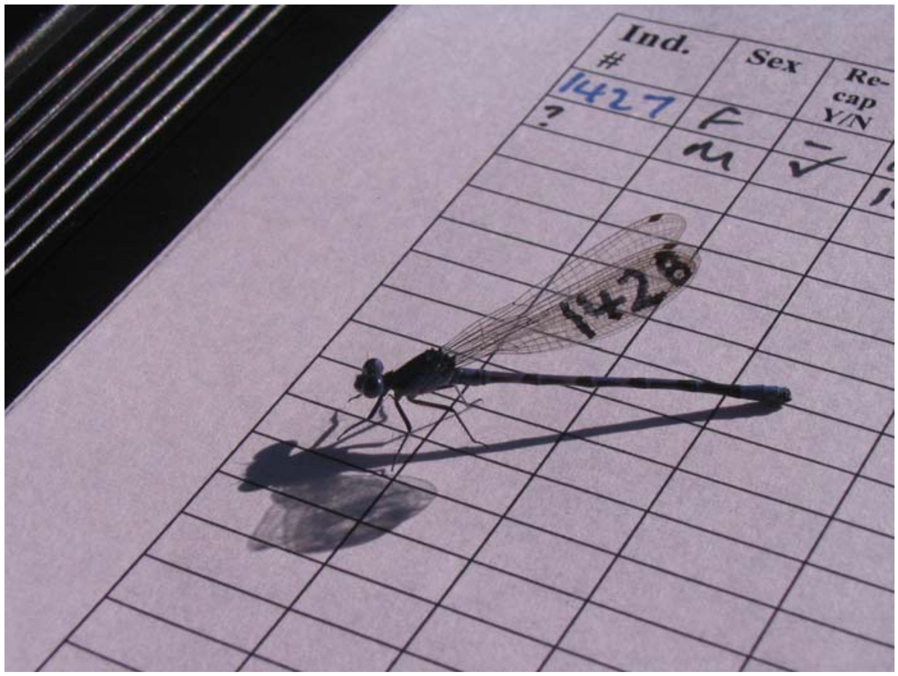
Dispersal Movements and Corridor Habitat for *Argia vivida* in Banff



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Dispersal movements and corridor habitat for *Argia vivida* in Banff

Dispersal has important consequences for population persistence via gene flow and 'rescue' effects, particularly for rare or fragmented populations. In BNP, the damselfly *Argia vivida* is at the northern limit of its range and is restricted to several small populations inhabiting thermal springs near the town of Banff (Pritchard 1971, Pritchard 1988, Westfall & May 1996, Rice 2003, Rice 2002). With additional scattered populations red-listed in British Columbia, *Argia vivida* is recognized by COSEWIC (Annual Report, May 2003) as potentially at risk.

A previous study noted dispersal between the 2 major thermal spring populations in Banff; Cave & Basin (CBHS) and Middle Springs (MSHS) (Rice, 2003). However, *Argia vivida* appear to be dependent on forest habitat for night roosting sites (Pritchard & Kortello 1997) and recent thinning of trees for fire control may impact movement patterns through the 1km long dispersal corridor between the two springs. Although movement of other damselfly species over 200m are infrequent, distances up to 1800m have been reported; these may require favourable winds, habitat, or topography (Purse et al 2003, Conrad et al. 1999, Mitchell 1962).

Forest thinning has the potential to alter habitat quality for *A. vivida* in several ways. If suitable night roosts are a requirement for dispersal then thinning may impede movement and isolate these populations. Conversely, thinned areas might permit more wind and sunlight to penetrate the forest, increasing flight distances and sunspots for basking. Daytime perching sites for *A. vivida* favour coarse woody debris, and brush piles from clearing may provide 'stepping stones' for dispersal. Burning of brush piles may impede movement through reduction in suitable perching sites, or alternatively, the dark surface of scorched wood may provide thermal advantage for basking and perching sites.

The objectives of this study are to:

1. Determine the dispersal distances of individual A. vivida within and between springs to evaluate connectivity of *A.vivida* populations in CBHS and MSHS.

2. Assess use of non-spring habitat in surrounding thinned/closed forest matrix (FM).

3. Assess use of daytime perching substrate, specifically as it relates to brush piles.

4. Determine night roosting site selection as it relates to tree species.

Findings from this study will be useful in guiding forest management practices in *A. vivida* habitat that promote conservation of the species.

Methods

Mark-release-recapture (MRR) techniques were used to determine the dispersal of *A. vivida* between MSHS and CBHS through the thinned and closed forest matrix (FM) between these two sites. Individuals were identified with a number applied to the left or right forewing using black waterproof ink. This technique has been extensively used with damselflies and considered to be harmless to marked specimens (Watts et al 2004). The time, location, sex, perch substrate (burned and unburned brush piles versus other substrates) and forest cover were recorded at each capture. We defined closed forest cover as >50% canopy cover in a 5m radius around the capture location and open forest as <50% canopy cover.

Sampling was conducted for a total of 15 days concentrated in 2 rounds of 5 and 10 consecutive days (weather permitting) during July and August. Sampling occurred on July 8-9, July 12-14, July 26-Aug 1 and Aug 3-5. A typical sampling day required calm winds, temperatures above 15 °C and some sun. Sampling periods would extend from 10:00 hrs to 16:00 hrs. Routes were established to encompass the available habitat at each hot spring and both springs were sampled simultaneously for 2 hours each day.

Additionally, east/west straight line transects were walked to systematically search the approximately $1km^2$ FM connecting the 2 sites and evaluate the distribution and habitat use of *A. vivida* within the dispersal corridor (Figure 1). These transects were spaced 50m apart and individuals within approximately 5m of the researcher were captured (See Appendix A for the locations of transect start and endpoints). The order in which the hot springs and the FM were sampled was alternated daily.

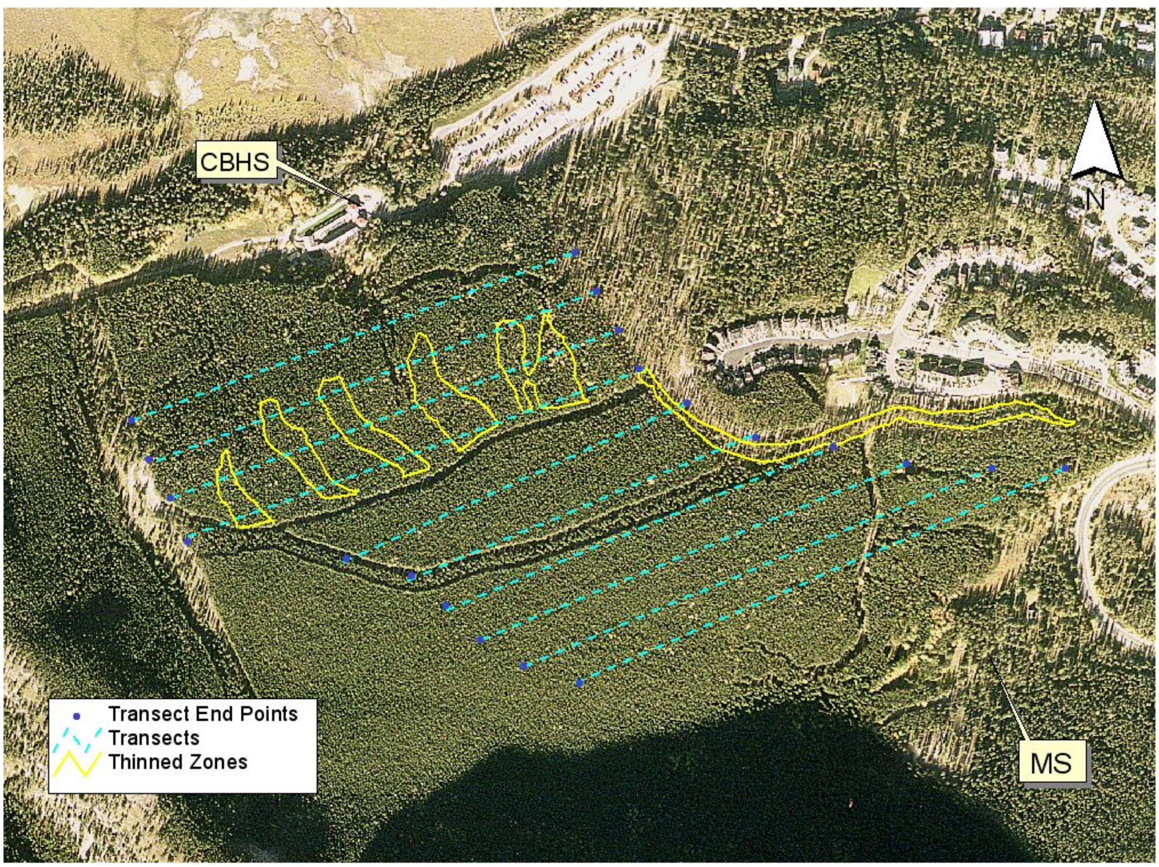

Figure 1. Study area on north slopes of Sulphur Mtn. near town of Banff.

We derived population size, survival and recruitment estimates for *A. vivida* using Jolly-Seber (Krebs 1989) methods. Locations of captured individuals were recorded in a GIS and dispersal distances calculated for recaptured individuals to create a distribution curve for *A. vivida* dispersal and assess movement between the two springs. Additionally, we evaluated *A. vivida* selection of burned versus intact brush piles as perch substrate. There were 173 unburned brush piles and 25 burned brush piles in the thinned forest. We used the proportion of unburned to burned brush piles to derive expected relative values for the combined use of these substrates and compared those values with the number (Mean ±95% Confidence Interval, C.I.) of A. vivida observed on these substrates.

For 3 evenings, July 28, 30 and August 2, roosting surveys were conducted at CBHS for 2 hours each evening between the hours of 6pm and 9 pm. For these surveys focal individuals were selected and intensively monitored to determine roosting sites and tree species.

Results

A total of 1473 individuals were captured and marked during 15 days of sampling at the 3 locations (Figure 2). Adult *A. vivida* were captured at CBHS mainly on the boardwalks and sidewalks near the CBHS historic site buildings. At MSHS captures were mainly on an old road cut, on trails adjacent to the hot spring outflow streams, near the abandoned Wheeler House, and on the trail beside Mountain Avenue. On transects within the FM, adult *A. vivida* were captured mainly in sunny open areas on and beside trails and in the sunny open areas of thinned forest. Captures occurred more sparsely in the closed forest where less sunlight penetrated the forest.

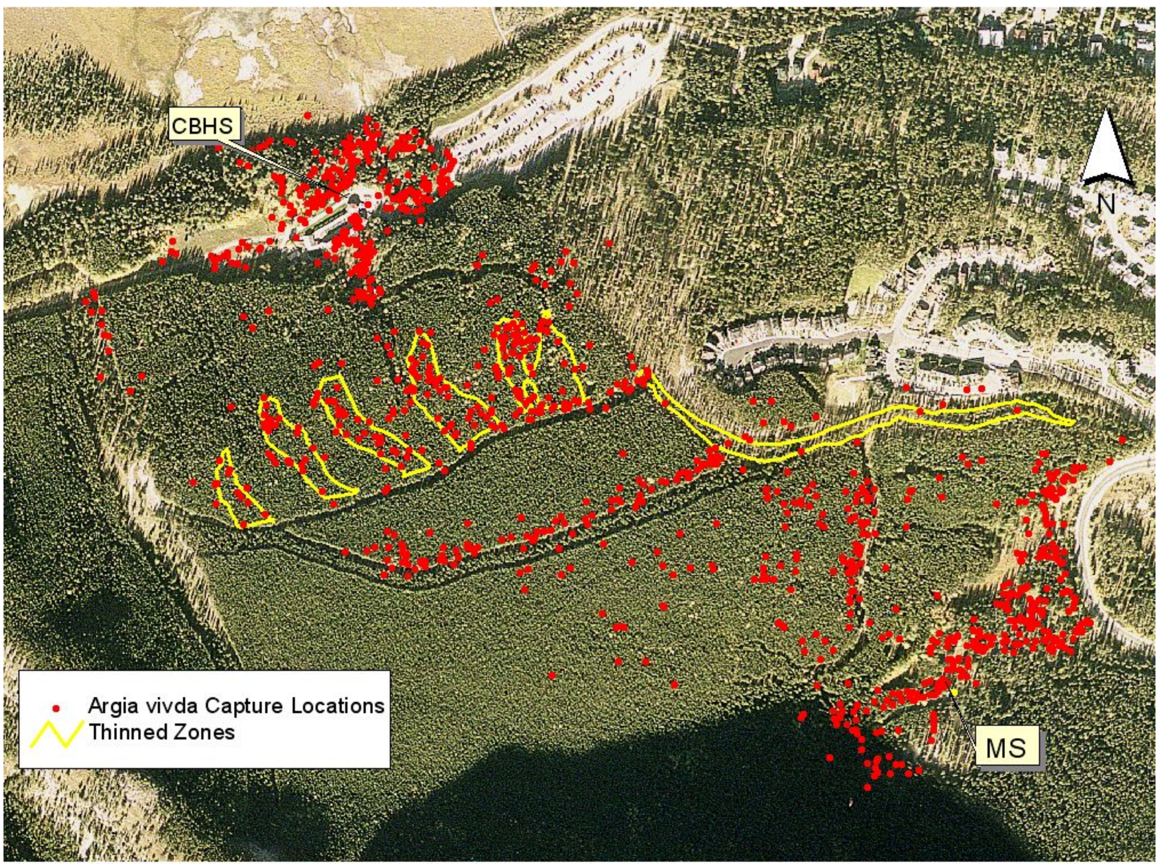

Figure 2. *A. vivida* capture locations.

An additional 79 recaptures were recorded. Of these recaptures, 72 were captured during regular sampling and 7 were incidental observations made by other researchers working concurrently at the two hot springs. Eight mortalities occurred due to mechanical injury from the butterfly nets used for capture and 4 probable mortalities were recorded when damselflies had trouble flying upon release. Of marked individuals, 76% were males and 24% were female. Population estimates ranged from 1936 to 18780 (Table 1). Only the last 9 days of sampling were used due to a paucity of recaptures during the first 6 days of sampling.

Table 1. Jolly-Seber Population Estimates

Sample	Proportion Marked (α)	Total Number (*N*)	Probability of Survival (ϕ)	Number Joining (*B*)	S.E. N	S.E. ϕ	S.E. *B*
1	-	-	0.888	-	-	0.375	-
2	0.018	4555.6	1.846	10369.0	4848.1	0	21030.8
3	0.019	18779.7	0.374	-5080.3	20748.2	0.201	7258.2
4	0.088	1936.4	0.794	1855.4	886.8	0.372	1403.2
5	0.071	3392.7	0.855	3784.9	1771.9	0.441	3271.8
6	0.048	6685.9	1.389	4827.0	3937.6	0.962	7848.1
7	0.045	14114.6	0.681	-3332.8	10714.8	0.644	5305.8
8	0.083	6277.1	-	-	5225.1	-	-
9	0.092	-	-	-	-	-	-

While most recaptured *A. vivida* dispersed less than 300m some individuals traveled further, to a maximum of 937m (Figure 3). Most recaptured individuals dispersed within the sample area where they were first captured or between the FM and one of the hot spring sites. Two individuals dispersed from MSHS to CBHS, with movement distances of 832m and 937m.

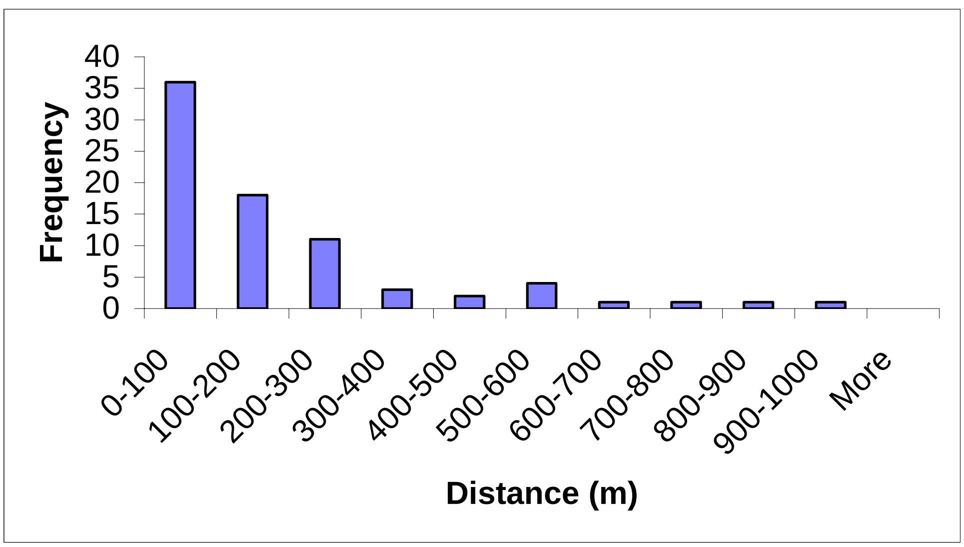

Figure 3. *A. vivida* dispersal frequency (n=79).

Dispersal distances of 600m to 900m were observed between 24 and 96 hours after initial capture, respectively, and so the scale of the sampling sites and time span of the sampling rounds was sufficient to pick out dispersers between springs (Figure 4). However, the 2 damselflies that traveled the farthest, from one spring to the other, were observed by researchers from other projects, one during the sampling rounds (August 7) and one after the last sampling round (August 28).

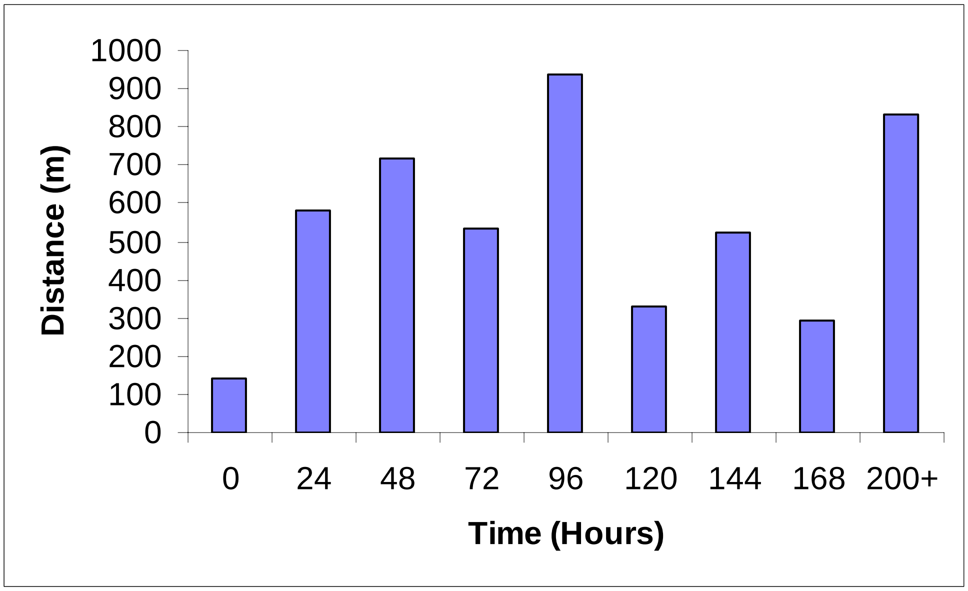

Figure 4. Recapture times and corresponding maximum dispersal distance.

At both hot springs and in the FM the majority of captures occurred in open areas. In the FM the captures in the open areas are split between naturally open areas and the thinned forest (Figure 5).

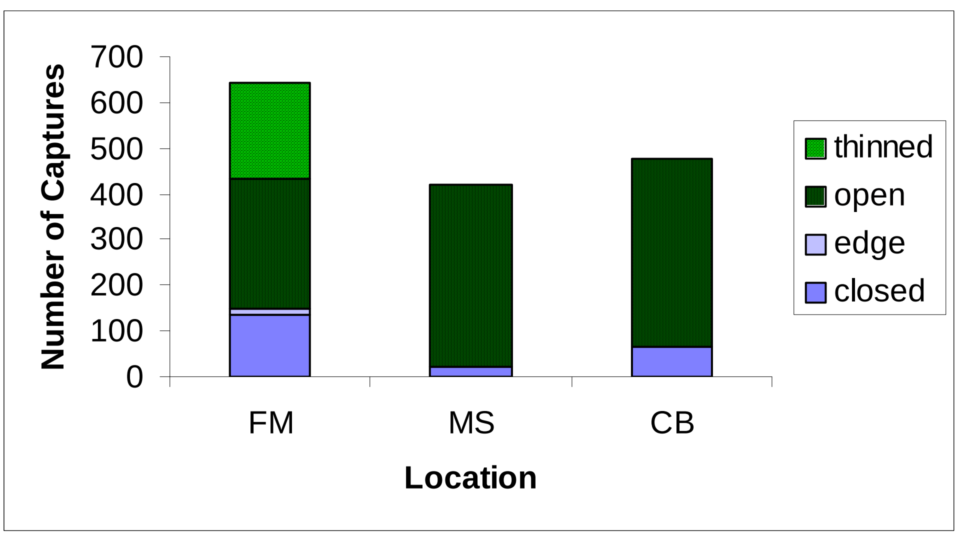

Figure 5. *A. vivida* forest type use by sampling location.

Bare ground and logs were the most frequent perch substrate for captured *A. vivida* (Figure 6). Other common perch substrates were characteristic of particular areas, for example, boardwalks are only found at CB and brush piles were only found within the FM.

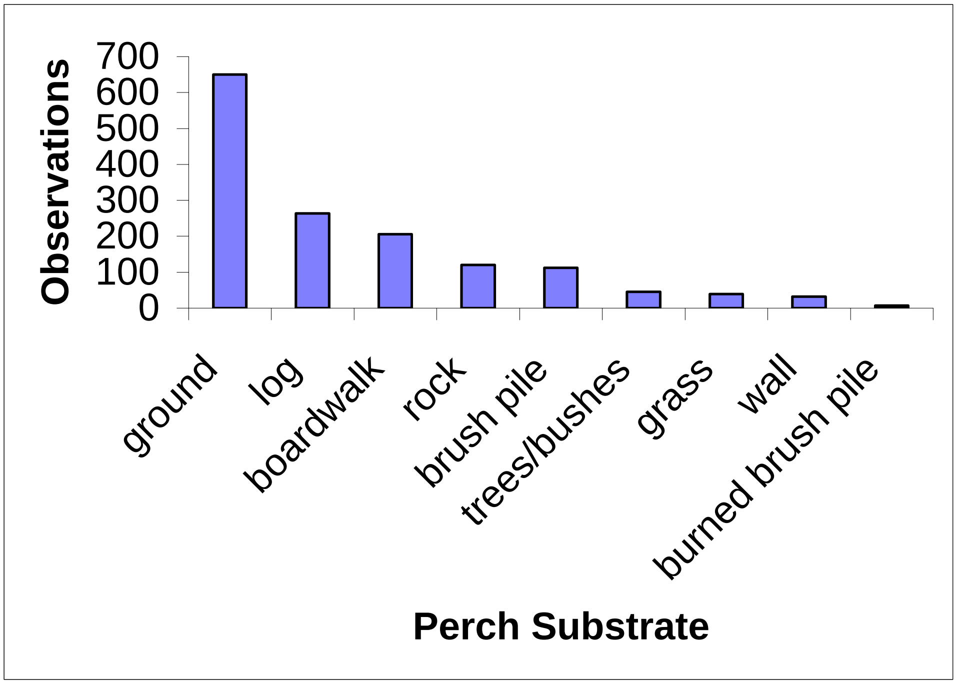

Figure 6. Perch substrate use by *A. vivida* for all sampling locations.

Comparing burned versus unburned piles as perch substrate, *A. vivida* used burned brush piles slightly less than expected (Figure 6).

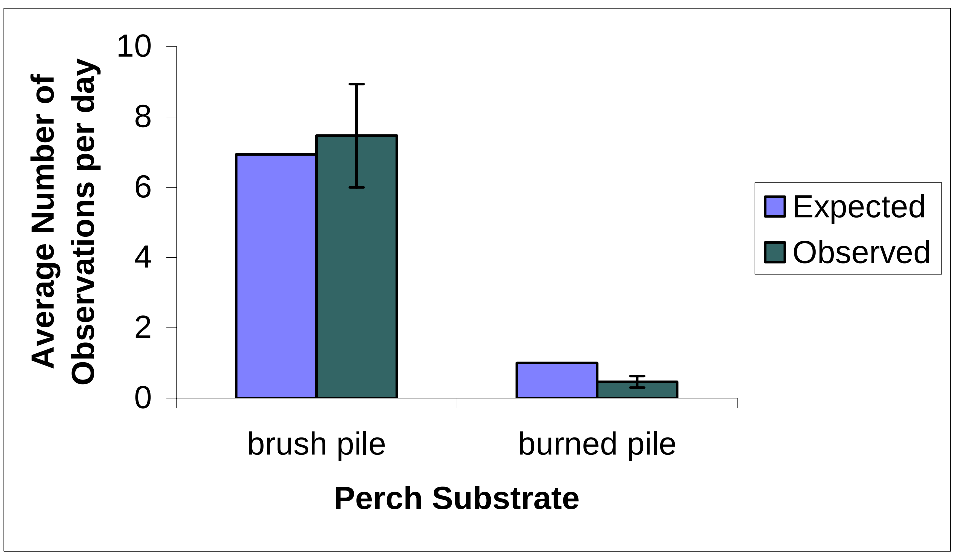

Figure 6. Observed and expected use of brush piles. Error bars are 95% confidence intervals.

The 3 evenings of night roosting surveys produced only 21 observations. *A. vivida* were observed roosting primarily in spruce trees at CBHS (Figure 7). Other tree species present were used less frequently.

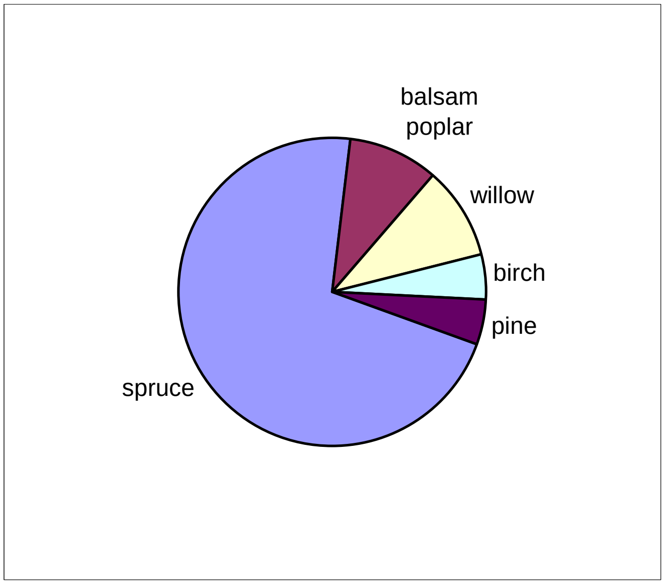

Figure 7. Night roosting tree observations (n=21).

Discussion

Forest thinning did not appear to impede *A. vivida* movement within the study area. Thinned areas provide suitable daytime habitat for *A. vivida* due to penetration of sunlight into the otherwise closed forest. Although brush piles of thinned debris were used as perching substrate, burnt brush piles were less desirable. Additionally, we confirmed that mature conifers, especially spruce, are important as night roosting habitat. We propose the need for careful planning of future thinning and treatment of woody debris in order to preserve habitat quality for *A. vivida* in Banff.

A. vivida have limited distribution in Canada, and are only found at springs in Alberta (Banff) and B.C. (The Kootenays, Okanagan, Pemberton, Field and Glacier) (Cannings et al. Pritchard 1971). Although we did not sample all potential *A. vivida* habitat in Banff, CBHS and MS are locally the 2 largest springs where A. vivida occurs. Our population estimates, while wide in range (1,936-18,779), may be useful as a baseline comparison for future studies.

We confirmed inter-spring dispersal between breeding sites at hot springs on the north-facing slopes of Sulphur Mountain. This has positive implications in terms of species persistence and the maintenance of genetic diversity for this uncommon odonate. Although the frequency of recaptured individuals dispersing over 300m was low, we surmise that movement of adults of up to 500m is not unusual, based on the high numbers and fairly even distribution of *A. vivida* within the approximately 1km^2 FM between the two source springs (Figures 2 and 3). In Banff, *A vivida* must disperse 800m or more to cover the distance between MSHS and CBHS. Since the proportion of the population that we marked was relatively small (0.018-0.088, Table 1), we expect that dispersal between CBHS and MSHS is not unusual and may be important in metapopulation dynamics.

Other odonate MRR studies have found maximum dispersal distances of 1.0 to 1.8km (Purse et al 2003, Conrad et al. 1999, Watts et al 2004). The time required to detect these movements is within our study design, but the paucity of larger movements and the fact that researchers outside of this study observed the longest dispersal movements, might warrant greater sampling effort in future.

Conrad et al (1999) found no difference in dispersal between male and female odonates, hence, we did not consider sex and dispersal for *A. vivida*. However, tenerals are as likely to disperse as adults for several odonates (Conrad et al 1999) and although tenerals were not captured in our study due to their fragility, they were observed throughout our study area. Consequently, tenerals may play an additional role in dispersal.

The most serious threat to odonate survival is anthropogenic disturbance of aquatic habitat (Canning 1998), however non-freshwater habitat is important for maturation, foraging and roosting (Conrad 1999) and provides connectivity between breeding sites. We observed considerable use of non-spring habitat with 641 damselflies (41% of the total) captured in the FM and 492 of these were in open or thinned forest. Other research has noted that *A. vivida* requires sunlight patches in order to bask and attain temperatures necessary for flight (Pritchard and Kortello 1997) and thinned forest provides more openings for sunlight to penetrate. *A. vivida* did not seem to discriminate between open areas along trails and recently thinned areas of the FM. Small openings like these may be most advantageous as they allow sunlight and still give some shelter from wind.

We found that the most common perches used by *A. vivida* were ground, logs, boardwalks at CBHS, rocks and brush piles in the FM (see also Pritchard and Kortello 1997). Burning of brush piles reduces the quantity of perching habitat and the use of the charred substrate in burned brush piles was less than expected, consequently this particular fuel management technique offers no discernable benefit to *A. vivida*.

Night roosting surveys suggest a strong preference for spruce at CBHS despite a mix of coniferous and deciduous trees at this site. As noted by Pritchard and Kortello (1997), breeding sites are strongly correlated with treed locations and *A. vivida* exhibits cryptic behaviour by matching its roosting angle to the branching angle of spruce twigs, suggesting an evolutionary association with treed habitat. Therefore, the pine/spruce dominated FM would appear to be important habitat and its composition would promote connectivity of the *A. vivida* populations at CBHS and MSHS through its use for night roosting.

Recommendations

We recommend that future forest thinning on the north slopes of Sulphur Mountain be carried out with consideration for *A. vivida* habitat quality. Patches of thinned forest allow sunlit areas, which will promote daytime use, while adjacent mature forest should be maintained to provide night roosting trees. For this reason, we do not recommend uniform thinning over the entire FM area. If brush piles are to be burned then some unburned woody debris, left as perching substrate, would be beneficial. Future population and dispersal studies should be conducted to monitor the possible effects of additional thinning on *A. vivida* habitat and population connectivity.

Appendix A

UTM coordinates for FM transects

Transect #	East End Transect UTM	West End of Transect UTM	Transect Length
1	598771,5669536	598256,5669341	551m
2	598796,5669492	598276,5669296	556m
3	598821,5669447	598301,5669251	556m
4	598846,5669401	598321,5669201	562m
5	598901,5669361	598506,5669181	434m
6	598981,5669321	598581,5669161	431m
7	599071,5669311	598621,5669126	487m
8	599156,5669291	598661,5669086	536m
9	599256,5669286	598711,5669056	592m
10	599341,5669286	598776,5669036	618m

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