Mapping Riparian Willow (*Salix* spp.) Communities with GNSS

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ABSTRACT

Willows (*Salix* spp.) are common shrubs that grow in rangeland riparian areas, and they serve as habitat for wildlife and maintain proper hydrological functioning condition. Characterizing these shrubs is beneficial to better understand the role these shrubs have on the ecosystem, but traditional methods of characterization can be time and labor-intensive and subject to error. This study used an alternative method to get these data: Real-Time Kinematic (RTK) Global Navigation Satellite System (GNSS) surveys. These surveys employed getting high-precision (**centimeter-resolution**) GPS points of six sites and the willow cluster canopy within those plots. These points were then used to map polygons that represent the cluster canopies. The polygon areas were calculated and compared to the plot areas to produce a % willow canopy cover for each of our sites. These data will be further compared with data from small Unmanned Aerial Vehicle (sUAV) surveys and our ground-based sampling surveys. The study sites are located in the Laramie Range in southeastern Wyoming.

WHY ESTIMATE VEGETATIVE COVER?

- Ecological indicator:
  - Vegetative cover estimates indicate site health, influence on succession, and influence on hydrological functioning.
  - Cover estimates can also be used as a measure of biomass.
  - % Cover of area can be used to compare many different types and species of vegetation.
- Management indicator:
  - Cover estimates can indicate places where erosion may be more likely in a site, identify vital wildlife habitat, and observe trends in site health over time and with changes in management, land-use, and climate. (Source: University of Idaho College of Natural Resources, "Why Measure Cover?")

WHY USE GNSS TO ESTIMATE COVER?

Cover estimates with traditional ground-based sampling methods (i.e., LPI, belt-transects) can be time and labor-intensive, frustrating, and prone to subjectivity from observers. High-resolution GNSS surveys offer a much faster and potentially more accurate way compared to traditional ground-based sampling surveys to measure canopy area of shrubs with a variety of shapes and sizes at the ground level.

METHODS

- Identifying plots: Six sites were identified in the 2019 field season. Survey pins were placed to mark 15-25 m stretches along one side of a stream to identify the stream reach for the site. At least two additional corners on the other side of the stream were marked with survey pins for the GNSS surveys. For sites that were very close together, a single plot was made for the GNSS surveys for convenience, since it was difficult to distinguish some clusters by site or sinuosity, or it was difficult to determine site boundaries on the other side of the stream.
- Identifying clusters: A cluster is an individual or group of individuals that have a closed or mostly-closed canopy. If the observer could not walk/crawl through individuals without getting constantly stabbed by branches, or could not look upwards and see large gaps in the canopy, or the roving unit could not be carried into the stand, then that willow individual/those individuals were put into a cluster. Each cluster has a minimum of 3 GNSS points associated with it.
- Collecting the points: These surveys employed Emlid Reach RS2 base (**Figure 2a**) and roving (**Figure 2b**) units, which are two RTK GNSS receivers. On June 3, 2020 the base unit was run for about 4.75 hours to collect a very precise location, which was then sent to Natural Resources Canada for exact positioning information with NRCan Rapid. This known location is 41°11'7.23916"N 105°23'28.03387"W at 2444.988 m in elevation. Surveys were conducted on August 12, 2020, August 17, 2020, and August 21, 2020. The base unit was set up in the known location at the same height for each survey, and the roving receiver unit was moved around the desired survey locations to collect the points and receive location corrections from the base unit. Once a cluster was identified, points were collected by placing the rover at several points along the edge of the cluster canopy. The rover tripod must touch or be directly underneath the outside edges in at least three places around the cluster. The number of points was dependent on the size and shape of the cluster, and point placement was fairly subjective. In general, points were gathered in a clockwise or counterclockwise direction, with more emphasis on strong changes in direction and less emphasis on fairly straight sections. In order to be collected, the point must be read as a "fixed" status. Points were named by site, cluster number, and point number.
- Putting the map together: The map was created using QGIS ver. 3.10.4 *A Coruña* with a WGS 84 coordinate reference system. Plot borders were created based on the GNSS point centroids for the 4 corners outlined with survey pins, then connected with a polygon creation tool. Each cluster was identified based on the GNSS points centroids and then connected with a polygon creation tool. Each cluster from a particular site was then merged into a single layer, so that each site had its own layer of cluster polygons. The Middle Crow Creek Watershed (HUC 12: 101900090101) was delineated with the USGS Watershed Boundary Dataset. Streamlines for the watershed were created by M.S. Student Kyle Fitch with the USGS National Hydrography Dataset.
- Map Analysis: The field calculator and "$area" function was used to calculate the area of each cluster in square meters.

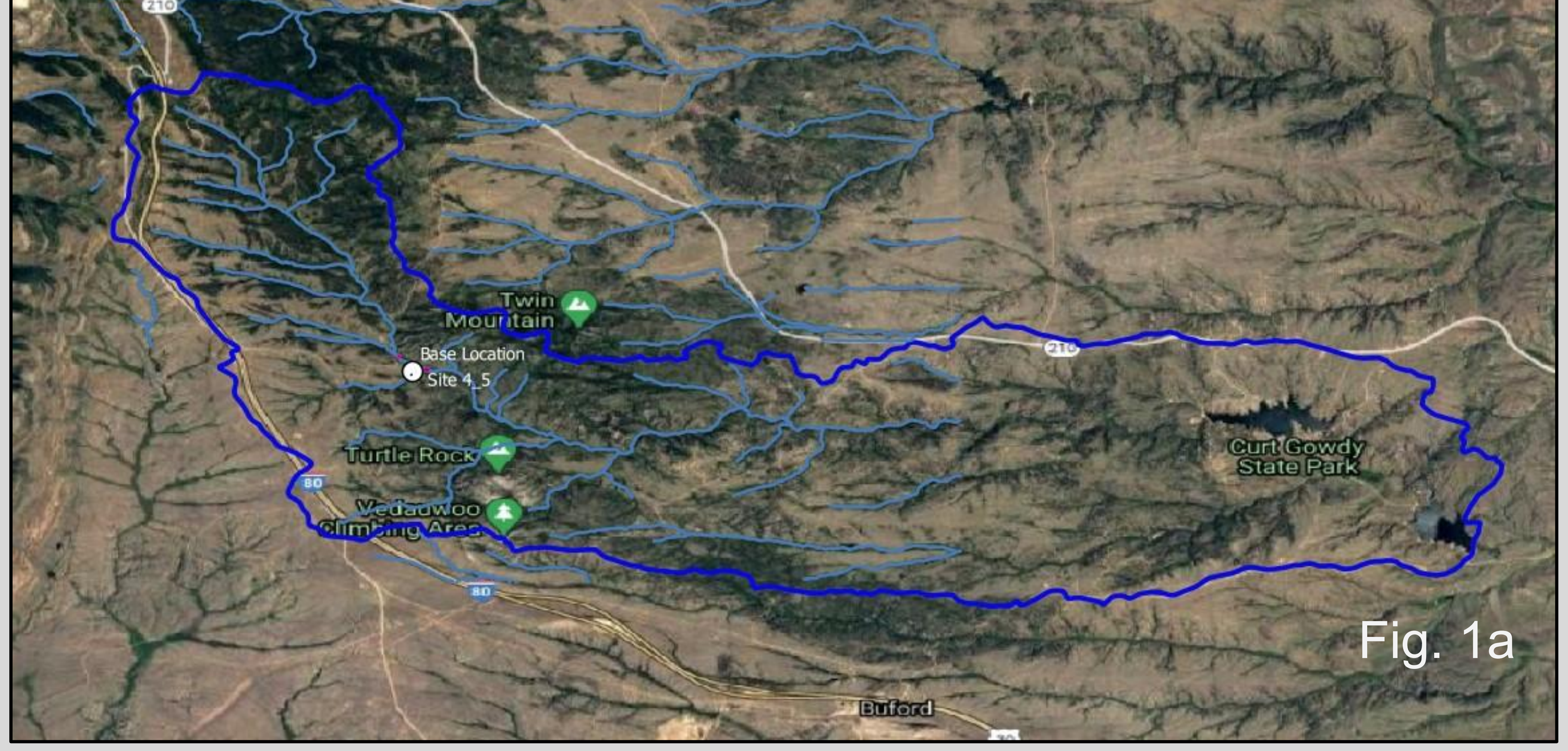


Fig. 1a

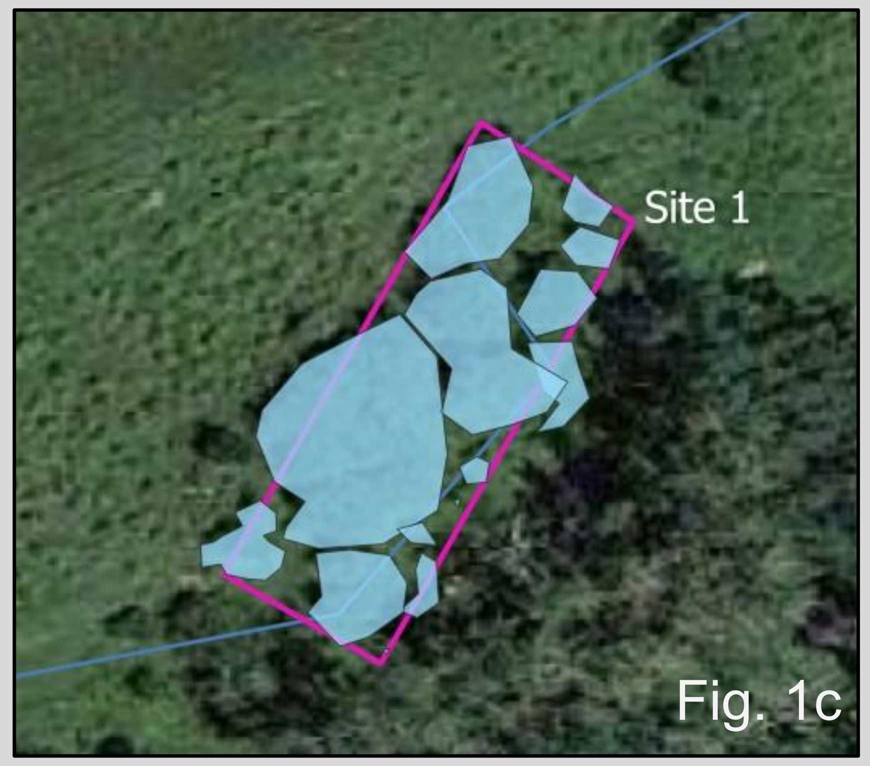


Fig. 1c

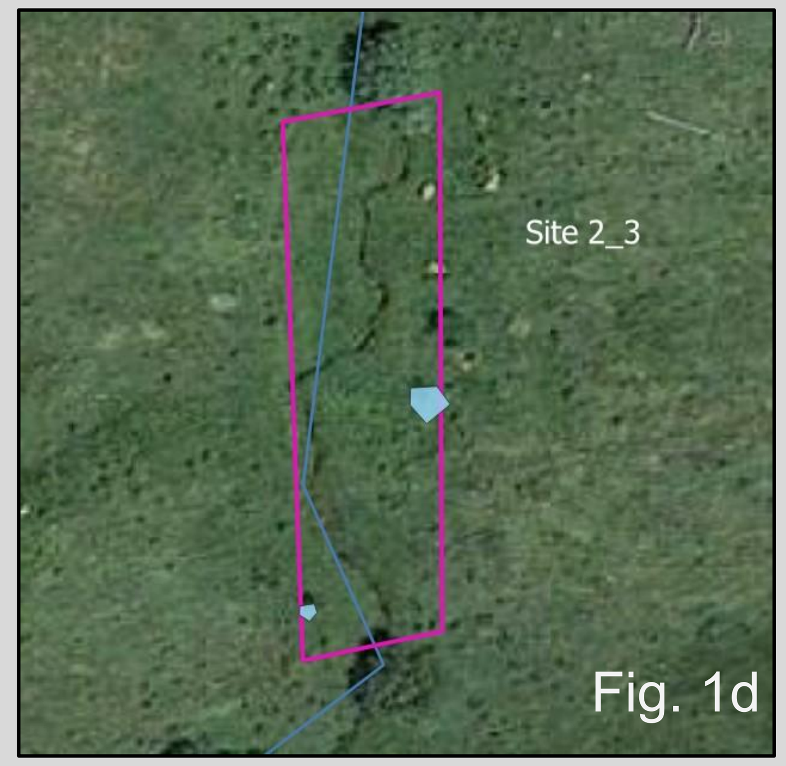


Fig. 1d

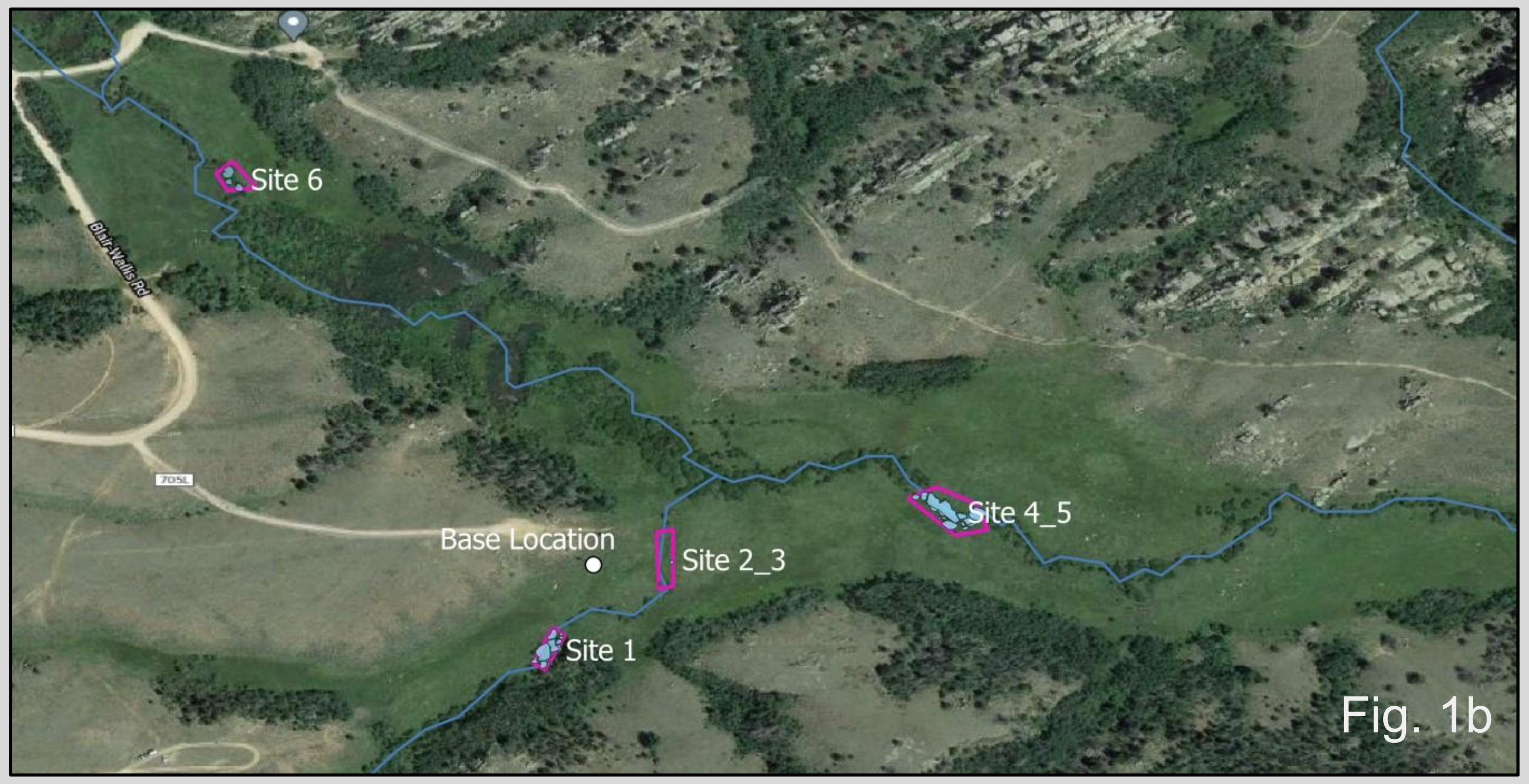


Fig. 1b

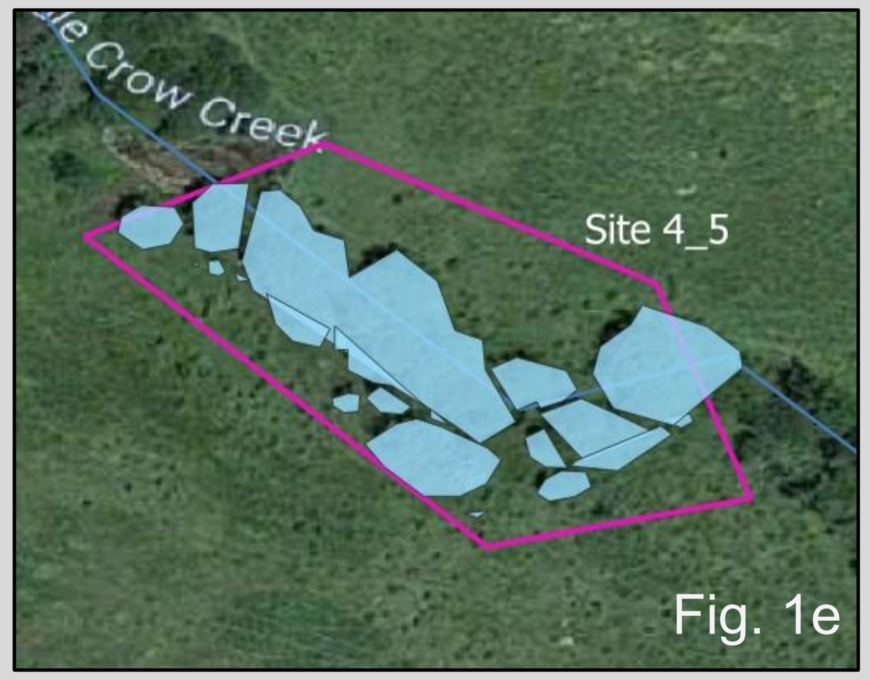


Fig. 1e

Fig. 1f


Fig. 2a


Fig. 2b

Drone Imagery

Figure 4a shows an orthomosaic of Sites 2 and 3 created using RGB imagery, these orthomosaics will continue for the rest of the sites in the future. **Figure 4b** and **4c** show two different 3-D models of the willows upstream of Sites 2 and 3. These will also be made for all sites to calculate diameters, circumferences, and volumes of the shrubs.

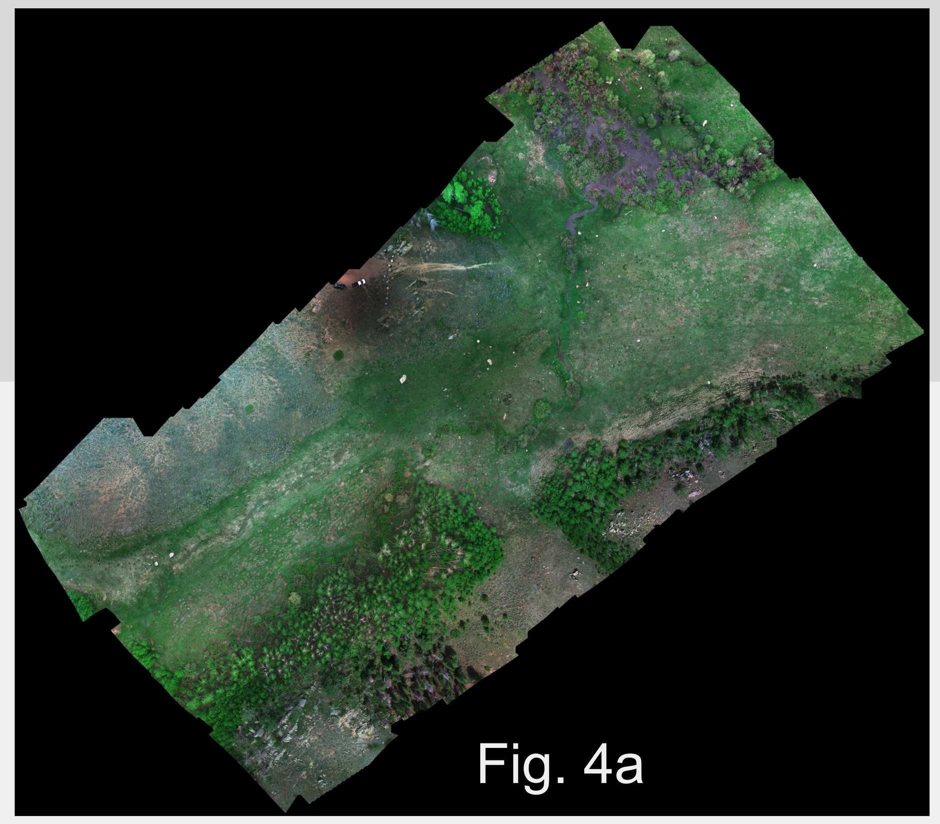


Fig. 4a

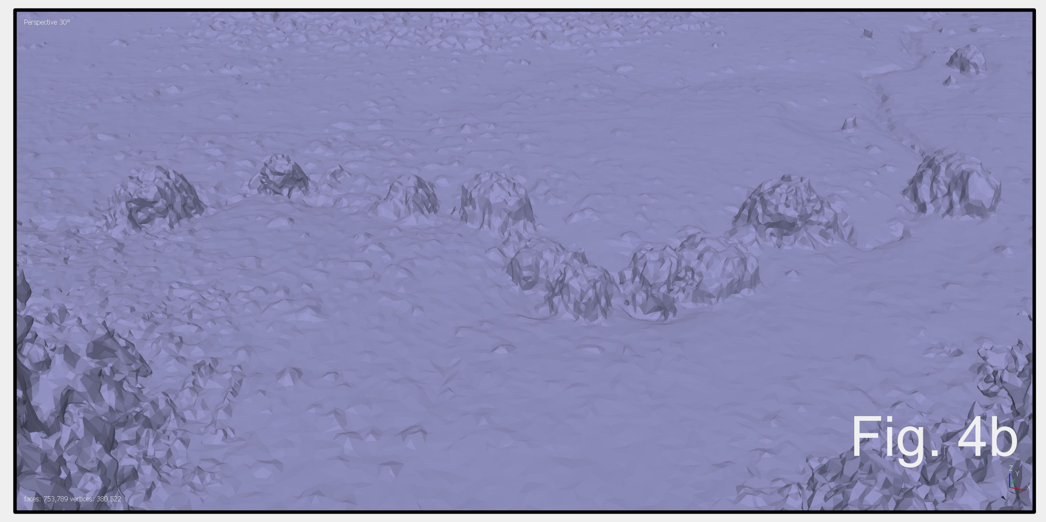


Fig. 4b

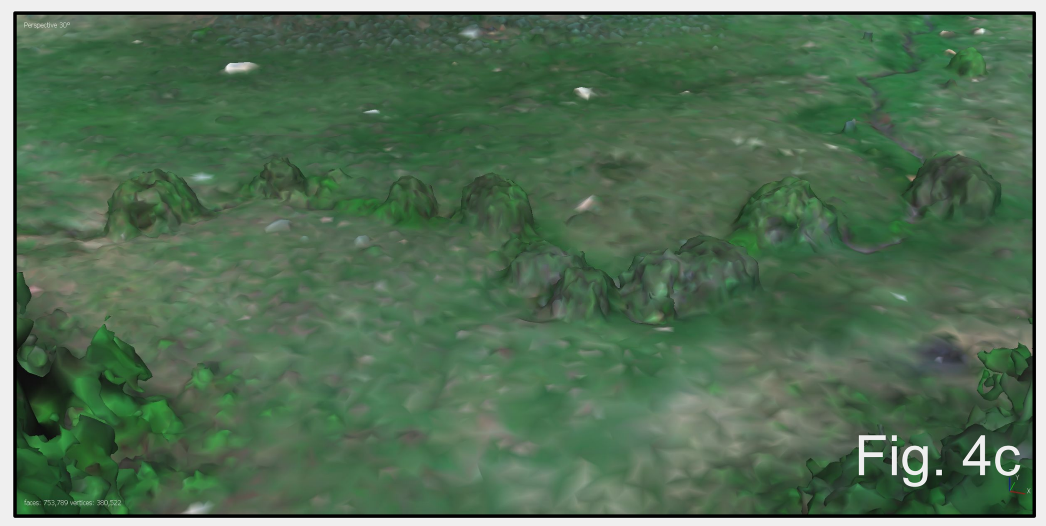
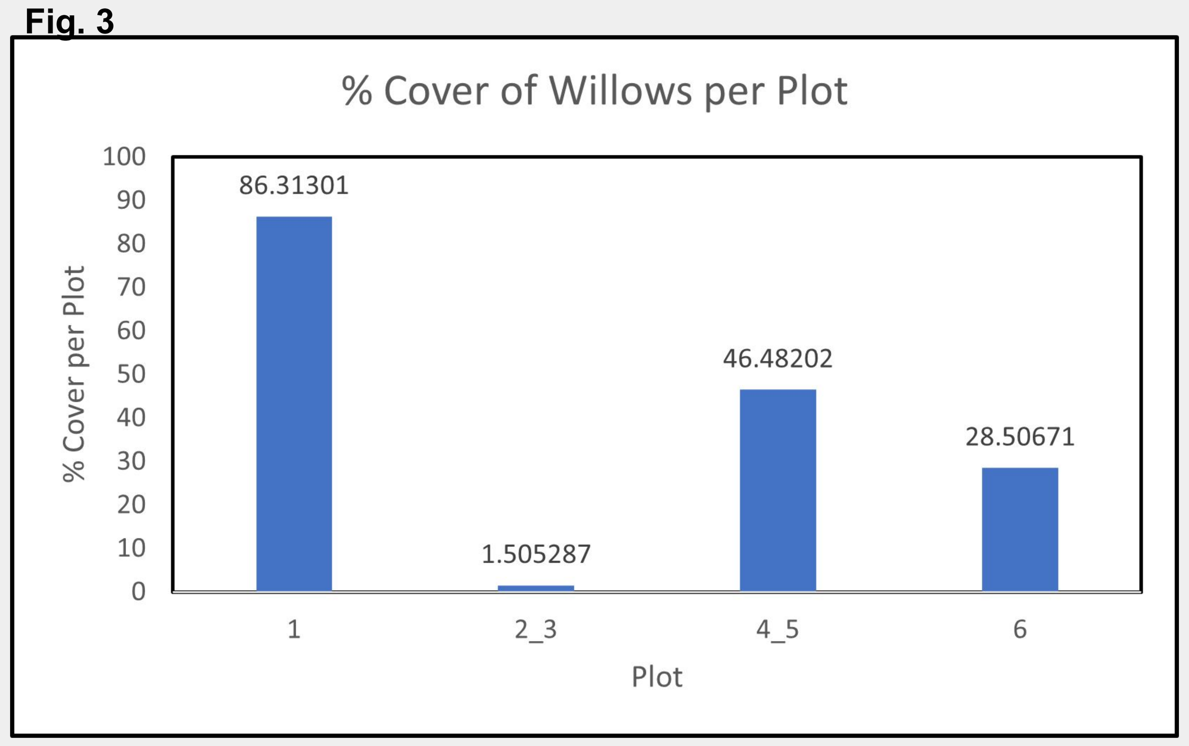


Fig. 4c

Table 1

Site	Plot	Plot Area (m^2)	Canopy Cover Area (m^2) per Plot	% Cover per Plot
1	1	266.852	230.328	86.31301
2	2_3	419.787	6.319	1.505287
3	2_3	419.787	0	0
4	4_5	960.877	297.217	30.93185
5	4_5	960.877	149.418	15.55017
6	6	297.793	84.891	28.50671

Fig. 3



RESULTS

Figure 1a shows the Middle Crow Creek Watershed. **Figure 1b** shows the location of each site and the GNSS base location (in white), with the streamlines mapped in the area of interest. **Figure 1c** shows the Site 1 plot (in pink) with the polygons (in light blue) that represent the amount of area covered by willow clusters. **Figure 1d** shows Sites 2 and 3 with the Site 2_3 plot outlined and the polygons that represent the amount of area covered by willow clusters. **Figure 1e** shows Sites 4 and 5 with the Site 4_5 plot outlined and the polygons that represent the amount of area covered by willow clusters. **Figure 1f** shows the Site 6 plot with the polygons that represent the amount of area covered by willow clusters.**Table 1** shows the results of the cover calculations from the plot and cluster polygon areas, with the % willow cover per site and plot. Site 1 is 86% covered by willow canopy, and Site 3 is 0% covered by willow canopy. While Site 4 and Site 5 are very close together, Site 4 has about twice as much willow canopy cover as Site 5. **Figure 3** shows the % willow canopy cover per plot. While this is similar to the % cover per site, this comparison is more realistic when comparing the survey results because the size of the sites aren't all the same, and thus a direct comparison from site to site is limited in what you can interpret from it. Comparing the plots with known sizes is more direct and the interpretations are straightforward. We can use both interpretations (site and plot) to understand the influence of willows on the riparian area.

DISCUSSION

Canopy area of willows is an important aspect of vegetation information, and helps us understand the density of willows within a specified area. This survey took two days to do, and while we were only measuring essentially one thing, it was much faster than measuring willows by hand. With the incredible accuracy of the points, it is a fairly reliable method of measuring % canopy area of the shrubs, which had a wide variety of shapes and sizes.

NEXT STEPS

- Compare with data from sUAV surveys
- Compare with data from ground-based sampling surveys

ACKNOWLEDGEMENTS

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