The European catfish can live for at least fifty years.

Invasive Alien Species native to parts of the EU:

The European catfish (*Silurus glanis*)

Scientific name(s)	*Silurus glanis* Linnaeus, 1758
Common names (in English)	European catfish, wels catfish, sheatfish
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1.1. Native range within the EU

The current native distribution of the European catfish, *Silurus glanis*, extends from Germany eastwards to Poland, up to Southern Sweden and down to Southern Turkey and north Iran, stretching through the Baltic States to Russia and to the Aral Sea of Kazakhstan and Uzbekistan (Copp *et al*., 2009). Cucherousset *et al*. (2018) have drawn up a map of its current native and introduced range. Archaeological evidence demonstrated that *S. glanis* was originally native to parts of Belgium, the Netherlands and France (Scheldt and Meuse basins). In late medieval times (12th century), the European catfish became extinct over much of its westernmost distribution area; however, relic populations persist today in southern Sweden, on the island of Sjælland in east Denmark, and in the north-western part of the Netherlands (van Neer and Ervynck, 2009). The records of *S. glanis* from the 1970s onwards outside these relict populations do not reflect a natural expansion, but correspond to specimens that were imported from Central Europe for breeding experiments and that escaped, or that were released intentionally for sports fishing (Verreycken *et al*., 2007; Van Neer and Ervynck, 2009). CABI (2019) reports the following EU countries to belong to the species native range: Austria, Bulgaria, Czechia, Estonia, Germany, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, and Sweden. Piria *et al*. (2016) indicate that the European catfish is both native and non-native in Croatia. Additionally, Urho and Lehtonen (2008) mention this species to be native and endangered in Finland.

1.2. Alien distribution within the EU

The European catfish was introduced in the UK (Copp *et al.*, 2009), North Italy (Lanzoni *et al.*, 2018) and Central Italy (Gualtieri and Mecatti, 2005). Thirty-two juveniles were illegally introduced by a German biologist and angler in the Ebro (Spain) in 1974 (Rodriguez-Labajos *et al.*, 2009). Abundant populations have now established in at least four river basins of that country (Copp *et al.*, 2009), where it is categorised as invasive (Carol, 2007; Carol *et al.*, 2009). It was also introduced in Portugal and first recorded in 2015 (Gkenas *et al.*, 2015). Croatia and Slovenia report both native and non-native populations that were translocated from the Danube to the Adrian basin (Piria *et al.*, 2016). In both countries the species gained a high FISK-score, likely posing a high risk of being invasive. It was illegally introduced in Belgium (followed by natural reproduction) (Verreycken *et al.*, 2007) and France (Valadou, 2007). The introduction of *S. glanis* to the Netherlands (from Hungary) was as a biocontrol agent for regulating cyprinid fish numbers and resulted in their accidental escape and dispersal to other waters (Copp, 2009). EU countries where *S. glanis* was reported to have been introduced, other than those mentioned above, are Denmark, Cyprus and Finland; however, the species appears to be now absent from the latter two (CABI, 2019). Urho and Lehtonen (2008), on the contrary, report that the species is native in Finland and still present. In Greece, *S. glanis* is both native and introduced (Economidis *et al.*, 2000), as is the case in Sweden, where natural populations of *S. glanis* have survived in three main areas: Emån, Möckeln and Båven. The fish has also been re-introduced to the lower Helgeå, and has likely been illegally introduced in an unknown number of lakes (Östby, 2018).

The situation in Luxembourg is unclear: Freyhof and Brooks (2011) report it to be native to Luxembourg; on the other hand, neither CABI (2019) nor Fishbase (Froese and Pauly, 2019) mention *S. glanis* to belong to the freshwater fauna of this country. The website 'neobiota.lu'[1] also does not refer to this species as non-native; however, introduced specimens of *S. glanis* are probably present in the Luxembourg part of the Moselle River, since they also frequently occur in the French part of this river (Valadou, 2007).

1.3. Status in EU Member States and the United Kingdom

AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
1	4	1		1	1	4	1	4	3	1	4	4	1
IE	**IT**	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SL**	**SK**	**UK**
	3	1	6	1		4	1	3	1	4	4	1	2

Presence codes: 1 – Native present; 2 – Alien; 3 – Alien invasive (i.e. evidence of impact); 4 – Both native and alien; 5 – Both native and alien invasive (evidence of impact); 6 – Cryptogenic.

Country names: AT – Austria; BE – Belgium; BG – Bulgaria; CY – Cyprus; CZ – Czechia; DE – Germany; DK – Denmark; EE – Estonia; EL – Greece; ES – Spain; FI – Finland; FR – France; HR – Croatia; HU – Hungary; IE – Ireland; IT – Italy; LT – Lithuania; LU – Luxembourg; LV – Latvia; MT – Malta; NL – Netherlands; PL – Poland; PT – Portugal; RO – Romania; SE – Sweden; SL – Slovenia; SK – Slovakia; UK – United Kingdom.

1.4. Areas within the EU where the subspecies is a potential threat, but not yet present

Ireland, Malta and Cyprus, the only EU countries where the species is not present, could be in danger of illegal stocking of *S. glanis* by anglers. However, being islands, these countries can better regulate the import of unwanted fish species, so should not be at great risk.

European catfish in a former surface mine near Leipzig, Germany.

2. Pathways of introduction

Their extremely large body size has resulted in *S. glanis* being an increasingly popular target species for recreational anglers in Europe, resulting in their intentional introductions into some western and southern European countries (Cucherousset *et al*., 2018). Another reason for *S. glanis* introductions has been as a biocontrol agent for regulating cyprinid fish numbers, while other specimens of European catfish have entered new areas from neighbouring countries as escapee fish of aquaculture facilities (Copp *et al*., 2009).

3. Significant impacts on biodiversity

Copp *et al*. (2009) conclude, in their review of *Silurus glanis*, that the existing evidence suggests that *S. glanis* is an opportunistic scavenger and, as such, does not appear to present a particularly great threat where introduced. The species greatest potential impact as a predator may be in Iberia and in other southern European countries, where a high endemism of small-bodied fish species is combined with an absence of native piscivorous fishes. In Greece, evidence (Paschos *et al*., 2004) suggests that *S. glanis* is able to hybridise with its congener *S. aristotelis* (Aristotle's catfish), which is listed in Annex II of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. After the establishment of *S. glanis* in the lowland backwaters of the Po River in north-eastern Italy, some native species significantly declined in abundance and biomass (i.e. *Alburnus arborella* and *Scardinius erythrophthalmus*) or disappeared (i.e. *Rutilus aula* and *Tinca tinca*) (Castaldelli *et al*., 2013). In SW France, Boulêtreau *et al*. (2018) report predation by European catfish on adults of Atlantic salmon *Salmo salar* in a fishway of the River Garonne. Previously, adult salmons were invulnerable to predation, because no predators were large enough to predate on them. In the same river, they also feed on another anadromous fish, the allis shad (*Alosa alosa*) (Syväranta *et al*., 2009). Also in France, Cucherousset *et al*. (2012) report the occurrence of a beaching behaviour used by *S. glanis* to capture birds on land (i.e. pigeons, *Columbia livia*). Guillerault *et al*. (2015) conclude that the European catfish in France may, in a few cases, impact fish communities or populations, but it does not appear to be responsible for a countrywide collapse in fish assemblages.

The European catfish is one of the rare species that feeds on perch (*Perca fluviatilis*) egg strands. The utilisation of these strands broadens the catfish diet niche width and represents an advantage against other fish predators. At least in localities where food sources are limited, multilevel predation by catfish may have an important impact on perch populations (Vejřík *et al*., 2017).

The human-assisted movement of *S. glanis* also provides a clear avenue for the introduction and spread of non-native parasites and diseases into new areas (Reading *et al*., 2012).

The European catfish prefers to remain in sheltered locations such as holes in the riverbed, sunken trees, etc.. © Harka, Akos. CC BY 3.0.

4.1. Measures to prevent introduction of the species

Measure 1: Adoption and enforcement of appropriate legislation

As the spread of European catfish is likely to continue due to illegal introductions, primarily for recreational angling (Cucherousset *et al*., 2018), the enforcement of appropriate legislation and codes of best practice (e.g. the European Code of Conduct on Recreational Fishing and Invasive Alien Species (Anon., 2014)) could be an effective means of limiting the risk of intentional spread of *S. glanis* by anglers between and within Member States (MS). However, the combination of the species large body sizes, making them highly attractive to specialist anglers, and their relative ease of capture, means that any regulatory framework designed to prevent further releases will be extremely difficult to implement effectively (Britton *et al*., 2011). In fact, a study about the socioeconomic drivers of *S. glanis* anglers in the UK showed that the awareness of potential risks and adverse ecological impacts associated with the species were significantly low, with only partial understanding of impacts and superficial comprehension of non-native fish legislative control measures shown by some anglers (Rees *et al*., 2017).

Several EU MS (for example, Belgium, UK, Spain) have legislation in place that prohibits the introduction of European catfish in open waters, but still many illegal introductions have been reported (Simoens *et al*., 2002; Carol, 2007; Copp *et al*., 2009).

Measure 2: Awareness raising activities, including education and training

Awareness of the threats posed by the introduction of invasive fish species (in this case *S. glanis*) by the public and key stakeholders is critical to reduce the risks of intentional (and unintentional) introductions. Fish farmers, anglers, fishery managers, governmental agencies and private fish pond owners should be informed about the risks of introducing European catfish intentionally for (trophy) angling, and unintentionally through escapes from ponds and fish farms. Providing scientifically robust information, awareness raising and training is needed for all the abovementioned stakeholder groups. The production of targeted publicity and identification materials is needed. Media campaigns can also be useful to spread awareness faster and further. Codes of best practice should be communicated in detail to the stakeholders, and promoted at a regional and national level. Information campaigns targeting anglers, and other water body users, on the threat caused by this invasive species should become widespread and be implemented for at least five years in each MS.

Long-term monitoring of the effectiveness of such awareness programmes should be applied, as well. The implementation of this measure will also diminish the chance of new introductions after eradication/management of an invasive fish species.

4.2. Measures to prevent secondary spread of the species

Measure 1: See measures in Section 4.1.

Measure 2: Prevent escapes from infested aquaculture and angling ponds

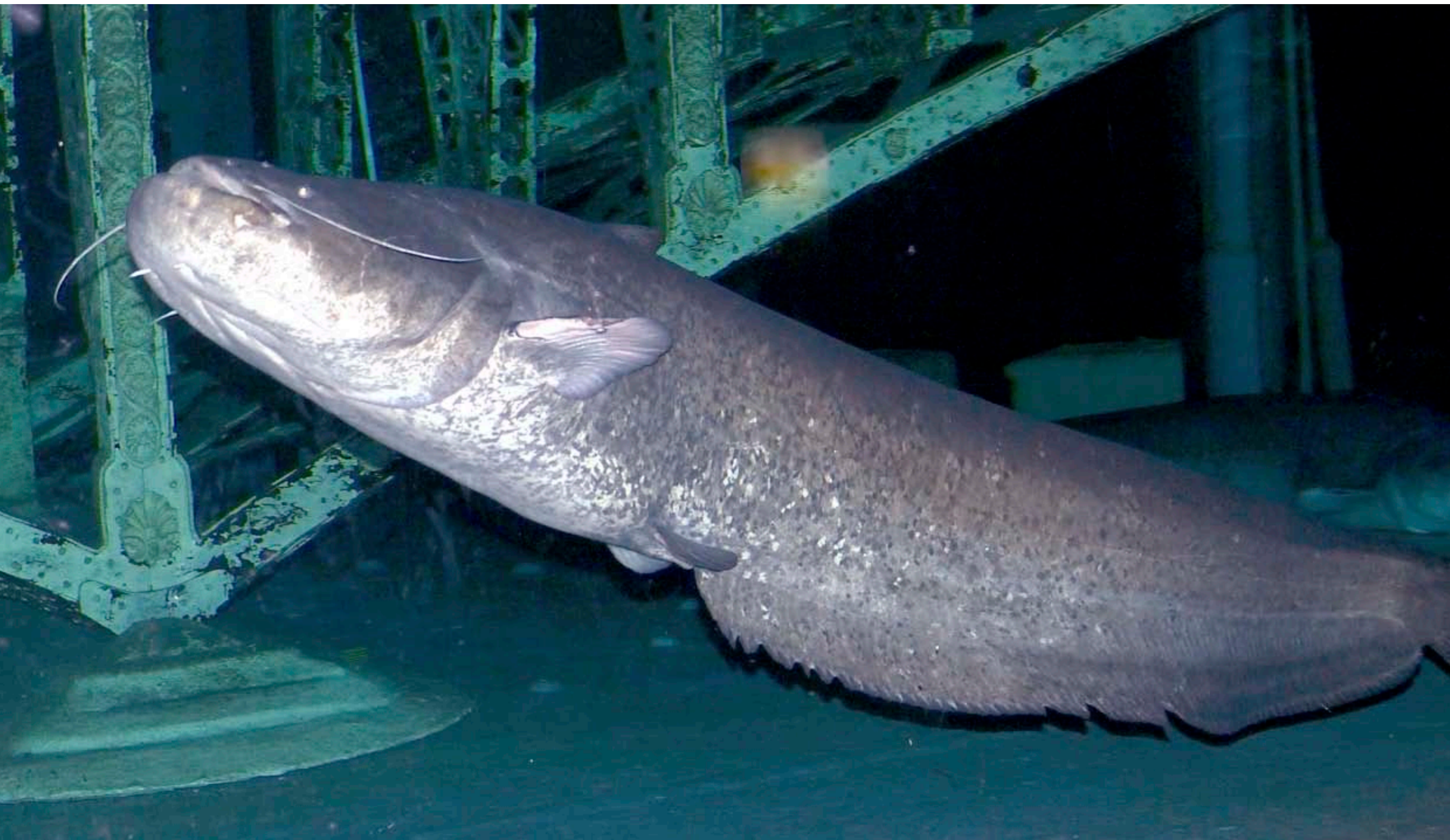
Typically, aquaculture and angling ponds are constructed on a natural water stream or canal. That water is used as a source for the fish ponds, while the surplus of water goes into the flood plain of the same stream. Reliable separation of larvae and small-sized young fish from departing water flow is a difficult task. Several multi-year studies showed that aquaculture ponds became centres of secondary distribution of invasive alien species in many regions (e.g. Beyer *et al*., 2007; Reshetnikov, 2013).

Preventing escapes of small specimens of invasive fish from infested ponds is very difficult (Reshetnikov, 2013). The installation of fine mesh screens on the outlets of ponds can prevent some escapes, but are sometimes responsible for flooding of ponds when the screens get blocked by debris and green algae (H. Verreycken pers. obs.). Therefore, screens should be regularly checked and cleaned. Special care should be taken when emptying ponds: aquaculture ponds are often emptied yearly, to harvest the cultured fish. The emptying is managed by a system of pipes that can be lowered so the water level drops, and the surplus water is guided to an adjacent canal, stream or river. Screen nets are used to prevent the escape of cultured fish, but often the meshes of these screens are not fine enough for stowaway specimens (especially larvae). Fine mesh screens should be used here, but this will tremendously slow the emptying of the ponds, thus creating economic loss (higher fish mortality, higher predation possibility, longer working times; H. Verreycken pers. obs.).

Measure 3: Effective surveillance (citizen alerts and eDNA)

The effective surveillance of existing populations of *S. glanis*, recurring to the use of different tools, can assist in reducing the spread of the species. *Silurus glanis* is a well-known species that cannot be confused with other European freshwater fishes. As such, encouraging rapid reporting by citizens of new incursions of the species increases the likely success of rapid response before the species can become established in new areas. eDNA techniques can also be used to investigate, or confirm, the presence of the species in new water bodies, possibly adjacent to already invaded ones. Parrondo *et al*. (2018) found that early warning by citizens, combined with the eDNA detection method, can be a helpful tool in the early detection of new areas invaded by *S. glanis*, allowing fast and effective management actions by stakeholders.

Camera flash reflection from the layer of tissue in the eye of an European catfish. © Bernard DUPONT. CC BY-SA 2.0.



The European catfish consumes its food in the open water or in the deep, where it can be recognized by its large mouth. © Vic Harkness. CC BY-SA 2.0.

4.3. Measures to rapidly eradicate the species at an early stage of invasion

Measure 1: Use of piscicides

Although there are no data on the use of piscicides to eradicate *S. glanis*, the use of rotenone has been successfully used for eradicating the invasive topmouth gudgeon *Pseudorasbora parva* in the UK (Britton *et al*., 2008, 2010), as well as the black bullhead *Ameiurus melas* from a small, isolated pond in Essex, England (UK Environment Agency, 2014). The use of rotenone for the control of invasive fishes is widespread in the USA (Ling, 2012; several U.S. Fish & Wildlife Service documents), and has also been successfully applied in South Africa to eradicate the invasive smallmouth bass *Micropterus dolomieu* in a 4 km reach of the Rondegat River (Weyl *et al*., 2013, 2014).

The use of piscicides may have EU/national/local legal restrictions. Rotenone was withdrawn from use in the European Union in 2007 (Schapira, 2010), but derogations are probably possible in some Member States (e.g. Britton *et al*., 2010). The potential to eradicate *S. glanis* populations depends on habitat type and the level of establishment of populations. If broadly dispersed in large lakes or river systems, eradication is probably impossible.

The use of piscicides is not species specific and kills a large amount of aquatic life, so it may be viewed as a controversial measure (Britton *et al*., 2010). As a result, its use in the USA has been challenged, halted, or discouraged by the American Fisheries Society.

4.4. Measures to manage the species once it has become widely spread

Measure 1: Mechanical removal

Standard ichthyological methods (fyke nets, electrofishing, ...) have poor capture success for European catfish (Vejřík *et al.*, 2017). Angling, on the contrary, is a very powerful technique to capture this species. Harvest of catfish has been shown to be positively correlated with angling effort; fishing grounds that displayed higher angling effort also displayed higher harvest rates of catfish (Lyach and Remr, 2019). Also Vejřík *et al*. (2019) consider angling an excellent technique for the population control of European catfish. They simulated the impact of angling on a catfish population by method of hook-lines and angling in two lakes (250 and 311 ha). Catfish were efficiently reduced to a harmless level by hook-lines and angling (depending on the approach of anglers). The time of the year when it is most efficient to apply this measure seems to be spring to early summer, with catch efficiency of 5.4 individuals per 10 baits in one day. According to their model, 11–18 bait-days, per 1 ha, per season, is sufficient to decrease catfish population to 10% of the original size. This measure may, however, be less successful in lotic systems, where active migration from neighbouring, inter-connected water catchments can occur (Verreycken, 2013).

Measure 2: Landing obligation

A landing obligation for caught *S. glanis* could be implemented. Due to their relative ease of capture (Britton *et al.*, 2011), anglers can efficiently remove European catfish from infested water bodies to an acceptable, manageable level (Vejřík *et al.*, 2019). However, for example, the obligation to kill the caught catfishes in the Ebro River, Spain, faced divided positions among the actors in charge of its implementation. While some anglers admitted the advisability of avoiding the spread of the species to other river basins, practically all of them expressed categorical opposition to the forced killing of the catches. Bioethical values and/or preservation of the sportive value of the rivers were adduced for defending a 'catch and release' policy, rather than the systematic killing of catches (Rodriguez-Labajos *et al.*, 2009). A similar opposition to landing obligation has been reported in Italy (E. Tricarico, pers. comm.).

Measure 3: Restoring hydromorphologic and thermal regimes

The European catfish is a fish of rich, weedy lakes and slow, deep lowland rivers in its native range; its preferred habitat is still waters (Copp *et al.*, 2009). In its non-native range, European catfish thrives well in anthropogenically altered, degraded habitats (Castaldelli *et al.*, 2013; Brevé *et al.*, 2014,) like reservoirs or dammed sections of rivers, especially where also the thermal regime has been changed by heated effluents of power plants (Cucherousset *et al.*, 2018). These anthropogenic activities have inadvertently created a favourable habitat that has assisted the colonisation of catfish (Brevé *et al.*, 2014). Although no scientific publications on this measure are available for *S. glanis*, it is highly probable that the restoration of natural regimes of rivers and lakes (faster flow, cooler water, removal of dams, ...) would negatively impact the populations of this non-native species.

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The European catfish is recognizable by its broad, flat head and wide mouth. © Epop. Public domain.

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