MARDON SKIPPER (*POLITES MARDON*) DISTANCE SAMPLING SURVEYS AT FOUR SENTINEL SITES IN OREGON AND WASHINGTON: YEAR 7

STATUS REPORT TO THE U.S. FOREST SERVICE, BUREAU OF LAND MANAGEMENT, AND THE INTERAGENCY SPECIAL STATUS / SENSITIVE SPECIES PROGRAM (ISSSSP)

Conrad Meadows mardon skipper site, Okanogan-Wenatchee National Forest, WA. Photo: Joan St. Hilaire, 2020.

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

DECEMBER 2020

XERCES SOCIETY for Invertebrate Conservation

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SUMMARY

This report summarizes Year 7 of a multi-year monitoring effort to document population and density estimates of mardon skippers (*Polites mardon*) at four sentinel sites in Oregon and Washington. Each year, the Xerces Society provides logistical support to BLM and USFS biologists and contractors to survey mardon skipper sites at Windy Valley (Rogue River-Siskiyou National Forest, OR), the Howard Prairie site complex (Jackson County Parks, managed by Medford BLM, southern OR), and Conrad Meadows (Okanogan-Wenatchee National Forest, WA). Xerces Society staff monitor the fourth site, Peterson Prairie (Gifford Pinchot National Forest, WA). The 2020 monitoring season took place from May through July, during which surveyors completed 6-8 visits per site to count skippers on established transects using distance sampling techniques. Data for all sites were provided to Xerces' biologists for analysis and reporting.

Population estimates for all sites trended higher in 2020 than 2019; some sites recorded the highest population estimates since monitoring began in 2014 (Appendices A and B). Population and density estimates for all sites in 2020 can be found in Table 1. Note that % CV are high and 95% CI are large at both the Howard Prairie site complex and Peterson Prairie's West Meadow. This is likely due to the low number of total butterfly observations at these two sites. See the Site Results and Discussion section for more site-specific details.

Table 1: Population and density estimates for all survey sites in 2020.

Region			2020			
	Site	Estimate	Pop. size	% CV	95% CI	
RRS	Windy Valley	Density (N/HA)	1656.2	22.84	957.54	2864.7
		Population (N)	1470.0	22.84	850	2542
S. OR Cascades	Howard Prairie	Density (N/HA)	**382.86**	**54.04**	**140.66**	**1042.1**
		Population (N)	**2213**	**54.04**	**813**	**6023**
	Lily Glen	Density (N/HA)	**32.90**	**54.97**	**10.23**	**105.76**
		Population (N)	**287**	**54.97**	**89**	**921**
	Pooled Estimate	Density (N/HA)	**172.49**	**48.26**	**69.788**	**426.35**
		Population (N)	**2499**	**48.26**	**1011**	**6178**
GIP	Peterson Prairie North Meadow	Density (N/HA)	196.28	26.50	102.78	374.83
		Population (N)	754	26.50	395	1439
	Peterson Prairie West Meadow	Density (N/HA)	**42.58**	**54.55**	**8.96**	**202.27**
		Population (N)	**89**	**54.55**	**19**	**425**
	Pooled Estimate	Density (N/HA)	141.94	24.82	79.29	254.07
		Population (N)	843	24.82	471	1509
OKW	Conrad Meadows	Density (N/HA)	5644	9.14	4690.7	6791
		Population (N)	21733	9.14	18062	26149

Notes: It is possible that the same individuals were counted on multiple site visits. Numbers in **bold** have a high coefficient of variance, with large 95% Confidence Intervals. The total numbers of observations for Peterson Prairie North was less than 20, which likely violates these same assumptions. As such, the population estimates for this site is unreliable, and the pooled data should be used instead of the individual site data.

The 2020 monitoring season was the 7th year of monitoring at the four sentinel sites in Oregon and Washington since the range-wide monitoring protocol was adopted. We recommend continuing annual monitoring for a minimum of ten years, although longer-term population monitoring—especially if active management is occurring at these sites—is ideal and important for developing and implementing, adaptive management strategies. At the beginning of each field season, we recommend that surveyors revisit the Distance Sampling protocol (Hatfield 2013) to review the assumptions of Distance Sampling and ensure that future surveys meet those assumptions. In particular, it is critical that surveyors focus on detecting 100% of butterflies on the survey transect, and, to the extent possible, monitor the population throughout the entire flight period of the butterfly. In addition to distance sampling at the four sentinel sites, we recommend continuing and/or implementing detection/no-detection surveys in a subset of historically occupied meadows (see Hatfield et al. 2013). Development and implementation of a standardized site condition assessment form would benefit the tracking of site condition through time (see Hatfield et al. 2018a for more details).

INTRODUCTION

Mardon skippers (*Polites mardon*) are small, stout butterflies with tawny orange wings. They are found in open meadow habitats in several disjunct areas in Washington, Oregon, and California. Similar to other members of the grass skipper family (Hesperiidae), they move in a skipping pattern, staying low to the ground. Mardon skippers are grass obligates as larvae, while adults have been documented using a variety of nectar sources. Detailed information about their life history and distribution can be found in Pyle and LaBar (2018) and previous monitoring reports (e.g., Fallon et al. 2019).

The small size (less than half an inch) of mardon skippers and their low flight activity results in low detectability during surveys, which makes population monitoring difficult (Potter and Olson 2012; Fallon and Hatfield 2013; 2014; 2015; Hatfield et al. 2016; 2017; 2018b; Fallon et al. 2019). Because of this, incorporating detectability into population estimates is essential, and distance sampling methods have been shown to work well for this species, since distance sampling uses a detection function to account for butterflies that may not have been detected during surveys.

From May through July of 2020, Xerces staff, USFS and BLM biologists, and independent contractors conducted distance sampling surveys at four sentinel sites in Oregon and Washington: Windy Valley, Howard Prairie, Peterson Prairie, and Conrad Meadows. All four of these sites have been surveyed annually using distance sampling methods since 2014. These sentinel sites were selected for several reasons:

(1) They host some of the largest populations of mardon skippers documented on federal lands in three of the four major areas from which this species is known,
(2) There would likely be enough skippers to conduct distance sampling (which assumes a minimum of 30 observations per site - per year),
(3) They can serve as barometers of mardon skipper activity (including peak flight periods to inform the best time to conduct detection/no detection surveys at other mardon skipper sites nearby),

(4) They inform population trends for each region. These seven years of surveys provide robust population estimates of known mardon skipper populations in three of the four major geographical areas from which this species is known.

It is important to note that while these sentinel sites may be used as barometers for regional population trends, additional satellite sites with smaller populations should be monitored regularly to determine if they remain extant.

METHODS

FIELD SURVEYS

Xerces Society staff established the distance sampling transects with the program Distance (Thomas et al. 2010) in 2014 using the Mardon Skipper Rangewide Monitoring Protocol (Hatfield et al. 2013). We adjusted the endpoints of some transects in 2014 and 2015 after surveyor feedback. Surveyors place endpoints in the field each year using GPS and delineate each transect with pin flags, rebar, PVC pipes with flags, and/or wooden stakes (see Appendix C for transect coordinates).

Sites are monitored over the course of the adult flight period, which usually runs from late May to the end of July, depending on the location and annual variation. As outlined in the Rangewide Monitoring Protocol, sites are visited a minimum of five times per season. Surveyors follow the general survey condition recommendations provided by Seitz et al. (2007) and modified by Hatfield (2013). Surveyors follow the distance sampling protocol outlined in Hatfield (2013).

DATA ANALYSIS

Surveyors provide data to Xerces staff at the end of the field season. We used Distance 7.2 Release 1 (Thomas et al. 2010) to estimate the mardon skipper abundance and density of each site. In the Results section that follows, we report several statistics for each sentinel site:

1) One-day skipper counts for each visit. These are somewhat similar to the one-day counts that have taken place in the past. However, the methodology for distance sampling is different from the modified Pollard walks, making direct comparisons difficult.
2) Population estimates, including estimated density (N/ha) and total population (N), as well as the Coefficient of Variation (%CV) and the 95% Confidence Intervals (95% CI) (Thomas et al. 2010). The Coefficient of Variation is a unit-less measure of error about a statistic, and thus allows a comparison of the amount of error between sites with different means (here reported as population estimates). Loosely interpreted, the 95% CI contains the mean population size (N), with 95% confidence. With similar means, a population with a larger %CV will have a broader 95% CI. Generally speaking, to detect trends in meadows with statistical significance ($p<0.05$), it would be necessary to have two means (N) with 95% CI that did not overlap. This means that detecting population trends in meadows with a high % CV, will be challenging.

The population estimates reported here are a pooled sum of the individual daily estimates of butterfly abundance. Daily population estimates are not reported here for simplicity, but those data are available from the Xerces Society upon request. The estimates provided are the best estimates of mardon skipper

populations to date, and as long as the sampling protocol is followed in future monitoring efforts, the numbers reported here can be compared to future surveys. The estimates could be improved if there were accurate measures of individual butterfly survivorship, which, to our knowledge, do not exist for this species.

SITE RESULTS AND DISCUSSION

WINDY VALLEY, ROGUE RIVER-SISKIYOU NF, OR

Figure 1: Windy Valley, Rogue River-Siskiyou National Forest, OR. Photo: Jessie Roughgarden, 2020.

The Windy Valley site (Figure 1) in southwest Oregon hosts the largest known mardon skipper population in the coastal Oregon region. Located at approximately 2,900 feet AMSL, it is composed of a seasonally wet meadow surrounded by coniferous forests. Mardon skippers continue to occupy approximately 0.89 hectares of habitat with bunch grasses and nectar plants at the northeastern edge of this meadow (see Map 1). The Chetco Bar wildfire lightly burned through this site in 2017 (Vaughn 2018, pers. comm.). During the 2020 distance sampling season, Rogue River-Siskiyou (RRS) field staff conducted 6 visits beginning on May 29 and ending July 21 (see Table 2).

Map 1: Windy Valley distance sampling survey site

Results

In 2020, 244 skippers were observed at the Windy Valley site. No mardon skippers were detected on the first or last site visit, indicating the full flight period was captured during the six visits. The peak count for 2020 was on June 25, with 99 individuals (Table 2). In the sampled occupied habitat, there is an estimated 1,656.2 mardon skippers per hectare (22.84 % CV), with a population estimate of 1,470 mardon skippers (22.84 % CV, habitat size of 0.887 HA, see Table 3).

Table 2: Number of skippers detected by date at Windy Valley.

Site	Area (HA)	# Transects	Total Distance of Transects (m)	5/29/2020	6/3/2020	6/18/2020	6/25/2020	7/7/2020	7/21/2020	Total Observed*
Windy Valley	**0.887**	**3**	**262.33**	**0**	**58**	**66**	**99**	**21**	**0**	**244**

*Note: This includes all skippers detected during distance sampling (not just mardon skippers). It is possible that the same individuals were counted on multiple site visits.

Table 3: Windy Valley population estimates in 2020.

		2020			
Site	Estimate	Pop. size	% CV	95% CI	
Windy Valley	Density (N/HA)	1,656.2	22.84	957.54	2864.7
	Population (N)	1,470.0	22.84	850	2542

Discussion

The 2020 monitoring season marks the third year of distance sampling since the Chetco Bar wildfire burned the entire occupied area in 2017. Three years post-fire, mardon skipper population estimates are higher than some pre- and all post-fire estimates (2016-2019; see Appendices A and B).

The detection function for this site (Figure 2) is unusual considering detections of mardon skippers, at most sites in most years, tend to drop off predictably the further one moves from the transect; note that detectability drops off completely just beyond 3 meters from the transect. In addition to mardon skippers, the surveyor observed various species of blues, sulphurs, and fritillaries.

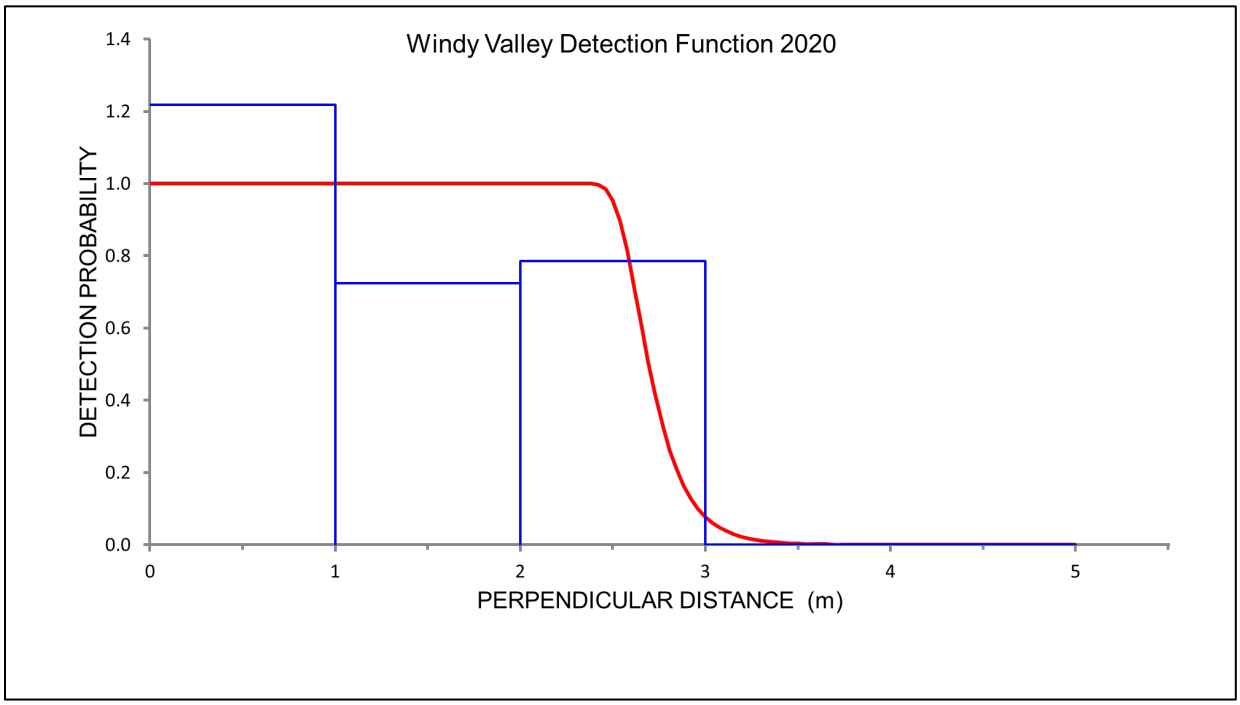
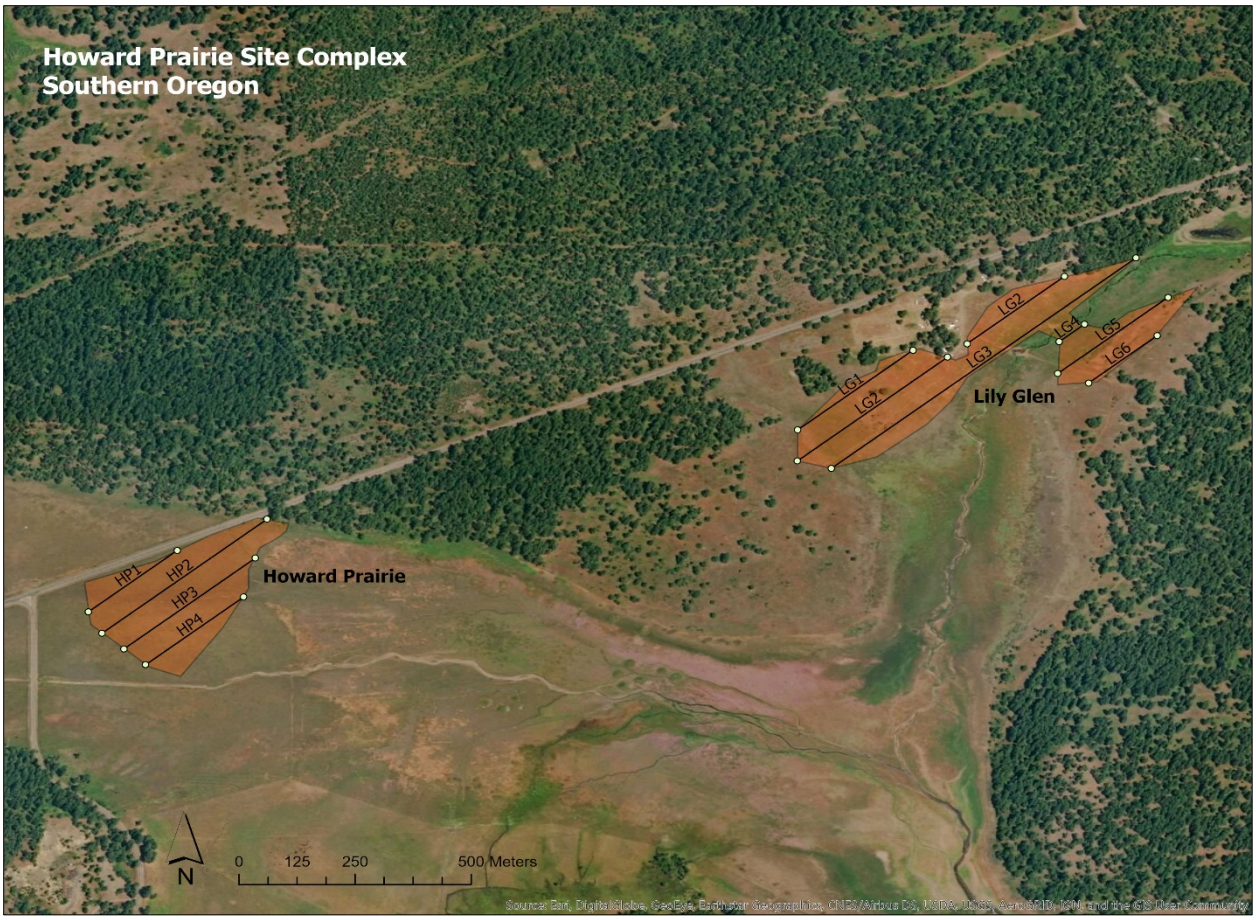


Figure 2: Windy Valley detection function

Howard Prairie Site Complex, OR

Figure 3: Short, early season vegetation in the meadow at Howard Prairie (left). Transect 2 at Lily Glen (right). Photos: Norm Barrett, 2020.

The Howard Prairie Site Complex is composed of its namesake prairie and the adjacent Lily Glen Park site (Figure 3). This site complex is located at approximately 4,550 feet AMSL. In 2020, surveyors were on site May 12 to place transects with pin flags along transect lines (see Map 2) and check for mardon skipper activity. Mardon skipper surveys occurred from May 23 through July 14 at Howard Prairie and May 23 through June 17 at Lily Glen. Mardon skippers were not detected until May 27, when they were present at Lily Glen and at Howard Prairie. Surveyors last detected mardon skippers on July 7 at Howard Prairie and June 9 at Lily Glen (see Table 4).



Map 2: Howard Prairie Site Complex distance sampling survey sites

Results

Throughout the season, 140 skippers were observed at Howard Prairie, and 12 skippers were observed at Lily Glen. Peak counts for the 2020 season occurred on May 27, 2020, at Lily Glen and June 9, 2020, at Howard Prairie (see Table 4). In the sampled occupied habitat, there is a pooled estimate of 172.49 mardon skippers per hectare (48.26% CV), and a population estimate of 2,499 mardon skippers at both sites (48.26% CV, the habitat was 14.49 HA). For 95% Confidence Intervals, see Table 5. Howard Prairie has a higher density of mardon skippers (382.86/HA) than Lily Glen (32.9/HA). Note the high % CV for all of these estimates.

Table 4: Number of skippers detected by site and date at the Howard Prairie complex.

Site	Area (HA)	# Transects	Total Distance of Transects (m)	5/23/2020	5/27/2020	6/2/2020	6/9/2020	6/17/2020	6/23/2020	6/30/2020	7/7/2020	7/14/2020	Total Observed*
Howard Prairie	5.78	4	1,084.5	0	1	6	66	20	30	16	1	0	140
Lily Glen	8.71	6	1,887.0	0	6	5	1	0	n/a	n/a	n/a	n/a	12
Pooled	14.49	10	2,971.5	0	7	11	67	20	30	16	1	0	152

*Note: It is possible that the same individuals were counted on multiple site visits.

Table 5: Howard Prairie and Lily Glen population estimates in 2020.

		2020			
Site	**Estimate**	**Pop. size**	**% CV**	**95% CI**	
Howard Prairie	Density (N/HA)	**382.86**	**54.04**	**140.66**	**1042.1**
	Population (N)	**2213**	**54.04**	**813**	**6023**
Lily Glen	Density (N/HA)	**32.90**	**54.97**	**10.23**	**105.76**
	Population (N)	**287**	**54.97**	**89**	**921**
Pooled Estimates	Density (N/HA)	**172.49**	**48.26**	**69.788**	**426.35**
	Population (N)	**2499**	**48.26**	**1011**	**6178**

Note the high % CV for all of these estimates.

Discussion

In 2020, population estimates are higher for both Howard Prairie and Lily Glen compared to 2019; moreover, in 2020 Howard Prairie had the highest population estimates recorded compared to all previous monitoring years (see Appendices A and B). Pooled population estimates for the Howard Prairie complex were also higher in 2020 than in all previous monitoring years (see Appendices A and B). However, these estimates should be interpreted with caution due to a large % CV for each site as well as the site complex.

As these two sites are different, detectability is also likely quite different (e.g., the plant community at Howard Prairie tends to be short and sparse, which may lead to higher detectability). As such, a pooled detection function (which has been provided in the past) may provide inaccurate population estimates. This year we provide separate detection functions for each site since the results were better this year as separate functions rather than pooled. In 2020, detection of mardon skippers dropped below 40% after one meter at Howard Prairie, and although they were rare, detections continued beyond seven meters from the transect (Figure 4). Additionally, distance sampling data for Howard Prairie show that observers have a higher number of observations at 3-3.5 m as they do just beyond 1 to 2 m (and similarly at 5 m compared to 4 m). Because of this, we emphasize that the focus should be concentrated on the transect line while conducting surveys so that data are not skewed. At Lily Glen, detection of mardon skippers dropped below 20% just beyond 1 m and dropped off completely beyond 2 m (Figure 5). This may occur because of the high stature of plants, which could lead to lower detectability at Lily Glen.

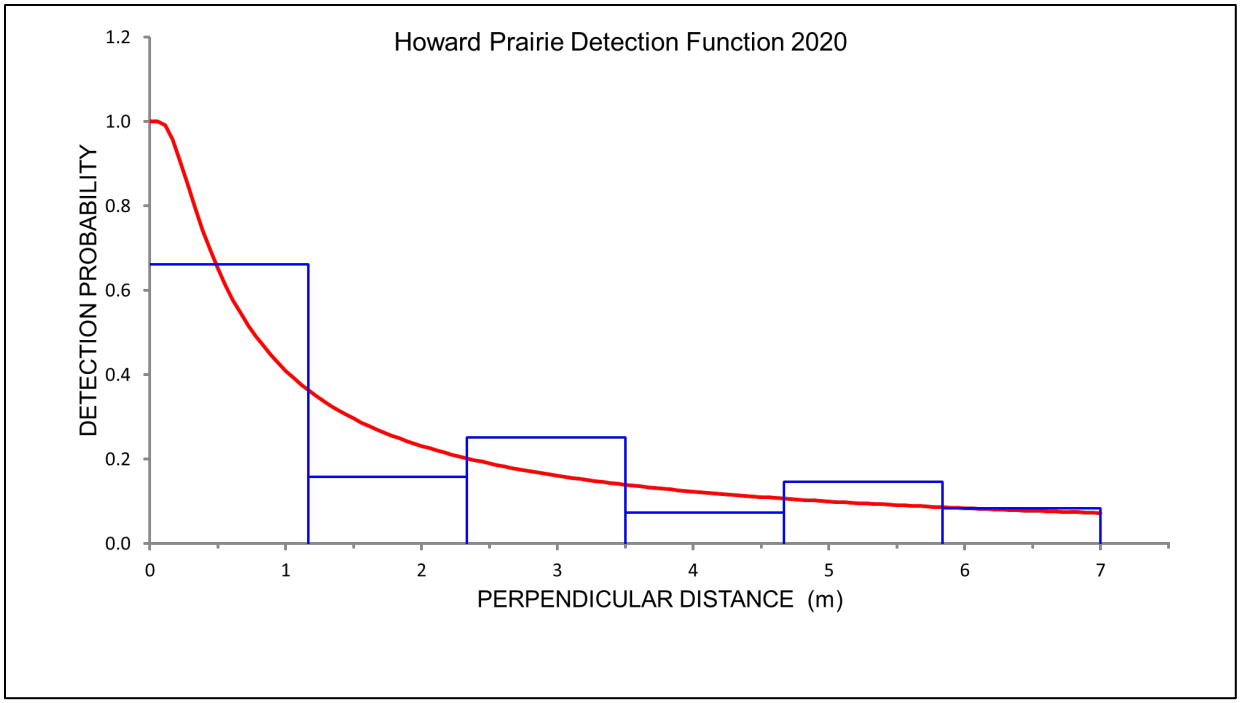


Figure 4: Howard Prairie detection function

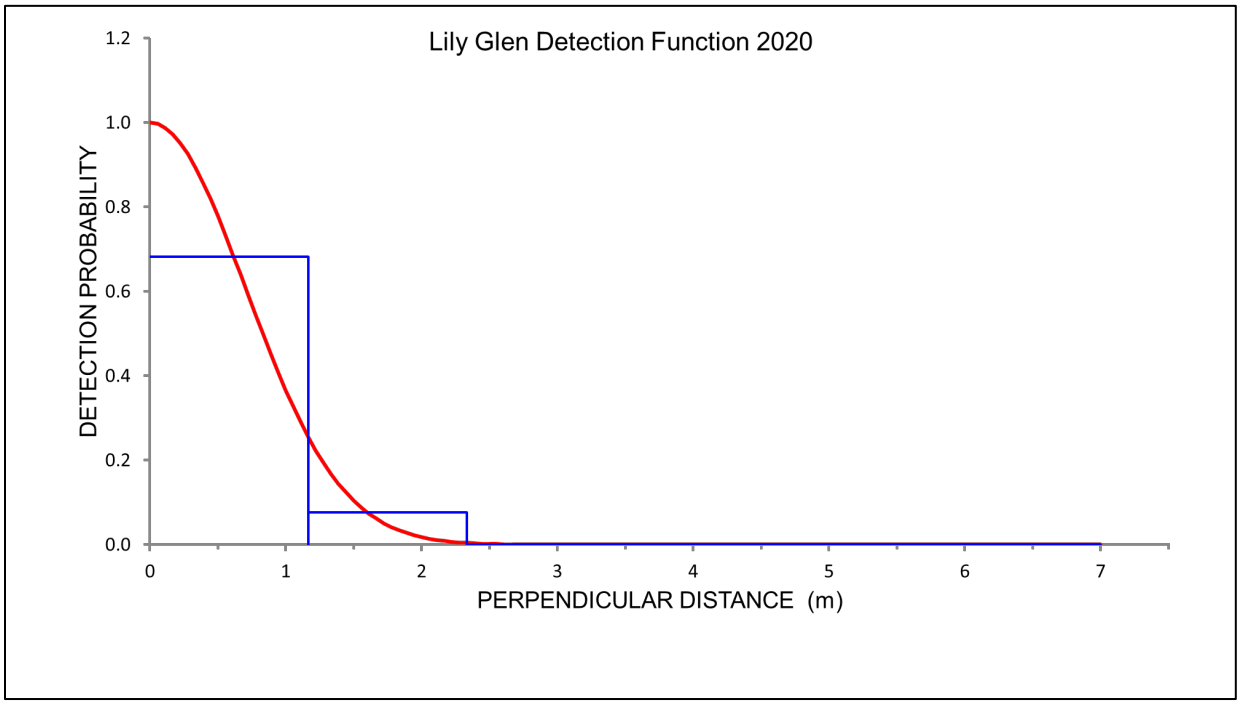


Figure 5: Lily Glen detection function

The following discussion is based on anecdotal observations by Norman Barrett:

Water availability at the Howard Prairie site complex may be an issue for mardon skipper populations. Weather over the winter included below average snow depths (NRCS 2020) and surface water was not

visible within ½ mile of either site (Barrett 2020). The drier conditions in 2020 permitted the complete survey of all transects; however, drought-like conditions which have occurred at the site complex in recent years may be leading to ecosystem-level changes (Barrett 2019; 2020). For example, anecdotal observations of early season floral species like camas lily, which are limited by soil moisture availability and have historically been dominant, have experienced declines in the amount of plants blooming and the duration of their bloom period (Barrett 2019; 2020). Despite this, cool weather and periodic rain at the beginning of the monitoring season allowed for cool, humid site conditions. The moist site conditions in 2020 appeared to sustain floral bloom periods for some plant species beyond what has been observed in the past (Barrett 2019; Fallon et al. 2019), including for several known mardon skipper nectar plants (Barrett 2020).

Howard Prairie is a large open meadow with two large trenches that carry water through the site. The site appears to dry out earlier than most other sites in the region and as a result may have a slightly earlier flight season. It also tends to have relatively few nectar sources during the flight period, although there is an abundance of host plants to support mardon skipper larvae. Early season flowering is usually dominated by camas lily, but in 2020 (as in 2019) less than 10% of the camas flowered and almost all had wilted and dried up by the end of May (Barrett 2019; 2020). However, in contrast to 2019, seasonal rains through May allowed for other flowering plants to bloom in sufficient quantity to support mardon skipper nectaring this year. For instance, meadow penstemon (*Penstemon rydbergi*), a favored mardon skipper nectar plant, was found in much higher density and bloomed over a longer period (3 weeks) in 2020 compared to 2019 (Barrett 2020). As this favored plant senesced, it was replaced by an unknown plant in the aster family, on which mardon skippers were observed nectaring. A sudden burst of tall grasses (waist high) were noted during the final two survey dates by surveyors. While the density of grasses was sparse and did not appear to impact survey efforts, the presence of the tall grass can impact detectability and could indicate a trend in the ecosystem that may be consequential to mardon skippers; as appears to be the situation at the Lily Glen site (Barrett 2020). Overall, mardon skipper numbers at Howard Prairie were higher and the season extended later into the year, as compared to all previous years of sampling (Appendices A and B). The abundant nectar food sources and local site conditions may explain the record population numbers documented at this site in 2020.

Lily Glen is a large meadow located just east of Howard Prairie with a permanent stream that bisects the site from NE to SW. There is a vernal pool habitat on the east side of the stream, which supports abundant *Plectritis congesta* (a known nectar plant) and mardon skippers. Most of the remainder of the meadow is a mix of fescue, forbs, and bare ground. In contrast to Howard Prairie, the shortest flight season was recorded at Lily Glen in 2020, compared to all previous years of monitoring. Similar to Howard Prairie, some flowering plants at Lily Glen experienced longer blooming periods during the 2020 monitoring season (Barrett 2020). This was especially true for seablush (*Plectritis congesta*) and mule ears (*Wyethia* sp.), which are known early to mid-season mardon skipper nectar plants; seablush bloomed through the entire survey period for the first time in the 7 years of surveys (Barrett 2020). Of particular concern, identified by the surveyor, is that several short grass pockets that previously hosted mardon skippers have now evolved into tall grass sites with no skippers, which is suspected to be a result of the overall drier site conditions experienced over three consecutive years (Barrett 2020). Based on anecdotal observations, dry site conditions may be a result of a lower water table related to

decreased reservoir levels (Barrett 2020). The surveyor speculates that because Lily Glen is a few feet higher than Howard Prairie the effects of a lowered warer table due to limited reservoir water could have affects on the plant composition at the Lily Glen meadow. Whether this partly explains the differences in grass and floral composition between the sites and the population trends of mardon skippers is unknown (Barrett 2020), but it would be of interest to explore with changes in reservoir levels.

For additional site details, see Barrett (2020).

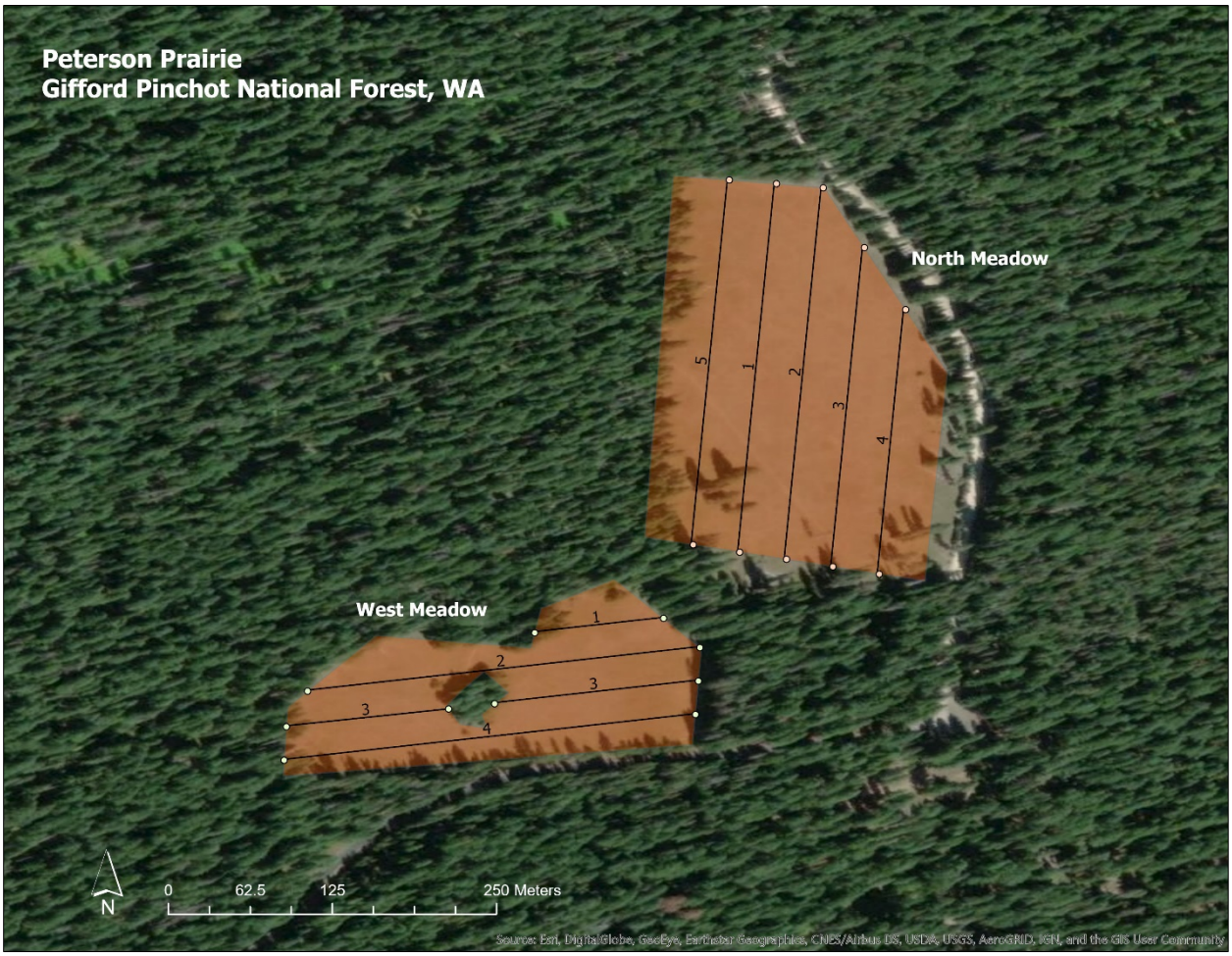
Peterson Prairie, Gifford Pinchot NF, WA

Figure 6: Paintbrush (*Castilleja* sp.) in Peterson Prairie's North Meadow. Photo: Xerces Society/Michele Blackburn, 2020.

Peterson Prairie is comprised of two xeric natural grass and forb meadows without a permanent water source; a low swale runs diagonally from NW to SE through the North Meadow, which retains moisture later into the summer. A Region 6 sensitive species, *Sisyrinchium sarmentosum* (pale blue-eyed grass) is found in and near this swale. There is a small aspen (*Populus tremuloides*) grove in the center of the

West meadow. The North Meadow (Figure 5) measures 3.84 hectares; the West Meadow 2.1 hectares (see Map 3). This site complex is located at approximately 3,000 feet AMSL.

In 2020, Xerces staff set up transects on May 29, and conducted an additional seven site visits from June 4 through July 13 (see Table 6). Xerces staff also conducted detection/no detection surveys at four additional known mardon skipper sites on the Gifford Pinchot NF; Lost Creek was visited on June 25 and the other three (Bunny Hill, King Mountain, and Mt. Adams Horse Camp) on July 3. These were originally planned as modified peak counts (see protocol description in Hatfield 2013), and Xerces staff expected to use mardon skipper estimates from Peterson Prairie to time these peak counts. However, it is possible that the latter three visits occurred just after the peak flight period for the region.



Map 3: Peterson Prairie distance sampling survey sites

Results

Throughout the 2020 season, 6 skippers were observed during distance sampling surveys in the West Meadow, and 53 were observed in the North Meadow (Table 6). The peak count of 25 skippers for the 2020 season occurred on June 19 (see Table 6).

Table 6: Number of skippers detected by site and date at Peterson Prairie in 2020.

Site	Area (HA)	# Transects	Total Distance of Transects (m)	6/4/2020	6/14/2020	6/19/2020	6/25/2020	6/29/2020	7/6/2020	7/13/2020	Total Observed*
West Meadow	2.1	4	697.58	0	0	1	5	0	0	n/a	6
North Meadow	3.84	5	1209.74	0	5	24	14	6	4	0	53
Pooled	5.94	9	1907.32	0	5	25	19	6	4	0	59

*Note: It is possible that the same individuals were counted on multiple site visits.

Table 7: Peterson Prairie population estimates in 2020.

		2020			
Site	Estimate	Pop. size	% CV	95% CI	
Peterson Prairie North Meadow	Density (N/HA)	196.28	26.50	102.78	374.83
	Population (N)	754	26.50	395	1439
Peterson Prairie West Meadow	Density (N/HA)	**42.58**	**54.55**	**8.96**	**202.27**
	Population (N)	**89**	**54.55**	**19**	**425**
Pooled Estimate	Density (N/HA)	141.94	24.82	79.29	254.07
	Population (N)	843	24.82	471	1509

In the sampled occupied habitat, there is a pooled estimate of 141.94 mardon skippers per hectare (24.82% CV), with a population estimate of 848 skippers (24.82% CV, habitat size of 5.94 HA, see Table 7). The population estimate for the North Meadow is 754 butterflies (26.5% CV) and 89 (54.55 %CV) in the West Meadow (Table 7) (however, note the high % CV and large 95% confidence intervals this year for the West Meadow, likely due to the low overall number of detections [n<20; see Table 6]). The North Meadow has a higher density of butterflies (196.28) than the West Meadow (42.58).

No mardon skippers were observed during the detection/no detection surveys. While Lost Creek was visited close to the mardon skipper peak at Peterson Prairie, the other three sites were not able to be surveyed during this time; therefore, the lack of any detections at Bunny Hill, Mt. Adams Horse Camp, and King Mountain should be interpreted with caution.

Figure 7: Bunny Hill satellite site, Gifford Pinchot National Forest, WA. No mardon skippers were observed. Photo: Xerces Society/Michele Blackburn, 2020.

Discussion

Mardon skipper population estimates have experienced fluctuations in both the North and West Meadows since surveys began in 2014; yet, still have not reached the population size documented during the first monitoring year (Table 8; Appendix B). However, the 2020 pooled population estimate for both meadows is higher this year compared with the past five monitoring seasons (Appendices A and B).

In 2020, population estimates for the North Meadow were higher than those reported in most monitoring years except 2014 and 2018 (Appendices A and B). While no butterflies were detected in the West Meadow the past two monitoring seasons (2018 and 2019), the 2020 population estimate is one of the highest recorded since 2015 (Table 8); however, note again the high % CV and large 95% confidence intervals this year (Table 7). Because there were few (n<20) detections in the West Meadow (see Table 6), we present only a pooled detection function (Figure 8). Despite what may be a stable population in the North Meadow, low skipper detections have persisted throughout the monitoring years, and population estimates remain at least three times lower than those recorded for 2014 (Appendices A and B).

Table 8: Population (N) estimates at Peterson Prairie West Meadow, 2014-2020.

Year	Pop. size	% CV	95% CI	
2014	255	18.3	174	255
2015	***14***	***49.87***	***5***	***37***
2016	***93***	***49.83***	***27***	***322***
2017	***14***	***93.03***	***1***	***171***
2018	n/a	n/a	n/a	n/a
2019	n/a	n/a	n/a	n/a
2020	***89***	***54.55***	***19***	***425***

Note high % CV for data in bold italics.

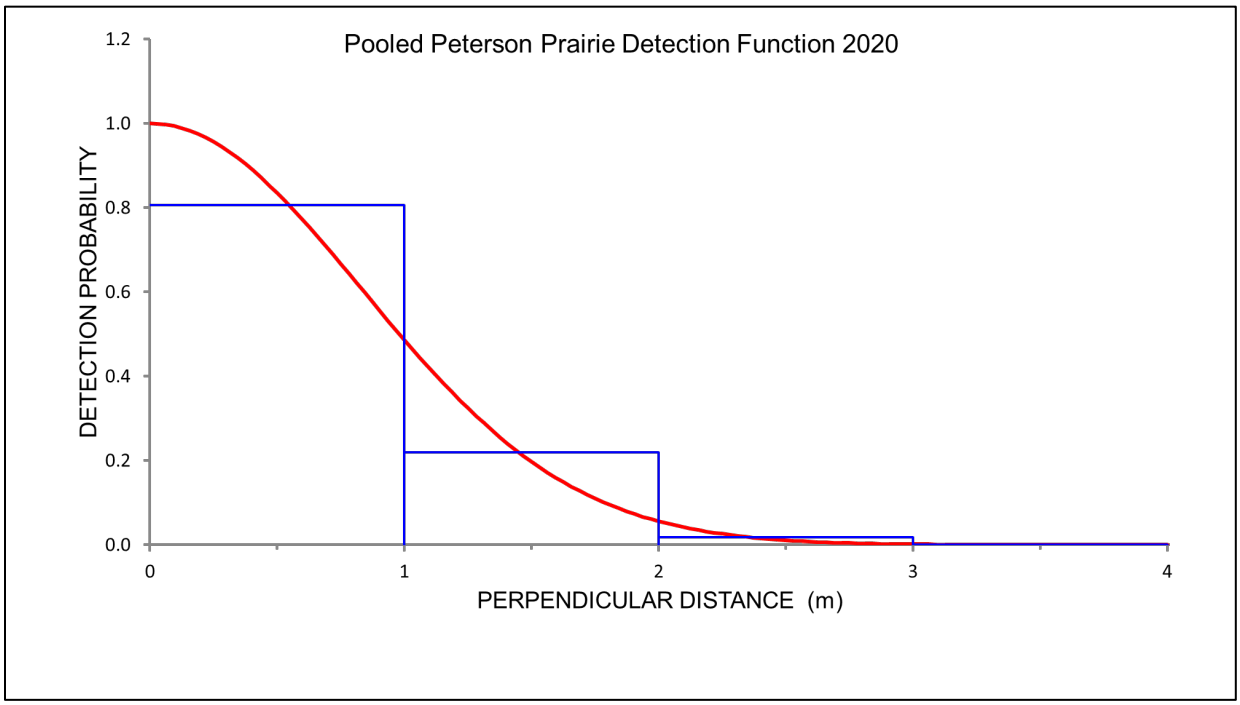


Figure 8: Pooled Peterson Prairie detection function

Moisture availability may be affecting mardon skippers at Peterson Prairie. The West Meadow does not have a swale to retain soil moisture later into the flight period like the North Meadow. Even with the swale, the North Meadow appears to be drying out. Wet meadow habitat in southwest Washington is expected to decrease under a warmer climate because of projected changes in hydrology, which may in turn lead to tree establishment and a shift from wet meadow to dry meadow habitats (Hudec et al. 2019). This can have a negative effect on mardon skippers, which require open, wet meadows. In the past, surveyors noted several specific areas of concern, including ongoing shrub and aspen encroachment in the West Meadow (Figure 8), which did not have any skipper detections in 2018 and 2019, and only a few detections in 2020. However, while some new aspen seedlings were present in the West Meadow, conifer and aspen encroachment was not as prevalent in 2020 compared with 2019 (Blackburn 2020, pers. obs.). This is as a result of efforts to remove saplings between the 2019 and 2020 monitoring seasons (Chartier 2020, pers. comm.). Ongoing active management of this site, including

control of encroaching aspen and conifer trees and provision of earlier season nectar sources, may benefit mardon skipper populations.

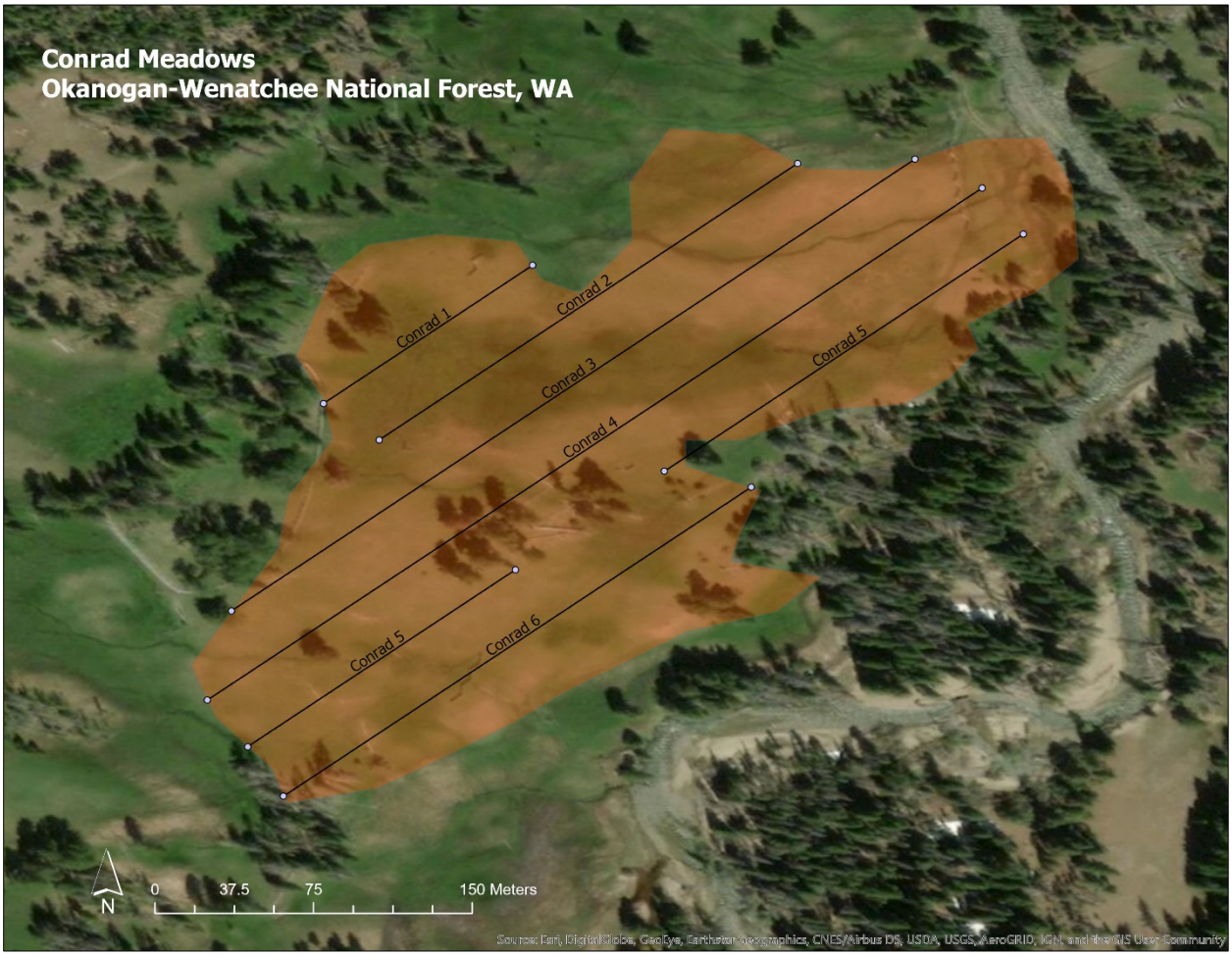
Similar to previous years, the most abundant nectar sources in 2020 were dusky horkelia (*Horkelia fusca*), camas (*Camassia quamash*), and purple violets (*Viola* spp.). Other blooming plants observed during the survey season included cinquefoil (*Potentilla* sp.), yarrow (*Achillea millefolium*), mariposa lilies (*Calochortus subalpinus*), paintbrush (*Castilleja* sp.), tiger lilies (*Lilium columbianum*), blue-eyed grass (*Sisyrinchium* spp.), a purple iris (*Iris* sp.), checkermallow (*Sidalcea* sp.), Oregon sunshine (*Eriophyllum* sp.), strawberry (*Fragaria* sp.), vetch (*Vicia* sp.), pearly everlasting (*Anaphalis margaritacea*), blue-eyed mary (*Collinsia* sp.), goldenrod (*Solidago* sp.), purple asters, and spreading phlox (*Phlox diffusa*). As in years past, numerous butterfly (including blues, fritillaries, swallowtails, and coppers) and bumble bee (including *Bombus bifarius, B. mixtus, B. melanopygus*, and unidentified cuckoo bumble bees) species were observed in the two meadows.

Conrad Meadows, Okanogan-Wenatchee NF, WA

Figure 9: Conrad Meadows with the Goat Rocks Wilderness in the background. Photo: USFS/Joan St. Hilaire, 2020.

Conrad Meadows (Figure 9) is part of a large complex of grass meadows near the edge of the Goat Rocks Wilderness (Map 4) at approximately 4,100 feet AMSL. Mardon skipper-inhabited areas are dominated

by native onespike oatgrass (*Danthonia unispicata*), with various species of *Poa* and *Carex* scattered throughout. In 2020, eight surveys were conducted at Conrad Meadows, with surveys beginning on June 3, when two mardon skippers were detected. Surveys continued until July 22, when 34 skippers were detected, indicating that the flight period likely extended beyond this date .



Map 4: Conrad Meadows distance sampling survey site

Results

Throughout the 2020 season, 2,744 skippers were observed in Conrad Meadows. The peak count of 882 butterflies occurred on June 25 (see Table 9). In the sampled occupied habitat, there is an estimated density of 5,644 mardon skippers per hectare (9.14% CV), and a population estimate of 21,733 mardon skippers (9.14% CV, habitat size of 3.85 HA, see Table 10). Note the low % CV for this site.

Table 9: Number of skippers detected by date at Conrad Meadows.

Site	Area (HA)	# Transects	Total Distance of Transects (m)	6/3/2020	6/10/2020	6/18/2020	6/25/2020	7/1/2020	7/8/2020	7/15/2020	7/22/2020	Total Observed*
Conrad Meadows	3.85	6	1,435.39	2	120	587	882	661	322	136	34	2,744

*Note: This includes all skippers detected during distance sampling (not just mardon skippers). It is possible that the same individuals were counted on multiple site visits.

Table 10: Conrad Meadows population estimates in 2020.

		2020			
Site	Estimate	Pop. size	% CV	95% CI	
Conrad Meadows	Density (N/HA)	5,644.00	9.14	4,690.70	6,791.00
	Population (N)	21,733.00	9.14	18,062.00	26,149.00

Discussion

Population estimates of mardon skippers continue to increase at Conrad Meadows (see Appendices A and B). In 2020, population and density estimates were over twice as high as the those recorded in 2019, which, until the current monitoring year, had the largest recorded estimates; this may in part be attributed to most of the flight season being captured during the past two monitoring years. Detection of mardon skippers dropped near 50% less than one meter beyond the transect in 2020. The 2020 detection function overall is irregular, as detections increased beyond 2.5 m from the transect (Figure 10). This is inconsistent with detection functions at this site from years past, which have historically shown a regular pattern. Because there were still mardon skippers flying on the last day of surveys, the annual estimate here should be interpreted as the low end as the length of the flight season is somewhat uncertain.

During the 2020 survey season, penstemon (*Penstemon* sp.), death camas (*Zigadenus* sp.), and common camas (*Camassia quamash*), cinquefoil (*Potentilla* sp.), and dandelion were in bloom on the first monitoring visit. Some of these species continued to flower into July, and were visited by mardon skippers (cinquefoil and penstemon). Other flowering nectar plants included purple asters, which were favored by mardon skippers later in the monitoring season.

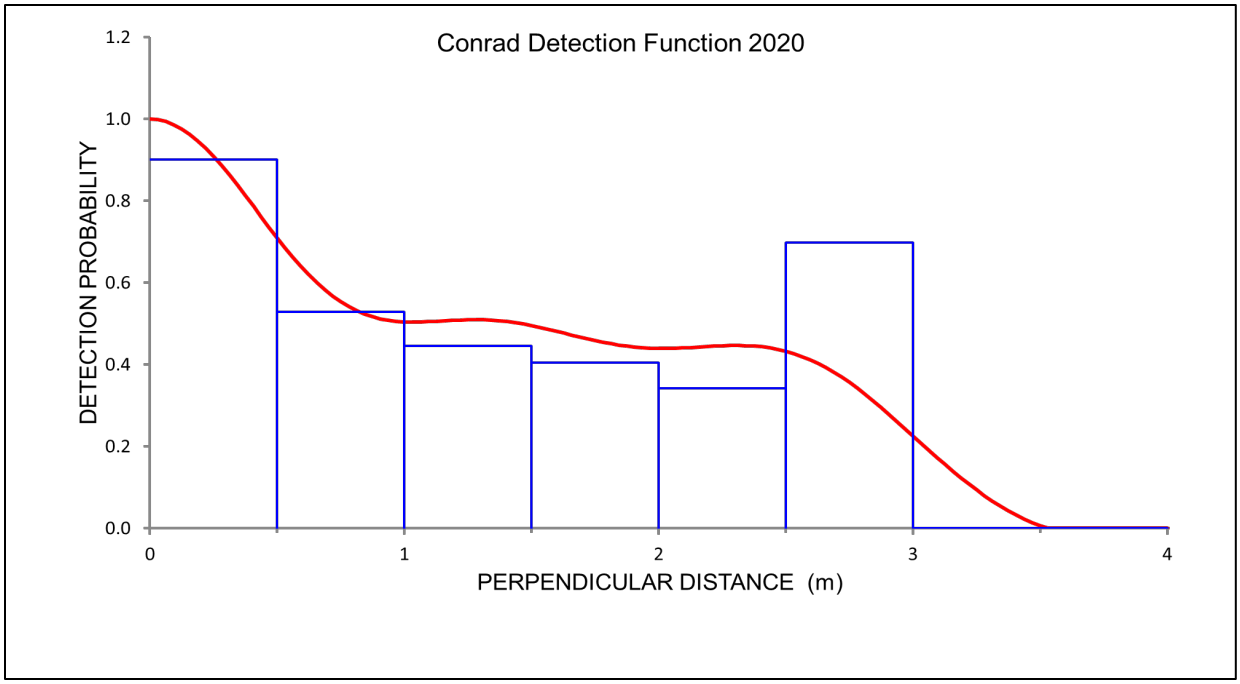


Figure 10: Conrad Meadows detection function

FUTURE SURVEYS & MANAGEMENT

We recommend continuing annual monitoring for a minimum of ten years using distance sampling surveys (ideally with 5-7 visits to each site within the adult flight period) to better understand the size of the population at each site and the distribution within each of the sites. It may take several more years to determine if there are any trends in these population estimates. We recommend that surveyors review the Distance Sampling protocol (Hatfield 2013) each year to review the assumptions of Distance Sampling, and to ensure that future surveys meet those assumptions. We particularly urge surveyors to focus on 100% detection on the survey transect, and to monitor the population throughout the flight period of the butterfly.

It is important to note how quickly detection of the mardon skipper drops off with distance in almost all of the environments surveyed (with the exception of Windy Valley). At some sites, in just over one meter, the probability of detection drops to 50% or less (see detection probability functions in results section for each site). This underscores the importance of using a sampling method that accounts for detectability when sampling for the mardon skipper. It is also notable that each meadow/habitat has vastly different detection functions, and that no two habitats are the same. Whether this is due to habitat differences, differences in butterfly behavior between locations, or observer differences is beyond the scope of this investigation, but worthy of consideration. If the differences are biological in nature (and not due to observer differences/error), they could be indicative of differences in mardon skipper ecology between the contrasting portions of the species' range.

We also recommend continued detection/no-detection surveys as outlined in Hatfield et al. (2013a) in a subset of historically occupied meadows. It has likely been several years since many of those sites have

been visited, and it would be good to reconfirm the species' presence throughout its range. This is particularly relevant as weather and climate patterns changes, which have the potential to affect small populations.

We stress the need to revisit these sentinel sites on an annual basis to assess effects of prior management activities and determine if additional work is needed to manage for the mardon skipper. In previous years, surveyors noted several specific areas of concern, including shrub and aspen encroachment. While sites like Peterson Prairie West have been managed to control encroachment, these sites will likely require ongoing active management to remove new growth. We provide general recommendations for conifer encroachment and invasive species removal in previous reports (see Hatfield et al. 2017), and also stress the need to consult with a butterfly habitat restoration specialist to develop site specific management plans.

ACKNOWLEDGEMENTS

We are grateful for the Interagency Special Status Sensitive Species Program's continued interest in and financial support of this project. Long term monitoring efforts are invaluable for detecting changes in populations and informing management actions at both occupied and potentially occupied sites. For this seventh year of monitoring, distance sampling surveys were conducted by Elizabeth Hooper (Windy Valley, RRS), Norman Barrett (Lily Glen and Howard Prairie), Joan St. Hilaire (Conrad Meadows, OKW), and Michele Blackburn (Peterson Prairie, GIP). At the Peterson Prairie site, we are grateful for additional help from Brian Shepard in setting up the initial transects. We are grateful for document review by Kelli Van Norman on a draft version of this report.

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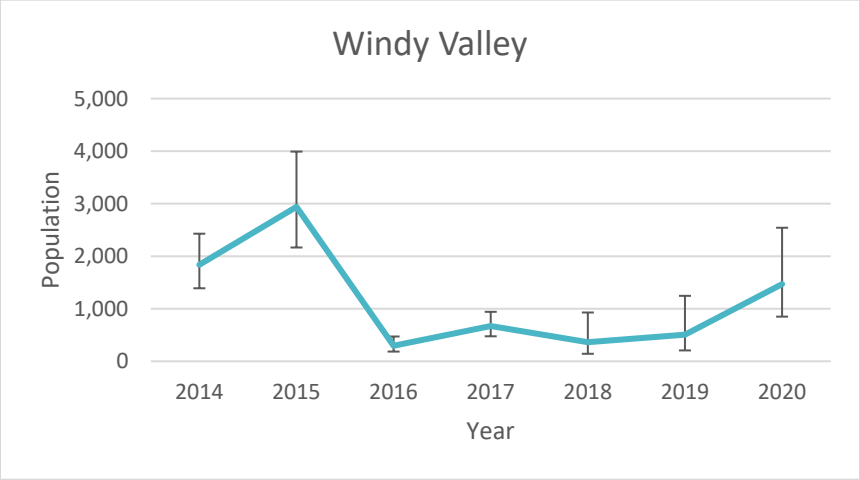
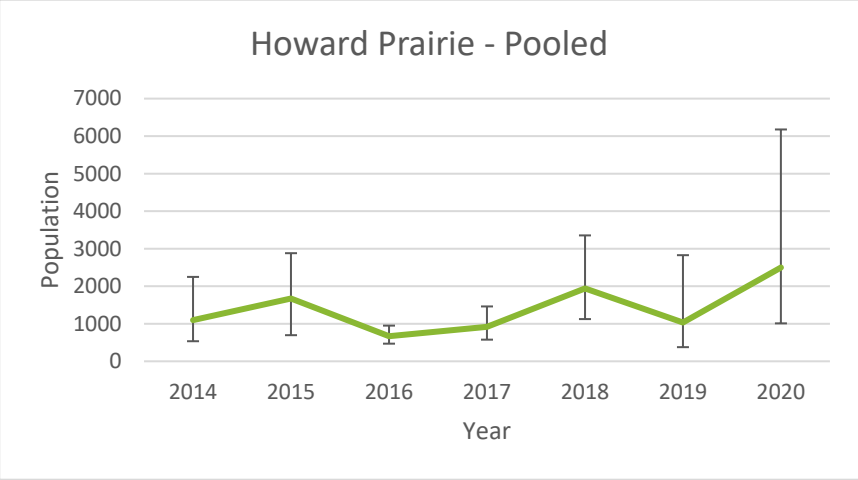
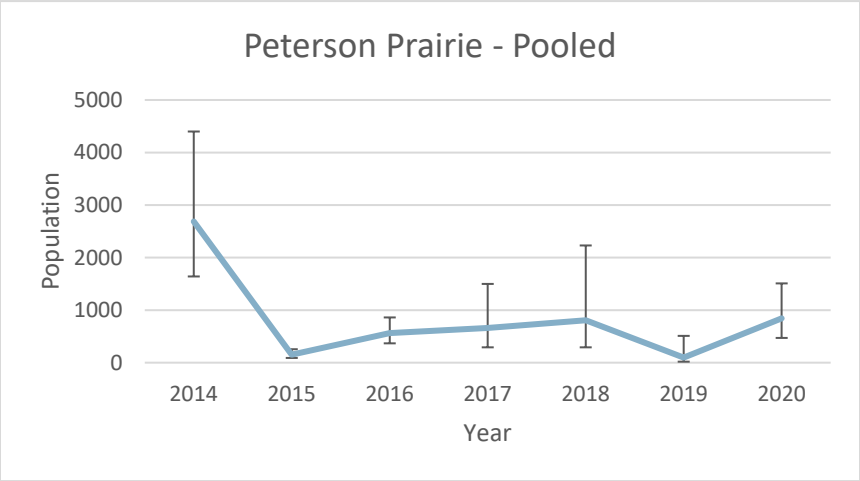
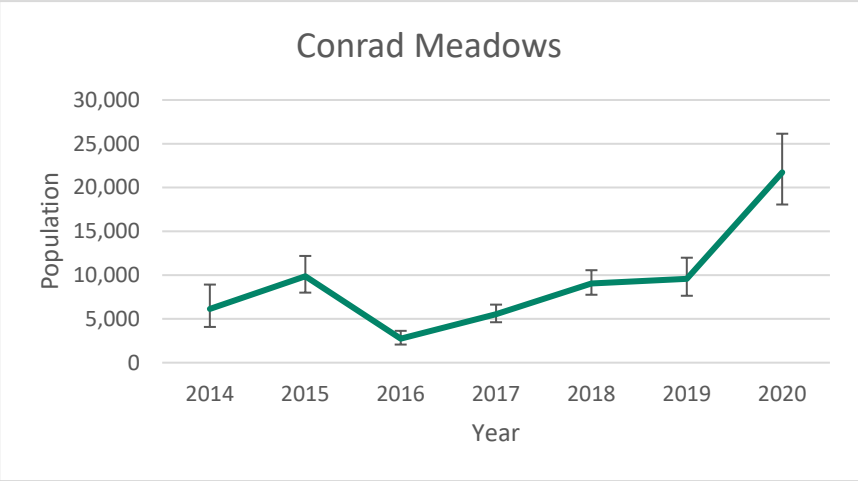
APPENDIX A: POPULATION ESTIMATES FROM 2014 TO 2020

Population estimates for all survey sites from 2014 through 2020. Pooled estimates are shown for Howard Prairie and Peterson Prairie. Note that the pooled estimate for Howard Prairie Complex this year is likely not as representative as in years past. Additionally, it is possible that the same individuals were counted on multiple site visits. Chart error bars represent the 95% CI.









APPENDIX B: POPULATION AND DENSITY ESTIMATES 2014-2020

Population and Density Estimates 2014-2020

Site	Estimate	2014				2015				2016				2017				2018				2019				2020			
		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI		Pop. size	% CV	95% CI	
Windy Valley	Density (N/HA)	2,070.6	14.1	1,566.1	2,070.6	3,314	14.1	2,441	4,499	333.47	22.19	209	532.4	754.8	14.08	536.61	1,061.7	410.45	31.72	160.95	1,046.8	572.52	32.56	233.38	1,404.5	1,656.2	22.84	957.54	2,864.7
	Population (N)	1,837	14.1	1,390	2,429.0	2,940	14.1	2,166	3,992	296	22.19	185	472	670	14.08	476	942	364	31.72	143	929	508	32.56	207	1246	1,470	22.84	850.00	2,542.0
Howard Prairie	Density (N/HA)	137.5	34.7	49.9	137.5	170.65	18.65	106.5	273.4	**147.9**	**431.8**	**4.61**	**4,741**	130.95	26.24	76.39	224.49	258.37	25.71	130.28	512.4	**151.2**	**54.31**	**54.118**	**422.44**	**382.86**	**54.04**	**140.66**	**1,042.1**
	Population (N)	794	34.7	288	794	986	18.65	616	1,580	**855**	**431.8**	**27**	**27,403**	757	26.24	442	1,298	1,493	25.71	753	2,962	**874**	**54.31**	**313**	**2,442**	**2,213**	**54.04**	**813.00**	**6,023.0**
Lily Glen	Density (N/HA)	52.4	28.7	27.2	52.4	**51.87**	**181.3**	**4.2**	**641.2**	35.81	26.61	19.7	66.16	**28**	**40.44**	**11.47**	**68.33**	**51.62**	**58.99**	**13.43**	**198.36**	**18.228**	**74.54**	**4.399**	**75.533**	**32.90**	**54.97**	**10.23**	**105.76**
	Population (N)	443	28.7	230	443	**452**	**181.3**	**37**	**5,585**	312	26.61	171	568	**244**	**40.44**	**100**	**595**	**450**	**58.99**	**117**	**1,728**	**159**	**74.54**	**38**	**658**	**287.00**	**54.97**	**89.00**	**921.00**
Pooled Estimate	Density (N/HA)	189.8	26.4	92.6	389.1	115.35	26.93	66.91	198.9	46.15	17.69	32.5	65.64	158.95	22.76	99.9	252.92	134.09	24.02	77.67	231.51	**71.27**	**53.48**	**26.028**	**195.15**	**172.49**	**48.26**	**69.79**	**426.35**
	Population (N)	1,097	26.4	535	2,249.0	1,671	26.93	696	2,881	669**	17.69	470	951	919	23.43	577	1,462	1,943	24.02	1,125	3,355	**1,033**	**53.48**	**377**	**2,828**	**2,499**	**48.26**	**1,011.0**	**6,178.0**
Peterson Prairie North Meadow	Density (N/HA)	633.5	21.8	367.8	633.5	71.25	30.63	21.66	71.25	124.85	25.74	66.1	236	165.65	31.91	70.63	388.52	**207.35**	**64.52**	**59.69**	**720.24**	**46.362**	**69.46**	**8.845**	**243.01**	196.28	26.50	102.78	374.83
	Population (N)	2,433	21.8	1,412	2,433.0	151	30.63	83	274	479	25.76	254	906	636	31.91	271	1,492	**796**	**64.52**	**229**	**2,766**	**178**	**69.46**	**34**	**933**	754	26.50	395.00	1,439.0
Peterson Prairie West Meadow	Density (N/HA)	121.2	18.3	82.8	121.2	**6.79**	**49.87**	**2.58**	**17.85**	**44.19**	**49.83**	**12.7**	**153.3**	**6.64**	**93.03**	**0.541**	**81.45**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**42.58**	**54.6**	**8.96**	**202.27**
	Population (N)	255	18.3	174	255	**14**	**49.87**	**5**	**37**	**93**	**49.83**	**27**	**322**	**14**	**93.03**	**1**	**171**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**89**	**54.6**	**19**	**425**
Pooled Estimate	Density (N/HA)	452.4	19.8	276.3	740.7	25.53	26.96	15.13	43.08	18.97	20.92	12.4	29	172.29	30.91	76.04	390.37	**135.95**	**54.84**	**49.2**	**375.64**	**46.362**	**69.46**	**8.845**	**243.01**	141.94	24.82	79.29	254.07
	Population (N)	2,687	19.8	1,641	4,400.0	152	26.96	90	256	563	20.92	368	861	662	30.91	292	1,499	**808**	**54.84**	**292**	**2,231**	**97**	**69.46**	**19**	**510**	843	24.82	471.00	1,509.0
Conrad Meadow	Density (N/HA)	1,593.1	15.8	1,060	2,316.7	2,291	10.56	1,858	2,824	712.14	13.76	537	943.9	1,436.9	8.65	1,199.3	1,721.7	2,350.4	7.69	2,014.1	2,742.8	2,485.5	10.47	1,984.5	3,113	5,644	9.14	4,690.7	6,791.0
	Population (N)	6,135	15.8	4,081	8,919.0	9,875	10.56	7,999	12,189	2,742	13.76	2,069	3,635	5,533	8.65	4,618	6,630	9,050	7.69	7,756	10,561	9,571	10.47	7,641	11,987	21,733	9.14	18,062	26,149

Note: Pooled estimates are shown for Howard Prairie and Peterson Prairie. It is possible that the same individuals were counted on multiple site visits. Numbers in **bold** have a high coefficient of variance, with large 95% Confidence Intervals.

APPENDIX C: ENDPOINTS FOR DISTANCE SAMPLING TRANSECTS

Coordinate endpoints for distance sampling transects. Coordinates are NAD 1983, Zone 10. Note that the Howard Prairie endpoints are different from those used in 2014.

Site	Points	UTM E (X)	UTM N (Y)
Windy Valley		**Transect**	**1**
	Start	405329.4	4687206.3
	End	405334.0	4687264.1
		Transect	**2**
	Start	405306.1	4687179.0
	End	405314.6	4687280.0
		Transect	**3**
	Start	405285.1	4687186.2
	End	405253.7	4687284.4
Howard Prairie		**Transect**	**1**
	Start	545512.4	4679411.2
	End	545653.7	4679552.5
		Transect	**2**
	Start	545534.7	4679362.8
	End	545796.2	4679624.3
		Transect	**3**
	Start	545569.7	4679327.1
	End	545778.3	4679535.7
		Transect	**4**
	Start	545604.7	4679291.3
	End	545760.2	4679446.8
Lily Glen		**Transect**	**1a**
	Start	546641.5	4679833.1
	End	546824.6	4680016.3
		Transect	**1b**
	Start	546641.7	4679762.6
	End	546879.8	4680000.8
		Transect	**2a**
	Start	546641.7	4679762.6
	End	546879.8	4680000.8
		Transect	**2b**
	Start	546910.6	4680031.6
	End	547064.7	4680185.8

Site	Points	UTM E (X)	UTM N (Y)
Lily Glen continued		**Transect**	**3**
	Start	546696.1	4679746.3
	End	547178.5	4680228.8
		Transect	**4**
	Start	547057.6	4680037.2
	End	547097.6	4680077.2
		Transect	**5**
	Start	547055.5	4679964.4
	End	547230.5	4680139.4
		Transect	**6**
	Start	547105.0	4679943.1
	End	547213.7	4680051.7
Peterson Prairie North		**Transect**	**1**
	Start	603607.9	5091704.6
	End	603622.5	5091984.8
		Transect	**2**
	Start	603632.6	5091699.4
	End	603647.4	5091982.2
		Transect	**3**
	Start	603657.4	5091694.3
	End	603670.1	5091937.0
		Transect	**4**
	Start	603682.2	5091689.2
	End	603692.7	5091890.4
		Transect	**5**
	Start	603583.1	5091709.7
	End	603597.6	5091987.3
Peterson Prairie West		**Transect**	**1**
	Start	603500.1	5091641.5
	End	603568.3	5091653.6
		Transect	**2**
	Start	603380.4	5091595.0
	End	603588.0	5091631.7

Site	Points	UTM E (X)	UTM N (Y)
Peterson Prairie West continued		**Transect**	**3a**
	Start	603369.6	5091567.8
	End	603455.4	5091582.9
		Transect	**3b**
	Start	603479.7	5091587.2
	End	603587.6	5091606.2
		Transect	**4**
	Start	603368.9	5091542.3
	End	603586.4	5091580.6
Conrad Meadows		**Transect**	**1**
	Start	631231.9	5151253.8
	End	631298.6	5151320.5
		Transect	**2**
	Start	631250.4	5151237.0
	End	631384.0	5151370.5
		Transect	**3**
	Start	631204.0	5151155.2
	End	631422.2	5151373.3
		Transect	**4**
	Start	631197.1	5151112.9
	End	631444.3	5151360.1
		Transect	**5a**
	Start	631210.7	5151091.1
	End	631296.2	5151176.6
		Transect	**5b**
	Start	631343.7	5151224.2
	End	631458.3	5151338.7
		Transect	**6**
	Start	631222.9	5151068.0
	End	631372.2	5151217.2