

Chapter 10. Conclusions: Conservation Actions, Monitoring, Research and Information Management Needs, and Plan Review/Revision

10.1. Conservation Actions

We have identified conservation actions to address problems facing Virginia's species of greatest conservation need and key habitats through a variety of approaches. The next sections provide some summarization of the results of these approaches. More detailed lists can be found in Appendices I, L, and M, and specific conservation actions for the Tier 1 SGCN can be found in the species narratives in the ecoregional chapters (Chapters 4-9). It should be noted that the actions identified may be beneficial for one species or species group but detrimental to another. A thorough examination of an action and its system-wide effects should be undertaken before implementation.

We identified eight general categories of conservation actions: coordination; education and outreach; enforcement; habitat management; land protection; planning; regulations, policy, and law; and species management. Within each of these categories there were a few consistent themes. These were repeatedly mentioned by the TACs, ESC, and community meeting participants and therefore can be considered the key elements of critical conservation actions.

Coordination

- Engage all private landowners (corporate and citizen) in conservation issues
- Work with public agencies to reduce threats and protect habitat
- Encourage all levels of government to include wildlife and wildlife issues in land use planning
- Improve cooperation between law enforcement entities (wildlife and environmental laws and regulations)
- Foster cooperation and partnerships for conservation between agencies, NGOs, and private entities
- Improve communication between all natural resource organizations

Education and outreach

- Inform all levels of government (city, county, state, and federal) of critical conservation issues and specific funding needs
- Educate and provide information to local planners and developers regarding wildlife and their role in its conservation
- Provide information to farmers regarding available programs and their benefits
- Educate landowners (corporate and citizen) about important land use and wildlife issues
- Better utilize existing programs and groups to reach citizens
- Engage a wide public audience in targeted conservation programs (urban, suburban, and rural; adult and youth)

Enforcement

- Increase enforcement and prosecution of existing industrial, environmental, and water quality standards, regulations, and laws
- Improve enforcement and prosecution of federal and state wildlife laws and regulations
- Increase number of and compensation for law enforcement personnel, and prioritize wildlife conservation and law enforcement in their duties
- Provide training to local and state law enforcement personnel in wildlife laws and regulations

Habitat management

- Increase participation in and rates of implementation of BMPs (agricultural, forestry, and urban) through increased funding, education, and other means
- Modify current habitat management practices (forestry, agriculture) to benefit a wide range of species
- Conserve, restore, or create important habitats and buffers

- Provide technical expertise to landowners
- Work with state agencies and localities to encourage native plantings and habitat management

Land protection

- Acquire or protect needed habitats (wooded wetlands, caves, riparian buffers, any large tracts, etc.)
- Continue or improve existing conservation easement programs

Planning

- Encourage and provide resources for county and municipal planners to consider wildlife and natural resources more comprehensively (e.g. zoning restrictions, impervious surface limits, wildlife corridors, and low impact development)
- Improve land use planning for urban, forestry, and agricultural uses

Regulations, Policy, and Law

- Expand incentive programs for voluntary conservation
- Review and tighten existing regulations and standards for water and air quality
- Establish permanent, dedicated funding (state and federal) for conservation
- Establish user fees on infrastructure and for recreational use of managed areas to promote conservation
- Develop legislation and regulations that better protect and conserve wildlife and their habitats
- Develop and fund a state exotic and invasive species policy

Species Management

- Control overabundant nonpredatory native species, exotic/invasive species, and certain predators (e.g. feral cats and muskrats)
- Improve the controls and coordination of fish stocking (grass carp, trout)
- Establish and continue to support existing reintroduction, propagation, and augmentation programs for rare species

The remaining sections provide more details of the conservation actions provided by the TACs, ESC, and community meetings.

10.1.1. Conservation Actions for the Top 10 Stress/Source Combinations

The TACs provided conservation actions to address the stresses and sources of stress they identified during a series of committee meetings. We applied a prioritization methodology to identify the top 10 stresses, sources of stress, and stress/source combinations (Section 3.3). We then selected those actions that address the top 10 stress and source of stress combinations. These actions are important to reduce or eliminate critical threats to the species of greatest conservation need and their habitats (See Chapter 3 for more discussion of threats). Due to important differences between the habitats and species, aquatic and terrestrial organisms are discussed separately. Stress/source combinations were discussed together if conservation actions were identical; for example, habitat destruction and habitat fragmentation from agriculture were combined because the TACs identified the same conservation actions for each of them.

10.1.1.1. Conservation Actions Addressing Threats to Terrestrial Species of Greatest Conservation Need

Predation from native species

- Maintain large habitat patches to reduce edge effects
- Control predators on barrier islands
- Create dredge spoil islands as new habitat
- Remove fish from amphibian breeding ponds

Habitat destruction and fragmentation from municipal development

- Restore, acquire, and create habitat

- Alter zoning regulations to prevent development in high elevation habitats
- Educate city and county land planners (PDCs)
- Review land use changes and predict future changes to prioritize areas for conservation
- Increase land use planning (reduction of sprawl)
- Emphasize protection of northern Virginia farms

Habitat destruction and fragmentation from agriculture

- Manage pasture to include warm season grass restoration
- Rotate haying areas and time mowing to avoid nesting season conflicts
- Improve Farm Bill incentives
- Work with large private landowners
- Implement agricultural BMPs
- Restore fire-maintained communities

Predation from exotic/introduced species

- Maintain large habitat patches to reduce edge effects
- Control predators (foxes on barrier islands, cats)
- Remove fish from amphibian breeding ponds

Habitat destruction and fragmentation from forestry

- Acquire and restore habitat
- Improve existing habitat by linking patchy habitats (particularly important for spruce-fir islands)
- Conserve existing mature stands
- Modify forestry practices to include uneven-aged stand management
- Implement and promote conservation easements for wooded wetlands
- Incorporate landscape context into forestry management (e.g., location of cuts, taking the landscape matrix into account when planning)
- Increase rate and amount of forestry BMP implementation
- Work with USFS and VDOF to amend forestry practices

Unintentional capture or killing on roadways

- Remove roadside shrubs serving as habitat or food for birds
- Create wildlife crossings (underpasses, fences, etc.)

Habitat destruction from exotic or introduced species

- Remove exotic vegetation (*Phragmites*, *Ailanthus*, garlic mustard, etc.)
- Control mute swan populations
- Investigate and implement methods to control hemlock/balsam woolly adelgids
- Replace cool season grasses with native warm season grasses

10.1.1.2. Conservation Actions Addressing Threats to Aquatic Species of Greatest Conservation Need

Sediment load alteration and turbidity alteration from agriculture

- Implement agricultural BMPs
- Restructure and provide landowner incentive programs
- Provide a facilitator/liaison between landowners and programs
- Investigate the effectiveness of BMPs in improving habitat for aquatic species
- Educate landowners and policy makers
- Work with county boards and planning groups on all issues
- Protect and establish riparian buffers

Organic pollutants from industrial rights-of-way

- Work with VDOT and railroads regarding possible solutions
- Improve hazardous material response time and effort

- Improve DEQ enforcement of violations

Channel or shoreline alteration from agriculture

- Implement agricultural BMPs
- Restructure and provide landowner incentive programs
- Provide a facilitator/liaison between landowners and programs
- Investigate the effectiveness of BMPs in improving habitat for aquatic species
- Educate landowners and policy makers
- Work with county boards and planning groups on all issues
- Protect and establish riparian buffers
- Restore natural stream channel
- Reclaim floodplain

Sediment load alteration from forestry

- Enforce existing DOF regulations
- Engage private, small foresters regarding sedimentation
- Implement forestry BMPs
- Investigate effectiveness of forestry BMPs
- Protection and establish riparian buffers

Toxins from industrial sources

- Engage DMME/OSM and coal companies on containment and contaminant reduction strategies
- Enforce existing regulations (especially coal processing byproducts)
- Investigate effects of drugs/pharmaceuticals in streams: what are effects, how can they be limited
- Investigate the effects of effluent from small industry
- Evaluate the need to change effluent permit limits

Sediment load alteration from mineral extraction

- Engage DMME/OSM and coal companies on containment and contaminant reduction strategies
- Enforce existing regulations
- In Coastal Plain, sand mining is an issue; actions include DEQ oversight and setting permit limits
- Investigate the effects of mining of landscape rock

Nutrient input alteration from agriculture

- Implement agricultural BMPs (including those specific to livestock)
- Restructure and provide landowner incentive programs
- Provide a facilitator/liaison between landowners and programs
- Investigate the effectiveness of BMPs in improving habitat for aquatic species
- Educate landowners and policy makers
- Work with county boards and planning groups on all issues
- Protect and establish riparian buffers

Channel or shoreline alteration from municipal development

- Educate landowners, PDCs, and developers on the importance of shoreline/riparian integrity
- Implement urban BMPs
- Restructure and provide landowner incentive programs
- Provide a facilitator/liaison between landowners and programs
- Investigate the effectiveness of BMPs in improving habitat for aquatic species
- Educate landowners and policy makers
- Work with county boards and planning groups on all issues including sustainable development
- Protect and establish riparian buffers and greenspace
- Educate riverfront landowners regarding the detrimental effects of bulkheads
- Reclaim floodplain

- Change zoning restrictions including smart growth initiatives

Nutrient input alteration from municipal development

- Create forest/upland buffers around marshes
- Upgrade wastewater treatment plants
- Enforce compliance with existing wastewater regulations
- Eliminate straight piping
- Review current regulations
- Educate county boards and PDCs
- Educate landowners regarding the use of fertilizers

It is important to recognize that although a number of the threats and actions identified in this section relate to agriculture and forestry, many of the recommended actions focus on the need to limit the extent to which farm and forest lands are converted to other uses. Productive farm and forest lands can be managed in a way that is beneficial for wildlife, whereas the feasibility of managing urban land for wildlife is extremely limited. That is why, along with recommendations for modifying agricultural and forestry practices, there are also recommendations for preserving farmland and forest land through conservation easements and land use management tools.

10.1.2. Priority Conservation Actions Identified by the TACs

Actions that were provided by the TACs were further prioritized by tying each specific action back to the tiered species it benefits (see Chapter 2 for details). The resulting lists include 11 highest priority conservation actions for terrestrial species and 11 highest priority conservation actions for aquatic species. These are not in order of importance.

Highest Priority Conservation Actions for Terrestrial Species

- Educate public regarding wildlife needs, water quality, water conservation
- Enforce industrial and environmental/water quality regulations and laws
- Alter some current forest management regimes (thinning, cuts at high elevations, lower stocking density, uneven-aged management)
- Conserve, maintain and improve existing habitat (large patches, link habitat islands)
- Create, restore, and reclaim habitat
- Establish or maintain forest buffers (maritime pine, etc.) and other upland management of areas surrounding marsh
- Implement applicable PARC habitat management guidelines when available
- Acquire habitat
- Develop time of year restrictions (discing of unpaved roads, human access)
- Control or remove exotic species
- Control predators (including feral cat)

Highest Priority Conservation Actions for Aquatic Species

- Coordinate with USACE, FERC, VMRC regarding permitting and relicensing for dams (fishways, removals, no new construction)
- Engage private foresters regarding water quality issues
- Improve hazmat response (improve timing and coordination between agencies)
- Educate developers and planners: water quality, greenspace, stormwater management
- Educate landowners: water quality, biocides, straight pipes, vegetation control, riparian areas, wetlands
- Improve DOF enforcement of regulations
- Enforce industrial and environmental/water quality regulations and laws (DEQ and others)

- Agricultural BMPs (education of and implementation)
- Increase land planning, coordinate with county boards and planning groups on all issues including sustainable development, sprawl reduction, impervious surface/elevational constraints, zoning
- Review of current wastewater regulations
- Upgrade wastewater treatment plants

Tables 10.1 and 10.2 present the all of the actions provided by the TACs in one of three priority groups. Table 10.1 presents actions that affect terrestrial species, and Table 10.2 presents actions that affect aquatic species. Some species, such as many herpetofauna, are represented in both tables. Birds were included in the aquatic conservation actions table if they use open water or wetlands exclusively or nearly so. This includes such species as wintering waterfowl and rails. Actions within each priority group are listed within an action category alphabetically. Of course, some of these actions may in some way benefit more species than are indicated. However, the TACs were asked to identify the most important actions to benefit the SGCN and not provide a comprehensive list of all beneficial actions. We chose to maintain this approach.

The table structure requires some further explanation. The first column lists the conservation action. The second indicates the taxonomic group(s) for which the action is beneficial. Within this set of columns, an “X” indicates that a group or multiple groups of species within that taxon would benefit from this action; an “I” indicates that an individual species within that taxon would benefit from that action. The threats and conservation actions for each of the mammal species was addressed individually, and some species that did not fit well into the habitat groups were handled separately. The next column indicates the habitat groups or areas that would be affected by this action. The second to last column indicates the species that were handled individually, and the final column indicates the action category to which the action belongs. For example, in Table 10.1, the conservation action “Alteration of current forest management regimes” would benefit terrestrial herpetofauna and birds in the Coastal Plain, early successional habitats, grasslands, high elevation deciduous forest, mature deciduous forest, and pine savannah. This action would also benefit the following individual mammal species: Appalachian cottontail, Delmarva fox squirrel, and snowshoe hare. The action is within the “Habitat Management” category. Descriptions of the habitat groups and group membership are presented in Appendix G. The entire list of conservation actions provided by the TACs is presented in Appendix I in its original format.

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Table 10.1. Conservation actions affecting terrestrial species distributed among priority groups and among action categories within each priority group. The actions are not further prioritized beyond the relative group assigned. X = habitat groups of this taxon are affected, I = individual species within this taxon are affected.

Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Highest Priority Conservation Actions							
Educate public: wildlife needs, water quality, water conservation	X	X		X	Barrier islands/beaches, mountain forests, wooded wetlands		Education
Enforcement of industrial and environmental/water quality regulations and laws (DEQ and others)	X			X	Coastal Plain, mountain forests, western Piedmont uplands		Enforcement
Alteration of current forest management regimes (thinning, cuts at high elevations, lower stocking density, uneven-aged management)	X	X	I		Coastal Plain, early successional habitats, grasslands, high elevation deciduous forest, mature deciduous forest, pine savannah	Appalachian cottontail, Delmarva fox squirrel, snowshoe hare	Habitat Management
Conserve/maintain/improve existing habitat (large patches, link habitat islands)		X	I	X, I	Grasslands, high elevation conifer forest, high-elevation deciduous forest, pine savannah	Carolina northern flying squirrel, Delmarva fox squirrel, regal fritillary, Virginia big-eared bat, Virginia northern flying squirrel	Habitat Management
Creation/restoration/reclamation of habitat	X	X, I	I		Atlantic white cedar swamps, barrier islands/beaches, coastal marshes, early successional habitats, grasslands, mountain forests, pine savannah, wooded wetlands	Eastern big-eared bat, marsh rabbit, Pungo white-footed mouse, purple sandpiper, snowshoe hare, southeastern fox squirrel, Wayne's warbler	Habitat Management
Forest buffers (maritime pine, etc.) and other upland management of areas surrounding marsh		X, I			Coastal marshes	Bicknell's thrush	Habitat Management

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Implement applicable PARC habitat management guidelines when available	X, I				Coastal Plain, Mount Rogers area, mountain forests, western Piedmont uplands	Bog turtle	Habitat Management
Acquire habitat	X	X	I		Coastal Plain, grasslands, high elevation conifer forest, pine savannah, western Piedmont uplands, wooded wetlands	Allegheny woodrat, Carolina northern flying squirrel, Delmarva fox squirrel, eastern big-eared bat, marsh rabbit, southeastern myotis, southern rock vole, southern water shrew, Virginia northern flying squirrel	Land Protection
Time of year restrictions (discing of unpaved roads, human access)	X	X			Barrier islands/beaches, Coastal Plain, western Piedmont uplands		Regulations/Policy/Law
Exotic species control/removal		X, I		X	Coastal marshes, high elevation deciduous forest, wooded wetlands	Black rail	Species Management
Predator control (including feral cat)	X, I	X			Barrier islands/beaches, coastal marshes, wooded wetlands	Chicken turtle, lizards, snakes	Species Management

High Priority Conservation Actions							
Coordinate with USFS, VDOF, and NPS to amend forestry practices and recreational use	X				Mountain forests		Coordination
Coordinate with wealthy landowners for management (large tracts of land available)		X		X	Grasslands, early successional habitats		Coordination
Work with timber companies to alter practices/protect large forest tracts		X	I		Mature deciduous forest, wooded wetlands	Southeastern myotis, eastern big-eared bat	Coordination

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Educate developers and planners: water quality, greenspace, stormwater management	X				Coastal Plain, western Piedmont uplands		Education
Educate farmers: riparian areas, biocides, nutrient pollution, other issues	X				Coastal Plain, Mount Rogers area		Education
Agricultural BMPs (education of and implementation)	X, I				Coastal Plain, western Piedmont uplands	bog turtle	Habitat Management
Forest pest management and control		X	I		High elevation conifer forest, mature deciduous forest, pine savannah	Carolina northern flying squirrel, Delmarva fox squirrel, Virginia northern flying squirrel	Habitat Management
Urban BMPs (education of and implementation)	X				Coastal Plain, western Piedmont uplands		Habitat Management
Wildlife crossings (underpasses, fences, etc.)	X				Coastal Plain, western Piedmont uplands		Habitat Management
Continue or increase conservation easements (wooded wetlands, groundwater)		X	I	I	Wooded wetlands	Cave invertebrates, Delmarva fox squirrel, eastern big-eared bat, eastern small-footed myotis, gray myotis, marsh rabbit, southeastern fox squirrel, southeastern myotis, southern rock vole, Virginia big-eared bat	Land Protection
Better landscape management (location of cuts, taking the landscape matrix into account when planning land management)	X	X			Mature deciduous forest, western Piedmont uplands		Planning

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Develop and implement an urban waterbird management plan		X			Coastal marshes		Planning
Increase land planning, coordinate with county boards and planning groups on all issues including sustainable development, sprawl reduction, impervious surfaces/elevational constraints, zoning	X	X	I	I	High elevation deciduous forest	American burying beetle, Delmarva fox squirrel, Pungo white-footed mouse, southeastern myotis	Planning
Review of land use changes and prediction of future changes to prioritize areas for conservation	X				Coastal Plain, western Piedmont uplands		Planning
Avoid indiscriminant mosquito control measures	X			X	Coastal Plain		Regulations/ Policy/Law
Carbon sequestration		X			Barrier islands/beaches		Regulations/ Policy/Law
Improve air quality/reduce emissions (NO _x , SO _x , particulates, metals)		X	I		High elevation coniferous forest, high elevation deciduous forest	Carolina northern flying squirrel, Eastern big-eared bat, southeastern myotis	Regulations/ Policy/Law

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Permit review processes (review forestry and development permits more closely, DGIF follow through on scientific collection permits)	X				Mountain forests		Regulations/ Policy/Law
Restructure/improve/ implement/provide/ coordinate/facilitate landowner and wildlife conservation incentive programs (including Farm Bill, Safe Harbor, HCPs)		X	I		Early successional habitats, grasslands	Delmarva fox squirrel	Regulations/ Policy/Law
Map non-native <i>Phragmites</i> stands		X, I			Coastal marshes	Black rail	Species Management

Priority Conservation Actions							
Coordinate with Bristol officials re: culvert maintenance, construction, and time-of-year restrictions			I			Gray myotis	Coordination
Coordinate with speleological groups to limit cave disturbance			I	I		Eastern small-footed myotis, many cave invertebrates	Coordination
Coordinate with USFS (fire regime and land management)		X			High elevation conifer forest		Coordination

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Coordinate with VDOT re: road construction			I			Delmarva fox squirrel	Coordination
Develop cooperative conservation agreements with USFS		X	I		Mature deciduous forest	Southern rock vole, southern water shrew	Coordination
Review USFS National Forest plans	X		I	I	Mount Rogers area	Appalachian grizzled skipper, southern rock vole, southern water shrew	Coordination
Speed bumps and signage	X, I		I			Delmarva fox squirrel, turtles	Coordination
Work with agencies to promote habitat			I			Pungo white-footed mouse	Coordination
Enforce and prosecute take/collection laws	I			I		Bog turtle, box turtle, spotted turtle, wood turtle, regal fritillary, possibly other butterflies	Enforcement
Increased DEQ oversight: power generation, nutrient inputs			I			Southeastern myotis	Enforcement
Construct artificial roosts (banks, old buildings)		I	I			Northern rough-winged swallow, eastern big-eared bat	Habitat Management
Forestry BMPs (implementation)	I	X			Wooded wetlands	Bog turtle	Habitat Management
Frequent burning of mature forest or herbicide application		X			Pine savannah		Habitat Management
High marsh management		I				Henslow's sparrow	Habitat Management
Maintain current forestry practices for early successional habitat			I	I		Arogos skipper, Dismal Swamp southeastern shrew, southern bog lemming	Habitat Management
Pasture management, haying rotation and timing		X			Grasslands		Habitat Management

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Conservation Action	Terrestrial Herpetofauna	Birds	Mammals	Terrestrial Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Cave gating			I	I	Blue Ridge, Ridge and Valley, Southern Cumberlands	eastern small-footed myotis, gray myotis, many cave invertebrates	Land Protection
Preserve buildings inhabited by bats			I			Eastern big-eared bat	Land Protection
Protection and establishment of riparian buffers and greenspace			I			Southern water shrew	Land Protection
Protect Virginia farms		X	I		Grasslands	Delmarva fox squirrel	Planning
Find alternatives to harmful insecticides		I	I			Loggerhead shrike, peregrine falcon, southeastern myotis	Regulations/ Policy/Law
Review regulations at Dulles airport (shipments of box and spotted turtles)	I					Eastern box turtle, spotted turtle	Regulations/ Policy/Law
Control of overabundant nonpredatory native species (striped skunk, deer)		X	I		Mature deciduous forest	Eastern spotted skunk	Species Management
Reintroduction/ propagation/ augmentation	I	I	I			Chicken turtle, fisher, peregrine falcon	Species Management

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Table 10.2. Conservation actions affecting aquatic species distributed among priority groups and among action categories within each priority group. The actions are not further prioritized beyond the relative group assigned. Only one mammal species was affected by any of these actions so no “Mammals” taxa column is included. X = habitat groups of this taxon are affected, I = individual species within this taxon are affected. The “Upper Tennessee” habitat group includes the Clinch, Powell, and Holston rivers in Virginia.

Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Highest Priority Conservation Actions								
Coordinate with USACE, FERC, VMRC re: permitting and relicensing for dams (fishways, removals, no new construction)	X			X, I		Chowan and James swamps and impoundments, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	Dwarf wedgemussel, James spiny mussel	Coordination
Engage private foresters regarding water quality issues	X	X		X	X	Big Sandy, Chowan, James, James swamps and impoundments, Potomac, Rappahannock, Roanoke, Upper Tennessee, York		Coordination
Improve hazmat response (improve timing and coordination between agencies)	X	X		X, I		Big Sandy, Chowan, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	James spiny mussel	Coordination
Educate developers and planners: water quality, greenspace, stormwater management	X	X		X, I	X	Big Sandy, Chowan, Chowan swamps and impoundments, Delmarva Peninsula drainage, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	James spiny mussel	Education
Educate landowners: water quality, biocides, straight pipes, vegetation control, riparian areas, wetlands	X	X, I	X	X, I	X, I	Chowan and James swamps and impoundments, New, Upper Tennessee; coastal marshes, wooded wetlands	Big stripetail stonefly, bog turtle, James spiny mussel, Tennessee heelsplitter	Education
DOF enforcement of regulations	X	X		X		Big Sandy, Chowan, James, James swamps and impoundments, Potomac, Rappahannock, Roanoke, Upper Tennessee, York		Enforcement

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Enforcement of industrial and environmental/water quality regulations and laws (DEQ and others)	X	X	X	X, I	X	Big Sandy, Chesapeake Bay, Chowan, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	James spiny mussel	Enforcement
Agricultural BMPs (education of and implementation)	X	X, I		X, I	I	Big Sandy, Chowan, Chowan and James swamps and impoundments, Delmarva Peninsula drainage, James, New, Pee Dee, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	Big stripetail stonefly, bog turtle, dwarf wedgemussel, James spiny mussel, Tennessee heelsplitter	Habitat Management
Increase land planning, coordinate with county boards and planning groups on all issues including sustainable development, sprawl reduction, impervious surface/elevational constraints, zoning	X	X	X	X, I	I	Big Sandy, Chowan, Chowan swamps and impoundments, Delmarva Peninsula drainage, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York	Brook floater, cryptic willowfly	Planning
Review of current wastewater regulations	X	X	X	X	X	Big Sandy, Chesapeake Bay, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York		Regulations/ Policy/Law
Upgrade wastewater treatment plants	X		X	X		Big Sandy, Chesapeake Bay, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York		Regulations/ Policy/Law
High Priority Conservation Actions								
Coordinate with DMME/OSM and coal companies on containment and contaminant reduction strategies	X	X		X		Big Sandy, Upper Tennessee		Coordination
Coordinate with VDOT, localities and railways regarding possible solutions to frequency of spills and pollution along rights-of-way	X	X		X	X	Upper Tennessee		Coordination

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Educate farmers: riparian areas, biocides, nutrient pollution, other issues	X	X	X	X		Chesapeake Bay, Chowan, Chowan swamps and impoundments, Delmarva Peninsula drainage, James, Potomac, Roanoke, Upper Tennessee, York		Education
Educate public: wildlife needs, water quality, water conservation	X	X	X	X, I	X	Big Sandy, Chowan, Chowan swamps and impoundments, Delmarva Peninsula drainage, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York; wooded wetlands	James spinymussel	Education
DMME/OSM enforcement of existing regulations	X	X		X		Big Sandy, Upper Tennessee		Enforcement
Enforce stream alteration violations	X			X	X	Clinch, Powell		Enforcement
Increased DEQ oversight: power generation, nutrient inputs	X			X		Big Sandy, Chowan, Clinch, Delmarva Peninsula drainage, Powell		Enforcement
Creation/restoration/reclamation of habitat	X		X	X		Big Sandy, Chowan, Delmarva Peninsula drainage, James, New, Pee Dee, Potomac, Rappahanock, Roanoke, York; coastal marshes, wooded wetlands		Habitat Management
Forestry BMP implementation	X	I	X		X	Big Sandy, Chowan, Chowan and James swamps and impoundments, James, New, Pee Dee, Potomac, Rappahannock, Upper Tennessee, York; wooded wetlands	Bog turtle	Habitat Management
Permit review processes (review forestry and development permits more closely, DGIF follow through on scientific collection permits)		X		X		Upper Tennessee		Regulations/ Policy/Law

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Restructure/improve/implement/ provide/coordinate/facilitate landowner and wildlife conservation incentive programs (including Farm Bill, Safe Harbor, HCPs)	X		X	X		Big Sandy, Chowan, Chowan and James swamps and impoundments, Delmarva drainage, James, Pee Dee, Potomac, Rappahannock, Roanoke, York		Regulations/ Policy/Law
Stormwater management		X		X, I	X	Clinch, New, Powell	Brook floater, James spiny mussel	Regulations/ Policy/Law
Stricter regulations on bait shops, pet shops, etc.	X	X			X	Chowan and James swamps and impoundments, James, New, Potomac, Rappahannock, Roanoke, Upper Tennessee, York		Regulations/ Policy/Law
Predator control (including feral cats, muskrat)			X	X		Clinch, Powell; coastal marshes, wooded wetlands		Species management

Priority Conservation Actions								
Coordinate with speleological groups to limit cave disturbance					I		Many cave invertebrates	Coordination
Coordinate with VDOT and localities re: road construction	I						Tennessee dace	Coordination
Insure Chesapeake Bay Act followed	X	X	X	X		Chesapeake Bay, Delmarva Peninsula drainage, James, Piankatank, Potomac, Rappahannock, York		Coordination
Oppose King William Reservoir; advocate constraints on water withdrawal for reservoir	X					York		Coordination
Work with timber companies to alter practices/protect large forest tracts	X		X			Chowan; wooded wetlands		Coordination
Determine/enforce minimum instream flows				I			James spiny mussel, dwarf wedgemussel	Habitat Management

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Floodplain reclamation	X		X		X	Roanoke; wooded wetlands		Habitat Management
Implement applicable PARC (habitat management guidelines) when available		X, I				Upper Tennessee	Bog turtle	Habitat Management
Reduce creosote contamination by replacing wooden bridges				I			James spinymussel	Habitat Management
Urban BMPs (education of and implementation)		X						Habitat Management
Wildlife crossings (underpasses, fences, etc.)		X				Coastal Plain, Upper Tennessee		Habitat Management
Cave gating					I	Blue Ridge, Ridge and Valley, Southern Cumberlands	Many cave invertebrates	Land Protection
Protection and establishment of riparian buffers and greenspace	X					Piankatank, Roanoke	Southern water shrew	Land Protection
Review of land use changes and prediction of future changes to prioritize areas for conservation		X				Upper Tennessee, Coastal Plain		Planning
Avoid indiscriminant mosquito control measures		X			X	Coastal Plain		Regulations/ Policy/Law
Change DEQ permit limits	X					New, James, Powell, Rappahannock, Roanoke, York		Regulations/ Policy/Law
Improve air quality/reduce emissions (NOx, SOx, particulates, metals)	X					James, Piankatank, Potomac, Rappahannock		Regulations/ Policy/Law
Better control and coordination of fish stocking (grass carp, trout)	X, I				X	Chowan and James swamps and impoundments, New	Tennessee dace	Species management
Control of overabundant nonpredatory native species (striped skunk, deer, beaver)				I			James spinymussel	Species management

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

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Conservation Action	Fishes	Aquatic Herpetofauna	Birds	Aquatic Mollusks	Aquatic Invertebrates	Habitat Groups Affected	Additional Individual Species Affected ¹	Action Category
Reintroduction/propagation/ augmentation	I	I		I			Atlantic sturgeon, chicken turtle, James spinymussel, Roanoke logperch, slender chub, shortnose sturgeon, yellowfin madtom	Species management

¹ These are species that were either not considered within a habitat group, or that were determined to have additional specific applicable conservation actions that other members of its habitat group(s) did not have.

10.1.3. Combined List of Conservation Actions From All Sources

The following table presents all conservation actions identified by the TACs, the external steering committee, and during the community meetings (Table 10.3). Actions were divided among eight categories: coordination, planning, education and outreach, species management, habitat management, land protection, enforcement, and regulations/policy/law. The categories should facilitate implementation, since partners can more easily identify their area of expertise and/or responsibility. As the information was gathered at different meetings with different styles and modes of interaction, actions were in many cases combined or generalized to reduce duplication, and no prioritization was done. Details such as target species and target audiences appear at the end of each action (where appropriate). The original results from each group are available in Appendices I and L. Appendix M contains an expanded list of more specific recommendations for education and outreach components based on broader conservation actions identified by the TACs, community meetings, and External Steering Committee.

Table 10.3. Categorized conservation actions identified by the taxonomic advisory committees, the external steering committee, and the community meetings.

Coordination			
Conservation Action	TAC	ESC	Community meetings
Improve hazardous material spill response and mitigation through planning and coordination between and within agencies	X		X
Coordinate with Bristol officials regarding culvert maintenance, construction, and time of year restrictions (gray myotis)	X		
Coordinate with DMME/OSM and coal companies on containment and containment reduction strategies	X		
Coordinate with owners of large tracts of land to include wildlife management	X		
Coordinate with speleological groups to limit cave disturbance	X		
Coordinate with USACE, FERC, and VMRC regarding permitting and relicensing for dams (fishways, removals, no new construction)	X		
Coordinate with USFS, VDOF, and NPS to amend forestry practices and recreational use (including fire regime)	X		
Coordinate with VDOT and localities regarding road and bridge construction projects and possible solutions to the frequency of spills and pollution along rights-of-way	X		
Develop cooperative conservation agreements with USFS	X		
Engage private foresters regarding water quality issues	X		
Insure Chesapeake Bay Act followed	X		
Institute speed bumps and signage where appropriate for wildlife	X		
Oppose King William Reservoir and/or advocate constraints on water withdrawal for reservoir	X		
Review USFS National Forest plans	X		
Work with agencies to promote habitat for the Pungo white-footed mouse	X		
Work with timber companies to alter practices and protect large forest tracts	X		
Encourage realignment of national priorities to include conservation		X	
Increase communication between related programs at all levels		X	
Increase representation and attendance at coordination meetings		X	
Leverage available funding across groups		X	
Share operational planning documents between agencies		X	
Use CWCS to develop interagency strategy for conservation		X	
Bring together agencies when developing extensive corridor greenways and blueways			X
Convene monthly meetings where partners can exchange information, progress reports, and goals			X

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Hire a grant writer to research and apply for grants provided at the federal level (Partner Grants)			X
Identify and network individuals working on the same species or species groups			X
Improve coordination between law enforcement agencies at the local, state, and federal levels to include sharing information on violations			X
Increase cooperation and partnerships between government agencies, NGO's, industry and the public to help ensure that conservation issues are addressed in a more proactive and unified manner			X
Share data with local conservation organizations to help them implement plan priorities			X
Work with agricultural groups to promote low impact and organic farming			X
Work with National Wildlife Trust Fund staff to conduct biological assessments for landowners			X

Education and Outreach

	TAC	ESC	Community meetings
Conservation Action			
Better inform policy makers about the economic benefits of conservation and more sustainable use of our natural resources		X	X
Educate developers and planners regarding water quality, greenspace, and stormwater management	X		
Educate farmers regarding the conservation of natural riparian areas, biocide use, nutrient pollution, and other issues	X		
Educate landowners regarding water quality, biocide use, wastewater, vegetation control, the benefits of intact riparian areas, and wetlands	X		
Educate public regarding wildlife needs, water quality and water conservation	X		
Establish an educational programs for nurseries		X	
Increase adult education		X	
Mandate and fund interagency field education experiences		X	
Secure dedicated funding for comprehensive educational program		X	
Develop a mass media campaign regarding how the general public can act and make decisions that benefit wildlife and the environment			X
Develop and implement activity-oriented programs such as fishing, hunting, and birding for urban youth			X
Develop and provide educational programs and outreach to a wide audience to include urban citizens, civic associations, and religious groups			X
Educate lawmakers on the need for estate tax reform to help maintain land in forest and agriculture			X
Encourage forest product companies to provide public access to their lands			X
Encourage the general public to be an active participant in conservation			X
Encourage game wardens and other to provide information on hunting, fishing, and land conservation to a wide range of groups including schools			X
Expand the lobbying efforts of the Virginia Association of Soil and Water Conservation Districts and the Farm Bureau to increase funding for agricultural BMPs			X
Identify and organize interested citizens to bring issues of conservation and funding to their representatives			X
Inform lawmakers of the shortfall in funding and the need for stronger enforcement and more funding for agricultural BMPs, staff, and equipment			X
Integrate existing programs into a more holistic curriculum			X
Identify and equip conservation groups to teach habitat management in schools			X

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Use television and the Internet more effectively to reach the public			X
Work with science and agriculture teachers to develop information for distribution			X

Enforcement

Conservation Action	TAC	ESC	Community meetings
Increase enforcement of existing industrial, environmental, and water quality standards, regulations, and laws	X		X
Enforce and prosecute take/collection laws	X		
Enforce existing DMME/OSM regulations	X		
Enforce violations of stream alteration regulations	X		
Improve enforcement of DOF regulations	X		
Establish simpler enforcement methods and procedures			X
Increase enforcement of non-compliant erosion and sediment control measures			X
Increase mandatory penalties for game law violations and enforce current penalties			X
Increase total number of and compensation for law enforcement field personnel			X
Prioritize wildlife conservation and law enforcement in duties of game wardens			X
Provide training in wildlife laws and regulations to local and state law enforcement personnel			X

Habitat Management

Conservation Action	TAC	ESC	Community meetings
Increase participation in and rates of implementation of BMPs (agricultural and urban) using education and other means	X	X	X
Alter current forest management regimes (thinning, cuts at high elevations, lower stocking density, uneven-aged management)	X		
Conserve/maintain/improve existing habitat (large patches, link habitat islands)	X		
Conserve and restore forest (maritime pine) and other upland buffers surrounding marsh habitat	X		
Construct artificial structures that mimic natural roosts such as river banks and old buildings	X		
Control and manage forest pest species	X		
Create/restore/reclaim habitat (including floodplain)	X		
Determine, where necessary, and enforce minimum instream flows	X		
Implement applicable PARC habitat management guidelines when available	X		
Implement forestry BMPs	X		
Improve pasture management to include haying rotation and timing	X		
Install wildlife crossings (underpasses, fences, etc.)	X		
Maintain current forestry practices for early successional habitat	X		
Manage high marsh habitat	X		
Manage pine savannah through frequent burning of mature forest or herbicide application	X		
Reduce creosote contamination by replacing wooden bridges	X		
Connect forest habitats through restoration			X
Develop better erosion and sediment controls			X
Encourage the planting of wildlife plots and native wildflowers by VDOT and			X

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localities			
Establish a statewide management policy for forest resources			X
Provide technical expertise to private landowners through USDA programs and local land conservancy efforts			X
Work with VDOT and localities to remove existing plantings of invasive, exotic plants and to prevent the future introduction of invasive plants (e.g. tree-of-heaven <i>Ailanthus altissima</i> and autumn olive <i>Elaeagnus umbellata</i>)			X

Land Protection

	TAC	ESC	Community meetings
Conservation Action			
Acquire habitat	X		
Continue or increase conservation easements (wooded wetlands, groundwater)	X		
Install gates on important cave resources	X		
Preserve buildings inhabited by bats	X		
Protect existing and establish new riparian buffers and greenspace	X		
Encourage forest product companies to put easements on their lands			X
Implement conservation efforts to conserve large tracts of habitat			X
Increase preservation of Coastal Plain habitats for migratory birds			X
Preserve high elevation habitat			X
Protect vernal pools through a certification program			X

Planning

	TAC	ESC	Community meetings
Conservation Action			
Encourage county and municipal planners to consider wildlife impacts and natural resources more thoroughly including sustainable development, sprawl reduction, impervious surface and elevational constraints, and zoning, and promote low impact developments including cluster development and the maintenance of continuous tracts of natural habitat	X		X
Develop and implement an urban waterbird management plan	X		
Improve landscape management (include the landscape matrix into account when planning land management and timber cuts)	X		
Protect Virginia farms through zoning and planning restrictions	X		
Review land use changes and prediction of future changes to prioritize areas for conservation	X		
Appraise land for ecological and development values		X	
Increase communication between the Virginia Association of Counties and the natural resource agencies and organizations in Virginia		X	
Coordinate with VDOT, other transportation agencies, and DCR to plan and mitigate for storm water runoff			X
Concentrate new affordable development or renewal in existing towns and cities to encourage the public to live close to work and services in existing infrastructure			X
Improve agricultural development plans			X
Increase planning and implementation of wildlife corridors that connect conservation areas			X
Provide technical assistance to local planning entities to prioritize and incorporate wildlife and natural resource issues into local and regional comprehensive plans			X

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Regulations, Policy, and Law			
	TAC	ESC	Community meetings
Conservation Action			
Expand incentives for voluntary conservation (BMP implementation, easements, “green” consumerism, small land owners)	X	X	X
Create more stringent standards and thresholds for air and water pollution levels permitted by industry and land development activities (NOx, SOx, particulates, metals)	X		X
Upgrade sewage treatment plants (small and large towns)	X		X
Dedicate significant state funding for and implement land protection and purchase of development rights (PDR) programs		X	X
Develop and fund a state exotic and invasive species policy		X	X
Establish permanent dedicated funding (federal and state) for conservation (particularly focused on nongame species)		X	X
Establish user fees on infrastructure and for nongame recreational use of managed areas to promote conservation efforts		X	X
Develop stricter regulations on bait shops, pet stores, and related	X		
Identify and require alternatives to harmful insecticides	X		
Institute time of year restrictions for discing of unpaved roads and for human access to certain habitats	X		
Investigate the feasibility of requiring carbon sequestration	X		
Recommend localities avoid indiscriminant mosquito control measures	X		
Require improved stormwater management	X		
Restructure, improve, and facilitate landowner and wildlife conservation incentive programs (including Farm Bill, Safe Harbor, and HCPs)	X		
Review current wastewater regulations	X		
Review regulations at Dulles airport (shipments of box and spotted turtles)	X		
Tighten permit review processes (review forestry and development permits more closely, improve DGIF follow through on scientific collection permits)	X		
Develop an incentive program to sell and buy native plants		X	
Empower local governments to control land use and manage growth		X	
Make provisions for strong economic incentives to reduce pollution		X	
Require evaluations of secondary impacts of major road projects		X	
Codify definition of what constitutes pollution			X
Develop legislation that promotes the maintenance of contiguous tracts of undeveloped land			X
Ensure conservation and ecological education are incorporated into SOLs			X
Identify watersheds that feed into bays or estuaries as “special conservation areas” and require increased protection and buffers in these areas			X
Require farm tenants to buy hunting licenses			X
Require the use of agricultural BMPs			X
Restore funding to the Chesapeake Bay Local Assistance Division to write farm conservation plans			X
Species Management			
	TAC	ESC	Community meetings
Conservation Action			

Control overabundant nonpredatory native species (deer, striped skunk, beaver) by developing/revising and implementing species management plans	X	X	X
Control and remove exotic/invasive species (animals and plants) including the establishment of a coordinated warning system and strike teams for early eradication	X	X	X
Control predators (including feral cats, muskrat)	X		
Establish and continue to support existing reintroduction, propagation, and augmentation programs for rare species	X		
Improve the controls and coordination of fish stocking (grass carp, trout)	X		
Map non-native <i>Phragmites</i> stands	X		
Address area-sensitive grassland species on sites larger than 250 acres (separate from early successional species)			X
Inventory vernal ponds (similar needs are described in Section 10.2)			X

10.1.4. Targeting Areas for Conservation

In order to describe the location of habitats essential to Virginia's species of greatest conservation need, we mapped confirmed and potential habitats, where possible, for all Tier 1 species (see ecoregional chapters 4-9 for details). This process provided the spatial data used to evaluate characteristics of their habitat and to predict locations essential to those species. The predicted, or potential, habitat is useful for directing species specific surveys (see Section 10.1.4 for specific examples) and for targeting conservation activities, such as land acquisition.

Expanding on this, we overlaid all confirmed and potential habitat layers available for Tier I species. We mapped these habitats within each ecoregion (included at the end of the ecoregional chapters) and statewide (Figure 10.1) to highlight areas that are likely important for one or more Tier I species. These maps include all Tier I terrestrial, aquatic and subterranean species for which we were able to map confirmed habitat (and potential habitat, where available). For species for which we had only confirmed areas, those locations were displayed. If both types of habitats were mapped, confirmed areas were only included if they were outside of the potential areas (see Section 2.4.6 for more details), therefore adding information. It is essential to understand that areas with the potential to support even a single Tier I species are important for conservation. It should also be noted that virtually every county in the Commonwealth contains habitat for at least one of the critically imperiled species. In addition, these maps reveal some extraordinary conservation opportunities by identifying areas containing a large extent of Tier I species habitat (e.g., wetlands in southeastern Virginia) as well as areas supporting habitat of many Tier I species within the same location (e.g., the Clinch River).

10.1.5. Implementation of Conservation Actions

The obvious next step following the completion and acceptance of Virginia's CWCS is the implementation of the proposed conservation actions, research, surveys, and monitoring projects. Our intent from the outset of the planning process has been to create a document that would make available a list of many conservation actions that could be used by any individual or group interested in supporting the conservation of Virginia's wildlife. We also recognize that there are certain actions that can only be undertaken by one or a few groups. These actions may involve regulatory changes, enforcement of existing regulations, or specialized habitat restoration.

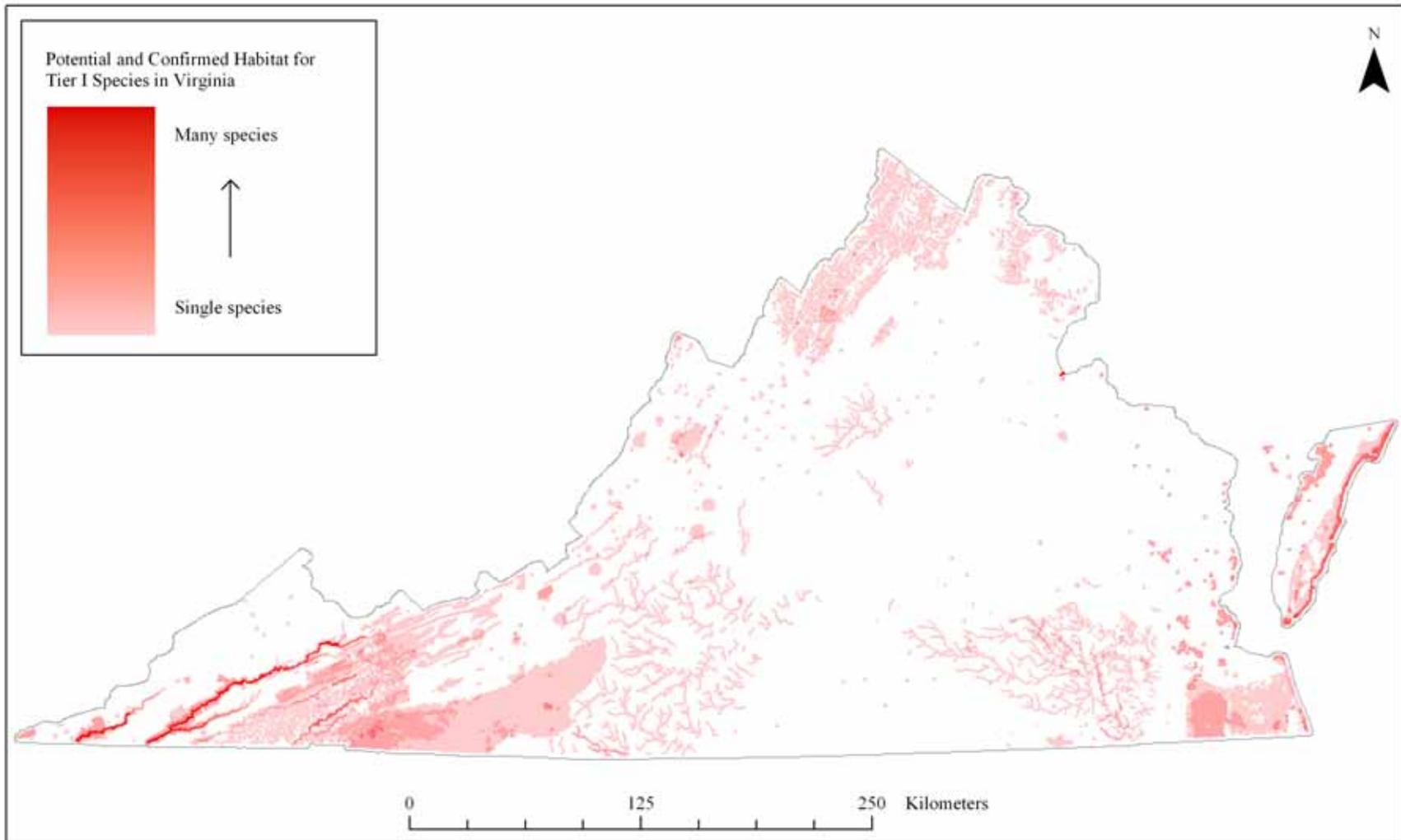


Figure 10.1. Potential and confirmed habitat for Tier I species. Darker shades represent areas with a higher co-occurrence of these habitats. See Chapters 4-9 for maps of individual species and compilations within each ecoregion.

An important component in implementation will be the development of specific goals, objectives, and performance measures for the conservation actions. Our framework for collecting input on conservation actions produced a tieback to the threats to the SGCN and the SGCN themselves. Therefore, identifying performance measures or monitoring protocols for successful conservation actions should be straightforward. Section 10.2.4 contains further discussion of this topic.

To jumpstart the implementation of the prioritized actions, we are planning an implementation kick-off meeting. At this meeting, agencies, organizations, and industries that can play critical roles in the implementation process will be asked to participate in a process of identifying actions they are willing to undertake alone and in partnership with other entities. One outcome of this meeting will be an updated list that identifies which entity or entities are best positioned to address specific conservation actions. To ensure that key stakeholders are involved in this process, DGIF will place emphasis on its outreach to large landholders, including military installations, Indian tribes, USFWS, NPS, USFS, DCR, VDOF, and others identified during this planning process.

In addition, DGIF plans to hire an implementation coordinator. This individual will serve a critical role in strategizing the implementation of actions and projects put forth in the CWCS. The coordinator will work within the agency and with other partners to identify and develop existing or potential projects, planning opportunities, and partnerships within the framework of the Strategy. This work could involve the Core Working Group and various internal and external committees. The CWCS Coordinator will be responsible for tracking the work being done within and outside DGIF as it relates to the CWCS and for developing specific conservation goals and projects. This person will also act as a liaison with key organizations such as IAFWA to remain current with funding opportunities (such as Teaming with Wildlife) and regional and national CWCS priorities.

During the development of the CWCS, a number of formal and informal committees were called upon to create, review, and provide specialized expertise at various phases. The Internal and External Steering Committees are likely to continue to function, but may change composition or lead to the development of new Implementation Work Groups. The implementation coordinator will work with these committees, and with the TACs and the Core Working Group. The implementation coordinator will also be responsible for coordinating public outreach and involvement during the implementation of the CWCS; these efforts may include updates on accomplishments distributed via the DGIF Web site, e-forum, and news releases; developing and delivering presentations at constituent gatherings, sponsoring periodic public input and information meetings; and other tools appropriate for ensuring public involvement.

10.2. Monitoring and Research

Four main objectives of monitoring and evaluation have been described: 1) basic research to gather data and generate conclusions about a topic, 2) status assessment to determine the condition of a variable (e.g., species or habitat), 3) measuring effectiveness of an action, and 4) accounting and certification which is undertaken to ascertain if a program is meeting its expectations (Stem et al. 2003). Monitoring in the context of the CWCS includes monitoring the success, or effectiveness, of the Strategy's implementation, monitoring or assessing the status of populations of SGCN and their habitats, and conducting basic research as recommended. Monitoring activities are vital to assessing changes in wildlife populations and habitats, evaluating the effectiveness of conservation actions, and instituting adaptive management.

10.2.1. Existing Biological Monitoring Efforts

There are many monitoring programs already in place. In many instances, monitoring of SGCN and their habitats is in place or could be dovetailed with existing programs, or these programs could be tailored to include some specifics for SGCN. However, many of the 925 SGCN will not be addressed without substantial planning and new effort. The information in this section includes many, but not all, natural resource monitoring activities that occur throughout Virginia, including wildlife, water quality, and air quality.

10.2.1.1. Fishes

The following are recent or ongoing fish monitoring efforts in Virginia. There are also some fish monitoring efforts underway within water quality monitoring efforts such as those at DEQ and DOH.

- DGIF monitors blackbanded sunfish through population assessments annually at known locations, and presence/absence is monitored at new sites (M. J. Pinder, DGIF, pers. comm.).
- DGIF contracts Conservation Fisheries, Inc. (Knoxville, Tennessee) to perform surveys for the yellowfin madtom *Noturus flavipinnis* in the upper Clinch. Regularly scheduled future monitoring is not planned at this time (M. J. Pinder, DGIF, pers. comm.).
- DGIF has surveyed for the sharphead darter *Etheostoma acuticeps* and Tennessee dace *Phoxinus tennesseensis*. Regularly scheduled future monitoring is not planned at this time (M. J. Pinder, DGIF, pers. comm.).
- USFS performs inventory and monitoring for the American eel *Anguilla rostrata* and candy darter *Etheostoma osburni* on USFS property (S. Croy, USFS, pers. comm.).
- USFS and the Center for Aquatic Technology Transfer (CATT) of the USFS Southern Research Station monitor stream fish habitat in select USFS streams (S. Croy, USFS, pers. comm.).
- NPS performs quantitative and qualitative fish sampling in 43 streams and 74 transects (Atkinson 2002; G. Olson, NPS, pers. comm.). Sampling occurs annually to every five years. The purpose of this monitoring is to document changes in trout and nongame fish populations, with emphasis on native trout species.
- DGIF conducts the Cold Water Stream Survey, in which a subset of trout streams is sampled annually to monitor fish populations and assist with management. Since 1976, standardized data of this type have been collected. Most individual records contain biological and physical information on a date-specific collection, including a list of species collected in a reach, water temperature, and pH.
- DGIF monitors rivers and streams identified as confirmed or potential migration routes, spawning grounds, or nursery areas for migratory fish species. This assessment surveys for the following species: alewife *Alosa pseudoharengus*, blueback herring *A. aestivalis*, American shad *A. sapidissima*, hickory shad *A. mediocris*, striped bass *Morone saxatilis*, and some populations of yellow perch *Perca flavescens*.
- DGIF has a Warmwater Stream Investigations Project, in which a subset of warmwater streams is sampled annually (F.D. Leckie, DGIF, pers. comm.). The primary objective is to collect physical, chemical, biological, and angler use data necessary to develop, implement, and evaluate objective-based management plans; make sound environmental impact assessments to prevent or minimize conditions resulting in the degradation of aquatic habitats; and provide better public utilization of these diverse, valuable resources.

10.2.1.2. Herpetofauna

The following are many of the recent or ongoing herpetofauna monitoring efforts in Virginia.

- USFS monitors the eastern tiger salamander *Ambystoma tigrinum*, Peaks of Otter salamander *Plethodon hubrichti*, Cow Knob salamander *P. punctatus*, and other herpetofauna populations on USFS land (S. Croy, USFS, pers. comm.).
- DGIF and A. H. Savitzky (ODU) monitor one population of the canebrake rattlesnake *Crotalus horridus* (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).
- DGIF contracts J. C. Mitchell (UR) and K. A. Buhlmann (Conservation International) to monitor the spotted turtle *Clemmys guttata* (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).
- USFS has prepared a wood turtle management plan for the George Washington National Forest (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).
- DGIF and USFS monitor wood turtles via population assessments annually at accessible sites, with annual habitat surveys at most other sites with turtles. Presence/absence surveys are conducted at new locations (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).

- DGIF, with assistance from and additional studies by VPI&SU, NPS, and DCR-NH, monitor bog turtles via population assessments annually at accessible sites; annual habitat surveys at most other sites with turtles. Presence/absence surveys are conducted at new locations (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).
- DGIF with NAAMP and citizen volunteers monitor anurans through the Frog and Toad Calling Surveys, which include surveys along routes three times per year (J. D. Kloepfer and M. J. Pinder, DGIF, pers. comm.).
- DCR-NH monitors several amphibian or reptile species on their natural area preserves, including the bog turtle *Clemmys muhlenbergii* and Mabee's salamander *Ambystoma mabeei* (R. K. Myers, DCR-NH, pers. comm.).
- NPS has developed inventory and monitoring protocols for streamside salamanders, wood frog *Rana sylvatica*, and spotted salamander *Ambystoma maculatum* (Jung 2002a; Jung 2002b).
- USFWS performs anuran callback surveys at Eastern Shore of Virginia, Great Dismal Swamp and Rappahannock River Valley NWRs. These surveys were also performed at Back Bay NWR in the past, but have been discontinued (P. Denom, J. Gallegos, J. McCauley, and D. J. Schwab, USFWS, pers. comm.).
- USFWS performs aquatic salamander surveys at Great Dismal Swamp NWR (D. J. Schwab, USFWS, pers. comm.).
- USFWS performs sea turtle crawl and nest surveys at Back Bay NWR and diamond-backed terrapin surveys at Nansemond NWR (J. Gallegos and D. J. Schwab, USFWS, pers. comm.).
- USFWS monitors northern diamond-backed terrapin *Malchemys terrapin* at Nansemond NWR (D. J. Schwab, USFWS, pers. comm.).
- USFWS surveys annually for amphibian egg masses in vernal pools at Mason Neck NWR (G. Weiler and J. Witt, USFWS, pers. comm.).

10.2.1.3. Birds

Much more monitoring of birds is occurring in Virginia than of any other taxonomic group. Bird TAC compiled a list of recent or ongoing projects (Table 10.4).

Additionally, DGIF developed the Virginia Bobwhite Quail Management Plan (DGIF 1995), goals of which include increasing knowledge of quail populations in regions that lack adequate trend data and producing a system to monitor changes in the availability of statewide quail habitat. Monitoring strategies of this goal include:

- Add 20% more quail call-count routes statewide, especially in the western portion of the state.
- Increase the number of quail hunter cooperators participating in the quail wing survey, especially in the western portion of the state.
- Continue the rural mail carrier survey with no modification. This survey is an excellent index of quail populations in late summer.
- Develop GIS applications to quantify the availability of statewide quail habitat and monitor changes in habitat.
- Contract for an investigation into the feasibility of using satellite imagery to identify quail habitat throughout large areas and evaluate effects of changes in land use on quail populations.
- Monitor, in four target counties, the effect of intensified habitat management.

The following marsh bird and colonial bird monitoring efforts are ongoing in Virginia (R. Boettcher, DGIF, pers. comm.):

- DGIF monitors marsh birds on Saxis WMA.
- USFWS monitors birds in the saltmarshes surrounding Fisherman Island, part of Eastern Shore of Virginia NWR.
- USFWS surveys tidal fresh marshes of the Rappahannock River Valley NWR.
- DGIF monitors productivity of Wilson's plover.

- DGIF and USFWS (Chincoteague NWR) monitor productivity of piping plovers:
 - USFWS surveys Assateague and Assawoman Islands.
 - DGIF surveys Metompkin and Cedar Islands.

The following bird monitoring is or has been performed by USFWS (these are in addition to those listed above.):

- Breeding landbird surveys at James River, Rappahannock River Valley, Great Dismal Swamp, Nansemond, Eastern Shore of Virginia, Occoquan Bay, and Back Bay NWRs. These surveys were discontinued at Back Bay NWR as of 2005 (J. Gallegos, USFWS, pers. comm.).
- Winter grassland bird surveys at Rappahannock River Valley NWR, 2003-2005 (J. McCauley, USFWS, pers. comm.).
- Shorebird and waterfowl surveys every 7-10 days at Back Bay NWR and False Cape State Park. Aerial winter waterfowl surveys occur at Great Dismal Swamp NWR. Monthly waterfowl surveys were recently discontinued at Rappahannock River Valley NWR due to funding shortages.
- Osprey production surveys were conducted for about 10 years at Back Bay NWR but were discontinued three years ago (J. Gallegos, USFWS, pers. comm.).
- Bald eagle summer roost surveys at James River NWR, nest surveys at Back Bay NWR, and population monitoring annually at the Potomac River NWR Complex (J. Gallegos, J. McCauley, G. Weiler, and J. Witt, USFWS, pers. comm.).
- Aerial surveys for wintering waterfowl are or have been done at Back Bay, Great Dismal Swamp, and Rappahannock River Valley NWRs (J. Gallegos, J. McCauley, and D. J. Schwab, USFWS, pers. comm.).
- Callback surveys for marshbirds are conducted at the Rappahannock River Valley, Back Bay, Nansemond, Eastern Shore of Virginia, and Fisherman Island NWRs (P. Denom, J. Gallegos, J. McCauley, and D. J. Schwab, USFWS, pers. comm.).
- Occoquan Bay NWR staff survey for neotropical migratory birds (G. Weiler and J. Witt, USFWS, pers. comm.).
- Other species for which surveys and/or monitoring are performed include piping plover *Charadrius melodus*, great blue heron *Ardea herodias*, American oystercatcher *Haematopus palliatus*, and brown pelican *Pelecanus occidentalis*.

The USFS maintains monitoring efforts for the following bird populations: cerulean warbler *Dendroica cerulea* (breeding), golden-winged warbler *Vermivora chrysoptera* (breeding), northern saw-whet owl *Aegolius acadicus* (breeding), Appalachian yellow-bellied sapsucker *Sphyrapicus varius appalachiensis* (breeding), and bald eagle *Haliaeetus leucocephalus* (S. Croy, USFS, pers. comm.).

The DCR-NH conducts surveys and monitoring for colonial and solitary shorebirds (nesting) and resident and migratory landbirds on DCR-NH natural area preserves and related properties (R. K. Myers, DCR-NH, pers. comm.).

10.2.1.4. Mammals

The following are recent or ongoing mammalian monitoring efforts:

- DGIF monitors biannually all known hibernacula of bat species that are listed as Federal or State threatened or endangered. Some of this monitoring is performed in cooperation with USFS (R. J. Reynolds, DGIF, pers. comm.).
- USFS monitors for presence or absence the Mount Rogers population of the Carolina northern flying squirrel *Glaucomys sabrinus coloratus* and Virginia northern flying squirrel *G. s. fuscus* (R. J. Reynolds, DGIF, pers. comm.; S. Croy, USFS, pers. comm.).
- In addition, small mammal sampling is planned for Great Dismal Swamp NWR (D. J. Schwab, USFWS, pers. comm.), and Fisherman Island NWR performs mammal track surveys monthly (P. Denom, USFWS, pers. comm.).

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Table 10.4. Existing bird monitoring efforts compiled by Bird TAC (J. L. Cooper, DGIF, and M. D. Wilson, CCB, pers. comm.).

Project or Goals	Objectives	Current Approaches or Strategies	Implemented By
BBS	Population size and trend estimates	77 routes established, 51 run within last 2yr	Volunteer and state
CBC	Population size and trend estimates	45 count circles	Volunteer and state
MAPS	Productivity and survivorship estimates	33-34 sites (2-4 new); 20-25 with long-term data	All
Hawk migration	Population size and trend estimates	3 long-term stations: one coastal/two mountain	DGIF, CVBO, DEQ, Volunteer
Hawk migration	Banding	2 coastal stations	DGIF, CCB
Songbird migration	Banding	1 coastal station	DGIF, CCB, DEQ, VSO
Mid-winter waterfowl survey	Population size and trend estimates	4 zones with 22 segments	DGIF, USFWS
Mid-winter bald eagle survey	Relative abundance, shoreline utilization, and age structure	6 routes; need summer and replicate surveys	DGIF, USFWS
Breeding Bird Atlas	Distribution and relative abundance	Atlas blocks	DGIF, volunteer
WMA surveys	Distribution, population size and trend estimates, habitat trends	Point counts and habitat type assessment	DGIF
Bald eagle recovery	Monitor population size and productivity; regulatory	Aerial surveys twice annually; need satellite tracking	DGIF, CCB, other partners (DOD)
Peregrine falcon recovery	Enhance and monitor productivity and survival	Nest box surveys; satellite tracking translocated birds; bridge surveys	DGIF, CCB, National Park Service
Red-cockaded woodpecker recovery	Enhance and monitor population size and productivity	Banding young, translocation, intense habitat and cavity management	DGIF, CCB, TNC, USFWS
Important Bird Area program	Guide conservation and monitoring through site selection	Land Certification program	DGIF, Audubon
Barrier island nest surveys	Population size and trend estimates	Summer survey	DGIF, TNC, CCB, FWS, Volunteers
Colonial waterbird surveys	Population size and trend estimates	Summer survey	DGIF, CCB

10.2.1.5. Freshwater Mussels

The following are recent or ongoing freshwater mussel monitoring efforts in Virginia (B. T. Watson, DGIF, pers. comm.):

- DGIF has monitored mussel augmentation sites at Clinchport (2001) and Cleveland Island (2002) on the Clinch River, the county road 833 bridge and Fletcher Ford (both 2004) on the Powell River, and plan to add a site on the Holston River. These surveys will continue annually on a five-year rotation (one site per year). Monitoring at these sites also includes the spiny riversnail *Io fluvialis*.
- DGIF, along with USFWS, USFS, VPI&SU, and others continue surveys for the James spiny mussel *Pleurobema collina* throughout the James River drainage. Though there is no set schedule, these surveys have continued since 1998.
- DGIF recently completed a mussel survey of selected sites in the Nottoway and Meherrin drainages, and will likely continue to survey this area.
- DGIF recently completed (1997/1998) a mussel survey, which also includes snail and crayfish species, in the South Fork Holston River drainage, as well as the New River drainage.
- DGIF, USFWS, VPI&SU, and TNC-Abingdon surveyed Indian Creek, Tazewell County, in the summer of 2004 to better determine the population status of the purple bean *Villosa perpurpurea* and the tan riffleshell *Epioblasma florentina walkeri* and the range of the Tennessee heelsplitter *Lasmigona holstonia*.
- DCR-NH conducted status surveys for the green floater *Lasmigona subviridis* and the brook floater *Alasmidonta varicosa* in 1995/1996 and re-surveyed selected sites for at least green floater presence in 2004, under a National Fish and Wildlife Foundation (NFWF) grant.
- USFS monitors the occurrence of the Tennessee heelsplitter *Lasmigona holstonia* in Wolf Creek near USFS land (S. Croy, USFS, pers. comm.).

10.2.1.6. Other Invertebrates

- DCR-NH monitors the sites of all cave invertebrate species that are listed on Federal or State threatened and endangered species lists (R. J. Reynolds, DGIF, pers. comm.).
- DCR-NH zoologists monitor populations of the regal fritillary *Speyeria idalia*, Mitchell's satyr *Noenympha mitchellii*, and rare skipper *Problema bulenta* (J. C. Ludwig, DCR-NH, pers. comm.).
- DCR-NH also monitors several invertebrate species on their natural area preserves, including the Big Cedar Creek millipede *Brachoria falcifera*, Cedar millipede *Brachoria cedar*, montane centipede *Escaryus cryptorobius*, Buffalo Mountain mealybug *Puto kosztarabi*, and northeastern beach tiger beetle *Cicindela dorsalis dorsalis* (R. K. Myers, DCR-NH, pers. comm.).
- Participants in the North American Butterfly Association's Butterfly Counts program take an annual census of butterflies of North America in various locations.
- USFWS performs odonate surveys for species makeup in late winter and early spring at Great Dismal Swamp NWR (D. J. Schwab, USFWS, pers. comm.), and surveys are performed annually for the northeastern beach tiger beetle *Cicindela dorsalis dorsalis* at the Eastern Shore of Virginia NWR (P. Denom, USFWS, pers. comm.).
- NPS, DCR-NH, many localities and counties perform gypsy moth *Lymantria dispar* sampling programs (G. Olson, NPS, pers. comm.; D. J. Schwab, USFWS, pers. comm.).
- USFS monitors populations of the grizzled skipper *Pyrgus wyandot* and Diana fritillary *Speyeria diana* (S. Croy, USFS, pers. comm.).

10.2.1.7. Terrestrial Habitat Monitoring Efforts

While there are probably dozens, if not hundreds, of terrestrial habitat monitoring projects occurring in Virginia at any time, probably the two most important, at a statewide scale, are the Natural Resource Inventory (NRI), which is performed by NRCS, and the Forest Inventory and Analysis (FIA), performed by DOF and coordinated nationally by USFS.

Natural Resource Inventory

This monitoring effort, which began in 1982, is used extensively in the CWCS. The goal of NRI is to track land use changes on non-federal lands nationwide. Most of the focus is on agriculture-related issues, such as areas in cropland, pasture, forest, water, and urban areas; erosion rates and other soil information; and participation in CRP, among others. These changes are assessed using remote sensing data and permanent, confidential field plots. In Virginia, there are 7,908 such plots, each of which is approximately 110 acres (44.5ha) (NRCS 2001). The survey is repeated on a five-year rotation, so data are available for 1982, 1987, 1992, and 1997 (NRCS 2001). This allows trends to be determined over a 15-year period. Additionally, because the surveys have been performed using a consistent methodology over time, trends can be derived not only at the state level, but also at the ecoregional level. This ecoregional analysis was performed by the NRCS for the CWCS. Results from the most recent NRI effort in Virginia can be found in the ecoregional chapters (4-9) and, for statewide status and trends, in Chapter 3.

Forest Inventory and Analysis

This monitoring effort uses remote sensing data and field data from permanent, confidential plots to determine change in forest cover and productivity (timber volume) nationwide. There are 4,691 permanent plots in Virginia. Each plot is surveyed once every five years, so that all plots are covered over a five-year survey cycle. Data that are recorded at each plot include individual tree species, age, diameter, height, condition, and presence of invasive species.

Though this survey began in 1940, many changes in methodology have occurred since, making it difficult to draw small-scale (i.e. ecoregional) conclusions about trends from these data. However, statewide trends (as well as national trends) are available. In addition, DOF provided current (as of 2001) forest cover by forest type for each ecoregion for inclusion in the CWCS. Results from the most recent FIA effort in Virginia can be found in the ecoregional chapters (4-9) and in Section 3.2.3 above.

Draft Wetlands Monitoring & Assessment Strategy

Through a grant from USEPA, DEQ's Office of Wetlands and Water Protection is creating a 10-year strategy to monitor and assess the quality of Virginia's wetland resources (DEQ 2004a). The objective is to produce a long-term implementation plan for a wetland monitoring and assessment program that protects Virginia's water resources.

The design of this monitoring strategy is three-tiered (DEQ 2004a). Sampling is based on internal and external factors of wetlands, and is meant to provide information on the ecological value of wetlands in a given watershed. The first level is a GIS-based analysis of existing NWI data sets, which is summarized by small watersheds or hydrologic units. In the second level, randomly selected wetlands are assessed based on a checklist of stressors including vegetation alteration, hydrologic modification, roadbeds, sedimentation, and toxicity/nitrification. The third level involves extremely detailed assessments of wetlands. These are targeted based on the amount of development pressure. Wetlands with the largest amount of pressure are given priority, since these wetlands have the most potential for cumulative impacts.

The data from this strategy are used in biannual 305(b) reporting of Virginia's wetlands status and trends. It will also help evaluate whether regulatory programs are effectively providing the state-mandated "no net loss" of wetland resources, and whether a net gain in wetlands resources is being achieved through voluntary programs. An interactive database will allow resource managers and agencies, planning groups, conservation organizations, and the public to access general information on Virginia's wetland resources.

There are several smaller scale monitoring activities underway that address some specific SGCN habitats. For example, USFS monitors the condition of red spruce and Fraser fir forests with regards to insect infestations and air quality impacts, DCR-NH monitors the response of various invasive species to different management regimes, and DCR-NH also monitors several ecological communities and dozens of plant species (S. Croy, USFS, pers. comm.; R. K. Myers, DCR-NH, pers. comm.).

10.2.1.8. Water Quality Monitoring Efforts

As mentioned regarding terrestrial habitat monitoring, there is an abundance of small-scale water quality monitoring underway. Many of these are led by the local watershed groups or citizen monitoring programs described in Section 10.2.1.8. Only those programs focusing at the statewide or broader scale are described in detail below.

Virginia Water Quality Assessment: 305(b)/303(d) Integrated Report

With the assistance of DCR, DEQ submits a water quality assessment report to USEPA every even numbered year. The latest report (DEQ and DCR 2004) summarizes Virginia's water quality conditions from January 1, 1998 to December 31, 2002. This report fulfills requirements of the United States Clean Water Act and the Virginia Water Quality Monitoring, Information, and Restoration Act.

Goals of Virginia's water quality assessment program include determining if water quality standards are met, as well as designing and implementing a restoration plan for waters that are considered impaired in terms of water quality (DEQ and DCR 2004). Water quality standards used in the assessment designate six different uses for waters: aquatic life, fish consumption, shellfish consumption, swimming, public water supply, and wildlife.

If a water body does not meet the water quality standards allow for any of the six designations, it is considered an impaired water. All of Virginia's impaired waters are placed on the federally mandated 303(d) list. Impaired water quality may be due to human activities or to natural processes. If water is impaired because of human activities, a water quality restoration plan must be developed, approved, and implemented. The plan must define the limit of a pollutant that a given water body is able to take in and still be able to meet water quality standards, which is referred to as a Total Maximum Daily Load (TMDL). Once the TMDL is approved, the TMDL implementation plan is developed. The implementation must then restore and maintain improved water quality.

In the 2004 assessment, DEQ and DCR incorporated Integrated Report guidance that was developed by USEPA (DEQ and DCR 2004). This guidance has 5 different categories, defined as follows:

- Category 1: Water that fully supports all designated uses.
- Category 2: Water that fully supports some designated uses, but there is either insufficient or no information regarding the remaining designated uses.
- Category 3: There is insufficient information to determine if designated uses are being met.
- Category 4: Waters are impaired or threatened but do not need a TMDL.
- Category 5: Waters are impaired and need a TMDL.

Additionally, Virginia has instituted subcategories under most of these USEPA categories.

Probabilistic Monitoring

As a result of the need to evaluate water quality in entire river basins throughout Virginia, DEQ recently added ProbMon, a probabilistic monitoring program, to its biological monitoring program (DEQ and DCR 2004). The primary objective of this program is to statistically assess the condition of all non-tidal permanent streams in Virginia. Locations of sampling stations have been randomly selected in order to analyze water quality conditions statistically. The ProbMon survey has occurred from 2001 to 2005. This spread of data collection over five years will help incorporate periods of wet, dry, and normal conditions. ProbMon is based on the techniques found in USEPA's Environmental Monitoring and Assessment Program (EMAP, DEQ and DCR 2004). ProbMon provides the public and policy-makers with estimates of extent and geographic coverage of aquatic resource conditions; estimates of current trends, alterations, and status of the state's aquatic resource indicators; statistical assessments and summaries of aquatic resources in Virginia; and accounts of relations between indicators of natural and anthropogenic stressors and condition of aquatic resources (DEQ 2001).

The National Water-Quality Assessment Program

The USGS commenced a second decade of thorough water-quality assessments under the National Water-Quality Assessment (NAWQA) Program in 2001 (USGS 2005). The NAWQA Program monitors surface and ground water, with a primary focus on streams and ground water. Over fifty major river basins and aquifers throughout the United States have been assessed in the NAWQA Program, four of which occur in Virginia: the Upper New River Basin, the Roanoke River Basin (as part of the Albemarle-Pamlico Sound study), the Potomac River Basin, and the Delmarva Peninsula. NAWQA's primary objective is to produce continual data that are consistent and comparable in order to support sound decisions on management and policy (USGS 2005). The design of NAWQA allows assessment of stream and groundwater condition throughout the country, changes in these conditions, and effects of natural features and human activities on these conditions (USGS 2005). Concerns that are addressed by NAWQA include increased nutrient and bacteria levels due to poultry and livestock; increased nutrients and pesticides from crop production; hydrologic system contamination by agricultural chemicals; higher concentrations of nutrients, pesticides, volatile organic compounds, and trace elements from municipal development; increased phosphorus and nitrogen and their effects on stream eutrophication; and aquatic community impacts caused by land-use changes, water-quality degradation, and habitat disturbance (USGS 2005).

10.2.1.9. Air Quality Monitoring Efforts

As required by USEPA, the annual Virginia Ambient Air Monitoring Data Report contains measurements of air pollutants and is compiled by DEQ, the City of Alexandria, and Fairfax County (DEQ 2004b). Monitoring sites are established in accordance with USEPA's criteria. Monitoring network operations correspond to USEPA guidance and conventional air quality monitoring practices, and all monitoring site data reported are quality assured in accordance with USEPA requirements.

In the 2003 report, Virginia is shown to continue to meet USEPA's National Ambient Air Quality Standards (NAAQS) (DEQ 2004b). Even though Virginia had fewer than the minimum standard days above ozone standards in this report, the state still experiences issues with ozone pollution during summer, especially in the areas of northern Virginia, Richmond, and Hampton Roads. These areas, along with Fredericksburg and Shenandoah National Park, have been placed on USEPA's list of nonattainment areas. These are areas that are not reaching the 8hr ozone standard based on 2001-2003 ozone measurements. Winchester and Roanoke are not meeting this standard either, but both have entered into Early Action Compacts (EACs), which require plans for air quality that strive to reduce ozone precursor pollutants, improve air quality, and prevent the designation of nonattainment. Also, the 2003 report shows that Virginia continues to meet the NAAQS for both PM₁₀ (particulate matter with an aerodynamic diameter equal to or less than 10µ) and PM_{2.5} (fine particulate matter); however, USEPA recommended including northern Virginia in the nonattainment list for PM_{2.5} in June of 2004, and currently northern Virginia is included in this list of nonattainment (DEQ 2004b).

10.2.1.10. Citizen Monitoring Efforts

Some citizen monitoring efforts previously mentioned are coordinated by or with state agencies, including BBS, Breeding Bird Atlas, Frog and Toad Calling Survey, and The North American Butterfly Association's Butterfly Counts. Another program, WildlifeMapping, is an ongoing citizen wildlife observation program coordinated by DGIF, designed to retrieve information on all types of wildlife from citizens across the state.

There are a few other citizen monitoring programs that are coordinated by non-governmental organizations. In the Alliance for the Chesapeake Bay (ACB) Citizen Monitoring Program, participants collect water samples weekly or bi-monthly to monitor water quality by using equipment, supplies, and protocols provided by ACB (ACB 2004). In the Izaak Walton League's Save Our Stream Program (working with DEQ and DCR), participants collect samples of macroinvertebrates from the stream, identify the organisms, and rate the water quality (IWL no date). This is usually done once each season. There are also many "Friends of" groups that conduct monitoring of water and habitat quality.

10.2.2. Species Monitoring and CWCS Implementation

When research projects and conservation actions from the CWCS are implemented, species or habitat monitoring should be included when appropriate. This is important to assess the effects of the actions on the SGCN and their habitats. Successful adaptive management is reliant upon effective monitoring: Conservation actions can be adapted to improve their success based on the results of monitoring efforts. To the degree practical, these monitoring efforts will utilize and build on existing programs described in Section 10.2.1. When appropriate, every effort will be made to link local and regional monitoring to national assessments. However, we also recognize that existing monitoring programs in the Commonwealth may fall short of meeting the needs described throughout this document. When considering monitoring protocols, project implementers should also consider the appropriate scale. For example, depending on the project, it may be more appropriate to monitor individual species, guilds, or communities.

10.2.2.1. Species-specific Monitoring Protocols

To assist in the development of monitoring protocols, we have assembled a list of relevant monitoring standards and protocols for various taxonomic groups.

Fishes

AFS (American Fisheries Society), AIFRB (American Institute of Fishery Research Biologists), and ASIH (American Society of Ichthyologists and Herpetologists). 2004. Guidelines for the use of fishes in research. Revised by the Use of Fishes in Research Committee. Retrieved from http://www.fisheries.org/html/Public_Affairs/Sound_Science/Guidelines2004.shtml, April 18, 2005.

Herpetofauna

ASIH (American Society of Ichthyologists and Herpetologists). 2004. Guidelines for use of live amphibians and reptiles in field and laboratory research, 2nd edition. Revised by the Herpetological Animal Care and Use Committee (HACC). Retrieved from http://www.asih.org/pubs/ASIH_HACC_Final.PDF, April 18, 2005.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. 1994. Measuring and monitoring biological diversity: Standard methods for amphibians. Smithsonian Institution, Washington D.C.

Mitchell, J. C. 1997. Amphibian monitoring protocols for Virginia. Virginia Department of Game and Inland Fisheries, Richmond, Virginia.

Birds

Bibby, C. J., N. D. Burgess, and D. A. Hill. 1992. Bird census techniques. Academic, London.

DeSante, D. F., K. M. Burton, P. Velez, and D. Froehlich. 2003. MAPS Manual, 2003 Protocol. Institute for Bird Populations, Point Reyes Station, California.

IAFWA (International Association of Fish and Wildlife Agencies). 2004. Monitoring avian conservation: Rationale, design, and coordination. The Coordinated Bird Monitoring Working Group.

Mammals

Wilson, D. E., F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, editors. 1996. Measuring and monitoring biological diversity: Standard methods for mammals. Smithsonian Institution, Washington, D. C.

Invertebrates

NABA (North American Butterfly Association). 2005. 31st Annual NABA Butterfly Count – 2005 instructions (USA). North American Butterfly Association. Posted at: <http://www.naba.org/counts.html>.

New, T. R. 1998. Invertebrate surveys for conservation. Oxford University, New York, New York.

Strayer, D. L. and D. R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society Monograph 8, Bethesda, Maryland.

10.2.2.2. National Park Service Protocols

In addition to those listed above, NPS has developed or is in the process of developing several standard monitoring protocols that will likely be useful beyond the park boundaries.

Forest Vegetation

Smith, D. W. and J. L. Torbert. 1990. Shenandoah National Park long-term ecological monitoring system, section II, forest component user manual, NPS/NRSHEN/NRTR-90/02. Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Rare, Threatened, and Endangered Plants and Plant Communities

NPS (National Park Service). 2002. RTE extended monitoring, site visit checklist. Natural Resources Branch, Division of Natural and Cultural Resources, Shenandoah National Park, Luray, Virginia.

NPS (National Park Service). 2002. RTE general monitoring, site visit checklist. Natural Resources Branch, Division of Natural and Cultural Resources, Shenandoah National Park, Luray, Virginia.

Gypsy Moth Lymantria dispar

Ravlin, F. W., S. J. Fliescher, and S. L. Rutherford. 1990. Shenandoah National Park long-term ecological monitoring system, section IV, gypsy moth component user manual, NPS/NRSHEN/NRTR-90/02. Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Freshwater Streams Including Macroinvertebrates

Voshell, J. R. and S.W. Hiner. 1990. Shenandoah National Park long-term ecological monitoring system, section III, aquatic component user manual, NPS/NRSHEN/NRTR-90/02. Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Streamside Salamanders

Jung, R. E. 2002a. Streamside salamander inventory and monitoring, Northeast Refuges and Parks. Patuxent Wildlife Research Center, U.S. Geological Survey, Laurel, Maryland.

Wood Frog Rana sylvatica and Spotted Salamander Ambystoma maculatum

Jung, R. E. 2002b. Wood frog and spotted salamander egg mass counts and percent vernal pools occupied by amphibian species on DOI lands in the northeastern United States. Patuxent Wildlife Research Center, U.S. Geological Survey, Laurel, Maryland.

Freshwater Fish

Atkinson, J. 2002. Shenandoah National Park fisheries monitoring protocol. Natural Resources Branch, Division of Natural and Cultural Resources, Shenandoah National Park.

Black Bears Ursus americanus

NPS (National Park Service). 2005. Guidelines for conducting the annual bait station survey for black bears in Shenandoah National Park. Shenandoah National Park, Luray, Virginia.

Oak Mast Crop Survey

Coggin, J. L. and C. H. Perry III. n.d. A system for evaluating the oak mast crop. Virginia Department of Game and Inland Fisheries.

In the instances where pre-defined protocols or existing programs fail to adequately address the need, monitoring projects will be established following protocol guidelines discussed in Oakley et al. (2003). The protocol narrative will provide an overview of the background and objectives; sampling design; field methodologies; data handling, analysis, and reporting; personnel requirements and training; operational requirements; and references (Oakley et al. 2003). These elements will facilitate periodic review and refinement of the monitoring program. Standard operating procedures will also be described to present details of the activities described in the protocol narrative (Oakley et al. 2003). Finally, supplemental materials, such as sample databases or decision support tools, will accompany the protocol narrative and standard operating procedures, particularly during the peer review process (Oakley et al. 2003). Opportunities for partnerships with other agencies and organizations will be investigated and pursued as appropriate.

10.2.3. Research and Monitoring Needs

Within each of the Tier I species accounts in the ecoregional chapters (4-9), there is a section devoted to research and monitoring needs that were identified by either the respective TAC or through literature review. For many species, particularly invertebrates, so little is known of their life history, habitat requirements, even distribution, that it is difficult to identify specific conservation actions to enhance populations and habitats of these species. In those cases, research and monitoring are, in effect, the conservation actions. For most SGCN, information is needed about stresses and sources of stress causing declines in species populations or to habitats and of corrective actions to reverse those trends. Specific recommendations provided by the TACs in those meetings are presented in Appendix J.

In a meeting held March 4, 2005, members of the External Steering Committee gathered to identify conservation actions needed to improve the status of wildlife in Virginia. Among those actions were several that can be more accurately described as research and monitoring needs. These include:

- Increase resources (people and money) directed to biological studies
- Initiate and complete a statewide vegetation map
- Implement statewide plant and animal surveys
- Increase ability to access non-public lands for research, assessment, and monitoring
- Increase funding for natural history and basic science projects
- Increase available research money
- Create a statewide inventory of invasive plants
- Research and fund the development of an early detection and response system for invasive species
- Develop a clearinghouse to collect and disseminate information

10.2.4. Monitoring and Adaptive Management

One of the keys to successful projects is effective project management. Effective project management helps ensure projects are running on time, on budget and within scope. Project management can be implemented at many scales. All of the projects related to the CWCS should follow the basic project management cycle. FOS (2002) provides a framework for the successful adaptive management of any project. The framework includes the following steps:

- 1) Design the project with a clear understanding of the issue to be addressed, the context in which the project is working, and the target audience of the results.
- 2) Plan the project with well-defined goals and objectives, an understanding of how the project addresses a need, and clear assignment of responsibilities among those involved.
- 3) Implement the project or action.
- 4) Evaluate or check progress, creating a link back to goals and objectives, develop indicators for the evaluation, create a monitoring plan, and develop a strategy to use the results of the monitoring and evaluation.
- 5) Analyze the results of the monitoring using a developed plan for storage, processing and analysis and determine why an action succeeded or failed.
- 6) Develop communications products for the target audience focused on management issues, and evaluate the success of these products.
- 7) Use the project results, and adapt this and subsequent projects based on the analyses; use these analyses in decision-making processes and in changing goals, objectives, and activities.
- 8) Lastly, this is an iterative process. Steps can be revisited as required. It is important to view this process as a learning experience and to foster a learning environment.

Throughout the process relevant stakeholders should be involved and a formal timeline and budget should be developed and managed (FOS 2002).

The Habitat Affinity database, which was developed to hold information on habitat requirements, distribution and threats related to the SGCN, will be modified to include a mechanism for tracking the implementation and success of specific conservation actions. This modification will include information on the entity involved, the timeframe of the project, the location of the project, and specific performance measures. Including this mechanism in the Habitat Affinity database will allow us to identify the species that should benefit from the action and threats that should be reduced. We can use this information to develop appropriate monitoring procedures. Additionally, this central repository will enable DGIF to monitor partnerships and public involvement in projects such as conservation easements, stewardship agreements, restoration and enhancement projects, and acquisitions or donations.

Using the project management framework and the enhanced Habitat Affinity database, DGIF and its partners will regularly review and evaluate conservation actions to keep the CWCS on task and updated with specific current needs (Table 10.5). DGIF will use existing reporting and evaluating mechanisms, such as annual reporting for Federal Assistance grants and revisions of partners' plans (e.g., National Forest Management Plans and National Wildlife Refuge Comprehensive Conservation Plans), to effectively integrate and adapt the Virginia CWCS.

The Department of Game and Inland Fisheries, in coordination with the existing External Steering Committee or future Implementation Working Groups, will hold periodic workshops and symposia to provide for expert review and evaluation of species, habitats, stresses, and the effectiveness of implemented conservation actions. Additionally, DGIF and its partners will sponsor workshops to begin incorporating marine wildlife into the CWCS using comparable techniques employed in this version of the document. The results of these meetings and updates will be incorporated into future iterations of the CWCS.

This adaptive process also includes continued input from stakeholders. The DGIF and its partners will keep the public informed of projects and results through annual progress reports, magazine articles, newsletter features, and Web site updates. Our adaptive management process provides for the biennial review and evaluation by the TACs of progress on CWCS projects, resulting in recommendations to better address

needs. The DGIF will consider and integrate these recommendations whenever possible in future iterations and updates of the CWCS.

The effectiveness of this document will be measured by the frequency and degree of use and integration of action items into the programs and operations of DGIF and its partners and stakeholders. Each partner will receive copies of the final CWCS, and updates resulting from the review and evaluation processes noted above, with a request to incorporate conservation actions and research and monitoring needs into their own wildlife conservation efforts. Annual accomplishment measures that relate to implementation progress and success will need to be quantified by the Implementation Working Group and may include variables such as acres of key habitats conserved or improved; research or surveys that address data gaps; information management advances; outreach to the public and partners; and partnership coordination. Qualitative metrics, such as improved coordination of activities between agencies and organizations, will also be used to measure implementation success. Success criteria might include a net increase in the acreage of key habitats protected through acquisition, easements, or restoration; an increase in the knowledge of SGCN and their habitats; successful completion of the most important conservation actions; a demonstrated increase in public and private partnerships and involvement in the conservation of wildlife resources in Virginia; and the long-term reduction in the number of species included on the Virginia list of SGCN.

10.3. Information Management Needs

The assembly, manipulation, and interpretation of a wide array of information, both spatial and tabular, have been and will be critical elements in the successful development and implementation of the CWCS. Throughout development of the Strategy, we identified gaps in information and its management. Filling these gaps will greatly improve our ability to assess the status and health of Virginia's wildlife and their habitats. We grouped these information needs into four broad categories: data and information, data standards, management of data/information, and relationships among partners.

10.3.1. Data and Information Needs

During the development of the Virginia CWCS, DGIF and the External Steering Committee identified a number of information management needs to be addressed to ensure successful implementation of the Strategy.

- Non-molluscan invertebrate species locations, habitat requirements, and life history
- Freshwater mollusk locations, habitat, and host fish
- Updated land cover spatial data
- Standard habitat classification with current and detailed maps for the state
- Updated wetland spatial and trends data
- Detailed descriptions of species-habitat relationships
- Spatial and trends data for early successional habitat
- Statewide consistent soils data
- Review of existing data for spatial accuracy

10.3.2. Data and Information Standards

Information and data are often collected or presented in different units or with differing methodologies. It is important that some minimum standards for collection and reporting are put into place and used in Virginia. Consistent use of existing standards and documentation of units of measurement, GIS data projection, and metadata would considerably improve data sharing and interpretation.

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Table 10.5. Evaluating the effectiveness of conservation actions in Virginia's CWCS (adapted from NCWRC 2005).

Work level	Time Scale	Type of Evaluation Questions	Conducted By	Methodology
Individual project	Semi-annual or annual reporting Annual evaluation	Did the project occur? Did it stay on budget and use funds properly? Who did the work? What was the quality of the work? Were the hours required reasonable and expected? Did it have the desired outputs? Are the performance indicators useful metrics of progress/success? Was there collaboration among partners? To what extent? Are there unintended consequences? What (if any) was public opinion of the project?	Program supervisors and staff	Cost accounting using DGIF time and cost accounting systems; Habitat Affinity database used to track project accomplishments
Adaptive management of project	Annual	After evaluation, how should future projects be changed or retained?	Program supervisors and staff	
CWCS conservation actions (i.e. program-level strategies)	Interim (every few years)	What is the status of the desired outcomes associated with each activity, as measured by performance indicators? Are the indicators valid measures? Are individual projects meeting the conservation actions called for in the Strategy? If not, why not?	Program supervisors, Implementation Steering Committee	Project tracking database tracking project accomplishments
Adaptive management of conservation actions	Interim (every few years)	After evaluation, how should future program-level activities and projects be changed or retained?	Program supervisors, Implementation Steering Committee	
CWCS Goals	Every 10 years	Are the conservation actions meeting the goals of the Virginia CWCS?	Program supervisors, Implementation Steering Committee	Project tracking database tracking project accomplishments

It is also important that states agree to some standards in the future, so that certain information from these strategies can be presented in regional and national assessments or evaluations. For example, during the development of this Strategy, the Core Working Group determined that each adjacent state was using a different ecoregional classification system within which to organize their information. This result is not entirely unexpected, given that a specific ecoregion framework was recommended, but not prescribed, and even the recommended framework changed during the course of the development of these strategies. Over the next 10 years, however, states and the trust territories should come together and agree upon the following:

- ecoregional classification;
- habitat classification;
- taxonomic standard;
- definition of Species of Greatest Conservation Need;
- definition of Habitats of Greatest Conservation Need;
- methods for measuring stresses on species and habitats; and
- methods for identifying and reporting trends of species and habitats.

Such coordination could be facilitated by USGS's National Biological Information Infrastructure, other programs within USGS or USFWS, or by IAFWA.

10.3.3. Management of Data and Information

We consider collection, storage, maintenance, and dissemination to be integral components of data and information management. It is extremely important to the implementation of the CWCS and to the review and revision process that agencies and organizations involved in wildlife and habitat management manage their data in such a way that it is collected according to certain standards (discussed above), stored securely, maintained with adequate quality control, and disseminated in a timely manner and in a usable form. We intend to make available many of the datasets and data layers developed in this process through the Internet. These data will also be available by data request. We began to address the quality and utility of our CWCS datasets (and development of dissemination tools) near the end of the initial CWCS development. This process will continue into the implementation phase.

10.3.4. Data and Information Sharing

This aspect of information management overlaps with those discussed above, but is so important that it bears specific and separate mention. It is absolutely essential that stakeholders begin to communicate and work together toward common goals. In part, this Strategy is intended to facilitate that work by providing a framework for all interested parties to participate in wildlife conservation toward common goals. In Virginia, data and information have not always been shared openly among natural resource agencies. Over the past several years, the situation has improved. Trust among partner agencies is a critical element in any data or information-sharing agreement. This trust must be earned through experience. We intend to openly share the data developed and used in the CWCS process (where appropriate, due to the sensitivity of some of the datasets).

The information management accomplishments and challenges parallel many of those identified in a national survey conducted recently by the OFWIM (2004). Information critical to this process existed in a variety of formats that required some integration; new systems had to be developed to address required elements; some existing "comprehensive" applications were actually selective by nature; limited detailed state- and species-specific information existed for a number of major taxonomic groups; and many datasets available did not document population or habitat health or trends. The DGIF and its partners recognize the value and necessity of supporting wildlife-related information management initiatives as critical underpinnings to the success of Strategy implementation. To that end, the DGIF supports the recommendations from OFWIM (2004), particularly:

- ensure that processes and methodologies are well documented and presented in the CWCS;
- document data deficiencies to be addressed for successful implementation and revision;
- commit SWG or related funding to address data deficiencies;
- coordinate information management and geospatial data issues between fish and wildlife agencies and key partners at local, regional and national levels;
- adopt national standards; and
- identify opportunities for inter-state or regional collaboration.

10.4. CWCS Plan Review and Revision

We propose to complete a comprehensive and formal revision of the actual Strategy in ten years. However, as noted above in Section 10.2 (Implementation Monitoring and Research), the agency and its partners will be reviewing, evaluating, and updating components of the CWCS annually through interim reports, project evaluations, and technical/stakeholder review and input. The databases and geospatial systems described previously will be used to track accomplishments of each element (research, monitoring, surveys, and conservation actions) described throughout this document and will provide the fluidity needed to adapt tracking criteria as new information becomes available.

We expect that considerable changes may occur within the first four to five years, with the implementation of processes to evaluate and integrate marine wildlife, and as basic life history information is gathered regarding Virginia's many invertebrate species of greatest conservation need. During the course of the next decade, we also expect to revisit the processes used to complete this initial Strategy and refine or revise them as new information and/or technologies for evaluation of the status of wildlife and habitats become available. We will have an opportunity to review and analyze the processes used in the development of the 55 other Strategies and make recommendations that strengthen the Virginia CWCS. We will also have an opportunity to more fully embrace the principles outlined in the IAWFA Guiding Principles document and determine how Virginia can work to attain or incorporate more of them in future iterations.

When a revision does occur, the appropriate technical and steering/advisory committees and teams will be assembled to complete this work. Many of those teams are already in place and will continue to function throughout implementation of the Strategy. During this review, we expect the teams to reevaluate species and habitat priorities based on new information gathered through surveys, research, and monitoring; to reprioritize conservation actions based on the accomplishments realized to date; to utilize new or improved approaches to the internal supporting processes; and to incorporate species groups (e.g., marine wildlife) that were secondarily addressed in the first iteration of the Strategy. Revisions will be advanced through the Steering Committees, who will endorse the incorporation of those revisions into the Strategy itself. All of these activities will begin approximately two years prior to the decade anniversary of the initial Virginia CWCS. Throughout this revision process, the implementation coordinator and CWG will also be responsible for coordinating stakeholder and public outreach and involvement. These efforts will include updates about the process, prior accomplishments, and opportunities for comment to be distributed via the DGIF web site, e-forum, and news releases; developing and delivering presentations at constituent gatherings, sponsoring public input and information meetings; and other tools appropriate for ensuring public involvement. Recommendations of merit will be incorporated into the draft document. The final revised CWCS will be presented to the Board of Game and Inland Fisheries and Virginia Secretary of Natural Resources for approval and endorsement.

10.5. Conclusion

The development of the Virginia CWCS presented a unique opportunity for the Commonwealth—an opportunity not only to assess the condition and status of the state's wildlife and habitat resources, but to provide a shared vision and establish unity of purpose in the management and conservation of this "common wealth." The true value of this initiative has been the recognition of common interests and the building of partnerships. Its long-term success will be borne out in the implementation of the recommended

actions by agencies and organizations across the state and the effectiveness with which we collectively manage these natural resources.

“To the end that the people have clean air, pure water, and the use and enjoyment for recreation of adequate public lands, waters, and other natural resources, it shall be the policy of the Commonwealth to conserve, develop, and utilize its natural resources, its public lands, and its historical sites and buildings. Further, it shall be the Commonwealth’s policy to protect its atmosphere, lands and waters from pollution, impairment, or destruction, for the benefit, enjoyment and general welfare of the people of the commonwealth.”

Article XI, Section 1, of the Constitution of Virginia

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