MARDON SKIPPER (*POLITES MARDON*) DISTANCE SAMPLING SURVEYS AT FOUR SENTINEL SITES IN OREGON AND WASHINGTON: YEAR 2

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

Mardon skipper nectaring on a *Calochortus* lily at Peterson Prairie, WA. Photo by Candace Fallon, the Xerces Society.

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

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SUMMARY

In May and June of 2015 Candace Fallon and Rich Hatfield (Xerces Society) revisited three established mardon skipper monitoring sites to set up sampling transects and provide distance sampling training to Forest Service biologists and biology technicians, BLM biologists, and contractors. These sites included Windy Valley (Rogue River-Siskiyou NF, OR), Howard Prairie Site Complex (Medford BLM, Jackson County Parks, and the Bureau of Reclamation, OR), and Conrad Meadows (Okanogan-Wenatchee NF, WA).

Table 1: Population and density estimates for all survey sites. Estimates from 2014 are provided for comparison.

		2014				2015			
Site	**Estimate**	**Pop. size**	**% CV**	**95% CI**		**Pop. size**	**% CV**	**95% CI**	
Windy Valley	Density (N/HA)	2,070.6	14.07	1,566.1	2,070.6	3,314	14.10	2,441	4,499
	Population (N)	1,837.0	14.07	1,390.0	1,837.0	2,940	14.10	2,166	3,992
Howard Prairie	Density (N/HA)	137.5	34.7	49.9	137.5	170.65	18.65	106.53	273.36
	Population (N)	794.0	34.7	288.0	794.0	986	18.65	616	1,580
Lily Glen	Density (N/HA)	52.4	28.7	27.2	52.4	51.87	***181.3***	4.20	641.18
	Population (N)	443.0	28.7	230.0	443.0	452	***181.3***	37	5,585
Pooled Estimates	Density (N/HA)	189.8	26.4	92.6	389.1	115.35	26.93	66.91	198.85
	Population (N)	1,097.0	26.4	535.0	2,249.0	1,671**	26.93	696	2,881
Peterson Prairie North Meadow	Density (N/HA)	633.5	21.8	367.8	633.5	71.25	30.63	21.66	71.25
	Population (N)	2,433.0	21.8	1,412.0	2,433.0	151	30.63	83	274
Peterson Prairie West Meadow	Density (N/HA)	121.2	18.3	82.8	121.2	6.79	***49.87***	2.58	17.85
	Population (N)	255.0	18.3	174.0	255.0	14	***49.87***	5	37
Pooled Estimate	Density (N/HA)	452.4	19.8	276.3	740.7	25.53	26.96	15.13	43.08
	Population (N)	2,687.0	19.8	1,641.0	4,400.0	152	26.96	90	256
Conrad Meadow	Density (N/HA)	1,593.1	15.84	1,060.0	2,316.7	2,291	10.56	1,858	2,824
	Population (N)	6,135.0	15.84	4,081.0	8,919.0	9,875	10.56	7,999	12,189

**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. See Table 6 for daily adjusted population estimates.

Agency staff or contractors then completed 5-7 distance sampling visits at each of these sites over the course of the adult flight period (May through July). A fourth site, Peterson Prairie (Gifford Pinchot NF, WA), was monitored by Candace Fallon for the entirety of the 2015 flight period. Data from all four sites were provided to Xerces at the end of the season for analysis and reporting. This is the second consecutive year that distance sampling has been conducted at these sites. At all sites except the Peterson Prairie complex, total population numbers were higher in

2015 than in 2014. Peterson Prairie population numbers dropped by an order of magnitude from a pooled high of 2,687 in 2014 to 152 in 2015. Population and density estimates for each site for 2014 and 2015 can be found in Table 1. See the Data Interpretation section for more information about these statistics, and the Site Results and Discussion section for more site-specific details. **Note:** the total number of mardon skipper detections for 2015 was less than 30 butterflies in Peterson Prairie West and Lily Glen – this low number of detections violates the assumptions of Distance Sampling. As such, the population estimates for these meadows are unreliable, and the pooled data should be used for each site.

Map 1: Mardon skipper range map

INTRODUCTION

Mardon skippers are grassland and open meadow obligates endemic to four distinct regions within Washington, Oregon, and California. These small, stout butterflies have tawny-orange and brown hairy bodies and wingspans generally less than an inch wide. They can be differentiated from other grass skippers by their ventral hindwing bands, which are longer than broad and often diffuse yellow to off white (Pyle 2002). They are univoltine and adults are active in late May to early July; they likely live from five days to two weeks (Potter et al. 2002). Females have been observed depositing eggs on multiple graminoid species and larvae feed exclusively on these. Adults are known to use a variety of nectar species, including *Potentilla diversifolia*, *P. gracilis*, *Wyethia augustifolia*, *Dichelostemma capitatum*, *Eriogonum umbellatum*, *Delphinium* spp., *Horkelia fusca*, *Plectritis congesta*, *Vicia* spp., and *Calochortus* spp., among others (Beyer & Black 2007; Kerwin 2011; Barrett 2015, pers. obs.; Fallon 2015, pers. obs.). Flight periods can vary from year to year based on population size and weather conditions, ranging from 10 days to more than a month (Potter et al. 2002).

The historic range of this species has been poorly documented, but it is thought to be in decline (Hatfield et al. 2013a). The mardon skipper is currently known from four major areas (Map 1): (1) southern Puget Sound, (2) the east side of the Cascade Mountains in Washington, (3)

the Cascade Mountains in southern Oregon, and (4) in Del Norte California and the southern coast of Oregon. Although previously listed as a federal candidate species under the Endangered Species Act, it was removed in the fall of 2012 (DOI, FWS 2012). It remains a State Endangered Species in Washington (WNHP 2014), and an OR/WA Bureau of Land Management and U.S. Forest Service Region 6 Sensitive Species (ISSSSP 2015). It has a global rank of G2G3T2T3 (imperiled) and state ranks of S1 in Washington and S2 in Oregon (ORBIC 2013, WNHP 2014).

Additional research on the effects of different management strategies is needed in order to develop long-term management strategies for this species. However, knowing the population estimates for each site is a critical first step. Previous one-day counts do not provide enough detail to detect changes in population size over time (Hatfield et al. 2013a). Distance sampling is a method of surveying that has the ability to provide an accurate population estimate as it incorporates the detectability of the butterfly, thus accounting for those butterflies that were missed in the course of a survey. In the case of a small, low flying butterfly like the mardon skipper, detectability in surveys is quite low (Potter & Olson 2012; Fallon & Hatfield 2013; Fallon & Hatfield 2014); thus incorporating detectability into population estimates is essential.

From May through July of 2015, Xerces staff, agency biologists, and 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 were first surveyed using distance sampling methods in 2014. These sentinel sites were selected for several reasons: (1) they hosted 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); and (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 smaller mardon population sites nearby) and inform population trends for each region. These two years of surveys provide the first robust population estimates of known mardon skipper populations in three of the four major geographical areas from which this species is known. For similar efforts in the southern Puget Sound region, see Potter and Olson (2012). After the 2016 field season, we should have a reasonable estimate of the size of the mardon skipper populations in each of these meadows, but trend information will be difficult to discern without several more years of data. It should also be noted that while these sites may be used as barometers for regional population trends, additional satellite sites with smaller populations should be monitored to determine if these remain extant. It has now been 4-5 years since many of these smaller populations have been surveyed.

METHODS

In 2014, Xerces staff established permanent distance sampling transects at four mardon skipper sites, based on the Mardon Skipper Rangewide Monitoring Protocol (Hatfield et al. 2013a). Some of these were adjusted during the 2014 and 2015 field seasons based on surveyor feedback. Endpoints for each transect were established with the program Distance (Thomas et al. 2010), and located in the field using GPS. Each transect was delineated in the field with pin flags, rebar, or wooden stakes (see Appendix for transect coordinates). Additional pin flags or tall PVC pipes with flags were placed along the transect route to facilitate surveys.

The dry warm weather in the winter and spring of 2015 suggested that the mardon season might be early and mardon skippers were first observed on the Conboy Lake NWR in Washington on May 15, 2015 (Wilson 2015, pers. comm.), approximately two weeks prior to the first detection date in 2014 (which occurred on May 29). This alerted surveyors to an earlier than usual survey period. Surveys subsequently took place at the four sentinel mardon skipper sites from May through July 2015. Each site was visited five to seven times over the course of the field season (see visitation tables for each site in the Site Results and Discussion section below). Surveyors followed the general survey conditions and time of day recommendations provided by Seitz et al. (2007) and modified by Hatfield (2013a):

- Weather conditions and time of day affect the activity and resulting visibility of butterflies. Weather parameters for butterfly surveying have been established by Pollard and Yates and are explained in their book *Monitoring Butterflies for Ecology and Conservation* (1994). Mardon skippers can be encountered outside of these conditions, but the survey would not meet protocol guidelines. Windy and/or cloudy conditions outside of the parameters stated below may occur during a survey. Be prepared to wait out conditions that are too cloudy and/or windy, and resume the survey when they pass.

- Conduct surveys only when ambient air temperature (air temperature in the shade) is greater than 55 degrees F (13 degrees C). Warmer temperatures above 60 degrees F (16 degrees C) are preferable.

- Survey between 1000 and 1600 hours.

- Survey only when sunshine is sufficient to cast a distinct shadow. Do not survey during rainy weather.

- Wind should be on average below 10 miles per hour or at or below Beaufort Scale 3 (leaves and small twigs constantly moving, light flags extended). Local wind conditions can vary considerably depending on habitat and exposure.

Surveyors also followed the sampling protocol for distance sampling mardon skippers in Hatfield et al. (2013a). Upon each visit the surveyor walked the length of each transect and counted the number of mardon skippers encountered, estimating the perpendicular distance to the transect line in ½ meter increments. At the end of the field season, Xerces staff used the program Distance (Thomas et al. 2010) to estimate the butterfly abundance and density of each site.

DATA INTERPRETATION

For each site, we report several statistics. At the most basic level, we report each site's individual one-day skipper count for each day that the meadow was visited. These are somewhat similar to the one-day counts that have taken place in the past. However, the methodology for distance sampling is different than the modified Pollard walks used in the past, and the two counts would be difficult to compare or interpret because of this. Additionally, we report the population estimates reported by the program Distance (Thomas et al. 2010). The statistics include the estimated density (N/ha) and total population (N), as well as the Coefficient of Variation (%CV) and the 95% Confidence Intervals (95% CI). 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 higher %CV, and thus larger 95% CI will be challenging.

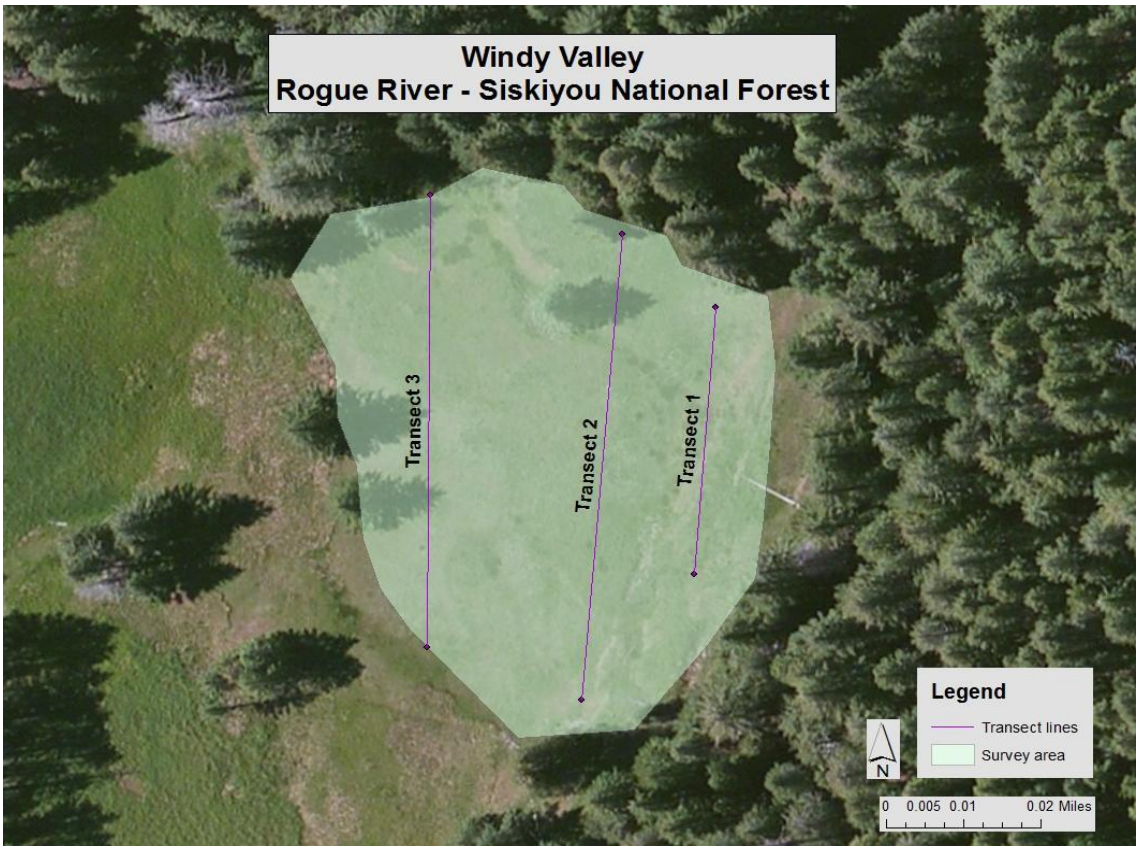
It is important to note that the population estimates reported here are a pooled sum of the individual daily estimates of butterfly abundance. Daily population estimates are not reported here for simplicity, but those data are available from Xerces upon request. The estimates provided are the best estimates of mardon skipper populations to date, and as long as the sampling protocol is followed in future monitoring efforts, the numbers reported here will be comparable 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 NATIONAL FOREST, OR

Figure 1: Windy Valley survey site with surveyors. Photo by Candace Fallon, the Xerces Society.

Windy Valley, in SW Oregon, is a small meadow surrounded by intact coniferous forests as well as remnants of the 2002 Biscuit Fire, which burned adjacent forests but not the meadow itself. The occupied area at this site is comprised of 0.89 hectares of bunch grasses and nectar sources at the northeast edge of a large seasonally wet sedge meadow. This site hosts the largest known mardon skipper population in the coastal Oregon region. Prior to this project's launch in 2014, the highest one-day count at this site was 226 mardon skippers on June 13, 2013. Xerces staff and Forest Service biologists were on site May 13th to place transects (see Map 2) and check for mardon skipper activity. Surveys began May 22 and ran through June 29, 2015 (see Table 2).



Map 2: Windy Valley distance sampling survey site

RESULTS

Throughout the season, 332 skippers were observed at the Windy Valley site. The peak count for 2015 was on June 11, with 89 individuals counted (Table 2). In the sampled occupied habitat, there is an estimated 3,314 mardon skippers per hectare (14.10% CV), with a population estimate of 2,940 mardon skippers within the meadow (14.10% CV, the habitat was 0.887 HA). For 95% Confidence Intervals, see Table 3.

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

Site	Area (HA)	# Transects	Total Distance of Transects (m)	5/22/2015	5/28/2015	6/4/2015	6/11/2015	6/16/2015	6/23/2015	6/29/2015	Total Observed*
Windy Valley	0.887	3	262.33	11	66	87	89	72	7	0	332

*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 2014 and 2015

		2014				2015			
Site	Estimate	Pop. size	% CV	95% CI		Pop. size	% CV	95% CI	
Windy Valley	Density (N/HA)	2,070.6	14.07	1,566.1	2,070.6	3,314	14.10	2,441	4,499
	Population (N)	1,837.0	14.07	1,390.0	1,837.0	2,940	14.10	2,166	3,992

DISCUSSION

In Fallon & Hatfield (2014), we noted that the 2014 estimates for this site (see Table 3) were likely significantly lower than the actual butterfly population in the meadow since the early part of the flight season was missed in the sampling schedule. Based on the daily count numbers (Table 2), it appears the full flight season was captured during the 2015 sampling season, and the 2015 population estimate is higher than that reported in 2014 (2,940 compared to 1,837). Note that skipper detections fall off by half after just one meter beyond the transect (Fig. 2).

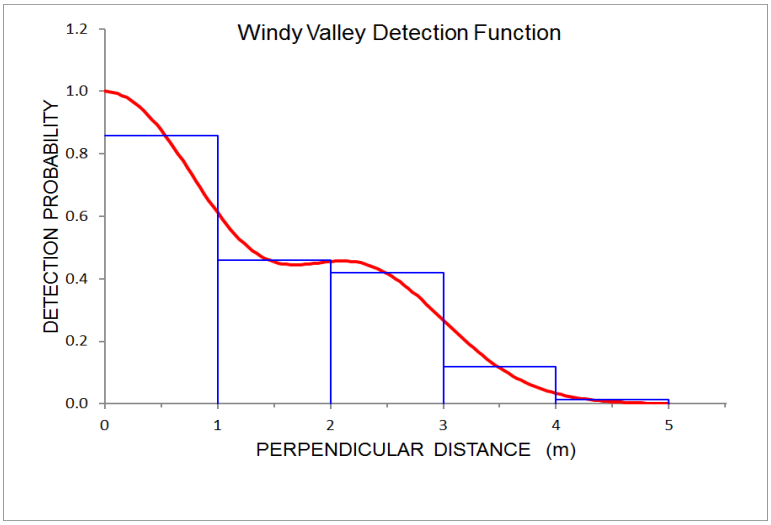


Figure 2: Windy Valley detection function

HOWARD PRAIRIE SITE COMPLEX, OR

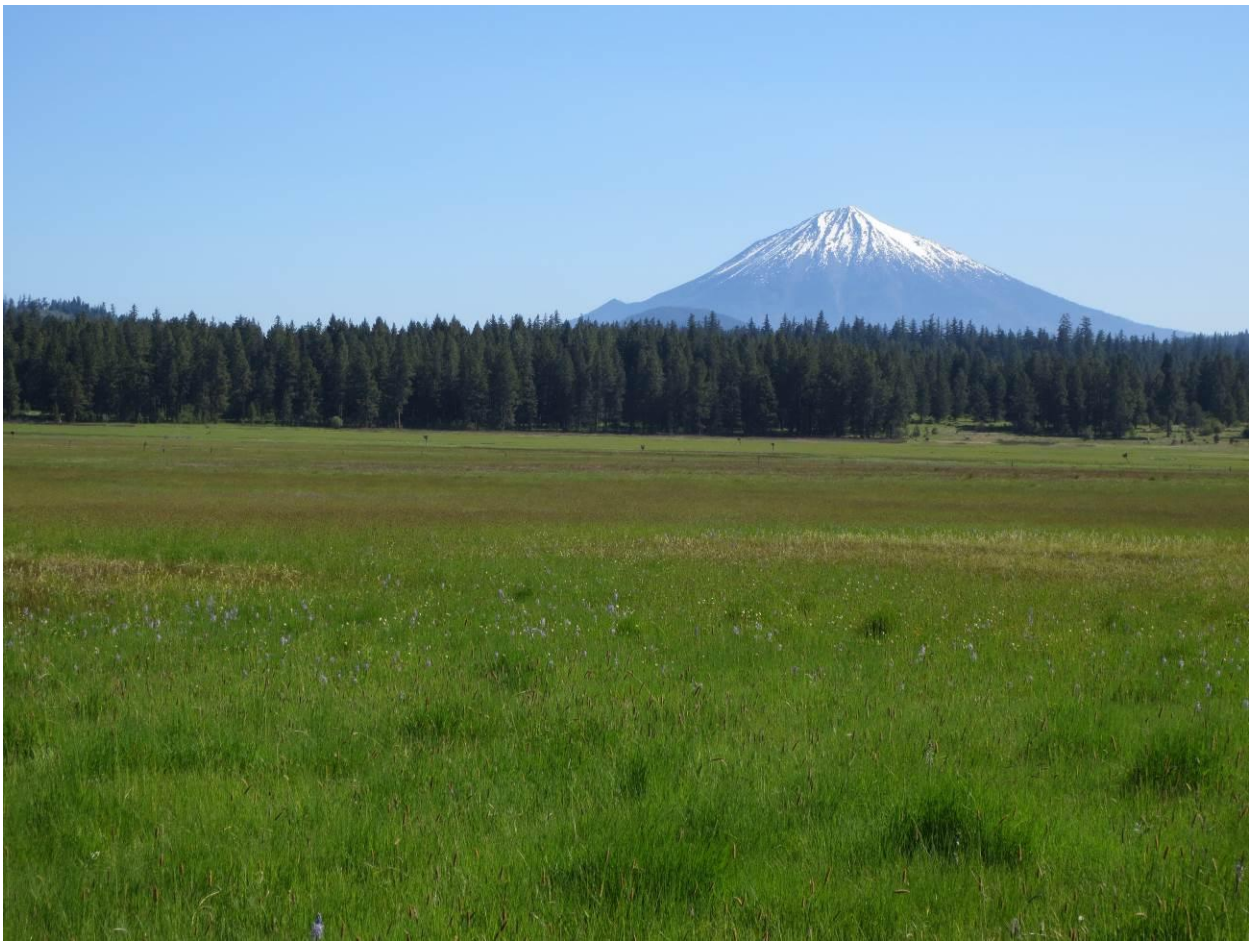
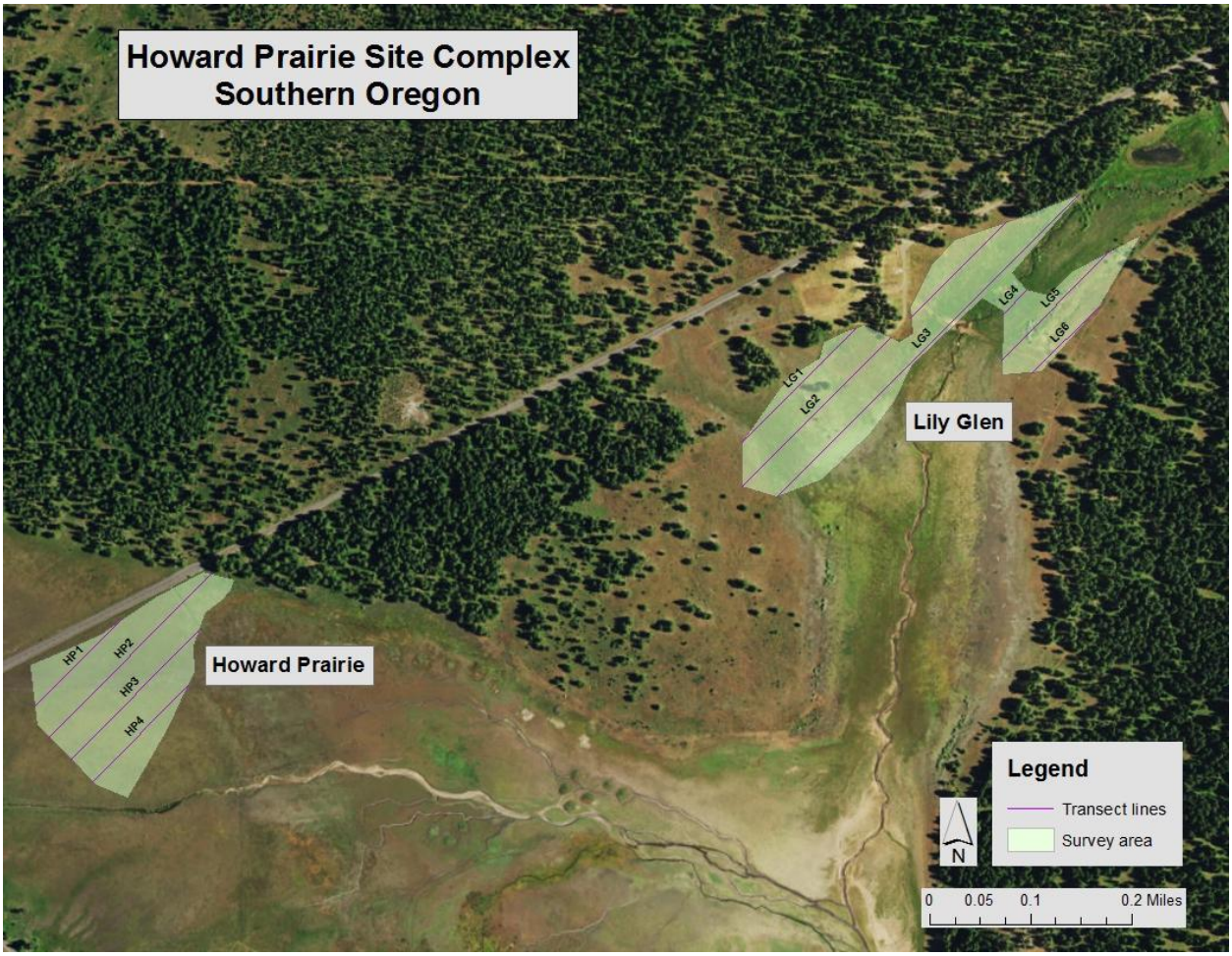


Figure 3: Mt. McLoughlin over the Howard Prairie survey site. Photo by Candace Fallon, the Xerces Society.

The Howard Prairie Site Complex is composed of its namesake prairie and the adjacent Lily Glen Park site. The Lily Glen Park is managed by the Jackson County Parks Department, and the remainder of both sites is managed by the Bureau of Reclamation. The Medford BLM District also manages the grazing allotment on the site. 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 does not appear to provide many sources of nectar during the adult flight period, although there is an abundance of host plants to support mardon skippers. Lily Glen is another large meadow 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 sporadic mardon skippers. Most of the remainder of the meadow is a mix of fescue, forbs, and bare ground.

Xerces monitored mardon skippers for the first time at the complex in 2012, conducting minimum population estimates (one-day counts) on two separate days that were believed to be near the peak of the flight period. These estimates suggested that the population within the complex was quite large, and possibly the largest population in the southern Oregon Cascades. During these one-day counts the peak count at Howard Prairie was 116 and the peak count at Lily Glen was 221.

In 2015, Xerces staff, BLM biologists, and two contractors were on site May 11th to place transects (see Map 3) and check for mardon skipper activity. Weather conditions were not conducive to butterfly activity (it was cold, wet and windy,); no skippers were detected. Surveys were carried out for mardon skippers at Howard Prairie from May 26, 2015 through June 26, 2015 and at the Lily Glen site from May 26 through June 30, 2015 (see Table 4).



Map 3: Howard Prairie Site Complex distance sampling survey sites

RESULTS

Throughout the season, 95 skippers were observed at the Howard Prairie site, and 27 skippers were observed at the Lily Glen site. The peak count for the 2015 season was on 6/8/2015 at the Lily Glen site, and on 6/5/2015 at the Howard Prairie site (See Table 4a). Because less than 100% of the butterflies captured at the end of the sampling period were mardon skippers we adjusted the final population estimates based on those observations (see Table 6). In the sampled occupied habitat, there is a pooled estimate of 189.8 mardon skippers per hectare (26.4% CV), with a population estimate of 1,097 mardon skippers within the meadow (26.4% CV, the habitat was 14.24 HA). For 95% Confidence Intervals, see Table 5. Howard Prairie has a higher density of mardon skippers (170.65/HA) than Lily Glen (51.87/HA). The population estimate for Howard Prairie is 986 mardon skippers (18.65% CV), and Lily Glen is 452 mardon skippers (181.3% CV).

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

Site	Area (HA)	# Transects	Total Distance of Transects (m)	Visit 1 (5/26/2015)	Visit 2 (6/4/2015 – 6/5/2015)	Visit 3 (6/8/2015 – 6/12/2015)	Visit 4 (6/16/2015 – 6/19/2015)	Visit 5 (6/23/2015 – 6/26/2015	Visit 6 (6/30/2015)	Total Observed*
Howard Prairie	5.78	4	1084.5	6	49	29	11	0	N/A	95
Lily Glen	8.71	6	1887.0	3	6	8	6	3	1	27

*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 5: Howard Prairie and Lily Glen population estimates in 2014 and 2015.

		2014				2015			
Site	Estimate	Pop. size	% CV	95% CI		Pop. Size**	% CV	95% CI	
Howard Prairie	Density (N/HA)	137.5	34.7	49.9	137.5	170.65	18.65	106.53	273.36
	Population (N)	794.0	34.7	288.0	794.0	986	18.65	616	1,580
Lily Glen	Density (N/HA)	52.4	28.7	27.2	52.4	51.87	181.3	4.20	641.18
	Population (N)	443.0	28.7	230.0	443.0	452	181.3	37	5,585
Pooled Estimates	Density (N/HA)	189.8	26.4	92.6	389.1	115.35	26.93	66.91	198.85
	Population (N)	1,097.0	26.4	535.0	2,249.0	1,671**	26.93	696	2,881

**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. See Table 6 for daily adjusted population estimates.

Table 6: Howard Prairie and Lily Glen adjusted population estimates based on observed daily mardon skipper percentages

Howard Prairie/Lily Glen	Pooled Daily Estimate	Pooled 95% Confidence Intervals (Unadjusted)		% Mardon (Pooled)	Adjusted Daily Estimate***
Visit: 1	127	48	338	0.33	41.91
Visit: 2	836	336	2078	0.88	735.68
Visit: 3	454	215	958	0.95	431.3
Visit: 4	200	88	456	0.815	163
Visit: 5	36	9	142	1	36
Visit: 6	18	2	137	0	0
Pooled (Sum)	1671	698	4109		1407.89***

***Note: The reported adjusted estimates do not include their associated %CV or 95% CI.

DISCUSSION

Howard Prairie

Population numbers at Howard Prairie were higher in 2015 than 2014 (Table 5). The plant community at this site is relatively short and sparse, so detectability is expected to be higher at this site than at Lily Glen (Figs. 4 and 5). Pooled detection functions for both Howard Prairie and Lily Glen are provided in Fig. 6; note that this combines detection curves for two different surveyors.

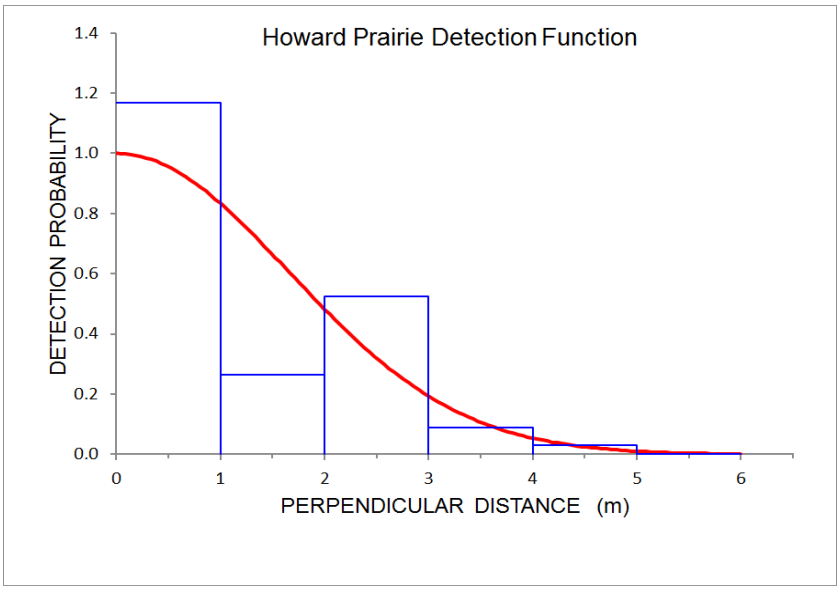


Figure 4: Howard Prairie detection function

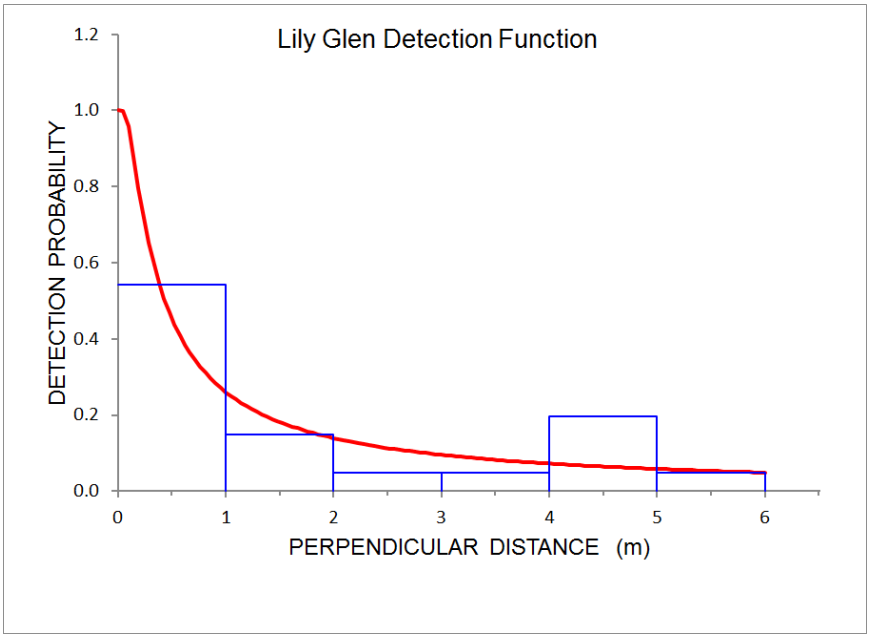


Figure 5: Lily Glen detection function

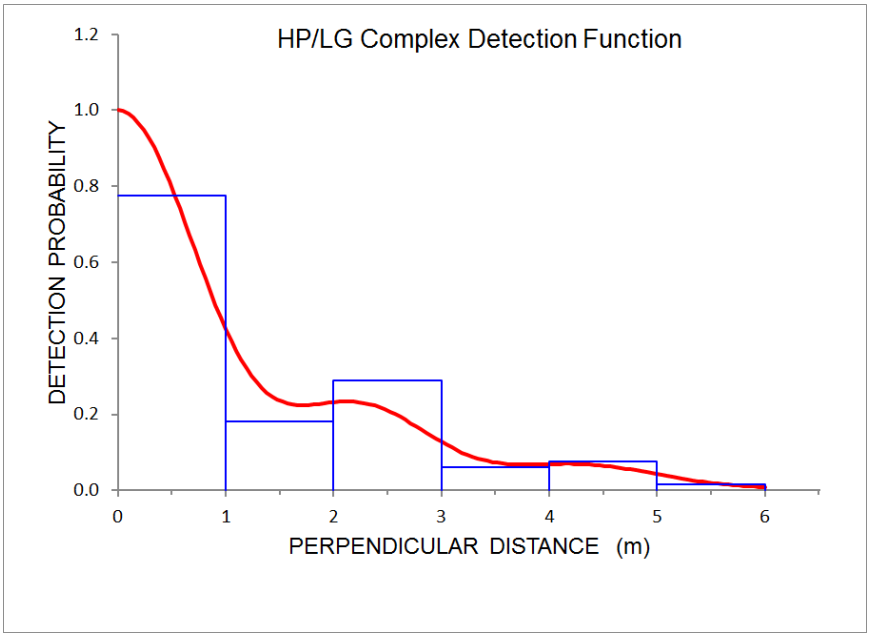


Figure 6: Howard Prairie Complex detection function

Lily Glen

Population estimates are roughly the same for Lily Glen in 2015 as they were in 2014. However, the Coefficient of Variance (% CV) at Lily Glen is incredibly high (181.3%), and would make detections of butterfly population trends difficult. This high % CV may be due to the lower density of butterflies in this habitat, compounded with the length of the transects and the size of the habitat. There were fewer than 30 butterflies detected over the course of the flight period this year, which is really below the necessary number of detections for high quality data. In this case, the pooled data should be considered for future comparisons, and not the data at Lily Glen. The plant community at Lily Glen is of considerably higher stature and is also denser than at Howard Prairie, thus overall detectability is lower at this site (Figs. 4 and 5). It should be emphasized that surveyors need to focus on the transect line while conducting surveys, as one of the assumptions of Distance Sampling is that detectability is 100% at zero, with detections falling off with distance away from the transect. Because the detection probability for Lily Glen is less than 1 at zero (Fig. 5), it does not appear to meet this assumption.

Lily Glen Horse Camp is an active county park popular with equestrians and recreationists and thus presents some unusual challenges for surveying. In 2014 the surveyor found that the use of a measuring pole and net could spook horses, particularly in the horse camps near Transect 1. As a result, we dropped the eastern segment of the transect to avoid this area. No skippers were observed in this dropped portion in 2014, although they had been observed in this segment in relatively high abundances in the past (Hatfield et al. 2013b). Transects 1, 2, and 3 were extended west in 2015 in response to surveyor feedback, and skippers were observed in these newly added sections. Barrett (2015, pers. obs.) continued to find skippers even further west of the newly extended transects, in the area where the high water usually occurs. This area is currently vegetated with flowering forbs and some grass, and skipper presence may be opportunistic during this dry year.

Overall temperatures during the survey season were very warm (often in the 80s and 90s F) and the surveyor noted decreased skipper activity as temperatures climbed throughout each survey session. By June 16, 2015, the site was getting very dry, with thatch crunchy underfoot and the *Plectritis* patch on the eastern end of the meadow drying up (Barrett 2015, pers. obs.). Mardon skipper numbers began declining quickly and remaining skippers were scattered across the landscape. The mudding sites that were present in 2014 were considerably drier this year as well (Barrett 2015, pers. obs.).

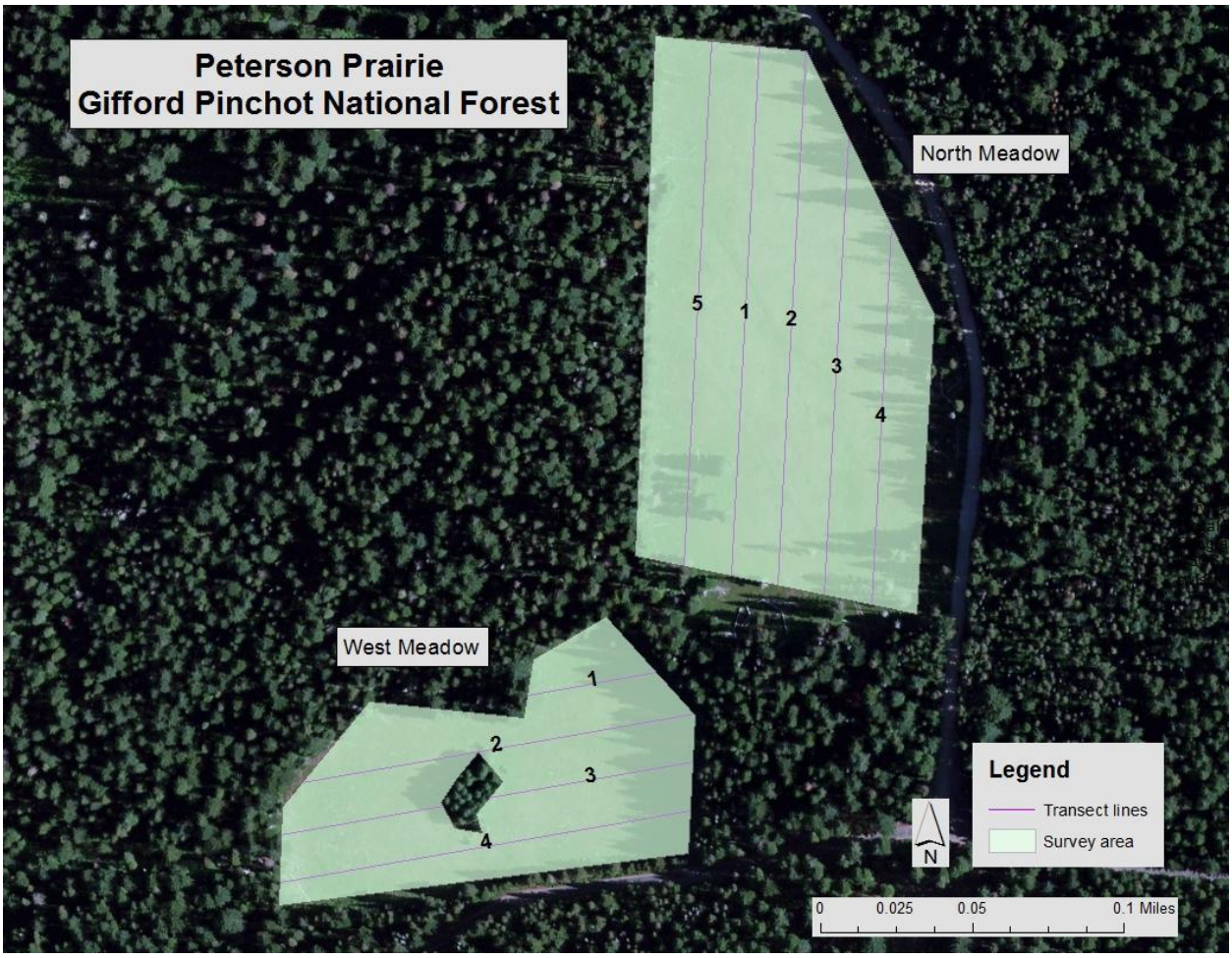
This park has active campsites, several of which are adjacent to the distance sampling transects, posing a potential problem if they are in use during the survey season. This could be especially disruptive if future surveys occur during the July 4th holiday weekend. The last survey date in 2014 was on July 2, and by July 3 the campground was filled with campers, horses and trailers, with additional campers expanding into the meadows. In 2015, the last survey date was on June 30, just shy of the holiday weekend. Unfortunately, this area was still impacted by County Parks personnel mowing the campground on June 16 to reduce fire danger, resulting in a 20 foot portion of Transect 1 getting mowed (Barrett 2015, pers. obs.). This level of park activity (in terms of both recreation and mowing) is of potential concern to the maintenance of high quality mardon skipper habitat within the meadow.

PETERSON PRAIRIE, GIFFORD PINCHOT NATIONAL FOREST, WA

Figure 7: Peterson Prairie North Meadow. Photo by Candace Fallon, the Xerces Society.

Peterson Prairie is comprised of two natural grass and forb meadows, with the North meadow measuring 3.84 hectares, and the West meadow measuring 2.1 hectares (See Map 4). The elevation of the site is approximately 3,000 feet. These are xeric meadows, without a permanent water source, but there is a low swale which 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 highest one-day count for mardon skippers at this site was in 2001 when 180 were counted in the north meadow and 49 in the west meadow (Wainwright 2012). Xerces staff set up transects on May 26, 2015, (see Map 4) and conducted all of the monitoring site visits for the remainder of the adult flight period, which ran from May 26 through June 18, 2015 (see Table 7).



Map 4: Peterson Prairie distance sampling survey sites

RESULTS

Throughout the season, 10 skippers were observed at the West Meadow site, and 121 skippers were observed in the North Meadow. The peak count for the 2015 season for both meadows occurred on 6/4/2015 (See Table 7). In the sampled occupied habitat, there is a pooled estimate of 25.53 mardon skippers per hectare (26.96% CV), with a population estimate of 152 skippers within the two meadows (26.96%CV, the habitat was 5.9 HA). For 95% Confidence Intervals, see Table 8. The north meadow has a higher density of butterflies (71.25/HA than the western meadow (6.79/HA). The population estimate for the northern meadow is 151 butterflies (30.63% CV), and the western meadow has 14 butterflies (49.87% CV). This is significantly lower than the estimates made in 2014 (Table 8). These Coefficients of Variance (% CV) are relatively high, and would make detections of butterfly population trends difficult. These high % CV are likely due to the low density of butterflies in this habitat, particularly in the West Meadow. There were fewer than 30 butterflies detected over the course of the flight period this year in the West Meadow, which is below the necessary number of detections for high quality data. In

this case, the pooled data should be considered for future comparisons, and not the data at the West Meadow alone.

Table 7: Number of skippers detected by site and date at Peterson Prairie.

Site	Area (HA)	# Transects	Total Distance of Transects (m)	5/26/2015	6/4/2015	6/9/2015	6/12/2015	6/18/2015	Total Observed*
West Meadow	2.1	4	697.58	2	6	0	0	2	10
North Meadow	3.84	5	1209.74	20	42	41	17	1	121

*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 8: Peterson Prairie population estimates in 2014 and 2015

		2014				2015			
Site	Estimate	Pop. size	% CV	95% CI		Pop. size	% CV	95% CI	
Peterson Prairie North Meadow	Density (N/HA)	633.5	21.8	367.8	633.5	71.25	30.63	21.66	71.25
	Population (N)	2,433.0	21.8	1,412.0	2,433.0	151	30.63	83	274
Peterson Prairie West Meadow	Density (N/HA)	121.2	18.3	82.8	121.2	6.79	49.87	2.58	17.85
	Population (N)	255.0	18.3	174.0	255.0	14	49.87	5	37
Pooled Estimate	Density (N/HA)	452.4	19.8	276.3	740.7	25.53	26.96	15.13	43.08
	Population (N)	2,687.0	19.8	1,641.0	4,400.0	152	26.96	90	256

DISCUSSION

Population estimates for Peterson Prairie in 2015 were significantly lower than those made in 2014 (see Table 8), even though the entire flight season appears to have been documented with regularly spaced visits that captured peak flight times (Table 7). Site conditions were notably drier in 2015 than in the prior year, with the majority of skippers observed being located in the moister swale in the north meadow and along the northern margin of this meadow, where mariposa lilies (*Calochortus subalpinus*) were blooming in abundance and attracting skippers. Insect populations undergo natural fluctuations from year to year; however, the multiple and likely compounding effects of drought on an already dry site like this could lead to local population declines. Low elevation snowpack throughout the Washington Cascades was less than 50% of the 1981-2010 median last winter (Fig. 8), which may have played a role in this year's lower population estimates.

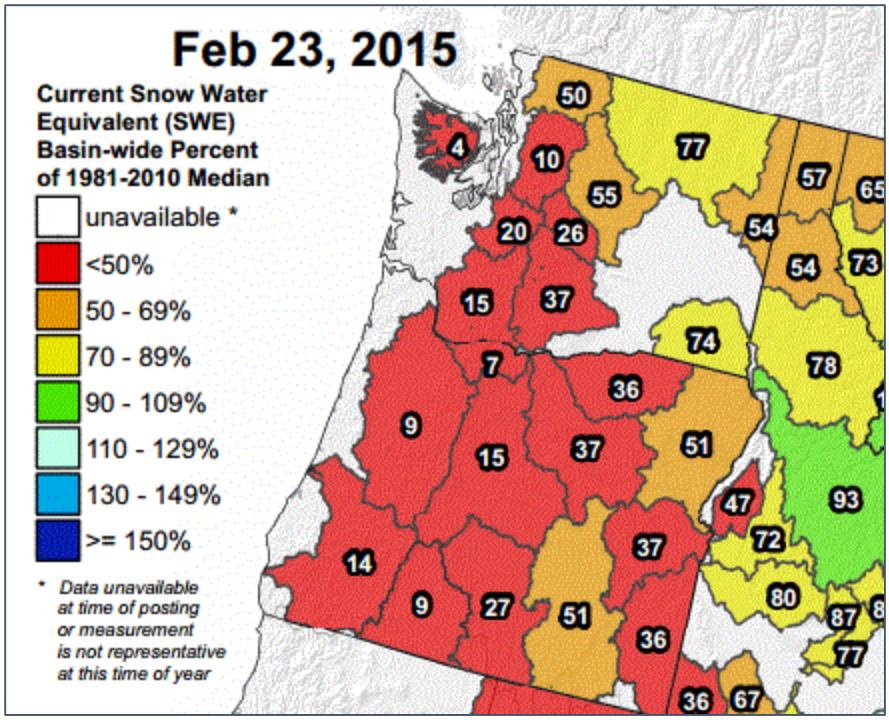


Figure 8: Snow Water Equivalent map depicting snowpack levels as of February 23, 2015 (NRCS 2015)

Peterson Prairie is a very dry site with limited nectar sources during the adult mardon skipper flight season. The most abundant nectar sources in 2015 were dusky horkelia (*Horkelia fusca*) and the aforementioned mariposa lilies (*Calochortus subalpinus*). Other blooming plants found during the survey season included cinquefoil (*Potentilla* sp.), yarrow (*Achillea millifolium*), camas (*Camassia quamash*), purple violets (*Viola* spp.), and spreading phlox (*Phlox diffusa*); however, no nectaring was observed on these species. Other than mardon skippers, the dominant butterflies noted during surveys included common meadow species such as western meadow fritillaries (*Boloria epithore*) and ochre ringlets (*Coenonympha tullia*), as well as pale tiger swallowtails (*Papilio eurymedon*), greenish blues (*Plebejus saepiolus*), northern blues (*Plebejus idas*), Lorquin's admirals (*Limenitis lorquini*), chalcedona checkerspots (*Euphydryas chalcedona*), Callippe fritillaries (*Speyeria callippe*), and a single monarch (*Danaus plexippus*).

Detection of mardon skippers fell to approximately 60% after just one meter from the transect in the north meadow and even more drastically after two meters in the west meadow (Figs. 9 and 10). A pooled detection curve for the two meadows is shown in Fig. 11. It is important to note that there were many more detections in the north meadow (see Tables 7-8), so its detection curve may be a more realistic representation of this species' detection function, at least in this habitat.

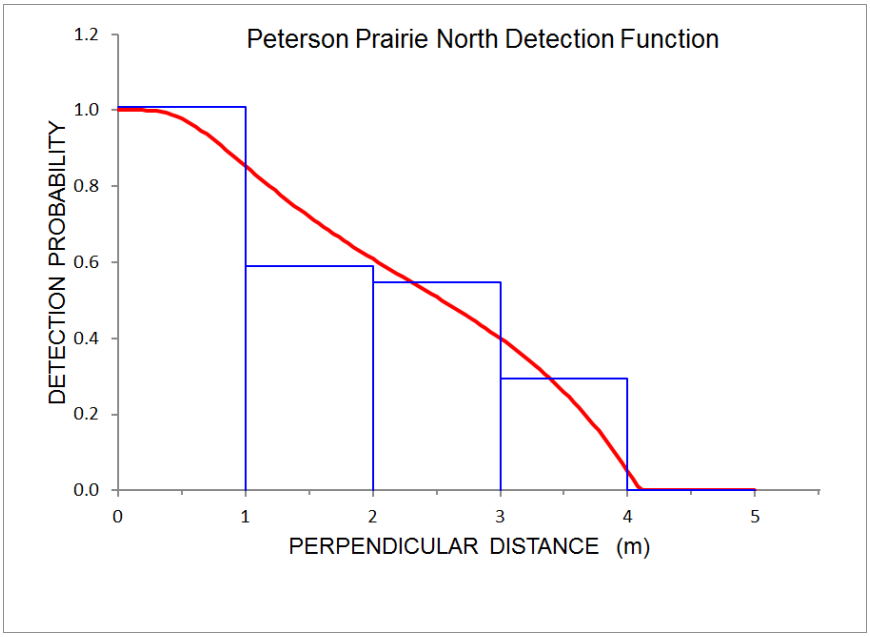


Figure 9: Peterson Prairie North detection function

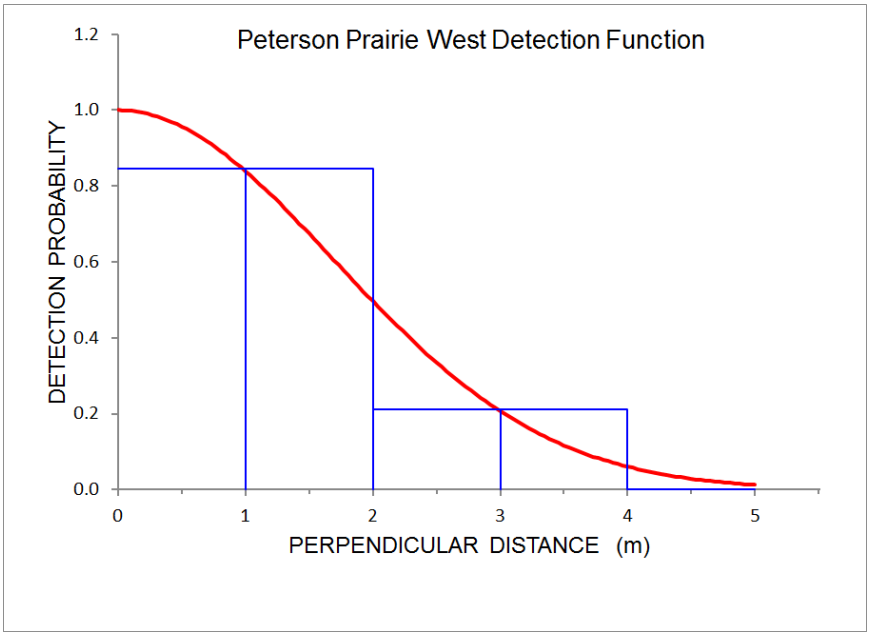


Figure 10: Peterson Prairie West detection function

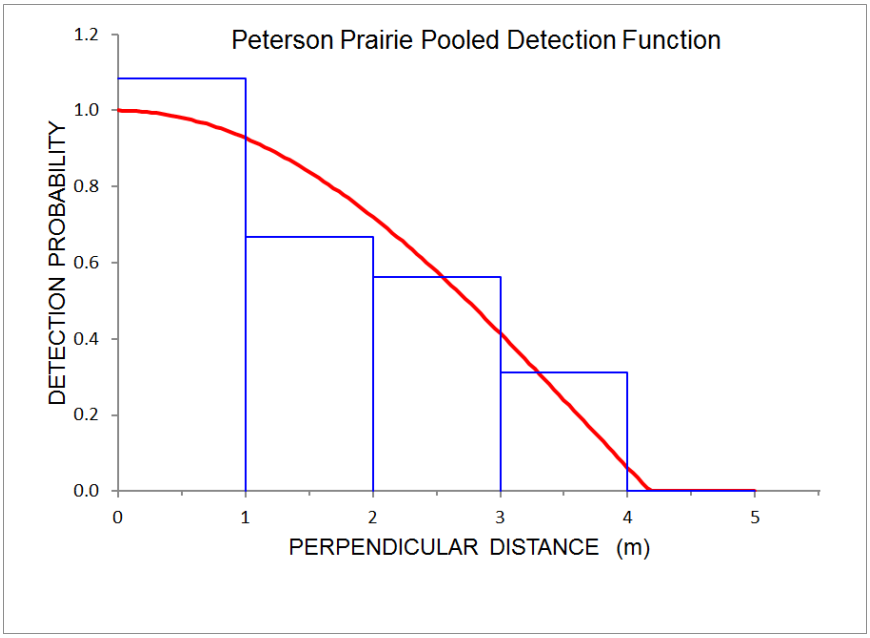


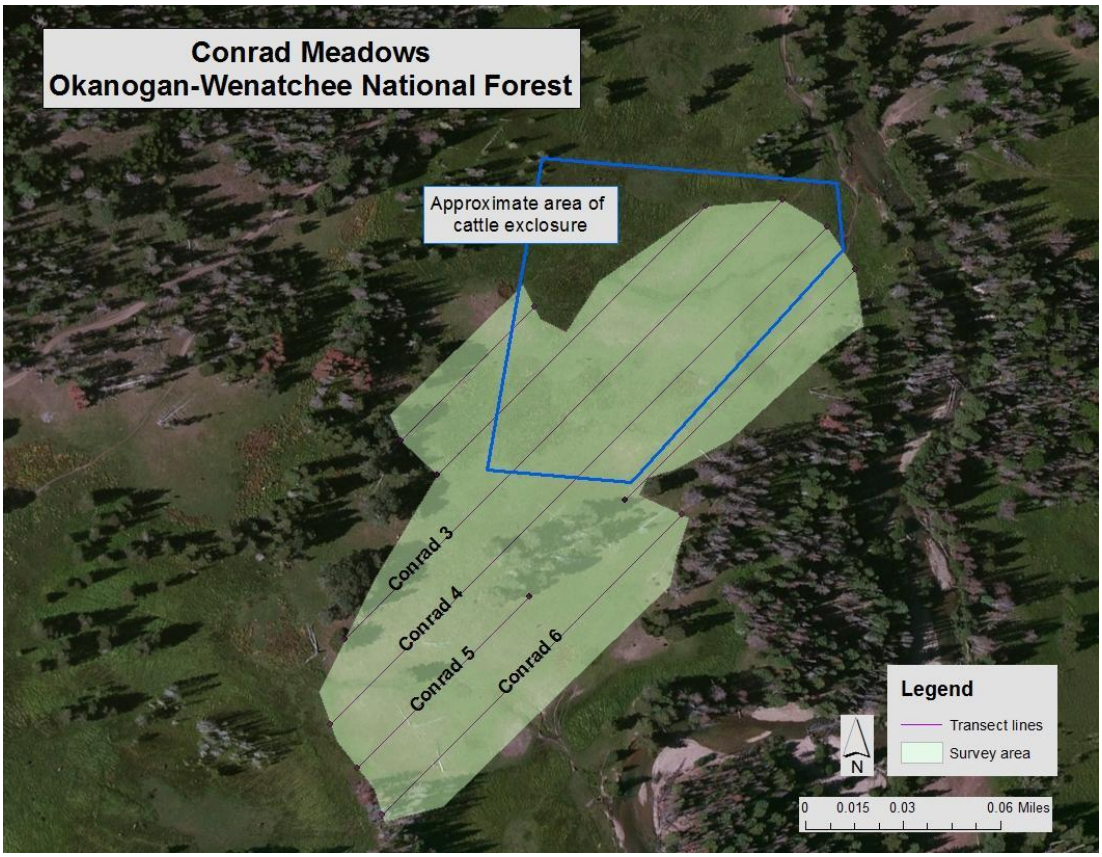
Figure 11: Peterson Prairie Complex detection function

CONRAD MEADOWS, OKANOGAN-WENATCHEE NATIONAL FOREST, WA

Figure 12: Conrad Meadows survey site. Photo by Candace Fallon, the Xerces Society.

The Conrad Meadows site is part of a large complex of grass meadows near the edge of the Goat Rocks Wilderness. Mardon-inhabited areas are dominated by native onespike oatgrass (*Danthonia unispicata*). Various *Poa* and *Carex* spp. are also scattered throughout the meadow. Blooming nectar plants included camas (*Camassia quamash*), slender cinquefoil (*Potentilla gracilis*), elephant's head (*Pedicularis groenlandica*) and delphinium (*Delphinium* sp.) (Fallon 2015, pers. obs., St. Hilaire 2015, pers. obs.) This site has been monitored since 2007 (although no surveys occurred in 2013), with the largest one-day population estimate occurring in 2009 with 931 mardon skippers (St. Hilaire 2012).

On June 8, 2015, Xerces and Forest Service staff reset the permanent distance sampling transects in this meadow using tall PVC pipes and flagging (see Map 5). These tall pipes made seeing the transects much easier for the surveyor, particularly since pin flags cannot be used at this site due to elk activity. Mardon skippers were very active on the transect set-up day, and surveys began soon after transects were established. Similar to the 2014 season, when the first visit was the highest recorded population estimate for the adult flight season, the beginning of the mardon skipper flight season was missed in 2015 (see Table 9).



Map 5: Conrad Meadows distance sampling survey site

RESULTS

Throughout the season, 2,182 skippers were observed in Conrad Meadows. The peak count for the 2015 season occurred on 6/8/2015 (See Table 9). In the sampled occupied habitat, there is a density of 2,291 mardon skippers per hectare (10.56% CV), and a population estimate of 9,875 mardon skippers (10.56% CV). For 95% confidence intervals, see Table 10.

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

Site	Area (HA)	# Transects	Total Distance of Transects (m)	6/8/2015	6/12/2015	6/17/2015	6/23/2015	6/26/2015	6/30/2015	Total Observed*
Conrad Meadows	3.85	6	1435.39	648	520	439	305	205	65	2,182

*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.

		2014				2015			
Site	Estimate	Pop. size	% CV	95% CI		Pop. size	% CV	95% CI	
Conrad Meadows	Density (N/HA)	1,593.1	15.84	1,060.0	2,316.7	2,291	10.56	1,858	2,824
	Population (N)	6,135.0	15.84	4,081.0	8,919.0	9,875	10.56	7,999	12,189

DISCUSSION

It is notable that these estimates are likely significantly lower than the actual butterfly population in the meadow. This is because the early part of the flight season was missed in the sampling schedule, as the first day that butterflies were detected was also the highest population estimate of the 2015 season (see Table 9). This also occurred in 2014. If possible, this site should be monitored more frequently early in the suspected adult flight period to ensure the beginning of the season is captured by distance sampling. It will also be important to note when comparing these surveys to future year's data that the beginning of the flight season was missed in both 2014 and 2015.

In most years, this site is grazed by both wild elk and domestic cattle throughout the adult flight period. However, cattle were not turned out during the survey period in 2015; it is likely they were released on the July 4th weekend, after surveys concluded. Conrad Meadow may be highly productive for mardon skippers due to the high complexity of the meadow (several different plant communities), variety of moisture from dry to wet (even moist areas during drought conditions), variety of grass heights (short to tall), and grazing intensities (from heavy to light) (St. Hilaire 2015, pers. obs.). The skippers appear to use different areas of the meadow as the flight season progresses, a behavior that is likely important for taking advantage of the best available resources.

Other butterfly species present during the first day of distance sampling (June 8, 2015) included Boisduval's blues (*Icaricia icarioides pembina*), greenish blues (*Plebejus saepiolus*), Milbert's tortoiseshells (*Nymphalis milberti*), parnassians (*Parnassius* sp.), western meadow fritillaries (*Boloria ephithore*), ochre ringlets (*Coenonympha tullia*), field crescents (*Phyciodes pulchellus*), checkered skippers (*Pyrgus* sp.), northern cloudywings (*Thorybes pylades*), juba skippers (*Hesperia juba*), and pale tiger swallowtails (*Papilio eurymedon*).

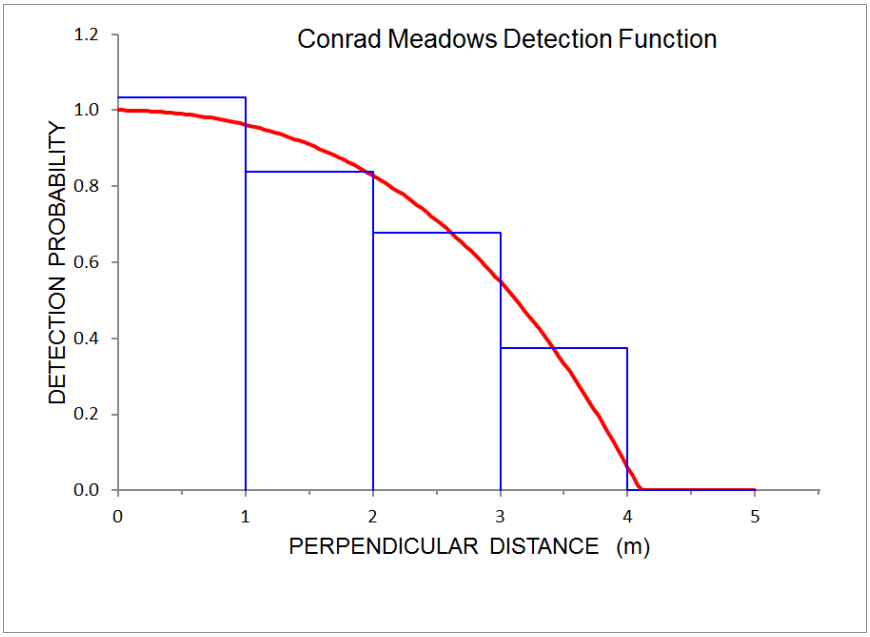


Figure 13: Conrad Meadows detection function

GENERAL RECOMMENDATIONS FOR MONITORING AND MANAGEMENT

FUTURE SURVEYS

We recommend continuing to monitor each of these sites 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. After the 2016 field season, we should have a fairly good idea about the size of the mardon skipper populations in each of these meadows, but it will take several more years to determine if there are any trends in those population estimates.

It is important to note how quickly detection of the mardon skipper drops off in almost all of the environments surveyed. 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 solidifies 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 instituting detection/no-detection surveys as outlined in Hatfield et al. (2013a) in a subset of historically occupied meadows. It has 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 patterns over the last two years have induced extremely early flight seasons, and the area has experienced prolonged drought conditions, which has the potential to affect small populations.

THREATS & GENERAL MANAGEMENT RECOMMENDATIONS

Throughout its range the mardon skipper is threatened by many different factors, including conifer encroachment, invasive grasses and forbs, grazing by domestic livestock, off-road vehicle (ORV) use, prescribed and natural fire, recreation (including camping), applications of Btk, climate change, and issues related to small population size and stochastic events. On a landscape scale, climate change is a longer term threat. Of these threats, conifer encroachment, ORV use in the meadows, grazing by livestock, and recreational use are the primary threats to mardon skipper populations at the meadows covered in this report. Below we discuss these threats and some general recommendations for management.

INVASIVE WEEDS AND CONIFER AND SHRUB ENCROACHMENT

Sites affected: All to some degree, but especially Lily Glen, Howard Prairie, and Peterson Prairie West

Conifer encroachment and invasive grasses and forbs are among the two most pervasive threats to mardon skipper habitat, yet control of these threats is attainable through active and adaptive management. Conifer encroachment and invasive species are threats because they have the ability to alter micro and macro-habitats within the meadow boundaries. Butterfly populations are constrained by temperature (Crozier 2003, 2004) and are restricted to especially warm macro- and microhabitats in temperate climates (Thomas et al. 2001). The small tufts of vegetation and open habitat structure selected by ovipositing females are likely to correspond to the warmest locations in the prairie or meadow (Forsberg 1987). The recent meta-analysis by Thomas et al. (2011) indicates that host plant condition is positively correlated with butterfly population health in the majority of well-studied taxa in temperate regions. Moreover, there is field evidence that populations that occupy high quality larval habitat are more persistent and more likely to serve as a source in a metapopulation (Thomas et al. 2011). Thus, for the mardon skipper, any process that has the potential to alter host plant conditions will also likely negatively affect mardon skipper populations; maintaining open meadow conditions should be a priority for this species.

In 2014, Xerces staff observed several areas at Lily Glen and Peterson Prairie that were in the early stages of conifer or shrub encroachment (see Figure 14). In areas where this is occurring, small trees and problematic shrubs should be removed as soon as possible, before they grow larger and reproduce. A plan should be developed that removes trees using methods that incorporate sensitivity to the butterflies' life history. We provide general recommendations for conifer encroachment and invasive species removal below, but also stress the need to consult with a butterfly habitat restoration specialist to develop site specific management plans.

Figure 14: Example of tree and shrub encroachment in mardon skipper meadow at Lily Glen, OR. Photo by Candace Fallon, the Xerces Society.

Ideally, a conifer removal plan would include the following:

- Remove all small trees under 4 inches Diameter at Breast Height (DBH) from the open meadow area of the site.
- Wherever possible, cut by hand with chainsaws or handsaws.
- Remove all downed wood and branches from the meadow area.
- Take care to avoid actions that could degrade habitat and kill individual skippers as a result of heavy equipment use, people trampling meadows, scattering or piling of trees or branches in meadows, or burning of piles in or adjacent to the occupied area of the site.
- Maintain a buffer of large trees at the edges of meadow since they may play an important role in maintaining the microclimate and hydrology of the local habitat. If thinning is needed for fuels and/or ecosystem needs only remove small diameter trees. If additional tree removal is needed consult with someone familiar with the effects of habitat restoration, mardon skipper biology, and their distribution within the meadow.

Used indiscriminately, herbicides can reduce the quality of habitat by removing floral resources and host plants, and may be directly toxic to some pollinators. However, herbicides are a cost-effective vegetation management tool and are the only tools available to control some noxious weeds. Judicious herbicide use can suppress

undesired vegetation while maintaining diverse habitat. We stress the need to consult with a butterfly habitat restoration specialist to develop site specific management plans that are specific to the life history requirements of the mardon skipper. Ideally, if herbicides are used:

- Use the most targeted active ingredient and formulation possible, applying during the life stages when weeds are most vulnerable.
- Conduct spot treatment of individual invasive or noxious weeds or woody plants with a backpack sprayer, weed wiper, or similar appropriate technology.
- If possible, apply herbicide treatments in fall when mardon skippers are not active.

RECREATION

Sites affected: All (to varying degrees)

Recreation in the form of camping, hiking, horseback riding, or off road vehicle (ORV) use can potentially harm mardon skippers and their habitat. These activities can directly affect mardon skippers by crushing eggs, larvae, pupae, or adults. In addition, the quality of mardon skipper habitat may be impacted by soil disturbance, introduction of non-native invasive weeds, and damage to nectar and host plant resources. The primary recreation uses at these four sites are camping, hiking, and horseback riding.

Windy Valley is subjected to the least recreational pressure due to being more difficult to access (the meadow is reached by hiking a 1.5 mile trail), although a small campsite is available adjacent to the meadow.

Peterson Prairie is easily accessible off a Forest Service road and there is evidence of off road vehicle (ORV) use in the larger north meadow (surveyors found vehicle parts and a piece of a helmet in the meadow).

Conrad Meadows is accessible via a gated and locked private road or a hiking and equestrian trail. As the trail through the meadow is an access point for the Goat Rocks Wilderness, horses and riders frequently ride across the mardon skipper occupied habitat.

Howard Prairie and Lily Glen are both accessible via good paved roads, although Howard Prairie appears to get fewer visitations. Lily Glen provides camping and recreation opportunities and functions as a County Park. This site probably gets the most recreation use out of all the mardon skipper sites covered in this report. Specific recommendations for Lily Glen include the following (note that all of these recommendations were also provided in the site-specific management plan developed in 2013. For more detailed recommendations, see Hatfield et al. [2013b]):

- Do not allow camping in the mardon skipper occupied areas
- Install a hard crossing in the creek bottom for horses to stabilize stream channel and install a sign to direct horse traffic to one crossing (see horse damage along creek margins, Fig. 15)
- Repair the pedestrian bridge and install a sign to direct pedestrians to the bridge (see Fig. 15)
- Ensure that only Certified Weed Free Hay is used on site.

Figure 15: Areas needing management attention, Lily Glen, OR. Photos by Candace Fallon, the Xerces Society.

LIVESTOCK GRAZING

Sites affected: Lily Glen, Howard Prairie, and Conrad Meadows

Livestock grazing may cause adverse impacts to butterfly populations by trampling all butterfly life stages, removing larval and adult food sources, and disturbing the soil and allowing weeds to invade (Warren 1993). Tall-grass and mixed-grass prairies appear to be very susceptible to the effects of overgrazing (McCabe and Post 1997, Royer and Marrone 1992, Royer and Royer 1998, cited in COSEWIC 2003), which can reduce or eliminate critical adult nectar sources and larval host plants. In a study on the Dakota skipper (*Hesperia dacotae*), Dana (1997) found that grazing cattle reduced skipper numbers in direct proportion to grazing intensity. However, grazing is not always detrimental; some light or rotational grazing created mixed grass vegetation structure that was actually preferred by the Dakota skipper (Dana 1991). In the absence of fire, and other natural disturbances, cattle grazing may play a role in maintaining the disturbance necessary to maintain open meadow habitats essential for mardon skippers. However, if the disturbance from grazing is too intense, it can have detrimental effects on butterflies and other plant and animal populations (Bilotta et al. 2007; Hatfield & LeBuhn 2007; Wallis De Vries et al. 2007; Dumont et al. 2009; Kimoto 2011).

The Lily Glen, Howard Prairie, and Conrad Meadow mardon skipper sites all occur within active grazing allotments, which are grazed at different times of year at different densities. Lily Glen and Howard Prairie are usually grazed in October and November, after the adult flight period has ended (Hatfield et al. 2013b). At Conrad Meadows, cattle are often present during the adult flight period in July but are excluded from part of the mardon skipper occupied habitat by a temporary fence (St. Hilaire 2014, pers. comm.). Further investigation into the effects of livestock grazing on mardon skipper populations is recommended at each of these sites. This should include site-specific research to determine the most appropriate combination of timing, intensity, and duration. Below we provide

some general recommendations for livestock grazing; for more detailed recommendations and management plans for these sites, see St. Hilaire (2012) and Hatfield et al. (2013b).

General recommendations:

- At the most severely impacted sites cattle should be excluded from the area to allow the habitat time to recover.
- Grazing should never be allowed during the flight period of the adult mardon skipper.
- Optimally, cattle should not be allowed to enter a site when mardon skipper larvae are active, although more research is needed to determine the impact of cattle on mardon skipper larvae at various times of the year.
- Use low stocking rates.
- Keep grazing periods short, with recovery periods for the habitat relatively long.

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APPENDIX: ENDPOINTS FOR DISTANCE SAMPLING TRANSECTS

Coordinates are NAD 1983, Zone 10. Note that the Howard Prairie endpoints are different than 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