STATE OF THE WATERSHED: ELK HEADWATERS, WEST VIRGINIA

October 20, 2008

Submitted to:

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

ABBREVIATIONS

CWP	comprehensive watershed plan
DO	dissolved oxygen
EHWA	Elk Headwaters Watershed Association
GIS	geographic information system
mg/L	milligram per liter
PADEP	Pennsylvania Department of Environmental Protection
PCPSD	Pocahontas County Public Service District
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

ACKNOWLEDGMENTS

This report was funded by the West Virginia Department of Environmental Protection Agency Nonpoint Source Program via a grant to the West Virginia Conservation Agency. The Elk Headwaters Watershed Association played a key role in organizing community support for this project.

Numerous people participated in meetings and supplied data and information, without which this report would not have been possible. The authors would like to thank the following people, and apologize for inadvertently omitting the names of others that also deserve to be thanked: Ralph Beckwith, George Bell, Leon Brown, Tim Craddock, Michael Dougherty, Thelma J. Fisher, Jen Fulton, Alvan Gale, J.F. Hodges, Sharon Kearns, Craig Mains, Larry Orr, Todd Petty, Tolly Peuleche, George Phillips, Pam Russell, Cynthia Sanders, Dave Saville, Tom Shipley, Gil Willis, and John Wirts.

1. INTRODUCTION

The Elk River headwaters, located in Pocahontas, Webster, and Randolph Counties of West Virginia, provide some of the best trout fishing in West Virginia and perhaps the whole eastern United States. The clean, clear, cold water in the Elk supports three kinds of reproducing trout and the highest biodiversity of fish in West Virginia: over 70 species (Stauffer et al., 1995). In addition to fish, the land and water in the upper Elk provide habitat for diverse species of breeding birds, and even for an endemic crayfish (Jezerinac et al., 1994).

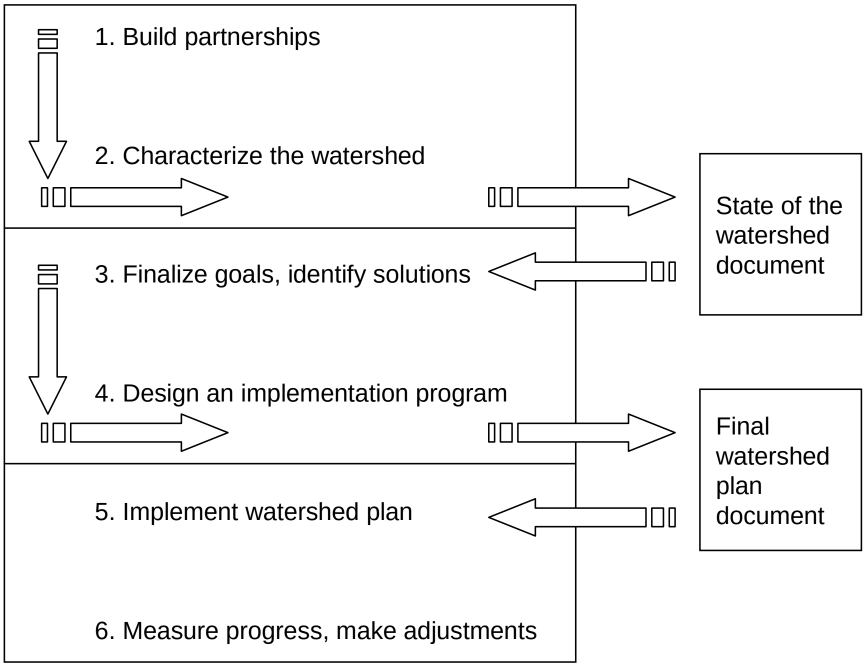
Timbering and tourism play major roles in the economy of the Elk Headwaters. Beckwith Lumber Company, which operates in many West Virginia counties, keeps its headquarters in Slaty Fork. Snowshoe Mountain Resort is a major draw to the area. Family-run operations depend on the pristine nature of the streams to help draw visitors to the headwaters to fish, hike, bike, and stay overnight. Together, these large and small businesses account for a significant amount of economic activity.

In the headwaters area, several debates in recent years have involved water quality and economic development issues. Residents, engineers, agencies, and local government entities have been debating the need and best location for a centralized wastewater treatment plant that would serve Snowshoe as well as residents and businesses in the valley. The fast pace of development of the watershed is a concern to some residents, and sedimentation of streams and more frequent flooding—two effects often linked to development—have been noted. In meetings in early 2008, stakeholders have identified other potential threats to water quality should proper management practices not be used: construction sites, riparian disturbances, aging septic systems, new impervious surfaces, logging operations, and farms.

If discharges are not controlled, these activities have the potential to discharge bacteria, nutrients, organic loads, heat, and suspended solids into the Elk Headwaters. These pollutants, as well as increased flows from impervious areas, can reduce aquatic invertebrate populations and threaten the trout and birds that depend on them. Threats to the ecological health of the Elk Headwaters are also ultimately threats to the economy that depends on clean water.

In early 2008, local stakeholders joined together to start to develop a Comprehensive Watershed Plan (CWP) that links future economic development with habitat protection. Figure 1 presents the general steps in the watershed planning and implementation process.

Figure 1: Steps in the watershed planning and implementation process



Source: USEPA (2005), with some adjustments.

The first Elk stakeholder meetings focused on identifying issues of concern and building partnerships—Step 1 in Figure 1. To help develop a common frame of understanding of the watershed as early as possible, stakeholders decided to develop this State of the Watershed report first, before going through the full CWP process.

This report characterizes the watershed based on the readily available data. An Expanded State of the Watershed report may be developed next that incorporates new data collected to support the CWP process. The ultimate goal of this process is to develop, and then implement, a CWP that is grounded in science and data and that reflects the goals and concerns of local stakeholders.

In short, stakeholders are aware of the unique nature of their watershed and are taking proactive steps now to ensure that it brings value to their local economy into the future.

2. WATERSHED CHARACTERISTICS

The Elk Headwaters watershed[1] extends from the headwaters above Slaty Fork to Webster Springs and drains approximately 241 square miles, as shown in Figure 2. The Elk Headwaters Watershed Association (EHWA) focuses its efforts on a somewhat smaller watershed: from the upper reaches of the headwaters downstream to Bergoo. For this report, there was a consensus among stakeholders to collect baseline information for the entire Elk Headwaters watershed, with the anticipation that the final CWP would focus most intensively on the Old Field Fork, Slaty Fork, and Big Spring Fork subwatersheds in Pocahontas County (Figure 3). Big Spring Fork drains a portion of Snowshoe Mountain Resort, and the debate regarding a new wastewater treatment plant has discussed sites in the Big Spring Fork and Old Field Fork subwatersheds. Table 1 lists general characteristics of all eight subwatersheds in the Elk Headwaters watershed.

Table 1: Elk Headwaters subwatershed characteristics

Subwatershed	Area (Square miles)	Stream length (Miles)	Average elevation (Feet)	Elevation range (Feet)
Abb Run	32	64	2,982	1,880 – 4,344
Back Fork	47	98	2,986	1,444 – 4,049
Bergoo Creek	51	114	2,923	1,440 – 4,495
Dry Fork	33	23	3,264	2,264 – 4,692
Big Spring Fork	21	48	3,448	2,661 – 4,843
Old Field Fork	28	38	3,504	2,661 – 4,705
Slaty Fork	5	5	3,655	2,713 – 4,423
Sugar Creek	23	49	2,841	1,913 – 4,049

[1] For this report, the Elk Headwaters watershed is based on 10-digit hydrologic unit code watershed called Upper Elk. While the United States Geological Survey (USGS) divides the Upper Elk into six subwatersheds, the Old Field Fork subwatershed is further subdivided in this report into three smaller subwatersheds: Old Field Fork, Big Spring Fork, and Slaty Fork. A total of eight subwatersheds are therefore included in this analysis.

Figure 2: The Elk Headwaters study area

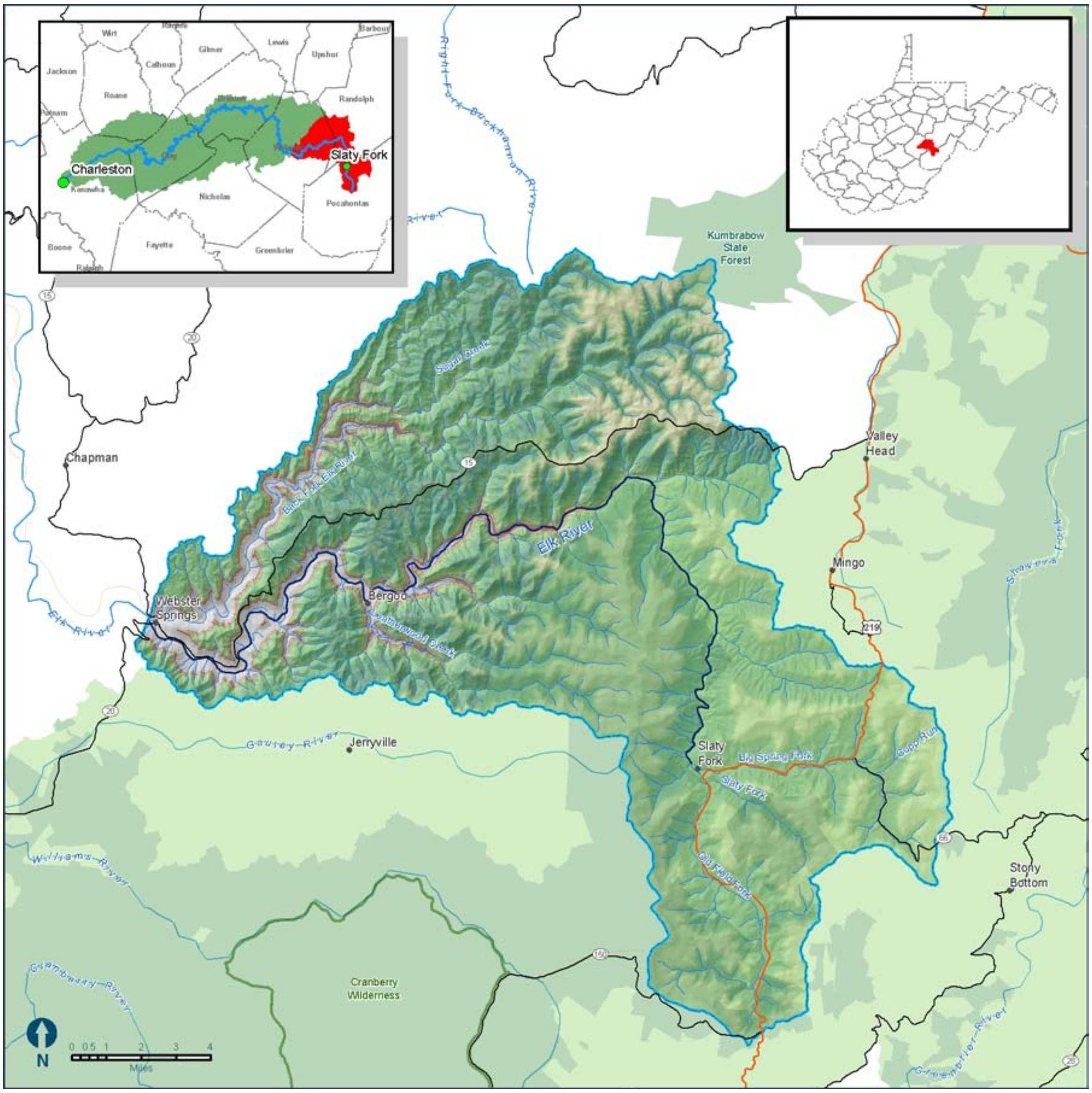


Figure 3: Subwatersheds in the Elk Headwaters watershed

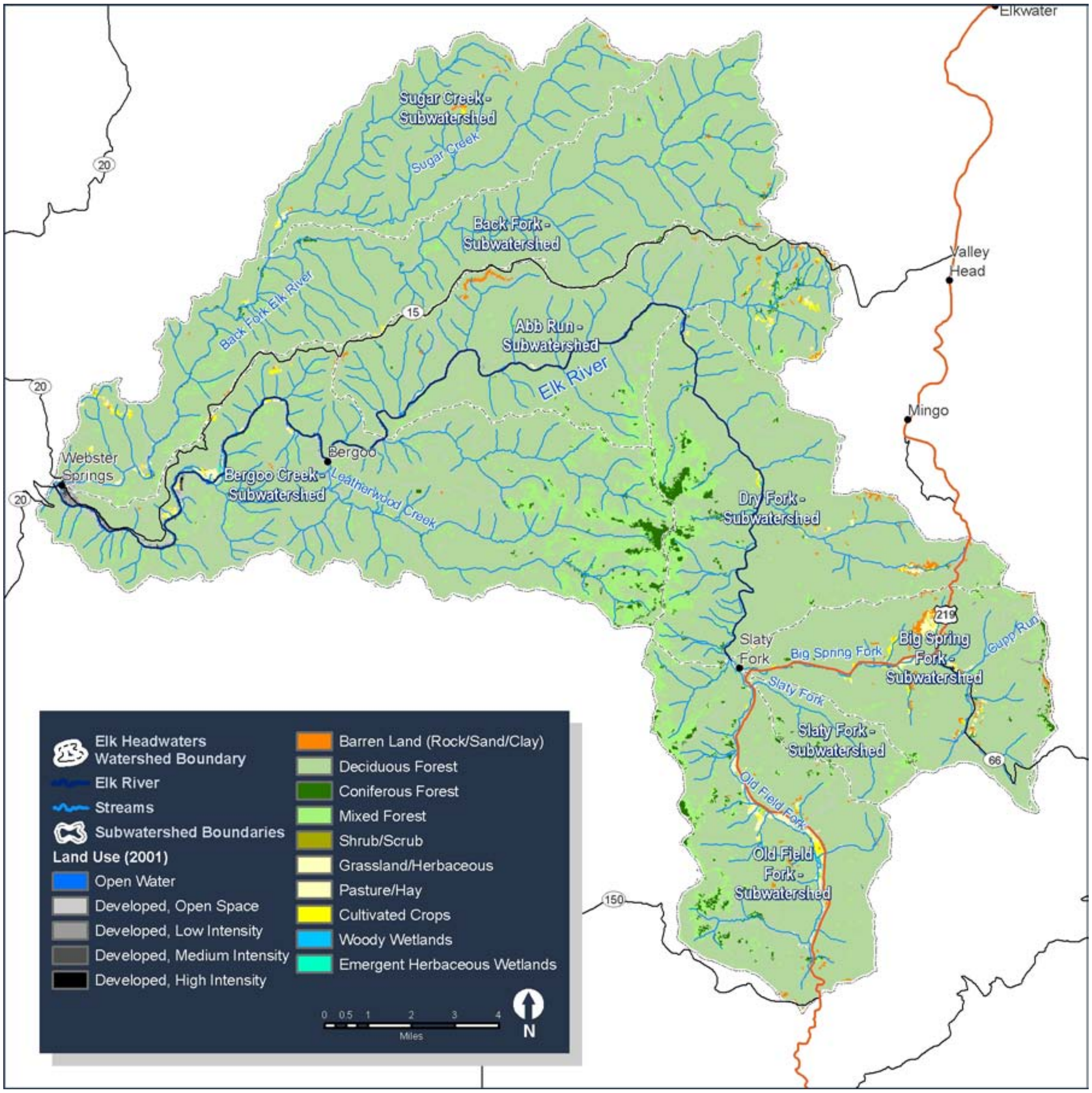
2.1 Land use

The Elk Headwaters is almost entirely forested, with 88.4% in deciduous forest, 5.6% in mixed forest, and 1.1% in coniferous forest in 2001 (Table 2 and Figure 4). However, many new developments have been built since this time, and these developments are not reflected in the 2001 data.

Table 2: Land use characteristics of the Elk Headwaters watershed (2001)

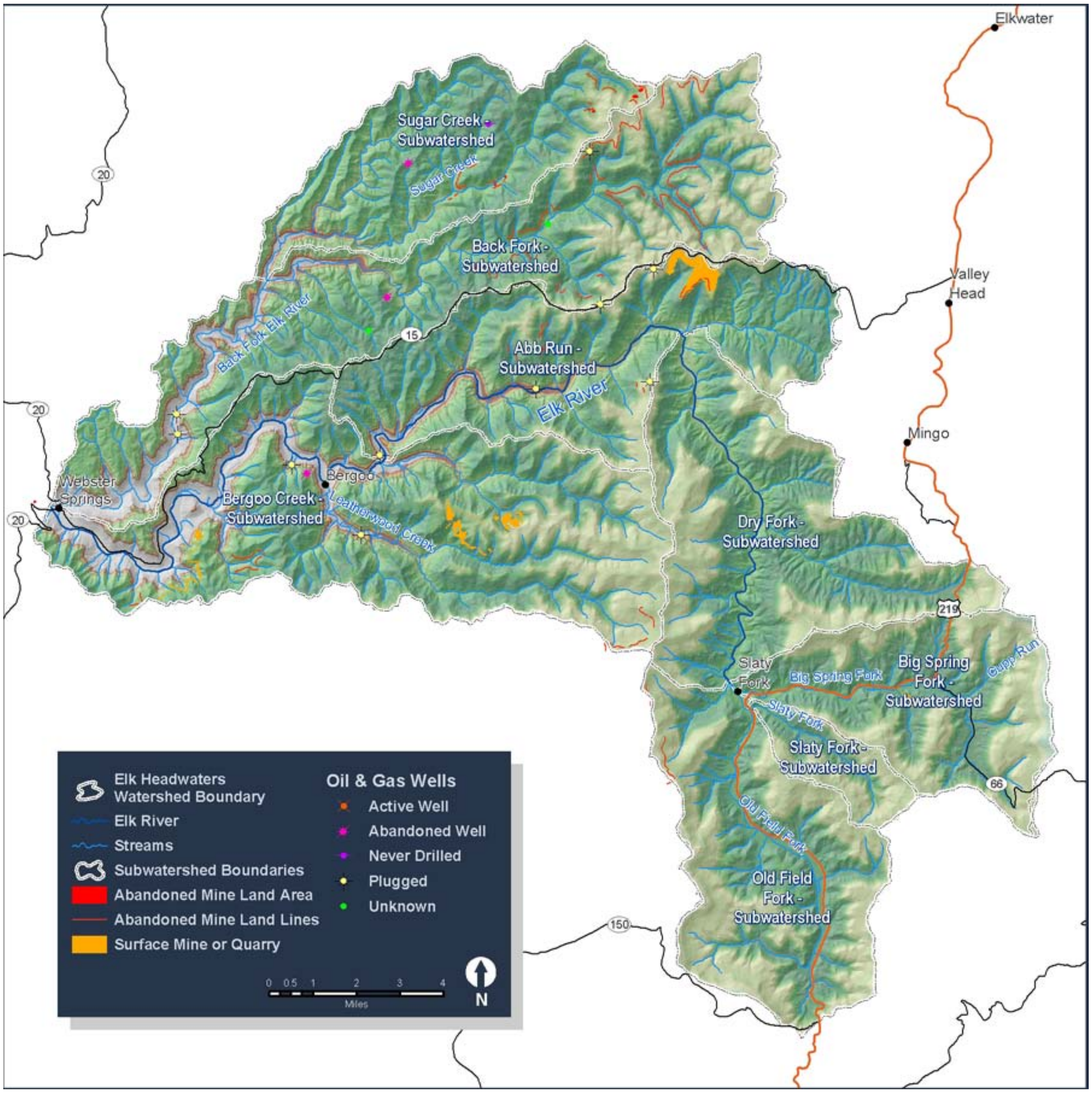
Land use description	Acres	Percent within watershed
Deciduous Forest	136,244	88.4%
Mixed Forest	8,601	5.6%
Developed, Open Space	4,897	3.2%
Coniferous Forest	1,731	1.1%
Pasture/Hay	806	0.5%
Barren Land (Rock/Sand/Clay)	710	0.5%
Cultivated Crops	517	0.3%
Open Water	257	0.2%
Developed, Low Intensity	226	0.1%
Developed, Medium Intensity	77	0.1%
Emergent Herbaceous Wetlands	35	0.02%
Woody Wetlands	22	0.01%
Developed, High Intensity	10	0.0%

Figure 4: Land use (2001)



Historical and current mining and quarry activities are minimal compared with some areas of West Virginia, but still have the potential to impact water quality. A total of 19 acres of abandoned mine lands, 1,615 acres of permitted surface coal mines, and 49 acres of underground coal mines are found within the watershed. In addition, 64 acres of permitted quarries are located within the watershed, with 48 acres actually disturbed. As of May 2008, 18 oil and gas wells are located across the watershed. Additional natural gas wells have the potential to be drilled now that the Marcellus Shale is being developed (See Section 2.3). Mining areas and wells are shown in Figure 5

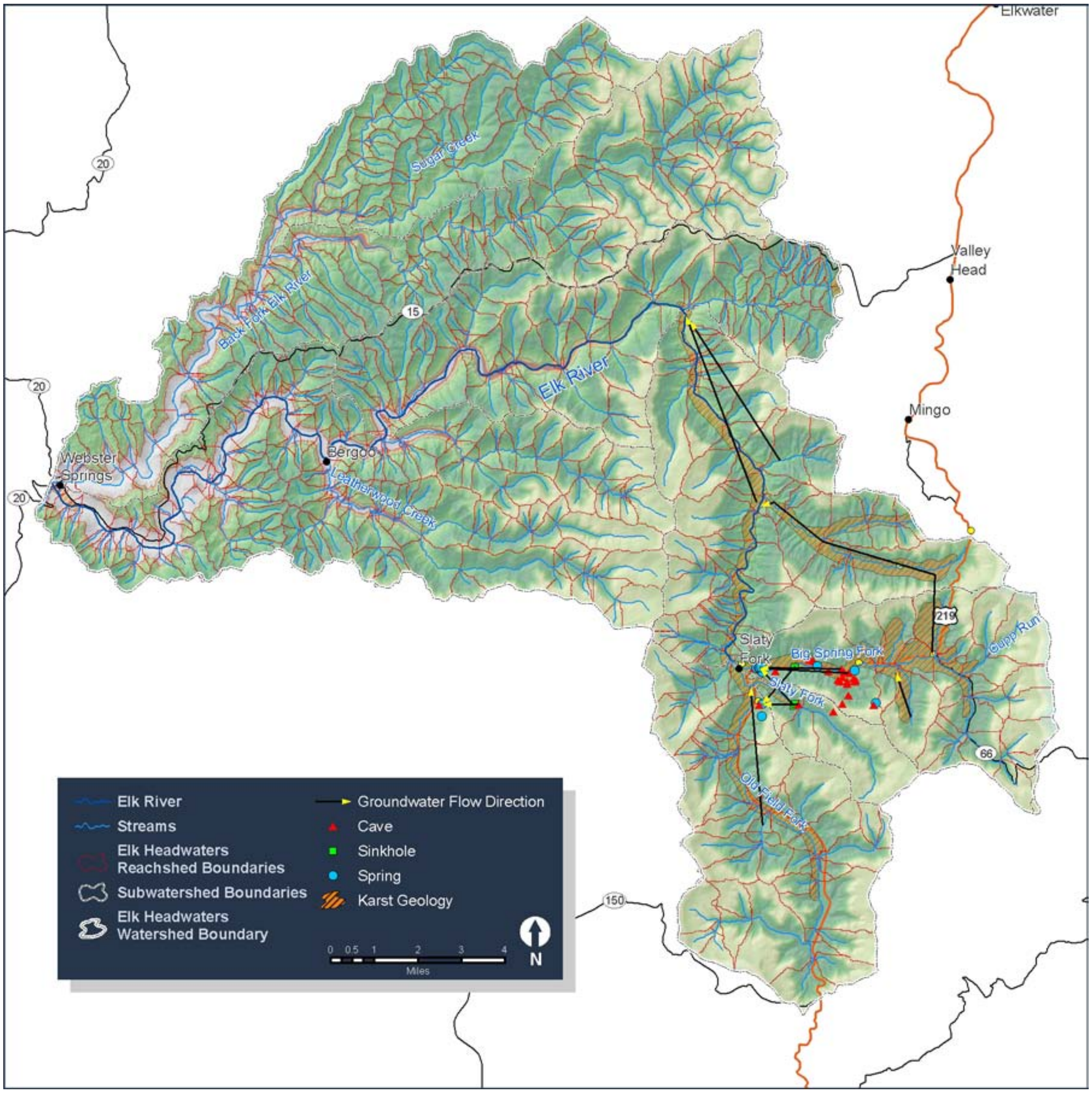
Figure 5: Mining and oil and gas operations



2.2 Surface water and karst hydrology

To map the Elk Headwaters—and to enable modeling in future phases of the CWP—a geographic information system (GIS) model was created that is comprised of reaches (streams), reachsheds (catchments of individual reaches), nodes, and other relevant watershed data. The eight subwatersheds in the Elk Headwaters watershed are further divided into 674 reachsheds, as shown in Figure 6.

Figure 6: Hydrology and karst features



This region has complex connections between surface water and groundwater due to karst geology. Karst is very important because as limestone dissolves, cavities and sinkholes develop. In some locations, surface water flows underground and travels through caves, and in other locations, underground streams flow back to the surface. Dry streambeds are not uncommon during some periods of the year. In fact, the Elk River north of Slaty Fork may be the largest sinking stream in West Virginia (Jones, 1997).

The karst geology in the Elk Headwaters provides one of the watershed's unique recreational resources: caves. But karst also affects the stability of the surface and makes the watershed sensitive to pollution. For example, if polluted water is transported in pipes across karst terrain, cracked pipes could discharge pollution directly to groundwater. Or if a wastewater treatment plant is built above karst-related cavities, this could lead to structural instability, with potential pollution discharges. Another potential effect of karst features is that sediment flowing downstream may be stored underground during low flows, only to be discharged back to the surface during high flows (Petty et al., 2005).

2.3 Marcellus Shale

In recent years, the potential for tapping the natural gas resources in the Marcellus Shale has become a topic of debate among surface and mineral owners in the Elk Headwaters watershed. The Marcellus Shale contains trillions of cubic feet of natural gas (USGS, 2002; PADEP, 2008), and new technologies have made it economical to tap this resource. In addition to the Elk Headwaters watershed, the Marcellus Shale underlies virtually all of West Virginia and portions of Ohio, Maryland, Pennsylvania, and New York (USGS, 2002).

Elk stakeholders report that land agents are making offers to lease land in order to access the Marcellus Shale. Concerns about the potential effects of Marcellus Shale drilling on water resources have been voiced by landowners, environmental organizations, and the West Virginia Farm Bureau (Kusik, 2008).

While leases can bring in much-needed money, water pollution and water quantity are concerns. In fact, in routine inspections, the Pennsylvania Department of Environmental Protection (PADEP) found violations at Marcellus Shale drilling operations that threatened the state's water resources. These violations included "poorly constructed water impoundments, inadequate erosion and sediment controls, improper waste and fluid disposal and unregistered and unapproved water withdrawals from streams." (PADEP, 2008)

Regarding pollution, well drillers pump fracing fluid into these wells in order to fracture the shale and release the natural gas. A portion of this fluid is returned to the surface. The exact composition of this fluid is considered proprietary by the gas companies, but some reports suggest that it contains substances that can harm the environment. The West Virginia Department of Environmental Protection (WVDEP) does not currently issue a special permit related to the discharge of this fluid from Marcellus Shale wells. PADEP issued its first Marcellus Shale permit in August 2008. At this early stage of the development of practices and permits for these wells, pollution from these wells remains a potential concern.

A second concern is water quantity. Finishing a Marcellus Shale well may take million of gallons of water, which may be withdrawn from local streams. Streams in the Elk Headwaters are not large, and the withdrawal of millions of gallons of water has the potential to noticeably affect flows, habitat, stream temperature, and the ecological health of the waters.

3. PRELIMINARY STAKEHOLDER ISSUES

Local stakeholders began meeting in 2008, and through a facilitated process identified preliminary issues to consider in a CWP. While a range of issues were raised, they are condensed into three main water-related issues:

1. Clean water,
2. Wastewater treatment, and
3. Sedimentation and flooding.

These water-related issues were raised in a broader context that recognized the importance of preserving traditional rural industries such as logging and agriculture in the Elk Headwaters. These industries continue to support the local economy, and they also help the community retain important cultural values.

Nature-based tourism also plays a major role in the area: Snowshoe Mountain Resort brings visitors to the watershed to ski, hike, and mountain bike. And smaller, family-run inns and guide services depend on the high quality streams and ecosystems to attract visitors.

Together, the traditional and tourism-based industries have a parallel vision for sustainability, a vision that will secure not only the community's economic future, but also its environmental integrity. The challenge with developing a CWP in such a watershed is for stakeholders with different viewpoints to develop a common vision, which will preserve the culturally significant industries and continue to support other sustainable interests.

3.1 Clean water

Water quality is a driving force that unites stakeholders in a common vision of a clean, sustainable watershed. For example, during an initial meeting, one stakeholder offered the following preliminary goal of a CWP for the Elk Headwaters: "West Virginia's cleanest rivers."

The fact that trout thrive in the Elk Headwaters is an indication of how clean the water remains, and also helps explain how clean water and a healthy economy are tied so closely together in this region. Trout are more sensitive to pollution than warm water fish species, as reflected by West Virginia's more stringent water quality criteria in trout waters for temperature, dissolved oxygen (DO), turbidity, iron, and six other parameters (Hansen, 2007).

Water quality can be impacted in many different ways. For example, bacteria from poorly treated wastewater can make water contact recreation unsafe: People who contact the water when swimming, fishing, or boating can get sick. Organic materials from wastewater can lead to algae blooms, which deplete oxygen from streams and make it difficult for fish to survive. Sedimentation from construction sites, farm fields, logging operations, or other sources can bury aquatic habitat, reduce insect populations, and harm fish that rely on insects for food. Sedimentation can also lead to additional frequency and severity of flooding. New impervious surfaces—roads, driveways, and roofs that come along with new development—produced faster flushes of storm water and more flooding.

The most fundamental goal of this State of the Watershed report is to compile existing data on water quality to understand where water is clean, where it is not, and what types of pollutant sources may be responsible.

3.2 Wastewater treatment

In 2002, WVDEP issued orders that cited numerous violations of Snowshoe Mountain Resort's National Pollutant Discharge System Elimination System (NPDES) permits for their three wastewater treatment plants. A vigorous debate ensued regarding the most appropriate approach for meeting Snowshoe's needs, while also serving the valley. In fact, wastewater treatment has been the most high-profile water quality issue in the Elk Headwaters watershed in the past decade.

Snowshoe's initial plans for treatment on the mountain were eventually shifted into plans for a regional plant in the valley. Opposition then focused on plans to site the plant on karst terrain on a parcel that had recently flooded, the danger of piping raw sewage across fragile karst, and the discharge of warm effluent into the headwaters of the Elk River.

In 2008, the Pocahontas County Commission determined that this parcel would no longer be considered. Later this year, the Pocahontas County Public Service District (PCPSD) chose a new site for the plant on Cupp Run, known as Alternative 7.

At the initial stakeholder meetings for the CWP, wastewater treatment issues were still front and center. While the CWP will not substitute for the engineering and environmental analyses that are required before a site can be formally selected and built, the CWP and this State of the Watershed report can inform residents and decision makers about wastewater-related water quality issues, and can help develop a common frame of understanding from which to move forward with wastewater decisions.

3.3 Sedimentation and flooding

Stakeholders also identified sedimentation and flooding as a second major issue in the Elk Headwaters watershed. According to anecdotal reports, Big Spring Fork has flooded more intensely in recent years. Anecdotal reports have also been provided of practices along stream banks that are likely to lead to additional sedimentation.

Sedimentation occurs when dirt is washed from the land or stream banks into the streams, and is deposited on the stream bed. Erosion can be natural, but is greatly accelerated when land is disturbed without proper best management practices when houses are built, fields are plowed, and hills are logged.

Sediment in streams can smother aquatic insects that fish rely on for food and can bury fish eggs (Sanders, 2004). In small streams, sedimentation not only reduces the diversity of fish, but also affects other animal communities (Waters, 1995). Trout, in particular, are more sensitive to sediment compared with warm water fish, as reflected by West Virginia's more stringent water quality criterion for turbidity in trout waters (47 Codes of State Rules 2, Appendix E, Section 8.32.1).

Flooding was also identified by the stakeholders as a key concern, and flooding and sedimentation can be directly related. Increased sediment loads can make stream channels smaller and can lead to greater flooding, because the same amount of water has less volume in which to flow. This increased flooding can then erode even more soil and lead to even greater amounts of sedimentation.

Flooding can have other causes. Development that increases impervious areas—roofs, driveways, and roads—causes faster flushes of stormwater to run into nearby streams. Compared with natural conditions, the same amount of precipitation therefore causes higher stream flows shortly after it rains.

In summary, activities that can cause erosion, sedimentation, and flooding include developing new impervious areas, performing improper operations on stream banks, channelizing stream flow, disturbing areas for construction, and modifying natural stream paths.

4. WATERSHED ANALYSIS RESULTS

For this State of the Watershed report, readily available data have been collected from a variety of reports (WVDEP, 1997; Sanders, 2004; Petty et al., 2005) and databases (EHWA, Trout Unlimited, WVDEP, WVDNR). When compiled, these data help local stakeholders reach a common understanding regarding the health of the water and issues related to wastewater treatment and sedimentation and flooding. Additional data collection is warranted before a final CWP is developed; these data needs are outlined in Chapter 6.

4.1 Clean water

4.1.1 Trout

Trout have been found throughout the Elk Headwaters; Figure 7 highlights the reachsheds in which brook, brown, or rainbow trout have been found by the West Virginia Division of Natural Resources (WVDNR) or by Sanders (2004), a West Virginia University (WVU) student who recently completed a master's thesis on the Elk Headwaters. Reachsheds in which fish data were compiled are shown as green or red, depending on whether or not trout were found. No trout data are available in the rest of the watershed, which is shaded gray.

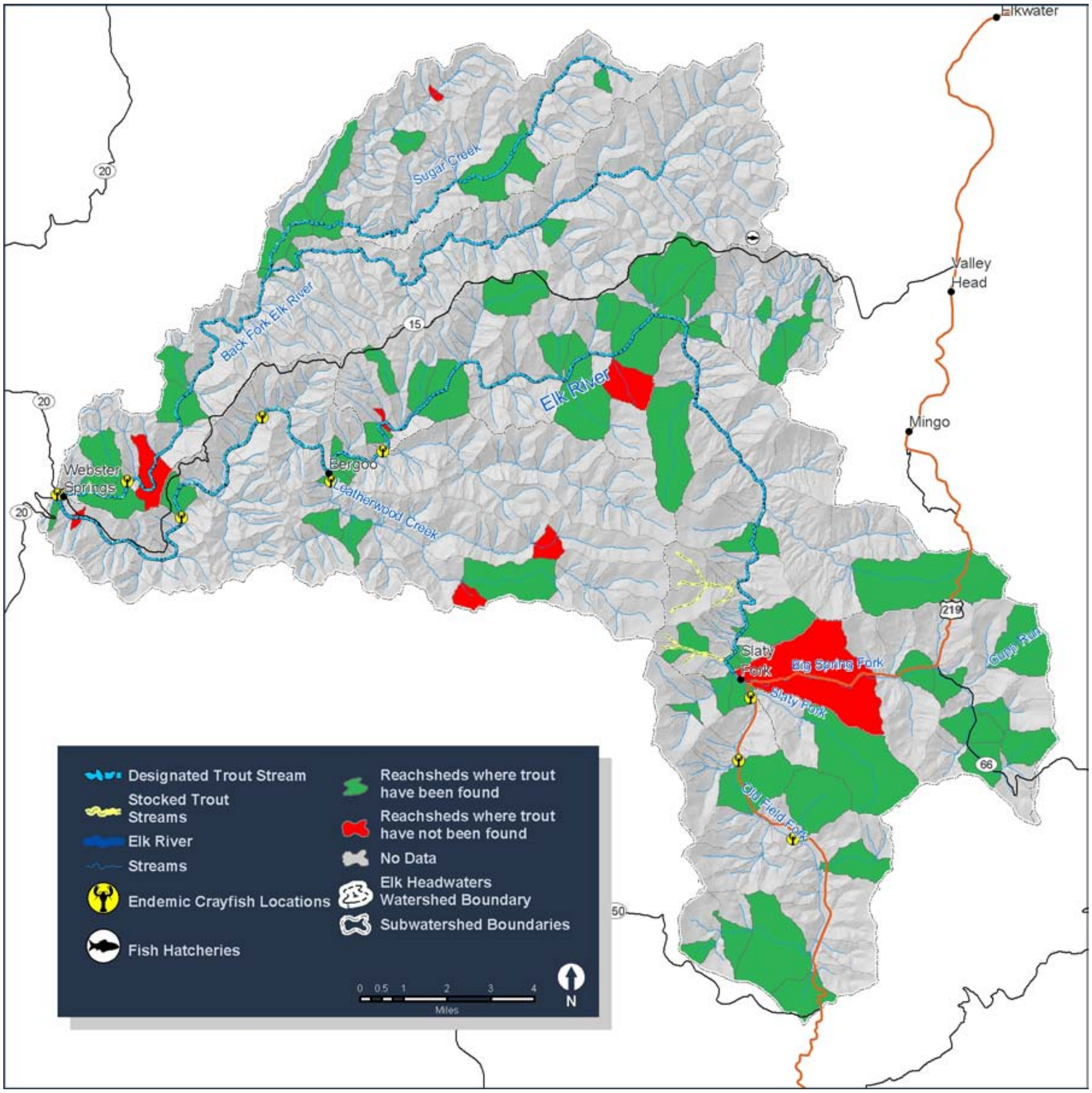
Of the 77 reachsheds surveyed by WVDNR and Sanders, trout were found in 69. The stories about the abundance of a variety of trout in the Elk Headwaters—as told by recreational guides and fly fishers and reported in trout magazines—are not just fish stories, but are backed up by scientific data.

Trout streams are also regulated differently by WVDEP. The streams shown in Figure 7 as "Designated Trout Streams" are listed as "Trout Waters" in the West Virginia Water Quality Standards rule (47 Code of State Rules 2, Appendix A). These waters receive more stringent water quality protections. Figure 7 also shows trout streams stocked by WVDNR.

As far back as 1970, WVDNR documented trout in the Elk Headwaters (Figure 8). From the 1970s through recent years, it has not been uncommon for WVDNR to find dozens—or even more than 100—individual trout in the Elk Headwaters.

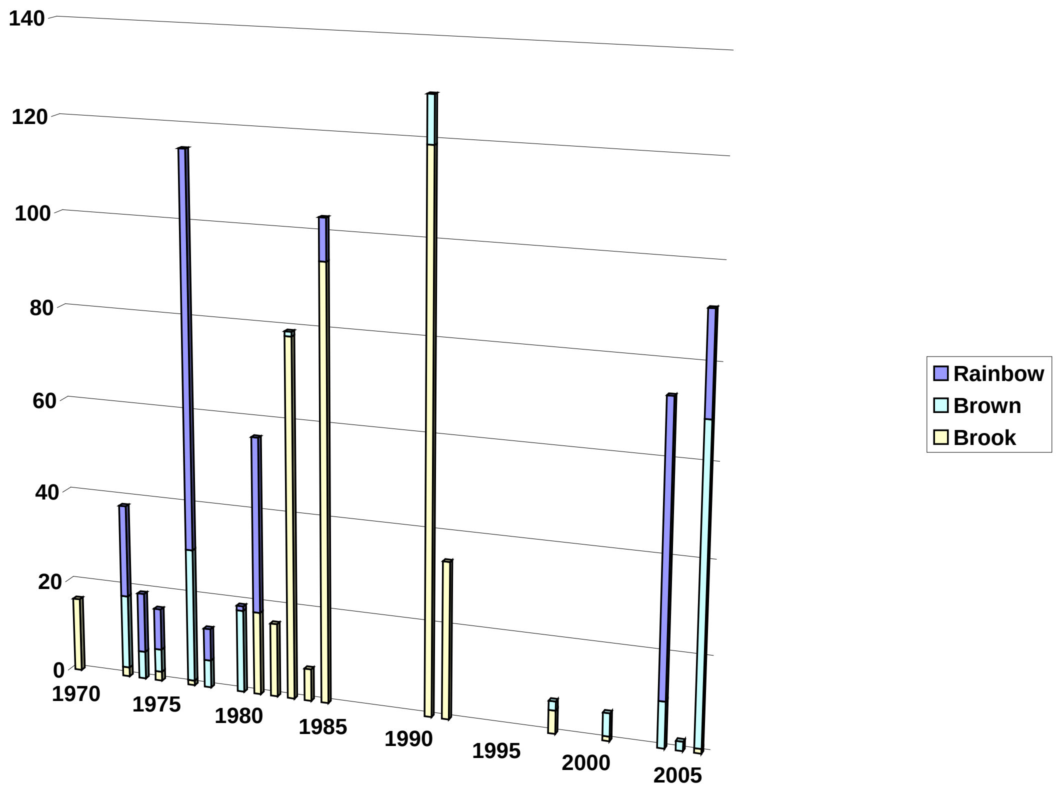
In addition to trout, the Elk Headwaters also supports an endemic crayfish (Jezerinac et al., 1994). These crayfish have been found at numerous locations throughout the headwaters, as shown by the yellow circles in Figure 7.

Figure 7: Trout and endemic crayfish



Source: Trout abundance from WVDNR database and Sanders (2004).

Figure 8: Trout abundance over time



Source: Trout abundance from WVDNR database and Sanders (2004).

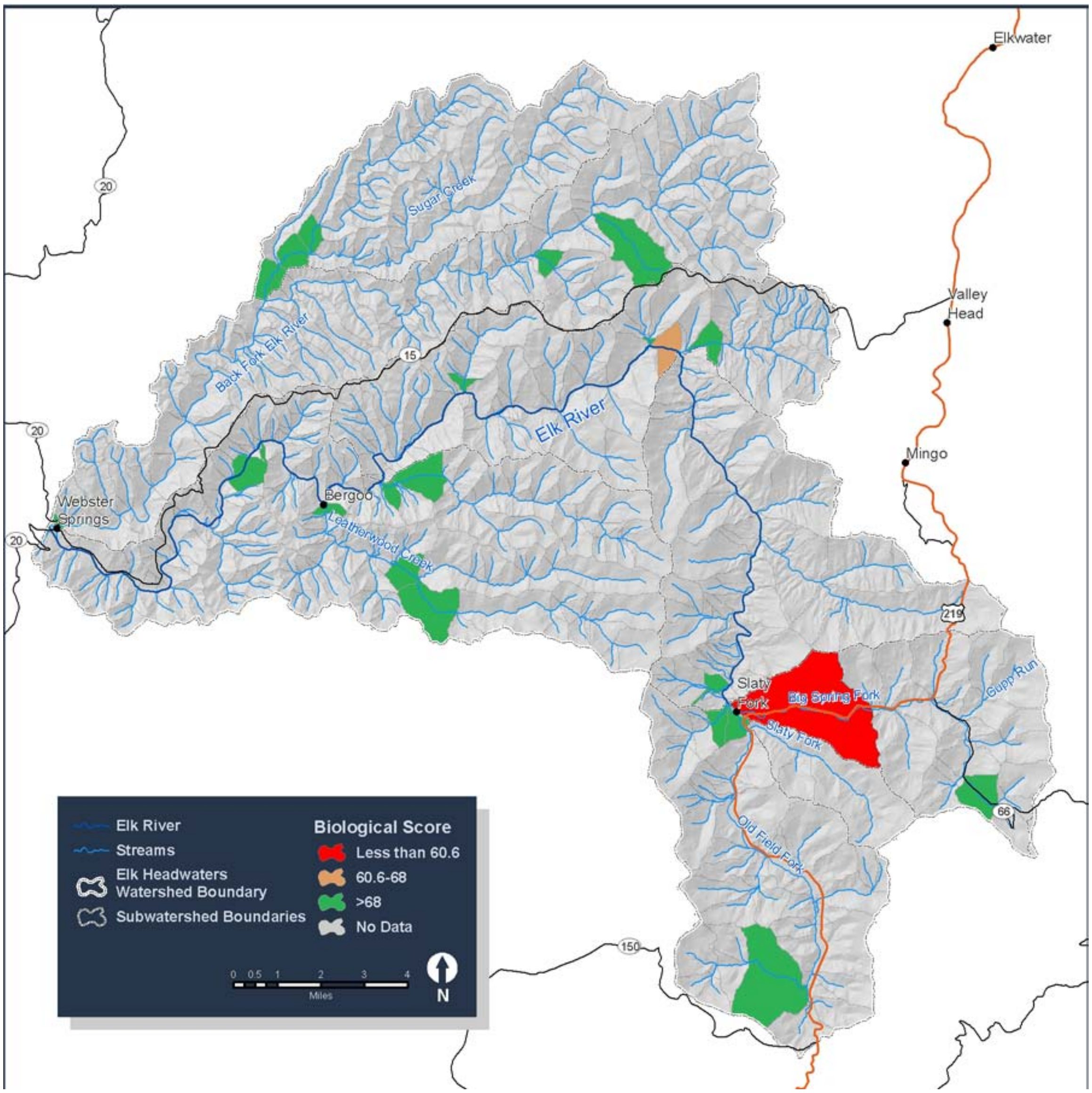
4.1.2 Benthic macroinvertebrates

The biological health of streams can be measured not just by the presence of fish, but also by the number and diversity of benthic macroinvertebrates. After collecting, identifying, and counting these insects, the West Virginia Stream Condition Index (WVSCI) is typically used to rank streams from zero to 100 (Tetra Tech, 2000). This metric, in turn, is then used by WVDEP to make impairment determinations. Streams are considered impaired with scores below 60.6, unimpaired with scores above 68, and in a gray zone between 60.6 and 68.[2]

Of the 48 WVSCI scores calculated in the Elk Headwaters watershed between 1997 and the present, only three would qualify the stream as impaired (Figure 9). All three of these low WVSCI scores were found on Big Spring Fork. One additional data point is in the gray zone; this point is on the Elk River and is shaded orange in Figure 9. Reachsheds for which no data are available are shaded gray.

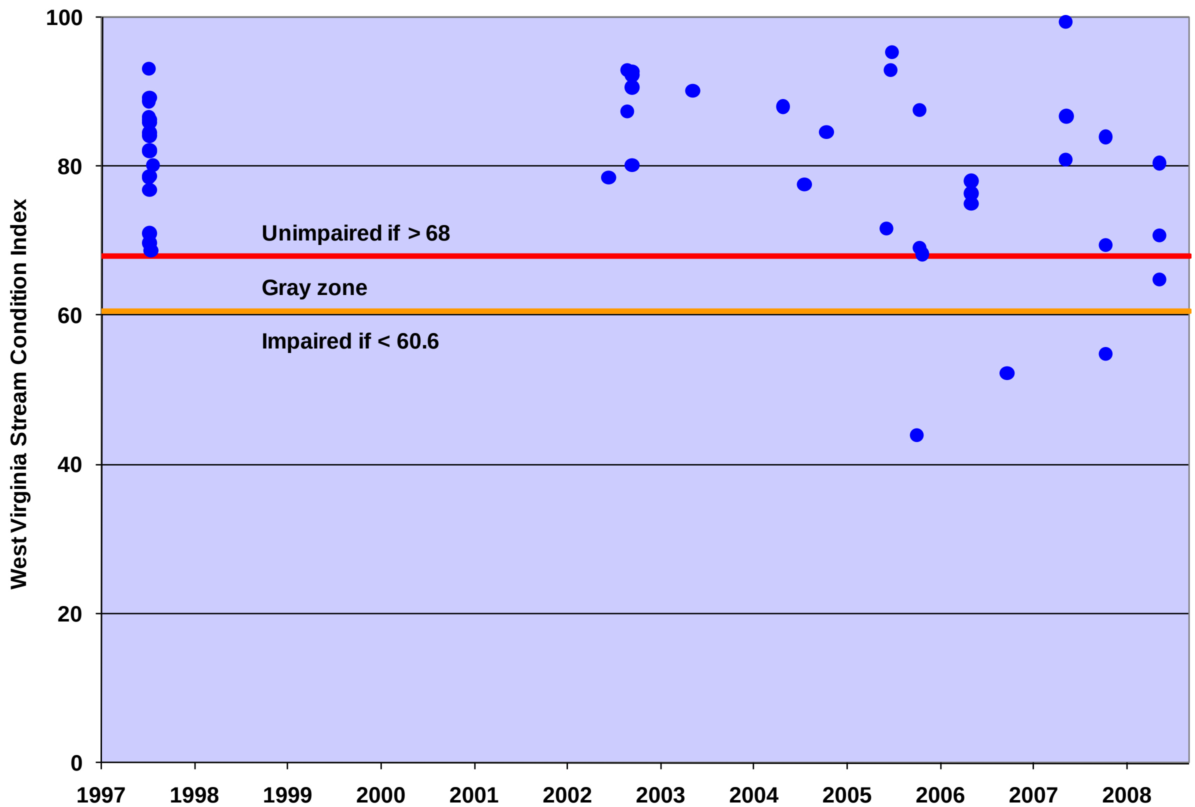
[2] WVDEP's gray zone for biological impairments is not to be confused with the gray shading used in Figure 9. Reachsheds are shaded gray when no data have been collected. The one reachshed in WVDEP's gray zone is shaded orange.

Figure 9: Biological scores



Source: WVSCI data from WVDEP Watershed Assessment Program database and EHWA database. For reachsheds with more than one biological score, the lowest score is shown.

Figure 10: Biological scores over time



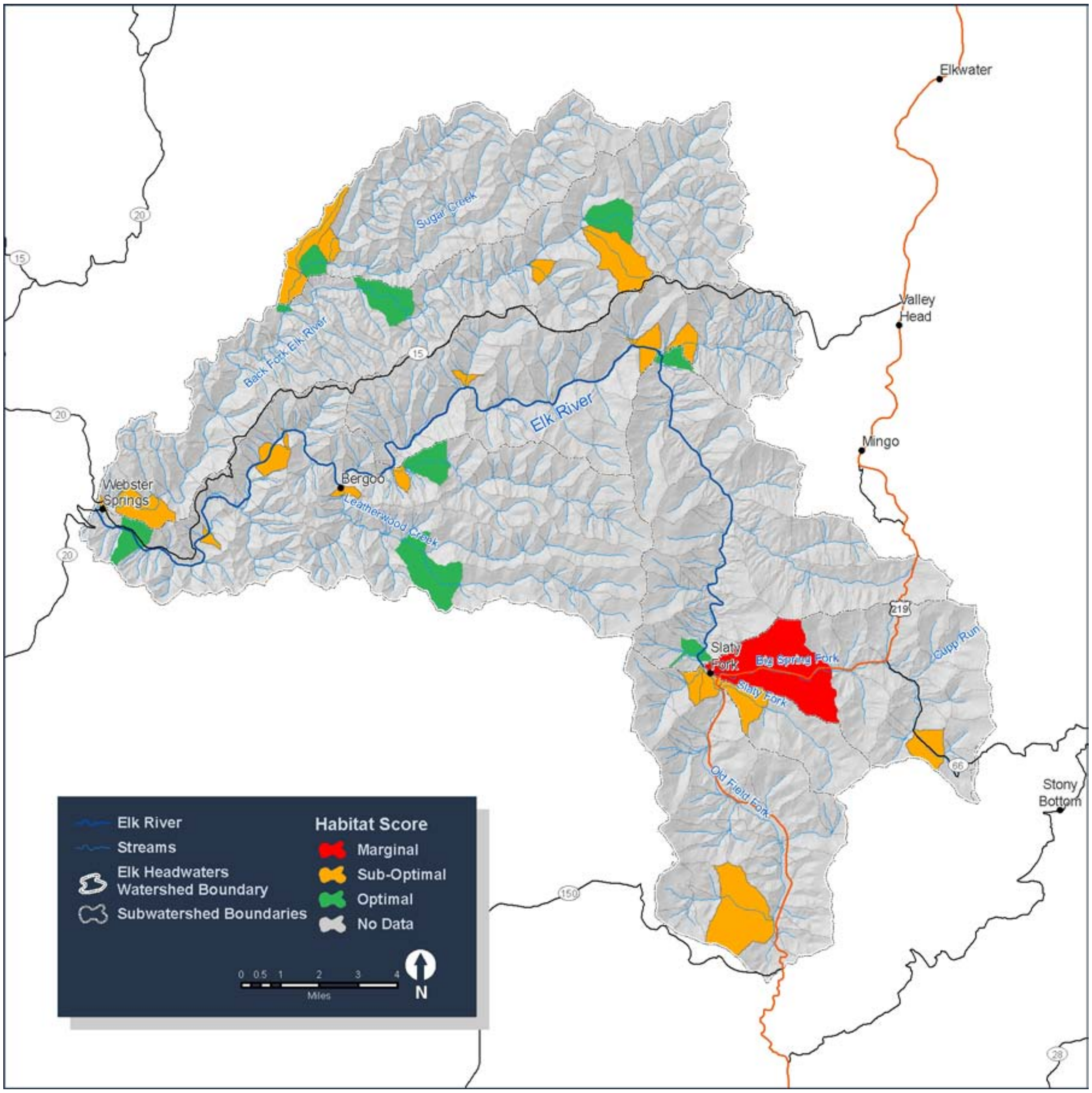
Source: WVSCI data from WVDEP Watershed Assessment Program database and EHWA database.

These WVSCI data suggest that, while on the whole the Elk Headwaters watershed is biologically healthy, there are reasons to be concerned. In particular, Big Spring Fork, with three recent WVSCI measurements suggesting impairment, may be becoming less biologically healthy.

4.1.3 Habitat

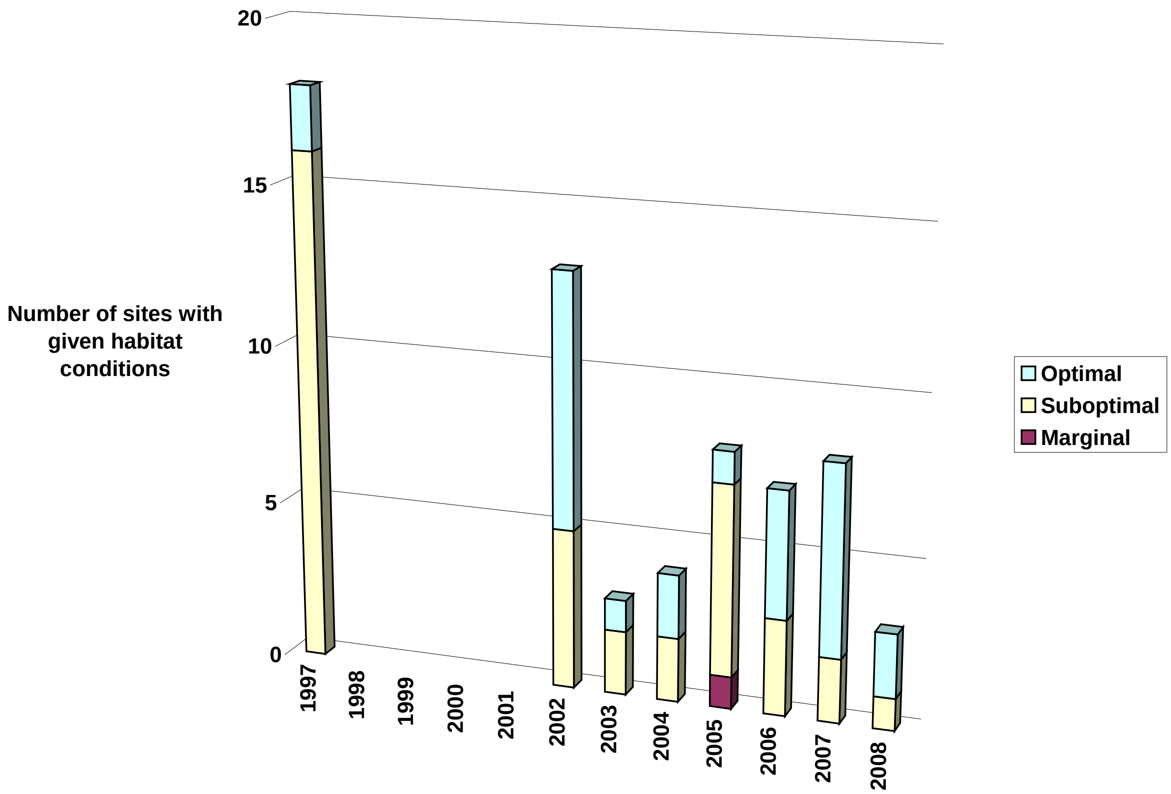
WVDEP and EHWA have ranked stream habitat as optimal, suboptimal, marginal, or poor. As shown in Figures 11 and 12, 64 habitat measurements were made across the Elk Headwaters. Of these, only one measurement was categorized as marginal: on Big Spring Fork. All other measurements were optimal, the highest category, or suboptimal, the next highest category. No stream habitats were classified as poor.

Figure 11: Habitat integrity



Source: Habitat scores from WVDEP Watershed Assessment Program database and EHWA database. For reachsheds with more than one habitat score, the lowest score is shown.

Figure 12: Habitat integrity over time



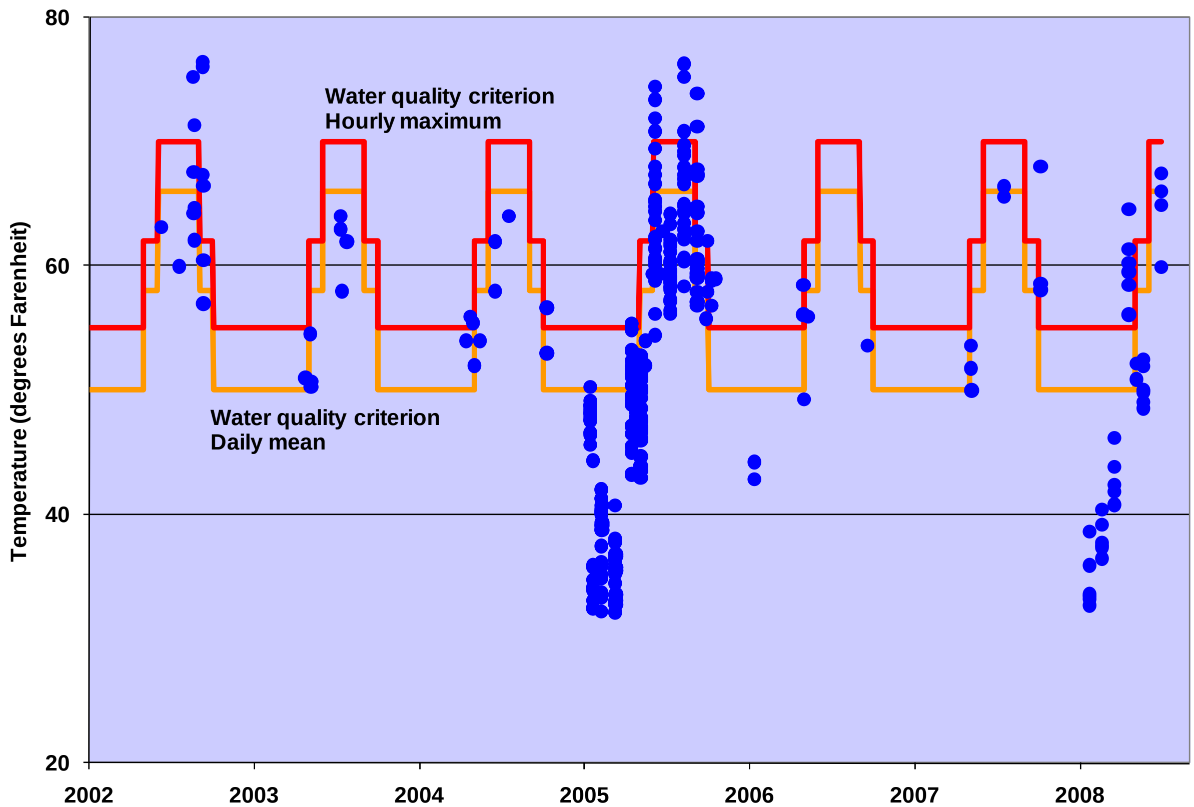
Source: Habitat scores from WVDEP Watershed Assessment Program database and EHWA database.

4.1.4 Water temperature

As shown in Figure 13, numerous data points were available to document water temperature across the Elk Headwaters watershed. The water quality standard for temperature varies by month for trout waters, and is shown as the orange and red lines (daily mean and hourly maximum, respectively) (47 CSR 2, Appendix E, Section 8.28.3).

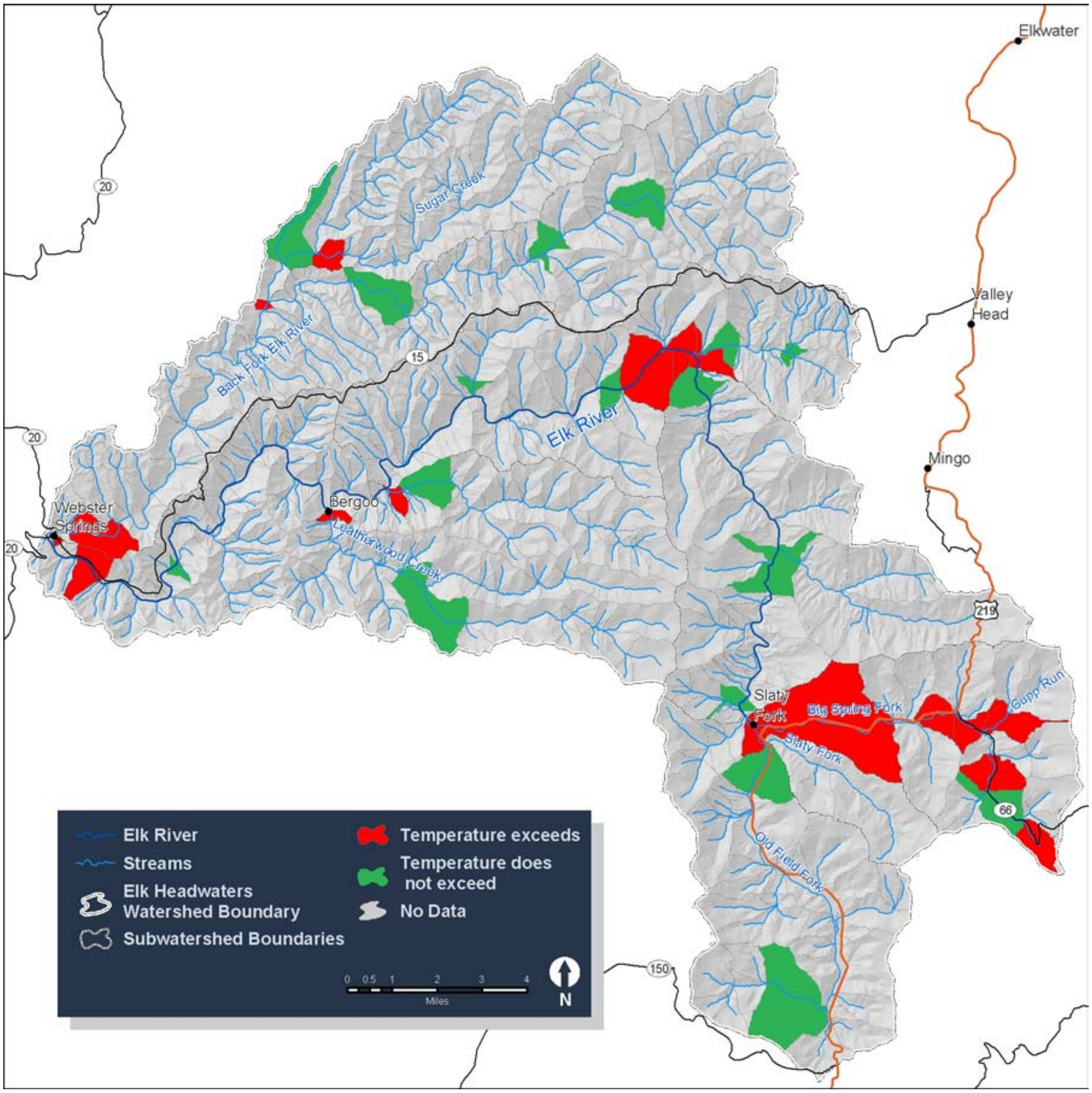
Of the 358 data points from 2002 to the present, 28% exceed the daily mean standard, and 12% exceed the hourly maximum standard. Figure 14 shades reachsheds red that have had at least one temperature exceedance. Reachsheds in which no data points exceed the criterion are shaded green, and the rest of the Elk Headwaters, where no temperature data were found, is shaded gray. Temperature exceedances are scattered across the watershed; however, a cluster of reachsheds that have exceeded the temperature water quality criteria are found in the Big Spring Fork subwatershed.

Figure 13: Water temperature over time



Source: Temperature data from WVDEP Watershed Assessment Program database, Trout Unlimited database, EHWA database, and Petty et al. (2005).

Figure 14: Water temperature

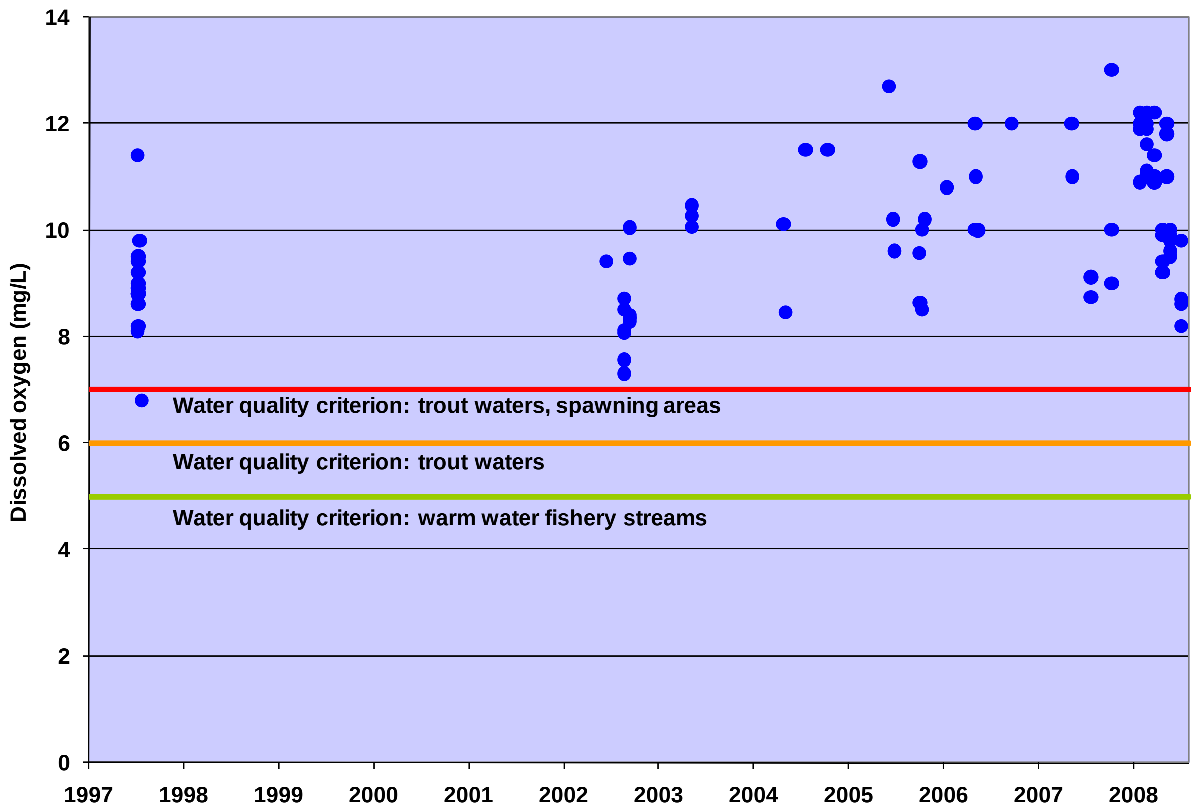


Source: Temperature data from WVDEP Watershed Assessment Program database, Trout Unlimited database, EHWA database, and Petty et al. (2005). For reachsheds with more than one temperature data point, the highest temperature is shown.

4.1.5 Dissolved oxygen

DO across the Elk Headwaters is sufficient to protect fish populations. As shown in Figure 15, virtually every data point collected since 1997 exceeds 7 milligrams per liter (mg/L), the most stringent DO criterion that applies to spawning areas in trout streams. The less stringent criteria—5 mg/L in warm water fishery streams and 6 mg/L in trout streams at all times—are met at all times (47 Code of State Rules 2, Appendix E, Section 8.12).

Figure 15: Dissolved oxygen over time



Source: DO data from WVDEP Watershed Assessment Program database and EHWA database.

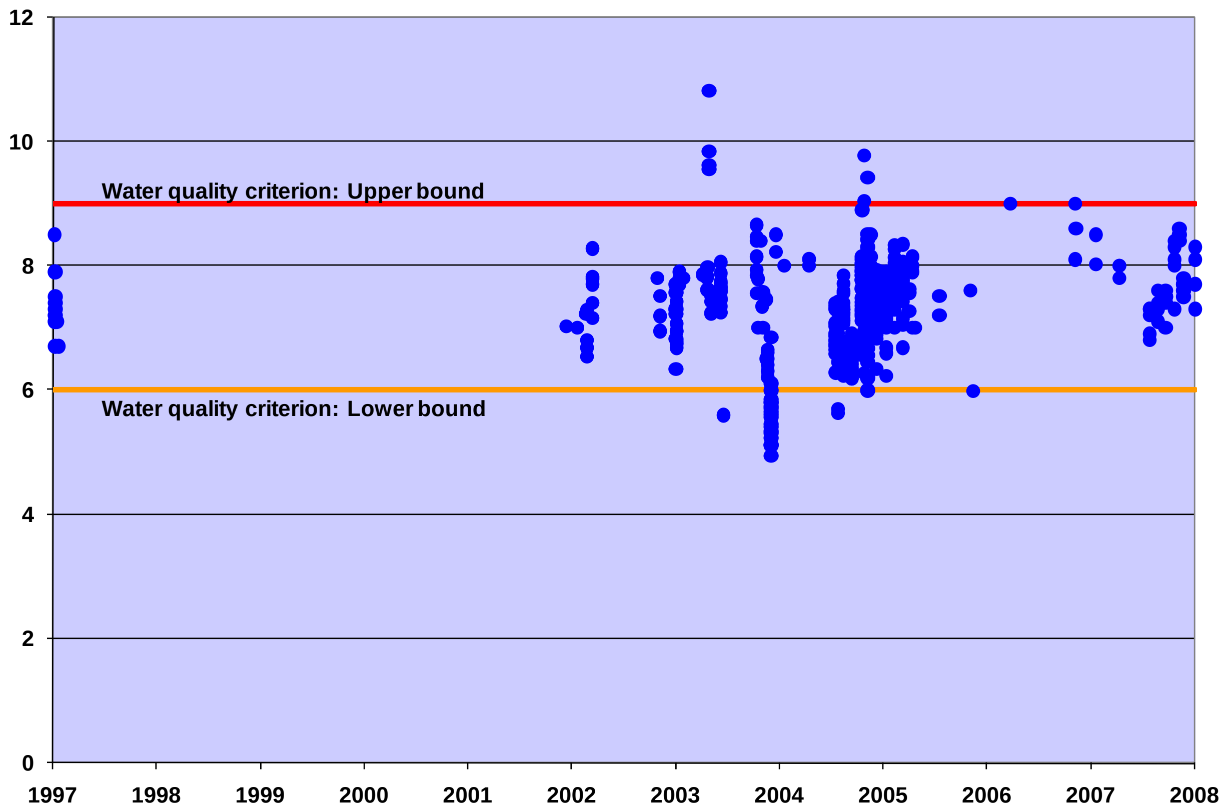
4.1.6 pH

According to West Virginia water quality standards, pH must be kept between 6 and 9 (47 Code of State Rules 2, Appendix E, Section 8.23). However, pH varies naturally from day to night, and the pH criterion allows higher values due to photosynthetic activity.

As shown in Figure 16, pH data points across the headwaters generally meet this criterion. However, a number of data points in the early-to-mid 2000s are above 9 and below 6.

The lowest pH measurements—those below 5.5—were found in the Abb Run and Back Fork subwatersheds. The highest pH measurements—those above 9.5—were all in the Abb Run watershed except for a single measurement on Big Spring Fork.

Figure 16: pH over time



Source: pH data from WVDEP Watershed Assessment Program database, Trout Unlimited database, EHWA database, Sanders (2004), and Petty et al. (2005).

4.1.7 Other water quality measurements

A range of other water quality measurements were compiled from readily available sources. These measurements are not discussed in this report because they generally do not indicate areas of concern.

4.2 <u>Wastewater treatment</u>

4.2.1 Site selection for a wastewater treatment plant

The most appropriate approach for meeting wastewater treatment needs at Snowshoe Mountain Resort and in the Elk Headwaters valley is still being debated. As mentioned above in Section 3.2, wastewater treatment has been a highly controversial topic in the region. Over the years, a number of alternative sites have been considered by PCPSD. These alternatives are shown in Figure 17 as yellow stars.

PCPSD announced Alternative 7 as its preferred alternative at a meeting in July 2008. This site is located on an unnamed tributary of Cupp Run, and would discharge to Cupp Run. As shown in Figure 17, this site seems to be off any major karst features. However, Thrasher Engineering

(2008) reports that a void was found beneath this site. Thrasher also acknowledges the risks of pumping raw sewage through karst areas to the plant site (Thrasher Engineering, 2008). It is not clear at this time exactly what process will be followed now that PCPSD has announced a preferred alternative.

Eight subdivisions with a total of 374 lots are now being built; these developments are shown in Figure 17 as green squares. As shown in Table 3, about one-third of these lots have already been developed. If these homes are not tied into well-functioning on-site wastewater treatment systems, then wastewater must be sent to a centralized or cluster system. New developments, therefore, must be taken into consideration as wastewater treatment plans are finalized for the Elk Headwaters.

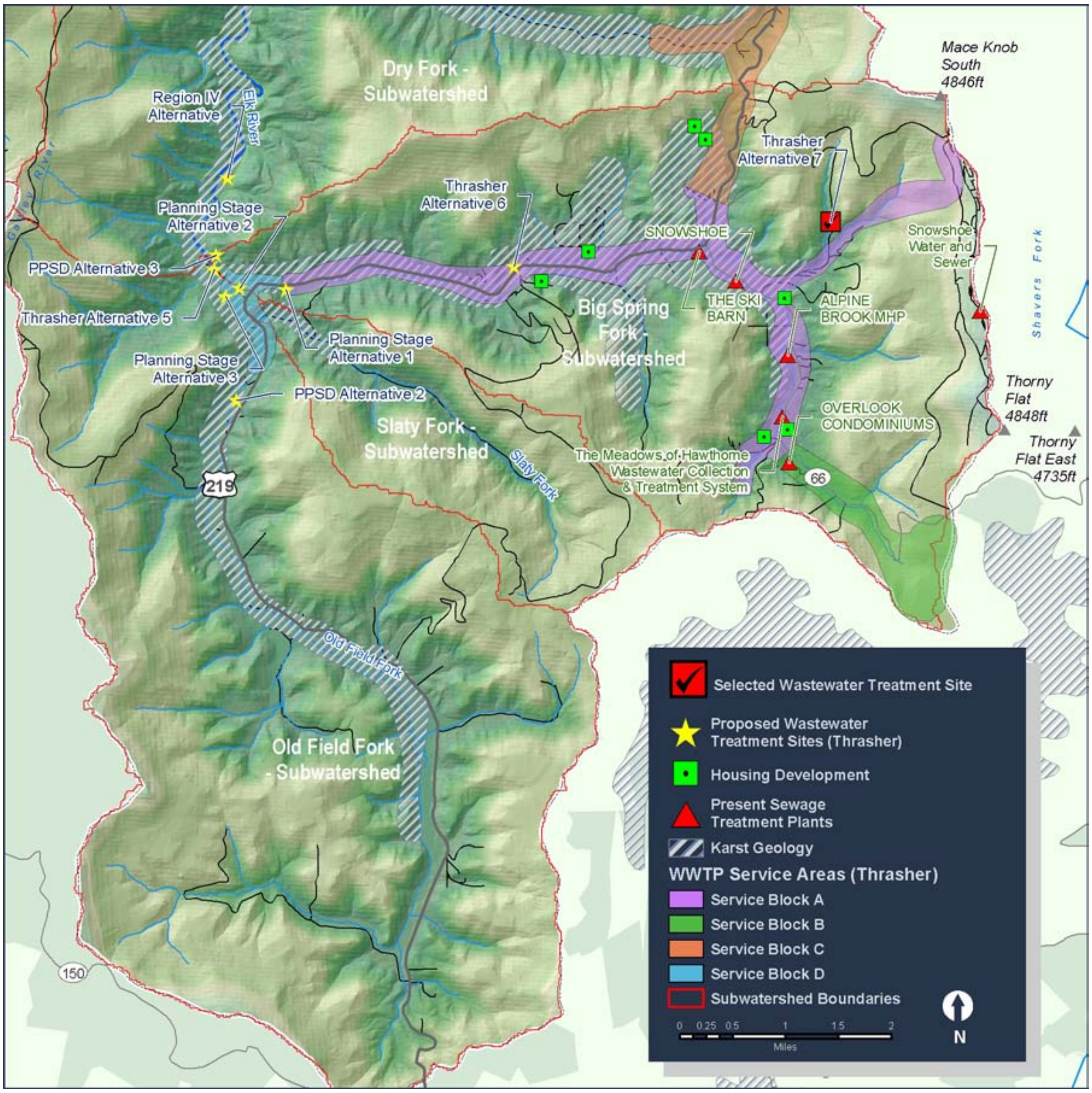
But housing developments have other implications too. During construction, disturbed soil can erode and add sediment to local streams. Trout are particularly sensitive to sediment pollution. After construction, new roofs, driveways, and roads increase the impervious area in the watershed, thereby increasing the likelihood that fast flushes of stormwater will cause floods in local streams.

Table 3: Subdivisions under development in the Elk Headwaters

Subdivision	Total lots	Total improved	Percent built
Slatyfork Farm	142	50	35%
Hawthorne	78	7	9%
Slatyridge	48	24	50%
Fassifern Field	29	7	24%
Headwaters	27	6	22%
Meadows	27	11	41%
Locust Glen	15	11	73%
Mt. Airy	8	4	50%
Total	374	120	32%

Source: Subdivision information from Michael Hughes.

Figure 17: Wastewater treatment plant siting alternatives



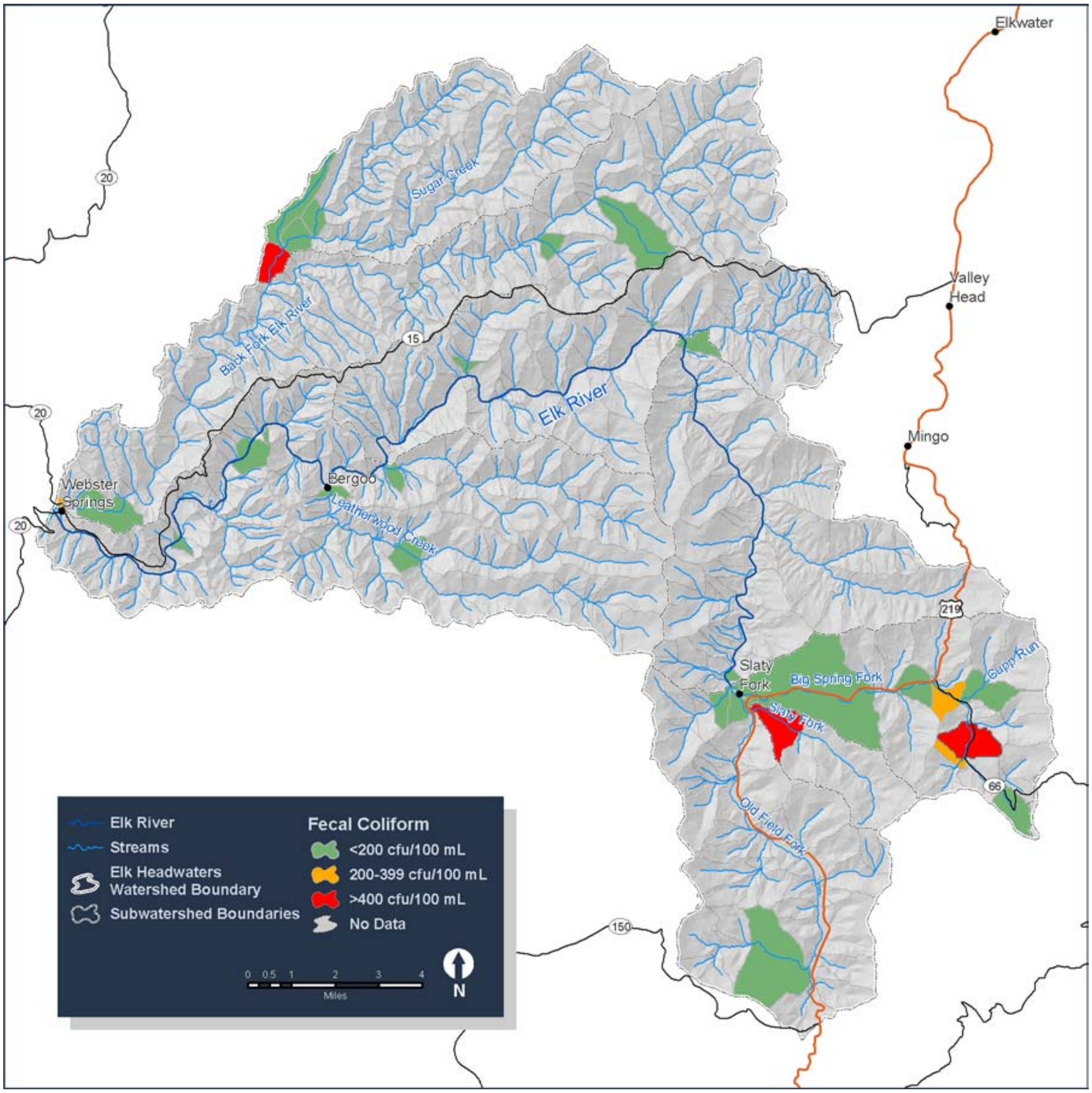
Source: Locations from West Virginia State GIS Technical Center, Thrasher Engineering, and Michael Hughes.

4.2.2 Bacteria

While sewage can impact receiving streams in a number of ways, one common indicator of sewage pollution is the presence of bacteria. Bacteria from wastewater can enter streams if untreated or poorly treated human sewage is directly discharged to streams, or if contaminated groundwater flows to surface waters. Storm water runoff can direct bacteria to streams from pet manure in developed areas. Farm animals and wildlife also contribute bacteria to streams. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with fecal material from people or warm-blooded animals.

A search of readily available data across the Elk Headwaters turned up 76 fecal coliform data points. As shown in Figure 18, only four of these data points—two from 1997 and two from 2008—exceed West Virginia's fecal coliform water quality standard of 400 cfu/100 mL.[3] Both recent exceedances were found in Big Spring Fork above Cupp Run.

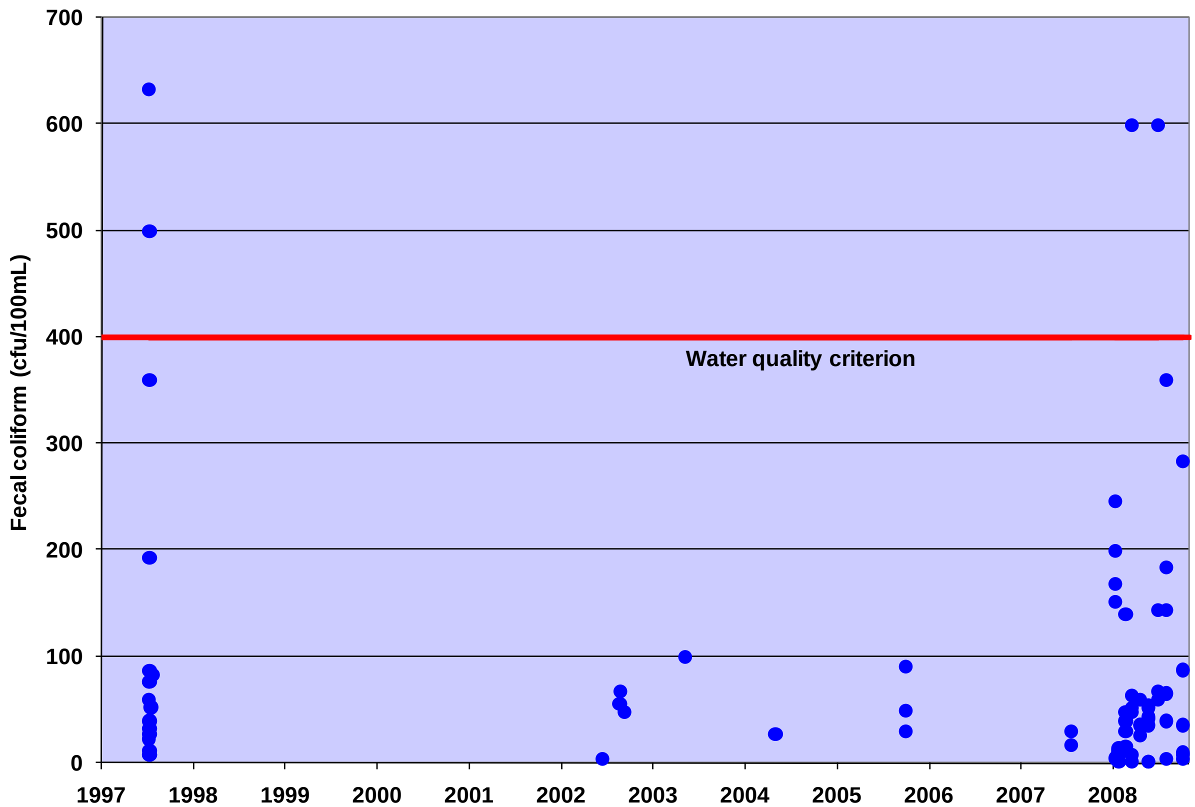
Figure 18: Bacteria



Source: Bacteria data from WVDEP Watershed Assessment Program database and EHWA database. For reachsheds with more than one fecal coliform data point, the highest concentration is shown.

[3] The fecal coliform water quality standard is actually somewhat more complicated, and reads as follows: "Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN or MF) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than ten percent of all samples taken during the month." (47 Code of State Rules 2, Appendix E, Section 8.13) Because fecal coliform data in the Elk Headwaters were not collected five times in a month, the higher criterion of 400 is most applicable.

Figure 19: Bacteria over time



Source: Bacteria data from WVDEP Watershed Assessment Program database and EHWA database.

4.2.3 On-site wastewater systems

Septic systems are utilized by individual homes and businesses across the Elk Headwaters watershed. In fact, in addition to Snowshoe's three wastewater treatment plants, only five additional permitted facilities are located in the watershed. Presumably, sewage treatment for all homes and buildings not hooked into one of these facilities is provided by on-site systems.

Septic systems vary in age and functionality. A septic survey has not been completed as part of this report. In the next phase of the CWP, a septic survey can be completed to confirm exactly where these systems are located and when they were installed. Another useful analysis would use GIS data to determine the areas in the Elk Headwaters most susceptible to septic failure based on characteristics of the soil and bedrock. These potential future analyses are discussed in Chapter 6.

4.3 Sedimentation and flooding

As discussed in Section 3.3, sedimentation can come from many types of activities that erode soil and wash it into streams. Sedimentation and flooding can be linked, although flooding can also be exacerbated by increases in impervious surfaces.

4.3.1 Sediment research on the Elk Headwaters watershed

Two recent reports researched sediment issues in the Elk Headwaters. In the first, a WVU master's thesis, Sanders (2004) collected field data and investigated sources and ecological consequences of deposited and suspended sediments in small tributaries of the upper Elk River. She found that land used for timber harvesting and developed lands contributed significantly more sediment to streams than low disturbance lands. Sanders also found a slight negative relationship between increased total suspended solids (TSS) and adult brook trout. In other words, sediment discharges into streams can threaten brook trout populations.

The second recent report was published by the WVU Division of Forestry, and also specifically studied sediment issues in the Elk Headwaters watershed (Petty et al., 2005). These researchers used their TSS and flow data to calculate mean TSS loads for subwatersheds across the Elk Headwaters watershed. As shown in Figure 20, the subwatersheds with the highest sediment loads include portions of the Big Spring Fork, Sugar Creek, and Back Fork subwatersheds.

In addition, Petty et al. (2005) conducted an analysis to relate activities on land with elevated TSS concentrations. Three factors were found to be related to TSS concentrations measured in streams: the amount of harvested timberland, the amount of developed land, and the amount of roads. More specifically, following relationship was found to be statistically significant:

$$\begin{aligned} TSS = {} & 0.84 \\ & + 0.48 * \text{\% cumulative harvest area} \\ & + 1.55 * \text{\% cumulative developed area} \\ & + 5.75 * \text{\% cumulative census road area} \end{aligned}$$

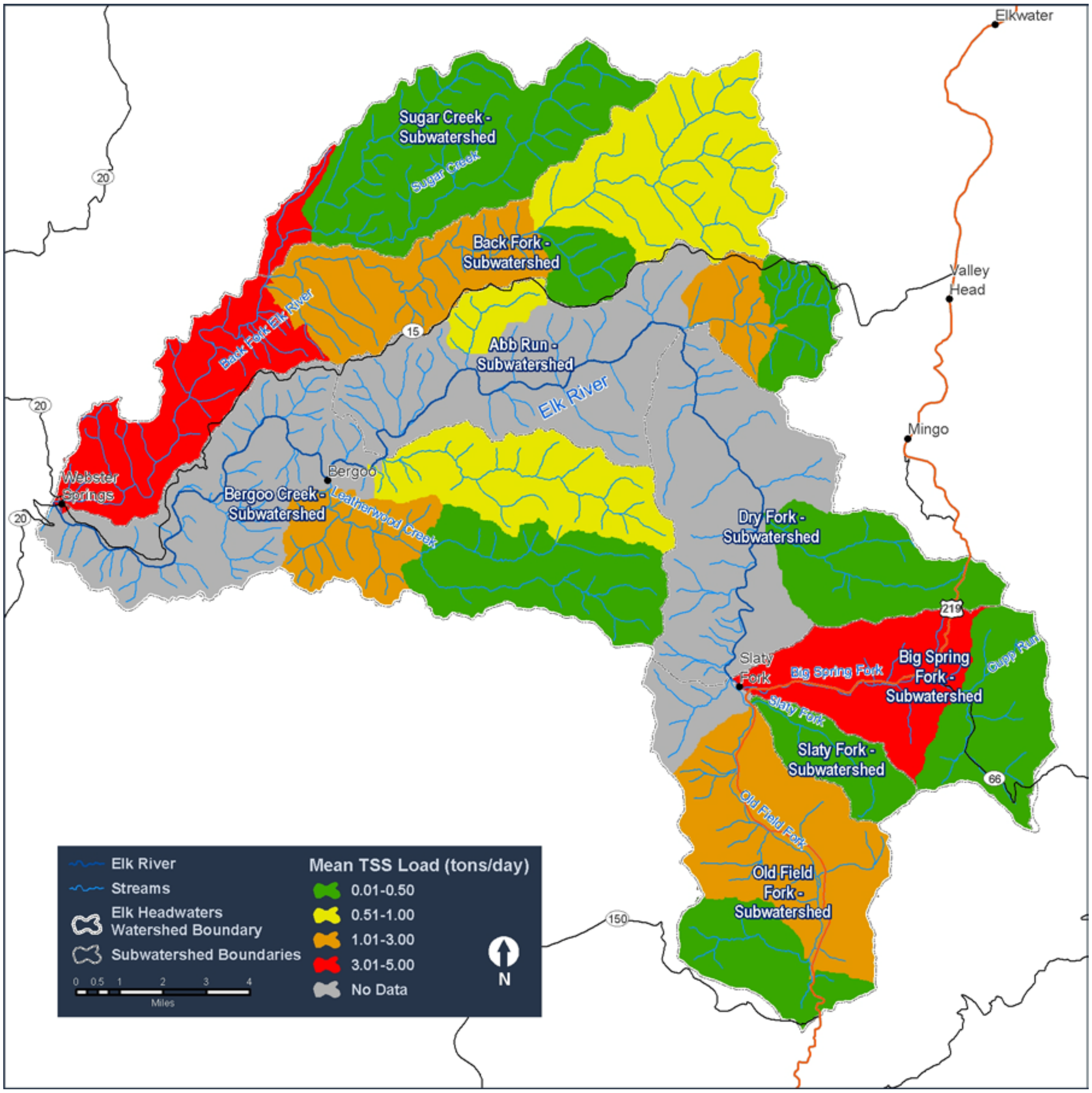
This equation can be used to predict future TSS concentrations based on potential development trends in specific subwatersheds.

4.3.2 Development trends and imperviousness

Development is a key factor related to sedimentation. When land is developed, new impervious surfaces create a greater likelihood of flooding. Despite the development taking place in some portions of the watershed, virtually all land in the Elk Headwaters watershed is still pervious (See land use characteristics above in Table 2).

Readily available GIS data indicate that impervious areas have increased from 1992 to 2001 across the watershed, and in the Big Spring Fork subwatershed in particular. However, more recent data are not available. Additional analyses would be helpful to calculate current impervious areas, and to track changes over time.

Figure 20: Mean TSS loads



Source: Copied from Petty et al. (2005), Table 18.

5. CONCLUSIONS

This State of the Watershed report helps set the stage for a full stakeholder-driven CWP process. Even though this report is based on readily available data only, certain broad conclusions can be drawn regarding the three preliminary stakeholder issues: clean water, wastewater treatment, and sediment and flooding.

5.1 Clean water

- **Trout are abundant throughout the Elk Headwaters.** In virtually all reachsheds surveyed, brook, brown, or rainbow trout were found.
- **The Elk Headwaters is biologically healthy.** Benthic macroinvertebrate scores across the watershed are virtually all above WVDEP's threshold for biological impairment, and many scores are optimal. However, Big Spring Fork, with three recent WVSCI measurements suggesting impairment, may be becoming less biologically healthy.
- **Habitat across the watershed is generally good.** Virtually all habitat measurements across the watershed are optimal or suboptimal. No habitat was found to be poor. Aquatic habitat is critical to maintaining support for healthy insect and trout populations into the future. The only site found to have marginal habitat was Big Spring Fork, during a single visit in 2005.
- **Water temperature is generally cold enough to support trout.** Most water temperature readings are colder than required by the temperature criterion for trout waters. However, 12% exceed the hourly maximum standard.
- **DO concentrations are high enough to support trout.** Across the watershed, virtually every DO concentration is well above the concentration required to support trout.
- **pH values are generally good, but low pH is found in certain subwatersheds.** While most pH measurements are within the range required by water quality standards, many are not. These violations are found in the Abb Run, Back Fork, and Big Spring Fork subwatersheds.

5.2 Wastewater treatment

- **While PCPSD has announced Alternative 7 as its preferred alternative, it is not clear at this time what process will be followed.** Additional study and environmental review may be required.
- **Bacteria levels across the watershed are generally low.** With the exception of one location, all recent fecal coliform measurements across the Elk Headwaters watershed are below the water quality criterion. The exception is Big Spring Fork above Cupp Run, where two recent measurements exceed the criterion.
- **On-site wastewater systems have not yet been inventoried, and potential problem areas have not been identified.** An accurate inventory of on-site systems will help to bring more information to the wastewater debate. In addition, an analysis of potential problem areas based on soil and bedrock characteristics would be valuable because it would help identify locations where septic systems are most likely to fail.

5.3 Sedimentation and flooding

- **Timber harvesting and developed lands contribute sediment to streams.** Based on recent research in the Elk Headwaters, a WVU master's thesis and a WVU research report both found that logging and development are related to sediment levels in streams.
- **Sedimentation in streams harms brook trout populations.** While the relationship was slight, sediment discharges to streams were found to impact adult brook trout.
- **Some subwatersheds contribute more sediment than others.** The subwatersheds with the highest sediment loads include portions of the Big Spring Fork, Sugar Creek, and Back Fork.
- **An equation has been developed to predict sediment concentrations from land activities.** This equation uses the amount of land used for timber harvests, development, and roads to predict sediment concentrations in streams, and can be a useful tool for future watershed management activities.

6. RECOMMENDATIONS

This State of the Watershed report is just a first step toward a full CWP. Funding permitting, stakeholders have expressed a preference for following up on this report with an Expanded State of the Watershed report that incorporates not just readily available data, but new data as well. Next, a full CWP will be developed that integrates the data with a facilitated stakeholder process to clarify watershed goals and identify practical solutions.

6.1 Expanded State of the Watershed report

The contents of an Expanded State of the Watershed report will depend upon funding, timing, and the desires of local stakeholders. Still, a number of options for additional data collection and analysis should be considered.

- **Refine land use and calculate land use trends.** Rather than relying on existing data sources, land use maps can be refined using aerial surveys, field observations, and GPS data. In addition, land use can be calculated for a series of historical years, allowing the modeling of future changes in land use. Land use changes are important for sedimentation, flooding, and wastewater issues.
- **Collect and integrate additional data on groundwater, underground streams, and karst.** In addition to the data presented in this report, additional data can be collected that will further characterize the unique water resources in the Elk headwaters.
- **Conduct further analyses of septic systems and areas of potential septic failure.** A septic survey can confirm where these systems are located and when they were installed. In addition, a GIS analysis could help determine the areas in the Elk Headwaters most susceptible to septic failure based on characteristics of the soil and bedrock. While bacteria levels measured in streams are generally low, additional analyses of on-site sewage systems will help to ensure that bacteria levels remain low, and can also be helpful as final decisions are made regarding regional wastewater treatment systems.
- **Create a vulnerability assessment.** A vulnerability assessment will consider relevant data on water quality, land use, and physical characteristics of the watershed to highlight the most vulnerable areas. Implications will be drawn regarding potential future wastewater, sediment, and flooding issues.
- **Research mineral resources in the watershed.** A more detailed analysis of abandoned and active coal mines, quarries, and oil and gas operations will help understand their potential impacts on water resources.
- **Keep abreast of water resources issues related to the Marcellus Shale.** Water quality and quantity have the potential to be impacted by the development of the Marcellus Shale. Companies are in the process of securing leases to access this deposit. While PADEP has revised its permitting process to protect water quality and quantity, WVDEP has not.

6.2 Full Comprehensive Watershed Plan

- **Define a common vision for the future that integrates economic development with environmental protection.** Stakeholders have indicated a desire to move forward with a CWP that is grounded in economic development, but that also protects the watershed's unique and healthy aquatic systems.
- **Ensure that the CWP supports traditional land uses such as logging and farming.** Preliminary stakeholder meetings have provided feedback that traditional land uses such as logging and farming should be continued, although with proper practices to ensure that they do not degrade streams. As the CWP process unfolds, it will be important to make sure that these interests are represented and that their concerns are taken into account.
- **Ensure that the CWP supports nature-based recreation.** Nature-based recreation—whether from the large Snowshoe Mountain Resort or small family-run inns and guiding services—are built upon a healthy watershed, and their continued prosperity depends upon protecting the watershed. It will also be important to ensure that these interests are represented in the development of a CWP.
- **Identify technologies, policies, and management strategies that will be necessary to achieve the stakeholders' vision.** Based on the issues identified in the State of the Watershed reports and the common vision for the future developed by stakeholders, appropriate technologies, policies, and management strategies will be identified. Expert analysis of technology choices will be conducted when warranted. Alternative future scenarios and watershed modeling will also be used to help develop appropriate strategies. Recommendations for action will be provided.
- **Create a model to predict sediment concentrations based on development trends.** A model will be built to predict the effects of future development and to evaluate potential future scenarios. For example, it can predict the water quality impacts should Big Spring Fork develop at an even more rapid rate, or if logging increases or decreases in certain subwatersheds.
- **Develop a GIS-based watershed management system.** A GIS-based system will be developed to support the analysis for the CWP, and this system will be transferred to local stakeholders to manage ongoing data collection. This GIS-based system would give stakeholders the ability to access watershed data and to model impacts to the watershed from proposed land use changes. The ultimate goal is a system to help stakeholders make informed decisions into the future.
- **Disseminate the CWP.** After the CWP is completed, it will be disseminated. Dissemination could include a wide range of activities including presentations or meetings with local, state, and federal agencies and elected representatives. Dissemination could also include Web sites, map servers, or other means of public education. Community outreach will be essential in building strong public support for implementation.
- **Implement the CWP.** During and after the dissemination stage, the chosen technologies, policies, and management strategies will need to be implemented. Implementation will not occur without a broad, community-supported effort and may require actions by citizens and government bodies and agencies at the local and state levels.

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