Land Mollusk Surveys on USFS Northern Region Lands: 2006

Prepared for:

USDA Forest Service
Northern Region

Prepared by:

Paul Hendricks, Bryce A. Maxell, Susan Lenard and Coburn Currier

Montana Natural Heritage Program
Natural Resource Information System
Montana State Library

June 2007

MONTANA
Natural Heritage
Program

Land Mollusk Surveys on USFS Northern Region Lands: 2006

Prepared for:

USDA Forest Service, Northern Region
P.O. Box 7669
Missoula, MT 59807

Agreement Number:

05-CS-11015600-033

Prepared by:

Paul Hendricks, Bryce A. Maxell, Susan Lenard and Coburn Currier

P.O. Box 201800 • 1515 East Sixth Avenue • Helena, MT 59620-1800 • 406-444-5354

This document should be cited as follows:

Hendricks, P., B. A. Maxell, S. Lenard and C. Currier. 2007. Land Mollusk Surveys on USFS Northern Region Lands: 2006. Report to the USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana 11 pp. plus appendices.

Executive Summary

Using published reports and the NatureServe web site as starting points, we compiled a list of 29 snail taxa within the U.S. Forest Service Northern Region (Region 1) area globally ranked in 2005 as G1G3 or T1T3, thereby meeting USFS Species of Concern (SOC) criteria, and two additional G5 snail taxa state ranked S1S2, thereby meeting USFS Species of Interest (SOI) criteria. We also compiled a list of eight slug taxa ranked in 2005 as G1G3, and three additional slug taxa ranked G4G5 but S1S2, again meeting the respective USFS criteria for SOC or SOI. Heritage Program surveys in 2005 included lands in both Idaho and Montana; the 2006 Heritage Program surveys were restricted to Forests in Montana.

We conducted a total of 156 site surveys across National Forest units in Montana in 2006, primarily targeting areas lacking prior surveys. SOC and/or SOI taxa were found at 49 (31.4%) of the sites. Site surveys were distributed on the Montana Forests as follows: Beaverhead-Deerlodge (14), Bitterroot (18), Custer (36), Flathead (15), Gallatin (9), Helena (15), Kootenai (24), Lewis & Clark (8), and Lolo (17).

We documented 106 locations for eight USFS Region 1 SOC taxa and five SOI taxa during our 2006 surveys: Striate Disc *Discus shimekii* (2 sites), Berry's Mountainsnail *Oreohelix strigosa berryi* (1 site), Robust Lancetooth *Haplotrema vancouverense* (9 sites), Humped Coin *Polygyrella polygyrella* (5 sites), Fir Pinwheel *Radiodiscus abietum* (25 sites), Pale Jumping-slug *Hemphillia camelus* (2 sites), Marbled Jumping-slug *Hemphillia danielsi* (5 sites), Magnum Mantleslug *Magnipelta mycophaga* (4 sites), Pygmy Slug *Kootenaia burkei* (7 sites), Reticulate Taildropper *Prophysaon andersoni* (1 site), Smoky Taildropper *Prophysaon humile* (24 sites), Lyre Mantleslug *Udosarx lyrata* (2 sites), and Sheathed Slug *Zacoleus idahoensis* (20 sites). Most locations are from west of the Continental Divide in mesic forest habitats (e.g., western redcedar, western hemlock, mesic Douglas-fir, grand fir). Distribution maps showing locations for all terrestrial mollusk taxa can be viewed at the Montana Natural Heritage Program Tracker website http://mtnhp.org/Tracker.

In 2006, we collected additional location data for two SOC and one SOI slug species new in 2005 to the known mollusk fauna of Montana: Pale Jumping-slug, Pygmy Slug, and Reticulate Taildropper. The 2006 survey also added several new Montana locations for a third SOC slug species, Smoky Taildropper, which was documented in Montana only once prior to 2004. As a result of the 2005 surveys, Global Ranks shifted downward for five species (Humped Coin, Fir Pinwheel, Pale Jumping-slug, Pygmy Slug, and Smoky Taildropper). Additional Global and State Rank adjustments may be warranted following the results of the 2006 survey effort. We collected distribution data on 31 additional non-SOC/SOI species as we encountered them during our surveys, including one species, Boreal Top (*Zoogenetes harpa*), new to the known terrestrial mollusk fauna of the state.

At least some SOI G4G5 taxa found during our 2005-2006 surveys may prove to be distinct from related coastal populations, as their disjunct distributions are similar to some vertebrate amphibian taxa (e.g., *Dicamptodon*, *Ascaphus*, *Plethodon*) now split into coastal and Rocky Mountain sister species. Therefore, we think it desirable to conduct genetic analyses of several mollusk SOC and SOI taxa to determine it they represent forms meriting full species status. Additional inventory is also desirable to fill remaining distribution gaps, describe habitat associations more thoroughly, and laying the foundation for development of a long-term monitoring scheme and standardized survey methodology.

Detection probabilities for terrestrial mollusks were evaluated with multiple surveys of individual sites on the Kootenai National Forest as a pilot project to: (1) compare naïve site occupancy rates with estimates adjusted for the fact that species are not detected at all sites where they are present;

and (2) plan future inventory and monitoring efforts. Models best fitting the resulting data all indicated that detection probabilities were not significantly different between surveyors. For those species with sufficient data, estimated detection probabilities ranged from a low of 0.095 to a high of 0.886, and approximated a normal distribution with mean = 0.48, median = 0.49, and mode approximating 0.6. Robust estimates of site occupancy resulting from multiple surveys of individual sites were almost universally higher than naïve site occupancy rates from single visit surveys (mean = 0.11, median = 0.05, mode approximating 0.06, and range = 0.00 to 0.658 higher).

The detection probability analysis indicates evaluating the effects of imperfect detection of species can be extremely important in preventing the designation of a species of management concern when it lacks justification for this attention. In general, simulations showed that: (1) when site occupancy rates are truly below 0.8, detection probabilities need to approach 0.4 before acceptable confidence intervals result; (2) existing levels of sampling effort (approximately 50 days or 200 surveys) is adequate for monitoring most individual species when detection probabilities exceed 0.4, but is inadequate for at least a few Species of Concern, and may be generally inadequate for monitoring larger groups of species across larger regions.

Increasing detection probability can dramatically reduce the size of confidence intervals. Pilot studies examining the effects of survey covariates (such as weather, temperature, and spring vs. fall surveys) on detection probability may result in cost savings. In the future we recommend additional pilot surveys to evaluate baseline levels of site occupancy and detection probability for all terrestrial mollusk species in Montana not evaluated with this pilot effort. Systematic surveys also need to address how detection probabilities vary with survey covariates (such as weather, temperature, and season of survey) and site covariates (such as cover type, elevation, aspect, and timber harvest regime). This will provide a sound basis for making decisions about the status of species and evaluating the impacts of forest management practices.

Acknowledgements

Fred Samson (USFS) recognized the need to address invertebrates in the Forest planning process, appreciating the extremely limited information available for management decision-making, and promoted the project through the USFS Regional Inventory and Monitoring (RIM) program. Henning Stabins (Plum Creek Timber Company) and the Amphibian Inventory Project provided us with additional records of SOC mollusk species helping fill significant gaps in distributions. Bill Bosworth, zoologist with the Idaho Conservation Data Center, provided the Montana Natural Heritage Program (MTNHP) with location data on SOC species tracked in the Idaho portions of the Northern Region; the Idaho records were especially critical for the production of new distribution maps in 2005, and fleshing out distributions of rare land mollusk species occurring on both sides of the Idaho-Montana border. Bill Leonard (Olympia, WA) and Tim Pearce (Carnegie Museum of Natural History) verified our tentative SOC and SOI slug identifications in 2005. Ryan Killackey conducted some of the surveys in 2006 and added many important new records. We thank them all.

Table of Contents

List of Tables

INTRODUCTION

Within and adjacent to the landscape bounded by the Northern Region are a large number of land mollusk species endemic to the Northern Rocky Mountains, and several additional species are restricted to the Pacific Northwest, with disjunct populations in northern Idaho and northwestern Montana (Frest and Johannes 1995, 1997, 2001; Hendricks 2003; Hendricks et al. 2006). Parts of the area bounded by the Northern Region, especially portions of the Lower Salmon River drainage, were recognized relatively early as centers of mollusk endemism, and drew attention of several early collectors (Frest and Johannes 1997). Nevertheless, many areas in Idaho as well as Montana were never visited or remain poorly inventoried, as demonstrated by the recent discovery of a new slug genus in northern Idaho (Leonard et al. 2003). Limited survey of the region is partly a result of timing. When much pioneering collecting of the terrestrial mollusk fauna was undertaken, roughly 1860-1950, many portions of the survey area were difficult to reach without significant commitment of time and resources. During the mid and late 20th century, when road access across the study area increased dramatically, far fewer malacologists were resident or active in the region. Only recently has there been recognition by biologists that many mollusk species in the region are threatened with a variety of potentially detrimental land use activities, prompting renewed inventories.

The US Forest Service is required under the National Forest Management Act of 1976 and Code of Federal Regulations (CFR 1985) to maintain a diversity of plant and animal species. Inventory is a first step in the evaluation of landscapes and their likelihood of supporting populations of animal species of conservation concern. Pursuant with this legislation and associated regulations, the Northern Region initiated surveys in 2005 for a suite of land mollusks listed as Species of Concern in Montana and Idaho (Hendricks et al. 2006). Objectives of the 2005 inventory included filling species distribution gaps, testing survey methodology, and collecting geospatial and habitat data for the development of predictive habitat models that can aid future survey efforts. The survey was continued in 2006 with the same objectives, and with the Montana Natural Heritage Program restricting its field effort to the nine National Forests within Montana.

Methods

Prior to conducting field surveys in 2005, we searched the published and gray literature to compile a list of high-priority "target" species (globally and state rare species in Montana, and globally rare species in Idaho), ranked above G4 or S4 (see Appendix A for rank definitions). Primary sources we used for this compilation included Pilsbry (1939, 1948), Frest and Johannes (1995, 1997, 2001), and Hendricks (2003). This resulted in a list of 41 species and subspecies (31 snails, 10 slugs) we considered to be of conservation concern (Appendix B); 12 of these taxa are ranked less than G3. We then generated a list of general habitat associations for the high-priority species (Appendix C), to help us prioritize habitats for our surveys in 2005 and 2006. Limited information for mollusks east of the Continental Divide in Montana made this process more problematic for the high-priority species that occur or might occur in that region.

We conducted field surveys for land mollusks during late September to late October 2006, when the weather was most suitable (cool and moist) for finding active snails and slugs. We visited all nine National Forests in the Northern Region of Montana, so survey effort was stratified by Forest (sometimes by mountain range within a forest) and spread thinly across the inventory area (sites surveyed are listed in Appendix D). However, we tried to spend more time on Forests with the least amount of prior survey effort or distribution information.

We selected sites for surveys based primarily on the presence of perennial water, moist mature conifer forest, aspen, and/or limestone talus or other rock outcrops. At each site, we conducted timed surveys while searching under leaf litter, dead wood and bark, rocks imbedded in the ground, or digging into talus. Usually within a survey site we searched several locations with habitat features (such as bryophyte mats, dead wood and imbedded rocks, or talus slopes) considered by experts to be favored by snails and slugs, often concentrating searches in riparian zones.

We recorded a variety of habitat and site information at each survey location on standardized data forms (Appendix E). Survey data from 2006 have been entered into the Montana Natural Heritage Program Point Observation Database (POD); copies of the Idaho POD data collected in 2005 were sent to the Idaho Conservation Data Center (CDC) in Boise. We collected voucher specimens of all Species of Concern (SOC) we discovered, as well as representatives of many other non-SOC taxa; vouchers were preserved in 95% ETOH in order to permit future genetic analyses. We sent SOC slug vouchers collected in 2005 to taxonomic experts. Their identifications were verified, and we used this knowledge to make species determinations of the 2006 material.

During 2006, we conducted a pilot study of detection probabilities and estimated site occupancy rates for a number of terrestrial mollusks on the Kootenai National Forest. This forest was chosen for preliminary study because it is one of two national forests in Montana where ten SOC or SOI species have been documented (see Appendix B) Details of the detection probability work are presented in Appendix F.

Results and Discussion

OVERVIEW

We conducted a total of 156 site surveys in 2006 (Appendix D). These were distributed on the Montana Forests as follows: Beaverhead-Deerlodge (14), Bitterroot (18), Custer (36), Flathead (15), Gallatin (9), Helena (15), Kootenai (24), Lewis & Clark (8), and Lolo (17). SOC and/or SOI taxa were documented at 49 (31.4%) of the sites, mostly west of the Continental Divide. We conducted no surveys in the northern portions of the Kootenai National Forest, and only a few on the Flathead and Lolo national forests in the Mission Mountains, Swan Range, and Swan Valley, even though the latter is an area of significant land mollusk endemism, with additional records of rare regional species (Fairbanks 1984; Frest and Johannes 1995, 1997, 2001; Hendricks 1998, 2003; Hendricks et al. 2006), and the former region likely harbors several SOC/SOI taxa. These two regions of northwestern Montana merit additional surveys.

We documented 106 locations for eight USFS Region 1 SOC taxa and five SOI taxa during our 2006 surveys (Table 1): Striate Disc *Discus shimekii* (2 sites), Berry's Mountainsnail *Oreohelix strigosa berryi* (1 site), Robust Lancetooth *Haplotrema vancouverense* (9 sites), Humped Coin *Polygyrella polygyrella* (5 sites), Fir Pinwheel *Radiodiscus abietum* (25 sites), Pale Jumping-slug *Hemphillia camelus* (2 sites), Marbled Jumping-slug *Hemphillia danielsi* (5 sites), Magnum Mantleslug *Magnipelta mycophaga* (4 sites),

Table 1. Number of survey sites where Species-of-Concern land molluscs were detected on Northern Region Forests in Montana during the 2006 survey (n = 156 sites). G Ranks are at the time of the 2006 surveys.

SPECIES		G RANK	TOTAL SITES	Montana[a]								
				B-D	BI	CU	FL	GA	HE	KO	L-C	LO
SNAILS												
Striate Disc	*Discus shimekii*	G5	2					2				
Robust Lancetooth	*Haplotrema vancouverense*	G5	9							9		
Berry's Mountainsnail	*Oreohelix strigosa berryi*	G5T2	1								1	
Humped Coin	*Polygyrella polygyrella*	G3	4							4		
Fir Pinwheel	*Radiodiscus abietum*	G4	24		2		1			17		4
SLUGS												
Pale Jumping-slug	*Hemphillia camelus*	G3G4	2							2		
Marbled Jumping-slug	*Hemphillia danielsi*	G2G3	5		4							1
Pygmy Slug	*Kootenaia burkei*	G2	7							4		3
Magnum Mantle-slug	*Magnipelta mycophaga*	G3	5							1		4
Reticulate Taildropper	*Prophysaon andersoni*	G5	2							2		
Smoky Taildropper	*Prophysaon humile*	G3	23				7			12		4
Lyre Mantleslug	*Udosarx lyrata*	G2	2		1							1
Sheathed Slug	*Zacoleus idahoensis*	G3G4	20		1					16		3

[a] Montana Forests codes: Beaverhead-Deerlodge (B-D), Bitterroot (BI), Custer (CU), Flathead (FL), Gallatin (GA), Helena (HE), Kootenai (KO), Lewis & Clark (L-C), Lolo (LO).

Pygmy Slug *Kootenaia burkei* (7 sites), Reticulate Taildropper *Prophysaon andersoni* (1 site), Smoky Taildropper *Prophysaon humile* (24 sites), Lyre Mantleslug *Udosarx lyrata* (2 sites), and Sheathed Slug *Zacoleus idahoensis* (20 sites). Many locations are from west of the Continental Divide in mesic forest habitats (e.g., western redcedar, western hemlock, mesic Douglas-fir, grand fir).

In 2006, we collected additional location data for two SOC and one SOI slug species, all discovered on the Kootenai National Forest in 2005 and new at that time to the Montana mollusk fauna. Pale Jumping-slug has now been documented at three sites, Pygmy Slug at 11 sites, and Reticulate Taildropper at two sites; three of the new Pygmy Slug sites are on the Lolo National Forest. In additional, in 2006 we greatly expanded the number of Montana locations documented for the Robust Lancetooth, from two 1950's records (Brunson and Osher 1957) to 11 total locations. The 2006 survey added 24 Montana locations to the seven in 2005 for the Smoky Taildropper, thereby bringing the total locations to about 35 for a G3 slug which was documented in Montana only once prior to 2004. We expected to document more than four new locations of Magnum Mantleslug, given the habits we surveyed, but we were more successful for this SOC species than during our autumn 2005 survey (Hendricks et al. 2006). To date, the slug with the fewest reported localities in Montana (other than the recently-documented Pale Jumping-slug) is the Lyre Mantleslug, known from just five sites even though it was first documented in the state in 1965 (Russell and Webb 1980); two of the five sites were a result of the 2006 surveys.

One snail species was added to the known Montana land mollusk fauna as a result of the 2006 survey: Boreal Top (*Zoogenetes harpa*). This species is widespread across the boreal regions of North America and the Palearctic (Pilsbry 1948; Forsyth 2004), and is ranked G5. It has no S Rank for Montana at this time. With additional survey documentation, it may eventually be added to the state Species of Concern list and might merit adding the SOI list for the Northern Region. A single individual was found in a cottonwood stand along West Rosebud Creek (6380 ft elevation) in the Beartooth Mountains of Stillwater County, on the Custer National Forest (Appendix D). We anticipate this land snail will be documented at other Montana sites, with additional survey effort, as it has been found in several mountain ranges of northern Wyoming (Beetle 1957, 1961, 1989).

As a result of the 2005 surveys, the Global Rank of Humped Coin changed from G2G3 to G3, the Fir Pinwheel changed from G3 to G4, Pale Jumping-slug changed from G3G4 to G4, the Pygmy Slug changed from G1G2 to G2, and Smoky Taildropper changed from G2 to G3. We anticipate additional Global and State Rank changes may occur as a result of the 2006 surveys. In summary, the 2005 and 2006 Northern Region surveys have made a significant contribution to our understanding of the current status of several land mollusk species of conservation interest in Montana.

At least some SOI G4G5 taxa we found during our 2005 and 2006 surveys (e.g., Robust Lancetooth, Reticulate Taildropper), and others known from northern Idaho but not yet documented in Montana, such as Blue-gray Taildropper (*Prophysaon coeruleum*) and Papillose Taildropper (*Prophysaon dubium*) (Leonard et al. 2003; Ovaska et al. 2004), may prove to be distinct from related coastal populations, as their disjunct distributions are similar to some vertebrate amphibian taxa (e.g., *Dicamptodon*, *Ascaphus*, *Plethodon*) now split into coastal and Rocky Mountain sister species. Thus, we think it desirable to conduct genetic analyses of several mollusk SOC and SOI taxa to determine if they represent forms meriting full species status.

Finally, we recorded 31 additional terrestrial mollusk species (including exotics) as we encountered them during our 2006 surveys. These species are not currently recognized as SOC or SOI, nor are they likely to merit such status, and will not be discussed further in this report. Distribution maps showing locations where we found these taxa can be viewed at the Montana Natural Heritage Program Tracker website http://mtnhp.org/Tracker. Available for viewing are our 2005 records, including two of the Chrome Ambersnail (*Catinella rehderi*) from Carbon and Fergus counties, Montana. Species of *Catinella* are impossible to identify to species based on shells alone (T. Pearce personal communication), so our identification of shells from these sites remains tentative, and influenced by one prior Montana record from Meagher County (Pilsbry 1948).

SPECIES ACCOUNTS

Striate Disc

(*Discus shimekii*)

We found this species at two sites in Park County, on the Gallatin National Forest, at about 5750 ft elevation (Table 1, Appendix D). The Striate Disc has a wide distribution in western North America (Pilsbry 1948; Frest and Johannes 1993; Forsyth 2004) and is ranked G5. It is a Montana SOC because of less than 10 documented occurrences in the state (Hendricks et al. 2006; Appendix G). Canopy at the 2006 sites included lodgepole pine and Engelmann spruce, with some scattered aspen; 22 shells were present at one site.

Robust Lancetooth

(*Haplotrema vancouverense*)

We found this species at nine sites between 2180-3700 ft elevation, in Lincoln and Sanders counties, on the Kootenai National Forest (Table 1, Appendix D and G). The Robust Lancetooth has a wide distribution in the Pacific Coast states and British Columbia (Forsyth 2004) and is ranked G5. It was a new Montana SOC in 2005 because of only two 1950's records from Sanders County (Brunson and Osher 1957), and none new in recent years. Frest and Johannes (2001) listed the Robust Lancetooth as only from northern Idaho, where it is rare. Populations in northern Idaho and northwestern Montana appear disjunct from the main coastal range, and should be examined genetically to determine if they actually are sister species. Canopy at the 2006 sites included western redcedar, grand fir, western hemlock, Douglas-fir, alder, or paper birch; live individuals and shells (usually only a few at each site) were found under wood, leaf litter, rocks, or bryophyte mats.

Berry's Mountainsnail

(*Oreohelix strigosa berryi*)

We found this subspecies at one site in central Montana at 5960 ft elevation in Fergus County, on the Lewis and Clark National Forest (Table 1, Appendix D and G). Berry's Mountainsnail is a narrowly distributed subspecies largely restricted to central Montana and the Black Hills (Frest and Johannes 1993). It is a member of a species found throughout western North America (Pilsbry 1939; Forsyth 2004). It is most abundant in the island mountain ranges of central Montana, especially the Big Snowy Mountains (Berry 1916). Canopy at the 2006 site included Douglas-fir. Eight live animals and eight shells were found.

Humped Coin

(*Polygyrella polygyrella*)

We found this species at five sites between 2570-3660 ft elevation in Mineral and Sanders counties, on the Kootenai and Lolo national forests (Table 1, Appendix D and G). The Humped Coin, first described from Montana and Idaho by Bland and Cooper (1861) and Cooper (1868), is also present in adjacent Washington and Oregon (Frest and Johannes 1995, 2001). In 2006, we found this species in the Clark Fork River drainage, and all known Montana sites are clustered in Sanders and Mineral counties (Hendricks 2003, 2005; Hendricks et al. 2006). Canopy at the 2006 sites included western redcedar, western hemlock, grand fir, Douglas-fir, alder, black cottonwood, and mountain maple. Live animals were found at all sites, with as many as 35 found on ferns, and in leaf litter and bryophyte mats.

Fir Pinwheel

(*Radiodiscus abietum*)

We found this species at 25 sites between 2180-6360 ft elevation, in Lincoln, Mineral, Missoula, Ravalli, and Sanders counties, on the Bitterroot, Flathead, Kootenai, and Lolo national forests (Table 1, Appendix D and G). The Fir Pinwheel is restricted to northern Idaho, western Montana, and adjacent parts of Oregon and Washington (Brunson and Russell 1967; Frest and Johannes 1995, 2001; Hendricks 2003, 2005; Hendricks et al. 2006). Canopy at the 2006 sites included western redcedar, grand fir, Douglas-fir, western hemlock, subalpine fir, alder, water birch, cottonwood, aspen, western larch, and Pacific yew. Up to 12 live individuals were present, mostly under downed wood, but also rocks and bryophyte mats.

Pale Jumping-slug (*Hemphillia camelus*)

We found this species at two sites between 2550-3250 ft elevation, in Lincoln and Sanders counties, on the Kootenai National Forest (Table 1, Appendix D and G). This species was first documented in Montana during the 2005 survey (Frest and Johannes 1995; Hendricks 2003; Hendricks et al. 2006). The Pale Jumping-slug appears to be restricted to northern Idaho, and adjacent parts of Washington, British Columbia, Alberta, and now Montana (Frest and Johannes 1995, 2001; Forsyth 2004). Frest and Johannes (1997, 2001) suggested individuals from the Lower Salmon River drainage in Idaho might represent a taxon distinct from those found to the north, but this possibility has not been resolved. Canopy at the 2006 sites included western redcedar, subalpine fir, Engelmann spruce, western hemlock, Douglas-fir, and cottonwood. Three individuals total were found under downed wood and rock.

Marbled Jumping-slug (*Hemphillia danielsi*)

We found this species at five sites between 3660-4950 ft elevation, in Mineral and Ravalli counties, on the Bitterroot and Lolo national forests (Table 1, Appendix D and G). This species was first documented in Montana in 1912 (Vanatta 1914; Frest and Johannes 1995; Hendricks 2003). Until recently, the global range was exclusively the Bitterroot Mountains. The Marbled Jumping-slug appears to be restricted to extreme western Montana south of the St. Regis River, near the state line with Idaho (Frest and Johannes 1995, 2001; Hendricks et al. 2006); it may occur in Idaho, but this has yet to be confirmed. Canopy at the 2006 sites included western redcedar, subalpine fir, Engelmann spruce, western hemlock, Douglas-fir, ponderosa pine, cottonwood, and aspen. Up to four individuals were found at a single site, under downed wood.

Pygmy Slug (*Kootenaia burkei*)

We found this species at seven sites between 2560-3860 ft elevation in Mineral and Sanders counties, on the Kootenai and Lolo national forests (Table 1; Appendix D and G). Only recently was this species discovered and described, from five sites in northern Idaho (Leonard et al. 2003). It was documented in Montana for the first time during the 2005 survey, at four sites (Hendricks et al. 2006). Canopy at the 2006 sites included western redcedar, western hemlock, grand fir, Douglas-fir, paper birch, alder, black cottonwood, western larch, and western white pine. Up to four individuals were found on and under downed wood and bark among leaf litter, and on bryophyte mats.

Magnum Mantleslug (*Magnipelta mycophaga*)

We found this species at four sites between 3330-6710 ft elevation in Granite, Lincoln, and Mineral counties, on the Kootenai and Lolo national forests (Table 1; Appendix D and G). Prior to the 2006 survey, this slug was known from < 20 sites in Montana (Hendricks 2003; Hendricks et al. 2006). Canopy at the 2006 sites included western redcedar, western hemlock, Douglas-fir, cottonwood, mountain maple, and paper birch. The highest elevation site was a ridge-top patch of lodgepole pine and subalpine fir completely surrounded by a 2003 stand-replacement burn, with evidence that the fire had burned the ground under the remaining live canopy where the slugs were found. Up to four individuals were found, under downed wood and rock.

Reticulate Taildropper (*Prophysaon andersoni*)

We found this species at two sites between 2180-2190 ft elevation in Sanders County, on the Kootenai National Forest (Table 1, Appendix D and G). One of these sites (Big Eddy Campground) was where the first Montana record was made for this species, during the 2005 survey (Hendricks et al. 2006). The second site in 2006 was a few miles upriver, at Bull River Campground. This slug has rarely been found in northern Idaho (B. Leonard personal communication). Frest and Johannes (2001) thought it might not be present at all in northern Idaho, despite the tentative records of Smith (1943). This species is widespread in coastal British Columbia, Washington, Oregon, and northern California (Forsyth 2004). Populations in northern Idaho and northwestern Montana appear disjunct from the main coastal range, and should be examined genetically to determine if they actually are sister species. Idaho populations of the congeneric Blue-gray Taildropper (*P. coeruleum*) and Papillose Taildropper (*P. dubium*) also appear disjunct from the coastal populations (Leonard et al. 2003; Ovaska et al. 2004), and these too deserve genetic comparison to determine their species status; both species are currently ranked G4, and the Reticulate Taildropper is ranked G5 (Appendix B). Canopy at the 2006 sites included western redcedar, grand fir, black cottonwood, paper birch, alder, and Pacific yew. Up to 14 individuals were found under downed wood and rocks.

Smoky Taildropper (*Prophysaon humile*)

We found this species at 23 sites between 2550-5630 ft elevation in Flathead, Lake, Lincoln, Mineral, Missoula, and Sanders counties, on the Flathead, Kootenai, and Lolo national forests (Table 1, Appendix D and G). This species is known only from northern Idaho and adjacent northwestern Montana (Pilsbry 1948; Frest and Johannes 1995, 2001; Hendricks 2005; Hendricks et al. 2006). Prior to 2004 this slug was known in Montana from a single site. With the 2006 locations, it has now been documented at about 35 sites. Canopy at the 2006 sites included western redcedar, grand fir, Douglas-fir, Engelmann spruce, subalpine fir, lodgepole pine, western hemlock, alder, paper birch, and cottonwood. Up to 11 individuals were found mostly under downed wood, bryophyte mats, or rocks.

Lyre Mantleslug (Udosarx lyrata)

We found this species at two sites between 2960-4065 ft elevation in Mineral and Ravalli counties, on the Bitterroot and Lolo national forests (Table 1, Appendix D and G). This species is restricted to northern Idaho and adjacent parts of western Montana (Webb 1959; Russell and Webb 1980; Frest and Johannes 1995, 2001; Hendricks 2003; Hendricks et al. 2006). Two subspecies are described; we are unable to distinguish these and assign our records only to the species level. Although known from Montana since 1965, there remain only six reported locations in the state, three of which were found in 2006 (two of these during the formal survey). Globally, there are fewer than 15 records (Hendricks et al. 2006). Canopy at the 2006 sites included western redcedar, western hemlock, grand fir, Engelmann spruce, and cottonwood. Only four individuals were found, under downed wood.

Sheathed Slug (*Zacoleus idahoensis*)

We found this species at 20 sites between 2190-4300 ft elevation in Lincoln, Mineral, Ravalli, and Sanders counties, on the Bitterroot, Kootenai, and Lolo national forests (Table 1, Appendix D and G). This species is restricted to northern Idaho and adjacent northwestern Montana (Pilsbry 1948; Frest and Johannes 1995, 2001; Hendricks 2003; Hendricks et al. 2006). The total number of documented Montana localities is 29. Canopy at the 2006 sites included western redcedar, grand fir, western hemlock, Douglas-fir, Engelmann spruce, subalpine fir, ponderosa pine, western larch, black cottonwood, alder, mountain maple, and paper birch. Up to five individuals were found, under wet downed wood.

Conclusions and Recommendations

The number of new locations we discovered in 2006 for land mollusk species of conservation concern in the USFS Northern Region area underscores our conclusion that current knowledge of the distribution, ecology, and status of this suite of species is woefully inadequate and largely fragmentary. We think additional non-random surveys, similar to those of 2005 and 2006, are needed to fill distribution gaps and gather additional habitat information. We also suggest a minimum of two additional years of random site surveys are needed to document species distributions and habitat associations, and to determine site occupancy rates as a measure of status in various habitats. During these efforts additional pilot surveys need to be conducted to evaluate baseline levels of site occupancy and detection probability for the remainder of the terrestrial mollusk species in Montana not evaluated with this pilot effort. Pilot surveys also need to address how detection probabilities vary with survey covariates such as weather, temperature, and season of survey. Conducting surveys under wetter environmental conditions when land mollusks are most likely to be active may dramatically increase detection probabilities and improve precision of estimates of site occupancy.

Future surveys focused on Species of Concern and Species of Interest (G1G3 or S1S3) should begin to explicitly evaluate site occupancy rates associated with different site covariates (e.g., cover type, elevation, aspect, timber harvest regime), while simultaneously calculating estimated detection probabilities. These will permit the creation of habitat suitability function models that can provide managers with tools to identify species' responses to management actions and highlight habitats that need particular management emphasis. Developing predictive habitat or ecological niche models may also prove useful for guiding surveys of some species groups, especially those associated with the moist forest types mentioned earlier. To increase the utility of predictive habitat models, it is also important that more-detailed habitat data are recorded when and where SOC and SOI species are found. Recent examples of the use of predictive models for conservation management of rare terrestrial mollusks in the Pacific Northwest and Black Hills are Dunk et al. (2004), Gaines et al. (2005), and Weaver et al. (2006).

Low estimates of detection probability, or insufficient data for calculation of estimates, were associated with a number of extremely small (<2-3 mm diameter) species during the 2006 pilot detection probability work. Thus, truly comprehensive monitoring protocols for all terrestrial mollusk species may need to include methods other than visual-encounter surveys (e.g., soil sample collections with extraction of small terrestrial mollusk species using a Berlese funnel).

Other recommendations, expressed previously (Hendricks et al. 2006), include the following: (1) Survey and modeling efforts should continue to be coordinated with the Idaho CDC and MTNHP; this coordination is especially desired to determine more fully the status of the many SOC and SOI species shared in the two states; (2) there remains a need for genetic studies to address current taxonomic questions for some species. We think some taxa currently considered conspecific with coastal populations (e.g., Robust Lancetooth, Reticulate Taildropper, Blue-gray Taildropper, and Papillose Taildropper) may prove to be distinct sister species (see discussions in Leonard et al. 2003, Ovaska et al. 2004), similar to the results of recent genetic studies of some Pacific Northwest amphibian genera (e.g., *Ascaphus*, *Dicamptodon*, *Plethodon*); (3) Finally, we think it would be useful to conduct some workshops on land mollusk identification and management. This will heighten awareness of this overlooked and poorly understood group of animals, and provide biologists and managers some of the basic tools they need to make informed management decisions.

Besides producing this summary document for the 2006 inventory, we anticipate future development of an illustrated field guide and/or poster that will aid District Biologists in survey work they conduct targeting SOC and SOI land mollusks, and heighten awareness of this important group of invertebrates among the general public; similar information and illustrations for Montana species will be made available in the near future in the Montana Natural Heritage Program on-line Animal Field Guide.

Literature Cited

Beetle, D. E. 1957. The mollusca of Teton County, Wyoming. The Nautilus 71:12-22.

Beetle, D. E. 1961. Mollusca of the Big Horn Mountains. The Nautilus 74:95-102.

Beetle, D. E. 1989. Checklist of recent mollusca of Wyoming, USA. Great Basin Naturalist 49:637-645.

Berry, S. S. 1916. Notes on mollusca of central Montana. The Nautilus 29:124-128.

Bland, T., and J. G. Cooper. 1861. Notice of land and freshwater shells collected by Dr. J. G. Cooper in the Rocky Mountains, etc., in 1860. Annals of the Lyceum of Natural History of New York 7:362-370.

Brunson, R. B., and U. Osher. 1957. *Haplotrema* from western Montana. The Nautilus 70:121-123.

Brunson, R. B., and R. H. Russell. 1967. *Radiodiscus*, new to molluscan fauna of Montana. The Nautilus 81:18-22.

Burnham, K.P. and D.R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. 2nd Edition. New York, New York. Springer-Verlag. 496 p.

CFR (Code of Federal Regulations). 1985. 36 Code of Federal Regulations. Chapter II 219.19:64.

Cooper, J. G. 1868. The shells of Montana. American Naturalist 2:486-487.

Dunk, J. R., W. J. Zielinski, and H. K. Preisler. 2004. Predicting the occurrence of rare mollusks in northern California forests. Ecological Applications 14:713-729.

Fairbanks, H. L. 1984. A new species of *Oreohelix* (Gastropoda: Pulmonata: Oreohelicidae) from the Seven Devils Mountains, Idaho. Proceedings of the Biological Society of Washington 97:179-185.

Forsyth, R. G. 2004. Land snails of British Columbia. Royal British Columbia Museum, Victoria, BC. 188 pp.

Frest, T. J., and E. J. Johannes. 1993. Land snail survey of the Black Hills National Forest, South Dakota and Wyoming. Final report to USDA Forest Service, Black Hills National Forest and USDI Fish & Wildlife Service, South Dakota State Office. 156 pp. + appendices.

Frest, T. J., and E. J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final Report to Interior Columbia Basin Ecosystem Management Project. Deixis Consultants, Seattle. 274 pp.

Frest, T. J., and E. J. Johannes. 1997. Land snail survey of the lower Salmon River drainage, Idaho. Idaho Bureau of Land Management Technical Bulletin No. 97-18.

Frest, T. J., and E. J. Johannes. 2001. An annotated checklist of Idaho land and freshwater mollusks. Journal of the Idaho Academy of Science 36:1-51.

Gaines, W. L., A. L. Lyons, and A. Sprague. 2005. Predicting the occurrence of a rare mollusk in the dry forests of north-central Washington. Northwest Science 79:99-105.

Hendricks, P. 1998. Rediscovery of *Discus brunsoni* Berry, 1955 and *Oreohelix alpina* (Elrod, 1901) in the Mission Mountains, Montana, with comments on *Oreohelix elrodi* (Pilsbry, 1900). The Nautilus 112:58-62.

Hendricks, P. 2003. Status and conservation management of terrestrial mollusks of Special Concern in Montana. Report to Region 1, U.S. Forest Service. Montana Natural Heritage Program, Helena, MT. 67 pp. + appendices.

Hendricks, P., Compiler. 2005. Surveys for Animal Species of Concern in northwestern Montana. Report to Montana Department of Fish, Wildlife, and Parks, State Wildlife Grants Program, Helena, Montana. Montana Natural Heritage Program, Helena, MT. 53 pp.

Hendricks, P. B. A. Maxell, and S. Lenard. 2006. Land mollusk surveys on USFS Northern Region lands. A report to the USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana. 11 pp. plus appendices.

Leonard, W. P., L. Chichester, J. Baugh, and T. Wilke. 2003. *Kootenaia burkei*, a new genus and species of slug from northern Idaho, United States (Gastropoda: Pulmonata: Arionidae). Zootaxa 355:1-16.

Leonard, W. P., L. Chichester, and K. Ovaska. 2003. *Prophysaon dubium* Cockerell, 1890, the papillose taildropper (Gastropoda: Arionidae): distribution and anatomy. The Nautilus 117:62-67.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83: 2248-2255.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, J.E. Hines, and L.L. Bailey. 2005. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence San Diego, CA. Elsevier. 344p.

Ovaska, K., W. P. Leonard, L. Chichester, T. E. Burke, L. Sopuck, and J, Baugh. 2004. *Prophysaon coeruleum* Cockerell, 1890, blue-gray taildropper (Gastropoda: Arionidae): new distributional records and reproductive anatomy. Western North American Naturalist 64:538-543.

Pilsbry, H. A. 1939. Land mollusca of North America (north of Mexico), Volume I Part 1. The Academy of Natural Sciences of Philadelphia Monographs Number 3 (1):1-573.

Pilsbry, H. A. 1948. Land mollusca of North America (north of Mexico), Volume II Part 2. The Academy of Natural Sciences of Philadelphia Monographs Number 3 (2):521-1113.

Russell, R. H., and G. R. Webb. 1980. The slug *Udosarx lyrata*: additional data on distribution, anatomy, and taxonomy. Gastropodia 2:8-10.

Smith, A. G. 1943. Mollusks of the Clearwater Mountains, Idaho. Proceedings of the California Academy of Sciences, fourth series, 23:537-554.

Vanatta, E. G. 1914. Montana shells. Proceedings of the Academy of Natural Sciences of Philadelphia 66:367-371.

Weaver, K. F., T. Anderson, and R. Guralnick. 2006. Combining phylogenetic and ecological niche modeling approaches to determine distribution and historical biogeography of Black Hills mountain snails (Oreohelicidae). Diversity and Distributions 12:756-766.

Webb, G. R. 1959. Two new north-western slugs, *Udosarx lyrata* and *Gliabates oregonia.* Gastropodia 1(3):22-23, 28.

APPENDIX A. GLOBAL/STATE RANK DEFINITIONS

Heritage Program Ranks

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

Global Rank Definitions (NatureServe 2003)

G1	Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction
G2	Imperiled because of rarity and/or other factors making it vulnerable to extinction
G3	Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations
G4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery
G5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery
T1-5	**Infraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank

State Rank Definitions

S1	At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state
S2	At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state
S3	Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas
S4	Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern
S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

Combination Ranks

G#G# or S#S#	**Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

Qualifiers

NR	Not ranked
Q	**Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

X	**Presumed Extinct**—Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	**Possibly Extinct**—Species known from only historical occurrences, but may never-the-less still be extant; further searching needed
U	**Unrankable**—Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	**Hybrid**—Entity not ranked because it represents an interspecific hybrid and not a species
?	**Inexact Numeric Rank**—Denotes inexact numeric rank
C	**Captive or Cultivated Only**—Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	**Accidental**—Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	**Zero Occurrences**—Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	**Potential**—Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	**Reported**—Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	**Synonym**—Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	**Breeding**—Rank refers to the breeding population of the species in Montana
N	**Nonbreeding**—Rank refers to the non-breeding population of the species in Montana

Appendix B. SOC Land Mollusks (including USFS SOC and SOI taxa): Distribution by Forest (G Ranks are at the time of the 2006 surveys).

		Montana[a]									Idaho[b]		
SPECIES	G RANK	B-D	BI	CU	FL	GA	HE	KO	L-C	LO	CL	I-P	N-P
Snails													
Allogona lombardii (ID)	G1												x
Allogona ptychophora solida (ID)?	G5T2T3												?
Anguispira nimapuna (ID)	G1										x		x
Cryptomastix harfordiana (ID)?	G3G4												?
Cryptomastix magnidentata (ID)?	G1												?
Cryptomastix mullani blandi (ID)?	G4T1											?	
Cryptomastix mullani clappi (ID)	G4T1												x
Cryptomastix sanburni (ID)?	G1											?	
Discus brunsoni (MT)?	G1				?								
Discus marmorensis (ID)	G1G3												x
Discus shimekii (MT, ID?)	G5					x		x				?	
*Haplotrema vancouverense** (MT, ID)	G5							x			x	x	
Helicodiscus salmonaceus (ID)	G1G2												x
Oreohelix alpina (MT)	G1				x								
Oreohelix amariradix (MT)	G1G2									x			
Oreohelix carinifera (MT)	G1									x			
Oreohelix elrodi (MT)	G1				x								
Oreohelix hammeri (ID)	G1												x
Oreohelix idahoensis baileyi (ID)	G1G2T1												x
Oreohelix idahoensis idahoensis (ID)?	G1G2T1T2												?
Oreohelix intersum (ID)?	G1												?
Oreohelix jugalis (ID)?	G1												?
Oreohelix strigosa berryi (MT)	G5T2			x		x	x		x				
Oreohelix strigosa goniogyra (ID)	G5T1Q												x
Oreohelix vortex (ID)?	G1G3												?
Oreohelix waltoni (ID)?	G1G3												?
Oreohelix yavapai mariae (MT)	G4T1					x							
Planogyra clappi (ID)	G3G4												x
Polygyrella polygyrella (MT, ID)	G3							x		x	x		x
Pristiloma idahoense (ID)	G2G3												x
Radiodiscus abietum (MT, ID)	G4		x		x			x		x	x	x	x

		Montana[a]									Idaho[b]		
SPECIES	**G RANK**	**B-D**	**BI**	**CU**	**FL**	**GA**	**HE**	**KO**	**L-C**	**LO**	**CL**	**I-P**	**N-P**
Slugs													
*Hemphillia camelus** (MT, ID)	G4							x		?	x	x	x
Hemphillia danielsi (MT)	G2G3		x							x			
*Kootenaia burkei** (MT, ID)	G2							x		x		x	
Magnipelta mycophaga (MT, ID)	G3		x		x			x		x	x	x	
*Prophysaon andersoni** (MT, ID)	G5							x				?	
Prophysaon coeruleum (ID)	G4											x	
Prophysaon dubium (ID)	G4											x	
*Prophysaon humile** (MT, ID)	G3				x			x		x	x	x	x
Udosarx lyrata (MT, ID)	G2		x							x	x		
Zacoleus idahoensis (MT, ID)	G3G4	x	x					x		x	x	x	x

[a] Montana Forests codes: Beaverhead-Deerlodge (B-D), Bitterroot (BI), Custer (CU), Flathead (FL), Gallatin (GA), Helena (HE), Kootenai (KO), Lewis & Clark (L-C), Lolo (LO).
[b] Idaho Forest codes: Clearwater (CL), Idaho Panhandle (I-P), Nez Perce (N-P).
* new species for Montana SoC list in 2005
? taxon apparently not yet recorded on USFS Region 1 lands, but in area and should be looked for

Appendix C. SOC Land Mollusks: Habitat Associations (G Ranks are at the time of the 2006 surveys).

		Moist Mixed-conifer Forest Riparian			Aspen	Dry Mixed-conifer Forest			Lime-stone Talus*
Species	**G Ranks**	**Cedar-hemlock, grand fir, Douglas-fir**	**Spruce-fir**	**Talus-rocky ground**		**Ponderosa pine, Douglas-fir**	**Juniper-sage**	**Talus-rocky ground**	
SNAILS									
Allogona lombardii (ID)	G1	x							
Allogona ptychophora solida (ID)?	G5T2T3						x	x	
Anguispira nimapuna (ID)	G1	x		x		x		x	
Cryptomastix harfordiana (ID)?	G3G4							x	x
Cryptomastix magnidentata (ID)?	G1			x				x	x
Cryptomastix mullani blandi (ID)?	G4T1			x					
Cryptomastix mullani clappi (ID)	G4T1							x	
Cryptomastix sanburni (ID)?	G1			x					
Discus brunsoni (MT)?	G1			x					
Discus marmorensis (ID)	G1G3	x		x		x			x
Discus shimekii (MT, ID?)	G5				x	x			
Haplotrema vancouverense (MT, ID)#	G5	x							
Helicodiscus salmonaceus (ID)	G1G2			x				x	
Oreohelix alpina (MT)	G1			x					x
Oreohelix amariradix (MT)	G1G2					x		x	
Oreohelix carinifera (MT)	G1					x	x	x	x
Oreohelix elrodi (MT)	G1			x					
Oreohelix hammeri (ID)	G1							x	x
Oreohelix idahoensis baileyi (ID)	G1G2T1							x	x
O. i. idahoensis (ID)?	G1G2T1T2						x	x	x
Oreohelix intersum (ID)?	G1							x	
Oreohelix jugalis (ID)?	G1G2							x	
Oreohelix strigosa berryi (MT)	G5T2					x		x	x
O. s. goniogyra (ID)	G5T1Q					x		x	
Oreohelix vortex (ID)?	G1G3							x	
Oreohelix waltoni (ID)?	G1G3						x	x	
Oreohelix yavapai mariae (MT)	G4T1							x	x

		Moist Mixed-conifer Forest Riparian			Aspen	Dry Mixed-conifer Forest			Lime-stone Talus*
Species	G Ranks	Cedar-hemlock, grand fir, Douglas-fir	Spruce-fir	Talus-rocky ground		Ponderosa pine, Douglas-fir	Juniper-sage	Talus-rocky ground	
SNAILS									
Planogyra clappi (ID)	G3G4	x							
Polygyrella polygyrella (MT, ID)	G3	x	x	x				x	
Pristiloma idahoense (ID)	G2	x		x					
Radiodiscus abietum (MT, ID)	G4	x	x	x					
SLUGS									
Hemphillia danielsi (MT)	G2G3	x	x						
Hemphillia camelus (MT, ID)	G4	x	x						
Kootenaia burkei (MT, ID)	G2	x							
Magnipelta magnipelta (MT, ID)	G3	x	x	x		x			
Prophysaon andersoni (MT, ID)#	G5	x							
Prophysaon coeruleum (ID)#	G4	x							
Prophysaon dubium (ID)#	G4	x		x					
Prophysaon humile (MT, ID)	G3	x	x	x					
Udosarx lyrata lyrata (MT, ID)	G2T2	x	x	x		x			
Zacoleus idahoensis (MT, ID)	G3G4	x	x						

These low G-rank taxa may prove to be distinct from coastal populations, as their disjunct distributions are similar to individual vertebrate taxa (e.g. *Dicamptodon, Ascaphus, Plethodon*) now split into coastal and Rocky Mountain species.

* Limestone talus associates may occur in either dry or moist sites, but are most often limestone or limestone-derived soil obligates.

Appendix D. USFS Northern Region Survey Sites in 2006 for Land Mollusks

Forest[a]	County	UTM NAD 27	Site Name	Elev (ft)	Date	SOC/SOI Taxa[b]
BD	Beaverhead	12: 298476E 5072333N	Mussigbrod Creek	6432	23 Oct	*
BD	Beaverhead	12: 288407E 5059287N	Trail Creek	6303	23 Oct	*
BD	Beaverhead	12: 296886E 5035549N	Big Lake Creek	6750	24 Oct	*
BD	Jefferson	12: 413913E 5110043N	Whitetail Creek	5506	28 Sep	*
BD	Jefferson	12: 410638E 5115782N	Little Boulder River	5151	28 Sep	*
BD	Silver Bow	12: 380157E 5106341N	Columbia Gulch	6198	28 Sep	
BD	Deerlodge	12: 373915E 5117828N	South Fork Dry Creek	6020	28 Sep	*
BD	Deerlodge	12: 310744E 5081326N	Pintlar Lake trailhead	6414	29 Sep	
BD	Deerlodge	12: 316642E 5081777N	Mudd Creek	6391	29 Sep	*
BD	Deerlodge	12: 322746E 5086618N	East Fork Fishtrap Creek	6503	29 Sep	*
BD	Granite	12: 316115E 5111975N	Elk Creek	6237	30 Sep	*
BD	Granite	12: 306932E 5106201N	Squaw Creek	6096	30 Sep	*
BD	Granite	12: 297333E 5124403N	West Fork Rock Creek	5817	30 Sep	*
BD	Granite	12: 336499E 5150364N	Middle Fork Douglas Creek	5716	30 Sep	*
BI	Ravalli	12: 283333E 5092089N	Moose Creek	5640	2 Oct	*
BI	Ravalli	12: 290175E 5092900N	Martin Creek	6700	2 Oct	*
BI	Ravalli	12: 273190E 5081852N	East Fork Bitterroot River	4590	5 Oct	*
BI	Ravalli	12: 284691E 5084610N	Meadow Creek	5350	5 Oct	*
BI	Ravalli	12: 281551E 5081596N	Meadow Creek	5850	5 Oct	
BI	Ravalli	11: 709644E 5044860N	West Fork Bitterroot River	5560	6 Oct	*
BI	Ravalli	11: 702093E 5046711N	Woods Creek	6360	6 Oct	Raab
BI	Ravalli	11: 709189E 5047660N	West Fork Bitterroot River	5460	6 Oct	*
BI	Ravalli	11: 709333E 5049556N	West Fork Bitterroot River	5410	6 Oct	*
BI	Ravalli	11: 710408E 5055848N	Alta	4980	6 Oct	*
BI	Ravalli	11: 710449E 5055760N	Alta	4940	6 Oct	*
BI	Ravalli	11: 698965E 5068789N	Nez Perce Fork (Fales Flat)	5090	7 Oct	
BI	Ravalli	11: 702626E 5111911N	Lost Horse Creek	4950	7 Oct	Heda
BI	Ravalli	11: 710538E 5150389N	Big Creek	4300	8 Oct	Heda, Zaid
BI	Ravalli	11: 711749E 5149859N	Big Creek	4220	8 Oct	Heda, Raab
BI	Ravalli	11: 712446E 5149714N	Big Creek	4065	8 Oct	Heda, Udly
BI	Ravalli	11: 713186E 5149539N	Big Creek	4120	8 Oct	
BI	Ravalli	12: 284325E 5166331N	Cleveland Mountain Spring	7100	1 Oct	
CU	Carbon	12: 606639E 5006828N	Phantom Creek trailhead	6140	3 Oct	*

Forest[a]	County	UTM NAD 27	Site Name	Elev (ft)	Date	SOC/SOI Taxa[b]
CU	Carbon	12: 607584E 5005703N	Alpine	6594	3 Oct	
CU	Carbon	12: 607325E 5005798N	Alpine Campground	6340	3 Oct	*
CU	Carbon	12: 610391E 5010129N	East rosebud Creek	5540	3 Oct	*
CU	Carbon	12: 606723E 5006613N	East Rosebud Creek	6194	3 Oct	*
CU	Carbon	12: 608375E 5008290N	East Rosebud Creek road	5787	3 Oct	*
CU	Carbon	12: 610878E 5011194N	Lower Sand Dunes picnic area	5536	3 Oct	*
CU	Stillwater	12: 599797E 5010890N	Mystic lake trailhead	6595	4 Oct	*
CU	Stillwater	12: 600246E 5011055N	Chicken Creek	6541	4 Oct	*
CU	Stillwater	12: 585946E 5022329N	Stillwater River	5210	3 Oct	*
CU	Stillwater	12: 599686E 5010749N	West Rosebud Creek trailhead	6570	3 Oct	*
CU	Stillwater	12: 604792E 5013393N	West Rosebud Creek	6060	3 Oct	*
CU	Stillwater	12: 601754E 5011728N	West Rosebud Creek	6384	4 Oct	Zoha
CU	Stillwater	12: 604908E 5013479N	West Rosebud Creek road	6092	4 Oct	*
CU	Carter	13: 539837E 5080004N	Heggen Creek	3760	26 Sep	*
CU	Carter	13: 541514E 5078783N	1.5 km SE Twentytwo Spring	3910	26 Sep	*
CU	Carter	13: 542401E 5077800N	Twentytwo Spring	3800	26 Sep	*
CU	Carter	13: 536610E 5074717N	Stagville Draw	3860	27 Sep	*
CU	Carter	13: 536798E 5074169N	Stagville Draw	3850	27 Sep	*
CU	Carter	13: 533457E 5073546N	Smith Creek	3850	27 Sep	*
CU	Carter	13: 537979E 5071532N	Ekalaka Park campground	3730	27 Sep	*
CU	Carter	13: 562598E 5052023N	Leebox Spring	3780	27 Sep	*
CU	Carter	13: 561884E 5050220N	Belltower Divide	4060	27 Sep	*
CU	Carter	13: 566630E 5049915N	2 km SSE White Rock Spring	4000	27 Sep	*
CU	Carter	13: 565346E 5050989N	S of White Rock Spring	4010	27 Sep	*
CU	Powder River	13: 433090E 5009600N	Gumbo Hill	3820	28 Sep	
CU	Powder River	13: 428465E 5012798N	Mason Prong Spring	4110	28 Sep	*
CU	Powder River	13: 414137E 5016311N	Dry Gulch Spring	3600	28 Sep	*
CU	Powder River	13: 414054E 5015956N	head of Dry Gulch	3740	28 Sep	*
CU	Powder River	13: 400481E 5020113N	2.5 km E Coal Bank Res.	3880	28 Sep	*
CU	Powder River	13: 424579E 5060223N	2.25 km E Horse Pasture Res.	3910	29 Sep	*
CU	Powder River	13: 424457E 5055243N	1 km N Bidwell Spring	4010	29 Sep	*
CU	Powder River	13: 424513E 5054287N	Whitetail Ranger Station	4000	29 Sep	*
CU	Powder River	13: 424967E 5054229N	Bidwell Spring	3890	29 Sep	*

Forest[a]	County	UTM NAD 27	Site Name	Elev (ft)	Date	SOC/SOI Taxa[b]
CU	Powder River	13: 424239E 5053983N	Holiday Campground	3980	29 Sep	*
CU	Powder River	13: 422805E 5053635N	East Fork Otter Creek	3770	29 Sep	*
FL	Missoula	12: 294475E 5253593N	Lindbergh Lake Campground	4330	25 Sep	*
FL	Missoula	12: 291613E 5248514N	Bunyan Lake	5630	25 Sep	Prhu
FL	Missoula	12: 288606E 5250969N	Glacier Lake trailhead	4900	25 Sep	Raab
FL	Missoula	12: 305522E 5258508N	Holland Falls	4120	25 Sep	*
FL	Missoula	12: 284168E 5271199N	N Fork Cold Creek	5530	26 Sep	Prhu
FL	Lake	12: 298455E 5303735N	S Fork Lost Creek trailhead	4760	26 Sep	Prhu
FL	Lake	12: 297644E 5304130N	S Fork Lost Creek	4400	26 Sep	*
FL	Lake	12: 291540E 5305221N	S Fork Lost Creek campsite	3380	26 Sep	Prhu
FL	Lake	11: 723363E 5319351N	Phillips Trailhead (Hunger Cr)	4030	27 Sep	Prhu
FL	Flathead	12: 283235E 5360061N	Emery Creek	3610	27 Sep	*
FL	Flathead	12: 291927E 5349331N	Murray Creek	3600	27 Sep	Prhu
FL	Flathead	12: 291495E 5354057N	Ryle Creek	3920	27 Sep	Prhu
FL	Flathead	11: 670807E 5381678N	Martin Falls	3660	28 Sep	*
FL	Flathead	11: 666181E 5377516N	Martin Creek	4900	28 Sep	*
FL	Flathead	11: 672544E 5385632N	Finger Lake trail	3200	28 Sep	*
GA	Park	12: 505403E 5016773N	Big Creek road	5740	5 Oct	Dish
GA	Park	12: 505602E 5016831N	Big Creek road	5786	5 Oct	Dish
GA	Park	12: 500999E 5007210N	Rock Creek	6848	5 Oct	*
GA	Park	12: 525309E 4987998N	Eagle Creek Campground	6365	6 Oct	*
GA	Park	12: 525296E 4990590N	USFS Road 3243	7075	6 Oct	*
GA	Park	12: 526742E 4991913N	USFS Road 3243	7568	6 Oct	*
GA	Park	12: 521519E 5046556N	Suce Creek trailhead	5589	7 Oct	*
GA	Sweetgrass	12: 558526E 5098894N	Halfmoon Campground	6670	2 Oct	*
HE	Lewis & Clark	12: 452666E 5185270N	Bowman Gulch	6380	1 Oct	*
HE	Broadwater	12: 487735E 5124847N	Flathead Indian Trail	6280	20 Sep	*
HE	Broadwater	12: 487285E 5126903N	Sulphur Bar Creek	5440	20 Sep	*
HE	Broadwater	12: 483927E 5130601N	Deep Creek	4790	20 Sep	*
HE	Broadwater	12: 490542E 5123442N	Hay Creek	6440	20 Sep	*
HE	Broadwater	12: 486442E 5135565N	E Fork Cabin Gulch	5990	20 Sep	*
HE	Broadwater	12: 484942E 5137290N	N Fork Deep Creek	6440	20 Sep	*
HE	Broadwater	12: 473258E 5161148N	Blacktail Creek	5960	21 Sep	*

Forest[a]	County	UTM NAD 27	Site Name	Elev (ft)	Date	SOC/SOI Taxa[b]
HE	Broadwater	12: 463647E 5164554N	Springs Gulch	5200	21 Sep	*
HE	Broadwater	12: 454861E 5166961N	Hellgate Gulch	4540	21 Sep	*
HE	Meagher	12: 468032E 5178811N	Wagner Gulch	5720	2 Oct	*
HE	Meagher	12: 471500E 5166770N	Ohio Gulch	5590	2 Oct	*
HE	Broadwater	12: 443920E 5125957N	S Fork Crow Creek	5210	4 Oct	*
HE	Broadwater	12: 442503E 5128124N	Muddy Lake Creek	5260	4 Oct	*
HE	Broadwater	12: 437896E 5126891N	Warner Creek	6680	4 Oct	*
KO	Sanders	11: 580294E 5323988N	Big Eddy Campground	2190	10 Oct	Hava, Pran, Zaid
KO	Sanders	11: 586332E 5320153N	Bull River Campground	2180	10 Oct	Hava, Pran, Raab
KO	Sanders	11: 596517E 5319822N	Upper Rock Creek	2800	11 Oct	Hava, Raab, Zaid
KO	Lincoln	11: 580325E 5339627N	Ross Creek Cedars	2870	11 Oct	Prhu, Raad, Zaid
KO	Sanders	11: 596808E 5330471N	E Fork Bull River	3070	11 Oct	Hava, Raab, Zaid
KO	Sanders	11: 588382E 5339275N	Mid Fork Bull River trailhead	2560	11 Oct	Kobu, Prhu, Zaid
KO	Lincoln	11: 600623E 5365508N	Old Hwy 2 trailhead	2890	12 Oct	Prhu, Raab, Zaid
KO	Lincoln	11: 572998E 5364945N	N & S Callahan Creek	2710	12 Oct	Hava, Prhu, Raad, Zaid
KO	Lincoln	11: 573542E 5365183N	Callahan Creek road	2910	12 Oct	Hava, Prhu, Raab, Zaid
KO	Lincoln	11: 579145E 5366525N	Threemile Creek	2800	12 Oct	Hava, Prhu, Raab, Zaid
KO	Sanders	11: 588577E 5304854N	Devil Gap (Marten Creek)	2610	13 Oct	*
KO	Sanders	11: 581679E 5302125N	Saddle Creek	3860	13 Oct	Kobu, Prhu, Raab, Zaid
KO	Sanders	11: 595746E 5308048N	USFS Road 2229	2650	13 Oct	Raab, Zaid
KO	Sanders	11: 582977E 5312574N	Skeleton Creek	3100	13 Oct	Popo, Prhu, Zaid
KO	Lincoln	11: 570983E 5352710N	Halverson Creek	3700	13 Oct	Hava, Raab
KO	Lincoln	11: 579916E 5353804N	Keeler Creek	2660	13 Oct	Prhu, Raab
KO	Lincoln	11: 577602E 5346726N	Spar Lake Campground	3330	13 Oct	Hava, Mamy, Prhu, Raab, Zaid
KO	Lincoln	11: 581495E 5347633N	Spar Lake Spring	2550	13 Oct	Heca, Prhu, Raab
KO	Lincoln	11: 586941E 5352291N	Camp Creek	2680	13 Oct	Raab, Zaid
KO	Sanders	11: 626351E 5303153N	Willow Creek Campground	3580	14 Oct	Kobu, Zaid
KO	Sanders	11: 619465E 5302850N	Sims Creek	2990	14 Oct	Kobu, Prhu, Raab, Zaid
KO	Sanders	11: 599641E 5280678N	Upper Beaver Creek	3250	14 Oct	Heca, Popo
KO	Sanders	11: 603481E 5283334N	Middle Beaver Creek	2870	14 Oct	Popo, Raab
KO	Sanders	11: 608006E 5283510N	Lower Beaver Creek	2570	14 Oct	Popo
LC	Fergus	12: 616655E 5176442N	Timber Creek Canyon	5960	25 Jul	Osbe
LC	Teton	12: 368757E 5302798N	S Fork Teton River	5500	21 Sep	*

Forest[a]	County	UTM NAD 27	Site Name	Elev (ft)	Date	SOC/SOI Taxa[b]
LC	Teton	12: 369884E 5303007N	S Fork Teton River	5420	21 Sep	*
LC	Teton	12: 372544E 5302913N	S Fork Teton River	5230	21 Sep	*
LC	Teton	12: 377469E 5302988N	Ear Mountain Ranger Stn	4950	21 Sep	*
LC	Lewis & Clark	12: 358054E 5261546N	Benchmark Creek	5290	22 Sep	
LC	Lewis & Clark	12: 358304E 5261187N	Wood Creek	5310	22 Sep	
LC	Lewis & Clark	12: 365827E 5252631N	Ford Creek	5690	22 Sep	*
LC	Lewis & Clark	12: 371269E 5251941N	Ford Creek	5160	22 Sep	*
LO	Granite	12: 284120E 5169437N	Welcome Creek Divide	6710	1 Oct	Mamy
LO	Granite	12: 287736E 5148426N	Cougar Creek	4420	2 Oct	*
LO	Granite	12: 287956E 5155209N	Butte Cabin Creek	4220	2 Oct	*
LO	Granite	12: 292083E 5159989N	Welcome Creek	4120	2 Oct	Mamy
LO	Missoula	12: 289921E 5208404N	Shoofly Meadow	5870	6 Oct	
LO	Missoula	12: 274132E 5202470N	Spring Gulch	3800	8 Oct	Prhu
LO	Powell	12: 337222E 5220245N	Monture Creek	4130	17 Oct	*
LO	Missoula	12: 303133E 5224471N	Placid Lake	4300	17 Oct	*
LO	Missoula	12: 277861E 5183509N	Little Park Creek	4320	23 Oct	*
LO	Missoula	12: 275460E 5202744N	Rattlesnake Creek	3680	24 Oct	*
LO	Sanders	11: 643267E 5294502N	Fishtrap Creek	3340	16 Oct	Kobu, Prhu, Zaid
LO	Sanders	11: 634742E 5283177N	Big Spruce Creek trailhead	3380	16 Oct	Raab
LO	Mineral	11: 635336E 5230839N	S Fork Little Joe Creek	3660	17 Oct	Heda, Kobu, Mamy, Popo, Prhu, Raab, Zaid
LO	Mineral	11: 645300E 5228267N	Dry Creek	3360	17 Oct	Kobu, Prhu, Raab, Zaid
LO	Mineral	11: 661245E 5219717N	Trout Creek	2960	17 Oct	Raab, Udly
LO	Missoula	11: 699840E 5183353N	Lolo Creek Campground	3750	20 Oct	Prhu
LO	Missoula	11: 716073E 5100643N	Fort Fizzle	3561	20 Oct	*

[a] National Forests: BD (Beaverhead-Deerlodge), BI (Bitterroot), CU (Custer), FL (Flathead), GA (Gallatin), HE (Helena), KO (Kootenai), LC (Lewis and Clark), LO (Lolo).

[b] blank = no mollusks detected; * = only non SOC/SOI mollusks detected; SOC/SOI taxa codes: **Dish** (Striate Disc, *Discus shimekii*), **Hava** (Robust Lancetooth, *Haplotrema vancouverense*), **Heca** (Pale Jumping-slug, *Hemphillia camelus*), **Heda** (Marbled Jumping-slug, *Hemphillia danielsi*), **Kobu** (Pygmy Slug, *Kootenai burkei*), **Mamy** (Magnum Mantle-slug, *Magnipelta mycophaga*)**Osbe** (Berry's Mountainsnail, *Oreohelix strigosa berryi*), **Popo** (Humped Coin, *Polygyrella polygyrella*), **Pran** (Reticulate Taildropper, *Prophysaon andersoni*), **Prhu** (Smoky Taildropper, *Prophysaon humile*), **Raab** (Fir Pinwheel, *Radiodiscus abietum*), **Udly** (Lyre Mantleslug, *Udosarx lyrata*), **Zaid** (Sheathed Slug, *Zacoleus idahoensis*), **Zoha** (Boreal Top, *Zoogenetes harpa*).

Appendix E. Data Forms

Locality Information

Ecoregion:	Sample Block:	Site No:	Locality:			
State:	County:	Map Name:	T	R	S	Section Description:
Owner:	Map Elevation: FT	Datum:	UTM Zone:	UTM East:	UTM North:	

Habitat Information

Date:	Observer(s)	Begin Time:	End Time:	Total Person Minutes of Search:	Area (M^2) Searched:
Percentage of Site Searched: 1-25 26-50 51-75 76-100	Percent Slope:	Aspect: N NE NW S SE SW E W			
Habitat Type: Spring/Seep Streamside Talus Deciduous Forest Conifer Forest Mixed Forest Shrub/Steppe Grassland Other_______					
Primary Canopy Species:	Overall Percent Canopy Cover: 0 1-25 26-50 51-75 76-100 Canopy Species Average DBH (cm): 0-5 5-15 15-30 30-60 >60				
Photo Frame Number(s) / Description(s):					
Weather: Clear Partly Cloudy Overcast Rain Snow	Air Temp: °C	Soil Temp: °C			
Soil Moisture: Dry Damp Wet Standing Water Snow	Rock Type: Igneous Metamorphic Sedimentary Note Specific Type (e.g. limestone, granite):________________________				
Habitat Threats:					

Mollusk Species Information

Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., H001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other _____________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., H001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other _____________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., LC001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other _____________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., G001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other _____________
Voucher Number & Description:	

N↑

Grid Scale:

* Draw a rough sketch of the site labeling major features such as streams, talus slopes, habitat cover types, etc. Be sure to indicate where animals were detected and label the following locations on the map: **G** = GPS reading, and **P→** = photo locations and directions of photos.

Other Notes:

Site ID (ecoregion, sample block, site number) ______________________________ **Date:** ____________

Mollusk Species Information Continued

Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., H001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other ______________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., H001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other ______________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., LC001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other ______________
Voucher Number & Description:	
Species:	Number Alive and/or Dead, Size, and Time at First Detection (e.g., 2 alive & 4 dead x 15mm Diameter or TL @ 10 minutes)
Tissue Number (e.g., G001A)	Substrate Association (Circle): under wood under 4-20cm rock fragments under >20cm rock fragments under bryophyte mat on bryophyte mat in rock fracture Other ______________
Voucher Number & Description:	

Other Species Information

Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:
Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:
Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:
Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:
Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:
Other Species: (millipedes etc.)	Time at First Detection:	Voucher Number:	Voucher Description / Comments:

Other Notes

Site Information

Ecoregion: One of the 14 ecoregion sections in Montana or 6 in the Idaho Panhandle.
Sample Block: Identify three digit number of the sampling block (range 001-999).
Site No: Identify three digit number of the site being surveyed within each sampling block (range 001-999).
Locality: Describe the specific geographic location of the site so that the type of site is described and the straight-line air distance from one or more permanent features on a 7.5-minute (1:24,000 scale) topographic map records the position of the site (e.g., Large talus slope 1.5 miles north of Engle Peak, N side of FS Road 225).
State: Use the two-letter abbreviation.
County: Use the full county name.
Map Name: List the name of the USGS 7.5-minute (1:24,000 scale) topographic quadrangle map.
T: Record the Township number and whether it is north or south.
R: Record the Range number and whether it is east or west.
S: Record the Section number
Section Description: Describe location of the site at the ¼ of ¼ section level (e.g., SENE indicates SE corner of NE corner).
Owner: Use abbreviation of the government agency responsible for managing the land you surveyed. (e.g. USFS, BLM). If private land was surveyed list the owner's full name to indicate that you did not trespass.
Map Elevation: The elevation of the site as indicated by the topographic map in feet (avoid using elevations from a GPS)
Datum: The map datum used (typically NAD 27 if off topographic map or WGS84 if off GPS unit on standard setting).
UTM Zone: Universal Transverse Mercator zone recorded on the topographic map.
UTM East: Universal Transverse Mercator easting coordinate in meters as recorded on the topographic map or GPS receiver. Be sure to note any major differences between UTM coordinates on the map and those on the GPS receiver.
UTM North: Universal Transverse Mercator northing coordinate in meters as recorded on the topographic map or GPS receiver. Be sure to note any major differences between UTM coordinates on the map and those on the GPS receiver.

Survey Information

Date: Use MM-DD-YY format (e.g. 05/12/00 for May 12 of 2000).
Observers: List names or initials of individuals involved with survey of this site and circle the name of the recorder.
Begin Time: List the time the survey began in 24-hour format.
End Time: List the time the survey ended in 24-hour format.
Total Person Minutes of Search: Record the total person minutes the site was searched (e.g. if one person surveys for 15 minutes and another surveys for 30 minutes, but takes 5 minutes to measure a specimen the total person minutes is 40 minutes).
Area (M^2) Searched: Area in square meters that was surveyed.
Percent of Site Searched: Circle the appropriate category.
Percent Slope: Percent slope of site. Enter range if variable.
Aspect: Circle primary aspect of the site.
Habitat Type: Circle the appropriate habitat type.
Primary Canopy Species: List the major plant species in the canopy (e.g., red cedar, western hemlock, grand fir, ninebark)
Overall Percent Canopy Cover: Circle the appropriate category for total canopy cover.
Canopy Species Average DBH: Circle the appropriate category.
Photo Frame Number(s) / Descriptions: The number of the photo as viewed on the camera's view screen and a description of the contents of the photograph (e.g., #13 = 1 x *Oreohelix strigosa* and #14-18 = 5 x habitat). Take photos of all portions of the site and anything else that may be of interest (e.g., millipedes, potential site threats).
Weather: Circle weather condition during survey.
Air Temp: Record air temperature in °C at chest height in the shade. °C = (°F – 32)/1.8
Soil Temp: Record soil temperature in °C at 10 cm depth. °C = (°F – 32)/1.8
Soil Moisture: Circle the appropriate category.
Rock Type: Circle the appropriate category; note specific type if known.
Habitat Threats: Note impacts from grazing, logging, mining, flooding, road building, weeds, fire, etc.

Species Information

For each species, record the genus name and species, if known. If species cannot be identified in the field, place a brief description of their morphology here. Record the number alive and dead, and size range for individuals encountered, and time at first detection for the first individual encountered (e.g., 2 x 15 mm diameter (shells) or TL = 80-90mm (slugs): @ 10 minutes). Record the tissue number or range of tissue numbers for tissue samples collected (see tissue collection protocols). Record the preliminary museum voucher specimen number and description for voucher specimens collected (see voucher specimen collection protocols). Circle the substrate the animal was associated with at time of detection. Record the presence of other species detected at the site (e.g., millipedes), the time at first detection, and the voucher number and description of animals collected (see voucher and tissue collection protocols).

Appendix F. Pilot Study of Detection Probabilities and Site Occupency

A Pilot Study Evaluating Effects of Detection Probability on Precision of Site Occupancy Estimates for Planning Future Inventory, Monitoring, and Habitat Modeling Efforts

Introduction

While our primary goals for the 2006 field season were to fill data gaps for as many terrestrial mollusk species as possible, we also completed some ground work for future inventory, monitoring, and predictive habitat modeling. We evaluated detection probabilities for terrestrial mollusks at 24 locations on the Kootenai National Forest in northwestern Montana within the known geographic ranges of a number of globally rare species. This was done in order to: (1) compare naïve site occupancy rates resulting from single visit field surveys with robust estimates of site occupancy, and identifying where corrections to estimates are required, especially for small cryptic terrestrial mollusks that are rarely detected at all sites where they are present; and (2) take steps to model species' occupancy rates in different habitats while simultaneously addressing the issue that detection probabilities may vary by a variety of site (e.g., elevation, habitat cover type, soil type) and sampling (e.g., weather, surveyor, time of year) covariates. Explicitly addressing imperfect detection of species, in the context of various site and sampling covariates, is important to ensure that: (1) species that appear to be rare (following single surveys of sites) truly are rare; (2) managers have a sound basis for making management decisions regarding the status of species in various habitats and portions of the species' range, where the species' status may be quite different; (3) monitoring programs are adequately designed (i.e. enough visits to enough sites) to detect biologically meaningful changes in the occupancy rates of different habitats; and (4) predictive distribution models account for variable rates of occupancy of different habitats.

Field Methods

To examine detection rates, 24 sites within the range of a number of globally rare species on the Kootenai National Forest, Lincoln and Sanders counties, Montana, were surveyed by two to five biologists at the same time. All biologists had 2-4 years experience conducting terrestrial mollusk surveys, but differing levels of experience with surveys in northwestern Montana. Surveyed areas ranged in size from circa 100 m^2 to 10,000 m^2, but individual surveyors typically surveyed a few non-overlapping square meters of habitat at each site during a 45-60 minute survey period. Sites were relatively homogenous in habitat cover-type and the presence of ground cover objects. Most sites where multiple surveys were conducted were of the same general cover type; typically Western Red Cedar (*Thuja plicata*), Grand Fir (*Abies grandis*), Western Hemlock (*Tsuga heterophylla*), Engelmann Spruce (*Picea engelmannii*), Douglas-fir (*Pseudotsuga menzezia*), Western Larch (*Larix occidentalis*), Black Cottonwood (*Populus balsamifera*), Alder (*Alnus incana*), and Paper Birch (*Betula papyrifera*). All surveyors completed standardized data forms (Appendix E) and collected voucher specimens for all animals that were not able to be definitively identified to species in the field. Shells of dead animals were placed in vials while shells or tissues of live snails and slugs were preserved in 95% ethanol in order to permit future genetic analysis. Species identifications were made based on comparisons with previous collections as well as identification materials in unpublished reports and the scientific literature (Forsyth 2004; Frest and Johannes 1995; Hendricks et al. 2006; Pilsbry 1939, 1948).

Data Analysis

We used program PRESENCE (Mackenzie et al. 2002, 2005) to compare the fit of a priori developed candidate models to the pilot terrestrial mollusk detection data. The specific goals of the modeling effort were to: (1) estimate detection probabilities (p) for individual species; (2) identify the extent to which detection probabilities differ between observers; (3) compare estimated site occupancy rates (Psi) to the naïve percentage of sites where species were detected; and (4) use estimates of (p) to identify the number of sites and number of surveys per site needed to achieve various confidence intervals for estimates of site occupancy in future inventory and monitoring efforts.

It is worth noting the assumptions associated with this modeling effort using program PRESENCE and the extent to which these assumptions may have been violated (Mackenzie et al. 2005). Key assumptions and the degree to which they were likely violated include:

(1) *Sampled patches are representative of unsampled patches, so that inferences can be correctly made to the entire population of interest.* Habitat cover types across all sites where the pilot detection probability surveys were performed were similar, so this assumption does not appear to have been significantly violated.
(2) *Species do not emigrate from or immigrate to the sample units between surveys (also known as the closure assumption).* Sites were all surveyed at the exact same time by all surveyors. Movement rates of terrestrial mollusks are negligible, so this assumption does not appear to have been violated.
(3) *Surveys are independent of one another (e.g., species detected by surveyor 1 do not depend on the species detected or presence of surveyor 2).* Surveyors typically had plenty of space to conduct their surveys without encountering areas where other surveyors had disturbed cover objects, and surveyors did not typically share significant amounts of knowledge about what species they detected or where they detected them. The assumption of independent surveys does not appear to have been violated.
(4) *Species are correctly identified so that there are no false detections.* Species that could not be definitively identified in the field by individual surveyors were collected as vouchers and identified in the lab by the senior author. This assumption does not appear to have been violated.
(5) *All sources of heterogeneity are modeled.* This assumption is almost certainly violated, because a number of site (e.g., elevation, cover type) and survey (survey technique such as focus on large cover objects versus focus on leaf litter) covariates were not incorporated into the candidate models. We do not consider this violation to be important in the context of the specific goals of this analysis. That is, we were largely focused on understanding approximate site occupancy and detection rates, difference between naïve site occupancy rates and estimates involving correction for detection probability, and planning for future inventory and monitoring efforts, not specific questions about how individual species respond to differences in habitat or habitat alterations.

A set of six simple a priori candidate models was developed in order to address these questions (Table F1). More complex models were not considered because the limited pilot data that was gathered was not suitable for estimating large numbers of parameters.

Table F1

Model Notation	Model Description
Psi (.), p(.)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) is constant across all surveyors.
Psi (2 groups), p(.)	There are two site occupancy rates (Psi) across all the sites surveyed with one set of sites having a higher site occupancy rate than the other set of sites. The reasons for differences in Psi are not modeled. Detection probability (p) is constant across all surveyors.
Psi (3 groups), p(.)	There are three site occupancy rates (Psi) across all the sites surveyed with each set of sites having a different site occupancy rate than the other. The reasons for differences in Psi are not modeled. Detection probability (p) is constant across all surveyors.
Psi (.), p(s)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by the individual surveyor.
Psi (2 groups), p(s)	There are two site occupancy rates (Psi) across all the sites surveyed with one set of sites having a higher site occupancy rate than the other set of sites. The reasons for differences in Psi are not modeled. Detection probability (p) varies by the individual surveyor.
Psi (3 groups), p(s)	There are three site occupancy rates (Psi) across all the sites surveyed with each set of sites having a different site occupancy rate than the other. The reasons for differences in Psi are not modeled. Detection probability (p) varies by the individual surveyor.

Relative fit of the a priori models to the data was evaluated using Akaike Information Criteria (AIC), which balances the fit of the model to the data to arrive at the most parsimonious model, with a penalty for the number of parameters used in the model (Burnham and Anderson 2002). The best-fitting model has the lowest AIC value. Models within two AIC values of one another essentially have the same level of support in how well they describe the data, given the number of parameters involved.

The Simulations module in program PRESENCE was used to examine different scenarios for future inventory and monitoring efforts. For these analyses, the true proportion of sites occupied was varied to encompass the wide range of site occupancy rates (0.05, 0.20, 0.40, 0.60, and 0.80) and detection probabilities (0.05, 0.20, 0.40, 0.60, and 0.80) observed during this pilot study and likely to be encountered with mollusk species in other regions of Montana. For each combination of site occupancy rate and detection probability, three major levels of survey effort and/or funding were considered; (1) 100 sampling days = 400 site surveys, which is approximately twice the level of effort made during the 2005 and 2006 field surveys, (2) 50 sampling days = 200 site surveys, which is approximately equal to the level of effort made during the 2005 and 2006 field surveys, and (3) 25 sampling days = 100 site surveys which is approximately equal to half the level of effort made during the 2005 and 2006 field surveys. A number of scenarios were considered for each level of survey effort, to examine the effect different allocations of the same level of effort had on the standard error (SE) of the estimate of the site occupancy rate (Psi). Variables used in these scenarios included the number sites surveyed multiple times (M), the number of times those multiple survey sites where surveyed (S), and the number of sites surveyed a single time (s).

Results and Discussion

Data sufficient for estimating site occupancy rates and detection probabilities was gathered for 19 of the 26 species found during the multiple-surveyor pilot surveys on the Kootenai National Forest (Table F2). The remaining seven species which had insufficient data for estimates were mostly either exotic species present at a handful of sites or they were extremely small so that they may easily have been missed using our visual encounter methods. Therefore, alternative methods appear to be justified for detecting and monitoring small (<2-3 mm diameter) species.

For those species with sufficient data, estimated detection probabilities ranged from a low of 0.095 to a high of 0.886, approximating a normal distribution with mean = 0.48, median = 0.49, and mode approximating 0.6 (Table F2). Results were similar for species meeting (G1G3 or S1S3) and not meeting (>G3 or S3) criteria for U.S. Forest Service Species of Concern or Species of Interest (Table F2). The lowest estimated detection probability for a species meeting the U.S. Forest Service Species of Concern criteria was 0.264 for *Magnipelta mycophaga*. Slugs had lower detection probabilities (range = 0.264-0.571) than the larger diameter (>2-3mm) snails (range = 0.312-0.886, but generally greater than 0.5). This was likely a result of surveys occurring during a dry period when slug species are less active near the surface; even if live snails weren't active at the surface, shells of dead individuals were still available for detection. Given the relatively dry conditions at the time of this pilot survey, we expect that the resulting estimated probabilities of detection for all slug species and larger diameter (>2-3mm) snail species represent low-end values which would improve under wetter conditions. Conducting surveys during wetter conditions to improve detection probabilities for G1G3 or S1S3 slugs is relatively more important (p ranging from 0.264-0.571) than for G1G3 or S1S3 snail species (p ranging from 0.597-0.886) (Table F2).

Models with detection probability constant across all surveyors consistently fit the data better than models with detection probability varying by surveyor (see best fitting models in Table F2). Thus, with this pilot data and analysis there is little evidence that there is a significant difference in detection probability between observers. However, we recommend examining a surveyor effect in all future analyses, especially if individuals with limited survey experience are part of an inventory or monitoring effort. We also recommend that future studies gather enough data to support modeling of site and sampling covariates.

Robust estimates of site occupancy resulting from multiple surveys of individual sites were almost universally higher than naïve site occupancy rates from single visit surveys (mean = 0.11, median = 0.05, mode approximating 0.06, and range = 0.00 to 0.658 higher). However, differences for species meeting U.S. Forest Service Species of Concern or Species of Interest criteria (G1G3 or S1S3) were not as great (mean = 0.070, median = 0.044, mode approximating 0.04, and range = 0.00 to 0.24 higher than naïve site occupancy rates). The greatest differences between naïve and robust estimates for non Species of Concern were for *Discus whitneyi* (0.66), *Euconulus fulvus* (0.483), and *Zonitoides arboreus* (0.125). The greatest differences between naïve and robust estimates for Species of Concern were for *Zacoleus idahoensis* (0.24) and *Prophysaon humile* (0.19). Differences for other species were ≤ 0.06. While it was encouraging to see that robust point estimates of site occupancy were not drastically different than naïve estimates for a number of species, the significant differences documented for several species clearly show that evaluating the effects of imperfect detection of species can be extremely important. If not evaluated these differences could lead to designating a species of management concern when they are actually common enough to lack justification for this attention. Furthermore, it is important to note that multiple site surveys allow confidence intervals to be calculated for robust estimates of site occupancy, while single-visit surveys do not. Understanding the precision of estimates of site occupancy for a species is extremely important when making management decisions. By examining the extent to which confidence intervals overlap for estimates conducted at different time intervals, it may be possible to measure status over time.

Simulations of standard error (SE) for site occupancy rates (Psi) resulting from a number of scenarios for survey effort, detection probability (p), number of sites surveyed multiple times (M), number of times those multiple survey sites where surveyed (S), and number of sites surveyed a single time (s), identified a number of combinations that resulted in unacceptable levels of precision for confidence intervals (Tables F3-1 through F3-9). We considered acceptable confidence interval widths to be a maximum of 0.38 (i.e., a SE $\leq$ 0.095). However, even this may not be acceptable for evaluating some management or status questions. When acceptable confidence interval widths were achieved, we highlighted scenarios in gray (see Tables F3-1 through F3-9) when they allowed the greatest number of sites to be surveyed for each level of survey effort. In some cases we highlighted multiple scenarios associated with the same level of survey effort in order to highlight tradeoffs that might be faced (e.g., providing coverage for all Region 1 mollusks versus just focusing on a smaller geographic region where the majority of Species of Concern or Interest occur). When no scenarios resulted in acceptable confidence intervals under a given level of survey effort, and Psi and p, then no scenarios were highlighted. In general, simulations (Tables F3-1 through F3-9) showed that:

(1) When site occupancy rates are truly below 0.8, detection probabilities need to approach 0.4 before acceptable confidence intervals result.
(2) Sampling efforts associated with approximately one half of the existing level of sampling effort (approximately 25 days or 100 surveys) only achieved acceptable confidence intervals when species had detection probabilities $\geq$ 0.6, and then only when site occupancy rates were also $\geq$ 0.2. Thus, this level of effort would certainly not be enough to derive confidence intervals acceptable for monitoring a number of the species, including several Species of Concern, for which site occupancy and detection probabilities were estimated in this pilot study.
(3) The existing level of sampling effort (approximately 50 days or 200 surveys) is adequate for monitoring most individual species when detection probabilities exceed 0.4. It is inadequate for at least a few Species of Concern, and it may be generally inadequate for monitoring larger groups of species across larger regions, because individual regions (e.g., northwest Montana versus central Montana) may need all sampling effort in order to achieve the desired confidence intervals.
(4) Doubling the sampling effort from existing levels (approximately 100 days or 400 surveys) allows acceptable confidence intervals to be calculated, with site occupancy as low as 0.05 when detection probabilities were as low as 0.4. Furthermore, this level of sampling effort allows simultaneous monitoring of two sets of species with non-overlapping ranges in at least two different parts of Montana, as long as detection probabilities are at least 0.4.
(5) Increasing detection probability can dramatically reduce the size of confidence intervals. Pilot studies examining the effects of survey covariates (such as weather, temperature, and spring vs. fall surveys) on detection probability may result in cost savings, by simply identifying the need to conduct surveys under conditions when detection probabilities are highest. Alternatively, pilot studies may show that detection probabilities do not vary seasonally that much for some species, allowing surveyors more flexibility in the timing of some surveys.

Table F2

Terrestrial Mollusk Detection Probability Summary

Species [1,2]	Global Rank	State Rank	Best Fitting Model [3]	Naïve Estimate Proportion of Sites Occupied	Psi = Estimated Proportion Sites Occupied (SE)	p = Estimated Probability of Detection (SE)
Haplotrema vancouverense	G5	S1S2	Psi (2 groups), p(.)	0.375	0.414 (0.111)	0.597 (0.088)
Hemphillia camelus	G4	S1S3	Psi (.), p(.)	0.083	0.127 (0.155)	0.277 (0.460)
Kootenaia burkei	G2	S1S2	Psi (.), p(.)	0.167	0.224 (0.116)	0.357 (0.169)
Magnipelta mycophaga	G3	S1S3	Psi (.), p(.)	0.042	0.066 (0.125)	0.264 (0.667)
Polygyrella polygyrella	G3	S1S3	Psi (.), p(.)	0.167	0.167 (0.076)	0.886 (0.110)
Prophysaon andersoni	G5	S1S3	Psi (2 groups), p(.)	0.083	0.092 (0.063)	0.571 (0.170)
Prophysaon humile	G3	S1S3	Psi (.), p(.)	0.500	0.693 (0.168)	0.339 (0.090)
Radiodiscus abietum	G4	S2S3	Psi (.), p(.)	0.708	0.758 (0.101)	0.612 (0.700)
Zacoleus idahoensis	G3G4	S2S3	Psi (.), p(.)	0.667	0.905 (0.140)	0.403 (0.072)
Allogona ptychophora	G5	SNR	Psi (.), p(.)	0.208	0.216 (0.086)	0.713 (0.125)
Anguispira kochi	G5	SNR	Psi (2 groups), p(.)	0.917	0.919 (0.057)	0.748 (0.052)
Arion intermedius [2]	G5	Exotic	Psi (.), p(.)	0.042	Inadequate data for estimates.	
Columella edentula	G5	SNR	Psi (.), p(.)	0.042	Inadequate data for estimates.	
Cryptomastix mullani	G4	SNR	Psi (2 groups), p(.)	0.708	0.729 (0.095)	0.736 (0.062)
Deroceras reticulatum [2]	G5	Exotic	Psi (.), p(.)	0.083	Inadequate data for estimates.	
Discus whitneyi	G5	SNR	Psi (.), p(.)	0.250	0.908 (0.778)	0.095 (0.086)
Euconulus fulvus	G5	SNR	Psi (.), p(.)	0.500	0.983 (0.373)	0.189 (0.087)
Limax maximus [2]	G5	Exotic	Psi (.), p(.)	0.083	0.092 (0.063)	0.571 (0.169)
Microphysula ingersollii	G4G5	SNR	Psi (2 groups), p(.)	0.792	0.846 (0.090)	0.553 (0.070)
Nesovitrea bineyeana	G5	SNR	Psi (.), p(.)	0.042	Inadequate data for estimates.	
Oreohelix strigosa	G5	SNR	Psi (.), p(.)	0.083	Inadequate data for estimates.	
Oreohelix subrudis	G5	SNR	Psi (.), p(.)	0.125	0.180 (0.119)	0.312 (0.211)
Punctum randolphi	G4	SNR	Psi (.), p(.)	0.083	Inadequate data for estimates.	
Vertigo modesta	G5	SNR	Psi (.), p(.)	0.167	Inadequate data for estimates.	
Vitrina pellucida	G5	SNR	Psi (2 groups), p(.)	0.167	0.224 (0.116)	0.357 (0.169)
Zonitoides arboreus	G5	SNR	Psi (.), p(.)	0.875	1.000 (0.000)	0.494 (0.056)

[1] Species above the hatched line meet criteria for USFS Species of Concern or Species of Interest [2] Exotic species [3] Psi = Site occupancy dependent on variable in parentheses
p = Probability of detection dependent on variable in parentheses • = Psi or p is constant across all sites
2 groups = Estimates of Psi best fit the data with by modeling 2 groups of sites with one group having a higher site occupancy than the other. This probably occurred as a result of surveying across species range boundaries or across habitat types that species occupy within the area where multiple surveys were conducted.

Table F3-1

Psi = 0.05 & p = 0.05

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.285**	**0.481**	**0.495**	**0.449**	**0.490**	**0.479**	**0.452**	**0.449**	**0.430**	**0.315**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.354**	**0.360**	**0.485**	**0.494**	**0.458**	**0.478**	**0.450**	**0.389**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.194**	**0.382**	**0.490**	**0.469**	-						

Psi = 0.05 & p = 0.20

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.469**	**0.474**	**0.479**	**0.260**	**0.462**	**0.483**	**0.494**	**0.345**	**0.452**	**0.470**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.430**	**0.453**	**0.476**	**0.489**	**0.324**	**0.420**	**0.461**	**0.469**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.398**	**0.454**	**0.468**	**0.486**	-						

Psi = 0.05 & p = 0.40

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.360**	**0.282**	**0.452**	**0.087**	**0.259**	**0.359**	**0.475**	**0.120**	**0.313**	**0.470**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.455**	**0.258**	**0.376**	**0.479**	**0.139**	**0.197**	**0.362**	**0.472**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.468**	**0.333**	**0.398**	**0.469**	-						

Table F3-2

Psi = 0.05 & p = 0.60

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.166**	**0.124**	**0.265**	**0.045**	**0.110**	**0.167**	**0.375**	**0.038**	**0.179**	**0.422**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.319**	**0.114**	**0.250**	**0.393**	**0.055**	**0.056**	**0.161**	**0.437**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.411**	**0.134**	**0.279**	**0.420**	-						

Psi = 0.05 & p = 0.80

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.054**	**0.017**	**0.081**	**0.029**	**0.016**	**0.017**	**0.135**	**0.018**	**0.047**	**0.286**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.154**	**0.043**	**0.084**	**0.234**	**0.036**	**0.027**	**0.065**	**0.303**	–		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.249**	**0.064**	**0.151**	**0.297**	-						

Psi = 0.20 & p = 0.05

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.313**	**0.411**	**0.422**	**0.407**	**0.451**	**0.464**	**0.486**	**0.455**	**0.489**	**0.474**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.260**	**0.397**	**0.437**	**0.470**	**0.413**	**0.453**	**0.484**	**0.492**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.219**	**0.364**	**0.452**	**0.491**	-						

Table F3-3

Psi = 0.20 & p = 0.20

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.325**	**0.278**	**0.420**	**0.079**	**0.281**	**0.378**	**0.440**	**0.170**	**0.363**	**0.448**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.415**	**0.272**	**0.390**	**0.434**	**0.153**	**0.249**	**0.379**	**0.451**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.424**	**0.355**	**0.418**	**0.443**	-

Psi = 0.20 & p = 0.40

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.087**	**0.064**	**0.165**	**0.056**	**0.063**	**0.121**	**0.300**	**0.055**	**0.142**	**0.376**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.191**	**0.079**	**0.137**	**0.306**	**0.076**	**0.085**	**0.148**	**0.380**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.333**	**0.163**	**0.272**	**0.389**	-

Psi = 0.20 & p = 0.60

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.037**	**0.036**	**0.066**	**0.058**	**0.037**	**0.047**	**0.116**	**0.042**	**0.045**	**0.228**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.061**	**0.057**	**0.064**	**0.133**	**0.078**	**0.058**	**0.054**	**0.204**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.156**	**0.092**	**0.117**	**0.247**	-

Table F3-4

Psi = 0.20 & p = 0.80

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.029**	**0.031**	**0.029**	**0.056**	**0.031**	**0.029**	**0.046**	**0.034**	**0.031**	**0.060**	-

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.043**	**0.054**	**0.043**	**0.057**	**0.079**	**0.051**	**0.044**	**0.078**	-

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.065**	**0.078**	**0.062**	**0.103**	-

Psi = 0.40 & p = 0.05

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.342**	**0.384**	**0.356**	**0.319**	**0.391**	**0.404**	**0.403**	**0.378**	**0.431**	**0.481**	-

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.289**	**0.349**	**0.380**	**0.402**	**0.352**	**0.392**	**0.414**	**0.476**	-

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.216**	**0.339**	**0.403**	**0.461**	-

Psi = 0.40 & p = 0.20

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.239**	**0.204**	**0.299**	**0.091**	**0.198**	**0.261**	**0.359**	**0.132**	**0.260**	**0.394**	-

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.288**	**0.208**	**0.271**	**0.359**	**0.144**	**0.200**	**0.276**	**0.389**	-

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.355**	**0.278**	**0.329**	**0.385**	-

Table F3-5

Psi = 0.40 & p = 0.40

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.091**	**0.069**	**0.141**	**0.072**	**0.075**	**0.106**	**0.206**	**0.068**	**0.108**	**0.273**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.136**	**0.087**	**0.110**	**0.205**	**0.097**	**0.086**	**0.108**	**0.260**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.203**	**0.134**	**0.181**	**0.282**	-

Psi = 0.40 & p = 0.60

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.047**	**0.046**	**0.063**	**0.070**	**0.049**	**0.055**	**0.098**	**0.053**	**0.061**	**0.149**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.071**	**0.074**	**0.066**	**0.097**	**0.099**	**0.075**	**0.075**	**0.158**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.111**	**0.099**	**0.097**	**0.158**	-

Psi = 0.40 & p = 0.80

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.037**	**0.039**	**0.037**	**0.068**	**0.040**	**0.039**	**0.046**	**0.042**	**0.042**	**0.064**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.052**	**0.068**	**0.053**	**0.055**	**0.097**	**0.065**	**0.054**	**0.072**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.077**	**0.096**	**0.079**	**0.083**	-

Table F3-6

Psi = 0.60 & p = 0.05

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.344**	**0.346**	**0.349**	**0.271**	**0.354**	**0.372**	**0.385**	**0.321**	**0.389**	**0.428**	**-**

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.288**	**0.334**	**0.347**	**0.353**	**0.297**	**0.339**	**0.364**	**0.426**	**-**

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.250**	**0.323**	**0.370**	**0.308**	**-**

Psi = 0.60 & p = 0.20

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.212**	**0.183**	**0.254**	**0.094**	**0.185**	**0.226**	**0.291**	**0.136**	**0.229**	**0.332**	**-**

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.249**	**0.187**	**0.234**	**0.290**	**0.136**	**0.182**	**0.228**	**0.329**	**-**

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.284**	**0.237**	**0.272**	**0.323**	**-**

Psi = 0.60 & p = 0.40

100 Sampling Days = 400 surveys

M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.101**	**0.082**	**0.137**	**0.071**	**0.083**	**0.111**	**0.185**	**0.074**	**0.115**	**0.224**	**-**

50 Sampling Days = 200 surveys

M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.141**	**0.092**	**0.118**	**0.188**	**0.101**	**0.098**	**0.119**	**0.228**	**-**

25 Sampling Days = 100 surveys

M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.190**	**0.132**	**0.165**	**0.225**	**-**

Table F3-7

Psi = 0.60 & p = 0.60

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.049**	**0.050**	**0.069**	**0.069**	**0.054**	**0.062**	**0.098**	**0.059**	**0.068**	**0.144**	**-**
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.075**	**0.074**	**0.067**	**0.108**	**0.096**	**0.076**	**0.077**	**0.140**	**-**		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.106**	**0.106**	**0.100**	**0.144**	**-**						

Psi = 0.60 & p = 0.80

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.036**	**0.039**	**0.040**	**0.068**	**0.041**	**0.041**	**0.049**	**0.046**	**0.048**	**0.076**	**-**
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.051**	**0.070**	**0.056**	**0.059**	**0.101**	**0.068**	**0.059**	**0.076**	**-**		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.074**	**0.098**	**0.079**	**0.082**	**-**						

Psi = 0.80 & p = 0.05

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.312**	**0.296**	**0.314**	**0.244**	**0.306**	**0.335**	**0.354**	**0.265**	**0.352**	**0.393**	**-**
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.309**	**0.295**	**0.316**	**0.318**	**0.250**	**0.290**	**0.345**	**0.392**	**-**		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.257**	**0.313**	**0.330**	**0.374**	**-**						

Table F3-8

Psi = 0.80 & p = 0.20

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.167**	**0.155**	**0.200**	**0.091**	**0.155**	**0.182**	**0.237**	**0.119**	**0.183**	**0.275**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.204**	**0.155**	**0.181**	**0.236**	**0.124**	**0.147**	**0.188**	**0.277**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.234**	**0.181**	**0.218**	**0.273**	-

Psi = 0.80 & p = 0.40

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.098**	**0.080**	**0.125**	**0.060**	**0.081**	**0.106**	**0.151**	**0.071**	**0.107**	**0.174**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.124**	**0.086**	**0.108**	**0.150**	**0.084**	**0.085**	**0.108**	**0.182**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.149**	**0.115**	**0.139**	**0.174**	-

Psi = 0.80 & p = 0.60

100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.050**	**0.047**	**0.071**	**0.055**	**0.050**	**0.063**	**0.092**	**0.058**	**0.067**	**0.119**	-

50 Sampling Days = 200 surveys									
M	100	50	50	50	25	25	25	25	0
S	2	4	3	2	8	6	4	2	0
s	0	0	50	100	0	50	100	150	200
SE	**0.071**	**0.061**	**0.064**	**0.095**	**0.080**	**0.069**	**0.071**	**0.117**	-

25 Sampling Days = 100 surveys					
M	50	25	25	25	0
S	2	4	3	2	0
s	0	0	25	50	100
SE	**0.106**	**0.086**	**0.094**	**0.122**	-

Table F3-9

Psi = 0.80 & p = 0.80											
100 Sampling Days = 400 surveys											
M	200	100	100	50	50	50	50	25	25	25	0
S	2	3	2	8	4	3	2	8	4	2	0
s	0	100	200	0	200	250	300	200	300	350	400
SE	**0.032**	**0.034**	**0.039**	**0.056**	**0.039**	**0.039**	**0.051**	**0.044**	**0.046**	**0.069**	-
50 Sampling Days = 200 surveys											
M	100	50	50	50	25	25	25	25	0		
S	2	4	3	2	8	6	4	2	0		
s	0	0	50	100	0	50	100	150	200		
SE	**0.045**	**0.056**	**0.051**	**0.056**	**0.081**	**0.061**	**0.057**	**0.074**	-		
25 Sampling Days = 100 surveys											
M	50	25	25	25	0						
S	2	4	3	2	0						
s	0	0	25	50	100						
SE	**0.063**	**0.080**	**0.070**	**0.079**	-						

Notations in Appendix:

Psi = true site occupancy rate

p = true detection probability

M = number of sites with multiple surveys

S = the number of times the multiple survey sites where surveyed

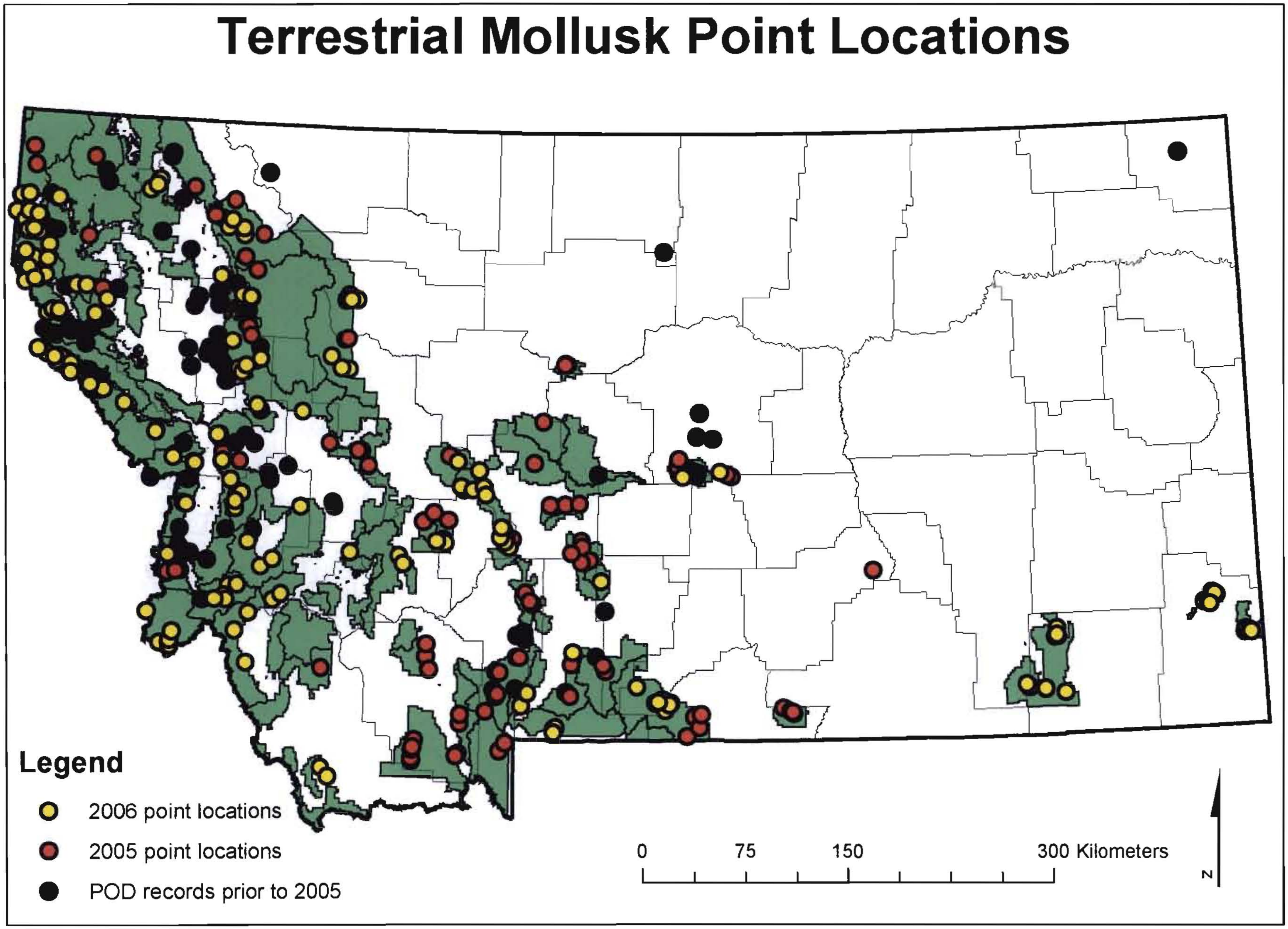
s = the number of sites surveyed a single time

SE = standard error of the estimate of site occupancy rate resulting from the level of survey effort (bolded headings), Psi, p, M, S, and s. Note that total width of confidence intervals is 4 times SE.

Note:

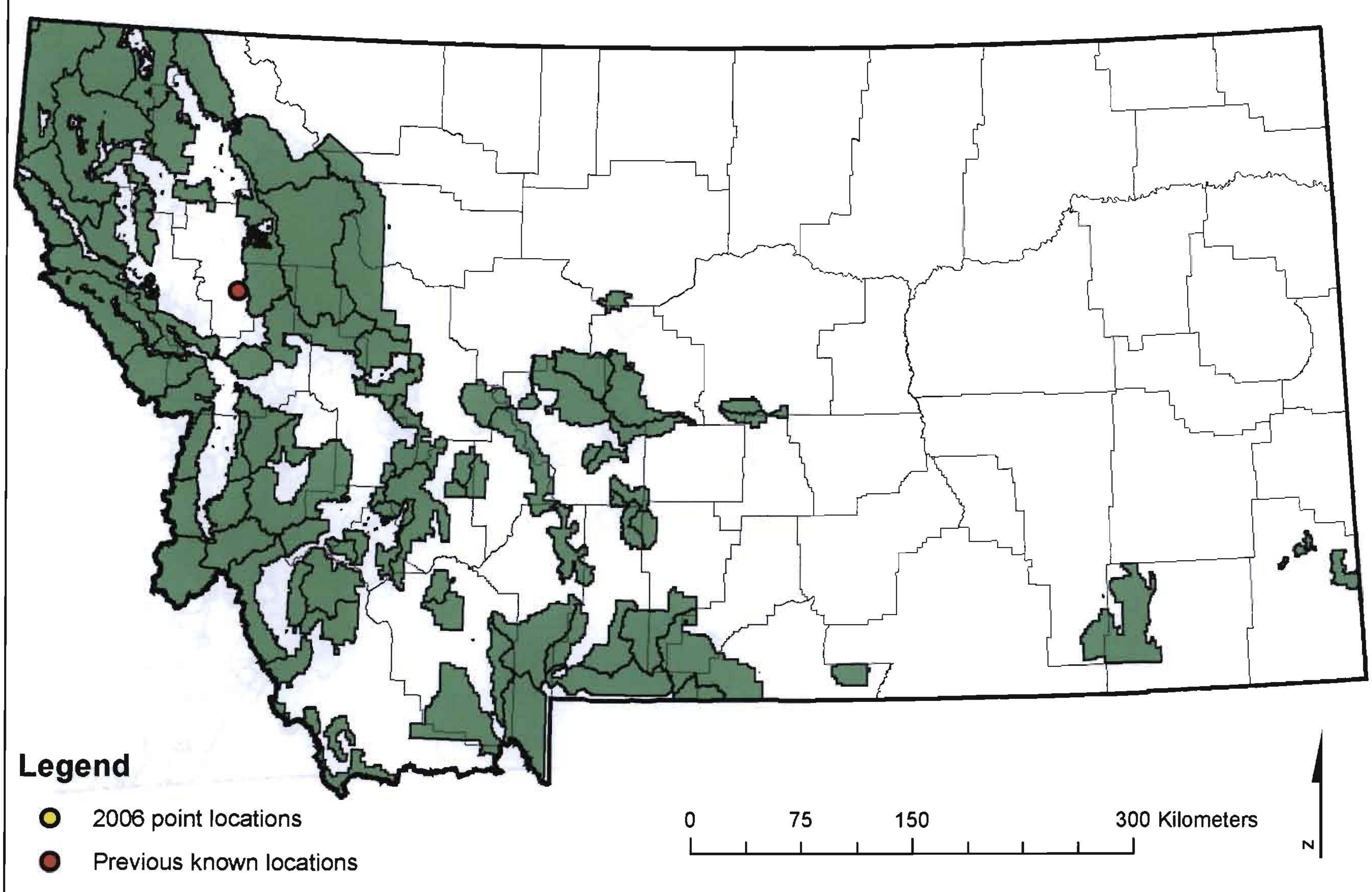
Combinations resulting in acceptable confidence intervals that allow the largest number of sites to be surveyed for each level of survey effort are highlighted in gray. If no combinations result in acceptable confidence intervals under a given level of survey effort and Psi and p, then no combinations are highlighted.

Appendix G. Distribution Maps for SOC/SOI Land Mollusks on USFS Region 1 Lands

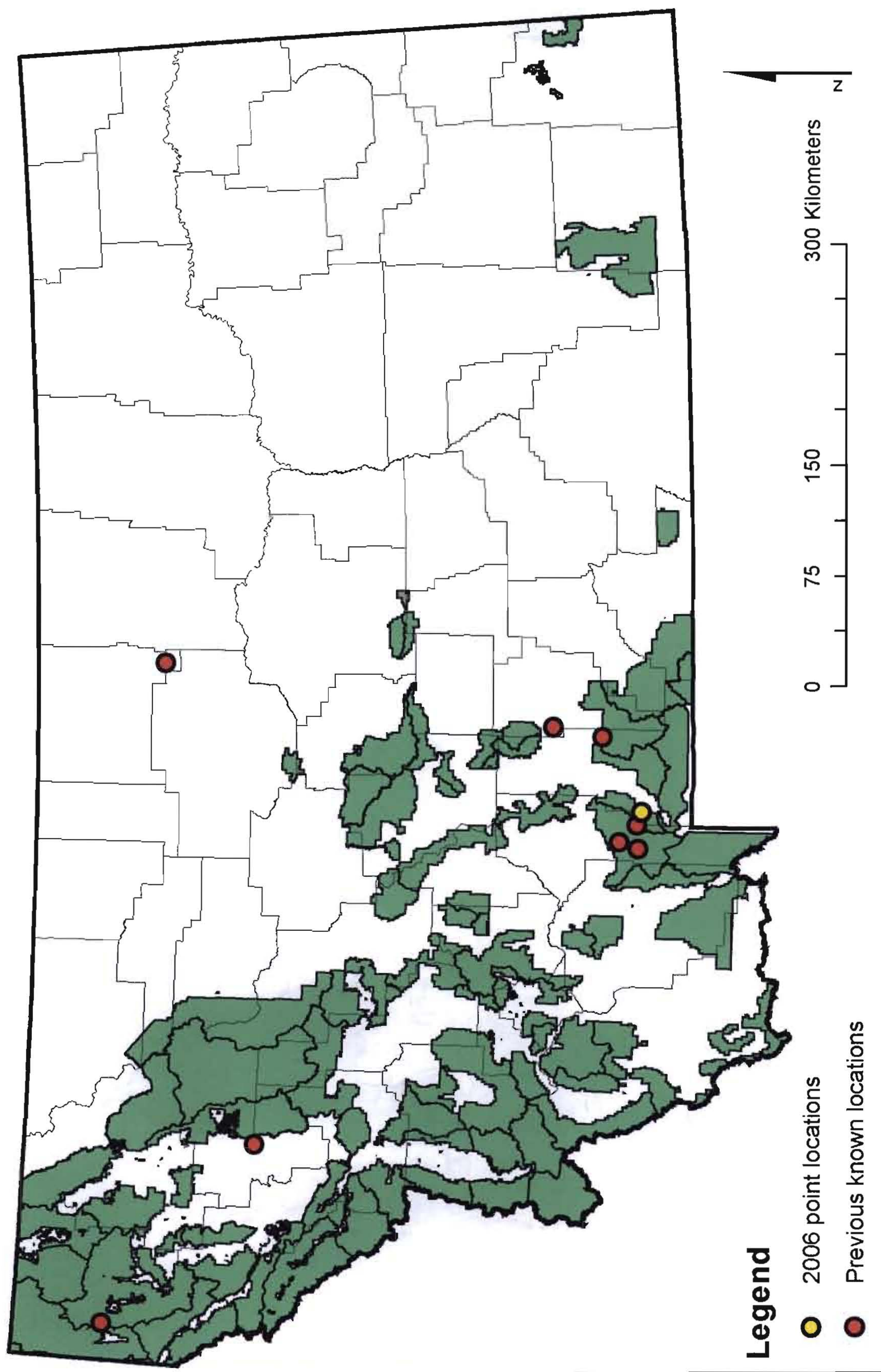


Terrestrial Mollusk Point Locations
Legend
2006 point locations
2005 point locations
POD records prior to 2005
0
75
150
300 Kilometers
N

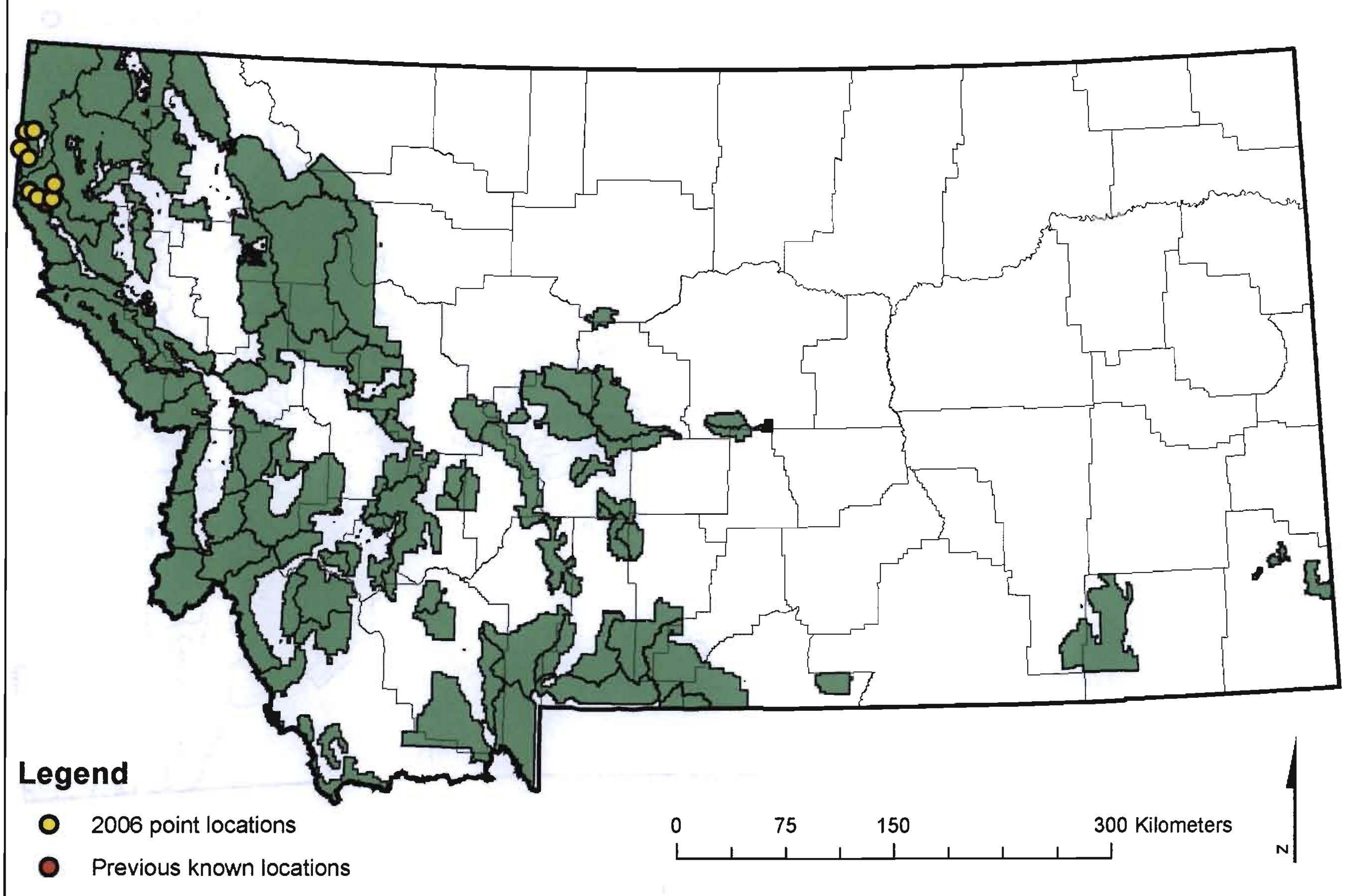
Lake Disc (*Discus brunsoni*)



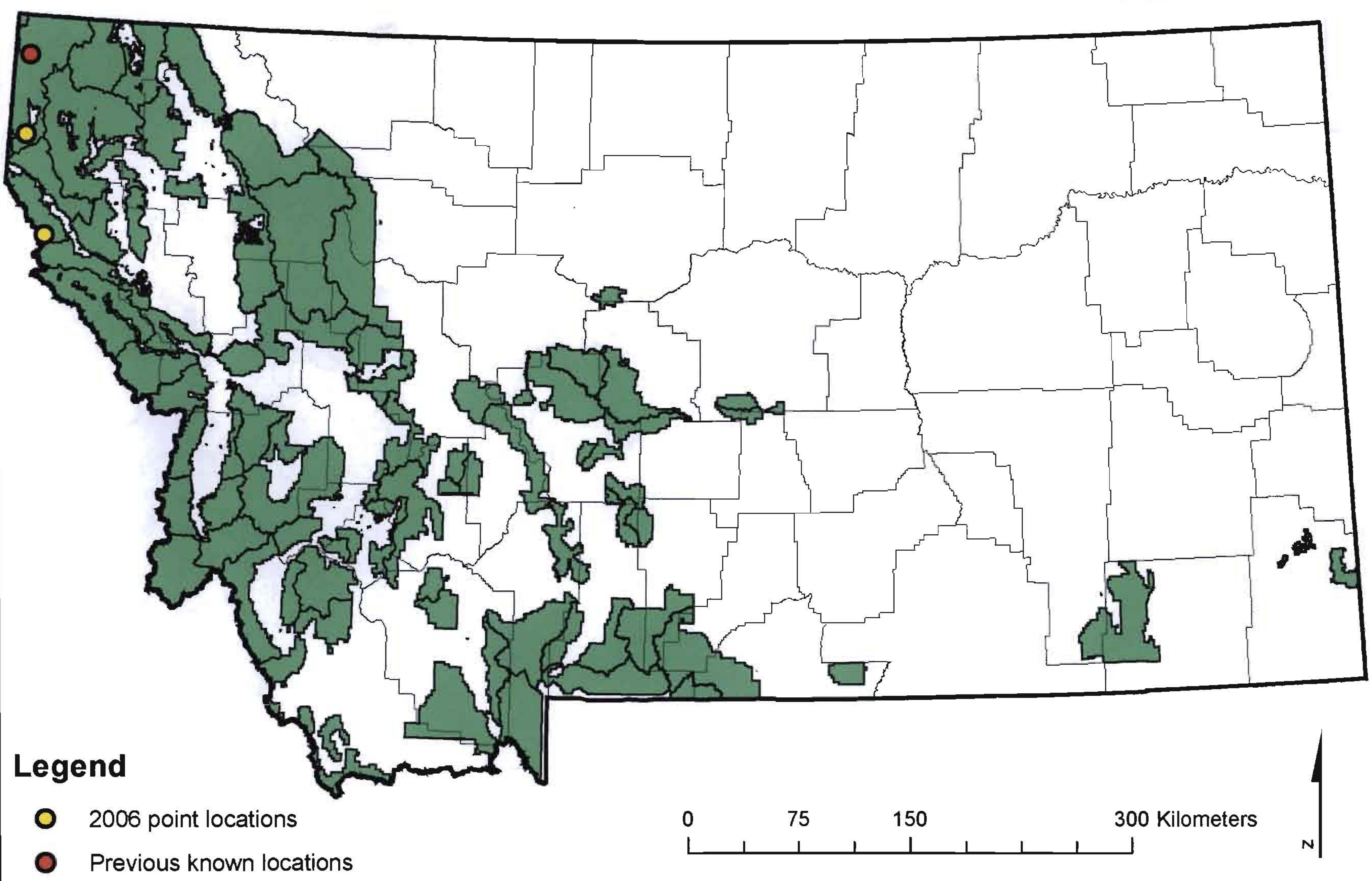
Striate Disc (*Discus shimekii*)



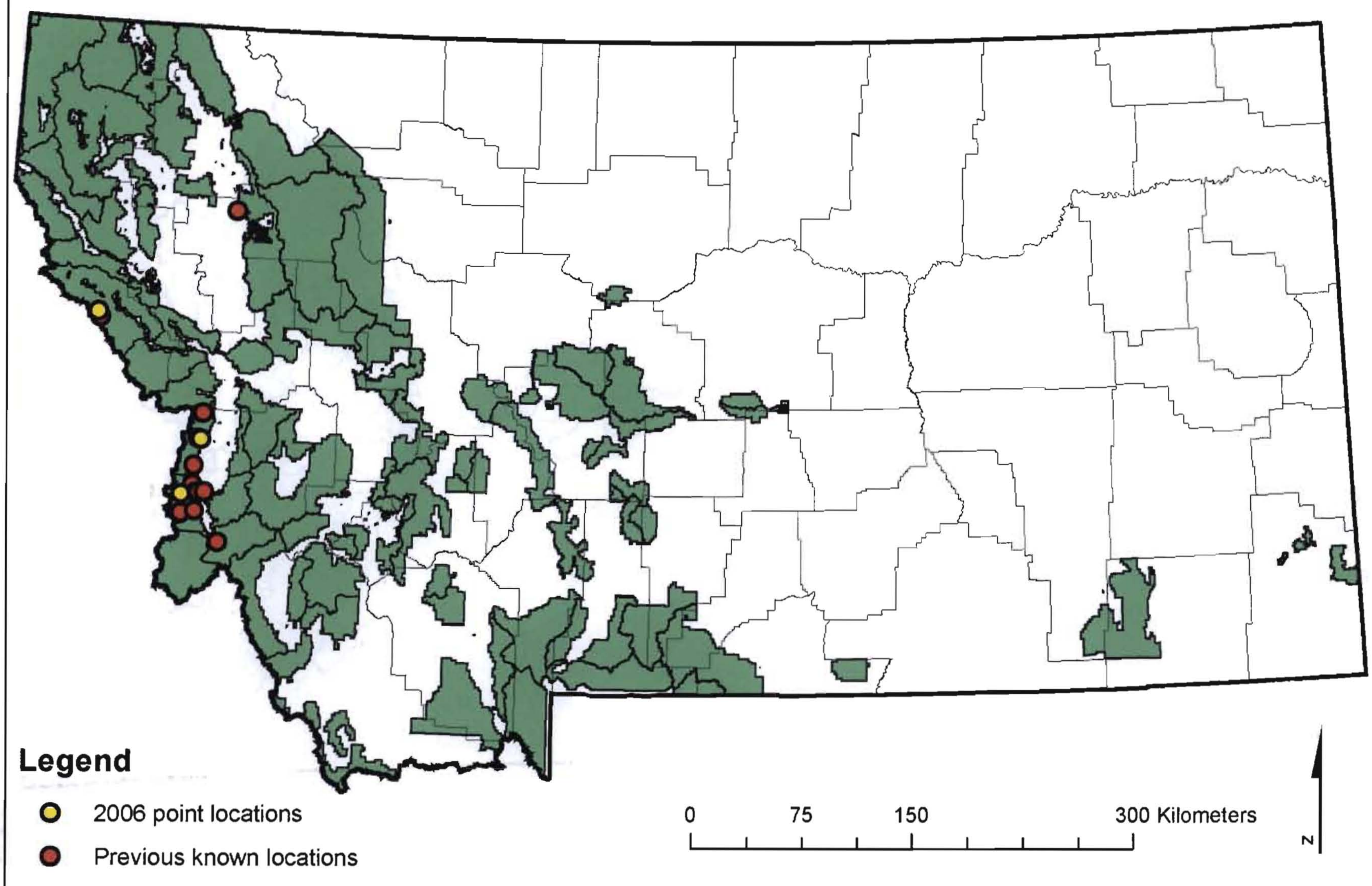
Robust Lancetooth (*Haplotrema vancouverense*)

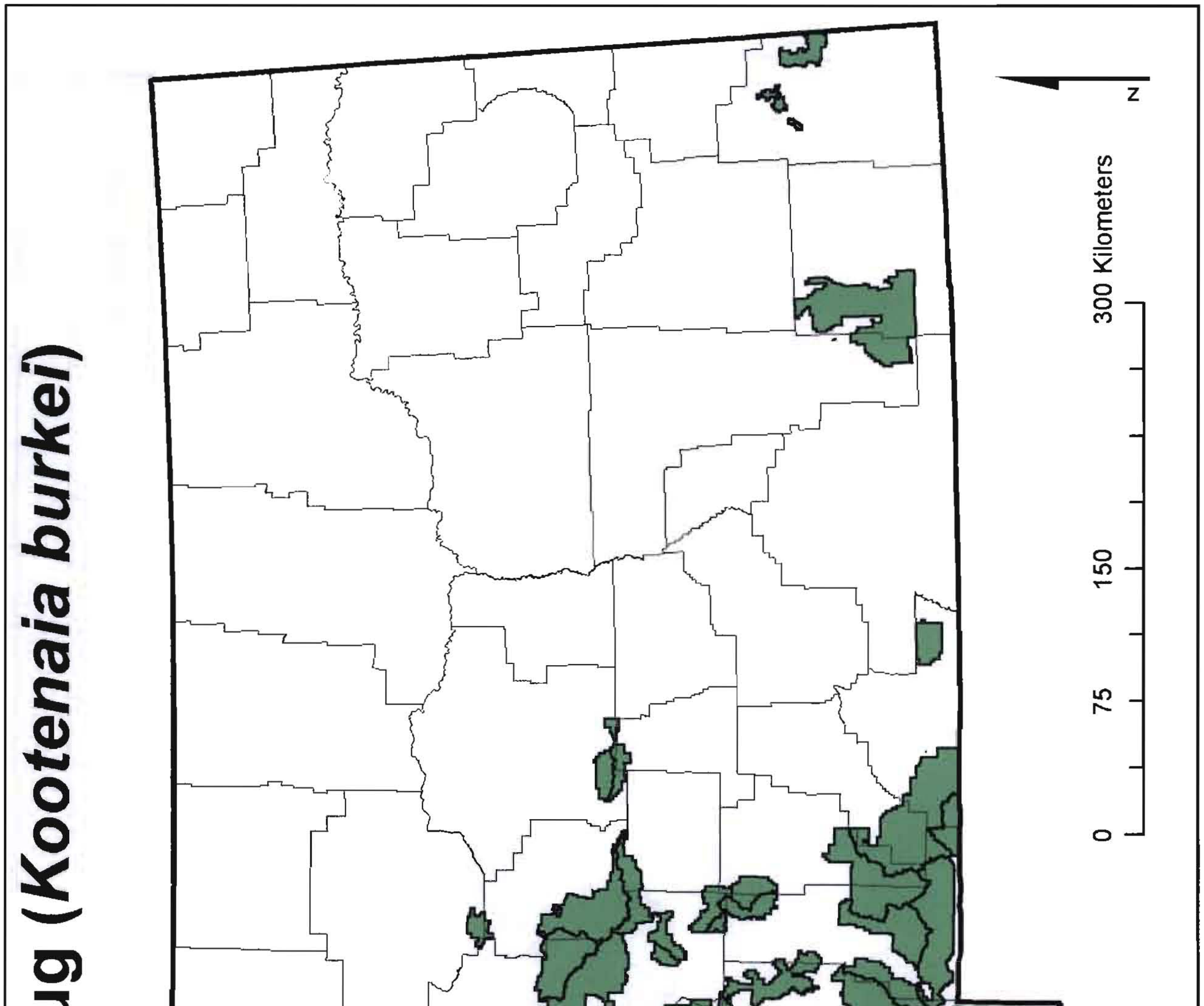


Pale Jumping-slug (*Hemphillia camelus*)

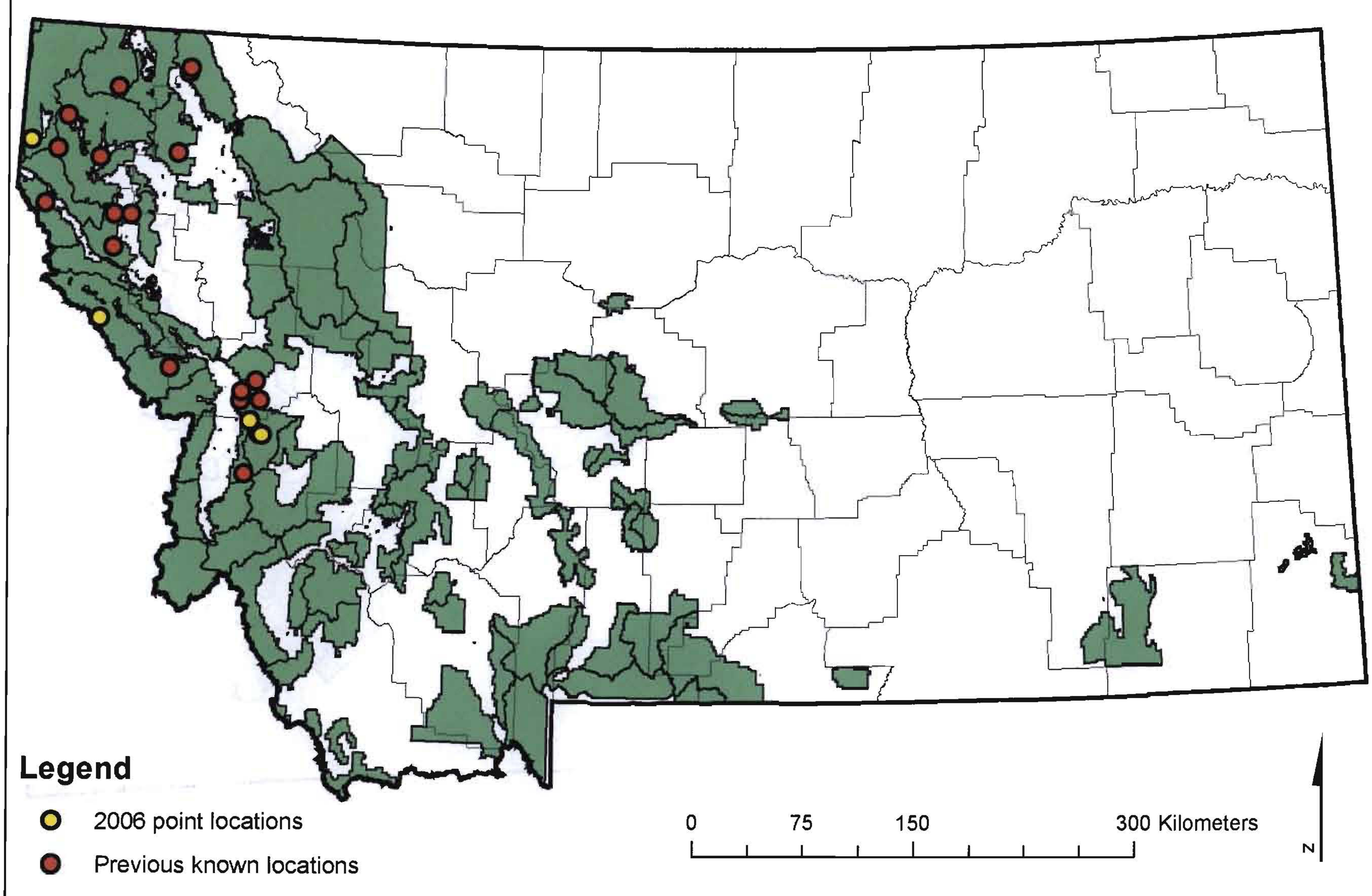


Marbled Jumping-slug (*Hemphillia danielsi*)

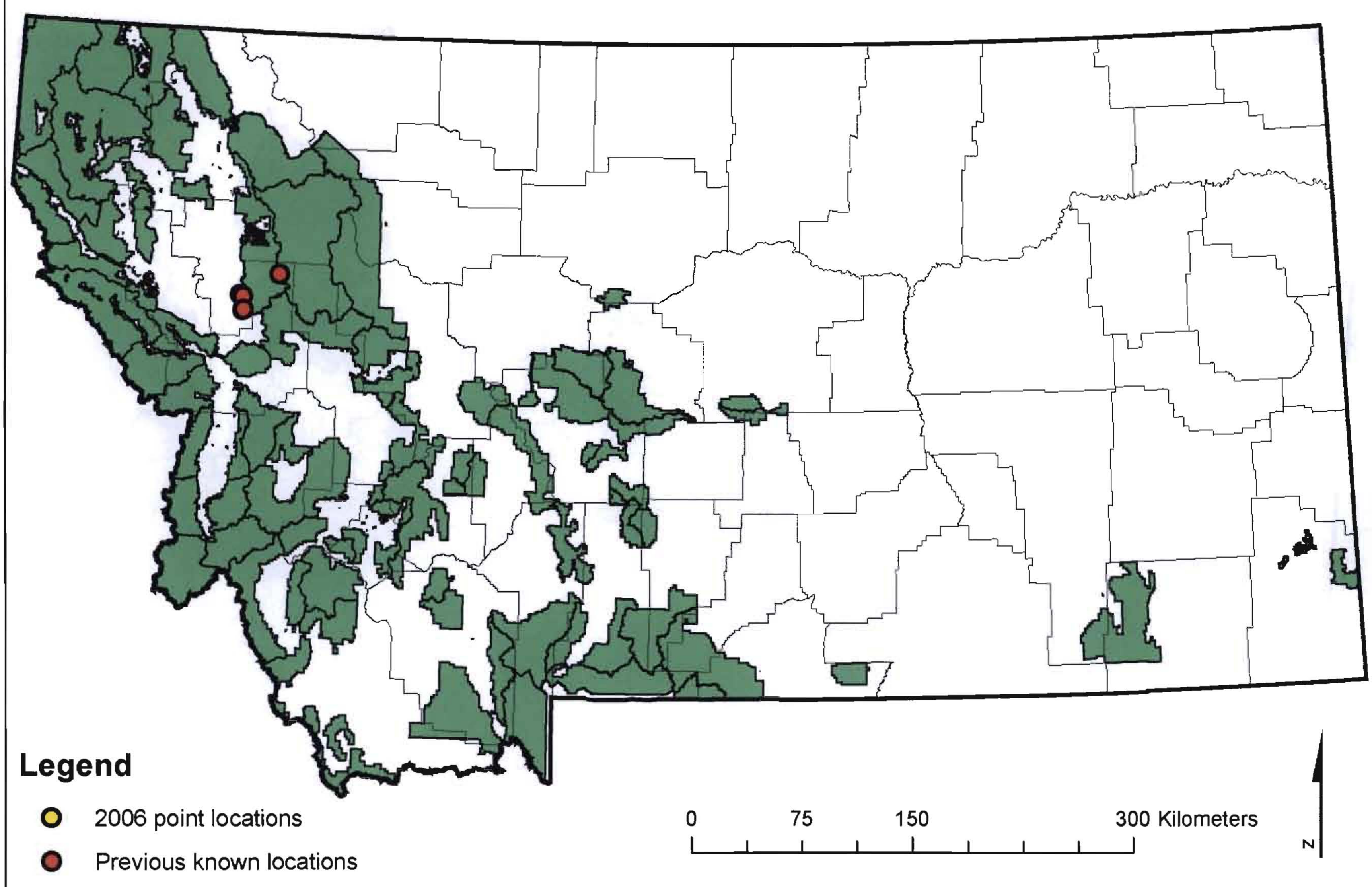



Pygmy Slug (*Kootenaia burkei*)
Legend
2006 point locations
Previous known locations
0
75
150
300 Kilometers
N

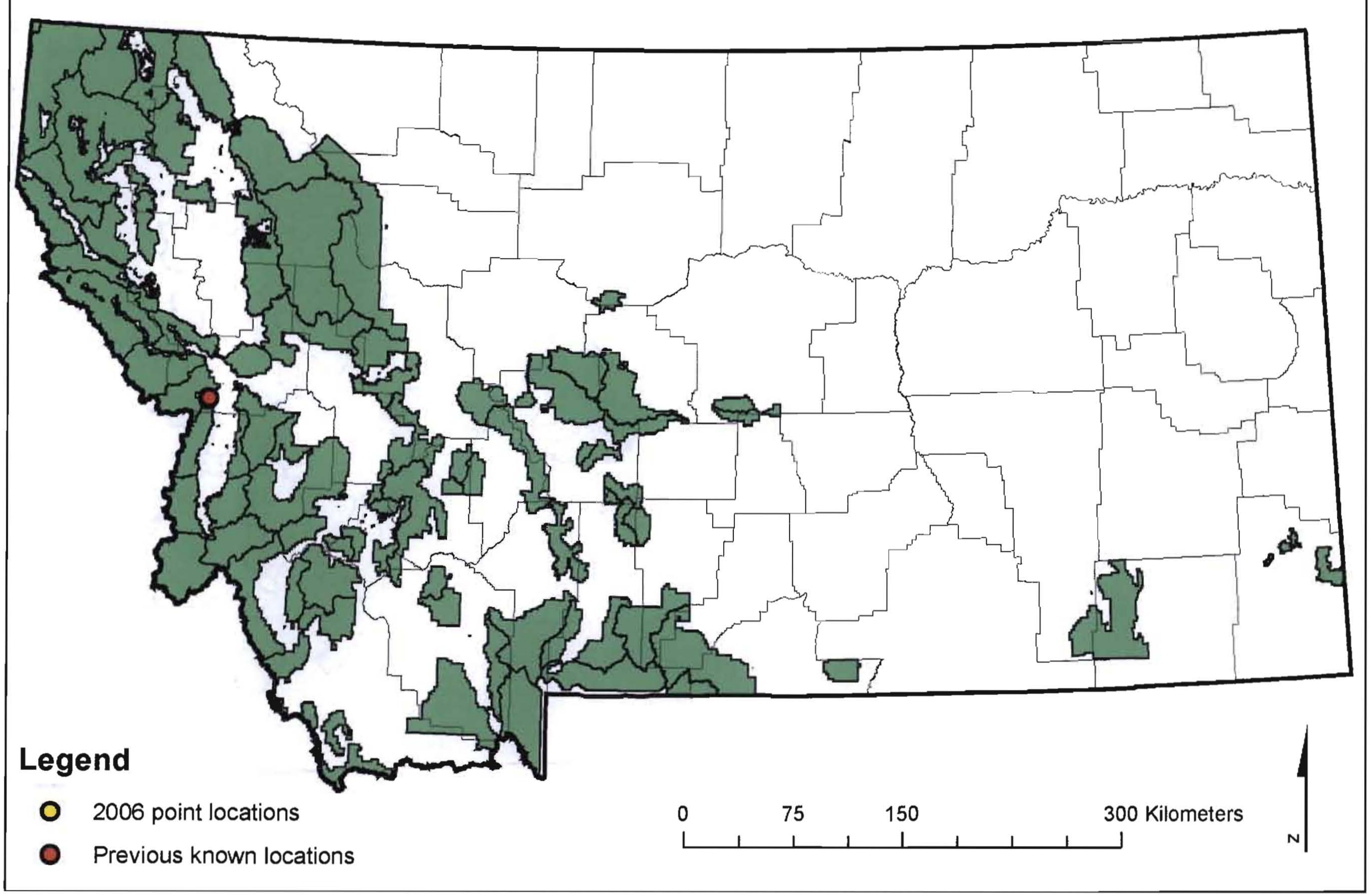
Magnum Mantleslug (*Magnipelta mycophaga*)

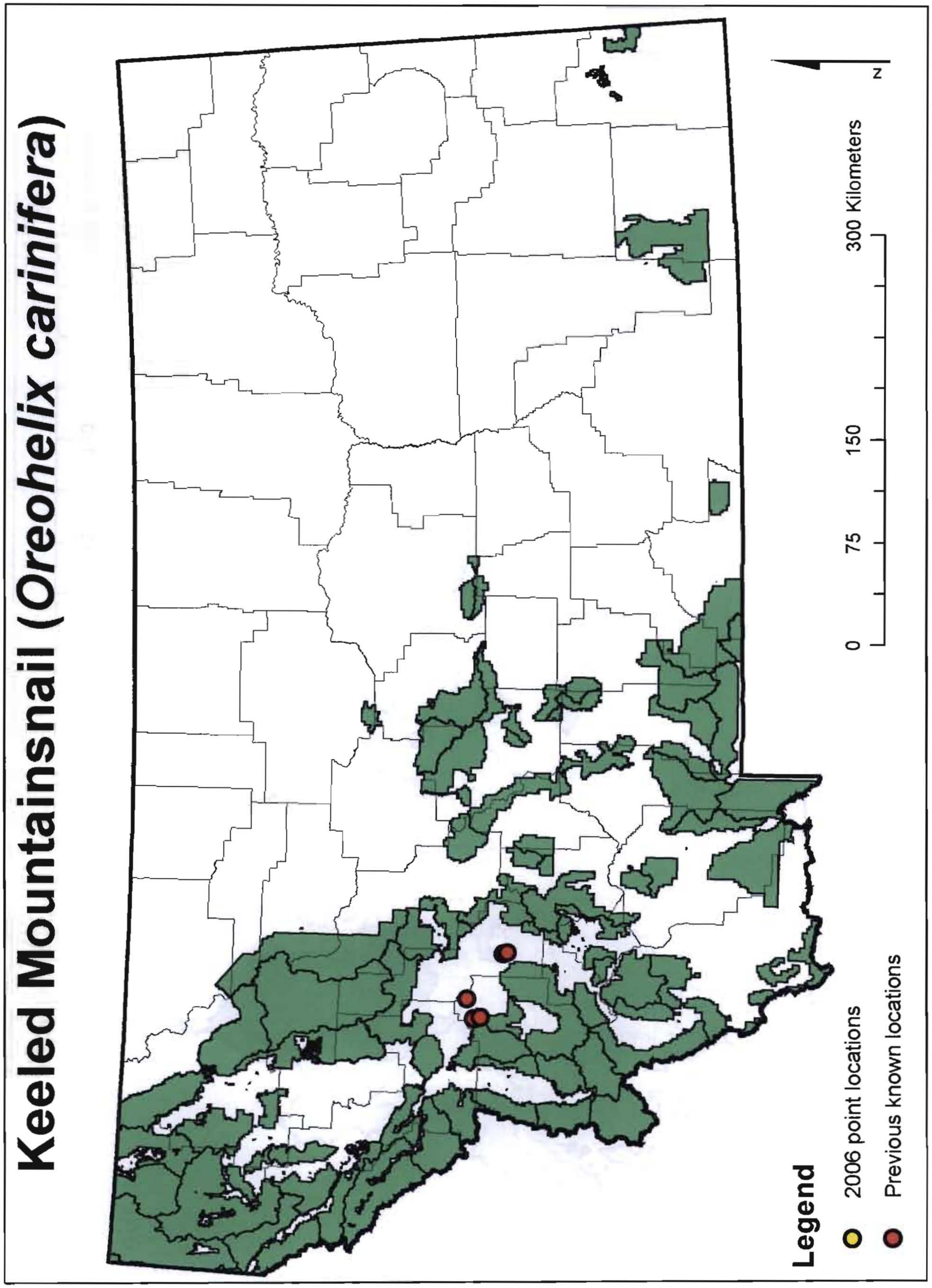


Alpine Mountainsnail (*Oreohelix alpina*)

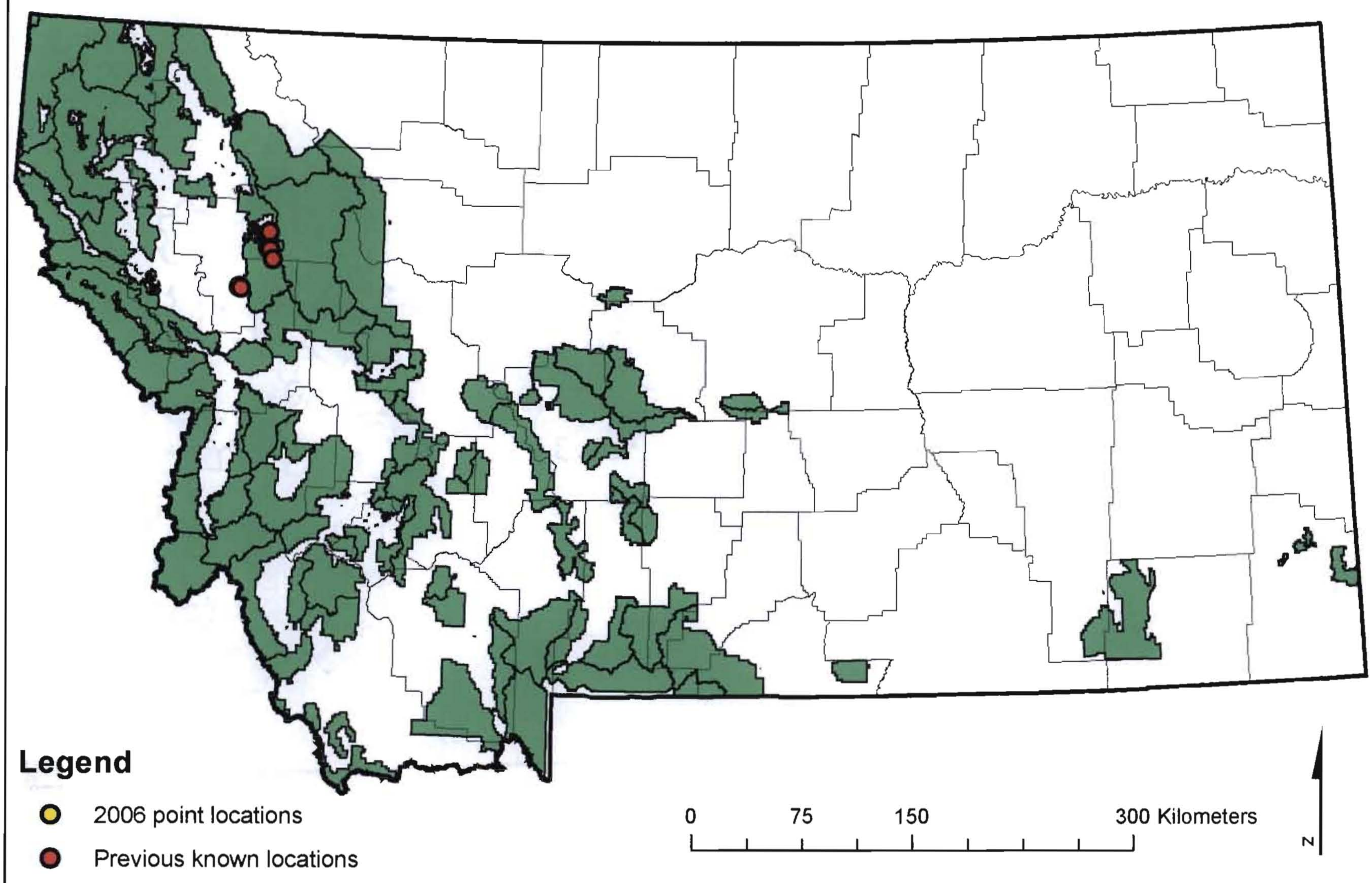


Bitterroot Mountainsnail (*Oreohelix amariradix*)

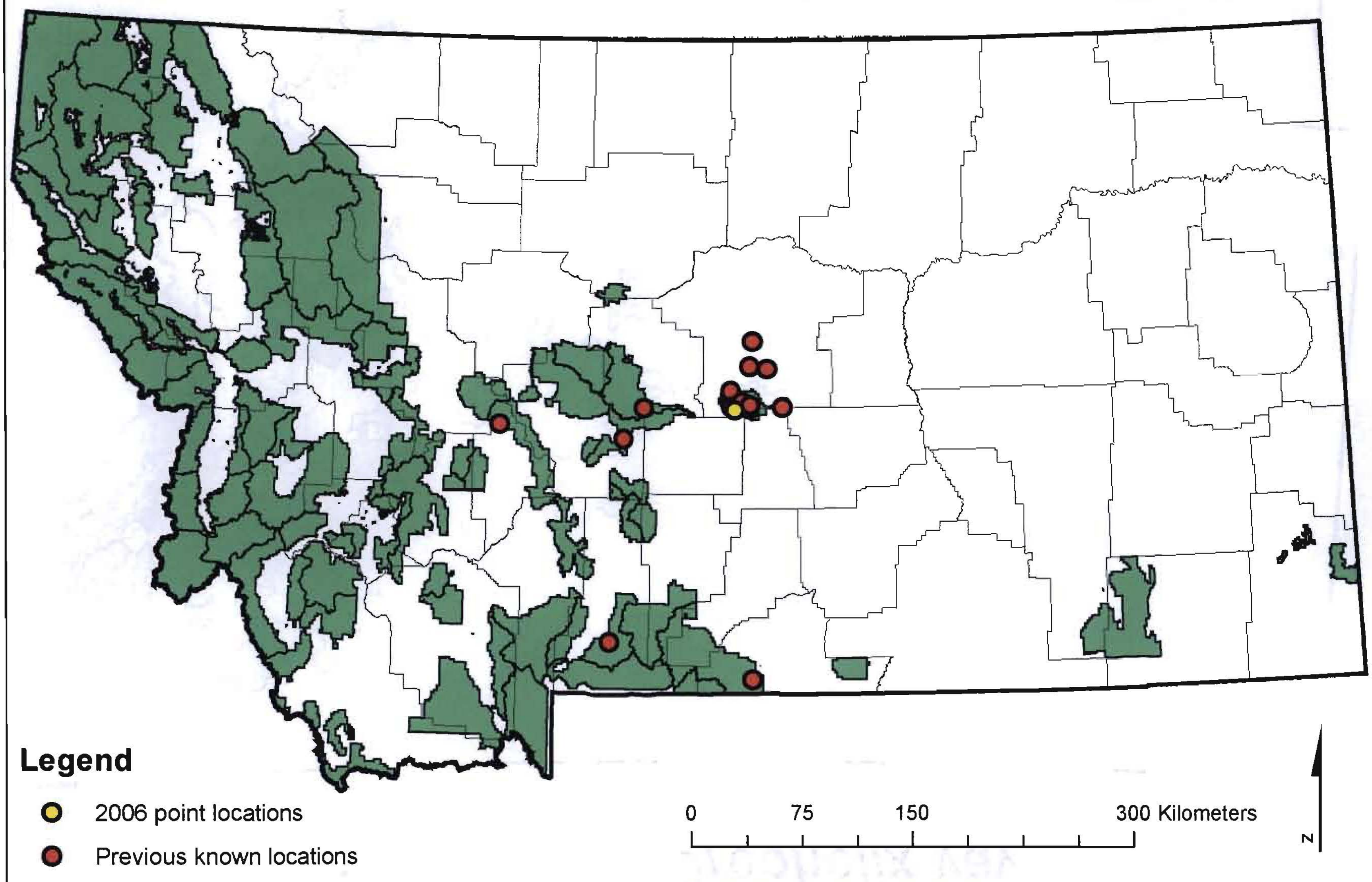


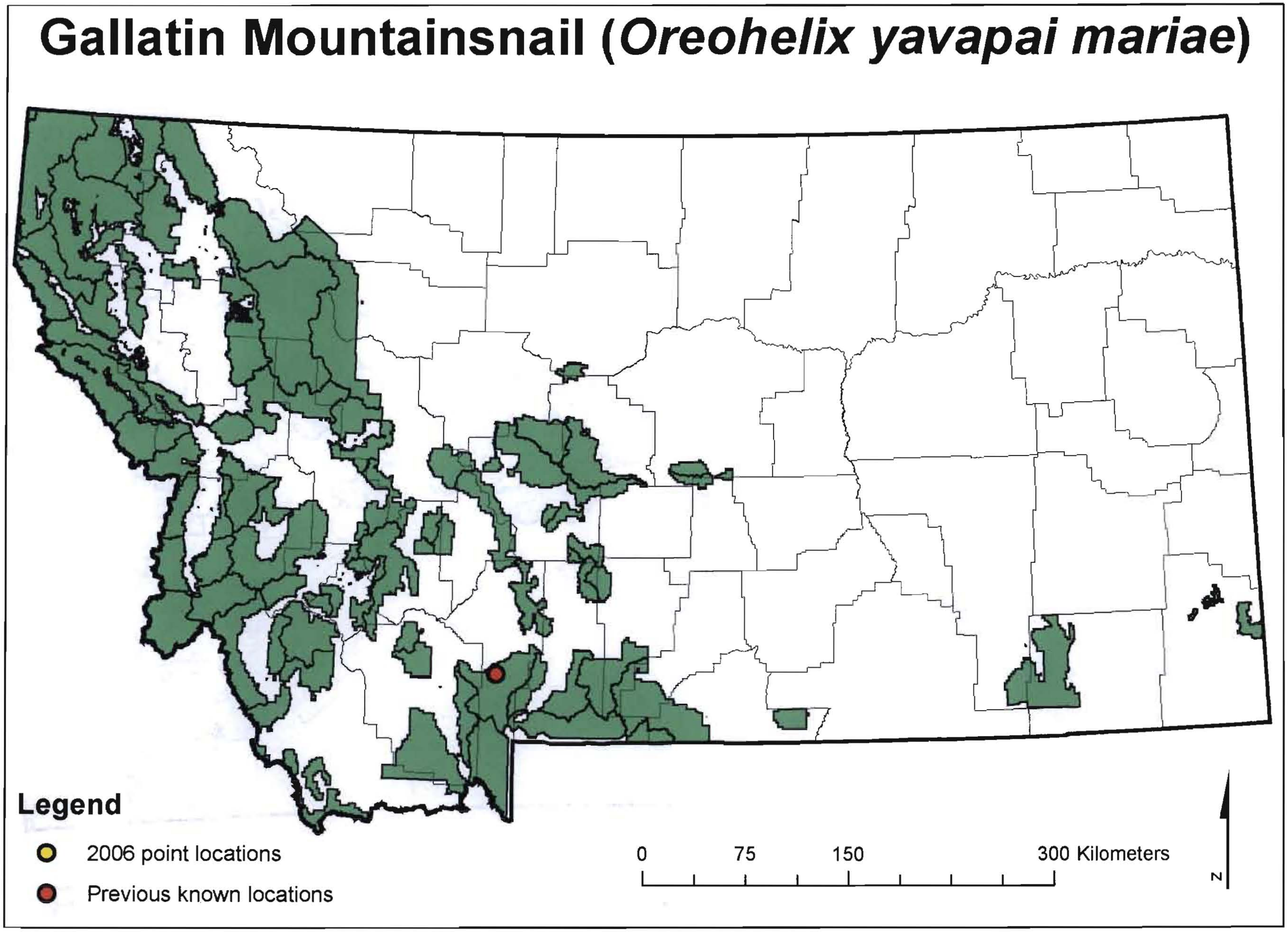

Keeled Mountainsnail (Oreohelix carinifera)
Legend
2006 point locations
Previous known locations
0
75
150
300 Kilometers
N

Carinate Mountainsnail (*Oreohelix elrodi*)

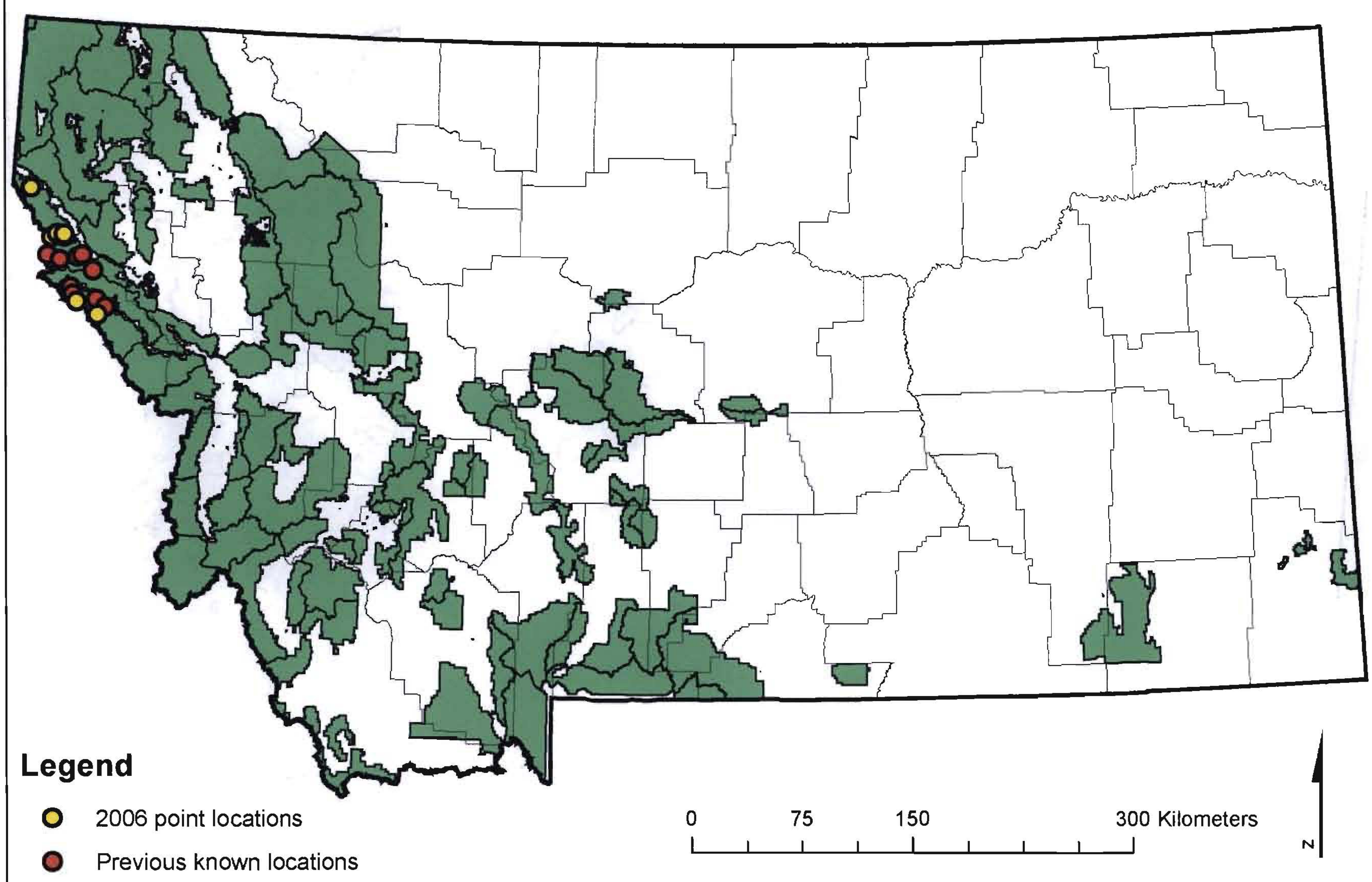


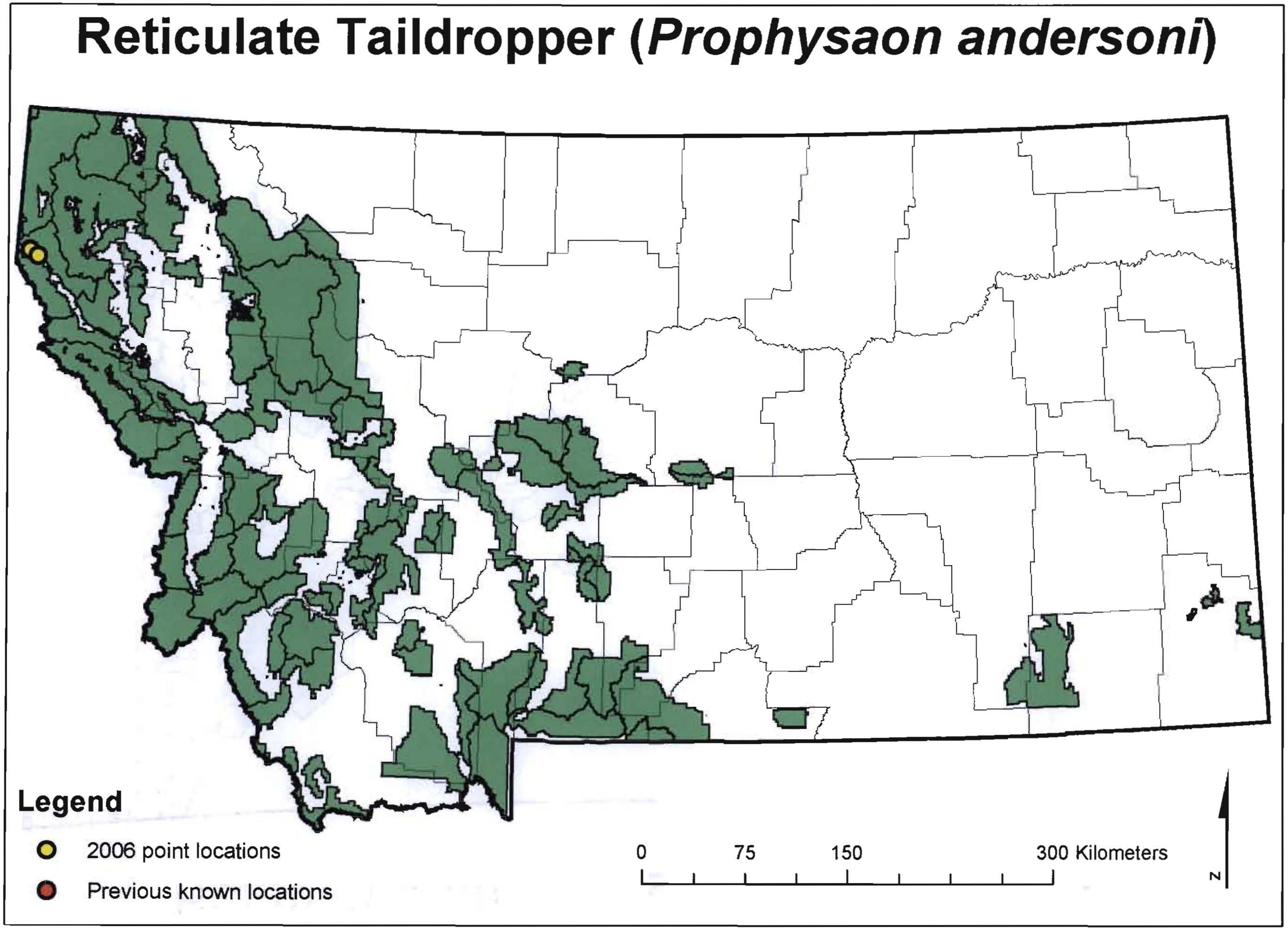
Berry's Mountainsnail (*Oreohelix strigosa berryi*)



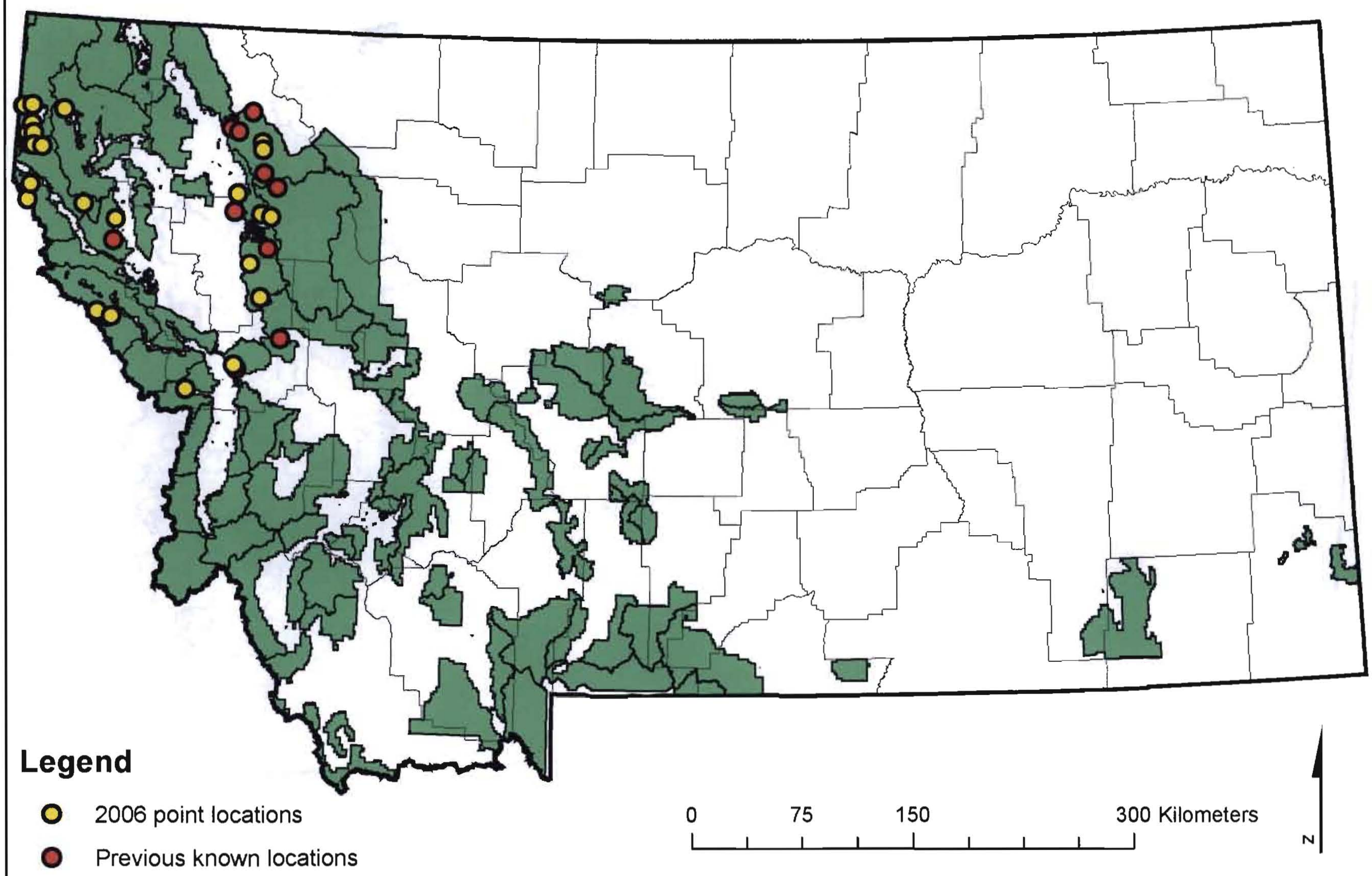

Gallatin Mountainsnail (Oreohelix yavapai mariae)
Legend
2006 point locations
Previous known locations
0
75
150
300 Kilometers
N

Humped Coin (*Polygyrella polygyrella*)

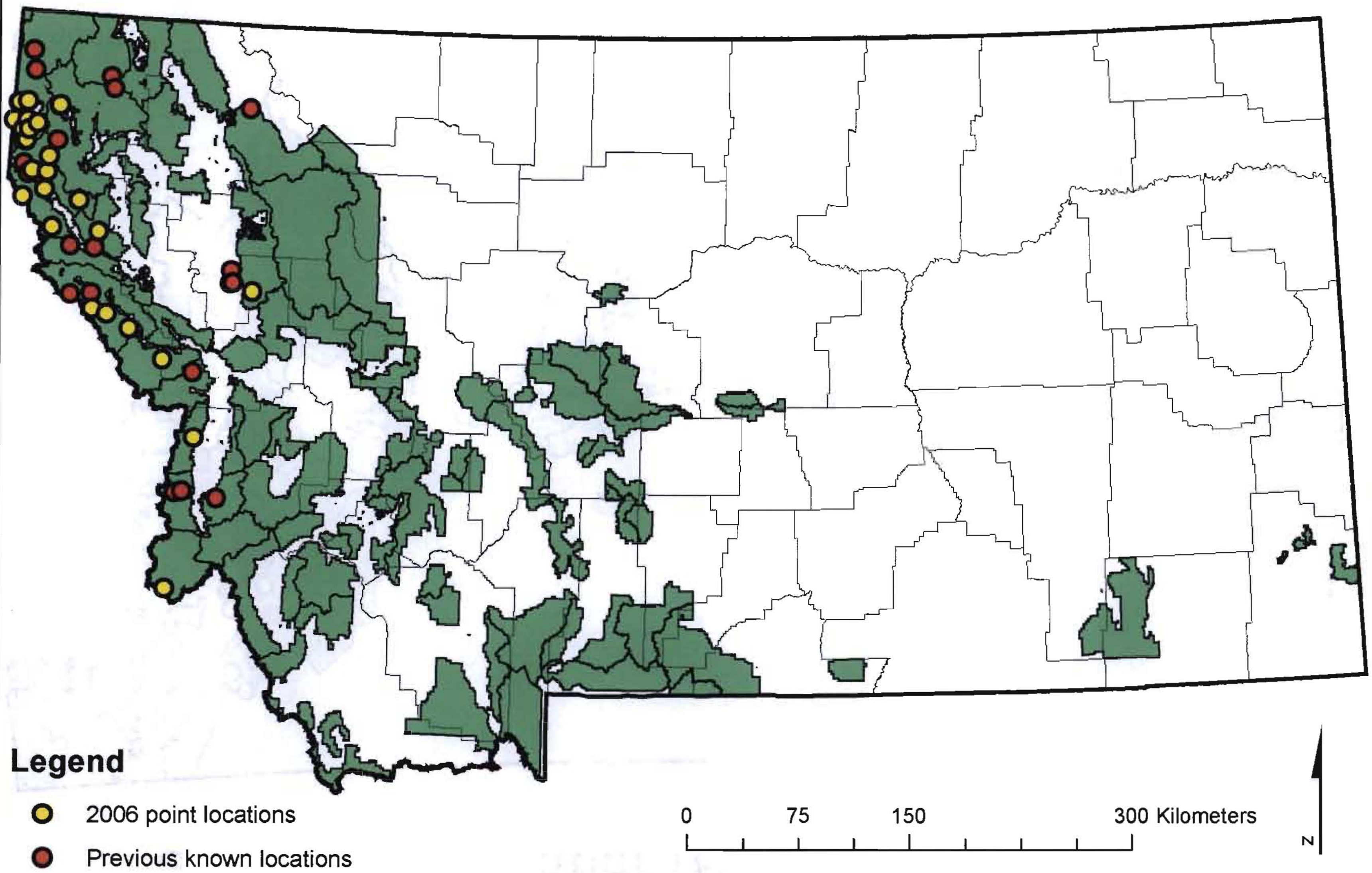


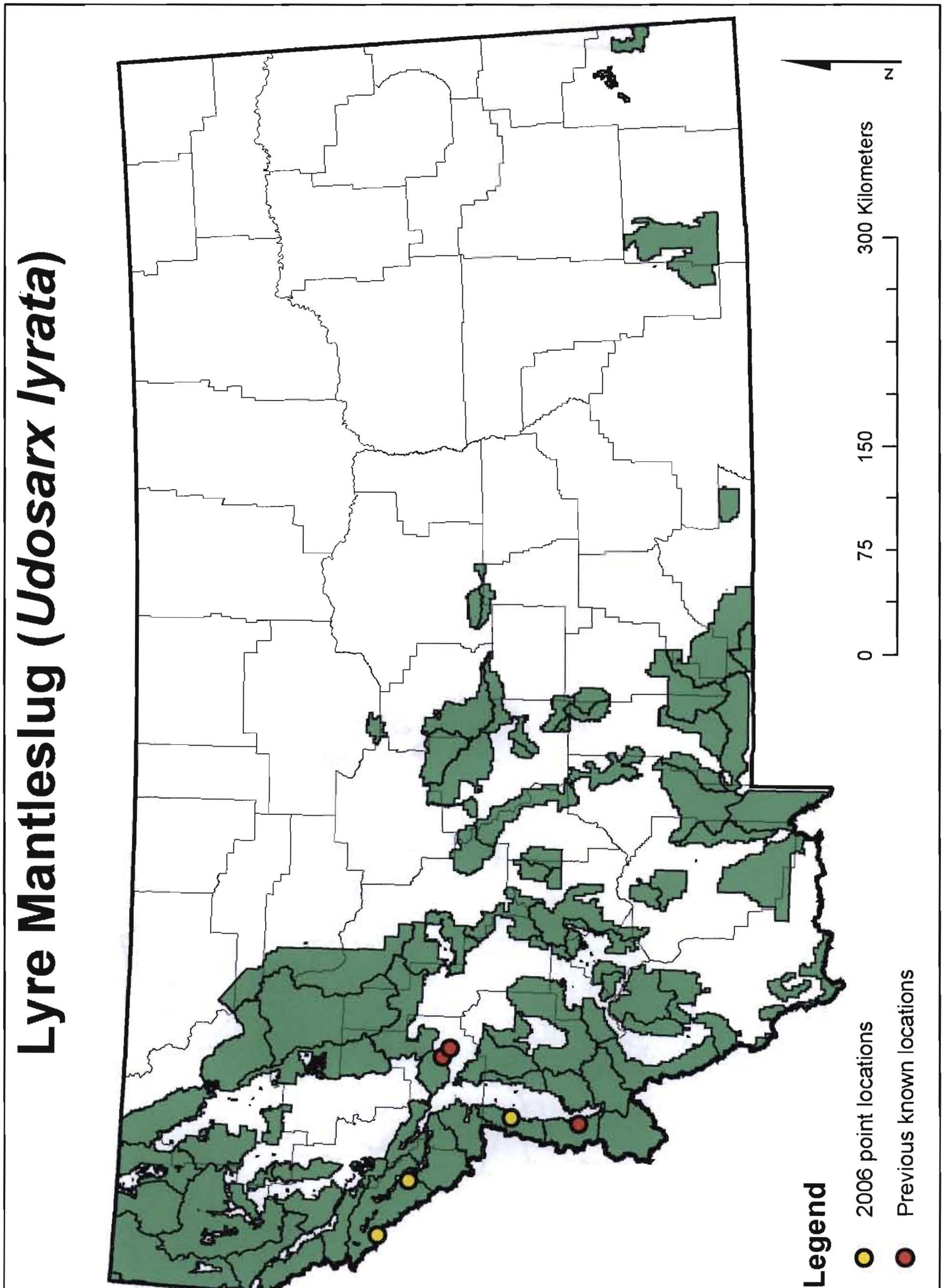

Reticulate Taildropper (Prophysaon andersoni)
Legend
2006 point locations
Previous known locations
0
75
150
300 Kilometers
N

Smoky Taildropper (*Prophysaon humile*)



Fir Pinwheel (*Radiodiscus abietum*)




Lyre Mantleslug (Udosarx lyrata)
Legend
2006 point locations
Previous known locations
0
75
150
300 Kilometers
N

Sheathed Slug (*Zacoleus idahoensis*)