SECTION 16 – ROCK HABITATS – CONTENT SUMMARY

16.1 Location and Condition of Rock Habitats
Table 16.1: Rock habitat types found in Pennsylvania.

16.2 Threats to Rock Habitats and Associated Species
16.3 Rock-Associated Wildlife Species
Table 16.2: WAP-Priority species associated with rock habitats (caves, rock outcrops, talus slopes, mines and tunnels) in Pennsylvania**.**
16.4 Rock-Associated Wildlife Trends
16.5 Conservation and Management Needs of Rock Habitats

16.6 STATEWIDE PRIORITY CONSERVATION ACTIONS – ROCK HABITATS
Level 1- highest priority over the next 1-5 years
Ensure Adequate Protection of High-Priority Caves
Identify High-Priority Rock Outcrops/Cliff/Talus Habitats

Level 2-priority over the next 5-10 years
Develop a Statewide Management Plan for Rock Cliff/Outcrop/Talus Habitats
Creation of Suitable Habitat During Mine Reclamation

16.7 STATEWIDE PRIORITY CONSERVATION ACTIONS – ROCK-ASSOCIATED SPECIES
Level 1 – highest priority over the next 1-5 years
Develop Multi-Species Management Guidance for Rock Habitats
Status Surveys of Priority Species
Research Effect of Forest Management and Other Land Use on WAP-Priority Species

Level 2 – priority over the next 5-10 years
Identify Critical Foraging Habitats Associated With High-Priority Hibernacula
Identification of Key Travel Corridors
Protect Summer Roosts at Highest-Priority Rock Outcrops/Caves

16.8 SPECIES OF GREATEST CONSERVATION NEED – ROCK HABITATS
Table 16.3. Species of Greatest Conservation Need Associated with Rock Habitats in Pennsylvania.

IMMEDIATE CONCERN
Allegheny Woodrat
Eastern Small-footed *Myotis*
Timber Rattlesnake

HIGH-LEVEL CONCERN
Mountain Earth Snake
MAINTENANCE CONCERN
Northern *Myotis*

16.9 Sources

Appendix 16.1 Species/Habitat Associations for Rock Habitats

Table 16.4 Specific species/habitat associations for rock-associated, WAP-Priority species in Pennsylvania.

SECTION 16 – ROCK HABITATS

The most essential feature of rocky habitat for wildlife is surface rock in the form of cliffs, ledges, outcrops, boulder fields, and caves. For most rock-associated species, heavily dissected rock with many crevices is preferred (Wright and Butchkoski 2005). In Pennsylvania, the most common rock habitat types are caves and talus slopes. In each case, common rock types are sandstone and limestone, both of which are abundant and widespread as surface rock and are still relatively undisturbed (Myers *et al.* 2000).

Man-made rock habitats, such as active and inactive mines and quarries, also can provide habitat for wildlife. In fact, in Pennsylvania, the federally endangered Indiana bat is found more often in abandoned limestone mines than in natural caves. Though this is likely because large, high-quality limestone caves were converted historically into mines, it nonetheless highlights the potential for man-made rock habitats to serve as assets when conserving WAP-Priority species.

16.1 Location and Condition of Rock Habitats

There are four different cave-types in Pennsylvania: terrestrial solution caves, aquatic solution caves, tectonic caves, and talus caves (Thorne *et al.*1995) (Table 16.1). Solution caves occur in limestone bedrock and are the most common cave in the state, particularly in the Ridge and Valley physiographic region. A diverse invertebrate community can be found here, as well as several Species of Greatest Conservation Need: the federally endangered Indiana bat; eastern small-footed bat, and; Allegheny woodrat.

Tectonic caves are formed by subsurface cracks in bedrock and may be associated with sandstone. They are usually dry and also used by bats and woodrats. Talus caves are formed in boulder piles where openings occur between rocks. Many reptiles and small- to mid-sized mammals may use these for cover. WAP-Priority species, such as the Indiana bat, eastern small-footed bat, Allegheny woodrat, timber rattlesnake, and the northern copperhead may be found using talus caves and talus slopes.

Man-made caverns, such as deep coal mine shafts or abandoned tunnels, also are inhabited by rock-associated wildlife. Surveys conducted by the Pennsylvania Game Commission indicate the importance of man-made sites: of the rock hibernacula sampled by the Game Commission, 77 percent of limestone mines, 100 percent of other types of mines, 81 percent of vehicle tunnels, and 100 percent of other types of tunnels were occupied by bats. Other man-made structures were occupied 92 percent of the time (Hart 2001). As mentioned previously, this is likely an artifact of historic use of rock habitats, but it does indicate that these man-made sights can contribute significantly to the conservation of WAP-Priority species.

Table 16.1: Rock habitat types found in Pennsylvania.

Rock Habitat Types in PA
Bare, exposed surface rock
Active mines
Abandoned mines
Caves
-- Terrestrial solution type
-- Aquatic solution type
-- Tectonic type
-- Talus type
Large rock float blocks
Rock talus
Boulder fields
Rock outcrops/cliffs

Talus slopes, boulder- and rock-strewn regions of mountains or mountainsides and ravines, provide critical habitat for several WAP-Priority species including the rock shrew, rock vole, Allegheny woodrat, eastern spotted skunk, timber rattlesnake, northern copperhead, eastern fence lizard, and northern coal skink. The complete distribution of talus slope habitat in the state is unknown at this time. However, the habitat type is closely associated with mountain ridges of the Northern Ridge and Valley physiographic region and the southwest (Allegheny Mountains) portion of the Northern Plateau.

Although the amount of appropriate rock habitat for rock-associated species in Pennsylvania is still large, it is likely to diminish and would be difficult to reestablish; only a few abandoned quarries and mines represent expanded opportunities for occupation (Chamblin *et al.* 2004).

16.2 Threats to Rock Habitats and Associated Species

(adapted from Appendix 2 and Wright and Butchkoski 2005)

The most significant threats for cavern wildlife are alteration of habitat and disturbance. Cave-associated species in Pennsylvania are subject to direct disturbance from humans wherever recreational use of caves is increasing. Human visitation, which spans the spectrum from commercialized tourism to recreational spelunking, can alter temperature, disturb hibernating bats, and introduce pollutants. When bats are disturbed, they use up their fat reserves. If disturbance continues, they may not survive through the winter. Hibernacula can be gated with special gates that allow air and bats to come and go, while people are excluded. Caves that are gated show increases in bat numbers through the years, suggesting that un-gated caves are often disturbed and bat numbers reduced (Hart 2001).

Closure of entrances or further opening of a cave can affect wildlife use and the air circulation patterns and air temperatures (Thorne *et al.*1995). Bats of Pennsylvania feed primarily on insects. Caves and mines may be blocked off completely by property owners out of safety and liability concerns. Complete closure of caves used by bats for hibernation can be deadly. In New Jersey, the recent closure of a mine sealed up the largest bat concentration in the entire state (Hart 2001). Vandalism or intentional destruction has been noted as well. Other threats include pollution of aquatic systems that maintain the humidity of the cave environment.

Rock outcrops, cliffs, and talus slopes are less likely to be disrupted, but most rock-associated WAP-Priority species (such as the Allegheny woodrat, timber rattlesnake, rock vole, and rock shrew) are associated with rock patches in a forest matrix; particularly within mesic oak-hickory forest communities where mast is abundant. Threats to these sites may be primarily threats to surrounding forest, which is needed to allow effective dispersal and genetic mixing of wildlife inhabiting talus areas. Even with abundant habitat, the population structure of rock-associated species is vulnerable if connections among the population units are lost and empty habitat patches are not recolonized.

Rattlesnake hunters have been known to disrupt these rocky habitats in search of timber rattlesnakes and copperheads. Large rocks were moved by jacks, winches, and chains. Gas, dynamite, and smoke bombs also were used to spook timber rattlesnakes from their refugia within the crevices of the rocky habitat. While there is evidence to suggest that this activity still persists, fairly recent regulations outlawing such practices appear to have decreased this destructive activity (C. Urban, personal communication).

Seemingly minor landscape changes can have profound effects on rock-associated species, even when the changes occur some distance away from occupied sites. Subtle barriers that reduce successful travel between patches may be significant threats. This is because rocky habitat is distributed in patches too small to sustain long-term populations, so each colony relies upon immigration and emigration from occupied sites. Barriers to wildlife associated with ridges and outcrops include new or widened roads, quarries, wind farms, and communications towers – all are examples of disturbances that could act as barriers to lower the rate of recolonization and increase isolation among occupied patches.

Nearby residential developments that share the landscape also can impose significant alterations to these populations. Anecdotal reports and observations suggest there is evidence local populations of timber rattlesnakes known to utilize dens or rocky basking habitat within one mile of these developments have declined over time, most likely because dispersing or foraging adult timber rattlesnakes entering residential yards were being killed by homeowners. Also, nearby rocky habitats are often frequented by local adolescents and young adults as 'party' sites. Broken glass bottles, beer cans, and other garbage and signs of disturbance often are found at these sites. Timber rattlesnakes subsequently often become absent from these sites (C. Urban, personnel communication).

Although the individual effects of each landscape change may be minor, if fewer rock patches are occupied, there will be fewer source populations for recolonization, which could lead to the eventual collapse of an entire metapopulation. A improved understanding of targeted species metapopulation dynamics will be necessary to recognize this effect, predict the fate of populations, and possibly intervene with artificial corridors or assisted recolonization. In particular, we need more data on dispersal distances, sex and age of successful colonists, and seasonal timing of their movements.

Forest management activities are another significant factor that is, unfortunately, not clear-cut in its impact. Snakes appear to tolerate selective cuts near hibernacula and talus sites that they use, as long as the logging operators are careful not to disturb them during winter hibernation and not to kill them as they disperse from the site in spring. Forest cuts can provide a boost in foraging opportunities for rattlesnakes as small mammal populations flourish. Forestry activities can have negative consequences for woodrats, however, if they expose them to generalist predators and competitors, and reduce the hard mast they rely upon. Additional research is needed on the long-term impacts of forest management practices on rock-associated species.

The limited work that has been done in this area indicates that habitat fragmentation accompanying timber harvest can impact rock-associated wildlife, such as Allegheny woodrats. Hassinger et al (1996) found that in the Pennsylvania Ridge and Valley province, woodrat populations within 1 kilometer of forest edge were 15 times more likely to have declined to zero than those more than 2 kilometers from forest edge; they concluded a large, intact forest buffer is important for population persistence. Castleberry et al (2002b) found that Allegheny woodrats would readily forage in clearcuts, but they did not assess whether such foraging exposed woodrats to greater predation risk than in intact forest.

Some forest stands have been repeatedly timbered; others have been converted to agriculture or residential use; remaining forests are increasingly fragmented by surrounding development or crisscrossed with roads, utility lines, ski trails, and timber access roads. Additional likely threats to rock-associated WAP-Priority species include possible acid mine drainage effects (in riparian rock habitats), acid rain precipitation effects on forest health, and recreational development, such as ski resorts

16.3 Rock-Associated Wildlife Species

Table 16.2: WAP-Priority species associated with rock habitats (caves, rock outcrops, talus slopes, mines and tunnels) in Pennsylvania**.**

IMMEDIATE CONCERN	SPECIFIC HABITAT REQUIREMENTS
Allegheny Woodrat – R *Neotoma magister*	Sandstone and/or limestone rock habitats in unfragmented oak-hickory forest communities
Eastern Small-footed Bat – R *Myotis leibii*	Deciduous/mixed forested areas with small, cool caves and mines, and rock outcrops
Green Salamander *Aneides aeneus*	Moist crevices in sandstone outcrops and ledges
Indiana Bat *Myotis sodalis*	Summer-riparian, bottomland or upland forests, old fields and pastures. Winter-caves, mines
Timber Rattlesnake – R *Crotalus horridus*	Sandstone and/or limestone rock habitats in unfragmented oak-hickory forest communities
HIGH LEVEL CONCERN	
Peregrine Falcon *Falco peregrinus*	Large cliffs across the state, most often associated with rivers. Large and medium-sized bridges and tall buildings also serve as nesting structures.
Eastern Spotted Skunk *Spilogale putorius*	Dry oak, Virginia pine, and pitch pine forested rocky ridges & ravines; reverting farmland
Mountain Earth Snake-R *Virginia valeriae pulchra*	Deciduous/mixed forests - moderate to steep hillsides with an abundance of rocky cover and vegetation.
Northern Coal Skink – R *Eumeces anthracinus anthracinus*	Open habitat (less than 50percent canopy cover by trees) where rocks and logs provide abundant cover
RESPONSIBILITY SPECIES	
Northern Myotis – R *Myotis septentrionalis*	Summer - exfoliating bark/snags in mature deciduous/mixed forests, also human structures. Winter - caves
PA VULNERABLE	
Rock Vole *Microtus chrotorrhinus*	High elevation, riparian red spruce/northern hardwood forests with large amounts of talus and rock and heavy forb cover
MAINTENANCE CONCERN	
Common Nighthawk *Chordeiles minor*	Rock outcrops; gravel rooftops in cities and towns
Eastern Fence Lizard *Sceloporus undulatus*	Open rock faces and talus in forest
Eastern Spotted Skunk *Spilogale putorius*	Dry oak, Virginia pine, and pitch pine forested rocky ridges & ravines; reverting farmland
Northern Copperhead *Agkistrodon contortrix mokasen*	Open, rocky areas in deciduous hardwood forest w/low surface vegetation, reduced amounts of shade, and soil temperatures elevated by sunlight
Rock Shrew *Sorex dispar*	Talus slopes within mesic oak-hickory communities with a dense shrub layer consisting of rosebay rhododendron at elevations over 1000m.

16.4 Rock-Associated Wildlife Trends

As stated previously, many WAP-Priority species associated with rock habitats have similar characteristics that render them particularly vulnerable to habitat changes and habitat degradation. Rock habitat sites are typically distributed in small patches interspersed with forest. As a consequence, species associated with rock habitats are typically found in relatively small population groups, each centered on one rock patch. Such populations are too small to be self-sustaining over the long term with stochastic fluctuations in population size. Instead, rock-associated species such as the Allegheny woodrat and timber rattlesnake appear to conform to a classic metapopulation model in which individual population units wink out from time to time and are reestablished through inter-patch dispersal, while the overall large population persists (McCullough 1996). Even with abundant habitat, such a population structure is vulnerable if connections among the population units are lost and empty habitat patches are not re-colonized. Gene flow among populations may be easily disrupted by filter barriers, such as roadways and unsuitable habitat.

In addition to gene flow/metapopulation issues, wildlife using these sites have evolved in an undisturbed forest environment and appear unsuited to endure increased generalist predators or competitors that often accompany fragmentation of the forest surrounding such sites. Disturbance by recreation is also a notable threat, although some low use of these sites does appear tolerated (e.g., rattlesnakes are not found in high-use talus areas, but are found on low use talus mountaintops). High levels of disturbance, and possibly disturbance during vulnerable times of the year, are generally not tolerated: rattlesnakes and woodrats are no longer found on some prominent hawk-watching mountaintops where they once occurred.

For more information on rock-associated wildlife trends, the reader is referred to the following pages of Appendix 2:

Rock Habitats	**Appendix 2, pages:**
Caves	191-194
Cave-associated wildlife trends	192-194
Talus slopes	194-196
Talus slope wildlife trends	195-196

16.5 Conservation and Management Needs of Rock Habitats

The distribution of rocky habitat in isolated patches too small to sustain long-term populations means that subtle barriers that reduce successful travel between patches may be a significant problem for WAP-Priority species. On ridges and outcrops, new or widened roads, quarries, wind farms, and communications towers are examples of disturbances that could act as barriers to lower the rate of recolonization and increase the isolation among

patches. A good understanding of metapopulation dynamics of target species will be necessary to recognize this effect, predict the fate of populations, and possibly intervene with artificial corridors or assisted recolonization. In particular for the Allegheny woodrat and many other species, there is a need for more data on population size, mortality/natality, dispersal distances, sex and age of successful colonists, and seasonal timing of their movements. For the timber rattlesnake, there is a need to continue to assess the population status, then focus on managing the forest via daylighting near basking sites.

Rock habitats of highest-priority species should be surveyed and mapped to assist with the development of conservation priorities aimed at promoting connectivity of known populations. Sites with woodrats and rattlesnakes may need special management to limit human intrusion and to limit human-associated fragmentation of surrounding forest to ensure the species continue to thrive. It will be important to determine what secondary characteristics of habitat are most favorable for the various rock-associated WAP-Priority species and to concentrate conservation efforts on those sites and features.

While irreversible habitat loss through development is not generally an issue, resource management activities occurring on public lands can significantly impact habitat quality, availability, and species' populations. Wind generation sites, if situated at increased elevations in rocky habitats, may further serve to restrict dispersal between populations of rock voles, rock shrews, Allegheny woodrats, and timber rattlesnakes. As previously discussed, barriers to dispersal represent significant conservation issues for these species.

Once obtained, species occurrence data, and location of exemplary sites should be added to the Pennsylvania Natural Diversity Inventory (PNDI) database. The PNDI database should then be used consistently to monitor potential impacts of development, logging, utility (pipeline, powerline, oil exploration, cellular towers, windmills), and recreational projects (trials, parks, campgrounds) upon priority sites. All projects that potentially impact habitat or populations should be examined prior to their initiation. Those found to have probable impacts should be evaluated by biologists for the extent of impact and, if necessary, altered to reduce those impacts.

Because rock habitats host so many Species of Greatest Conservation Need and Immediate/High-Level Concern species, multi-species management guidelines should be developed for these habitats. A primary emphasis of such guiding documents should be to ascertain best management practices for forests surrounding rock sites. The Game Commission's Wildlife Diversity Section has identified rock habitats as a priority habitat for SWG'06 funding, so that multi-species management guidelines may be developed.

Additionally, there is a need to begin (in the case of rock voles, rock shrews) or continue (in the case of Allegheny woodrat and timber rattlesnake) long-term monitoring to ascertain population densities at each site. Through these through long-term monitoring, the impact of

isolation mechanisms such as roads and recreational uses on the dispersal of target species may be better understood. Development of population viability models would also be useful.

16.6 STATEWIDE PRIORITY CONSERVATION ACTIONS – ROCK HABITATS

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

- **Ensure Adequate Protection of High-Priority Caves**

Conservation Objective: To protect known hibernacula for high-priority bats
Target: Protect known hibernacula from complete closure and also from disturbance during winter months (November – March). Presently, there are 3 known Indiana bat hibernation sites in need of protection from disturbance.
Measure: Assess proportion of known hibernacula under protection.
Issues: Closing of caves and mines for safety and liability reasons; disturbance of hibernating bats by humans visiting the caves and mines during winter.
Prioritized Implementation actions:
Level 1

- Continue PGC annual hibernacula surveys
- Identify and assess degree of disturbance at all known hibernating sites.
- Develop an outreach program to private landowners and public land managers to increase awareness of the need to protect hibernating bats and their hibernacula.
- Prevent the complete closure of caves and mines that are used as hibernacula.
- Install gates on caves and mines that are important hibernating sites.

Level 2

- Survey high-priority sites every 2 years to monitor the status of target populations.
- Monitor gated hibernacula during the swarming periods to identify and control any unnatural predation such as feral cats.
- Review and incorporate, as appropriate, recommendations from the Bat Hibernacula Management Plan for the Commonwealth of Pennsylvania. (Hart 2001) and Bat Conservation International's bat management recommendations

Coordination:
Pennsylvania Game Commission
Public and private landowners

- **Identify High-Priority Rock Outcrops/Cliff/Talus Habitats**

Target: To identify and protect high-priority rock sites
Measure: Sites identified
Issue: Though caves receive regular survey and monitoring attention through the activities of the Pennsylvania Game Commission, other types of rock habitats have not received much

targeted attention. There is a need to locate high-priority rock habitats throughout Pennsylvania.

Prioritized Implementation Actions:

Level 1

- Create GIS-based maps of possible habitat in Pennsylvania, based on existing information
- Collect data based on intensive habitat analysis targeted at producing usable habitat maps for predicting potential habitat
- Ground-truth predicted habitat
- Sample all predicted habitats at least one time.
- Upon capture of any specimens, begin live-trap surveys to delineate extant populations.

Level 2

- Use GIS and landscape analysis, in conjunction with data from previous PGC/PFBC site surveys (for woodrats, rattlesnakes, rock voles, rock shrews, etc.), to explore and differentiate habitat and environmental characteristics of successful versus declining woodrat/rattlesnake areas, including the spatial distribution of habitat patches.
- Develop population models to understand minimum viable population size for Allegheny woodrats/timber rattlesnakes in Pennsylvania habitats and predict the long-term fates of populations under different conditions. This effort should help to identify regions where management will be of maximum benefit.
- Survey for the entire suite of rock-associated WAP-Priority species at appropriate locations.

Coordination:

Pennsylvania Game Commission
Pennsylvania Fish and Boat Commission
Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry
Conservation partners
Pennsylvania Biological Survey, Mammal Technical Committee
Private forest land owners (Pensylvania State University Forest Stewardship Program)

Level 2-priority over the next 5-10 years

- **Develop a Statewide Management Plan for Rock Cliff/Outcrop/Talus Habitats**

Target: To develop a proactive, strategic approach to conserving rock habitats and associated species

Measure: Planning activities

Issue: At present, there is no Conservation Management Plan in effect or planned-for rock habitats in Pennsylvania. The perceived ecological unimportance of rock habitats, particularly cliffs, outcrops and talus slopes, has limited the conservation attention directed toward these sites. However, these habitats host several Species of Greatest Conservation Need, as well as Immediate Concern and High-Level Concern species.

Prioritized Implementation Actions:
Level 1

- Develop a network of cooperators/technical experts to guide the development of a Conservation Management Plan for rock habitats.
- Develop a network of specialists involved with various aspects of habitat conservation, including resource managers from the Department of Conservation and Natural Resources and the Pennsylvania Game Commission.
- Continue inventory and monitoring of known populations including the collection of micro- and landscape habitat characteristics.
- Develop low-impact trapping regimes increasing trap survivability and thereby lessening the impacts to populations.
- Create an updated GIS-based map for existing habitat, as well as maps and layers, based on predicted occurrence of viable habitat.

Level 2

- Incorporate conservation-planning issues at the state level to develop habitat corridors encouraging dispersal. Include all appropriate levels of state and local governments, as well as private citizens, in this planning, because of the possibility of generating changes to proposed recreational and industrial development plans.
- Encourage environmental planning that identifies and protects existing habitat corridors and develops safe habitat corridors where needed.
- Assess the feasibility of using the soon-to-be-completed Woodrat Recovery Plan as a model process for a statewide plan for rock habitats.

Coordination:
Pennsylvania Game Commission, Bureau of Wildlife Management
Pennsylvania Game Commission, Bureau of Land Management
Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Natural Heritage Program
Pennsylvania Natural Heritage Program
Pennsylvania Biological Survey Taxonomic Technical Committees
Pennsylvania Science Office of The Nature Conservancy
The Nature Conservancy
The Western Pennsylvania Conservancy
Pennsylvania Department of Agricultural
Private landowners

- **Creation of Suitable Habitat During Mine Reclamation**

Target: Design sub-surface mine reclamation to provide high-quality hibernacula for cave-associated species.
Measure: Development of reclamation recommendations

Issue: Reclaimed sub-surface mines represent an opportunity for bat conservation. Currently, Indiana bats are found in abandoned mines more than in natural caves, and abandoned mines also serve as hibernacula for other WAP-Priority bat species (eastern small-footed myotis and northern myotis). Research is needed to design a basic plan for underground roosts so these man-made habitats will continue to provide suitable hibernation habitat for target species.

Prioritized Implementation Actions:

- Survey abandoned mines for priority species prior to reclamation through interior surveys or trapping of spring/fall swarms.
- Develop a configuration of entrances and passages to trap and maintain cold air within the required temperature ranges [3-6°C (37-46°F) for Indiana bats].
- Identify the smallest configuration that would provide the necessary requirements for hibernation of Indiana bat (or other target species).
- Implement and test this basic design in reclamation of abandoned mine lands.

Coordination:

Pennsylvania Game Commission
Pennsylvania Department of Environmental Protection
Private industry

16.7 STATEWIDE PRIORITY CONSERVATION ACTIONS – ROCK-ASSOCIATED SPECIES

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

- **Develop Multi-Species Management Guidance for Rock Habitats**

Target: Develop a decision-support guidebook providing public and private land managers with the information necessary to effectively manage these important plant-animal ecosystems, which are host to several Immediate Concern WAP-Priority species, as well as Species of Greatest Conservation Need.

Measure: Publication and dissemination of guidance

Issue: Because rock habitats host so many Species of Greatest Conservation Need and Immediate/High-Level Concern species, multi-species management guidelines should be developed for these habitats.

Conservation Strategies:

- Incorporate information derived from research on land-use impacts to target populations.
- Provide information to land managers to assist them in identifying rock habitat communities.
- Provide an understanding of how size, condition and landscape context affect the viability of the habitat system.
- Present a summary of the stresses and sources of stress affecting rock habitat systems.

- Describe management options appropriate for achieving desired management objectives.
- Present best management practices for the WAP-Priority species that depend upon rock habitats (woodrat, timber rattlesnake, rock vole, green salamander, peregrine falcon, etc.).

- Include information on managing possible dispersal corridors (As an example, overstory could be thinned on sites between colonies to enable dispersal/create corridors between sites).
- Develop guidelines for cooperators in other areas to conserve and enhance woodrat habitat. Develop public education outreach for the Allegheny woodrat as a flagship species, including its ecological role and identification of sign.

Coordination:
Pennsylvania Game Commission
Pennsylvania Department of Conservation and Natural Resources
Conservation partners
Pennsylvania Biological Survey Mammal Technical Committee, Important Mammal Areas Project
Private forest land owners (Pennsylvania State University Forest Stewardship Program)
Pennsylvania State University Wildlife Extension
Conservation partners

- **Status Surveys of Priority Species**

Target: To gather information on population status, distribution and abundance of urban-suburban-associated species *when* such information is needed to prioritize conservation efforts
Species Target(s) – Status Surveys:

IMMEDIATE CONCERN	**HIGH-LEVEL CONCERN**	**PENNSYLVANIA VULNERABLE**	**MAINTENANCE CONCERN**
EASTER SMALL-FOOTED MYOTIS-R	MOUNTAIN EARTH SNAKE-R	ROCK VOLE	ROCK SHREW
			NORTHERN MYOTIS-R
			EASTERN FENCE LIZARD

Measure: Survey design and implementation
Issue: Establish basic information regarding the population size, structure, viability and management/recovery needs of WAP-Priority species. Initial emphasis should be on Species of Greatest Conservation Concern. Emphasis on Immediate Concern and High-Level Concern species would also be appropriate.
Prioritized Implementation Actions:

- Survey and identify extant and historical sites throughout species' ranges.
- Survey other sites of potential habitat throughout their ranges to detect new population occurrences.
- Estimate population size and age structure and assess population health.
- Identify life history requirements and optimum habitat characteristics.
- Identify key characteristics of successfully breeding populations.
- Identify extant threats that may jeopardize remaining populations.
- Implement management and recovery actions.
- Survey areas between known sites to assess for suitability as dispersal corridors.
- Develop a monitoring protocol to record breeding and evaluate population changes at known sites.

Coordination:
Pennsylvania Game Commission
Pennsylvania Fish and Boat Commission
Pennsylvania Biological Survey Technical Committees
Conservation partners
Colleges and universities

- **Research Effect of Forest Management and Other Land Use on WAP-Priority Species**

Target: Research the effects of human-induced habitat changes on target species
Measure: Studies completed and/or reviews of existing literature
Issue: Land-use decisions and forest management activities can have long-term implications for rock-associated species because of their metapopulation demographic structure.
Prioritized Implementation Actions:
Level 1

- Designate public land areas with active WAP-Priority populations, appropriate habitat, and existing forest buffer as management areas.
- With cooperating agencies, delineate buffer zones and define disturbance limits for management areas.
- Research best management practices for forestry operations surrounding rock sites.
- Incorporate information on populations into conservation planning efforts for the regions and sites involved.

Level 2

- Develop ongoing population monitoring to measure the success of management.
- Conduct experimental habitat manipulation and monitor its effects on local populations. (As an example, overstory could be thinned to promote forb growth on or near a den/basking site).
- Develop monitoring protocols for rock habitats.

Coordination:
Pennsylvania Game Commission
Pennsylvania Fish and Boat Commission
Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry
Conservation partners
Pennsylvania Biological Survey Mammal Technical Committee
College and universities

Level 2 – priority over the next 5-10 years

- **Identify critical foraging habitats associated with high-priority hibernacula**

Target: There is a need to research landscape usage around high-priority hibernacula using telemetry.
Measure: Studies initiated
Issue: Habitat(s) surrounding high-priority hibernacula must be identified and protected to ensure habitat quality for high-priority WAP-Priority species (particularly WAP-Priority bats and snakes).
Prioritized Implementation Actions:
Level 1

- Identification/mapping of pre-hibernation foraging sites in a GIS format.
- Identification/mapping of travel corridors to foraging sites in a GIS format.
- Identification/mapping of foraging areas utilization distribution (kernelling) in a GIS format.

Level 2

- Habitat evaluation of foraging sites and traveling corridors.
- Timeline of activities during the pre-hibernation foraging period.
- Location and evaluation of roosting/basking/denning sites.
- Telemetry triangulation points for foraging and traveling.

Coordination:
Pennsylvania Game Commission
Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Biological Survey, Mammal Technical Committee
Conservation partners
Colleges and universities
Private land owners

- **Identification of Key Travel Corridors**

Target: To identify travel corridors that connect contiguous rock-associated species' colonies, as well as summer/winter habitat sites
Measure: Studies initiated

Issue: Many rock-associated species rely upon contiguous (snakes, small mammals) or non-contiguous (bats) non-rock habitats for their survival and rely on established travel corridors. Research is needed to understand migration patterns to summer habitats.
Prioritized Implementation Actions:

- Assess habitat utilization during migration (foraging & roosting).
- Identify and map (in a GIS format) priority travel corridors.
- Locate and evaluate roosting/basking/denning sites.
- Develop timeline of activities during the migration (roosting/denning, traveling, foraging).
- Telemetry study of foraging and traveling activity to identify priority site targets.
- Develop map (in a GIS format) that provides best location information possible with timeline during the migration period.

Coordination:
Pennsylvania Game Commission
Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Biological Survey, Mammal Technical Committee
Conservation partners
College and universities
Private landowners

- **Protect Summer Roosts at Highest-Priority Rock Outcrops/Caves**

Target: Limit disturbance during summer of roosting bats in caves and in crevices on rock walls.
Measure: Determine percentage of known summer roosts that are protected.
Issues: Bats using caves as summer roosts may be disturbed by human visitors. Some rock-faces with crevices that are used as roosts may be impacted by rock-climbers.
Prioritized Implementation actions:
Level 1

- Identify and assess current and potential disturbance at important summer roost sites, such as caves and rock walls.
- Limit seasonal access (May – August) to caves in areas where maternity colonies or roosting bats might be disturbed.
- Limit seasonal access (May – August) to rock-climbing in areas where this activity could impact maternity colonies or summer roosting bats.

Coordination:
Pennsylvania Game Commission
Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Biological Survey, Mammal Technical Committee
Conservation partners
Local recreation interests

16.8 SPECIES OF GREATEST CONSERVATION NEED – ROCK HABITATS

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. 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 (Table 16.3). Focusing "endangered species prevention" efforts and proactive management on the following species associated with rock habitats will provide conservation results that will have the greatest impacts at the state, regional, national, and global levels. See Appendix 3 for detailed species accounts and Section X for SGCN conservation summaries.

Table 16.3. Species of Greatest Conservation Need Associated with Rock Habitats in Pennsylvania.

	Ohio Hills	Lower Great Lakes	Northern Plateau	Pocono Plateau	Ridge and Valley	Piedmont	Coastal Plain
ALLEGHENY WOODRAT - R			xx		XX		
EASTERN SMALL-FOOTED MYOTIS-R			xx	xx	XX		
TIMBER RATTLESNAKE - R			XX		xx		
MOUNTAIN EARTH SNAKE - R	XX		XX				
NORTHERN MYOTIS - R	xx		XX		XX	xx	

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

16.9 Sources

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Appendix 16.1 Species/Habitat Associations for Rock Habitats

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. This also complicates the conservation of species and key habitats. Further complicating the effort of associating species with key habitats is that fact that a habitat's quality and/or function may rely upon unknown and/or off-site mechanisms. 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 fraught with incompleteness, it is nevertheless worthwhile to try 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 16.4 Specific species/habitat associations for rock-associated, WAP-Priority species in Pennsylvania.

Category	Dominant Vegetation	Micro-quality	WAP-Priority Species	Specific Type	Physiographic Area*
Cliff, rock outcrop			Peregrine Falcon		
			Common Nighthawk		
Large rock float block		Moist	Green Salamander	Sandstone outcrop south of Monongehela River	NP (Allegheny Mountains portion)

Cliff, rocky outcrop, rocky ridgetops	In mature deciduous hardwood forest		Allegheny woodrat-R	Sandstone, limestone rock in oak-hickory/oak dominated forest	RV, NP (Allegheny Mountains portion)
			Timber rattlesnake-R	Oak-dominated	RV, NP
			Northern copperhead	Open sites in younger forest w/ oak present	
			Eastern Small-footed Bat-R		RV, NP
Rocky Ravines		riparian	Eastern fence lizard		RV
			Eastern Spotted Skunk		RV – Huntingdon, Fulton, Franklin Counties)
Talus slopes	In mature deciduous hardwood forest		Allegheny woodrat-R	Sandstone, limestone rock in oak-hickory/oak dominated forest	RV, NP (Allegheny Mountains portion)
			Timber rattlesnake-R	Oak-dominated	RV, NP
			Northern copperhead	Open sites in younger forest w/ oak present	
			Eastern Spotted Skunk		RV – Huntingdon, Fulton, Franklin Co.)
			Eastern Small-footed Bat-R		RV, NP
			Eastern fence lizard		
			Northern Coal Skink-R		NP

			Mountain Earth Snake-R		NP – Laurel Hill area for presence/absence
		Riparian w/ forb cover	Rock vole	N. hardwoods, high elevation (3000+ft)	NP (and Poconos)
		W/ dense shrubs, deep litter, and nearby water	Rock Shrew	W/dense rosebay rhododendron (3000+ ft)	NP, RV, OH
Caves, Mines, Tunnels		W/large entrances & passages	Northern *Myotis*-R	Wall crevices in cool temp areas w/ high humidity	
		Cold caves/mines w/air flow	Indiana Bat	Mines with 3-□°C (37-4□°F) temps	
		Small, cold caves	Eastern Small-footed Bat-R	Floor/wall crevices and rocks lying on floor	RV, NP
		Sandstone, limestone	Allegheny Woodrat-R	In mature, oak-type forest	RV, NP (Allegheny Mountains portion)

*** 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**