Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Occurs in disjunct populations that are not genetically differentiated so movement corridors may be important. This species is very habitat selective. They use moist talus habitats among mossy rocks and logs in spruce/ fir and northern hardwood forests, cedar swamps, and krummholz. May be naturally rare due to habitat specificity. Rock vole has been reported in three-five year old clearcuts with slash however, not in Vermont. Critical habitat includes cool, moist talus and mossy rocks usually with a stream or other surface water in the immediate vicinity.

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Mesic aspect of habitat is important so the loss of forest cover may dry out the site. Loss of connectivity may be a problem. Habitat is isolated and local populations may go extinct. Repopulation may require habitat corridors of coniferous forests that connect optimal habitats. Activities that destroy or degrade talus habitat would impact rock vole populations.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition from meadow mouse as a result of habitat conversion, particularly near talus areas, could limit the rock vole. Metapopulation structure is not clearly understood but local populations appear to go extinct and then are repopulated. In Massachusetts and West Virginia populations were negatively affected by high levels of deer over the long term (Healey and Brooks 1988).

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
Global Trend:
State Rank: S2
State Trend: unknown
Extirpated in VT? no
Regional SGCN? No

Assessment Narrative:

Ranked as S2 in Vermont and considered a species of special concern. Talus slopes are the species' refugal habitat. In some locations, rock voles may be found in early successional forest habitat (Kirkland 1977; Martell and Radvanyi 1977) and krumholtz. There is uncertainty as to why the population fluctuates so much and there are relatively few known populations. The relatively narrow habitat requirements of this species make it vulnerable to habitat alterations. Furthermore, because rock voles occur in disjunct populations, it is dependent upon movement corridors. It is also speculated that these disjunct populations could be negatively impacted by landscape changes that favor the meadow vole (Microtus pennsylvanicus) which is a suspected competitor of the rock vole.

Distribution

There are a number of historic records indicating the species' existence and distribution in the state. These records include: 20 specimens from Island Pond at 1400' elevation (1937-1940); two specimens from Brighton on the talus slopes of NW Bluff Mountain (1953); one specimen from near Smugglers cave, Mt. Mansfield (1954); four specimens from Nebraska Notch, Mt. Mansfield (1958-1959); and two specimens (one male and one female) from Nebraska Notch, Mt Mansfield (1966). More contemporary records of the rock vole in Vermont include: Whenlock WMA (Chipman, 1994); West Mountain WMA (Kilpatrick, 2001); East Mountain, East Haven (Kilpatrick, 2005), and East Charleston (Kilpatrick, pers. comm.). The Vermont Small Mammal Atlas also recorded six specimens from four sites in Essex and Caledonia counties between 2008 and 2010 (Kilpatrick and Benoit 2011). Unknown populations were verified inhabiting talus slopes on Brousseau Mountain (Averill, Essex Co.), Umpire Mountain (Victory, Essex Co.) and Wheeler Mountain (Sutton, Caledonia Co.) and the population from West Mountain WMA was verified to still exist (Kilpatrick and Benoit 2011).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Historic Records Only	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Occurs in disjunct populations that are not genetically differentiated so movement corridors may be important. This species is very habitat selective. They use moist talus habitats among mossy rocks and logs in spruce/ fir and northern hardwood forests, cedar swamps, and krummholz. May be naturally rare due to habitat specificity. Rock vole has been reported in three-five year old clearcuts with slash however, not in Vermont. Critical habitat includes cool, moist talus and mossy rocks usually with a stream or other surface water in the immediate vicinity.

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Mesic aspect of habitat is important so the loss of forest cover may dry out the site. Loss of connectivity may be a problem. Habitat is isolated and local populations may go extinct. Repopulation may require habitat corridors of coniferous forests that connect optimal habitats. Activities that destroy or degrade talus habitat would impact rock vole populations.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition from meadow mouse as a result of habitat conversion, particularly near talus areas, could limit the rock vole. Metapopulation structure is not clearly understood but local populations appear to go extinct and then are repopulated. In Massachusetts and West Virginia populations were negatively affected by high levels of deer over the long term (Healey and Brooks 1988).

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Basic Life History	Medium	Telemeter to determine home range movements
Research	Distribution and Abundance	High	Determine distribution and abundance as well as corridor needs
Research	Population Genetics	Medium	Research genetics to determine changes in population structure and size.
Research	Other Research	High	Determine appropriate management strategies to improve and conserve habitat.
Monitoring	Population Change	Medium	In a multi year monitoring effort, re-census historical habitats and survey in other likely habitats and map confirmed habitats.
Monitoring	Monitor Threats	Medium	Monitor encroachment by medow mice.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	Medium	Minimize permanent fragmentation between populations.	Amount of habitat between populations protected or conserved.	UVM	SWG

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Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? no

Assessment Narrative:

The woodland vole is frequently considered a pest in agricultural settings (especially in apple orchards) though much of the reported damage is the result of meadow voles (Microtus pennsylvanicus). Despite appearing to do well in agricultural landscapes, little is known about this species outside this setting or in its native habitat. Fewer than 50 specimens have been collected in the state and is known historically from very few localities .

Distribution

Known historically from very few localities including the flanks of Ide Mountain, West Lyndon Center (Miller, 1964); Island Pond (Miller, 1964); Sherburne (Osgood, 1936); and from Colchester and Duxbury (Kilpatrick, pers. com). Woodland voles occur in orchards in Putney, Mendon, and Bennigton (Kilpatrick, 1979). The Vermont Small Mammal Atlas obtained two specimens from two localities in Orleans and Windsor counties from 2008 to 2010; one was trapped in the Skitchewaug WMA (species verified by DNA sequencing) and another collected from a garden in Charleston (Kilpatrick and Benoit 2011). Records were also verified from Addison County and Chittenden County (Kilpatrick and Benoit 2011).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Defining habitat characteristic of the woodland vole is well-drained sandy loam soils. Found in all places with these soils (e.g. agricultural fields and older forests). Favors well-drained upland forests, grasslands, meadows, or orchards but can be found in marshes and swamps (DeGraff and Yamasaki, 2001). May require a ground cover of leaves or duff or grass. Forages primarily below ground digging tunnel systems 3 inches to 12 inches below ground. Nests are found under dead and down material, rocks, or in burrows. They are active throughout the year and eat tubers, roots and bulbs, seeds, nuts fruits, bark and leaves (DeGraff and Yamasaki, 2001). Can be a problem in orchards.. Prefers large expanses of forest and grassland habitats,

Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Unknown Habitat Threats

Description of habitat threat(s): Habitat requirements unknown.

Non-Habitat Threats:

Trampling or Direct Impacts

Pollution

Description of non-habitat threat(s): Because of human/vole conflicts, the application of rodenticides may cause a decline of this species in orchards and other developed lands. The status of the wooland vole in forested habitats is unknown.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Develop baseline data on habitat requirements outside of agricultural areas.
Research	Distribution and Abundance	Medium	Develop baseline data on distribution and abundance outside of agricultural areas.

Species Strategies

Strategy Type	*Strategy Priority*	*Strategy Description*	*Performance Measure*	*Potential Partners*	*Potential Funding Sources*
Standards	Medium	Develop guidelines for pest control professionals for the non-lethal control of the species.	Number of trained pest control professionals	Agricultural extension, Pest Control Professionals	SWG

Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

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Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
Global Trend:
State Rank: S5
State Trend: Declining
Extirpated in VT? no
Regional SGCN? no

Assessment Narrative:

The muskrat has traditionally been one of the most heavily exploited furbearers in North America owing to its abundance, relative ease of capture and highly prized fur (Boutin and Birkenholz 1987). Across its range today, most jurisdictions, including Vermont, maintain regulated trapping and hunting seasons for the species. The muskrat plays an important ecological role serving as a significant prey source for a variety of predators including raptors, river otter and American mink (Holmengen et al 2009). In recent decades, anecdotal evidence indicates a nationwide decline in muskrat populations. Such noted declines have been most prominent in the northeast. Despite much knowledge regarding the biology and management of muskrats, little empirical evidence exists indicating either the magnitude of such declines and/or any possible contributing factors (Roberts and Crimmins 2010).

Distribution

Muskrat harvest records in Vermont indicate well established populations in all major watersheds.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
Middle Connecticut
West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
Passumpsic

Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

St. Francois River
Upper Connecticut
White
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Muskrats occupy almost every type of freshwater aquatic habitat in eastern North America (Boutin and Birkenholz 1987). Muskrat have flexible habitat requirements as long as there is permanent water and protection through burrows and vegetated lodges. Highest population densities exist where emergent vegetation is at a 1:1 ratio to open water.

Habitat Types:

Marshes and Sedge Meadows

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Invasion by Exotic Species

Unknown Habitat Threats

Description of habitat threat(s): Although the specific effects of habitat alteration on muskrats are poorly understood, the anthropogenic degradation of muskrat habitat is widely recognized as a potential contributing factor to the decline of populations throughout the region. Increased sedimentation and stream flashiness resulting from poorly planned land management and/or excessive development could, for example, alter the ratio of open water to emergent vegetation within watersheds to the detriment of muskrats. Similarly, human activities resulting in the spread of invasive plant species, such as phragmites, can cause a reduction in the abundance and diversity of native taxa, including muskrats, by creating monotypic stands.

Non-Habitat Threats:

Genetics

Loss of Relationship with Other Species

Predation or Herbivory

Description of non-habitat threat(s): Previous studies of contaminant levels in muskrats have shown that muskrats bioaccumulate heavy metals (Halbrook et al. 1993, Stevens et al. 1997). While the direct

Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

effects of such contaminants on muskrats remain uncertain, there is continued concern that the long-term persistence of such contaminents in the environment could limit muskrat populations. While the significance and magnitude of other non-habitat threats are poorly understood, it is speculated that changes in predatory communities, diseases and alterations of natural water cycles all potentially contribute to observed declines in muskrat populations regionally.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	High	Continue closely monitoring the distribution and abundance in Vermont
Research	Threats and Their Significance	High	Determine what factors may be influencing population declines, focusing in particular on pollution and habitat degradation.
Research	Other Research	Medium	Conduct a cause specific mortality study to aid in the identifiction of significant mortality factors in Vermont.
Monitoring	Monitor Threats	Medium	Monitor the accumulation of contaminants such as heavy metals and PCBs in the tissues of muskrats throughout all watersheds in Vermont.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Determine causes of observed declines in regional muskrat populations	Number of hypotheses evaluated	UVM, AFWA	SWG, PR
Policy & Regulations	Medium	Support and cooperate with regional efforts to curb pollution via the development and implementation of appropriate policy and regulations	Reduction in the prevalence of contaminants in Vermont's water bodies	DEC, EPA	
Compliance & Enforcement	High	Enforce existing laws with respect to water quality protection	Increased compliance with existing laws	DEC, EPA	
Compliance & Enforcement	High	Enforce existing laws with respect to riparian and wetland habitat protection	Area and/or linear distance of riparian and wetland habitat protected	DEC, EPA, USACE	
Invasive Species Control & Prevention	Medium	Identify and restore muskrat habitat impaired by invasive plants, and develop and implement measures aimed at preventing further introduction of such species	Acreage of habitat restored and number of preventative measures adopted		

Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

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Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3
Extirpated in VT? no

Global Trend:
State Trend: Fluctuating
Regional SGCN? yes

Assessment Narrative:

Although the southern bog lemming is relatively rare in collections, it is by no means an uncommon animal (Whitaker and Hamilton 1998). A number of historical records are available primarily for southern Vermont (Kirk 1916, Osgood 1938, Godin 1977). When combined with recent records (Brooks et al. 1998, Kilpatrick 2003, Decher and Kilpatrick 2005, Kilpatrick and Benoit 2011) some 268 specimens of the southern bog lemming confirm the occurrence at over 35 different localities throughout the state (see Kilpatrick and Benoit 2011). The species is believed to exist in scattered colonies that often inhabit only a small portion of the suitable habitat. Although little is known about potential threats to this species in Vermont, it is believed southern bog lemmings are vulnerable to changes in habitat, competition with meadow voles and to a variety of disease and parasites.

The southern bog lemming is listed as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states.

Distribution

The southern bog lemming is known from throughout the state with the exception of Grand Isle, Franklin, and Orange Counties

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Historical Records
Champlain Hills	Confident	**Vermont Valley**	Historical Records
Northern Green Mtns	Confident	**Southern Green Mtns**	Historical Records
Northern VT Piedmont	Probable	**Taconic Mtns**	Historical Records
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The southern bog lemming uses a wide variety of habitats in addition to sphagnum bogs, including wet meadows and marshes, grassy openings in woods, and among mossy boulders in spruce forests (Linzey 1983). In Southern Canada, New York and New England most captures are associated with sphagnum bogs or heavily forested areas (Coventry 1942, Goodwin 1932, Hamilton 1941). The southern bog lemming will use clearcuts and other small forest openings with adequate ground cover (Kirkland 1977). Recent small mammal surveys in Vermont (Kilpatrick and Benoit 2011) found southern bog lemming among small rock outcrop in a mesic spruce forest and in a red pine plantation. Doutt et al. (1973) suggested that the major feature common to Synaptomys habitats was that they were marginal for Microtus and Linzey (1981, 1984) documented

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

competitive exclusion of Synaptomys by Microtus in southwestern Virginia. Southern bog lemmings have been collected from hairy-tailed mole burrows (Eadie 1939).

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Climate Change

Description of habitat threat(s): Although little has been documented about the potential habitat related threats to this species, it is believed southern bog lemmings are vulnerable to the degradation of preferred habitats resulting from climate change, forest succession, and/or direct human impacts. Habitat threats are of particular concern with respect to a potentially drying climate and the direct loss of sphagnum bogs.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition from Microtus (meadow vole) in sites where habitat has been altered and/or forest succession has favored this species. Southern bog lemmings carry a heavy ectoparasite parasite load (Wassel et al. 1978) and several endoparasites have been confirmed (Erickson 1938, Whitaker and Adalis 1971).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Determine baseline information
Research	Distribution and Abundance	High	Determine baseline information
Monitoring	Population Change	High	1) Begin low-level monitoring in appropriate habitats to determine distribution, abundance, and population status and trends. 2) Better understand distribution, abundance and changes in population.

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Monitor distribution and abundance of species	Distribution maps	UVM	SWG, PR

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

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Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

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Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
Global Trend:
State Rank: SU
State Trend: Unknown
Extirpated in VT? no
Regional SGCN? No

Assessment Narrative:

Although there are no historical or recent records of the northern bog lemming in Vermont, records are know from surrounding states including a recent specimen from Whiteface Mountain, NY (Sanderson 1988), and three specimens from New Hampshire including two from Coos Co., from Fabyans near the base of Mt Washington (Preble 1899) and Bean's Purchase (Yamasaki 1997) and one from Mt Moosilauke, Grafton Co. (Clough and Albright 1987). Five specimens have been verified from Maine from two localities in Piscataquis Co., one being Mt Katahdin and the other a low elevation site near the western border of Baxter State Park (Clough and Albright 1987). Additional specimens are known from Quebec (Cross 1938, Banfield 1974). The northern bog lemming is among the rarest mammals in New England and eastern Canada and is likely vulnerable to local extirpation (Banfield 1974). The subterranean habits of bog lemmings (Banfield 1974, Godin 1977, Degraff and Yamasaki 2001) likely results in infrequent captures of these rodents by traditional collecting methods. This, combined with the difficulty in identification (Clough and Albright 1987), probably contributes substantially to the rarity of northern bog lemmings in surveys and collections of small mammals. A recent small mammal survey in New Hampshire (Yamaski 1997) employing methods to increase the captures of several rare small mammal species captured a single northern bog lemming at one of the 108 sites surveyed. No northern bog lemmings were captured at the 51 sites recently surveyed in Vermont and none were identified among the southern bog lemming specimens examined (Kilpatrick and Benoit 2011). Despite a lack of evidence of the species in the state, Vermont appears to have viable habitat.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The northern bog lemming has been taken at high elevation sites (3700 - 4500 ft.) in spruce-fir forest with dense herbaceous and mossy understory and in alpine sedge meadows containing sphagnum and surrounded by dense spruce-fir Krummholtz (Clough and Albright 1987). At least two records are known from relatively low elevations (1300 - 1600 ft.) in New Hampshire from habitats ranging from a stand of spruce-budworm

Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

killed spruce-fir forest with a shrub and ground layer consisting of a dense covering of raspberry, ferns, and sedges, and having sphagnum moss in scattered damp places (Clough and Albright 1987) to a wet meadow and mossy streamside (Preble 1898). Habitat requirements included moist loose soils of leaf mold with sphagnum present (Banfield 1974, DeGraff and Yamasaki, 2001). Northern bog lemmings feed on grasses and sedges and use burrows several inches below the ground (Banfield 1974). They are active year round, in summer constructing spherical nest of dried grasses in burrows and in winter nesting on the ground (Banfield 1974).

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Softwood Swamps

Open Peatlands

Current Threats

Habitat Threats:

Conversion of Habitat

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Two hypotheses for the rarity of this species have been proposed by Clough and Albright (1987); northern bog lemmings require a habitat that is scarce and/or the species cannot coexist with other species of small mammals. Neither hypothesis is strongly supported by the available data. However, habitat conversion that results in the elimination of peat lands, sphagnum bogs and moist wooded areas with a solid floor of thick sphagnum could be a problem for the northern bog lemming. Climate change that results in increasing temperatures, could result in dryer habitats that would allow the meadow vole population to increase and thereby compete and displace northern bog lemmings. Development of roads, trails and powerlines could also provide access for meadow vole populations and result in increased competition with the northern bog lemming.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Habitat changes that benefit the meadow vole could result in increased competition that negatively affects the northern bog lemming.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine habitat requirements. Map appropriate habitat.
Research	Distribution and Abundance	High	Conduct a dedicated search for northern bog lemming using species specific methods (pit fall traps and drift fences) in sphagnum-dominated vegetative communities.
Monitoring	Range Shifts	Medium	

Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Conduct targeted surveys for northern bog lemmings.	Distribution map	UVM	SWG
Research	High	Determine habitat requirements	Map appropriate habitats	UVM	SWG

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Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4
Global Trend:
State Rank: SX
State Trend: N/A
Extirpated in VT? Yes
Regional SGCN? No

Assessment Narrative:

Believed to be extirpated in Vermont and the rest of New England. Based on bounty records, wolves were historically common in Vermont but were eliminated from the state by the mid to late 1800's as the result of a $20.00 bounty and habitat changes. There is uncertainty regarding the genetic ancestry of the wolves that inhabited the northeastern United States historically, including Vermont (Wilson et al. 2003, Koblmuller et al. 2009, Kays et al. 2009). Rigorous DNA analysis of additional historic samples from Vermont and the northeastern United States may help clarify this issue.

The wolf is currently considered extirpated in the Northeast but populations exist in southern Canada with potential for migrants to arrive in Vermont within next 20 years. However, the St. Lawrence River and adjacent agricultural/urban/suburban environments in southern Quebec and Ontario may pose substantial barriers. Additionally, dispersal rates for wolves in southern Ontario and Quebec appear to be relatively low and canids are harvested heavily in these regions, which will likely reduce the number of wolves successfully dispersing into New England (Wydeven et al. 1998). The ability of coyote hunters in the northeast to effectively discern wolves from coyotes in the field may also influence the likelihood of natural wolf recolonization. Recovery/reintroduction efforts are complicated by taxonomic uncertainty about the wolf or wolves that historically occupied the region, by public attitudes towards wolves, and by potential interactions with the eastern coyote. Regardless, populations of gray wolves, eastern wolves, and wolves of mixed ancestry in Ontario and Quebec are within plausible dispersal distance of Vermont (Wydeven et al. 1998, Fuller et al. 2003). Thus, it is possible that eastern and/or gray wolves enter Vermont periodically and the potential for natural recolonization of the state exists

Distribution

It is believed that wolves existed throughout Vermont prior to European settlement. This belief is supported by bounty records which clearly indicate the existence of wolves in nearly all biophysical regions of the state.

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Historic Records Only	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Historic Records Only	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Historic Records Only	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Historic Records Only		

Distribution by Watershed:

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Wolves are considered to be habitat generalists and usually select habitat to maximize predation success rather than for specific vegetation characteristics per se (e.g., Mech et al. 2003). Much of the suitable habitat for wolves in Vermont is likely forested, however wolves would be likely to occupy any patches of undeveloped terrestrial habitat that support adequate prey densities and where they are protected from human-caused mortality. Although wolves use a variety of habitat types across their range, they tend to occupy relatively contiguous patches of forests in remote areas with relatively low human and road densities (Mladenoff et al. 1995, Benson et al. 2012). Wolves require an adequate prey base to persist. Deer, moose, and beaver would likely be the main prey for wolves in Vermont Mladenoff and Sickley (1998) and Harrison and Chapin (1998) estimated that approximately 53, 500 to 58, 500 km2 of suitable habitat remains in northern New England. Mladenoff and Sickley (1998) further suggested that this habitat could support 702 to 1439 wolves. Harrison and Chapin (1998) suggested that 2470 km2 and 1430 km2 of suitable "core" and "dispersal" habitat, respectively, existed in Vermont based on road densities, human densities, and available forested habitat. Fuller et al. (2003) recommended that the smallest demographically viable wolf population might include 2-3 adjacent packs of 4 wolves each that were 40-60 km from other wolves. Thus, the 950 km2 of suitable core habitat estimated to exist in Vermont might support approximately 8 packs of 4 wolves at average ungulate densities (8 deer/ km2) with wolf territories of approximately 300 km2 (Fuller et al. 2003). Some of the core habitat identified by Harrison and Chapin (1998) is somewhat isolated in the central and southwestern portions of the state which might limit connectivity between patches. However, there is considerable evidence of wolves crossing highways and areas used intensively by humans in both Europe and North America (Merrill and Mech 2000, reviewed by Boitani 2003) suggesting that wolves might be able to successfully navigate the fragmented New England landscape. Mech (2006) found that Mladenoff and Sickely's predictive model for wolf recolonization in Wisconsin (and potentially for the Northeast) failed to account for the wolf's adaptability and capacity to colonize areas deemed <50% probable, including 22% of colonized areas with low probability. Additionally, Harrison and Chapin (1998) noted that much of the core habitat in Vermont is in the northeastern portion of the state and is contiguous with an expansive area of suitable habitat in New Hampshire, Maine, and Quebec meaning that wolves in Vermont could be connected with a larger regional population should recolonization occur. Territory size and density of wolves are strongly influenced by the availability of prey. Mean territory size is larger (>1000 km2) and smaller (< 200 km2) in areas with lower and greater prey densities, respectively (Mech and Boitani 2003, Fuller et al. 2003). Thus, the estimates for wolf numbers and territory sizes would likely shift depending on the local densities of deer and moose in areas of suitable habitat within Vermont. Regional corridors and habitat linkages are critical to maintaining wolves in potentially fragmented landscapes. Three important elements to wolf population viability are adequate prey, absence of excessive human exploitation, and relatively undeveloped blocks of habitat (Fritts and Carbyn 1995; Fuller 1997; Haight et al. 1998 in Parson 2003).

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Human activity associated with roads, vehicles, and houses seem to negatively influence use of an area by wolves. Conversion of forest and other natural habitat to non-forest (development and agriculture) also negatively affects wolf densities. Wolves cannot survive without adequate prey, adequate protection, and adequate public support (Theberge et al, 1996 in Tumosa 2003). Connectivity with other wolf packs in the region is important to recovery of wolves in the northeast. Potential core habitat in southern Vermont appears to be disconnected from core habitat in northeastern Vermont (Harrison and Chapin 1998).

Non-Habitat Threats:

Genetics

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Competition

Parasites

Harvest or Collection

Loss of Prey Base

Trampling or Direct Impacts

Description of non-habitat threat(s): Competition/hybridization with eastern coyotes may influence the probability of successful wolf recolonization of Vermont. Eastern wolves readily hybridize with eastern coyotes where they come into contact (e.g., Rutledge et al. 2010, Benson et al. 2012, Monzon et al. 2014). Hybridization would likely be rampant in Vermont between recolonizing eastern wolves (which would be at low density) and coyotes (which would be much more abundant). Conversely, gray wolves and admixed gray wolves such as those inhabiting Minnesota, Wisconsin, and Michigan have not been documented to hybridize with coyotes in the wild (e.g., Wheeldon et al. 2010). Thus, dispersing gray wolves from Quebec and Ontario may have a higher probability of avoiding genetic swamping from eastern coyotes and establishing a viable population in Vermont. The eastern coyote is now the dominant large canid predator in the Northeast and it is not clear how the existing coyote population would respond to the establishment of a wolf population. A better understanding of the ecological role of the eastern coyote in Vermont would help clarify the extent to which these smaller canids are able to occupy the ecological niche of wolves.

Thiel (1985) found that when wolves were persecuted by humans in Wisconsin populations did not persist where road densities exceeded approximately 1km/km2. However, with sufficient protection from human-caused mortality wolves have been documented persisting at road densities greater than 1km/km2 as public attitudes about wolves shifted (Mech 1989, Fuller et al. 1992, reviewed in Fuller et al. 2003). Thus, protection from hunting and trapping mortality may facilitate viable wolf populations in fragmented habitat with higher human population and road densities.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	Medium	Document and map the distribution of large wild canids based on DNA analysis.
Research	Population Genetics	High	Determine the genetics of large wild canids in Vermont and monitor wolf colonization events.
Research	Taxonomy	High	Determine the species of wolf historically found in Vermont.
Research	Other Research	High	Determine public attitudes towards wolves in Vermont and New England
Monitoring	Other Monitoring Needs	High	Monitor wolf colonization events

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Determine public attitudes towards wolf recovery possibly by partnering with University researchers to conduct a rigorous evaluation of public opinions.		NWF, Keeping Track, Sportsmen's Federation, University researchers, wildlife educators	USFWS, SWG
Policy & Regulations	Medium	Develop statewide protocol to guide state/federal wildlife management actions in response to wolf immigration. Results of the species restoration strategy may provide information that can be used to reevalute the rank for this strategy in the future.	Degree to which partners adopt the protocols	USFWS, USFS, NWF, VTFSC, Agency of Agriculture, NRCS, Farm Bureau, RPCs, Law Enforcement,	USFWS, SWG
Species Restoration	High	Evaluate VT large canid ancestry via DNA analysis/ morphology to monitor possible recolonization. Obtain tissue samples and morphological measurements from large canids trapped, shot, hit by cars, or otherwise observed in VT.		NWF, Keeping Track, Sportsmen's Federation, VTA,	NWF, USFWS, SWG
Compatible Resource Use	Medium	Develop and distribute outreach and educational materials to help hunters and trappers better distinguish between coyotes for wolves.	Literature, web-videos, public presentations, informational signs, media articles are all necessary for increased public awareness.	USFWs, VFWD, hunting and trapping organizations	VFWD, USFWS

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

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Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

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Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S5 **State Trend:** Stable
Extirpated in VT? No **Regional SGCN?** no

Assessment Narrative:

Gray foxes are widespread throughout Vermont and occupy most major habitat types including forests, shrublands, agricultural areas, and the margins of urban environments. Despite being relatively common, little is known about basic characteristics of the species in the state, including distribution, demographics, diet and space use behavior, and interactions with other species. Similarly, little is known about threats facing the species. Gray foxes elsewhere are negatively impacted by competition from larger carnivores such as red foxes, coyotes, and bobcats, and diseases such as rabies and canine distemper. Gray foxes also appear to be expanding their range northward into Quebec.

Distribution

Gray Fox harvest records indicate a widespread distribution of the species in Vermont with records of occurrence in all biophysical regions.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Few studies have been undertaken on gray foxes regionally in New England and even range-wide, despite their widespread distribution and perception as a common species (Fuller and Cypher 2004). Studies elsewhere indicate that foxes occur in densities that range from 0.4/km2 (California) to 1.5/km2 (Florida), and that foxes occupy home ranges that vary in size from 75 ha (West Virginia) to 653 ha (Alabama) (Fritzell and Haroldson 1982, Fuller and Cypher 2004). In Vermont, a radio-telemetry study indicated that average gray fox home range size was 4.43 km2 in the Champlain Valley (n=5, 2 females/3 males, Ingle 1990). Gray foxes in this study occurred primarily in hardwood forested areas and avoided open habitats. Basic demographic estimates, such as density and population size, and home range/habitat use characteristics have not been adequately quantified in Vermont. Gray foxes elsewhere associate mainly with deciduous forest, but use other forest types, shrublands, agricultural lands, fields, and farmlands, and the margins of urban environments (Fritzell and Haroldson 1982). They typically use successional forests, habitat mosaics and managed woodlands.

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Current Threats

Habitat Threats:

Habitat Alteration

Unknown Habitat Threats

Description of habitat threat(s): Unknown, but distribution and abundance appears to be linked to forest habitats. Changes in forest cover, especially deciduous forest, due to development (e.g., residential housing, roads, urban expansion) may impact the species in Vermont.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition and mortality from coyotes, bobcats, and red foxes represent potential threats. These three species have been shown to compete with gray foxes elsewhere (Chamberlain and Leopold 2005, Farias et al. 2005), and may negatively impact the species in Vermont. Diseases such as rabies and distemper represents another potential concern (Fuller and Cypher 2004).

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S5 **State Trend:** Stable
Extirpated in VT? No **Regional SGCN?** no

Assessment Narrative:

Gray foxes are widespread throughout Vermont and occupy most major habitat types including forests, shrublands, agricultural areas, and the margins of urban environments. Despite being relatively common, little is known about basic characteristics of the species in the state, including distribution, demographics, diet and space use behavior, and interactions with other species. Similarly, little is known about threats facing the species. Gray foxes elsewhere are negatively impacted by competition from larger carnivores such as red foxes, coyotes, and bobcats, and diseases such as rabies and canine distemper. Gray foxes also appear to be expanding their range northward into Quebec.

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Distribution by Biophysical Region:

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Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Few studies have been undertaken on gray foxes regionally in New England and even range-wide, despite their widespread distribution and perception as a common species (Fuller and Cypher 2004). Studies elsewhere indicate that foxes occur in densities that range from 0.4/km2 (California) to 1.5/km2 (Florida), and that foxes occupy home ranges that vary in size from 75 ha (West Virginia) to 653 ha (Alabama) (Fritzell and Haroldson 1982, Fuller and Cypher 2004). In Vermont, a radio-telemetry study indicated that average gray fox home range size was 4.43 km2 in the Champlain Valley (n=5, 2 females/3 males, Ingle 1990). Gray foxes in this study occurred primarily in hardwood forested areas and avoided open habitats. Basic demographic estimates, such as density and population size, and home range/habitat use characteristics have not been adequately quantified in Vermont. Gray foxes elsewhere associate mainly with deciduous forest, but use other forest types, shrublands, agricultural lands, fields, and farmlands, and the margins of urban environments (Fritzell and Haroldson 1982). They typically use successional forests, habitat mosaics and managed woodlands.

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Current Threats

Habitat Threats:

Habitat Alteration

Unknown Habitat Threats

Description of habitat threat(s): Unknown, but distribution and abundance appears to be linked to forest habitats. Changes in forest cover, especially deciduous forest, due to development (e.g., residential housing, roads, urban expansion) may impact the species in Vermont.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition and mortality from coyotes, bobcats, and red foxes represent potential threats. These three species have been shown to compete with gray foxes elsewhere (Chamberlain and Leopold 2005, Farias et al. 2005), and may negatively impact the species in Vermont. Diseases such as rabies and distemper represents another potential concern (Fuller and Cypher 2004).

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Identify important habitats and quantify patterns of habitat selection.
Research	Basic Life History	Medium	Estimate home range characteristics.
Research	Distribution and Abundance	High	Refine distribution and abundance data.
Research	Threats and Their Significance	Medium	1) Examine how habitat alteration impacts distribution and abundance. 2) Determine the effects of zoontic diseases (distemper and rabies). 3) Determine effects of competition with coyotes and other sympatric carnivores such as fisher.
Monitoring	Range Shifts	Medium	Determine possible range shifts and population changes due to climate change.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote less development of high quality habitats.	Amount of high quality habitat protected or conserved	VTrans, Town Planning Commissions, Town and Regional Cons Comms, VLT, Keeping Track	SWG, Vtrans

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

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Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:**
State Rank: S1 **State Trend:** Increasing
Extirpated in VT? Unknown **Regional SGCN?** Yes

Assessment Narrative:

Despite having been previously extirpated from Vermont, recent evidence indicates the presence of two distinct populations of American marten in the state (VFWD unpublished data). Although little is known regarding their full extent and distribution, these populations are likely at risk due to their presumed small size and limited distribution. Relative to most other forest-associated mammals, marten have large spatial requirements, low population densities and specific habitat needs (Buskirk and Ruggerio 1994) making populations particularly vulnerable to factors influencing habitat suitability. Forest management practices that fail to consider marten habitat requirements, for example, may result in a decrease in marten density and productivity over the landscape (Gosse et al. 2005, Payer and Harrison 1999, Johnson et al. 2009, Fuller and Harrison 2005). Furthermore, interspecific relations with sympatric carnivores such as fisher and red fox are widely hypothesized to be limiting factors for marten population recovery and expansion (Krohn et al 2004, Siren 2009). Vermont furbearer harvest data indicate widespread and abundant populations of many competing carnivores throughout the state (VFWD unpublished data). Last, the strong correlation between marten occurrence and the annual accumulation of suitable snow depths makes the persistence of this species in Vermont vulnerable to changes in the climate (Krohn 2012, Kelly 2005, Siren 2009, and Carroll 2007).

Distribution

Although believed to have occurred throughout the state prior to European contact, American marten were extirpated from Vermont in the 1800's due to excessive land clearing and unregulated trapping. Since 2000, a total of 25 marten occurrences have been confirmed in Vermont(VFWD unpublished data). The majority of these were reported from the northeast corner of the state in Essex (13), Caledonia (4) and Orleans (1) counties. The remaining marten were reported from the high elevation towns of the southern Green Mountains in Bennington (4) and Windham (3) counties. Additionally, remote camera surveys conducted in 2012 documented the occurrence of two individual marten in the town of Sunderland (Bennington County).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

In general, American marten are associated with forested habitats that provide overhead cover and complex physical structure near the forest floor (Payer and Harrison 2003, Andruskiw 2008, Godbout and Ouellet 2010). Although these forest characteristics are most closely associated with older seral stages, the use of younger, managed forests by marten has also been well documented where previous harvesting practices have favored the retention of course woody debris, and have maintained residual basal areas greater than 18m2/ha and at least a 30% canopy closure in winter (Thompson et al 2012, Payer and Harrison 2003, Fuller and Harrison 2005). In the northeast, suitable marten habitat is provided by a wide range of forest types including mixed coniferous-deciduous forests and forests dominated by deciduous trees (Kelly 2005, Payer and Harrison 1999). Marten avoid open areas such as those occurring naturally on the landscape (e.g. wetland meadows and stands recently disturbed by fire, Gosse et al. 2005) and those resulting from human activities (e.g. clearcutting and infrastructure development; Payer and Harrison 1999, Siren 2009). Jensen et al (2012) documented a significant demographic response of the marten population to fluctuations in annual mast crop production indicating the importance of mast producing trees as a component of suitable marten habitat. Several studies have documented a close association of annual snow fall rates and occupied marten habitat suggesting a strong preference for deep snow where certain morphological adaptions may give marten competitive advantages over sympatric carnivores (Krohn 2004, Kelly 2005, Carroll 2007).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Because American marten life history is strongly influenced by adult survival (Buskirk et al. 2012), the recovery and growth of Vermont's marten populations will require favorable environmental conditions over long periods of time. Thus, habitat stochasticity resulting from anticipated changes in the climate (Carroll 2007, Krohn 2012, Kelly 2005), the broadscale implementation of forest management practices that do not adequately account for marten habitat requirments (Thompson et al. 2012, Fuller and Harrison 2005, Payer and Harrison 2003), and further fragmentation of the lanscape (Siren 2009) jeopardizes the persistence of marten in the state.

Non-Habitat Threats:

Harvest or Collection

Competition

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Disease

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Competition with, and predation by, sympatric carnivores such as fisher and red fox could negatively influence the distribution and persistence of marten in Vermont (Krohn et al 1995, Kelly 2005, Siren 2009). The effects of climate change will likely exacerbate the adverse impact of interspecific completion on marten as carnivore communities shift northward into marten range and the species' competitive advantages are diminished as a result of lower snowfall accumulations (Carroll 2007, Krohn et al. 2005). Although the incidental take of marten in fisher traps has been documented in Vermont (VFWD unpublished data), it is not currently known to be a limiting factor of the marten population. In fact, the continued harvest and management of competing carnivores could prove to be an overall benefit to marten despite this infrequent take. Although difficult to assess, the impacts of unregulated take and interspecific competition need to be considered where the maintenance of marten populations is a priority.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Perform a habitat suitability analysis of Vermont in order to identify key marten habitats, to help predict distribution of the speices in the state and to facilitate the developemnt of appropriate conservation actions.
Research	Distribution and Abundance	High	Collect baseline data on marten distribution and abundance in Vermont in order to assess the status of the population and develop appropriate conservation strategies.
Research	Threats and Their Significance	Medium	Examine the affects of interspecific competion with fisher and assess how certain habitat features, fisher harvests and snow depths influence this relationship.
Research	Population Genetics	High	Conduct a genetic analysis of marten in Vermont in order to determine the source of the species in the state, particularly of the southern population.
Research	Other Research	High	Assess the effectiveness and practicality of various trap configurations and trapping techniques for minimizing the incidental take of marten.
Monitoring	Population Change	Medium	Develop and implement a plan for monitoring the marten population in Vermont.
Monitoring	Habitat Change	Medium	Develop and implement a plan for monitoring changes in suitable marten habitat resulting from habitat conversions, forest management practices and climate change.
Monitoring	Range Shifts	Low	Monitor range shifts of competing carnivore populations resulting from climate change.

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	Medium	Support and cooperate with larger efforts to curb global climate change.			
Compatible Resource Use	High	Promote forest management practices that provide for the life history requirements of marten	Number of acres of forest land positively influenced	Coverts, UVA, USFS, Industrial forest landowners, VFPR, VLT landowners, Forest Legacy landowners	
Standards	Medium	Develop best management practices for forest management within key marten habitats	The successful development and subsequent dissemination of best management practices	UVM, VFPR	SWG
Standards	High	Develop best management practices for fisher trapping in order to minimize incidental take of marten	Number of trappers employing best management practices and the number of marten taken	Vermont Trappers Association, AFWA, NHFG, MDIFW, NY DEC	Vermont Trappers Association, AFWA, SWG
Compatible Resource Use	High	Continue managing competing carnivores within key marten habitats, particularly fisher, via regulated trapping	Maintenance of healthy furbearer populations	Vermont Trappers Association	
Standards	Medium	Develop and implement guidelines and mitigation strategies for minimizing impacts to key marten habitats from regulated land use activities such as the development of energy infrastructure	Number of acres protected from conversion		

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

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Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S3S4 **State Trend:** unknown
Extirpated in VT? no **Regional SGCN?** no

Assessment Narrative:

The distribution and abundance of long-tailed weasels in Vermont are poorly understood and no records of their occurrence were collected during a statewide small mammal survey between 2008 and 2010 (Kilpatrick and Benoit, 2011). Although the extent to which these factors influence the population is poorly understood, the species is vulnerable to current pest control practices and could be potentially impacted by the application of pesticides.

Distribution

Only 22 verified records of the long-tailed weasel are available for Vermont but these confirm a wide spread distibution of this species in Orleans, Essex, Chittenden, Caledonia, Addison, Rutland, Windsor and Bennington counties. No additional records of their occurrence were collected during a state wide small mammal survey between 2008 and 2010 (Kilpatrrick and Benoit, 2011)

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Probable	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The long-tailed weasel inhabits the broadest range of any of the weasels from low elevations to above treeline across the continent (Novak et al, 1987). They occupy a variety of habitats from forest and shrubs adjacent to stone walls to fields, wetlands and standing water. Where it overlaps with the short-tailed weasel, it may occupy more open habitats while the short-tailed weasel is more common in forested or wetland areas. Areas with high prey density are important. The long-tailed weasel feeds on small mammals such as mice, rabbits, voles and ground nesting birds. Water seems to be a critical factor. Hamilton (1933) reported that they can drink 25cc of water per day and therefore, it may be restricted to habitats in close proximity to standing water. The long-tailed weasel is more of a food generalist than the short-tailed weasel. On average, long-tailed weasels will take 1.5 voles per day (Powell 1973 in Wild Furbearer Mgt 1987). The weasel uses excavated burrows or holes and/or crevices for den sites (DeGraff and Yamasaki, 2001).

Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Marshes and Sedge Meadows

Wet Shores

Early Succession Boreal Hardwoods

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): Although the full extent and nature of impacts are poorly understood, it is suspected that the conversion of habitat via natural succession or anthropogenic degradation could negatively affect weasel populations.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): Predation on long-tailed weasels by domestic pets, foxes and raptors could be a factor limiting the distribution and abundance of this species. Similarly, when existing in close proximity to humans, exposure to pest control practices and potential for road kill may be a problem. Weasels could be affected directly and/or indirectly by pesticide use.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	High	Determine abundance, distribution, and status of the Vermont population.
Research	Threats and Their Significance	Medium	Examine how current pest control practices, including the use of pesticides, influence long-tailed weasel populations.
Research	Other Research	Low	Examine how predation, particularly by domestic pets, influecnes long-tailed weasel populations.
Monitoring	Population Change	Medium	Develop and implement a plan for monitoring the long-tailed weasel population in Vermont.
Monitoring	Habitat Change	Medium	Examine how forest succession and anthropogenic changes of the landscape influence long-tailed weasel populations.

Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Develop outreach materials informing the public of the importance of keeping domestic pets under control	Development and dissemination of outreach materials		
Standards	Medium	Develop Best Management Practices for pest control professionals and landowners to follow for minimizing damage by and lethal control of long-tailed weasels	Development and dissemination of BMPs	NWCOs, Pest Control Professionals	SWG

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Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
Global Trend:
State Rank: S5
State Trend: stable
Extirpated in VT? no
Regional SGCN? no

Assessment Narrative:

The Northern River Otter's pisciviorous diet and high trophic position make it a noteworthy indicator of pollution in aquatic systems (Melquist and Dronkert 1987). Of 20 otter tested for mercury in Vermont in 2001, for example, two had levels higher than that recommended by the EPA (K. Royar, pers. Com). Prey may also be susceptible to pollution and acid rain. Because of their strict aquatic nature, otter populations are susceptible to changes in riverine and lacustrine habitats which alter the physical character of these habitats and/or impact the prey upon which they depend.

Distribution

Otter are annually harvested in every watershed in Vermont during a regulated trapping season.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

Middle Connecticut
West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut

Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

White
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Otter are adaptable to many different wetland habitats including beaver created wetlands, lakes, streams and ponds. Intact vegetation along the perimeter of streams, lakes and wetlands is an important habitat feature of otter habitat. Beaver bank dens and lodges are also used by otter. Beaver created wetlands provide critical foraging and denning habitat. Log jams resulting from fallen trees also provide shelter and foraging habitat. Otter also require healthy aquatic systems that provide an adequate prey base.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Forested riparian buffers are key components of otter habitat. Loss and/or degradation could influence otter habitat selection and productivity. Historically, otter were limited by human encroachment, habitat destruction, and unregulated harvest. In Vermont, the extirpation of beaver, loss of habitat, and pollution resulted in a much reduced population throughout the 1800's and early 1900's. Otter populations have rebounded with the return of the beaver. Although not strongly supported in recent literature, it is expected that increasing development pressure and pollutants such as mercury could negatively affect future population levels. Despite this potential vulnerability, contemporary harvest records in Vermont indicate a well distributed, abundant population of otter in recent decades. Furthermore, should Vermont's otter population begin experiencing the effects of development, pollution and/or climate stressors, the mechanisms for detecting and addressing such population trends are currently in place.

Non-Habitat Threats:

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Although the effects of pollutants are not believed to be a limiting factor for the otter population in Vermont, contaminants such as PCB's, mercury, and other heavy metals are known to accumulate in the tissue of otter and negatively affect reproduction and survival.

Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	Medium	Monitor distribution and abundance
Research	Threats and Their Significance	High	Determine the impact of heavy metals and contaminants on otter populations in each watershed.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Privately-Owned Protected Areas		Maintain riparian buffer strips along streams, rivers, lakes, ponds, and wetland habitats.	Number of linear miles of vegetated riparian buffers	Trout Unlimited, NRCS, USFWS, NWTF, DEC, Vt. F&P	SWG, USFWS, NRCS, FSA, CREP
Species Restoration		Provide a suitable prey base.		Trout unlimited, DEC	TU, DEC, USFWS, SWG
Policy & Regulations		Eliminate acid rain and the input of mercury into otter habitat.	Decrease acid, mercury, and heavy metal deposition into Vermont lakes, rivers, and streams	DEC, EPA,	DEC, EPA
Compliance & Enforcement		Enforce the Clean Water Act	Increase the number of bodies of water that meet class A designation	Trout Unlimited, NRCS, USFWS, USFS, Wild Turkey Federation, DEC, Vt. Forests & Parks	EQIP, SWG, EPA, NWTF

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Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
Global Trend:
State Rank: S1
State Trend: Fluctuating
Extirpated in VT? yes
Regional SGCN? no

Assessment Narrative:

Recovery of lynx in Vermont may be limited by global climate change (Carroll 2007, Hoving et al. 2005). Although the influence of competition from coyote, fisher, and bobcat, which could also be exacerbated by global climate change (Peers et al. 2013), may not be clearly understood (Ray et.al. 2002), there is some indication that lynx populations existing at the margins of their range may be limited by these sympatric carnivores (Peers et al. 2013, Vashon et al. 2012). Harvest records for fisher, bobcat and coyote in northeast Vermont (VFWD unpublished data) and track surveys conducted within Vermont's two largest blocks of unfragmented suitable lynx habitat (Farrell 2012) indicate well-established populations of these competing carnivores. Suitable lynx habitat in Vermont is limited and occurs in relatively small patches distributed over the northeastern portions of the state. As a result of this habitat condition, the effects of fragmentation could result in the isolation of Vermont's lynx population from populations to the north further jeopardizing its ability to persist in the state (Koehler et al. 2008, Murray et al. 2008). Also, because Canada lynx exhibit strong selection for habitats where snowshoe hares are abundant (Fuller et al. 2007, Vashon et al. 2008, Squires et al. 2010), the suitability of Vermont's currently occupied lynx habitat could change markedly with future changes in landscape-level hare densities and changing habitat associated with forest management; thus, successful conservation of lynx populations in Vermont will require the protection and management of large tracts of snowshoe hare habitat (Simons-Legaard et al. 2013, Murray et al. 2008).

Distribution

Historical records of Canada lynx in Vermont are scarce. Prior to this century, lynx were documented in the state on only four occasions (Windham 1928, St. Albans 1968, Calais 1797 and Addison County 1937: Vermont archived bounty records). Since 2003, nine lynx sightings have been confirmed in Vermont. Eight of the sightings were recorded in Essex County and one in Orleans County (unpublished data, VFWD). Since 2012, Intensive snow track and remote camera surveys have successfully detected lynx in the Nulhegan Basin (Bernier 2011 & 2013). Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Bernier 2011).

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☐

Along the southern periphery of their range, lynx prefer a variety of habitat types including mid-successional coniferous forests and edge habitat with moderate to abundant understory cover (Koehler et al. 2008, Maletzke et al. 2008, Vashon et al. 2008b). Lynx tend to avoid open areas and mature forests having little horizontal cover (Vashon et al. 2008b). Lynx select for stands where snowshoe hare are abundant (2.4 hares/ha, Vashon et al. 2008) such as areas of dense softwood in association with 11 - 21 year old regenerating clear-cuts or similarly aged partially harvested stands (Fuller et al. 2007, Simons-Legaard 2013). Organ et al. (2008) identified the "tip up mounds" of blown down trees as features commonly used as natal dens and further found that the presence of within stand structure capable of providing visual obscurity at 5 meters from the den was a significant predictor of den site selection by lynx. Hoving (2005) determined that lynx populations in this region are unlikely to occur in areas of low annual snowfall (<270cm) or areas dominated by deciduous forests.

Habitat Types:

Spruce Fir Northern Hardwood

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Changes in the climate that result in the reduction of annual snowfall could greatly influence the distribution of lynx in the northeast (Hoving 2005). Decreased snowfall can affect lynx through decreased prey vulnerability and decreased competitive advantage over sympatric carnivores (Carroll 2007). Furthermore, although there is evidence that the degree of diet specialization of lynx in the southern parts of their range is less than in their northern counterparts, the long-term persistence of lynx in Vermont could be limited by the availability of suitable snowshoe hare densities (Roth et al. 2007, Simons-Legaard et al. 2013). Thus, the loss of suitable hare habitat from both natural (i.e. forest succession) and human caused disturbances (i.e. forest management favoring deciduous forest composition) could adversely affect lynx in Vermont. In addition, because the viability of lynx populations in the southern part of their range is suspect in the absence of ingress from northern populations (Murray et al. 2008), the maintenance of landscape connectivity with these northern areas of occupancy is of critical importance. Although Farrell (2012) concluded that lynx connectivity across the northeast is expected to remain stable in the coming decades, the long-term persistence of lynx in Vermont remains dependent upon interstate and international commitments to maintaining these connective habitats (Murray et al. 2007).

Non-Habitat Threats:

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Loss of Metapopulation Structure

Competition

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Peers et al. (2013) determined that lynx are subjected to niche displacement in areas of overlap with bobcat. In Vermont, bobcat harvest data (VFWD unpublished data) and the results of extensive snow track surveys conducted since 2012 (Bernier 2012 & 2013) indicate a well-established, sympatric bobcat population. Furthermore, the effects of climate change could increase the competitive pressure on lynx by altering the distribution and abundance of competing carnivores populations and by decreasing their competitive advantages over these sympatric species (Carroll 2007). In addition, the primary source of mortality of lynx in Maine was predation, especially by fisher, accounting for nearly 42% of lynx deaths (Vashon et al. 2012). Similar to bobcats, harvest data and track survey results also indicate an abundance of fisher within Vermont's most suitable lynx habitats.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	High	Collect baseline data on lynx distribution and abundance in Vermont in order to assess the status of the population and develop appropriate conservation strategies.
Research	Threats and Their Significance	High	Examine the affects of competition with sympatric carnivores and assess how certain habitat features such as snow depth, managing furbearer populations, and a changing climate may influence this relationship.
Monitoring	Population Change	High	Continue monitoring for the presence of the species in the state.
Monitoring	Habitat Change	Medium	Develop and implement a plan for monitoring changes in suitable lynx habitat resulting from habitat conversions, forest management practices and climate change.
Monitoring	Range Shifts	Low	Monitor range shifts of competing carnivore populations resulting from climate change.
Monitoring	Monitor Threats	Medium	Identify and monitor impacts to key connective corridors serving to link Vermont's lynx population with core populations to the north.

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote forest management practices that provide for the life history requirements of lynx	# of acres of snowshoe hare habitat available within potential lynx range	Vt. Forest and Parks Dept, Industrial forest landowners, Coverts	EQIP, SWG, USFWS
Compatible Resource Use	High	Maintain connectivity of habitat between Maine, New Hampshire, Quebec and Vermont.	# of acres of corridor habitat conserved	TNC, VLT, NHF&G, Conservation Fund, NWF, Keeping Track, Coverts	TNC, VLT, Conservation Fund, USFWS, Forest Legacy
Compatible Resource Use	High	Continue managing competing carnivores within key lynx habitats, particularly fisher, via regulated trapping	Maintenance of healthy furbearer populations	Vermont Trappers Association	
Policy & Regulations	Medium	Support and cooperate with larger efforts to curb global climate change.			

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

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Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S4 **State Trend:** Unknown
Extirpated in VT? no **Regional SGCN?** Yes

Assessment Narrative:

The bobcat is apparently common and well distributed throughout Vermont although higher densities appear to exist in the Champlain Valley and the Taconics possibly due to higher prey densities. Bobcats have declined since the middle of the 20th century due to land use changes affecting prey densities and to increasing competition from other carnivores such as fisher and coyote. Statewide population estimates are unknown, but carrying capacity has been estimated.

The bobcat uses a variety of habitats and the relative suitability of habitats in the Vermont landscape have been quantified (see below). Bobcat occurrence appears to be positively related to the amount of mixed forest and forested wetland habitats. Critical habitats, such as those used for denning remain largely unquantified.

Landscape change represents a primary threat to bobcats, especially as they appear to depend on connected expanses of undeveloped habitat. Conversion of natural habitat to housing and other forms of development will most likely affect the distribution and abundance of the species in Vermont. Similarly, the impacts of climate change, particularly with respect to changes in prey and sympatric carnivore distribution and abundance, may present significant challenges to bobcats through the future.

Distribution

Bobcats occupy home ranges that include a variety of habitats. Average home range size for bobcats based on a study in the Champlain Valley was 57.3 km2 (Donovan et al. 2011) Male home ranges (n=10) averaged 70.9 km2 while female home ranges (n=4) averaged 22.9 km2. Based on patterns of use in home ranges, bobcats respond positively to shrub, deciduous forest, coniferous forest, and wetland cover types within 1 km of a location and negatively to roads and mixed forest cover within 1 km of a location. Similar results have been found in New Hampshire with bobcats preferring areas with few roads, limited human development, high stream densities, and steep topography (Broman et al. 2014). Another study conducted repeated surveys throughout Vermont and concluded that bobcat probability of occupancy was positively related to the percentage of both mixed forest and forested wetland habitat within 1 km of survey sites (Long et al. 2011). In Vermont, steep, rocky cliffs may be important as winter refuges and breeding habitat.

The size of the bobcat population is uncertain in Vermont. Donovan et al. (2012) estimated the maximum carrying capacity of females in northwestern Vermont (WMU 1, 1,153 km2) as 42. Using a similar approach, carrying capacity across Vermont has been estimated as 1,150 (835 females, 316 males) (J. Murdoch, pers. comm.).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Bobcats occupy home ranges that include a variety of habitats. Average home range size for bobcats based on a study in the Champlain Valley was 57.3 km2 (Donovan et al. 2011) Male home ranges (n=10) averaged 70.9 km2 while female home ranges (n=4) averaged 22.9 km2. Based on patterns of use in home ranges, bobcats respond positively to shrub, deciduous forest, coniferous forest, and wetland cover types within 1 km of a location and negatively to roads and mixed forest cover within 1 km of a location. Similar results have been found in New Hampshire with bobcats preferring areas with few roads, limited human development, high stream densities, and steep topography (Broman et al. 2014). Another study conducted repeated surveys throughout Vermont and concluded that bobcat probability of occupancy was positively related to the percentage of both mixed forest and forested wetland habitat within 1 km of survey sites (Long et al. 2011). In Vermont, steep, rocky cliffs may be important as winter refuges and breeding habitat.

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Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Bobcats distribution appears to relate mainly to forest cover and forest wetland habitat, both of which positively influence probability of occurrence in the landscape. Changes to these two habitats and others that offer important resources like rocky ledges for denning represent a primary threat to the species. Conversion of habitats due to development like residential housing and roads or even climate change will most likely affect bobcat distribution and abundance (Bettigole et al. 2014).

Non-Habitat Threats:

Competition

Loss of Prey Base

Description of non-habitat threat(s): Bobcat numbers have declined since coyotes became established in Vermont. The specific impacts of coyotes and other carnivores such as fisher remain largely unstudied in the Northern Forest. Prey species have also declined in some areas due to loss of early successional habitat and have presumably impacted bobcat numbers.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Identify and quantify critical habitats for reproduction, such as rocky, ledge areas.
Research	Distribution and Abundance	High	Determine the location of source and sink populations and identify the habitat parameters associcated with these populations.
Research	Threats and Their Significance	Medium	1) Examine how habitat loss, conversion, and fragmentation impacts distribution and abundance. 2) Determine competition effects with coyotes and other sympatric carnivores such as fisher.
Monitoring	Range Shifts	Medium	Assess possible range shifts and population changes due to climate change.

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote less development of high quality habitats.	Amount of high quality habitat protected or conserved	VTrans, Town Planning Commissions, VLT, Regional and Town Cons Comms, Keeping Track	SWG, AOT
Species Restoration	Medium	Provide important prey base	Number of acres of rabbit and hare habitat protected	Coverts, USFS, VWA, Northern, USFS, VFPR, Ruffed Grouse Society	USFWS, Ruffed Grouse Society, EQIP
Species Restoration	Medium	Identify necessary habitats and develop actions for protection	Number of necessary habitats mapped and protected	Coverts, USFS, VWA, VLT, UVM	UVM, VLT, USFS, USFWS

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Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: SH **State Trend:** N/A
Extirpated in VT? yes **Regional SGCN?** No

Assessment Narrative:

The Mountain Lion, also known as Puma, Cougar and Catamount is listed as endangered in Vermont. It is believed to be extirpated in the East (except in southern Florida). The USFWS declared the Eastern cougar (Puma concolor couguar) extinct in 2011 though it remains federally endangered pending delisting. Anecdotal reports of field sightings are fairly frequent; however, both field and incidental evidence is absent. Even in lowest densities, Mountain Lions are hit, shot, snared, wander into towns and cities, and are photographed on cell phones, point & shoot cameras, and random remote wildlife cams. A Black Hills, SD male left field and incidental evidence in four states across 1500 miles before being hit by a car in Milford, CT, June 2011. All North American Mountain Lions are one subspecies genetically, though the taxonomy remains disputed (Culver et al. 2000); which suggests that conservation efforts should be focused on the entire puma Genus. Confirmations of Mountain Lions with both North and South American DNA (former captives or descendants) have been documented in Ontario (Rosatte, 2011), Quebec and New Brunswick (Lang, et al. 2013), There is no evidence of breeding in eastern Canada. The closest breeding colonies to Vermont remain southwest Florida, the Dakotas and Nebraska. Recent research show mountain lions are keystone species for ecosystem functioning (Ripple et al. 2014).

Distribution

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Historic Records Only	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Historic Records Only	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Historic Records Only	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Historic Records Only		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Mountain Lions are no longer understood to be wilderness obligates, with the widest range across more habitats, including urban landscapes, of any terrestrial mammal in the western hemisphere. Beier (1993), using simulated population dynamics, estimated that an area of 1,000 to 2,200 square kilometers (372 to 818 square miles, depending on the demographics of a particular population) was needed for a population of 15-20 adult cougars to have a very low risk (<98%) of extinction within 100 years. Area of 600 - 1600 km 2, and smaller (Beier. 1993), might suffice where adequate dispersal corridors allow movement among populations. Smallest documented home range is 39 km2 (Laundre and Loxterman 2006). Mountain Lions are breeding in suburban-

Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

exurban-wildland matrix habitat throughout the western US, and have recovered range east to the Dakotas/Nebraska without assistance. Space-use patterns differ little between wildland and residential environments (Kertson et al, 2011), though reproductive behaviors (communication/denning) require greater buffers from development than non-reproductive behaviors (movement/feeding) within the suburban/exurban/wildland matrix (Wilmers et al, 2013) Specific dispersal barriers include roads and nighttime illumination (Beier 1993, 1995); identifying and protecting wildlife corridors can mitigate dispersal mortalities. Male dispersal and settlement patterns based on mating opportunities; fenale patterns based on avoiding other Mountain Lions (Stoner et al. 2013). Mountain Lions are the epitome of a generalist predator (Knopf and Boyce 2014), though they favor and are adapted for medium-sized ungulates. Deer/ Elk wintering habitat is seasonally favored. (Lindzey 1987).

Adirondack Park, an area roughly comparable to the state of Vermont, could support as many as 350 Mountain Lions (Laundre, 2013). Glick (2014) found that the Northeast region east of the Hudson River could support from 322 - 2,535 Mountain Lions.

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

Description of habitat threat(s): Where they still exist, Mountain Lions can be found in a multitude of habitas, ranging from closed forest to semi-open shrublands. Human development/disturbance appears to affect little the use of areas by Mountain Lions as they are found in suburban to exurban environments. Human intolerance to their presence in these areas is the main negative impact on their survival. Prey availability and habitat characteristics can affect Mountain Lion distribution and survival. Loss of habitat connectivity between source populations limits dispersal, range expansion, and genetic variability (Ernest et al. 2003).

Non-Habitat Threats:

Harvest or Collection

Trampling or Direct Impacts

Loss of Prey Base

Description of non-habitat threat(s): Negative human attitudes among certain demographics towards Mountain Lions in regards to human safety and perceived impacts on deer populations can impact successful establishment/ maintenance of Mountain Lion populations in the East Florida public attitude surveys found broad public support for Mountain Lion recovery, including residents of a proposed relocation region and among sportsmen (Duda and Young. 1995; Cramer. 1995). However, a successful test-release of Texas Mountain Lions to southern Georgia/north Florida concluded that resistance from just a handful of inviduals can impede recovery efforts (Belden and McCown. 1996). Pending federal delisting could jeopardize any potential for recolonization if eastern state protections are not established, maintained and enforced,

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Monitoring	Population Change	Medium	Continue current low-level monitoring and incidental Mountain Lion evidence documentation (track, scat, kills, photographs, etc.). Consider active pheromone station monitoring (e.g Lang et al. 2013) to detect VT presence. Collect genetic material for testing.

Species Strategies

Strategy Type	*Strategy Priority*	*Strategy Description*	*Performance Measure*	*Potential Partners*	*Potential Funding Sources*
Policy & Regulations	High	Pending federal delisting, maintain and enforce state protections of entire puma Genus.			
Research	Medium	Identify areas within state that could support viable Mountain Lion populations (Glick 2014) and develop a state recovery plan.			
Awareness Raising and Communications	High	Determine public attitudes towards Mountain Lion recovery efforts in VT (e.g. McGovern and Kretser 2014); Provide interpretive and public education material about Mountain Lions.			

Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

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Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

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Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S5 **State Trend:** Declining
Extirpated in VT? yes **Regional SGCN?** no

Assessment Narrative:

Moose were extirpated from Vermont by the early 19th century due to forest clearing and no legal protection. Following regrowth of the forest, restoration of beavers, and nearly a century of protection, moose immigrated from New Hampshire in the 1970's and their numbers and distribution in Vermont grew rapidly in the 1980's and 90's. By the time the former WAP was written in 2005, moose numbered over 5,000 animals and were reproducing throughout the state. Moose were recognized in the 2005 WAP as a "special category" species, along with beaver and white-tailed deer, due to their socioeconomic value and potential of having a significant ecological effect on the landscape. SWG funds were not intended to be directed at these three species at that time.

Currently, the statewide moose population is about half of what it was in 2005. Most of this reduction was by design in order to bring numbers in northeastern Vermont down below ecological carrying capacity and allow for adequate regeneration of trees in managed stands. The current population estimate of 2500 moose is below the minimum target of 3,000 as called for in Vermont's 10-year Big Game Management Plan--the state's guide for moose management. Moose health and nutrition as reflected by body weight and ovulation rate has declined, and warmer weather from spring through autumn has likely contributed to higher incidence of parasites, most notably the winter tick and brainworm, and abnormally high levels of heat stress.

Distribution

Highest densities in the Northeastern Highlands and Northern Vermont Piedmont.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Hardwood Swamps

Softwood Swamps

Marshes and Sedge Meadows

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Fragmentation from ski area and recreational trail expansions; ridgetop windfarms. Heat stress from warming climate.

Non-Habitat Threats:

Parasites

Description of non-habitat threat(s): Increased levels of parasites, most notably Dermacentor albipictus and Paralaphostrongylus tenuis.

Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Health condition and effects from parasites and disease.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	Medium	Keep moose densities below 0.75/sq km and deer densities below 10/2.6sq km in order to reduce winter tick and brainworm infection rates.	Reduced levels of winter tick infestation. Reduced incidence of brainworm cases.	USFWS	PR
Habitat Restoration	Medium	Increase amounts of early successional habitat, especially in the Central and Southern Green Mountains.	Improved Moose body weights and ovulation rates	USFWS	SWG, PR

Bibliography

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