

DAM REMOVAL PROGRESS 2023

 DAM
REMOVAL
EUROPE

All-time record in removed barriers

The removal works of Torreval Dam at Cega River, Spain in autumn of 2023
© Pao Fernández Garrido

The removal works of a weir at Starohorský potok, Slovakia in autumn of 2023
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INTRODUCTION

European rivers have been fragmented for centuries by more than 1.2 million instream barriers (Belletti et al. 2020), classified in different categories (dams, weirs, culverts, fords, ramps). These barriers cause habitat degradation and biodiversity loss, and they alter the natural nutrient flow. They also modify the natural sedimentation, and thus amplify the erosive power of water downstream. Barriers also modify the water level and impact the recharge of the aquifer. Low-head barriers (e.g. weirs) also pose a threat to human lives and are thus known as drowning machines (cf. page 11), while barriers that have outlived their useful lives and now remain obsolete are at risk of structural failure.

Lately, the tide is turning and barrier removal is recognized as an effective and useful river restoration tool in Europe. The number of barrier removals¹ increases year after year (Table 1) and new European countries are starting to implement this practice to restore river connectivity and ecological continuity. Most barrier removals occur in western and northern Europe, where barrier density is highest, but this restoration tool is gaining attention in other European regions too, like the Balkans. Mainstreaming barrier removal in regions and countries with relatively unfragmented rivers is imperative and timely, to hamper the accelerating pressure for hydropower development. Dam Removal Europe (DRE) coalition publishes a progress report on an annual basis to evaluate the advancement in the implementation of EU policies and to analyse the progress and impact of dam removal utilization as a river restoration measure in each European country (Figure 1).

The significance of river connectivity has been recently recognized in the most official way, as it is a central topic of the EU Nature Restoration Law², which includes an obligation to remove man-made barriers to contribute to restore the free-flowing condition of at least 25000 km of rivers in Europe by 2030. On the 27th of February 2024, the European Parliament approved the Nature Restoration Law, following the provisional agreement reached by European member states in November 2023. It now must be adopted by the Council, before being published in the EU Official Journal and entering into force 20 days later. According to the EU Nature Restoration Law, ecosystems will have to be restored in all member states, contributing to the EU's climate and biodiversity objectives and enhanced food security. To achieve these goals, member states must put in place restoration measures in at least 30% of habitats that are now in poor condition and are covered by the new law.

DAM REMOVAL EUROPE

Dam Removal Europe (DRE) is a coalition of seven organizations: the World Wildlife Fund, The Rivers Trust, The Nature Conservancy, the European Rivers Network, Rewilding Europe, Wetlands International Europe, and the World Fish Migration Foundation. The overall ambition of DRE is to restore the free-flowing state of rivers and streams in Europe. In that respect, DRE aims to establish barrier removal as a restoration tool and to mainstream this practice. Through a bottom-up process DRE has created a continuously growing European network and it is working towards a holistic approach to remove barriers.

¹ A barrier must have been removed through the full vertical extent of the structure for the total width (total removal) or a significant portion of the stream width (partial removal) permitting fish passage and ecological flow. Technical fishways and bypasses were not considered barrier removals and thus were not included in this report

² European Commission, [Nature Restoration Law](#)

YEAR	NUMBER OF REMOVED BARRIERS	NUMBER OF COUNTRIES
2020	101	11
2021	239	17
2022	325	16
2023	487	15

Table 1. Number of removed barriers and of countries that reported removals to Dam Removal Europe per year. Note: barrier removals which took place in England, Scotland, Wales and Northern Ireland are considered under UK as a single unit

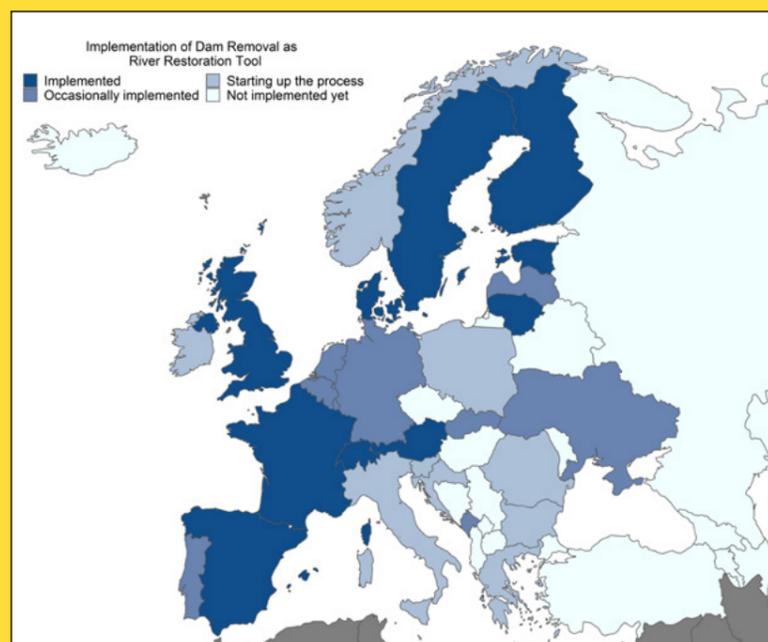


Figure 1. Implementation of dam removal as a river restoration tool in Europe. Note: barrier removals which took place in England, Scotland, Wales and Northern Ireland are considered under UK as a single unit

DATA COLLECTION & RESULTS

The data presented in this report were collected through: (1) direct written requests to public authorities of European countries dealing with barrier removals, river restoration projects and water management, and (2) relative requests to the European DRE network (~3600 people from 40 countries). Data were provided by ministries, municipalities, water agencies, river trusts, NGOs, scientists, researchers, and river restoration practitioners. Accurate estimations

of the total number of barrier removals executed per year is a highly complex endeavour because the verification process of such projects and whether they satisfy the criteria of a barrier removal is time-consuming. The lack of centralized process to gather such information nationwide is lacking in most European countries. In that respect, the final number of removed barriers reported herein should be considered an underestimation.

Based on the information gathered, DRE reports that in 2023:

- ✂ At least 487 barriers were removed in 15 European countries (Figure 2)
- ✂ France was the trailblazer of barrier removal in Europe (Figures 2-3), followed by Spain, Sweden and Denmark
- ✂ 46% of the removed barriers were weirs and 36% were culverts³. Dams were the next most common type of the removed barriers (12%), followed by ramps, sluices and fords
- ✂ 78% of the removed barriers were lower than 2 m, 20% were 2-5 m high and 2% were more than 5 m high⁴
- ✂ More than 4300 km were reconnected through barrier removals⁵

The total number of removals in 2023 represents a 49.8% increase from the previous year (325 barrier removals in 2022; Mouchlianitis 2023; Table 1).

These results can be attributed to a combination of:

- ✂ the newly available funding opportunities (e.g., European Open Rivers Programme),
- ✂ the coordinated efforts of national and regional public authorities (e.g., Spanish Ministry for the Ecological Transition and the Demographic Challenge, Danish Ministry of Environment, Ministère de la Transition écologique et de la Cohésion des territoires), and
- ✂ the mainstreaming activities over the past 8 years by the DRE coalition and the increase of public awareness all around Europe through courses, seminars, webinars, publications in national and international media

In summary, the number of European countries that reported barrier removals in 2023 decreased by 1 compared to last year (Table 1). Similarly to 2022 (Mouchlianitis 2023), most of the removed barriers were weirs, as these structures have a high probability of being old and/or obsolete and can be removed in a cost-efficient way (Garcia de Leaniz and O'Hanley 2022). In addition, most of the removed barriers were low-head structures (≤ 2 m high) as was the case in 2022 (Mouchlianitis 2023). Such structures are the most abundant longitudinal riverine barriers throughout Europe and can be removed easier than larger structures, whose removal might also face stronger opposition from local communities and stakeholders (Belletti et al. 2020). Lastly, this year's report shows an increasing trend in the total number of removals for a third year in a row (Table 1).

This report does not include obsolete barriers that had fallen into decay and collapsed naturally or functional barriers that suffered structural failure due to extreme precipitation. Such incidences, of both small (e.g., weirs) and big (e.g., dams) barriers, have occurred around the world causing immense property and environmental damages and have even claimed innocent lives. In 2023 at least three incidences occurred in Europe: in Norway, N. Ireland and Slovenia, and triggered landslides and floods that forced downstream communities to evacuate. Given the magnitude of the latent hazard, DRE compiles information on these incidences to raise awareness, which can also be used to make well informed decisions and assist in the prioritization of barrier removal projects.

³ Type was available for 200 out of the 487 barriers that were included in this report

⁴ Height was available for 196 out of the 487 barriers that were included in this report

⁵ Number of reconnected km was available for 166 out of the 487 barriers that were included in this report

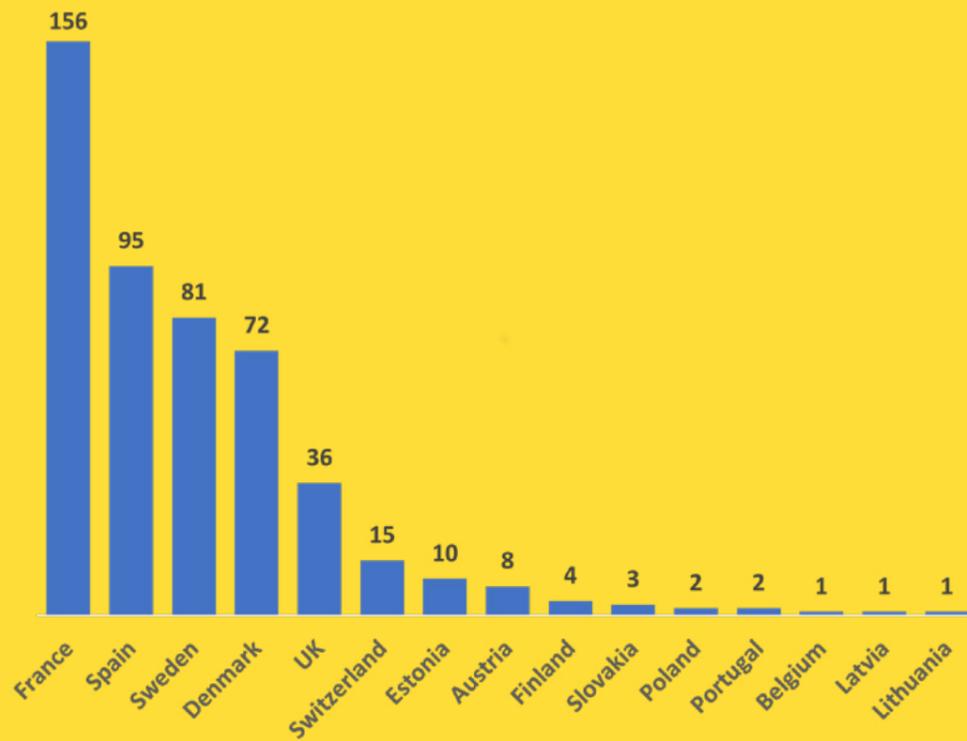


Figure 2. Number of removed barriers per country in 2023. Note: UK removals include 20 removals from England, 13 from Wales and 3 from Scotland

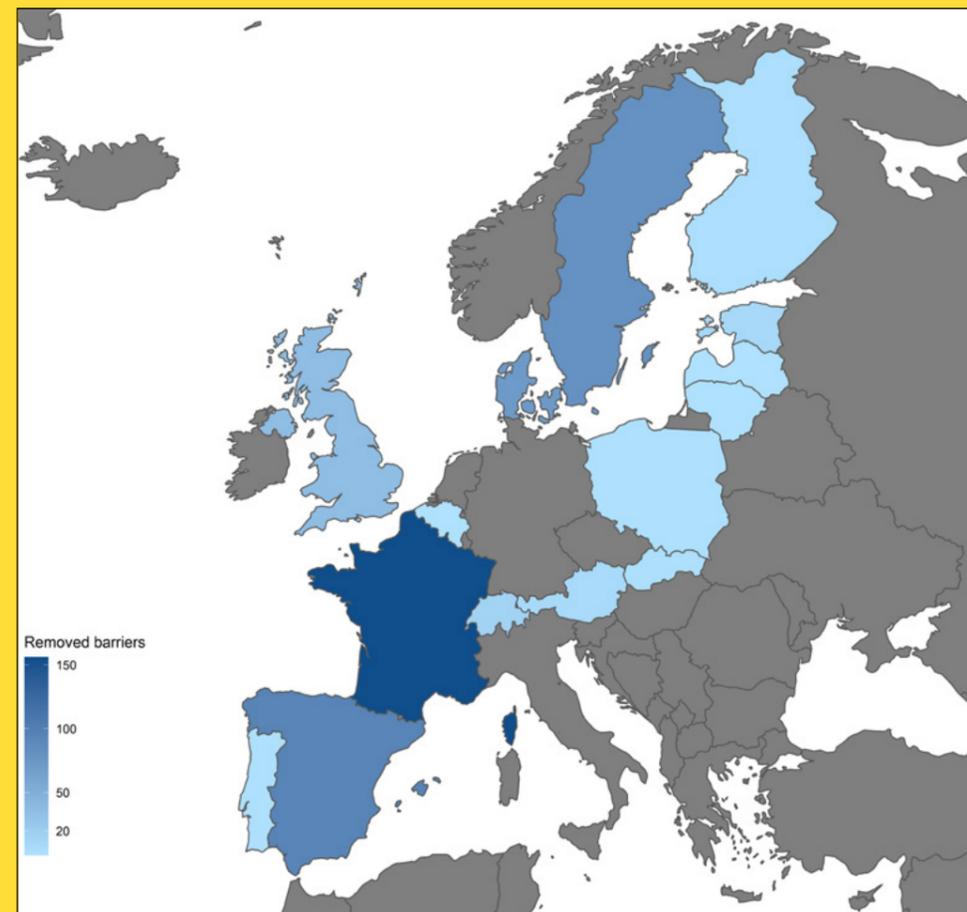


Figure 3. Map of European countries that reported barrier removals in 2023. Colour gradient refers to the number of removals per country. Note: barrier removals which took place in England, Scotland, Wales and Northern Ireland are considered under UK as a single unit

A FREE-FLOWING HIITOLANJOKI RIVER AT LAST

Hiitolanjoki is a 53-km-long transborder river that runs for 8 km in Southeastern Finland before entering Russia to flow into Lake Ladoga, and its catchment area is approximately 1470 km². It is of high ecological importance, since it inhabits the last remaining stock of the naturally landlocked salmon in Finland. However, its corridor has been dammed for over 100 years and access to upstream fish spawning grounds had been blocked. On the Finnish side of the border, three hydropower dams (Kangaskoski, Lahnasenkoski, Ritakoski) had been fragmenting Hiitolanjoki River in Rautjärvi, South Karelia, in the southeast part of the country.

The Hiitolanjoki project is the largest river restoration project ever done in the Finland. To restore the free-flowing conditions of the river, this ambitious project was initiated 25 years ago. In 2017, South Karelia

Foundation for Recreation Area acquired the three operational hydropower plants, with the support of many financiers, including Rautjärvi municipality, WWF Finland and the Ministry of Agriculture and Forestry, including a large group of corporate partners and private citizens. In 2021, works started, with the removal of the Kangaskoski, the lowermost of the three dams, where ecological improvement was instantly shown, with salmon spawning nests being spotted in the newly opened section of the river only a few weeks later. Lahnasenkoski, the largest of the three dams, was demolished in July 2022, and Ritakoski Dam one year later (Figure 4).

This project has opened up 54 km of highly important habitat for salmon and other fish species. In addition to the high ecological relevance of this project, it is also important for the socio-economic advancement of the area, which can now attract investments in the areas of touristic and recreational activities for current and new entrepreneurs.

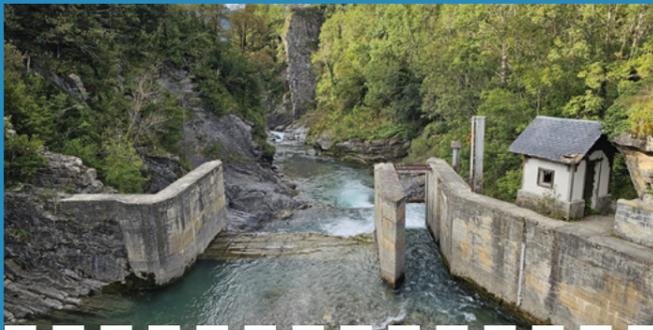
Figure 4. The removal site at Hiitolanjoki River, Finland: (left) before and (right) after the removal operations of the Ritakoski Dam © Mikko Nikkinen / Storymakers



BEFORE AND AFTER REMOVAL



CRIBYNAU WEIR – CLYWEDOG RIVER – WALES, UK
© Cyfoeth Naturiol Cymru - Natural Resources Wales



ESTACIÓN DE AFORO TORLA – ARA RIVER – SPAIN
© Ebro River Basin Authority



GALAXES WEIR – ODELEITE RIVER – PORTUGAL
© ANP / WWF



VANAVESKI WEIR – VASALEMMA RIVER – ESTONIA
© State Forest Management Centre



JURÁŇOV POTOK DAM – JURÁŇOV POTOK RIVER – SLOVAKIA
© (left) Hol'ma; (right) Očadlík / WWF Slovakia



URRUTIENEA DAM – NIVELLE RIVER – FRANCE
© Charlie Pichon



BARRAGE DE LE TRUIE D'OR – EAU D'HEURE RIVER – BELGIUM
© DE LE COURT Bernard / Service public de Wallonie





Figure 5. The removal site at Linhouse Water, a tributary of Almond River, Scotland, UK: (left) before and (right) after the removal operations of the Morton Quarry Weir © Forth Rivers Trust



DAM REMOVAL BY ALL MEANS NECESSARY

Forth Rivers Trust staff removed the Morton Quarry Weir by hand (Figure 5)! In September-October 2023, this 2-m-high historic relic of the 1800s oil shale industry, situated on the Linhouse Water, a tributary of the Almond River in West Lothian, Scotland, UK was deconstructed. The weir was located in a steep gorge prohibiting access to heavy machinery and the costs associated with creating such access were exorbitant. Thus, the weir was dismantled by hand; a remarkable achievement thanks to the dedication and craftsmanship of the Forth Rivers Trust staff. The removal process involved stripping away the weir's top concrete layer as well as the natural cobblestone weir beneath. The cobblestones were redistributed downstream of the removal site to enhance the aquatic habitat in the Linhouse Water.

This was a novel, low-cost method that caused minimal disruption to the habitat, and could potentially be replicated in similar projects. The weir removal has restored access to 8.5 km of pristine fish spawning habitat upstream. Trout and salmon were spotted at the site attempting to migrate upstream during the removal works. Poaching incidents that used to occur downstream of the weir due to the blocked fish passage have now been eliminated. Surprisingly, during the removal, a 300-360 million years old fossil was revealed belonging to the genus *Lepidodendron* (Figure 6), an extinct genus of tree-sized lycopsid plants that lived during the Carboniferous Period.



Figure 6. A 300-360 million years old fossil belonging to the genus *Lepidodendron* revealed during the removal of the Morton Quarry Weir © Forth Rivers Trust

DROWNING MACHINES

Low-head dams (i.e., weirs) that are especially dangerous due to the formation of an inescapably strong subsurface current (submerged hydraulic jump) are usually called "drowning machines" (Figure 7). These structures have caused hundreds of fatalities in the U.S. in the last 20 years; more than any other kind of riverine barrier. Currently there is no overview of the accidents and fatalities that occur in European rivers due to such structures nor a centralized way to report them.

In 2023, DRE performed a first attempt to collect such information from around Europe to increase awareness of the safety risks these structures pose to swimmers, kayakers, and other recreationalists. Incidents have been recorded since the 19th century and are occurring regularly.

The main findings can be summarized as below:

- ✂ 82 incidents (129 fatalities) were found in 16 countries
- ✂ There were a few rivers where more than one incident was reported
- ✂ It is highly probable that incidents at drowning machines will lead to fatalities. In 80.5% of the incidents there were at least one fatality
- ✂ The age of the people involved in the incidents ranged from 2 to 59 years old. Most of them were in their mid-20s to mid-30s
- ✂ The people involved in the incidents were engaged in different activities, like swimming, canoeing, rafting, fishing, or paddle boarding
- ✂ Warning signs are not enough to prevent such incidents. In at least 15 of the reported cases, there were warning signs that were ignored by the people involved

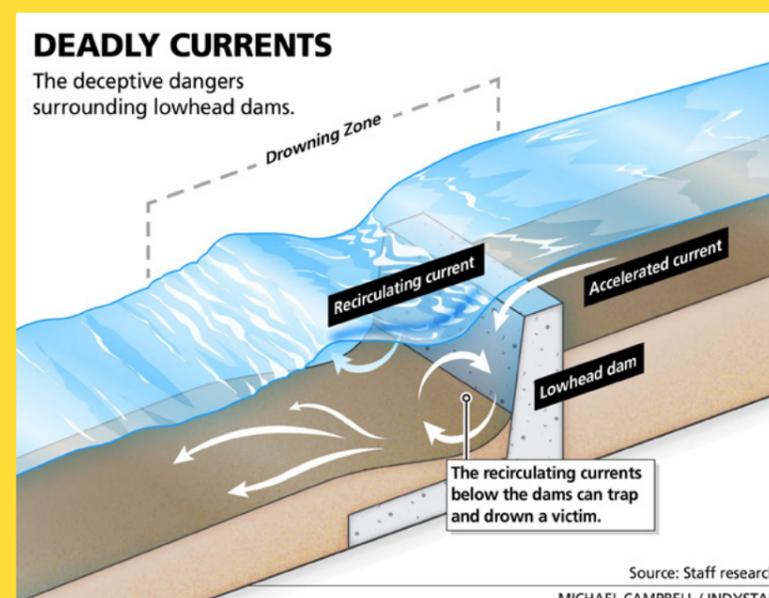


Figure 7. Low-head dams (i.e., weirs) that form an inescapably strong subsurface current (submerged hydraulic jump) are especially dangerous and are usually called "drowning machines" © Michael Campbell / INDYSTAR

SCALING UP DAM REMOVAL IN SOUTHEASTERN EUROPE

Barrier removal has only occurred sporadically and has yet to be established as a mainstream river restoration tool in Southeastern Europe (<https://damremoval.eu/dam-removal-map-europe/>; Figure 3). To address this gap, a 1.2 million Euro project, *Scaling up dam removal: implementation plan for Southeastern Europe*, was initiated in the autumn of 2023. Funded by the European Open Rivers Programme and led by Dam Removal Europe and the World Fish Migration Foundation, the project brings together several local partners, such as Fauna & Flora, MedINA Greece and the WWF offices in Slovakia and Adria region (Figure 8). Other partners include Wetlands International Europe, European Rivers Network and WWF

Netherlands. The project's interventions will facilitate funding applications to the Open Rivers Programme, shape national legislation and policies, and provide expertise and tools for stakeholders.

The key objectives include:

- ✂ **Developing a pipeline of 100 barriers to be removed in the region**
- ✂ **Encouraging and supporting organizations to remove barriers**
- ✂ **Advocating for the integration of barrier removal into national policies**
- ✂ **Sharing successes and benefits of barrier removal to the public and decision-makers**



Figure 8. Fieldtrip during the Romanian International Seminar in November 2023 within the framework of the Scaling up dam removal: implementation plan for Southeastern Europe project © Mihaela Faur / Flora & Fauna

NEXT STEPS

The support offered by DRE empowered practitioners to restore the connectivity of thousands of river kilometers in the past years, thereby enhancing freshwater biodiversity and enabling migratory fish to access their historical spawning sites after centuries. This impactful outcome was achieved not only through the removal of physical river barriers but also through dedicated and persuasive efforts to influence decision-makers and communities.

Europe has seen dam removal going from strength to strength since 2015. We want to continue on this trajectory, so that dam removal becomes business as usual in all European countries. DRE will continue to support this process to mainstream and scale up barrier removal in Europe by enabling knowledge exchange, connecting practitioners, and celebrating successful projects through courses, seminars, webinars, workshops, and dissemination activities (e.g., [case studies](#) and newspaper articles).

DRE will support countries/regions to initiate the implementation of dam removal projects, where barrier removal is yet

to be seen as a tool for river restoration (e.g., Balkans). In addition, following the outcomes of the long negotiation process to prepare and approve the Nature Restoration Law, DRE will use the momentum to work side-by-side with partners to provide continued support to EU countries that are still in the initial phase of this process, and influence neighboring countries. DRE has the most accurate – and constantly updated – database of removed barriers in Europe, to evaluate the advancement in the implementation of European policies and to analyze the progress of this river restoration measure in each country.

DRE will continue monitoring and reporting the trends in barrier removal and will keep providing guidance, assistance and the necessary tools to river restoration practitioners. In that respect, DRE has launched a new toolbox and put in place a freely accessible online helpdesk. Additional information on these new services, upcoming projects/events and relative news can be found on the DRE website (<https://damremoval.eu/>) and via the DRE Newsletters (subscription available through the DRE website).

Acknowledgements

Dam Removal Europe coalition and World Fish Migration Foundation wish to express their gratitude to all the public authorities and everyone who provided valuable information/data/photos on barrier removals.

References

- (1) Belletti B., Garcia de Leaniz C., Jones J., et al. (2020). More than one million barriers fragment Europe's rivers. *Nature* 588: 436–441.
- (2) Garcia de Leaniz C., O'Hanley J.R. (2022). Operational methods for prioritizing the removal of river barriers: Synthesis and guidance. *Science of the Total Environment* 848: 157471
- (3) Mouchlianitis F.A. (2023). *Dam Removal Progress 2022*. World Fish Migration Foundation



The removal site at Leuchar Burn, Aberdeenshire, Scotland, UK: (left) before and (right) after the removal operations of the Garlogie Dam in summer of 2023 © SEPA



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Resources and tools

For more information about dam removal showcases, events, tools and resources, visit: www.damremoval.eu

World Fish Migration Foundation

World Fish Migration Foundation is the coordinator of the Dam Removal Europe coalition, working together with other international NGOs to restore rivers in Europe that have high natural or cultural importance by removing obsolete barriers and ensure healthy free-flowing rivers.

Dutch Postcode Lottery & ForestPeace Foundation

World Fish Migration Foundation is proudly supported by the Dutch Postcode Lottery and the ForestPeace Foundation to enable and scale up dam removal as a viable tool for river managers in Europe. Interested in becoming a donor too and help to restore free-flowing rivers in Europe? Send an email to: info@fishmigration.org

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