

IDENTIFYING RARE MONTANE MEADOW PARNASSIAN BUTTERFLY POPULATIONS ACROSS GRAND TETON NATIONAL PARK, WYOMING

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♦ ABSTRACT

The pristine, protected ecosystem of Grand Teton National Park (GRTE) is the ideal location to study the relationships between butterfly populations and the habitats on which these insects depend. Two montane meadow butterfly species, *Parnassius clodius* and *Parnassius smintheus*, were investigated in this study to identify patterns of habitat occupancy relating to variables across GRTE and into the surrounding territory of Bridger-Teton National Forest (BTNF). Population dynamics of *P. clodius* have been intensively studied by our research group over several consecutive years in one isolated population in Grand Teton National Park. However, little has been investigated regarding the Parnassian butterflies' population range across the GRTE ecosystem. For this study, presence-absence butterfly surveys were conducted across 45 meadow sites in preferred habitat during the *Parnassius* flight season (June – July 2013). We found that *P. clodius* occupied 80% of the meadows surveyed, which was far greater than was originally predicted. *P. smintheus*, the more rare Parnassian butterfly in the GRTE ecosystem, was only found at 9% of the meadows surveyed. Understanding population ranges and habitat limits of these butterfly populations will be useful for managers and scientists within GRTE, and will assist conservation efforts for other related Parnassian species that are threatened or endangered worldwide due to habitat loss and climate change.

♦ INTRODUCTION

The Clodius Parnassian (*Parnassius clodius*) and Rocky Mountain Parnassian (*Parnassius smintheus*) are two range-restricted high-elevation montane meadow butterfly species whose survival is highly dependent upon their surrounding environment. Montane meadow butterflies are sensitive to synchrony in plant-insect interactions relating to spring emergence timing, constrained to potentially shrinking habitats caused by tree encroachment (Roland et al. 2002, Roland and Matter 2007), and vulnerable to genetic isolation due to their small, isolated populations (Dirnbock et al. 2011). These two Parnassian species currently exist in several locations across Grand Teton National Park (GRTE) and the surrounding ecosystem. However, the related European Apollo Butterfly (*Parnassius apollo*) has been declining since the turn of the century due to long-term climatic changes, habitat succession, anthropogenic factors, and intrapopulation factors that include genetic erosion and behavioral changes in small demes (Nakonieczny et al. 2007).

Although *P. clodius* and *P. smintheus* are not currently threatened species, recent population fluctuations determined by mark-recapture studies performed by the Debinski lab from 1998 – 2000 (Auckland et al. 2004) and from 2009 – 2012 (Sherwood and Debinski, unpublished data) on one population of *P. clodius* in GRTE indicate the need for additional monitoring. Mark-recapture studies were conducted on what is considered to be one of the largest populations of *P. clodius* in GRTE along Pilgrim Creek Road (Auckland et al. 2004) to assess population parameters including sex ratio, population

size, percentage of mated females, and emergence dates for males and females. However, there is limited information about the general population range of this butterfly genus across GRTE and it would be valuable to know how the Pilgrim Creek population compares to other populations within the ecosystem.

To determine where current populations of Parnassian exist in the park and surrounding ecosystem, presence-absence butterfly surveys were conducted for this study in potentially suitable habitat for *P. clodius* and *P. smintheus* in meadows across GRTE and into Bridger-Teton National Forest (BTNF) territory. In addition, potentially suitable habitats of *P. clodius* and *P. smintheus* were analyzed in the GRTE and BTNF study sites by collecting vegetation and nectar data to identify habitat requirements for these rare species. The results of this research will allow us to 1) estimate the current distribution patterns for each of the two species, 2) determine the fine-scale differences in habitat requirements between the species, and 3) develop a more rigorous model of habitat suitability for each species.

♦ METHODS

Study area

The butterfly and plant communities of GRTE, located within the large-scale protected ecosystem of the Greater Yellowstone Ecosystem (GYE), have been studied intensely by our lab over the last two decades. From 1997 to 2007, Debinski and colleagues collected long-term data on plant and butterfly distributions across 55 montane meadows in GYE along a hydrological gradient ranging from hydric to xeric meadows (Debinski et al. 2006, Debinski et al. 2010, Debinski et al. 2013). Parnassian butterflies' habitat preferences as determined by the long-term plant and butterfly surveys (Debinski et al. 2006, Debinski et al. 2010, Debinski et al. 2013), along with GIS vegetation data layers provided by the 2002-2005 Grand Teton National Park Vegetation Mapping Project (Cogan et al. 2005) were used to locate potentially suitable Parnassian habitat in the GYE ecosystem. GRTE includes a wide variety of habitat types encompassing both hydrological and elevation gradients. Based on the butterflies' known habitat preferences, meadow sites for this study were restricted to montane mesic forb herbaceous vegetation, montane xeric forb herbaceous vegetation, and meadows with low sagebrush (*Artemisia arbuscula*) or tall sagebrush (*Artemisia tridentata*) vegetation cover.

Field surveys

Presence-absence butterfly surveys were performed for *P. clodius* and *P. smintheus* across 45 meadow sites of the butterflies' preferred habitat requirements in GRTE and BTNF in the summer of 2013. To account for imperfect detection, presence-absence surveys were conducted twice at each site throughout the butterflies' flight season (MacKenzie et al. 2002) with two independent observers searching for the butterflies for 30 minutes (MacKenzie et al. 2006) for a total of four surveys per site. If the butterfly species occupied the meadow in at least one out of the four butterfly surveys, then the butterfly was considered present at that meadow site. Butterfly surveys were only performed during optimal butterfly survey conditions (mid-June to mid-July at times between 10:00 and 17:00 hours when the temperature was above 21°C and wind was <16km/h).

♦ RESULTS

As seen in Appendix 1, *P. clodius* was present at 36 out of the 45 meadow sites surveyed and *P. smintheus* was located at three out of the 45 meadow sites surveyed. The two Parnassian species only occupied the same meadow site once throughout the study and six of the study sites were unoccupied by both species. Of the sites surveyed for this study, *P. clodius* was found across a wide range of elevations from 2,006 meters to 2,503 meters and *P. smintheus* occurred at a more restricted range of 2,043 meters to 2,099 meters. Figure 1 shows a map of the study area of GRTE and BTNF displaying the population range of the more common Parnassian butterfly across the GYE ecosystem, *P. clodius*.

♦ DISCUSSION

This research indicates that *P. smintheus* is considered to be the more rare Parnassian species in GRTE, however this trend does not hold true across their habitat range in the entire GYE ecosystem. Based on previous butterfly and bird surveys conducted by the Debinski Lab, *P. smintheus* was more abundant in the northern region of the GYE ecosystem in Gallatin National Forest (Debinski et al. 1999, Debinski et al. 2006, Debinski et al. 2010). Of the meadow sites with preferred Parnassian habitat requirements, *P. clodius* occupied a surprisingly high percentage of the meadows, far exceeding our prior predictions of their population range in GRTE. While it is encouraging in the context of long-term viability that *P. clodius* was found at more sites than was

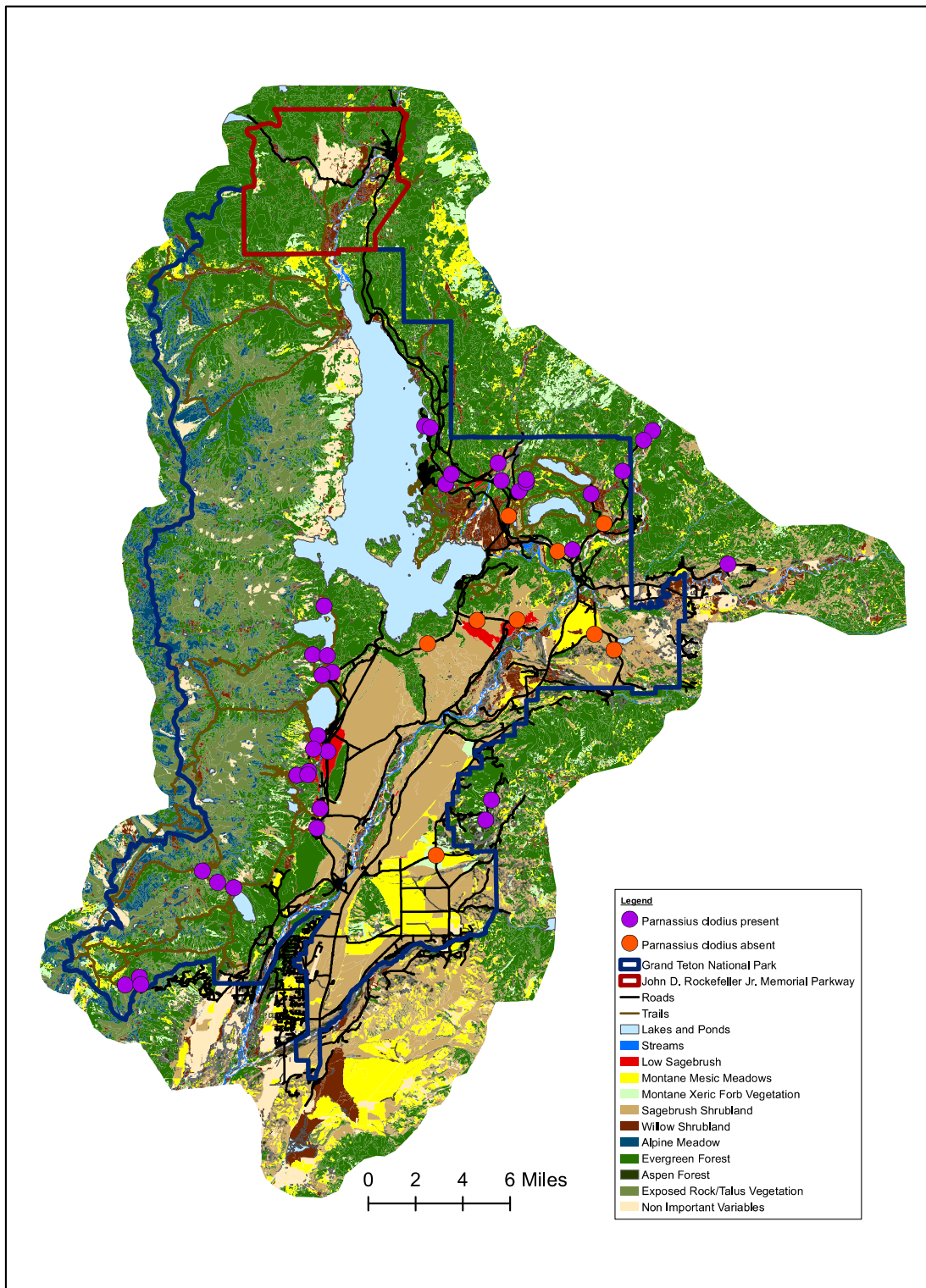


Figure 1. Vegetation map of Grand Teton National Park displaying occupancy of *Parnassius clodius* butterfly in meadow study sites surveyed from mid June – mid July 2013.

originally predicted, it is important to also consider the total number of butterflies recorded at each study site summed across the four surveys. The majority of meadows occupied by *P. clodius* had an overall low abundance: 22 out of the 36 meadows contained less than 8 individuals. The remaining 13 sites had higher abundance, ranging from 14 to 35 total individuals recorded throughout the study. Additional mark-recaptured studies would need to be performed at these sites to obtain a better estimate of the population sizes before any conclusions could be made on the status of these populations.

Occupancy modeling analysis in program PRESENCE (Hines and MacKenzie 2006) is currently being conducted using these butterfly presence-absence data to estimate detection probabilities (p) and the probability of a site being occupied (ψ) for both species across all of the meadow sites. Additionally, vegetation data for each meadow site were collected and vegetation analysis is underway to determine what habitat variables influence the occupancy of these montane butterflies.

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Appendix 1: UTM (Universal Transverse Mercator) coordinates of the Grand Teton National Park and Bridger–Teton National Forest study sites (UTM NAD 1983 Zone 12N) with presence-absence data of butterflies *Parnassius clodius* and *Parnassius smintheus* for each meadow site collected from mid June – mid July 2013.

Meadow Site	UTM Northing	UTM Easting	Parnassian Presence-Absence
Aimee's Meadow	533942	4861337	<i>P. clodius</i> present
AMK Ranch	528713	4865045	<i>P. clodius</i> present
AMK Road	529077	4864934	<i>P. clodius</i> present
Antelope Flats	529470	4835784	Both species absent
Bearpaw Lake Intersection	521838	4852775	<i>P. clodius</i> present
Bearpaw Lake Trail	522079	4849388	<i>P. clodius</i> present
Buffalo Fork	549358	4855639	<i>P. clodius</i> present
Christian Pond	534432	4858912	Both species absent
Climbers Ranch	521577	4838973	Both species present
Cow Lake 1	535004	4851840	<i>P. smintheus</i> present
Cow Lake 2	532269	4851812	<i>P. smintheus</i> present
Cygnets Pond	530146	4861081	<i>P. clodius</i> present
Death Canyon Phelps Lake Junction	515719	4833590	<i>P. clodius</i> present
Death Canyon Ranger Cabin	513571	4834713	<i>P. clodius</i> present
Death Canyon Trail	514608	4833957	<i>P. clodius</i> present
Dump Road	530523	4861790	<i>P. clodius</i> present
Elk Ranch 1	540261	4850850	Both species absent
Elk Ranch 2	541592	4849795	<i>P. smintheus</i> present
Grand View 1	535627	4861193	<i>P. clodius</i> present
Grand View 2	535609	4861415	<i>P. clodius</i> present
Grand View Parking	535142	4860599	<i>P. clodius</i> present
Hidden Falls Trail	521439	4843954	<i>P. clodius</i> present
Lozier Hill Meadow	538775	4856609	<i>P. clodius</i> present
Lozier Hill Road	537747	4856522	Both species absent
Lupine Meadow	521129	4843032	<i>P. clodius</i> present
Mt. Moran Turnout	528887	4850207	Both species absent
North Jenny Lake	522388	4848251	<i>P. clodius</i> present
Paintbrush Canyon Trail	521072	4849468	<i>P. clodius</i> present
Pilgrim Creek	533718	4862533	<i>P. clodius</i> present
Rendezvous Mountain 1	508298	4826970	<i>P. clodius</i> present
Rendezvous Mountain 2	509291	4827468	<i>P. clodius</i> present
Rendezvous Mountain 3	509376	4827000	<i>P. clodius</i> present
Shadow Mountain Hairpin	532852	4838189	<i>P. clodius</i> present

Sound of Music	533257	4839554	<i>P. clodius</i> present
String Lake Parking	521728	4848059	<i>P. clodius</i> present
Surprise Lake Meadow	520001	4841263	<i>P. clodius</i> present
Surprise Lake Trail 1	520818	4841498	<i>P. clodius</i> present
Surprise Lake Trail 2	520745	4841270	<i>P. clodius</i> present
Taggart Lake Trailhead	521361	4837657	<i>P. clodius</i> present
Timbered Island	522115	4842890	<i>P. clodius</i> present
Two Ocean Lake Road 1	540926	4858405	Both species absent
Two Ocean Lake Road 2	540030	4860396	<i>P. clodius</i> present
Wilderness Road 1	544237	4864715	<i>P. clodius</i> present
Wilderness Road 2	543598	4864076	<i>P. clodius</i> present
Wilderness Road 3	542182	4861987	<i>P. clodius</i> present