AQUATIC RESOURCES

Aquatic Habitat and Populations

Aquatic ecosystems consist of complex interactions among and between the physical, chemical, and biological environment. Aquatic habitats consist primarily of the physical and chemical components that develop in relation to land-forming processes dictated primarily by the geomorphic setting, climate patterns, watershed conditions, and disturbance regimes. The biological component of aquatic ecosystems is largely dependent on characteristics associated with available aquatic habitats.

Associations between aquatic biota and their habitats typically develop over extended periods of time (*e.g.* thousands of generations) as a reflection of long-term survival strategies that are adopted by aquatic species in assuming or exploiting their ecological niche. As such, aquatic habitat requirements can vary considerably between different species or between developmental stages (*e.g.* age classes of fish) of the same species. Though specific habitat requirements may differ at the aquatic species level, development and maintenance of suitable habitats for aquatic organisms associated with a particular aquatic community generally rely upon a shared set of ecological processes and functions. Direct alterations to aquatic habitats, the processes responsible for creating and maintaining them, or the ability for aquatic organisms to freely move among them can influence the health, composition, and structure of dependent aquatic communities.

Reference Conditions

Physical conditions and trends associated with fluvial aquatic habitats are most notably structured around a foundation of stream channel and riparian area conditions and processes. Reference conditions in the Upper Greenbrier Watershed are described for stream morphology, flow rates, storm flows, stream sedimentation, and riparian habitats under other sections in this document. Water chemistry properties associated with aquatic habitats are largely a reflection of geochemistry and soil nutrient properties of the contributing watershed area as well as atmospheric deposition rates. Reference conditions for soil acidification, acid deposition, and stream acidity (pH) are also described under other sections in this document.

Historical accounts from a fisheries survey of streams in the Upper Greenbrier Watershed also provide insight into reference conditions for aquatic resources in the watershed. As early as 1935, streams in the Upper Greenbrier Watershed were generally described as once being excellent trout streams which had become poorly shaded, spread to several times their original width, and possessed stream flows so low (or dry) and warm that they were no longer suitable for trout during the summer months (McGavock and Davis 1935).

In consideration of conditions that are believed to have existed in the Upper Greenbrier Watershed prior to the turn of the 20th century, it is concluded that reference aquatic habitat conditions were considerably better suited to native brook trout populations and associated coldwater biota than current conditions.

Aquatic habitat composition would have likely consisted of a greater percentage of pool habitats that were larger and deeper than the infrequent, small, and shallow pools typically present today. Much of this pool habitat would have been formed and maintained by complexes of large woody debris that consisted of larger, more stable forms than streams possess today. The high quality pools with complex woody debris features would have served as excellent trout rearing habitat as well as cover and refugia for all aquatic inhabitants during periods of potential distress (*e.g.* flooding, over-wintering, low flow conditions). In addition, woody debris complexes would have provided excellent substrate for aquatic macro-invertebrates and other organisms that would bolster aquatic food webs.

Given that streams would likely have been more stable in reference conditions, stream beds likely consisted of deeper substrate profiles. This condition would have not only enabled deeper scour for better pool development but it would have potentially provided higher quality interstitial habitat for aquatic benthic organisms, facilitated higher quality spawning areas, allowed for greater retention of water to potentially moderate the effects of seasonal low flows, and helped reduce the flashy nature of stream discharge under certain circumstances.

In addition to possessing higher quality aquatic habitats, streams in reference conditions would not have contained artificial barriers to suitable habitats. Many life history strategies exhibited by aquatic species native to the Upper Greenbrier Watershed require movement along the stream gradient to ensure long-term viability in the face of hazards and stochastic events associated with the natural environment. Although natural barriers in the form of waterfalls and similar features occasionally exist in streams, these typically occur more toward the steeper headwater extremes of the watershed. Aquatic populations that are native to the Upper Greenbrier Watershed continue to exhibit migration behavior that, under reference conditions would have enabled favorable exploitation of suitable habitat to help sustain viable population levels.

The Upper Greenbrier Watershed did not possess lentic (lake) habitats in its reference condition.

Current Conditions

Streams within the Upper Greenbrier Watershed are currently inhabited by 38 fish species representing *Catostomidae* (sucker), *Centrachidae* (bass), *Cottidae* (sculpin), *Cyprinidae* (minnow), *Percidae* (perch), and *Salmonidae* (trout) fish families (Welsh *et al.* 2007). Table AQ-1 lists the distribution of the 29 native fish species and 9 non-native fish species for the four 6th level Hydrologic Units that comprise the Upper Greenbrier Watershed area. A single asterisk (*) in the table indicates a Regional Foresters sensitive species; a double asterisk (**) indicates the Forest Management Indicator Species; and a triple asterisk (***) indicates non-native species to the Upper Greebrier Watershed.

Table AQ-1. Known Fish Species Distribution by 6th Level Hydrologic Unit

Common Name	Scientific Name	6th Level Hydrologic Unit and Code			
		Little River	Headwaters East Fork Greenbrier	West Fork Greenbrier	Outlet East Fork Greenbrier
		050500030101	050500030102	050500030103	050500030104
central stoneroller	*Campostoma anomalum*	Y	Y	Y	Y
rosyside dace	*Clinostomus funduloides*				Y
whitetail shiner	*Cyprinella galactura*			Y	Y
tonguetied minnow	*Exoglossum laurae*	Y	Y	Y	Y
striped shiner***	*Luxilis chrysocephalus*		Y	Y	Y
bigmouth chub *	*Nocomis platyrhychus*	Y		Y	Y
silver shiner	*Notropis photogenis*	Y	Y	Y	Y
rosyface shiner	*Notropis rubellus*		Y	Y	Y
New River shiner *	*Notropis scabriceps*	Y	Y	Y	Y
telescope shiner***	*Notropis telescopus*	Y	Y	Y	Y
mimic shiner	*Notropis volucellus*			Y	
Kanawha minnow *	*Phenacobius teretulus*		Y	Y	Y
mountain redbelly dace	*Phoxinus oreas*	Y	Y	Y	Y
bluntnose minnow	*Pimephales notatus*	Y	Y	Y	Y
western blacknose dace	*Rhinichthys obtusus*	Y	Y	Y	Y
longnose dace	*Rhinichthys cataractae*	Y	Y	Y	Y
creek chub	*Semotilus atromaculatus*	Y	Y	Y	Y
white sucker	*Catastomus commersoni*	Y	Y	Y	Y
northern hogsucker	*Hypentelium nigricans*	Y	Y	Y	Y
brown bullhead	*Ameiurus nebulosus*				Y
channel catfish	*Ictalurus punctatus*				Y
rainbow trout***	*Oncorhynchus mykiss*	Y	Y	Y	Y
brown trout***	*Salmo trutta*	Y	Y	Y	Y
brook trout**	*Salvelinus fontinalis*	Y	Y	Y	Y
mottled sculpin	*Cottus bairdii*	Y	Y	Y	Y
Kanawha sculpin	*Cottus kanawhae*	Y	Y	Y	Y
rock bass***	*Ambloplites rupestris*			Y	Y
redbreast sunfish	*Lepomis auritus*				Y
green sunfish	*Lepomis cyanellus*	Y	Y	Y	Y
bluegill sunfish***	*Lepomis macrochirus*				Y
smallmouth bass***	*Micropterus dolomieui*		Y	Y	Y
largemouth bass***	*Micropterus salmoides*				Y
greenside darter	*Etheostoma blennioides*	Y	Y	Y	Y
rainbow darter	*Etheostoma caeruleum*				Y
fantail darter	*Etheostoma flabellare*	Y	Y	Y	Y
candy darter *	*Etheostoma osburni*	Y	Y	Y	Y
Appalachian darter *	*Percina gymnocephala*		Y	Y	Y
Roanoke darter	*Percina roanoka*			Y	

Four fish species, one aquatic amphibian species, and two mussel species listed as Regional Foresters Sensitive Species (RFSS) have been documented in one or more streams in the Upper Greenbrier Watershed (Welsh *et al.* 2007; Clayton 2004; Stauffer *et al.* 1995; West Virginia Heritage Database). These aquatic RFSS include candy darter (*Ethoestoma osburni),* Appalachian darter (*Percina gymnocephala)*, New River shiner (*Notropis scabriceps*), Kanawha minnow (*Phenacobius teretulus*), eastern hellbender (*Cryptobranchus alleganiensis*), elktoe

(*Alasmidonta marginata*), and green floater (*Lasmigona subviridis*). The four RFSS fish species along with bigmouth chub (*Nocomis platyrhychus*) are endemic to the New River drainage that contains the Upper Greenbrier Watershed (Stauffer 1995). Brook trout is identified as the only aquatic Management Indicator Species (MIS) in the Forest Plan for the Monongahela National Forest. No aquatic species that are federally listed in association with the Endangered Species Act (ESA) are known to occur within the Upper Greenbrier Watershed.

The concentrated collection and persistence of special status aquatic species within the Upper Greenbrier Watershed suggests an elevated ecological importance for this aquatic ecosystem. A recent study of candy darter provides an example of the potential ecological significance. In an investigation of hybridization between native candy darter and an introduced darter species, variegate darter (*Etheostoma vriatum*), Switzer *et al.* (2007) found candy darter populations in the Upper Greenbrier Watershed to be free from the genetic introgression and genetic swamping that is occurring with the introduced variegate darter in lower portions of the Greenbrier River system. The authors raised the idea that increased conservation efforts may be needed in areas possessing genetically pure candy darter populations to prevent the loss of these populations.

Many fish species that occur within the Upper Greenbrier Watershed (*e.g.* the Centrachids, Catastomids, and many of the Cyprinids) are associated with warm-to-cool water habitats. These communities primarily occur in larger stream reaches associated with the East Fork and West Fork Greenbrier River, Little River of the East and West Forks, as well as smaller tributary streams that have suitable temperature ranges. Most fish species that have been introduced and continue to exist in streams within the Upper Greenbrier Watershed are associated with warm-to-cool water fish communities. It is believed that warmwater habitats are distributed more widely throughout the Upper Greenbrier Watershed today than they would have been in reference conditions.

Other species, particularly native brook trout, have a relatively low tolerance for warm stream temperatures. These species are associated with coldwater aquatic communities that are typically centered on stream reaches with the coolest stream temperatures. In the Upper Greenbrier Watershed, coldwater aquatic communities are most likely to occur in streams dominated by spring-fed discharges such as several tributaries draining slopes on the southwest side of the West Fork Greenbrier River, and in smaller tributary streams that are predominantly shaded from the effects of solar radiation. Though other trout species (*i.e.* rainbow trout and brown trout) that have been introduced into the Upper Greenbrier Watershed are typically associated with coldwater fish communities, these species were opportunistically introduced (McGavock and Davis 1935) and continue to be stocked in part because they are a sport fish that tolerate warmer, more impaired stream temperatures than native brook trout can tolerate.

The West Virginia Code of State Rules establishes general Water Use Categories and Water Quality Standards for waters of the State (Title 47, Series 2.16). At a minimum, all waters in West Virginia are designated for the Propagation and Maintenance of Fish and Other Aquatic Life (Catergory B) as well as Water Contact Recreation (Category C) unless otherwise designated by the State Rules. Certain waters of the State are specifically designated as Trout Waters (Category B2) that are defined by West Virginia Code as “streams or stream segments which sustain year-round trout populations” (Title 47, Series 2.18). Table AQ-2 identifies

streams within the Upper Greenbrier Watershed that are currently designated as B2 streams or have recently been proposed for B2 designation.

Table AQ-2. West Virginia B2 Trout Water Status of Streams in the Upper Greenbrier Watershed

Stream Name	Stream Reach	Currently B2 Stream	Proposed B2 Stream	Brook Trout
East Fork Greenbrier River	above impoundment at tannery		X	X
Johns Run	entire length		X	X
Little River/EF Greenbrier	road mile 1.5 to headwaters	X	X	X
Buffalo Fork Lake	entire length	X	X	X
Big Run				X
Old House Run				X
Reservoir Hollow				X
Rambottom Run				
Gum Cabin Hollow				X
Fivemile Hollow	entire length	X	X	X
Poca Run	entire length		X	X
Long Run	entire length		X	X
Grassy Run				
Lick Run				X
Walderman Run				X
Bearwallow Run				
Campbell Run				
Mullenax Run	entire length	X	X	X
Abes Run	entire length	X	X	X
Burning Run				X
Simmons Run				X
Bennett Run				X
West Fork Greenbrier River	entire length	X	X	X
Mountian Lick Creek				X
Fill Run	entire length		X	X
unnamed West Fork tributary	entire length below spring			X
Little River/WF Greenbrier	road mile 3.9 to headwaters	X	X	X
Span Oak Run	entire length		X	X
Clubhouse Run	entire length		X	X
Elklick Run (Clubhouse Run)				X
Hinkle Run				X
Hansford Run				X
Lukins Run				X
Cove Run				
Old Road Run				X
Iron Bridge Run				X
Mill Run				X
Gertrude Run				X
Elklick Run (WF Greenbrier)				X
Fox Run				X
Mikes Run				X
Snorting Lick Run				X

Table AQ-2 also provides information on streams in the Upper Greenbrier Watershed where brook trout have been documented within the last 25 years or so. Though brook trout have been found in these streams, the health of their populations varies considerably by stream.

Annual and seasonal variation of habitat conditions such as stream flows and stream temperature can bring about shifts in species distribution as aquatic organisms migrate to seek more favorable habitat conditions. As such, coldwater fish species such as brook trout may be found in the larger stream reaches during the cooler, wetter periods, yet retreat to more limited and concentrated habitats that offer coldwater refugia with the onset of warmer summer conditions. Areas offering coldwater refugia are typically associated with spring-fed streams and smaller tributary streams that are predominantly shaded from the effects of solar radiation. By contrast, warmwater species may expand their range toward the headwaters during warmer, summer baseflow conditions.

The ability for aquatic populations to move between habitats in response to environmental conditions or other instinctive behavior is dependent on the accessibility of these habitats. Road stream crossings frequently inhibit or completely prevent aquatic organism passage between suitable habitats. Spatial analysis of roads and streams in the Upper Greenbrier Watershed indicates the density of road stream crossings is 1.0 road crossing for every mile of road. Not all of the 262 road stream crossings that potentially exist within the watershed would be expected to inhibit aquatic organism passage. However, several road stream crossings that occur in perennial streams within the Upper Greenbrier Watershed were surveyed in 2002 and during 2007 specifically for the purpose of assessing aquatic organism passage (see Table AQ-3). The surveys were conducted upstream and downstream of specific road stream crossings. Information from these surveys indicates that artificial barriers to aquatic organism passage are having considerable effects on aquatic habitat connectivity (see Figure AQ-1). The resulting fragmentation of aquatic habitats is likely contributing to impaired health of aquatic populations and possibly extirpated segments of isolated aquatic populations.

Figure AQ-1. Fish Passage Barrier in the Upper Greenbrier Watershed

Table AQ-3. Summary of Fish Population Assessments Conducted in Summer of 2002

Stream	Road Crossing	Road	Abundance				More Fish Species found downstream than upstream?	Aquatic MIS or RFSS Present?	Exotic Species DS but not upstream?
			All Fish		Brook Trout				
			US	DS	US	DS			
Johns Run	ef 01	CR250/4	19	30	2	4	no	yes	no
Buffalo Fork - trib	ef 06	FR54	4	20	1	0	yes	yes	no
Big Run	ef 08	FR54	57	58	0	1	yes	yes	no
Poca Run	ef 09	FR52	115	94	56	39	no	yes	no
EF Greenbrier River	ef 10	FR51	435	246	1	1	yes	yes	no
Abes Run - trib	ef 11	FR51							
Abes Run	ef 12	FR51							
Poca Run	ef 13	SH28	47	56	47	44	yes	yes	no
Long Run	ef 14	FR57	72	80	20	36	no	yes	no
Long Run - trib	ef 15	FR57							
Long Run - trib	ef 16	FR57							
Buffalo Fork - trib	ef 17	FR54	0	12		0	yes	no	no
EF Greenbrier River	ef 18	FR254	247	146	2	4	yes	yes	no
Mullenax Run - trib	ef 19	FR51							
Mullenax Run - trib	ef 20	FR51							
Walderman Run - trib	ef 22	SH28	6	13	6	3	yes	yes	no
Cove Run	wf 01	FR44							
Cove Run	wf 02	railtrail							
Iron Bridg Run	wf 03	FR44							
Iron Bridg Run	wf 04	railtrail							
WF Greenbrier - trib	wf 05	FR44							
Mill Run	wf 06	FR44							
Gertrude Run	wf 07	FR44							
Elklick Run	wf 08	FR44	436	282		0	no	yes	no
WF Greenbrier - trib	wf 09	FR45							
Fox Run	wf 10	FR44							
Mikes Run	wf 11	FR44	121	186		0	no	no	yes
WF Greenbrier - trib	wf 12	FR43	11	21	2	1	yes	yes	no
Snorting Lick Run	wf 13	FR44	0	10	0	3	yes	yes	no
Mountain Lick Cr - trib	wf 14	CR250/8	154	126	1	1	yes	yes	no
Little River (WF)	wf 15	FR17	180	229	0	1	no	yes	no
Little River (WF)	wf 16	FR17	245	275	7	6	yes	yes	no
Little River (WF) - trib	wf 17	FR17							
Little River (WF)	wf 18	CR250/9	150	150		0	no	no	no
Snorting Lick Run	wf 19	FR35	0	4	0	4	yes	yes	no
Snorting Lick Run	wf 20	FR854	58	36	3	15	no	yes	no
Gertrude Run	wf 21	FR178	6	111	1	0	yes	yes	no
Elklick Run - trib	wf 22	FR178A							
Elklick Run - trib	wf 23	FR179	0	6	0	6	yes	yes	no
Snorting Lick Run - trib	wf 24	FR35							
WF Greenbrier River?	wf 25	private?	322	326	0	2	no	yes	no
WF Greenbrier - trib	wf 26	FR44	0	3	0	3	yes	yes	no
WF Greenbrier - trib	wf 27	railtrail	86	133	7	0	no	yes	no
WF Greenbrier - trib	wf 28	railtrail?							
WF Greenbrier - trib?	wf 29	railtrail?							
WF Greenbrier - trib	wf 30	railtrail							

Stream	Road Crossing	Road	Abundance				More Fish Species found downstream than upstream?	Aquatic MIS or RFSS Present?	Exotic Species DS but not upstream?
			All Fish		Brook Trout				
			US	DS	US	DS			
WF Greenbrier - trib?	wf 31	railtrail?							
Fox Run	wf 32	FR369	8	70	1	6	yes	yes	no
WF Greenbrier - trib	wf 33	FR44							
WF Greenbrier - trib	wf 34	CR250/1	60	39	9	10	no	yes	no
Little River (WF)	wf 35	FR97	76	75		0	no	no	no
Snorting Lick Run	wf 36	FR35	0	29	0	2	yes	yes	no

There are an estimated 263 miles of mapped streams in the Upper Greenbrier Watershed and 22 acres of an artificial impoundment (Lake Buffalo). The discussion of aquatic habitats is focused on the fluvial stream system. As previously discussed, physical conditions and trends associated with fluvial aquatic habitats are most notably structured around a foundation of stream channel and riparian area conditions and processes. Current conditions in the Upper Greenbrier Watershed are described for stream morphology, flow rates, storm flows, stream sedimentation, and riparian habitats under other sections in this document. This information in combination with data from aquatic habitat and population surveys and other field observations provide the basis for the discussion of current aquatic habitat conditions.

Aquatic habitat within the Upper Greenbrier Watershed remain in an impaired condition as a result of the combined effects from historic and present day activities. Aquatic habitat composition is an important consideration when assessing habitat quality and suitability for various aquatic species. Aquatic habitat composition is highly skewed toward simplistic shallow habitats that are typically characterized as riffles. Deeper water habitats such as pools are largely under-represented and of poor quality and complexity. Though relatively scarce in streams, large woody debris is a primary pool formative feature for the infrequent pools that exist. The correlation between large woody debris and pool densities highlights the instrumental role that woody debris plays in developing and maintaining important aquatic habitat conditions.

The aquatic habitat composition in the Upper Greenbrier Watershed is likely influencing the structure of aquatic communities. Riffle-dwelling species such as sculpin and darters may potentially benefit from the abundant riffle habitat. Species such as native brook trout that rely on quality pool habitat or a balance of different habitats to satisfy critical life history requirements are likely to be experiencing reduced population levels which can be attributed, in part, to poor habitat composition.

Another important habitat consideration relates to the quality of stream substrates. Most aquatic species that are native to the Upper Greenbrier Watershed thrive in colder streams that possess clean gravel and cobble dominated substrates. As larger particle sizes in the stream substrates become embedded with smaller grains such as sand and silt, these finer sediments tend to clog interstitial spaces between the larger substrate particles and impair the utility and productivity associated with these habitats. Stream sedimentation rates and the accumulation of fine sediments on the stream bottom have previously been discussed and characterized as high

relative to reference conditions. The increased stream sedimentation rate is having a negative influence on the reproductive success of aquatic organisms and can adversely alter the composition and productivity of aquatic benthic communities.

Water chemistry properties associated with aquatic habitats are largely a reflection of geochemistry and soil nutrient properties of the contributing watershed area as well as atmospheric deposition rates. Current conditions for soil acidification, acid deposition, and stream acidity (pH) are also described under other sections in this document. Tables WQ-2 and WQ-3 in the Water Quality section list water chemistry data that is available for streams in the Upper Greenbrier Watershed. Though the current status of stream water chemistry in the Upper Greenbrier Watershed may deviate from that of the reference condition, chemical analysis of stream water samples indicates that current water chemistry is not likely to be playing a significant role in limiting the productivity of the aquatic environment.

Aquatic habitat and populations in the Upper Greenbrier Watershed reflect the long-lasting residual effects of human-induced and natural events that have altered hillslope hydrology, compromised stream channel integrity, degraded in-stream habitat, impaired riparian areas, introduced non-native aquatic species, and fragmented aquatic habitat. Though aquatic habitat and populations have been compromised from their reference conditions, many of these conditions have likely improved since the mid-1900s. Hill slopes are mostly reforested. Riparian areas continue to progress toward conditions where floodplain stability and natural woody debris recruitment will once again provide the vital structure needed for long-term stream channel stability and enhanced aquatic habitats. Rehabilitation of sediment sources has helped reduce stream sedimentation rates from conditions that likely prevailed following extensive timber activities and fires in the early 1900s. Continuing a trend toward improved aquatic health is largely dependent upon sustaining or advancing recovery trends for these and other critical watershed processes.

Desired Conditions

Streams are in dynamic equilibrium; that is, stream systems normally function within natural ranges of flow, sediment movement, temperature, and other variables that provide for healthy aquatic systems. Stream channel and bank stability is protected during management activities. The physical integrity of aquatic systems, stream banks, channel substrates and other habitat components are intact and stable. Where channel shape is modified (e.g., road crossings), the modification preserves channel stability and function. Streamside vegetation contributes to the protection and maintenance of water quality, water quantity, nutrient inputs, and physical channel integrity to support channel function, aquatic biota, aquatic habitat, floodplain function, aesthetic values and designated uses (Forest Plan, p. II-9).

The amount, distribution, and characteristics of habitat are present at levels necessary to maintain viable populations of native and desired non-native aquatic species. For Regional Forester Sensitive Species (RFSS), management actions do not contribute to a trend toward federal listing. Human activities do not prevent populations from sustaining desired distribution and abundance, especially during critical life stages. Habitat conditions support populations of species of ecological, socio-economic, cultural, and recreational significance.

Distribution of native and desired non-native fish and other aquatic species is maintained or is expanding into previously occupied habitat, with inter-connectivity between and within meta-populations. Efforts are in place to prevent new introductions of undesirable non-native fish species and to reduce degrading effects from past introductions. Restoration activities have resulted in maintaining necessary water temperatures, reducing pollutants such as sediment, and removing human-caused barriers to fish passage to restore populations and habitat connectivity where genetic contamination to native fish species from exotic species is not an issue (Forest Plan, p. II-29).

Riparian and Wetland Habitat

Reference Conditions

No reference, or undisturbed, watershed conditions exist within the Greenbrier River drainage in which to compare and contrast the existing conditions. We can speculate that prior to disturbances associated with creating agricultural openings and the extensive 1900-1920 logging period, streams primarily flowed through forested riparian areas. The LWD that would fall into the stream channels from these riparian forests were probably more mature and larger diameter than the stands comprising the riparian areas today. Larger trees are generally more stable and last longer than smaller-diameter trees. We can also speculate that spruce was a greater component of LWD than what we see today. With the natural recruitment of LWD, channels were more stable, had greater habitat complexity, pool development and cover. There was probably more reach types characterized as step pool and/or pool-riffle than the dominance of plane bed reaches under current conditions. With no roads to modify storm flows and increase erosion, stream channels would be more stable and have lower levels of fine sediment than what we find today. Stream shading was likely greater in the forested riparian areas, resulting in cooler water temperatures.

Presettlement estimates of wetlands would be even more speculative. However, it is logical to assume that the extensive logging and burning that occurred in the last century, along with concurrent and subsequent mill site, community, and agricultural development, resulted in significant changes to the wetland conditions that existed in the watershed prior to European settlement.

Current Conditions

Riparian resources within the Upper Greenbrier Watershed are primarily those associated with riparian and streamside management zones along streams, and mapped wetlands that are typically adjacent to streams. There are an estimated 6,322 acres or riparian area in the Upper Greenbrier Watershed today, or 7.4 percent of the total watershed area. An estimated 5,078 of those acres are on NFS lands, the remainder are on private lands. Roughly 89 percent of the riparian areas in the watershed are considered forested, 92 percent on NFS lands and 77 percent on private lands. However, most riparian areas are still deficient in large trees, snags, and LWD. The riparian forests have, for the most part, only begun to develop these characteristics in the second-growth stands that are now reaching maturity. Non-forested areas are a mixture of

wetlands, pastureland, road corridors, recreational sites, and—on private lands—agricultural fields and residential development.

Improved aquatic health is largely dependent upon the continued recovery and aging of riparian forests to restore the LWD that was an important component of these systems. Protecting riparian areas and timber stands along active channels will be an important element in restoring the components for a healthy watershed. Rehabilitation of existing sources of sediment will also help to reduce the amount of fine sediment influencing streams within the assessment area.

There are an estimated 660 acres of wetlands in the Upper Greenbrier Watershed; 430 acres (65 percent) on NFS lands and 230 acres (35 percent) on private lands. Numerous emergent, scrub/shrub and forested wetlands of small to moderate size occur throughout portions of the watershed. Blister Swamp is an emergent wetland (wet meadow) of better than 10 acres size, mostly on private land in the extreme headwater of the East Fork. Additional wetland lines the East Fork channel downstream on private and NFS lands. Many tributaries of both the East and West Forks have wetland habitat adjacent to the stream channels. Land and shallow water immediately surrounding Lake Buffalo is also considered riparian/wetland habitat (Figure 1-1). Although wetlands comprise less than one percent of the watershed, they provide numerous ecological benefits and are reservoirs of diversity, as seen in the rare plants and animals associated with wetland habitat described in the Vegetation and Wildlife sections of this assessment.

Wetlands and floodplains are protected by Executive Orders 11990 and 11988. The Forest Plan also provides protection for sensitive wetland and riparian areas through many standards and guidelines.

Desired Conditions

Wetland and floodplains function as detention/retention storage areas for floodwaters, sources of organic matter, and habitat for aquatic and riparian species (Forest Plan, p. II-9).

Streamside vegetation contributes to the protection and maintenance of water quality, water quantity, nutrient inputs, and physical channel integrity to support channel function, aquatic biota, aquatic and wildlife habitat, floodplain function, aesthetic values, and designated uses (Forest Plan, p. II-9).