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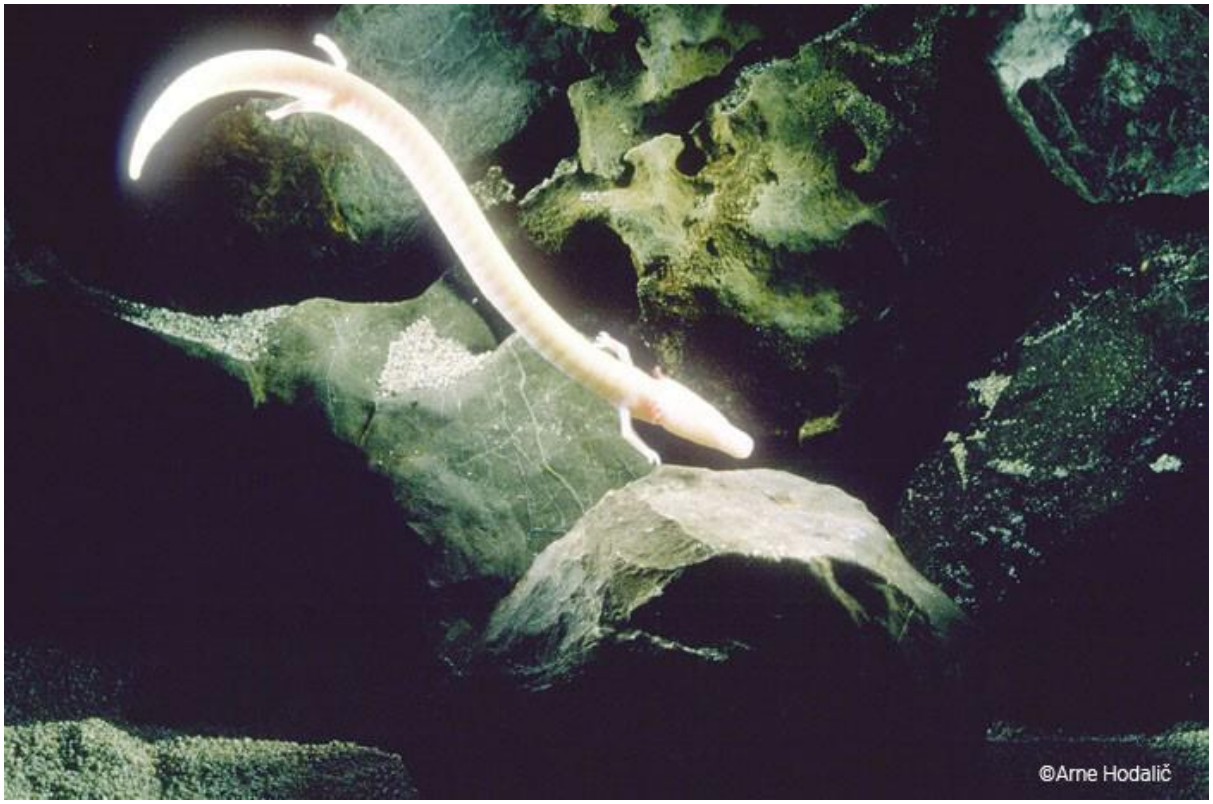
EDGE

EVOLUTIONARILLY DISTINCT & GLOBALLY ENDANGERED

Survival Blueprint

Olm, *Proteus anguinus*



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1. STATUS REVIEW

1.1 Taxonomy: Chordata > Amphibia > Caudata > Proteidae > *Proteus* > *anguinus*

Most populations are assigned to the subterranean subspecies *Proteus anguinus anguinus*. Unlike the nominate form, the genetically similar subspecies *P.a. parkelj* from Bela Krajina in Slovenia is pigmented and might represent a distinct species, although a recent genetic study suggests that the two subspecies are poorly differentiated at the molecular level and may not even warrant subspecies status (Goricki and Trontelj 2006). Isolated populations from Istria peninsula in Croatia are genetically and morphologically differentiated as separate unnamed taxon (Goricki and Trontelj 2006).

Croatian: Čovječja ribica
English: Olm, Proteus, Cave salamander
French: Protee
Slovenian: Čovješka ribica, močeril
German: Grottenolm

1.2 Distribution and population status:

1.2.1 Global distribution:

Country	Population estimate (plus references)	Distribution	Population trend (plus references)	Notes
Croatia	68 localities (Jelić et al. 2012)	3 separate subpopulations: Istria, Gorski kotar and Dalmatia	Decline has been observed through devastation of several cave systems in all regions (Jelić et al. 2012)	
Italy	29 localities (Sket 1997)	Just the easternmost region around Trieste, Gradisce and Monfalcone	A decline has been observed in the population of Goriza (Italy) (Gasc *et al.* 1997).	
Slovenia	158 localities (Sket 1997)	4 populations distributed from Vipava river in the west (border with Italy) to Kupa river in the east (border with Croatia)	A decline has been observed in the population in Postojna (Slovenia) (Gasc *et al.* 1997).	
Bosnia and Herzegovina	57 localities (Kotršan 2002)	3 isolated populations: Sanski Most, Neretva river (Ljubuški, Čapljina) and Popovo polje (border with Montenegro)	Unknown	

* There is an introduced population in France in the CNRS subterranean laboratory in Moulis (introduced in 1952) and in the Vicenza area (north-eastern Italy) in the 1800s (P. Edgar pers. comm.).

This Survival Blueprint will from here forward mostly deal only with populations of *Proteus anguinus* in Croatia and Bosnia and Herzegovina.

1.2.2 Local distribution:

Country	Region / province	Site	Level of Protection	Population size	Reference(s)	Notes
Italy	Region of Kras - Carso	Area southwest of Gorizia - westernmost Proteus localities in range	None	Unknown; same population as Gorizia in Slovenia	Sket 1997	
Slovenia	Region of Kras - Carso	Area southwest of Gorizia - westernmost Proteus localities in range	None	Unknown; same population as Gorizia in Italy	Sket 1997	
Slovenia	Region of Dolenjska and Stičina in Slovenia	Group of localities south of Ljubljana, between Radensko polje and Kupa river + area around Stičina	None	Unknown	Sket 1997	
Slovenia	Region of Bela Krajina	Cave systems in Bela Krajina – home of black olm – *P. anguinus parkelj*	None	Unknown	Sket 1997	
Slovenia	Cave systems around Ljubljanica and Pivka rivers in Slovenia	Very rich region with many confirmed localities. They follow the triangle Pivka-Lož-Vrhnika	None	Unknown; connected to population in Gorski kotar in Croatia	Sket 1997	
Croatia	Istria	Cave systems around Mirna and Raša rivers	None; all caves are protected as habitat type.	Unknown	Sket 1997, Jelić et al. 2012	
Croatia	Gorski kotar in Croatia	Very large cave systems in Croatian part of mountain region called Gorski kotar	None; all caves are protected as habitat type.	Unknown; connected to population in Dolenjska in	Sket 1997, Jelić et al. 2012	

				Slovenia		
Croatia	Dalmatia	Formed by many small and probably isolated localities in different river shads. Northernmost population is by Krka river, followed by populations by Jadro, Cetina, and Neretva river.	Krka populations located in Krka National Park; all caves are protected as habitat type.	Unknown; connected to Herzegovina population in Bosnia and Herzegovina	Sket 1997, Jelić et al. 2012	
Bosnia and Herzegovina	Sana River district	Caves around Sanski Most city	None	Unknown	Sket 1997; Kotršan 2002	
Bosnia and Herzegovina	Herzegovina	Caves around Ljubuški and Čapljina	None	Unknown; connected with Dalmatian population in Croatia	Sket 1997; Kotršan 2002	
Bosnia and Herzegovina	Herzegovina (Trebinje)	Caves around Trebinje city and in Popovo polje (valley) around Trebišnjica river.	None; only Vjetrenica cave in popovo polje is formally protected but devastated for tourism	Unknown	Sket 1997; Kotršan 2002	

1.3 Protection status:

Global category of threat: VU B2ab(ii,iii,v)

Justification: listed as Vulnerable since 1984 because its Area of Occupancy is less than 2,000 km^2, its distribution is severely fragmented, and there is continuing decline in the extent and quality of its habitat, and presumably also in the number of mature individuals (Arntzen et al. 2009).

European category of threat: VU B2ab(ii,iii,v)

National category: Croatia EN B2ab(ii,iii,iv,v); **Bosnia and Herzegovina** NE (not evaluated)

Conservation actions:

- Strictly protected by Croatian Nature Protection Act (Official gazette 70/05; 139/08; 57/11); not officially protected in Bosnia and Herzegovina
- Annexes II and IV of the EU Habitats Directive, marked as "priority" species
- Appendix II of the Bern Convention

Part of the range of the species is located within protected areas (National parks and Natural parks). All subterranean objects are part of the Croatian Ecological Network. Olm is listed in the National Ecological Network as a target species for the following types of environmentally significant areas: Ogulinsko-plaščansko area, Polje Jezero, Sinjsko polje, Ombla, National park Krka, Rupečice spring, Rupečice sinkhole, Komarčeva, Crnačka špilja, Rokina bezdana, Markarova špilja, Antić špilja, cave opposite to the lake Torak, cave Miljacka II, Zagorska peć near Ogulina, sinkhole Crni Vir and Pincinova jama (Jelić et al. . 2012).

1.4 Habitat and resource assessment:

Olm is an endemic stygobiont of the underground waters of Dinaric region (Gottstein 2010). The main features of a subterranean life are lack of light, no light-dark cycle, and a relative air humidity near full saturation value. The temperature of underground waters tend to be more constant than in surface waters. The ideal temperature range for the Olm is between 5˚C and 15˚C. Water temperature in cave can also seasonally vary. Rokina Bezdana in Lika

region in average values 7˚C, but temperature here is variable and is reported to sometimes fall below 5˚C (Garašić 1980a). In some other localities, lower temperatures in caves probably occur during melting of snow or after heavy cold rains in spring, when high quantities of cold surface water penetrate underground. However, there is no locality in Slovenia where this animal is likely to live for a longer period at temperatures below 8˚C (Sket 1997). The highest temperature measured in a Proteus habitat has been 14˚C in Istra (Rađa 1980a).

Proteus populations are many, but its habitats are deep cracks and fissures in the limestone caves, therefore it is not directly accessible to man and population estimation cannot easily be performed. More often, the specimens can be found in marginal parts of its habitat, where the animals were flushed out by heavy rains or were hunting for food (Grzimek 2003).

1.5 Biology and ecology:

Olm breathes with gills and skin, but under hypoxic conditions it breathes with lungs. Proteus does not require high concentrations of oxygen, which corresponds to their low metabolism level, which in turn is another adaptation to a subterranean lifestyle. While conducting the study of resistance of the olms to the lack of oxygen in the water, an evident hyperemia (an increased amount of blood in the capillaries of an organ or a body part) of gills and skin was noticed and animals often swam to the surface of the water in order to catch the air. While observing the olm, it can be seen to breathe air, , whereas in the literature various views debating this can be found. Olms capability of "air swallowing" has been known for a long time from a laboratory in Germany, while the French explorers denied it. Briegleb (1962) noted it again and explained as "life necessary". Durand (1976) considered it to be an abnormal animal behaviour caused as a result of unsuitable conditions such as a high water temperature and lower oxygen concentration. The results of the study “Breathing of air and problematic of lungs role in Proteus [Udisanje vazduha i problematika uloge pluća kod proteusa]“ Sojar et al. 1981suggest that frequent inhalation of air is significant only in a very deoxygenated water. Thus, one can consider that the lungs are an organ used for breathing when the concentration of oxygen in the water drops below its critical value (Sojar et al. 1981).

Olms are primarily predators; its natural food includes detritus and cave invertebrates. They seem to feed on insect larvae, usually larvae of Trichoptera, Ephemeroptera, Plecoptera and Diptera, mollusca (*Belgrandiella*) and freshwater amphipods (*Niphargus, Asellus, Synurella*) (Bizjak-Mali & Bulog 2004). The groundwater ecosystems, including cave and karstic

aquifers, are characterized by limited food supplies during most of the year. The reason lies in the fact that the groundwater ecosystems lack autotrophic production and sporadic, unpredictable, allochthonus input. Because of these conditions, periods of prolonged starvation are common events in the life of subterranean organisms, so olms are able to survive for a long period of time without food. In addition, some authors reported that *P. anguinus* could survive food deprivation for exceptional period, ranging between 18 and 96 months, withhout any signs of illness (Hervant et al. 2001b). The low and discontinuous food supplies along with darkness in subterranean environments require more time to be spent on food searching. Besides, the prey is invisible and often dead (brought in by occasional floods). During the search for prey olms compensate for the absence of eyes in several ways. The olm is capable of sensing very low concentrations of organic compounds in the water. Using its scent *Proteus* evaluates the quality and quantity of the prey. The sensory epithelia of the inner ear is very specifically differentiated, enabling the olm to receive sound waves in the water, as well as vibrations from the ground. It is known that the lateral line organs register low vibrations of the liquid environment (Durand 1976). In addition, the olm has the ability to register weak electronic fields (Hervant et al. 2001b).

Breeding in *Proteus* appears to be aseasonal, reflecting the stability of their subterranean habitat (Grzimek 2003). Relatively limited information is available on the reproductive biology of *Proteus anguinus*, because of the fact that they live in total darkness (Guillaume et al. 1999). The olm can reproduce in two ways, discovered in a research laboratory in Moulis in France (Kovačević 1984). *Proteus* reportedly has in some degree the capability of viviparity, giving birth to a pair of well-developed young in low temperatures, and laying eggs in high temperatures. Although the adult individuals group in places hidden under the rocks, in the breeding season males determine their territory and defend them from competing males. When the female enters into that territory, courtship begins. Courtship culminates in the male depositing a packet of sperm (spermatophore) which the female catches and introduces it into its cloacal cavity. Spermatozoa are then stored in the lumen of cloacal glands, the spermathecae, for six months or more. Thus, the fertilization occurs when the eggs pass through the cloaca during the laying. When the male leaves the territory, the female is searching for a place to lay her eggs. After two to three days the female lays eggs, which may number up to 100 or more per clutch. The eggs are usually attached beneath some object, such as a rock or a log, and are guarded by the female. The eggs are large (5-6 mm), full of yolk, and unpigmented. The incubation period lasts two to six months, depending on the species and the temperature (Grzimek 2003).

The olm is the amphibian with the longest lifespan. It has a slow development, reaching adulthood between 14 and 18 years of age and lives for more than 60 years (Hervant et al. 2001b). Voituron et. al (2011) have suggested two possible explanations for the animal's extreme longevity. The first is the animal's exceptional level of inactivity - it only eats about once a month, and does not have to escape from predators, because it has none in its natural environment. Since it does not extend much energy, its metabolic rate mostly stays at the baseline rate, while most other species' metabolisms are often running much above their basal rate. Their second theory is that the olm's mitochondria function differently from normal mitochondria - they are able to process more ATP with less oxygen (Welsh 2010).

1.6 Threat analysis:

Human-induced threats to the speleological objects and associated fauna are varied and numerous. The major threats on underground habitats are:

- urban pollution such as garbage dumps in karstic springs and sinkholes (Cave in Vodnjan, Markarova cave)
- restriction of water levels
- Ttourists excessive visitation of caves (Đuderina jama), bringing with them strong lights and heaters
- dams and small-scale hydroelectric power stations which cause a change in the stream profile and reduce food intake into the underground (system Vilina cave – Ombla spring)
- modification of water flow
- destruction of caves and their associated networks of cracks by exploitation of guarries, building of roads and highways and widening of highways, clandestine excavations in the remoter parts of caves, or because of vandalism
- pollution of the underground waters and dumping of organics acids in the underground river (Rokina bezdana – pollution of Stajničko polje as well as Jezerana leads to the accumulation of waste water in the underground which the local people use as drinking water)
- illegal collection of this species for the pet trade (Bedek et al. 2009, Ozimec 2006)

It is necessary to protect the speleological objects through water resource management and regulations of tourists visiting the caves. Pincinova jama is given some form of statutory protection because the cave holds especially high numbers of species (*Proteus anguinus,*

Niphargus heberer, Hadzia fragilis, Sphaeromides virei, Troglocaris schmidti and others), but it is still in danger. Nimfer, the spring in the center of Pula is not currently threatened, and this state should be maintained, and there should be educational information and signage at the site with information about the olm. A similar situation occurs at Krčevac spring, where there should also be educational signage. In Istrian mines with *Proteus* presence, such as coal mine Raša, all sources of pollution should be removed, the surface water restored with the goal of protection of the underground fauna. On some localities is necessary to set up round tables to initiate social discussion to stop throwing garbage in the cave and organize the educations and sensitisation of local people (Rušećica-Zeleno jezero, Obajdin špilja, Golubinka). It is desirable to educate people about the consequences of negative effects on underground systems, such as Zagorska Mrežnica source, which is by underground streams associated with several localities that together supply the Ogulin region with drinking water. Many caves need further research (Klisura, cave opposite to the lake Torak, Miljacka I, Miljacka II and Miljacka V) and funds should be raised for research. Objects in the Krka National park, with a constant accumulation of water, stand out for being particularly important as olm habitats, as well as for many subterranean crustaceans, snails and other cave visitors such as bats. Objects near the Krka river are in the low protected area (Miljacka I, Miljacka II, Miljacka II, Miljacka IV, Miljacka IV and cave opposite to the lake Torak), so they are not threatened for now. Miljacka III is located in the canyon and are relatively inaccessible to humans. Objects such as Markarova špilja, Antića špilja and Ivina pećina can be closed with a metal grate with locked doors to regulate human activities and prevent waste dumping into the pit. Furthermore, it is necessary to continue with education efforts to spread the world about such incredible creatures before it will be too late to act.

1.7 Stakeholder analysis:

Country	Stakeholder	Interest	Current activities	Impact	Intensity	Proposed activities
Regional /Croatia	Croatian Herpetological Society HYLA	Conservation and research	Leading partner in PROTEUS project	+	Critical	
Regional /Croatia	Croatian Institute for Biodiversity	Research	Scientific backup	+	Critical	Scientific analysis of the data
Croatia	State Institute for Nature Protection SINP	Conservation; Main governmental organisation for nature protection	Partners in PROTEUS project	+	Medium	
Croatia	Natural History Museum in Zagreb	Research	Practitioners	+	Low	
Hungary	Hungarian Natural History Museum	Research	Practitioners	+	Low	
Croatia	Zagreb city ZOO	Conservation	Practitioners; PROTEUS project	+	Low	Captive breeding
International	Zoological Society of London	Conservation	Funders	+	Medium	
International	MAVA foundation	Conservation	Funders	+	Medium	
Croatia	Croatian water management agency	Commercial	Water use and management	-	Critical	
Croatia	Croatian touristic agency	Commercial	Tourism promotion and management	+/-	Medium	
Regional	Speleological Societies of Croatia and B&H	Practitioners	Practitioners	+/-	Medium	
Croatia	Croatian Biospeleological Society	Conservation and research	Practitioners	+	High	

Croatia	Society for Karst Research FREATIK	Research	Practitioners	+	Medium	
Bosnia and Herzegovina	Herpetological Society of B&H	Conservation and research	Partner in PROTEUS project	+	High	
Bosnia and Herzegovina	Water management agency of B&H	Commercial	Water use and management	-	Critical	
Bosnia and Herzegovina	B&H touristic agency	Commercial	Tourism promotion and management	+/-	Medium	
International	Devon Karst Research Society (UK and Hungary)	Research	Practitioners	+	Low	
Bosnia and Herzegovina	Zelena brda (Trebinje)	Research	Practitioners	+	Low	

1.8 Factors influencing success of survival blueprint implementation:

	Description	Threats	Opportunities
Socio-cultural effects			
Economic implications	Our project goal is to improve general condition of *Proteus anguinus* habitat (underground karst waters). Underground ecosystem services will also be affected by climate change such as the provision of drinking water that can deteriorate through acidification, quality and flow.	Underground aquifers that supply drinkable water to 2/3 of Croatia and B&H human population (5 mil) can become polluted or disappear.	Maintenance of water quality is important for health and economic reasons as well as for olm conservation.
Existing conservation measures	1. PROTEUS project in Croatia and Bosnia and Herzegovina: CHS-Hyla/ZSL/MAVA/MBZ (2012-present)	Captive bred population made up of 20 individuals of uneven sex (2 males and 18 females). Female	Natural populations need to be monitored to try to observe breeding in natural conditions.

	2. A joint strategy for the protection of the endangered underground endemic *Proteus anguinus* and its natural karst habitat in the Trebišnjica river basin: Devon Karst Research Society and Zelena brda (2000-2013); working in Trebišnjica river basin (Trebinje city) 3. Captive breeding and rehabilitation centre for olm: CHS-HYLA and Zagreb ZOO (2013-present) – cooperation with Tular laboratory in Slovenia 4. No accurate estimates of olm population size either globally or nationally, and the current rate of decline is unclear. There are no standardized methods for survey and monitoring across the range.	olms lay eggs only every 7 years and this makes breeding a very rare event. Populations can go extinct in any part of olm range because there is no monitoring to indicate decline. Some populations already have gone extinct.	Natura 2000 monitoring scheme and protocol for Croatia are being developed through PROTEUS project (CHS-Hyla)
Administrative/political set-up		Lack of legislation in B&H	
Appeal of species	Considered as species living in clear drinkable water. Therefore it is perfect as iconic umbrella species. Everybody knows what olms are, but they do not know where it lives or any other details. Most people in Croatia think it lives only in Slovenia.	Threat is that there will not be willingness to react in cases of major habitat destruction (water management, draining, flooding, etc.)	Use the local trust in olm to guarantee clear drinkable water as an indicator species. Raise people's will to control water supplies independently from large water exploitation companies.

2. ACTION PROGRAMME

Vision (30-50 years)	
There are viable populations of olm in all major regions across its natural range that exist in clear and healthy underground aquifers guaranteeing, as iconic umbrella species, protection of clear drinkable water for human population.	
Goal(s) (5-10 years)	
Conserve the health of the karst underground and water supply for cave animals and as drinkable water for the humans, using the olm as umbrella species.	
Objectives	**Prioritisation**
1. Monitoring of *Proteus anguinus* in 25 Natura 2000 cave systems in Croatia	Critical
2. Monitoring of *Proteus anguinus* in 15 selected cave systems in Bosnia and Herzegovina (following Natura 2000 protocol)	Critical
3. Research of cave systems with suspected populations of *Proteus anguinus*	Medium
4. Study on *Proteus anguinus* ecology *in situ* and *ex situ*	High
5. Establishment of Rehabilitation and captive breeding centre for *Proteus anguinus* in Croatia	Medium
6. Restoration of 10 cave systems defined as being in poor condition	High
7. Education on importance of preservation of *Proteus anguinus* and karst habitats	Medium
8. National olm action plans produced and endorsed in Croatia and Bosnia and Herzegovina	Critical
9. Developing international cooperation between scientific and expert organizations working on research and conservation of *P. anguinus*	Low

Activities	Country / region	Priority	Associated Cost in €	Time scale	Responsible stakeholders	Indicators	Opportunities and threats	Activity type
1. Monitoring of *Proteus anguinus* in 25 Natura 2000 cave systems in Croatia								
1.1 Preparation of Natura 2000 monitoring scheme and program for *Proteus anguinus*	Croatia	**Critical**	4000 €	2014	CHS – Hyla; State institute for nature protection	Developed programme that is used regularly during monitoring		Law & Policy
1.2 Cave diving for monitoring 6 NATURA 2000 cave systems (4 times per year)	Croatia	**Critical**	16800 € /year 84000 €	Continuously every year 2014 - 2018	CHS – Hyla; Society for Karst Research FREATIK	Yearly population estimate for all localities	High waters (floods)	Species management
1.3 Environmental DNA monitoring of Natura 2000 sites	Croatia	**High**	5000 € / year 25000 €	Continuously every year 2014 - 2018	Hungarian Natural History Museum	Analysis report	High waters dilute DNA and it is not detectable	Species management
1.4 Water physico-chemical parameters in *Proteus anguinus* habitat (6 monitoring sites)	Croatia	**Low**	3000 € / year 15000 €	Continuously every year 2014 - 2018	CHS – Hyla; certified lab	Analysis report		Species management
1.5 Preparation of 2 workshops for building capacity for Natura 2000 biogeographical seminar	Croatia	**Low**	2200 €	2014	CHS – Hyla; State institute for nature protection	Workshop result send to the EU Commission	Opportunity to enlarge the size of Natura 2000 sites based on concrete scientific evidence presented by local NGOs	Law & Policy
2. Monitoring of *Proteus anguinus* in 15 selected cave systems in Bosnia and Herzegovina (following Natura 2000 protocol)								
1.1 Preparation of national monitoring protocol for *Proteus anguinus*	Bosnia and Herzegovina	**Critical**	2000 €	2015	CHS – Hyla; Herpetological Society of B&H	Developed protocol that is used regularly during monitoring		Law & Policy

1.2 Cave diving for monitoring 6 selected cave systems	Bosnia and Herzegovina	**Critical**	16800 € /year 84000 €	Continuously every year 2014 - 2018	CHS – Hyla; Society for Karst Research FREATIK	Yearly population estimate for all localities	High waters (floods)	Species management
1.3 Environmental DNA monitoring of inaccessable systems	Bosnia and Herzegovina	**High**	5000 € / year 25000 €	Continuously every year 2014 - 2018	Hungarian Natural History Museum	Analysis report	High waters dilute DNA and it is not detectable	Species management
1.4 Water physico-chemical parameters in *Proteus anguinus* habitat	Bosnia and Herzegovina	**Low**	3000 € / year 15000 €	Continuously every year 2014 - 2018	CHS – Hyla; certified lab	Analysis report		Species management
3. Research of cave systems with suspected populations of *Proteus anguinus*								
2.1 Further research of cave systems in Natura 2000 sites in Croatia	Croatia	**Critical**	7000 €	2014 - 2015	CHS – Hyla; Society for Karst Research FREATIK; Speleological society's			Species management
2.2 Further research of suspected cave systems and search for new olm populations in Croatia and Bosnia and Herzegovina, Montenegro	Region	**High**	4000 € / year 20000 €	2014 - 2018	CHS – Hyla; Society for Karst Research FREATIK; Speleological society's		Confirmation in Montenegro is very uncertain	Species management
2.3 Building of GIS database of cave systems and GAP Analysis (+ maintenance and data entry)	Region	**Low**	5000 €	2014 - 2018	CHS – Hyla; Society for Karst Research FREATIK; Speleological society's; Croatian Biospeleological Society			Species management
4. Study on *Proteus anguinus* ecology *in situ* and *ex situ*								
4.1 Further development in	Regional	**Critical**	11000 €	2014 - 2018	CHS – Hyla; Society for Karst Research			Improving knowledge

ecological research using cave diving in selected systems					FREATIK; Devon Karst Research Society			
4.2 Setting up *in situ* laboratory in Rupećica cave and Markarova cave by installation of night vision cameras	Croatia	**Medium**	4500 €	2015 - 2016	CHS – Hyla; Natural History Museum	3 cameras set up in each cave system provide 24 hour monitoring		Improving knowledge
4.3 Regional philogeographical study (mtDNA, nDNA)	Regional	**Medium**	7000 €	2014 - 2015	CHS – Hyla; Hungarian Natural History Museum			Improving knowledge
4.4 Phylogeny study on interconnection of close cave system populations (micro satellite DNA) – defining conservation units	Regional	**High**	9000 €	2015 - 2018	CHS – Hyla; Hungarian Natural History Museum		Detection of underground interconnections that are not possible to detect with any mechanical method	Improving knowledge
5. Establishment of network for Rehabilitation and captive breeding centres for *Proteus anguinus* in Croatia								
5.1 Purchase of land and house for captive breeding / rehabilitation / educational centre in Ogulin area	Croatia	**Medium**	80000 €	2015 - 2017	CHS - Hyla	Land transferred to CHS – HYLA ownership	Land owners are not willing to sell the land.	Species management
5.2 Further development and expansion of rehabilitation/education centre in Zagreb city ZOO	Croatia	**Low**	30000 €	2014 - 2018	Zagreb city ZOO			Species management

6. Revitalization of 10 cave systems defined as being in poor condition								
6.1 Waste extraction from 8 cave systems - *Proteus anguinus* habitats registered as in need of restoration	Croatia	**Medium**	24000 €	2014 - 2017	CHS – Hyla; Society for Karst Research FREATIK; Speleological society's; Croatian Biospeleological Society	Habitats quality improves in 8 localities		Land/water management
6.2 Reduction of number of invasive species in *Proteus anguinus* habitat (4 localities defined as problematic); continuous eradication	Croatia	**High**	18000 €	2014 - 2018	CHS – Hyla; Society for Karst Research FREATIK	Detection of increase in olm population on these sites	Possibly the recovery after reduction of invasive fish, will take longer than 2018	Land/water management
6.3 Classification of all visited cave systems in manner of pollution and habitat quality (defining threats and future measures to be taken)	Regional	**Low**	7000 €	2014 - 2016	CHS – Hyla; Society for Karst Research FREATIK; Speleological society's; Croatian Biospeleological Society			Improving knowledge
7. Education on importance of preservation of *Proteus anguinus* and karst habitats								
7.1 Education and public awareness Activities in region and internationally	Region, Internatio nal	**Medium**	15000 €	2014 - 2018	All stakeholders			Education & awareness
7.2 Educational exhibitions about preservation of *Proteus anguinus* and its habitat in Zagreb ZOO and in	Croatia	**Low**	15000 €	2016 - 2018	CHS - Hyla	Number of people visiting the exhibition per year	Opportunity to educate local population and include them into the cave rehabilitation and water	Education & awareness

Ogulin							management	
8. National olm action plans produced and endorsed in Croatia and Bosnia and Herzegovina								
8.1 Compiling and publication of first national action plan for *Proteus anguinus*	Croatia	**Critical**	4000 €	2014	CHS – Hyla	Action plan finished and published	Action plan needs to be submitted to the national authorities for evaluation and official signature. There could be disagreeing on national interest (economic, touristic etc.)	Law & Policy
8.1 Field investigation of threats and possible conservation actions in cave systems in Bosnia and Herzegovina	Bosnia and Herzegovina	**Critical**	3000 €	2014 - 2015	Herpetological Society of Bosnia and Herzegovina			Law & Policy
8.3 Compiling and publication of first national action plan for *Proteus anguinus*	Bosnia and Herzegovina	**Critical**	4000 €	2015 - 2016	CHS – Hyla; Herpetological Society of Bosnia and Herzegovina	Action plan finished and published	Action plan needs to be submitted to the national authorities for evaluation and official signature. There could be disagreeing on national interest (economic, touristic etc.)	Law & Policy
9. Developing international cooperation between scientific and expert organizations working on research and conservation of *P. anguinus*								
9.1 Organizing annual international conference on conservation and research of *Proteus anguinus*	Regional	**Medium**	20000 €	2014 - 2018	All stakeholders	Number of experts visiting the conference and number of contributions.		Capacity Building Education & awareness
9.2 Writing and	Regional	**Low**	6000 €	2014 - 2018	All stakeholders	Number of	This is a good	Education &

publishing scientific and expertise papers through cooperation						published papers.	opportunity to publish comprehensive regional publications in fast publishing peer reviewed journals.	awareness
Total cost to achieve the Goal "Conserve the health of the karst underground and water supply for cave animals and as drinkable water for the humans, using the olm as umbrella species."								**545, 700 €**