Should Zander (Sander lucioperca) be removed from British waterways?

Figure 1: A picture of a Zander (*Sander Lucioperca*) (Angling Times, 2021)

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Introduction and Background

The introduction of non-native species can lead to the establishment of sustainable populations which naturally disperse and invade (Gozlan et al., 2010). *Sander lucioperca*, commonly known as Zander or pikeperch is a large bodied piscivorous freshwater fish native to eastern Europe, from Germany to eastern and central Russia (Nolan and Britton, 2018). It is characterised by its elongated body, sharp teeth and predatory nature. Zander can grow to a meter in length and weigh over 10 kilograms with the British record Zander weighing 21lb 5oz (9.7kg) (Canal and Rivers Trust, 2021). Zander prefer habitats of slower moving water such as lakes, canals and large rivers, they thrive in both turbid and clear water conditions (Sterligova et al., 2012). Zander have excellent eyesight and are predominantly nocturnal hunters, primarily hunting smaller fish but they have been known to feed on invertebrates including shrimp, especially in their juvenile stages of life (Hempel et al., 2016).

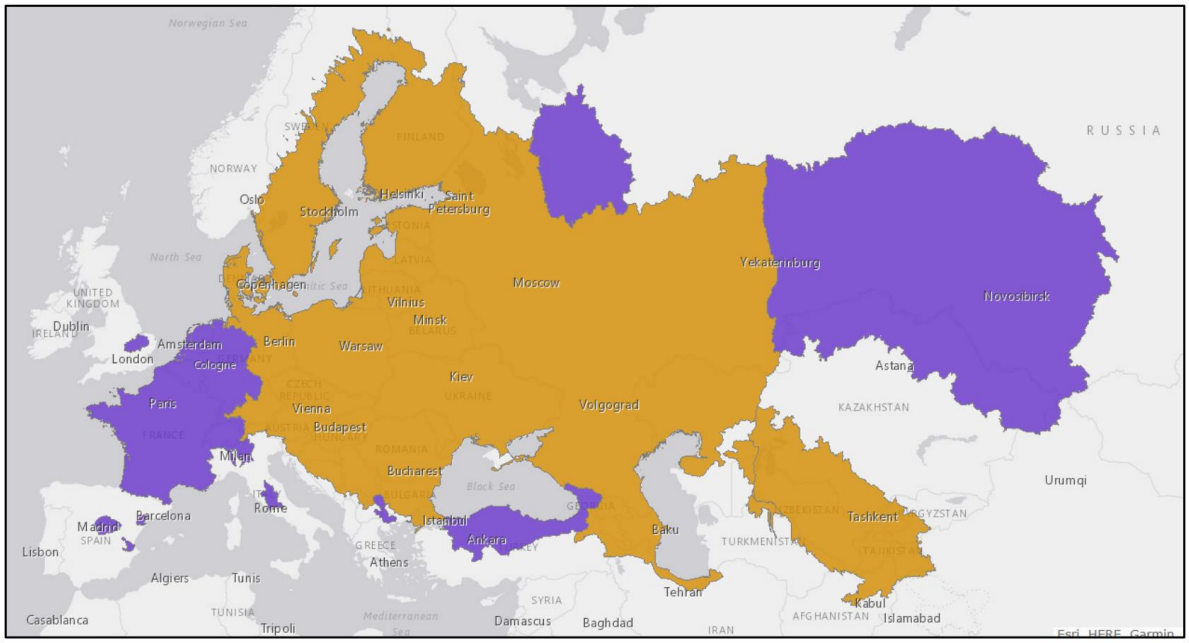

Figure 2. A map of the distribution of S. lucioperca (Davies, 2021) Mustard denotes native populations, purple is introduced populations.

In Britain, the first recorded introduction of Zander was in 1878, when 23 individuals of German origin were stocked into Woburn Abbey Lakes in the east of England by the Duke of Bedford (Copp et al., 2003). Many subsequent introductions and natural dispersion took place throughout the twentieth century. Self-sustaining populations of Zander are now widespread across central and western England, including within the River Trent and River Avon (Nolan and Britton, 2018; Nunn et al., 2007). In the United Kingdom, Zander are currently classified as a non-native invasive species making it illegal to return them once caught from any body of water (Canal and Rivers Trust, 2021).

The ecological impact of Zander in British waterways is under-researched and fiercely debated. Although it remains illegal to release Zander when caught from open waters, Nolan 2021 reported that “94% of surveyed predator anglers reported to always adopt catch-and-release practices” when catching Zander. Davies (2021), reports a degree of ambiguity surrounding the invasive status of Zander in Great Britain. It found that some studies concluded the evidence of Zander impact is equivocal. Alternatively, some studies found evidence of decline in the numbers of native fishes. Economically, Zander offer no commercial fishing value however a growing recreational market is currently established with an estimated over £20 million spent annually on recreation Zander fishing.

This paper aims to discuss whether Zander should be classified as a non-native invasive species and removed from British waterways where possible or, if they should be reclassified and how this may be possible.

Ecological Impact

The ecological impact of introduced Zander in Britain is not fully understood, however by examining their relationships with their habitats within their better-studied native range, the impact of Zander within the UK can be better understood. The presence of Zander in a waterway does have the potential to disrupt the local ecosystem and food webs. As Zander are mainly a piscivorous species, they will predate on native fish, potentially leading to a decline in their population (Nolan and Britton, 2018). This predation pressure has the potential to disrupt an ecosystem, affecting the abundance and distribution of other fish such as roach and gudgeon. Lappalainen et al. (2005) reported the use of Zander as a biomanipulation tool to reduce the number of unwanted cyprinids. Sterligova et al. (2012) found that during the first years of introduction to a new water body, there was a population outbreak of Zander which somewhat depleted the food supply and forced Zander to result to cannibalism. Campbell (1992) also highlighted how Zander can be cannibalistic with a tendency to increase in importance with lengths over 250mm. Crivelli (1995) noted the extinction of endemic species and displacement of others after the introduction of Zander to Lake Egridir, SW Antolia. Jepsen et al. (2000) revealed the predation of young trout (Salmo trutta) by Zander during their downstream migration in Dennmark. Lammens et al., (1992) showed Zander have directly affected fish community structure in Dutch lakes through predation pressure. Only roach of fork length >200mm coexisted with Zander in open water with smaller roach confined to the littoral zones of the lakes where Zander numbers were lower.

Zander may also compete for food resources with native predatory fish such as pike (*Esox Lucius)* and perch (*Perca fluviatillis*). This competition could lead to changes in the growth rates and size structures of native fishes, potentially impacting the health of aquatic communities (Gerasimov et al., 2013). Nolan, 2021 noted how Zander usually occupy higher trophic level positions than other piscivorous fishes. This shows that Zander occupy different niches to native piscivorous fishes such as pike and perch and therefore, may not always be in direct competition with these fish. Zander and pike also have different spawning habits with pike spawning on shallow weedy areas when water temperatures are between 6 and 14^{o}C (Frost and Kipling, 1967; Masters et al., 2005). Zander prefer to spawn when water temperatures are 8 – 16^{o}C and exhibit nest spawning behaviour on rocky and gravel grounds (Lappalainen et al., 2005). The introduction of Zander to a German lake caused shifts in the distribution of perch as a direct response to intraspecific competition. Changes in the distribution of roach, a common prey species of Zander, were observed in the same waterbody (Schulze et al., 2006)

Zander can also be carriers for certain parasites which could be transmitted to native fish species, potentially leading to new disease dynamics in local fish populations (Matvienko et al., 2015). This aspect is not fully understood and further investigation is needed to assess the significance of this issue.

Economic Impact

There is currently no commercial fishing operation in place for Zander within the UK however there is a recreational fishing market. It's estimated that £1.74 billion was spent annually by over one million freshwater anglers (Salado and Vencovska, 2018). The total number of days spent fishing was reported as 22.3 million and the number of days spent specifically targeting Zander was 226,000, 1.17% of the total. Assuming an equal amount of money is spent targeting different species, this equates to a total of £20.4 million spent on recreational Zander fishing. The number of days people spent fishing for Zander is low (226,000) when compared to other species such as carp, perch and pike which had 7.4, 1.8 and 1.7 million days spent fishing for them respectively. This figure may be low due to the smaller distributions of Zander in Britain when compared to other predatory fish such as pike and perch, which can be found throughout the UK and are often targeted alongside Zander.

The canal and rivers trust estimate a loss of income due to Zander to be in the range of £60,000 to £90,000 (Canal and Rivers Trust, N.D). This is largely due to angling clubs no longer wanting to lease stretches of canal containing Zander due to the ecological shift and reduction in the number of target species for the club in these areas. The trust reported an annual spending of up to £1 million on the management of non-native invasive species (Canal and Rivers Trust, N.D.), including but not limited to Zander.

As it currently stands, considerably more money is spent by anglers targeting Zander (£20.4 million), than the Canal and Rivers Trust currently loses from the presence of Zander (£60000-£90000) and spends on the removal of Zander (up to £1 million).

Table 1: Total days spent course fishing in 2015 by species (Salado and Vencovska, 2018).

Coarse fishing	Total days	Average days per angler per year
Carp	7,440,000	17
Bream	2,980,000	11
Roach	2,470,000	10
Perch	1,810,000	7
Pike	1,720,000	7
Tench	1,630,000	6
Barbel	1,550,000	6
Chub	1,230,000	5
Rudd	1,168,000	6
Crucian carp	1,013,000	5
Catfish	453,000	3
Eel	425,000	3
Dace	347,000	2
Zander	262,000	2

Current policy and actions

Zander are currently classified as a non-native invasive species (Canal and Rivers Trust, 2021) making it illegal to return Zander to the water once caught from any body of water, even those with a valid KIFR permit to hold them. Valid KIFR permits to stock Zander can be obtained if a lake or stillwater is enclosed, meaning they are not connected to any river systems. The Canal and Rivers trust are at the forefront of Zander removal in the UK. The tactics currently employed by the Canal and Rivers trust for the removal of Zander are outlined in Canal and Rivers Trust (N.D.). They focus on aiding native fish stock recovery and halting further migration of Zander to other areas of the canal and river network, protecting Sites of Special Scientific Interest (SSSIs). The trust deem the eradication of Zander to be logistically challenging and expensive however it has not been ruled out as a future option. The trust currently follow guidance from Phil Smith who concluded in the 1990's that electric fishing at the limits of the range of Zander three times per year would be sufficient measure in preventing further migration out of their existing range (Canal and Rivers Trust, N.D.). The Canal and Rivers Trust state that "with recent advances in design of boom boat electric fishing equipment, it is believed that twice per annum should now be sufficient to reduce Zander biomass to the extent that it allows Cyprinid stocks to recover" (Canal and Rivers Trust, N.D.). The current methods employed by the Canal and Rivers Trust focus on preventing the spread of Zander and removing Zander to mitigate their impacts on native fish populations. The trusts efforts also consider legal implications, loss of income and recreational fishing markets with management actions tailored to inhibit negative impacts on fisheries and comply with regulatory requirements (Canal and Rivers Trust, N.D.).

Arguments for removal

The status of Zander as non-native is undebatable as there is no record of the presence of Zander in Britain before their introduction in 1878. Their status of invasiveness is more debatable. However, many studies have shown that the introduction of zander has impacted ecosystems throughout Europe. Although few studies have analysed Zander populations in Britain, and those that have came to different conclusions, the invasive nature of Zander throughout Europe must be considered. Zander predation has been shown to impact native populations, causing declines in population and biodiversity. Removing Zander from effected waterways could benefit native biodiversity, restoring ecological balance and protecting native fish populations. The removal of Zander to prevent further movement across Britain's waterways is more economically viable than the complete eradication of Zander. This approach would reduce the spread of Zander into new waterways however it's effectiveness would be limited without adequate funding.

While Zander does contribute to the recreational fishing industry, the economical value of Zander is small compared to the species it largely predates on such as roach and bream (Davies, 2021). Salado and Vencovska, (2018) reported the total days spent angling for roach and bream was over 5 million whereas just 262,000 days were spent angling for Zander. Although the distribution of roach and bream is much larger than that of Zander in Britain, the presence of Zander and possible reductions in its prey species where Zander are present poses large economic implications. Canal and Rivers Trust (N.D.) reported current losses through non-renewal of leases due to the presence of Zander as £60,000 to £90,000 per year. Only two fishing clubs with the most interest in Zander are spending £3000 a year. The presence of Zander in its waterways has caused large losses for the Canal and Rivers Trust, the removal of Zander could alleviate some of these losses.

Arguments against removal

The complete eradication of Zander from British waterways would require substantial finances and resources. Given their widespread distribution and reproductive capacity, the complete eradication of Zander from British waterways is unfeasible. Eradication efforts could strain budgets, diverting funds from other important projects. Given this, efforts would be best focused on the successful management and monitoring of Zander populations.

The gap in comprehensive research on Zanders long-term ecological impact in British waterways is significant. Although studies from other countries can be used to assess the potential impact of Zander on British waterways, they aren't completely comparable. Davies

(2021) reported that studies conducted within the UK had differing findings, showing that more research is required to truly understand the impact of Zander in British waterways. It reported that some studies showed a decline in prey species of Zander. Although this is noteworthy it's likely that the populations of Zander hadn't reached an ecological balance. Sterligova et al. (2012) found that after some years, once the populations of prey fish had been somewhat depleted, Zander turned to cannibalism. This demonstrates that Zander populations are capable of managing themselves, potentially meaning that as some of the studies analysed in Davies (2021) which showed a decrease in prey populations lacked long term monitoring, their results may be distorted by this period of balancing where prey fish populations were lower and Zander hadn't yet become cannibalistic, controlling their own population.

Ecosystems can undergo environmental changes due to anthropogenic pressures, leading to the spread of non-native species such as the Zander and the emergence of new communities. These processes suggest ecosytems can reach equilibrium whilst including non-native species like Zander without significant impacts to biodiversity. This adaptation could involve reaching new stable states that incorporate non-native species in a way that doesn't necessitate their removal (Storch et al., 2021). In this case, the removal of Zander would be unnecessary.

Zander has become a prized catch for anglers and the presence of Zander enhances the experience of many recreational anglers, contributing to the local economy. Although the number of days spent angling for Zander is relatively low (Salado & Vencovska, 2018), this is likely due to their small distribution in comparison to other popular species. Fishing for Zander can require specialist equipment and their low distribution means anglers may travel further to catch them, increasing their economic value when compared to other fish. The removal of Zander would lower their economic value to the recreational fishing market. Whilst the presence of Zander may result in lower populations of prey species in some waterbodies, people wanting to target these fish have many more privately managed lakes, rivers and canals to target them where Zander aren't present and their populations remain high.

A large portion of the angling community values the presence of Zander. An informal survey conducted on a Facebook page containing anglers of various disciplines showed that 97% of 76 anglers surveyed were against the removal of Zander. Nolan (2021) showed that 94% of anglers surveyed released Zander when caught despite current legislation making this illegal. This indicates a strong opposition to the removal of Zander. Public support is crucial

for the success of conservation measures and current policies do not align with the opinion of most recreational anglers.

It seems unlikely that the presence of Zander in British waterways would be detrimental to some ecosystems or species, as in the case of the signal crayfish (Peay et al., 2014). The apparent issue with the presence of Zander in British waterways seems to be the short-term shifts in some ecosystems, changing the dynamics of some recreational fisheries in the short-term. Zander have been present in many river systems throughout the UK for some time without causing long term impacts. Without definitive evidence of widespread negative effects, the justification for removal of Zander remains debatable and potentially unethical. More research is needed to fully understand their role within local ecosystems.

Recommendations

There is a current lack of research into the effect of Zander populations on British waterways. Although it would seem that Zander have the ability to integrate into current ecosystems without detrimental impact on native fish populations, definitive scientific research is needed to prove this. Zander are currently classified as a non-native invasive species and without decisive scientific proof showing that they are not invasive, legislation shouldn't be changed. Without a full understanding of the impact of Zander, a change in the current classification of Zander as non-invasive could be catastrophic for some fisheries and ecosystems. The risk of changing legislation without scientific evidence is apparent and therefore, until evidence is presented proving Zander are non-invasive, the law should remain as it is to air on the side of caution.

The potential for an economically beneficial recreational fishery for Zander is large and general angling opinion is that Zander shouldn't be classified as invasive. Therefore research should be conducted to asses the impact of Zander and if reclassification would be secure. One potential option for a study would be to collect data on Zander populations, native species populations, and ecosystem health indicators across multiple sites within British waterways over a significant time period. This could include fish population surveys and water quality measurements. Alternatively, Zander could be introduced into lakes with different features, simulating potential areas of Zander impact, with the appropriate KIFR permits. The populations of Zander and native species could be measured over time to assess the impact of introduced Zander with native British fish species.

Conclusions

Zander have been present in Britain since 1878 and within British river systems for at least 50 years (Nolan and Britton, 2018). In this time no long-term detrimental impacts have been reported. It would seem that Zander are capable of integrating into native ecosystems without causing long-term impacts on native fish populations however no research is currently published concluding this. Scientific research is needed to prove this in order for legislation to be changed. For now, the law around Zander should remain the same and they should remain classified as a non-native invasive species. Although this classification may not be correct, a lack of research means that reclassification of Zander could have unforeseen impacts. Further research into the impacts of Zander is needed to better understand how their presence alters natural ecosystems and if reclassification is the right thing to do.

References

Angling Trust (2021) Trust adopts a 'balanced approach' to zander | Angling Times. [Online] [online]. Available from: https://www.anglingtimes.co.uk/news/stories/trust-adopts-a-balanced-approach-to-zander/ (Accessed 2 February 2024).

Campbell, R.N. (1992) "Food of an introduced population of pikeperch, Stizostedion lucioperca L., in Lake Egirdir, Turkey," *Aquaculture Research*, 23(1), pp. 71–85.

Canal & River Trust (2021) *Zander*. [Online] [online]. Available from: https://canalrivertrust.org.uk/things-to-do/fishing/caring-for-our-fish/freshwater-fish-species/invasive-and-non-native-fish/zander. (Accessed 2 February 2024).

Canal and Rivers Trust (n.d.) Zander and other non-native fish species: Frequently Asked Questions.

Copp, G. H., Wesley, K. J., Kovac, V., Ives, M. J., & Carter, M. G. (2003) "Introduction and establishment of the pikeperch Stizostedion lucioperca(L.) in Stanborough Lake (Hertfordshire) and its dispersal in the Thames catchment.," *The London Naturalist*, 82, 13 9–1 5 4.

Crivellì, A.J. (1995) "Are fish introductions a threat to endemic freshwater fishes in the northern Mediterranean region?," Biological Conservation, 72(2), pp. 311–319.

Davies, G. (2021) "GB Non-native Species Rapid Risk Assessment (NRRA): Rapid Risk Assessment of: Sander lucioperca (L.) (Zander or Pikeperch)." nonnativespecies.org

Frost, W.E. & Kipling, C. (1967) "A Study of Reproduction, Early Life, Weight-Length Relationship and Growth of Pike, Esox lucius L., in Windermere," *Journal of Animal Ecology*, 36(3), p. 651.

Gerasimov, Yu.V., Strelnikov, A.S. & Иванова, M.H. (2013) "Dynamics of structural indices of populations of zander Stizostedion lucioperca (Percidae) of the Rybinsk Reservoir for 1954–2010," Journal of Ichthyology, 53(1), pp. 41–51.

Gozlan, R.E., Andreou, D., Asaeda, T., Beyer, K., Bouhadad, R., Burnard, D., Caiola, N., Cakić, P., Đikanović, V., Esmaeili, H.R., Falka, I., Golicher, D., Harka, Á., Jeney, G., Kováč, V., Musil, J., Nocita, A., Povž, M., Poulet, N., et al. (2010) "Pan-continental invasion of Pseudorasbora parva: towards a better understanding of freshwater fish invasions," *Fish and Fisheries*, 11(4), pp. 315–340.

Hempel, M., Neukamm, R. & Thiel, R. (2016) "Effects of introduced round goby (Neogobius melanostomus) on diet composition and growth of zander (Sander lucioperca), a main predator in European brackish waters," *Aquatic Invasions*, 11(2), pp. 167–178.

Jepsen, N., Pedersen, S.H. & Thorstad, E.B. (2000) "Behavioural interactions between prey (trout smolts) and predators (pike and pikeperch) in an impounded river," Regulated Rivers, 16(2), pp. 189–198.

Lammens, E.H.R.R., Frank-Landman, A., McGillavry, P.J. & Vlink, B. (1992) "The role of predation and competition in determining the distribution of common bream, roach and white bream in Dutch eutrophic lakes," Environmental Biology of Fishes, 33(1–2), pp. 195–205.

Lappalainen, J., Malinen, T., Rahikainen, M., Vinni, M., Nyberg, K., Ruuhijärvi, J. & Salminen, M. (2005) "Temperature dependent growth and yield of pikeperch, Sander lucioperca, in Finnish lakes," *Fisheries Management and Ecology*, 12(1), pp. 27–35.

Masters, J.E.G., Hodder, K.H., Beaumont, W.R.C., Gozlan, R.E., Pinder, A.C., Kenward, R.E. & Welton, J.S. (2005) "Spatial Behaviour of Pike Esox Lucius L. in the River Frome, UK.," *Aquatic Telemetry*,

Matvienko, N.I., Vaschenko, A., Назаров, A.Б. & Aishpur, A. (2015) "Eustrongylidosis in predatory fish species of Dnieper reservoirs," *Zoology and Ecology*, 25(3), pp. 235–238.

Nolan, E. (2021*) Ecological and recreational interactions of the native pike Esox lucius and the invasive pikeperch Sander lucioperca in England*. [Online]. University of Bournemouth.

Nolan, E.T. & Britton, J.R. (2018) "Spatial variability in the somatic growth of pikeperch Sander lucioperca, an invasive piscivorous fish," *Ecology of Freshwater Fish*, 28(2), pp. 330–340.

Nunn, A.D., Bolland, J.D., Harvey, J. & Cowx, I.G. (2007) "Establishment of self-sustaining populations of non-native fish species in the River Trent and Warwickshire Avon, UK, indicated by the presence of 0+ fish," *Aquatic Invasions*, 2(3), pp. 190–196.

Peay, S., Dunn, A.M., Kunin, W.E., McKimm, R.J. & Harrod, C. (2014) "A method test of the use of electric shock treatment to control invasive signal crayfish in streams," Aquatic Conservation: Marine and Freshwater Ecosystems, 25(6), pp. 874–880.

Salado, R. & Vencovska, J. (2018) A survey of freshwater angling in England: Phase 1: angling activity, expenditure and economic impact.

Schulze, T.J., Dörner, H., Hölker, F. & Mehner, T. (2006) "Determinants of habitat use in large roach," Journal of Fish Biology, 69(4), pp. 1136–1150.

Sterligova, Ryukshiev & Il'mast (2012) "Comparative biological characteristics of zander Sander lucioperca (L.) in Lakes Onega and Vygozero," *Inland Water Biology*, 5(2), pp. 208–213.

Storch, D., Šímová, I., Smyčka, J., Bohdalková, E., Tószögyová, A. & Okie, J.G. (2021) "Biodiversity dynamics in the Anthropocene: how human activities change equilibria of species richness," *Ecography*, 2022(4), .