

In a four-year study spanning 36 European countries, scientists surveyed almost 1,700 miles of river by foot—and found at least 1.2 million obstacles preventing European rivers from flowing freely. That’s more than one barrier for every mile of river (or 0.74 barriers per kilometer). Rivers in Europe are more fragmented—meaning their natural flows are interrupted by man-made barriers—than any other continent’s rivers, new research shows. There’s more than one barrier per mile on average in Europe’s rivers, which chokes off life in these critical arteries. But public awareness is sparking calls to take out small dams, weirs, and ramps.

“The numbers we found are higher than expected, and show that European rivers are broken,” says Barbara Belletti, a river geomorphologist who led the study at the Polytechnic University of Milan.

Artificial barriers, like dams, are one of the biggest threats to river ecosystems. They stop the natural flow of sediments and prevent migratory fishes from travelling up or downstream to complete their lifecycles. Thousands of large dams across Europe were catalogued in the study, which is published this week in *Nature*. However, researchers found that at least 85 percent of barriers on European rivers are actually smaller structures such as weirs, culverts, fords, sluices, and ramps. These shorter barriers, most under two meters (6.5 feet) in height, are often overlooked even though their cumulative impact on river connectivity may be substantial. While large storage dams can change how an entire river behaves, almost all barriers, no matter how small, have some effect on river life.

“Smaller barriers, because there are so many of them, may in fact be more harmful,” says Carlos Garcia de Leaniz, a professor of aquatic biosciences at Swansea University in Wales and project coordinator of AMBER, the European Union Horizon 2020 program providing the first pan-European assessment of river fragmentation.

At the same time, he says, there is some good news: “Mitigation efforts to improve river connectivity may not be as complicated as some had feared, since many of these smaller barriers are obsolete and could be easily taken out.”

With about 7,000 large dams, Europe generates 13 percent of its electricity from hydropower. (Find out more about how hydropower works here.) Although most of the larger hydropower plants in Europe were constructed in the aftermath of World War II, much of Europe’s river fragmentation can be traced back centuries. Many weirs (smaller barriers that regulate water flow) and low dams were built during the early days of industrialization to support factories and windmills, as well as agriculture across the continent. As the researchers soon found out, little data existed on the number and location of the barriers except for the largest of dams. While some countries, like France, maintained

good national databases on river barriers, others did not.

Such smaller structures often can't be detected by satellites, so an assessment of them had to be built on "ground truthing": walking surveys of the rivers. "We said, let's go to the river and find out what's there," says Garcia de Leaniz. "There is no substitute for boots on the ground."

While teams of scientists fanned out to the three dozen European countries—surveying at least five rivers in each country in continuous stretches of 20 kilometers (12.5 miles)—an app was also created so citizen scientists could log new barriers. Study leader Belletti, who is now at the French National Center for Scientific Research in Lyon, France, was part of a four-person team surveying the upper part of the Orco River, which originates inside the Gran Paradiso National Park high in the Italian Alps. She was aware beforehand of two large dams along the river, but was surprised to find four small barriers, all lower than two meters, inside the park.

"No one had any idea that they were there," she says.

The researchers created close to 630,000 records of the barriers they found. Recognizing there were likely many more barriers that could not be recorded, they calculated a correction factor for each country, arriving at the total of 1.2 million barriers. The findings show that the highest density of barriers occur in the heavily modified rivers of Central Europe, while relatively barrier-free rivers can still be found in the Balkans, the Baltic states, and parts of Scandinavia and southern Europe.

Dam tear-downs

Migratory fish, in particular, are hurt by large dams, which may block them from reaching spawning areas despite passageways built to let fish through. A study earlier this year found that populations of migratory freshwater fish have declined by 76 percent globally since 1970, with an even greater decline in Europe: a staggering 93 percent.

"This can be directly attributed to river fragmentation," says Herman Wanningen, the director of the World Fish Migration Foundation in Groningen, the Netherlands.

While there are plans to build a cascade of new dams in the relatively pristine Balkans region, some other countries in Europe seem to be following the path of the United States, where a large-scale effort to take down dams and restore rivers began several decades ago. Last month, California and Oregon renewed plans to soon tear down four dams on the Klamath River to unlock hundreds of miles of waterways for struggling salmon, in what would be the country's largest dam demolition ever.

In Estonia, the removal of the Sindi Dam and other barriers along the country's Pärnu River

is expected to free up more than 1,850 miles (3,000 kilometers) of waterways. In France, two large dams are being removed on the Sélune River in order to reconnect the river and the ocean.

“When calculating the total costs for relicensing, maintenance, and income from energy production, the conclusion is in many cases that it’s cheaper to remove dams and to think about ways to produce energy in a more efficient way,” says Wanningen, a co-author on the Nature study.

No brainer

Researchers hope that the new study will bring increased attention to the outsized role that smaller barriers may play in disrupting a river’s ecosystem. Low weirs, ramps, and fords may block the passage of everything from weak-swimming invertebrates (such as crayfish) to aquatic plants, not to mention the vital sediments that rivers transport. “For many organisms, it doesn’t matter if the barrier is one or 20 meters high; they can’t get through anyway,” says Garcia de Leaniz.

It makes sense, he says, to focus removal efforts on small barriers that are easier to take out than a large dam. At the same time, perhaps some barriers should not be removed because they prevent the intrusion of an invasive species or shield a watershed from pollution. “We want to connect good habitats with other good habitats, not bad ones,” he says.

In Sweden, which like most European countries gets almost all of its hydropower-generated electricity from large dams, removal efforts have been targeted at small-scale dams and weirs. A fund recently set up by some of the largest hydropower companies in the country, aimed at improving environmental standards of all dams, offers landowners and small-scale dam operators financial aid to remove structures.

“For most people, it’s a no-brainer [to accept this offer] ... since these operations are often totally unviable economically,” says Christer Borg, director of Älvräddarna (translated as River Savers), an influential environmental organization in Sweden. Borg believes up to 1,000 small-scale dams could be dismantled as a result of the program.

A similar strategy has been pursued in Finland. Mitigation efforts there initially focused on removing culverts in small creeks, for example, before moving on to target smaller obsolete dams, and, in three years, even small hydropower stations still in use. A public service campaign on dam removals has moved opinion in Finland by highlighting the benefits that many Finnish people associate with free-flowing rivers, including various leisure activities (funny PSA here), rather than focusing on the subject as an infrastructure matter people may find abstract.

“We’ve seen a remarkable turnaround in attitudes on this issue, with a large majority of Finnish people in favor of removing even hydropower dams now,” says Sampsa Vilhunen, the head of the marine and freshwater program at the World Wildlife Fund in Finland.

Belletti says she, too, is seeing greater public awareness around Europe concerning the importance of river connectivity. She believes the mapping project can help inform the implementation of the European Union’s Biodiversity Strategy, which aims to reconnect 25,000 kilometers (15,500 miles) of Europe’s rivers by 2030.

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