**Headline:** Removing Hydropower Dams Can Restore Ecosystems, Build Climate Resilience, and Restore Tribal Lands

**Teaser:** Hydropower dams, initially celebrated as feats of engineering, are now scrutinized for their negative environmental and societal impacts.

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**Source:** Independent Media Institute

**Credit Line:** This article was produced by [Earth | Food | Life](https://independentmediainstitute.org/earth-food-life/), a project of the Independent Media Institute.

**Tags:** Climate Change, Economy, Environment, Social Justice, Human Rights, Indigenous Resistance, Europe, Europe/Spain, Europe/France, Europe/Sweden, Europe/The Netherlands, Europe/Estonia, Asia, Asia/Japan, Asia/China, North America/United States of America, Science

**[Article Body:]**

A free-flowing river supports abundant fish and wildlife, provides drinking water, and other intangible recreational benefits. But humans have sought to block rivers with dams for millennia. While dams have provided benefits like hydroelectricity and water storage, they have also been [ecologically disastrous](https://web.mit.edu/12.000/www/m2012/finalwebsite/problem/dams.shtml). Besides blocking fish migrations, these human-made structures can destroy seasonal pulses of water that keep ecosystems in balance. Some dams—especially those used for power—can deplete water in streams, leaving entire stretches of river bone dry.

Dams are not built to last forever. [Most have a lifespan of more than 50 years](https://thinkprogress.org/oroville-aging-dams-across-the-country-94386c1982ce/), and [70 percent](https://www.infrastructurereportcard.org/dams/) of dams in the United States will be older than that by 2030, according to the American Society of Civil Engineers 2021 Infrastructure Report Card. The cost of repairing and maintaining these obsolete structures can be significant—even more [expensive](https://www.mma.org/study-removing-dams-less-expensive-than-repairing-maintaining-them/) than removing them altogether.

“Dams are not like the pyramids of Egypt that stand for eternity,” [said](https://www.nytimes.com/1998/07/15/us/heralding-a-new-era-babbitt-chips-away-at-harmful-river-dams.html) former Secretary of the Interior Bruce Babbitt in 1998. “They are instruments that should be judged by the health of the rivers to which they belong.”

The [National Inventory of Dams](https://nid.sec.usace.army.mil/) (NID), an online database maintained by the U.S. Army Corps of Engineers, tracks 92,366 dams across the United States as of October 18, 2024, with an average age of 63 years. Of these, 16,720 dams are classified as “high hazard potential,” meaning their failure will likely result in loss of life and significant economic damage. Less than 40 percent of the dams in the inventory provide critical services such as water supply, irrigation, hydropower, navigation, or flood risk reduction. However, it’s important to note that the NID has size limits for inclusion in its inventory; there are [more than 500,000 dams in the United States](https://www.eesi.org/briefings/view/050124dams#:~:text=There%20are%20over%20500%2C000%20dams,dams%20are%20abandoned%20or%20outdated.).

Removing dams is the fastest way to restore a river. The selective removal of outdated or unsafe dams offers an economical and effective way to eliminate liability for dam owners while improving river health. By restoring rivers to their natural state, dam removal can result in a wide range of long-term benefits, including enhancing public safety and quality of life and boosting economic development in communities nationwide. Dam removal can also protect Tribal lands, increase property values, protect against flooding, support wildlife and biodiversity, and enhance recreational opportunities.

In addition to restoring the river channel, restoring the low-lying areas—or floodplains—around rivers is an essential part of dam removal, and it gives our waterways room to spread out. Healthy floodplains [provide](https://www.americanrivers.org/resource/reconnecting-floodplains/) vital habitats for fish and wildlife, help rivers accommodate floodwaters resulting from frequent and intense storms, and—in concert with limiting development in areas prone to flooding— shore up some communities’ resilience in the era of climate change.

**Case Study: Bloede Dam**

In cases like [Bloede Dam](https://dnr.maryland.gov/fisheries/pages/fishpassage/bloede.aspx), which blocked the natural flow of the Patapsco River in Maryland, removal was the preferred option for a dam owner burdened with an unsafe structure. Like many outdated dams in the United States, the Bloede Dam’s [negative impact](https://www.americanrivers.org/patapsco/index.html) on the Patapsco River exceeded its usefulness. It generated electricity for less than 20 years before its [turbines became clogged](https://www.wmar2news.com/news/region/howard-county/bloede-dam-to-be-removed-some-concerned-about-historical-significance) with sand and rock, making maintenance too costly. Consequently, the power company shut it down. Despite this, the dam stood for around a century, blocking the river’s natural flow and acting as a drowning hazard in a public park until it was [removed](https://www.americanrivers.org/patapsco/index.html) in 2018.

During that time, it blocked migrating fish like alewife and blueback herring from reaching upstream habitats where they spawn and grow. Publicly owned dams like Bloede can significantly cost taxpayers in necessary upkeep and repairs–often for structures that no longer serve a purpose. In addition, the Bloede Dam was a [low-head dam](https://www.boat-ed.com/indiana/studyGuide/Low-Head-Dams/10101602_35260/) with water continuously flowing over the crest of the dam, creating a dangerous swirl at the dam’s base. Low-head dams have resulted in thousands of fatalities across the nation, and Bloede Dam led to the [deaths of at least 10 people](https://www.bayjournal.com/news/people/man-missing-presumed-drowned-at-bloede-dam/article_19e0dde4-e663-54aa-9936-c45a768ef74f.html) between 1981 and 2015.

In September 2018, [explosives blasted a hole in the concrete Bloede Dam](https://www.baltimoresun.com/news/maryland/environment/bs-md-bloede-dam-explosion-20180912-story.html), opening a new era of ecosystem restoration. Over the following weeks, the remainder of the dam was removed with explosives and heavy equipment. The dam’s removal restored more than [65 miles of habitat](https://dnr.maryland.gov/fisheries/pages/fishpassage/bloede.aspx) for resident and migratory fish. For diadromous fish species, which must migrate between fresh and marine waters to complete their life cycle, it meant that their freedom of movement had finally been restored. Several species of diadromous fish migrate between the Patapsco River and Chesapeake Bay, returning to where their ancestors have spawned for millennia.

This reconnected river is now safer for visitors and is helping to revitalize the health of the entire Chesapeake Bay. Removing Bloede Dam opened more than 65 miles of spawning habitat to native river herring, American shad, and hickory shad. Without the dam blocking them from tributaries that are key to their migration, American eel can now access 183 miles of open river.

In addition to restoring the river ecosystem, the removal of the Bloede Dam means that visitors to the park can safely enjoy this now-thriving river. Since its removal, we have witnessed local communities return to its banks, kayaking through the former impoundment, fishing from recently uncovered boulders in the stream, and cooling off on hot summer days. Removing unused dams like Bloede is one of the most important things we can do to maintain healthy rivers and the ecosystems and economies they support.

**A Brief History of Hydropower Dams**

While damming rivers began in [ancient times](https://tataandhoward.com/a-history-of-dams-from-ancient-times-to-today/), the construction of hydropower dams started in earnest during the Industrial Revolution to power local mills. Hydropower dams began powering the electricity grid in the early 20th century, driven by the demand for reliable and renewable energy sources. These massive engineering projects were feats of modern ingenuity and engineering, promising electricity, flood control, irrigation, and water supply. Once seen as symbols of progress and innovation, many hydropower dams are now recognized for their significant negative ecological and social impacts. Removing dams as they become uneconomical or unsafe is essential to restoring river ecosystems and communities.

More than 2,500 hydropower dams have been built across the country. Federal agencies, states, municipalities, and private organizations own these. Most of the dams were built during a building boom that lasted from the 1930s to the 1970s. Several federal agencies took part in reshaping rivers, including the Bureau of Reclamation, which oversees water resource management; the Bureau of Land Management, which administers federal lands; and the Army Corps of Engineers, which operates and maintains approximately [740 dams](https://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/) across the United States.

In retrospect, most of these projects’ ecological and social costs were often overlooked and continue to be forgotten.

Rivers were dammed, ecosystems were disrupted, wildlife migrations were blocked, and communities, many Indigenous, were displaced. As environmental awareness grew in the latter half of the 20th century, the negative impacts of dams became more evident, [leading](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/dam-removal) to a reevaluation of their role and the dam removal movement.

The dam removal movement was ignited with the removal of the Edwards Dam on the Kennebec River in Maine in 1999. This federally regulated hydropower dam fully blocked fish migration for 160 years, and environmental groups advocated for its removal. Edwards Dam was the first project for which the Federal Energy Regulatory Commission denied a relicensing application and ordered a dam to be removed against the owner’s wishes, determining that the river’s ecological, economic, and community benefits outweighed the hydropower production of the project.

Across the nation, tens of thousands of dams that have outlived their purpose continue negatively impacting natural ecosystems. [Removing](https://www.americanrivers.org/2016/10/removing-dams-can-save-lives/) these dams could save money, reduce the liability of owning them, and restore the natural environment.

Between 1912 and 2023, 2,119 U.S. dams were [removed](https://www.americanrivers.org/2024/02/saying-adios-to-80-dams-in-2023/), with more than three-quarters demolished since the turn of the 21st century. The nation saw a major milestone in 2023 with the initiation of the nation’s [largest dam removal project](https://www.americanrivers.org/2024/02/saying-adios-to-80-dams-in-2023/) on the Klamath River in California. Still, only [46 federally regulated hydropower dams](https://www.americanrivers.org/resource/the-practitioners-guide-to-hydropower-dam-removal) have been removed, representing less than 3 percent of removals across the country.

“Dam removal can rewrite a painful chapter in our history, and it can be done in a manner that protects the many interests in the [Klamath River] basin,” [wrote](https://www.circleofblue.org/2016/world/interior-department-supports-klamath-dam-removal/) U.S. Interior Secretary Sally Jewell in 2016.

**Indigenous Communities and Tribal Land**

In many cases, removing dams restores Indigenous territory. We must acknowledge that the land and rivers [in the Americas](https://www.npr.org/2022/10/10/1127837659/native-land-map-ancestral-tribal-lands-worldwide) and [many regions across the globe](https://native-land.ca/) are the homelands of Indigenous communities who have been stewards of these lands for thousands of years. The historical and ongoing injustice of the theft of tribal lands must be addressed through legislation, regulation, restoration, cooperation, community engagement, and increasing awareness by citizens and local, state, regional, and federal agencies.

Many hydropower developments have [negatively impacted](https://americanindian.si.edu/nk360/pnw-history-culture-barriers/dams.html#page2) Indigenous communities by depleting native fish runs, damming sacred rivers and sites, and disrupting the communities’ relationships with waterways. Therefore, removing dams and letting rivers flow naturally is an essential part of respecting the values of these tribes and supporting their efforts to ensure land and water protection and restoration.

“Removing dams can serve as a form of land back for Native nations,” said Heather Randell, an assistant professor at the University of Minnesota, in a February 2024 episode of the [podcast](https://www.resources.org/resources-radio/the-effects-of-dams-on-tribal-lands-with-heather-randell) Resources Radio. “Dam removal can be a way to restore tribal sovereignty over their ancestral land and enable tribes to rehabilitate the land and water ecosystems that supported their livelihoods for thousands of years and were damaged by dam construction,” said Randell, who co-authored the article, “[Dams and Tribal Land Loss in the United States](https://iopscience.iop.org/article/10.1088/1748-9326/acd268#erlacd268s2),” published in the journal Environmental Research Letters in August 2023.

**Impacts on Wildlife**

While hydropower dams provide renewable energy, they often cause substantial ecological disruption. Dams alter water flow, temperature, and sediment transport, leading to degraded water quality and negatively impacting aquatic habitats. [Fish populations](https://www.fws.gov/node/265254), particularly migratory species, suffer as dams block access to spawning grounds, causing a decline in biodiversity.

One of the most significant environmental impacts of dams is the [fragmentation of river ecosystems](https://www.sciencedirect.com/science/article/pii/S0048969723005557). Rivers naturally flow from their headwaters to the sea, creating diverse habitats that support a wide range of species. Dams interrupt this flow, creating reservoirs often inhospitable to native species and promoting the proliferation of non-native ones. This disruption can lead to the collapse of local fisheries and the loss of recreational activities that are dependent on healthy, free-flowing rivers. Hydropower dams can be incredibly impactful as they are often constructed on the mainstem of rivers, lower in the watershed, and can completely cut off the watershed’s upper reaches from migratory species.

For example, in October 2023, the Oregon Capital Chronicle [reported](https://oregoncapitalchronicle.com/2023/10/31/court-case-on-fate-of-snake-river-dams-imperiled-salmon-postponed-at-least-45-more-days/) that the Nez Perce Tribe would do “whatever it takes to save the salmon” while referring to a lawsuit challenging the federal government’s plan to keep dams on the Snake River functional. The U.S. Army Corps of Engineers has four dams on the lower Snake River, the largest tributary of the Columbia River in the Pacific Northwest. These dams collectively kill [50-80 percent](https://repository.library.noaa.gov/view/noaa/61914/noaa_61914_DS1.pdf) of juvenile salmon and steelhead fish that try to migrate downstream.

“As Nimiipuu (Nez Perce), we are bound to the salmon and the rivers—these are our life sources,” said Shannon F. Wheeler, chairman of the Nez Perce Tribe, in a March 2024 [press release](https://critfc.org/2024/03/05/landmark-agreement-between-tribes-states-fed-govt-signed/) about the landmark agreement between the federal government, tribes, and states from the Pacific Northwest to restore salmon and other native fish populations in the Columbia River Basin. “We will not allow extinction to be an option for the salmon, nor for us,” he said.

The U.S. government has lost several lawsuits, with federal judges [ruling](https://www.courthousenews.com/northern-california-dam-flood-control-operations-found-to-harm-endangered-salmon/) that dams threaten salmon populations in violation of the Endangered Species Act (ESA).

In May 2024, a federal judge [ruled](https://www.pressdemocrat.com/article/news/russian-river-protected-salmon-dam-releases/) that the U.S. Army Corps of Engineers violated the ESA by releasing water from the Coyote Valley Dam on Lake Mendocino County, California, which disturbed endangered salmon and steelhead trout populations in the Russian River. Intended as flood control (in preparation for a storm, for example), the released water increased the river’s turbidity (amount of sediment or organic matter), harming fish [development](https://www.noaa.gov/sites/default/files/legacy/document/2020/Oct/07354626215.pdf) and [survival](https://www.adfg.alaska.gov/static/home/library/pdfs/habitat/85_01.pdf).

After a dam is built, the land upstream of the structure becomes permanently flooded as the reservoir fills. Water inundation can [harm wildlife and water quality](https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/how-dams-damage-rivers/) and even [trigger natural disasters like earthquakes](https://www.slu.edu/news/2018/september/earthquake-research.php).

**Impacts on Water Security and Safety**

Dams can lead to the [accumulation of sediment](https://phys.org/news/2023-01-sediment-endangers.html), which puts access to clean water at risk. In a paper published in December 2022 in the journal Sustainability, researchers from the United Nations University Institute for Water, Environment and Health [warned](https://unu.edu/press-release/trapped-sediment-robbing-worlds-large-dams-vital-water-storage-capacity) of dams’ threat to water security, saying that thousands of the world’s large dams are filling up with sediment to such a degree that they may lose more than 25 percent of their storage capacity—around 1.65 trillion cubic meters—by 2050.

According to the [study](https://www.mdpi.com/2071-1050/15/1/219), “The decrease in available storage by 2050 in all countries and regions will challenge many aspects of national economies, including irrigation, power generation, and water supply.”

Dredging sediment from reservoirs to reclaim storage space is often cost-prohibitive. Sediment can also contain [harmful pollutants](https://www.usgs.gov/mission-areas/water-resources/science/sediment-associated-contaminants/), including legacy chemicals like TDDT, PCBs, and the pesticide chlordane; chemicals currently in use like the insecticide bifenthrin and a variety of flame retardants; and metals like lead, zinc, and cadmium, which concentrate in sediment instead of water.

The sediment release during dam removal must be carefully managed to prevent downstream contamination and ecological damage. Sediment management is a [critical aspect](https://www.fs.usda.gov/pnw/pubs/journals/pnw_2022_duda001.pdf) of the dam removal process, as the sudden release of stored sediments can smother aquatic habitats, harm aquatic biota, and degrade water quality, affecting both wildlife and human communities downstream.

**Economic and Social Considerations**

Each dam removal project requires detailed studies, engineering, permits, and planning. Evaluating the economic and social implications of dam removal is crucial. While the initial construction of dams has often spurred economic growth, their long-term costs—including maintenance, environmental degradation, and lost recreational activities—can outweigh the benefits. The financial burden of maintaining aging dams can be [significant](https://www.resources.org/archives/dismantling-dams-can-help-address-us-infrastructure-problems/), and many communities find that removing outdated structures is more cost-effective than continuing to repair them.

Communities may experience significant changes, both positive and negative, from dam removal. These include job losses in the hydropower sector. Their removal, however, leads to potential gains in tourism and recreation. Engaging with stakeholders and conducting a thorough cost-benefit analysis are essential steps in decision-making. The [revitalization of river ecosystems](https://www.fisheries.noaa.gov/national/habitat-conservation/river-habitat) can lead to new economic opportunities, such as increased tourism, enhanced recreational fishing, and the [restoration](https://www.icomos.org/public/risk/2001/dams2001.htm) of cultural heritage sites often submerged or inaccessible due to dam reservoirs.

Moreover, dam removal can have profound social impacts. For Indigenous communities and other groups with historical ties to river landscapes, dam removal can represent a restoration of ancestral lands and a reconnection with cultural practices centered on river ecosystems. However, addressing communities’ concerns is essential; comprehensive planning and open communication are vital in balancing these diverse needs and ensuring a smooth transition.

**Planning and Preparation for Dam Removal**

Successful dam removal requires meticulous planning and preparation. Initial assessments should evaluate the dam’s structural condition, potential environmental impacts, and the logistical aspects of removal. Engaging with local communities and stakeholders from the early stages is essential to ensure their concerns and insights are integrated into the planning process.

Another critical step is obtaining the necessary regulatory permits. This involves navigating federal, state, and local regulations, which can be complex and time-consuming. Collaborating with regulatory agencies can help streamline this process.

An [environmental impact assessment](https://www.epa.gov/sites/default/files/2014-05/documents/us-eia-experience.pdf) is often required to ensure dam removal complies with legal standards and minimizes adverse ecological effects.

**Technical Aspects of Dam Removal**

The technical aspects of dam removal are multifaceted. Engineering and construction methods must be tailored to the specific characteristics of each dam and its surrounding environment. Techniques can range from controlled deconstruction to blasting and everything in between, depending on the dam’s size, type, and location. Hydraulic modeling and simulation tools can also help predict the effects of dam removal and design effective removal measures.

Managing sediment and water flow during removal is a significant consideration that can and has been successfully managed thousands of times. Strategies must be developed to handle the release of trapped sediments and stabilize riverbanks. [Sediment management](https://www.americanrivers.org/2023/08/sedimentation-and-dam-removal-bringing-a-river-back-to-life/) plans often include phased removal, sediment dredging, and sediment traps or silt fences to control sediment dispersion. Ensuring the safety of workers and nearby communities is paramount throughout the removal process. Safety protocols include monitoring for structural stability, water quality testing, and emergency response plans.

Innovative engineering solutions have been developed to address these challenges. For example, temporary diversion channels or cofferdams can help control water flow during the deconstruction process, minimizing downstream impacts. [Cofferdams](https://www.dot.ny.gov/main/business-center/contractors/construction-division/construction-repository/CIM_553.pdf) are sometimes designed as temporary enclosures to allow excavation and deconstruction in an environment with reduced water flow. They also protect workers. Cofferdams were constructed during the dismantling of the Elwha Dam. To remove the taller Glines Canyon Dam, temporary spillways were built to help drain the reservoir.

**Case Studies and Lessons Learned**

Examining past dam removal projects provides valuable insights and lessons. Successful case studies, such as removing the [Elwha and Glines Canyon dams](https://www.nps.gov/olym/learn/nature/dam-removal.htm) on the Elwha River in Washington state, highlight the potential for ecological recovery and community benefits. These projects faced numerous challenges, from technical difficulties to stakeholder opposition, but ultimately demonstrated the feasibility and advantages of dam removal.

The [Elwha River restoration project](https://www.nps.gov/olym/learn/nature/elwha-ecosystem-restoration.htm), one of the largest dam removal efforts in U.S. history, offers a compelling example of the benefits of dam removal. Following the removal of the Elwha and Glines Canyon dams, which began in September 2011, the river has experienced a dramatic recovery. Salmon and steelhead trout have returned to their historic spawning grounds, and the Elwha River ecosystem has shown [significant signs](https://www.nps.gov/olym/learn/nature/restoration-and-current-research.htm) of recovery. The project also provided valuable lessons in sediment management, stakeholder engagement, and adaptive management practices.

Other notable examples include the removal of the [Edwards Dam](https://www.nrcm.org/programs/waters/kennebec-restoration/history-edwards-dam/) on the Kennebec River in Maine and the [Marmot Dam](https://www.fs.usda.gov/pnw/sciencef/scifi111.pdf) on the Sandy River in Oregon. Both projects resulted in substantial ecological benefits, including the return of native fish species and improved water quality.

“Ten years after the Edwards Dam in Augusta, Maine, was removed from the Kennebec River, the river has totally come alive,” [according to the Natural Resources Council of Maine](https://www.nrcm.org/programs/waters/kennebec-restoration/history-edwards-dam/). “The coalition of groups that worked on this project for more than a decade knew that the benefits would be enormous, and they have been. The Edwards Dam had blocked the river since 1837. Since its removal on July 1, 1999, the water quality in the river has improved, millions of fish are returning to long-lost spawning habitat, ospreys and eagles soar along the river, and Maine people and visitors paddle [in] what feels like a wilderness river.”

The Western Rivers Conservancy also [reported](https://www.westernrivers.org/discover/blog/ten-years-after-the-dam-came-out/) the overall positive impact of the Marmot Dam removal project. “For a century, Marmot Dam had impeded access to nearly 100 miles of salmon and steelhead habitat in the upper Sandy River basin. The best-case scenario—everyone’s highest hope—was that Sandy’s salmon and steelhead would be spawning again in the upper river within two years. Some believed it would take 20.”

“To everyone’s surprise, Sandy’s fish proved people wrong. Within 48 hours of the dam coming out, threatened coho salmon were already swimming upriver from the dam site. Within months, the Sandy flushed out the equivalent of 150 Olympic-size swimming pools full of sediment, a process that was expected to take two to five years,” added the [report](https://www.westernrivers.org/discover/blog/ten-years-after-the-dam-came-out/) by the conservancy, highlighting the advantages of allowing the river to flow unobstructed.

These case studies reveal the incredible and fairly rapid restoration of natural ecosystems after dam removal.

**Post-Removal Monitoring and Restoration**

The work does not end when the dam is removed. Post-removal observation and monitoring are essential for tracking the ecological recovery of the river and its surroundings. This includes monitoring water quality, sediment transport, and the return of fish and wildlife. Long-term monitoring helps identify potential issues and ensures timely interventions to support the river’s recovery.

Likewise, habitat restoration efforts, such as replanting native vegetation and restoring wetlands, can add to the ecological benefits of dam removal. [Riparian vegetation plays a crucial role](https://www.fs.usda.gov/nac/practices/riparian-forest-buffers.php), including stabilizing riverbanks, filtering pollutants and sediments from runoff into waterways, protecting croplands and downstream areas from flood damage, and providing habitat and food sources for native wildlife. Restoration projects often involve partnerships with local conservation groups, volunteers, and government agencies to achieve these goals.

[Adaptive management](https://www.doi.gov/sites/doi.gov/files/migrated/ppa/upload/TechGuide.pdf) is a critical component of post-removal restoration. This approach involves regularly assessing the effectiveness of restoration efforts and making adjustments as needed. Adaptive management recognizes the dynamic nature of river ecosystems and allows practitioners to respond to unexpected challenges and opportunities. By incorporating scientific monitoring and community feedback, adaptive management ensures that restoration efforts are effective and sustainable in the long term.

**Policy and Legislation**

The regulatory framework governing dam removal can be complex, involving various government agencies and other stakeholders. Understanding and navigating this framework is crucial for successfully completing dam removal projects. Policy changes, such as the introduction of streamlined permitting processes and [increased](https://www.americanrivers.org/media-item/federal-funding-advances-critical-dam-removal-projects/) funding for river restoration, have facilitated dam removal efforts.

In April 2024, the U.S. Fish and Wildlife Service provided $70 million in grants for 43 projects to remove dams and other river barriers in 29 states. [Federal initiatives](https://crsreports.congress.gov/product/pdf/R/R46946), state programs, and local regulations are integral in shaping the process.

Navigating the legal landscape requires collaboration with regulatory bodies, environmental organizations, and community stakeholders. Compliance with environmental laws, such as the [Clean Water Act](https://www.epa.gov/laws-regulations/summary-clean-water-act) and [Endangered Species Act](https://www.epa.gov/laws-regulations/summary-endangered-species-act), is essential. Additionally, obtaining the necessary permits often involves conducting detailed ecological impact assessments and engaging in public consultations to address community concerns.

**Climate Change and Hydropower Dams**

Climate change adds another layer of complexity to the issue of hydropower dams. Changing precipitation patterns, frequent extreme weather events, and shifting temperature regimes affect dams’ operation and environmental impact. Some regions may experience reduced water availability, diminishing the effectiveness of hydropower generation, while others may encounter increased flooding risks.

According to a 2017 [study](https://www.sciencedirect.com/science/article/pii/S0022169417305991) published in the Journal of Hydrology, “the trade-offs between reservoir releases to maintain flood control storage and drought resilience, ecological flow, human (domestic, agricultural, and industrial) water demand, and energy production (both thermoelectric and hydroelectric) will increasingly need to be reconsidered in light of climate change, population growth, and water technology deployments.”

Extreme weather events, which have become more frequent and intense due to climate change, can imperil dam infrastructure. Kristoffer Tigue of Inside Climate News [wrote](https://insideclimatenews.org/news/05072024/midwest-dams-in-poor-condition/) in July 2024, “[C]limate change presents a growing threat to the nation’s nearly 92,000 dams, many [of them] more than 100 years old, as heavy rainfall, flooding and other forms of extreme weather become more common and severe.”

The Midwest—notably Illinois, Iowa, Missouri, Wisconsin, and Minnesota—maintains a high risk for severe flood damage from rivers due to the increased severity and frequency of extreme weather events tied to climate change. The [Fifth National Climate Assessment](https://nca2023.globalchange.gov/chapter/24/), the federal government’s primary report on climate change impacts and risks, released in November 2023, points out that since 2018, the Midwest has experienced 30 failures or near-failures of aging dams.

Dam removal can be part of broader [climate adaptation and mitigation strategies](https://necasc.umass.edu/projects/small-dam-removal-tool-climate-change-resilience). Restoring natural river flows can enhance ecosystem resilience to climate change by improving habitat connectivity and supporting biodiversity. Free-flowing rivers can act as natural buffers against floods and droughts, providing essential ecosystem services that help communities adapt to changing climatic conditions.

Removing dams [reduces greenhouse gas emissions](https://therevelator.org/dam-removal-climate/), particularly methane. Methane is produced underwater by the anaerobic decomposition of organic material like algae and other vegetation sequestered in a dam’s reservoir. This process happens naturally in lakes but is unnatural when a dam causes it. Free-flowing rivers do not emit methane.

A [study](https://cordis.europa.eu/article/id/418240-tropical-dams-an-underestimated-source-of-greenhouse-gas-emissions) conducted between 2013 and 2019 by scientists at Uppsala University in Sweden found that hydropower dams in tropical environments were “methane factories.” Project coordinator Sebastian Sobek said, “We found that methane bubbling (ebullition) was the most relevant conduit for greenhouse gas emissions in most reservoirs under study.” While the study focused on tropical environments, the unnatural process of methane release through the decomposition of organic materials occurs anywhere there is a dam.

**Global Opinion on Dam Removal**

The movement to remove hydropower dams is not confined to the United States; it is a global phenomenon. Worldwide, countries recognize the benefits of restoring free-flowing rivers.

Europe, in particular, has seen a surge in dam removal projects driven by the [European Union’s Water Framework Directive](https://environment.ec.europa.eu/topics/water/water-framework-directive_en), which aims to achieve good ecological status for all water bodies in the region. Countries like France, Spain, and Sweden have [undertaken](https://www.theguardian.com/environment/2023/apr/25/record-number-of-dam-barrier-removals-helps-restore-rivers-across-europe-aoe) significant dam removal projects, leading to improved river health and increased biodiversity.

In Asia, countries such as Japan and China are also beginning to address the impacts of aging dams. Japan has [removed several obsolete dams](https://wildsalmoncenter.org/2019/11/12/in-hokkaido-the-dams-finally-come-down/) to restore river ecosystems and improve fish passage. Meanwhile, facing severe river pollution and biodiversity loss, China has been [exploring dam removal](https://www.bloomberg.com/news/features/2021-08-14/china-wants-to-shut-down-thousands-of-dams) as part of its broader environmental protection initiatives.

“China benefited so much from decades of water conservancy projects,” Ma Jun, director of the Institute of Public and Environmental Affairs, [told](https://www.bloomberg.com/news/features/2021-08-14/china-wants-to-shut-down-thousands-of-dams) Bloomberg News in 2021. “Maybe it’s time for the industry to pay back for the environmental restoration.”

The [biggest dam removal in Europe’s history](https://damremoval.eu/3300km-of-free-flowing-river/), conducted in 2018, has restored more than 2,050 miles of free-flowing rivers in Estonia.

“Our vision is to have rivers full of fish,” [said](https://truthout.org/articles/jump-starting-the-dam-removal-movement-in-the-us/) Herman Wanningen of the World Fish Migration Foundation, a Dutch organization that works to protect fish populations and free-flowing rivers. There are great examples around the world where the environment is healthier because rivers were set free. We want to share these inspiring stories and show that dam removal is a viable option.”

Sharing knowledge and experiences across borders can help interested parties worldwide to develop more effective strategies for restoring rivers and supporting sustainable water management practices.

**Future Directions and Innovations**

As the practice of dam removal evolves, so do the technologies and methodologies used to carry out these projects. Advances in remote sensing, [geographic information systems](https://www.esri.com/en-us/what-is-gis/overview), and [environmental DNA](https://www.chesapeakebay.net/news/blog/who-lives-here-tracking-species-by-the-dna-they-leave-behind) are providing new tools for monitoring and assessing the impacts of dam removal. These technologies enable more precise measurements of ecological changes and can help identify the most effective restoration techniques.

Innovations in engineering are also making dam removal safer and more efficient. Techniques such as advanced blasting methods allow for the controlled dismantling of dams with minimal environmental disruption. Furthermore, improved sediment management practices and eco-friendly construction materials are enhancing the sustainability of dam removal projects.

Integrating climate resilience into dam removal planning will be crucial. As [climate change continues to alter hydrological patterns](https://www.nbcnews.com/science/science-news/climate-change-throwing-water-cycle-chaos-us-rcna137892), interested parties must consider how restored rivers can adapt. This might involve designing restoration projects that enhance floodplain connectivity, improve groundwater recharge, and support diverse and resilient ecosystems.

**How Local Communities Help Rivers Run Free**

Interested parties can help restore rivers in their communities. The first step is to learn if the dams in your area serve their intended purposes. The [National Inventory of Dams](https://nid.sec.usace.army.mil/#/) is an excellent place to start.

Connect with your local river volunteer group and cleanup organizations to participate in river conservation. Make your voice heard during discussions about proposals to build new dams and relicense existing dams. Spend time getting to know your local river or stream. Talk to your local, state, and federal elected officials about why removing dams that have outlived their usefulness can help restore ecosystems and biodiversity, honor Indigenous communities, support local communities, and combat climate change.

Individuals and groups interested in learning more about dam removal can join American Rivers’ [National Dam Removal Community of Practice](https://www.americanrivers.org/national-dam-removal-community-of-practice/) to access the latest resources, including training opportunities and shared expertise, to expand and accelerate the practice.

My organization, [American Rivers](https://www.americanrivers.org/), and the [Hydropower Reform Coalition](https://hydroreform.org/) have created the “[Practitioner’s Guide to Hydropower Dam Removal](https://www.americanrivers.org/wp-content/uploads/2023/10/Practitioners-Guide-to-Hydropower-Dam-Removal.pdf),” which offers a detailed roadmap for those interested in getting involved in hydropower dam removal. It provides a thorough overview of the procedures, challenges, and benefits of dam removal. In addition, American Rivers has a [Basic Guide for Project Managers](https://www.americanrivers.org/wp-content/uploads/2015/06/NatlDamProjectManagerGuide_06112015.pdf) for removing non-powered dams.

Removing hydropower dams represents a transformative approach to river restoration, offering substantial ecological, economic, and social benefits. Practitioners can restore river ecosystems and revitalize communities, including tribal nations and Indigenous communities, by learning from past experiences, engaging with stakeholders, and leveraging new technologies.

As global awareness of environmental sustainability grows, the momentum for dam removal is likely to increase. By fostering international collaboration and innovation, we can restore the world’s rivers to their natural, free-flowing states, providing invaluable benefits for future generations.

Serena McClain, the director of river restoration at American Rivers, who has assisted in the removal of dozens of dams, said it best: “With dam removal, it’s not about what we’re taking away. It’s what we’re gaining. This is about getting people to embrace the power and potential of a natural river. Free-flowing rivers will give us so much if we just give them the chance.”