



*Bloede Dam in Patapsco Valley State Park is seen on April 25, 2011. (Photo by Alicia Pimental/Chesapeake Bay Program)*

## I. Introduction

The Chesapeake Bay watershed covers over 64,000 square miles, and has more than 140,000 miles of mapped rivers and streams, and over 5,000 dams and [165,000 road-stream crossings](#). Fish passage projects are vital to restore connectivity in streams and rivers aquatic resources with emphasis on migratory and resident fish throughout the Chesapeake Bay watershed.

Dams and other obstructions block the natural migration of diadromous fish (those that migrate between sea and freshwater) to their historic spawning habitats. These blockages contribute to the decline of target fish populations including Chesapeake Bay Watershed migratory and resident fish such as American shad, hickory shad, river herring, American eel and brook trout. Fish populations can also be impacted by habitat and water quality conditions, bycatch, overfishing, possible shifts in migratory patterns and spawning areas driven by climate change, and many others.

Implementing fish passage projects by removing obsolete dams, installing fish lifts or ladders, replacing culverts, and providing other passageways allow migratory fish to return to upstream spawning and nursery grounds and provides stream access to resident fish. These activities also reduce river fragmentation and improve habitat and water quality for other aquatic living resources. In addition to the ecological benefits, dam removal and road-stream crossing improvements provide many social benefits including increased safety and recreational opportunities, and support climate resilience by reducing flood-risk.

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## II. Goal, Outcome and Baseline

This management strategy identifies approaches for achieving the following goal and outcome:



### ***Vital Habitats Goal***

Restore, enhance and protect a network of land and water habitats to support fish and wildlife, and to afford other public benefits, including water quality, recreational uses and scenic value across the watershed.

### ***Fish Passage Outcome***

Continually increase access to habitat to support sustainable migratory fish populations in the Chesapeake Bay watershed's freshwater rivers and streams. By 2025, restore historical fish migration routes by opening an additional 132 miles every two years to fish passage. Restoration success will be indicated by the consistent presence of alewife, blueback herring, American shad, hickory shad, American eel and brook trout, to be monitored in accordance with available agency resources and collaboratively developed methods.

### **Fish Passage Objectives (2011-2025)**

The Fish Passage Workgroup will implement priority projects to remove barriers, replace culverts, install passage structures and monitor for presence of target species. More specifically, the fish passage objectives are:

1. By 2025, restore historical fish migratory routes by opening an additional 132 miles of river and stream habitat every two years to fish passage, with restoration success indicated by the presence of alewife, blueback herring, American shad, hickory shad, American eel and/or brook trout.
2. Document return of fish to opened stream reaches by establishing the presence or absence of target species at a select number of projects.
3. Use the [Chesapeake Fish Passage Prioritization Tool](#) that was developed by the workgroup to implement high priority dam removal and fish passage projects.

### **Baseline and Current Condition**

The workgroup members implement projects involving the removal of dams, creation of fishways (when dam removal is not feasible), and replacement of culverts to restore fish passage. From 1989 to 2021, approximately 30,526 miles of river and stream habitat in the Chesapeake Bay watershed have been opened and are accessible for fish migration.

The [Chesapeake Fish Passage Prioritization Tool](#) is used to calculate the number of miles opened each year. This is determined through a geographic information system (GIS) analysis where a fish passage project is located and mapped, and an assessment of the number of river and stream miles made accessible to target species is calculated. The mileage is not broken down by state. Monitoring includes miles of river and stream habitat opened and the presence of target species and is reported every two years.

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### III. Participating Partners

**Team Lead:** Vital Habitats Goal Implementation Team

**Workgroup Lead:** Fish Passage Workgroup

**Opportunities for Cross-Goal Team Collaboration:**

**Goal Implementation Teams:** Sustainable Fisheries Goal Implementation Team, Water Quality Goal Implementation Team, Maintain Healthy Watersheds Goal Implementation Team

**Workgroups:** Stream Health Workgroup, Brook Trout Action Team, Wetlands Workgroup.

**Active Current Participation and Role (signatories in bold):**

**Level of Participation - High:**

- National Oceanic and Atmospheric Administration
  - Provides technical assistance and funding for fish passage/dam removal projects
- U.S. Fish and Wildlife Service
  - Fish Passage Workgroup Co-Chair
  - Provides technical assistance and funding for fish passage/dam removal projects
- **Maryland Department of Natural Resources**
  - Fish Passage Workgroup Co-Chair
  - State Fish Passage Coordinator
  - Provides technical assistance for fish passage/dam removal projects
  - Manages fish passage/dam removal projects
- **Pennsylvania Fish and Boat Commission**
  - State Fish Passage Coordinator
  - Provides technical assistance for fish passage/dam removal projects
  - Manages fish passage/dam removal projects
- **Virginia Department of Game and Inland Fisheries**
  - State Fish Passage Coordinator
  - Provides technical assistance for fish passage/dam removal projects
  - Manages fish passage/dam removal projects
- American Rivers
  - Manages/implements fish passage/dam removal projects
- The Nature Conservancy
  - Provides technical support for the Chesapeake Bay Fish Passage Prioritization Tool

**Level of Participation - Medium:**

- U.S. Army Corps of Engineers
- University of Maryland Center for Environmental Science
- Natural Resources Conservation Service
- National Fish and Wildlife Foundation
- Chesapeake Bay Trust
- Smithsonian Environmental Research Center
- U.S. Geological Survey
- Biohabitats, Inc.

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## Local Engagement

Engagement from local governments, nonprofits, and watershed associations is critical to achieve Fish Passage Workgroup Outcomes, and the workgroup is working with local partners. These partners are engaged in identifying potential fish passage projects, developing feasible alternatives, and building community and landowner support. A number of nonprofits listed above provide a critical role in the fish passage strategy by serving as project managers for dam removal projects, pursue and manage grant funding, and provide technical assistance for a wide variety of fish passage tasks. Technical assistance includes the development of the Chesapeake Fish Passage Prioritization Tool and development of technical scope of work for feasibility, design and construction of dam removal and fish passage projects.

## IV. Factors Influencing Success

*Many factors with wide-ranging levels of importance and management potential, influence the ability to re-open fish passage miles within the watershed. A thorough understanding of these factors is essential for project success.*

### 1. Community/Landowner Willingness, Legislation to Incentivize or Mandate Barrier Removal Projects

Now armed with a scientifically based prioritized list of dam removal projects, the workgroup is facing another challenge. Obtaining permission from dam owners to move forward with projects has proven to be complicated with many private dam owners opting to keep their dams in place. Existing state fish passage laws require landowners to provide fish passage at dams and other blockages or install fish ladders, but enforcement and compliance is costly and time consuming.

### 2. Funding

The ability to achieve change through fish passage projects is largely limited by a lack of resources. Resources are also needed to increase capacity for managing projects and completing pre-removal work to make projects “shovel ready”.

### 3. Understanding the Ancillary Benefits of Fish Passage Projects (Policy Makers, Dam Owners and Local Government)

In addition to ecological benefits, fish passage projects also provide many social benefits. For example, there is increased recognition of the role dam removal and road-stream crossing improvements provide to increase climate resilience and reduce owner liability. Many dams are attractive nuisances and removal results in public safety improvements. One example of improvements to public safety is the removal of the Bloede Dam in Patapsco Valley State Park in Maryland, where multiple deaths have occurred at the dam site. Flood reduction benefits can be realized in some cases and can result in less nuisance flooding of roadways and bridges. Dam removal can also improve public access to rivers and streams.

### 4. Target Species Populations in Decline Region-wide (Unmanageable)

Populations of target species, particularly river herring, shad and American eel, have been declining nationwide. For example, Maryland commercial harvest of river herring has been falling since the early 1970s when the yearly average was approximately 700,000 pounds. Between 1990 and 1999 the yearly average was roughly 164,000 pounds and from 2005 to 2010 the average was just 35,200 pounds.

It is important to note that the Fish Passage Outcome is simply a mileage opened goal. There is no outcome established based on target species population size or whether the barrier removal project resulted in an increase or decrease in target population numbers. We list the following factors influencing target population

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size for the purpose of making the readers aware that fish populations can be impacted by the following: habitat and water quality conditions, bycatch, overfishing, invasive species, possible shifts in migratory patterns and spawning areas driven by climate change, and many others. The workgroup does not see these factors directly influencing whether the mileage outcome is met, but instead as factors influencing the overall recovery of a target fish species.

#### **5. Selecting Most Cost-Effective Projects for Implementation**

Prioritization allows the workgroup to focus on the highest priority fish passage projects in the watershed and maximize the ecological benefits obtained for the limited funding available for fish passage projects.

## **V. Current Efforts and Gaps**

With the average cost of stream barrier removal in Maryland, Virginia, and Pennsylvania hovering around \$200,000, this workgroup will need more than \$20 million in project implementation funds in order to have a chance of meeting this outcome (Strategy Statement Document, 2010). The [Chesapeake Fish Passage Prioritization](#) and [North Atlantic Aquatic Connectivity Collaborative](#) tools will help guide dam removal and road-stream crossing restoration efforts and strategically invest public funds.

Additional priorities of the workgroup are related to willingness of landowners to implement fish passage projects. Efforts continue to coordinate between fish passage experts and dam safety offices to help to target high risk and high priority dams. Work is also underway to develop an outreach strategy to communicate ecological and social benefits of dam removal and culvert replacement projects, and to increase landowner willingness to participate with fish passage restoration programs.

Information is needed to develop standardized assessment tools for fish passage evaluations, swimming performance and energetics, methods of motivating fish to enter and pass diversion structures, and the development of a fish passage database to provide a systematic, georeferenced source of data for scientific assessment of distribution and performance of all known upstream fish passage structures, including upstream distribution limits of target fish species. Data needs include bycatch information and effects of climate change on migratory patterns and spawning habits.

## **VI. Management Approaches**

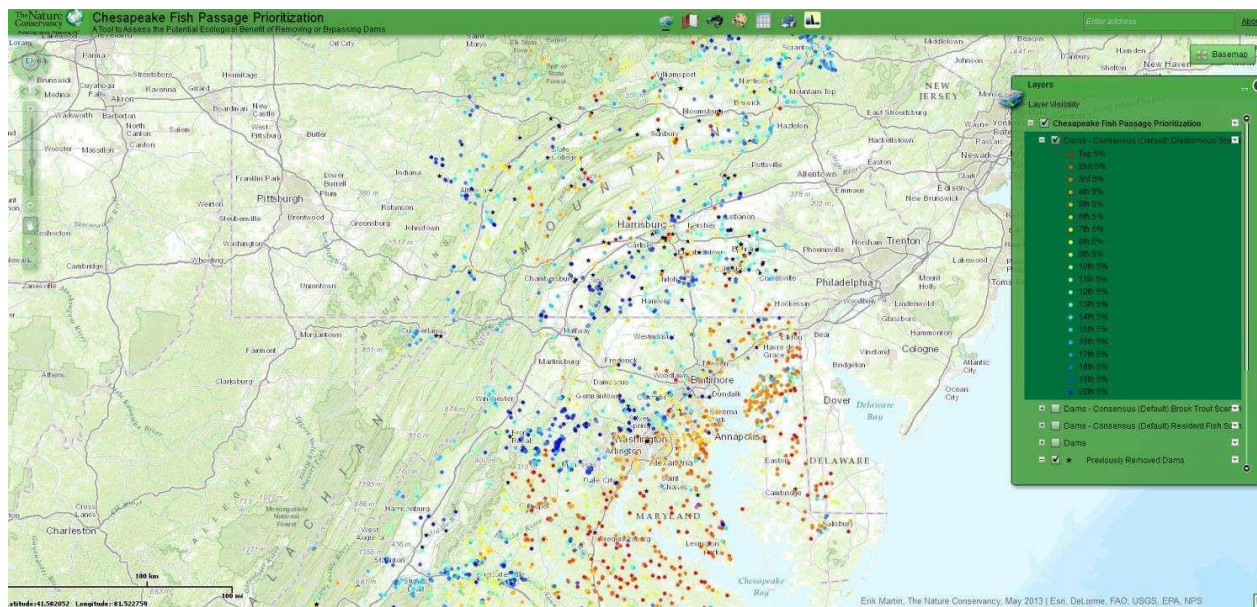
*The partnership will work together to carry out the following actions and strategies to achieve the Fish Passage Outcome. These approaches seek to address the factors affecting our ability to meet the goal and the gaps identified above.*

### **Prioritization Efforts for Fish Passage Projects**

Throughout the Northeast, hundreds of dams have been removed over the last two decades to provide additional habitat for recreational and commercial fish species, and species of conservation concern. Given the likelihood of future constraints on availability of funds and staff, it is critical to be more strategic about investments in fish passage restoration projects. One approach to strategic investment of public funds is to assess the likely ecological "return on investment" associated with a fish passage project.

Through the Chesapeake Bay Program's Fish Passage Workgroup, federal, state and local partners have been working together to prioritize fish passage projects in the Chesapeake Bay. In FY12, The Nature Conservancy, in concert with members of the workgroup, developed a GIS model to assist the workgroup in strategically identifying key barriers to fish passage. The project focused on collecting and processing spatial data and, using

a consensus-based approach, developing a priority ranking for dam removals and fish passage projects. This tool is publicly available and can be found at: <https://www.maps.tnc.org/chesfpp/#/explore>



**Figure 1. Priority barrier removal projects shown by the red and orange points.**

The tool uses GIS data to rank potential barrier removal projects throughout the Chesapeake Bay watershed (**Figure 1**). The overarching goal of the project was focused on the difficult task of determining what metrics should be used to assess barrier removal, given data limitations and the limits of GIS technology. In the end, a total of 39 metrics from five metric categories were used in analysis: Connectivity Status, Connectivity Improvement, Watershed and Local Condition, Ecological, and Size/System Type. These metrics were calculated in GIS and can be used by decision makers, like the State Fish Passage Coordinators, to rank each dam according to its potential to benefit to diadromous and resident fish and brook trout if removed or bypassed. In 2023, the tool was updated to add known road-stream crossing barrier sites and climate and economic justice map layers. Layers will be used to prioritize fish passage restoration at road-stream crossings and to ensure workgroup projects are inclusive of overburdened and underserved communities.

In general, high priority barrier removal projects have the following qualities:

- **First Blockages for Migratory Fish:** The tool's primary focus was on the coastal states of Maryland, Virginia and Pennsylvania with the intention of maximizing the benefits to diadromous fish species such as river herring and shad, which spend their lives in saltwater but move to freshwater to spawn. The connectivity between the ocean and freshwater rivers, where spawning occurs, is critical to the survival of these species. Removal of the first barriers fish encounter on their spawning runs from the ocean to the headwaters is the first priority of the workgroup. These first barrier projects benefit a wide variety of species including river herring, shad, and American eel.
- **Benefits to Multiple Species:** The workgroup also focuses on barrier removal projects that benefit more than one species.
- **Largest Habitat Gains:** Projects that open longer and larger stretches of high-quality habitats are a priority for barrier removal.
- **High Quality Habitat:** Projects in areas with less impervious surface and have stream health scores in the "good to excellent" range are higher priority locations for barrier removals projects. As stream health

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improves in watersheds due to efforts to meet the Stream Health Outcome in the *Watershed Agreement* ([Stream Health Management Strategy](#)), water quality may improve to support target fish species, which would make these watersheds suitable for fish passage efforts.

- **Brook Trout:** Also of interest to the workgroup are barrier removal projects that benefit brook trout, and these miles are counted toward the Fish Passage Outcome. However, the Fish Passage Workgroup will not address an overarching brook trout management strategy. A separate brook trout management strategy is being developed in partnership with the Brook Trout Action Team (BTAT) to support the Brook Trout Outcome in the *Watershed Agreement*. High priority barrier removal projects benefiting brook trout will be conducted in areas designated as "priority watersheds" through the BTAT strategies. Additional details on potential Brook Trout projects and priority areas can be found in the [Brook Trout Management Strategy](#).

### **Obtaining the Mileage Goal**

The workgroup is committed to **restoring 132 stream miles to fish passage every two years**.

Over the next two years, the workgroup will continue fish passage restoration efforts already under way through various project teams. The workgroup will continue to apply for restoration grants to fund feasibility, design and fish passage implementation. Various federal agencies and nonprofits offer grant funding opportunities including: the National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, Chesapeake Bay Trust, and National Fish and Wildlife Foundation. Additional federal funding, specifically for dam removal and road-stream crossings, is also available through the Infrastructure Investment and Jobs Act. There is no dedicated funding for barrier removal projects provided directly from the Chesapeake Bay Program. Oftentimes, project managers have to leverage several funding sources to complete one project, which significantly increases time and staff efforts. A dedicated funding source for larger scale projects that will award funds for planning through implementation in larger amounts would increase efficiency and effectiveness of fish passage restoration programs.

Fish passage restoration projects often take two to five years from the feasibility phase through implementation, due to the need for planning, design and engineering phases. Several federal, state and local permits are required and the process for obtaining a permit can take more than one year. For some more complicated projects, infrastructure relocations (sewer lines, water lines and road modifications) are needed to remove the river obstruction. As the workgroup has targeted fish passage restoration since 1989, many of the "easy" projects have been completed, leaving the more complicated and costly projects to be done. The rate of restoration projects completed in the states has declined over time in light of this fact. Interagency collaboration with state and Federal wetland and waterways regulatory programs to develop programmatic approaches to streamline permitting for dam removal projects and road-stream crossings that incorporate fish passage considerations will accelerate project delivery.

### **Project Development**

While fish passage prioritization exists, the feasibility of removing the dams and replacing road-stream crossings needs to be further investigated by State Fish Passage Coordinators through field assessments and design studies.

Assessments and design studies include sediment character and quality, fish species present, and determining any environmental tradeoffs. Fish passage restoration could inadvertently facilitate the spread of invasive species but may be appropriate where the projected ecological benefits outweigh the risk of invasive species spread.

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## **Dam Removal**

Many of the barriers in the Chesapeake Bay watershed are privately owned. One of the primary responsibilities of the workgroup is to develop new barrier removal projects using the [Fish Passage Prioritization Tool](#). Now that a prioritized grouping of dams exists, outreach efforts can continue in areas having "clusters" of high priority removals. The workgroup will highlight ancillary benefits through the use of outreach materials and public workshops with the goal of making dam owners, policy makers and local governments more aware of the additional benefits. Targeted outreach is likely more effective than general mailings, workshops and other types of non-targeted outreach campaigns. Another option may include providing a cash incentive through buyouts, one-time cash payments and/or tax credits to dam owners who give permission to remove their dams.

Many older dams are inadequately maintained and present public safety hazards. Safety inspection and repair orders completed by the states for these dams need to be prioritized to ensure public safety. In the event dam owners do not wish to undertake appropriate repairs to ensure public safety, these dams should be evaluated for removal. Providing legislation or enforcement of landowners who own dams in poor condition and do not bring dams up to current standards could provide public safety benefits as well as the opportunity to provide fish passage.

Focusing on these high-priority communities, the workgroup will test several dam owner incentives and community outreach tools in an effort to foster a system of cooperation. The lessons learned in these communities will result in the following outputs:

1. Creation of a model for dam owner (and broader community) engagement that can be replicated in communities throughout the region and beyond.
2. Establishment of a pool of three to five high-priority dam removal projects that will have willing dam owners, completed baseline assessments, and will be ready for future implementation.

## **Road-stream crossings**

The workgroup will invite Federal and state Departments of Transportations (DOT) to become workgroup members and to attend workgroup meetings. The prioritized list of road-stream crossing sites will be shared with the DOT's, and we will work collaboratively to identify sites to plan, design, and implement restoration. Fish passage restoration typically consists of culvert replacements or retrofits, and can be incorporated into already planned infrastructure improvement projects. Fish passage restoration can also be the primary focus and therefore be the main purpose of the project. Some road-stream crossings are privately owned and maintained, and may require additional partnerships with locally based agencies and non-government organizations to provide outreach to private landowners.

## **Approaches Targeted to Local Participation**

Local governments, watershed associations, nonprofits and the private sector, including private landowners, all have a role in this strategy. Local governments often own the dams and road-stream crossings targeted for fish passage restoration and permission is needed to pursue the project. Nonprofits are involved in several ways as listed in the "participating agencies" part of this strategy. Their role includes managing and implementing removal projects, providing funding for projects and conducting outreach on the multiple benefits provided from reconnection of the river systems. Private landowners must give permission in order for project managers to pursue future projects. River keepers and local government officials may be able to better assist in outreach efforts due to their relationships with potential dam owners. The workgroup will use the Climate and Economic Justice Screening Tool to ensure participation and project implementation is inclusive of underserved and overburdened communities.



## VII. Monitoring Progress

### Miles of Stream Opened

Fish passage coordinators in Maryland, Virginia and Pennsylvania, and workgroup members from West Virginia, New York, Delaware, and Washington, DC will report mileage opened annually using the mileage produced through the [Chesapeake Fish Passage Prioritization Tool](#).

### Presence of Target Species

Beginning in 2012, the Fish Passage Workgroup began documenting the presence of target species such as American eel, river herring and shad at fish passage projects. The timing and frequency of sampling is based on life history considerations of the target species. At a minimum, this parameter should be monitored post-implementation, and at a maximum it could be monitored on an annual or seasonal basis. Once target fish presence is detected upstream of the project site post-implementation, monitoring presence/absence of target fish species can be terminated. With some barrier removal projects, the project team may determine long term fisheries monitoring is appropriate. This more comprehensive monitoring will commence as funding and resources allow.

## VIII. Assessing Progress

The Fish Passage Workgroup previously reached its goal of “1,000 stream miles by 2025” and has adopted a revised goal of 132 miles every two years. The workgroup will calculate miles opened using the [Chesapeake Fish Passage Prioritization Tool](#). The Fish Passage "Opening Rivers to Migratory Fish" Indicator is part of tracking the restoration and protection efforts at the Chesapeake Bay Program. It is the indicator that [tracks progress](#) toward the Fish Passage Outcome in the 2014 Watershed Agreement.

Historically, State Fish Passage Coordinators only counted American shad river miles as opened by fish passage projects toward achieving the previous goal. These miles were calculated by hand using USGS topographic maps. Unfortunately, there are no historical records of these calculations which affect the validity of the data set and the indicator that is reported to the public. The lack of these data also results in double counting stream miles opened when calculating miles for future removal projects.

The current methodology takes into account the full range of the Fish Passage Outcome's target species. When a dam is removed or a fishway is constructed, the entire upstream habitat (not just mainstem miles) can be potential habitat for the Fish Passage Outcome's target species. For example, American eel distribution ranges from the mainstem Chesapeake Bay to headwater streams, and American shad have a smaller habitat range. Unlike the old methodology, this measures the entire upstream network of functional miles. The functional

## Lessons Learned

### Fiscal

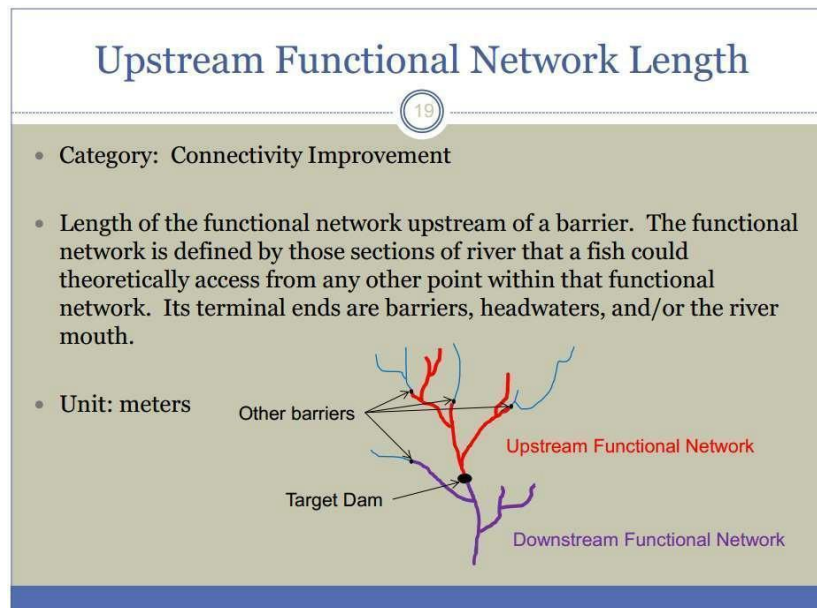
While much of the "low-hanging fruit" with regards to dam removal has been picked, our partners continue to open stream miles for migratory fish.

Opportunities to restore fish passage through the retrofitting or removal of culverts-in addition to the removal of dams-has been a major focus of the workgroup this year. Various new funding opportunities are anticipated and many of the dam removal and road retrofit projects would likely score highly for potential funding given the community benefits that would result through project implementation. One lesson learned is to better communicate the community resilience benefits that result from our fish passage projects.

### Scientific Knowledge

There are potential new tools under development for estimating target species abundance and population size. The workgroup is investigating potential funding pathways to continue developing these new technologies (example: eDNA analysis) that would allow for easier and more cost-effective ways to determine project success.

network is defined by the sections of river that a fish could theoretically access (*Figure 2*). Its terminal ends are barriers and headwaters.



The [Fish Passage Prioritization Tool](#) has the ability to measure the functional network mileage when a new project is implemented. The tool is web accessible and all State Fish Passage Coordinators are able to use the tool to ensure annual data reporting is consistent and comparable. Using the tool to calculate the mileage reported through the indicator creates a more reliable, consistent data set that will continue to support the integrity of the indicator in the future. In the absence of geographic data on instream habitats that would meet target species requirements once passage is provided, total upstream miles made accessible was selected as the metric to assess progress. It is recognized, however, that some species have habitat requirements that would limit their utilization of upstream habitats. Last, the upstream miles opened to fish passage can be added to the tool for viewing miles opened to fish passage since 1989.

## IX. Adaptively Managing

The Fish Passage Workgroup will meet in the spring and fall of each year to share progress and discuss any new challenges or opportunities. The Workgroup will use this time to review performance assessment information and adjust management strategies, if appropriate. Workgroup will report outcomes progress and any adaptive management plans biennially through the Strategy Review System process.

## X. Biennial Work Plan

Biennial work plans for each management strategy have been developed. It will include the following information:

- Each key action
- Timeline for the action
- Expected outcome
- Partners responsible for each action
- Estimated resources