Chapter 6

Conservation Priorities, Action Plans, and Conservation Strategies for North American Rodents

Eric Yensen, David J. Hafner, and Joseph A. Cook

Conservation measures such as those recommended in this Action Plan will always be limited by logistic and economic considerations. Therefore, it is necessary to establish priorities for those rodent taxa and habitats in greatest need of project funding and implementation. As noted by Mace *et al.* (1992:19), priority for conservation action does not depend solely upon the category of threat, but includes "numerous other factors, such as the likelihood that restorative action will be successful; political, economic, and logistical considerations; and perhaps the taxonomic distinctiveness of the taxon in question."

Today, conservation efforts are shifting away from saving single species on a crisis basis and toward protection of habitats and ecosystems. The hope is that saving habitats will frequently protect the species contained therein, including more cryptic species whose threatened status has not yet been revealed. However, conservation agencies will still need to assimilate recommendations from diverse taxon-directed groups such as the IUCN Specialist Groups. Thus, we offer here our suggestions regarding important habitats for conservation action, rodent species deserving conservation priority, and some thoughts on appropriate strategies for rodent conservation.

In order to better focus on those taxa truly in need of conservation efforts, we have examined all taxa currently listed by state, provincial, federal, or private agencies as threatened, and recommend that a number of these be excluded from such listing. We understand that we may not have had full access to all information regarding the status of these taxa, and that some may in fact require conservation measures. For those taxa, we hope that the critical information will be made available for future action plans.

Patterns of vulnerability

Nature of threats

The most pervasive threat to North American rodents of global conservation concern is conversion of critical habitat. Habitat conversion has been effected through agricultural development, urban expansion, grazing, fire suppression, logging of old-growth forest, and recreational activities. Of the 86 species included in this Action Plan, nearly one-half (35) are threatened by conversion of their preferred habitat; 15 of those are threatened at the specific or generic level. Of 12 species and 63 subspecies listed as Conservation Dependent or at higher levels of threat, fully 10 species and 39 subspecies have suffered from habitat conversion. Agricultural conversion of natural habitats has spread for centuries in an east-to-west wave that has fragmented tracts of continuous habitat and reduced or eliminated pockets of others. Elimination of habitat for urban or industrial development has been a more recent phenomenon of this century. In many cases, agricultural conversion preceded urban or industrial development. Specific effects of agricultural conversion on endemic rodents are variable, but would include radical changes in food availability, food types, and dietary diversity; mechanical disruption of burrow systems; flooding of burrows by irrigation; toxic effects of pesticides; intentional poisoning and trapping of rodents; and predation by domestic and feral dogs and cats associated with urban areas.

Introduced exotic species pose a more insidious threat to native rodent species, resulting in habitat conversion, increased predation, and direct competition. Although the adverse effects of introduced exotic species on oceanic islands have long been appreciated, it is now apparent that invasive species are affecting the structure of ecosystems and native biological diversity on continents as well (Vitousek *et al.* 1996). These exotics are widespread, ranging from escaped cultivated plant species and feral domesticated animals (particularly domestic cats) to accidentally introduced insects that serve as vectors of disease or are direct pest species. Probably no region in the North American continent is unaffected by introduced species, but they are particularly prevalent in certain areas. Of the estimated 2,000 species of invasive non-native plants that now occur in the continental United States (United States Congress, Office of Technology Assessment 1993), California and Florida each have nearly 1,000 of these introduced exotics; five of the six most threatened biotic communities included in our Priority 1 are in California and Florida. Vitousek *et al.* (1996) note that the eastern deciduous forests have recovered

substantially from extensive clearing that occurred during the 1800s, but have suffered this century from repeated invasion of non-native species (particularly insect pests and pathogens). Moreover, they predict that invasive species "will continue to be the greatest threat to the diversity of these forests in the foreseeable future."

Direct extermination by humans has been implicated in dramatic declines in several species. Broadcast of poisoned grain resulted in widespread extirpation of two species of prairie dogs and a ground squirrel. The fur trade may have been responsible for decline in one subspecies of beaver.

For 77 taxa (nearly one-half of the total included in this Action Plan), the nature of threat, if any, is unknown. These taxa are considered to be of conservation concern based on evidence of declining populations or highly restricted or declining distributions. Clearly, conservation actions depend on the prompt identification of the nature and extent of threat to these populations.

Geographic patterns

Threatened rodents are not randomly or evenly distributed across North America, but instead are concentrated in areas of high biological diversity that are subject to intense habitat alteration. Eight geographic regions contain 50% (84 of 168) of the threatened taxa included in this Action Plan. These areas are: 1) the San Joaquin Valley, California (a restricted regional desert that has been largely converted to agriculture); 2) coastal and barrier-island habitat of Florida (largely converted for urban development); 3) Pacific Coast Douglas Fir and Redwood forests along the coast from northern California to southern British Columbia (which have suffered from urban expansion, logging, agricultural development, and introduction of exotic species); 4) Coastal Chaparral communities of southern California (subjected to agricultural and urban development, as well as introduction of exotic species); 5) the Mojave Desert of southern California (severely impacted along its western margin by agricultural and urban development); 6) the Columbia Basin of Washington and Oregon (a restricted desert-grassland that has been subjected to agricultural conversion); 7) deciduous and remnant boreal forests of the Appalachian Mountains (a formerly widespread and continuous forest system that has been severely reduced and dissected through deforestation, agricultural development, and urban expansion); and 8) the Transverse Ranges bordering the Los Angeles Metropolitan Area of southern California (subjected to grazing and urban development).

Island endemics are susceptible to extinction due to small population sizes and limited habitat, and are particularly vulnerable to introduction of exotic species. At least 39 species have representative populations of concern that are restricted to either actual islands (oceanic, landbridge, or in lakes), ecological islands of critical habitat, or both; at least five of these species are threatened. Drastic effects of exotic species on insular faunas have been well documented throughout the world (e.g., Savidge 1987; Freed *et al.* 1988; Schofield 1989). In Alaska alone, Bailey (1993) reported introduction of arctic fox (*Alopex lagopus*) or red fox (*Vulpes vulpes*) on at least 455 islands. Many of these introductions probably have resulted in the decline of seabird colonies (Murie 1959). Their effects upon endemic rodents are unknown. However, introduced exotics have been implicated in the extinction of native rodents in other island systems (Konecny 1987*a*, 1987*b*; Owen 1977; Smith *et al.* 1993).

Populations restricted to ecological islands may be subject to the same threats as those on actual islands. These include forest or boreal taxa isolated on cool, mesic mountaintops in the arid Southwest, as well as rodents dependent on mesic conditions that persist in isolated riparian or montane environments.

Taxa in need of basic survey to determine the nature and extent of any threat (Data Deficient) are of potential conservation concern due to restricted geographic range. Of seven species and 49 subspecies listed as Data Deficient, two species and 25 subspecies occur on either actual or ecological islands, and three species and 18 subspecies have restricted ranges within habitat that appears to be more widespread. The single Data Deficient species known to have been subjected to habitat conversion (*Spermophilus townsendii*) also has a highly restricted range. Further investigation may reveal that some of these Data Deficient taxa are not valid, and are instead members of widespread, secure taxa; that others, although distinct taxa, are in fact secure and not immediately threatened within their restricted range; and that others will require immediate action to mitigate threats to their continued survival.

Twenty-one species have limited species ranges (10 species) or highly restricted subspecies ranges (40 subspecies of 11 species), and so are considered as vulnerable or potentially vulnerable to adverse human impact. Most of these taxa historically had small geographic ranges, with two exceptions: the black-tailed prairie dog (*Cynomys ludovicianus*) and Allegheny woodrat (*Neotoma magister*) formerly were widespread, but poisoning campaigns and conversion of prairie habitat, and clearing of eastern forests (respectively) have greatly reduced and fragmented these formerly widespread distributions.

Taxonomic vulnerability

The majority of North American rodents of conservation concern belong to the four most common of the eight families of rodents that occur north of Mexico: Muridae (rats and mice), Sciuridae (squirrels and chipmunks), Heteromyidae (desert rodents), and Geomyidae (pocket

gophers; Table 6.1). These four families account for 96.6% of the North American species, and 95.2% of the North American subspecies. In Table 6.1, the proportion of species and subspecies within each family are shown as: total composition of the North American rodent fauna; those included in this Action Plan that are threatened above the level of Lower Risk (least concern); those that are at least Vulnerable or Conservation Dependent (excluding LR[least concern] and LR[near threatened]); and Data Deficient taxa. The number of subspecies within the major four families that are threatened is roughly in proportion to their contribution to the total subspecies of North American rodents. However, there are proportionately fewer species of rats and mice (Muridae) that are threatened, while there are more species of squirrels (Sciuridae) and pocket gophers (Geomyidae) that are of conservation concern. This probably is a direct reflection of the smaller average distribution of species of squirrels and pocket gophers relative to that of rats and mice. Thus, it appears that although families of North American rodents are affected by adverse impact in proportion to their relative diversity, murids tend to be more secure at the species level due to generally broader distributions, while the more limited average geographic range of sciurids and geomyids leaves them particularly vulnerable at the species level.

Both ground squirrels (Sciuridae) and pocket gophers (Geomyidae) are sedentary rodents that form numerous geographic races, often with limited distributions. Further, they prefer deep, well-drained, fertile soils that are often converted to agriculture and other types of development. Ground squirrels usually have spotty distributions, but in favorable years populations expand and occupy marginal areas. In unfavorable years, populations survive only in better sites, which serve as temporal refugia. The impact of conversion of these refugia during favorable years may not be evident until an unfavorable period, when populations disappear from marginal sites and have no refugia to which they can retreat. Currently, some threatened species of ground squirrels persist only as fragmented populations in marginal localities, with interconnecting dispersal corridors cut off. At these marginal sites, ground squirrels may be abundant for a time, then become extinct locally during a series of years with unfavorable climate. Without interconnecting dispersal corridors, there is little possibility of recolonizing sites. This may explain the recent loss of many populations of Washington ground squirrel, *Spermophilus washingtoni* (Betts 1990), and Townsend's ground squirrel, *Spermophilus townsendii.* Difficulties in recolonizing extirpated sites may be compounded by an already low ability to disperse. In the Mohave ground squirrel, *Spermophilus mohavensis*, average effective dispersal rate over the last 6000 years has been estimated at ≤5m per year (Hafner 1992).

Rats and mice (Muridae) are proportionately overrepresented in the Data Deficient category (both species and subspecies). This is less likely due to taxonomy than it is to geography: four of seven DD species and 20 of 53 DD subspecies occur in Alaska, the rodent fauna of which has a high proportion of murids and has been historically underexplored (MacDonald and Cook 1996). Although murids make up the highest proportion of North American species (39.3%), they are even more dominant in Alaska, where they compose fully 58.3% of the state's rodent species. All four of the DD species and 14 of 20 DD subspecies from Alaska are murid rodents.

The most important overall pattern of vulnerability of North American rodents is the pervasiveness of threat. Although some regions have experienced greater adverse impact, and some families are perhaps more vulnerable to such impact, rodents of conservation concern are found in virtually every state and province, and only one of eight families of North American rodents (porcupines, family Erethizontidae) is not represented in this Action Plan. Of the 206 species in North America north of Mexico, 86 (41.7%) are included in this Action Plan; 27 (13.1%) are threatened or near threatened at the species level.

Table 6.1. Taxonomic composition of rodents of conservation concern relative to their proportional occurrence in the rodent fauna of North America (north of Mexico; "Total").
Figures are percent contribution of each family to the total; subspecies counts include monotypic species; status codes are defined in Appendix 2. Figures indicated by boldface are departures from expected proportions that are referred to in text.

		Species:				Subspecies:			
		Total	>LR(lc)	>LR(nt)	DD	Total	>LR(lc)	>LR(nt)	DD
Family	*n* =	206	27	12	7	1426	117	73	53
Muridae		39.3	**22.2**	**16.7**	**85.7**	35.3	41.9	32.9	**58.5**
Sciuridae		32.5	33.3	**58.3**	14.3	20.4	17.1	24.7	22.6
Heteromyidae		18.0	18.5	24.0	0.0	14.9	16.2	17.8	17.0
Geomyidae		6.8	**18.5**	0.0	0.0	24.6	19.7	17.8	0.0
Dipodidae		1.9	3.7	0.0	0.0	2.2	3.4	4.1	0.0
Aplodontidae		0.5	3.7	0.0	0.0	0.5	1.7	2.7	0.0
Castoridae		0.5	0.0	0.0	0.0	1.7	0.0	0.0	1.9
Erethizontidae		0.5	0.0	0.0	0.0	0.4	0.0	0.0	0.0

Conservation priorities and recommended actions

The following factors were included in determining our list of priorities:

- It is most cost-effective to direct conservation efforts and funds to those regions that include concentrations of endangered taxa. Although specific conservation measures depend on details of each taxon's ecological needs and threats, it is probable that closely-related taxa of a particular region (e.g., San Joaquin Valley desert rodents) will share many needs and threats. Thus, we have attempted to identify endangered communities or ecosystems containing several species of rodents of conservation concern.
- No ongoing conservation effort should be jeopardized because of a lower priority ranking, which indeed may result from success of that effort. Administrative costs involved in planning and implementing any new effort prohibit constant shifting of funds as priorities change, and instead underscore the need to complete ongoing programs.
- Taxa of greater taxonomic distinctiveness should be accorded higher priority, but the geographic range of related taxa must also be considered. Although taxonomic treatment is notoriously uneven, particularly of allopatric populations, we have assumed (in the absence of more detailed genetic data) that the current taxonomy is the single best indicator of the evolutionary distinctiveness of the taxon.
- Some peripheral populations of widespread species, particularly in the Southwestern Region, may be of conservation concern due to natural climatic changes. Because natural changes are beyond human control, we give much higher priority to taxa that are threatened by human activities. Indeed, there is a growing conviction that taxa that suffer habitat restriction or are otherwise imperiled due to natural climate change should be monitored and studied without interference in the process of decline (even to the point of extirpation or extinction). It is imperative, however, that these populations be noted as susceptible to adverse human activities, and often it will be necessary to investigate possible human-induced threats. Because of the pervasiveness of human-induced habitat changes (e.g., due to grazing, fire control, or alteration of ground water regimes), it may be difficult to determine if declines in some populations are natural, human-induced, or both.
- In all cases, the degree of threat, especially if well-documented, is always a primary consideration.

We have classified the threatened taxa into six categories, according to priority for conservation action (Table 6.2). These categories correspond to the urgency with which the action should be taken, and more or less parallel the IUCN Red List categories. However, the first priority, endangered communities, necessarily includes taxa assigned to a wide variety of threat categories, and some Data Deficient taxa are included at higher priority levels because it is possible that they are at risk now and could be lost before we have sufficient information.

Priority 1: Endangered Communities

We have identified eight geographic areas or biotic communities (in a broad sense) of critical concern for rodent conservation in North America; we encourage others to identify additional areas of high concentration of taxa of conservation concern.

The single most-impacted biotic region is the **San Joaquin Valley desert of central California**. The San Joaquin Mammalian Faunal Region (as defined by Williams and Kilburn 1992) includes 22 endemic species and subspecies of mammals, fully one-half of which "face proximate threats of extinction due to anthropogenic causes, primarily loss of habitat" (Williams and Kilburn 1992). Eleven taxa of eight species of rodents in the San Joaquin Valley are of conservation concern (see Fig. 6.1): San Joaquin antelope ground squirrel (*Ammospermophilus nelsoni*, EN); giant kangaroo rat (*Dipodomys ingens*, CR); Merced kangaroo rat (*Dipodomys heermani dixoni*, LR[nt]); San Joaquin kangaroo rat (*Dipodomys nitratoides*, LR[nt]; *D. n. brevinasus*, LR[nt]; *D. n. exilis*, CR; and *D. n. nitratoides*, CR); San Joaquin pocket mouse (*Perognathus inornatus neglectus*, LR[nt]; and *P. i. psammophilus*, LR[nt]); San Joaquin Valley woodrat (*Neotoma fuscipes riparia*, CR); San Diego desert woodrat (*Neotoma lepida intermedia*, DD), and Tulare grasshopper mouse (*Onychomys torridus tularensis*, DD).

Florida coastal and island habitats have suffered from extensive development, leaving surviving patches of habitat extremely susceptible to further development or natural disasters (e.g., hurricanes). Sixteen taxa of eight species are of conservation concern (see Fig. 6.2): Big Cypress fox squirrel (*Sciurus niger avicennia*, LR[cd]); Goff's southeastern pocket gopher (*Geomys pinetis goffi*, EX); Florida saltmarsh vole (*Microtus pennsylvanicus dukecampbelli*, VU); Key Largo woodrat (*Neotoma floridana smalli*, EN); Marsh rice rat (*Oryzomys palustris natator*, DD); Cotton mouse (*Peromyscus gossypinus allapaticola*, VU; and *P. g. restrictus*, EX); beach mouse (*Peromyscus polionotus allophrys*, EN; *P. p. decoloratus*, EX; *P. p. leucocephalus*, LR[nt]; *P. p. niveiventris*, LR[nt]; *P. p. peninsularis*, EN; *P. p. phasma*, EN; and *P. p. trissyllepsis*, CR; another subspecies of beach mouse, *P. p. ammobates* [EN], is restricted to barrier islands of adjacent Alabama); and insular hispid cotton rat (*Sigmodon hispidus*

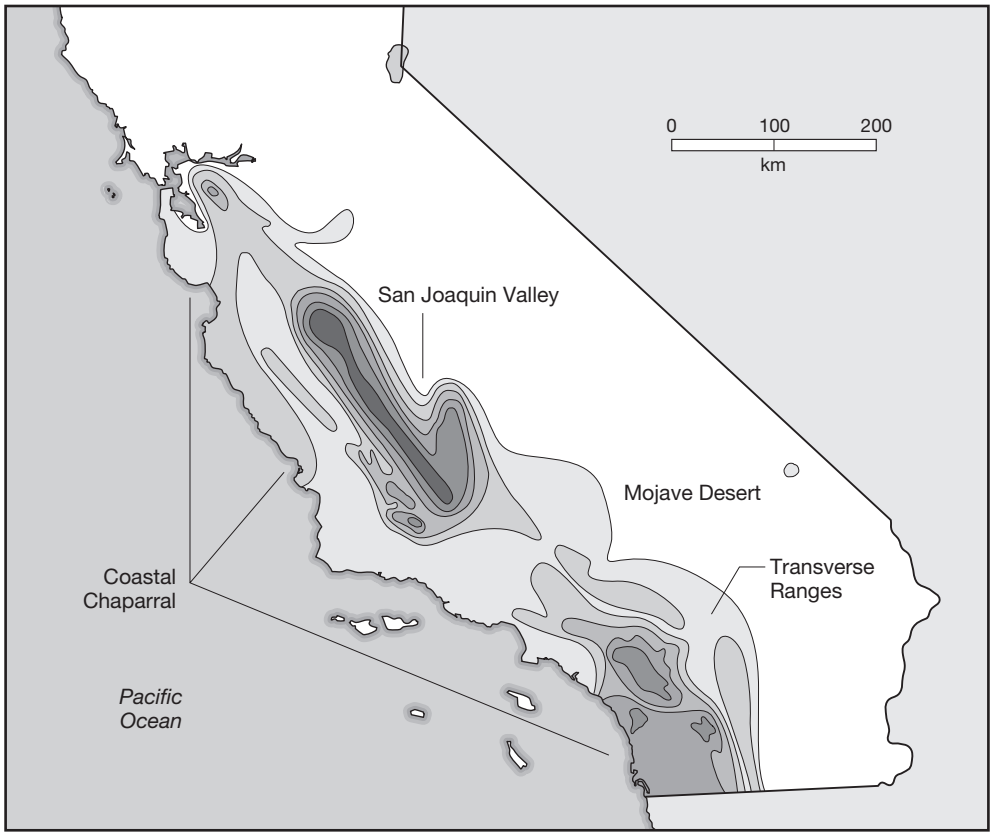


Figure 6.1. Distribution of rodent taxa of conservation concern (34 taxa of 19 species) in four Endangered Communities (Priority 1) in central and southern California: San Joaquin Valley Desert (11 taxa, 8 species), Coastal Chaparral (14 taxa, 8 species), Mojave Desert (7 taxa, 5 species), and Transverse Ranges (4 taxa, 3 species); several taxa occur in more than one of the communities. Lightest shading represents a single species, darker shadings represent higher density of species (up to six species).

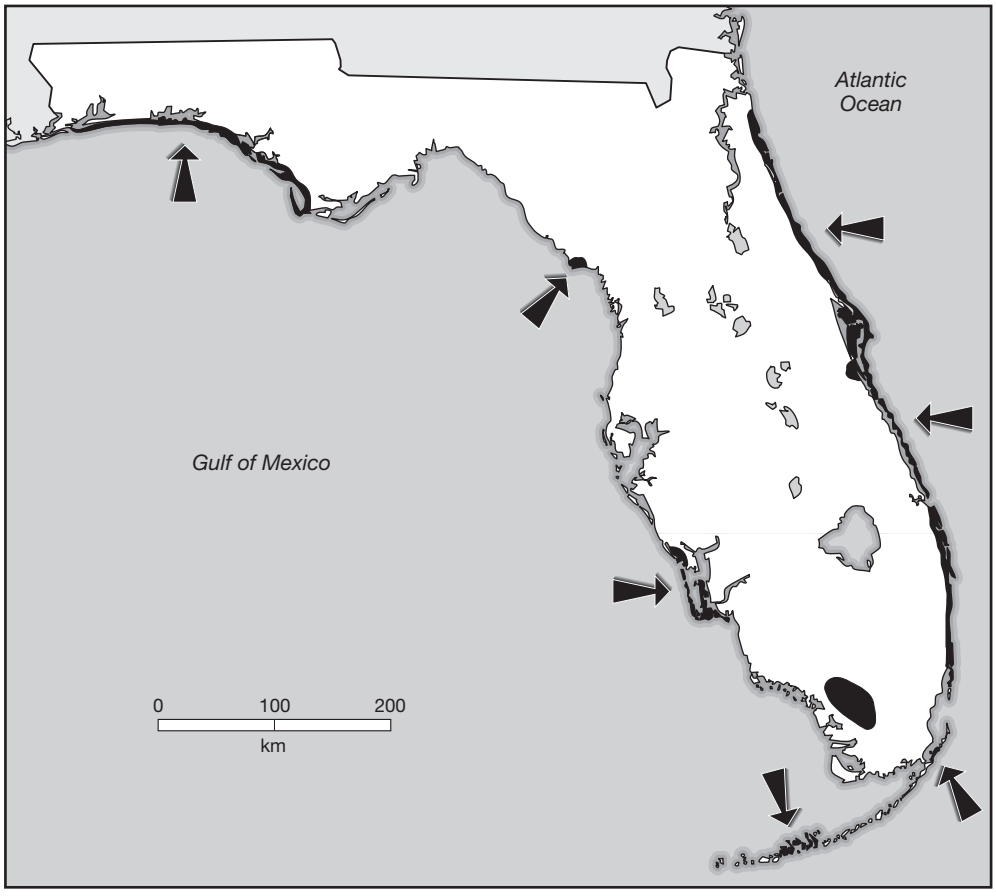


Figure 6.2. Distribution of rodent taxa of conservation concern in the Florida Coastal and Island Habitats (a Priority 1 Endangered Community; 16 taxa of 8 species).

Table 6.2. Priority listing of North American rodents of conservation concern.
Status codes are defined in Appendix 2.

	Red List Category	
	Species	**Subspecies**
PRIORITY 1: ENDANGERED COMMUNITIES		
1.1 San Joaquin Valley Desert (California)		
Species:		
Ammospermophilus nelsoni	EN:A1a;B1;B2c	
Dipodomys ingens	CR:A1a;B2c	
Dipodomys nitratoides	LR(nt)	
Subspecies:		
Dipodomys heermanni dixoni		LR(nt)
Dipodomys nitratoides brevinasus		LR(nt)
Dipodomys nitratoides exilis		CR:B1;B2c
Dipodomys nitratoides nitratoides		CR:A1c
Perognathus inornatus neglectus		LR(nt)
Perognathus inornatus psammophilus		LR(nt)
Neotoma fuscipes riparia		CR:B1;B2c
Neotoma lepida intermedia		DD
Onychomys torridus tularensis		DD
1.2 Florida Coastal and Island Habitats		
Subspecies:		
Sciurus niger avicennia		LR(cd)
Geomys pinetis goffi		EX
Microtus pennsylvanicus dukecampbelli		VU:D2
Neotoma floridana smalli		EN:B2c;C2b
Oryzomys palustris natator		DD
Peromyscus gossypinus allapaticola		VU:D2
Peromyscus gossypinus restrictus		EX
Peromyscus polionotus allophrys		EN:B1;B2c
Peromyscus polionotus ammobates		EN:B1;B2c
Peromyscus polionotus decoloratus		EX
Peromyscus polionotus leucocephalus		LR(nt)
Peromyscus polionotus niveiventris		LR(nt)
Peromyscus polionotus peninsularis		EN:B1;B2c
Peromyscus polionotus phasma		EN:B1;B2c
Peromyscus polionotus trissyllepsis		CR:B1;B2c
Sigmodon hispidus insulicola		LR(nt)
1.3 Pacific Coast Douglas Fir and Redwood Forests (British Columbia, Washington, Oregon, California)		
Species:		
Aplodontia rufa	LR(nt)	
Marmota vancouverensis	EN:C2b;D	
Thomomys mazama	LR(nt)	
Arborimus albipes	DD	
Arborimus pomo	DD	
Microtus townsendii	LR(nt)	
Zapus trinotatus	LR(nt)	
Subspecies:		
Aplodontia rufa nigra		VU:B1;B2d;B2e
Aplodontia rufa phaea		VU:B1;B2e
Thomomys mazama couchi		VU:B1;B2c
Thomomys mazama glacialis		VU:B1;B2c
Thomomys mazama helleri		LR(nt)
Thomomys mazama louiei		CR:A1c;C2b
Thomomys mazama melanops		LR(nt)
Thomomys mazama pugetensis		VU:B1;B2c
Thomomys mazama tacomensis		EX
Thomomys mazama tumuli		VU:B1;B2c
Thomomys mazama yelmensis		VU:B1;B2c
Microtus townsendii cowani		LR(cd)
Microtus townsendii pugeti		LR(nt)
Zapus trinotatus orarius		LR(cd)

Table 6.2 ... continued

	Red List Category	
	Species	**Subspecies**
1.4 Coastal Chaparral Communities (California)		
Species:		
Dipodomys stephensi	LR(cd)	
Subspecies:		
Chaetodipus californicus femoralis		DD
Chaetodipus fallax fallax		DD
Chaetodipus fallax pallidus		DD
Dipodomys heermanni berkeleyensis		VU:B1;B2c
Dipodomys heermanni morroensis		CR:B1;B2c;D
Perognathus longimembris bangsi		DD
Perognathus longimembris brevinasus		VU:B1;B2c
Perognathus longimembris internationalis		DD
Perognathus longimembris pacificus		CR:B1;B2c;C1;C2a;C2b
Neotoma fuscipes annectens		DD
Neotoma fuscipes luciana		DD
Neotoma lepida intermedia		DD
Onychomys torridus ramona		DD
1.5 Mojave Desert (California)		
Species:		
Spermophilus mohavensis	VU:B1;B3d	
Subspecies:		
Spermophilus tereticaudus chlorus		DD
Dipodomys merriami collinus		DD
Dipodomys merriami parvus		DD
Microtus californicus mohavensis		VU:A1d;A2d;D2
Microtus californicus scirpensis		VU:B1;B3c;B3d
Neotoma lepida intermedia		DD
1.6 Columbia Basin (Washington and Oregon)		
Species:		
Spermophilus townsendii	DD	
Spermophilus washingtoni	VU:A1a;B1;B2d;C2a	
Subspecies:		
Microtus pennsylvanicus kincaidi		LR(nt)
Onychomys leucogaster durranti		DD
1.7 Appalachian Mountains		
Species:		
Neotoma magister	LR(nt)	
Subspecies:		
Glaucomys sabrinus coloratus		VU:A2c;B1;B2c
Glaucomys sabrinus fuscus		VU:A2c;B1;B2c
Sciurus niger vulpinus		DD
Clethrionomys gapperi maurus		LR(nt)
Microtus chrotorrhinus carolinensis		LR(nt)
Neotoma floridana haematoreia		LR(nt)
1.8 Transverse Ranges (southern California)		
Species:		
Perognathus alticola	LR(nt)	
Subspecies:		
Glaucomys sabrinus californicus		DD
Perognathus alticola alticola		CR:B1;B2b
Perognathus alticola inexpectatus		LR(nt)
Microtus longicaudus bernardinus		DD
PRIORITY 2: IMMEDIATE CONSERVATION ACTION NEEDED		
Glaucomys sabrinus griseifrons		EN:A1c;A2c;B1;B2c
Spermophilus brunneus	EN:B2d;B3d	
Spermophilus brunneus brunneus		CR:B1;B2d
Spermophilus brunneus endemicus		VU:B1;B3d

Table 6.2 ... continued

	Red List Category	
	Species	**Subspecies**
Tamias minimus atristriatus		CR:A1a;B1;D
Tamias umbrinus nevadensis		CR:A1a
Tamiasciurus hudsonicus grahamensis		CR:B1;C2b
Reithrodontomys raviventris	VU:A1c;A2c;B2c	
Reithrodontomys raviventris halicoetes		LR(cd)
Reithrodontomys raviventris raviventris		EN:A2c;B1;B2c
Zapus hudsonius preblei		EN:B1;B2c
PRIORITY 3: VULNERABLE SPECIES		
Cynomys parvidens	LR(cd)	
Tamias palmeri	VU:A2c	
Dipodomys elator	VU:B1;B2c	
Podomys floridanus	VU:A1a;A2d	
PRIORITY 4: NEAR-THREATENED SPECIES		
Cynomys ludovicianus	LR(nt)	
Tamias canipes	LR(nt)	
Geomys arenarius	LR(nt)	
Geomys personatus	LR(nt)	
Geomys personatus fuscus		LR(nt)
Geomys personatus maritimus		VU:D2
Geomys personatus streckeri		VU:D2
Geomys texensis	LR(nt)	
Geomys texensis bakeri		LR(nt)
Thomomys idahoensis	LR(nt)	
Thomomys idahoensis confinus		LR(nt)
Microtus breweri	LR(nt)	
Neofiber alleni	LR(nt)	
PRIORITY 5: VULNERABLE (OR SUSPECTED VULNERABLE) SUBSPECIES		
Marmota caligata sheldoni		DD
Marmota caligata vigilis		DD
Spermophilus tridecemlineatus alleni		DD
Tamias minimus selkirki		VU:D2
Tamias quadrivittatus australis		VU:C2a;D2
Tamias umbrinus sedulus		DD
Geomys pinetis cumberlandius		VU:D2
Geomys pinetis fontanelus		VU:D2
Thomomys talpoides douglasi		VU:B1;B2c
Dipodomys microps alfredi		DD
Dipodomys microps leucotis		VU:B1;B2c
Microdipodops megacephalus atrirelictus		VU:D2
Microdipodops megacephalus nexus		DD
Microdipodops pallidus restrictus		VU:D2
Microtus abbreviatus abbreviatus		DD
Microtus abbreviatus fisheri		DD
Microtus californicus stephensi		DD
Microtus longicaudus coronarius		DD
Microtus longicaudus leucophaeus		DD
Microtus mogollonensis hualpaiensis		VU:B1;B2c;D2
Microtus montanus codiensis		DD
Microtus montanus fucosus		VU:D2
Microtus montanus nevadensis		VU:D2
Microtus montanus zygomaticus		DD
Microtus oeconomus amakensis		DD
Microtus oeconomus elymocetes		DD
Microtus oeconomus innuitus		DD
Microtus oeconomus popofensis		DD
Microtus oeconomus punukensis		DD
Microtus oeconomus sitkensis		DD
Zapus hudsonius campestris		VU:B1;B2c

Table 6.2 ... continued

	Red List Category	
	Species	Subspecies
PRIORITY 6: EXTINCT, LOWER PRIORITY, OR UNKNOWN THREAT		
Extinct Subspecies:		
Sigmodon arizonae arizonae		EX
Sigmodon fulviventer goldmani		EX
Synaptomys cooperi paludis		EX
Synaptomys cooperi relictus		EX
Lower Risk (near threatened) Subspecies:		
Sciurus niger shermani		LR(nt)
Geomys pinetis colonus		LR(nt)
Thomomys talpoides limosus		LR(nt)
Thomomys talpoides segregatus		LR(nt)
Thomomys umbrinus emotus		LR(nt)
Perognathus flavus goodpasteri		LR(nt)
Microtus californicus vallicola		LR(nt)
Microtus montanus arizonensis		LR(nt)
Microtus montanus rivularis		LR(nt)
Microtus pennsylvanicus admiraltiae		LR(nt)
Microtus pennsylvanicus provectus		LR(nt)
Microtus pennsylvanicus shattucki		LR(nt)
Neotoma floridana baileyi		LR(nt)
Peromyscus maniculatus anacapae		LR(nt)
Peromyscus maniculatus clementis		LR(nt)
Peromyscus truei comanche		LR(nt)
Sigmodon arizonae plenus		LR(nt)
Sigmodon hispidus eremicus		LR(nt)
Synaptomys borealis artemisiae		LR(nt)
Synaptomys borealis sphagnicola		LR(nt)
Zapus hudsonius luteus		LR(nt)
Lower Risk (conservation dependent) Subspecies:		
Sciurus niger cinereus		LR(cd)
Data Deficient Species:		
Dicrostonyx exsul	DD	
Dicrostonyx nunatakensis	DD	
Dicrostonyx unalascensis	DD	
Dicrostonyx unalascensis stevensoni		DD
Dicrostonyx unalascensis unalascensis		DD
Microtus abbreviatus	DD	
Data Deficient Subspecies:		
Spermophilus elegans nevadensis		DD
Spermophilus lateralis wortmanni		DD
Spermophilus parryii kodiacensis		DD
Spermophilus parryii lyratus		DD
Spermophilus parryii nebulicola		DD
Castor canadensis phaeus		DD
Clethrionomys gapperi solus		DD
Microtus chrotorrhinus ravus		DD
Ondatra zibethicus ripensis		DD
Peromyscus leucopus ammodytes		DD

insulicola, LR[nt]). Unfortunately, the barrier islands and sandbars to which these species are restricted are dispersed and cannot be effectively conserved in a single area reserve. Two other species of conservation concern in Florida are not restricted to coastal areas or barrier islands, but could benefit peripherally from preservation of these habitats: Florida mouse (*Podomys floridanus*, VU) and round-tailed muskrat (*Neofiber alleni*, LR[nt]).

Pacific Coast Douglas Fir and Redwood Forests (northern California to British Columbia), including coastal islands, continue to suffer reduction from logging, agricultural conversion, and urban development. Seventeen taxa of seven species of rodents in these coastal forests are of conservation concern (see Fig. 6.3): mountain beaver, the only living representative of the family Aplodontidae (*Aplodontia rufa*, LR[nt]; *A. r. nigra*, VU; *A. r. phaea*, VU),

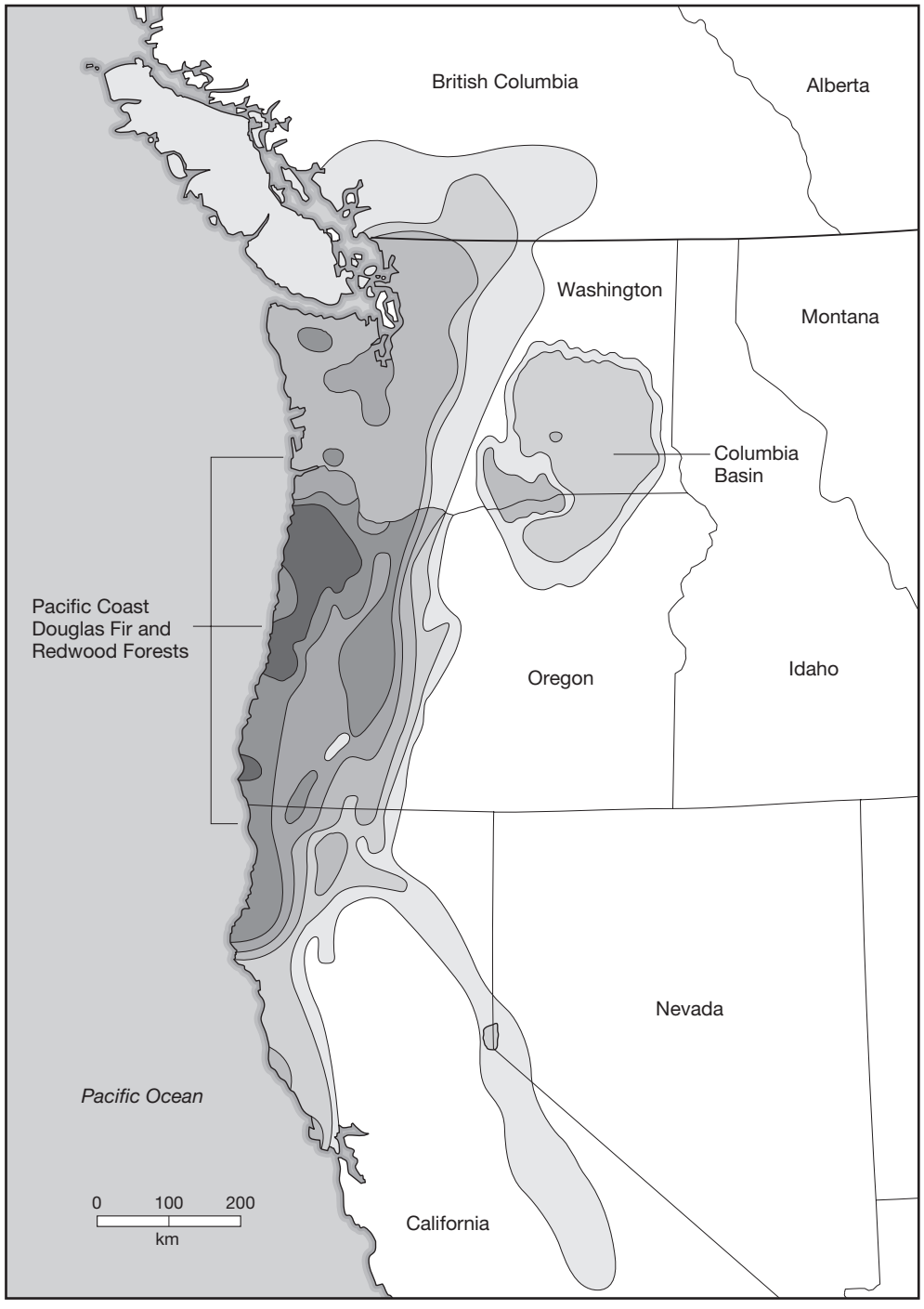


Figure 6.3. Distribution of rodent taxa of conservation concern (21 taxa of 11 species) in two Endangered Communities (Priority 1) in northern California, Oregon, Washington, and British Columbia: Pacific Coast Douglas Fir and Redwood Forests (17 taxa, 7 species), and Columbia Basin (4 taxa, 4 species). Lightest shading represents a single species, darker shadings represent higher density of species (up to six species).

Vancouver marmot (*Marmota vancouverensis*, EN); western pocket gopher (*Thomomys mazama*, LR[nt]; *T. m. couchi*, VU; *T. m. glacialis*, VU; *T. m. helleri*, LR[nt]; *T. m. louiei*, CR; *T. m. melanops*, LR[nt]; *T. m. pugetensis*, VU; *T. m. tacomensis*, EX; *T. m. tumuli*, VU; *T. m. yelmensis*, VU); white-footed vole (*Arborimus albipes*, DD); red tree vole (*Arborimus pomo*, DD), Townsend's vole (*Microtus townsendii*, LR[nt]; *M. t. cowani*, LR[cd]; *M. t. pugeti*, LR[nt]); and Pacific jumping mouse (*Zapus trinotatus*, LR[nt]; *Z. t. orarius*, LR[cd]).

Coastal chaparral communities of California are rapidly disappearing in the face of urban development. Fourteen taxa of eight species of rodents are of conservation concern in these coastal regions (see Fig. 6.1): California pocket mouse (*Chaetodipus californicus femoralis*, DD); San Diego pocket mouse (*Chaetodipus fallax fallax*, DD; and *C. f. pallidus*, DD); Stephens' kangaroo rat (*Dipodomys stephensi*, LR[cd]); Heermann's kangaroo rat (*Dipodomys heermanni berkeleyensis*, VU; and *D. h. morroensis*, CR); little pocket mouse (*Perognathus longimembris bangsi*,

DD; *P. l. brevinasus*, VU; *P. l. internationalis*, DD; and *P. l. pacificus*, CR); dusky footed woodrat (*Neotoma fuscipes annectens*, DD; and *N. f. luciana*, DD); San Diego desert woodrat (*Neotoma lepida intermedia*, DD); and southern grasshopper mouse (*Onychomys torridus ramona*, DD).

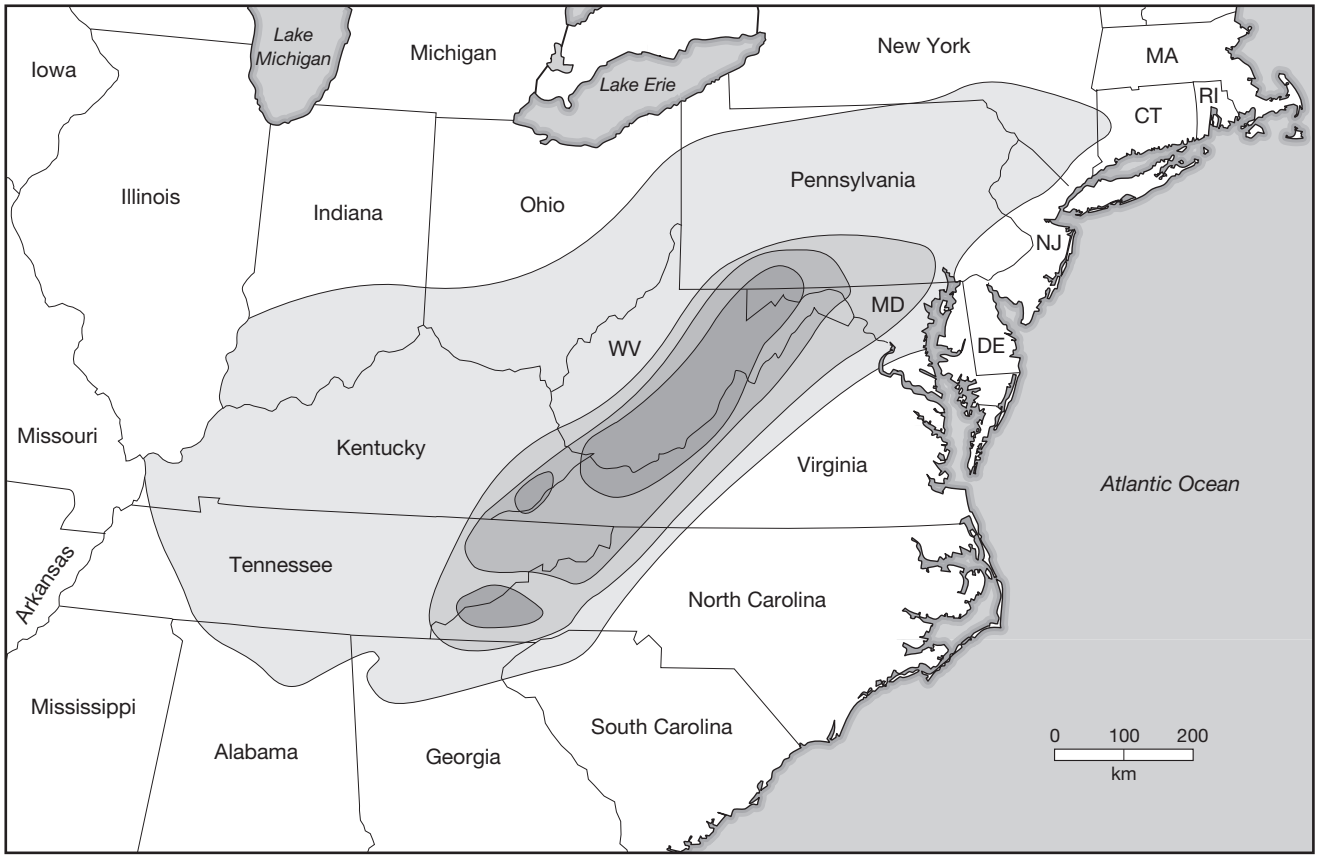
The **Mojave Desert** of southern California faces increasing threat from the continued expansion of the Los Angeles and San Diego metropolitan areas. Seven taxa of five species are of conservation concern (see Fig. 6.1): Mohave ground squirrel (*Spermophilus mohavensis*, VU); Palm Springs round-tailed ground squirrel (*Spermophilus tereticaudus chlorus*, DD); two subspecies of Merriam's kangaroo rat (*Dipodomys merriami collinus*, DD; and *D. m. parvus*, DD); two subspecies of California vole (*Microtus californicus mohavensis*, VU; and *M. c. scirpensis*, VU); and San Diego desert woodrat (*Neotoma lepida intermedia*, DD).

The **Columbia Basin in eastern Washington and adjacent Oregon** has been almost completely converted to agriculture. All taxa that are endemic or largely restricted to the basin are affected. Four taxa of four species of rodents are of conservation concern in the Columbia Basin (IUCN Red List categories indicated): Washington ground squirrel (*Spermophilus washingtoni*, VU), Townsend's ground squirrel (*Spermophilus townsendii*, DD); potholes meadow vole (*Microtus pennsylvanicus kincaidi*, LR[nt]); and northern grasshopper mouse (*Onychomys leucogaster durranti*, DD).

Deciduous and remnant boreal forests of the Appalachian Mountains have a long history of fragmentation (from clearcutting), agricultural conversion, suburban sprawl, pollution (particularly acid rain), and fire suppression. Taxa that previously enjoyed a relatively large, continuous distribution now survive in disjunct patches of habitat, where they are susceptible to local extirpation from a variety of causes. Seven taxa of six species are of conservation concern (see Fig. 6.4): Allegheny woodrat (*Neotoma magister*, LR[nt]); northern flying squirrel (*Glaucomys sabrinus coloratus*, VU; *G. s. fuscus*, VU), fox squirrel (*Sciurus niger vulpinus*, DD); southern red-backed vole (*Clethrionomys gapperi maurus*, LR[nt]); rock vole (*Microtus chrotorrhinus carolinensis*, LR[nt]); and eastern woodrat (*Neotoma floridana haematoreia*, LR[nt]).

The **Transverse Ranges of southern California** contain ecological islands of montane habitat that have historically been isolated by surrounding deserts, and have been subjected to increasing habitat degradation by expansion of the Los Angeles Metropolitan Area. Five taxa of three species are of conservation concern (see Fig. 6.1): white-

Figure 6.4. Distribution of rodent taxa of conservation concern in the Appalachian Mountains (a Priority 1 Endangered Community; 7 taxa of 6 species). Lightest shading represents a single species, darker shadings represent higher density of species (up to four species).



eared pocket mouse (*Perognathus alticola*, LR[nt]; *P. a. alticola*, CR; *P. a. inexpectatus*, LR[nt]); northern flying squirrel (*Glaucomys sabrinus californicus*, DD); and long-tailed vole (*Microtus longicaudus bernardinus*, DD). The flying squirrel is known from the San Bernardino and San Jacinto Mountains, and may occur in the San Gabriel Mountains (Vaughan 1954); the pocket mouse is known from the San Bernardino Mountains (*P. a. alticola*) and Tehachapi Mountains (*P. a. inexpectatus*); the vole is known only from the San Bernardino Mountains.

Endangered communities can be conserved most effectively by establishment of reserves or interconnected systems of reserves in each of the priority areas. Each of the endangered communities identified herein includes rodent taxa that are seriously threatened, as well as taxa whose survival is not currently in jeopardy (Lower Risk) or for which information is lacking (Data Deficient). Preserves would mitigate impact on those taxa currently threatened, and hopefully prevent other endemic taxa from becoming threatened. A system of preserves is already being established in the San Joaquin Valley, and some of the critical habitat in the other regions has gained a measure of protection. However, sufficient continuous habitat must be set aside in order to successfully preserve these communities, and a coordinated management plan must be developed. As noted by Williams (1992), "habitat acquisition is not habitat protection." Without a comprehensive management plan in each of the four regions that uses adequate "information on species geographic distributions, habitat requirements, population statuses, demographics, population genetics, and requirements for dispersal," an uncoordinated system of splintered and competing conservation plans "limits options for recovering species from endangerment and risks jeopardizing others." We advocate a community approach to conservation, but it is critical that a community-wide management plan consider specific requirements of as many component species as possible.

Priority 2: Taxa needing immediate conservation action

Taxa from seven species of rodents (including all populations of two species) are in need of immediate conservation action, but are not found in the endangered communities listing in Priority 1 (three additional species and 14 additional subspecies needing immediate conservation action are included in Priority 1 listing). These taxa could be lost in the next few years if immediate action is not taken. The Idaho ground squirrel (*Spermophilus brunneus*, EN; *S. b. brunneus*, CR; *S. b. endemicus*, VU), and saltmarsh harvest mouse (*Reithrodontomys raviventris*, VU; *R. r. raviventris*, EN; and *R. r. halicoetes*, LR[cd]) each have highly restricted distributions. The Prince of Wales Island flying squirrel (*Glaucomys sabrinus griseifrons*, EN) is restricted to forested areas that have been heavily logged. Three Priority 2 subspecies are restricted to cool, forested habitat on the tops of mountains ('sky islands') in the arid Southwest, all of which have been or are being subjected to extensive human impact: Peñasco least chipmunk (*Tamias minimus atristriatus*, CR) in southern New Mexico, Hidden Forest chipmunk (*Tamias umbrinus nevadensis*, CR) in southern Nevada, and Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*, CR) in southern Arizona. Preble's meadow jumping mouse (*Zapus hudsonius preblei*, EN) no longer occurs at historical sites, and is limited to decreasing patches of appropriate habitat in eastern Colorado; appropriate habitat has been destroyed by encroaching agricultural or urban development.

Whereas the success of community-level (Priority 1) conservation plans will often depend on the cooperation of private landowners and businesses, and so will require extensive public education programs, we urge state and federal conservation agencies to take a more unilateral and aggressive approach to halt immediately clear threats to the continued existence of Priority 2 taxa. These actions are likely to be unpopular with the public, and extreme care must be taken to avoid unnecessary obstruction of private interests. Ideally, a brief moratorium on development of critical habitat will allow private interests and government agencies sufficient time to develop a plan that permits continued, controlled development while mitigating or reversing environmental threats. Amendments to the Endangered Species Act (ESA) of the United States that were proposed in 1996 would have greatly reduced federal powers on private lands, in some cases eliminating the option of preserving critical habitat for high-priority species. We urge the U.S. Congress to strengthen, or at least not weaken, legal powers of the ESA, and at the same time streamline bureaucratic processes that would delay nonintrusive developments and thereby place unnecessary and unpopular financial burden on private interests.

Priority 3: Vulnerable species

Unless conservation action plans are developed and implemented soon, four species (one of which is the sole representative of the genus) could become Endangered, Critically Endangered, or Extinct in the near future. These include one monotypic genus (Florida mouse, *Podomys floridanus*, VU) and three monotypic species (Utah prairie dog, *Cynomys parvidens*, LR[cd]; Palmer's chipmunk, *Tamias palmeri*, VU, of southern Nevada; and Texas kangaroo rat, *Dipodomys elator*, VU). A conservation action plan is already in effect only for the Utah prairie dog; without it, this species would be listed as Vulnerable or Endangered. Similarly, Stephens' kangaroo rat (*Dipodomys stephensi*, included in Priority 1) would be

listed as Vulnerable without the conservation action plan already in place. Two additional monotypic species listed as Vulnerable (*Spermophilus washingtoni* and *Spermophilus mohavensis*) are included among Priority 1 communities.

Threats to Vulnerable species are of two sorts: a long history of agricultural, mining, or urban development that has resulted in extensive loss and fragmentation of appropriate habitat (*Podomys floridanus, Cynomys parvidens, Dipodomys elator*); or more recent threat of urban expansion (*Tamias palmeri*), agricultural conversion (*Spermophilus washingtoni*), or both (*Spermophilus mohavensis*) on a restricted distribution.

It is probably not necessary to risk adverse public opinion by taking an aggressive approach for Vulnerable (Priority 3) or Near Threatened (Priority 4) species. However, conservation efforts must begin at once in order to prevent situations where emergency actions are necessary. Where conservation plans exist, they should be implemented immediately with public and private cooperation. Where sufficient natural history information is lacking to develop action plans, gathering of these data should be a high priority. We urge federal and state conservation agencies to take advantage of graduate programs in biology at regional universities, where adequate expertise can be obtained with limited budgets in order to collect the necessary information. In this regard, we recommend programs such as the Share with Wildlife tax check-off fund administered by the Endangered Species Program of the New Mexico Department of Game and Fish. This program has funded a large variety of research projects conducted by graduate students, targeting 'low-profile' species that are less familiar to the public.

Priority 4: Near Threatened species

Eight species considered as Near Threatened, LR(nt), but not included among Priority 1 listing are of next highest priority. The black-tailed prairie dog (*Cynomys ludovicianus)* and round-tailed muskrat (*Neofiber alleni*), like the Allegheny woodrat (*Neotoma magister*; included in Priority 1) are monotypic species that have suffered extensive fragmentation of appropriate habitat over a historically large geographic range. Three other monotypic species have highly restricted distributions, but no known immediate threat to their continued existence: gray-footed chipmunk (*Tamias canipes*), desert pocket gopher (*Geomys arenarius*), and beach vole (*Microtus breweri*). Three other species have relatively restricted distributions and immediate threats to a significant proportion of their subspecies (as is the case with six other Near Threatened species included in Priority 1 communities): Idaho pocket gopher (*Thomomys idahoensis*; 1 of 3), Texas pocket gopher (*Geomys personatus*; 3 of 6), and llano pocket gopher (*Geomys texensis*; 1 of 3).

Priority 5: Vulnerable (or suspected Vulnerable) subspecies

One to six subspecies each of 17 wide-ranging species are considered Vulnerable (VU), or are Data Deficient but suspected of being Vulnerable. These 31 subspecies are all peripheral to the main distribution of their respective species, are usually of very restricted distribution, and generally represent a small proportion of the species' diversity (as measured by numbers of recognized subspecies). There is persuasive evidence of existing threat and a high probability of continued threat to the survival of 12 of the subspecies. Fifteen additional Vulnerable subspecies are included in Priority 1 communities.

Six of the 17 species involved are widespread boreal mammals, as is the northern flying squirrel (*Glaucomys sabrinus*, Vulnerable subspecies of which are included in Priority 1 communities). Their Vulnerable subspecies are relicts of full-glacial expansions that have persisted in peripheral montane or wetland areas: hoary marmot (*Marmota caligata*); least chipmunk (*Tamias minimus*); Colorado chipmunk (*Tamias quadrivittatus*); Uinta chipmunk (*Tamias umbrinus*); northern pocket gopher (*Thomomys talpoides*); and meadow jumping mouse (*Zapus hudsonius*). Six of the 17 species are voles (*Microtus*), Vulnerable subspecies of which are peripheral relicts of full-glacial distributions that have persisted on landbridge islands, in wet areas in desert mountains, or along ephemeral desert springs: insular vole (*Microtus abbreviatus*); California vole (*Microtus californicus*); long-tail vole (*Microtus longicaudus*); Mogollon vole (*Microtus mogollonensis*); montane vole (*Microtus montanus*), and tundra vole (*Microtus oeconomus*). Five of the 17 species are desert species, peripheral subspecies of which are vulnerable to agricultural or urban development: round-tailed ground squirrel (*Spermophilus tereticaudus*); Merriam's kangaroo rat (*Dipodomys merriami*); chisel-toothed kangaroo rat (*Dipodomys microps*); dark kangaroo mouse (*Microdipodops megacephalus*); and pale kangaroo mouse (*Microdipodops pallidus*). Two Vulnerable subspecies of the southeastern pocket gopher (*Geomys pinetis*), restricted to a small island and to a single colony along the Atlantic coast, respectively, are suffering human encroachment.

Single subspecies of three species may already be extinct. Although listed as Data Deficient (DD), their precarious position necessitates more immediate evaluation of their conservation status. Allen's thirteen-lined ground squirrel (*Spermophilus tridecemlineatus alleni*) may be extinct or only exist in small, isolated populations. The Punuk Island tundra vole (*Microtus oeconomus punukensis*) was not found in 1979 on one of the two small islands where it has historically occurred. The Montague Island hoary marmot (*Marmota caligata sheldoni*) has not been reported since 1908.

Seven other subspecies that are Data Deficient are included in this section. Of the seven subspecies that are considered Imperiled by The Nature Conservancy (Table 5.1), six are included here as higher priority for basic status survey. Four occur on small islands: two subspecies of *Microtus oeconomus* from Alaska (*M. o. amakensis* and *M. o. elymocetes*), *Microtus abbreviatus abbreviatus* from Hall Island in Alaska, and *Dipodomys microps alfredi* from Gunnison Island in the Great Salt Lake, Utah. *Tamias umbrinus edulus* is known only from Mt. Ellen in the Henry Mountains of Utah, a 'sky island' in an arid region. *Microtus californicus stephensi* occurs along coastal beaches of the Los Angeles metropolitan area. Each of these six subspecies may be in a particularly vulnerable or critical condition due to a combination of restricted distribution and human impact. The seventh subspecies considered by The Nature Conservancy as Imperiled is *Peromyscus leucopus ammodytes* of Monomoy Island, Massachusetts. The threat posed to this subspecies is natural introgressive hybridization with the mainland subspecies during intermittent connections with the mainland. The subspecies may no longer exist, and does not merit a high priority for immediate study. In the spirit of efficiency of field survey and a community approach to conservation, one other Data Deficient subspecies is included here: *Microtus longicaudus leucophaeus* should be studied during survey of the Mt. Graham red squirrel, *Tamiasciurus hudsonicus grahamensis*, which is a Priority 2 species.

Priority 5 Vulnerable subspecies present an interesting set of possibilities and opportunities for the species as well as for conservation and evolutionary biologists. As genetically differentiated populations isolated on the periphery of the species' distribution, they may represent new evolutionary trajectories for the species. Alternatively, they may represent failed lineages, doomed to extirpation by natural climatic change. It is critical that we attempt to differentiate between adverse human impact on such isolated populations and the results of natural climatic change. By attempting to resist normal biological change (which includes extinction of failed lineages), we would be further interfering with the environment: effecting adverse human impact under the guise of conservation. Further, such victims of climatic change may provide natural laboratories in which to monitor the extent and pace of environmental change, and study the processes of extinction and replacement.

For peripheral, isolated subspecies that are judged to be Vulnerable, the most important first step is to identify the probable nature of threat as due to either human impact or climatic change. In either case, the limited habitat for these isolated populations will render them particularly susceptible to human impact. If the threat does not involve adverse human impact, however, we recommend continued monitoring to observe changes in the genetics, population structure, or ecology of the population during reduction (even to the point of extinction), and changes in community structure following extinction.

Priority 6: Taxa with Lower or unknown level of threat; Extinct subspecies

Recognizing that some form of conservation action or exploratory survey is justified for every rodent listed in this Action Plan above the category of Lower Risk (least concern), the rodents in less-immediate jeopardy are included in this final category. These are of three sorts: 1) Extinct subspecies (four), for which there exists persuasive evidence of extinction (four other Extinct subspecies are included in Priority 1 communities); 2) Near Threatened (21) or Conservation Dependent (one) subspecies, the extinction of which would not elevate the threat category of the respective species, because they do not constitute a large percentage of the species' subspecific diversity or geographic distribution; and 3) Data Deficient species (four) and subspecies (12), for which there is probably no immediate cause for concern, but which merit detailed survey to determine their conservation status. In order to be successful, a long-range, proactive conservation program must consider the Data Deficient taxa, and hopefully avoid the possibility of their becoming of conservation concern.

Recommendations for delisting of taxa previously considered to be threatened

Three groups of taxa of North American rodents of conservation concern can be identified:

- those known to be subjected to some degree of threat or potential threat, including those that may be extinct;
- those whose distribution, location, or ecology indicates that they may be threatened or potentially threatened, but for which sufficient information is not currently available (Data Deficient); and
- those taxa that have been considered by state or federal agencies to be in need of protection, but that are not globally threatened.

Taxa may be included in this third category because studies conducted subsequent to listing may have documented their more secure status (Table 6.3). Alternatively, many taxa have been included on state federal lists simply because of a restricted distribution in that state or country, although these populations are merely at the margins of widespread ranges of taxa that are not threatened elsewhere (Table 6.4). We judge these

'peripheral taxa' to be of less concern than subspecies or species whose existence is globally threatened. Finally, some taxa have been found to be indistinct from another form that is widespread and not currently of conservation concern (Table 6.5).

We recommend the 115 taxa in these three tables for removal (delisting) from state, provincial, or federal lists of threatened wildlife. Although we understand that human-mitigated detrimental impact to any natural population is regrettable and should be avoided, limited funds and practical considerations force us to focus on those populations that are most at risk. Retention of secure, widespread taxa on state and federal lists would serve only to dilute the effort that should be directed at globally threatened taxa. Similarly, widespread taxa that are on state, provincial, and federal lists only because of their peripheral distribution in that region (peripheral taxa; Table 6.4) should be of far lower priority in management decisions. Because a taxon's distribution would be expected to contract or expand due to natural climatic change, these peripheral populations might often be ephemeral, and their loss would not necessarily signal any threat to the taxon's survival. Finally, taxa that have been found to be indistinct from another, widespread taxon (Table 6.5) should not be considered to be of any conservation concern. We have elected to include here taxa that are considered by experts in the field to be synonymous with widespread taxa, rather than wait for publication of a formal taxonomic synonymy. We recommend retention of taxa on state and federal lists that are believed to have suffered extinction during this century, as it is possible that surviving populations may have been overlooked (as was the case with a jumping mouse, *Zapus hudsonius luteus*, in New Mexico), or that systematic study may reveal their synonymy with extant populations and reintroduction may be considered.

As we have stressed elsewhere in this report, these recommendations are based on the best information currently available. We hope that circulation of this report will bring to our attention more information about these rodents, and this new information may result in reassignment of taxa. Certainly, 'current status' of any species, particularly one subjected to an immediate threat, can change rapidly; we can only hope that such change will be an improvement in that status, but expect that at least some taxa now judged to be at low risk of extinction will require conservation action in the future.

Table 6.3. Rodent taxa previously listed as threatened or endangered, whose status now appears to be of no immediate conservation concern.

	Historical distribution	State/Province listed	Federal status
APLODONTIDAE			
Aplodontia rufa californica	CA,NV	CA,NV	C2C
SCIURIDAE			
Marmota flaviventris notioros	CO		C2
Sciurus arizonensis catalinae	AZ		C2
Sciurus nayaritensis chiricahuae	AZ		C2
Spermophilus elegans	CO,NE,UT,WY	WY	
Tamias speciosus speciosus	CA		C2
GEOMYIDAE			
Geomys bursarius breviceps	LA		C3C
Thomomys bottae guadalupensis	NM,TX	TX	C2
Thomomys bottae limpiae	TX	TX	C2
Thomomys bottae mearnsi	NM		C2
Thomomys bottae paguatae	NM		C2
Thomomys bottae texensis	TX	TX	C2
HETEROMYIDAE			
Microdipodops megacephalus albiventer	NV		C2
Perognathus amplus amplus	AZ		C2
Perognathus amplus cineris	AZ		C2
MURIDAE			
Clethrionomys gapperi brevicaudus	WY,SD	WY	
Microtus californicus sanpabloensis	CA	CA	C3C
Microtus mogollonensis navaho	AZ,UT	AZ,UT	C2
Microtus townsendii pugeti	WA	WA	C3C
Peromyscus leucopus easti	VA	VA	C3C
Peromyscus leucopus fusus	MA		C3C

Table 6.4. North American rodent taxa previously listed as threatened or endangered due to peripheral distribution in a particular state or country, but that are wide-ranging and not considered to be of conservation concern elsewhere.

	Historical distribution	State/Province listed
SCIURIDAE		
Cynomys leucurus	MT,WY,UT,CO	MT,WY
Glaucomys sabrinus	widespread	ID,ND,NV,WA,
Glaucomys volans volans	widespread	NS
Marmota monax	widespread	MT
Sciurus aberti	widespread	UT,WY
Sciurus carolinensis	widespread	SD
Sciurus griseus	WA,OR,CA,NV	NV,WA
Spermophilus beldingi	widespread	UT
Spermophilus elegans elegans	CO,NE,UT,WY	UT
Spermophilus lateralis lateralis	widespread	WY
Spermophilus spilosoma	widespread	SD,UT,WY
Spermophilus tridecemlineatus	widespread	UT
Spermophilus variegatus	widespread	ID
Tamias amoenus	widespread	UT
Tamias dorsalis	widespread	ID,WY
Tamias ruficaudus	widespread	WA
Tamias striatus	widespread	FL,SD
Tamias umbrinus	widespread	ID,MT
Tamiasciurus douglasii	widespread	NV
GEOMYIDAE		
Thomomys talpoides	widespread	MN,UT
HETEROMYIDAE		
Chaetodipus hispidus	widespread	LA,MT,ND,WY
Chaetodipus intermedius	widespread	UT
Dipodomys deserti	widespread	UT
Dipodomys ordii	widespread	ND,WA
Dipodomys spectabilis baileyi	AZ,NM	AZ
Perognathus fasciatus	widespread	UT,WY
Perognathus flavescens	widespread	IA,MO,WY
Perognathus flavescens perniger	ND	ND
Perognathus flavus	widespread	WY
Perognathus longimembris gulosus	ID,UT,NV	ID
Perognathus parvus	widespread	WY
MURIDAE		
Clethrionomys gapperi	widespread	IA
Lemmiscus curtatus levidensis	widespread	WY
Lemmiscus curtatus pallidus	widespread	SD
Lemmiscus curtatus pauperrimus	OR,WA	WA
Microtus canicaudus	OR,WA	WA
Microtus chrotorrhinus chrotorrhinus	widespread	MN
Microtus longicaudus	widespread	SD,WY
Microtus ochrogaster	widespread	MN
Microtus pinetorum	widespread	MN
Microtus richardsoni	widespread	WY
Neotoma stephensi	UT,AZ,NM	UT
Onychomys torridus	widespread	UT
Oryzomys couesi aquaticus[1]	TX,MX	TX
Peromyscus crinitus	widespread	WY
Peromyscus eremicus	widespread	UT
Peromyscus gossypinus	widespread	KY,MO
Peromyscus leucopus	widespread	WY
Peromyscus nasutus	widespread	UT
Peromyscus truei	widespread	WY
Phenacomys intermedius	widespread	MN,WY
Reithrodontomys humulis	widespread	AR,LA
Reithrodontomys montanus	widespread	AR,MO,WY
Sigmodon ochrognathus[1]	AZ,NM,TX,MX	TX
Synaptomys borealis	widespread	MN
Synaptomys borealis chapmani	widespread	ID,MT
Synaptomys cooperi	widespread	IA

[1] Federal C2 candidate taxon

Table 6.5. North American rodent taxa previously listed as threatened or endangered, but that probably are not distinct from wide-ranging taxa of secure status according to the cited authority.

	Historical distribution	USA status	State listed	Reference
SCIURIDAE				
Cynomys ludovicianus arizonensis	USA: AZ,NM,TX Mexico	-	AZ,TX	Pizzimenti (1975)
GEOMYIDAE				
Thomomys bottae abstrusus	NV	C2	-	J. L. Patton (pers. comm.)
Thomomys bottae amargosae	CA	C3B	-	J. L. Patton (pers. comm.)
Thomomys bottae bonnevillei	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae convexus	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae curtatus	NV	C2	-	J. L. Patton (pers. comm.)
Thomomys bottae detumidus	OR	C2	-	J. L. Patton (pers. comm.)
Thomomys bottae dissimilis	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae hualpaiensis	AZ	C2	-	Hoffmeister (1986)
Thomomys bottae minimus	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae muralis	AZ	C2	-	Hoffmeister (1986)
Thomomys bottae nesophilus	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae powelli	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae robustus	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae sevieri	UT	C2	UT	J. L. Patton (pers. comm.)
Thomomys bottae suboles	AZ	C2	-	Hoffmeister (1986)
Thomomys bottae subsimilis	AZ	C2	-	Hoffmeister (1986)
Thomomys umbrinus quercinus	AZ	C2	-	Hoffmeister (1986)
HETEROMYIDAE				
Chaetodipus intermedius nigrimontis	AZ	C2	-	Hoffmeister (1986)
Dipodomys californicus eximius	CA	C2	CA	Williams (1986)
Dipodomys elephantinus	CA	C3B	CA	Best (1986)
Dipodomys merriami frenatus	UT	C2	UT	Durrant and Setzer (1945)
Dipodomys microps russeolus	UT	C2	-	Durrant (1952)
Dipodomys ordii cineraceus	UT	C2	-	Durrant (1952)
Microdipodops megacephalus nasutus	NV	C2	-	Hafner (1981)
Perognathus amplus ammodytes	AZ	C2	-	Hoffmeister (1986)
MURIDAE				
Neotoma mexicana bullata	AZ	C2	-	Hoffmeister (1986)
Neotoma micropus leucophaea	NM	C2	-	Birney (1973)
Oryzomys palustris planirostris	FL	C2	FL	Humphrey and Setzer (1989)
Oryzomys palustris sanibeli	FL	C2	FL	Humphrey and Setzer (1989)
Peromyscus eremicus papagensis	USA: AZ Mexico	C2	-	Hoffmeister (1986)
Peromyscus eremicus pullus	AZ	C2	-	Hoffmeister (1986)
Reithrodontomys megalotis arizonensis	AZ	C2	-	Hoffmeister (1986)
Reithrodontomys megalotis limicola	CA	C3B	-	Collins and George (1990)
Reithrodontomys megalotis ravus	UT	C2	-	Durrant (1952)
Reithrodontomys megalotis santacruzae	CA	C3B	-	Collins and George (1990)
Sigmodon arizonae jacksoni	AZ	C2	-	Hoffmeister (1986)

Recommended conservation strategies

In order to be effective, conservation strategies for rodents should be proactive and should include sustained, multidisciplinary, and collaborative approaches. These will necessarily require public education and involvement of governmental and private conservation agencies, research institutions, and private landowners. Conservation strategies will be more successful if they are based upon sound and adequate information about the rodents involved, which will require renewed efforts at gaining basic data. The polemicism, hyperbole, and rhetoric that has characterized over two decades of environmental debate since the passage of the U.S. Endangered Species Act must be replaced by fair and honest consideration of all facets of environmental issues. Conflicts must be resolved in a manner that includes both protection and rational use of natural resources, and avoids alienation of the public.

A proactive, habitat-based approach

Traditional tactics of rallying support for conservation of a particular species may be less productive for rodents than for more charismatic species. In the past, conservation action normally has been taken only after a species' survival has become imperiled. In the United States, action typically involves listing of a particular species under the Endangered Species Act, followed by design and eventual implementation of a recovery plan. Due to the substantial investment of funds and labor in this process, it has been employed primarily to the benefit of more charismatic species such as bald eagles, peregrine falcons, and wolves. Action for other species (e.g., snail darters, spotted owls), or action involving fundamental social or economic change (e.g., patterns of timber harvest, construction projects) has been controversial. Few rodents will be considered charismatic by the public, and consequently they are rather poor candidates for species-focused conservation efforts.

The large number of rodent taxa of conservation concern would also render species-by-species approaches ineffective. Extensive human impact on North American ecosystems, coupled with the diversity, habitat specificity, and low dispersal capabilities of most rodents, have placed one-half of the monotypic species of rodents in North America in some level of jeopardy, while nearly one-half of the total species have at least one subspecies of conservation concern.

We recommend a shift in emphasis from conservation of individual (often charismatic) species to the conservation of functional ecosystems. Preservation of larger areas of natural habitat is usually necessary to ensure the long-term survival of individual species. Moreover, habitat preservation will incidentally conserve co-occurring species, protecting species whose threatened status may be unknown to biologists and preventing others from becoming imperiled. Thus, this habitat approach is more proactive, more effective, and more cost-efficient. At the same time, we caution that the needs of individual threatened taxa, when known, must be considered in the overall management plan, and that establishment of larger habitat preserves is not a substitute for continued study of the interactions and dynamics of component species.

An ecosystem approach should emphasize the important ecological roles occupied by rodents. Rodents are important in soil aeration, soil fertility, and penetration of ground water into the soil (pocket gophers; Dalquest 1948; Ingles 1949, 1952); as prey for furbearers (Magoun and Johnson 1991) and predatory birds, and as keystone species supporting entire carnivore food webs (ground squirrels; Yensen *et al.* 1992); as keystone species supporting up to 170 associated species (prairie dogs; Miller *et al.* 1994); and play an integral role in forest health through their relationships with mycorrhizal fungi (chipmunks, voles, flying squirrels; Maser *et al.* 1978, C. Maser *et al.* 1986, Z. Maser *et al.* 1986).

The black-tailed prairie dog (*Cynomys ludovicianus*) provides a particularly cogent example of the enormous impact of rodents on ecosystems. This species merits our conservation concern even though it is not globally threatened. Secure populations exist in a number of states, and they are often locally abundant. However, black-tailed prairie dogs now occupy less than two percent of their former distribution, and surviving populations are fragmented and isolated (Miller *et al.* 1994). At the same time, an estimated 170 other species are associated with the black-tailed prairie dog, and several, including black-footed ferrets (*Mustela nigripes*) and swift foxes (*Vulpes velox*), are closely dependent upon *C. ludovicianus* (Miller *et al.* 1994, B. Ruediger pers. comm.). Thus, the distribution of this species tightly restricts the distribution and security of a wide variety of associated and dependent species. Ironically, the economic arguments used to justify eradication of prairie dogs now appear to be specious (Miller *et al.* 1994).

Sustainable strategy

In 1980, The World Conservation Union, United Nations Environment Programme, and World Wide Fund for Nature sought to end counterproductive battles between developers and environmentalists by declaring that "conservation is *not* the opposite of development" (IUCN/UNEP/WWF 1980). In the ongoing and accelerating conflicts between these two camps, mistakes have been made on both sides, including deliberate misrepresentation of biological data, political stacking of appointed review boards, and public name-calling. Clearly, a new strategy is needed, as outlined in *Caring for the Earth: A Strategy for Sustainable Living* (IUCN/UNEP/WWF 1991). In this sense, we particularly endorse principles and actions directed at changing personal attitudes and practices, enabling communities to care for their own environments, and providing a national framework for integrating development and conservation. Without a substantial shift in strategy, we can expect current patterns of adverse impact and extinction to accelerate.

Collaborative efforts

While we remain cautiously optimistic that a framework can be developed in which development and conservation can be integrated in a sustainable conservation strategy, we are discouraged at the lack of cooperation and collaboration among the diverse government and private conservation agencies. Conservation efforts of state and

provincial agencies are notoriously uneven, and the diversity of criteria and codes for recognition of threatened species is truly bewildering. In our survey of state conservation agencies, we found that many states lack non-game conservation departments, or existing departments often have no contact with similar agencies in neighboring states. This uncoordinated approach results in redundant, inefficient, and misdirected conservation efforts. It is truly a rare species that has a geographic limit coincident with a political border, yet state conservation efforts rarely look beyond the state's borders or consider the global status of species.

Conservation agencies, whether federal, state, provincial, or private, must develop more innovative ways to gather the necessary natural history information for Data Deficient taxa; to gain a sharper appreciation of the specific threats to Lower Risk (Near Threatened) taxa; and to monitor the status of Lower Risk (Conservation Dependent) taxa. In order to avoid duplication of effort, rapidly determine the appropriate action plan for a given taxon, and promote efficient use of limited funds, conservation agencies must develop cooperative efforts among themselves and with academic institutions. One particularly successful model appears to be the growing network of state and provincial Heritage Programs that are set up by The Nature Conservancy (TNC) and, in many cases, adopted by state and provincial governments. Many state conservation agencies are already working closely with the local Heritage Program. We strongly recommend that more states and provinces follow this example, and that federal conservation agencies become active partners in cooperative efforts. We recognize that this will involve dropping territorial attitudes, and in some cases redundant agencies will have to be relocated, merged, or dissolved. Such changes would certainly be justified and rewarded if the result is a coordinated, cost-efficient, and proactive network of conservation agencies that works with the public and private interests to conserve biodiversity.

There exists an unfortunate variety of threat categories to which species of conservation concern are assigned. Often, state regulatory agencies have developed their own criteria, which bear little resemblance to those of even neighboring states. A noteworthy exception to this pattern involves TNC's scheme, which is used by all Heritage Programs. These criteria are very similar to Red List criteria employed by the IUCN, except that TNC has both state and global status assignments. Red List and TNC assignments of species included in this Action Plan are both listed in Table 5.1, and global rankings are compared in Table 6.6. In general, there is a rough correspondence between Red List and TNC rankings at the species level, but subspecies are assigned to ranks of higher threat by TNC than to Red List categories in this Action Plan. A number of species and subspecies of rodents not included in this Action Plan have been assigned global ranks of G3 (species) or T3 (subspecies) or higher threat by TNC (Table 6.7). Although these may include invalid taxa, we include them here as possible candidates for consideration in future action plans.

In order to enact a more proactive approach to conservation issues, regulatory agencies must gain knowledge of Data Deficient taxa and devise means to avoid costly future mitigation. Certainly, higher-priority taxa necessarily demand the greater proportion of limited federal and state funding. However, our experience has been that cooperative efforts between regulatory agencies and academic institutions has been inadequately exploited in most regions. By forging stronger ties with regional universities and natural history museums, conservation agencies can have increased access to studies currently underway, and increase opportunities for graduate or undergraduate study with little expenditure of limited funds. Most of the Data Deficient taxa are in need of basic natural history information that could be obtained through field work conducted by undergraduate students supervised by appropriate mentors. Funding for such work is readily available through federal programs such

Table 6.6. Comparison of global-status rankings for taxa ranked by both IUCN (this Action Plan) and The Nature Conservancy (TNC).
Number of taxa not ranked by TNC shown in parentheses. Status codes are defined in Appendix 2.

n (species)	*n* (subspecies)	IUCN Category	TNC status (species) Mean rank	TNC status (species) Range	TNC status (subspecies) Mean rank	TNC status (subspecies) Range
0	7 (1)	EX	(GX)	-	TX	TX–T1
1	12	CR	G2	-	T1	TX–T2
2 (1)	7 (1)	EN	G2G3	G2–G3	T1T2	T1–T2
6	25 (5)	VU	G2	G1G2–G3	T1	TX–T3
2	2 (2)	LR(cd)	G2	G1G2–G2	T2T3	T2–T3
15	35 (5)	LR(nt)	G3G4	G1–G5	T2T3	TH–T5
52	-	LR(lc)	G5	G4–G5	(T5)	-
5 (2)	36 (13)	DD	G3G4	G3–G4	T2T3	T1–T4T5

Table 6.7. Rodent species listed at a threat category of G3 or higher, and subspecies listed at a threat category of T3 or higher by The Nature Conservancy, not included in Tables 6.3-6.5, and not included in this Action Plan. This list may include invalid taxa.

	Historical distribution	Global status	State status
SCIURIDAE			
Marmota olympus	WA	G3	S?
Sciurus aberti kaibabensis	AZ	G5T3	S3
Spermophilus parryii osgoodi	AK	G5T3?	S3?
Spermophilus tridecemlineatus monticola	AZ	G5T3	S3
Tamias amoenus celeris	NV	G5TH	SH
Tamias panamintinus acrus	CA	G5T1T2	S1S2
Tamias speciosus callipeplus	CA	G5T1T3	S?
Tamiasciurus hudsonicus picatus	AK	G5T3?	S3?
GEOMYIDAE			
Geomys knoxjonesi	NM,TX	G3	TX: S2
Geomys personatus davisi	TX	G4T2	S2
Geomys texensis texensis	TX	G3T2	S2
Thomomys bottae pervagus	CO,NM	G5T3	CO: S2
Thomomys talpoides clusius	WY	G5T2	S2
Thomomys mazama hesperus	OR	G4G5T2T3?	SU
Thomomys mazama niger	OR	G4G5T2T3?	SU
HETEROMYIDAE			
Dipodomys compactus compactus	TX	G4T3	S3
Dipodomys ordii cineraceus	UT	G5T1	S1
Dipodomys panamintinus argusensis	CA	G5T1T3	S?
Dipodomys panamintinus panamintinus	CA	G5T3	S3
Perognathus flavescens relictus	CO	G5TH	SH
Perognathus inornatus inornatus	CA	G4QT2T3	S2S3
Perognathus parvus xanthonotus	CA	G5T3	S3
MURIDAE			
Arborimus longicaudus longicaudus	OR	G4T3	S3
Arborimus longicaudus silvicola	OR	G4T3	S3
Clethrionomys gapperi rupicola	PA	G5T3Q	S3
Clethrionomys gapperi stikinensis	USA: AK Canada: BC	G5T2T3	AK: S?
Clethrionomys gapperi wrangeli	AK	G5T2T3	S2S3
Clethrionomys rutilus albiventer	AK	G5T3	S3
Clethrionomys rutilus glacialis	AK	G5T3	S3
Clethrionomys rutilus insularis	AK	G5T3	S3
Clethrionomys rutilus orca	AK	G5T3	S?
Lemmus sibiricus nigripes	AK	G5T3	S3
Microtus ochrogaster ludovicianus	LA	G5TX	SX
	TX		SX
Microtus oeconomus unalascensis	AK	G5T3	S3
Microtus pennsylvanicus nesophilus	NY	G5TX	SX
Peromyscus maniculatus algidus	USA: AK Canada: BC,YT	G5T3	AK: S?
Peromyscus sitkensis oceanicus	AK	G5T3Q	S3
Peromyscus sitkensis sitkensis	AK	G5T3?	S3?
Reithrodontomys megalotis distichlis	CA	G5TH	SH
Sigmodon hispidus exsputus	FL	G5T2	S2
Synaptomys cooperi helaletes	NC	G5T3	S2?
	VA		S3

as the Research Experience for Undergraduates program of the National Science Foundation. In many cases, the necessary information is already available, having been gathered incidentally during other studies (e.g., observations noted during studies directed at evolutionary relationships of a taxon) but has not been included in a publication.

Public involvement

Recently, the U.S. Fish and Wildlife Service has been using "conservation agreements" as alternatives or supplements to the Endangered Species Act, sometimes in lieu of listing. Conservation agreements are fixed-term agreements between land owners, land managers, governmental

agencies, or other interested parties that specify actions that will be taken on behalf of a species of conservation concern. Conservation agreements have the advantage of being much less expensive, more rapid, and more flexible than formal listing, and involve the people directly impacted by conservation efforts of the species in question. Another approach that is proving to be successful is the use of conservation easements, in which land owners receive something of value (e.g., money or tax credits) in exchange for restrictions on the use of their property that help ensure the survival of a species. We feel that such direct involvement of all parties with interests in the area and the animal in question is highly preferable to the all-too-common confrontational politics of conservation.

Need for basic research

The role of taxonomy and systematics in conservation biology and wildlife management cannot be overstated (Vane-Wright *et al.* 1991; Rojas 1992). Failure to recognize the limitations of existing taxonomies has resulted in serious management mistakes (Daughtery *et al.* 1990; May 1990). The major problem in rodent conservation is lack of solid information. The subspecies-level (and in some cases, species-level) taxonomy of most groups is outdated and often based upon few specimens.

Recall that for 77 taxa (nearly one-half of the total included in this Action Plan), the nature of threat, if any, is unknown. The need for basic survey and taxonomic study is perhaps most obvious in southeastern Alaska and adjoining British Columbia, which together include the most extensive temperate rain forest in the world (Alaback 1991). The fauna and flora of the area are characterized by a high rate of endemism stemming from the large number of islands and complex topography of the region. Most of southeastern Alaska is under federal jurisdiction in Glacier Bay National Park or Tongass National Forest, the largest national forest in the United States that covers some 80% of southeastern Alaska. Federal legislation (National Environmental Policy Act of 1969, Endangered Species Act of 1973, National Forest Management Act of 1976) has mandated the conservation of biological diversity as a national goal in forests, yet surprisingly little has been done to rigorously inventory the biotic diversity of the coastal forest ecosystem of southeastern Alaska, a significant portion of which has been clearcut logged (Kiester and Eckhardt 1994). Much of our knowledge of rodent distributions in this region derives from biological surveys conducted at the beginning of this century. In Alaska, two of these, the Alexander Expeditions of 1907 and 1909 (Heller 1909; Swarth 1911) remain our best sources of information. Unfortunately both were limited in geographic scope and in time spent at collecting localities. Despite the restricted coverage of these early studies (24 islands sampled out of more than 1000), three new species and 23 subspecies of small mammals were described as endemic to this region of North America (Hall 1981). Since that time, technological and theoretical advances have greatly enhanced our ability to describe genetic variation and species boundaries (Hillis and Moritz 1990; Avise 1994).

Rodent conservation cannot take place in an information vacuum, and the need for basic taxonomic studies and modern inventories must be addressed immediately. Museum collections play an important role in this basic research, housing the most complete documentation of species and habitats that are disappearing at an accelerating rate. Museum specimens provide physical documentation for species identifications and associated data on reproduction, habitat, and parasites (Yates 1987). Expansion of museum collections should include biological inventories of threatened and disappearing habitats and species, voucher specimens from biological surveys, and diversified samples including frozen tissue collections (Miller 1993).

Concluding remarks

Lidicker (1989) asked if rodent conservation was a viable issue. We feel the question can be answered in the affirmative. Despite the large number of taxa for which we have insufficient information, documented conservation problems do indeed exist for a substantial proportion of North American rodents. The geographic and ecological diversity of rodents, combined with their value as biological indicators of specific habitats, should promote their inclusion in conservation programs directed at ecosystems. Similarly, their abundance and ubiquity should encourage cooperation among government and private conservation agencies. In effect, rodents deserve a central role in conservation programs.

In addition to specific actions directed at individual species, we have suggested or endorsed newer approaches to conservation: protecting entire ecosystems, involving the public through conservation agreements and easements, increasing cooperation among conservation agencies, and developing innovative means to gather needed data. In the final analysis, success of these conservation efforts will depend on a major shift in public attitudes towards our environment. Unless we voluntarily adopt actions that limit human population growth, decrease environmental pollution, and integrate development and conservation into a strategy for sustainable living, conservation efforts will be fighting a continual retreating action. Rodents have not enjoyed a favored place in human appreciation; if considered at all, it is usually in a negative context. If the public can learn to appreciate the value of rodents to the survival of our environment and to human welfare, then there is certainly cause for hope of success in our conservation efforts.