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**SECTION 22 – RIPARIAN THICKETS/ FORESTS**

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Riparian forest, the forest that primarily grows along rivers and streams, is a critical habitat type in the state. Riparian forest provides a buffer that filters runoff into rivers and streams and supports a variety of wildlife species.

Rivers or streams extend more than 83,000 miles in Pennsylvania with riparian habitat occurring over an estimated 172,067 acres. Therefore, one would expect copious amounts of riparian forest to occur in the Commonwealth. However, riparian forests have been extensively cleared throughout Pennsylvania's history and to the present day. The effects of riparian forest clearing were noted as early as 1753:

*“Our runs dry up apace; several which formerly would turn a fulling mill are now scarce sufficient for the use of a farm. The reason of the which is this, when the country was covered with woods and the swamp with brush, the rain that fell was detained by these interruptions and so had time to insinuate into the earth and contribute to the springs and runs. But now the country is clear'd, the rain as fast as it falls is hurried into the rivers and washes away the earth and soil of our sandbanks in our creeks and rivers; and hence several creeks mentioned by Mr. Penn to be navigable are no longer so”* (quotation from “Pennsylvania Agriculture and Country Life 1640-1840” as cited in Delaware Estuary Program Report #94-03).

Today, the condition of riparian forest is still highly impaired in many locations. In some urbanized areas, riparian forests have been depleted or so altered that their function in buffering stream quality is reduced or eliminated. The amount of riparian forest that exists in Pennsylvania is unknown, but natural riparian communities comprise less than two percent of the land area across the country.

**22.1 Location and Condition of Riparian Habitats**

(adapted from Appendix 2; Gross 1999)

The Commonwealth contains significant portions of three river systems: the Allegheny/Monongahela/Ohio, the Susquehanna, and the Delaware. Although these rivers potentially demark large riparian forest, the landscape around rivers is greatly impacted by development, including road-building and damming of waters over flood plains. European settlers followed rivers deeper into the interior of the colonies and found the floodplains suitable for habitation. As a consequence, most forests along the state's larger rivers are greatly disturbed and highly fragmented. Seasonally-flooded riparian forest, such as Cussawago Creek Bottoms, are extremely rare in this highly-developed state. As stated in Section 12, loss of valley forests has been made high-quality riparian and valley forest a rare habitat type of high conservation concern.

Natural communities comprising riparian forest can vary with ecoregion and topography (Peterson and Kimball 1995; Table 22.1). Riparian forest found in unglaciated regions of southern Pennsylvania are characterized by silver maple, sycamore, black willow, river birch, pin oak, ashes, hawthorns and box elder (Majumdar *et al.* 1989). In the glaciated northern tier, hemlock and other species are important components of riparian forest habitats. Floodplain trees that can tolerate flooding are often mixed with upland species in riparian areas. Floodplain forest type generally occurs at lower elevations and includes bottomland-hardwood communities, including forests dominated by sycamore, box-elder, elms, maples, ash, or cottonwood.

Riparian forests are not well represented on Pennsylvania’s public lands. Relatively few state game lands, state parks, or state forests contain sizeable streamside forest. Overall, western Pennsylvania has one of the highest proportions of riparian cover along its rivers (Goodrich *et al.* 2002). One of the most outstanding examples of riparian forest is Enlow Fork of Wheeling Creek on the border between Washington and Green counties. Riparian habitats of the Ridge and Valley province also are considered relatively high-quality because of their relative lack of development.

**Table 22.1:** Riparian Forests/Wetlands found in Pennsylvania. For detailed descriptions, readers are referred to the following sections of Appendix 4:

Natural Community Type	Appendix 4, pages
<b><i>Riparian Forests (aka “Broadleaf Floodplain Forests”)</i></b>	
Red Maple – Magnolia Coastal Plain Palustrine Forest (‘coastal plain forest’)	21
Great Lakes Region lakeplain Palustrine Forest	21
Sycamore - (River Birch) - Box Elder Floodplain Forest	21
Silver Maple Floodplain Forest	22
Red Maple - Elm - Willow Floodplain Forest	22
<b><i>Riparian Wetlands</i></b>	
Red Maple - Elm - Willow Floodplain Swamp	22
<b><i>Community Complex</i></b>	
River Bed-Bank-Floodplain Complex	72

**22.2 Riparian Forest-Associated Species**

Many wildlife species are associated with riparian zones for some part of their lives (Table 22.2). Streamside forest is important to fish and aquatic wildlife because it shades the water and reduces temperature, filters sediment from runoff, filters pollutants, and helps maintain stream flow during drier periods by slowing surface water runoff (Peterson and Kimball 1995). The debris and snags associated with riparian-water edges provide habitat for fish,

reptiles and amphibians that are part of the aquatic food chain. Even upland species not closely associated with riparian habitats may travel to rivers for water in summer months. In addition, riparian forests provide travel corridors for many wildlife species: In some areas, degraded riparian habitats are the only “wild” habitats remaining.

Some species are specifically associated with riparian zones, and even within the broad category of riparian habitat, species may have unique habitat requirements (Appendix 22.1). Red-shouldered hawks, bald eagles, warbling vireo, mink, river otter, and others can be found using riparian areas for most of their life cycle. Warbling vireos build their nests in canopy trees along riversides and feed in the mature foliage (McWilliams and Brauning 2001). The mature trees and wetland habitat attracts red-shouldered hawks, although they also can be found in mature forested wetlands or ravines away from rivers. Frogs and salamanders lay their eggs in temporary pools associated with riverine floodplains. Prior to their decline, peregrine falcons historically nested on cliffs associated with rivers in 21 counties of Pennsylvania and fed on ducks and other riparian birds (Brauning 1992).

The Susquehanna is bounded by nearly a mile of riparian forest on both sides of the river, including islands with large trees. Yellow-throated vireo and warbling vireo are two of its most common breeding birds, inhabiting the tops of the large sycamores and silver maples along its shore. The abrupt ‘pit-suh’ of the acadian flycatcher and ascending buzzy trill of the northern parula are common sounds in riparian forests (Gross 1999). The Louisiana waterthrush also needs riparian forest with high canopy. The rich undergrowth that characterizes the deep soil of these forests lends diversity to the forest and supports many ground-foraging birds.

In southern counties, riparian forests support a rich diversity of birds. One summer resident, the cerulean warbler, is one of the most severely declining neotropical migrants (Robbins *et al.* 1989). Its numbers have not been declining dramatically in Pennsylvania, but the state holds some responsibility for keeping the range of the species intact (Rosenberg and Wells 1995). Because of this responsibility role, the species has been designated as a WAP Species of Greatest Conservation Need for Pennsylvania. The cerulean warbler is most commonly found in the western counties and especially on wooded hillsides near and along streams (Ickes 1992). Ceruleans are especially sensitive to forest fragmentation (Robbins *et al.* 1989). The yellow-throated warbler also is associated with riparian forests, especially in the southern and southwestern counties. It has been found primarily in tall sycamores or white pines along streams (Ickes 1992). The Kentucky warbler resides in forest bottomlands where spicebush and many wildflowers grow in profusion. The future of these warblers and other riparian forest birds may rely on conservation efforts on behalf of this ecosystem in the face of ongoing developmental pressure.

**Table 22.2 WAP-Priority Species associated with riparian forests/thickets in Pennsylvania (\* see also, WAP Section 21 – Thicket/Shrub Habitats)**

<b>IMMEDIATE CONCERN</b>	<b>SPECIFIC HABITAT REQUIREMENTS</b>
<b>Allegheny Woodrat – R</b> <i>Neotoma magister</i>	Sandstone and/or limestone rock habitats in unfragmented oak-hickory forest communities
<b>Indiana Bat</b> <i>Myotis sodalis</i>	Summer-riparian, bottomland or upland forests, old fields and pastures. Winter-caves, mines
<b>Kirtland’s Snake</b> <i>Clonophis kirtlandii</i>	Damp vacant lots with debris for cover; open, damp woods/grassy areas in urban/suburban areas; prairie wetlands, wet meadows, the grassy edges of creeks, streams, and ponds and relatively open, wet woods (often in urban/suburban settings) with crayfish burrows
<b>Timber Rattlesnake – R</b> <i>Crotalus horridus</i>	Sandstone and/or limestone rock habitats in unfragmented oak-hickory forest communities
<b>West Virginia Water Shrew</b> <i>Sorex palustris punctulatus</i>	clear mountain streams at elevations > 1,500 to 2,000 feet with high-quality, moderate flow and deeply undercut banks, ground cover greater than 75 percent
<b>Wood Turtle – R</b> <i>Glyptemys insculpta</i>	Large streams and associated riparian and forested habitats (edge habitats) with thick cover, sunlight, and food availability. Nesting habitat is open-canopy riparian thickets, well-drained soils with sparse vegetation.
<b>HIGH LEVEL CONCERN</b>	<b>SPECIFIC HABITAT REQUIREMENTS</b>
<b>Bald Eagle</b> <i>Haliaeetus leucocephalus</i>	Shallow flat-water with abundant fish, roost trees and large trees within a mile of water for nesting
<b>Cerulean Warbler – R</b> <i>Dendroica cerulea</i>	Large stands of mature deciduous forest with large, well-spaced trees with dense, high canopies
<b>Eastern Ribbon Snake</b> <i>Thamnophis sauritus sauritus</i>	Riparian edges of emergent marshes, bogs, streams, rivers, ponds and lakes with with dense sedges, grasses, rushes, and emergent shrubs, and lots of frogs
<b>Northern Flying Squirrel</b> <i>Glaucomys sabrinus</i>	Mature, mixed-deciduous-hemlock/spruce/fir stands with closed canopies, open ground cover with a rhododendron component, and thick leaf litter.
<b>Queen Snake</b> <i>Regina septemvittata</i>	Small, shallow streams, rivers, lakes, and marshes with abundant crayfish and overhanging woody vegetation
<b>Shorthead Garter Snake – R</b> <i>Thamnophis brachystoma</i>	Riparian old fields and meadows with grasses, sedges, low herbaceous growth, and early successional perennials
<b>Silver-haired Bat (migrant)</b> <i>Lasiorycteris noctivagans</i>	Mature (possibly old growth) coniferous, mixed forests near water
<b>PENNSYLVANIA VULNERABLE</b>	
<b>Blackpoll Warbler</b> <i>Dendroica striata</i>	High elevation, spruce-dominated wetlands and forests
<b>Black-crowned Night-Heron</b> <i>Nycticorax nycticorax</i>	Shallow aquatic/terrestrial margins of fresh, brackish and salty aquatic environments -in both remote wetlands and city parks
<b>Great Egret</b> <i>Ardea alba</i>	Wade Island - nests built at or near the top of river birch, silver maple, green ash, American sycamore, black willow

<b>Osprey</b> <i>Pandion haliaetus</i>	Shallow water areas with artificial or natural nesting structures
<b>Rock Vole</b> <i>Microtus chrotorrhinus</i>	High elevation, riparian red spruce/northern hardwood forests with large amounts of talus and rock and heavy forb cover.
<b>Rough Green Snake</b> <i>Opheodrys aestivus</i>	Riparian thickets and lake shores where trees or woody shrubs (1-3 meters in height) dominate the vegetation
<b>Yellow-bellied Flycatcher</b> <i>Empidonax flaviventris</i>	Conifer forests and wetlands in higher elevations and northern counties; nest within large blocks of forested wetlands
<b>Yellow-crowned Night Heron</b> <i>Nyctanassa violacea</i>	Riparian forest. Nests located 30 – 80 ft up on a horizontal branch in tall shade trees, such as American sycamore ( <i>Platanus occidentalis</i> ), with open understory along riparian margins.
<b>MAINTENANCE CONCERN</b>	<b>SPECIFIC HABITAT REQUIREMENTS</b>
<b>Acadian Flycatcher</b> <i>Empidonax virescens</i>	Unfragmented riparian deciduous forest in south. Riparian hemlock forest in north.
<b>Alder Flycatcher</b> <i>Empidonax alnorum</i>	Wet shrubby habitats, including brushy swamps, alder bogs, edges of beaver ponds, and wet meadows with woody vegetation
<b>American Woodcock</b> <i>Scolopax minor</i>	Mix of habitats, including small, scattered openings and dense stands of shrubs and young trees
<b>Blue-headed Vireo</b> <i>Vireo solitarius</i>	Mature unfragmented mixed and conifer forest with structural diversity (hemlock-associated species)
<b>Canada Warbler</b> <i>Wilsonia canadensis</i>	Hemlock-dominated ravines and wet sites in northern hardwood and mixed forest with a dense understory of shrubs such as rhododendron or hobblebush; higher elevations (greater than 457 meters)
<b>Great Blue Heron</b> <i>Ardea herodias</i>	Riparian deciduous and mixed forest (breeding); forested wetlands (breeding); wetlands and slow-moving water (foraging)
<b>Hoary Bat</b> <i>Lasiurus cinereus</i>	Roosts within foliage of coniferous and deciduous trees near forest edge; often forage over woodland streams and ponds
<b>Kentucky Warbler</b> <i>Oporornis formosus</i>	Lowland deciduous forests with well developed ground cover and a dense brushy or vine understory, often near streams
<b>Louisiana Waterthrush -R</b> <i>Seiurus motacilla</i>	Mature, forested watersheds with medium-high gradient headwater (1st-3rd order) streams, with well-developed banks (ravines) and/or plentiful overturned trees with exposed root masses; high-quality stream indicator
<b>Northern Water Shrew</b> <i>Sorex palustris albibarbis</i>	High-quality streams with moderate flow, deeply undercut banks, dense ground cover (> 75 percent) within hardwood forests (and mixed forests at higher elevations); 1,500 feet or more
<b>Red-shouldered Hawk</b> <i>Buteo lineatus</i>	Extensive lowland, deciduous, or mixed forests, interspersed with small openings or marshes
<b>River Otter</b> <i>Lontra canadensis</i>	High quality rivers and streams
<b>Rock Shrew</b> <i>Sorex dispar</i>	Talus slopes within mesic oak-hickory communities with a dense shrub layer consisting of rosebay rhododendron at elevations over 1,000 meters
<b>Willow Flycatcher</b> <i>Empidonax traillii</i>	Low-elevation shrub swamp, wet meadow, and brushy habitats along streams and the edges of ponds and marshes; sometimes dry upland sites

<p><b>Winter Wren</b> <i>Troglodytes troglodytes</i></p>	<p>High elevation, coniferous/mixed forests, with a substantial hemlock component; nests often near water, particularly streams in hemlock ravines but sometimes near bogs or swamps</p>
<p><b>Yellow-breasted chat</b> <i>Icteria virens</i></p>	<p>Low, dense shrub habitats with an open or partially open tree canopy in regenerating clear-cuts, forest edges, abandoned farmland, burned forest, and shrubby margins</p>
<p><b>Yellow-throated Vireo</b> <i>Vireo flavifrons</i></p>	<p>Deciduous forests, riparian woodland, tall floodplain forest, lowland swamp forest, mixed forest, orchards, and groves of shade trees with open understory</p>

**22.3 Threats to Riparian Forest Habitats and Associated Species**

Much of the riparian habitat in Pennsylvania, especially in the major river valleys, has been drastically impacted by agriculture, urbanization and other human activities. Riparian forests are typically highly fragmented, decreasing their value to area-sensitive residents such as the cerulean warbler and yellow-throated vireo.

Several key threats may impact the long-term quality of riparian forests in Pennsylvania, chief among these are acid mine drainage, acid rain levels and stream channelization. Additionally, sedimentation created during logging, road-building, and other construction activities may disrupt the aquatic/terrestrial food chain to such an extent that associated species are not able to persist in affected sites.

Perhaps most devastating to species associated with riparian forests is habitat loss through development. As mentioned previously, riparian forests have been impacted by human settlement since the earliest days of Penn’s Woods. These pressures increasingly threaten, impact and deforest woodlands and riparian forests in northern Pennsylvania. Areas in the state’s northeast are being lost to development at a high rate, because of the demand for vacation homes and cabins and other recreational amenities. If not properly managed, this growth will likely affect both stream levels and quality as habitat is altered and run-off increases.

Loss of mature forest habitat along stream valleys represents the most serious long-term problem facing cerulean warblers and many other species. Many formerly occupied areas of undisturbed mature forested stream valleys have now been replaced by suburban or urban development and agriculture. Impacts degrading water quality, reducing forest canopy cover, increasing forest fragmentation and disturbing headwater stream banks are the major threats to these species. Acid mine drainage and acid deposition are potentially severe impacts in western Pennsylvania and the Appalachians in general (Mulvihill *et al.* 1997). Loss of eastern hemlock cover to hemlock woolly adelgid infestation may be important in the eastern coniferous/mixed forests (T. L. Master, ESU, unpublished data).

Statewide, one of the most serious threats to Pennsylvania's forests is the lack of regeneration. When young trees are not being produced to replace older, or dead and dying, trees, the forest is fundamentally threatened. Factors that reduce the ability of forests to regenerate include browsing by white-tailed deer, acid deposition, poor timber harvest practices, suppression of fire, non-native diseases and pests, and others. At high densities, white-tailed deer can have substantial impact; however, as deer densities decline many other factors can influence a forest's ability to regenerate.

## **22.4 Conservation and Management Needs of Riparian Habitats**

### **Riparian Buffers**

The width of riparian forest needed to serve as an ecological buffer can vary with the landscape and target species (Peterson and Kimball 1995). Some species are easily extirpated from strips of riparian forest if strips are too narrow. Studies designed to ascertain specific recommendations for the suggested width of strips has yielded a variety of results.

Some studies suggest that riparian strips should be at least 60 meters on either side of a river to prevent extirpation of more area sensitive species, other suggest more or less. Maintaining riparian forest buffers of at least 100 meters is probably a good working rule until further research is accomplished for target species. For some ecological functions, however, a buffer may be appropriate up to 600 feet (Peterson and Kimball 1995).

Continued statewide emphasis on establishing and protecting buffer zones along streams should yield tremendous benefit to riparian forest-associated species. See Table 22.6 at end of this section for a summary of tools useful in conserving riparian buffers.

### **Targeted Management on Public Lands**

The small percentage of riparian habitat managed by the Commonwealth may cause land managers to under-estimate the importance of the riparian forest as a habitat type. However, many WAP-priority species rely upon riparian forests for their survival, and most remaining large tracts of valley forest in the Commonwealth are publicly-owned. These public lands are extremely important for the conservation of forest-dependent species.

### **Protection of Remaining High-Quality Riparian Habitats**

Maryland's Partners in Flight Plan (1997) provides several excellent recommendations on protecting and managing high-quality riparian buffers. This Plan suggests avoiding even the loss of small forests (<25 acres or 10 hectares) in some areas, especially along streams and riparian corridors where forests are scarce. These sites are important, perhaps critical, to the survival of migrating birds in many habitat suites. In areas that can provide high-quality habitat for riparian grassland- or riparian thicket-dependent species, however, removal of small woodlots may be warranted.

**Targeted Protection of Priority Species**

Amphibians and reptiles tend to use riparian areas 100 to 200 feet in width, while otter and mink are found most often within 330 feet of the water (Appendix 2). Large mammals such as red foxes, fishers, coyotes, bobcats may utilize riparian corridors that extend up to 400 feet. Bald eagles, red-shouldered hawks, and songbirds may associate with corridors extending more than 300 feet (Peterson and Kimball 1995). Thus, to accommodate a range of wildlife, a 300- to 600-foot forested buffer is recommended.

For Louisiana waterthrush, a Species of Greatest Conservation Need, conservation efforts should be targeted at headwater streams and wetlands of high water quality within large forest patches. In smaller forest tracts, maintaining at least a 100-meter buffer of mature forest cover along streamside and ravine habitat may make these areas suitable for this species.

The greatest threat to colonial-nesting herons/egrets in riparian areas continues to be logging of forests without regard to the presence of colonies, especially on private lands where most colonies occur (Gill 1985, Schwalbe and Ross 1992). Of 39 known owners of property on which great blue herons nest in Pennsylvania, only 10 (26 percent) are public (PGC 2002). Despite wildlife protection laws prohibiting the taking (or disturbance) of birds on nests, fines are insignificant to many developers or landowners and protection does not extend to the non-breeding season (Ross 1990). Disturbance can easily result in abandonment of an entire colony, especially early in the nesting cycle and when located within 200-300 meters of the colony (Ross 1990, Butler 1992).

Though scattering of disturbed colonies to locations nearby may occur in the same and subsequent years, these 'splinter' colonies often do not persist. Ross, however, documented the likely merger of the two largest great blue heronries in the state after abandonment of one in 1997: the following year the second heronry (11 kilometers away) doubled in size to nearly 400 nests (PGC 2002 and unpublished data). This large colony persists, but has gradually declined in size by 12 percent over the past five years (Brauning and Siefken 2004).

**22.5 STATEWIDE PRIORITY CONSERVATION ACTIONS – RIPARIAN HABITATS****Level 1 – highest priority over the next 1-5 years****• Riparian Forest/Thicket Restoration**

Target: To identify, protect, and restore riparian forest/thicket habitats.

Measure: Riparian forest/thicket inventory and/or acres/stream-miles restored.

Issues: Development, urban sprawl, and roads have led to increasingly smaller available patch sizes and the near elimination of riparian thickets and heavy fragmentation of riparian



forests. Historic loss of riparian habitat can be countered by restoration and/or establishment of riparian habitat where feasible, through the goals of 1) Maintaining existing riparian habitat to support current population levels of associated species; 2) Supporting restoration efforts aimed at degraded riparian sites to create or improve habitat for associated species, and; 3) Establish riparian habitat in areas lacking habitat.

Prioritized Implementation Actions:

Level 1

- Identify the highest quality (largest, most non-fragmented, etc.) deciduous riparian forest/thicket stands.
- Participate in outreach programs for landowners, developers, and local officials regarding the importance of high-quality riparian forests/thickets.
- Identify and partner with organizations and groups that can protect these lands and provide financial support for private landowners.
- Restore degraded riparian forests/thickets to provide habitat for tolerant forest wildlife, corridors for wildlife movement, and to improve water quality.
- Partner with existing water-quality, open-space programs to assess the feasibility of cooperating on the establishment and restoration of riparian thickets/forests.
- Identify “missing links” in the chain of riparian forests/thickets along waterways within the Coastal Plain and target these areas for landowner outreach and restoration, where feasible.

Level 2

- Participate in outreach programs for landowners, developers, and local officials regarding the importance of high-quality riparian forests/thickets.
- Identify and partner with organizations and groups that can protect these lands and provide financial support for private landowners.
- Incorporate the goals and implementation recommendations of the planning document “Pennsylvania Stream Relief: A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams,” as well as other riparian conservation efforts, as feasible and appropriate, to benefit WAP-Priority species.

Coordination:

- State agencies (PGC, DCNR, DEP) – land management practices
- Federal agencies (USGS, USFS) – land management practices
- Local governments – land use planning, landowner incentives
- Private landowners with mature riparian deciduous habitats – outreach, incentives
- Ornithological organizations (Audubon) - research
- Universities and colleges - research
- Local land conservancies – landowner/public outreach
- Environmental Education Centers (Tinicum, Silver Lake Nature Center)
- Breeding Bird Atlas participants - monitoring

Related Plans :

1. Partner In Flight Landbird Conservation Plan for Area 24 (Allegheny High Plateau)

2. Partner In Flight Landbird Conservation Plan for Area 17 (Northern Ridge and Valley)
3. Partner In Flight Landbird Conservation Plan for Area 10 (Mid-Atlantic)
4. U.S. Department of Agriculture's Forest Service Conservation Assessment for the red-shouldered hawk.
5. A Gap Analysis of Pennsylvania
6. The Nature Conservancy Eco-Regional Plan for the Allegheny High Plateau
7. The Allegheny National Forest Land and Resource Management Plan
8. Pennsylvania Department of Conservation and Natural Resource Forest Management Plan
9. Pennsylvania Department of Environmental Protection, Pennsylvania Stream ReLeaf: A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams

Target: To provide a process for statewide identification and protection of exemplary sites.

Measure: Sites/acreage/stream flow protected.

Issue : There remains a lack of information and targeted management attention for high-priority streams and rivers, particularly warm-water systems.

Prioritized Implementation Actions:

- Identify sites that may provide critical habitat during critical times of the year.
- Targeted protection of sites during critical times of the year.
- Remove impediments to fish and aquatic species' movement.
- Stabilize priority watersheds (e.g. revegetation, reforestation, minimizing disturbances).
- Establish objective criteria for EV (Exceptional Value) designations of warm-water systems.
- Identify EV warm-water sites.
- Improve coordination required to protect exemplary sites.

Coordination:

Pennsylvania Fish and Boat Commission

Pennsylvania Department of Environmental Protection

Conservation Partners

### **Level 2 – priority over the next 5-10 years**

- **Targeted State-Level Management of Highest-Priority Sites**

Target: Establish buffer zones along streams.

Measure: Protection measures for riparian habitats developed; stream miles/acreage/sites protected; buffer acreage restored; management plans developed; population changes in indicator species.

Issue: Protection of essential habitats and consideration of the spatial ecology of target species are vitally important to conserving ecologically-relevant riparian buffers. Although the level of protection would be expected to vary with habitat type and target species,

statutes such as those in Florida and Massachusetts that delineate 100-foot buffer zones around wetlands/streams/rivers would protect many riparian-associated wildlife species. Priority watersheds would include French Creek drainage, a globally-significant waterway and other waterways supporting Species of Greatest Conservation Need as well as Immediate/High-Level Concern species.

Prioritized Implementation Actions:

Level 1 Implementation Actions:

- Identify highest-priority riparian habitats for Immediate/High-Level Concern species.
- Support voluntary measures, incentive programs, and legislation, as necessary, to protect riparian habitats.
- Enact management guidance and implementation policies to protect highest-priority sites.
- Assess the impacts of human-associated management activities during nesting season (April – October).
- Participate in the National Fish Habitat Initiative.
- Direct agricultural stabilization/incentive program efforts toward high-priority watersheds.
- Support streambank fencing/riparian buffer establishment/enhancement, and other practices available under the Farm Bill conservation programs and other relevant state and federal programs that help reduce siltation and sedimentation.

Coordination:

Chesapeake Bay Foundation  
 Partners in Amphibian and Reptile Conservation  
 National Fish Habitat Initiative  
 USDA Natural Resource Conservation Service  
 Pennsylvania Department of Conservation and Natural Resources  
 Pennsylvania Department of Transportation  
 Pennsylvania Department of Environmental Protection  
 Pennsylvania Fish and Boat Commission  
 Pennsylvania Game Commission  
 Private landowners  
 Conservation partners

• **Enhance and Restore High-Priority Lotic and Riparian Habitats**

Target: Comprehensive status assessment of imperiled or stressed watersheds and development of a systematic approach to stabilization and enhancement of lotic and riparian habitats.

Measure: Miles and/or acreage of lotic and riparian habitat restored/enhanced, number of watersheds stabilized.

Issue: Many watersheds in the Commonwealth are unstable, because of hydraulic modifications, loss of vegetative buffers, poor water quality, limited water quantity, urbanization, agriculture and other anthropogenic influences. Instability results in loss of

critical and high-quality lotic and riparian habitats and associated organisms. Existing watershed assessments, stream restoration plans, and other information currently exists for many watersheds. Where absent, surveys should be completed. This information should be collated and used to develop a strategy to stabilize watersheds and restore/enhance lotic and riparian habitats using a more “comprehensive” or “watershed” approach. The strategy should advance efforts to link restoration projects in a given watershed to maximize the availability of funding support and overall project benefits. Watersheds that provide critical habitat for Immediate/High-Level Concern species should be of highest priority.

Prioritized Implementation Actions:

Level 1

- Collate existing information on the status of watersheds and complete inventories on those where information is insufficient.
- Develop watershed restoration plans or use existing plans in conjunction with biological information to prioritize restoration efforts.
- Identify federal, state, county and private funding sources to support project planning and implementation.

Level 2

- Maximize funding and restoration opportunities by linking multiple projects and initiatives when practical.
- Provide coordination to project partners to advance restoration projects from the “conceptual” or “design” phase through to implementation and completion.
- Conduct surveys to monitor and evaluate project results.

Coordination

Pennsylvania Fish and Boat Commission  
 Pennsylvania Game Commission  
 Pennsylvania Department of Environmental Protection  
 Pennsylvania Department of Conservation and Natural Resources  
 National Oceanic and Atmospheric Administration  
 National Resource Conservation Service  
 U.S Environmental Protection Agency  
 U.S. Forest Service  
 U.S. Geologic Survey  
 U.S. Fish and Wildlife Service  
 U.S. Park Service  
 Land Conservancies  
 Colleges and universities  
 Private landowners  
 Conservation partners

## 22.6 STATEWIDE PRIORITY CONSERVATION ACTIONS – SPECIES' SUITES

### Level 1 – highest priority over the next 1-5 years

- **Colonial-Nesting Birds – Rookery Protection**

Target: Long-term protection of the five largest heronries in Pennsylvania

Measure: landowner agreements, acreage protected, land use/zoning measures

Issue: Protection methods for large breeding colonies in glaciated provinces need to be developed, especially with regard to heronries on private property. Easements, purchases, and public education should be considered.

Prioritized Implementation Actions:

#### Level 1

- Use information from existing surveys (e.g., Breeding Bird Atlas, PGC annual rookery surveys) to identify largest colonies.
- Use information from existing surveys (e.g., Breeding Bird Atlas) to guide the search effort for additional high-priority sites.
- Continue PGC heron/egret monitoring activities.
- For bank swallows, nest holes are evenly spaced within a bank surface, so larger banks have the potential to support larger colonies and should be afforded the highest conservation priority.

#### Level 2

- Monitor colonies to assess threats and population sizes.
- Assess the feasibility of developing a statewide bank swallow monitoring program based on a network of volunteer counters (similar to the PGC Summer Bat Concentration Survey).
- Characterize active nests/colony sites.
- Evaluate food resources at active sites and assess potential habitat.
- Identify and conserve active foraging areas, if they are determined to be a limiting factor.
- Protect significant wetlands and riverine segments near the five largest great blue heronries in Pennsylvania.

Coordination:

Pennsylvania Game Commission

Pennsylvania Department of Conservation and Natural Resources

Pennsylvania Department of Transportation

Important Bird Areas Program

Important Mammal Areas Program

American Society of Civil Engineers

Civil engineers, aggregate extraction companies, etc.

Audubon societies, Pennsylvanian Society for Ornithology, local bird clubs.

Private landowners

Research institutes and universities

- **Ensure Adequate State-Level Protection to Reduce Losses of Adult Turtles**

Target: Develop management guidelines to help reduce road mortality of nesting females. Enact regulations to prohibit the removal of northern map turtles, and other highly-collectible species, from wild populations –when such collection has potentially-significant and demonstrated population impacts.

Measure: Habitat management guidelines developed; Pennsylvania collection and possession regulations evaluated; nest sites/acreage targeted for protection.

Issue: Because of very limited distribution and geographic isolation, northern map turtles in Pennsylvania is especially vulnerable to extinction. The loss of adult turtles, particularly reproductive females, is among the greatest threats to population stability. Female northern map turtles and other riverine turtles often use human-altered, disturbed sites for nesting, including areas along highways containing fill materials and spill piles of coal slag. Because such areas are disturbed habitats, they are rarely considered ecologically-valuable or worthy of protection. But in some instances, the availability of such sites may be important for maintaining viable turtle populations. Some areas may serve hundreds of nesting females each year and such areas should be designated for protection. In addition, because eggs, hatchlings, or nesting females are present at nesting areas during all months of the year, disturbances to such sites (e.g., heavy equipment operations) at any time may negatively impact northern map turtles. Road mortality of nesting females may be substantial in some areas, and legal removal of adult turtles from the wild may also be very damaging. Current regulations in Pennsylvania allow individuals with a fishing license to remove from the wild, and possess, two northern map turtles at any given time.

Prioritized Implementation Actions:

Level 1

- Support research and survey activities aimed at developing management guidelines to reduce road mortality of nesting female turtles.
- Support efforts in Pennsylvania to eliminate legal or illegal removal of northern map turtles, and other vulnerable species, from wild populations.
- Support efforts of the Pennsylvania Fish and Boat Commission Non-Game and Endangered Species Division to reduce commercial exploitation of northern map turtles and other WAP-priority turtles.

Level 2

- Evaluate and revise current regulations to ensure adequate protection.

Coordination:

Partners in Amphibian and Reptile Conservation

Pennsylvania Department of Conservation and Natural Resources

Pennsylvania Department of Transportation

Pennsylvania Department of Environmental Protection

Pennsylvania Fish and Boat Commission

Pennsylvania Game Commission

Private landowners

Conservation partners

**Level 2 – priority over the next 5-10 years**

• **Identify and Protect Essential Turtle Nesting Sites and Monitor Populations**

Target: Identify and protect major nesting areas associated with streams and rivers.

Measure: Status of major nesting areas; population status and trends of target species; acreage/sites protected; management plans developed.

Issue: Spotting scope surveys appear to be the most effective means to determine the presence and densities of *Graptemys* species (Lindeman 1998). No densities of *G. geographica* have been established for viable populations, but target densities for the federally-threatened *G. flavimaculata* are 2.2 and 4.4 basking turtles per 100 m in two river systems in the southeast United States (U. S. Fish and Wildlife Service 1993). Surveys are also required to document major nesting areas for *G. geographica* in Pennsylvania. Some nesting areas may serve hundreds of females each year and such sites should be designated for protection.

Prioritized Implementation Actions:

Level 1

- Identify and protect major nesting areas associated with streams and rivers.
- Evaluate status of major nesting areas.
- In areas where road mortality of nesting females is substantial, short (< 1 m high) fencing should be installed to eliminate the ability of females to move onto roadways, although such a strategy should be employed only as a last resort.
- Carefully examine open-canopy habitats along major rivers for the presence of nesting areas prior to activities such as road construction; such areas should be avoided where they are found.

Level 2

- Delimiting range in the state for highest-priority species.
- Determine status of extant populations and habitat.
- Identify and secure permanent monitoring stations where population information, along with habitat measurements, may be made at regular intervals.

Coordination:

Partners in Amphibian and Reptile Conservation  
 Pennsylvania Department of Conservation and Natural Resources  
 Pennsylvania Department of Transportation  
 Pennsylvania Department of Environmental Protection  
 Pennsylvania Fish and Boat Commission  
 Pennsylvania Game Commission  
 Private landowners  
 Conservation partners

**22.7 STATEWIDE PRIORITY CONSERVATION ACTIONS – RIPARIAN-ASSOCIATED SPECIES**

**Level 1 – highest priority in the next 1-5 years**

- **Status Surveys of SGCN, Immediate Concern, High-Level Concern Species**

Target: Comprehensive status assessment of imperiled species in need of additional information to make a status determination.

Measure: Surveys completed.

Issue: Many river-associated species represent imperiled taxonomic groups, but comprehensive status assessments are lacking. Up-to-date status information is necessary in order to allocate funding, recovery and management activities. All known sites where populations of PA Vulnerable and priority PFBC Candidate species are extant or historic should be surveyed in an effort to determine the status of what are often our rarest species. Information on population densities, structure, and health in the state is required to prioritize conservation actions. In some cases, information on genetics issues must also be understood in order to make a priority characterization.

Target Species – Status Assessments, Distribution/Abundance Surveys:

<b>IMMEDIATE CONCERN</b>	<b>HIGH-LEVEL CONCERN</b>	<b>PENNSYLVANIA VULNERABLE</b>	<b>MAINTENANCE CONCERN</b>
WEST VIRGINIA WATER SHREW (Southern Water Shrew)	QUEEN SNAKE	ROCK VOLE	ROCK SHREW
WOOD TURTLE -R	EASTERN RIBBON SNAKE		EASTERN HOGNOSE SNAKE
			FOUR-TOED SALAMANDER
			FOWLER’S TOAD
			NORTHERN LEOPARD FROG

Prioritized Implementation Actions:

Level 1

- Resurvey locations of recent records, as necessary.
- Design sampling protocols to enable population estimates and age structure analyses, and physical and chemical habitat characteristics.



- Develop a search image, based on extant factors and conditions at each occupied site and, if possible, prepare a predictive model to aid in the identification of potential habitat elsewhere. These tools should then be applied to searches within occupied drainages, and, if effective, expanded to others.

Level 2

- Identify and secure permanent monitoring stations where population information, along with physical and chemical habitat measurements, may be made at regular intervals.
- Designate and secure an adequate number of fixed monitoring stations and survey at five-year intervals. Stations should be selected at locations that will accommodate monitoring of other species of concern.
- Validate predictive models of occurrence.

Coordination

Pennsylvania Fish and Boat Commission

U.S. Fish and Wildlife Service

Land Conservancies

Colleges and universities

Private landowners

Conservation partners

**Level 2 – priority over the next 5-10 years**

• **Long-Term Monitoring of Priority Species and Populations**

Target: Long-term monitoring of priority species' populations. Target species include hellbender, madtoms, darters, map turtle, redbelly turtle and other species with adequate population size for monitoring efforts.

Measure: Monitoring efforts initiated; population status and trends of target species; distribution and abundance information collected.

Issue: Currently, many stream- and river-associated species, including terrestrial species and fish, are not adequately monitored to detect population trends. In the case of fish, routine monitoring should provide an overall indication of changes in habitat quality - information that could be used to benefit other WAP-Priority species. Fish species accounts in Appendix 3 provide detailed monitoring recommendations depending on the level of conservation concern.

Prioritized Implementation Actions:

Level 1

- Use established monitoring programs to find new occurrence sites for target species.
- Initiate and/or increase participation in more specialized surveys. Encourage the collection of data from WAP-priority species during routine PFBC aquatic sampling/monitoring efforts.
- Conduct specific surveys for rare species in appropriate habitat as specified in Appendix 3.
- Map occupied locations for future reference.

- Encourage the tracking of data collected in the above surveys for Immediate/High Level and PA Vulnerable species in the PA Natural Heritage Program.

Level 2

- Monitor locations where target species were located in the above-mentioned surveys.
- As some standard projects are established or run their course, initiate and/or increase participation in more specialized surveys that would be especially effective for target species in the same ecosystems.
- Conduct specific annual monitoring surveys for Immediate Concern species as recommended in Appendix 3.

Coordination:

Pennsylvania Fish and Boat Commission  
 Pennsylvania Game Commission  
 Pennsylvania Department of Conservation and Natural Resources  
 Allegheny National Forest  
 Conservation partners  
 Colleges and universities

Target Species – Long-Term Monitoring:

<b>IMMEDIATE CONCERN</b>	<b>HIGH-LEVEL CONCERN</b>	<b>PENNSYLVANIA VULNERABLE</b>	<b>MAINTENANCE CONCERN</b>
Wood Turtle - R	Bald Eagle	Osprey	Eastern Hognose Snake
			Louisiana Waterthrush – R
			Map Turtle

**22.8 SPECIES OF GREATEST CONSERVATION NEED – RIPARIAN THICKETS/FORESTS**

Significant effort was made in the course of WAP development to identify and emphasize the unique role of Pennsylvania in conserving species of concern. A guiding objective of WAP planning was to reach beyond ‘rarity,’ a reactive mode that forces managers to simply document the declines of a species. In order to achieve truly comprehensive, truly proactive management, managers must begin to direct attention to those species and habitats for which Pennsylvania serves a responsibility role.

Considering species of concern through the dual lens of responsibility *and* imperilment quickly reveals where conservation actions should be directed under the State Wildlife Grants program. Focusing “endangered species prevention” efforts and proactive management on the following species associated with riparian thickets/forested habitats will provide conservation results that will have the greatest impacts at the state, regional,

national, and global levels (Table 22.4). See Appendix 3 for full species accounts of all WAP-Priority species associated with riparian thickets/forests.

**Table 22.4: Species of Greatest Conservation Need – Riparian Thickets/Forests**

Refer to Appendix 3 for full species accounts of Species of Greatest Conservation Need as well as other WAP-Priority species.

	Ohio Hills	Lower Great Lakes	Northern Plateau	Pocono Plateau	Ridge and Valley	Piedmont	Coastal Plain
<b>ALLEGHENY WOODRAT - R</b>			xx		XX		
<b>TIMBER RATTLESNAKE - R</b>			XX		xx		
<b>WOOD TURTLE - R</b>	xx	xx	xx		XX	xx	
<b>CERULEAN WARBLER - R</b>	XX	XX	xx (Allegh mtns)				
<b>SHORTHEAD GARTER SNAKE</b>	xx	xx	XX (Northwest portion)				
<b>LOUISIANA WATERTHRUSH - R, I</b>	XX	xx	xx	XX	XX	xx	

**XX – primary area of distribution**  
**xx - secondary area of distribution**  
**(xx) – likely extirpated from area**

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## 22.9 Sources

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**Appendix 22.1 Species-Habitat Associations for Riparian Habitats of Pennsylvania**

Clearly defining species-habitat associations is somewhat complicated. For each wildlife species, the particular habitat it uses is complex and often comprised of several parts of a landscape and several land-cover types or communities. Additionally, many species change their habitat use during various seasons and life stages and this further complicates the conservation of species and key habitats. Also, the effort of associating species with key habitats is confounded because the habitat’s quality and/or function may rely upon unknown and/or off-site mechanisms. Thus, for a species to be adequately conserved, all aspects of its key habitat(s) must be available in a quantity and quality sufficient for its survival.

Though complicated and incomplete, it is nevertheless vitally important to attempt to associate species with their key habitats to begin formulating conservation goals and objectives. The following table contains summary information describing specific species/habitat associations relative to the habitat type covered in this section. This information is in DRAFT form and is in need of further refinement and additional input from technical experts to ensure its accuracy. Currently, Pennsylvania lacks a meaningful way to classify communities relative to terrestrial vertebrates. This is recognized as an ongoing priority by Pennsylvania’s natural resource agencies.

Species-specific information detailing specific habitat requirements, the location and relative condition of key habitats, threats and factors affecting habitat quality and population trends of target species can be found in Appendix 3: WAP-Priority Species Assessments.

**Table 22.5 WAP-Priority species associated with specific types of riparian forest habitat in Pennsylvania.** (\*Species which are limited to a specific physiographic area are noted, otherwise, the species occurs in various physiographic areas)

Category	Specific types	Micro-quality	WAP-Priority Species	Community Type	Physiographic Area *
<b>Riparian Thickets</b>	Early successional	Riparian Thickets	Rough Green Snake		P
			Eastern Ribbon Snake		
			Queen Snake		OH, P
			Yellow-breasted chat		
		W/clearings	Wood Turtle-R		
			Kirtland’s Snake		OH
			American woodcock	Hawthorne, alder, aspen ,	

				dogwood	
<b>Mid-successional/ Second growth Riparian Forest</b>	Deciduous		Hoary Bat		
		With tall trees for nesting	Great Blue Heron		
			Great Egret		
			Black-crowned Night-Heron		
			Yellow-crowned Night Heron		
			Bald Eagle		
			Osprey		
			River Otter		
			Queen Snake		OH, P
			Shorthead Garter Snake -R		
			Indiana Bat		
		W/ dense understory	Kentucky Warbler		
<b>Mature Riparian Forest</b>	Deciduous	>400-500 ft wide buffers	Acadian flycatcher	Dense canopy – indicator species for high-quality riparian forest. Beech forests in south	
		tall canopy with spreading crowns	Yellow-throated vireo	Indicator of tall canopy forests	
		Patchy w/ clearings	Wood Turtle - R		
			Cerulean Warbler - R	large, well spaced trees with dense, high	OH

				canopies	
	Higher elevation	W/ rocky substrate/talus and heavy forbs/shrubs	Allegheny Woodrat-R	N. Hardwoods, oak-dominated	RV, NP (Allegheny Mountains portion)
			Timber rattlesnake-R	N. Hardwoods, oak-dominated	NP, RV
			Rock Vole	N. hardwood forests (3000+ft)	NP (and Poconos)
			Rock Shrew	N. Hardwoods w/dense rosebay rhododendron (3000+ ft)	NP, RV, OH
		Wide riparian forests buffers (>30 m) W/ dense vegetation near ground	Yellow-bellied flycatcher	High elevation boreal conifer swamps and swampy riparian	NP
		W/Dense ground cover (>75 percent), med-high canopy closure along high-quality streams of moderate gradient w/undercut banks	Northern Water Shrew	n. hardwoods (mixed forests at higher elevations)	NP – (NC, NE portion) Appalachian Plateau, Poconos 1500+ ft elevation
					OH
<b>Mixed Riparian Forest</b>	Mid-successional/ Second Growth		Hoary Bat		
			Red-shouldered Hawk	With openings/clearings	
		W/dense	West Virginia	Mixed	NP – (SW



		ground cover and riparian undercut banks, (>75 percent) vegetative cover	Water Shrew	deciduous/ conifer forest	portion) Allegheny mountains region (Somerset county area)
		W/Dense ground cover (>75 percent), med-high canopy closure along high-quality streams of moderate gradient w/undercut banks	Northern Water Shrew	n. hardwoods (mixed forests only at higher elevations)	NP – (NC, NE portion) Appalachian Plateau, Poconos 1500+ ft elevation
		W/Open ground cover Closed canopy (>75 percent)- W/hemlock or spruce	Northern Flying Squirrel	open ground cover with high stem density (rhodo component), and thick leaf litter – near water	NP, Poconos
		Unfragmented	Allegheny Woodrat-R	N. Hardwoods, oak-dominated	RV, NP (Allegheny Mountains portion)
			Timber rattlesnake-R	N. Hardwoods, oak-dominated	NP, RV
			Canada warbler	Hemlock ravines w/ dense understory	
			Red-shouldered Hawk		
			Acadian Flycatcher		
			Alder		

			Flycatcher		
			Willow Flycatcher		
	Mature		Great Blue Heron	mature hardwood or mixed hardwood/conifer forests, usually near rivers, wetlands, or lakes	
		High quality/unfragmented	Yellow-throated Vireo		
			Louisiana Waterthrush-R	High quality; streams; W/open to moderate shrub layer	
		>400-500 ft wide buffers	Acadian flycatcher	Dense canopy – indicator species for high-quality riparian forest. Beech forests in south; hemlock in north	
			Silver-haired bat		
		(southern PA)	Acadian Flycatcher		
Coniferous Riparian Forest			Blue-headed vireo		
	High elevation Mature Hemlock		Winter Wren	indicator species for high-quality mature and old-growth coniferous forests	NP

		Area sensitive - wide riparian (>30 m)	Yellow-bellied flycatcher	High elevation boreal conifer swamps and swampy riparian	NP
		Area sensitive >400-500 ft wide buffers	Acadian flycatcher	Dense canopy – indicator species for high-quality riparian forest. Beech forests in south; hemlock in north	
		Closed canopy (>75 percent)- W/hemlock or spruce	Northern Flying Squirrel	open ground cover with high stem density (rhodo component), and thick leaf litter – near water	NP, Poconos
	High elevation Mature Spruce		Blackpoll warbler	high elevation, spruce-dominated wetlands and forests.	NP – western Wyoming Co.

\* Species largely or entirely restricted to a specific physiographic area (LGL – Lower Great Lakes, OH – Ohio Hills, NP – Northern Plateau, RV – Ridge and Valley, P – Piedmont, CP – Atlantic Coastal Plain

**Appendix 22.2 Methods to conserve existing riparian forest buffers**

**TABLE 22.6. METHODS TO CONSERVE EXISTING RIPARIAN FOREST BUFFERS.** For more information on managing and restoring riparian buffers in Pennsylvania, the reader is referred to the planning document “Pennsylvania Stream Relief: A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams” (DEP 1998)

METHOD	DESCRIPTION	CANDIDATES FOR IMPLEMENTATION
<p><b>Conservation Plans</b></p>	<p>A written plan for a landowner detailing best management practices for conservation of the land; a riparian forest buffer will control and prevent soil erosion.</p> <p>Contact: county conservation districts, Natural Resources Conservation Service, Cooperative Extension Service.</p>	<p>Business/Industry</p> <p>Agriculture</p> <p>Government</p> <p>Local municipality</p> <p>School</p> <p>Non-profit organization</p> <p>Private landowner</p>
<p><b>Conservation Easements</b></p>	<p>A legal agreement landowners voluntarily make restricting the type and amount of development that occur in perpetuity. Executed between private property owners and qualified conservation organizations. These arrangements, if perpetual, provide federal income, estate and gift tax benefits; restrictions are flexible. Disadvantages include abdicating some rights relating to property use; easements do not have to be perpetual; and the landowner remains responsible for land maintenance and other costs of the land.</p> <p>Contact: land trusts, conservancies (see "Wetland and Riparian Stewardship in Pennsylvania," pp. 19-24 and "Protecting Unique Land Resources: Tools, Techniques, and Tax Advantages" by J.A. Gutanski, 1997).</p>	<p>Business/Industry</p> <p>Agriculture</p> <p>Private landowner</p> <p>School</p> <p>Government</p> <p>Local municipality</p> <p>Non-profit organization</p>
<p><b>Farmland Protection Programs</b></p>	<p>Preservation of farmland by purchasing development rights from farmers. May include additional provision to conserve riparian forest buffers</p>	<p>Agriculture</p> <p>Government</p>

	Contact: county and local governments.	Local municipality Private landowner Non-profit organization
<b>Open Space Preservation</b>	Preserving open space through a variety of incentives, e.g. bond issues, grant programs, parks and recreation, land development practices, etc.  Contact: county and local government.	Non-profit organization Agriculture Government Local municipality
<b>Zoning</b>	Townships implementing land development and stormwater management plans through their zoning ordinances.  Contact: township board of supervisors, township zoning board, township planning board.	Local municipality Private landowner

<b>METHOD</b>	<b>DESCRIPTION</b>	<b>CANDIDATES FOR IMPLEMENTATION</b>
<b>Transferable Development Rights (TDRs)</b>	Local governments have the right to limit development in one area while opening other areas for development in a process of relocating "zones" through enacting TDRs. Practicable because of zoning codes, land use ordinances and/or regulations. TDRs allow land to remain in the private sector while avoiding undesirable development. Complicated standards of allocation, purchase and sale of development rights need to be established for a legally defensible system.  Contact: township board of supervisors, private consultants, real estate attorneys.	Government
<b>Land Use Planning</b>	Townships planning for development can consider conserving existing riparian forest buffers in subdivision and land development plans.  Contact: county planning commission, township board of supervisors, township planning commission, private consulting firm.	Local municipality

<p><b>Forest Management Plan</b></p>	<p>A plan written by a professional forester that describes forest management for a particular area; a riparian forest buffer can be a recommendation of the plan.</p> <p>Contact: Dept. of Conservation and Natural Resources Forest Stewardship Program (cost-shared), independent forest business.</p>	<p>Business/Industry</p> <p>Agriculture</p> <p>Government</p> <p>Local municipality</p> <p>School</p> <p>Non-profit organization</p> <p>Private landowner</p>
<p><b>Change Ownership</b></p>	<p>Change ownership of the land to a public entity that will manage for riparian forested buffers - rails to trails, conservancy, park system, land trust, greenway. The private landowner (land donor) benefits from the tax write-off. (See "Wetland and Riparian Stewardship in Pennsylvania" pp. 29-30 for more information on sale and donation options).</p> <p>Contact: land trusts, conservancies, government agencies.</p>	<p>Local municipality</p> <p>Government</p> <p>Non-profit organization</p> <p>Agriculture</p> <p>School</p> <p>Private landowner</p>
<p><b>Leases</b></p>	<p>Rental agreements by a landowner to a conservation group for a specific period of time. Advantages include monthly income to owner. Disadvantages are that leases generally may give unrestricted control to the leasing organization and the buffer conservation is not perpetual.</p> <p>Contact: legal services, conservation groups (see "Protecting Unique Land Resources: Tools, Techniques, and Tax Advantages" by J.A. Gutanski, 1997)</p>	<p>All</p>

METHOD	DESCRIPTION	CANDIDATES FOR IMPLEMENTATION
<b>Land Swap</b>	Change ownership of property by deed swap. Contact: legal services.	Industry Agriculture Government Local municipality School Non-profit organization Private landowner
<b>Mutual Covenants</b>	Agreements between nearby or adjacent landowners to manage the future use of the land for conservation. These can be permanent, can be enforced by any single landowner (or future landowners) against other involved members of the covenant. Loss of market value from mutual covenants can not be claimed as a charitable deduction on income tax returns.  Contact: legal services.	All
<b>Mitigation for Lost Public Lands</b>	Any public lands needed for transportation projects are replaced with other land (usually of the same type), which then becomes public land. Existing streamside buffers can be replaced with other streamside buffers. If the public landowner wishes, streamside buffers could be considered for replacement of non-buffered land taken.  Contact: Pa. Dept. of Transportation.	Local municipality Government
<b>Grant Programs</b>	Funding programs that support development of watershed management plans which will include riparian forest buffer conservation.  Contact: private foundations, state government.	Non-profit organization Private landowner School Municipality

<p><b>Written Policies</b></p>	<p>Written environmental policies within the business, organization, agency that includes the conservation of riparian forest buffers.</p>	<p>Business/Industry Agriculture Government Local municipality Business Private landowner</p>
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<p><b>METHOD</b></p>	<p><b>DESCRIPTION</b></p>	<p><b>CANDIDATES FOR IMPLEMENTATION</b></p>
<p><b>Management Agreements</b></p>	<p>Pacts between landowners and conservation agencies where one agrees to manage the property in a manner consistent with conservation goals. Landowners may receive direct monetary returns or other types of cost-share assistance; it is ordinarily easier to terminate than a lease but management agreements are not permanent.</p> <p>Contact: land trusts, conservancies.</p>	<p>All</p>
<p><b>Floodplain Management</b></p>	<p>Rigid application of policies regarding development in floodplains. (Management plans could add further support to existing federal and state regulations regarding waterways, wetlands and floodways).</p> <p>Contact: local government, county planning commission.</p>	<p>Local municipality</p>
<p><b>Water Resource Protection Regulatory Programs</b></p>	<p>Existing state and federal wetland, floodway and other regulatory programs can further promote riparian forest buffer conservation through various mitigation and restoration techniques.</p> <p>Contact: Dept. of Environmental Protection, Army Corps of Engineers.</p>	<p>Government</p>