# Biodiversity Strategy 2030

# Sharing water

# Restoring pre-Anthropocene fragmentation to boost the functionalities and the biodiversity of wild rivers

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**Plan**


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**Summary**

There is a huge contrast between the measures that are being taken to slow down climate disruption in the next 50 years or so, and the fact that it only takes a few minutes for most aquatic organisms to die when the water disappears. What was unthinkable 20 years ago is now becoming a reality with the appearance of extremely long droughts, which completely dry up our rivers, a situation that experts predict will become more and more severe in the coming years.

In all the countries of the world, when the rain no longer falls, the only way to have water is to store it in large quantities with dams or reservoirs when the rain is too abundant and causes flooding. Everything that contributes to facilitate the flow of water directly to the sea without keeping any, inevitably leads to a disaster for humans and nature. This situation is totally artificial. Water has always been retained in rivers, even before there were humans on earth.

In this context, the integral safeguarding of the historical aquatic biodiversity takes a back seat to the need to allow as many of the organisms that compose it today to survive until climate disruption is stopped, which is at least a century. One of the actions will be to restore their habitat, i.e., the pre-Anthropocene wild rivers in which this biodiversity has flourished. The main challenge is to reconstitute the natural fragmentation of wild rivers, consisting of hundreds of thousands of small dams that woodjams and beavers had built over 10 million years. The levelling of the highest dams we have built, used to produce energy and drinking water, has become impossible, except to put human life in danger. However, it is these large dams that have physically blocked the movement of fish and sediments, fuelling the strategy of restoring ecological continuity by destroying obstacles. A strategy which, in order to be applied, has been forced to fall back on the removal of small structures apparently "without determining human use", such as mill or agricultural weirs. Unfortunately, this policy eliminates the only characteristic components of wild rivers that still exist today: the small structures, initially built by animals, then by mill builders. Their presence causes a slowing of the current and a raising of the water line at the origin of all the natural functionalities of wild rivers. Natural functionalities transferred to the current rivers thanks to the weirs. It is likely that the perpetual destabilization of the hydrological regime of rivers by repeated operations of hydromorphology, and more particularly the destruction of weirs conducted over the last 40 years, have largely contributed to the disorientation of migratory species, as well as sedentary ones, participating in the acceleration of the erosion of aquatic biodiversity over such a short period of 30 years, while the climate is degrading much more slowly.

Besides, what would we do to restore wild rivers today without intervening directly in the river? It's simple, we would have to get another engineer to do the job who has proven himself before us. the beaver. It is the only known engineer of the "river ecosystem". And what would the beaver do to rebuild this ecosystem that we would entrust to him after having erased all our structures across the minor or major bed: he would rebuild our mill weirs in wood, but of the same size. This is proof that the key to the wild river lies in this type of structure.

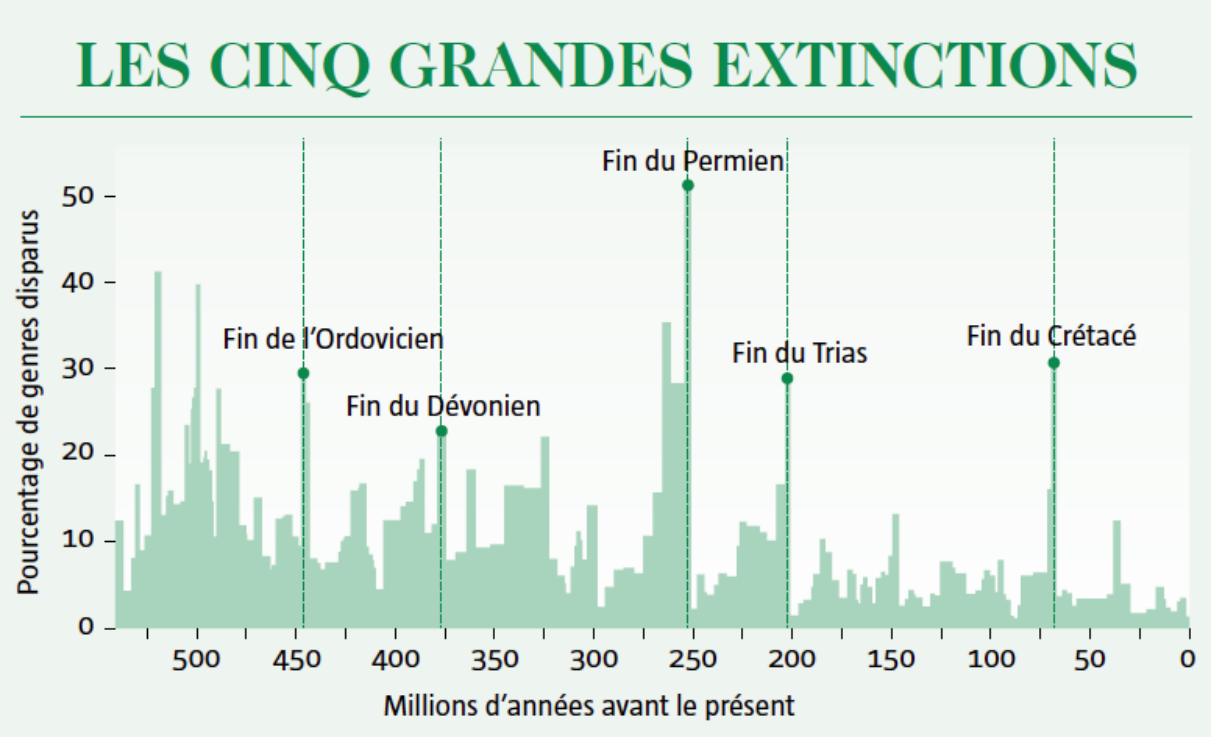
This proposal relies on the contrary on the existing fragmentation, to transform the disadvantages related to the movement of certain migratory species, into advantages. The first of these being, for dams, the ability to feed the river permanently, even during intense droughts that dry up the springs. The collateral benefits of water inflows allow the correction of other parameters that are degrading

for fish in temperate zones: temperature, when water is taken from the base of a large structure creating a thermal depth gradient, and flow, which is very important for diadromous migrants, especially during low-water runs. But water inflows, during low water periods, are also a good way to mitigate invisible obstacles, such as pollution, by diluting them to keep them below the lethal threshold. The impact of pollution is pernicious, corresponding to a progressive loss of fish vitality, but much less spectacular than the accumulation of fish at the foot of a structure, which is not necessarily linked to a physical difficulty to cross it. The international study on drug residues, whose presence in our rivers dates back to the 20th century, explains much better the acceleration of the loss of aquatic biodiversity concomitant to this period, than the presence of mill weirs dating back 1000 years!

Incidentally, regulating temperature, flow and pollution is also an efficient tool to limit the reproduction of so-called "invasive" species, taking advantage of the current degraded conditions, by restoring the competitiveness of traditional species, so as to let nature, and not man, choose the composition of tomorrow's species assemblages. They will necessarily be different from those of yesterday, biodiversity being a dynamic process. Interfering with nature by privileging certain species to the detriment of others, economically less interesting, is certainly the best way to end up tomorrow with rivers devoid of any life. This proposal aims to help nature to position itself next to humans whose expansion is inexorable, not to direct it, nor to manipulate it.

**Introduction**

Among all living species, only one has undergone a particular evolution of its brain that has finally allowed it to master all the others, and then to master the nature that surrounds it to put it at its service: man. Why him? We don't know. But the result is there, magnificent for some, and sad for others. Magnificent, because he has succeeded in considerably increasing his life expectancy, that he can communicate with his fellow creatures wherever he is on the planet; sad, because by living longer, his population is constantly increasing, inevitably encroaching on the habitats of other species, accelerating their gradual disappearance and, finally, most probably endangering his own existence. Man has triggered the 6th mass extinction, or rather accentuated this extinction, since studies reveal that this process has already taken place 5 times.

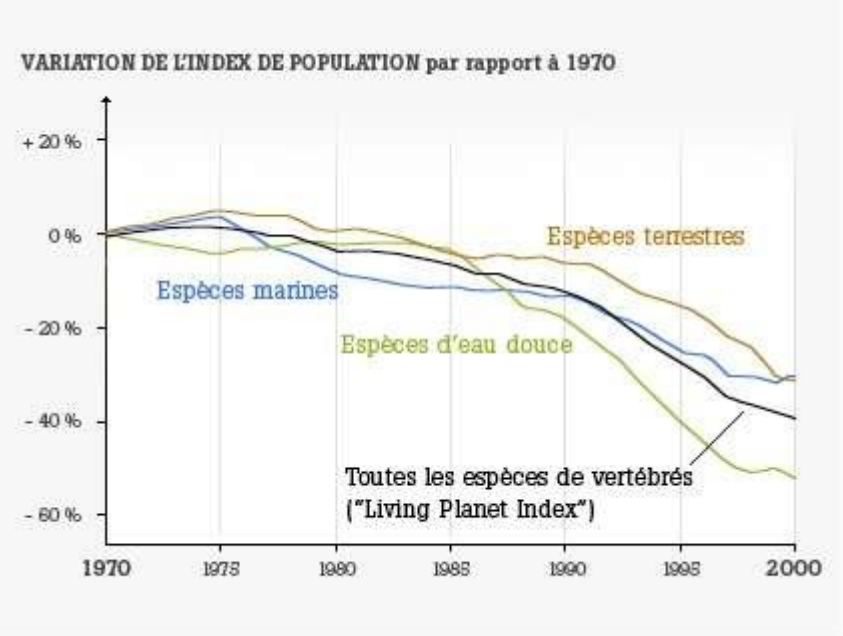



*This graph represents marine extinctions, as they provide the best points of comparison. These are genera, not species. Thus the extinction of the end of the Permian concerns a little more than half of the genera but 95% of all species. The dinosaurs disappeared at the end of the Cretaceous. These are genera, not species. Thus the extinction of the end of the Permian concerns a little more than half of the genera but 95% of all species. The dinosaurs disappeared at the end of the Cretaceous*

*(Boundles Biology, 8 January 2016)*

This is both worrying and reassuring since it proves that life is systematically reborn, in other forms, and that species also appear and disappear between major extinction peaks that are separated by several tens of millions of years.

The concern arises from the fact that currently, the disappearance of species is too fast. Their decline can be seen over a few decades as shown in the graph below (Futura Planète). And since our lives also depend on the lives of animals, there is reason to worry. If the slow process of climate




degradation, which should take one or two centuries, can be measured significantly over such a short period of 30 years, during which more than 50% of freshwater species have disappeared, there is no doubt that in 2030, they will almost all have disappeared if measures are not taken to immediately mitigate the impact of climate change. Unfortunately, it is physically impossible, no matter how hard we try to correct climate change, to bring about a sufficiently large improvement in the climate, in such a short period of time, to restore conditions for the development of our traditional aquatic species. Especially since several limits have been crossed for some time, such as the extreme heat of the oceans (70% of the planet's surface) which passed a point of no return in 2014 (Tanaka & Van Houtan, 2022). This is why, like other think tanks, we propose in this document a program of actions to preserve freshwater aquatic species, until other parameters improve and they can take care of themselves as in the past.

In all the proposals elaborated so far, published by the European Commission or by governments, the guideline is to erase all human traces in the ecosystems. According to them, this action would be sufficient to give them back the aspect (and the functions) they had when we were still great apes, and to allow the fauna and flora to return to its former richness and balance. In support of what is in fact only a hypothesis, it is indeed in the zones where there are no or very few men on the planet that the fauna is generally the most abundant, even if it is all the same dependent on its distant activities, since they are not spared by the global warming which has no border.

This program wants to be pragmatic, aware that it is totally impossible to restore the biodiversity that existed 100 or 200,000 years ago, as this would suppose that we could put an end to the natural dynamics of evolution of biodiversity, a process that occurs regularly since the earth has existed, and especially to regulate the human population. On the other hand, after the 6th extinction, there will be a 7th. Why, under the pretext that we are part of this extinction, would there not be others

afterwards, life being reborn each time under other forms? Our objective is much more modest. As it is impossible to bring back in 20 years the temperature of the globe and the global pollution, to the level they were before the industrial era, 2 centuries ago, the proposals do not aim at preventing the extinction of all the species, but at slowing down this extinction to allow some of them to adapt to the new environmental rules and especially not to figure ourselves among the doomed species.

Our proposals are based on the observation of nature and the techniques capable of mitigating instantly, that is to say in less than 10 years, the effects of climate change on species in general. It seems to us dangerous to concentrate actions to save a few species at all costs, under the pretext that they are emblematic and ancient, with measures that lead to the elimination of others, considered as commonplace. We do not know what the future will be like at the speed things are going, we think that we must try to recreate a natural balance that is favourable to the greatest number of species, emblematic or not. This does not mean that the species that would disappear in our countries, would disappear forever from the planet, they would move north and return at the next ice age

**The tracks**

Many aquatic species are disappearing because their environment and habitat are degrading too fast to allow them to adapt. Therefore, recreating a wild river ecosystem, with its habitats and water quality, as close as possible to what existed 1,000 years ago, is an avenue to pursue, making as few concessions as possible.

For species to adapt to a new environment, they need a sufficiently long period of time, several hundred years, provided that the characteristics of this new environment remain stable and do not constantly change. This is not the situation at present. Even if we stopped all our greenhouse gas emissions tomorrow, climate degradation would still continue for at least a century! This directs the actions towards a local mitigation of the effects of climate change which are the most impacting for the local aquatic fauna. (Without forgetting that the heavy interventions for hydromorphological works are carried out constantly).

As a fish lives in water, the factors determining its existence are rather simple to prioritize.

- Priority 1: permanent presence of water. The absence of water is obviously the most dramatic situation for a fish since it will die in a few minutes. With 95% of a territory as big as France under drought alert in recent years and the total drying up of a large number of rivers, this parameter is at the top of the list of concerns. No water, no life.

- Priority 2: permanent presence of an aquatic environment compatible with the biological cycle of fish in our temperate regions, corresponding to that which has allowed the aquatic fauna we know to multiply for thousands if not millions of years before our era. In other words, a stable ecosystem, with the least polluted water possible and an adequate temperature to restore the competitiveness of our temperate climate species.

- Priority 3 concerns, for a certain number of species, and in particular the most famous ones, the migratory ones, the need to move in the river to reach spawning grounds with very particular but well-known characteristics, and to feed.

The originality of this proposal lies in this hierarchy of actions. In fact, all the others place the restoration of ecological continuity as a matter of urgency, i.e. the restoration of the movement of fish to spawning grounds that are apparently always located in the most upstream areas of the watershed of rivers and coastal streams. To restore this continuity, they advocate the destruction of transverse structures. (Example: Biodiversity Strategy 2030 - Barrier Removal for River Restoration; European Commission 2021). The reasons why this strategy seems inappropriate to us are based on the fact that it only responds to the least important of the priorities listed above based on the needs of a fish that lives in water: the permanent presence of water. The destruction of obstacles reduces the overall water mass of the river, reducing its capacity to resist drought; the drying up of the bed will be much faster. The rivers in Europe are not like the Mekong or the Colorado where the large dams are very numerous, offering an evaporation surface so important that it can effectively lead to a complete stop of the flows, especially if one adds to it the withdrawals for agriculture or cities. This is not the case in Europe, where there are far fewer large structures and where the cessation of flow is due to the drying up of springs. It seems somewhat surprising that in the prospect of ever more pronounced droughts in the coming decades, dams and ponds should be destroyed because they capture water that would normally flow into rivers, while they fill up when there is a surplus of water. There is no other way to get water when it stops raining and the water table is at its lowest, than to collect it on the surface when there was too much, and to store it in sufficient quantity to resist evaporation. This is a sine qua non condition for there to be aquatic life somewhere in our territories.

At first glance, the removal of structures allows certain species to circulate freely. But this has not yet resulted in an increase in migratory fish populations (Cadet, 2018, 2021). But aquatic biodiversity is not only composed of species that must move to distant spawning grounds. What happens to the others? Paradoxically, whatever the proposal, the question of obstacles is always at the heart of the actions, because they play a paradoxical role in the river. When the river is fed normally and there is always water, the obstacles and especially the most difficult to cross seem to slow down the migrations; but when the water does not circulate any more or little, the water retained by the structures becomes a crucial asset to allow the survival of the aquatic fauna. We consider that most of the time, we are currently in this second situation.

Even scientists may have a contrasting view of the impact of these river barriers. A recent study by Hoffmann-Legrand (2021) shows that the parameter "ecological continuity" was not found to be significant in explaining the decline of diadromous species, unlike the parameter "temperature (sea and river)" and "flow", two factors that are prioritized in our project. On the contrary, Merg et al (2020), shows that statistically the removal of structures over 10 m high would have no impact on the decline of aquatic biodiversity compared to small structures less than 2 m high! However, in the field, naturalists, as well as citizens, have seen salmon, for example, accumulate at the foot of large dams. The press having widely reported these events which made the happiness of the fishermen, but displeased the workers of the Allier district who could not eat salmon anymore! Long before the dam blocked the river, salmon had already been returning to the river for about 10 million years. However, the press didn't mention it, simply because there was no miraculous fishing, the salmon were not blocked by the structures that existed before the big dams, i.e. the mill weirs. Even if

fisheries were done at this level, the fish were much more difficult to catch because they did not stay as long downstream from the weirs, which they always eventually crossed. Otherwise, they would have disappeared before.

However, we must realize that if the large dams had not been built, salmon and other fish would still be declining today. All our species living in temperate zones for thousands of years, operate their reproduction at water temperatures between 5 and 12°, optimum around 8 / 9°. With an average increase of 2° of the terrestrial temperature, salmon, sea trout, lamprey, pike..., have lost 50% of their reproduction period. And inevitably, according to IPCC forecasts, 50% of what remains will be lost in 30 years. Reproduction no longer occurs every year, since this average erases the warmest years, which are currently broken year after year. So, even if these species reach their breeding grounds, they will not breed or will breed too little. Unfortunately for them, by removing small structures to facilitate their movement, we radically complicate it by lowering the water level, even making it disappear, and we increase the effect of pollutants that are concentrated in a smaller volume of water.

Naturally, these high water temperatures will be favourable to certain species that have settled in more recently, introduced by man or taking advantage of the canals built between the river basins, for example between the Danube and the Rhine (Bravard & Lévêque, 2020). Asian gudgeon, catfish, sun perch, carp and whitefish will indeed multiply, but only if there is water in the river. Currently, their survival is no longer assured because of the repetitive droughts which make the water disappear completely from the rivers, affecting this time all the aquatic organisms.

Therefore, encouraging the movement of fish towards their reproduction area without securing the presence of water, does not appear to be a relevant strategy to safeguard our aquatic biodiversity until the end of the century.

## A. From the anthropized river to the wild river: impact of obstacles

Everyone would like to return to the wild, free-flowing rivers they were before humans diverted or neutralized their flows for their own benefit. It is logical to imagine that in those pre-human times, aquatic species flourished in our rivers of water in a balanced way. From there, to imagine that by removing everything that man has built in our rivers, it will be possible to return to wild rivers, there is only one step! But this approach comes up against an unacceptable consequence which is the endangerment of a part of humanity very dependent on the use of rivers. However, the situation can only improve if it were possible to get closer to the concept of a "pre-Anthropocene wild river" but on condition that we sort out what is possible and what is not in order to preserve the human species.

The work of soil scientists and naturalists teaches us that our wild rivers and streams were not so free when we were not around...

- The streams were all clogged with woodjams, because before there were men to remove them, nobody did. Undoubtedly, these woodjams are very important elements for a river to behave like a wild river, but we must admit that we cannot restore this characteristic, because of the disastrous consequences it would have on our infrastructures, like bridges, and from floods. However, it is very simple to achieve, we just have to stop maintaining the riparian zones. Ecologically speaking, our riverbanks would then be "wild", particularly useful for filtering runoff, but this is unfeasible.

- Wild rivers were never canalized, whereas they are all partially canalized in the crossings of cities, whatever their size, including major rivers, and this on important proportions of their linear. For example, if the Orne is 170 km long, the first 15 km, almost 10%, are concreted in the crossing of Caen. There is no question of the river spreading out and flooding the city. For the Seine, which is 776 km in length, the 100 km corresponding to the Paris area are totally canalized and with the other cities, it is likely that 30% of its length can no longer become wild. This parameter must be taken into account because it concerns all European rivers whose bed has been fixed.

- Since 6 million years before our era, rivers less than 10 to 12 m wide were colonized by beavers. These animals had built millions of dams less than 3 m high on all our watersheds to the point of accumulating so much sediment that they sometimes caused a displacement of the bed, as excavations by pedologists have revealed. Beavers are major players in creating the wild river, as they are called "ecosystem engineers" because of their unique ability in the animal world to build structures in the minor river beds. In other words, contrary to what one could imagine, the water did not flow freely. Its path was constantly blocked by woodjams and beaver dams. Since this animal was reintroduced in Europe, researchers have been able to show that these strings of small structures have a positive impact on the sorting and management of sediments and on biodiversity. The change in the hydrological regime of the river upstream of the reservoirs, with calmer water, favours the diversification of habitats and therefore of species, to the great benefit of carnivorous fish, especially migratory ones. These species were not bothered at all by the multitude of "dams" that they had to cross to reach their spawning grounds (obvious natural selection of the strongest and most able to reproduce). The raising of the water line in favour of the river vegetation, the management of the vegetation or the creation of wetlands were favourable to the establishment of many other species: fish, amphibians, mammals, birds, insects, aquatic plants... This enrichment has made the beaver a species recognized as a "facilitator of life" but also as a "keystone" (Paine, 1969), i.e. a species that has a disproportionate effect on its environment compared to the size of its population.

It must be noted that another species, formerly an animal, Homo sapiens, is also capable of building "dams" in all respects similar to those of the beavers, eliminated by hunting in the Middle Ages, but in infinitely lower density. It is also a "keystone" species, obviously. The convergence of the heights (less than 3 m) allows the works of the men and the animals to resist the majority of the water blows, contrary to higher works, which would have been built with the rudimentary techniques of the time. It is interesting to note that if Merg (2020) had performed his statistical analysis on the millions of beaver dams present in Europe 1 million years ago, he would have come to the exact opposite

conclusion of that obtained with the weirs of the same height. That is to say, that these small obstacles are catalysts of biodiversity and not the opposite! This shows that it is important to compare statistical results with those observed in the field. In the case of fragmentation by structures, it was easy, van Looy et al., 2014, show that the weirs built by humans, (just like those built by beavers), do lead to an increase in aquatic biodiversity. This is inevitable, since there is habitat diversification.

- If beaver structures are called "dams", it is because before man, they were the most imposing constructions in our rivers. From the middle of the 19th century, men were technically able to dominate nature, and to build structures of several tens of meters high, which have nothing "natural" anymore, across the minor bed and especially the major bed, capable of completely blocking the flow and exchanges in the streams and even rivers. Hence the use of the word "weir" or "causeway" to describe low structures, in the minor bed only, similar to those of the beavers, but built by men. These large dams, which are used to generate renewable energy, to regulate flooding of major cities, to provide drinking water or for irrigation, are of major economic importance. It seems unrealistic to imagine that they could be destroyed, despite their ecological impact on the river. We will have to make-do with them.

If we look at our rivers and streams today, we have to admit that the elements that most distance them from a typical wild river: artificialization of the banks in cities, large dams and the disappearance of woodjams, are also those that cannot be removed or restored. This probably explains why all the current proposals fall back on the destruction of small structures, whereas these are, on the contrary, the only structures characteristics of wild rivers that can be removed. Paradoxically, by destroying them, the anthropization of our rivers increases and does not decrease it.

Our approach, centred on the principle of wild rivers, will thus be articulated around the only elements which bring our anthropized rivers closer to wild rivers: the presence of many structures of less than 3 m high represented by the mill and agricultural weirs. With as a complementary objective, to transform as much as possible the unavoidable degrading elements present in our rivers, into advantages.

**1. 20 years of destruction: assessment**

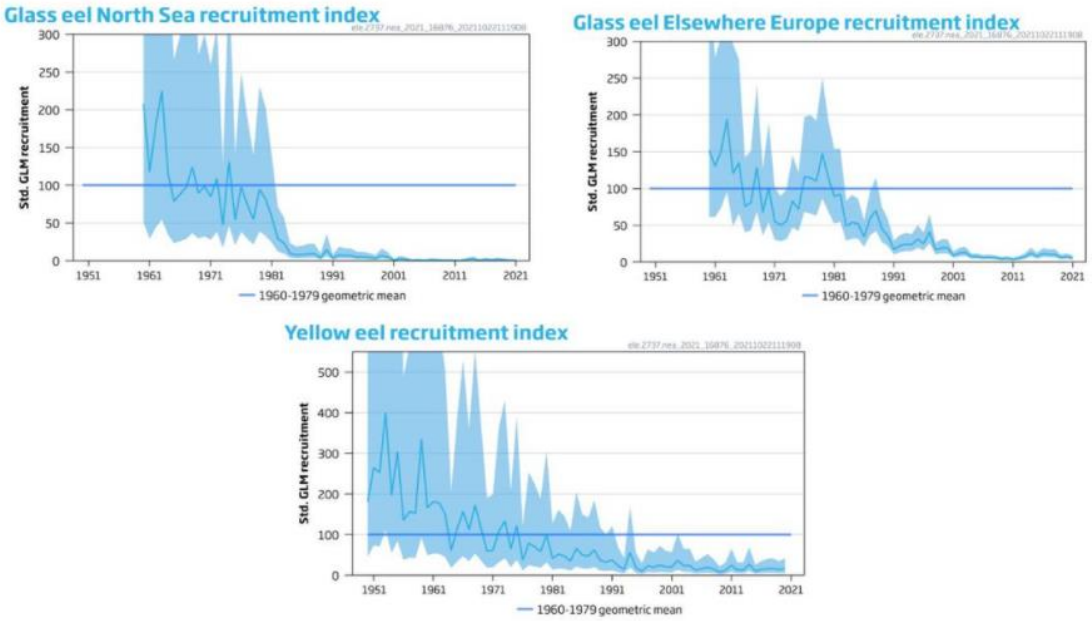
The observation of the decline of our fish populations is particularly instructive.

- Between the Middle Ages and the 19th century, 100,000 mill or agricultural structures occupied the minor bed of all our watersheds: No decline in biodiversity. In 1892, 200 t of salmon and 50 t of shad were caught in the Loire Maritime in France alone, according to Bachelier, 1963, 1964.

- After the construction of the big dams in France, from 1850 onwards, blocking this time minor and major bed: visual decline of the emblematic migratory species blocked each year at the foot of the big dams (example: Allier), reported by the press.

- After 1970. In the last 30 years alone, according to Hoffmann Legrand (2021), shad and sea lamprey have declined by more than 80%, salmon have not changed, while eels and sea trout have increased

very slightly. Note that this result is not confirmed by European studies that reveal that eels are in total extinction (Sonne et al., 2021), to the point that the International Council for the Exploitation of the Sea recommends a total halt to fishing in 2022.




The figures on the resource leave little room for doubt about the risk that the species faces (ICES Report/SW Repro)

*Even if some eel populations are almost 100% infested by the nematode Anguillicola crassus, and that the multiplication of crossing devices allows all eels, even the sickest ones, to reach the aggregation areas, in complete contradiction with the usual management of an epizootic, it is unlikely that this parameter alone explains this disastrous situation universally in Europe. Drug pollution that disrupts the development of internal organs seems more realistic especially considering that all European rivers are contaminated.*

This sequence inspires several thoughts:

- The destruction of obstacles does nothing to facilitate the movement and reproduction of species, since, according to Hoffmann-Legrand, it is those that, a priori, have the most difficulty in crossing the obstacles, that benefit the least from the many weir removals that have been carried out, for example, in the north of France.

- If these barriers were truly an impediment to movement, all migratory species should be on the rise, especially in the Loire River basin (where the greatest number of deletions have been carried out), while the decline of species there continues inexorably (White paper on ecological continuity, FFAM, 2017).

- On the other hand, how could a fish that lives on average 5 years, and that would be blocked every year in the same places by a succession of small mill weirs or by a large dam, have survived for almost 100 years, when theoretically it could not reproduce?

It is obvious that the fish still managed to reproduce, therefore necessarily by changing spawning areas and without having to go up to the end of the watershed. This is not a scoop. This phenomenon occurred recently in Alaska where, following a volcanic eruption, a wall blocking access to Surprise Lake collapsed, allowing the salmon to change their migratory route to come and reproduce there. In Europe, it would have been interesting to study this extremely efficient survival process since it allows us to have fish today. This was theoretically impossible if the axiom "obstacle = no reproduction" was true.

Our objective will therefore be to reconstitute these survival strategies, compatible with our anthropized rivers, in order to rehabilitate them.

## 2. The consequences of the constant disturbance of the ecosystem through the restoration of ecological continuity

On this basis, it is possible to hypothesize that it is the restoration of ecological continuity that has accelerated the extinction of migratory fish. In the case of Alaska, it is easy to imagine that the considerable disruption of the hydrological regime of the river has completely disoriented the salmon and sent them to an unknown area where, by chance, they found better conditions to reproduce than in the usual area. These animals do not insist on returning to their historical spawning grounds, their instinct is to return to the river from which they came, period. In Alaska, no other upheaval in subsequent years has challenged their new destination. The situation is notoriously different in France. Indeed, the destruction of a weir profoundly modifies the hydrological regime of the river, creating an unusual situation that disorientates the fish in search of a spawning ground. They enter new stretches where, unfortunately, favourable spawning areas do not exist, at least, no more than elsewhere. But, contrary to what happens in nature, the upheavals due to hydromorphology works are repeated year after year. There is a strong chance that this has accelerated the decline of our migratory species confronted each year with a "new river". And this, all the more easily as the destruction of the structures never leads the fish to be in less polluted or cooler areas, but on the contrary, in areas at the head of the basin which lacks water almost every year because of climate change. It is not only diadromous migrants that are affected, all fish are affected. Benitez et al, 2022, shows that in the Meuse, 20 years after the construction of a fish pass, the fish community has completely changed, but with a 14-fold decrease in the total number of fish, considerably reducing its resilience.

This is why we propose to stop all operations that are described as morphological "restoration" of the river but which are in fact operations of permanent destabilization of the hydrological regime to which all species living in this liquid environment are extremely sensitive. All the more so since the climatic environment is not stable, which forbids any hope of adaptation. The objective will be, on the contrary, to try to reinforce and stabilize the hydrological regime of the rivers most favourable to diadromous migrants by finding solutions to adjust the water masses to the needs of the fish throughout the year. According to this approach, the river will automatically be adapted to other uses and ecological services, for one simple reason: it will always contain enough water.

## 3. Barriers and natural selection for migratory fish survival

The idea that it is enough to erase all that man has built across rivers or on their banks to regenerate a true wild river, free, functional, allowing aquatic organisms to resist climate change is not realistic.

Most migratory species such as salmon are declining worldwide, even where man has not built anything in their path.

The many television programs show us that these wild rivers that salmon go up, are not really "long quiet rivers". In America, the salmon have to cross numerous waterfalls several meters high, at the top of which hordes of bears are waiting for them, often scuppering their attempts to move upsteam. Obviously, only the strongest ones manage to pass. A ruthless natural selection, quite classical in the wild world, which reinforces the vigour of the stock. In France, natural selection is no longer accepted. It is considered that if 100% of the fish could reach the spawning ground, they would reproduce in masse and the population would be reconstituted, but this is incorrect. In Kamchatka, for example, the spawning grounds where the fish have laid their eggs are also heavily trampled by predators that follow their movements. In our countries, anyone who approaches a spawning ground will be immediately condemned!

It is therefore quite legitimate to question the need to facilitate the movement of such athletes by destroying our structures, especially the smallest ones which seem, on the contrary, to be essential to maintain natural selection and generate a vigorous wild strain resulting from the reproduction of the most successful individuals. Even if, because of the considerable decrease in the number of migratory fish that go upstream, it could be envisaged to help them with crossing devices on certain structures, morphologically obviously too difficult to cross. According to the Scientific Council of the ex-AFB/OFB, this concerns no more than 10% of them (deliberation n°CS/2018-02).

*One of the goals of this proposal is to restore this selection process by retaining objectively passable barriers, to get as close as possible to the constraints of wild rivers that have allowed diadromous fish like salmon to survive for 10 million years*.

## B. Invisible barriers

### 1. Natural physical barriers

One would think that anything visible across the stream bed would be listed as a barrier, but this is not the case. Natural weirs are not listed. They are however very numerous, probably as numerous as the man-made structures, especially those less than 3 m high. What is the point of removing a human weir if it is surrounded by natural obstacles of the same height or by a large dam?

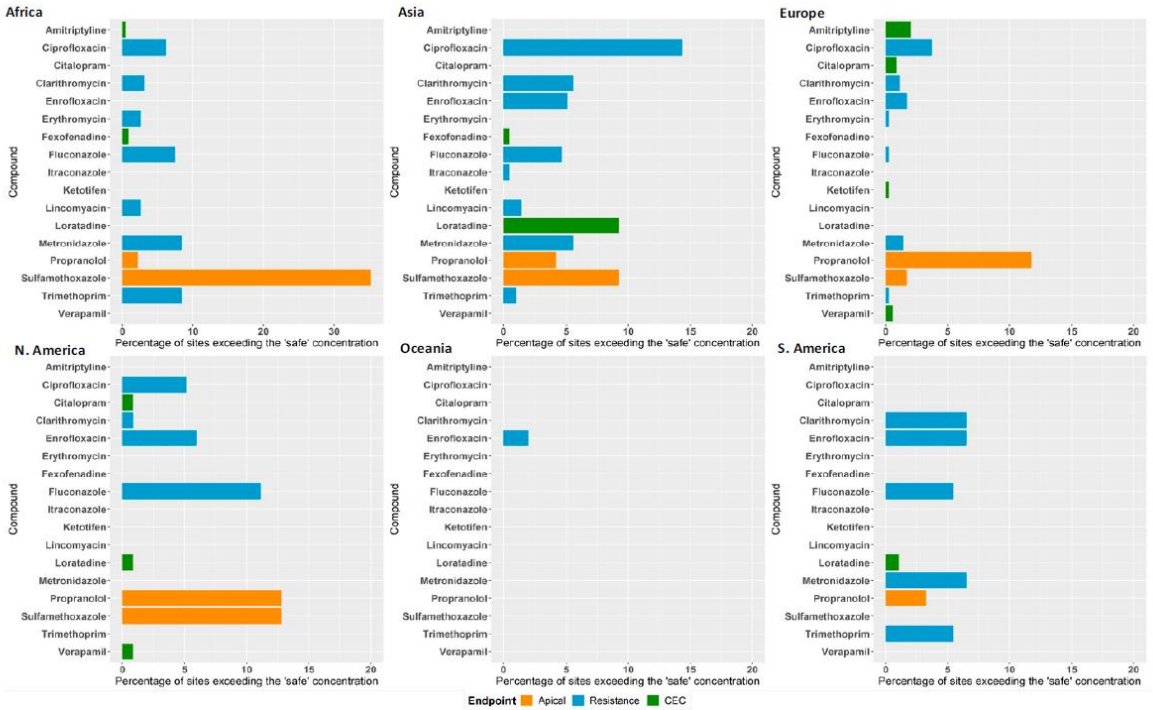
*Our proposal will aim to map and list natural obstacles of equivalent height to those in the flow barrier reference list in order to take them into account in the passage of fish*.

### 2. Chemicals

There are no water-related articles that do not discuss pollution and its adverse effects on aquatic organisms, supported by a few scientific publications. We have some punctual works: Eljarrata and Barceló, 2018, or of Bizarro et al, in 2014, or of the team of Professor Cajaraville, or of Barbara Demeneix (tomorrow all morons because of endocrine disruptors), which show that it is urgent to act. When migratory fish pass from the marine environment to the freshwater environment at the mouth of rivers, they are contaminated by high concentrations of endocrine disruptors. And as it is

during this transition that important physiological transformations take place both for respiration and for the development of reproductive organs, researchers have noted a high proportion of individuals both female and male, that are certainly unable to reproduce. In 2022, Kestemont at the University of Namur, shows alarming effects of drug residues in the nervous system of trout, in the liver and in the reproductive system. The fish had higher concentrations of female hormones downstream of the treatment plants than upstream. Under these conditions, all the investments that can be made to promote the movement of species will not lead to the desired result: reproduction. It seems highly desirable to address these pollution issues as a priority. More recently (2021), Czech researchers (Horký et al., 2021) have made an astonishing discovery by demonstrating that trout were becoming addicted to the concentrations of amphetamines that can be found in our rivers, to the point of endangering their instinct for feeding and reproduction. This is extremely worrying insofar as an identical behaviour could be generated by cocktails of drug residues, explaining that individuals will stop their run if the upstream river no longer contains the contaminants that attract them. A stop of migration which, until now, is automatically attributed to the weirs. It must be recognized that drugs are found in the sewage of cities rather than in the countryside, constituting so many invisible obstacles. Let us recall that France is in the process of being condemned by the EU for non-compliance with the standards of collective sanitation of a hundred cities of more than 2000 inhabitants, including fifteen very populated agglomerations. During its ascent of the rivers, the fish will be confronted with various sources of pollution, rather of urban origin downstream and rather of agricultural origin upstream.

A major step has just been taken with an international study on 61 drug residues in 258 rivers from 104 countries (Wilkinson et al, 2022). The results reveal significant concentrations of several molecules in our European rivers, likely to seriously disrupt fish reproduction.



*Percent of sites in the global monitoring study where concentrations of active pharmaceutical ingredients exceeded: lowest predicted no-effect concentrations (PNECs) (Dataset S12) derived from apical ecotoxicological endpoints for algae, fish, and daphnia (orange bars); critical environmental Concentrations (CECs) estimated based on human plasma therapeutic concentrations and uptake predictions for fish (green bars); and "safe" target concentrations for antimicrobial resistance (AMR) selection (blue bars).*

The extremely rapid degradation of fish communities in the 20th century is undoubtedly better explained by this intoxication, which appears during the same period, than by the presence of thresholds that have existed for 1000 years! This spatial study should be completed by a temporal study insofar as the concentration of these pollutions increases when the water mass decreases, in particular in low water, but also when structures are removed. To act quickly in this field, the only lever that can be implemented is dilution, i.e., the multiplication of weirs and dams to significantly increase the water mass during low water periods.

One of the objectives of this proposal will be to carry out a spatial and temporal analysis of the successions of chemical obstacles along the rivers and to evaluate the impact of the flow on this parameter. It is from this knowledge that we will be able to overcome them, while waiting to be able to eliminate them.

## 3. Socio-economic barriers: fishing, catfish regulation and stocking

### - Fishing

In France, the National Plan for Diadromous Migratory Species aims to promote a certain number of species that are certainly emblematic and endangered, to the detriment of others that are less "interesting" in terms of fish. No measures are taken to restrict the capture of fish that are harassed and stressed by fishermen during their entire run, day after day. The minimum sizes that are protected result in the capture of the largest specimens, i.e., the best spawners. Even on no-kill runs, no one questions the impact of the stress resulting from the fish's struggle to break free of the line and its physical ability to pass even the smallest structures that are in its path. Even if the wounds inflicted by the hook on the fish's mouth are a priori not serious, it is legitimate to ask what the impact of this wound will be on potential infections, when the water temperature increases. It is only recently that scientists have sounded the alarm and proposed to completely close the fishery on the endangered eel. In order to avoid this situation for other species, *we propose to totally close the fishery in all rivers hosting diadromous species for 10 years, but to organize it in canals or rivers that have been decommissioned because they are ecologically unrecoverable*.

### - Catfish

The catfish, an invasive species and a major predator, benefits from a preferential treatment because its size makes it a trophy for fishermen. As a result, the work conducted on this species by official

agencies tends to minimize its impact on aquatic fauna. Yet, work reveals that diadromous migrants account for up to 75% of their prey during the run (Boulêtreau et al, 2018). It appears imperative to regulate catfish, even though invasive species will gradually become part of the freshwater fish communities in our territory. Today, no protected area can maintain its balance without human intervention. In the case of fish, it is interesting to note that if most of these "invasive" species are not particularly able to cross obstacles, they have succeeded in colonizing all the rivers of France! There is no doubt that a policy aiming at removing all obstacles in rivers will further encourage their dispersion in areas where they would not yet be present. Recall that transforming a lentic zone into a lotic zone by destroying a weir does not eliminate all invasive species; some are adapted to flowing water (Benitez et al., 2022)

*We propose to reduce the catfish populations by an adapted fishing, otherwise, the "Darwin's nightmare" is at our doors!*

**- The releases of repopulation**

It is difficult to imagine that farmed fish become wild fish the moment they are released in their environment. Work carried out by the Loire Departmental Fishing Federation has shown that after decades of trout releases, their genetic diversity had regressed (Identification of genetic diversity and program to safeguard trout populations in the Loire Department, FDF42, 2016). Hoffmann-Legrand (2021) has recently expressed reservations about this practice insofar as stocking necessarily selects some life traits that are not necessarily adapted to all situations encountered in a watershed.

*We propose to reduce releases to rivers that do not or no longer support wild diadromous or holobiotic migrants, and which will be reserved for fishing*.

**- Prey**

In this field, the level of knowledge is nil. Nothing is done to know what is the influence of climate change on prey and their availability for fish. *We propose funding for a research program in this area*.

## C. Proposals to extend aquatic biodiversity

These proposals are based on actions that will allow threatened species and their offspring to encounter conditions conducive to their life cycle from the time they enter the river until they return to the sea, without harming other aquatic or terrestrial organisms.

### Priority 1: Avoiding the absence of water in the rivers

Everything we can do to help fish is completely useless if there is no water in the river. This is a risk that seems to be very real today, even in the traditionally more watered regions in the in north

western Europe. There are not many options for having water available when springs and rivers dry up: either a large dam must be built to release water for several months, or ponds or basins must be built from which water can be pumped to the river when it is needed. Finally, dilution by water inflow is limited to a few weeks per year during low water periods.

**How to keep water**: For a river, an upstream dam is undoubtedly the best solution that has proven itself. Water releases in the Ain River between 2018 and 2020 have kept water flowing in the riverbed, saving much of the aquatic wildlife. These dams also mitigate the power of floods that are just as devastating as droughts. In the Loire, the Renaison is the only river in good condition on the left bank of the Loire in the Roannais area. The 8 other rivers in the same sector are in bad condition because they dry up almost every year in summer. However, the Renaison is cut in two parts by two dams which definitely block the ecological continuity, without affecting the aquatic biodiversity. For several years, young salmon have been released in this river with the hope that they will go up one day... to where? at the foot of the dams, since the mills' weirs downstream are more and more often destroyed. However, the concreting of the bed at the foot of the dam with its completely artificial hydrology does not really seem to correspond to a wild river! As for the trout, they reproduce perfectly upstream and downstream of the dams. This observation proves that the permanent presence of water is a much higher priority than the need to go up a river to reproduce. Diadromous and especially holobiotic species are perfectly capable of reconstituting spawning grounds in other parts of the river. Targeting rivers with a high capacity reserve upstream is certainly an asset to preserve aquatic biodiversity, including emblematic species.

When there is no large dam, the strategy must consist of maintaining the mill or agricultural weirs and creating new ones, so as to avoid the complete drying up of too long river bed linear in case of intense drought. On the other hand, knowing that evaporation can cause the loss of 1 cm of water per day, it is important to have reservoirs at least 1.5 to 2 m deep that can resist up to 3 months without rain. In the absence of catastrophic drought, Donati et al., 2020, demonstrated that a mill impoundment of this depth is neither lentic nor lotic, but generates a thermal depth gradient that allows fish to stay in slightly cooler water when environmental characteristics are no longer conducive to run timing. These stops can only occur in calmer, deeper water areas. This is another reason why the destruction of reservoirs is counterproductive for the survival of diadromous species. With climate change, which modifies not the total annual rainfall, but the distribution of rainfall, the low water flows during the run are increasingly low (Cadet, 2021). The run only resumes when there is occasional rainfall that is sufficiently strong to temporarily increase the flow of the river (Report Fishing Association, Orne, Touques, Vire, 2021). This situation could be mimicked by small releases of water from reservoirs located along the river or drawing from reserves dug near the watercourses.

In all the documents concerning the safeguarding of aquatic biodiversity, the emphasis is placed on the movement of adults to the spawning grounds, but no attention is paid to juveniles. However, these juveniles also need the reservoirs where space is also a guarantee of safety and feeding.

Finally, it should be remembered that when these structures are too difficult to cross, it is always possible to build crossing devices, but that in any case the return to the source of the watercourse is not inevitable, fish can reproduce well before reaching the head of the watershed (Hoffmann-Legrand) and that having a succession of reservoirs to provide a little water in low water is an essential condition for the upstream migration, reproduction of fish and the development of juveniles.

**When to store water**. With the modification of rainfall distribution, and the increase in the frequency of floods, it is quite simple to collect water outside the watercourses only on the occasion of these exceptional events. When water flows over water, soils are saturated, taking some of the surplus can only help to control the destructive potential of the flood. The river will not miss this water, especially if it is returned to it later in low water period.

**Where to keep water**. It is necessary to target the rivers and streams that are most likely to offer the most stable fish-friendly conditions possible over time, rather than trying to intervene on the whole territory, based on assessments that were made more than 15 years ago when the climatic context only frightened a few specialists at the time. The first criterion to be taken into account is the effective presence of diadromous fish and to abandon the areas that could be potentially favourable if ever the climate change was controlled. This will avoid the dispersion of means.

The consequences of this strategy. The measures taken to promote the presence of water and its management focused primarily on diadromous species, by maintaining the reservoirs in the rivers, make it possible to achieve the objective with respect to the most fragile species, but without harming the presence of those that do not migrate and prefer calmer and deeper waters. They are all part of the food chain and the diversification of the environment guarantees an equivalent diversification of prey, whether for adults or juveniles, which are largely forgotten by current strategies.

But in addition, this reasoned conservation of the weirs allows humans to exploit the driving force of water and to produce renewable hydroelectric energy in significant quantities, which will help regulate the climate and thus make traditional species competitive (6 billion kWh for watermill only in France). In addition, the natural absorption of CO2 by microscopic organisms present in water bodies in general, as well as in the sea, will also contribute to mitigate climate change. Finally, the raising of the water line by the succession of structures in the minor bed, automatically reinforces the supply of the water table (Darcy's law), which cannot be said to be unaffected at present because of pumping, made compulsory by the disappearance of surface water storage areas. Even if agricultural practices must change, no plant grows without water and beyond our food security, it is also our landscape and its regional and national diversity that is in the balance, being shaped by agriculture for centuries. It is crucial that this practice be allowed to continue, all the more so as the abandonment of cultivated plots, synonymous with a return to nature, would in any case not have a sufficiently rapid impact on global warming to allow a return to the pre-industrial situation. But it would have dramatic consequences on the human species!

**Priority 2: Good water quality**

It is not in winter, when water is abundant, that the problems of physical and chemical quality of water arise the most, but during low water. As the pollutants do not evaporate, their concentration increases, as does the water temperature, especially when the river is no longer flowing. Naturally,

the larger the body of water impounded, the less impact surface heating will have on fish, since it simultaneously generates a thermal depth gradient (Donati, 2020). Mill impoundments are often blamed for warming river water, but a thorough study shows that these are only superficial changes. Moreover, scientists in their studies do not take fragmentation into account at all when estimating water temperature, they use the temperature of the atmosphere. For example, Hoffmann-Legrand (2021) demonstrates that water temperature has a significant impact on migrants, but not "the restoration of ecological continuity", whereas if the destruction of structures on certain western rivers (such as the Touques) had indeed caused a significant difference in temperature, the parameter would have been significant. This is not the case. On the other hand, we propose a dynamic management of the low water levels, with artificial contributions of water, completely impossible currently in particular because all the policy led until now aimed at reducing the mass of water stored in the bed of the river rather than to increase it as we recommend it. A large mass of water obviously has a greater thermal inertia and it is this parameter, more than the instantaneous and temporary warming, that is important for aquatic biodiversity.

As for pollution, it is difficult to act to reduce it insofar as the chemical molecules that are most penalising for the physiology of diadromous and all fish, are extremely difficult to detect. Currently, no treatment plant eliminates drug residues or endocrine disruptors. Therefore, there is only one way to mitigate the impact of pollution: dilution, i.e., increasing the mass of stored water flowing in the river during the driest months. This is entirely feasible, but only if you target the most promising watersheds (including using IPCC forecasts), not if you generalize the actions to the entire country, under the pretext that there might be migratory fish everywhere. The advantage of the dilution technique is that it is totally dependent on measures to ensure that water is always present in the riverbed, even during the most intense drought episodes, as described above.

The most delicate part of the migration is at the mouth of the river. It is in this interface between the saltwater and freshwater environment that endocrine disruptors will do the most damage to the fish, which undergo physiological transformations of adaptation and maturation of reproductive organs (Kestemont, University of Namur, 2022). The Spanish study (Bizarro, C. et al.,2014) confirmed the impact of this pollution on gonad development. There is no way to act directly and quickly on these chemical disruptors present in the water in infinitesimal doses, but we can hope that a greater flow during low water should cause a kind of "washing" of the mouth followed by a very strong dilution in the sea.

Mouths are currently the only places where a study of the impact of pollution on migrants has been undertaken, simply because no large-scale research has been conducted to characterize and map chemical barriers along the entire length of a river. Completion of this research project will help refine urgent actions to improve freshwater fish movement and health.

Collateral benefits include the lagoon effect (Pinay et al., 2017), which is triggered whenever river water is slowed by a structure, even if it crosses it by overflow. Only in the calmer water do the biological processes that will digest certain pollutants such as nitrates, phosphorus, and some pesticides take place. This lagoon system has been widely copied by communities in small towns that use it to treat wastewater. The water that comes out of a mill is always cleaner and more oxygenated than the water that goes in, which is very favourable to fish.

**Priority 3: Specific species**

**The diadromous species** reproduce in specific places in our rivers more or less far from the mouth. The current fragmentation, considered by many to be responsible for the disappearance of these species, is certainly not as dramatic as it is made out to be, since the fish still reproduced for decades after access to their spawning grounds was theoretically definitively prohibited. They found spawning grounds elsewhere, in new areas, which proves that the ascent to the most extreme point of the watershed is not mandatory.

It is technically possible to reconstitute spawning grounds at shorter distances from the mouth, which will offer the ideal characteristics from the granulometric, hydrological and thermal point of view, likely to be used by the fish, knowing that they are perfectly capable of changing spawning grounds as we have previously explained. The weirs cannot be considered as irremediable brakes to the movement, since it is quite obvious that these fish had to cross obstacles of "natural height", i.e., similar to those which were built by the beavers, reproduced with the identical one by the builders of mill. It should be noted that globally, all structures taken together, from 20 cm to 50 m in height, the scientific council of the AFB, now OFB, has estimated that only 10% of them pose crossing problems. It is important not to substitute ourselves for nature, which has never sent migratory fish into channels without difficulties, and therefore without the natural selection that is indispensable for the emergence of resistant wild strains.

**Farmed fish**. The deleterious effects of hydromorphology operations to facilitate the movement of fish have been aggravated by the stocking of fish intended to reinforce the numbers. These farmed fish are domesticated fish with seriously eroded instincts. Even if farmed salmon are a priori capable of returning to the river in which they were released, their interbreeding with wild individuals constitutes a genetic pollution that reduces the adaptive potential of the species (Hoffmann-Legrand, 2021). It should be remembered that there is only one wild salmon conservatory in Chanteuges in the Haute-Loire, whose fish are sent to many French and European rivers, which does not correspond to the wild behaviour of salmon.

If more important efforts are to be made with regard to its emblematic species, one of the most important would be to permanently close fishing for several years and not only fishing for these few species. From the shore, the fisherman can only identify his catch after bringing it ashore, injuring, stressing and exhausting it, which compromises the rest of its journey, when it is a migratory species.

**Invasive species**. In our rivers, invasive species are all those that are unable to survive in running water, assuming that if humans had not built structures that slow down the water, they would not have been able to settle and therefore would not exist. This assumption implies that before the mill weirs, there were no obstacles across the minor bed of the rivers, which is totally false, since there were the woodjams and the multitudes of beaver dams. In other words, even if man has voluntarily added up to 40% of the aquatic species, they have always had the capacity to survive in our pre-

Anthropocene wild rivers and would have ended up there at some point. Indeed, since these species do not migrate, how is it possible that their distribution area is constantly increasing while their crossing capacities, independently of the fact that they are sedentary, are much lower than those of salmonids? Assuming that they benefit from external assistance by birds that release their prey or by fishermen, their extension can be explained first of all by the fact that they reproduce better in warmer water, thus benefiting from global warming which gives them an advantage over others. They are invasive by inadvertence, because the traditional species were no longer able to occupy the usual space. Since it remains impossible to stop global warming quickly, it is extremely important not to destroy their habitat in the river, i.e., the partially lentic reservoirs. By reinforcing a policy of destroying structures, there is a risk of seeing the disappearance of the so-called "invasive" species and of ending up with a completely empty river, since the traditional species will not multiply because of global warming. (The dramatic decrease of fish number and diversity following the fish pass building in Belgium is alarming; Benitez, 2022) This is so even if the habitat, which the law has arbitrarily chosen for them, and which does not resemble at all that of a prehistoric wild river, is unfortunately abused as "restored". For temperate zone fish, it is a double punishment: different environment and different habitats. The conservation of freshwater biodiversity can only be established on new species assemblages, necessarily different from those "before" and which will include species that are considered for now as non-native. This is a law of nature that does not take into account how we label species in relation to our own interests.

Finally, the only truly invasive species are precisely those that we release to support the population before the opening of the fishery, without having measured the impact they will have on food competition, nor on the life traits of wild individuals after hybridization, because they will suddenly occupy the space of endemic strains. For trout, for example, the releases practiced for fishing for the past 40 years, have made the wild strains disappear unless they were isolated by an impassable obstacle (Genetic study of trout, Loire fishing association, 2016). In other words, the management of this fragmentation, whose artificiality is proportional to the height of the structure, must absolutely be integrated into the management plan to protect the relictual aquatic biodiversity. No global approach on a national scale can be envisaged to safeguard the "historical" equilibrium between species everywhere, but on the other hand, they can be preserved in places in a totally artificial way, whenever it has been possible to erase the warming and pollution of the water. The simplest way is to mechanically construct spawning areas where fish can reproduce for some time, knowing that, despite everything, these species that live partially in an uncontrollable environment like the sea are not saved because a small part of their existence is reinforced.

## D. Conclusion:

To perceive the decline of aquatic biodiversity over a period as short as about 30 years is certainly a particularly alarming situation that justifies the search for urgent scientifically justified solutions. In order to predict the impact of the measures to be taken, scientists need sufficiently large numbers of data to obtain results statistically significant. In the field of aquatic biodiversity, the only data available today are climatic, hydrological and morphological, thanks to the census of structures on

European rivers. In fact, the latter constitute the only parameter on which it is possible to act quickly with an artificial and especially visual statistical "justification".

Even if the objective was to erase all traces of man in order to free nature and safeguard aquatic biodiversity, it quickly became clear that this strategy could not be applied to current rivers, except to put the very existence of human beings in danger, who need water not only to survive like animals, but to live comfortably. It was therefore necessary to resign ourselves to the destruction of small obstacles, such as mill weirs, whose use has often been abandoned following administrative pressures, thus becoming a priori useless for us and, by particular interest, for nature. Unfortunately, these small structures, although built by men, are the only rehabilitated remnants of the prehistoric wild rivers that hosted the aquatic biodiversity we wish to restore. They are the ones that generate the natural functionalities of the rivers whose different services have managed to compensate for degradations that did not exist before human activities generated pollution and accelerated climate degradation. In other words, by erasing these services, it will be impossible to slow down the erosion of aquatic biodiversity, since this operation simultaneously worsens the impact of the two parameters: hydrology and temperature, which are statistically associated with the disappearance of aquatic species. On the contrary, it is by reinforcing the actions of these small neo-dams within the river ecosystem that it will be possible to stabilize, or even reverse this disastrous trend towards the disappearance of these fish, which some people consider (out of interest) as real fish! It depends on one thing: the permanent presence of sufficient water to quickly mitigate the impact of global warming, while waiting for the measures taken to reduce our greenhouse gas emissions and pollution to be effective in a context of human population that continues to grow. We will not save nature by eliminating humans, and vice versa, and in any case, not by taking measures to prevent storing water in the land when it runs out. Strengthening our network of ponds, reservoirs, weirs and dams and exploiting their potential will solve 99% of our problems of erosion of aquatic biodiversity, while waiting for better days. This "water for all" strategy puts an end to the idea that everything man has done is harmful to nature and the planet, except for what he is going to do now, which is bound to be beneficial since it will reduce his quality of life. The cruel events that are taking place in Ukraine have just brutally reminded us that no country, even a rich one, potentially capable of buying elsewhere what it has not produced at home in the name of a biased vision of environmental protection, must still secure its energy and food independence. Now, these two fundamental needs depend on a resource which, by chance, we have abundantly in Europe: water; provided that we take care to make sufficient reserves that will serve to feed nature AND humans. If one lacks it, the other will lack it. It is urgent to put an end to all programs that aim to reduce our water stocks by facilitating the direct flow of our rivers to the sea.

The collapse of the world's biodiversity is a problem for which everyone knows the solution: the reduction of CO2 and other greenhouse gas emissions. The techniques to achieve this are also well known: no more transportation, no more agriculture, no more heating, no more of everything that makes life liveable. In other words, the solutions are not applicable. We can only hope for a small progressive improvement that can in no way put an end to the great animal extinction. To act quickly, there is only one solution: we must mitigate the most harmful consequences of our greenhouse gas emissions: temperature and pollution. The tool to moderate the impact of these two parameters while participating in the reduction of greenhouse gas emissions is water. We know how to reduce temperature with water, we know how to dilute pollution with water and we know how to produce renewable energy with water. To those who find this proposal sometimes utopian, we

answer that a few weeks ago, we thought that around 2050 or 2100, human mortality was going to increase in Europe as a result of global warming... Today, with the events in Ukraine, we are not at all sure that humanity is going to survive the next nuclear war which is still possible tomorrow and we are totally sure that we will have a food shortage, in our so rich countries, in a few weeks, before the end of 2022.

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