongly suggest to proclaim eel, together with pelican, for a flagship species of whole Lake Skadar.

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