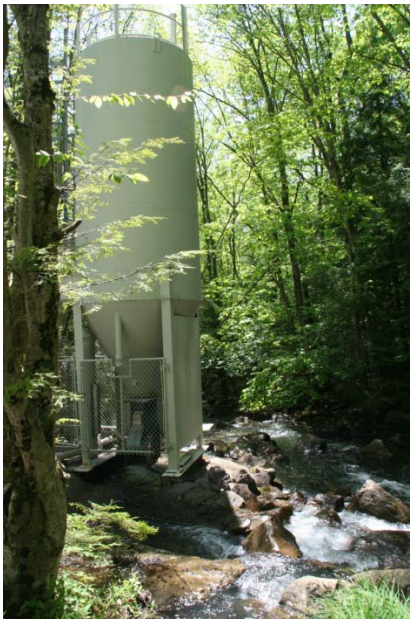
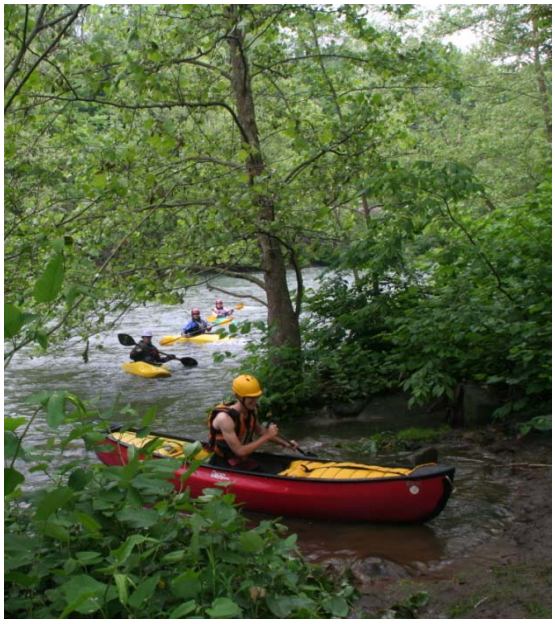
The Benefits of Acid Mine Drainage Remediation on the North Branch Potomac River





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Prepared for:

Maryland State Water Quality Advisory Committee

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Downstream Strategies
building capacity for sustainability

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The Benefits of Acid Mine Drainage Remediation on the North Branch Potomac River

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ABBREVIATIONS

AMD	acid mine drainage
AML	abandoned mine land
AMR	Abandoned Mine Reclamation
AW	American Whitewater
cfs	cubic feet per second
FMA	Fisheries Management Area
FWPCA	Federal Water Pollution Control Administration
ICPRB	Interstate Commission on the Potomac River Basin
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MMEC	Morgan Mining & Environmental Consultants
NBP	North Branch Potomac
O&M	operations and maintenance
SMCRA	Surface Mining Control and Reclamation Act
SFMA	Special Fisheries Management Area
UPRC	Upper Potomac River Commission
US	United States
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

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- David Duree (Advanced Systems);
- Meg Ellis (Garrett County Economic Development Department, grant administrator);
- Neil Jacobs (Chair, Acid Mine Drainage Subcommittee);
- Alan Klotz (Maryland Department of Natural Resources);
- Constance Lyons Loucks (Maryland Department of the Environment Mining Program);
- Sull McCartney (Trout Unlimited);
- Ed Merrifield (Potomac Riverkeeper);
- Joe Mills (Maryland Department of the Environment Mining Program);
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- Victoria Woodward (Past Chair, Maryland State Water Quality Advisory Committee).

EXECUTIVE SUMMARY AND KEY FINDINGS

After decades of impairment, a successful program initiated by innovative staff at Maryland state agencies has transformed the North Branch Potomac River into a popular recreational river and a driver of local economic development. This remarkable improvement in water quality is the direct result of the installation of eight dosers since 1992, which add alkaline material to the river and its tributaries to treat acid mine drainage from abandoned coal mines.

Largely due to these improvements in water quality, fishing opportunities have increased. Above Jennings Randolph Lake, the river is a high quality fishery with about 20 miles stocked and managed by the State of Maryland. Naturally reproducing trout are found below the lake, and further downstream, trout and reproducing smallmouth bass populations are present. Whitewater releases from Jennings Randolph Lake provide boating opportunities that do not exist elsewhere in the eastern United States, with high cliffs, interesting rock outcroppings, and a western feel. Not only has the quality of life improved for local residents, but also a sustainable economic foundation has developed around this newly rejuvenated resource.

However, State efforts to maintain the remarkable progress in returning the North Branch to health is in jeopardy, unless a stable source of funding is found to pay the $321,000 annual bill to operate and maintain the dosers indefinitely into the future. If future funding for this program is not secured, pollution would again flow untreated to the NBP and its tributaries, commercial outfitters would lose customers, and anglers would seek out other streams for trout and bass fishing and spend less money in Garrett and Allegany Counties.

This study calculates the local economic benefits generated in these Maryland counties stemming from acid mine drainage remediation on the North Branch, so that policy makers can make informed decisions about future funding to ensure that this remediation continues. These benefits are calculated from a survey of North Branch anglers and boaters, and include three types: local spending, the economic impacts of that spending, and the willingness-to-pay even more for recreational experiences.

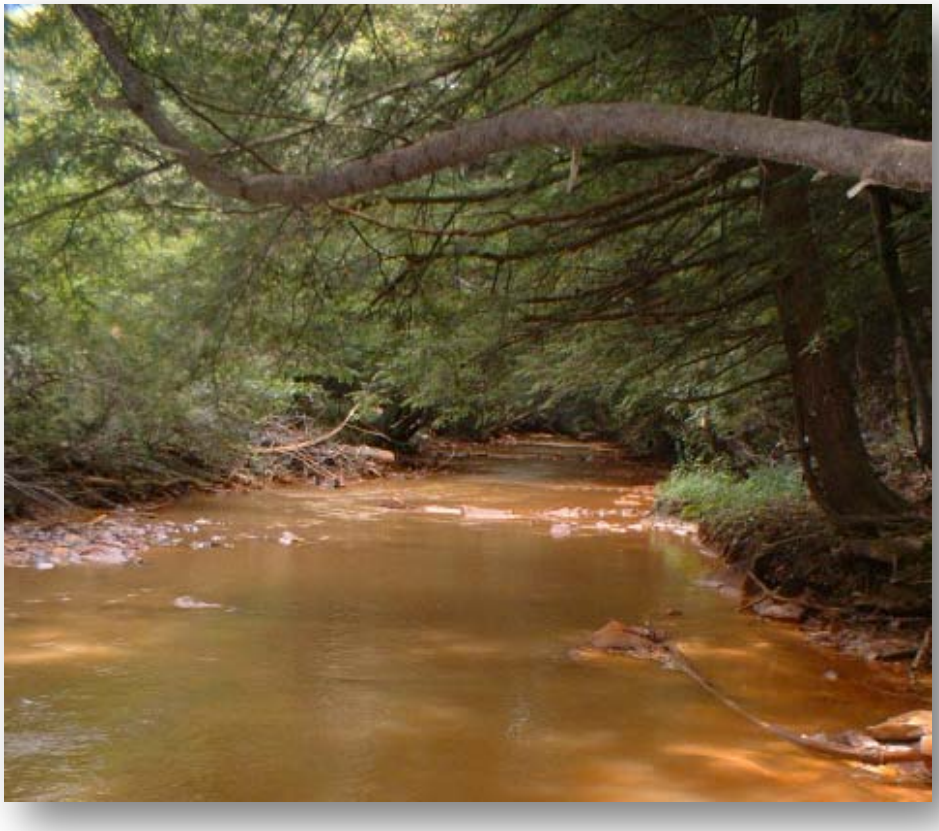
Local benefits are not always easily quantified in dollar terms; therefore, this report also documents numerous other benefits from the doser program, including improvements in water quality and fish, public and private recreational investments, increased recreational use, and cleaner source water for water withdrawals.

Finding 1: Decades ago, the North Branch Potomac was dead due to pollution from coal mines and other sources.

In the 1940s, an estimated 173,000 pounds of acidity entered the Potomac River system from abandoned coal mines each year; through the 1960s, the problem worsened—to 120,000 pounds *daily*. Even as recently as the 1970s, abandoned coal mines discharged a significant amount of acid mine drainage and impaired an estimated 450 stream miles. While acid mine drainage was the most important water quality issue, other problems existed such as pollution from a pulp and paper mill in Luke and wastewater from the towns of Luke and Westernport, Maryland and Piedmont, West Virginia.

> *"Back when I was a kid, you wouldn't even want to wade in it, not if you wanted to keep your shoes."*
>
> Local professional

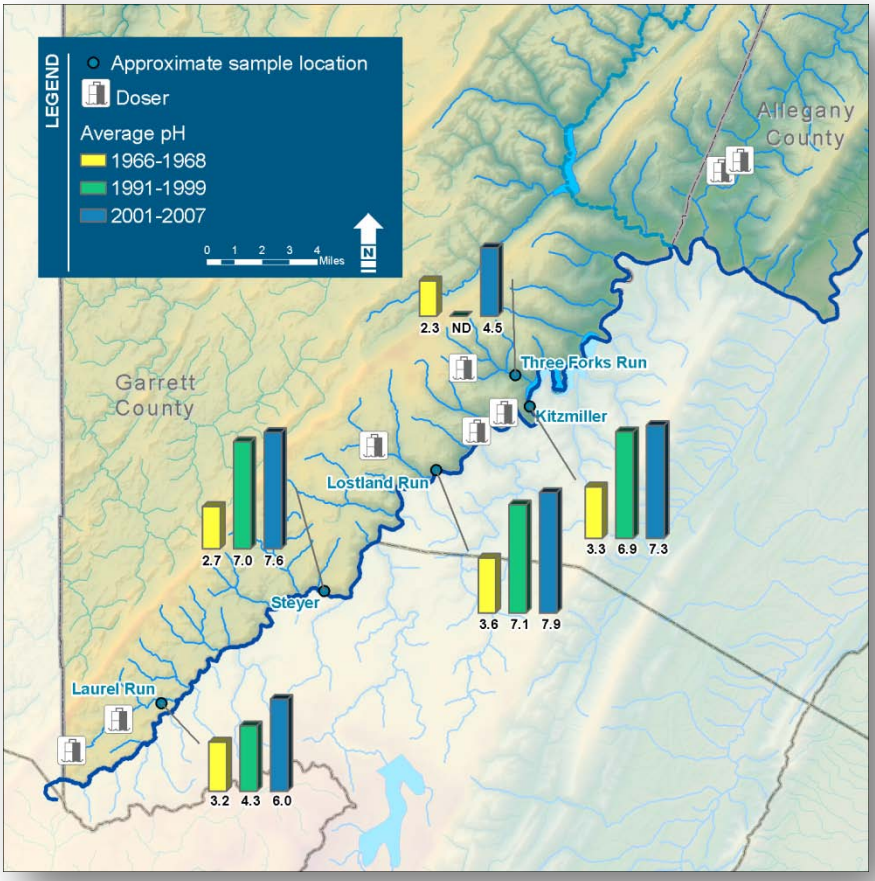
Laurel Run, an acid mine drainage-impacted tributary of the North Branch Potomac River



Finding 2: The North Branch Potomac is now much cleaner, largely due to the installation of dosers since 1992.

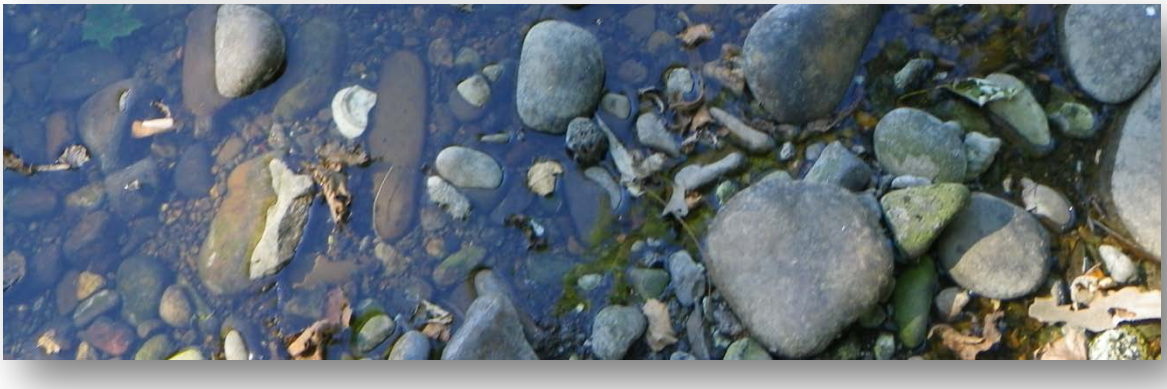
Eight dosers, which treat acid mine drainage flowing into the North Branch Potomac and select tributaries, have been successful. According to one comprehensive study, data collected at all ten locations downstream from the dosers on the North Branch Potomac River now demonstrate compliance with Maryland's water quality standard for pH.

Improvements in water quality since the 1960s



With water quality improved, aquatic life has returned. Trout and bass, stocked by the Maryland Department of Natural Resources, now naturally reproduce in the upper and lower sections of the North Branch.

When the river was polluted, few people considered using it for drinking water. Yet today, water is withdrawn for drinking at an industrial facility and for a small town, and two new drinking water withdrawal permits are pending.

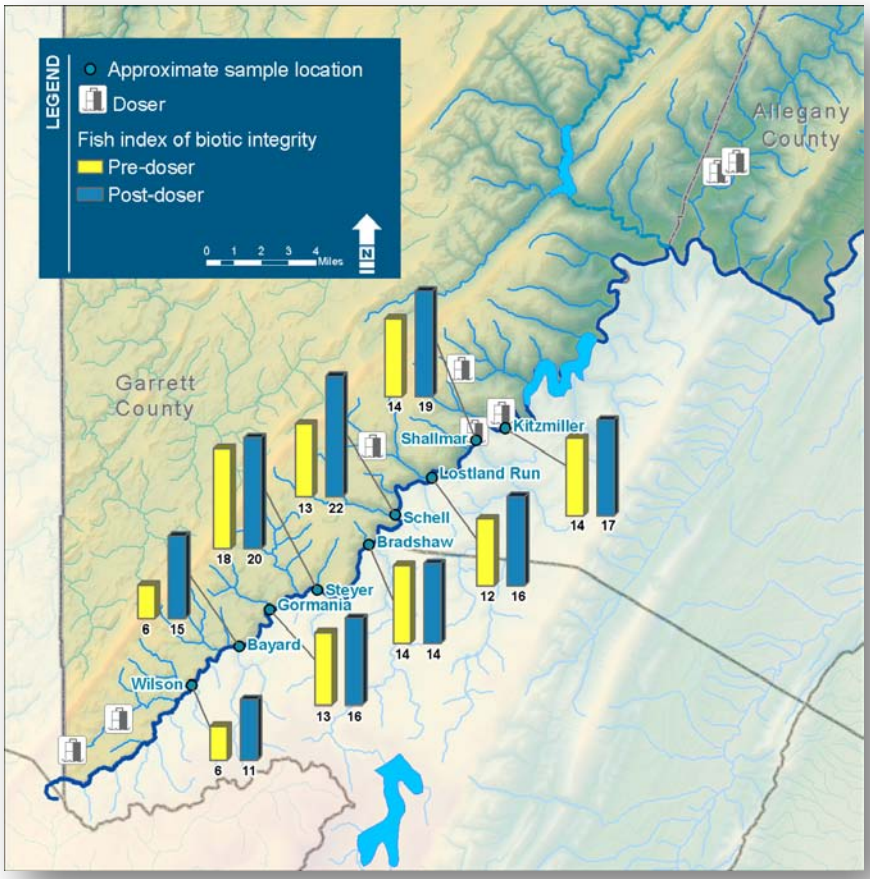


Finding 3: The North Branch Potomac is now an important fishery; anglers fish for trout and bass from above Kitzmiller down to Cumberland.

Angling was not possible decades ago due to pollution, but now provides the foundation for most of the local economic benefits quantified in this report. In addition to these economic benefits, fishing opportunities make the region a more attractive place to live and work based on its improved quality of life.

> *"I'd never dreamed when I was a kid that I'd ever catch any fish in [the North Branch Potomac], let alone trout."*
>
> Local angler

Pre- and post-doser fish index of biotic integrity



Finding 4: Commercial and private recreational use of the North Branch has increased dramatically since the dosers have been installed, reflecting the improvements in water quality and the active management of the resource by state and federal agencies.

Currently, at least 13 commercial angling and whitewater boating outfitters use the North Branch for their businesses. In addition, tens of thousands of recreational visits to Jennings Randolph Lake are now logged each year; the lake, managed by the United States Army Corps of Engineers, provides a range of amenities for visitors.

All eight current angling outfitting businesses on the North Branch started after acid mine drainage remediation began.

Whitewater boaters on the North Branch Potomac River

In recent years, more than 30,000 people annually have visited the river at Barnum, including more than 1,000 boaters each year.

The State of Maryland spends significant resources stocking fingerling and adult trout, and buying and maintaining Fisheries Management Areas to provide river access.

Finding 5: North Branch Potomac anglers and boaters are now spending an estimated $2.1 million per year in Garrett and Allegany Counties.

Through an original survey of boaters and anglers, we find that spending on supplies, guides, accommodations, food, and other items totals about $2.1 million per year in Garrett and Allegany Counties.

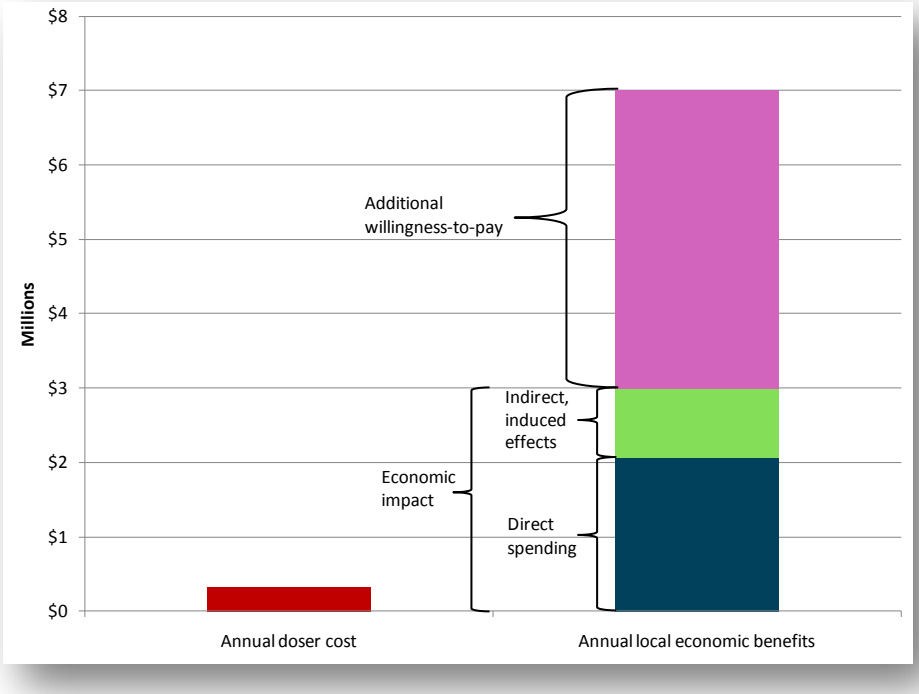
Finding 6: Angler and boater spending provides an economic impact of about $3.0 million per year in Garrett and Allegany Counties.

Taking into account the cycling of expenditures through the local economy, we find that the boaters' and anglers' spending results in an output, or economic impact, of about $3.0 million per year in Garrett and Allegany Counties. This impact includes the $2.1 million in direct spending, as well as indirect and induced effects. It includes, for example, employee compensation for about 40 full-time equivalent jobs and $266,000 in state and local taxes. These tax dollars alone approach the roughly $321,000 per year needed to operate and maintain the dosers. The full economic impact is almost ten times higher than the annual doser costs.

Finding 7: Anglers and boaters are willing to pay even more for their recreational experience: approximately $4.1 million per year.

According to our survey results, anglers and boaters receive a higher value from their recreational experiences than they already pay. In fact, they are willing to pay an additional $4.1 million per year for these experiences. The willingness of recreational users to pay additional costs for their trips points to the value of this recreational asset and to the possibilities for securing long-term funding.

Doser costs versus local economic benefits



Finding 8: Without a change of policy, the dosers must be shut down, threatening the economic resource that the North Branch Potomac has become.

Maryland's Acid Mine Drainage Abatement and Treatment Fund is used to pay for the operation and maintenance of these dosers as well as other acid mine drainage projects. All deposits to this fund come from annual federal Abandoned Mine Reclamation Fund grants. While this system has worked well for many years, changes in the federal program put the State of Maryland's progress in jeopardy. Annual grants are set to expire in 2022. A shorter-term concern is that the balance in Maryland's Fund is declining.

> *"An opportunity exists for the State…to protect waters of the state by continuing remediation efforts at the current level."*
>
> Theaux Le Gardeur,
> Backwater Angler

While the clean-up of the North Branch has produced a robust recreational economy based on clean streams and healthy fisheries, this economy could be crippled if funding for the dosers is shut off. Were treatment to stop, water quality in the river, as well as the trout, bass, and other aquatic life that depend on clean water, would be severely impacted. The economic activity—especially that related to fishing—that depends on the dosers would be significantly harmed.

The Laurel Run doser

The total amount of funding required to operate and maintain the dosers is about $321,000 per year; a portion of this funding may be paid by the federal Abandoned Mine Reclamation Fund but is subject to the changing practices and policies of the federal government. To put this in perspective, it is a small fraction of the economic impact from North Branch anglers and boaters in Garrett and Allegany Counties.

The dosers have turned the North Branch Potomac from a dead river into a very popular recreation destination. Anglers and boaters provide an important boost to the local economy. It is up to policy makers to determine whether and how to ensure that the dosers continue operating so that the North Branch can continue to provide local economic benefits into the indefinite future.

1. INTRODUCTION

The purpose of this project is to calculate the local economic benefits that existing AMD remediation systems generate in Garrett and Allegany counties, so that policy makers can make informed decisions about future funding to ensure that AMD remediation continues.

After decades of impairment, a successful program initiated by innovative staff at Maryland state agencies has transformed the North Branch Potomac River (NBP) into a popular recreational river and a driver of local economic development (Figure 1 and Figure 2). This remarkable improvement in water quality is the direct result of the installation of eight dosers since 1992, which add alkaline material to the river and its tributaries to treat acid mine drainage (AMD)[1] from abandoned coal mines.

Largely due to these improvements in water quality, fishing opportunities have increased. Above Jennings Randolph Lake, the NBP is a high quality fishery with about 20 miles stocked and managed by the State of Maryland. Naturally reproducing trout are found below the lake, and further downstream, trout and reproducing smallmouth bass populations are present (MDNR, undated). Whitewater releases from Jennings Randolph Lake provide boating opportunities that do not exist elsewhere in the eastern United States (US), with high cliffs, interesting rock outcroppings, and a western feel. Not only has the quality of life improved for local residents, but also a sustainable economic foundation has developed around this newly rejuvenated resource.

However, State efforts to maintain the remarkable progress in returning the NBP to health is in jeopardy, unless a stable source of funding is found to pay the $321,000 annual bill to operate and maintain the dosers indefinitely into the future. If future funding for this program is not secured, pollution would again flow untreated to the NBP and its tributaries, commercial outfitters would lose customers, and anglers would seek out other streams for trout and bass fishing and spend less money in Garrett and Allegany Counties.

This study calculates the local economic benefits generated in these Maryland counties[2] stemming from AMD remediation on the NBP, so that policy makers can make informed decisions about future funding to ensure that this remediation continues. These benefits are calculated from a survey of North Branch anglers and boaters, and include three types: local spending, the economic impacts of that spending, and the willingness-to-pay even more for recreational experiences. The cost of operating and maintaining the dosers is only a small fraction of these local economic benefits.

In addition to this quantitative information, survey respondents provided numerous comments that add color and context to this study. For example, key themes and quotes from anglers and boaters about the qualities of the NBP are listed in Table 1.

Local benefits are not always easily quantified in dollar terms. Chapters 4 through 7 of this report document numerous other benefits from the doser program, including improvements in water quality and fish, public and private recreational investments, increased recreational use, and cleaner source water for water withdrawals.

Chapters 2 and 3 describe Maryland's doser program, as well as the angling and whitewater outfitters, food and lodging establishments, and other businesses that now benefit from the rejuvenated NBP. These businesses, along with the local economic benefits they provide, are in jeopardy should funding not be sufficient to operate and maintain the dosers into the future.

[1] AMD is acidic water that flows from underground or surface coal mines, and is formed when acid-producing coal seams come in contact with water and oxygen. AMD typically has low pH and high levels of metals such as iron, aluminum, and manganese.

[2] While not documented in this study, additional economic benefits certainly accrue to the local economy in West Virginia, which borders the southern side of the NBP, as well as other nearby counties in Maryland and Pennsylvania.

Figure 1: The North Branch Potomac River and the study area of Garrett and Allegany Counties

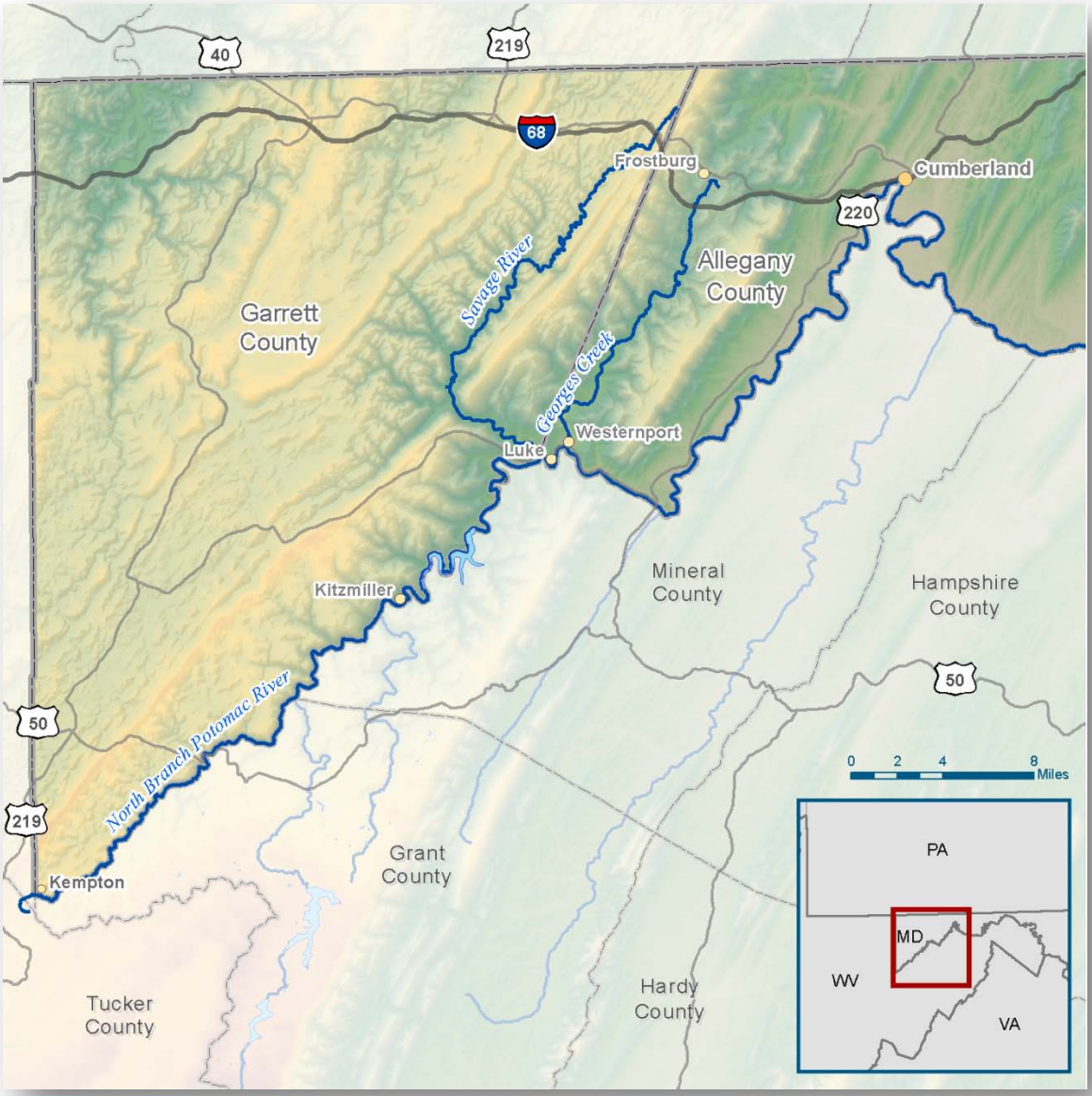
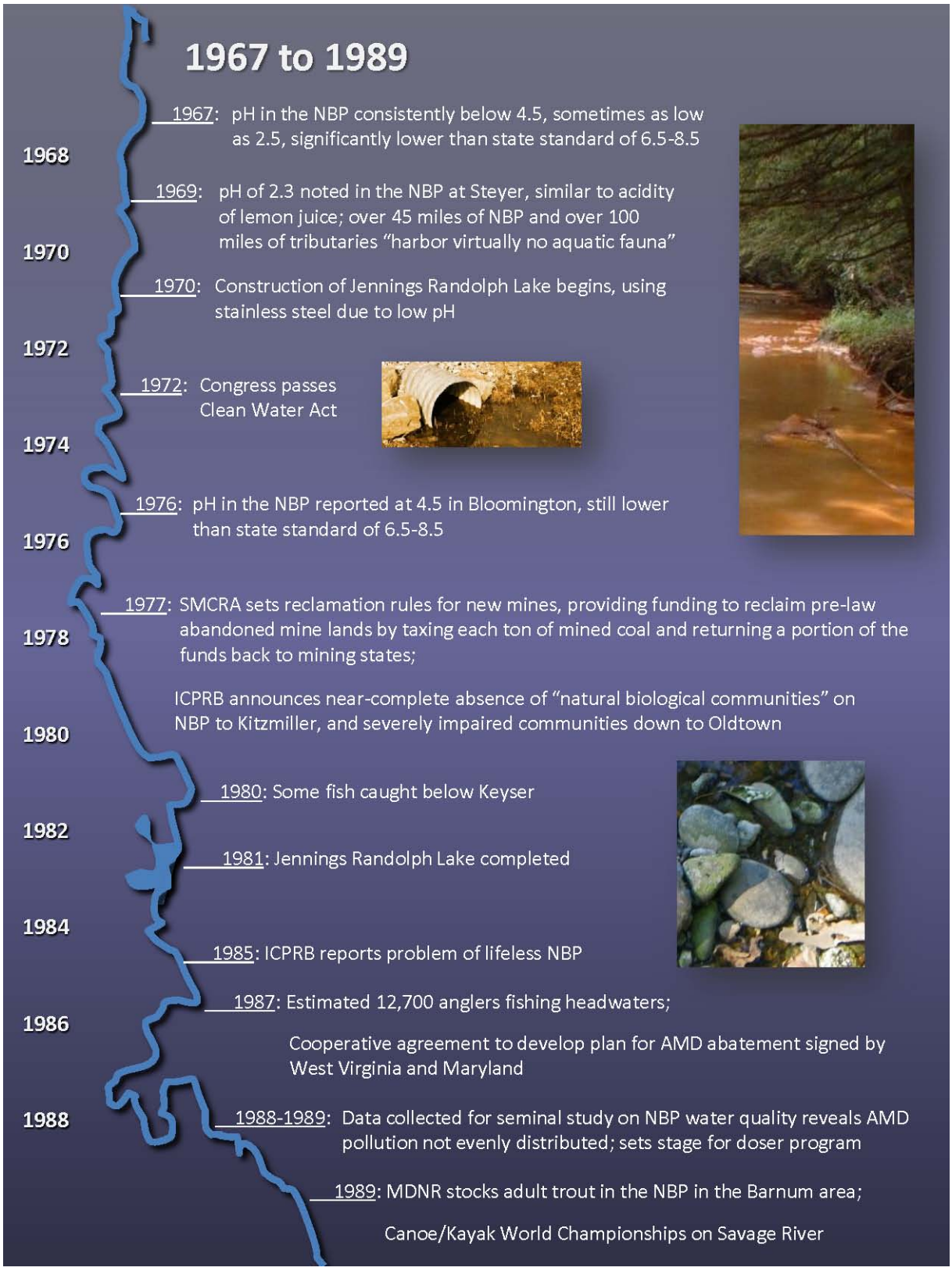


Figure 2: Timeline of key events related to the North Branch Potomac River



1990 to Future

1990

1991: Natural reproduction of trout in the lower NBP

1992: First doser installed at Kitzmiller;

Whitewater boating releases from Jennings Randolph Lake begin

1992

1993: Kitzmiller doser fully operational;

Smallmouth bass stocking begins in the lower NBP

1994

1994: Laurel Run, Lostland Run, and Gorman dosers fully operational;

Trout and bass stocking begins in the upper NBP;

Smallmouth bass reproduction first documented in the upper NBP

1996

1996: Three Forks doser fully operational;

~730 total visitors to Barnum for whitewater releases

1997: Bass reproducing in the lower NBP, so stocking stops

1998

1999: Cabins and tent sites for rent at Barnum area by Mineral County

1990s: Water quality at Steyer, Lostland Run, and Kitzmiller meets state standards

2000

2000: Trout fingerling stocking begins between Westernport and Pinto;

Kempton doser fully operational

2002

2003: McDonald doser fully operational

2004

2006: Shallmar doser fully operational;

2006

AMR Fund's Set-Aside Program reauthorized, with a concurrent increase in allowable set-aside from 10% to 30%;

13 commercial angling and whitewater boating outfitters use the NBP

2008

2008: ~31,880 total visits to Barnum and 1,234 visitors to Barnum for whitewater releases

2009: Trout stocked—70,000 rainbow and 11,500 brown—between Westernport and Pinto

2010

2010 : Three dosers in West Virginia's Abrams Creek begin operations

2011 : Mill Run doser fully operational (anticipated date)

Future

2022 : Annual AMR Fund allocations to State of Maryland set to expire

Table 1: Themes and quotes about unique qualities of the North Branch Potomac River

Themes	Quotes
River is a gem	"North Branch is a gem. Unlike anything anywhere nearby. It could be a major trout stream destination for anglers from miles around. The fish are big and the water is big."
Western feel	"The NBP is a treasure in Maryland and the closest thing I have found to replicate a western trout river in Maryland."
No eastern substitutes	"North Branch of the Potomac has turned into one of the best trout rivers and one of the most enjoyable fishing float trips on the east coast. It has helped to elevate trout fishing in the Mid-Atlantic to a point arguably comparable to western trout fishing. It would be an absolute tragedy if it were lost."
Good seasonality	"This stream has one of the few bottom release waters in the tri-state area. That means that trout fishing is available at a quality level 12 months out of the year."
Local interest	"[I] live in the area and feel that this is a great local asset."
Non-local interest	"I travel in from Virginia and [it] is over a 3 hour trip. I spend numerous overnight trips to the NBP annually; it is one of my favorite fisheries."
	"I lived in [Montana] for 14 years where I had dozens of rivers to fish that were closer to my house there than the North Fork is to my house here. Yet, the NBP when it is good, is as scenic and fishable for quality fish as almost any stream in Montana…From my humble point of view to even consider stopping the dosing shows a complete lack of foresight and an amazing overabundance of ignorance concerning this magnificent resource. You have no idea what you have here!"
Lifetime of use	"I love the North Branch. I am 24 now and my father began taking me up there when I was in second grade. I plan on going and fishing the Barnum area for the rest of my life."
Tradition	"My dad first took me to the NBP in 1997. I have now been taking my son. He asks to go camping there every spring. I would not like to lose this tradition our family has been keeping up for so many years now."
River improvements	"I'm only about a mile from the North Branch and I go there all the time…[I]t's a beautiful place. I recall when the river ran red. It's much better the way it is now."
	"The dosers should stay on the North Branch headwaters. I live in Garrett County. I have seen the North Branch run red as a child. I never thought I would see the great shape it is in now."
Improved quality of life	"The restoration of the North Branch has greatly increased the beauty and the attractiveness of the area as a place to recreate and to live. It would be a great loss to revert back to the dead and prior unattractive conditions."
Success story	"The dosers are a tremendous success story after a long, long line of bad news."
	"Please don't let the North Branch die. It has made a terrific comeback from the degradation caused by coal mining operations and we need to do whatever it takes to keep it healthy."
Fish attract people	"The main reason I recreate on the North Branch is the trout fishery and I'd probably not go back unless the trout fishery were maintained."
Increased use	"I have been going to fish the North Branch for the past 12 years. [Now,]…there are more people."
	"I have noticed fishing and public use pressure is increasing on the North Branch of the Potomac as Deep Creek Lake development increases."
Potential future use	"The North Branch has a tremendous potential as a world-class cold water fishery. I think this potential has only begun to be realized and I hope that work continues to achieve the full potential of the resource. Add some more camping sites…Create some web site content that helps people learn about the river…and how to locate nearby services."
	"The NBP is turning into an amazingly productive fishery, especially in this part of the country where trout rarely have cold, clean water. Its history of pollution and its lack of access have made it the best kept secret I know…If the water quality continues to improve, word will spread and the NBP will become a very popular destination."

2. MARYLAND'S ACID MINE DRAINAGE TREATMENT SYSTEMS

2.1 Funding for acid mine drainage treatment

The 1977 federal Surface Mining Control and Reclamation Act (SMCRA) was one turning point for the NBP; it set reclamation rules for new mines and also provided funding to reclaim pre-law abandoned mine lands (AMLs)[3] by taxing each ton of mined coal and returning a portion of these funds back to mining states via the Abandoned Mine Reclamation (AMR) Fund. In federal fiscal year 2011, Maryland is receiving $2.7 million; in fiscal year 2012, the grant will increase to $3.0 million (Garner, 2010).

The AMR Fund's priority system has restricted the use of these grants, making it difficult to spend most allocated funds on AMD remediation. To help overcome this obstacle, the AMR Set-Aside Program allows states to designate a portion of their allotment toward the remediation of AMD. While the rules that apply generally would limit the amount that Maryland can set aside to about $400,000-$600,000 per year, Senator Sarbanes inserted language into a federal appropriation bill that allows Maryland to set aside up to $1 million annually for AMD remediation (Garner, 2010).

These funds are deposited into a State Special Fund called the AMD Abatement and Treatment Fund, which is used to pay for the operation and maintenance of the 38 current AMD treatment systems, including ten dosers and 28 passive treatment systems. This Fund, to a much lesser extent, is also used to fund salaries of state employees who perform AMD remediation work and as match for other federal funds for the construction of new AMD treatment projects. All deposits to this fund come from annual AMR Fund grants (Garner, 2010).

While this system has worked well for many years, changes in the federal program put the State of Maryland's progress in jeopardy. Annual allocations from the AMR Fund are set to expire in 2022, when the AMR Fund is fully spent. A shorter-term concern is that the balance in Maryland's Fund is declining.

2.2 Types of acid mine drainage treatment

AMD can be treated using passive or active systems. Passive systems include, for example, anoxic limestone drains, reducing and alkalinity-producing systems, sulfate-reducing bioreactors, open or oxic limestone channels, limestone or steel slag leachbeds, compost wetlands, and manganese removal beds. Although passive systems have a relatively high upfront cost, they are designed to have minimal annual costs other than periodic maintenance and annual sampling. In contrast, active systems require up-front capital investments and annual operations and maintenance (O&M) expenditures. Dosers, which are active treatment systems, require the periodic purchase of alkaline materials that are metered into streams using waterwheel or bucket systems.

According to a 2008 report, the State of Maryland[4] had invested $5.4 million in both passive and active AMD treatment systems (CTL and MDE, 2008). Some of these passive systems are in the NBP watershed, including three above Jennings Randolph Lake. These include projects on Elklick Run: an underground anoxic limestone drain, oxidation ponds, and wetlands (Figure 3). Similar projects have been installed in the Georges Creek watershed, and additional active and passive systems are planned in Aarons Run.

[3] In addition to AMLs, two other categories of coal mines may also generate AMD. Bond forfeiture sites are mines whose operators have forfeited their bonds since 1977 rather than implement all of the required reclamation. Active mines have treatment systems, and do not normally discharge AMD to receiving streams. While these other sources may be locally important, this project focuses on AMLs rather than bond forfeiture sites or active mines.

[4] While the staff have remained basically the same since the doser program began, it has been implemented through several state agencies including the Maryland Department of the Environment (MDE) Bureau of Mines, MDE Abandoned Mine Lands Division, and Maryland Department of Natural Resources (MDNR).

Figure 3: The Elklick I passive treatment system

Photos: Constance Lyons Loucks, MDE.

2.3 The doser program

Dosers provide active AMD treatment, and work by adding alkaline material directly to streams. As this material mixes with the polluted stream water, it raises the pH, which causes metals to precipitate out and fall to the bottom of the stream bed, thereby reducing metals loads and associated acid loads. Downstream from the area where the metals accumulate, streams are cleaner.

As shown in Table 2, the cost to install the eight dosers in the NBP watershed totaled $943,614. Annual O&M, which includes maintenance, the chemical reagent, and monitoring, is estimated at $321,159 per year, or about $40,000 each.

The original goal of the doser program was to improve pH on the NBP to 6.2 for three months each year, thus providing water of sufficient quality to support stocked trout. After installation of the initial dosers, it became clear that the program could go well above and beyond this initial goal.

The overarching goal of the doser program is to heal the NBP, rather than its tributaries. Therefore, most dosers are located on its tributaries so that the chemical reactions occur before they reach the NBP.

The original goal of the doser program was to improve pH on the NBP to 6.2 for three months each year, thus providing water of sufficient quality to support stocked trout. After installation of the initial dosers, it became clear that the program could go well above and beyond this initial goal.

Since then, the goal has been expanded to support a year-round fishery and biological recovery of the NBP mainstem. Additional dosers have been installed, and adjustments have been made. The chemicals used have included hydrated lime, pebble quicklime, and limestone.

The current plan is to continue keeping the dosers running year-round in order to restore native fish, hold over fish from year-to-year, and support a year-round smallmouth bass population.

The current plan, having recovered the biological base of fish and benthic macroinvertebrates, is to continue keeping the dosers running year-round in order to restore native fish, hold over fish from year-to-year, and support a year-round smallmouth bass population.

Table 2: Costs associated with the eight dosers in the upper North Branch Potomac watershed

			Operations and maintenance cost ($/year)			
Doser	Year in service	Capital cost ($)	Annual maintenance	Chemical reagent	Sampling	Total
Kitzmiller	1993	63,250	13,993	16,472	1,128	31,592
Lostland Run	1994	71,700	11,747	5,040	1,128	17,915
Laurel Run	1994	162,000	12,650	34,125	1,128	47,903
Three Forks	1996	93,541	12,795	25,025	1,498	39,318
Kempton	2000	125,424	13,114	73,500	3,718	90,332
McDonald	2003	177,388	12,804	21,300	3,718	37,822
Shallmar	2006	215,155	14,012	14,300	2,608	30,919
Mill Run	2011	125,000	13,730	10,500	1,128	25,358
Total		**943,614**	**104,845**	**200,262**	**16,054**	**321,159**

Source: CTL and MDE (2008) except the capital cost for the Mill Run doser, which is from Loucks (2010c). Note: These operations and maintenance costs were estimated in 2008, and may change in the future based on inflation and the cost of materials and labor. The year in service is the year the doser became fully operational, except for the Mill Run doser, which is an anticipated date.

The current eight dosers are shown in Figure 4 (This figure also shows many watershed features described in later chapters). In 1992, installation began on the first doser: the Kitzmiller doser. By 1994, the first four dosers were fully operational, and included the Kitzmiller, Lostland Run, Laurel Run, and Gorman dosers. The Gorman doser was since moved to Mill Run, and is not shown in Table 2 or Figure 4.

After the original four dosers, the Three Forks, Kempton, and Shallmar dosers were installed, bringing the total to seven dosers upstream of Jennings Randolph Lake. Downstream of the lake, the Georges Creek watershed is treated by the McDonald Doser, and the Gorman doser has been relocated to Mill Run in the same watershed. While this doser is not operational yet, it should be operational in summer 2011 (Mills, 2010a).

2.3.1 *The Kempton and Laurel Run dosers*

A Pumpkonsult slurry doser is located on Laurel Run (Figure 5), downstream from the 1.5-4 million gallon-per-day Kempton discharge. The Kempton Aquafix waterwheel doser was added upstream in 2000. A non-electric-powered machine, the Kempton doser now treats the Kempton discharge with calcium oxide (pebble lime) before it reaches the Laurel Run doser, where it is treated with calcium hydroxide. These steps ensure continual treatment of the mine discharge, even if the electric-powered Laurel Run doser loses power.

Figure 4: Dosers, Special Fisheries Management Areas, and boat access points

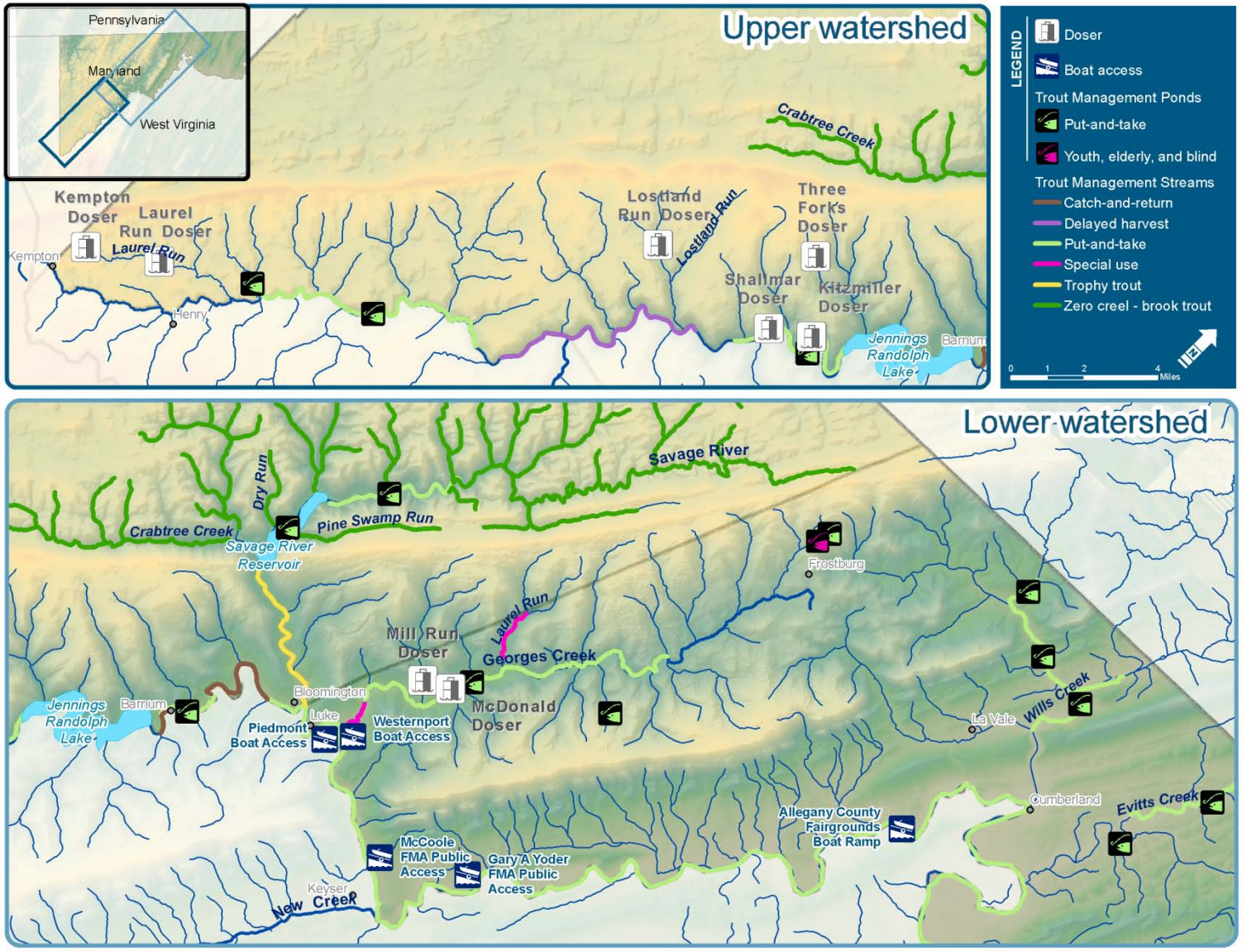


Figure 5: The Laurel Run doser

Photo: Evan Hansen.

2.3.2 *The Lostland Run doser*

The Lostland Run Boxholm bucket doser (Figure 6) is one of the original four dosers; limestone is used as the alkaline material. This doser is the exception because it was designed to recover the tributary itself, not just the NBP. However, excess alkalinity resulting from the doser improves the mainstem as well. This doser is more visible to the general public than the others; therefore, a sign was erected (Figure 7). The stream also had an existing brook trout population that survived over the years. After the Lostland Run doser was installed, an immediate improvement in brook trout population was reported (Mills, 2010b).

After the Lostland Run doser was installed, an immediate improvement in brook trout population was reported.

2.3.3 *The Shallmar doser*

The Shallmar Aquafix waterwheel doser (Figure 8) dispenses calcium oxide. It is upstream of Kitzmiller, near the confluence of the West Virginia tributary, Abrams Creek.

Figure 6: The Lostland Run doser

Photo: Sera Zegre.

Figure 7: Sign at Lostland Run doser

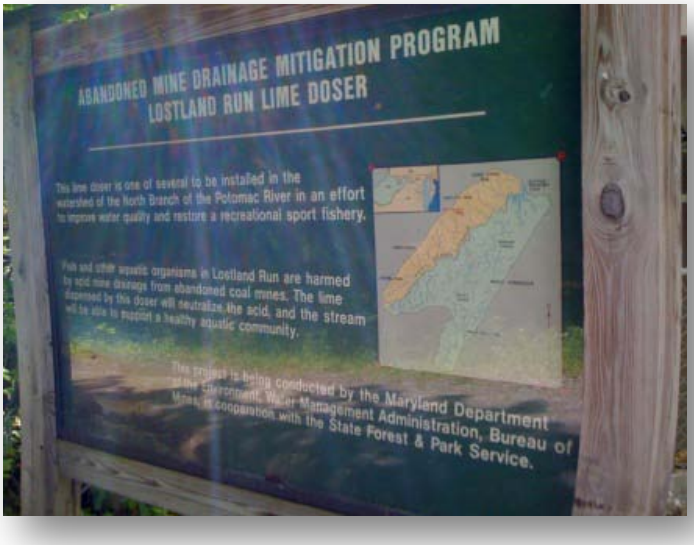


Photo: Evan Hansen.

Figure 8: The Shallmar doser

Photo : Constance Lyons Loucks, MDE.

2.3.4 *The Kitzmiller doser*

The Kitzmiller Aquafix waterwheel doser also uses calcium oxide and treats discharge that flows directly to the NBP.

2.3.5 *The Three Forks doser*

This Aquafix waterwheel doser was added in 1996. The State of Maryland supported the installation of this doser to treat the chemical barrier created by AMD at Three Forks Run. More specifically, the Maryland Board of Public Works would not want to approve a major AML construction contract for reclamation of the Vindex AML site without also addressing the extremely bad AMD discharging from the numerous abandoned deep mines at the site (Loucks, 2010a). The Three Forks doser improved poor water quality in the headwaters of Jennings Randolph Lake, allowing walleye from the lake to swim upstream to spawn.

2.3.6 *The McDonald doser*

This doser on Georges Creek was originally a Boxholm bucket doser, but was later upgraded to an Easy Dose 9. It now uses hydrated lime to reduce acid input near Barton from the pre-law abandoned McDonald mine (Loucks, 2010b; MDE, undated; Mills, 2010c).

2.3.7 *The Mill Run doser*

The water-powered, limestone Mill Run doser is now under construction. The doser has been moved to this location from its original location on the NBP near Gorman. The confluence of Mill Run is downstream of the McDonald doser. Other treatment efforts have already improved the condition of Mill Run, but the new doser will allow further recovery of Mill Run, Lower Georges Creek, and the NBP at Westernport.

2.4 Themes and quotes regarding the dosers

In our survey, respondents commented on the doser program and their feelings about future funding; representative quotes are provided in Table 3.

Table 3: Themes and quotes about the dosers

Themes	Quotes
Do not stop the dosing	"DON'T STOP THE LIME DOSING!! As a chemist, even a slight increase in the acidity will upset the pH balance and kill off the biosphere in the river."
Willingness-to-pay	"I did mean $100.00, not $1.00. I know that it wouldn't be popular with many, but I support organizations such as the Potomac Riverkeeper, and a contribution to keep the dosers going would be along the same lines. Where can I send a check?" "This is a great fishery, and it has come so far. It would be a waste to see go to [expletive deleted]. I would pay a daily access fee, or a daily parking fee in designated lots, or even a yearly parking pass that allows parking near the river."
Concern with recreational fee	"All sportsmen and women have an obligation to protect and preserve the environment; if a fee is involved, then so be it. My concern with any fee to be tacked on to the licensing structure relates to its use. There would have to be specific language in the regulation, stating that the money collected from the fee charged would only go to the purported purpose: for the operation/maintenance of the dosers."
Unfair burden on recreation enthusiasts	"It is unreasonable to place the burden of the cost to remediate the river on those who did not cause the problem." "I think the fees associated with clean up should be levied through coal severance taxes. Sportsmen did not create the problem and taxing them directly to solve it is wrong." "Maryland fishing and hunting license and taxes are already high enough, and you will certainly lose dedicated fisherman and outdoorsman should you levy higher fees."
Polluters should pay	"I find it amazing that the mine owners have been let off the hook and the American tax payer or fisherman is going to be taxed for this." "There should be more responsibility put on the coal-mining industry in cleaning up their mess. People involved in recreation are asked to leave-no-trace, industry should do the same and set aside funds to make that happen." "This burden of AMD rests squarely on the shoulders of those who created this problem." "The entities responsible for the AMD should bear the costs of remediation." "While I have no problem with user fees to improve fish habitat I believe those who profit from degrading our rivers…should pay the total cost of both current and previous damage." "The laws should require the person who pollutes to pay for clean-up."
Federal government	"Lobbying both the state Legislature and Congress can't hurt. Since the Potomac impacts 3 states, the Federal government should assist…Also, educating the general public of this situation may generate funds and/or support."
Longer term solution needed	"A longer term solution to the water quality needs to be developed with inclusion of remedial funding by all parties including the mining operations…Enacting environmental quality standards for mining would be a positive step in reducing more environmental damage. The source of the problems and those contributing to the source must be held accountable and contribute their respective share of the funding. Tolerating the continued lack of concern from the mining interest toward natural resources must be changed."

2.5 The role of Jennings Randolph Lake

Jennings Randolph Lake works in conjunction with the active and passive treatment systems to improve the water quality of the NBP. Its primary purpose was to provide for water quality (Hakala, 2010). The lake acts as a giant settling pond by slowing the river flow and allowing solids to settle out; these solids include precipitated AMD metals such as iron. The lake stratifies due to differences in temperature, and outlets at

different levels allow for some control over the quality of water released from the dam (Sheer and Harris, 1982). Since 1981, the United States Army Corps of Engineers (USACE) has managed releases from the dam to promote water quality in the river by discharging water at specifically chosen levels based on temperature and acidity (Figure 9; Hakala, 2010).

Figure 9: Bridge to intake control tower at Jennings Randolph Lake

Photo: Sera Zegre. Note: The intake control tower is the structure used to regulate the water level at the lake. Air vents are visible below the bridge on lower right side of image in a vertical line; water intake valves are located upstream the bridge, on the left side of the image.

According to current Head Dam Operator Mark Tucci, who helped with construction of the dam in the late 1970s, everyone back then considered the river and future lake to be "dead:"

> The water was like vinegar, so everything [in the dam was] constructed out of stainless steel [e.g., the air vent piping, gates, and liners]. Typically, if the water were not at low pH, the dam wouldn't have to be made out of stainless steel. That was a special requirement because of the anticipated low pH.
>
> That's why it's such a spectacular story…to go from a dead river to a trout fishery.

Tucci agreed that the dam and the dosing program work to create a pH that is "basically neutral," as well as prime habitat for trout. In addition to pH and temperature regulation, the releases allow for water reoxygenation, which helps provide conditions suitable for the establishment of a trout fishery below the dam (Advisory Committee, 2006).

"The water was like vinegar, so everything [in the dam was] constructed out of stainless steel."

Mark Tucci, Head Dam Operator, Jennings Randolph Lake

3. RECREATION-RELATED BUSINESSES

The doser program has made it possible for angling and whitewater outfitters to start and grow their businesses. In this chapter, we introduce these outfitters, as well as other shops and businesses that benefit from clean water in the NBP.

3.1 Angling outfitters

We solicited information from angling outfitters using focus group, questionnaire, and interview formats; a total of eight angling outfitters offered information about their business experiences on the NBP. Appendix A provides details on our methods.

A number of angling outfitters in Allegany and Garrett Counties, as well as one in Baltimore County, currently provide commercial angling services on the NBP, including wade and float fishing (Table 4). Most angling outfitters operate their businesses on the NBP between Barnum and Cumberland. Although some outfitters venture to the more remote setting upstream of the Jennings Randolph Lake, that area is not as highly used for guided angling due to unpredictable flows and limited access. Besides the NBP, these outfitters also use the Savage, Youghiogheny, and Casselman Rivers.

Table 4: Angling outfitters that currently operate on the North Branch Potomac River

Business	Other related amenities	Location	Year outfitting business began	Year began outfitting on the NBP
Backwater Angler	Shop	Monkton, MD	2001	2001
Eastern Trophies Fly Fishing		Swanton, MD	2003	2003
North Branch Angler		Oakland, MD	2002	2002
Sang Run Outfitters		McHenry, MD	1995	2000
Savage River Lodge Fly Fishing	Accommodations	Frostburg, MD	2001	2001
Savage River Outfitters	Shop, accommodations	Swanton, MD	2006	2006
Spring Creek Outfitters		Oakland, MD	1994	1994
Orvis-Endorsed Fly Fishing Outfitter at Wisp Resort	Lodging, shop, rentals	McHenry, MD	2006	2006

Source: Focus groups, questionnaires, and interviews. Note: Backwater Angler was renamed in 2001 with new ownership; from 1992-2001 it was called On the Fly and had some level of outfitting on the NBP.

The angling outfitters that we contacted estimate that the majority of their clients are either from Maryland or the mid-Atlantic region of West Virginia, Virginia, Pennsylvania, and Washington, D.C. Most of the NBP angling outfitters conduct 80-90% of their business on the NBP.[5] In contrast, none of the whitewater outfitters discussed in the following section use the NBP as their primary venue.

All current angling outfitters on the NBP started after AMD remediation began.

Some of the angling outfitters have operated their businesses on the NBP since the mid-1990s; others started their businesses in 2002 to 2006 (Table 4). All of the current angling outfitters that operate on the NBP started after AMD remediation began, which indicates the integral link between angling outfitting businesses and water quality.

According to outfitters, the NBP offers an experience that other rivers in the region do not. Outfitters each speak to the "western feel" of the river that is big, cold, and flat. One angling business owner called the river

[5] There were two exceptions: one was 10% and another was 40%; both of these exceptions have other related amenities.

a “gem:” “It looks like a great western river.” Although they agreed that the river feels like the west, they also argued that its eastern location near several major cities makes it an eastern asset.

Angling outfitters also spoke to the uniqueness of the NBP in its current condition compared to other river experiences in the region; the NBP offers a cold water, big water, trout-filled experience that is unique in the eastern US. One angling outfitter described the “productive trout fishery” below the dam: “You don’t have any other pieces of water in the area with the combination of cold water, consistent flows, and big fish.” Another angling outfitter spoke to the fish in the river:

> The NBP is Maryland's equivalent to big water found out west, and also home to large trout, primarily stocked rainbows. There are large wild brown trout or holdovers in addition to cutthroat trout, and the occasional brook trout.

“The NBP is Maryland’s equivalent to big water found out west.”

Angling outfitter

Angling outfitters also described the long season made possible by dam releases: “The cold waters attract fly-fishing people all year,” said one angling business owner. Angling outfitters appreciate that the river has fewer commercial and private boaters than other areas such as the Youghiogheny.

Prior to the installation of the dosers and the dam, there was no fishery. The angling outfitters said that before they started guiding, outfitters noted that the river was “an AMD mess,” “dead,” and “lifeless.” Outfitters recognized the importance of a healthy NBP fishery to their business: “Catching fish is what brings our clients back,” agreed a group of angling outfitters. An angling survey respondent noted: “I come for the resurrected smallmouth fishery.”

Prior to the installation of the dosers and the dam, there was no fishery.

Outfitters recognized that they would not have a business if the NBP were allowed to revert back to its prior AMD-impacted condition. A few outfitters also expressed concerned about visitors’ perception of the river, and how that relates to business. Theaux Le Gardeur of Backwater Angler said, “If they get spooked over [water quality]…if the dosers are not in operation and the fisheries decline…they’ll go elsewhere.”

Outfitters were aware of the economic impacts of water-based recreation on the NBP. Guides and outfitters commented in support of doing “everything possible” to maintain the “fantastic fishery” on the NBP; one outfitter spoke to the personal importance of the fishery: “It is a place of great importance to myself and my family as we rely on my guide service to provide for us.” Theaux Le Gardeur of Backwater Angler spoke to broader economic losses if remediation stopped:

> If remediation on the Potomac River efforts are halted, the loss in income formerly derived from a viable and well-recognized fishery (not to mention a certain loss in out of state license fees from these residents of the aforementioned states that currently view the Potomac as a "destination" fishery) will occur and the effects will be very real to small business operators who base their livelihood on healthy waters of the state.

3.2 Whitewater outfitters

In addition to angling outfitters, we also solicited information from five whitewater boating outfitters via interviews and questionnaires.

Only one of the five whitewater outfitters who currently operate on the NBP is located in Garrett or Allegany Counties. In contrast to the angling outfitters, all of the whitewater outfitting businesses that currently operate on the NBP started before AMD remediation began (Table 5).

Table 5: Whitewater outfitters who currently operate on the North Branch Potomac River

Business	Location	Year business began	Year began outfitting on the NBP
Cheat River Outfitters	Albright, WV	1975	Unknown
Historical River Tours	Harpers Ferry, WV	1983	1983
Precision Rafting Expeditions	Friendsville, MD	1981	1989
River and Trail Outfitters	Knoxville, MD	1972	1976
River Riders	Harpers Ferry, WV	1987	1999

Source: Focus groups, questionnaires, and interviews. Note: The business that is now River Riders started in the mid-1970s; it was incorporated as River Riders in 1987.

Whitewater outfitters provide commercially guided whitewater rafting day trips on the NBP from Barnum to Bloomington. One outfitter said he is exploring the opportunity to offer guided kayak and canoe trips between Keyser and Cumberland. Because there are only four scheduled whitewater releases per year in April and May (see Section 6.4), outfitters said that their NBP trips make up only a small portion of their total business: 1-10%. One owner of a whitewater business explains that these trips make up only 5% of his business because, "you can't run a viable business [solely] on the North Branch because of the limited releases." This outfitter, however, speculated that more scheduled releases could increase business.

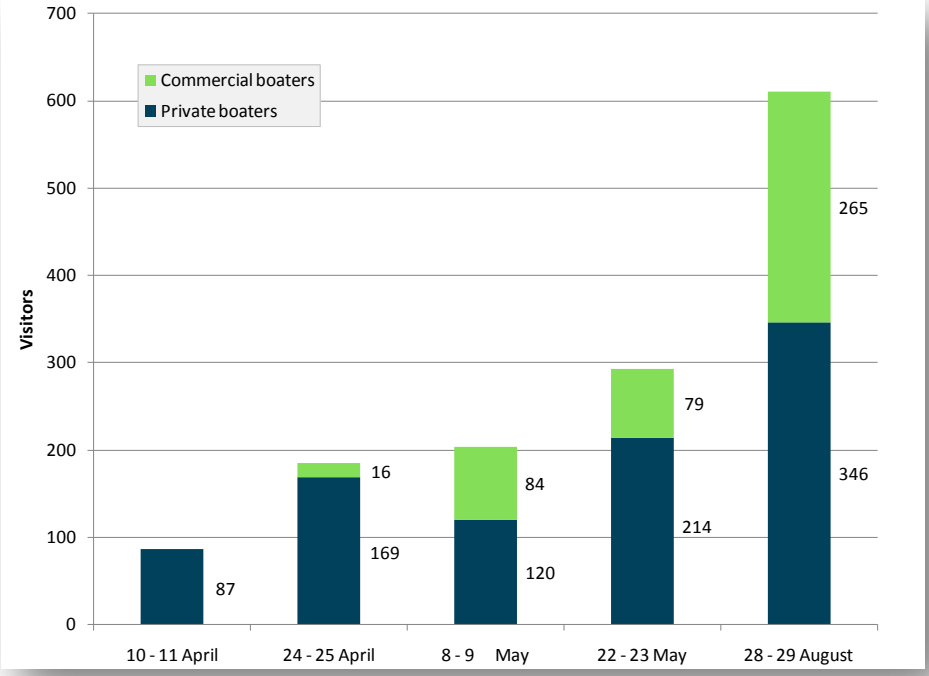
Although whitewater outfitters can market and schedule guided trips over four known weekend whitewater releases, they are also notified anywhere from two to four weeks in advance of additional releases that are suitable for whitewater use. These unscheduled water quality releases often occur in the late summer or early fall, and account for many of the commercial whitewater trips. On August 28 and 29, 2010, for example, over 600 commercial and private boaters were counted at Barnum (Figure 10).

All whitewater outfitters interviewed said that they could bring more people to the area if they could have more *scheduled* releases, especially during the warmer months of June, July, or August. Whitewater trips during warmer months are more marketable due to the cold water temperature from the dam releases. One whitewater business owner said that the whitewater trips in April are often unbooked due to the cold air and water; whitewater use trend data demonstrate higher use in the warmer months.

Whitewater outfitters agreed that there is room for growth in commercial trips if they had more scheduled releases, especially in late summer and early fall.

One whitewater business owner has offered guided whitewater trips on the NBP since 1976. He said that although less than 1% of his business is on the NBP, "there is room for growth if more releases are added on the whitewater section in the fall…[and] other times of the year."

Figure 10: Barnum Whitewater Area visitor use, 2010



Source: Mineral County Parks and Recreation Commission (2010). Note: August dates were for an unscheduled water quality release.

Outfitters suggested that scheduled whitewater releases during the warmer summer months could make more of an economic impact. One whitewater business co-owner said he had around 60-70 clients during the May 2010 scheduled whitewater releases; he shared his client numbers from an unscheduled water quality release as an example of how many potential clients he could book if whitewater releases were scheduled during warmer months:

> During the August [water quality] release, I can get 80 people without marketing [because I only know two weeks in advance]. With one month notice, we can have more.

Whitewater outfitters who operate on the NBP also operate on the Shenandoah, Youghiogheny, and Cheat Rivers, which all offer similar whitewater experiences. Although there are substitutes available for the whitewater experience on the NBP, the river has some unique values. According to Lee Baihly, owner of Historical River Tours, the river offers big waves, beautiful scenery, and predictable flow:

> The North Branch offers to our customers a fun straightforward "Big water" experience in a beautiful setting. The scenery on the river is as good or better than any other river in the region. The intimate feeling of the river is unique for commercially run Class III rivers in the area. The fact that it is run with scheduled releases allows our customers to count on a good ride.

"The scenery on the river is as good or better than any other river in the region. The intimate feeling of the river is unique for commercially run Class III rivers in the area."

Lee Baihly, Owner,
Historical River Tours

Outfitters also commented on the strategic location of the NBP, which is within four hours of the Washington, D.C./Baltimore metropolitan areas, and also within driving distance of Pittsburgh. Erik Neilson, co-owner of Historical River Tours, said that the Barnum stretch of the river "is one of the best family whitewater recreation opportunities in the country," especially because of its driving distance to large metropolitan areas.

Outfitters spoke to the water quality changes over time, and recognized these improvements as contributing to a better experience. One whitewater business owner started guiding in 1976, before Jennings Randolph Dam was built: "At that time there was significant evidence of acid mine drainage, red rocks and no life in the river." According to whitewater outfitters, although water quality improvements are *important* to the boating experience, water quantity or adequate flow is *necessary* for whitewater outfitters. One outfitter agreed that changes to water quality would not be good; however, at least in the short term, water quality degradation would not change a "good ride in a beautiful setting" that the NBP offers.

3.3 Outfitting shops

In addition to the angling and whitewater outfitters, numerous other businesses are tied to the improvement in water quality in the NBP. For example, Backbone Mountain Sports Shop is located within three miles of the NBP. According to owner Rich Skeweris, who is also president of the local chapter of the Ruffed Grouse Society, his business benefits from anglers there. Because his father worked in the area's mines and he has hunted the area since childhood, he has noticed many improvements over the years. From his childhood, he remembers the river running orange: "It would be a crying shame if it gets back to that and it will happen if it is not treated." He hoped to see a more permanent federal or state funding strategy so that it will continue to be treated: "So many people care about the North Branch, that's where we all hunt and fish."

Other area outfitting shops also benefit from angling use on the NBP. One of the angling survey respondents claimed he spends at least $2,000 annually at Spruce Creek Outfitters' shop in Spruce Creek, Pennsylvania: "This does not include what I spend at other shops in the area, lodging, food, transportation and gas expenses. People who fly fish are willing to spend a lot of money to experience the right place."

> *"I spend at least $2,000 annually at Spruce Creek Outfitters' shop… People who fly fish are willing to spend a lot of money to experience the right place."*
>
> Angling survey respondent

Another nearby outfitting shop is the Orvis-endorsed retail shop at Wisp Resort in McHenry, Maryland. Although they hesitate to correlate the impact of AMD remediation efforts on their retail profits, they documented large increases in profits in the season from 2008-2009; during that time, Orvis retail profits increased 45% and Orvis outfitter profits increased 20% (Epp, 2010).

Located about three hours from the NBP in Monkton, Maryland, Backwater Angler is a specialty retail shop that benefits from the angling opportunities on the NBP. Theaux Le Gardeur of Backwater Angler related the economic importance of the western Maryland fishery, which is in part defined by the NBP and Savage Rivers, to the shop. Le Gardeur said that Backwater Angler serves as a hub and destination shop for fisherman from the Baltimore, Washington, D.C., and northern Virginia metropolitan areas; the shop sees thousands of anglers annually that call the NBP their "home waters." Le Gardeur explained the shop's clientele:

> We see anglers every week on their way to western Maryland fisheries. If we have 15-20 people in the shop, easily a quarter to a third of our customers are headed out there [to the NBP and Savage Rivers].

Le Gardeur said that he witnesses anglers traveling to the NBP and Savage rivers regardless of flow and conditions because anglers want to visit that special area of Maryland. With the economic downturn, he said that he has witnessed more anglers opting for staying within the region: "We've seen a decided decrease in anglers travelling to storied destination streams in the mountain west in favor of fly fishing and exploring home waters within an easy drive."

Although the Backwater Angler shop is in Baltimore County, it stocks and sells products exclusively for the NBP and Savage Rivers: "We are selling gear specific to that river." For example, they sell fly rods of certain length and stiffness; due to slick rocks, they sell studs to put in shoes and wading staffs. "The gear they purchase is unique to the river and can include items that are used with intent to pursue larger fish in the more open waters of the Potomac." The regional angler with the NBP and Savage Rivers as a destination "allows us the opportunity to sell different types of gear," said Le Gardeur.

> *"The gear they purchase is unique to the [NBP, which] allows us the opportunity to sell different types of gear."*
>
> Theaux Le Gardeur, Backwater Angler

3.4 Food and lodging

Businesses other than outfitters also benefit from AMD remediation in the NBP watershed. Specifically in Garrett and Allegany Counties, our survey demonstrates an economic impact from the doser program of $3.0 million, which benefits restaurants, hotels, gas stations, and other local businesses.

> *Specifically in Garrett and Allegany Counties, our survey demonstrates an economic impact from the doser program of $3.0 million, which benefits restaurants, hotels, gas stations, and other local businesses.*

One challenge with quantifying benefits to other businesses is that many will not know how much of their business is generated from people using the NBP for recreation. For example, some businesses may benefit from AMD remediation and water-based recreation in the nearby Youghiogheny River watershed. Another challenge in quantifying benefits to other businesses in the area surrounding the NBP is that there are relatively few businesses in close proximity to the river. One angling survey respondent, for example, commented that "many of the economic benefits go to West Virginia with all the services of Keyser nearby." In comparison to the nearby Deep Creek Lake area, the NBP touts far fewer tourist amenities and infrastructure.

Informal interviews and focus groups with private anglers and boaters, as well as commercial angling and boating guides and outfitters, indicated an awareness of nearby businesses, as well as a willingness to support them. Water-based recreationists said they enjoy frequenting local food establishments, but recognize there are few options. The Maryland and Delaware Canoe Trail's paddling guide book, for example, encourages supporting local shops (Gertler, 2002). This sentiment is also echoed on a Web-based whitewater boating guide, American Whitewater's (AW's) National River Database (2009): "[W]e can make some friends by patronizing the little restaurant in town (and by the way, don't forget the teensy snack and bait shop in Barnum too)."

> *"[W]e can make some friends by patronizing the little restaurant in town (and by the way, don't forget the teensy snack and bait shop in Barnum too)."*
>
> Source: AW (2009).

Aware of the angling opportunities in the area, Mike Dreisbach developed the Savage River Lodge, which has contributed over $35 million to the local economy since it opened 11 years ago. Located outside of Frostburg, Maryland, the lodge won the Maryland Chamber of Commerce Small Business of the Year award in 2009 for its local economic contributions. The Savage River Lodge is dependent on the local angling opportunities such as the NBP, according to Dreisbach (2010).

The Savage River Lodge, which contributed over $35 million to the local economy in the last 11 years, is dependent on local angling opportunities such as the NBP.

The Savage River Lodge offers guided fly fishing opportunities, which focus on the Deep Creek area in the spring, transferring to the NBP in the summer months when the NBP offers the only cold water fishery in the area. Dreisbach stressed the importance of the NBP's fly fishing opportunities on his lodging and guiding businesses. Savage River Lodge, for example, is a member of Trout Unlimited's Outfitters, Guides, and Business Members Program; this endorsement highlights fly fishing opportunities on the area's rivers, such as the NBP (Dreisbach, 2010).

The Savage River lodge estimated that their fly fishing activities in 2009 were worth $89,250.

Dreisbach documents visitor use by activity, which includes hiking, biking, fly fishing, cross country skiing, snowshoeing, wine caching, geocaching, birding, hunting, and team building. Using Savage River Lodge visitor use numbers, Dreisbach (2010) estimated the economic value of each event type using $425 as the value of a visitor per day, which includes high end lodging, fine dining, and personalized guiding. Based on documented visitor use of 210 fly fishing events, Dreisbach estimated a contribution of $89,250 from fly fishing activities in 2009.

Fred Engle, owner and operator of the Candlewyck Inn, which provides food and lodging in Keyser, West Virginia, said he has witnessed more activity in the past 5-10 years:

> We've started to have a lot of fishers stay, eat, and drink. The activity…has been a good thing. [Clean water] can only be a good thing.

As an example of increased activity, he explained that a group of 20 anglers from Annapolis stay every year with him. He also mentioned how he sees whitewater boaters at his place and at the other lodging option in Keyser, the Keyser Inn, during whitewater releases. "People are spending money there," he said. He suggested a marketing campaign by the state or county to encourage people to visit and experience the clean water and beautiful mountains. Speaking to efforts to continue improved water quality, Fred Engle said:

> Anything that can be done to encourage growth and sustainability will have a positive impact on my business and the region.

Joe DeMucci of Deep Creek Vinelli, Inc. owns property along the NBP, as well as a service station and convenience store near the bridge at Kitzmiller. Although his Kitzmiller store is currently idle due to a fire over two years ago, DeMucci said that his store received "more activity than you'd expect" in that area. He said he saw an "enormous amount of anglers, hikers, and tourists."

Although he was impressed by the visitor traffic, DeMucci said: "There's no place for them to stay." He said that was also the feedback he received from his customers; when they left the area to stay elsewhere, other activities kept them from returning to the NBP. He suggested that the NBP has been "neglected…as far as pushing tourism and creating tourism amenities and infrastructure." DeMucci suggested that much could be done at the state and county levels to make the area more accessible to visitors and tourists, which in turn

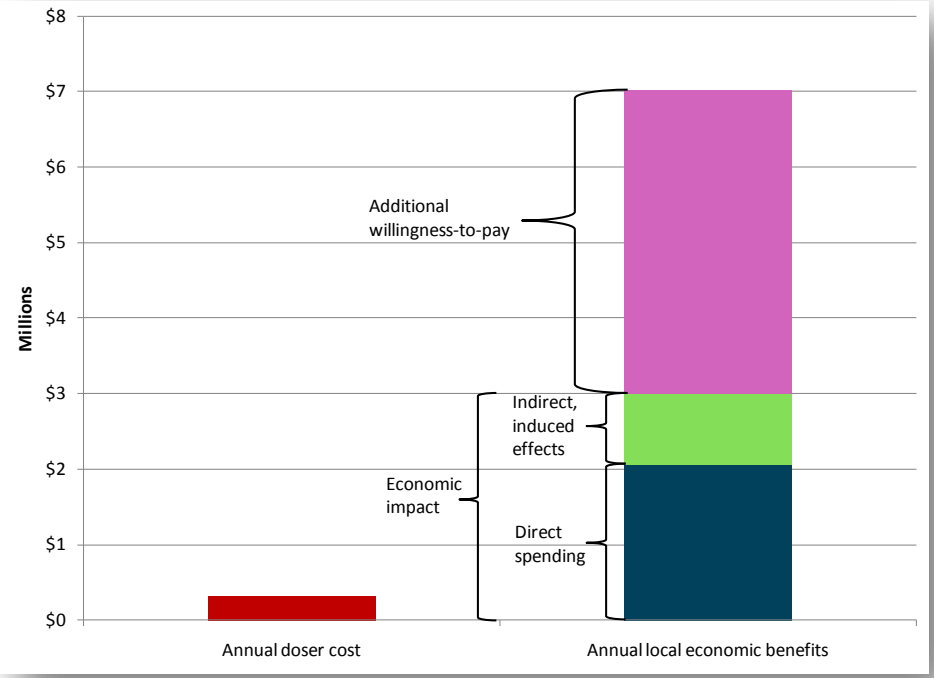
would offer economic opportunities: “People have to provide a service industry.” DeMucci offered that development can occur while still preserving the area’s solitude and beauty: “When I see the Potomac River, I appreciate the value of looking at trees, and solitude…development can occur…there’s an opportunity for growth in the tourism industry.”

Although this study primarily focuses on Garrett and Allegany Counties, there is obvious economic impact from the NBP in at least two other counties: Baltimore County, Maryland and Mineral County, West Virginia. At the Barnum site, the Mineral County Parks and Recreation Commission has rented cabins since 1999 and campsites since 2006; campsites are $10 per night, and the cabins rent for either $33.60 or $56.00 per night. Cabin and tent rental have both increased since 1999 and 2006, respectively. In 2009, for example, 1,976 visitors rented cabins at Barnum (Figure 25, below).

4. ECONOMIC BENEFITS FROM ACID MINE DRAINAGE REMEDIATION

AMD remediation can benefit local economies in several ways.[6] In this study, we focused first on the expenditures made by anglers and boaters and Garrett and Allegany Counties that support outfitters and hotels, restaurants and gas stations. We then calculated the broader economic impact of these expenditures—jobs created, salaries paid, and taxes generated—as well as the willingness of anglers and boaters to pay even more for their recreational experiences.[7] Figure 11 summarizes these benefits and compares them with the cost of operating and maintaining the dosers each year.

Figure 11: Doser costs versus local economic benefits



Note: Benefits are calculated from our survey using angler and boater spending and willingness-to-pay in Garrett and Allegany Counties.

Before describing our analysis, it is helpful to highlight some of the themes and quotes provided by survey participants related to their perceived economic benefits from recreation on the NBP (Table 6). Many anglers and boaters who responded to our survey were aware of the positive impacts of their recreational spending.

[6] While economic benefits analyses are typically performed for impaired watersheds, the NBP is different. In this case, remediation projects have been installed and water quality has already improved. This study is based on observed water quality and economic improvements, rather than improvements that are expected to happen in the future.

[7] Other potential economic benefits not quantified in this study include (1) money spent locally on remediation; (2) higher property values near cleaner streams; and (3) more options for cleaner, cheaper drinking water.

Table 6: Themes and quotes about perceived economic benefits from recreation on the North Branch

Themes	Quotes
Local economic benefits	"I spend thousands of dollars a year fishing…I am willing to pay for restoration and maintenance of these invaluable resources. If the rivers were no longer fishable, I would not visit western Maryland."
Outfitter income	"Please do everything possible to maintain the fantastic fishery that is the North Branch. It is a place of great importance to myself and my family as we rely on my guide service to provide for us."
Businesses benefits	"Clean up this river and establish a healthy fishery and I will spend thousands of dollars in your region. If you are not convinced of this, please call Spruce Creek Outfitters…and ask …what I spend a year in his shop. It is at least $2,000 a year. This does not include what I spend at other shops in the area, lodging, food, transportation and gas expenses. People who fly fish are willing to spend a lot of money to experience the right place. It will come back to you..."
Property investments	"I invested with three friends in a recreational property near the North Branch because I valued the fishing there so much. I travel there from northern Virginia (DC metro) frequently with my family and friends, bringing many people to the area to spend their leisure dollars." "I'm a businessperson and can see clearly that the local economic benefit far exceeds the $300k annual cost of the lime dosers. I own a $400k property in the area and pay taxes, solely because of the fishing on the North Branch. I spend 15-20 weekends per year in the area."
Not many businesses	"The only reason that I did not spend more money in Maryland on my most recent trip is that there were no businesses in Maryland along the path of my trip…"

We performed a survey to calculate the local economic benefits provided by anglers and boaters on the NBP. Our survey methods are described in Appendix A. In summary, we received completed surveys from 385 people: 306 anglers and 79 boaters. Our total average response rate was 29%.

The demographics of the survey respondents are also described in Appendix A. Most notably, while 95% of respondent boaters were known to live outside of Garrett and Allegany Counties, only 68% of anglers were non-local. For this reason, we divide anglers into two subgroups: local and non-local.

4.1 Recreational spending

Recreational spending was computed from a survey question that asked respondents to report their most recent recreational trip spending in Allegany and Garrett Counties while visiting the NBP. A detailed description of our calculations is included in Appendix A. In summary, respondents report a total of over $130,000 in recreational spending on their most recent trips, or just less than $400 on average (Table 7). Reflective of our sample make-up, the largest spending categories were guide and tour expenses along with accommodations.

The spending total for each respondent was then converted to "per person per day" estimates, resulting in an average expenditure of about $125 per person per day (Table 8).

The average survey respondent reported spending a total of $125 per person per day.

Table 7: Reported recreational spending in Allegany or Garrett Counties, per trip

	Transportation, gas	Guide, tour, rafting	Restaurants, fast food	Licensing, supplies, equipment	Food and beverages at grocery stores	Accommodations	Gifts, souvenirs, clothes	Total
Average	$63.99	$169.94	$79.99	$79.25	$43.70	$107.09	$26.08	**$398.48**
Median	$40.00	$3.00	$35.00	$35.00	$20.00	$38.00	$0.00	**$180.00**
Total	**$20,093**	**$29,570**	**$22,556**	**$17,752**	**$11,581**	**$24,631**	**$4,121**	**$130,304**

Note: N=327.

Table 8: Reported recreational spending in Allegany or Garrett Counties, per person per day

	Transportation, gas	Guide, tour, rafting	Restaurants, fast food	Licensing, supplies, equipment	Food and beverages at grocery stores	Accommodations	Gifts, souvenirs, clothes	Total
Average	$22.94	$32.30	$21.69	$18.34	$10.11	$17.42	$2.43	**$125.24**
Median	$15.00	$0.00	$10.00	$2.58	$6.25	$0.83	$0.00	**$65.00**
Total	**$7,501**	**$10,562**	**$7,094**	**$5,998**	**$3,307**	**$5,697**	**$795**	**$40,954**

Note: N=327.

We divided our respondents into three groups: local anglers from Allegany or Garrett Counties, non-local anglers, and boaters. Spending estimates for each of these three groups are shown in Table 9, Table 10, and Table 11. As expected, non-local anglers have the highest per person per day spending at $132. Being primarily non-local, boaters had the second highest daily spending, but 45% less than anglers. At $44 per day, local anglers spend about one-third that of non-local anglers.

Table 9: Estimated local angler recreational spending per person per day

	Transportation, gas	Guide, tour, rafting	Restaurants, fast food	Licensing, supplies, equipment	Food and beverages at grocery stores	Accommodations	Gifts, souvenirs, clothes	Total
Average	$11.94	$5.00	$6.21	$13.69	$5.49	$1.55	$0.54	**$44.43**
Median	$10.00	$0.00	$0.00	$4.17	$3.33	$0.00	$0.00	**$35.00**

Note: N=50.

Table 10: Estimated non-local angler recreational spending per person per day

	Transportation, gas	Guide, tour, rafting	Restaurants, fast food	Licensing, supplies, equipment	Food and beverages at grocery stores	Accommodations	Gifts, souvenirs, clothes	Total
Average	$19.61	$42.73	$19.57	$14.91	$10.44	$22.20	$2.55	**$132.02**
Median	$15.00	$0.00	$12.50	$8.75	$6.67	$7.50	$0.00	**$90.00**

Note: N=191.

Table 11: Estimated boater recreational spending per person per day

	Transportation, gas	Guide, tour, rafting	Restaurants, fast food	Licensing, supplies, equipment	Food and beverages at grocery stores	Accommodations	Gifts, souvenirs, clothes	Total
Average	$16.41	$12.72	$13.70	$8.78	$7.53	$13.06	$1.11	**$73.31**
Median	$13.33	$0.00	$12.00	$0.00	$5.00	$4.00	$0.00	**$48.75**

Note: N=75.

After calculating the average amount spent by the anglers and boaters surveyed, we then calculated the total spending among all people who fish and boat on the NBP. This requires annual recreation use estimates for the three populations of recreational users on the NBP. Survey data as well as external sources were utilized to estimate the number of recreational use days annually (Table 12); our strategy is described in Appendix A. We calculated total spending in Allegany and Garrett Counties by multiplying the average per person per day spending by the number of recreational user days for each of the three user populations.

Over one-half of the estimated $2.1 million in annual spending was from local anglers (Table 12). Non-local anglers were the second largest and boaters were a distant third. The estimated spending totals by category and user population are shown in Table 13.

Table 12: Recreational user days and annual spending, North Branch Potomac

Recreational user population	Annual recreational user days	Average spending per person ($/day)	Annual spending estimate
Anglers			
Local	26,200	$44.43	$1,164,073
Non-local	6,200	$132.02	$818,514
Subtotal	**32,400**		**$1,982,587**
Boaters	1,100	$73.31	$80,641
Total	**33,500**		**$2,063,228**

Table 13: Annual spending by category from recreational use on the North Branch Potomac

Spending category	Angler, local	Angler, non-local	Boater	Total
Transportation, gas	$312,930	$121,582	$18,054	**$452,565**
Guide, tour, rafting	$131,000	$264,933	$13,987	**$409,920**
Restaurants, fast food	$162,710	$121,332	$15,073	**$299,115**
Licensing, supplies, equipment	$358,750	$92,447	$9,658	**$460,855**
Food and beverages at grocery stores	$143,937	$64,744	$8,287	**$216,968**
Accommodations	$40,488	$137,657	$14,364	**$192,509**
Gifts, souvenirs, clothes	$14,259	$15,819	$1,219	**$31,296**
Total	**$1,164,073**	**$818,514**	**$80,641**	**$2,063,228**

Table 12 and Table 13 summarize the spending by anglers and boaters who recreate on the NBP. Because aquatic habitat and fishing in the NBP would be impacted greatly by discontinuance of the dosers, anglers were asked: “If the North Branch of the Potomac could no longer support fish populations and was no longer

stocked with trout due to AMD damage from doser removal, would you continue fishing in other rivers in Allegany and Garrett Counties?"

Responses to this and a follow-up question provided an opportunity to gauge the potential reduction in spending from anglers should the dosers be removed. We computed that anglers would spend about 45% less in Allegany and Garrett Counties based on a reduction in the number of fishing trips if the NBP were no longer available for trout fishing.

Anglers would spend about 45% less in Allegany and Garrett Counties if the NBP were no longer available for trout fishing.

It is important to note that these spending estimates occur each year, and may increase in future years should recreational use on the NBP increase. Using existing data, we considered recent trends in angling in Maryland and in visitor use along the NBP; these results are shown in Chapter 7. Data are insufficient to estimate changes in recreational use in the future; therefore, we do not project changes in recreational spending over time.

4.2 Economic impact

We then evaluated the broader economic impact—commonly referred to as output—of the recreational spending by NBP anglers and boaters. The economic impacts were computed by summing three effects on the economy: direct, indirect, and induced. Direct refers to increased jobs, income, and output resulting from the recreational spending itself, such as employment of river guides. Indirect refers to the jobs, income, and output that are created when goods and services are purchased locally to support the recreation. For example, food is purchased locally by outfitters. Finally, induced jobs, income, and output stem from the additional purchases made within the community with the earnings created from the direct and indirect impacts. For example, motel owners buy food at the local grocer and fill their vehicles at the local gas station.

Figure 12 illustrates these three components of economic impact, which total $3.0 million per year. The direct spending, as calculated in the previous section, totals $2.1 million, and makes up the largest portion of the total. The indirect and induced effects—$0.5 and $0.4 million, respectively—make up the remainder of the $3.0 million economic impact.

Table 14 presents these results for each user population. Employment is expressed as full-time equivalent jobs, total value added includes compensation for employees, as well as certain taxes. Total economic impact, or output, is the total additional dollar value of goods and services produced in the two-county economy.

Once again, local angler recreational spending has the largest impact of the three populations. In total, anglers' and boaters' spending contributes about 40 jobs to the local economy and provides an economic impact of about $3.0 million to the two counties. These additions may seem relatively small given an economy of $3.03 billion and 55,000 jobs in Allegany and Garrett Counties during 2008 (based on IMPLAN output for these two counties); however, it is also instructive to compare this economic output to the total annual operations and maintenance cost of the doser program, which is approximately $321,000.

Recreational spending on the NBP contributes about 40 jobs to the local economy and adds about $3 million to the economic output of Garrett and Allegany counties.

Figure 12: The components of economic impact to Garrett and Allegany Counties

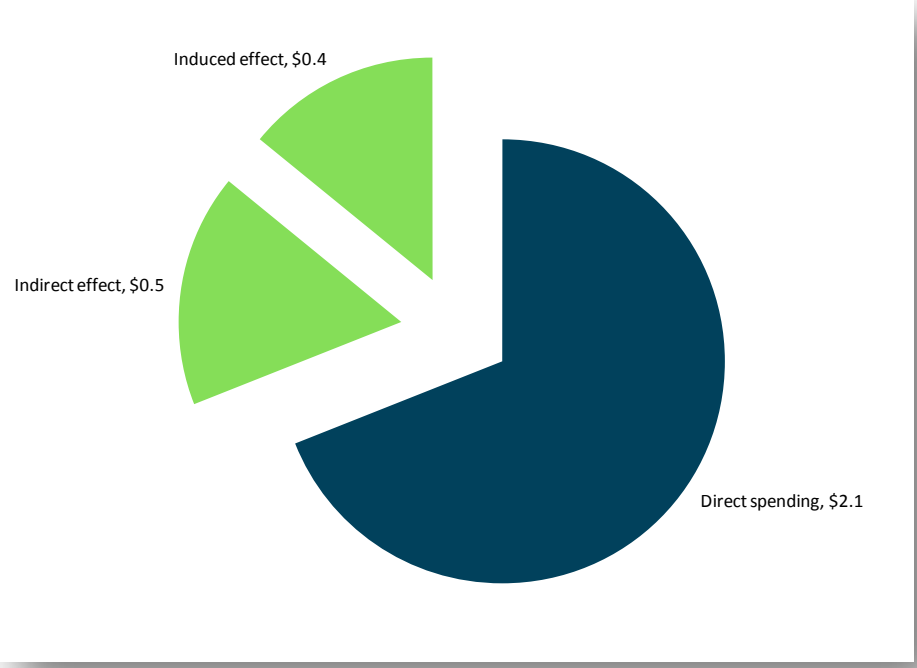


Table 14: Economic impact from recreational use on the North Branch Potomac

Recreational user population	Employment (Full-time equivalents)	Total value added	Economic impact
Angler, local	23.8	$946,000	$1,681,149
Angler, non-local	14.9	$611,222	$1,193,457
Boaters	1.5	$63,575	$117,570
Total	**40.3**	**$1,620,800**	**$2,992,177**

Note: Total value added includes compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Economic impact is reported as output by IMPLAN.

Based on our analysis, we estimate that approximately $266,000 of the $3.0 million in economic impact are additional state and local taxes. Tax dollars are mainly sales and business property taxes (about 70% of total tax revenue computed by IMPLAN), but would include other taxes or fees collected by local governments such as motor vehicle, personal property, and personal income taxes.

These economic impact estimates occur each year, and may increase in future years should recreational use on the NBP increase. As with our spending estimates, data are insufficient to project changes in recreational use and the economic impact of recreational spending over time.

4.3 Willingness-to-pay

It is common for recreational users to be willing to pay even more for their recreational experiences. In addition, it is common for recreational users—as well as the population at large—to be willing to pay to preserve the quality of a recreational resource for a wide variety of reasons, whether they use the resource

or not. We calculated both values.[8] Appendix A provides details on our survey questions and calculation methods.

We started by calculating anglers' and boaters' willingness-to-pay for their recreational use. The mean estimates of per person per day willingness-to-pay shown in Table 15—$289 for anglers and $59 for boaters—represent the average value of a recreation day on the NBP. Both estimates are on the high end of literature estimates for the value of recreation experiences. We project that the relatively unique recreational experiences offered by the NBP for the Mid-Atlantic region (cold water trout fishing late into the summer season and long stretches of undeveloped land along the river) may warrant these higher-than-average values.

In order to project these sample values onto the user population, the angler population was again divided into local and non-local. As shown in Table 16, for the estimated 33,500 user days on the NBP, we calculate a willingness-to-pay of $4.1 million.

Table 15: Per-user willingness-to-pay for recreation on the North Branch Potomac

Recreational user population	Mean	Median
Anglers		
Per Trip	$637	$103
Per Day	$289	$47
Boaters		
Per Trip	$118	$57
Per Day	$59	$29

Table 16: Total willingness-to-pay for recreation on the North Branch Potomac

Recreational user population	Mean willingness-to-pay per user day	Annual recreational user days	Willingness-to-pay for recreation
Anglers			
Local	$383 (sample) $59 (literature)	26,200	$2,394,680
Non-local	$263	6,200	$1,630,600
Subtotal		**32,400**	**$4,025,280**
Boaters	$59	1,100	$64,900
Total		**33,500**	**$4,090,180**

Note: For local anglers, the $383 mean value was used for 10% of the local angler population, and the $59 literature value was used for the remaining 90%.

Finally, anglers and boaters were asked to express their willingness-to-pay to preserve the NBP in its current state by financially supporting the continued operation of dosers. Again, details on our questions and calculations are provided in Appendix A. We calculate an aggregate one-time preservation value of $332,000. This value underestimates the economic value that society derives from preserving the NBP in its current state: If the broader population of non-users had been surveyed in this study throughout Maryland and the Mid-Atlantic region, this value would have been higher. Still, this value provides a lower-bound on the value that people place on preserving a clean NBP.

[8] While the spending and economic impacts described in the previous section are focused solely on Garrett and Allegany Counties, the willingness-to-pay values are spread throughout the entire region.

5. IMPROVED WATER QUALITY AND AQUATIC LIFE

Economic benefits from recreational spending such as employment, wages, and taxes are important and are the focus of this study; however, AMD treatment provides benefits that may or may not be accounted for in our economic calculations.

For example, improved water quality and the return of healthy fish populations to once-dead portions of the NBP provide improved ecosystems and fishing opportunities, leading to increases in overall quality of life. The value people place on preserving water quality is somewhat captured by our willingness-to-pay calculation described above, but our estimate only includes river users as opposed to the entire population. In this chapter and those that follow, we consider several benefits that are not effectively captured in our economic analysis, including improved water quality, better fish and benthic macroinvertebrate populations, new investments in improved fisheries management and recreational access, increased recreational use, and cleaner source water for water withdrawals.

5.1 Water quality

High acidity, often measured as low pH, can be harmful to fish and other organisms that live in rivers. High concentrations of dissolved metals are also detrimental to aquatic life. As AMD mixes with cleaner water, pH rises and metals precipitate out of solution. These metals coat stream beds, which harms habitat and leaves streams aesthetically unpleasing.

Coal mining has been ongoing in the NBP watershed since the 1700s (MDE, 2008), and AMD has been affecting the streams at least since the 1890s (Morgan, 2000). By the 1940s, an estimated 173,000 pounds of acidity entered the Potomac River system from AMLs each year; through the 1960s, the problem worsened—to 120,000 pounds *daily* (FWPCA, 1968; ICPRB, 1990). In 1967, pH was consistently below 4.5, sometimes dipping as low as 2.5 (FWPCA, 1968). A 1969 report noted that the lowest pH on the mainstem was 2.3 at Steyer, with 3.3 being the highest value for the study period—well below the current water quality standard (Clark, 1969).[9] Even as recently as the 1970s, AMLs discharged a significant amount of AMD to the NBP and impaired an estimated 450 stream miles (CTL and MDE, 2008).

At Bloomington in 1976, pH on the NBP was reported at 4.5 (ICPRB, 1977). Installation and improvement of wastewater treatment plants reduced bacteria loads, and the completion of the Bloomington Dam in 1981—now known as Jennings Randolph Lake—also served to improve water quality (ICPRB, 1990; MDNR, 1987; Mills, 1996). Inflow waters stratify due to differences in temperature; outlets at different levels allow for some control over the quality of water released from the dam (Sheer and Harris, 1982). Improved water quality enabled the establishment of a recreational fishery downstream of the dam; water quality, however, was inconsistent.

The Interstate Commission on the Potomac River Basin (ICPRB) and other agencies have recognized the river's potential for recreation since the 1950s, and the impacts of poor water quality on recreational use have been duly noted (ICPRB, 1990; MDNR, 1987; Mills, 1996). In the late 1980s, the federal Office of Surface Mining Reclamation and Enforcement joined with West Virginia and Maryland agencies to commission a study. Ultimately published in 1994, this seminal study of NBP water quality in 1988 and 1989 revealed that AMD pollution was not evenly distributed through the watershed. In order to better understand the problem, the study measured water quality at low, normal, and high flows and used a computer model to pinpoint the best locations for dosers. These techniques found that only four to six subwatersheds and one to two direct discharges to the NBP produced over 90% of the acid load in the upper NBP watershed at both high and low flow conditions (MMEC, 1994). Iron, aluminum, manganese, and sulfates were found to have similarly small,

[9] Maryland's water quality standard for pH requires surface waters to be between 6.5 and 8.5.

though not identical, sets of originating subwatersheds. According to a different study, "Fifty-two individual sites in the watershed yield AMD, with approximately ninety percent of the acid loading coming from thirteen sites in four North Branch subwatersheds and two major AMD discharges directly into the North Branch" (Morgan, 2000, p 5).

Figure 13: Laurel Run, an acid mine drainage-impacted tributary of the North Branch Potomac River

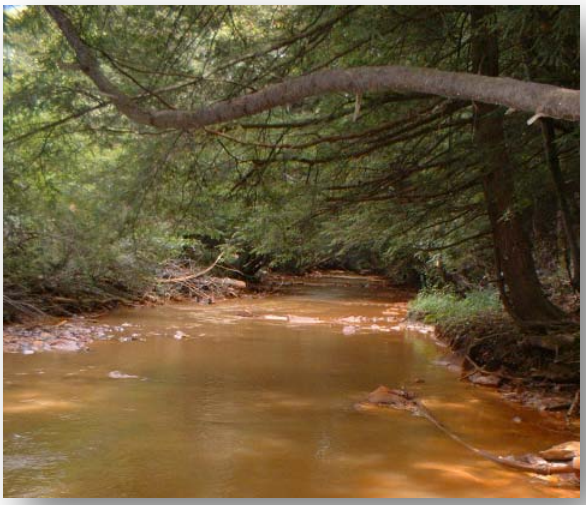


Photo: Evan Hansen.

Since the dosers have been installed, all ten monitoring locations on the NBP demonstrate compliance with Maryland's water quality standards.

Based on recommendations of the MMEC study, the State of Maryland devised a plan to remediate the watershed through the use of strategically placed dosers (Mills, 1996) (see Section 2.3). Water quality, aquatic life, and habitat data were collected at 16 stations prior to and following doser installation to understand the effects of the treatment systems (Morgan, 2000). Water quality data show that improvements in pH met or exceeded predicted targets at all stations affected by dosers, with control stations—those upstream of treatment facilities—showing steady or decreasing pH (Morgan, 2000). These improvements surpassed expectations modeled as part of the doser planning process. Since the dosers have been installed, all ten monitoring locations on the NBP demonstrate compliance with Maryland's water quality standards.

Figure 14 illustrates changes in pH from the 1960s through the 2000s at five monitoring locations downstream of doser installations. As shown, pH has noticeably improved since the 1960s. In four of five locations for which comparable data are available, pH values that were very acidic in the 1960s now meet state standards.

In the event that the dosers stop operating, this recent compliance with current state regulations would likely be reversed, as the NBP would return to its pre-doser condition.

While pH at many streams improved following doser installation, the 1996 Maryland Biological Stream Survey (MBSS) showed 14% of stream miles within the NBP watershed still chronically acidified, with another 50% susceptible to acidification during and after large storms (MDNR, 2000). In 2010, a follow-up MBSS report is expected to be published based on data collected in 2007-2009; this report will further refine agencies' understanding of the benefits of the doser program (MDNR, 2010e).

While AMD was the most important water quality issue in the NBP for decades, other problems existed. For example, pollution from New Page's[10] pulp and paper mill in Luke—as well as the towns of Luke and Westernport, Maryland and Piedmont, West Virginia—caused visible pollution in the NBP before a wastewater treatment plant was built. Treatment of the industrial discharge has since dramatically decreased pollution (Klotz, 2010a). In 1991, for example, the paper mill added a secondary clarifier to settle out solids as part of a permit renewal; this third clarifier reduced suspended solids by 20-25% (Pavol, 2010).

Water quality improvements made through AMD remediation have increased the political pressure on the Maryland Department of the Environment (MDE) to impose stricter discharge limitations via its NPDES program (Gertler, 2010). The Upper Potomac River Commission's (UPRC's) Westernport Wastewater Treatment Facility has discharged cleaner effluent from the treatment plant in the past 20-30 years: "I don't think our permits were as stringent in the past," said Superintendant Scott Shoemaker (2010). "If the pH in the receiving stream is four, you can't expect a permit to be stricter."

Improved water quality has also increased flexibility in the timing of industrial discharges. For example, because pH is one parameter used by New Page to gauge discharge timing, the more neutral and uniform water quality that now exists offers fewer constraints (Wendell, 2010).

5.2 Fish

In pre-human times, brook trout, which are native to Maryland, were plentiful in the state. Now among the most sought-after sport fish, brook trout populations in Maryland have changed with human development:

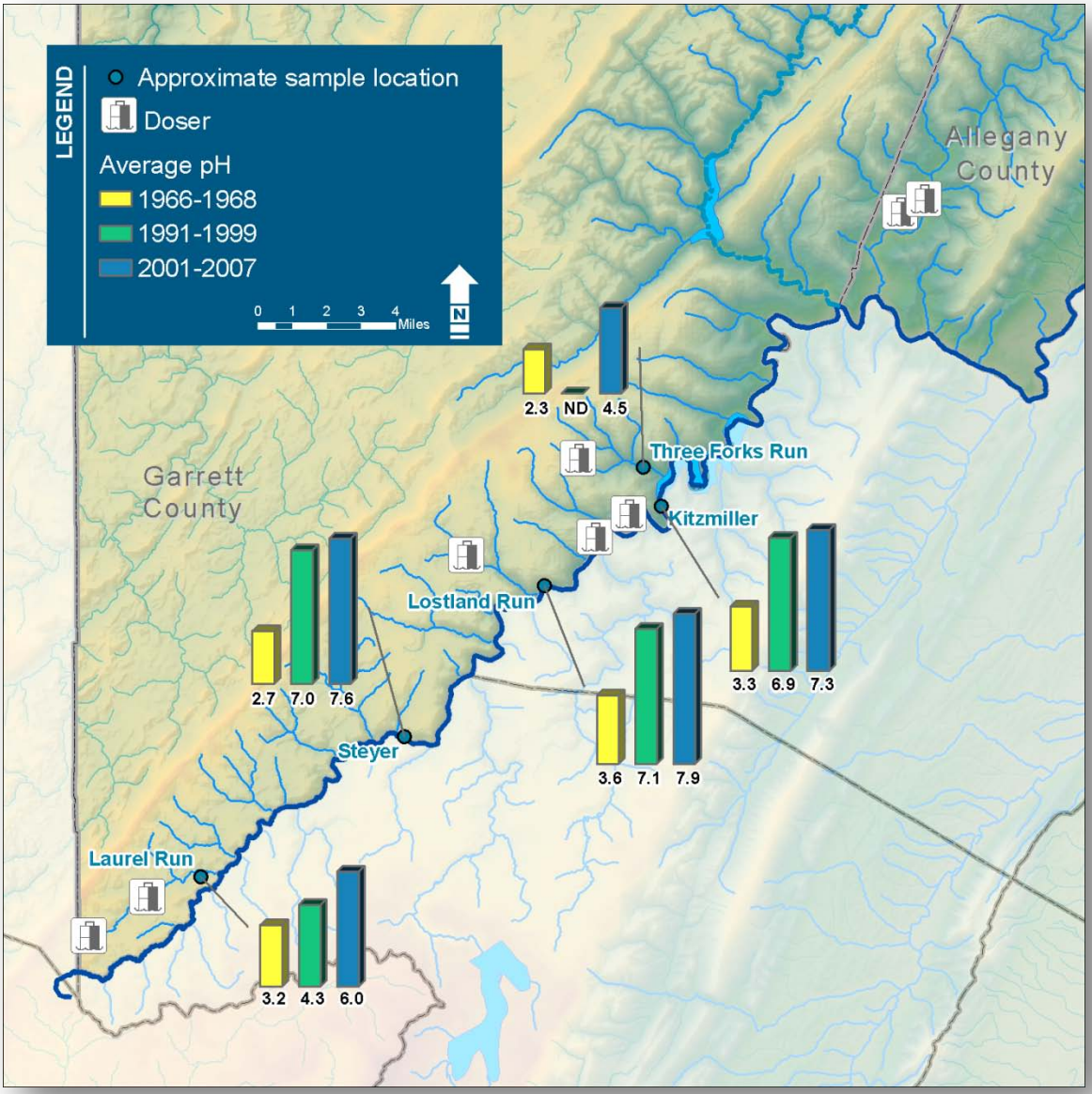
> Anthropogenic alterations to Maryland's environment…have resulted in the extirpation of brook trout from 62% of their historic habitat in Maryland. Of the remaining 151 streams where brook trout populations are found, over half are in westernmost Garrett County, the least developed area of Maryland. The vast majority (82%) of the remaining populations are classified as "greatly reduced," meaning that within the subwatersheds where they occur they occupy only 1% to 10% of the area that was historically inhabited (MDNR, 2006, p 7).

Brook trout were not the only aquatic life impacted by human development and coal mining. By the late 1960s, studies found that "over 45 miles of the North Branch and over 100 miles of tributaries harbor[ed] virtually no aquatic fauna" (FWPCA, 1968, p 9). A decade later, a similar pronouncement was made—a near complete absence of "natural biological communities" on the mainstem down to Kitzmiller, and severely impaired communities down to Oldtown (ICPRB, 1977). The problem was restated in a 1985 report (ICPRB, 1985). While AMD was a problem for aquatic communities for several decades, some tributaries that were less impacted by coal mining, including the Savage River, continued to support naturally reproducing fisheries (Sheer and Harris, 1982).

Currently, trout are stocked annually in the NBP watershed at several locations along the NBP and Savage Rivers throughout the season (Heresniak, 2009; MDNR, 2010c). In addition to trout, other types of fish such as largemouth and smallmouth bass have been stocked; some populations are naturally reproducing with the improving water quality. Run by MDNR, Albert Powell Fish Hatchery in Hagerstown, Maryland raises the majority of the rainbow and golden trout for Maryland's freshwater trout fishery (MDNR, 2010a). The MDNR trout stocking program is funded entirely though the sale of freshwater fishing licenses, trout stamps, and anglers' and boaters' tax dollars (MDNR, 2010d).[11] The MDNR Fisheries Service stocks remote areas of the NBP on rail through a cooperative agreement with CSX.

[10] The New Page plant was formerly owned by Westvaco.
[11] These funds come through the Federal Sportfish Restoration Program.

Figure 14: Improvements in water quality since the 1960s



Source: FWPCA (1968), MDE (2010b), Morgan (2000). Note: ND=No data. pH is a measure of the acidity or basicity of water. Values less than 7 are acidic, and values greater than 7 are basic. Maryland's surface water quality standards require pH to be between 6.5 and 8.5.

Following water quality improvements after the installation of the first dosers in the 1990s, MDNR began stocking trout and bass in the upper NBP (Mills, 1996; Morgan et al., 1998): "Smallmouth bass reproduction was first documented in the upper NBP in 1994 and again in 1995 in the Kitzmiller area of the river," but were thought to be inhibited from upstream migration by AMD entering the mainstem through West Virginia's Abrams Creek (Klotz and Pavol, 2000, p 2). In 1993, MDNR reintroduced smallmouth bass between Luke and Cumberland, but stopped in 1997 when the bass were naturally reproducing (Pavol, 2010). In 2000, MDNR began stocking trout fingerlings on the NBP between Westernport and Pinto (Pavol, 2010).

Measures of fish community health have been studied. As shown in Figure 15, most stations experienced an improved fish index of biotic integrity following doser installation, with the most dramatic improvements measured at Wilson, Bayard, and Schell (Morgan, 2000).

Most stations experienced an improved fish index of biotic integrity following doser installation, with the most dramatic improvements measured at Wilson, Bayard, and Schell.

MBSS data from 1996, however, revealed that the NBP Basin as a whole had 29% of stream miles rating "very poor" (MDNR, 2000). Additionally, embeddedness and "condition and connectivity of refugia" are still problems, inhibiting recovery of benthic macroinvertebrates and thus also of fish in the tributaries (Morgan, 2000; Morgan et al., 1998). While trout are stocked in portions of the watershed, and naturally reproducing populations of brook and brown trout occur in the Savage River, NBP, and some tributaries, surveys still suggest that fish have not returned to several of the tributaries within the watershed, primarily due to agricultural and AMD pollution (MDNR, 2005 and 2006).

The overall improvements in water quality that help sustain fish populations have helped make the NBP a popular fishing destination. The river hosts a rising number of visitors (Figure 23), and at least 13 commercial angling and whitewater boating outfitting businesses. The eight current angling outfitters began their operations between 1994 and 2006 (Table 4), due to water quality improvements and the presence of bass and trout in the NBP.

Tributaries to the NBP are also popular fishing destinations. The Savage River currently hosts many brown trout, as well as brook trout and a smattering of rainbows. Overall trout density in the Savage River tailwaters is as high as 1,258 adult trout per mile in places. While there is some concern over invasive algae, overall aquatic health is good (MDNR, 2010a).

Due to its relatively rugged and rural setting, the NBP and its tributaries have a high potential to host reproducing brook trout populations in the long term, contingent upon continuing AMD remediation efforts (MDNR, 2006).

5.3 Benthic macroinvertebrates

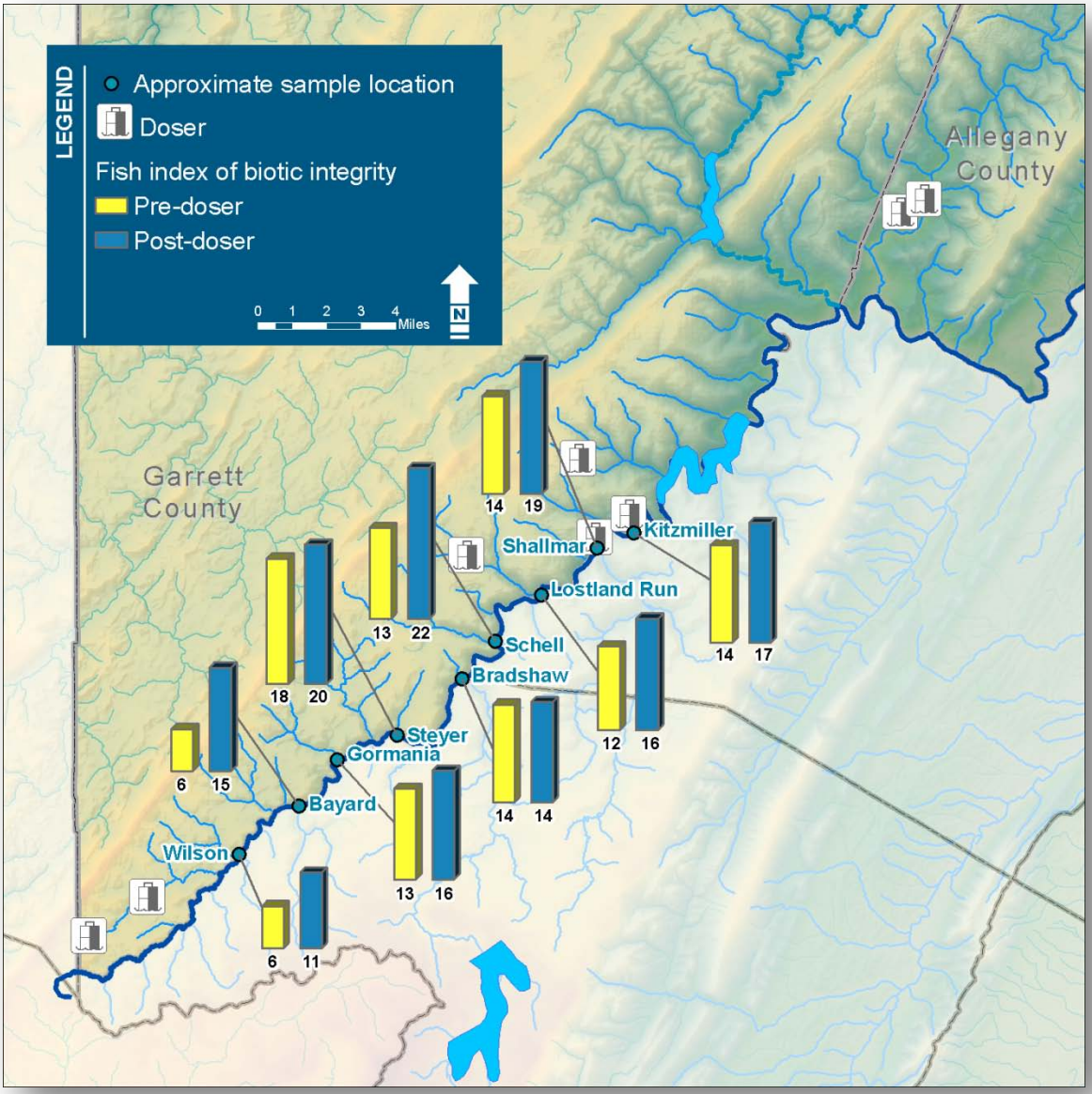
Benthic macroinvertebrates are another indicator of stream health. Benthic macroinvertebrates are animals without backbones that live on the bottom of streams during all or part of their life cycle and that are large enough to see with the naked eye. These organisms—mayflies, stoneflies, and many others—are important parts of ecosystems and are also good proxies for measuring the general biologic health of streams. Low benthic scores indicate low species diversity and a high percentage of tolerant species.

Benthic scores have been measured at several locations in the NBP watershed since the mid-1970s, providing a look at trends over time. Throughout the 1970s, and, in some cases into the early 1990s, the benthic monitoring stations on the mainstem often had fewer than 50 total organisms—many fewer than the 100 organisms needed to calculate a reliable diversity index (Friedman, 2009).

While conditions still do not support full recovery of benthic macroinvertebrates, their health has improved throughout the watershed. Notably, as of the latest report, all stations in the upper NBP display an improving trend. While the station on Georges Creek still displays erratic numbers, all of the mainstem stations have had at least 100 total organisms since at least 2000, allowing for the calculation of a diversity index (Friedman, 2009).

Notably, as of the latest report, all stations in the upper NBP display an improving trend.

Figure 15: Pre- and post-doser fish index of biotic integrity



Source: Morgan (2000). Note: Data are from 1991-1999. Only stations on the mainstem that are downstream of installed dosers are shown. The index of biotic integrity measures changes in the composition of biological communities, and is a useful tool for confirming the recovery of impaired waters.

6. IMPROVED FISHERIES MANAGEMENT AND RECREATIONAL ACCESS

The NBP is now a very popular destination for anglers and boaters, due in large part to the remediation of AMD by the dosers. To complement the improvements in water quality and make the NBP a more desirable recreational destination, the State of Maryland has actively invested in and managed the NBP fisheries through the designation of Special Fisheries Management Areas (SFMAs), stocking of trout, and development of access points.

6.1 Fisheries management

SFMAs are waters regulated by particular fishing regulations to help address the MDNR Fisheries Service's dual missions of protecting aquatic ecosystems and providing fishing opportunities. Table 17 outlines Maryland's SFMA relevant to the NBP and its tributaries. Figure 4, above, maps these areas together with other key watershed features.

The NBP contains a total of over 50 miles of managed trout waters with varying degrees of restrictions. This includes 29 miles in the upper NBP (Klotz, 2010a). A catch-and-return bass area, for example, has been established on the NBP between Keyser and Cumberland. This area hosts a reproducing smallmouth bass population, with a smaller population of largemouth bass (MDNR, 2010a).

Special Fisheries Management Areas on the NBP are fished by many local and visiting anglers. Cool summer temperatures allowed anglers to catch rainbow trout throughout the 2009 season in the delayed harvest area alongside the Potomac State Forest (MDNR, 2010a). Farther downstream, trophy-sized rainbow and brown trout have been caught in the catch-and-return area below Jennings Randolph Lake (MDNR, 2010a). Trophy rainbow and brown trout are also found in the zero creel limit stretch between Westernport and Pinto. Fingerlings—70,000 rainbow and 11,500 brown—were stocked in this area in 2009 (MDNR, 2010a).

Table 17: Special Fisheries Management Areas

Fishing area	Provisions	Prohibitions	Creel limit	Season
Catch-and-return trout	Artificial lures and flies only; Catch-and-release only	No possession of trout; No use of possession of natural bait, live bait, or scent enhanced device	0	Jan 1 - Dec 31
Catch-and-return bass	Catch-and-release large or smallmouth bass	No possession of large or smallmouth bass	0 (large or smallmouth)	Open
Put-and-take trout	Limited to 5:30 AM-10:00 PM or where more restrictions are posted	n/a	5	Open
Trophy trout – artificial lures	Artificial lures & flies only; Single hook with hook point only	No treble hooks; No use of possession of natural bait, live bait, or scent-enhanced device	2	Open
Trophy trout – artificial flies	Artificial flies & streamers only; Conventional fly fishing tackle only	No use of spinning, spin cast, casting reels; No use of possession of natural bait, live bait, or scent-enhanced device	2	Open
Delayed harvest trout - group II (harvest season)	n/a	No tackle restrictions	5	Jun 16 - Sept 30
Delayed harvest trout - group II (catch & release season)	Catch & release all trout species; Artificial flies & lures only	No possession of trout; No use of possession of natural bait, live bait, or scent-enhanced device	0	Oct 1 - Jun 15
Zero creel limit - all trout species	Catch & release all trout species	No tackle restrictions No possession of trout	0	Open
Zero Creel Limit - brook trout	Catch & release brook trout only	No use of possession of natural bait, live bait, or scent enhanced device	0 (brook trout) 2 (all other species)	Open
Youth & blind trout fishing area	Limited to persons: < 16 yrs old and blind 5:30 AM -10:00 PM	n/a	5	Open
Under 16 yrs, 65 yrs+, and blind trout fishing area	Limited to persons: < 16 yrs old and blind 5:30 AM -10:00 PM	n/a	5	Open

Source: MDNR (2009). Note: Tributaries in this table include Savage River, Georges Creek, and Laurel Run. Aggregate creel limits include all trout species unless specified. The only size minimums are found in trophy trout areas: 12 inches for brook trout and 18 inches for brown trout. Creel limits are aggregate, per day and per possession.

Figure 16: Examples of the Special Fisheries Management Areas and public access signage

Photos: Evan Hansen.

Figure 17: Sign across river that indicates a Special Fisheries Management Area

Photo: Sera Zegre.

As water quality improved and angler interest increased, MDNR has made significant investments in the NBP fisheries. In 2009, for example, MDNR invested a total of over $90,000 in management activities such as stocking fish and improving access (Table 18).

Table 18: Estimate of North Branch Potomac fisheries investments in 2009

Investment type	Value
Fingerling trout (71,664)	$16,482
Adult trout (20,375)	$45,844
Fish population surveys and reports	$10,000
Property maintenance salaries	$6,000
Maintenance supplies	$2,000
Grants for improvement at two launch sites	$10,000
Total	**$90,326**

Source: Klotz (2010b). Note: The cost to purchase trout is an estimate because some were donated.

6.2 Public land investments and recreational access

Private and commercial rafting, kayaking, and canoeing—as well as fishing—can be organized around established river access points. Established areas with amenities such as boat ramps and parking areas create opportunities for the visiting public and consolidate visitor use and impact. Boating and angling, however, can also occur at and around undeveloped access points. Table 19 provides an overview of the whitewater boating opportunities and access points—also used by anglers—to the NBP and its tributaries. These whitewater boating opportunities are recognized by local and regional guidebooks, as well as AW, a national membership organization of whitewater enthusiasts and river conservationists that manages the most comprehensive database of boatable whitewater river and creek sections in the US (AW, 2009). Figure 18 provides examples of existing access points along the NBP. These access points are also mapped above in Figure 4.

The dosers have played an important role in improving water quality in the NBP, and land use patterns play very important roles in terms protecting the investment in dosers and maintaining high water quality. Existing federal, state, and county lands protect riparian areas from development and provide river access. Public lands outside of the riparian areas also protect users' viewsheds and recreational experiences. New public properties provide improved access for river users, and also help to protect riparian areas from development.

One documented development pattern has been the acquisition of riverside properties by MDNR, which are now included in MDNR's North Branch Potomac Fisheries Management Areas (FMAs); these properties are shown in Figure 19 and listed in Table 20. These earliest acquisition occurred in 1995, after the first dosers were installed. These acquisitions represent significant investments by MDNR to provide access to and protect water quality in the NBP.

Figure 18: River access points in Maryland along the North Branch Potomac River

Barnum

Bloomington

McCoole FMA

Gary A. Yoder FMA

Allegany County Fairgrounds

Photos: Allegany County Fairgrounds, McCoole: Alan Klotz. Barnum: Evan Hansen. , Gary A Yoder FMA and Bloomington: Sera Zegre.

Table 19: Whitewater boating sections on the North Branch Potomac River and its tributaries

Section	Difficulty	Miles	Flow range
Mainstem (upstream to downstream)			
Henry to Gormania	I-III	8	5-7 feet
Gormania to Kitzmiller	III-IV	15	4-7 feet
Kitzmiller to Jennings Randolph Lake	II-III	3	3.5-6.5 feet
Barnum to Bloomington (or Piedmont and Westernport)	II-III	6.5 (2)	400-2,500 cfs
Bloomington to McCoole FMA	I-II	6.5	400-2,400 cfs
McCoole FMA to Gary A. Yoder FMA	I	6	400-2,400 cfs
Gary A. Yoder FMA to Allegany County Fairgrounds	I	14.4	400-2,400 cfs
Tributaries			
Savage River: Avilton Lonaconing Road to Head of Savage Reservoir	II(V)	12.5	300-2,000 cfs
Savage River: Dam to NBP	III-IV	4.5	250-2,000 cfs
Stony River**:** Route 50 to NBP Kitzmiller Section	III-IV	6.7	450-1,000 cfs
Abrams Creek**:** US 50 Bridge to NBP	II-IV	8.7	400-2,000 cfs
Difficult Creek**:** to NBP near Potomac State Forest	IV-V	4.4	n/a

Source: AW (2009) with modifications based on MDNR et al. (2005). Note: Alternative access point near Bloomington wastewater treatment plant is noted in parenthesis. cfs = cubic feet per second.

Table 20: Properties acquired as part of North Branch Potomac Fisheries Management Areas

Site	Acres	Previous owner	Acquisition year	Purchase price
Folly Run: South Track FMA	125	Conservation Fund	1995	$472,675
Laurel Run: North Track FMA	147	Conservation Fund	1995	Included with Folly
McCoole FMA	16	The Potomac Conservancy	2005	$33,800
Gary A Yoder FMA	1.2	Private	2001	$16,200

Note: FMA = Fisheries Management Area. The purchase price for Folly Run also includes Laurel Run and an additional 342 acres on the Savage River. The Gary A Yoder site was previous called Black Oak.

At least two additional areas may be acquired and placed in public ownership in the future: a six-acre arrowhead-shaped parcel that is an in-holding near Folly Run and a 100-200 acre parcel upstream of Jennings Randolph Lake, adjacent to Potomac State Forest.

To analyze riverside land use changes over time, we divided the river into five sections. We grouped sections with concentrations of public land that would not be subject to development change over time; we also grouped the sections by descriptive qualities. As shown in Figure 19, the sections, from upstream to downstream, include:

1. Kempton to Potomac State Forest,
2. Potomac State Forest (through Jennings Randolph Lake) to North Branch FMA,
3. North Branch FMA to Keyser,
4. Keyser to Pinto, and
5. Pinto to the Cumberland Dam.

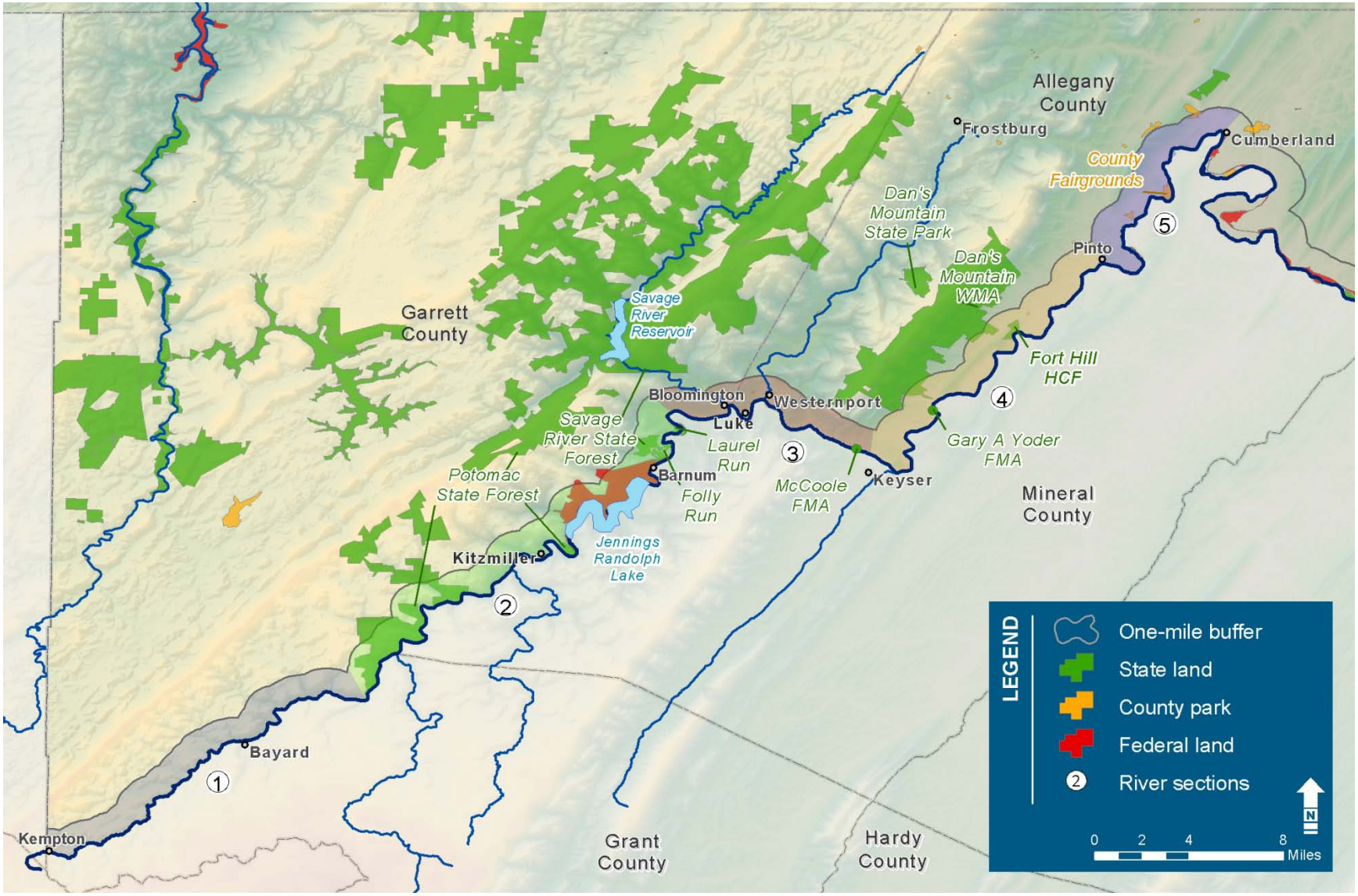
A significant number of public lands are located across Garrett and Allegany Counties. State lands include state forests, a state park, and a wildlife management area; county parks and federal lands are also present. Most of these public lands, however, are not within one-half mile of the NBP. Within this one-half mile buffer, the percentage of each section in public land varies considerably. For Section 2, almost two-thirds of this buffer is in public land (Table 21). The other sections have significantly less public land: from 0-5%.

Table 21: Public land in Maryland within one-half mile of the North Branch Potomac

	Acreage				Percent
Section	Federal	State	County	Total	public
1. Kempton to Potomac State Forest	0	0	0	4,507	0%
2. Potomac State Forest to North Branch FMA	1,893	2,229	0	6,375	65%
3. North Branch FMA to Keyser	0	8	6	2,835	1%
4. Keyser to Pinto	0	142	0	4,475	3%
5. Pinto to the Cumberland Dam	0	0	163	3,099	5%

Note: FMA = Fisheries Management Area.

Figure 19: Public land holdings and river sections



6.3 Private land investments

Private lands along the river corridor are also important for protecting wild areas and for enhancing river users' experiences. In fact, some recreation enthusiasts have purchased property near the river based on both private and commercial recreational interests.

An angling survey respondent invested in the area based on recreational opportunities:

> I invested with three friends in a recreational property near the North Branch because I valued the fishing there so much. I travel there from northern Virginia (D.C. metro) frequently with my family and friends, bringing many people to the area to spend their leisure dollars. We need to do anything possible to preserve and enhance the value of this fishery.

Another angling survey respondent spoke to the value of the lime dosers in general, and offered a personal example of his tax contributions to the area from his property there:

> I'm a businessperson and can see clearly that the local economic investment far exceeds the $300k annual cost of the lime dosers. I own a $400k property in the area and pay taxes, solely because of the fishing on the North Branch. I spend 15-20 weekends per year in the area.

One whitewater boating outfitter said that he owns riverside property near Bloomington that he purchased in 1983; he also said that his neighbors included a few other commercial whitewater outfitters.

One example of how water-based recreation resources can add to land values comes from nearby Deep Creek Lake. Although not located in the NBP watershed, vacation rental homes in the Deep Creek Lake area rent for more if they provide lakefront access. The increase in rental rates—an average of $169 per day in 2008—was twice the increase for rental homes with access to ski slopes (Nelson, 2010).

6.4 Management of Jennings Randolph Lake for recreation

USACE manages Jennings Randolph Lake, as well as the river flow and temperature downstream from the dam, for various angling and boating recreation opportunities.

In 1992, when the doser program began, USACE started offering whitewater releases from the lake by an Act of Congress to provide whitewater recreation on a seven-mile section of pool-drop whitewater with Class I, II, and III rapids on the NBP. The boat launch is located at the Barnum Whitewater Area, a 45-acre area owned by USACE and leased by the Mineral County Parks and Recreation Commission in West Virginia. Amenities at the launch site include parking and restroom facilities, as well as eight primitive cabins with electrical service available for rent. The Mineral County Parks and Recreation Commission charges a $2 per person fee for access to Barnum on release dates (Donnellan, 2010).

The North Branch Advisory Group, founded under ICPRB, was created in 1997 to bring different user groups of the river together to help optimize the management of the releases for recreation, as well as for water quality and supply. Because higher than usual flows create more optimum whitewater conditions, regularly scheduled releases—contingent upon water availability—allow for more predictable recreation opportunities on the Barnum section of the NBP. There are four scheduled releases of between 850 and 1,500 cubic feet per second (cfs) for whitewater boating in April and May; whitewater releases last six hours, between 10:00 AM and 4:00 PM. The whitewater releases alternate with releases for anglers during these months. Additionally, Memorial Day weekend releases alternate annually to allow for more equitable opportunities

among boaters and anglers. Alternate weekends accommodate the low flows necessary to optimize angling opportunities (Donnellan, 2010). According the angling outfitters, optimum flow for commercial float fishing opportunities is about 400 cfs.

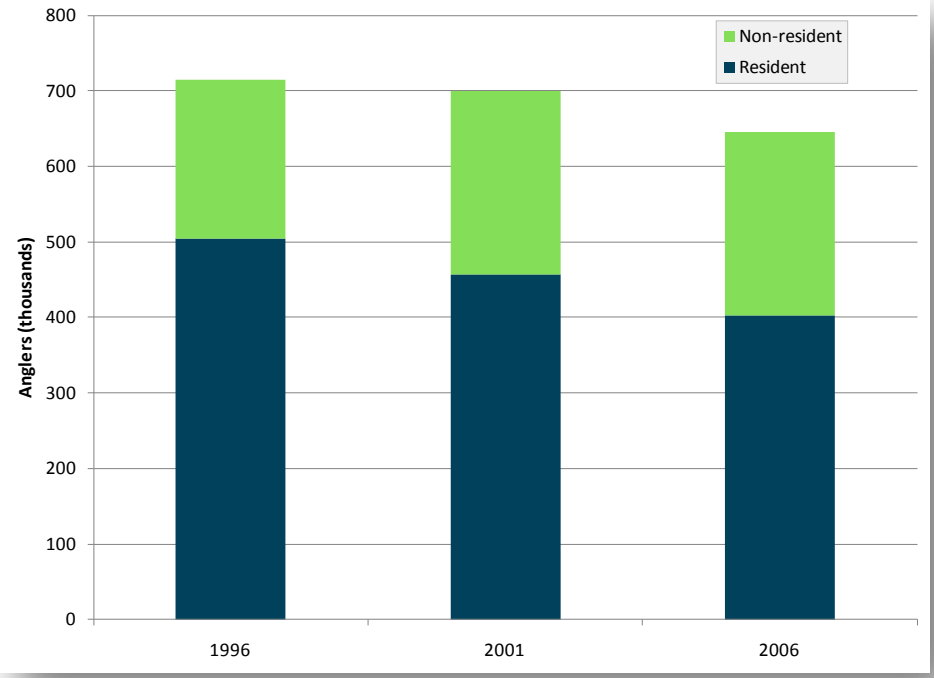
In addition to the scheduled spring whitewater releases, USACE also provides artificially varied flow releases from Jennings Randolph Lake that are also suitable and advertised for whitewater recreation. Usually, one or two of these releases occur in August through October annually.

7. INCREASED RECREATIONAL USE

7.1 Fishing in Maryland

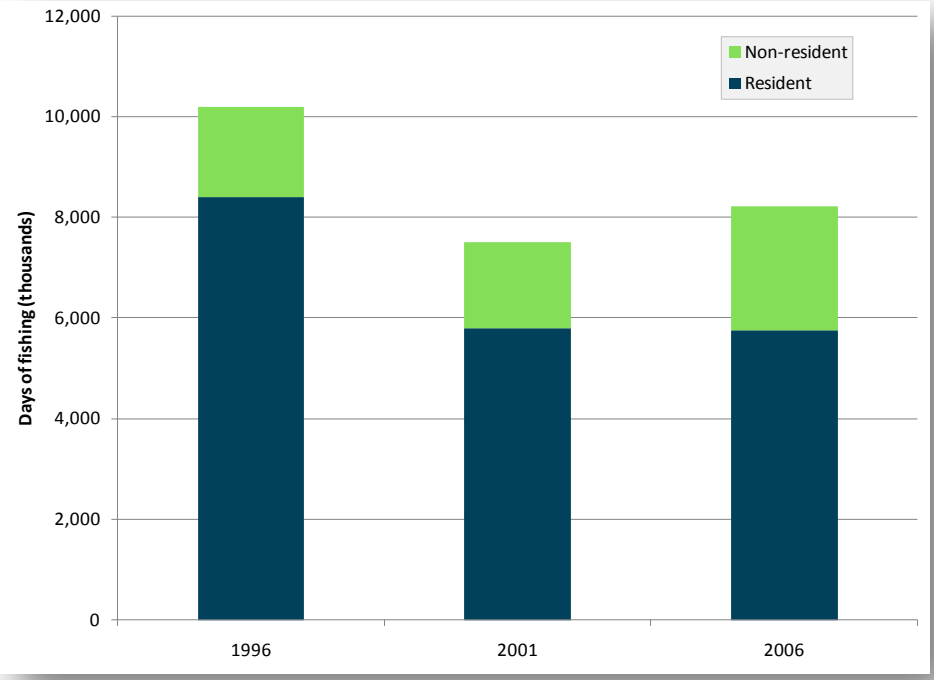
The US Fish and Wildlife Service conducted surveys of wildlife-associated recreation in Maryland in 1996, 2001, and 2006 that demonstrate state trends. The 2006 report found no significant changes in total anglers or days fishing between 1996 and 2006 data. The number of resident anglers, however, declined by 17% between 1996 and 2006 (Figure 20); this percent change was significant at a 90% confidence interval (USFWS, 2008). Although both total anglers and total days of fishing in Maryland have declined from 1996 to 2006, more anglers from out of state are coming to Maryland to fish more often. Non-resident anglers and non-resident days fishing in Maryland both show an upward trend (Figure 20, Figure 21).

Figure 20: Anglers in Maryland, 1996-2006



Source: USFWS (1998; 2003; 2008).

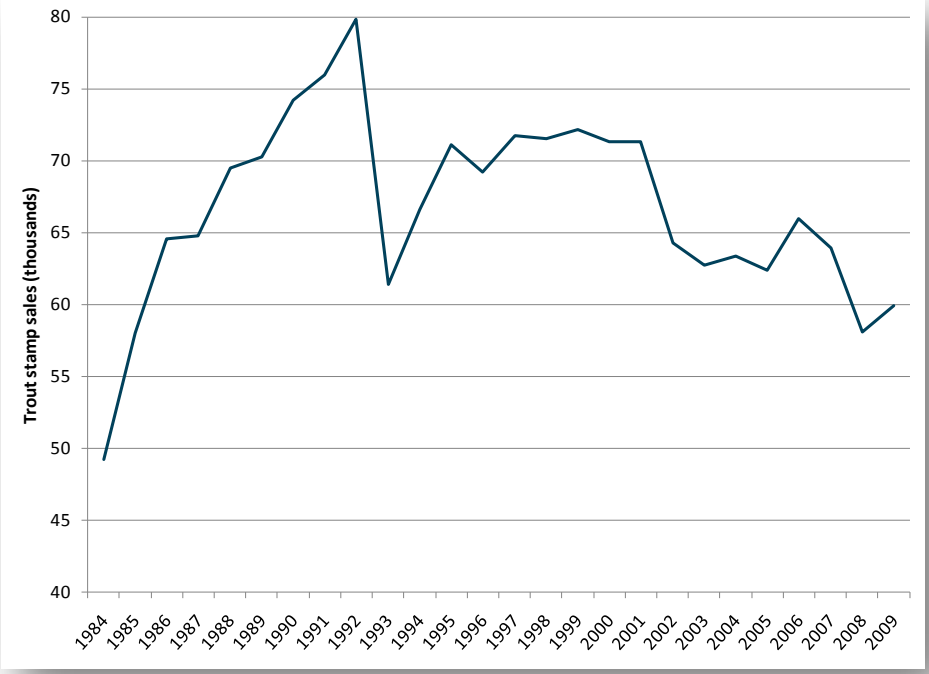
Figure 21: Days of fishing in Maryland, 1996-2006



Source: USFWS (1998; 2003; 2008).

The number of anglers who use the NBP for trout fishing has not been counted; however, trends in the purchase of Maryland trout stamps provide an indication of the use of the NBP for trout fishing in recent decades. The purchase of an annual $5 trout stamp allows individuals 16 years of age or older to fish in any special catch-and-return trout management area and to possess trout taken from non-tidal waters of Maryland. Because the NBP borders two states, anglers on the West Virginia side do not need a Maryland trout stamp. The number of Maryland trout stamps sold annually has remained relatively constant between 1984 and 2009 (Figure 22).

Figure 22: Annual Maryland trout stamp sales, 1984-2009



Source: MDNR (2010b).

MDNR sold trout stamps and senior trout stamps from 1963-1992; the senior trout stamp was abolished in 1993, which is indicated by the sharp drop in 1993 numbers in Figure 22.

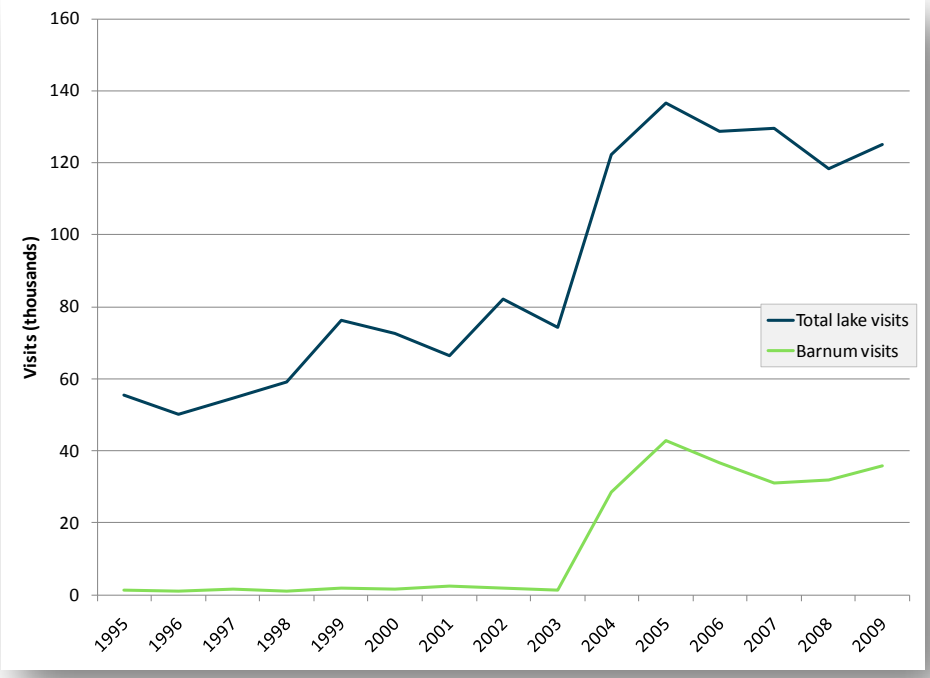
7.2 Jennings Randolph Lake use

The dam at Jennings Randolph Lake impounds the NBP about 10 miles upstream from Luke. When it started to be built in 1973, it was originally named Bloomington Dam and Lake; six years after it began releasing water in 1981, it was renamed to honor the West Virginia Senator Jennings Randolph (Tucci, 2010). USACE began tracking and estimating recreation visits to seven sites at Jennings Randolph Lake in 1995; since then, total visits have more than doubled (Figure 23).[12]

The sites tracked include the following: Howell Run Boat Launch, West Virginia Overlook, Maryland Overlook, Robert W. Craig Campground (day and overnight uses), Howell Run Picnic Area, Maryland Boat Launch, and Barnum Whitewater Area. Visits to these sites have averaged almost 126,800 annually from 2004-2009.

[12] These data are based on visual counts, as well as a traffic counter that was installed at Barnum in 2004, which accounts for the spike in visits shown in Figure 23.

Figure 23: Visits to Jennings Randolph Lake (total) and Barnum, 1995-2009



Source: USACE (2010).

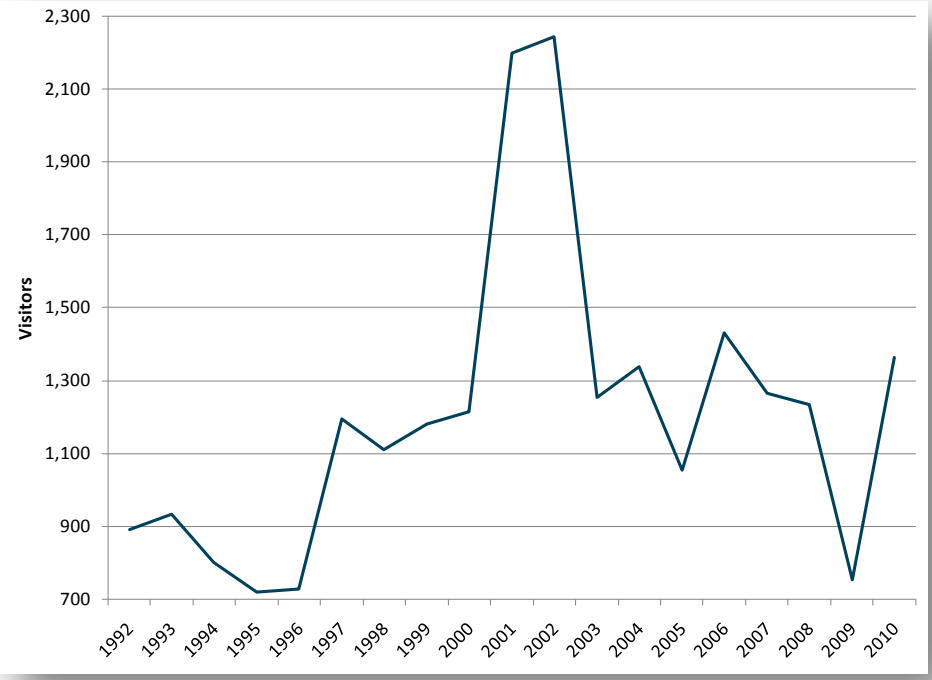
7.3 Barnum use

The Barnum area is the only Jennings Randolph Lake site located on the river proper, downstream of the dam. Although the Barnum data are only one piece of the broader Jennings Randolph Lake data, Barnum visits show a similar trend. Since 2004, Barnum area visits have comprised about 20-30% the total lake visits; Barnum has averaged almost 34,500 visits annually from 2004-2009 (Figure 23).

Since 1992, when the doser program began, USACE has offered scheduled spring whitewater releases from the dam for private and commercial whitewater boater use. In addition, 1-3 water quality releases that are also suitable for whitewater recreation occur annually in the late summer or early fall. Since 1996, 5-7 total releases have occurred each year (Fritz, 2010). Whitewater use, documented during these releases, has accounted for about 2-5% of total visitor use at Barnum between 1992 and 2009. Annual whitewater use since 1992 has ranged from 720 in 1995 to 2,244 in 2002; from 2004-2009, Barnum whitewater release visitors have averaged around 1,200 users annually (Figure 24).

Although whitewater users comprise a relatively small proportion of annual use on the NBP, they offer a tangible economic contribution through use fees. Private and commercial whitewater users pay a visitor use fee of $2 per person at Barnum for whitewater releases. From 1992 to August 2010, revenue from whitewater fees totaled over $43,000.

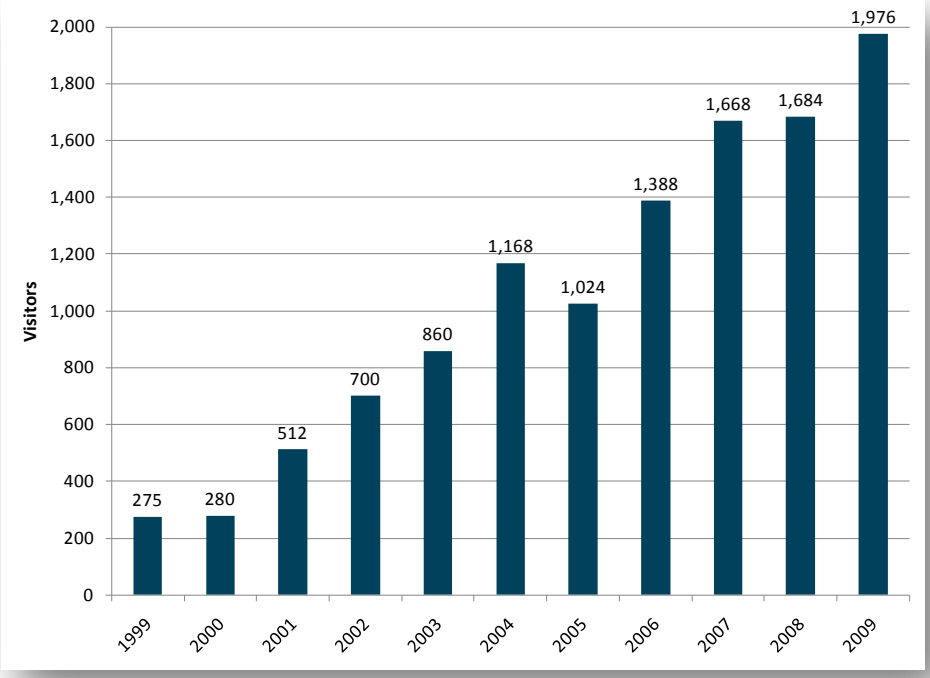
Figure 24: Whitewater release visitors, 1992-2010



Source: Mineral County Parks and Recreation Commission (2010). Note: Data for 2010 only includes January through August.

Mineral County Parks and Recreation Commission offers eight cabins and multiple campsites for rent at Barnum, a 45-acre site along the river leased from USACE. Cabin rentals started in July 1998, and have increased since then. In 2009, 1,976 individuals stayed at these cabins (Figure 25).

Figure 25: Barnum cabin rental visitor numbers by year, 1999-2009



Source: Mineral County Parks and Recreation Commission (2010). Note: In 1999, Mineral County had five four-person cabins for rent. In 2003-2004, it built an additional four-person cabin. In 2007, it built two more cabins that fit up to ten people. In fall 2009, it started building another cabin that will fit up to ten people.

7.4 Non-commercial use

Other non-commercial groups use the NBP for teaching and training. The Adventure Sports program at Garrett College uses the river to teach whitewater kayaking, canoeing, and rafting. According to Executive Director and Professor Michael Logsdon (2010), the program was also "responsible for procuring and managing a public take-out in Bloomington on property owned by the Garrett County Sanitary District. This was accomplished through an agreement with the Sanitary District and with funds from the Maryland DNR Waterway Improvement fund." In addition to teaching, the river also provides a perfect training ground for Bethesda Center of Excellence, the official US Olympic and World Training Center for competitive whitewater and downriver paddle sports.

Other non-commercial groups and organizations that use the river include:

- AW;
- Conewago Canoe Club, York, Pennsylvania;
- Greater Baltimore Canoe Club;
- Canoe Club of Greater Harrisburg, Pennsylvania;
- Monocacy Canoe Club (Washington, D.C. metro area);
- Free State Fly Fishers Club in Annapolis, Maryland;
- Trout Unlimited (Potomac Patuxent, Seneca Valley, and P. Pendleton Kennedy chapters);
- West Virginia Angler;
- Ruffed Grouse Society (Local chapter); and
- Middle Atlantic Four Wheel Drive Association.

8. CLEANER SOURCE WATER FOR WITHDRAWALS

Changes in surface water quality, such as AMD remediation, affect the availability of clean and affordable drinking water; surveys of operators in Pennsylvania's West Branch Susquehanna River watershed documented just these effects (Hansen et al., 2008). In addition, new industry and development may avoid areas where clean water supplies are not available. In this chapter, we identify water withdrawals from the NBP from Kempton to Cumberland, and highlight the benefits of AMD remediation efforts on those uses as reported by water withdrawal permit holders.

Active water withdrawals on the NBP have been permitted since the 1950s by the State of Maryland. Table 22 lists withdrawals between Kempton and the Cumberland area. Within this area, only one entity is currently permitted for drinking water withdrawal; other withdrawals supply industrial and agricultural water.

Table 22: Water withdrawals on the North Branch between Kempton and the Cumberland area

				Permitted flow (gallons per day)	
Name	Location	Type	Description	Average	Maximum
New Page Paper Company	Upper North Branch Potomac	Industrial, drinking	Drinking water for: (a) New Page, (b) Luke, (c) Piedmont backup	52,000,000	75,000,000
Upper Potomac River Commission	Upper North Branch Potomac	Industrial	Process water	250,000	260,000
Private	Upper North Branch Potomac	Agricultural		45,000	500,000
Private	Upper North Branch Potomac	Agricultural		3,000	12,000
AES Warrior Run Limited Partnership	Cumberland area	Industrial	Cooling water	21,000	2,500,000
Private	Cumberland area	Agricultural		72,000	440,000
Allegany County Public Works	Cumberland area	Agricultural	Watering ball fields	400	3,000

Source: MDE (2010a). New Page Paper Company is listed as Luke Paper Company in its permit.

8.1 Drinking water

New Page Paper Company, formerly Westvaco, has been located in Luke, Maryland since the 1800s, and is the only entity currently permitted for water withdrawals from the NBP for domestic use (MDE, 2010a). The company has been permitted with MDE since 1956 as the Luke Paper Company (MDE, 2010a). New Page treats water for domestic use onsite, and has also supplied drinking water to the town of Luke free of charge for over 40 years (Koontz, 2010). The City of Piedmont also uses New Page's withdrawal from the NBP as a backup source for drinking water; its primary source is the Savage River (Jackson, 2010).

Water quality improvements have positively impacted this facility. New Page has measured water quality indicators such as turbidity and pH for over 40 years, and has documented changes. According to Technical Director Ken Wendell, Ph.D., who has been with the company since 1976, pH measurements were below 4 in the 1970s, but now the pH is more neutral and uniform up and downstream of the mill. Wendell (2010) postulates that Jennings Randolph Dam and the lime dosing program contribute to reductions in turbidity, and also create a more uniform and neutral pH: "The lime dosing has a tremendous impact on keeping the river better and more uniform" (Wendell, 2010).

These changes reduce the need for chemical additions for domestic and industrial water processing at the New Page facility: "It's helped with costs for us, as well as overall aesthetics. We hope it continues." Besides reduction in costs, Wendell speaks to the water quality improvements: "The change in water quality, the change in fish—it's remarkable" (Wendell, 2010).

> *"The lime dosing has a tremendous impact on keeping the river better and more uniform… It's helped with costs for us, as well as overall aesthetics. We hope it continues."*
>
> Ken Wendell, Ph.D.
> Technical Director,
> New Page Paper Company

The other drinking water withdrawals in the area are taken from tributaries to the NBP. The City of Keyser, for example, gets its water from New Creek, and the northern end of Mineral County, West Virginia gets domestic water from Allegany County, Maryland (Mineral County Planning Commission, 2010). The Savage River provides drinking water for Tri Towns and Piedmont (Jackson, 2010), and the City of Cumberland's water originates from Pennsylvania's Lake Koon and Gordon reservoirs, whose primary tributaries include Evitts Creek, Growden Run, and Oster Run (City of Cumberland, 2010).

8.2 Industrial water

Three entities are currently permitted for water withdrawals from the NBP for industrial use (MDE, 2010a). In addition to New Page, which uses water for industrial uses onsite, these industrial users include AES Warrior Run and UPRC. The AES Warrior Run withdrawal is about 10 miles below Cumberland, and is used for non-contact cooling water for a coal–fired power plant.

UPRC was established in 1935 to manage the water resources of Allegany County and Election District 4 (Bloomington) in Garrett County, Maryland. Since 1960, the Commission also has operated the Westernport Wastewater Treatment Facility, which treats the industrial waste from New Page, as well as municipal sewage from Westernport and Luke, Maryland and Piedmont, West Virginia (Maryland State Archives, 2010). UPRC withdraws water from the NBP for the Westernport Wastewater Treatment Facility; the water, however, is primarily for emergency purposes. The facility uses unfiltered water from New Page for pumps, sprays, and other industrial uses. For drinking water, the facility uses City of Westernport water, withdrawn from the Savage River (Shoemaker, 2010).

8.3 Proposed water withdrawals

Beyond current withdrawals, there are two permits currently under consideration: Alliance Tactical Systems and Allegany County Commissioners. Alliance is a Navy ballistics lab that plans to withdrawal water about 10 miles upstream from Cumberland for industrial and domestic use. Allegany County plans to withdraw water upstream from Cumberland for a new 2 million gallon per day drinking water facility (Yoder, 2010).

As part of the proposed drinking water facility, Allegany County commissioned a water quality study on the NBP that included sampling between December 2005 and February 2006; the water quality sampling results determined the water to be treatable for drinking water (Yoder, 2010).

Both of these proposed permits include drinking water use, which speaks to the water quality improvements on the North Branch: "A proposed intake [in the North Branch upstream from Cumberland] is saying something about where we're at," said Scott Shoemaker (2010) from UPRC. Interviewees discuss an historic stigma of poor water quality in the NBP; one professional who works in the area commented on this reputation that he's known since childhood:

> Until the last few years, no one would ever consider drinking water from the Potomac. Back when I was a kid, you wouldn't even want to wade in it, not if you wanted to keep your shoes.

"Until the last few years, no one would ever consider drinking water from the Potomac. Back when I was a kid, you wouldn't even want to wade in it, not if you wanted to keep your shoes."

Local professional

An employee of Alliance Tactical Systems, and long-time resident of the area, remembers the river as a child: "It was pretty ugly and it stunk all the time." He spoke to AMD remediation effects on the river now that his employer is proposing to withdraw from it:

> Just the fact that it's got trout in it—that should be enough reason to support the dosing program. I have caught trout [in the NBP]. I'd never dreamed when I was a kid that I'd ever catch any fish in there, let alone trout.
>
> I would expect the dosing has adjusted the pH where we probably won't have to adjust it… Metals precipitate at the lake that we won't have to deal with. If dosing wasn't taking place, the metals would go straight through to us.

"[T]he dosing has adjusted the pH where we probably won't have to adjust it."

Employee,
Alliance Tactical Systems

9. CONCLUSION

The installation of dosers that treat AMD from abandoned coal mines has transformed the NBP into a popular regional recreational river. While unimaginable decades ago when the river was heavily polluted, anglers now fish for trout and bass, and boaters float the whitewater released from Jennings Randolph Lake.

Together, anglers and boaters now spend tens of thousands of days recreating on the NBP each year and pump about $2.1 million per year into Garrett and Allegany Counties. These expenditures then circulate through the local economy, producing about $3.0 million in annual economic impact.

Directly and indirectly, NBP anglers and boaters are responsible for the creation of about 40 full-time equivalent jobs and the generation of about $266,000 in state and local taxes each year.

> *"An opportunity exists for the State…to protect waters of the state by continuing remediation efforts at the current level."*
>
> Theaux Le Gardeur,
> Backwater Angler

Over and above their expenditures, NBP anglers and boaters are willing to pay more for their recreational experience: approximately $4.1 million per year. This is because anglers and boaters receive a higher value from their recreational experiences than they already pay.

While the clean-up of the NBP has produced a robust recreational economy based on clean streams and healthy fisheries, this economy could be crippled if funding for the dosers is shut off. Due to changes in federal policy, funding continues to be uncertain. While currently we are in a more promising period, there are no guarantees that this scenario will prevail due to changing practices and policies at the federal government.

Were treatment to stop, water quality in the NBP, as well as the trout, bass, and other aquatic life in the river, would be severely impacted. The economic activity—especially that related to fishing—which has built up around the improved NBP would be significantly harmed.

The amount of funding required to operate and maintain the dosers is only about $321,000 per year. To put this in perspective, the economic impact from NBP anglers and boaters in Garrett and Allegany Counties alone is almost ten times higher than this cost; the state and local tax dollars alone that are generated from the use of the NBP are close to this annual cost.

The dosers have turned the NBP from a dead, AMD-impaired river into a very popular recreation destination. Anglers and boaters provide an important boost to the local economy. It is up to policy makers to determine whether and how to ensure that the dosers continue operating so that the NBP can continue to provide local economic benefits into the indefinite future.

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APPENDIX A: RESEARCH METHODS AND RESULTS

Sample, response rate, and methods

While AMD remediation has benefitted people who participate in a wide range of outdoor activities, we collected primary data through surveys of the two main types of river users: anglers and boaters. Boaters make up a lower proportion of the overall visitor use because whitewater releases are only scheduled four weekends of the year. Our sample was proportionate to total use; therefore, we sampled more anglers than boaters.

For anglers, we created our sample from three main populations: (a) commercial angling clients, (b) private anglers, and (c) 2009 Maryland trout stamp purchasers. A sample of commercial angling clients were obtained via outfitters through their contact lists. Clients were e-mailed a letter asking them to participate in the survey. Upon consent, an e-mail invitation to an Internet-based survey (using Survey Monkey with a unique link for each respondent) was sent. For recreational users who do not use professional services, contact was made on the river or via response cards left at Mineral County's cabins at Barnum to gather either e-mail or US mail addresses. In addition, the survey was advertized on the Web on the following sites: wvangler.com, switchfisher.com, Backwater Angler website, and postings or e-mails to regional Trout Unlimited memberships. Once contact information was collected in person, via response card, or by e-mail, we provided participants with paper surveys or access to the online survey, as appropriate. The trout stamp population (N=500) comprised our local population of anglers, and consisted of random samples of 50 addresses from the senior list and 450 Garrett and Allegany county addresses from the trout stamp list. We sent information about the study to these people; those who returned the response card were sent a paper survey, unless an electronic survey was requested.

For boaters, we created our sample from one main population, which consisted of those who responded to: (a) response cards left in Mineral County cabins at Barnum, (b) contact information collected onsite via commercial and private user intercepts, and (c) website postings, consisting of posts on regional internet message boards asking for e-mails of those with interest in participating. The posts were made to the following canoe club boards: Greater Harrisburg, Greater Baltimore, Monocacy, and Conewago. Our total survey population excludes regional anglers (i.e., in West Virginia), as well as non-anglers and non-boaters.

Table 23 contains the statistics on the survey response rates. The overall responses were slightly below our goal of 400 completed surveys. We received a total of 385 completed surveys, 79 from boaters and 306 from anglers. Although the boater response rates were high (68%), our lowest response rate was from the angler trout stamp population. All response rates seem proportional to the level of personal interaction in providing information about the survey. No rewards were included in the mailings.

We used somewhat different survey instruments for anglers and boaters. After developing draft surveys, we pre-tested them by soliciting anglers and boaters to complete the survey and offer feedback. The survey pretests were conducted with private boaters and anglers in both individual and group settings. We solicited feedback on, for example, values offered in the survey, as well as the wording and meaning of questions. Based on feedback from the pretests, we modified the survey and created final versions. Due to the extent of passion for the NBP and opinions about continued funding for remediation, we also added several open-ended questions to capture additional comments and opinions.

Table 23: Survey response statistics

	Sent	Responded	Response rate
Boaters	116	79	68%
Anglers			
Via outfitters	706	197	28%
Via other	77	67	87%
Via trout stamp	435	42	10%
Subtotal	**1,218**	**306**	**25%**
Total	**1,334**	**385**	**29%**

Note: Of the 435 delivered to the trout stamp list, 63 responded as interested and were sent surveys. The total number (435) sent out was used to calculate response rate.

Our survey instrument was designed to assess the economic benefits of water-based recreation made possible by AMD remediation, and asked about the following main topics: (a) general use of the NBP, (b) recent trip purpose and spending, (c) extent of value placed on protection of the NBP, and (d) demographic information. To assess the economic value of the river that would be lost if it were to revert back to its damaged state, we use two contingent valuation questions. One was used to calculate a use value, and the other a preservation or existence value. For the use value, we presented one of nine randomized values for each survey ranging from $5-$600 for the anglers and $1-280 for the boaters; these values were based on previous studies and feedback from the pretest. We included an alternative in this question to ensure that respondents considered other fishing locations, creating a conservative valuation. The other contingent valuation question captured preservation value because a respondent does not have to utilize the resource to value it.

Demographics

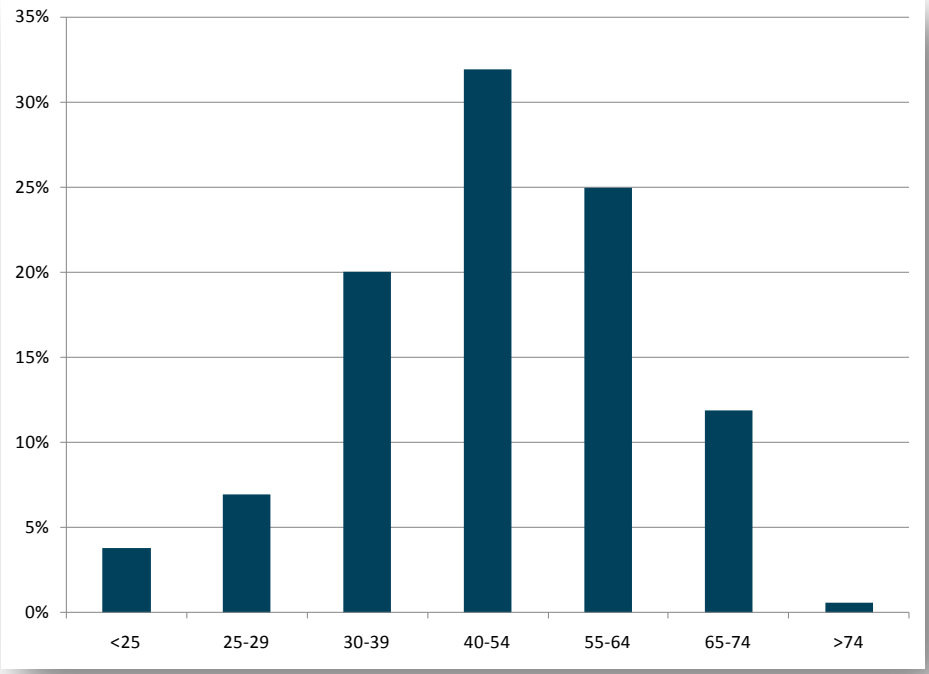
Most of our survey respondents were male; a higher proportion of the boater respondents were female than the angler respondents (Table 24).

Table 24: Gender of survey respondents

Respondent type	Female	Male
Anglers	4%	96%
Boaters	23%	77%
Total	**8%**	**89%**

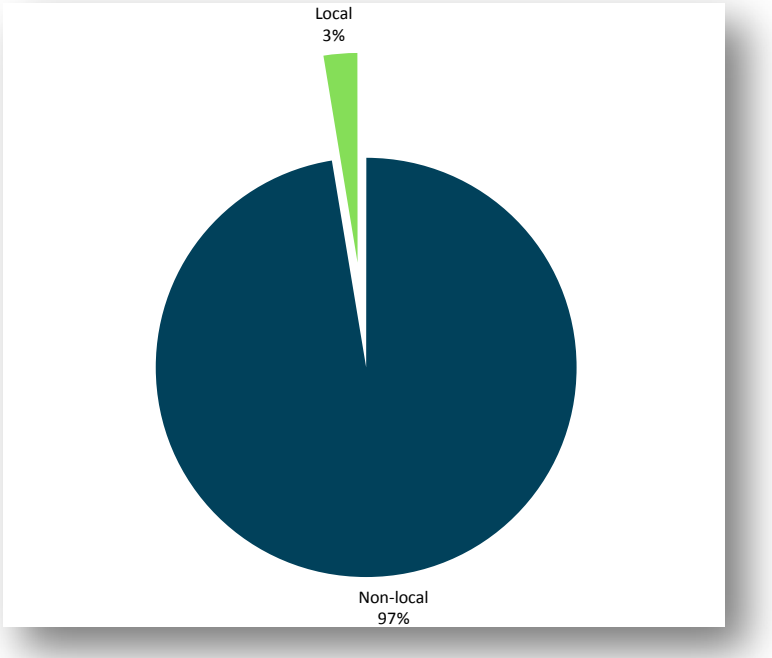
In relationship to age, the angler (N=266) and boater (N=79) samples were relatively similar; in total, 77% of respondents were 30-64 years old (Figure 26).

Figure 26: Age of survey respondents



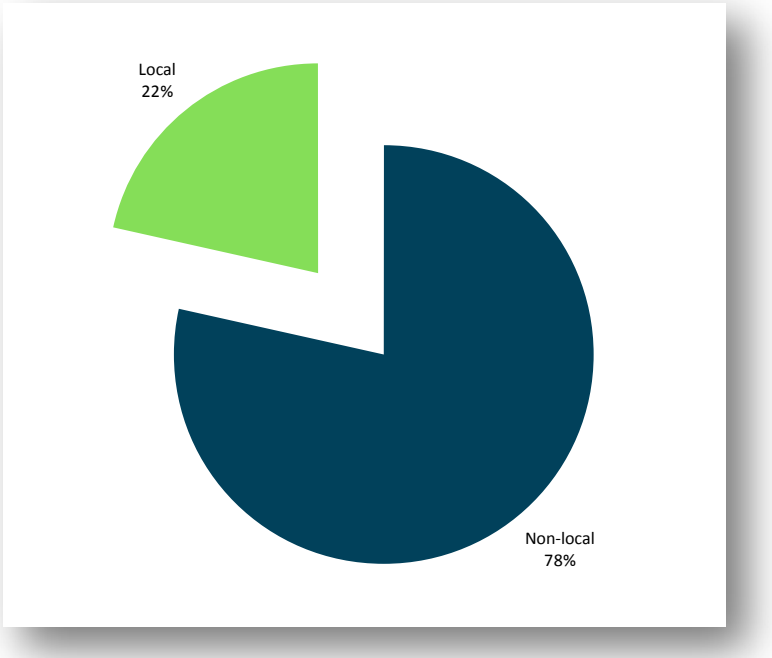
We differentiated between local and non-local anglers. Local anglers included those with zip codes in Garrett or Allegany counties; non-local included all others. Of the respondents, most of the boaters (97%) were non-local (Figure 27); a lower proportion of anglers (78%) were non-local (Figure 28). A 1987 creel census on the NBP river found 95% of the angers (N=824) were from Maryland (Fedler, 1987). A 1993 shore angler creek survey of both the NBP (N=40) and Savage River (N=78) found 68.6% from Maryland and 27.1% from West Virginia (Cummins and Gibbons, 1993). Both studies, however, differentiated anglers by state rather than by individual counties.

Figure 27: Boater respondent location of residence



Note: N=77.

Figure 28: Angler respondent location of residence



Note: N=265.

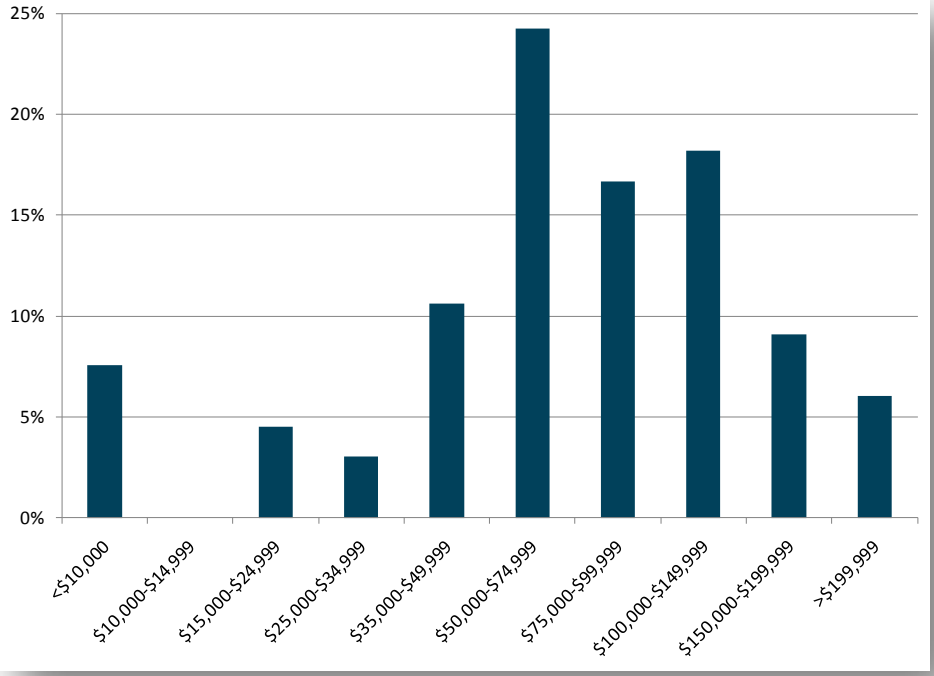
In relationship to education, the angler and boater samples were relatively similar; in total, 81% of respondents have a college or graduate degree (Table 25). The household income for boaters and anglers is presented in Figure 29 and Figure 30.

Table 25: Survey respondent education level

	Anglers	Boaters	Total
Eighth grade or less	0%	0%	0%
High school diploma	15%	9%	13%
Technical school	5%	6%	6%
College degree	39%	46%	41%
Graduate school	41%	39%	40%

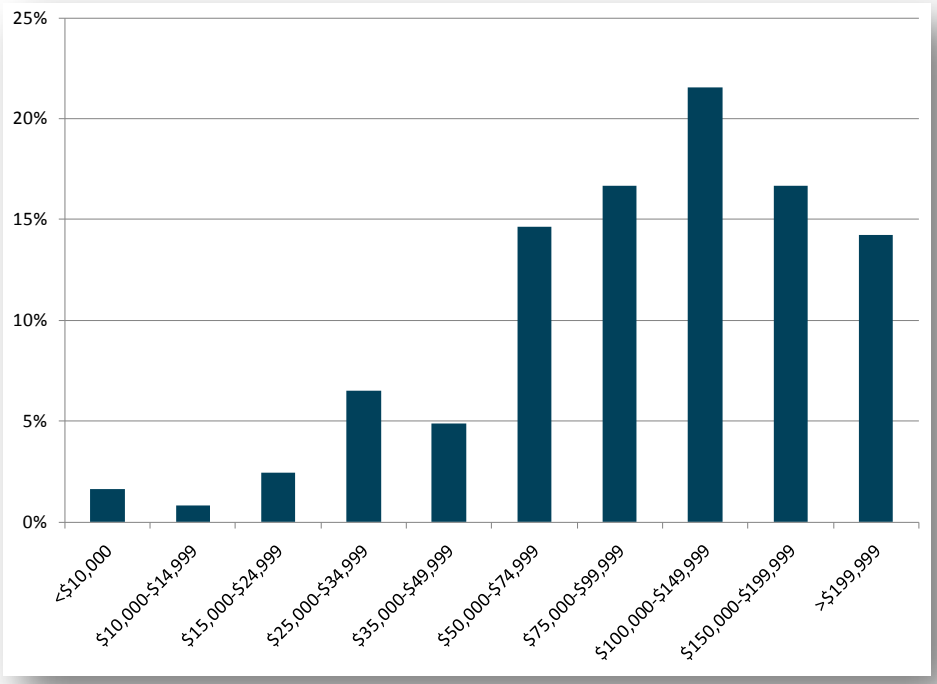
Note: Angers N=265; boaters N=79.

Figure 29: Boater respondent annual household income



Note: N=66.

Figure 30: Angler respondent annual household income



Note: N=246.

Recreational spending calculations

A total of 327 respondents in our sample provided enough information to compute their recreational spending per trip (Table 7) and per person per day (Table 8). Our entire sample reported over $130,000 in spending on their most recent trips (96% of trips were in 2009 or 2010). Across all respondents, average spending per trip was just under $400. Reflective of our sample make-up, the largest spending categories were guide and tour expenses along with accommodations. The spending total for each respondent was converted to "per person per day" estimates by dividing trip spending by total days in the trip, and dividing again by the number of persons on the trip. The average was $125 per person per day.

The population estimate sought for this analysis was defined as a recreational user day: one person recreating all or part of a day on the NBP. Three different populations were identified in order to estimate the amount of spending from the entire population of NBP recreational user days: local anglers from Allegany or Garrett Counties, non-local anglers, and boaters.[13] To estimate per person per day spending for each population, we divided our sample into these three populations. Angler respondents whose location was not reported were dropped from these estimates. In addition, one outlier respondent was excluded from the local anglers sample population due to her extremely high reported spending.[14]

Survey data as well as external sources were utilized to estimate the number of recreational use days for the three populations of recreational users on the NBP.

[13] Almost all boaters in our sample (97%) were non-local so a location distinction was not judged to be meaningful for this portion of recreational users.
[14] This one respondent reported spending three times higher than the total spending by all other local anglers in our sample. Inclusion of this one outlier respondent would have increased the average per person per day estimate by three times.

For boaters, our strategy to compute user population was the simplest: find the average of 2009 and 2010 Barnum daily visitor use data during whitewater releases to determine a population of boaters on the North Branch.

For anglers, our analysis was complicated by dividing into local and non-local plus only counting those anglers who obtained licenses from Maryland due to our interest in spending in Allegany or Garrett Counties. For non-local anglers, survey data provided excellent information from a sample population based on the outfitters and guides e-mail list. We divided this population into local (9%) and non-local (91%) portions based on survey responses. The non-local portion was multiplied by the survey average for reported 2009 visits for non-local anglers from the outfitter list (4.78) and by the average number of days at the NBP for the most recent visit (1.8). In addition, the survey sample population obtained from various other sources was largely comprised of non-local anglers; therefore, their estimated days of fishing use were added to non-local use.

Fishing use by local anglers was the most complicated to estimate. We combined survey and external data for this calculation. From the survey, we included the estimated number of angler user days from the local portion of the outfitters and guide lists. As part of the survey population, we sampled from the trout stamp and senior lists for residents in Allegany and Garrett Counties (a 2009 population of 7,216). The response rate from this portion of the survey was very low: 10%. To be conservative when inferring from our sample to the population of trout stamp and senior lists, we assumed that the computed number of trips multiplied by days per trip from our sample would represent only 10% of this population. For the other 90% of this population, we assumed a use rate of one-third of the average from our sample (three fishing use days annually). Using this sample correction lowers the mean number of fishing days for the entire local angler sample from about 9 to 3.6. Our correction reduces a bias of more fishing by survey respondents than non-respondents that has been observed by Thomson and Huppert (1987). Our simple correction reduces the mean number of local angler fishing days by 60%, which is similar to the bias corrections of 57% computed by Thomson (1991) for telephone surveys of fishing activity in California.

The populations of recreational users are shown in Table 12. Total recreation user days on the NBP were estimated at 33,500, with most of this use coming from local anglers. This estimate was judged to be reasonable based on two considerations. First, our estimated usage was less than the 2009 estimated usage at Barnum (35,707 visits), which estimates primarily usage by both West Virginia and Maryland anglers below Jennings Randolph Dam. Second, the estimate of 32,400 angler days of trout fishing on the North Branch is 12% of the estimated number of angler days for trout fishing in Allegany and Garrett Counties.[15] This percentage of usage on the NBP relative to other local fishing areas was regarded as conservative.

Our estimates of annual angler and boater expenditures were surprisingly similar to those projected in 1992, when PKF Consulting (1992) estimated that if the NBP fishery were to be fostered, annual angler expenditures within Garrett County could be about $1.9 million.

Our estimates of daily angler expenditures are about 20% higher than similar fishing expenditures computed for the entire state of Maryland by the national survey of fishing, hunting, and wildlife (USFWS, 2008). The most recent survey showed that freshwater fishing trip and equipment expenditures In Maryland were an average of $47 per fishing day in 2006 ($50 in 2009 dollar values). Our estimate of recreational expenditures per angler fishing day is $61 when weighted by estimated local and non-local fishing days on the NBP. Our slightly higher average daily expenditures estimate stems from two factors: (1) we included a larger range of expenditures (our estimate includes gifts, souvenirs, clothes, etc.), and (2) the non-local angler portion of our sample was dominated by those anglers who used outfitters (and thus on their e-mail lists). Non-local anglers

[15] 261,000 trout angler fishing days were estimated for Allegany and Garrett Counties from reported fishing trips in 1987 to these two counties (Fedler, 1987), adjusted to 2009 by trout stamp sales and multiplied by the average number of days per trip from survey data for local anglers.

had a much higher average daily expenditure ($132 versus $44) than local anglers, of which about one-half of this difference was due to increased expenditures for guiding services. Our estimate of local anglers' average daily expenditures was slightly below the 2006 survey average.

Economic impact calculations

We used version 3.0 of the IMPLAN software (Minnesota IMPLAN Group, 2010) for this analysis. Annual recreation spending data were utilized as a combination of commodity and sales changes within industries, where the model computed economic impacts as if this spending was an addition to the current economy. Our analysis utilized "Case Study 12: Impacts of Wildlife Tourism" (Minnesota IMPLAN Group, 2010) as a guide for the combination of increased industry sales and commodities from annual recreation spending. Calculations were performed for boaters, local anglers, and non-local anglers. Because the spending data are annual, all impacts are projected as annual and as existing in 2009. Results are summarized in Table 26 through Table 29.

Table 26: IMPLAN results for boaters

Impact type	Employment (Full-time equivalents)	Total value added	Economic impact
Direct effect	1.2	$44,341	$81,271
Indirect effect	0.2	$9,835	$19,833
Induced effect	0.2	$9,399	$16,466
Total	**1.5**	**$63,575**	**$117,570**

Note: Total value added includes compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Economic impact is reported as output by IMPLAN.

Table 27: IMPLAN results for local anglers

Impact type	Employment (Full-time equivalents)	Total value added	Economic impact
Direct effect	18.9	$669,450	$1,164,068
Indirect effect	2.3	$135,851	$270,627
Induced effect	2.6	$140,699	$246,454
Total	**23.8**	**$946,000**	**$1,681,149**

Note: Total value added includes compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Economic impact is reported as output by IMPLAN.

Table 28: IMPLAN results for non-local anglers

Impact type	Employment (Full-time equivalents)	Total value added	Economic impact
Direct effect	11.3	$412,492	$818,500
Indirect effect	1.9	$107,975	$215,956
Induced effect	1.7	$90,756	$159,001
Total	**14.9**	**$611,222**	**$1,193,457**

Note: Total value added includes compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Economic impact is reported as output by IMPLAN.

Table 29: Total IMPLAN results

Impact type	Employment (Full-time equivalents)	Total value added	Economic impact
Direct effect	31.4	$1,126,284	$2,063,840
Indirect effect	4.4	$253,661	$506,416
Induced effect	4.5	$240,855	$421,921
Total	**40.3**	**$1,620,800**	**$2,992,177**

Note: Total value added includes compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Economic impact is reported as output by IMPLAN.

Similar to our study, Ahmadi (1991) examined the economic impact from tourism recreation on the Savage River State Forest to the entire state economy of Maryland. Overall, Ahmadi found that tourism on the forest increased state economic output by $26.8 million and jobs by 432. When broken down by recreational activity, fishing had an economic output of $3.66 million and increased jobs by 61, and boating had a $2.08 million impact with 34 jobs. When compared to our estimates on the NBP, these higher estimates reflect a state economy as compared to a regional economy and a greater number of visitor days on this state forest than on the NBP: 50% higher for fishing and 2,297% higher for boating.

Our estimates of jobs generated from angling and boating on the NBP were similar to that projected by PKF Consulting (1992), which estimated that if the NBP fishery were to be fostered, 30-40 FTEs would be created within Garrett County. Our economic impact estimates were also similar. PKF Consulting (1992) estimated that if the NBP fishery were to be fostered, the potential maximum incremental economic impact to Garrett County would be about $3.4 million annually (PKF Consulting, 1992). This increase would be over and above the $169,880 of economic impact existing in 1992.

Willingness-to-pay calculations

Both anglers and boaters were asked about their willingness-to-pay for a recreational trip on the NBP. This expression of willingness-to-pay measures a use value from the recreational experience. Question B9 was posed as a yes/no response to an increased expense for recreating on this river. The economic theory for computation of this user willingness-to-pay value followed Hanemann (1984). Freeman (2003) provides a detailed explanation of the methods utilized here. Limited dependent variable logit models were estimated to explain the probability of a respondent saying yes to Question B9 in each survey. The explanatory variables in the model included those in Table 30.

Other variables tried but ultimately excluded from the model due to low explanatory power included: respondents' demographics of income, education level, and gender; respondents' self-reported knowledge about the NBP; whether or not respondents identified coal mine pollution in Question A2 as an environmental problem in Western Maryland rivers and streams; the year of the most recent recreational trip to the NBP; and whether or not respondents identified a local or non-local alternative recreational river in Question B8. The complete logit model estimations are presented below.

From this model, willingness-to-pay for a recreational trip can be computed as either a mean or a median value. The mean estimate is based on an average value of integration of logit function for each respondent observation with all variables at their reported values and varying the variable *BID* between zero and the highest increase presented to any respondent ($600 for anglers and $280 for boaters). The median estimate is the computed dollar value for *BID* when the probability of saying yes is set at 0.50. Dalton et al. (1998) note the use of the median as a measure of central tendency for willingness-to-pay values is conceptually incorrect. Thus, they recommend that the mean is the more appropriate measure.

Table 30: Explanatory variables utilized in logit model estimation to Question B9 response

Variable (Survey question number)	Coding	Impact on probability of a "Yes" response	
		Anglers	Boaters
BID: Per person dollar increase in trip expenses presented to respondent (B9)	Computed as natural log	Negative*	Negative*
ENVPROB_A: Opinion about environmental problems in Western MD streams – coal mine pollution (A2)	1=environmental problem; 0=not an environmental problem	-	Positive*
ENVPROB_B: Opinion about environmental problems in Western MD streams – water flows & temperature (A2)	1=environmental problem; 0=not an environmental problem	-	Positive*
TRIPS: Number of trips to the North Branch in 2009 (A6)	1=1 trip; 2=2-4 trips; 3=5-7 trips; 4=8-10 trips; 5=10+ trips	Positive	Negative
REASON: Main reason for trip (B2)	Anglers: 1=fishing; 0=other Boaters: 1=kayaking; 0=other	Negative	Positive
DAYS: Number of days in most recent trip (B3)	Coded as number reported by respondent	Positive	-
QUALITY: Rating quality of trip (B5)	2=excellent; 1=good; 0=fair or poor	Positive*	Positive*
TOTAL: Total spending reported (B6)	Summation of seven spending categories	Positive	Positive*
AGE: Age of respondent (D2)	2010 minus year of birth	Positive*	-
NONLOCAL: Residence of respondent (D3)	1=non-local zip code reported; 0=local or no zip code reported	Positive*	-

Note: Each variable marked with an asterisk (*) has a coefficient that is statistically different from zero at p<0.05.

Both the median and mean per trip estimates are shown in Table 15 for the angler and boater sample populations. Per-trip estimates were converted to per-day based on the average number of days reported per trip (2.2 for anglers and 2.0 for boaters). The mean estimates of per person per day willingness-to-pay ($289 for anglers and $59 for boaters) represent the average value of a recreation day for an angler on the NBP. Both estimates are on the high end of literature estimates for the value of recreation experiences.

For trout fishing, the mean daily value from seven fishing valuation studies was $59 per person (2009 dollar value).[16] The highest value observed was $357 per day (2009 dollar value) from tourists in Wyoming. For boating, six studies from the northeast region and Ohio found mean per day values of between $2.6 and $69 (2009 dollar values) with an average of $38.[17] We project that the relatively unique recreational experiences offered by the NBP for the Mid-Atlantic region (cold water trout fishing late into the summer season and long stretches of undeveloped land along the river) may warrant these higher-than-average willingness-to-pay values.

In order to project these sample values onto the user population, the angler population was again divided into local and non-local. The mean willingness-to-pay values were computed to be $263 per user day for non-local and $383 for local anglers (Table 16). This is a surprising result as non-local willingness-to-pay values are often higher than local residents for trout fishing recreation (Dalton et al., 1998). As was done with the use estimate above, we assumed that our local angler sample willingness-to-pay reflected only 10% of the local angler population due to the low response rate. For the other 90%, we used a literature average of $59 per use day to compute the total. The total willingness-to-pay for recreation on the North Branch of the Potomac was estimated to be over $4.1 million annually (Table 16). This is the value that recreational users receive

[16] These studies and their location are: Rosenberger et al. (2005) from the Cheat River in West Virginia, Caudill (2005), a 19-state average, Rosenberger and Loomis (2001) from the Northeast US, Dalton et al. (1998) from Wyoming, Choi et al. (1993) from Oklahoma, Johnson and Walsh (1987) from Colorado, and Sorg and Loomis (1986) from Idaho.

[17] These studies are: Ayalasomayajula et al. (2007),Parsons et al. (2003), Rosenberger and Loomis (2001), Hellerstein (1991), and Rosenthal and Cordell (1984).

from utilizing the NBP to fish or boat. Anglers from Allegany and Garrett Counties received over 57% of this recreational value.

The willingness-to-pay values, based on Loomis's work referenced in this document, range from $33.79 to $37.86 per activity day, for value of kayaking (in 1999 dollars).

Finally, anglers and boaters were asked to express their willingness-to-pay to preserve the NBP in its current state by financially supporting the continued operation of dosers. Anglers were presented with an additional annual fee on the trout stamp. Boaters were given the opportunity to make a one-time donation to a restoration fund. Since each question was an open-ended, fill in the blank response, willingness-to-pay values for preservation can be computed from a simple mean of the responses. Average angler willingness-to-pay was adjusted downward using Question C3 to reflect respondents' reduced purchases of trout stamps with this annual fee. Protest zero responses were excluded from both sample averages.[18] The mean willingness-to-pay for anglers from the outfitters and other sample populations was computed to be $28 while for local anglers from the trout stamp sample, the mean willingness-to-pay was $10. For boaters, their mean willingness-to-pay was $72. To determine a total preservation value, these willingness-to-pay values were aggregated across all sample populations with 90% of the trout stamp population assumed to have a willingness-to-pay of $1 annually. Angler annual willingness-to-pay was converted into a one-time payment value using an 11% discount rate (Benson, 2006). The aggregate one-time preservation value was $332,000.

This value represents an underestimate of the economic value that society derives from preserving the NBP in its current state. If the broader population of non-users had been surveyed in this study throughout Maryland and the Mid-Atlantic region, this value would have been higher.

[18] These respondents had a zero response and indicated that either someone else should pay, government would waste the money, or that not enough money could be raised. Thus, their zero value did not accurately reflect their WTP value for continued operation of the dosers.

Logit model statistics

Output from LIMDEP software for Logit Model

```
+--------------------------------------------+
| Binary Logit Model for Binary Choice       |
| Maximum Likelihood Estimates               |
| Model estimated: Sep 11, 2010 at 10:09:25PM.|
| Dependent variable                   B9    |
| Weighting variable                 None    |
| Number of observations              230    |
| Iterations completed                  6    |
| Log likelihood function       -134.9171    |
| Number of parameters                  9    |
| Info. Criterion: AIC =          1.25145    |
|   Finite Sample: AIC =          1.25501    |
| Info. Criterion: BIC =          1.38599    |
| Info. Criterion:HQIC =          1.30572    |
| Restricted log likelihood     -159.4239    |
| McFadden Pseudo R-squared      .1537204    |
| Chi squared                   49.01341    |
| Degrees of freedom                    8    |
| Prob[ChiSqd > value] =         .0000000    |
| Hosmer-Lemeshow chi-squared =   5.72327    |
| P-value=  .67820 with deg.fr. =       8    |
+--------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Characteristics in numerator of Prob[Y = 1]					
Constant	1.67938264	1.259769	1.333	.1825	
BID	-.78775513	.18978547	-4.151	.0000	4.59307696
TRIPS	.15608000	.12362321	1.263	.2068	2.53043478
REASON	-1.05454498	.68129558	-1.548	.1217	.94347826
DAYS	.12171683	.11714502	1.039	.2988	2.20000000
QUALITY	.46428595	.21545481	2.155	.0312	.98695652
TOTAL	.00039300	.00033824	1.162	.2453	445.613043
AGE	.02125770	.01061270	2.003	.0452	48.0043478
NONLOCAL	.83491436	.42068815	1.985	.0472	.79130435

Information Statistics for Discrete Choice Model.			
	M=Model	MC=Constants Only	M0=No Model
Criterion F (log L)	-134.91715	-159.42385	-159.42385
LR Statistic vs. MC	49.01341	.00000	.00000
Degrees of Freedom	8.00000	.00000	.00000
Prob. Value for LR	.00000	.00000	.00000
Entropy for probs.	134.91715	159.42385	159.42385
Normalized Entropy	.84628	1.00000	1.00000
Entropy Ratio Stat.	49.01340	.00000	.00000
Bayes Info Criterion	1.36234	1.57544	1.57544
BIC(no model) - BIC	.21310	.00000	.00000
Pseudo R-squared	.15372	.00000	.00000
Pct. Correct Pred.	71.30435	.00000	50.00000

Means:	y=0	y=1	y=2	y=3	y=4	y=5	y=6	y>=7
Outcome	.5000	.5000	.0000	.0000	.0000	.0000	.0000	.0000
Pred.Pr	.5000	.5000	.0000	.0000	.0000	.0000	.0000	.0000

Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).
Normalized entropy is computed against M0.
Entropy ratio statistic is computed against M0.
BIC = 2*criterion - log(N)*degrees of freedom.
If the model has only constants or if it has no constants,
the statistics reported here are not useable.

Boater WTP Model

Binary Logit Model for Binary Choice	
Maximum Likelihood Estimates	
Model estimated: Sep 24, 2010 at 11:51:17AM.	
Dependent variable	B9
Weighting variable	None
Number of observations	70
Iterations completed	8
Log likelihood function	-29.73346
Number of parameters	8
Info. Criterion: AIC =	1.07810
Finite Sample: AIC =	1.11182
Info. Criterion: BIC =	1.33507
Info. Criterion:HQIC =	1.18017
Restricted log likelihood	-47.11082
McFadden Pseudo R-squared	.3688612
Chi squared	34.75471
Degrees of freedom	7
Prob[ChiSqd > value] =	.1243551E-04
Hosmer-Lemeshow chi-squared =	9.07316
P-value= .24745 with deg.fr. =	7

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Characteristics in numerator of Prob[Y = 1]					
Constant	1.36817897	5.05844726	.270	.7868	
BID	-2.42828472	1.13332074	-2.143	.0321	4.14215776
ENVPROB_A	.68018993	.72294806	.941	.3468	.25714286
TRIPS	-.49970885	.38831618	-1.287	.1981	1.85714286
ENVPROB_B	1.70429063	.85321360	1.997	.0458	.70000000
QUALITY	1.45342395	.61707493	2.355	.0185	1.45714286
TOTAL	.55925047	.20146923	2.776	.0055	2.51285714
REASON	4.90086955	2.78178635	1.762	.0781	.91428571

Information Statistics for Discrete Choice Model.			
	M=Model	MC=Constants Only	M0=No Model
Criterion F (log L)	-29.73346	-47.11082	-48.52030
LR Statistic vs. MC	34.75471	.00000	.00000
Degrees of Freedom	7.00000	.00000	.00000
Prob. Value for LR	.00001	.00000	.00000
Entropy for probs.	29.73346	47.11082	48.52030
Normalized Entropy	.61280	.97095	1.00000
Entropy Ratio Stat.	37.57368	2.81897	.00000
Bayes Info Criterion	1.27438	1.77087	1.81114
BIC(no model) - BIC	.53677	.04027	.00000
Pseudo R-squared	.36886	.00000	.00000
Pct. Correct Pred.	81.42857	.00000	50.00000

Means:	y=0	y=1	y=2	y=3	y=4	y=5	y=6	y>=7
Outcome	.6000	.4000	.0000	.0000	.0000	.0000	.0000	.0000
Pred.Pr	.6000	.4000	.0000	.0000	.0000	.0000	.0000	.0000

Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).
Normalized entropy is computed against M0.
Entropy ratio statistic is computed against M0.
BIC = 2*criterion - log(N)*degrees of freedom.
If the model has only constants or if it has no constants, the statistics reported here are not useable.

```
+---------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable B9         |
+---------------------------------------+
| Proportions P0= .600000   P1= .400000  |
| N =      70 N0=      42   N1=      28  |
| LogL=      -29.733 LogL0=     -47.111  |
| Estrella = 1-(L/L0)^(-2L0/n) = .46178  |
+---------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .41449 |    .36886  |       .72094  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .41863 |    .57826  |       .39134  |
+---------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.07810       1.33507  |
+---------------------------------------+
```

Qualitative methods

The survey instrument included several open-ended questions to capture additional comments and opinions. The comments from these questions, as well as e-mail and phone call communication from interested parties, were analyzed through an open coding process (Berg, 2007), then organized and refined to determine key themes that offer more detailed understandings of changes and issues on the NBP.

In addition to data collected through our survey instrument, we also solicited information from angling outfitters using focus group, questionnaire, and interview formats. A two-page questionnaire was developed integrating previous research and relevant concepts, and asked about outfitters' background, customer base, and experiences on the NBP; this questionnaire guided the focus group and interviews. Between March and August 2010, a total of eight angling and five whitewater boating outfitters offered information about their business experiences on the NBP.

Between March and August 2010, we conducted additional semi-structured interviews with other businesses, officials, and residents about their experiences with changes in water quality on the NBP. Interviews were used because they can capture complexity and depth of contextual meanings and real world phenomena, and offer rich and detailed understandings of issues through the structure and responsiveness of the research process (Berg, 2007; Rubin and Rubin, 2005). We contacted commercial angling and whitewater boating outfitters, outfitting stores, and food and lodging businesses. We also contacted other businesses and officials with knowledge of existing or proposed water withdrawal permits for the NBP.

Qualitative survey responses

Survey respondent comments from three open-ended response questions demonstrate the intensity of interest in this issue from survey respondents (Table 31).

Table 31: Number of comments from survey's open response questions

	Number of respondents	Number commented	Percent commented	Total
Angler	306	153	50%	**248**
Boater	79	47	59%	**80**
Total	**385**	**200**	**52%**	**328**

One open-ended survey question specifically asked respondents about suggestions to improve their recreational experiences. Although boaters and anglers had some different suggestions, overlaps included the following: increase recreational releases from the dam, increase releases during the summer months, improve water quality, increase camping opportunities, and address elements of the pulp mill as shown in Table 32.

Table 32: Summary of suggested improvements from survey respondents

Anglers	Boaters
Increase recreational releases from the dam	Increase recreational releases from the dam
Provide releases during the summer months	Provide releases during the summer months
Improve water quality	Improve water quality
Increase camping opportunities (e.g., Keyser to Cumberland)	Increase camping opportunities, improve scheduling with Lake
Clean pulp mill discharge	Remove pulp mill odor
Increase and improve trails and access	Increase recreational releases on the Savage River
Increase enforcement, curb poaching	
Reduce flows of releases to accommodate wading	
Increase stocking/stop stocking (more wild)	
Reopen trout rearing pens	
Address nitrogen below dam	
Respect private property	

APPENDIX B: RIPARIAN LAND USE

The eight dosers were placed in the 1990s and 2000s. A comparison of land use from 1973 and 2002—the latest year for which land use data are available—helps to understand whether these dosers and the improved water quality in the NBP have had a noticeable impact on land use patterns. These data suggest that, overall, land use near the NBP has not changed substantially in the previous three decades.

The five river sections shown above in Figure 19 are used here, and include:

1. Kempton to Potomac State Forest,
2. Potomac State Forest (through Jennings Randolph Lake) to North Branch FMA,
3. North Branch FMA to Keyser,
4. Keyser to Pinto, and
5. Pinto to the Cumberland Dam.

Table 33: Land use patterns in Maryland within one-half mile of the North Branch Potomac, 1973

Section	Agri-cultural	Extractive and barren	Forest	Other develop-ment	Water and wetlands
1. Kempton to Potomac State Forest	18.8%	0.5%	80.4%	0.3%	0.0%
2. Potomac State Forest to North Branch FMA	5.0%	7.2%	79.7%	2.5%	5.6%
3. North Branch FMA to Keyser	1.7%	0.0%	72.5%	22.8%	3.0%
4. Keyser to Pinto	44.2%	0.0%	39.8%	10.5%	5.4%
5. Pinto to the Cumberland Dam	11.0%	1.0%	36.2%	44.7%	7.1%

Table 34: Land use patterns in Maryland within one-half mile of the North Branch Potomac, 2002

Section	Agri-cultural	Extractive and barren	Forest	Other develop-ment	Water and wetlands
1. Kempton to Potomac State Forest	14.7%	4.8%	77.7%	2.8%	0.0%
2. Potomac State Forest to North Branch FMA	2.9%	7.8%	80.2%	3.4%	5.6%
3. North Branch FMA to Keyser	1.1%	0.0%	69.7%	25.2%	4.1%
4. Keyser to Pinto	34.7%	0.0%	44.7%	15.1%	5.5%
5. Pinto to the Cumberland Dam	7.1%	0.0%	44.9%	41.1%	6.9%