

Survey of Craters of the Moon National Monument and Preserve for Rare Invertebrates

2008



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ABSTRACT

Craters of the Moon National Monument and Preserve (CRMO) contains potential habitat for several species of conservationally important invertebrates. We conducted surveys for 3 species known to occur in or adjacent to CRMO: the Idaho dunes tiger beetle (*Cicindela arenicola*), the Idaho point-headed grasshopper (*Acrolophitus pulchellus*), and the blind cave leiodid beetle (*Glacivicola bathysciodes*). We found blind cave leiodid beetles at 2 previously reported localities (Beauty and Boy Scout caves) and at 1 new location (Last Chance Cave). We also encountered other cave invertebrates of interest. We did not detect the Idaho dunes tiger beetle, but we did locate potentially suitable habitat. We also did not detect the Idaho point-headed grasshopper, and we did not locate habitat that matched descriptions of occupied habitat.

ACKNOWLEDGMENTS

This project was funded by the National Park Service, and we would particularly like to thank John Apel and Mike Muntz of Craters of the Moon National Monument and Preserve for their interest in this project and support of the process. William R. Bosworth (Idaho Department of Fish and Game Conservation Data Center) was the lead biologist for this project. Field data were collected by Suzin Romin, Tim Weekley, William Bosworth, Seren Askew, and Beau Gunter. Suzin Romin, William Bosworth, and Tim Weekley compiled this report.

SUGGESTED CITATION

Idaho Conservation Data Center. 2008. Survey of Craters of the Moon National Monument and Preserve for Rare Insects. Idaho Department of Fish and Game, Boise, Idaho. iii + 16 pp.

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INTRODUCTION

Craters of the Moon National Monument and Preserve (CRMO) contains habitat for several invertebrates identified as Species of Greatest Conservation Need in the Idaho Comprehensive Wildlife Conservation Strategy (IDFG 2005) and as Idaho Sensitive Species by the Idaho State Office of the Bureau of Land Management (BLM) (BLM 2003). During 2007, we surveyed sites in CRMO for 3 species: the blind cave leiodid beetle (*Gladicavicola bathyscioides*), the Idaho point-headed grasshopper (*Acrolophitus pulchellus*), and the Idaho dunes tiger beetle (*Cicindela arenicola*). The blind cave leiodid beetle is among several species of cave-obligate invertebrates known to occur in CRMO. The beetle has been documented in 6 lava-tube caves in Idaho, including 3 caves in CRMO. The Idaho point-headed grasshopper is endemic to east central Idaho, occurring in shrub-dominated, xeric habitat, but the species has not been reported to occur in CRMO. This species is known to occur only in the Birch Creek and Big Lost River drainages, which lie north-northeast of CRMO. The Idaho dunes tiger beetle is endemic to Idaho, occurring in scattered localities in south-central and southeast parts of the state, including areas at the south CRMO boundary. Habitat is characterized by sandy substrate and sparse vegetation.

METHODS

Cave Invertebrate Surveys

We surveyed caves where the blind cave leiodid beetle was known to previously occur (Boy Scout Cave, Beauty Cave) or where suitable habitat was likely to occur based on documented cave habitat features. Caves with year-round ice or cold temperatures were identified by CRMO staff and by querying CRMO's caves database. We surveyed invertebrates in: Boy Scout Cave, Beauty Cave, Indian Tunnel, Holiday Cave, Horseshoe Cave, Tom Thumb Tunnel, and Arco Tunnel. We surveyed the main chambers and accessible major side chambers with the exception of Arco Tunnel, which we surveyed from the entrance to the Breakdown Room and to the lava slides in the west branch beyond the Forum (Fig. 1). We visited each cave once, with the exception of Boy Scout and Beauty caves, which we visited twice. East Tepee, West Tepee, and Ice Lake caves potentially containing suitable habitat, but we did not enter these caves for safety considerations. Lava River Cave likely does not contain suitable habitat and was not entered to avoid disturbing Townsend's big-eared bats (*Corynorhinus townsendii*) that were present in the entrance at the time the cave was visited.

A team of 4-6 people systematically searched the cave floor, rock formations, rock undersides, walls, and low ceilings. We left bait stations of rolled oats and apple slices at 2 locations in both Boy Scout and Beauty caves. In each of these caves, we placed 1 bait station next to ice and water near the middle of the cave and placed a second bait station near the back. Each station comprised approximately 3 grams of oats and a 1/16 section of an apple.

We noted other invertebrates encountered and identified these organisms to the finest taxonomic unit we were capable of identifying reliably.

Idaho Dunes Tiger Beetle Surveys

We surveyed 16 kipukas and 5 sandy locations in CRMO along the southern perimeter of the Wapi lava flow (Fig. 2). Kipuka locations were provided by CRMO staff and were in an area where Idaho dunes tiger beetles had previously been reported (Makela 1994). Numbers used to refer to individual kipukas correspond to the "Name" field in a GIS shapefile (kipuka_pt.shp) provided by CRMO staff. Three surveyors searched for adult beetles, larval burrows, or suitable habitat. The amount of time spent at each kipuka varied, depending on kipuka size and complexity of habitat. Where we encountered potentially suitable habitat characterized by sandy substrate and low-density vegetation, we visited all nearby kipukas. When we found several kipukas in a cluster with unsuitable habitat, particularly where soils were not optimal for tiger beetles, we proceeded to another cluster. Unmapped sandy areas, typically outside the edge of the lava flow, were surveyed opportunistically.

Idaho Point-headed Grasshopper Surveys

We searched 3 areas for grasshoppers in CRMO north of Highway 20. Search areas comprised: a slope and ridgeline from 1860 m elevation to 2130 m elevation, 2.5 km northwest of the CRMO visitor center (Fig. 3, Site 1); the ridgeline and slope of the northwest side of Sunset Cone and the adjacent plain northwest of the crater, from 1830 m elevation to 1890 m elevation (Fig. 3, Site 2); and the lower western slope of Grassy Cone and the adjacent plain, from 1820 m elevation to 1890 m elevation, 2.3 km west of the CRMO visitor center (Fig. 3, Site 3). We also surveyed a gently rolling area of xeric shrubland near the southern boundary of CRMO, at 1340 m elevation, adjacent and up to the southeast edge of the Wapi lava flow (Fig. 2, Site 4). A team of 3-4 people searched each site, capturing grasshoppers in nets. We also captured and identified grasshoppers while hiking between caves and kipukas.

RESULTS

Cave Invertebrate Surveys

We found blind cave leiodid beetles in 3 caves: Boy Scout (3 beetles, 7 Aug 2007; 1 beetle, 8 Aug 2007), Beauty (1 beetle, 7 Aug 2007; 1 beetle, 8 Aug 2007), and Last Chance (1 beetle; 7 Aug 2007). Beetles were found on the cave floor or rock debris. One individual was found at an oat bait station. In each of these caves, we measured cave floor temperatures between 2-7°C. Wet surfaces were also characteristic of these caves, which contained puddles of standing water or sheets of ice. Floors consisted of fractured igneous rock, as opposed to deposits of fine sediments, and fissures in the floors sometimes contained ice. Similar conditions were also encountered at Arco Tunnel and Holiday Cave, though no beetles were found. We did not find ice in Arco Tunnel, but the floor temperature was near freezing, and water and wet rocks were prevalent. Holiday Cave contained ice and dripping water.

We did not find similar conditions in Indian Tunnel, Horseshoe Cave, or Tom Thumb Tunnel. Horseshoe Cave contained a small damp area, but no standing water or ice. Indian Cave was warmer and drier than other caves surveyed. Tom Thumb Tunnel is a very short, dry tube having large openings on each end. In each of these caves, we did not consider conditions to be suitable for cave obligate invertebrates.

In addition to blind cave leiodid beetles, we found several other invertebrates that are obligate cave inhabitants. We found the highest diversity of invertebrates in Arco Tunnel, Beauty Cave, and Last Chance Cave (Table 1). In Arco Tunnel, we encountered harvestmen (Opiliones), mites (Acari), millipedes (Diplopoda), and web-spinning fly (Diptera) larvae. In Beauty Cave, we found harvestmen, millipedes, springtails (Collembola), and an unidentified wingless hexapod (Diplura). In Last Chance Cave, we found harvestmen, millipedes, and a camel cricket (Orthoptera: Rhaphidophoridae); we also found pigmented, web-spinning spiders, which we do not regard as cave obligates, residing in fissures in the cave floor. Invertebrates encountered elsewhere included millipedes in Boy Scout Cave and Holiday Cave, and web-spinning dipteran larvae in Indian Tunnel. We did not regard a centipede (Chilopoda) found in Indian Tunnel to be a cave-obligate species. We did not encounter any invertebrates in Horseshoe Cave or Tom Thumb Tunnel.

Idaho Dunes Tiger Beetle Surveys

We did not find tiger beetles in any kipukas or sandy areas. Soils at kipukas ranged from sand to mixtures of silt and clay. We regarded areas that had predominately silt or clay soils to be unsuitable. Many kipukas contained small patches of open sand, often adjacent to the pressure-ridge perimeter; most kipukas lacked firm sand suitable for larval burrows. Most kipukas surveyed were extensively vegetated with shrubs (e.g. sagebrush [*Artemisia* sp.], rabbitbrush [*Chrysothamnus* sp.], bitterbrush [*Purshia tridentata*]) and forbs. Invasive plants (e.g., cheatgrass [*Bromus tectorum*] and tumble mustard [*Sisymbrium altissimum*]) dominated the vegetation of many of the kipukas.

Generally, we found more sand and fewer weeds in kipukas and sandy areas along the southeast margin of the Wapi lava flow (Fig 2). Kipukas 528, 559, 566, 567, and 570 had habitat that was potentially suitable, but suitability was generally degraded by invasive weeds (Table 2). We encountered 5 areas of potentially suitable habitat that were not kipukas (Table 2). An area northwest of kipuka 538, in particular, was characterized by deep sand, sparse vegetation, and few invasive plants. Kipukas along the southwest margin of the Wapi lava flow (519, 528, 529, 536-539) and kipukas 513 and 508 (Fig 2) appeared to be unsuitable for tiger beetles. Dense stands of tumble mustard and cheatgrass were common, and soil was composed predominately of silt or clay.

During our visit, we encountered cattle within CRMO along the southeast edge of the Wapi lava flow. The small dune southeast of kipuka 570, one of the most promising areas of deep sand, had been trampled by cattle. On the southwestern side of the Wapi lava flow, an off-road vehicle trail was noted as a source of disturbance to kipuka 538.

Idaho Point-headed Grasshopper Surveys

We did not find Idaho point-headed grasshoppers. Band-winged (Oedipodinae) and spur-throated (Melanoplinae) grasshoppers were common at all sites surveyed. In the northern portion of CRMO (Fig. 3, sites 1-3), we also found small numbers of stridulating slant-faced grasshoppers (Gomphocerinae). Vegetation most similar to previously reported habitat for this species occurred on the ridgeline within Site 1 at 2070-2130 m elevation, where short (< 0.5 m), sparse sagebrush (*Artemisia* sp.) shrubs, bunchgrasses, and prickly pear (*Opuntia polyacantha*) were common plants.

DISCUSSION

Cave Invertebrates

Prior to our surveys, the blind cave leiodid beetle was known to occur in 6 lava-tube caves in Fremont, Butte, Lincoln, and Power counties. The beetle has also been documented in a limestone cave in Wyoming on the west side of the Teton Mountains (Peck 1981). We confirmed that the blind cave leiodid beetle continues to persist in Boy Scout and Beauty caves on CRMO, where the species had previously been reported to occur. We also found individuals in Last Chance Cave, approximately 2 km east of Beauty Cave, where a population had not been previously documented.

The blind cave leiodid beetle is believed to occur only in subterranean habitat and has been found only in caves having year-round cold temperatures and appreciable amounts of moisture. Many of the reported sites contain perennial ice formations; Westcott (1968) reported beetles on ice mounds, on large ice stalagmites, and floating in melt-water above an ice floor. Beetles also occur on rock formations (Naseath 1974), and Peck (1970) attracted beetles to bait more commonly among rocks than at the edge of ice or on ice. We found beetles in habitat consistent with these previous reports: at temperatures $\leq 7^{\circ}\text{C}$ on damp or wet cave surfaces, as well as near and in standing water. Maximum cave temperature that can be tolerated by this species is not known, and we do not suggest that 7°C is a maximum threshold. We do not know whether cave temperature limits distribution because virtually all caves that we entered that contained wet surfaces were relatively cold caves.

Blind cave leiodid beetles are likely to occur in additional caves throughout CRMO. In all caves in which we detected the beetle, we did not encounter large numbers of individuals, suggesting that the species could be overlooked even when present in some proportion of caves surveyed. Although we did not find blind cave leiodid beetles in Holiday Cave or Arco Tunnel, both lava tubes appear suitable for the species. Also, we did not survey all caves for reasons of safety. For example, based on descriptions in CRMO's records, Lava Lake Cave is likely suitable for blind cave leiodid beetles. Access to this cave, in our estimation, would require rock climbing gear or other specialized equipment.

Other invertebrates we encountered should also be considered to be of importance in the context of resource management and conservation. Two endemic cave-obligate

harvestmen are known from the eastern Snake River Plain. One of these, *Speleomaster lexi*, is known from a cave complex near Mammoth Cave in Lincoln County (Briggs 1974). The second species, *S. pecki*, is known only from Boy Scout Cave (Briggs 1974) and to our knowledge was last collected in 1974. Those individuals were found at 4°C under breakdown adjacent to a perennial ice formation (Briggs 1974). We did not encounter harvestmen in Boy Scout Cave, but it is possible that the individuals from Arco Tunnel, Beauty Cave, and Last Chance Cave may be *S. pecki* or *S. lexi*. Identification of these individuals would need confirmation by a specialist in this group of organisms.

Boy Scout Cave is also the only reported locality of a cave-obligate mite, *Flabellorhagidia pecki* (Elliott 1976). We did not encounter mites in Boy Scout Cave, but the mites observed in nearby Arco Tunnel may be the same species. A collembolan (*Tomocerus flavescens*), a millipede (*Idagona westcotti*), and a campodeidid (*Plusiocampa* sp.) have also been reported from Boy Scout Cave (Peck 1973), and these taxa likely correspond to the invertebrates we found during our surveys. Confirmation of the identification of these species would require confirmation by a specialist.

The primary threat to blind cave leiodid beetles and other cave-obligate invertebrates is alteration of cave habitat. Changing conditions could directly cause increased mortality rate or depressed reproductive success, or provide conditions favorable to competitors, predators, or pathogens. Climate change could affect temperature and water availability in caves. Human activities in caves could affect habitat. For example, the modification of a cave entrance can have dramatic effects on air and moisture exchange and cause important changes to the cave climate. Although experienced spelunkers are generally aware of the fragility of cave environments, lava tube caves are popular with inexperienced spelunkers and are susceptible to both unintentional damage and vandalism. The effects of increased nutrient loads in caves is also a potential cause of habitat change. Occupied lava tube caves generally contained low levels of organic material. Cave organisms are adapted to these conditions, and the accumulation of organic material in caves could provide conditions that would allow the invasion of organisms that would not normally survive in this environment. Finally, the introduction of insecticides, either airborne or transported by sufficient quantities in underground water supplies, should be a consideration for resource managers.

Idaho Dunes Tiger Beetle

The Idaho dunes tiger beetle is found in areas having pure sand substrate and sparse vegetation. Adult Idaho dunes tiger beetles require unconsolidated, open sand for foraging and thermoregulation. Larvae live in burrows located in flat areas of firm sand where the sand is at least a meter thick, often on the windward side of sand dunes (ISCE 1996). Populations have been reported in portions of Fremont, Jefferson, Clark, Bonneville, Bannock, Power, Blaine, Minidoka, and Lincoln counties and perhaps also Madison and Bingham counties. A population formerly occurring in Minidoka County near Heyburn appears to have been extirpated (Anderson 1989; Shook and Clark 1988). The species has been found outside the CRMO southern boundary in sandy

locations adjacent to the Wapi lava flow (Makela 1994). Reported locations include sites along Quigley Road, 2.3 km north of Quigley Siding; a site south-southwest of Rattlesnake Butte; dunes immediately south of the Union Pacific rail line, along the southern edge of the Wapi lava flow; and sites north of Lake Walcott (Makela 1994).

During our investigations we found some areas of potentially suitable habitat, but did not find tiger beetles at any site. In general, areas we visited that had been formerly occupied and areas that appeared to have suitable sandy substrate were dominated by invasive plants, particularly cheatgrass. These plants decrease or even eliminate the extent of open, unvegetated areas used by Idaho dunes tiger beetles and can also alter the consistency and composition of soil to the extent that it no longer is suitable for larval burrows. We were unable to detect the species during surveys focused on sandy areas along the southern boundary of CRMO. Pockets of potential habitat such as the sandy areas northwest of kipuka 538, the dune southeast of kipuka 570, the sandy sites southeast of 558, along with kipukas 559 and 567 appeared to remain potentially suitable.

Habitat loss as a result of invasive plants appears to be among the most important threats to the viability of Idaho dunes tiger beetle populations. However, other resource management issues are important considerations with respect to any populations that persist in or near CRMO. A conservation strategy for the Idaho dunes tiger beetle (ISCE 1996) recommended that insecticides not be applied within 0.5 mile (0.8 km) of known or potential Idaho dunes tiger beetle habitat. Livestock disturbance of larval burrows and off-road vehicle use also potentially affect population viability. Larvae are particularly vulnerable to mortality from trampling (ISCE 1996) or vehicles (ISCE 1996; LaBonte 1995; Shook and Clark 1988; Anderson 1989), which can cause population decline as a result of juvenile recruitment when disturbance is pervasive within habitat patches. Bauer (1991) found that 80% of Idaho dunes tiger beetle larval burrows stepped on by cattle never reopened. While off-road vehicle use is not legal within the monument, CRMO has limited staff to monitor incursions. Livestock grazing is permitted within CRMO, on rangeland administered by the BLM.

Idaho Point-headed Grasshopper

The Idaho pointed-headed grasshopper is endemic to Idaho, known to occur only in the Birch Creek and Big Lost River drainages of east-central Idaho. Few collections have been made; the most recent was during 1993 when only 2 individuals were found during a 4-day survey (Kell et al. 1993). During 2002 and 2003, Baker (2003) made repeated visits to all known locations but was unsuccessful at finding any individuals. Because of the paucity of knowledge of this species, nothing authoritative can be said with regard to the extent of range beyond these drainages (Baker 2003).

The species has previously been found in xeric shrub-dominated habitat. Bruner (1890) found individuals under spiny hopsage (*Grayia spinosa*). Baker (2003) found no spiny hopsage in the Birch Creek areas that he surveyed but did find considerable saltbush (*Atriplex* sp.) and black sagebrush (*Artemisia nova*). His interviews with previous collectors did not shed any definitive light on the grasshopper's food plant preferences.

Scoggan and Brusven (1972) described the area from which they collected specimens as flat to gently rolling terrain having extremely gravelly, rocky soil and low, sparse vegetation.

No areas that we surveyed closely resembled reported habitat. We found low-growing, sparse shrubs growing along ridgelines in the northern part of CRMO, but vegetation was not typical of the xeric shrub communities described by others.

MANAGEMENT IMPLICATIONS

CRMO contains important habitats for invertebrates that should be provided consideration in resource management decisions. We make the following recommendations as a starting point toward a proactive approach to invertebrate conservation.

1. Evaluate insecticide transport from adjacent agricultural lands. Sixty miles of the CRMO boundary lie adjacent to private lands, most of which are irrigated agricultural fields. During periodic insect outbreaks, agricultural landowners often request that nearby public lands be treated with diflubenzuron, carbaryl, malathion, and other insecticides. Whether insecticides accumulating in water (e.g., water found in wet caves) or airborne drift concentrations are sufficient to pose threats to insect populations should be a consideration of resource managers. Although our position is that population losses as a result of contamination are somewhat unlikely, this position is largely conjectural in the absence of models or empirical data.
2. Promote research, inventory, and monitoring of cave invertebrate faunas. Cave habitat occurring within CRMO represents a rarely encountered resource that has not been intensively inventoried. Our findings suggest that much remains to be discovered with respect to the composition and ecology of cave invertebrates in CRMO.
3. Minimize disturbance to areas potentially inhabited by Idaho Dunes tiger beetle. Disturbance (e.g., recreational uses, livestock) can cause degradation of important substrate characteristics, cause direct mortality of animals, and provide conditions that facilitate weed invasion. The characteristics of suitable tiger beetle habitat (i.e., sparse vegetation, sand substrate) are the same characteristics that make these areas attractive to off-road vehicle recreation but relatively low-value for livestock grazing.
4. Consider efforts to restore unique habitat (e.g., sand dunes, kipukas) that are over-run with invasive weeds. Although this is a daunting task, habitats such as dunes and kipukas may be uniquely and sustainably responsive to weed management.

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Table 1. Distribution of cave-obligate invertebrates encountered during 2007 cave surveys.

Cave	Blind Cave Leiodid Beetle	Harvestman	Mite	Millipede	Collembola	Diplura	Camel Cricket	Web fly larvae
Arco Tunnel		✓	✓	✓				✓
Beauty Cave	✓	✓		✓	✓	✓		
Boy Scout Cave	✓			✓				
Indian Tunnel								✓
Holiday Cave				✓				
Horseshoe Cave								
Last Chance Cave	✓	✓		✓			✓	
Tom Thumb Tunnel								

Table 2. Kipukas surveyed for Idaho dunes tiger beetles. Kipuka number corresponds to the name field in CRMO's kipuka_pt.shp file. Other Sandy Areas are sites at the edge of the Wapi lava flow. Suitable habitat was sand substrate and low vegetation density. Areas indicated to have potentially suitable habitat are unlikely to be occupied in current condition but are potential targets for restoration.

	UTM (NAD 1983 Zone 12)		
	Easting	Northing	Suitability
Kipukas			
508	309249	4747368	Not Suitable
513	311303	4739286	Not Suitable
519	315187	4736428	Not Suitable
528	313841	4736851	Potentially Suitable
529	313996	4736357	Not Suitable
536	314867	4733643	Not Suitable
537	314211	4733124	Not Suitable
538	313499	4733476	Not Suitable
539	313126	4732757	Not Suitable
558	320399	4732409	Not Suitable
559	320786	4733239	Potentially Suitable
566	321439	4734321	Potentially Suitable
567	321333	4734545	Potentially Suitable
568	320991	4733643	Not Suitable
569	320746	4733557	Not Suitable
570	321680	4734261	Potentially Suitable
Other Sandy Areas			
Small dune 100 m SE of 558	320490	4732350	Potentially Suitable
Sandy area 300 m SE of 558	320679	4732296	Potentially Suitable
Dune 900 m SE of 570	322448	4733843	Suitable
Sandy area 650 m NW of 538	312999	4733875	Suitable
Sandy area 400 m NW of 538	313127	4733653	Suitable

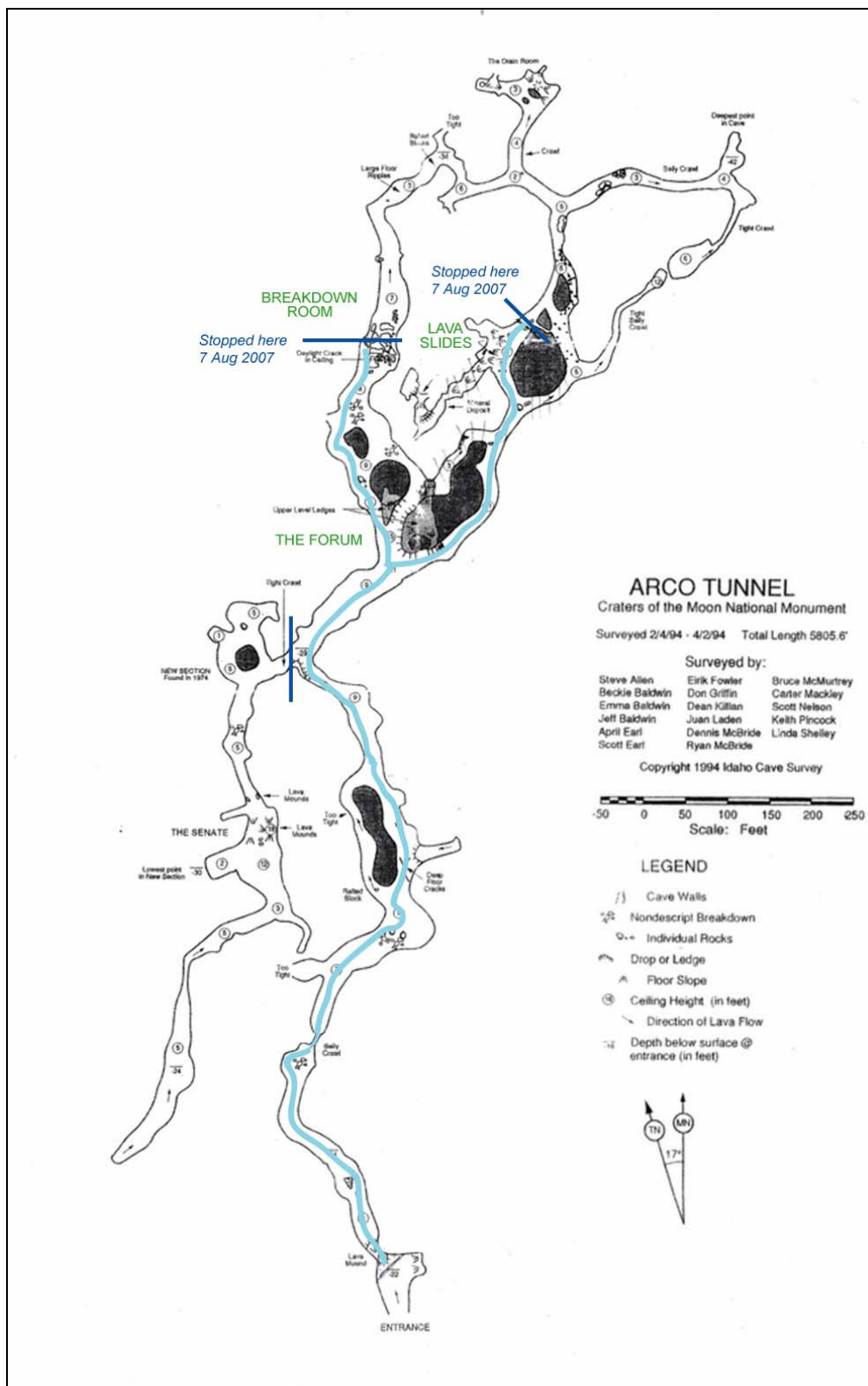


Figure 1. Arco Tunnel, showing location of The Forum, Breakdown Room, and Lava Slides. Light blue line shows approximate survey path.

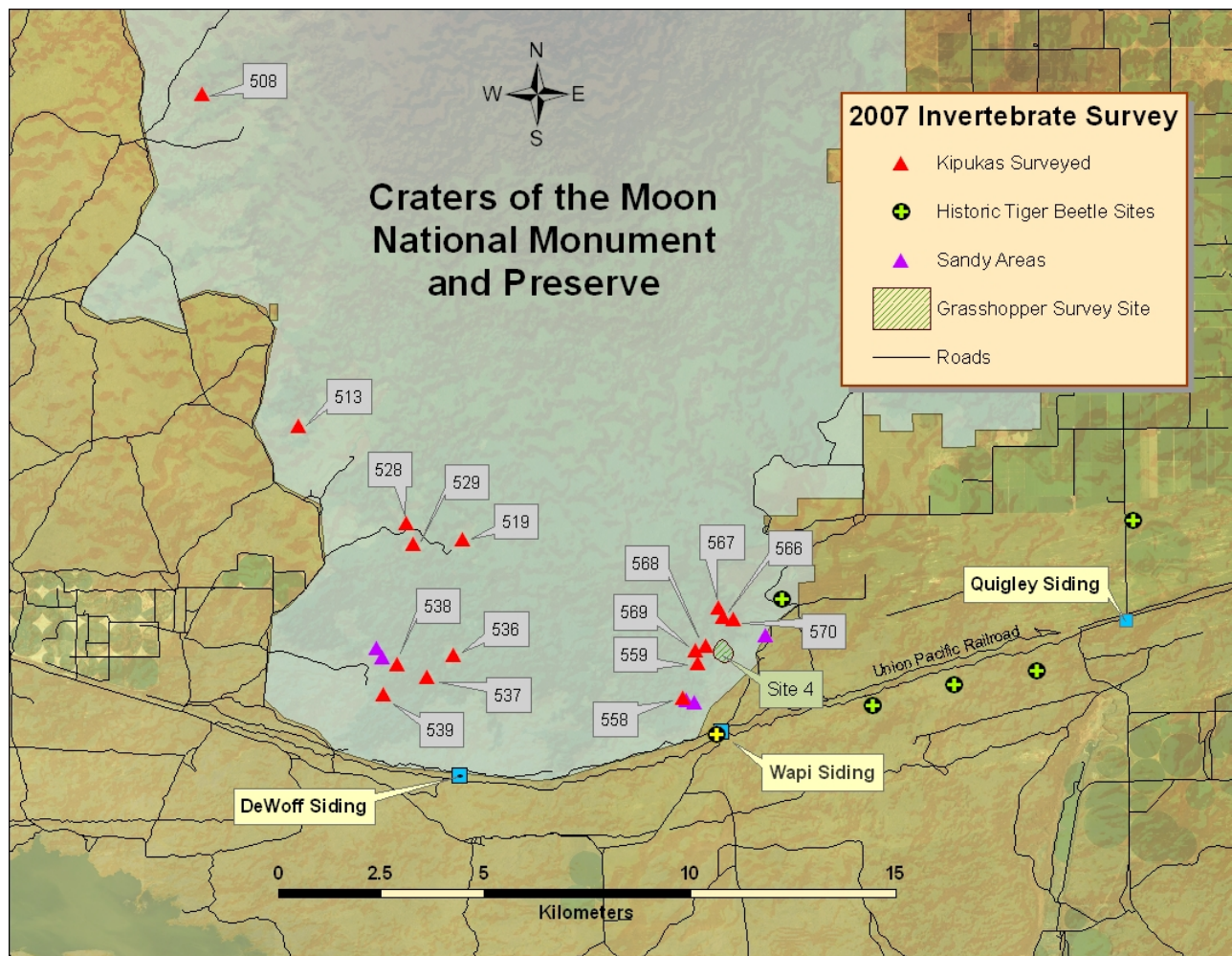


Figure 2. Southern portion of Craters of the Moon National Monument and Preserve and surrounding agricultural and range lands.

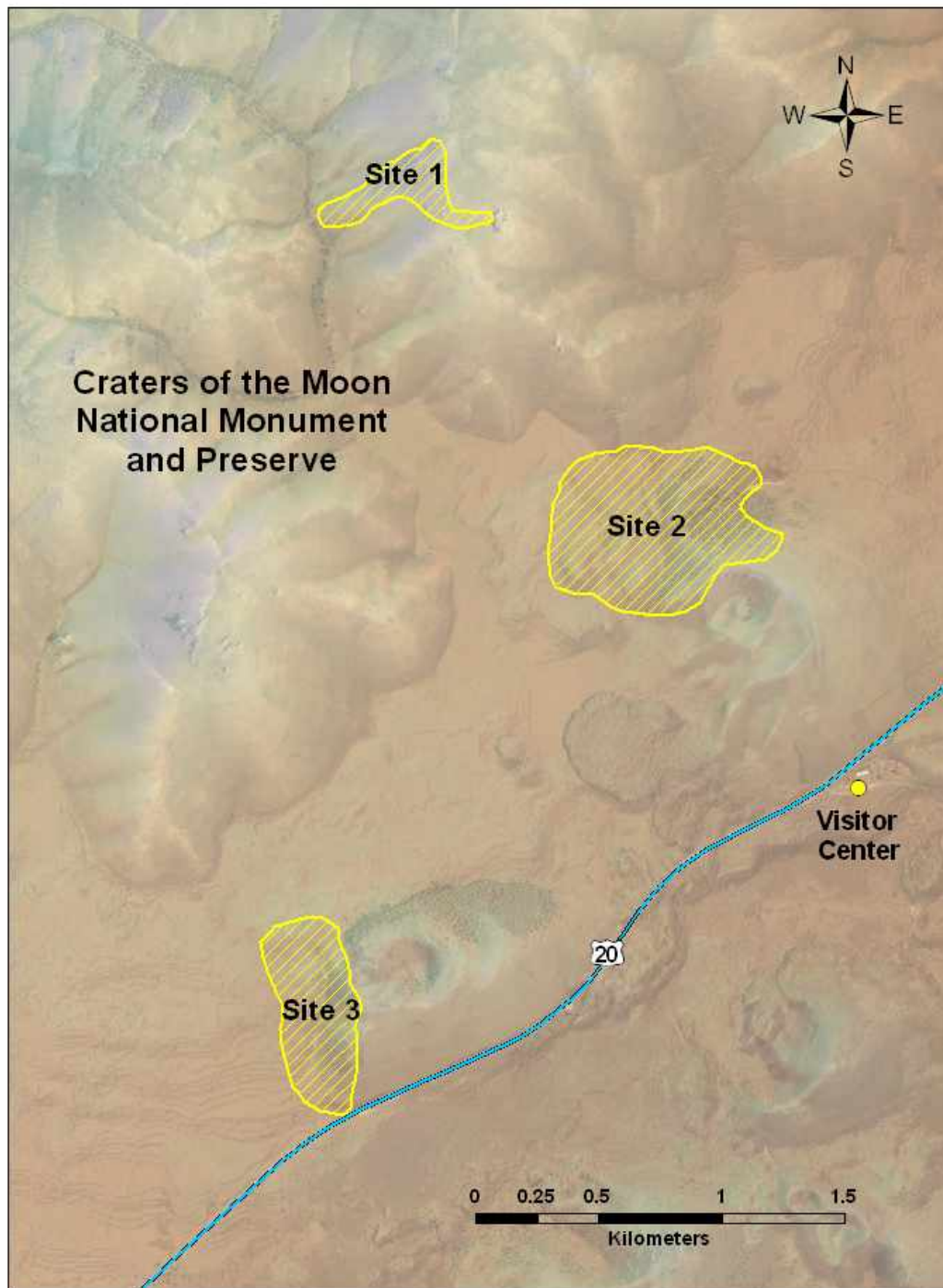


Figure 3. Idaho point-headed grasshopper survey sites in the northern portion of Craters of the Moon National Monument and Preserve.