"Surveys for Proposed Special Concern Jumping Spiders of Minnesota"

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Abstract

We surveyed 87 sites in 16 counties across Minnesota to assess the occurrence of eight special concern jumping spider species at protected natural areas, typically containing remnants of prairie plant communities. Overall, 526 jumping spiders were collected, primarily by sweep netting, including at least 19 species previously collected in MN and four of the species of special concern (Marpissa grata (Gertsch, 1936), Paradamoetas fontana (Levi, 1951), Pelegrina arizonensis (Peckham & Peckham, 1901), and Sassacus papenhoei Peckham & Peckham, 1895). None of these species exceeded 5% of the total identified catch. Three jumping spiders were represented by only a single specimen (Habronattus viridipes (Hentz, 1846), S. papenhoei, and Sitticus palustris (Peckham & Peckham, 1883). Two species were very common, comprising 63% of the total identified catch: Pelagrina insignis (Banks, 1892) and Phidippus clarus Keyserling, 1884. Significant range extensions are reported for M. grata and Marpissa pikei (Peckham & Peckham, 1901). Special concern species that were not collected may not have been present or may have been missed due to sampling protocols (methods, seasonal timing, or site selection).

This study is the first to use a geopositioning system (GPS) for a spider survey in the state, which facilitated establishment of relocatable sample sites within target areas. At many sites, sampling effort and areal coverage was substantially increased from earlier reconnasance work. These established sites introduce a more systematic approach to aquiring census data and can now be used to monitor spider populations over time.

Although results from any one study in one portion of a season should be interpreted cautiously, we found good correspondence between our data and previous accounts of spider abundance and habitat associations (most by B. Cutler). Areas of high conservation value for listed special concern jumping spiders appear to include Stearns, Swift, Washington, and Winona Cos., including a high diversity site (Lake Elmo County Nature Reserve) not presently designated as a State Natural Area or managed by The Nature Conservancy.

We suggest continued field work at known sites in search of the four uncollected special concern species and for monitoring jumping spider populations at specific high-interest sites. We also suggest that such information be placed within a larger, landscape context by adding survey data from new sites on public lands that may not presently be managed for invertebrate conservation. In particular, large gaps in species range maps should be explored, as well as the northern tier of counties that remains unsampled to date.

Introduction

Recent estimates of earth's biodiversity have been found to differ by more than an order of magnitude (Wilson, 1992), rekindling interest in field surveys and taxonomic studies worldwide. Within the range of estimates, there is, however, consensus on the primacy of invertebrate biodiversity on this planet (New, 1995) and strong assertions that they are essential to ecosystem function (Wilson, 1987). In the case of spiders, arguments for biodiversity surveys and conservation efforts include their inherent scientific value, their ecological roles as generalist and possibly keystone predators, and their possible use as indicator species. Majer (1983, as cited by New) lists seven attributes of ants that make them useful indicator species, and spiders meet them as well: they are abundant, have high species richness, there are specialist species, they occupy high trophic levels, are easily sampled, are usually easily identified, and they respond to changing environmental conditions.

The State of Minnesota, Department of Natural Resources, has proposed including eight jumping spider species (Araneae: Salticidae) mainly known from prairie sites on its list of Endangered, Threatened, and Special Concern Species within the state. Only a few researchers have performed surveys for jumping spiders, and their efforts have been concentrated in southern portions of the state (Cutler et al., 1988). Sampling has occurred sporadically over decades and in some cases collection localities are only roughly described.

In this study, we were interested to resample some known locations for proposed special concern jumping spiders and also to extend field surveys into less studied areas. We sought to confirm species presence at historical sites, add new collection localities to evaluate distribution patterns and habitat associations, and provide a framework for future population monitoring efforts. A special feature of our work is establishment of relocatable sampling sites through use of geopositioning system (GPS) technology with 15 m map accuracy.

Materials and Methods

We conducted field surveys with one team of two persons from 28-May to 18-June 1996 at eleven previously sampled (historic) and eleven new areas across Minnesota (Table 1). All areas sampled are established State Natural Areas (SNAs) or conservation areas set up by The Nature Conservancy (TNC), with the exceptions of one state forest and one county natural area. Approximate boundaries of target areas were located on 1:24000 USGS topographic maps by Robert Dana and Rich Baker (Minnesota Department of Natural Resources, Conservation Division, St. Paul, MN), supplemented with descriptions given in "A Guide to Minnesota's Scientific and Natural Areas", published by the same agency.

Table 1. Areas in Minnesota visited during this study.

Area	County
Historic	
Hole In The Mountain TNC	Pipestone
Kasota Prairie TNC	Le Sueur
Kellogg-Weaver Dunes SNA	Wabasha
Kellogg-Weaver Dunes TNC	Wabasha
Ottawa Bluffs TNC	Le Sueur
Jeffers Petroglyphs Vicinity TNC (Prairie Banks)	Cottonwood
Rockville-Tamarack Bog TNC	Stearns
Roscoe Prairie TNC/SNA	Stearns
Rushford Sand Dunes SNA	Fillmore
Solana State Forest	Aitkin
Whitewater Bluffs SNA	Winona
New	
Agassiz Dunes TNC	Polk
Bonanza Prairie (Big Stone Lake) SNA	Big Stone
Chippewa Prairie TNC	Swift
Clinton Prairie SNA	Big Stone
Iron Horse Prairie SNA	Dodge
Lake Elmo County Nature Reserve	Washington
Lundblad Prairie TNC	Murray
Prairie Coteau SNA	Pipestone
Prairie Smoke Dunes SNA	Norman
St. Croix Savannah SNA	Washington
Uncas Dunes SNA	Sherburne

Over an automobile route within Minnesota of 3500 miles (~5600 km), we sampled 87 sites in 16 counties, in general sequence from the SE corner of the state, along the southern quarter, up the western third, and ending in the east-central portion of the state. We timed the trip to coincide with a period of normally high spider abundance and maturity, though a cool, wet spring appeared to have delayed biological events several weeks from average dates.

At a given location, we usually captured jumping spiders using sweep nets repeatedly drawn through grass or other low vegetation while walking (perpendicular to the direction of travel), although on a few occasions we also used a stationary limb-beating technique on tree saplings. A total of 16,500 sweeps were made during the project, either within grids (in sets of 400 sweeps) or as spot samples (100 sweeps).

Grids were 50 m x 50 m, laid out using tape measures and pin flags (Figure 1). The latitude and longitude of the midpoint of a baseline was recorded using a Magellan 2000 GPS receiver (which has an accuracy of 15 m) and locations were also sighted onto 1:24000 scale USGS topographic maps. With only one exception made due to terrain (Site 15), the direction of

the eight transect lines within a grid ran perpendicular to the base line (azimuth recorded using a Brunton compass). Flags were placed every 5 m along the baseline and at the corners and midpoint of the opposite line.

Starting 5 m from the midpoint of the baseline, each person walked four adjacent lines in one half of the grid, making 50 sweeps per line. Spiders collected from each half were dumped from nets onto a plastic (naugahyde) tarp, individually captured using jars, and emptied into a single glass bottle containing 70% propanol solution. Overall, we estimate that ~3% of spiders observed on the tarp escaped during this process. The time to establish and sample each grid was approximately one hour.

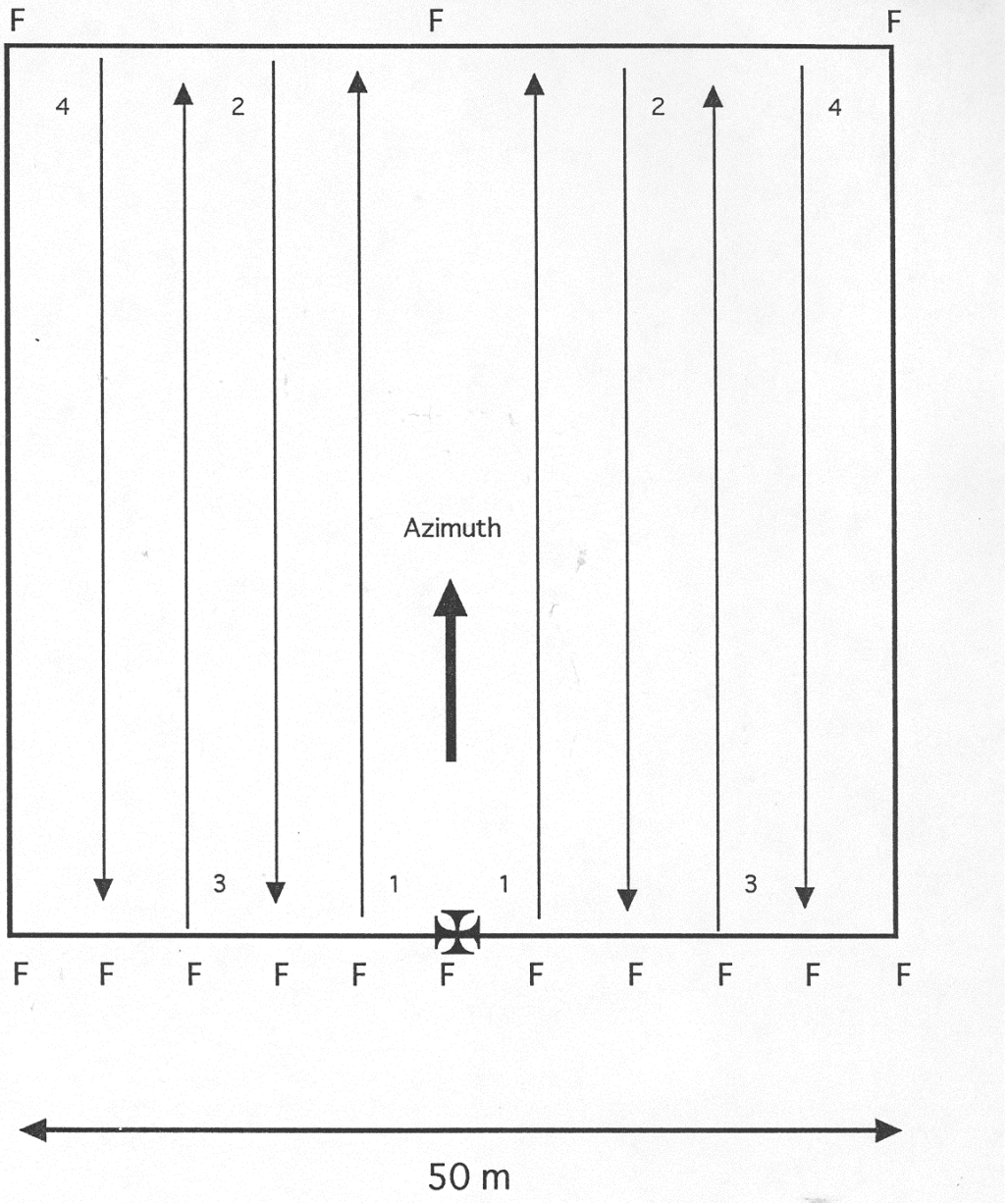
Spot sampling supplemented grids in areas that appeared distinctive to us or were too small for grid establishment. Usually each person collected 50 sweeps in the immediate area surrounding the recorded coordinates and samples were combined for the site. On a few occasions, one person made all 100 sweeps. Spot sampling usually took about 15 minutes per site. Limb beating involved placing a 1 m x 1 m plastic tarp underneath tree branches and hitting the branches 30 times in approximately 15 seconds with a hickory ax handle to dislodge spiders, which fell to the tarp and were collected.

In all cases, we tried to conduct sampling under dry and calm conditions. Wet grass can make netting stick to itself, reducing the catch and making spiders difficult to remove. Wind can cause spiders dislodged from vegetation during sweeping to miss the net, can invert the nets during sweeping, and can blow spiders off the collection tarp prior to capture. Some spiders also use retreats in adverse weather and escape collection. In one case of severe conditions prior to a tornado warning (05-Jun-1996), we returned to the same site the following day to repeat sampling.

Jumping spider species (including species of special concern) were sometimes recognized in the field, but final determinations were made by WJE in the laboratory using a 25x Zeiss binocular dissecting microscope and a key by Kaston (1978). Bruce Cutler (Department of Entomology, University of Kansas, Lawrence, KS) provided substantial assistance identifying representatives of species that WJE was previously unfamiliar with. Age and sex of each specimen was identified by genitalia as female, male, immature male, and immature (sex unknown). Species names follow latest taxonomic revisions.

From count data, we analyzed spider occurrence on state, regional, county, and area spatial scales. On the state level, we also calculated relative abundance using percent of catch and rank. At the county level, we calculated relative abundance using collection rate from sweep net samples (number of individuals per sweep). In most cases, this pooled results from several collection areas within each county, which we posit is more useful than site-to-site comparisons (nearly all based on a single day of sampling, subject to vagaries of weather and site selection).

Figure 1. Sampling grid arrangement of eight transect lines (50 sweeps each).



✠	GPS reading along baseline
F	Flag
1	Transect Line Sequence

Results

A total of 526 jumping spiders representing at least 19 species was collected (Table 2), including four of eight listed species of special concern (Marpissa grata (Gertsch, 1936), Paradamoetas fontana (Levi, 1951), Pelegrina arizonensis (Peckham & Peckham, 1901), and Sassacus papenhoei Peckham & Peckham, 1895. The four special concern species not found are: Habronattus texanus (Gertsch & Muliak, 1936); Phidippus apacheanus Chamberlain & Gertsch, 1929; Phidippus pius Scheffer, 1906; Tutelina formicaria (Emerton, 1891).

We identified 98% of the spiders collected to genus level and 89% to species level. Among completely identified spiders, two species were very common, comprising 63% of the total count: Pelagrina insignis (Banks, 1892) and Phidippus clarus Keyserling, 1884. None of the other 18 species collected constituted more than 5% of the count, and three were represented by single individuals (Habronattus viridipes (Hentz, 1846), S. papenhoei, and Sitticus palustris (Peckham & Peckham, 1883)). All 20 species were previously reported from Minnesota (Cutler, 1977; 1978; Wolff, 1984), though several new localities were identified.

Table 2. Jumping spiders collected during this study.

Species	Count	%	Rank
Eris militaris (Walckenaer, 1837)	22	4.7	3
Evarcha hoyi (Peckham & Peckham, 1883)	22	4.7	3
Ghelna canadensis (Banks, 1897)	3	0.6	14
Habronattus cognatus (Peckham & Peckham)	22	4.7	3
Habronattus decorus (Blackwall, 1846)	3	0.6	14
Habronattus viridipes (Hentz, 1846)	1	0.2	17
Maevia inclemens (Walckenaer, 1837)	9	1.9	10
Marpissa grata (Gertsch, 1936)	3	0.6	14
Marpissa pikei (Peckham & Peckham, 1901)	14	3.0	8
Neon nellii Peckham & Peckham, 1889	21	4.5	6
Paradamoetas fontana (Levi, 1951)	10	2.1	9
Pelegrina arizonensis (Peckham & Peckham, 1901)	21	4.5	6
Pelagrina insignis (Banks, 1892)	138	29.4	2
Pelagrina proterva (Walckenaer, 1837)	8	1.7	11
Phidippus clarus Keyserling, 1884	159	33.9	1
Phidippus princeps (Peckham & Peckham, 1883)	5	1.1	13
Sassacus papenhoei Peckham & Peckham, 1895	1	0.2	17
Sitticus palustris (Peckham & Peckham, 1883)	1	0.2	17
Tutelina similis (Banks, 1895)	6	1.3	12
Total completely identified (89%)	469	100.0	---
Habronattus sp.	2		
Phidippus sp.	2		
Tutelina sp.	41		
Unidentified	12		
Total incompletely identified (11%)	57		
Total collected (100%)	**526**		

At a regional scale, only three species (Evarcha hoyi (Peckham & Peckham, 1883), P. insignis, and P. clarus) were found in more than half of the 16 counties visited (Table 3), whereas four were found in only one county (H. viridipes, P. fontana, S. papenhoei, and S. palustris). Though collected from only five counties, Habronattus cognatus (Peckham & Peckham), was distributed widely across the state.

Table 3. Geographic patterns by county (16 visited) for collected jumping spiders.

Species	# Counties Found In	% Counties Found In	Pattern
Eris militaris	7	44	S half of state
Evarcha hoyi	10	63	widespread
Ghelna canadensis	2	13	E half of state
Habronattus cognatus	5	31	widespread
Habronattus decorus	2	13	S half
Habronattus viridipes	1	6	SE corner (Wabasha)
Maevia inclemens	3	19	SE quarter
Marpissa grata	3	19	S half
Marpissa pikei	3	19	S half
Neon nellii	5	31	S half
Paradamoetas fontana	1	6	central (Stearns)
Pelegrina arizonensis	5	31	NW and SE
Pelagrina insignis	11	69	widespread
Pelagrina proterva	2	13	SE corner
Phidippus clarus	14	88	widespread
Phidippus princeps	2	13	central
Sassacus papenhoei	1	6	SE corner (Winona)
Sitticus palustris	1	6	E edge (Washington)
Tutelina similis	3	19	middle

County-level details for collected species of special concern include:

M. grata

Previously found in six northern and eastern counties (Gertsch, 1936; Cutler et al., 1988) including Stearns and Washington Cos. where we confirmed it, but also found by us in Murray Co., extending the known range limit of this MN and MI endemic species ~200 km (~120 miles) to the southwest;

P. fontana

Previously found in four east-central counties (Cutler et al., 1988), including Stearns Co. where we confirmed it;

P. arizonensis

Previously found in five eastern counties (Cutler et al., 1988), including Sherburne, Wabasha, and Winona Cos. where we confirmed it, but also found by us in Polk and Washington Cos. within its regional range;

S. papenhoei

Previously found in two southeastern counties (Cutler et al., 1988), including Winona Co. where we confirmed it.

Cutler et al. (1988) list Marpissa pikei (Peckham & Peckham, 1901) as a rare jumping spider, but one presently not listed as a special concern species due to fragmentary information, entirely from Wabasha Co. We found M. pikei at three new locations including Big Stone, Swift, and Winona Cos., extending the known western range limit of this species ~400 km (250 mi).

Jumping spider species richness by county varied from 1 to 11 in our survey (mean of 6), with no clear pattern of geographic "hotspots" within the state (Table 4). We recorded highest species richness from Stearns, Washington, and Winona Cos. and lowest species richness from Dodge, Murray, and Norman Cos. The former recorded two each of three special concern species. Murray, Polk, Sherburne, and Wabasha Cos. each recorded one special concern species.

The mean number of individual spiders captured per sweep by county was .031 (variance = .046, range = .003 - .194), giving some relative indication of spider abundance, though these numbers were sometimes obtained from only a single day of collection. Relatively high spider abundance was observed in Stearns and Swift Cos. and marked lower abundance found during sampling in Dodge, Murray, and Wabasha Cos. (Table 4).

Table 4. Relative abundance by county for collected jumping spiders.

County	Minimum # Species (incl. SC)		# Indiv.	# Sweeps	# Indiv./ Sweep
Aitkin	5		12	500	.024
Big Stone	4		22	1100	.020
Cottonwood	6		11	800	.014
Dodge	1		2	600	.003
Fillmore	5		17	400	.043
Le Sueur	6		38	1500	.025
Murray	2	(M. grata)	8	1300	.006
Norman	2		27	500	.054
Pipestone	6		71	2800	.025
Polk	5	(P. ariz.)	29	700	.041
Sherburne	6	(P. ariz.)	11	600	.018
Stearns	9	(M. grata, S. pap.)	82	1000	.082
Swift	6		97	500	.194
Wabasha	6	(P. ariz.)	30	1400	.009
Washington	11	(M. grata, P. ariz.)	39	1900	.021
Winona	9	(S. pap., P. ariz.)	30	900	.033
Mean	6		33	1031	.031
Variance	6.9		28	638	.046
Total	19		526	16500	

Table 5. Species presence by area name for fully identified jumping spiders, all methods.

Area	Species	# spp.	# ind.
Agassiz Dunes TNC	E. hoyi H. agilis H. cognatus P. arizonensis P. insignis P. clarus	6	28
Bonanza Prairie (Big Stone Lake) SNA	M. pikei P. clarus	2	16
Chippewa Prairie TNC	E. hoyi M. pikei N. nellii P. insignis P. clarus	5	86
Clinton Prairie SNA	P. insignis P. clarus	2	4
Hole in the Mountain TNC	E. hoyi N. nellii P. insignis P. clarus	4	47
Iron Horse Prairie SNA	P. clarus	1	2
Jeffers Petroglyphs Vicinity TNC (Prairie Banks)	H. cognatus N. nellii P. insignis P. clarus	4	9
Kasota Prairie TNC	E. hoyi P. insignis P. proterva P. clarus	4	31
Kellogg-Weaver Dunes SNA	E. militaris H. viridipes P. arizonensis P. insignis	3	8
Lake Elmo County Nature Reserve	E. militaris E. hoyi G. candensis H. decorus M. grata N. nellii P. arizonensis P. clarus S. palustris	9	27
Lundblad Prairie TNC	M. grata P. clarus	2	8
Ottawa Bluffs TNC	E. militarus P. clarus	3	5

Table 5. Continued

Area	Species	# spp.	# ind.
	T. similes		
Prairie Coteau SNA	H. agilis H. cognatus P. clarus	3	24
Rockville-Tamarack Bog TNC		0	0
Roscoe Prairie TNC/SNA	E. militaris E. hoyi H. cognatus M. grata P. fontana P. insignis P. clarus P. princes T. similes	9	72
Rushford Sand Dunes SNA	E. militaris M. inclemens P. insignis P. proterva	4	15
Solana State Forest	E. hoyi G. canadensis P. insignis P. clarus T. similes	5	10
St. Croix Savannah SNA	P. insignis P. clarus	2	2
Uncas Dunes SNA	E. hoyi H. cognatus M. inclemens P. arizonensis P. clarus P. princes	6	10
Whitewater Bluffs SNA (bluffs & floodplain)	E. militaris E. hoyi M. pikei N. nellii P. arizonensis P. clarus S. papenhoei	7	25

At the area level (Table 5), both Lake Elmo County Nature Reserve and Roscoe Prairie SNA/TNC areas had high spider species richness (= 9), and Chippewa Prairie TNC and Roscoe Prairie SNA/TNC had the highest spider abundance (all sampled on single days).

At the level of individual species of special concern, we obtained the following results:

M. grata

A total of three specimens (1 female, 2 males) were collected from three sites (#5, Lake Elmo County Nature Reserve; #40, Lundblad Prairie TNC; and #78, Roscoe Prairie SNA). Cutler (pers. comm) previously collected it at Roscoe Prairie, and except for that locality, noted that he has never found more than one individual at a site. Our results do not change this pattern. At all of our sites, this species was found near water (wetlands and ponds); at both #5 and #40 it was swept from grass and sedge near cattails and at #78 swept from willows.

P. fontana

A total of 10 specimens (all immature) were collected from three sites, all at Roscoe Prairie SNA (#76, #77, #78) adjacent to cattail wetlands. Cutler (pers. comm.) reports Robert Dana previously collected it "near" Roscoe Prairie.

P. arizonensis

A total of 21 specimens (14 females, 3 males, 4 immatures) were collected from eight sites within six areas in the NW and SE parts of the state (#2 and #4 at Lake Elmo County Nature Reserve; #9 at Kellogg-Weaver SNA; #13 at Kellogg-Weaver TNC; #19 at Whitewater SNA (floodplain along west side of Whitewater River); #67 and #68 at Agassiz Dunes TNC; and #83 at Uncas Dunes SNA). With the exception of the Lake Elmo sites (an old field and near a wetland), specimens were associated with sandy soil or dunes, twice in association with areas supporting both prairie grass and moss. Cutler (1995) reported it from three sand prairie sites including the Kellogg-Weaver vicinity and Whitewater Wildlife Management Area.

S. papenhoei

A single immature specimen was collected from site #19 (Whitewater SNA, floodplain) together with P. arizonensis where grass and moss covered sandy soil. Cutler (pers. comm.) has previously associated S. papenhoei with xeric sites.

The following additional species are described because of their rarity during this study or previous work suggesting their rarity within Minnesota (e.g., Cutler et al., 1988):

H. viridipes

A single adult male was collected from site #11 at Kellogg-Weaver SNA from a cluster of young aspen clones (~ 1.5 m tall).

M. pikei

A total of 14 individuals (9 females, 5 immatures) were collected from three sites (#15 at Whitewater Bluffs, #53 at Chippewa Prairie TNC, and #57 at Bonanza Prairie), two of which (#15 and #57) are hill prairies. Barnes (1958) associates this species with xeric habitats.

S. palustris

A single adult female was collected from site #1 at Lake Elmo County Nature Reserve from grass and sedge adjacent to a wetland.

Tutelina sp.

A total of 41 immature individuals were collected from 16 sites across the state (see Appendices for details). Wolff (1984) lists three species from MN (Tutelina elegans (Hentz, 1846), Tutelina formicaria (Emerton, 1891), and Tutelina similis (Banks, 1895)). All of our adult Tutelina were identified as T. similis and it is likely, but not certain, that these immatures are also of that species (Cutler, pers. comm.).

A complete listing of spiders collected, including geographic coordinates, age and sex information, and notes on site characteristics is presented in Appendix 1. Appendices 2-5 are designed for quick overviews of subsets of the data: Appendix 2 is sorted by species name linked to area name; Appendix 3 is sorted by site name linked to species name, Appendix 4 is sorted by species linked to county name; Appendix 5 is sorted by county linked to species name. A complete dataset is provided on a DOS disk, enclosed, in Lotus 1-2-3 format for digital transfer to DNR/Heritage Program databases.

Finally, as both participants in this study are birders, Appendix 6 details observations of 61 bird species encountered during this project, which we hope will contribute to biological inventories of these sites.

Discussion

Cutler et al. (1988) note that only five collectors have previously searched for Minnesota jumping spiders, primarily in the south and central regions of the state. We added two more names to this list and extended surveys, some probably for the first time, into western and north-western regions of Minnesota. In 21 days, we sampled 87 sites among 22 protected natural areas in 16 counties. A unique aspect of our work is the first use of geopositioning system (GPS) technology to record spider sampling locations (within 15 m accuracy), which will allow future monitoring for spiders at specific, relocatable sites.

Our inventory confirms the presence of four special concern jumping spider species M. grata, P. fontana, P. arizonensis, and S. papenhoei within protected natural areas. A 200 km range extension of M. grata, an MN and MI endemic, is reported due to its discovery at Lundblad Prairie (Murray Co.), which should stimulate additional collection activity in the SW portion of the state. One other new location at Lake Elmo County Nature Reserve was also

found. P. fontana was found near previous collection sites at Roscoe Prairie SNA, associated with wetland areas as reported by Cutler et al. (1988). P. arizonensis was found at eight sites from the NW to the SE corners of MN, including three new areas (Agassiz Dunes, Lake Elmo County Nature Reserve, and Uncas Dunes), appearing more commonly than other listed special concern species. S. papenhoei was represented by a single late-instar immature specimen from the Whitewater area, along a sandy floodplain. This species was associated with P. arizonensis, consistent with reports by Cutler et al. (1988), and was the most rarely collected of these four special concern species. M. pikei, cited by Cutler et al. (1988) as being taken infrequently from Wabasha Co., was discovered in fair numbers at three new sites (Bonanza Prairie, Chippewa Prairie, and Whitewater Bluffs), providing a ~400 km increase in the known western range limit of this species, and suggesting new target areas between them.

Eight other species, not presently considered special concern species, each comprised less than 2% of the total catch in this study, consistent with, but not proving, rarity in the state. We have shared this information with B. Cutler who may be able to comment on these and other species from his experience. They include: Ghelna canadensis (Banks, 1897); Habronattus decorus (Blackwall, 1846); H. viridipes (only 1 individual); Maevia inclemens (Walckenaer, 1837); Pelegrina proterva (Walckenaer, 1837); Phidippus princeps (Peckham & Peckham, 1883) (though Cutler et al. (1988) report it as "common"); S. palustris (1 individual at Lake Elmo, a site lacking SNA or TNC designations); and Tutelina similis (Banks, 1895) (6 individuals, but 41 others likely as immatures).

The four special concern species not found are: Habronattus texanus (Gertsch & Muliak, 1936); Phidippus apacheanus Chamberlain & Gertsch, 1929; Phidippus pius Scheffer, 1906; Tutelina formicaria (Emerton, 1891). The absence of specimens may confirm the rarity of these species or indicate we were not sampling in the right places at the right time with sufficient intensity.

In the case of H. texanus, we sampled areas of likely habitat at both sites reported by Cutler et al. (1988) (Hole In The Mountain and Ottawa Bluffs). In the absence of additional information, our work suggests it is rare.

P. apacheanus is reported by Cutler et al. (1988) from three locations (Kellogg-Weaver Dunes, Rushford Dunes, and Whitewater), all visited during this study. However, based on the late-maturing phenology of this species (Cutler, pers. comm.) with an earliest date of August 6, it appears our efforts were too early to encounter adults. Two immature (unidentified) Phidippus individuals were collected from oak saplings and lupines at Rushford. Our work does not add information on the status of this species.

P. pius is reported by Cutler et al. (1988) from four locations, including two we visited (Hole In The Mountain and Kasota Prairie); we also visited sites near the other two locations (Jeffers Petroglyphs Historical Site and near the town of Pipestone). In the absence of additional information, our work suggests it is rare.

T. formicaria has been reported only from Allison Savanna in Anoka Co., described as a "consistent" locality by Cutler (pers. comm.). Although we visited this site, due to weather, we did not sample for spiders, and cannot add information to its status.

Overall, it is our impression that the eight species recommended by DNR for special concern status are justified, given that perhaps the most comprehensive survey done to date has failed to turn up four species (H. texanus, P. apacheanus, P. pius, and T. formicaria) and one other species (S. papenhoei) is known from a single specimen. Of the three other special concern species, P. arizonensis was the most commonly encountered during this study, though it was not especially common relative to the total sample (4.5%). Using overall relative abundance from our samples as a guide to status within the state, nine other jumping spider species appear rare (< 2% of the total sample) and may merit consideration for future lists.

We suggest that additional surveys for jumping spiders be done with regularity in the future to place these results in better context for management decisions. For currently listed special concern jumping spiders, high value conservation areas appear to occur in Stearns, Swift, Washington, and Winona Cos. These species may directly benefit from the protection of additional similar habitat in these areas.

Together, Wabasha and Washington Cos. contain six of nine other "rarely collected" species of our study (G. canadensis, H. decorus, H. viridipes, M. inclemens, Tutelina sp., S. palustris). In particular, Lake Elmo County Nature Reserve (Washington Co.) appears to be an area with high spider biodiversity, and it is one of only two sites we visited that is not an SNA or TNC property. We do not know if invertebrate conservation is a management concern there, but perhaps it should be (nine identified jumping spider species including M. grata, P. arizonensis, and the only S. palustris specimen, plus Tutelina sp.).

Gauging the status of the four uncollected special concern species will require additional field work in areas of historical occurrence, especially Hole In The Mountain and Allison Savanna for H. texanus, P. pius, and T. formicaria. Selecting at least some sampling dates in August and September may facilitate collection of P. apacheanus, and possibly other species.

Finally, it is likely that new records of jumping spiders, possibly including new species, will be obtained from further exploration of areas in Minnesota that are not presently designated SNA or TNC properties. Time spent in other state lands (forests, parks, wildlife areas) can compliment inventories at currently protected sites and perhaps guide management decisions, including those related to future land designations or acquisitions. In particular, the northern tier of counties in Minnesota remains essentially unsampled for jumping spiders.

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