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D3.1 - Protocols of best catfish (*Silurus glanis*) capture methodologies in small and large lakes and reservoirs

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PREFACE

This document aims to provide to a wide public a protocol for sampling the European/wels catfish (*Silurus glanis*) in lakes and reservoirs. It is based on over 30 years of experiences of BCCAS Fish Ecology Unit with European/wels catfish sampling in the native area of the Czech Republic (both reservoirs and lakes), direct sampling of lakes in Italy and reservoirs in Portugal and it is complemented by current experiences of local research teams from MARE, GRAIA and CNR-IRSA.

Following methods are evaluated (in an ascending order of efficiency/by-catch reduction, i.e. selectivity) for European/wels catfish population control and eradication and they are further discussed for individual, selected water bodies involved in the LIFE Predator project: beach seining, purse seining, trawling, fyke nets, electrofishing, gillnets (standard CEN and Portuguese marine/large-mesh type), long-lines, spear fishing, and anglers.

The most recent knowledge about the efficiency of selected (most-promising) methods for catfish sampling is summarized in details in following scientific publications:

Vejřík L., Vejříková I., Blabolil P., Bartoň D., Sajdlová Z., Kočvara L., Peterka J., Muška M., Duras J., Jůza T., Ribeiro F., Rivaes R., Ribeiro D., Castro B., Moncada M., Čech M. (2024). **Long-lines for research monitoring and efficient population regulation of an invasive apex predator, European catfish (*Silurus glanis*)**. *Heliyon* 10: e34125. DOI: 10.1016/j.heliyon.2024.e34125

Vejřík L., Vejříková I., Peterka J., Čech M. (2019). **Methods for capturing catfish and potential regulation of catfish population** *In: Advances in Animal Science and Zoology Ed. Owen P. Jenkins, Nova Science Publishers* ISBN: 978-1-53616-048-2: 135-142

Vejřík L., Vejříková I., Kočvara L., Blabolil P., Peterka J., Sajdlová Z., Jůza J., Šmejkal M., Batroň D., Kubečka J., Čech M. (2019). **The pros and cons of the invasive freshwater apex predator, European catfish *Silurus glanis*, and powerful angling technique for its population control**. *Journal of Environmental Management* 241: 374-382

Santos G. S., Ribeiro F., Pereira E., Silva A. F., Almeida P. R., Ribeiro D., Quintella B. R. (2024). **Behaviour of the Apex Predator European Catfish (*Silurus glanis*) on a Recently Invaded Reservoir**. *Ecology of Freshwater Fish*, 0:e12817: 1-18

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European catfish (*Silurus glanis*) biology and ecology (*short overview*)

European/wels catfish (herafter catfish) is the largest freshwater fish in Europe reaching a maximum size of over 2.8 m and maximum weight of over 150 kg. It is a non-selective, opportunistic apex predator able to prey on a large variety of animals from water insect larvae, crayfish and fish to amphibians, waterbirds and mammals. Unlike all the other fish species, it is also able to feed on e.g. the unpalatable egg strands of Eurasian perch (*Perca fluviatilis*) (Vejřík et al. 2017 – Scientific Reports, Vejřík et al. 2017 – PloS ONE). Due to a large mouth and an extreme gulping power, it is able to swallow a prey up to 60% of its own size (by length; Vejřík et al. 2017 – Scientific Reports). Catfish is spawning in pairs into the nest composed of any brushy substrates (like e.g. soft roots of willow or alder). Large female can produce up to 1 million of oocytes, but see recent work of Panfili et al. (2024 – Marine and Freshwater Research) and Gkenas et al. (2025 – Journal of Vertebrate Biology). Male is guarding the nest and at this time it becomes very aggressive. Since catfish is a warm water fish also the optimum spawning temperature is high (18-22 ^{o}C). Catfish seems to prefer any type of shelters like drowned trees and branches, submerged macrophytes, boulders, rocks, artificial constructions, etc., where it rests for a significant part of the day. Each individual has a strong fidelity to one such a place from which it carries out its daily trips to check the territory and search for food. In adult individuals, this cruising consists in a swimming track of ~4-8 km per day, i.e. the territory is relatively large (Říha et al. 2025 – Freshwater Biology). The European/wels catfish is a native species to most of the West, Central and especially East Europe, however, it is an invasive alien species (IAS) in southwestern Europe (for more details see De Santis and Volta 2021 – Water, Gkenas et al. 2023 – Limnetica, De Santis et al. 2024 – Neobiota).

Methods of catfish capturing

Catfish occupies and uses most habitats and areas of lakes and reservoirs. As mentioned above, it uses any type of shelters for resting and most of the area of the water body for searching for food, i.e. both littoral and pelagic habitats; in reservoirs being present along the whole longitudinal profile from the tributary to the dam area and also in bays. Since it is a warm water species, the only limitation in occurrence is a cold water below the seasonal thermocline (Jarić et al. 2022 - Freshwater Biology) or oxygen depletion in some parts of the water body (Daněk et al. 2014 - KMAE, Westrelin et al. 2022 – Aquatic Ecology). From all the reasons mentioned above, it is evident that, except of some drastic methods like application of poisonous chemicals (e.g. rotenone) or complete drying of the locality, any single sampling method used in freshwater ichthyology could not effectively cover all the habitats of catfish presence and all the aspects of catfish behavior. There is a clear need of at least two (at some water bodies ideally 3-4) sampling methods to be used in parallel for the purpose of significant reduction or eradication of this IAS species.

Active and passive capturing methods

Active methods are those methods when the sampling gear goes actively through the water masses – using man or boat power – and catch the fish irrespective of its movement and/or feeding behavior. They actively collect the fish when the fish is present in the trajectory of the sampling gear, even in a situation the fish is sleeping and is motionless (methods 1, 2, 3, 5, 8; see below).

Passive methods are those methods which are fully dependent on fish movement and/or feeding behavior. The sampling gear is set at a selected place of the water body and passively collects the fish in case of its swimming (e.g. diurnal or annual migrations), searching for food or feeding. For a success of these methods, there is a fundamental need of fish to either enter/entangle into the gear or catch the laid bait. Motionless fish or sedentary fish (or satiated fish in special cases) are not collected even in a situation they occur in a close proximity to these sampling gears (methods 4, 6, 7, 9; see below).

1. Beach seining ..... p. 6

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1. Beach seining (active method, non-selective; Fig. 1)

The method is widely used as a traditional, primitive way of fish community sampling in both lakes and reservoirs as well as in marine system. It is strictly located to beaches without any obstacles on the bottom like stumps, boulders, drowned trees or fallen branches, as well as dense submerged or emerged macrophytes (e.g. *Myriophyllum* spp., *Potamogeton* spp., *Phragmites* spp., *Typha* spp., *Nymphaea* spp., *Nuphar lutea*, *Persicaria amphibia*, etc.). In most cases, the by-catch represents up to 100% of the overall catch (both day and night sampling) meaning that catfish 1) only occasionally uses this habitat, 2) is able to avoid this sampling gear, or 3) is able to escape the area of the haul. The method was specifically applied also in the lower Tagus River, Portugal, in lotic sections of this watercourse, particularly in slow moving waters and along the seven years of dataset in this river encompassing twelve field stations throughout 130 km, and from a total of 68 beach seining, only 1.5% of the seines were collecting catfish with a huge by-catch of several other species (MARE, unpublished data).

The method is not suitable for catfish capturing and could not be recommended for catfish reduction and eradication.

2. Purse seining (active method, non-selective; Fig. 2)

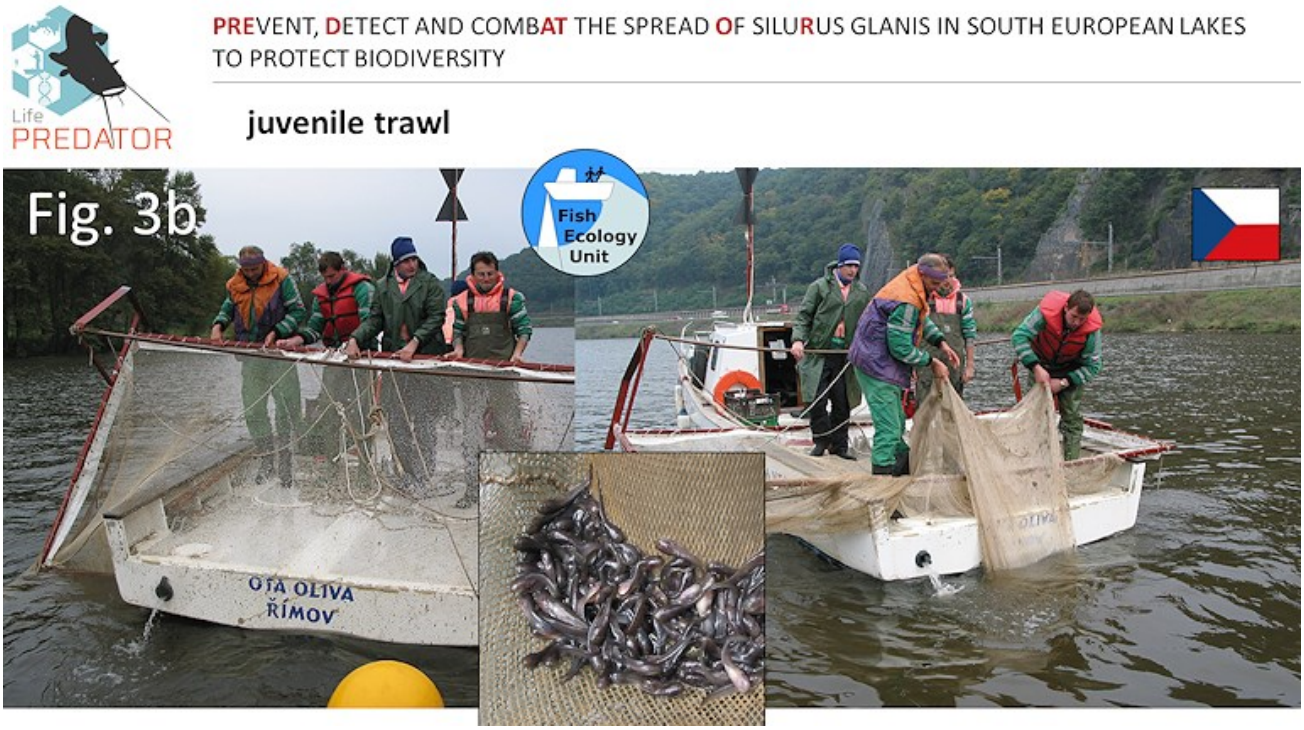
The method is adopted from the marine environment for sampling of the open pelagic/epipelagic habitat of lakes and reservoirs free of any possible obstacles (including e.g. *Lemna* or *Azolla* coverage). Due to relatively limited sampling volume (for this large habitat) catfish is not a subject of the catch and the by-catch is usually 100%.

The method could not be recommended for catfish reduction and eradication.

3. Trawling (active method, non-selective; Fig. 3a, b, c)

It is another method adopted from the marine environment for sampling of pelagic habitat, which is, however, used in large lakes and reservoirs for decades. In case of adult trawling (Fig. 3a), large volume of the open water could be sampled and during the nighttime, catfish could be a subject of the catch. However, the by-catch of other fish species is still enormous, representing ~98% of the overall biomass. Nighttime juvenile trawling (Fig. 3b) in mid- to late summer and ichthyoplankton trawling (Fig. 3c; details in Sajdlová et al. 2025. Journal of Fish Biology) in late spring could be used for a monitoring of catfish reproduction success and the amount of possible population recruitment. The method is equipment and man-power demanding and of generally low efficiency.

The method could not be recommended, as a standard, for catfish reduction and eradication (just for catfish early stages monitoring).


PREVENT, DETECT AND COMBAT THE SPREAD OF SILURUS GLANIS IN SOUTH EUROPEAN LAKES TO PROTECT BIODIVERSITY
juvenile trawl
Fig. 3b
Fish Ecology Unit
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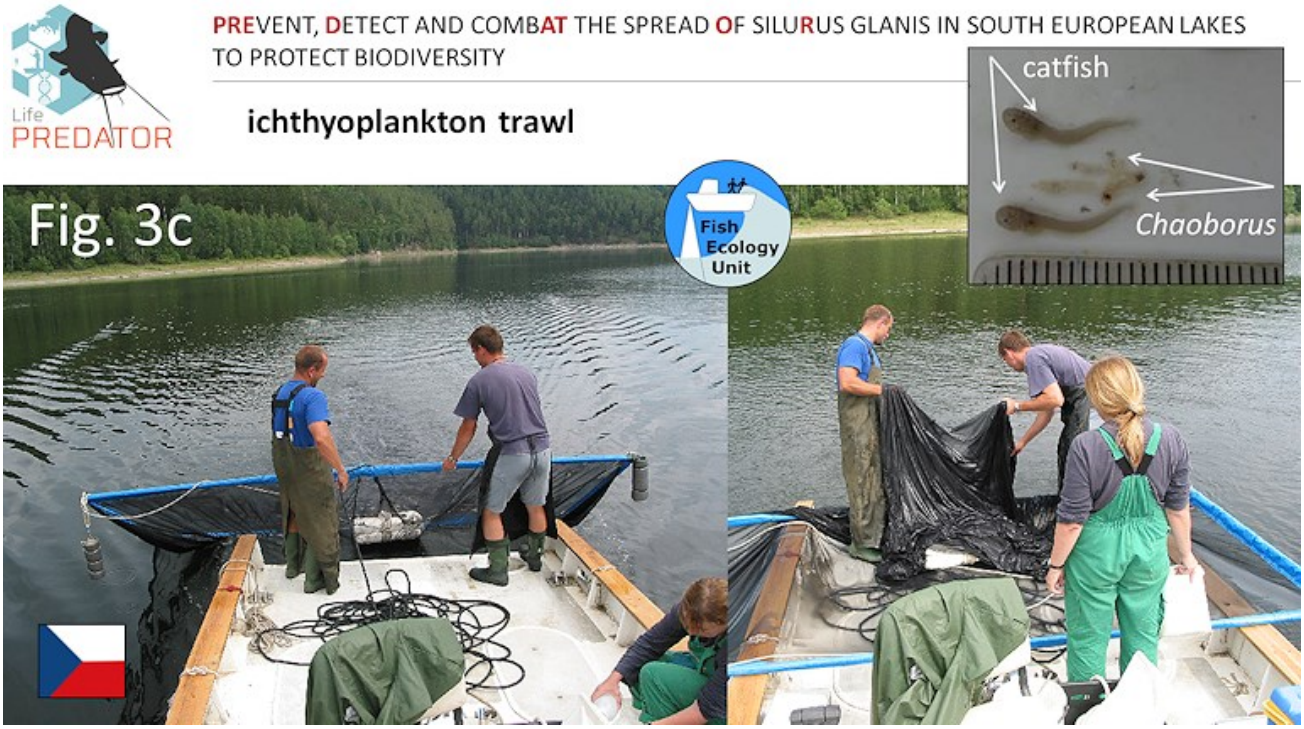
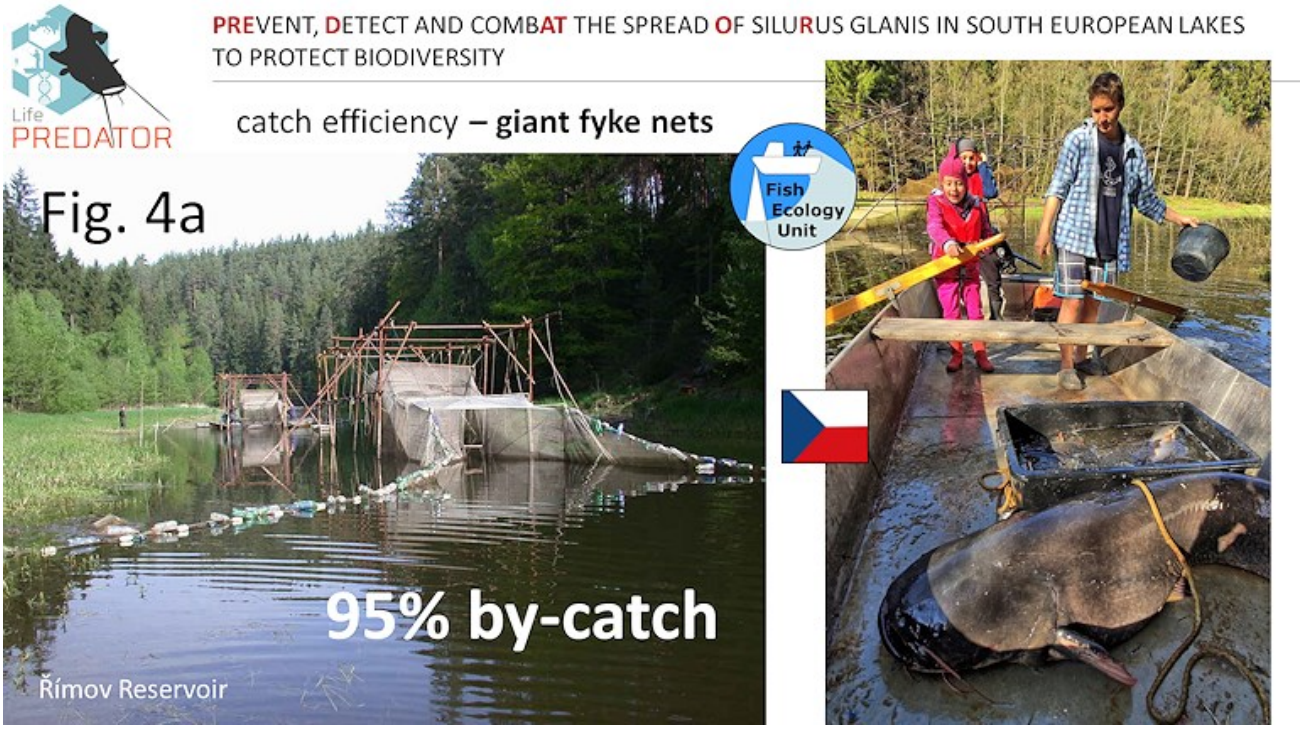

PREVENT, DETECT AND COMBAT THE SPREAD OF SILURUS GLANIS IN SOUTH EUROPEAN LAKES TO PROTECT BIODIVERSITY
ichthyoplankton trawl
catfish
Chaoborus
Fig. 3c
Fish Ecology Unit

4. Fyke nets and traps (passive method, non-selective; Fig. 4a, b)

This method could be effective in periods of catfish mass movement to specific parts of the lake/reservoir, typically following the spawning migration of its prey, cyprinids, like in small to middle sized lake/reservoir tributaries. One of the limitations is the water current and the amount of natural and/or artificial litter (e.g. leaves, tree branches, rubbish, urban waste) carried by the water masses. Since the method is non-selective, the by-catch is still very high, representing ~95%. In superabundant catfish populations, this value could be much lower. In conditions of channel systems (like e.g. Camarque, France) the method could produce more reasonable catfish catches (see Panfili et al. 2024 – Marine and Freshwater Research).

The method could be recommended in specific parts of the water body (reservoir/lake tributaries) and periods of the year (mass cyprinid spawning) for catfish reduction and eradication. It could be also recommended in catfish pre-spawning period when individuals are searching for appropriate spawning substrate, with fyke-nets being installed parallel to the shore/reedbeds (typically Italian small-shallow lakes).



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fyke nets and traps
Fig. 4b
Fish Ecology Unit

5. Electrofishing (active method, non-selective, however, the by-catch could be let in the water unhandled; Fig. 5a, b)

It is a classical sampling method for freshwater systems, in case of lakes and reservoirs used from the boat. However, even with the powerful electroshocker it is restricted to the shoreline and shallows to a maximum depth of ca. 2 m. The usual by-catch is still very high, ~85% or higher. The efficiency could be significantly increased when used in specific periods of the year and/or at places of catfish mass aggregations: 1) when catfish follow the spawning stock of cyprinids (or are lured to these specific areas by substances produced by the spawning fish) and concentrated below their spawning grounds in tributaries; 2) during the period of catfish pre-spawning and spawning when pairs of fish of approx. the same size are distributed along the shore, usually under the tree canopy, partly submerged. This period could be simply identified by black locust tree (*Robinia pseudoacacia*) blooming (late April - late June in general or even earlier in warmest parts of Europe); 3) In shallow Italian lakes, the best period of the year to do electrofishing is late autumn to winter, when the catfish find shelter along the wooden/rocky refugia, or under the reeds undercuts. In this period the fish metabolism is also slow and their escape ability is highly reduced. In contrast, the summertime fish are more reactive, and many shallow lakes (at least in southern Europe) are partially covered by macrophytes, limiting the navigation and catches in general. In Portugal, in some shallow areas of some reservoirs, during peak summer or while catfish protect their nests electrofishing efficiency towards large specimens seems to be effective (Santos et al. 2025 – Ecology of Freshwater Fish). During the summer months, small catfish at the age of 0+ and 1+ could be effectively sampled using electrofishing along the rock and boulder shores (e.g. Belver, Cedillo) and along the man-made navigation (e.g. Avigliana Grande). More time is needed till the electroshocked catfish get out the shelter and swim off the shoreline to the “open water”, i.e. the fishing crew has to be more patient at a single sampling place. It has to be kept in mind, however, that the method is non-selective, sampling all the fish present in the field of electrodes and could be harmful to the rest of the fish stock, especially when repeatedly used – neural and muscle problems, gill bleeding, spine break, etc. Electrofishing is also time-consuming and demanding in terms of human labor but might be applied by non-specialized people for capture (F. Ribeiro, pers. observation).

The method could be recommended as the easiest way of catfish capturing, reduction and eradication, in some systems very efficient (e.g. Campagna, Comabbio).

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catch efficiency - electrofishing
Fish Ecology Unit
Fig. 5a
85% by-catch

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electrofishing
Fish Ecology Unit
Lake Campagna (May 2024)
Fig. 5b

6. Gillnets (passive method, of low selectivity; Fig. 6a, b, c)

It is another classical sampling method used especially in standing freshwater systems, lakes and reservoirs in particular, and the method used for ecosystem quality evaluation within the Water Framework Directive (WFD) of the EU. However, the EU standard gillnets – EU norm (CEN, 2005; Fig. 6b) could not be recommended for catfish effective sampling due to generally small mesh sizes (max. 55 mm knot-to-knot), bad design, fine nylon material and high cost. Also, the small size of individual panels (one single mesh size 2.5 m wide, 30 m in total for 12 different mesh sizes in random design of the gillnet) is not suitable for mass catfish sampling. In contrary, the gillnets used by professional fishermen, like the "Portuguese type" adopted from marine environment could be recommended for this purpose. These gillnets are significantly draped (floating line and the lead line are shorter than the nylon net by some 20%), panels are longer and deeper, nylon is stronger, with a single mesh size 200, 220, 240 and 280 mm used as most effective (stretch/diagonal measurement in Portugal, i.e. 100, 110, 120 and 140 mm knot-to-knot according to CEN mesh size measurement; 80, 100, 110, 120 mm knot-to-knot gillnets for this purpose used in Italy). Even with this type of gillnets the by-catch is usually above 80%, most of this by-catch is constituted by large invasive fish, such as common carp (*Cyprinus carpio*), pikeperch (*Sander lucioperca*) and gibel/Prussian carp (*Carassius auratus* taxonomic group). Notwithstanding, in particular cases, mesh sizes can be optimized to decrease considerably the by-catch proportion of native species and capture mostly non-native species, or even increase the probability of capturing catfish. It has to be also kept in mind that gillnets are extremely destructive to fish (some species are not able to survive when entangled), and *vice versa*, especially larger fish are very destructive to gillnets (when entangled, they can completely destroy a reasonable piece of the net – particularly large carp, large catfish). Another negative aspect is that this technique in run-of-river reservoirs often become covered by floating aquatic vegetation which increases the time spent in gear cleaning and decreases dramatically gillnet efficacy. Nevertheless, due to this easiness of using gillnets and the familiarity of this technique by commercial fishermen this could be easily implemented.

Despite noticeable disadvantages, large mesh-sized gillnets could be recommended for catfish reduction and eradication in most LIFE Predator sites (Portuguese reservoirs or Lake Maggiore in particular).

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catch efficiency - gill nets
Fig. 6a
Fish Ecology Unit
60-80% by-catch
Žlutice Reservoir

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PREVENT, DETECT AND COMBAT THE SPREAD OF SILURUS GLANIS IN SOUTH EUROPEAN LAKES TO PROTECT BIODIVERSITY
CEN gillnets
(examples of fish catch)
Fig. 6b
Fish Ecology Unit
photo: Jiří Peterka

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PT gillnets
Fig. 6c
Meimoa Reservoir (April 2024)
Cedillo Reservoir (April 2024)

7. Long-lines (passive method, highly selective; Fig. 7a, b, c)

This old method is adopted from the marine environment where it is traditionally used for fishing for largest predatory fish like tuna, swordfish, sailfish, marlin or shark, i.e. targeting specifically the trophic level represented by catfish in fresh waters of Europe (cf. Fig. 7c). The method is highly selective to catfish and could be even more selective when large bait fish are used (>20-30 cm TL). Usual by-catch is much less than 10%, in some study sites zero (Campagna, Cedillo – Ponsul branch) or close to zero (Belver, Meimoa, Cedillo, Avigliana Grande – in all cases targeting other non-native predatory fish species). The only other significant target species by this method could be the pike (*Esox* spp.) when large individuals, over 70 cm TL, are present in the system. This by-catch in some of the studied areas is positive thing once these species (e.g. pikeperch, perch, pike) are also non-native to Portugal, Spain and other regions. In case of Italian lakes and *Esox cisalpinus*, the species of conservation concern, the by-catch of this species could be eliminated by using a bunch of earthworms instead of fish as a bait (see Vejřík et al. 2024 – Heliyon). However, gaining significant mass of earthworms is time consuming, keeping them alive in warm Mediterranean climate is challenging, and buying them is costly. Similarly, capturing the bait fish in quantity and quality (minimum size) could be demanding and limiting in some cases. This is clearly a limiting factor observed in Belver and Meimoa reservoirs, due to their lower fish productivity. Moreover, according with national legislation, to use longlines in Portugal with live bait warrants a specific license to be issued by national authorities. Following this, it has to be also kept in mind that using live fish as a bait is roughly 10 times more efficient compared to using dead fish. At some water bodies the catch could be then 4 - 6 kg of catfish per bait per 24 hours of exposition (overnight in fact). Long-lines target larger catfish than any other sampling method, even the largest individuals in the system (Fig. 7c). They also enable save removal of such a fish from the water body (unlike e.g. spear fishing, see below).

For all the details of long-line set-up, use and efficiency see the work of Vejřík et al. (2024) published in *Heliyon*, or previous works published in *Scientific Reports* (2017), *Journal of Environmental Management* (2019) or *Advances in Animal Science and Zoology* (2019).

Long-lines could be recommended for catfish capturing and eradication at any lake or reservoir systems where the open water is present (free pelagic habitat in a reasonable distance from any obstacles where the caught catfish could be further entangled and lost finally).

PREVENT, DETECT AND COMBAT THE SPREAD OF SILURUS GLANIS IN SOUTH EUROPEAN LAKES TO PROTECT BIODIVERSITY

catch efficiency – **long-lines**

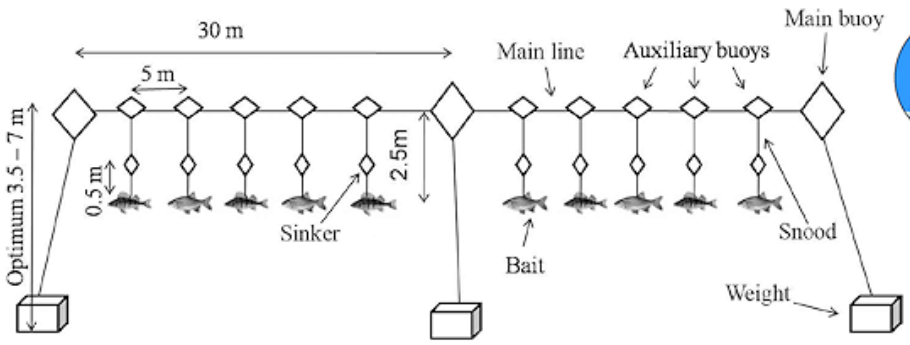

Fig 2. The scheme of longlines, fishing method used for catfish sampling in Milada and Most Lakes.

doi:10.1371/journal.pone.0169000.g002

Fig. 7a

<10% by-catch

Vejřík et al. (2017a, b, 2019, 2024)

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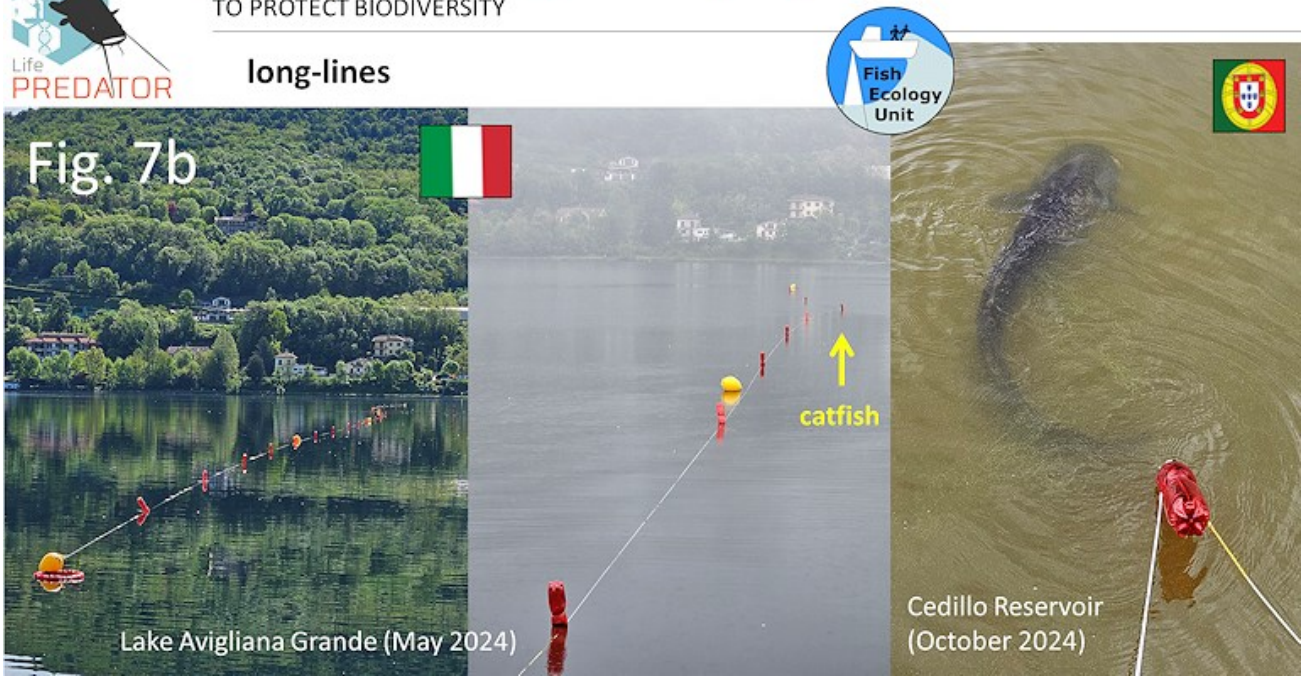
long-lines

Fig. 7b



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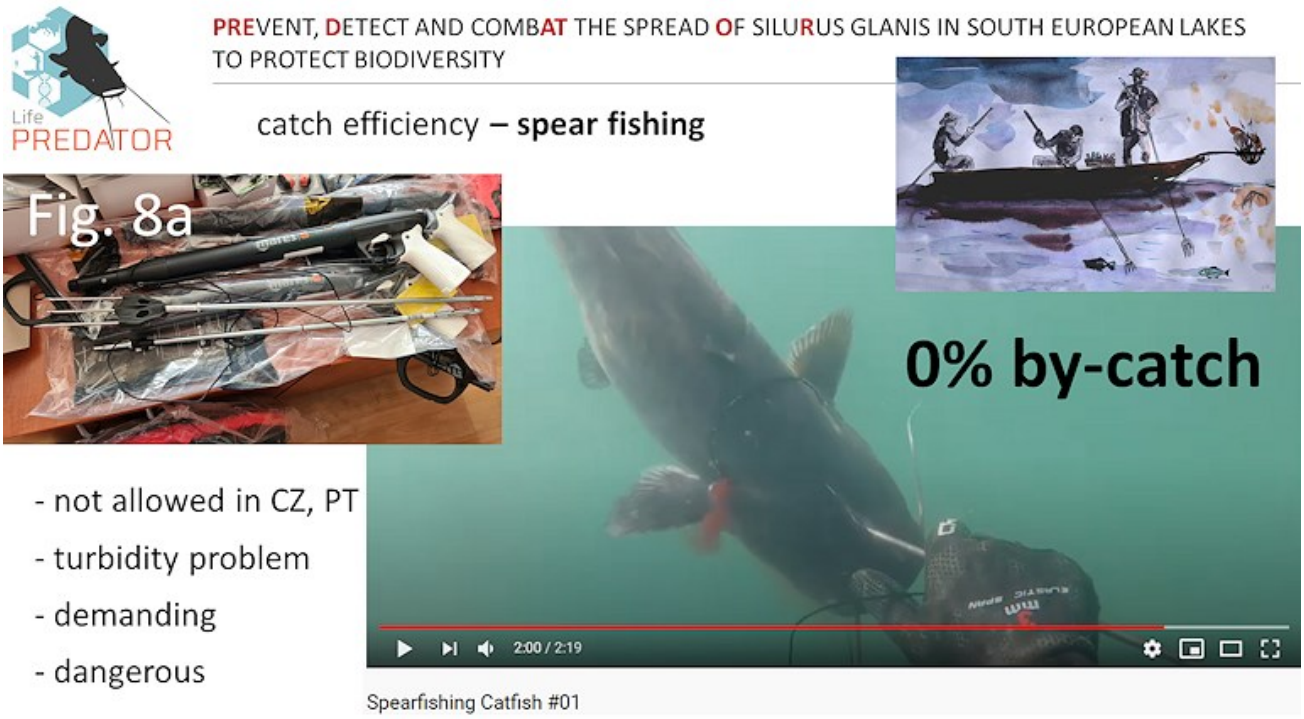
The largest fish caught in Portuguese freshwaters ever...
long-lines
Fig. 7c
Fish Ecology Unit
228 cm
91.5 kg
Cedillo Reservoir
Ponsul branch
15 October 2024

8. Spear fishing (active method, extremely selective; Fig. 8a, b, c)

This old method is adopted from the marine environment where it is traditionally used for fishing along the shore, on cliffs and reefs for a variety of valuable fish species. The method is forbidden in the Czech Republic (ethically inacceptable for both government and public) and Portugal, being too efficient and extremely destructive to fish populations. It is used, however, for catfish yield in eastern European countries like Russia and Ukraine. In Italy, spear fishing in freshwaters is restricted to some limited areas, but it is considered to be useful for fish control purposes. The main limitation of the method is the water transparency, which is (e.g.) a problem in many Iberian reservoirs, and the hunting skills of the snorkeler/diver. Capturing of large individuals could pose a significant danger to the snorkeler/diver when the fish is not killed immediately (bad shot out of the spine or head).

The method could be recommended for catfish capturing and eradication in clear water lakes (e.g. Maggiore, Avigliana Grande), including official spearfishing tournaments, which have an increasing popularity worldwide (including World Championships in freshwater spear fishing). It might be possible in Meimoa reservoir although needs special permits by national authorities.



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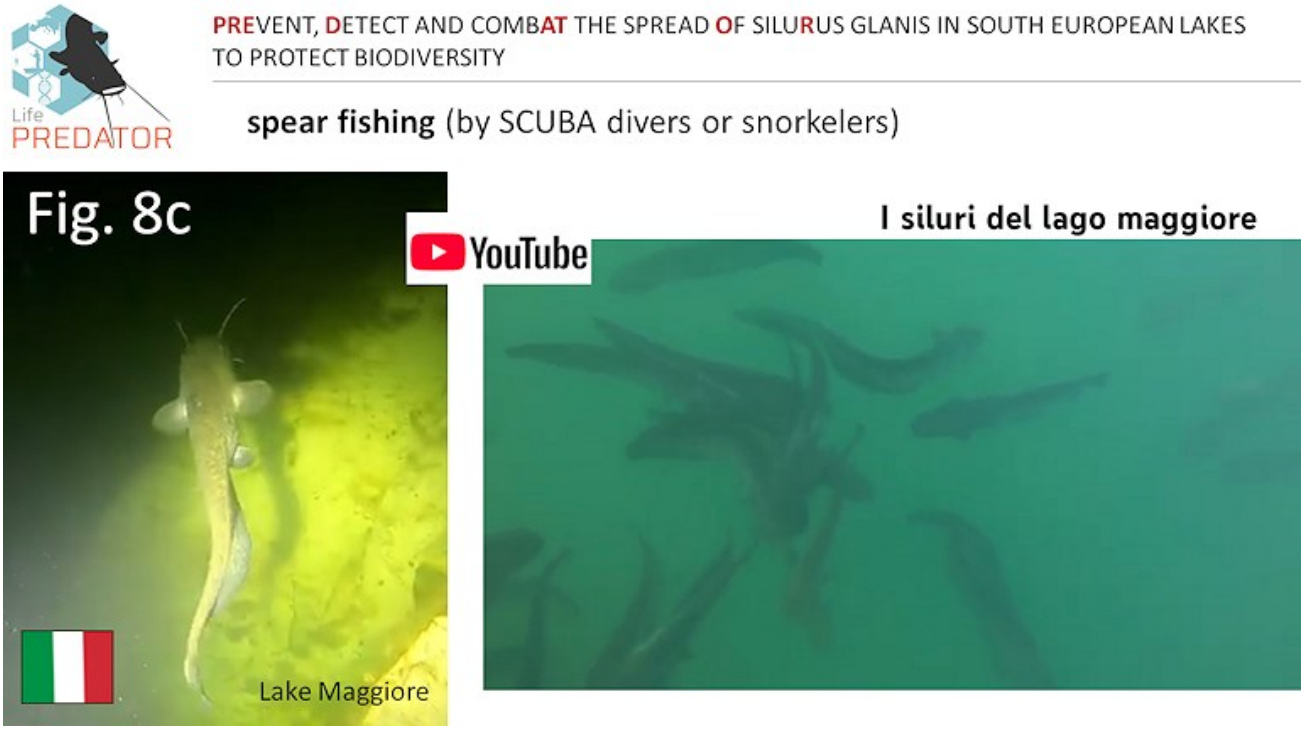
spear fishing (by SCUBA divers)
Fish Ecology Unit
Fig. 8b
Lake Avigliana Grande (May 2024)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spear fishing (by SCUBA divers or snorkelers)
Fig. 8c
Lake Maggiore
YouTube
I siluri del lago maggiore

9. Specialized catfish anglers (passive method, selective; Fig. 9)

The specialized catfish anglers could be utilized for catfish reduction e.g. within the officially organized catfish tournaments. Since this is a specific community of anglers, very much focusing on trophy fishing and broadly applying the “catch and release” approach to the fish through Europe, the involvement of this community may also resulted in: 1) targeting other predatory fish species, 2) focusing on exceptional catfish catch only, 3) releasing of catfish catch, exceptional catch particularly, 4) spreading the catfish specimens to other localities.

This method could be recommended with some reservation (particularly limited to local fishing societies, at least in Italy). Currently, in Portugal there are some pilot studies being developed in 2025.

Summary

When selecting for the best method of catfish sampling several factors have to be taken into consideration: gear selectivity (i.e. amount of by-catch), yield efficiency, man-power and equipment availability (and cost), know-how and skills of the crew, legislation (regional, national, EU). Also conditions in individual water body like water current, presence of macrophytes, boat traffic or public use have to be kept in mind. Considering all these constraints and limitations, three methods could be recommended as a reasonable, general standard for catfish reduction and eradication in south Mediterranean lakes and reservoirs (despite all their negative aspects): long-lines (p. 17-19), large mesh-sized gillnets (p. 14-16), and electrofishing (12-13). In specific periods of the year, also fyke nets (p. 10-11) could be a promising tool for catfish mass sampling (Table 1). Other methods are either problematic (spear fishing, anglers) and have to be recommended with caution or non-effective (e.g. beach seine, purse seine, CEN gillnets) and could be not recommended for this specific purpose.

Table 1. A general summary of active and passive methods recommended as effective for catfish (*Silurus glanis*) capture in south Mediterranean water bodies. The most suitable methods are in bold. It has to be kept in mind that individual sampling methods are site dependent and their usage could differ e.g. with the season and presence/absence of macrophytes, holidaymakers, waterbirds, etc., and with the fish stock and presence/absence of valuable or endangered fish species. A – anglers (specialized), E – Electrofishing, F – fyke nets and traps, G – gillnets (large mesh but not CEN), L – long-lines, S – spear fishing.

Lake/reservoir typology	Active methods	Passive methods
Large deep lakes	E, S	**G**, L, F, A
Large shallow lakes	**E**	**G**, **F**, L, A
Small deep lakes	**E**, S	**L**, A
Small shallow lakes	**E**	**L**, F, (**G**), A
Large reservoirs	E	**L**, G, F
Small reservoirs	**E**	**L**, **G**, A

Sommario

Quando si deve scegliere il metodo migliore per la cattura del siluro devono essere presi in considerazione molteplici elementi: la selettività dello strumento (ad es. la quantità di catture accessorie e non desiderate), l'efficienza di prelievo, il numero e l'impegno orario degli addetti alle operazioni, la disponibilità della strumentazione e i suoi costi, l'esperienza e le capacità del personale coinvolto, le normative locali, regionali, nazionali, europee. Inoltre occorre prendere in considerazione anche le condizioni del corpo idrico nel quale si intende agire: correnti, presenza di piante acquatiche, traffico di imbarcazioni pubbliche e private. Considerando tutti questi elementi, per l'eradicazione o la riduzione del siluro nei laghi naturali e artificiali dell'Europa meridionale si possono consigliare tre metodi: palamiti o palangari (Long-lines, p. 17-19), reti branchiali a grandi maglie (p. 14-16) e elettropesca (p. 12-13). In specifici periodi dell'anno anche le nasse possono essere utili per catturare una biomassa significativa di siluro (Tabella 1). Altri metodi di cattura possono essere più problematici o difficili da gestire (ad es. la pesca subacquea o la pesca sportiva) e devono essere valutati attentamente; altri ancora possono essere del tutto inefficaci (ad es. reti a circuizione tirate da riva, o reti branchiali CEN) e non sono consigliabili quali metodi specifici per la cattura del siluro.

Tabella 1. Sommario generale dei Metodi che risultano più efficacy per la cattura del siluro (Silru glanis) nei corpi idrici presenti nell'Europa medirionale. I Metodi Migliori e più adatti sono evidenziati in grassetto. Occorre tenere a mente che l'utilizzo di ciascun metodo è vincolato al sito dove vengono svolte le operazioni, alla stagione, alla presenza o assenza di piante acquatiche o uccelli acquatici, ai turisti, e non in ultimo alla presenza di specie ittiche di interesse conservazionistico. A – Pescatori specializzati (Anglers), E – Elettropesca (Electric fishing), F – nasse (Fyke nets e Traps), G – reti branchiali a maglie larghe (Gillnet not CEN), L – palamiti (long-lines), S – pesca subacquea (spear fishing)

Laghi naturali e artificiali	Metodi attivi	Metodi passivi
Laghi grandi e profondi	E, S	**G**, L, F, A
Laghi grandi e poco profondi	**E**	**G**, **F**, L, A
Laghi piccoli e profondi	**E**, S	**L**, A
Laghi piccoli e poco profondi	**E**	**L**, F, (**G**), A
Laghi artificiali grandi	E	**L**, G, F
Laghi artificiali piccoli	**E**	**L**, **G**, A

Resumo

A seleção do melhor método de amostragem de peixe-gato-europeu, também conhecido com siluro, deve ter em conta vários fatores: a seletividade do equipamento (i.e. quantitativo de *bycatch* de outras espécies); a eficiência na capturabilidade; a disponibilidade de mão-de-obra e equipamento, bem como o seu custo operacional; o conhecimento e competência da equipa operacional, e a legislação (regional, nacional e Europeia). É também necessário ter em conta as condições locais das massas de água, como o caudal, a presença de macrófitas, o tráfego fluvial ou o uso público da massa de água. Considerando estas condicionantes, três métodos podem ser recomendados como padrão geral e praticável com vista à redução populacional ou erradicação de peixe-gato-europeu em lagos e albufeiras do sul do Mediterrâneo: os palangres (p. 17-19), as redes de emalhar de malha grande (p. 14-16) e a pesca eléctrica (12-13). Em períodos específicos do ano, também o botirão (*fyke-nets*, p. 10-11) pode ser uma ferramenta promissora para a captura em massa de peixe-gato-europeu (Tabela 1). Outros métodos são pouco aplicáveis (pesca submarina, pescadores lúdicos) e devem ser recomendados com diversas reservas ou, então, não são de todo eficazes (por exemplo, redinhas, redes de cerco, redes de emalhar de norma CEN) e, consequentemente não podem ser recomendados para este fim específico.

Tabela 1. Sumário geral dos métodos ativos e passivos recomendados para a captura de peixe-gato-europeu (*Silurus glanis*) em massas de água lênticas do sul do Mediterrâneo. Os métodos mais adequados estão indicados a negrito. A seleção dos métodos mais adequados está dependente das características das massas de água, e a sua aplicação ser condicionada sazonalmente pela presença/ausência de macrófitas, veraneantes ou aves aquáticas mas também condicionada à presença de repovoamentos piscícolas e presença/ausência de espécies piscícolas economicamente importantes ou ameaçadas. PLD – Pescadores Lúdico-desportivos (especializados), PE – Pesca Elétrica, AeB – Armadilhas e Botirão, RE – Redes de Emalhar (Malha larga, exclui redes de Norma CEN), PAL – Palangres, Csub – Caça Submarina.

Tipologia de Massa de Água	Métodos Ativos	Métodos Passivos
Grandes lagos e profundos	PE, Csub	**RE**, PAL, AeB, PLD
Grandes lagos e pouco profundos	**PE**	**RE**, **AeB**, PAL, PLD
Pequenos lagos e profundos	**PE**, Csub	**PAL**, PLD
Pequenos lagos e pouco profundos	**PE**	**PAL**, AeB, (**RE**), PLD
Grandes albufeiras	PE	**PAL**, RE, AeB
Pequenas albufeiras	**PE**	**PAL**, **RE**, PLD

Sampling strategy for selected lakes and reservoirs

Italian lakes

Lake Maggiore (large and extremely deep lake – 212.5 km^2, max. depth 372 m, steep stony or rocky banks as well as shallows with beds of emerged macrophytes, huge pelagic zone)

Large and deep gillnets of professional fishermen could be recommended (not the CEN gillnets) for catfish reduction in the open water of the lake.

Long-lines could be used as a supporting method of catfish reduction in shallower areas of large bays (Verbania, Locarno, Ispra, etc.), with at least 100 hooks exposed daily in each suitable part of the lake. The by-catch of other predatory fish species could be reduced by using a bait fish >20 cm TL or earthworms.

Electrofishing of the shallow shoreline with the beds of emerged macrophytes or of rocky artificial zones (with refuges) could be recommended as a supporting method of catfish reduction in the lake.

Fyke nets installed in shallow bays parallel to reedbeds could be also recommended as a supporting method of catfish reduction in the lake, especially at the time of catfish pre-spawning period.

Spearfishing catfish tournament could be recommended as a supporting method of catfish reduction in the lake using both snorkelers and SCUBA divers since, according to SCUBA divers, catfish are present there around the steep rocks and in caves at least to a depth of 70-80 m (Fig. 8c; https://www.youtube.com/watch?v=TQz5xKOsL_0&t=488s

or https://www.youtube.com/watch?v=SNgjX3nV6M4&t=34s).

Anglers' catfish tournament could be recommended as a supporting method of catfish reduction in the lake since specialized anglers are highly effective in fishing for this trophy fish (see e. g. Catfish World by Yuri Grisendi on Facebook or YouTube).

The last two methods are recommended for this large lake system from two main reasons: 1) Lake Maggiore is in highly populated area, which represents an unique opportunity for public relation of LIFE Predator project and idea/knowledge dissemination, and 2) both spear fishermen and anglers can be easily controlled that they really do what they have to do by e. g. a public science.

Lake Campagna (small lake - 10 ha, shallow, extensive and diverse natural shoreline, limited pelagic zone)

Electrofishing of the shoreline of the whole lake seems to be extremely efficient especially at the time of catfish pre-spawning and spawning periods which could be simply identified by black locust

tree (*Robinia pseudoacacia*) blooming. In this period, the catfish reduction by 90%, or even more, could be reached within less than one week of intensive electrofishing.

Long-lines could be used as a supporting method of catfish reduction, with at least 25 hooks exposed daily and changing the position of the line each third day of exposition. Sunfish (*Lepomis* sp.) and bass (*Micropterus* sp.) could be used as a bait (no by-catch recorded during the sampling by the Czech BCCAS team, pike *Esox cisalpinus* seems to be no more present in the lake, possibly due to a predation by catfish).

Gillnets are not recommended from following reasons: 1) useless by-catch which has to be processed, 2) dangerous structures (trees e.g.) in the lake, 3) presence of large common carps (usually 5-10 kg) which will destroy the nets.

Lake Avigliana Grande (middle sized lake - 107 ha, relatively deep, circle shaped with relatively limited shoreline, 1/2 man-made, and extensive pelagic zone)

Long-lines could be used as a main method of catfish reduction, with at least 25-50 hooks exposed daily per one month (or two separated 14 days periods within the growing season) and changing the position of the line/lines each 3-4 days of exposition. Sunfish and bass could be used as a bait (no by-catch of pike *Esox cisalpinus* recorded during the sampling of the Czech team, although some last individuals were still present in the lake according to the BCCAS electrofishing results and SCUBA diving monitoring).

Electrofishing could be used as an efficient supporting method of catfish reduction in very shallow water in between deposited branches and woody debris, littoral vegetation and especially in stony bank structures which is the habitat where small catfish (up to 40 cm TL) are hidden.

Gillnets are not recommended from following reasons: 1) useless by-catch which has to be processed, 2) dangerous structures (trees e.g.) in the lake, 3) presence of extremely large common carps (up to 30 kg!!) which will destroy the nets completely, 4) significant public traffic on the lake.

Note: In this lake a spearfishing tournament and anglers' tournament for catfish reduction should be considered.

Lake Comabbio (middle sized lake - 340 ha, shallow) – GRAIA sampling strategy adopted

Electrofishing: this technique was very effective in containing the catfish in Lake Comabbio. The characteristics of the riparian belt in some areas express a good number of refuges suitable for this species and not being particularly wide allows one to be incisive with this type of fishing. The environments to be sampled must have medium-deep water (50-100 cm) up to the shore and a good number of refuges represented mainly by undercut (clumps of floating *Phragmytes*) and plants in the water. The most profitable period in terms of catching fish is the late autumn, winter

and early spring (December to May) before the laminetum expands, making the undercut unreachable and leaving numerous escape routes for the fish.

Gill nets: this fishing technique has also proved very effective. The nets used must have a mesh size of no less than 80 mm in order to ensure a certain selectivity in catches. In particular, the best yield is observed with meshes of 100, 110 and 120 mm in diameter. The nets will be positioned in the middle of the lake in the October-January period (mesh size ≥ 80mm) and in the sublittoral area in the October-December and April-May period (mesh size ≥ 100mm). The use of nets as a catching tool for the catfish can be successfully carried out throughout Lake Comabbio.

Lake Sirio (small lake - 29 ha, relatively deep – max. depth 43.5 m, circle shaped with relatively limited shoreline, partly artificial)

Since the Czech BCCAS team did not do any sampling of this lake, it can hardly provide any particular suggestion for this system (unless the general conditions are the same or similar to either Avigliana Grande or Campagna).

Note: Since all the Italian lakes are in heavily populated areas, in all these systems, some type of controlled anglers' competition to reduce the catfish numbers could be applied.

Portuguese reservoirs

International Cedillo Reservoir (Tagus River, large reservoir - 1400 ha, canyon-shaped, relatively deep, with large reservoir branches and numerous small tributaries, natural shoreline of steep rocks and boulders)

Long-lines could be recommended as the main method of catfish reduction in the reservoir (invasive species, e.g. Prussian carp, bass, sunfish, catfish, pikeperch etc. as a bait), targeting middle and especially large sized individuals. This method could be implemented by a specialized team done by researchers and in the future applied by park rangers aided by commercial fishermen.

Portuguese gillnets could be recommended (not the CEN gillnets) as a complementary method of catfish reduction in the reservoir (in co-operation with local professional fishermen), targeting mainly middle sized individuals. Nevertheless, the tests reveal gillnets having a by-catch higher than 95%, being almost a quarter of those, native species. Thus, mesh sizes should be large enough to minimize native species by-catch, considering that there is a relation between mesh size and the proportion of native and alien species captures. The larger the mesh size the lower the proportion of native fish (MARE, unpubl. data). There is an enormous advantage in using this, because commercial fishermen could actually help in targeting directly invasive fishes, and in particularly the catfish. However, in the main channel of the Tagus River located in run-of-river reservoirs (Cedillo, Fratel and Belver) there is a high risk of net loss due to woody debris or floating vegetation covering the net and reducing the catches. These negative factors could be minimized by setting nets in some tributaries and bays (more frequent in Cedillo, than in Fratel and Belver), or setting the nets diagonally to the main flow. Net depth should take in to account the catfish depth and activity patterns described by Santos et al. (2024 – Ecology of Freshwater Fish), where is more recommend to set the nets between April and October mostly at surface areas (less than 5 meters deep).

See Project Youtube video at the link below (Italian, Portuguease and Czech version also available there):

https://www.youtube.com/watch?v=pmYAWUNkWpM

Electrofishing of the stony shoreline could be recommended as a supplementary method for fishing for small sized catfish individuals (0+ and 1+ fish particularly).

Fyke nets and traps could be recommended as a supplementary method for catfish reduction to be installed in small tributaries in period of mass cyprinid spawning.

Fratel Reservoir (Tagus River, large reservoir - 1000 ha, canyon-shaped, relatively deep, with large reservoir branches and numerous small tributaries, natural shoreline of steep rocks and boulders)

Similar sampling protocol as suggested for Cedillo but see the previous note about gill nets.

Belver Reservoir (Tagus River, middle-sized reservoir - 286 ha, canyon-shaped, relatively deep, with reservoir branches and numerous small tributaries, natural shoreline of steep rocks and boulders)

Similar sampling protocol as suggested for Cedillo but see the previous note about gill nets (the same problem like in Fratel).

Anglers' catfish tournament could be recommended as a supporting method of catfish reduction in the reservoir, however, with reservation.

Meimoa Reservoir (Tejo River basin, middle-sized mountain reservoir - 240 ha, canyon-shaped, deep, with relatively small tributaries, natural shoreline of steep rocks and boulders as well as gentle shores)

Similar sampling protocol as suggested for Cedillo. In case of gillnets, the risk of gillnet loss and vegetation degradation is minimal, comparatively to run-of-river reservoirs (such as Cedillo, Fratel and Belver). The limiting factor is currently the low catfish density.

Anglers' catfish tournament could be recommended as a supporting method of catfish reduction in the reservoir, however, with reservation.

Note: The anglers' catfish tournament should be considered for Belver and Meimoa, since these reservoirs are well accessible and used by anglers for fishing. In contrast, e.g. in Cedillo (Parque Natural do Tejo International), this attempt seems to be risky and has a strong potential to cause more problems than benefits.