Bighorn sheep movements and mineral lick use in Waterton-Glacier International Peace Park

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OVERVIEW

- **What:** Over 168,400 GPS locations from 97 bighorn sheep from 17 different social groups. Location intervals ranged from 15 min – 5 hours.
- **When:** 2002 – 2011, ~1 year/ bighorn sheep
- **Where:** Glacier National Park, Waterton Lakes National Park, and the Blackfeet Reservation.
- **Why:** The need to access to mineral licks may drive large movements and influence disease exposure, predation risk, and genetic connectivity.

Figure 1. Bighorn sheep ewe with lambs in front of Sexton Glacier in Glacier National Park.

EXPLORING MINERAL LICK USE WITH GOOGLE EARTH

We plotted bighorn sheep and mineral lick locations on maps to examine movements across the landscape in contrast to movements toward mineral licks (Figures 2-3). Exploring movements around mineral licks in GoogleEarth allowed us to develop criteria to accurately identify probable mineral lick visits.
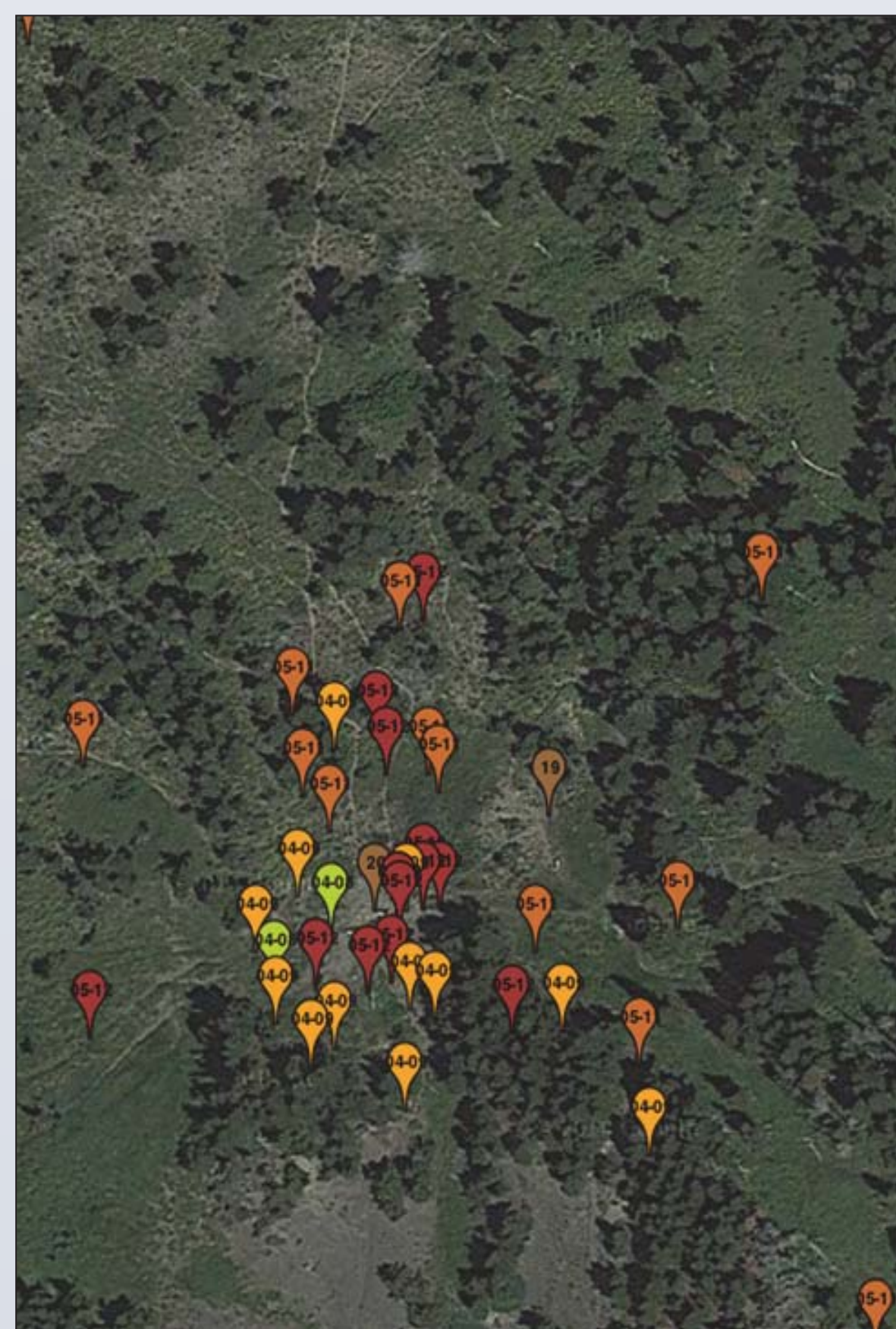

Figure 2. South Two Medicine ram locations near the Little Dog mineral licks produced in GoogleEarth. Lick locations are brown and each bighorn sheep is a different color. Game trails likely created by mineral lick use are apparent in aerial imagery.
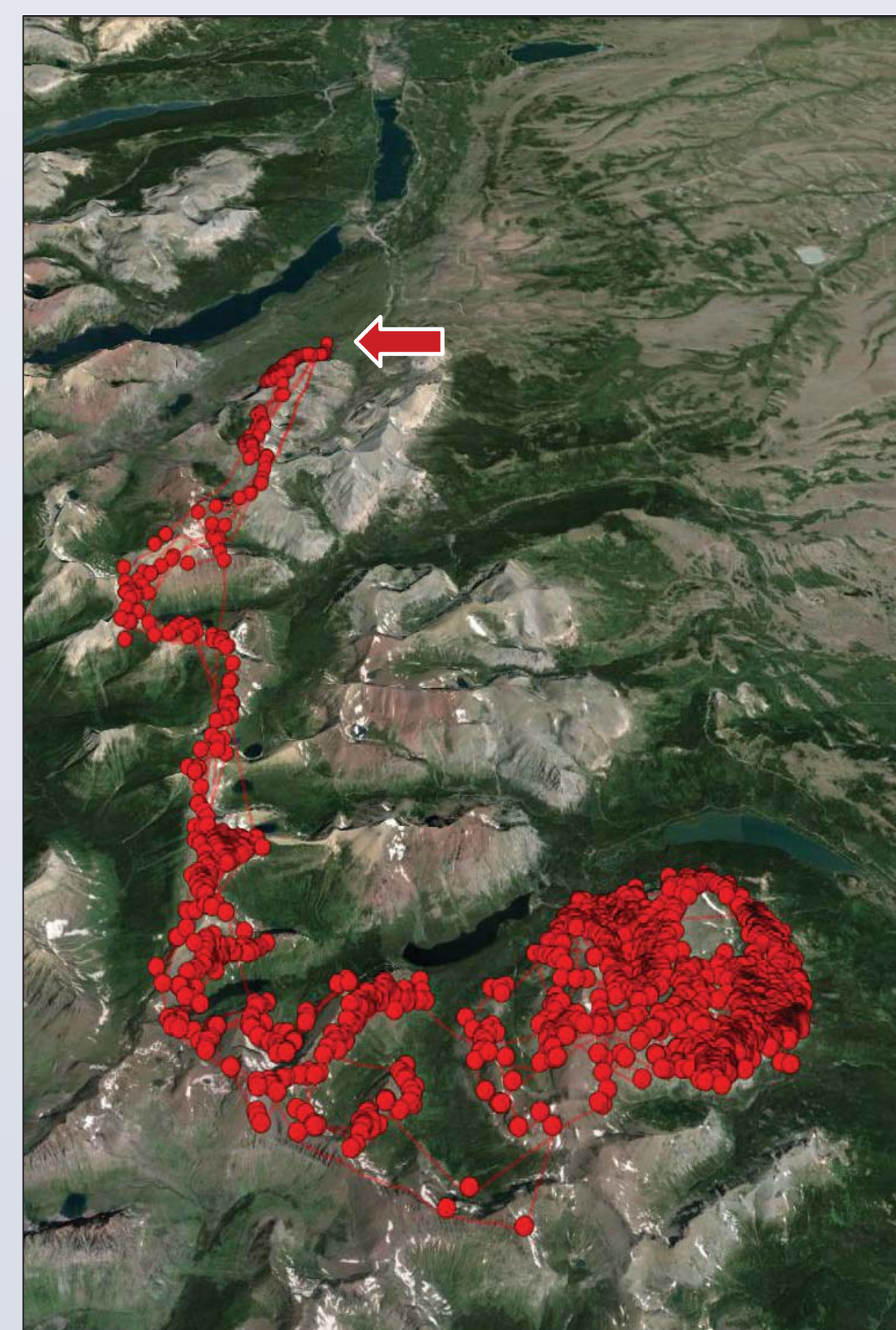
Figure 3. A typical mineral lick visit outside of a ewe's 95% kernel density estimate (kde). This bighorn ewe travelled outside of her 95% kde in Two Medicine to visit the Curly Bear Mineral Lick (red arrow). She made the trip 4 times, in late June, early July, late July, and early September.

MINERAL LICK USE

We compared bighorn sheep GPS collar data with the locations of 13 known mineral lick locations to identify potential mineral lick visits.

- **88%** of bighorn sheep with summer and fall data (78 out of 89) visited at least 1 of 5 known mineral lick locations.
- **45%** of bighorn sheep had a mineral lick present in their 95% kde.
- Frequency of mineral lick use was highly variable among individuals, ranging from 1 to 25 visits during one year, with a mean of 3 visits.
- **76%** of mineral lick visits took place during May – August (Figure 4).
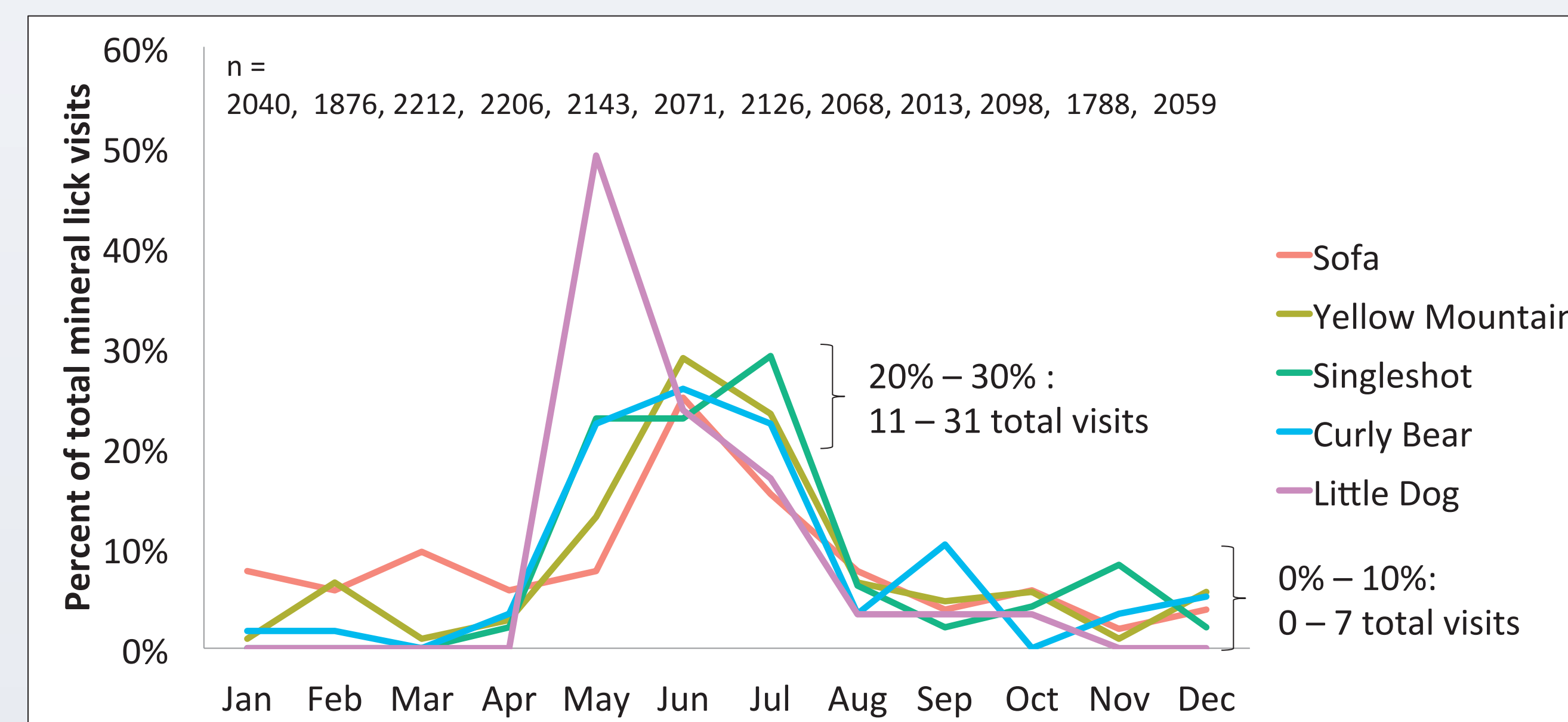- **89%** of mineral lick visits took place during daylight hours.

Figure 4. Percent of total mineral lick visits per month at each mineral lick location. Sample size (n, the total number of days recorded per month for 78 bighorn sheep with mineral lick visits) varied little across months.

MOVEMENTS RELATED TO MINERAL LICK USE

We compared movement parameters (speed, angle to mineral lick, and distance) with mineral lick visits and grouped results by social group and location (Figure 5).

- Social groups consistently used one mineral lick location.
- Only 1 ram and no ewes used two different mineral lick locations.
- The movement parameters to a mineral lick depended on the mineral lick's proximity to the 95% kde for the sheep. Many bighorn sheep traveled a significant distance outside of their 95% kde to visit a mineral lick.
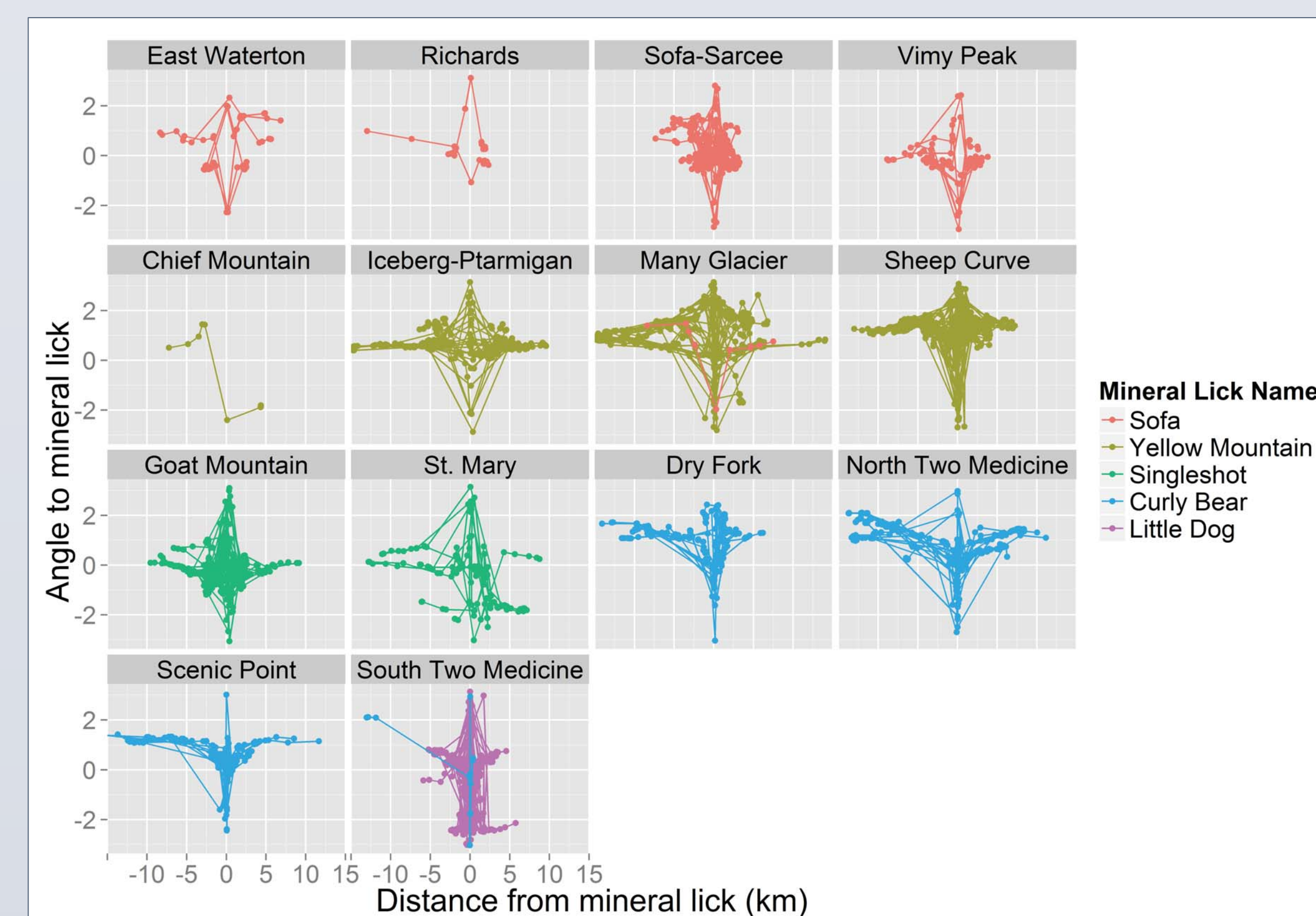

Figure 5. Plots of distance from mineral lick vs. angle to mineral lick in radians by bighorn sheep social group. Mineral licks are labeled in different colors. Consecutive steps toward and away from a lick are connected by a line. Note that movements are strongly directed towards the lick as the animals approach (angle = 0) and then typically are away from the lick once the animal is at the lick. Angle = 3 and angle = -3 are movements 180 degrees away from the lick.

GENERAL MOVEMENT AND CONNECTIVITY

We assessed how bighorn sheep use the landscape by summarizing movement characteristics spatially. We split lines connecting GPS locations by 500 m² grid cells. For each grid cell, we summarized the total number of lines per grid, total number of unique bighorn sheep, mean distance travelled, mean speed, mean relative angle of movement, and standard deviation of the absolute angle of movement. We classified the type of movement by grid cell with the goal of identifying broad areas used as movement corridors, habitat, and potential sites for population monitoring (Figure 6).

- Area used by bighorn sheep varied seasonally. Sheep used more area overall during summer than winter.
- Highly used areas in winter had more movement lines than highly used areas in summer, suggesting higher visitation rate of used areas in winter.
- We documented only two potential movements between the north and south sections of the study area, which were separated by St. Mary Lake.
- There was less connectivity between distinct use areas during the winter, in comparison to the summer season.
- Highly used areas (those with the most movements) shifted throughout the year, likely due to seasonal variation in forage availability and security needs.
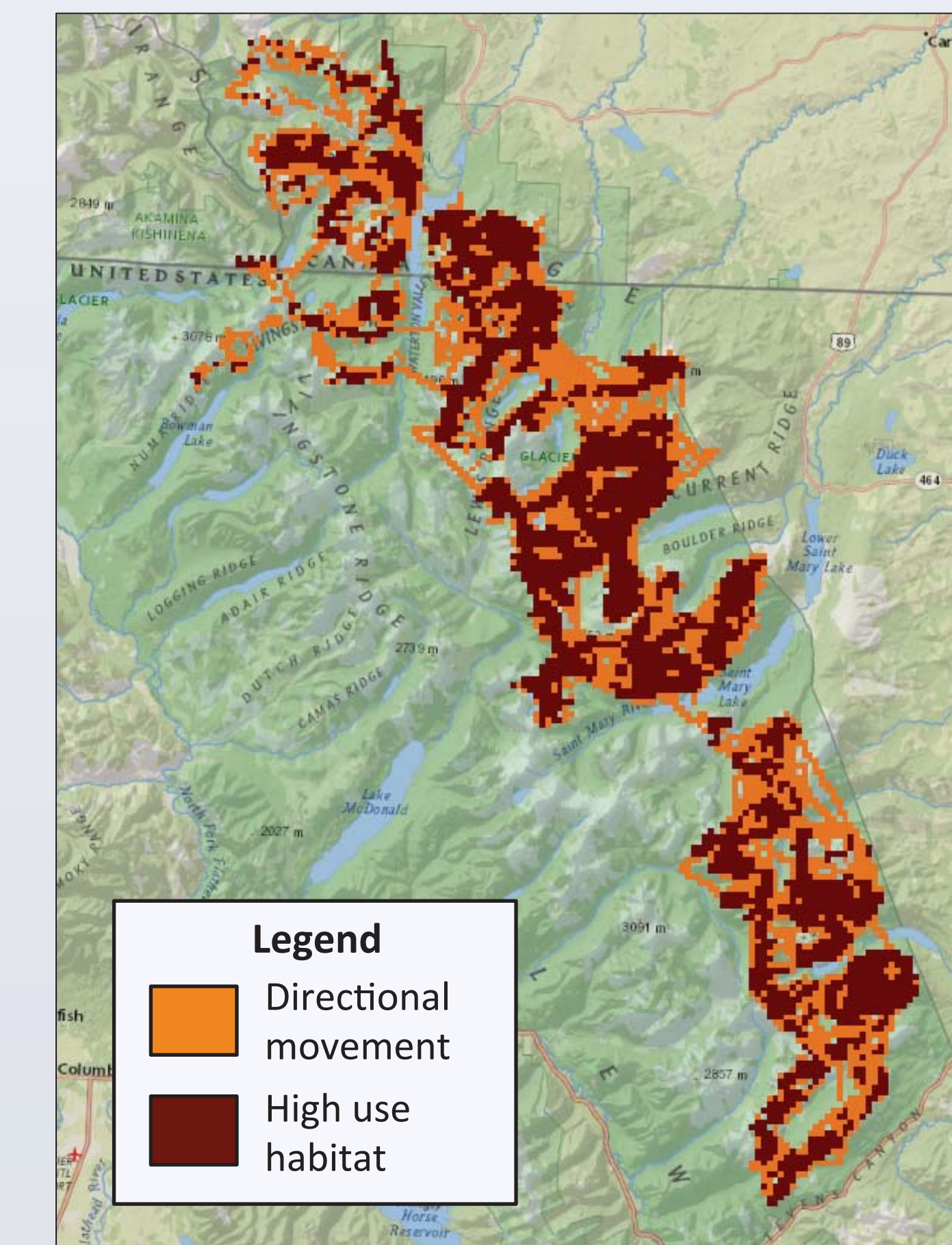

Figure 6. Areas used for directional movement and high use habitat by 97 bighorn sheep. Directional movement classification included grid cells with an angular deviation less than 1 radian for any bighorn sheep. High use habitat classification included grid cells with greater than 5 movement lines and an angular deviation greater than 1 radian for any bighorn sheep.

IMPLICATIONS FOR MANAGEMENT AND MONITORING

- Mineral licks are an important and spatially limited resource.
- Only 5 mineral lick locations were used by a large proportion of the bighorn sheep population during daylight hours. These locations may be prime remote monitoring locations.
- Bighorn sheep from multiple social groups use the same mineral licks, which may influence infectious disease dynamics. Looking at temporal use is our next step.
- Mineral lick areas and movement corridors to mineral licks comprise an important resource for bighorn sheep that should be accounted for in management and conservation plans.