



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, having more than 140,000 miles of mapped rivers and streams and more than 5,000 dams. Fish passage projects are vital to restore connectivity in streams and rivers for migratory and resident fish in 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. Fish blockages are also a factor in the decline of migratory and resident fish like American shad, hickory shad, river herring, American eel and brook trout.

Dams are only one factor contributing to declines in target fish populations. Fish populations can also be impacted by habitat conditions and water quality, bycatch, climate change driving possible changes in migratory patterns and spawning areas, overfishing and many others.

Implementing fish passage projects by removing dams or installing fish lifts, ladders and other passageways allows migratory fish to return to upstream spawning and nursery grounds while resident fish are able to move freely throughout streams. Dam removal can also improve the quality of surrounding habitat by reducing river fragmentation, increasing habitat opportunities for other aquatic living resources, and potentially improving water quality. Additional benefits from dam removal can include increased safety and recreational opportunities as well as reduced flooding potential.

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

By 2025, restore historical fish migratory routes by opening 1,000 additional stream miles, with restoration success indicated by the presence of alewife, blueback herring, American shad, hickory shad, American eel and/or brook trout. The Fish Passage Workgroup is dedicated to restoring connectivity to creek, stream and river habitats for migratory fish through dam removal and fish passage projects. While the Fish Passage Workgroup is primarily focused on blockage removals that benefit diadromous species, the group acknowledges the benefits of dam removal to resident species. As such, brook trout was added to the Fish Passage strategy target species list.

Fish Passage Objectives (2011-2025)

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

1. During the period of 2011-2025, restore historical fish migratory routes by opening 1,000 additional stream miles, 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 within the Chesapeake Bay watershed.
3. Use the Chesapeake Bay Fish Passage Tool that was completed by the workgroup to implement high priority dam removal and fish passage projects.

The outcome was developed by the Chesapeake Bay Program's Fish Passage. The workgroup believes the goal is measurable and attainable under the current working conditions and has limited the target to 1,000 miles opened by 2025 in light of decreased funding available and the complicated nature of remaining fish passage projects.

Baseline and Current Condition

The workgroup members implement projects involving the removal of dams or the creation of fishways when dam removal is not feasible. Stream miles opened are counted that benefit a specific list of target species: alewife, blueback herring, American shad, hickory shad, American eel and/or brook trout. From 1989 to 2013, approximately 2,576 miles in the Chesapeake Bay watershed have been opened and are accessible for fish migration.

The progress of this outcome is measured from zero miles starting in 2011. During the period of 2011 to 2013, the Fish Passage Workgroup reported a total of 215 stream miles re-opened (21.5% progress toward the *Watershed Agreement* outcome).

The number of miles opened each year is determined through a GIS exercise where a dam removal or fish passage project is located and mapped and an assessment of the number of stream miles accessible to target species is calculated. The mileage is not broken down by state. Monitoring includes miles of stream habitat opened and the presence of target species. The performance assessment is measured with two year milestones of 132 miles every two years.

III. Participating Partners

Team Lead: Vital Habitats Goal Implementation Team

Workgroup Lead: Fish Passage Workgroup

Opportunities for Cross-Goal Team Collaboration: Fisheries Goal Team/Water Quality Goal Team/Healthy Watersheds Goal Team

Active Current Participation and Role (signatories in bold):

Level of Participation – High:

- National Oceanic and Atmospheric Administration (NOAA)
 - Fish Passage Workgroup Chair
 - Provides technical assistance and funding for fish passage/dam removal projects
- U.S. Fish and Wildlife Service (USFWS)
 - Provides technical assistance and funding for fish passage/dam removal projects
- **Maryland Department of Natural Resources (MDNR)**
 - State Fish Passage Coordinator
 - Provides technical assistance for fish passage/dam removal projects
 - *Manages fish passage/dam removal projects*
- **Pennsylvania Fish and Boat Commission (PFBC)**
 - 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 (VDGIF)**
 - 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
- U.S. Army Corps of Engineers (USACE)
 - Reviews permit applications and authorizes fish passage/dam removal projects in waters of the United States
 - Could cost-share removal under ecosystem restoration mission

- The Nature Conservancy (TNC)
 - Provides technical support on the fish passage prioritization tool

Level of Participation – Medium:

- 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

Local Engagement

Local governments, non-profits and watershed associations are engaged in identifying potential dam removal projects, providing information on fish passage alternatives, and organizing community events related to dam removal projects. A number of non-profits are listed above who serve a critical role in the fish passage strategy by serving as project managers for dam removal projects, grant applicants and stewards of fish passage funding, and technical assistance for a wide variety of fish passage tasks. Technical assistance includes development of the Chesapeake Bay Fish Passage 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 prioritization 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 legal action against all dams in noncompliance is costly and time consuming.

2. Funding

The ability to achieve change through fish passage projects is largely limited by a lack of resources.

3. Understanding the Ancillary Benefits of Dam Removal (Policy Makers, Dam Owners and Local Government)

Dam removal projects provide many ancillary benefits beyond restoring habitat for target fish species. For example, removal can result in reduced liability for dam owners when the dam is removed. 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 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. Furthermore, dam removal can result in improved 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 about 700,000 pounds. Between 1990 and 1999 the yearly average was roughly 164,000 pounds. From 2005 to 2010 the average was just 35,200 pounds.

It is important to note 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 size for the purpose of making the readers aware fish populations can be impacted by the following: habitat conditions and water quality, bycatch, climate change including possible changes in migratory patterns and spawning areas, overfishing, 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 dam removals 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). While the workgroup has completed the Chesapeake Bay Fish Passage Prioritization tool to help guide dam removal efforts and strategically invest public funds, limited culvert data has been added to the tool. An assessment of road crossings would help determine potential barriers or fish passage benefits, while helping the workgroup to align limited financial recourses with the best projects for the outcome.

Additional priorities of the workgroup are related to landowner willingness for dam removal. Efforts continue to coordinate between fish passage experts and dam safety offices help to target high risk and high priority dams. Development of an outreach strategy could be an opportunity to develop high quality materials to help educate landowners on ancillary benefits of dam removal.

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, 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. 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. 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 geographic information system (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. The tool is publicly available and can be found at <http://maps.freshwaternet.org/chesapeake>.

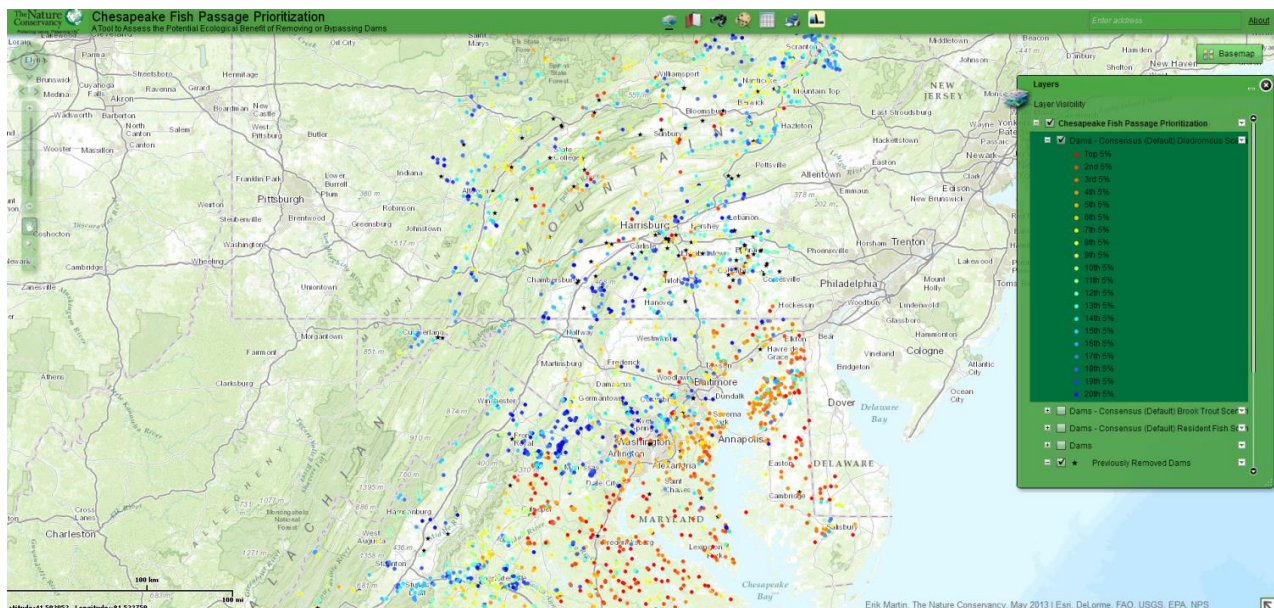


Figure 1. Priority barrier removal projects shown by the red and orange points.

The tool uses GIS data to rank potential barrier removal projects throughout the Maryland, Virginia and Pennsylvania portions of the Chesapeake Bay watershed. 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 a 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 fish if removed or bypassed. The tool also includes information on brook trout at the request of the Eastern Brook Trout Joint Venture (EBTJV).

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. While American eel is listed as a target species for the workgroup, the general guidance is that these projects are of a lesser priority to the workgroup compared to barriers that benefit a wide variety of 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 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 EBTJV 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 EBTJV strategies. Additional details on potential Brook Trout projects and priority areas can be found in in the [brook trout management strategy](#).

Obtaining the Mileage Goal

The workgroup is committed to opening 1,000 additional stream miles for fish passage by 2025. To achieve this goal, *132 miles will be reopened every two years.*

Over the next two years, the workgroup will continue efforts on dam removal already under way through various project teams. Several projects are in the planning, design and implementation phase for 2018-2019. These projects include:

- Maryland: Bloede Dam (underway in the Patapsco River)
- Pennsylvania: Krady Mill Dam (Chique's Creek), Gunter Valley Dam (Trout Run)

The workgroup will continue to apply for restoration grants to fund design and removal of barrier projects. Various Federal agencies and nonprofits offer grant funding opportunities including: NOAA, USFWS, Chesapeake Bay Trust and National Fish and Wildlife Foundation. There is no dedicated funding for barrier removal projects provided directly from the Chesapeake Bay Program. Often times, project managers have to obtain and combine several sources of funding to complete one removal, increasing time and staff efforts for the removal project. The workgroup needs a more dedicated funding source for larger scale removals that will award funds for planning through implementation in larger amounts.

Dam removals 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 removals, infrastructure relocations (sewer lines, water lines and road modifications) are needed to remove the river obstruction. As the workgroup has targeted removals and fish passage since 1989, many of the “easy” projects have been completed, leaving the more complicated and costly projects to be done. The rate of dam removals completed in the states has declined over time in light of this fact.

Project Development

While dam removal prioritization exists, the feasibility of removing the dams 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. Removal of dams and other obstructions in streams could inadvertently facilitate the spread of invasive species. Removal projects may be appropriate where the projected ecological benefits outweigh the risk of invasive species spread.

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 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. Establish 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.

Approaches Targeted to Local Participation

Local governments, watershed associations, nonprofits and the private sector, including private dam owners, all have a role in this strategy. Local governments often own the dams targeted for removal 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 dam owners 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 personal connections with potential dam owners.

VII. Monitoring Progress

Miles of Stream Opened

Fish passage coordinators in Maryland, Virginia and Pennsylvania report mileage opened annually using the mileage produced through the Chesapeake Bay Fish Passage 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 uses two-year milestones to assess performance. In order to open 1,000 stream miles for fish passage by 2025, the workgroup must open 132 miles every two years. The workgroup will calculate miles opened using the new Chesapeake Bay 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 network is defined by the sections of river that a fish could theoretically access (Figure 2). Its terminal ends are barriers and headwaters.

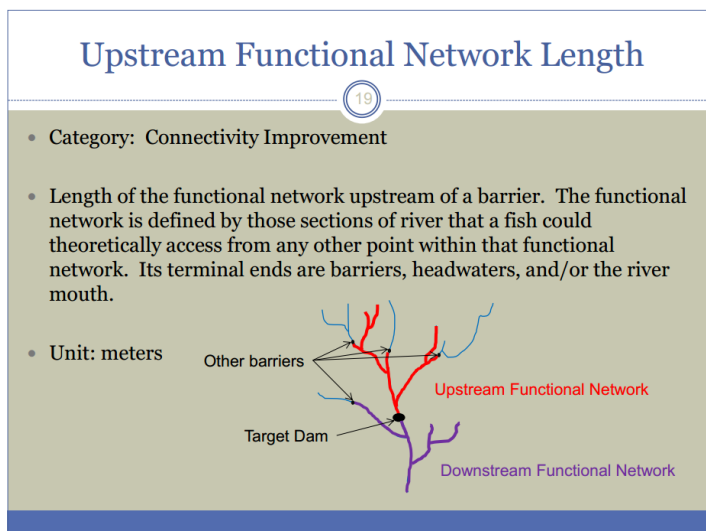


Figure 2: Description of Upstream Functional Network Length

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

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 (NFWF Resilience Grants for example) are anticipated and many of the dam removal and road retrofit projects would likely score highly for potential funding given the community benefits (reduced flooding and safer roads) 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.

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 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.

The workgroup will develop GIS maps at the 1:24,000 scale showing watersheds and river miles made accessible to diadromous fish passage from 1989 to the present. These maps will help tell the story of passage over time and highlight the success of the workgroup. Once the watershed maps are developed, the workgroup can reassess the 1,000-mile goal and determine whether this goal is an underestimate, overestimate or realistic goal to meet by 2025. The Fish Passage Workgroup's vision is to focus more on watersheds in need of fish passage work and less on overall river miles opened.

While removal of obstructions in rivers for the purpose of fish passage is the focus of this strategy, the workgroup will also investigate if continued or enhanced monitoring should occur on existing fish passage structures, such as fish ladders, to determine efficiencies in passing target fish. If monitoring is deemed important, the workgroup will determine means in which to fund monitoring studies through existing grant programs.

Outreach and education strategies for local government and landowners will also be re-evaluated based on the high-priority community study. The workgroup plans to test several dam owner incentives and outreach tools to determine the most effective outreach strategy.

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